

COMPREHENSIVE PAVEMENT DESIGN MANUAL



Design Division &
Technical Services Division

New York State Department of Transportation

COMPREHENSIVE PAVEMENT DESIGN MANUAL

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COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 1: Introduction and Glossary

JUNE 30, 2000

**CHAPTER 1
INTRODUCTION AND GLOSSARY**

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CHAPTER 1 INTRODUCTION AND GLOSSARY

1.1 PURPOSE

The primary function of the Comprehensive Pavement Design Manual (CPDM) is to provide the project designer with a single-source compilation of current Department policy and guidance pertaining to pavement design. This manual should be used in combination with the Highway Design Manual (HDM) for designing pavements.

Variations from this manual will be necessary for special conditions, or between the issuances of new or revised source documents and any corresponding updates of the CPDM. Consequently, instructions in this document are not intended to preclude the exercise of individual initiative and engineering judgment in reaction to site-specific conditions or the application of current state of the art practices. Rather, such initiative and judgment is encouraged when it is appropriate and there is a rational basis for deviation. However, it is equally important that there be consistency statewide in the application of this manual. The objective is uniformity of design for the same or similar conditions.

The CPDM consists primarily of documents, that prior to the CPDM, have been published elsewhere in the Department. With the CPDM, it is planned to continuously update this document to provide a current cohesive text that addresses pavement evaluation and design with well organized cross-referencing to supporting documents where appropriate. Relevant excerpts of related documents are included and commentary is provided as necessary.

The organization of this manual is intended to reflect the sequence of events that a typical project might follow: evaluation of an existing distressed pavement, determination of the scope of the remedial effort, detailed design of the selected alternative, construction, and maintenance of the completed project.

Development of the CPDM was recommended by the Technical Services Division Joint Standing Committee on Pavement Design. The committee also determined that the Geotechnical Engineering Bureau shall be responsible for updating the manual in cooperation with Design Quality Assurance Bureau (DQAB) to keep it current with NYSDOT approved pavement design policy and procedures.

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1.2 CHAPTER OUTLINE

The following is an outline of the CPDM with a brief description of each chapter:

Chapter 1, *Introduction and Glossary* - states the purpose and objectives of the CPDM, a brief overview of each chapter and a glossary of common pavement related terms.

Chapter 2, *Evaluation of Existing Pavements* - contains guidance and uniform procedures for evaluating pavement and shoulder conditions (consists primarily of the NYSDOT Pavement Rehabilitation Manual, Volume I, *Pavement Evaluation*).

Chapter 3, *Project Development Process* - references the manuals that contain the required procedures and documentation for the design of a NYSDOT pavement project from the project initiation stage through the preliminary and detailed design stages. Relevant excerpts from the *Scoping Procedure Manual* and the *Design Procedure Manual*, are included which highlight some of the specific steps in the design process where pavement issues must be addressed and decisions documented. Section 3.3 - *Pavement Treatment and Type Selection Process*, describes specific design procedures for NYSDOT pavement projects and identifies when further documentation is required (e.g., a *Pavement Evaluation and Treatment Selection Report* (PETSRS) and/or a *Pavement Type Selection Report*). Section 3.3 also includes criteria to determine which process applies to maintenance projects. Section 3.4 includes the goal report *Programmatic Quality Assurance Pavement Rehabilitation Treatment Selection Process*, to monitor the quality and uniformity of project-level PETSRS. The above documents reference the Pavement Rehabilitation Manual, Volume II, *Treatment Selection*. Note that while Volume II contains key information on preparing a PETSRS and the economic considerations involved in pavement treatment selection, it is included in Chapter 5 of the CPDM entitled *Rehabilitation*, since Volume II also contains significant guidance on pavement overlay design.

Chapter 4, *New Construction/Reconstruction* - contains guidance on the design and construction of new and reconstructed pavements, from the Highway Design Manual (HDM), Chapter 3, *Typical Sections*. The ESAL-based design procedure is an improved version of the *New York State Thickness Design Manual for New and Reconstructed Pavements*, which has been incorporated into this chapter.

Chapter 5, *Rehabilitation* - contains guidance on the design and construction of pavement overlays. Excerpts from the HDM, Chapter 3, *Typical Sections*, are included along with the entire Pavement Rehabilitation Manual, Volume II, *Treatment Selection*, which contain most of the current guidance on pavement overlay design.

Chapter 6, *Materials* - contains guidance of current design-related materials issues for HMA and PCC pavements.

Chapter 7, *Shoulders* - contains new guidance on the design of full-depth and partial-depth shoulders for new construction/reconstruction and rehabilitation projects.

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Chapter 8, *Pavement Joints* - contains guidance on the design and construction of transverse and longitudinal joints for PCC and HMA pavements and considerations for isolating utilities (e.g., catch basins) in PCC pavements in urban areas.

Chapter 9, *Subsurface Pavement Drainage* - contains new guidance on the design of pavement drainage systems for new construction/reconstruction and rehabilitation projects.

Chapter 10, *Preventive Maintenance* - contains guidance on preventive maintenance treatments (e.g., crack sealing) that may be used to repair deteriorated components of a pavement so that it may achieve its intended design service life.

Due to size restraints, the pavement-related specifications referred to in the CPDM will not be included in the manual. These specifications are easily obtainable from the Design Quality Assurance Bureau of Design Division or from the NYSDOT Design Division server.

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1.3 GLOSSARY

1.3.1 Acronyms

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Cement (see also HMA)
CPR	Concrete Pavement Restoration
DAD	Design Approval Document
DPM	Design Procedure Manual
DQAB	Design Quality Assurance Bureau
EPP	Expanded Project Proposal
ESAL	Equivalent Single Axle Loading
FDR	Final Design Report
FHWA	Federal Highway Administration
FOB	Freight on Board - Purchasing agency picks up the paving material and delivers it to the paving site. Who does the paving is not specified. The State pays for the material at the production facility.
FWD	Falling Weight Deflectometer
HDM	Highway Design Manual
HMA	Hot Mix Asphalt
IPP	Initial Project Proposal
JPCP	Jointed Plain Concrete Pavement
JRCP	Jointed Reinforced Concrete Pavement

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LCC	Life Cycle Cost
LCCA	Life Cycle Cost Analysis
M&PT	Maintenance and Protection of Traffic
NEPA	National Environmental Policy Act (1969 et seq)
PCC	Portland Cement Concrete
PETSR	Pavement Evaluation and Treatment Selection Report
PIL	Priority Investigation Location
PMS	Pavement Management System
PRM	Pavement Rehabilitation Manual
PS&E	Plans, Specification, and Estimate
RGE	Regional Geotechnical Engineer
RME	Regional Materials or Maintenance Engineer
RTS	Regional Technical Services
SEQR	State Environmental Quality Review Act (1988 et seq)
SSM	Scope Summary Memorandum - A brief report documenting the scope of a proposed, minor project. The SSM is used by NYSDOT to obtain approval from upper level management of a project's scope before beginning preliminary design.
SUPERPAVE	Superior Performing Asphalt Pavement - It is a comprehensive method of designing paving mixes tailored to the unique performance requirements dictated by the traffic, climate, and structural section at a particular pavement site. It facilitates selecting and combining asphalt binder, aggregate, and any necessary modifier to achieve the required level of pavement performance. It was developed under Strategic Highway Research Program (SHRP).
T&L	Truing and Leveling - HMA layer used on rehabilitation projects to change cross

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slope, grade, or level out dips in the roadway. This layer usually consists of base or binder materials. Important to note that it is not to be used over substantial lengths of the project to effectively increase the overall maximum overlay thickness or add a second pavement course.

VPP	Vendor Placed Paving - vendor delivers, vendor places. The State pays for the material in place.
WIM	Weigh In-Motion - A device placed in the pavement lane to count and measure vehicle weight.

1.3.2 Definition of Common Terms

Asphalt - Treated Permeable Base - Asphalt layer with limited fine aggregate, that is placed at the bottom of an asphalt section where needed to provide drainage and support. It satisfies the requirement of ESAL - based design for a 100 mm drainable layer below HMA pavements.

Base Course - The layer or layers of a specified designed thickness placed on a subbase to support surface and binder courses.

Binder Course - The asphalt layer between the top and base courses.

Bleeding - Identified by a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflective surface that may be tacky to the touch in warm weather.

Block Cracking - Cracks that divide the asphalt surface into approximately rectangular pieces, typically one square foot or more in size.

Blowup - The result of localized upward movement of a PCC slab along a transverse joint or crack.

Cement-Treated Permeable Base - A coarse aggregate drainage layer stabilized with cement. (An ESAL- based design requires the use of a 100 mm layer of cement or asphalt-treated permeable base below the PCC pavement).

Chipping - Breaking or cutting off of small pieces from the hardened PCC surface.

Cohesive Failure - The loss of a material's ability to bond to itself. Results in the material splitting or tearing apart from itself (e.g., joint sealant splitting).

Composite Pavement - A pavement structure composed of an asphalt concrete overlay over a Portland cement concrete slab.

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Construction Joint - A joint made necessary by a prolonged interruption in placing PCC or HMA pavement.

Contraction Joint - A transverse joint placed at designated intervals in a rigid slab to control objectionable shrinkage cracks in the PCC slab.

Corner Break - A portion of a PCC pavement separated by a crack intersecting the transverse and longitudinal joints, which extends down through the slab, allowing the corner to move independently from the rest of the slab.

Distortion - Any deviation in the pavement surface from its original shape.

Distress - Any indication of poor or unfavorable pavement performance or signs of impending failure; any unsatisfactory performance of a pavement short of failure.

Dowel - A plain round steel bar which extends into two adjoining PCC slabs so as to transfer shear loads.

Drainage Coefficients - Factors used to modify layer coefficients in flexible pavements or stresses in rigid pavements as a function of how well the pavement structure can handle the adverse effect of water infiltration.

Durability Cracking - A series of fine, hairline crescent-shaped cracks in the concrete surface usually paralleling a joint or major crack and usually curving across slab corners. These are caused by freeze-thaw expansive pressures within certain aggregates. Also called "D" cracking.

Edge Cracking - Fracture and materials loss in pavements without paved shoulders which occurs at the edge of the pavement. This occurs due to soil movement beneath the pavement.

Edgedrain - An underdrain located beneath the pavement at the edge of pavement or shoulder.

Embankment - The portion of fill section situated between the embankment foundation and the subgrade surface.

Equivalent Single Axle Load (ESAL) - One pass of 80 kN single axle loading (dual tires).

Expansion Joint - A joint located to provide for expansion of a rigid slab, used to prevent development of lateral compression between adjacent slabs or to isolate pavement structures.

Fatigue Cracking - A series of small, jagged, interconnecting cracks caused by failure of the asphalt concrete surface under repeated traffic loading (also called alligator cracking).

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Fault - The difference in elevation between opposing sides of a PCC joint or crack.

Flexible Pavement - An HMA pavement structure that maintains intimate contact with, and distributes loads to, the subgrade, and depends on aggregate interlock, particle friction, and cohesion for stability.

Hairline Crack - Barely visible cracks in a random pattern in a PCC surface which do not extend to the full depth of the pavement. They are primarily due to shrinkage.

Joint Seal Damage - Any distress associated with the joint sealant, or lack of joint sealant.

Lane-to-Shoulder Separation - Widening of the joint between the traffic lane and the shoulder.

Lane-to-Shoulder Dropoff - The difference in elevation between the traffic lane and shoulder.

Layer Coefficient (a_1, a_2, a_3) - The empirical relationship between structural number (SN) and layer thickness which expresses the relative ability of a material to function as a structural component of the pavement.

Leave Slab - The section of PCC pavement just past a joint, crack, or other significant roadway feature relative to the direction of traffic.

Load Transfer - The ability of a joint or crack to transfer a portion of a load applied on one side of the joint or crack to the other side of the joint or crack.

Longitudinal Joint - A joint parallel to the long dimension of a pavement.

Low Volume Road - A roadway generally subjected to low levels of traffic; in this manual, structural design is based on a range of 18-kip ESALs from 50,000 to 1,000,000 for flexible and rigid pavements, and from 10,000 to 100,000 for aggregate surface roads.

Maintenance - The preservation of the entire roadway, including surface, shoulders, roadsides, drainage, structures, and such traffic control devices as are necessary for its safe and efficient utilization.

Map Cracking - A series of interconnected hairline cracks in Portland cement concrete pavements that extend only into the upper surface of the concrete. Includes cracking typically associated with alkali-silica reactivity.

Modulus of Subgrade Reaction (k) - Westergaard's modulus of subgrade reaction for use in rigid pavement design (the load in pounds per square inch on a loaded area of the roadbed soil or subbase divided by the deflection in inches of the roadbed soil or subbase, psi/in.).

Patch Deterioration - Distress occurring within a repaired area.

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Patch - An area where the pavement has been removed and replaced with a new material.

Pavement Design Life - As defined by AASHTO, this is the initial performance period of the pavement structure in years. The design life is the useful life of the pavement structure and drainage system after which time the road may need total reconstruction from the subbase up. See Section 4.5.1.1 for details.

Pavement Service Life - A period of time over which a pavement performs its design purpose based on past research and performance experience.

Pavement Structure - The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

Pavement Rehabilitation - Work undertaken to extend the service life of an existing pavement. This includes placement of additional surfacing material and/or other work necessary to return an existing roadway, including shoulders, to a condition of structural or functional adequacy. This could include the complete removal and replacement of the pavement structure.

Performance Index (PI) - The summary of present serviceability indexes over a time period.

Performance - A measure of the accumulated service provided by a pavement, i.e., the adequacy with which a pavement fulfills its purpose.

Polished Aggregate - The coarse aggregate in concrete exposed by the wearing away of surface mortar and texturing.

Popouts - Small pieces of PCC pavement broken loose from the surface as a result of localized expansive forces.

Pothole - A bowl-shaped depression in the pavement surface.

Present Serviceability Index (PSI) - Numerical index of the ability of a pavement in its present condition to serve traffic.

Pumping - The ejection of water and fine materials through cracks in the pavement under moving loads.

Raveling - The wearing away of an HMA pavement surface caused by the dislodging of aggregate particles.

Reflection Cracking - The fracture of asphalt concrete above joints in the underlying jointed concrete pavement layer(s).

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Resilient Modulus - A measure of the modulus of elasticity of roadbed soil or other pavement material.

Rigid Pavement - A pavement structure that provides high bending resistance and distributes loads to the foundation over a comparatively large area.

Roadbed - The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulder (also known as subgrade surfaces).

Roughness - Irregularities in the pavement surface that adversely affect the ride quality.

Rutting - Longitudinal surface depression in the wheel paths.

SAFETAP - Safety Appurtenance Program - An initiative designed to ensure that safety considerations are incorporated into the Department's maintenance paving projects. It requires a project review of maintenance paving sites by a team of qualified Department staff for the purpose of deciding upon safety work to be implemented before, at the time of, or soon after, construction.

SAFE-TRAK - A quick, simple process that includes safety criteria to be used in assisting with the selection, scoping, and design of 100% state funded paving projects. It is intended to be used for preventive and corrective maintenance resurfacing projects that meet the SAFE-TRAK screening criteria.

Scaling - The deterioration of the upper 3 to 12 mm (0.125 to 0.5 in) of the concrete surface, resulting in the loss of surface mortar.

Select Material - Suitable native material obtained from roadway cuts or borrow areas or other similar material used for subbase, shoulder surfacing, slope cover, or other specific purposes.

Serviceability - Ability of a pavement to serve traffic with safety and comfort and with a minimum of detrimental effects to either vehicle or pavement.

SF Delivered - State Forces Delivered - Vendor delivers the material to a paving site. The paver can be a state owned and operated paver, a rented paver with State operators, or a paver rented with operators. The State pays for the material delivered to the site.

Shoving - Permanent, longitudinal displacement of a localized area of the HMA pavement surface caused by traffic pushing against the pavement (usually occurs at intersections).

Single Axle Load - The total load transmitted by all wheels of a single axle extending the full width of the vehicle.

Spalling - The cracking, breaking, chipping, or fraying of the concrete slab surface usually within

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0.6 m (2 ft) of a joint or crack.

Stabilization - The modification of soils or aggregates by incorporating materials that will increase load bearing capacity, firmness, and resistance to weathering or displacement.

Stripping - The separation of bituminous films from aggregate particles in the presence of moisture.

Structural Number (SN) - An index number derived from an analysis of traffic, roadbed soil conditions, and environment. The SN is then converted to thickness of flexible pavement layers through the use of suitable layer coefficients related to the type of material being used in each layer of the pavement structure.

Subbase - The layer of specified granular material placed on subgrade to support a base course, typically 300 mm thick.

Subgrade - The top surface of a roadbed which consists of suitable material and on which the subbase or select granular subgrade materials are constructed. The subgrade area is that portion of embankment situated above either of the following: a) a line located 0.6 m below the subgrade surface and extended to the intersection with the embankment side slopes, or b) the embankment foundation, whichever is higher.

Surface Course - One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and disintegrating effects of climate. The top layer of flexible pavements is sometimes called "wearing course."

Tack Coat - A bituminous emulsion placed between asphalt lifts for adhesion.

Tie Bar - A deformed steel bar or connector embedded across a longitudinal joint in a PCC slab to prevent separation of abutting slabs.

Transverse Joint - A joint perpendicular to the long dimension of a pavement.

Underdrain - A drain located under the pavement, usually deeper than edgedrains and intended to lower the groundwater by means of gravity flow.

Water Bleeding - The self-generated flow of mixing water within, or its emergence from, freshly placed concrete or mortar.

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Chapter 2: Evaluation of Existing Pavements

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CHAPTER 2 EVALUATION OF EXISTING PAVEMENTS

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Chapter 2 - Appendix

Appendix 2A - Pavement Rehabilitation Manual: Volume 1 - Pavement Evaluation

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2.1 INTRODUCTION

The appropriate time to perform a pavement evaluation is when a project is initiated. The advantage of having the information at this time is:

1. Alternate rehabilitation treatments can be evaluated to analyze estimated cost versus the length of expected service.
2. Adequate funds can be programmed for the project.

Candidate projects for rehabilitation are usually identified either by the Transportation Maintenance Resident Engineer or by a network condition survey rating. The actual condition of the pavements may range from pavements that are in poor condition and require significant work to pavements that are in good condition and need only preventive maintenance.

Many different maintenance or repair techniques can be applied to pavements to extend their service lives. Use of these techniques is often a cost-effective strategy (in the framework of life-cycle cost), and delays the placement of a costly overlay, recycling, or even reconstruction, for several years.

When evaluating the feasibility and effectiveness of applying maintenance or rehabilitation methods, the three main factors, which are discussed in this chapter should be considered: (1) surface distress condition, (2) structural condition, and (3) functional condition of the existing pavement. The current NYSDOT pavement evaluation process as discussed in this chapter consists of surface distress condition for every project, and limited structural condition depending on the project site. The evaluation report is included in the Pavement Evaluation and Treatment Selection Report (PETSR) as discussed in Section 3.4 of Chapter 3.

This chapter also describes additional special distress, structural, and functional condition surveys that are not required by the PETSR but are included here for informational purposes only.

2.2 PAVEMENT CONDITION SURVEYS REQUIRED BY THE PETSR

Pavement condition surveys required by the PETSR include the following:

- Distress condition survey.
- Transportation Maintenance Engineers Information.
- Field investigations, if required.
- Condition report.

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EVALUATION OF EXISTING PAVEMENTS

The uniform procedures for evaluating the condition of pavements is outlined in the Pavement Rehabilitation Manual, Volume 1, *Pavement Evaluation*. This manual is included in this chapter as Appendix 2A. The procedure includes the following steps:

1. Acquire project information from records which provide history, features, and related data on the pavement.
2. Perform a field distress survey on the pavement and shoulders if required by Section 3.3 of Chapter 3.
3. Obtain information from the Transportation Maintenance Resident Engineer on the pavement, shoulder, foundation, and drainage performance.
4. Perform a field investigation of the pavement, shoulders, foundation, and drainage as necessary.
5. Prepare a report on the condition (Pavement Evaluation and Treatment Selection Report, PETSRS).

The project information shall be collected using a standard format developed for the pavement evaluation procedure. This information will identify the proposed project, provide the history of the performance, list roadway features, and provide related pavement data. The information should be available from records in the Region Office. The information shall be collected before making the field survey and should be checked during the field survey. The form for collecting project information is included in Appendix A to the Pavement Rehabilitation Manual, Volume 1, *Pavement Evaluation*. This manual is included as Appendix 2A in this chapter.

2.2.1 Pavement Distress Condition Survey

When a pavement evaluation is conducted, the following information needs to be collected if the engineer is to make knowledgeable decisions regarding rehabilitation needs and strategies:

1. Distress Type - Identify each type of distress. The distress types should be placed in categories.
2. Distress Severity - Note the level of severity for each distress type present to assess degree of deterioration.
3. Distress Amount - Note the relative area (percentage of the project) affected by each combination of distress type and severity.

A technically sound engineering condition survey must address each one of these needs. To meet these needs, NYSDOT developed a pavement evaluation manual for use in performing pavement

distress surveys. The Pavement Rehabilitation Manual, Volume 1, *Pavement Evaluation* (Appendix 2A of this chapter), contains uniform procedures for evaluating the condition of pavements and shoulders and includes standard forms developed for collecting project information and pavement and shoulder distress data. This manual should be used to evaluate pavement condition prior to any pavement design activities being performed.

As part of the procedure for evaluating the condition of pavements, a field distress survey is completed on the pavement and shoulders. Section 3.3 of this manual discusses the type of project that requires a pavement distress survey.

The field survey should be completed by a team of two people; one to drive and collect data, the other to collect and record data.

The field survey shall be performed when the entire pavement and shoulder surfaces are visible. If the survey is performed when frost is in the ground, this condition should be noted, since the frost can magnify the distress.

The location of the information collected from the pavement in the field survey shall be identified by the reference marker system. If reference markers do not exist, other readily discernable permanent features such as structures, crossroads, interchanges, etc., should be used to identify locations.

For further detail on the distress data collection procedure, refer to Appendix 2A of this chapter.

2.2.2 Transportation Maintenance Engineers Information

The Transportation Maintenance Resident Engineer shall be consulted to obtain information concerning the influence of the seasons, which may not be apparent at the time of the pavement evaluation survey. The consultation should include the level of maintenance required on the pavement and shoulders, and locations (identified by reference markers) of drainage problems, frost heaves, settlements, or other foundation problems. The information should be documented and become part of the PETSRS.

2.2.3 Field Investigations

At times in-depth field investigations will be warranted to determine the cause of some types of distress. These would usually include coring the pavement and/or shoulders, or investigating foundation or drainage problems. The Regional Materials Engineer (RME) is available for investigating pavement problems and the Regional Geotechnical Engineer (RGE) is available for investigating the shoulders, roadway foundation, drainage, and suitability of pavement rubblizing. The information and data (in summary form) and conclusions obtained from the investigation shall be part of the PETSRS.

EVALUATION OF EXISTING PAVEMENTS

Full-depth pavement cores provide information on the condition and makeup of underlying pavement layers. Usually only a few cores are necessary to provide the information to make a treatment decision. If conditions are uniform, coring in a typical area will be representative of the entire project. Where conditions are extremely diverse, a core in each area is desirable. Cores may have an impact on the repair method chosen.

2.2.4 Condition Report

The information obtained from the pavement survey, consultation with the Transportation Maintenance Resident Engineer and any field investigation shall be condensed into the PETSRS. The report shall state the severity and extent of each type of distress appearing in the pavement, shoulders, and foundation. Drainage deficiencies should also be included. This report will become part of the PETSRS (if required) and summarized in the Design Approval Document (DAD).

2.3 PAVEMENT CONDITION SURVEYS NOT REQUIRED BY THE PETSRS

These are special tests and are not required as part of Pavement Evaluation and Treatment Selection Report (PETSRS). These tests are performed only by request and as determined by the Regional Materials Engineer or Regional Geotechnical Engineer.

2.3.1 Automated Distress Survey

In recent years, tremendous advances have been made in the development of automated equipment that can be used to collect, store, and process distress data. This equipment is capable of measuring most pavement distress types at higher speeds. Other advantages of automated distress survey equipment include:

1. More consistent measurements.
2. Increase in safety.
3. No disruption to traffic flow.
4. Predictable productivity.
5. Highly objective output.
6. Increase in sample size.

As a part of the pavement performance monitoring program, NYSDOT uses outside qualified vendors to perform automated distress surveys on about 50 test sites every two years.

The majority of this automated information is collected on segments of the National Highway System (NHS) within NYS and is used currently to evaluate performance of different pavement treatment types as a part of the pavement performance monitoring program. This type of distress survey is not used to evaluate pavement condition on individual projects but on a network level.

2.3.2 **Structural Condition Using Nondestructive Deflection Survey**

The structural capacity refers to a pavement's ability to support current or future traffic loadings and is measured by the pavement structural condition evaluation. Knowledge of the pavement structural condition provides valuable information in the selection and design of feasible alternatives to rehabilitate that pavement.

To determine the structural capacity of a pavement, a structural condition evaluation must be performed. This evaluation can be performed using a nondestructive (NDT) deflection testing and analysis.

Deflection-based NDT devices produce deflections on the pavement surface under dynamic loadings. These deflections are measured by a set of sensors located at specific distances from the load center. NYSDOT currently uses a Falling Weight Deflectometer (FWD) to perform deflection testing for pavement structural evaluation. FWD testing is used in conjunction with the pavement distress survey, materials sampling, and layer thickness information, to determine the pavement layer moduli, and other parameters of both rigid and flexible pavements.

FWD testing in NYSDOT is currently limited to the following activities:

- Deflection survey of 50 statewide sites as a part of pavement performance monitoring program.
- Deflection survey of 48 statewide sites as part of a SUPERPAVE performance monitoring program.
- Determination of load transfer efficiencies at joints and cracks of PCC pavements.
- Determination of the appropriateness and effectiveness of cracking and seating, and rubblizing operations.

The Pavement Design Services Group of Geotechnical Engineering Bureau maintains and operates the FWD. This type of deflection survey is not used to evaluate pavement structural condition on individual projects.

2.3.3 **Roughness Survey**

Roughness survey is an important part of the pavement construction acceptance process.

Roughness is a measure of a pavement's functional performance, that is, how well the pavement is providing a smooth, safe ride to the traveling public. Roughness can develop from surface irregularities that are built into a pavement during construction, and surface irregularities that develop after construction (due to traffic loading, climatic effects, and other factors). The primary purpose of performing roughness surveys for a given project is to obtain a roughness profile so that locations of severe roughness can be identified.

The standard unit for roughness measurement is the *Profile Index* (PI). The PI is a numeric scale that ranges from 0 to 200 mm/km (0 to 13 in/mi), with larger values indicating greater roughness. These roughness surveys are performed using profilographs by the contractor as part of construction QC/QA program. This type of survey is not used to evaluate pavement condition on individual projects.

2.3.4 **Pavement Friction**

Pavement friction is a measure of the forces at the tire-pavement interface that resist the sliding of a braking tire and also allow a rolling tire to make directional changes to the vehicle. Sufficient pavement friction normally exists on dry pavements for all reasonable vehicle maneuvers (Note: dry pavements contaminated with petroleum products, organic residue, or covered with hard particles such as fine gravel may not provide adequate friction in some instances). During heavy rain, or when a condition of heavy runoff or ponding occurs on the pavement, vehicles can travel at sufficient speed to ride up on the film of water, resulting in the tire losing contact with the pavement surface, causing a loss of steering control and severely diminished braking action. This condition is called hydroplaning.

Pavement friction is influenced by three factors: microtexture, macrotexture, and cross slope.

- Microtexture is the surface "roughness" of the individual coarse aggregate particles in the case of flexible pavements, or the surface roughness of the hardened concrete paste in the case of rigid pavements. It contributes to the total frictional force through the molecular adhesion that is developed when the pavement contacts a vehicle's tires.
- Macrotexture refers to the coarse texture of the pavement which is controlled by the coarse aggregate size in flexible pavements, and by surface texture in rigid pavements. It contributes to the total frictional force through hysteresis by deformation of the rubber tire surface, and improves pavement-tire contact by providing escape channels for the surface water at the pavement-tire interface.
- Cross slope reduces water film thickness by providing surface drainage. This assists pavement-tire contact and thereby reduces the likelihood of hydroplaning.

The Department uses a locked-wheel test trailer system conforming to the requirements of ASTM E 274 to measure pavement friction. The system measures the friction developed by a fully locked, ribbed test tire dragged at a constant speed on an applied film of water of specified thickness. This

test is designed to be very sensitive to the frictional forces developed through adhesion and hysteresis, while deemphasizing a pavement's ability or inability to drain water.

NYSDOT ensures adequate pavement friction by controlling the type of aggregates used in pavement surface courses and surface texturing techniques. Specification requirements vary, depending on use factors such as traffic volume, vehicle characteristics, speed, and project location. While there is no established "safe" friction number (FN) for highways, it is intuitive that higher friction equates to shorter stopping distances and possibly better directional control during extreme maneuvers. As part of its pavement management program, the Department established a Programmatic Design Target Friction Number measured at 64 km/h of 32, or $FN(64) = 32$. (Expressed in English units, the parentheses are dropped: $FN_{40} = 32$ refers to a friction number of 32 tested at 40 mph.) This friction level ensures the assumed friction values in the AASHTO Minimum Stopping Sight Distance Design Criteria for wet pavements are exceeded. Pavements with severe geometries or heavy braking and/or turning patterns should be given priority consideration when their friction numbers fall significantly below this level.

The Materials Bureau performs pavement friction tests on all aggregate mixes and all texture treatments specified by the Department. Due to seasonal limitations, pavement friction testing is performed between May and December each year. Pavement friction test results for project scoping can usually be provided in the same construction season requested, depending on the testing work load. Additionally, FN data which were obtained in response to a special study or Priority Investigation Location (PIL) study is available upon request from the Materials Bureau.

6/30/00

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 2: Appendix 2A

Pavement Rehabilitation Manual

Volume I: Pavement Evaluation

6/30/00



Pavement Rehabilitation Manual

VOLUME I: PAVEMENT EVALUATION

M.A.P. CODE 7.42-4-4

**MATERIALS BUREAU
NEW YORK STATE DEPARTMENT OF TRANSPORTATION**

PAVEMENT REHABILITATION MANUAL

VOLUME I

PAVEMENT EVALUATION

**JUNE 1990
REVISED FEBRUARY 1992**

**MATERIALS BUREAU
WAYNE J. BRULE, DIRECTOR**

**NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NY 12232-0861**

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SAFETY

The Pavement Evaluation Survey takes place in a potentially hazardous location. Dense, high speed traffic areas are particularly dangerous. Consequently, attention to safety is paramount.

Pavement evaluators should assess the risks and consult with their Region Safety Coordinator to plan and arrange backup support where necessary.

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SCOPE

Volume I of the Pavement Rehabilitation Manual contains uniform procedures for determining the condition of pavement and shoulders. Also included are standard forms that have been developed for collecting project information and pavement and shoulder distress data.

Volume II of the manual, entitled Treatment Selection, shows how the collected distress data is used to select appropriate rehabilitation alternatives and develop life cycle costs for the alternatives. Also, included is an example of a pavement evaluation report that is prepared for the client once the above described analysis is completed.

These volumes supersede "The Pavement Evaluation And Rehabilitation Manual" published by the Materials Bureau in March 1984.

INTRODUCTION

The success of a pavement rehabilitation treatment is dependent upon choosing the best treatment for the intended repair. In order to choose the best treatment, it is necessary to analyze alternate treatments. A proper analysis of alternatives requires a thorough evaluation of the existing pavement, shoulders, foundation and drainage.

The appropriate time to perform a pavement evaluation is when a project is initiated. The advantage of having the information at this time is:

1. Alternate rehabilitation treatments can be evaluated to analyze estimated cost versus length of expected service.
2. Adequate funds can be programed for the project.

Candidate projects for rehabilitation are usually identified either by the Highway Maintenance Resident Engineer or by the network condition survey rating. The actual condition of the pavements may range from pavements that are in poor condition and require significant work to pavements that are in good condition and need only preventative maintenance.

GENERAL PROCEDURE

The general procedure for evaluating the condition of pavements include the following steps:

1. Acquire project information from records which provide history, features and related data on the pavement.
2. Perform a field distress survey on the pavement and shoulders.
3. Obtain information from the Highway Maintenance Resident Engineer on the pavement, shoulder, foundation and drainage performance.
4. Perform a field investigation of the pavement, shoulders, foundation and drainage as necessary.
5. Prepare a report on the condition.

PROJECT INFORMATION

The project information shall be collected using a standard format developed for this pavement evaluation procedure. This information will identify the proposed project, provide history of the pavement, list roadway features, and provide related pavement data. The information should be available from records in the Region Office. The information shall be collected before making the field survey and should be checked during the field survey. The form for collecting project information is in Figure 1.

PAVEMENT AND SHOULDER CONDITION SURVEY

The evaluation procedure shall consist of making a field survey of the proposed project and collecting data on the severity and extent of major forms of distress that appear in the pavement and shoulders.

The field survey should be completed by a team of two people as described on pages 2 and 4; one to drive and collect data, the other to collect and record data.

The field survey shall be performed when the entire pavement and shoulder surfaces are visible. If the survey is performed when frost is in the ground, this condition should be noted since the frost can magnify the distress.

The location of the information collected from the pavement in the field survey shall be identified by the reference marker system. If reference markers don't exist, other readily discernable permanent features such as structures, cross-roads, interchanges etc. should be used to identify locations.

Distress Data Collection

The data shall be collected using a standard format developed for this pavement survey procedure. This format provides assurance that all components of the roadway relating to the pavement and shoulders are evaluated and that the distress is described in standard terminology.

Procedures for collecting data on the severity and extent of distress in pavements and shoulders are in the Appendices as follows:

- Appendix A - General Instructions
- Appendix B - Rigid Pavement
- Appendix C - Flexible Pavement or Flexible/Rigid Pavement
- Appendix D - Shoulders

Initially, the survey team shall ride the entire proposed project at or near the posted speed limit to obtain an overview of the pavement and shoulder condition. A determination shall be made on whether the distress is relatively uniform in severity and extent along the full length of the proposed project or if the distress is localized.

After the ride-through at posted speed, the surveyors shall ride the entire proposed project on the shoulder, if possible, at a slow speed (5 mph) to observe all forms of distress in the pavement and shoulders. At this speed, some of the major forms of pavement distress and foundation problems are apparent and shall be recorded as to type of distress and location. Also, isolated distress is noted and collected during this second ride through.

PAVEMENT EVALUATION REPORT*PROJECT INFORMATION***General**

Region: _____ County: _____ Route No.: _____ PIN _____

Project Identification: _____

Begin RM _____ End RM _____ Total Length: _____

Original Contract Date(s): _____

Latest Pavement Rehabilitation Date(s): _____

Roadway Features

Roadway: Divided _____ Non-Divided _____
 Median: Flush _____ Raised _____ Concrete Median Barrier _____
 Curbs: Mountable _____ Non-Mountable _____
 AC _____ PCC _____ Stone _____

Pavement:

Lanes: No. _____ Width(s) _____
 Type: Reinforced PCC _____ Non-Reinforced PCC _____
 AC _____ AC over PCC _____
 Thickness (normal): Total _____ (AC _____ PCC _____)
 Reinforced and Non-Reinforced PCC Pavements only:
 Slab Length _____
 Load Transfer Type: Dowels _____ 2 Component _____
 Transverse Joints: Contraction _____ Expansion _____

Subbase:

Type: _____ Thickness (nominal): _____

Shoulders:

Type: AC _____ PCC _____ Gravel _____ Thickness _____
 AC or Surface Treatment/Stabilized Gravel _____ Thickness _____
 Width: Both _____ Driving Lane _____ Passing Lane _____

Drainage:

Type: Open System _____ Closed System _____

Related Pavement Data

Traffic AADT (Range) _____ Date _____ % Trucks _____
 Sufficiency Rating Surface Score _____ Date _____

Prepared By _____ Date _____

Figure 1

The next step will take place on the third drive-through by stopping on the shoulder and collecting detail condition data for pavement and shoulders. This should be done at the first *one-tenth mile section in each one-half mile interval* of the proposed project.

The location of the one-tenth mile section shall be identified by reference markers or by other means previously stated. If all or part of the one-tenth mile section falls on a bridge deck, approach slab, or at an at-grade intersection, the one-tenth mile section shall be moved ahead in the one-half mile interval until all the one-tenth mile section is located beyond these areas.

Under normal circumstances, the pavement condition data shall be collected as follows:

Roadway Type	Area Surveyed
Multi-lane, divided or undivided	Driving lane and right shoulder, both directions
Two-lane, two-way	One lane and adjacent shoulder
Ramps and one lane roadways	Pavement and right shoulder

If the lanes are not uniform in condition across the roadway, data shall also be collected from the additional lane(s) to represent the pavement.

An example would be a four lane divided portland cement concrete pavement where the driving lanes exhibit considerably more distress than the passing lanes.

Following the collection of distress data, the severity and extent shall be determined for each distress type indicated on the form. If some distress types do not occur, the form shall indicate that none exists. The extent of most types of distress will be described as a percentage, numerical count, or its presence in the section. Forms for distress data collection for the various pavement types and shoulders are shown in Figures 2 and 3.

Highway Maintenance Input

The Highway Maintenance Resident Engineer shall be consulted to obtain information concerning the influence of the seasons, which may not be apparent at the time of the pavement survey. The consultation should include the level of maintenance required on the subject pavement and shoulders and locations (identified by reference markers) of drainage problems, frost heaves, settlements or other foundation problems. The information from the consultation shall be documented and it shall become part of the condition report.

Field Investigations

At times in-depth field investigations will be warranted to determine the cause of some types of distress. These would usually include coring the pavement or shoulders or investigating foundation or drainage problems. The Regional Materials Engineer is

available for investigating pavement problems and the Regional Soils Engineer is available for investigating the shoulders, roadway foundation and drainage. The information and data (in summary form) and conclusions obtained from the investigation shall be part of the condition report.

Full-depth pavement cores provide additional information on condition and makeup of underlying pavement layers. Usually only a few cores are necessary to provide such information for a treatment decision. If conditions are uniform, coring in a typical area will be representative of the entire project. Where conditions are extremely diverse, a core in each area is desirable. Cores may have an impact on the repair method chosen. Cores are valuable for the following reasons:

<u>Distress</u>	<u>Information</u>	<u>Decision</u>

RIGID

Spalling	Depth affected	Full- or partial-depth repair
Cracks	Depth, concrete condition, mesh location and condition	Full- or partial-depth repair, working or nonworking cracks
Faulted Transverse Joints	Type and condition of load-transfer device	Full- or partial-depth repair, forecast performance
Asphalt Concrete Overlay Patching	Condition and depth of overlay and underlying concrete pavement	Overlay or remove, repair, and overlay

FLEXIBLE or FLEXIBLE OVER RIGID

Cracking	Type, thickness and condition of overlay; lab tests for layer properties	Overlay or mill and overlay, recycle
Rutting	Type, thickness and condition of layers; lab tests for layer properties	Overlay or mill and overlay, recycle or mill and inlay
Widening	Identify widening and pavement differences; type, thickness, and condition of layers	Overlay or remove, repair, and overlay
Asphalt Concrete Overlay Patching	Condition and depth of overlay, condition of underlying layers	Overlay or remove, repair, and overlay

Condition Report

The information obtained from the pavement survey, consultation with the Highway Maintenance Resident Engineer and any field investigation shall be condensed into a final condition report. The report shall state the severity and extent of each type of distress appearing in the pavement, shoulders and foundation. Drainage deficiencies should also be included. Figure 4 shows a brief outline of the format of the condition report.

NYSDOT MATERIALS BUREAU

DISTRESS DATA FORM

Region _____ County _____ Route No. _____ Pin _____

PAVEMENT
RIGID ☒

Number of Lanes _____ Survey Pertinent to _____ Lane(s) _____ Direction _____

Date Insp. _____ Inspectors _____ Sheet _____ of _____

DISTRESS	SEVERITY		SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	%	
			Beginning Ending							
SETTLEMENTS & HEAVES (#)	N	None								
	P	Present								
BLOWUPS (#)		Partial Width								
		Full Width								
ASPHALT CONC. OVERLAY PATCHING (#)	N	None								
	G	Good								
	F	Fair								
	P	Poor								
JOINT SEALER FAILURE ☒	N	None								
	F	Failed								
TRANSVERSE JOINT FAULTING (MEASURE) ☒	N	None								
	L	<3/8"								
	M	3/8"-3/4"								
	H	>3/4"								
TRANSVERSE JOINT SEPARATION (#)										
TRANSVERSE JOINT DISTRESS (# JOINTS)	N	No Spalls								
	L	Minor 3" max. Width								
	M	Occs. >3" Width								
	H	Many >3" Width								
LONGITUDINAL JOINT SEPARATION (#)										
LONGITUDINAL JOINT DISTRESS (# SLABS)	N	No Spalls								
	L	Minor 2" max. Width								
	M	Occs. >2" Width								
	H	Many >2" Width								
SLAB CRACKING (# SLABS)	N	None								
	L	Light								
	M	Moderate								
	H	Heavy								
WHEEL PATH RUTTING (MEASURE) ☒	N	None								
	L	< 3/8"								
	M	3/8"-3/4"								
	H	>3/4"								
SCALING/ NON-JOINT SPALLING (# SLABS)	N	None								
	L	Light								
	M	Medium								
	H	Heavy								

SHOULDER SURVEY PERTINENT TO: BOTH ☐ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N	None								
	L	Single Crack								
	M	Multiple Cracks								
	H	Mult. Cracks w/Patholes								
LANE/SOULDER SEPARATION (MEASURE) ☒	N	None								
	L	<1/4"/Sealed								
	M	1/4"-1"								
	H	>1"								
LANE/SOULDER DROPOFF (MEASURE) ☒	N	None								
	L	< 1"								
	M	1"-2"								
	H	>2"								
SHOULDER DEFORMATION ☒	N	None								
	P	Present								

NYSDoT MATERIALS BUREAU

DISTRESS DATA FORM

Region _____ County _____ Route No. _____ Pin _____ PAVEMENT
 Number of Lanes _____ Survey Pertinent to _____ Lane(s) _____ Direction _____ FLEXIBLE ☐
 Date Insp. _____ Inspectors _____ Sheet _____ of _____ FLEXIBLE/RIGID ☐

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
		Beginning Ending	(1)	(2)	(3)	(4)	(5)	TOTAL SUM %	
CORRUGATIONS (%)	N None								
	P Present								
SETTLEMENTS & HEAVES (#)	N None								
	P Present								
ASPHALT CONC. OVERLAY OR SPRAY PATCH (#)	N None								
	G Good								
	F Fair								
	P Poor								
WHEELPATH CRACKING (%)	N None								
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
FULL WIDTH TRANSVERSE CRACKING (#)	N None								
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
LONGITUDINAL CRACKING (%)	N None								
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
EDGE CRACKING (%)	N None								
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
CRACKING OTHER (%)	N None								
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
SLIPPAGE CRACKS ☒	N None								
	P Present								
RAVELLING (%)	N None								
	P Present								
WHEELPATH RUTTING (MEASURE) ☒	N None								
	L < 3/8"								
	M 3/8"-3/4"								
	H > 3/4"								
WIDENING DROPOFF (MEASURE) ☒	N None								
	L < 3/8"								
	M 3/8"-3/4"								
	H > 3/4"								

SHOULDER SURVEY PERTINENT TO: BOTH ☐ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N None							
	L Single Crack							
	M Multiple Cracks							
	H Mult. Cracks w/Potholes							
LANE/SOULDER SEPARATION (MEASURE) ☒	N None							
	L < 1/4"/Sealed							
	M 1/4"-1"							
	H > 1"							
LANE/SOULDER DROPOFF (MEASURE) ☒	N None							
	L < 1"							
	M 1"-2"							
	H > 2"							
SHOULDER DEFORMATION ☒	N None							
	P Present							

Figure 3

Pavement

Summarize severity and extent for each type of distress appearing in the pavement.

Shoulders

Summarize severity and extent for each type of distress appearing in the shoulders.

Foundation

Summarize foundation problems.

Drainage

Summarize drainage problems.

Figure 4 - Condition Report Outline

APPENDIX A
General Instructions for Completing
Distress Data Forms

APPENDIX A

This appendix gives general instructions for completing the Distress Data Forms. The instructions are outlined from top to bottom of the form and are broken-down into five major parts:

1. Heading
2. Pavement Section Surveyed
3. Distress Data Collection Procedure
4. Remarks
5. Shoulder Survey Heading

HEADING

The heading information is identical for all pavement type distress data forms. The following details the information to be recorded in the heading.

Region, County, and Route No. - Pertinent to the survey location.

Direction - The direction of travel while conducting the survey. This should be reported as (North, South, East, or West). For undivided highways this identifies which lane is used for conducting the detailed survey. For example, a two way East/West roadway for which the direction of travel is east would have the Eastbound lane and its adjacent shoulder used to conduct the detailed survey.

PIN - Project Identification Number. A previously determined number to identify the proposed project to be surveyed.

Number of Lanes - The total number of lanes in both directions on an undivided highway or the total number of lanes in the direction of the survey on a divided highway. If the highway is divided, denote it with a (D) after the number of lanes.

Survey Pertinent to _____ Lane(s) - The lane(s) that exhibit the distress indicated on the form, and which lanes they are.
(All - all lanes; DL - driving lane; CL - center lane; ML - median lane.)

See Figures A1 and A2 for examples of typical heading completions.

NYSDOT MATERIALS BUREAU

DISTRESS DATA FORM

Region 1 County Saratoga Route No. 187 Pin 158753 PAVEMENT
 Number of Lanes 3(D) Survey Pertinent to 2 Lane(s) DL&CL Direction North RIGID ☒
 Date Insp. 3/13/90 Inspectors B. Alert, B. Careful Sheet 1 of 6

Figure A1

Figure A1 is an example of a six-lane divided highway. The survey was conducted on the northbound lanes and was pertinent to only two of the three lanes, those being the driving lane (DL) and the center lane (CL). The median lane (ML) did not exhibit the same types and/or severity levels of distress as the other lanes and, therefore, would be surveyed separately.

NYSDOT MATERIALS BUREAU

DISTRESS DATA FORM

Region 1 County Essex Route No. 22 Pin 175252 PAVEMENT
 Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction South FLEXIBLE ☒
 Date Insp. 3/13/90 Inspectors D. Bond, D. Lamb FLEXIBLE/RIGID ☐
 Sheet 1 of 4

Figure A2

Figure A2 is an example of a two lane undivided highway. The survey was conducted on the southbound lane and was pertinent to both north and southbound lanes, both lanes exhibited similar distress.

PAVEMENT SECTION SURVEYED

Record the 4 digits from the bottom row of the roadside reference marker. These numbers shall be recorded for both the beginning and ending point of each half mile section. The detailed survey will then be conducted on the first tenth mile segment of the half mile sections, unless the tenth mile segment is obstructed with a bridge or intersection as previously explained under Distress Data Collection. See Figure A3 for a typical example.

DISTRESS	SEVERITY	SECTION						EXTENT		REMARKS
		(1)	(2)	(3)	(4)	(5)				
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	

Figure A3

DISTRESS DATA COLLECTION PROCEDURE

Each distress category and severity level is defined under the distress descriptions in Appendices B-D. These appendices should be referred to for the specific method of measuring and determining the severity and extent of distress. Photos are included to aid in determining the different levels.

Three different methods of recording distress and severity are used as follows:

1. Percentage Estimation (%)
2. Numerical Count (#)
3. Indication of Presence (✓)

The method used to record the extent of distress is indicated by the symbols above on the Distress Data Form and also is explained in Appendices B-D under How to Measure.

1. **Percentage Estimation** - is used primarily on the Flexible Pavement or Flexible/Rigid Pavement distress data form (Figure 3). The percentage concept is used to estimate the percentage of a particular type of distress and severity level that exists within the tenth mile detailed survey pavement length affected. Refer to the distress descriptions (Appendices B-D) for the specific method of measuring and determining the severity and extent of distress. The estimated percentage is documented on the data form by entering a number from 1 to 10 in the appropriate boxes; 1 represents 10%, 2 represents 20%, up to 10 which represents 100%. If no distress is present in a detailed survey section a 10 (100%) is recorded in the None box. Note - for each type of distress the summation of the individual severity levels for each tenth mile section evaluated should equal 10. See Figure A4 for a typical example.

DISTRESS	SEVERITY	SECTION								REMARKS
			(1)	(2)	(3)	(4)	(5)	EXTENT		
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
WHEELPATH CRACKING (%)	N	None	6		1			7	14	
	L	Single Crack	4	8	5	6	5	28	56	
	M	Multiple Cracks		2	4	4	5	15	30	
	H	Mult. Cracks w/Potholes						0	0	

Figure A4

2. **Numerical Count** - is used for those forms of distress that are discrete in their occurrences, such as settlements and heaves, blowups, transverse joint distress, etc. Each level of severity should be counted and noted for the appropriate distress categories. Refer to the distress descriptions (Appendices B-D) for the specific method of measuring and determining the severity and extent of distress. Some forms of distress are counted within the tenth mile detail survey section only, while others are counted for the entire half mile survey section. If no distress is present, indicate this with a checkmark in the None box. See Figure A5 for a typical example.

DISTRESS	SEVERITY	SECTION							EXTENT TOTAL		REMARKS
			(1)	(2)	(3)	(4)	(5)				
		Beginning	1000	1005	1010	1015	1020				
		Ending	1005	1010	1015	1020	1025				
		SUM	%								
FULL WIDTH TRANSVERSE CRACKING (#)	N	None	✓								
	L	Single Crack		III	II				5		
	M	Multiple Cracks			IIII	IIII	III		14		
	H	Mult. Cracks w/Potholes				II			2		

Figure A5

3. **Indication of Presence** - For this method of measuring and recording distress use a checkmark in the appropriate distress category and severity level. Refer to the distress descriptions (Appendices B-D) for the specific methods of measuring and determining the severity level present. If no distress is present, indicate this with a checkmark in the None box. See Figure A6 for a typical example.

DISTRESS	SEVERITY	SECTION								REMARKS
			(1)	(2)	(3)	(4)	(5)	EXTENT		
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
WHEELPATH RUTTING (MEASURE) ☒	N	None	✓					1	20	
	L	< 3/8"		✓	✓		✓	3	60	
	M	3/8"-3/4"				✓		1	20	
	H	>3/4"						0	0	

Figure A6

Extent Totals - After the entire project has been evaluated the ratings for each section shall be summed up for each individual severity level and the total placed in the summation box on the last form. For some distress types that are measured by either using a Percentage Estimation, Numerical Count or an Indication of Presence (checkmark, ✓), a percent of distress is calculated.

For those distress categories where project percentages would be misleading such as a non-uniform type of distress, the percent column is blacked out and therefore should not be calculated, but should be summarized in the Condition Report.

REMARKS

Any narrative remarks concerning a section should be made in this space referring to the section by the numbers indicated in the parenthesis under the section heading. Remarks could include differences in distress levels from one lane to another, unusual road conditions not recorded on the form, differences in distress levels between right and left shoulders, or any information that the survey team feels may be pertinent to the survey. See Figure A7 for a typical example.

DISTRESS	SEVERITY	SECTION							EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)		TOTAL		
		Beginning	1000	1005	1010	1015	1020				
		Ending	1005	1010	1015	1020	1025	SUM	%		
EDGE CRACKING (%)	N	None	10	10	4	2	3	29	58		(3)M-Severity
	L	Single Crack			4	8	6	18	36		Level Assco.
	M	Multiple Cracks			2		1	3	6		With Rt. Pav't.
	H	Mult. Cracks w/Potholes						0	0		Edge only

Figure A7

SHOULDER SURVEY HEADING

Check off which side(s) exhibits the distress indicated on the form. See Figure A8 for a typical example.

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

Figure A8

SHOULDER DISTRESS DATA COLLECTION PROCEDURE

This section is completed following the same directions outlined for the pavement distress data collection. Refer to Appendix D for specific methods of measuring and determining the severity and extent of shoulder distress.

APPENDIX B
Distress Data Collection Procedures
Rigid Pavement

SETTLEMENTS AND HEAVES

Description: Settlements are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. Heaves are localized upward displacements of the pavement surface. (Figure B1)

Causes:

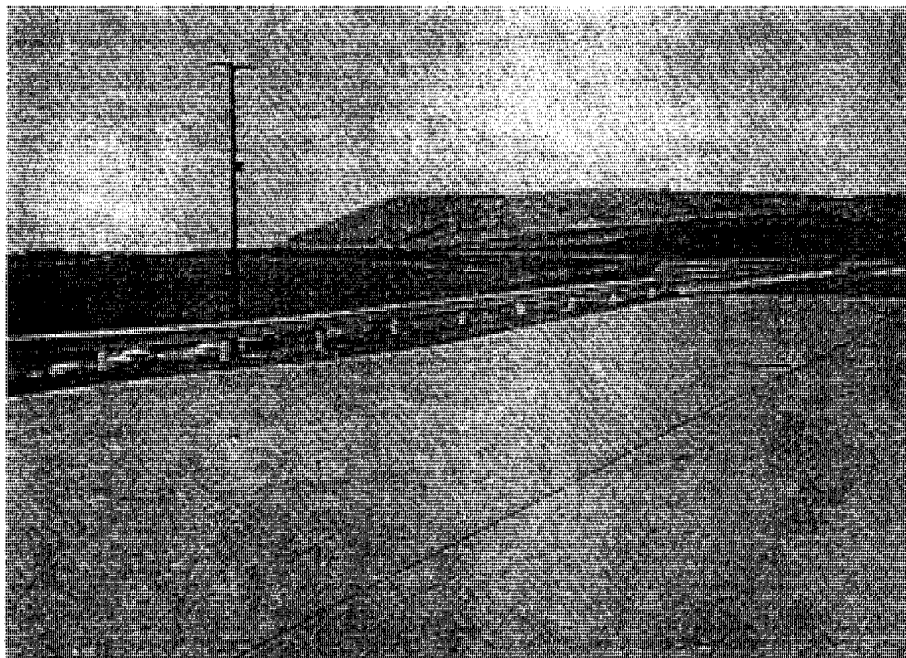
1. Frost action (heaves)
2. Settlement of the base

Severity Levels: No degrees of severity are defined. Settlements and heaves should be noted only when they have a noticeable effect on the ride.

How to Measure: Record the number of settlements and/or heaves counted in each half mile survey length.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
SETTLEMENTS & HEAVES (#)	N	None	✓	✓			✓		
	P	Present			1	1		2	

% Calculation Not Required



Typical Bridge Approach Settlement

Figure B1 - Settlements and Heaves

BLOWUPS

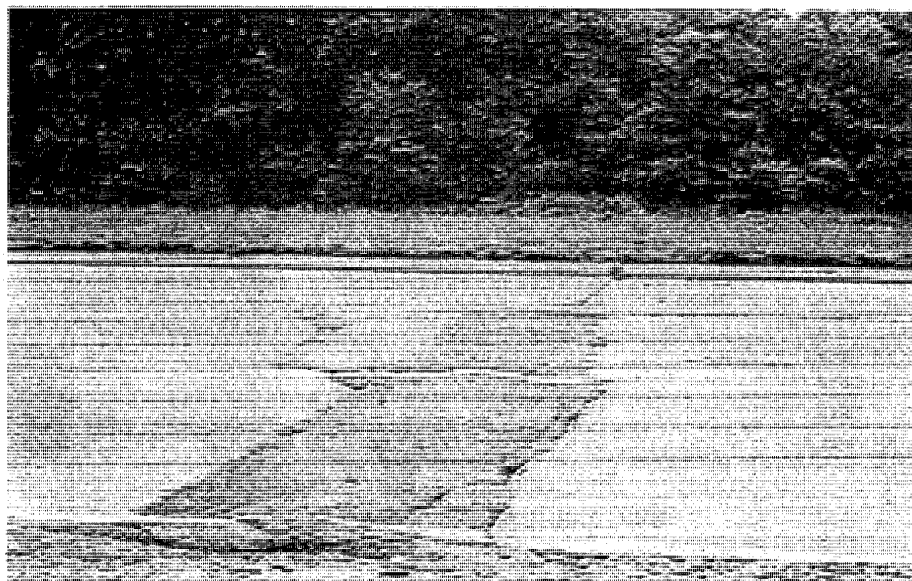
- Description:** A localized buckling or shattering of a slab generally occurring at a transverse joint or crack which may or may not have been patched with bituminous concrete. (Figure B2)
- Causes:** An infiltration of fines in unsealed transverse joints which acts as an incompressible medium. This incompressible medium will buildup due to the normal contraction which takes place in cold weather and the infiltration of abrasive sand and roadway dirt. The normal expansion during warmer weather will cause compressive stresses which are relieved when the pavement buckles or shatters.
- Since blowups may not occur in all the lanes of a multilane pavement, shearing forces develop in the longitudinal joints as lanes move independently. These forces cause longitudinal tie bars to bend and shear off. Once the lanes are no longer tied together, further separation occurs at the longitudinal joint as infiltration continues.
- Severity Levels:** A partial width blowup occurs in one or some of the lanes of a multilane pavement. It does not extend across the full pavement width. Adjacent transverse joints will be seen to be misaligned as the slabs move toward the pressure relief caused by the blowup. A full width blowup occurs across the entire pavement width and does not cause transverse joint misalignment.
- How to Measure:** Tally and note number in each category in each half mile survey length.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
BLOWUPS (#)	Partial Width			✓	✓	1	1	2	
	Full Width		1					1	

% Calculation Not Required



Blowup Showing
Shattered Concrete
Before Repair



Partial Width Blowup That Occurred In The
Near Lanes Only And Has Been Repaired With
Asphalt Concrete

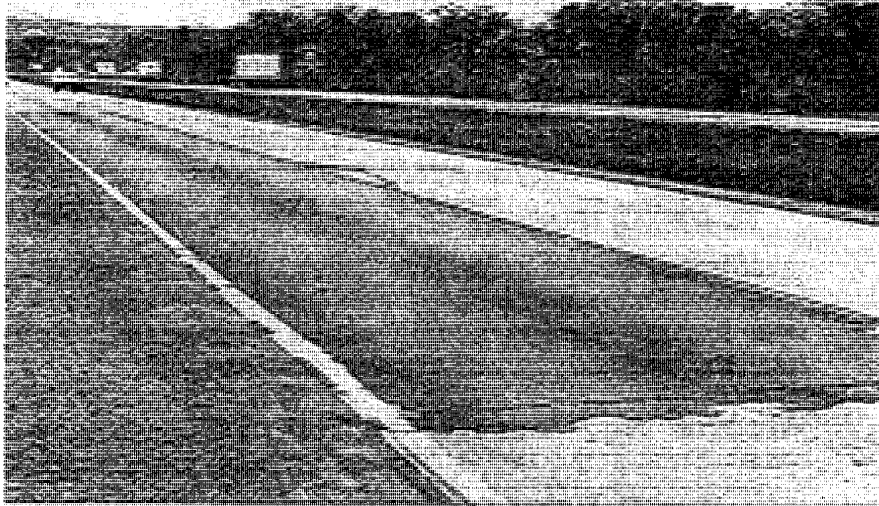
Figure B2 - Blowups

ASPHALT CONCRETE OVERLAY PATCHING

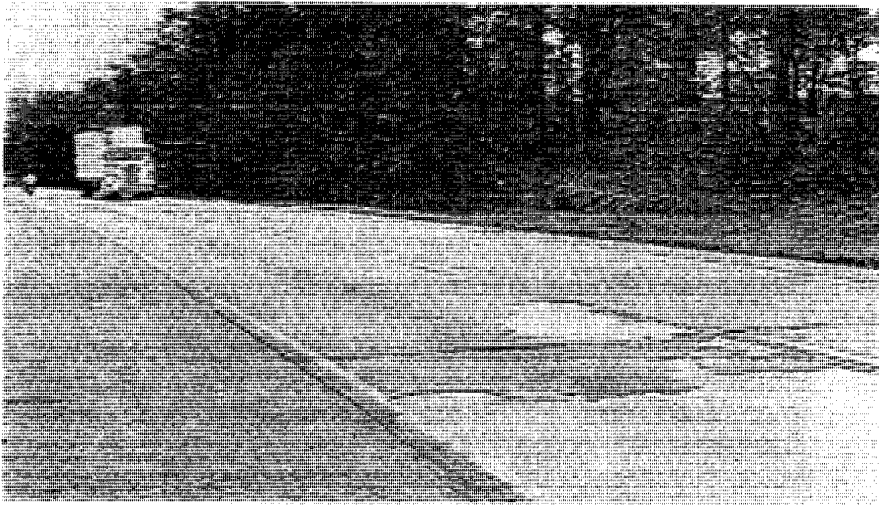
- Description:** A lane or full pavement width, paver laid, asphalt concrete patch placed to improve rideability over localized distress. May be over one or two slabs or several hundred feet long. (Figure B3)
- Causes:** A localized settlement and/or excessively cracked, scaled or spalled pavement slab.
- Severity Levels:**
- | | |
|-------------|---|
| Good | Like new. Original condition of asphalt concrete overlay. |
| Fair | Underlying problem reflecting through. Cracks showing, potholes, spot patching by Maintenance forces. |
| Poor | No longer serviceable, extensive deterioration has reflected through or the asphalt concrete has deteriorated to the extent where replacement is necessary. |
- How to Measure:** Tally and note approximate length of each patch under remarks in each half mile survey length.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
ASPHALT CONC. OVERLAY PATCHING (#)	N	None		✓	✓	✓			(1) 120' Long-DL
	G	Good							(5) 180' & 240'
	F	Fair					11	2	Long-DL
	P	Poor	1					1	

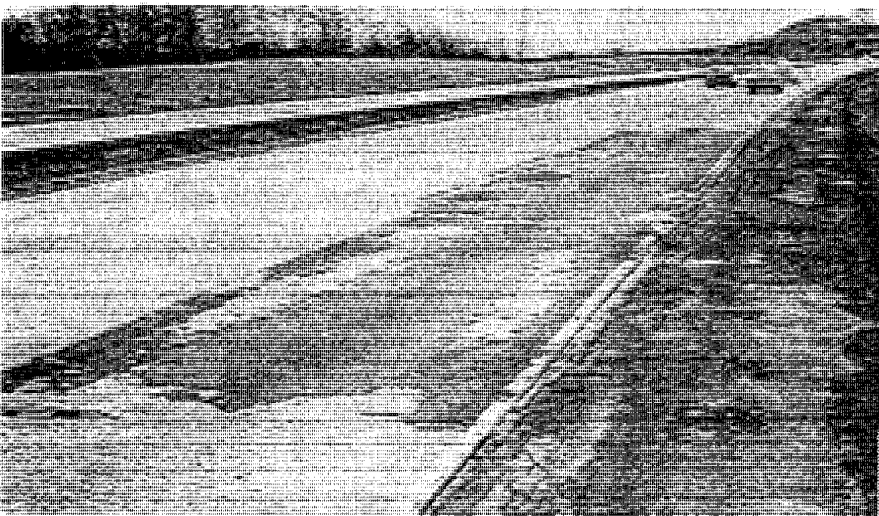
% Calculation Not Required



Good



Fair



Poor

Figure B3 - Asphalt Concrete Overlay Patching

JOINT SEALER FAILURE

Description: Liquid Sealers - Failure is characterized by loss of bond (adhesion) between the sealer and joint faces, internal tearing (cohesion) within the sealer itself and/or entrapment of incompressibles within the sealer matrix and/or loss of sealer from the joint. (Figure B4)

Preformed Neoprene Sealers - Failure is characterized by loss of recovery from a compressed state (compression set) and/or internal web sticking, allowing the infiltration of water and incompressibles into the joint and/or loss of sealer from the joint.

Causes: When the major portion of New York's PCC pavements were being constructed in the 1960's, little was known about the relationship between joint width and slab length. In addition, the joint sealers available at the time lacked the flexibility and recoverability characteristics needed to perform satisfactorily for an extended period of time when exposed to environmental extremes. This lack of knowledge also extended to construction, resulting in inadequate joint groove preparation prior to sealing, and poor sealer installation practices. Consequently, joint sealers failed within a short period of time. To further complicate this problem, maintenance and replacement of failed joint sealers with suitable materials has been practically non-existent.

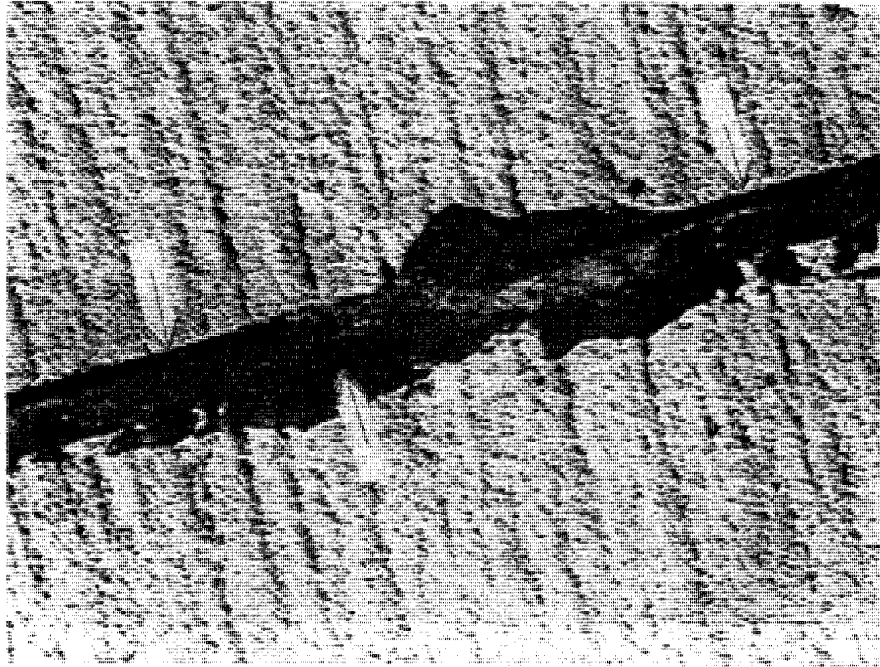
Severity Levels: Determine through observation whether or not joint sealers have failed.

In some instances sealer failure is unmistakably evident, as the entire sealer may be missing. However, many times sealers appear to be functioning but, in fact, have exceeded their serviceable life. This generally occurs if observations are made during warm periods when pavement joints are at their narrowest because of slab expansion. At this time of year, gaps caused by cohesion failure, loss of adhesion and compression set may not be discernable. However, they can easily be detected with a thin bladed putty knife or similar instrument used as a probe to detect these gaps. It is also very helpful to cut and remove a section of sealer from the joint. This allows inspection of the joint grooves and liquid sealers for infiltration of incompressibles and the inspection of preformed sealers for compression set.

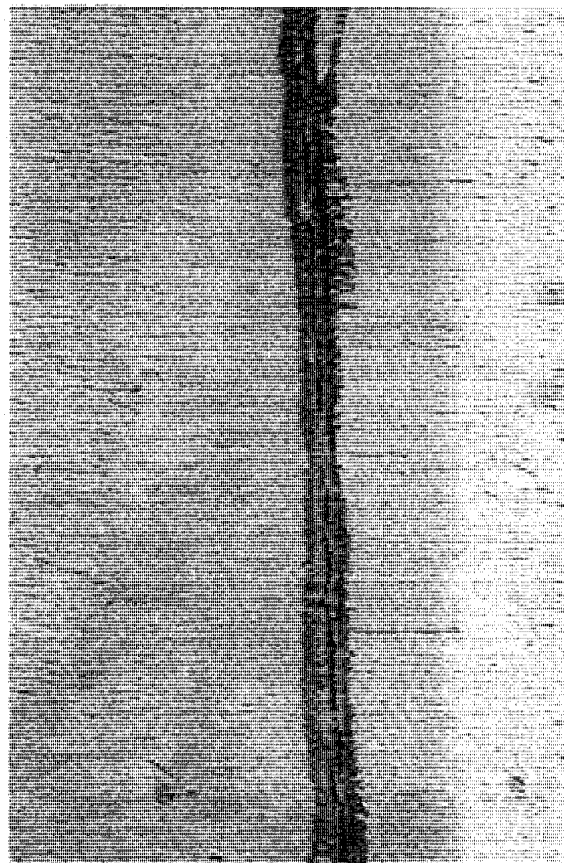
How to Measure: Check category which represents tenth mile detail survey section.

DISTRESS	SECTION									REMARKS
	SEVERITY		(1)	(2)	(3)	(4)	(5)	EXTENT		
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
JOINT SEALER FAILURE ☒	N	None						0	0	
	F	Failed	✓	✓	✓	✓	✓	5	100	

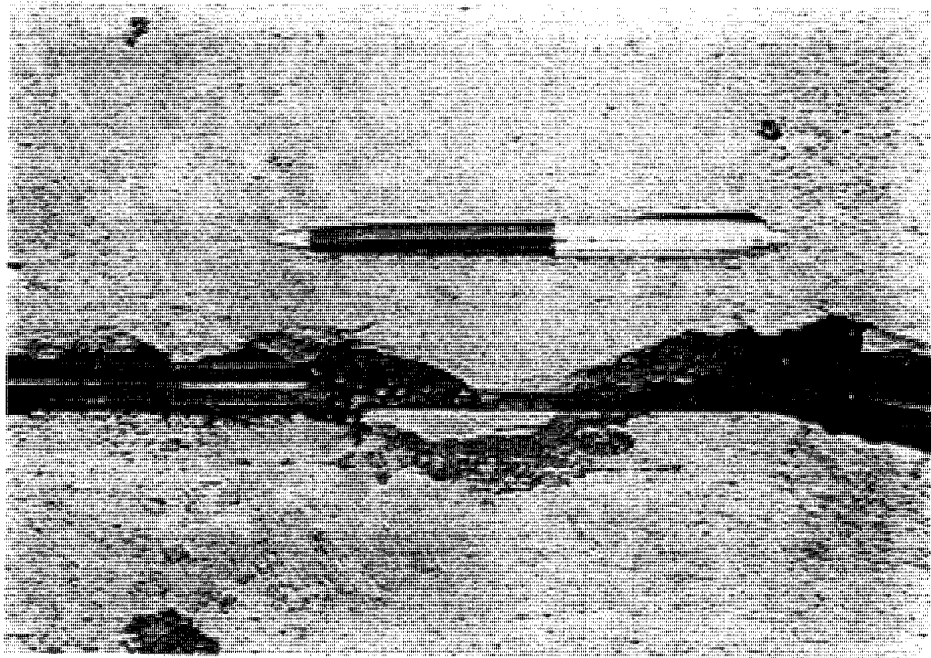
$$\% = \frac{\text{Sum of Checkmarks per Severity Level}}{\text{Sum of Number of Sections Evaluated}} \times 100$$



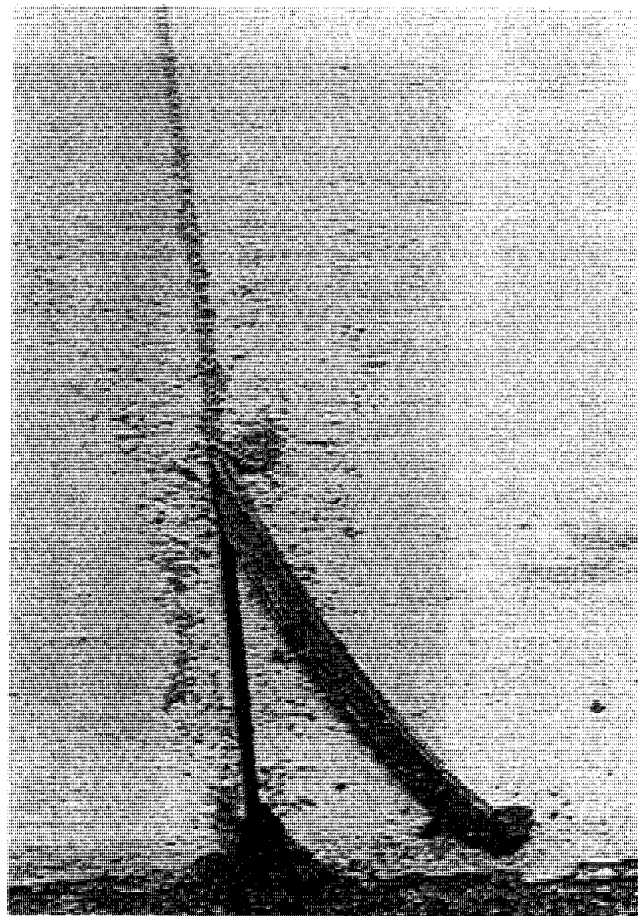
Liquid Sealer Adhesion Failure



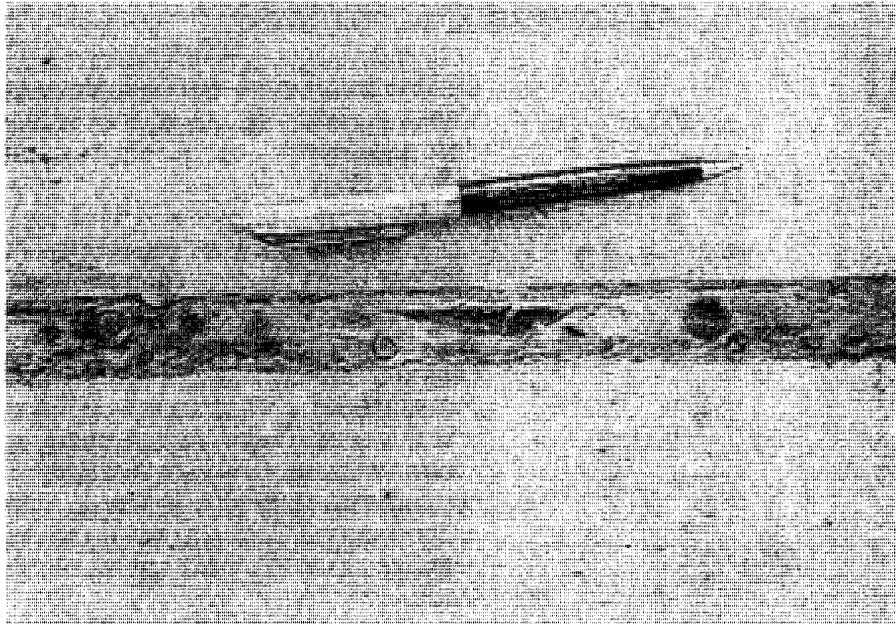
**Liquid Sealer
Cohesion Failure**



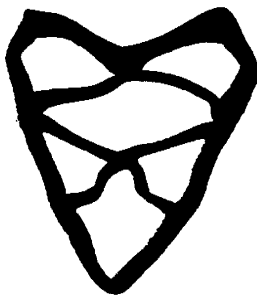
Preformed Neoprene Sealer Broken From Stretching During Installation



**Preformed Neoprene Sealer
Compression Set Failure
Allowing The Infiltration
Of Incompressible Materials**



Incompressible Infiltration In A Liquid Sealer



**New Preformed Neoprene
Sealer**



**Failed, Preformed Neoprene Sealer
(Compression Set, Web Sticking)**

Figure B4 - Joint Sealer Failure

TRANSVERSE JOINT FAULTING

Description: Differential vertical displacement of abutting slabs at joints or slab cracks creating a step deformation on the pavement surface. (Figure B5)

Causes: Loss of load transfer caused by a combination of; unsealed joints, which allow water and deicing salts to penetrate, traffic loads and load transfer device design. Salts cause corrosion of the malleable iron type load transfer device which are weakened due to metal loss and fail due to traffic loads. The water weakens the base which is displaced by traffic loadings in the area. Faulting progresses with time as base material is displaced due to water and continuing traffic loads.

Severity Levels:

Low	Elevation difference less than 3/8"
Medium	Elevation difference between 3/8" and 3/4"
High	Elevation difference greater than 3/4"

How to Measure: Measurement should be taken 1 foot from the edge of the pavement lane with a combination square as shown in the photo. Measure to the nearest 1/8 inch at 2 transverse joints, during the tenth mile detail survey. Checkmark the category in which the average of the measurements fall as shown in the example.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS	
		(1)	(2)	(3)	(4)	(5)	TOTAL			
		Beginning	1000	1005	1010	1015	1020			
		Ending	1005	1010	1015	1020	1025	SUM		%
TRANSVERSE JOINT FAULTING (MEASURE) ☒	N	None						0	0	
	L	<3/8"	✓	✓		✓		3	60	
	M	3/8"-3/4"			✓			1	20	
	H	>3/4"					✓	1	20	

$$\% = \frac{\text{Sum of Checkmarks per Severity Level}}{\text{Sum of Number of Sections Evaluated}} \times 100$$

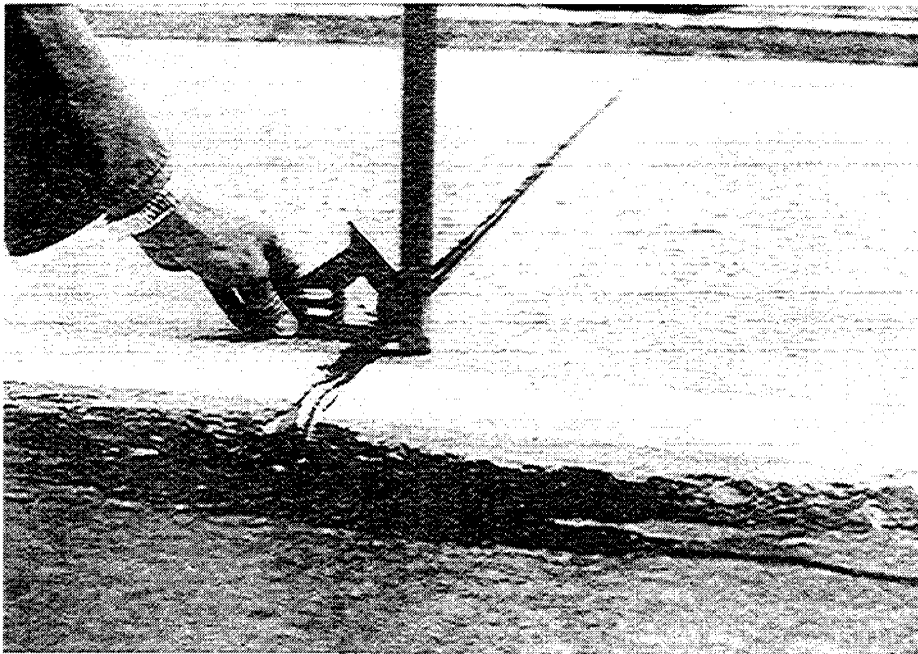


Figure B5 - Transverse Joint Faulting

TRANSVERSE JOINT SEPARATION

Description: Increase in joint width from the time the joint was originally constructed. (Figure B6)

Causes: Infiltration of incompressible material during the contraction cycle of the pavement slabs. As slabs move toward blowups and/or pressure relief joints, space is provided for continued infiltration increasing widening.

How to Measure: The number of joints in each tenth mile detail survey, 1 1/2 inches or greater in width are tallied.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
TRANSVERSE JOINT SEPARATION (#)			III II			IIII	III	16 35	

$$\% = \frac{\text{Sum of Joints (Counts)}}{*9 \text{ Joints/Section} \times \text{Number of Sections}} \times 100$$

** 9 Joints/Section is based on 60 ft. long slabs. If different slab lengths are encountered, evaluate the tenth mile section (500 ft.) but change the number of joints appropriately in the denominator for calculating %.*

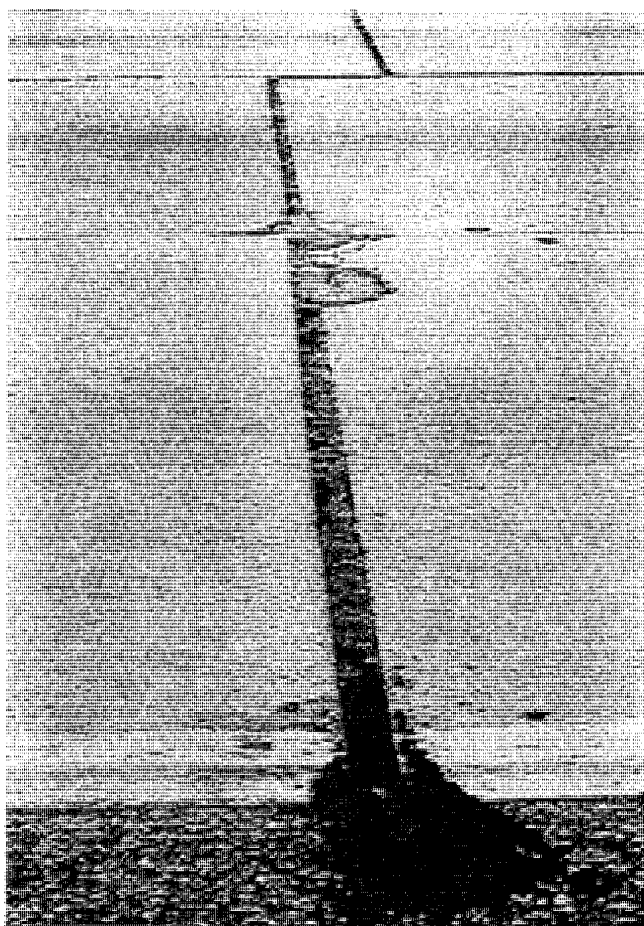


Figure B6 - Transverse Joint Separation

TRANSVERSE JOINT DISTRESS

Description:

Spalling

A piece of concrete joint edge which has cracked and broken away from the slab. Spalls may range in size from minor chips to large pieces constituting major joint damage. Spalls usually do not extend through the thickness of the slab but meet the joint at an angle. Spalls may be patched with asphalt concrete or a concrete material. (Figure B7)

Causes:

Spalling is due to an internal or external force on concrete which causes it to fracture.

An internal force due to metal corrosion and/or expansion of absorptive aggregates will cause spalling.

An external force, such as a stone or other incompressible caught in the joint between expanding slabs, will create enough stress to cause chipping or a large piece of concrete to break away. Ice expanding in a crack will also cause stress and result in spalling.

Severity Levels:

Low

A minor spall with a maximum width dimension of three inches. This dimension is measured from the joint face to the edge of the spall. Chipping of the joint face would fall in this category. Joints with chipping or minor spalls as defined above would be able to be sealed with a poured sealer.

Medium

Two or less spalls per joint whose width dimension is greater than the 3 inches in the Low severity level. A joint falling in this category would be able to be sealed with a pourable sealer after the spalls are permanently repaired.

High

Three or more spalls per joint whose width dimension is greater than the 3 inches in the Low severity level. A joint falling in this category is so extensively deteriorated that the most cost effective solution may be asphalt patching followed by an asphalt overlay.

(Continued)

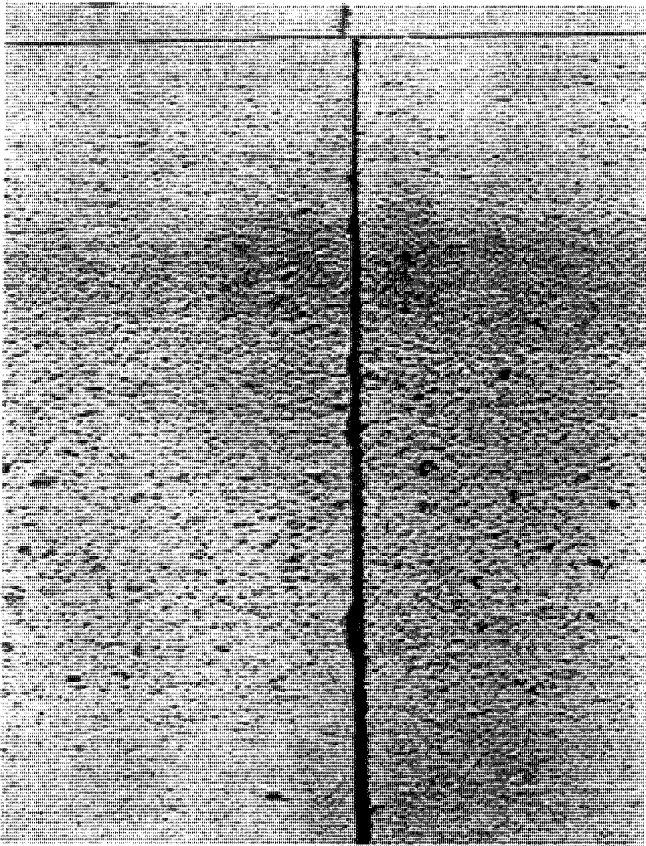
TRANSVERSE JOINT DISTRESS
(Continued)

How to Measure:

The number of joints falling in each severity level are tallied during the tenth mile detail survey as shown in the example.

DISTRESS	SEVERITY	SECTION							REMARKS		
		(1)	(2)	(3)	(4)	(5)	EXTENT				
		Beginning	1000	1005	1010	1015	1020	TOTAL			
		Ending	1005	1010	1015	1020	1025	SUM			%
TRANSVERSE JOINT DISTRESS (# JOINTS)	N	No Spalls						0	0		
	L	Minor 3" max. Width						4	9		
	M	Occs. >3" Width						30	67		
	H	Many >3" Width						11	24		

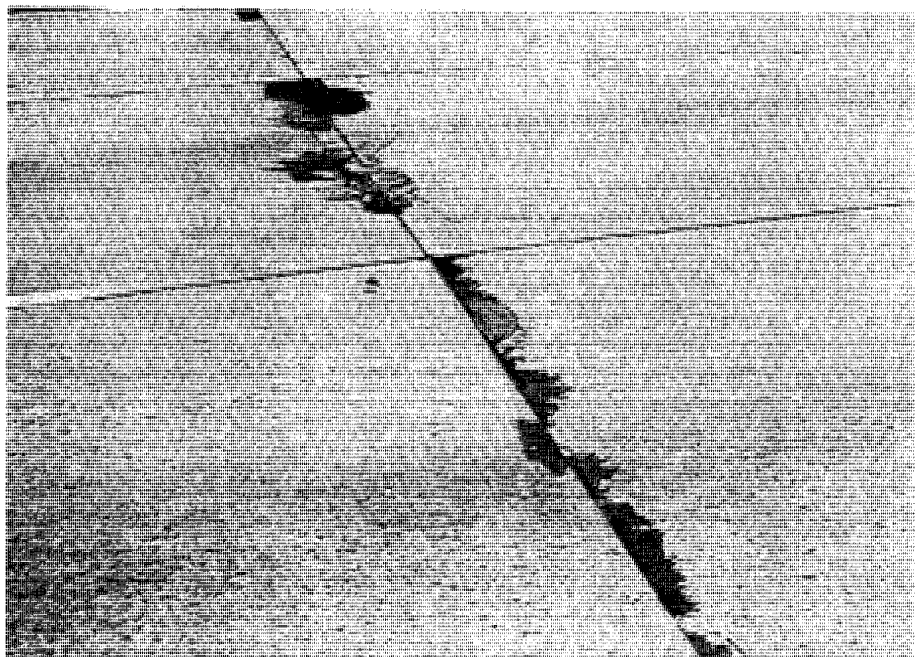
$$\% = \frac{\text{Sum of Joints (Counts) per Severity Level}}{9 \text{ Joints/Section} \times \text{Number of Sections}} \times 100$$



Low



Medium



High

Note the severity of wheelpath wear as shown by the varying degrees of exposed large aggregates in the three examples above.

Figure B7 - Transverse Joint Distress

LONGITUDINAL JOINT SEPARATION

- Description:** Increase in joint width from the time the joint was originally constructed. (Figure B8)
- Causes:** Failure of the longitudinal joint ties between pavement lanes due to corrosion, infiltration, and independent movement of pavement lanes (See Blowups).
- How to Measure:** The number of pavement slabs (60 feet nominal) in each tenth mile detail survey, where the longitudinal joints have widened to 1 inch or greater in width are tallied.

DISTRESS	SEVERITY	SECTION						EXTENT		REMARKS
		(1)	(2)	(3)	(4)	(5)				
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
LONGITUDINAL JOINT SEPARATION (#)			III II			III	III	16	40	

$$\% = \frac{\text{Sum of Slabs (Counts)}}{*8 \text{ Sixty ft. Slabs/Section} \times \text{Number of Sections}} \times 100$$

** 8 Slabs/Section is based on sixty ft. long slabs. If different slab lengths are encountered, evaluate the tenth mile section (500 ft.) but change the number of slabs appropriately in the denominator for calculating %.*

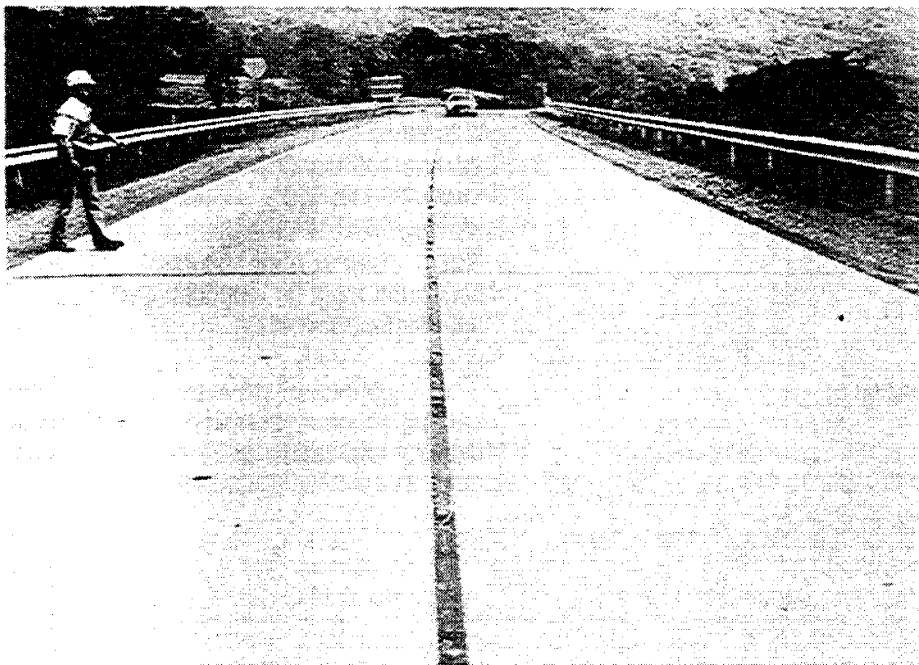


Figure B8 - Longitudinal Joint Separation

LONGITUDINAL JOINT DISTRESS

Description: See Transverse Joint Distress and Figure B9

Causes: See Transverse Joint Distress

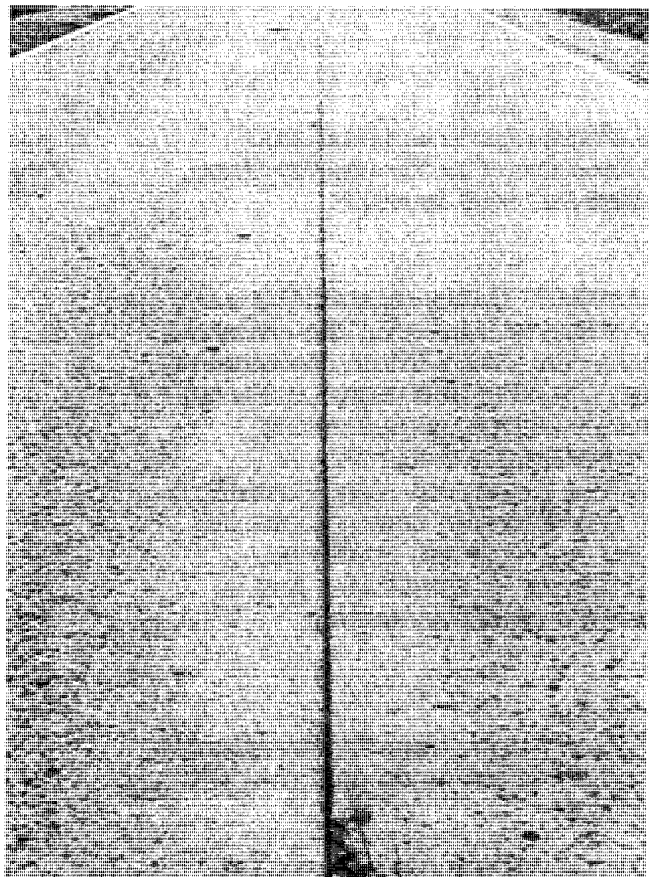
Severity Levels:

Low	Minor spalls or chipping with a maximum width dimension of two inches. Joints at this severity level would be able to be sealed with a pourable sealer.
Medium	Two or less spalls per sixty foot length of pavement having a width dimension greater than two inches. A joint falling in this category would be able to be sealed with a pourable sealer after the spalls are permanently repaired.
High	Three or more spalls per sixty foot length of pavement having a width dimension greater than two inches. A length of pavement falling in this category is so extensively deteriorated that the most cost effective solution may be asphalt patching followed by an asphalt overlay.

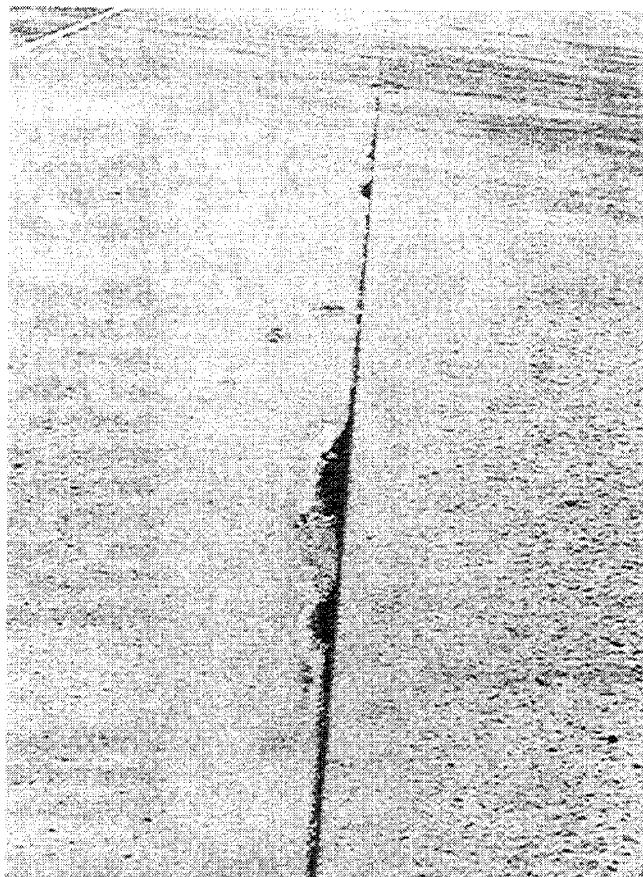
How to Measure: The number of pavement slabs (60 feet nominal) falling in each severity level are tallied during the tenth mile detail survey.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
LONGITUDINAL JOINT DISTRESS (# SLABS)	N	No Spalls		III	IIH	III	III III	20 50	
	L	Minor 2" max. Width	III	III	II	III		14 35	
	M	Occs. >2" Width	II	I	I	I		5 13	
	H	Many >2" Width	I					1 2	

$$\% = \frac{\text{Sum of Slabs (Counts)}}{8 \text{ Sixty ft. Slabs/Section} \times \text{Number of Sections}} \times 100$$



Low



Medium



High

Figure B9 - Longitudinal Joint Distress

SLAB CRACKING

Description:

A crack or cracks within a pavement slab that propagate in any direction. Cracks may vary from hairline to more than one inch in width. (Figure B10)

Causes:

Slab cracking is common. It may occur either early in the life of a pavement or later after the pavement has been subjected to the action of the environment and traffic loading. Cracking that occurs early can usually be attributed to shrinkage and curling stresses, poor construction practices such as improper handling and placement of load transfer devices, improper curing and/or sawing joints too late. Cracking occurring later can usually be attributed to load transfer lockup or loss, loss of subbase support and/or excessive loading.

Severity Levels:

- Low** Cracks less than 1/8" in width generally free of spalls, have not faulted and/or do not open and close with changes in temperature.
- Medium** Cracks 1/8" or greater in width generally free of spalls and/or have not faulted that can be effectively cleaned, and sealed.
- High** Cracks 1/8" or greater in width which are spalled and/or faulted and cannot be effectively cleaned and sealed. Generally slabs containing cracks of this magnitude should be broken and seated and overlaid or replaced.

How to Measure:

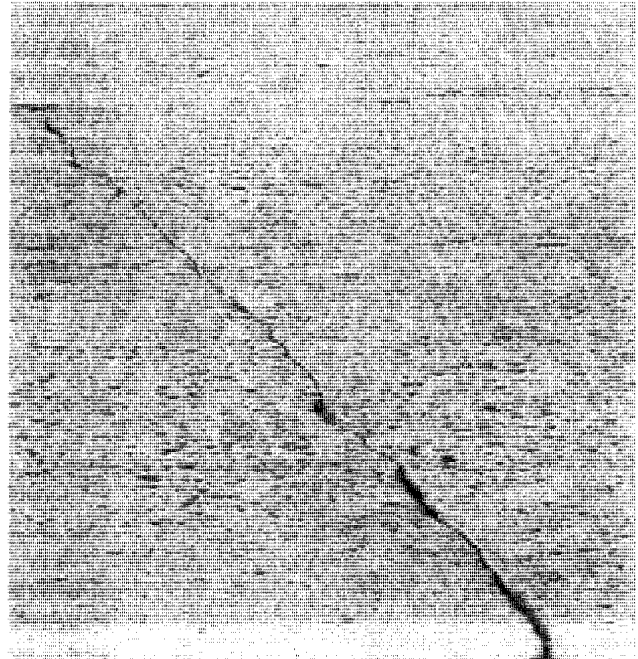
Tally and note the number of cracked slabs that are in each category in the tenth mile long detail survey section.

DISTRESS	SEVERITY	SECTION						EXTENT		REMARKS
		(1)	(2)	(3)	(4)	(5)				
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
SLAB CRACKING (# SLABS)	N	None						24	60	
	L	Light						5	12	
	M	Moderate						3	8	
	H	Heavy						8	20	

$$\% = \frac{\text{Sum of Slabs (Counts)}}{8 \text{ Sixty ft. Slabs/Section} \times \text{Number of Sections}} \times 100$$



Low



Medium



High

Figure B10 - Slab Cracking

WHEELPATH RUTTING

Description: Loss of mortar and fine aggregate resulting in the exposure and polishing of the larger aggregate and rutting in the wheelpaths of the pavement surface disrupting cross-slope drainage. (Figure B11)

Causes: Wear due to winter abrasives and wheel repetitions.

Severity Levels:

Low	Average rut depth less than 3/8 inch
Medium	Average rut depth of 3/8 - 3/4 inch
High	Average rut depth of greater than 3/4 inch

How to Measure: Measure depth to the nearest 1/8 inch, in right hand wheel path, at one location during tenth mile detail survey. Checkmark category in which measurement falls.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
WHEELPATH RUTTING (MEASURE) ☒	N None							0 0	
	L < 3/8"		✓	✓	✓		✓	4 80	
	M 3/8"-3/4"					✓		1 20	
	H > 3/4"							0 0	

$$\% = \frac{\text{Sum of Checkmarks per Severity Level}}{\text{Sum of Number of Sections Evaluated}} \times 100$$



Figure B11 - Wheelpath Rutting

SCALING NON-JOINT SPALLING

Description:

Irregularities in the pavement slab surface other than those occurring at joints and characterized by scaling, popouts and/or spalling. These distress types may be patched with asphalt. (Figure B12)

Causes:

Scaling is caused by excessive water used in finishing the concrete's surface or lack of proper amount of entrained air, in combination with freezing and thawing.

Popouts are caused by expansive or absorptive coarse aggregate which spalls the concrete surface.

A common example of spalling is corrosion of pavement reinforcing mesh which causes a spall in the pavement surface. This is prevalent when the cover over the mesh is shallow.

Severity Levels:

Low	Minor isolated scaling less than one half inch deep and/or popouts. No spalling.
Medium	Scaling $\frac{1}{2}$ to 1 inch deep and/or two or less spalls per slab. (spalls are noted only if greater than 1 square foot in area)
High	Scaling greater than 1 inch deep. Three or more spalls per slab.

How to Measure:

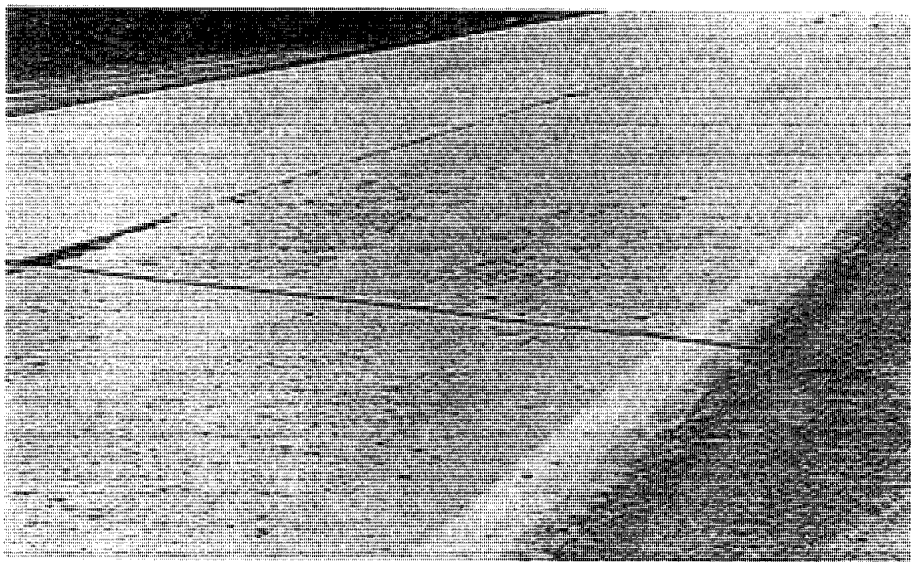
Observe and tally the number of slabs (60 ft.) that fall in each severity level during the one-tenth mile detail survey.

DISTRESS	SEVERITY	SECTION							EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)		TOTAL		
		Beginning	1000	1005	1010	1015	1020	Ending	SUM	%	
		Ending	1005	1010	1015	1020	1025				
SCALING/ NON-JOINT SPALLING (# SLABS)	N None		411 III	411 III	411 III	411 I	411 II	37	92		(4) scaling
	L Light					II		2	5		(5) spalling
	M Medium						I	1	3		
	H Heavy							0	0		

$$\% = \frac{\text{Sum of Slabs (Counts)}}{8 \text{ Sixty ft. Slabs/Section} \times \text{Number of Sections}} \times 100$$



Low Spalling
Popouts



Medium Scaling
Showing Deterioration
Of Mortar



Heavy Spalling
Due To Corrosion
Product Expansive
Pressure And Shallow
Concrete Cover Of
The Reinforcing Mesh.

Figure B12 - Scaling Non-Joint Spalling

NYSDoT MATERIALS BUREAU

DISTRESS DATA FORM

Region 12 County Excelsior Route No. 99 Pin 1201.50PAVEMENT
RIGID ☒Number of Lanes 2(D) Survey Pertinent to 2 Lane(s) All Direction NorthDate Insp. 3/13/90 Inspectors A. Hunt, W. Judge Sheet 1 of 1

DISTRESS	SEVERITY		SECTION					EXTENT		REMARKS	
			(1)	(2)	(3)	(4)	(5)	TOTAL	SUM		%
			Beginning Ending	1000 1005	1005 1010	1010 1015	1015 1020				
SETTLEMENTS & HEAVES (#)	N	None	✓	✓							
	P	Present			I	I			2		
BLOWUPS (#)		Partial Width				I	I		2		
		Full Width	I						1		
ASPHALT CONC. OVERLAY PATCHING (#)	N	None		✓	✓	✓					(1) 120' Long-DL
	G	Good									(5) 180' Long-DL
	F	Fair					II		2		240' Long-DL
	P	Poor	I						1		
JOINT SEALER FAILURE ☒	N	None	✓						1	20	
	F	Failed		✓	✓	✓	✓	✓	4	80	
TRANSVERSE JOINT FAULTING (MEASURE) ☒	N	None							0	0	
	L	<3/8"	✓	✓		✓			3	60	
	M	3/8"-3/4"			✓				1	20	
	H	>3/4"					✓		1	20	
TRANSVERSE JOINT SEPARATION (#)			III	II		III		III	16	35	
TRANSVERSE JOINT DISTRESS (# JOINTS)	N	No Spalls							0	0	
	L	Minor 3" max. Width			III				4	9	
	M	Occs. >3" Width	III	III	III	III	III	III	30	67	
	H	Many >3" Width	III	II				III	11	24	
LONGITUDINAL JOINT SEPARATION (#)						III		III	10	25	
LONGITUDINAL JOINT DISTRESS (# SLABS)	N	No Spalls		III	III	III		III	20	50	
	L	Minor 2" max. Width	III	III	II	III			14	35	
	M	Occs. >2" Width	II	I	I	I			5	13	
	H	Many >2" Width	I						1	2	
SLAB CRACKING (# SLABS)	N	None	III	III	III	III			24	60	
	L	Light					III		5	12	
	M	Moderate					III		3	8	
	H	Heavy			III	III			8	20	
WHEELPATH RUTTING (MEASURE) ☒	N	None							0	0	
	L	< 3/8"	✓	✓	✓		✓		4	80	
	M	3/8"-3/4"				✓			1	20	
	H	>3/4"							0	0	
SCALING/ NON-JOINT SPALLING (# SLABS)	N	None	III	III	III	III	III	III	37	92	(4) scaling
	L	Light				II			2	5	(5) spalling
	M	Medium					I		1	3	
	H	Heavy							0	0	

SHOULDER SURVEY PERTINENT TO: BOTH ☐ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N	None							
	L	Single Crack							
	M	Multiple Cracks							
	H	Mult. Cracks w/Potholes							
LANE/SOULDER SEPARATION (MEASURE) ☒	N	None							
	L	< 1/4"/Sealed							
	M	1/4"-1"							
	H	>1"							
LANE/SOULDER DROPOFF (MEASURE) ☒	N	None							
	L	< 1"							
	M	1"-2"							
	H	>2"							
SHOULDER DEFORMATION ☒	N	None							
	P	Present							

APPENDIX C

Distress Data Collection Procedures Flexible Pavement or Flexible/Rigid Pavement

*This section includes asphalt overlays on
flexible as well as on rigid pavement*

CORRUGATIONS

Description:

Corrugations are series of ripples occurring at fairly regularly spaced intervals perpendicular to the pavement centerline. They usually occur at points where traffic accelerates and decelerates. (Figure C1)

Possible Causes:

Traffic action combined with:

1. Pavement that has poor stability properties
2. Excessive moisture in the base
3. Contaminated asphalt

Severity Levels:

No degrees of severity are defined. Corrugations should be noted only when they affect the ride.

How to Measure:

Estimate the percentage of the 500 foot section affected. If significant differences exist between lanes note under remarks.

DISTRESS	SEVERITY	SECTION								REMARKS
			(1)	(2)	(3)	(4)	(5)	EXTENT		
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
CORRUGATIONS (%)	N None		10	10	9	10	10	49	98	
	P Present				1			1	2	

$$\% = \frac{\text{Sum of Section Percentages}}{\text{Number of Sections Evaluated}} \times 10$$

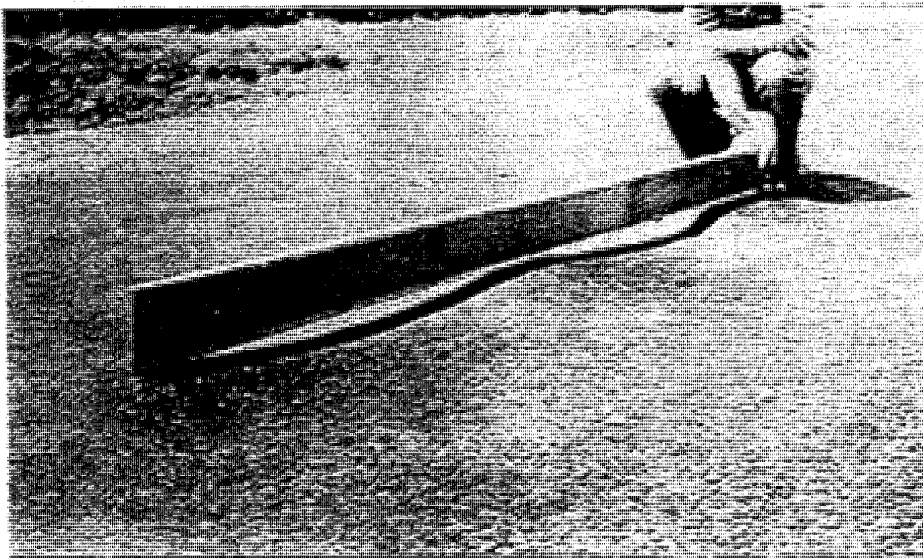


Figure C1 - Corrugations

SETTLEMENTS AND HEAVES

Description:

Settlements are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. Heaves are localized upward displacements of the pavement surface. (Figure C2)

Possible Causes:

1. Settlement of the base
2. Frost action (heaves)

Severity Levels:

No degrees of severity are defined. Settlements and heaves should be noted only when they affect the ride.

How to Measure:

Record as the number of settlements and/or heaves counted in each half mile survey length.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
SETTLEMENTS & HEAVES (#)	N None		✓		✓	✓	✓		
	P Present			II				2	

% Calculation Not Required



Severe Heave

Figure C2 - Settlements And Heaves

ASPHALT CONCRETE OVERLAY OR SPRAY PATCH

Description: A partial lane, a lane or full pavement width of asphalt concrete or spray patch placed to improve rideability over localized distress areas. (Figure C3)

Possible Causes: A localized settlement and/or excessive surface distress.

Severity Levels:

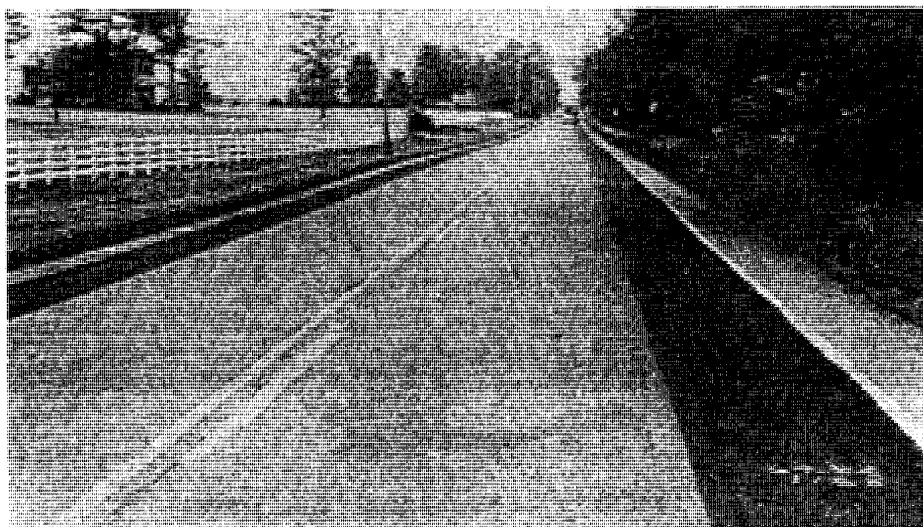
Good	Good condition, asphalt concrete overlay shows no signs of distress.
Fair	Underlying problem reflecting through, such as cracks showing, potholes, spot secondary patching, etc.
Poor	Poor condition, extensive cracking, potholes and/or ravelling. Patch replacement necessary.

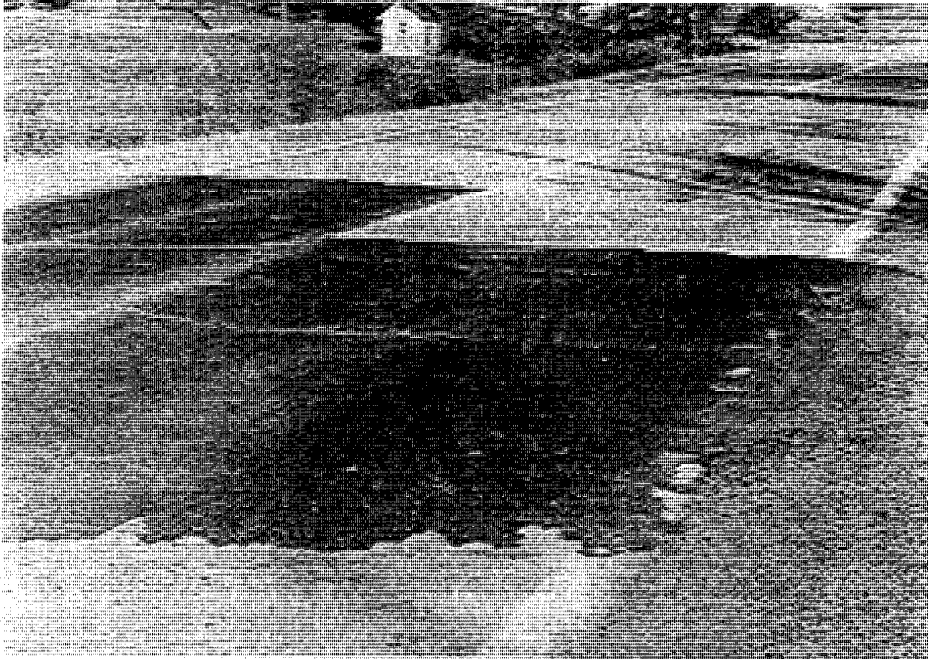
How to Measure: Tally and note approximate length of each patch under remarks in each half mile survey length.

DISTRESS	SEVERITY	SECTION							REMARKS
			(1)	(2)	(3)	(4)	(5)	EXTENT	
		Beginning	1000	1005	1010	1015	1020	TOTAL	
		Ending	1005	1010	1015	1020	1025	SUM	
ASPHALT CONC. OVERLAY OR SPRAY PATCH (#)	N	None	✓	✓		✓	✓		(3) 500' long-EB 1000' long both lanes
	G	Good			II			2	
	F	Fair							
	P	Poor							

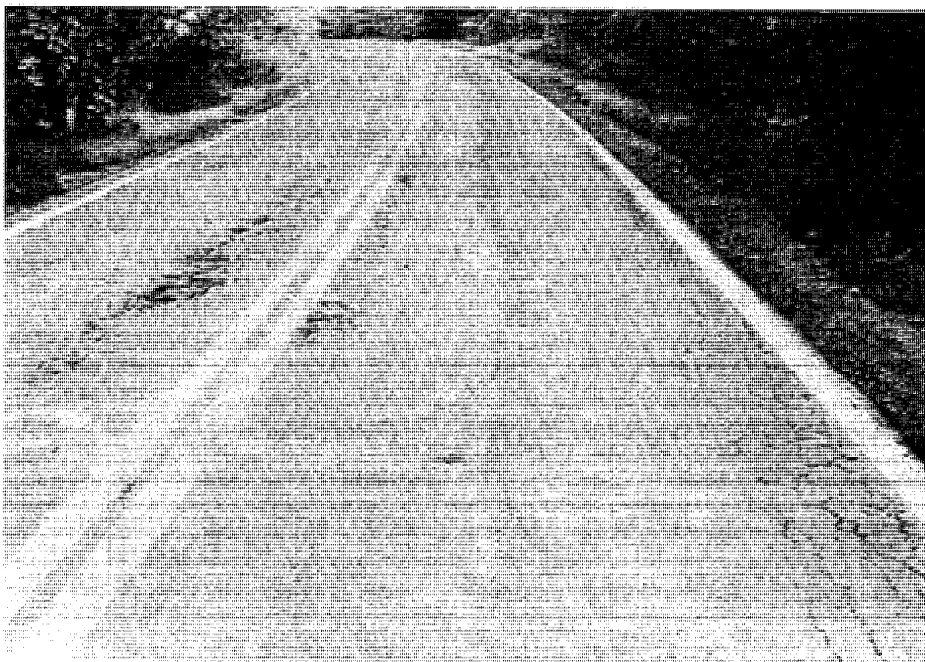
% Calculation Not Required

Good





Fair



Poor

Figure C3 - Asphalt Concrete Overlay Or Spray Patch

WHEELPATH CRACKING

Description: Visible fractures or separations only within the wheelpaths (approximately 3 feet wide per wheelpath). The cracking begins as single or multiple longitudinal cracks. After repeated traffic loading the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are normally less than 1 foot on the longest side. (Figure C4)

Possible Causes: Wheelpath cracking is a load related failure of the pavement. Any one or combination of the following may result in wheelpath cracking:

1. Unstable base
2. Inadequate drainage
3. Insufficient pavement thickness
4. Degradation and/or stripping in the asphalt concrete

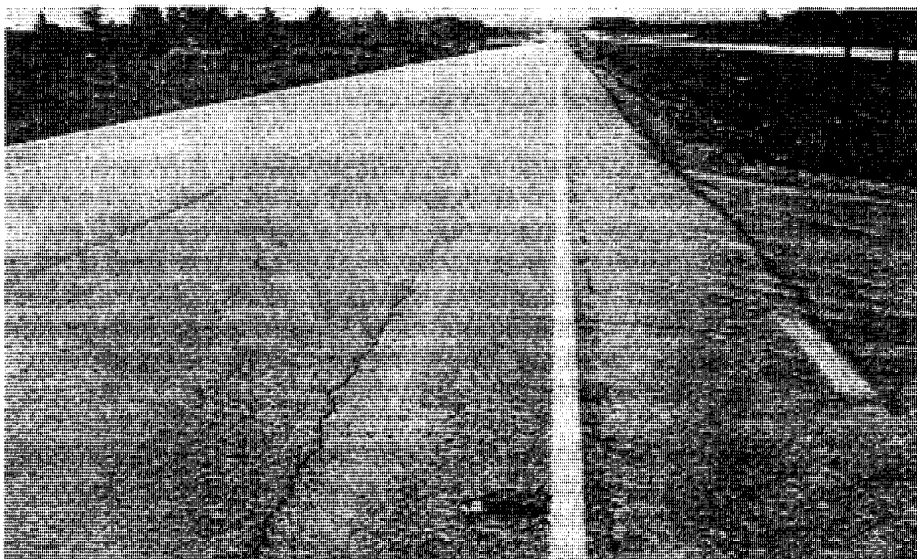
Severity Levels:

Low	Single Crack. This includes cracks that are effectively sealed.
Medium	Multiple cracks ravelled. This includes cracks that have been effectively sealed.
High	Multiple cracks which have pieces broken or missing (potholes).

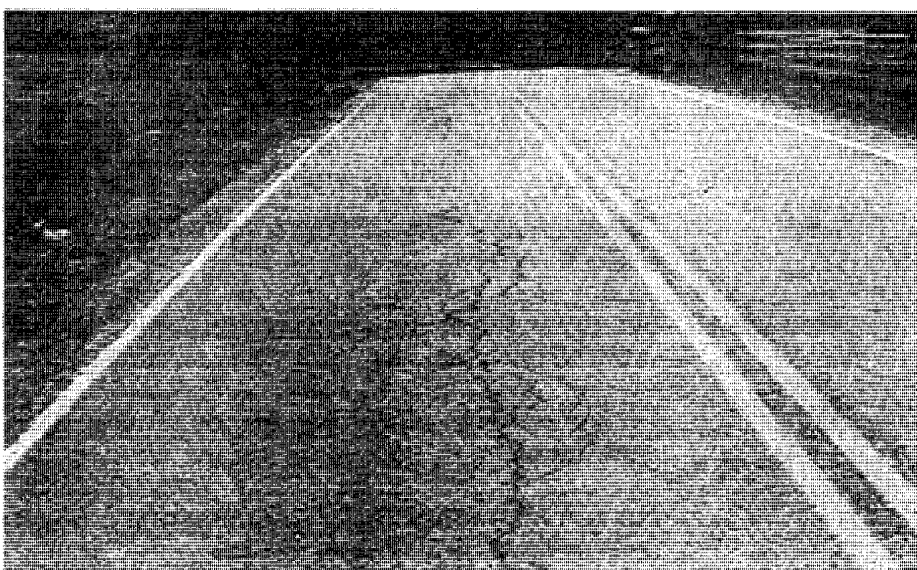
How to Measure: Estimate the percentage of the 500 foot section affected. One wheelpath that is cracked for the entire length would represent 100 percent, or cracking over entire length, changing from one wheelpath or lane to another, would also represent 100 percent.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
WHEELPATH CRACKING (%)	N None		6		1			7 14	
	L Single Crack		4	8	5	6	5	28 56	
	M Multiple Cracks			2	4	4	5	15 30	
	H Mult. Cracks w/Potholes							0 0	

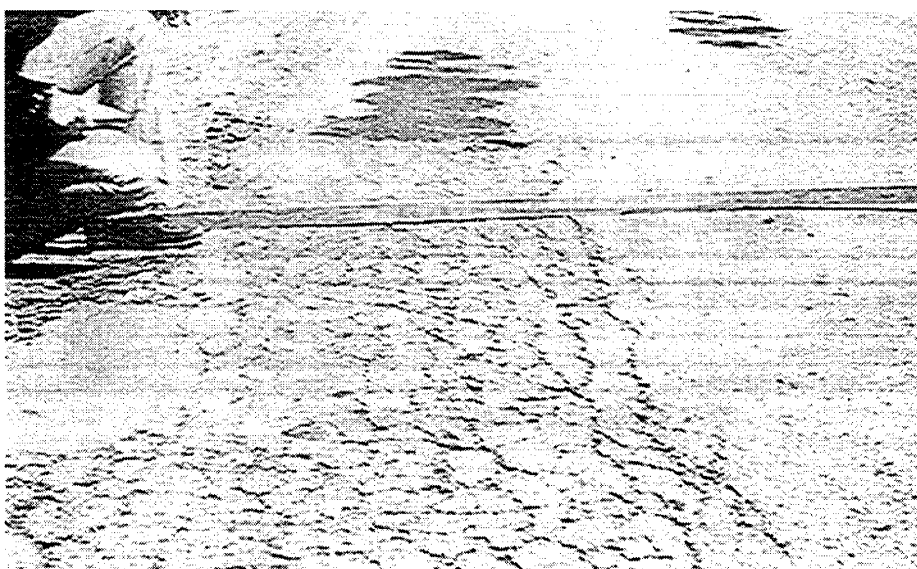
$$\% = \frac{\text{Sum of Section Percentages}}{\text{Number of Sections Evaluated}} \times 10$$



Low



Medium



High

Figure C4 - Wheelpath Cracking

FULL WIDTH TRANSVERSE CRACKING

Description: Visible fractures or separations of the pavement surface perpendicular to the pavement centerline. On overlaid pavements, these cracks can be associated with the underlying transverse contraction and/or expansion joints. They will have uniform spacing, usually 20 feet, 60 feet or 100 feet depending on the PCC pavement joint spacing design. Thermal cracks are similar on the surface in flexible pavement. (Figure C5)

Possible Causes:

1. Shrinkage due to temperature changes and/or hardening of the asphalt. (Thermal cracks)
2. Frost action.
3. Base settlement or movement.
4. Movement of the underlying concrete slab in either a horizontal or vertical direction overstresses the asphalt concrete overlay resulting in a reflection crack. Movements in the concrete slab are due to temperature fluctuations and loading.

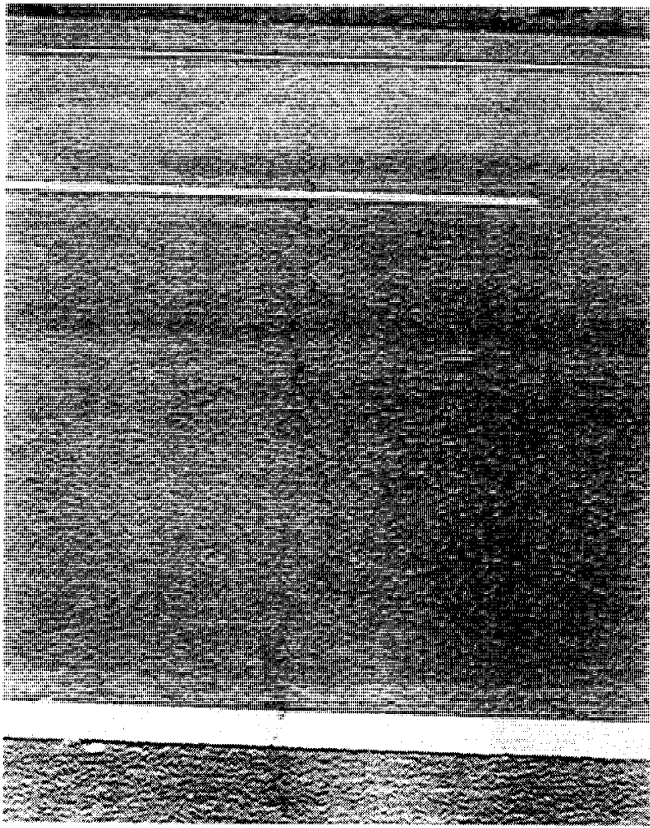
Severity Levels:

Low	Single crack. This includes a crack that is effectively sealed.
Medium	Multiple cracks that may be ravelled. This includes cracks that have been effectively sealed.
High	Multiple cracks which have pieces broken or missing (potholes).

How to Measure: Record the number of cracks occurring at each severity level within the 500 foot section.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)		
		Beginning	1000	1005	1010	1015	1020	TOTAL	
		Ending	1005	1010	1015	1020	1025	SUM %	
FULL WIDTH TRANSVERSE CRACKING (#)	N	None	✓						
	L	Single Crack		III	II			5	
	M	Multiple Cracks			IIII	IIII	IIII	14	
	H	Mult. Cracks w/Potholes				II		2	

% Calculation Not Required



Low



High

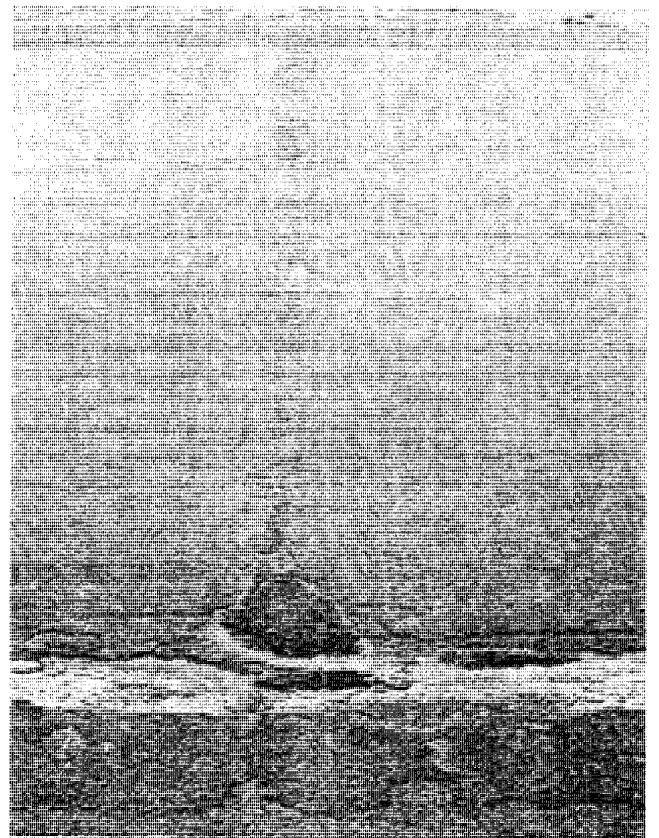


Figure C5 - Full Width Transverse Cracking

LONGITUDINAL CRACKING

Description: Visible fractures or separations of the pavement surface parallel to the pavement centerline and at least 20 feet in length. This does not include cracks in the wheelpaths (3 feet wide per wheelpath) or cracks within 1 to 2 feet of the edge of pavement. (Figure C6)

Possible Causes:

1. A poorly constructed paving lane joint.
2. Reflection cracking from an underlaying PCC joint.

Severity Levels:

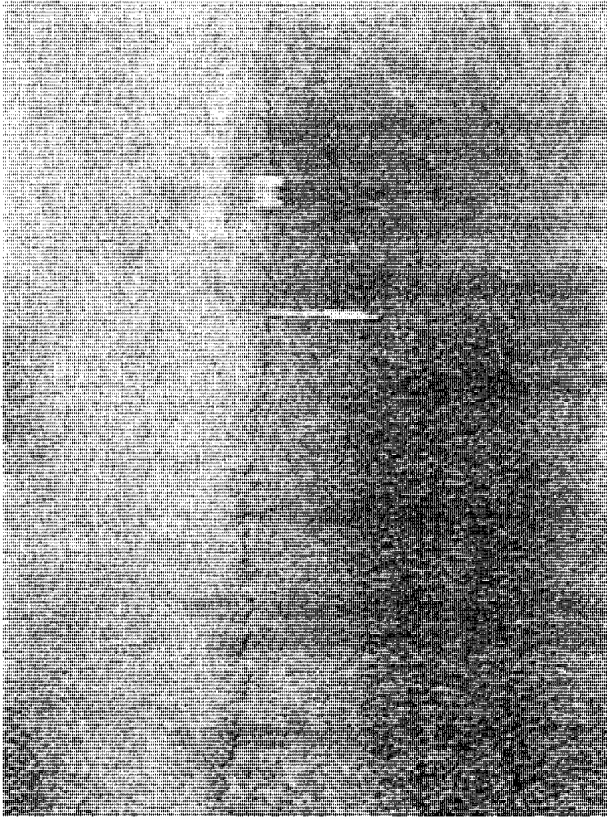
Low	Single crack. This includes cracks that are effectively sealed.
Medium	Multiple cracks that may be ravelled. This includes cracks that have been effectively sealed.
High	Multiple cracks which have pieces broken or missing (potholes).

How to Measure: Estimate the percentage of the 500 foot section affected. One crack extending the entire length would represent 100 percent.

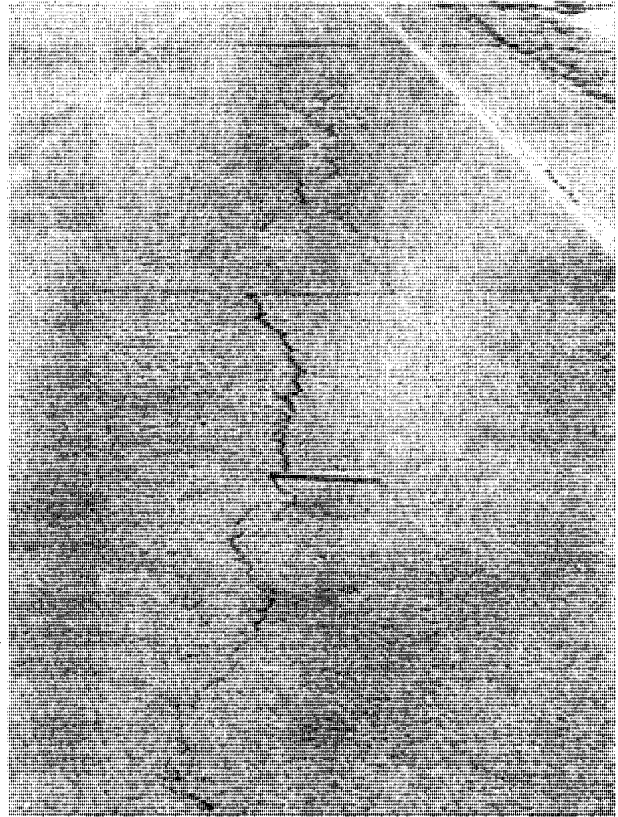
DISTRESS	SEVERITY	SECTION							EXTENT		REMARKS
		(1)	(2)	(3)	(4)	(5)					
		Beginning	1000	1005	1010	1015	1020	TOTAL			
		Ending	1005	1010	1015	1020	1025	SUM	%		

LONGITUDINAL CRACKING (%)	N	None	10	10			2	22	44	
	L	Single Crack			8	6	1	15	30	
	M	Multiple Cracks			2	4	7	13	26	
	H	Mult. Cracks w/Potholes						0	0	

$$\% = \frac{\text{Sum of Section Percentages}}{\text{Number of Sections Evaluated}} \times 10$$



Low



Medium



High

Figure C6 - Longitudinal Cracking

EDGE CRACKING

Description: These are longitudinal cracks within 1 to 2 feet of the edge of the pavement with or without transverse cracks branching towards the pavement edge. (Figure C7)

Possible Causes:

1. Lack of lateral (shoulder) support
2. Base failure
3. Frost action
4. Inadequate drainage

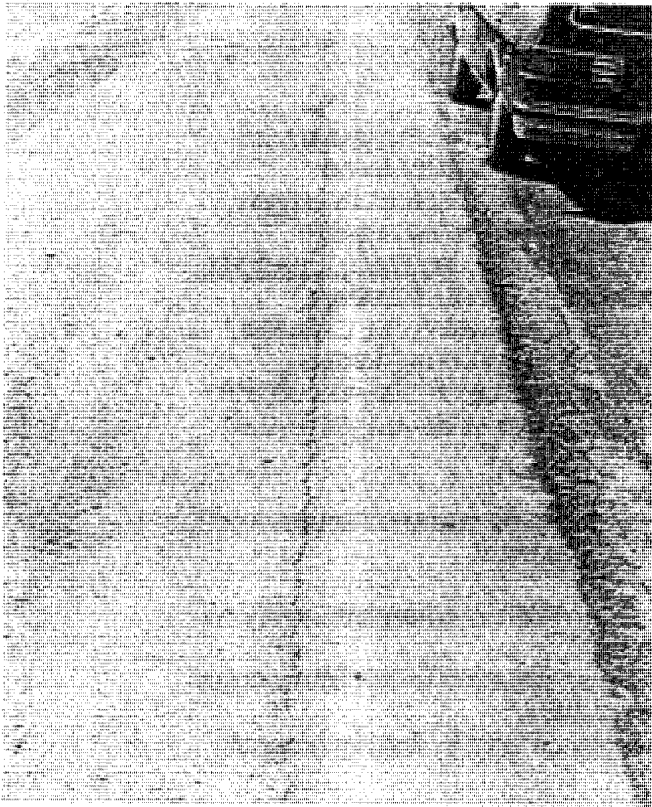
Severity Levels:

Low	Single crack. This includes cracks that are effectively sealed.
Medium	Multiple cracks that may be ravelled. This includes cracks that have been effectively sealed.
High	Multiple cracks which have pieces broken or missing (potholes).

How to Measure: Estimate the percentage of the 500 foot section affected. Rate the right-hand edge with respect to the survey direction. If significant difference in the left-hand edge exists, note under remarks.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
EDGE CRACKING (%)	N None		10	10	4	2	3	29 58	
	L Single Crack				4	8	6	18 36	
	M Multiple Cracks				2		1	3 6	
	H Mult. Cracks w/Potholes							0 0	

$$\% = \frac{\text{Sum of Section Percentages}}{\text{Number of Sections Evaluated}} \times 10$$



Low



Medium

High



Figure C7 - Edge Cracking

CRACKING (OTHER)

Description:

Visible fractures or separations of the pavement surface either Longitudinal (parallel to the pavement centerline), less than 20 feet in length; Transverse (perpendicular to the pavement centerline), less than full width, or Block Cracking (a series of interconnecting cracks forming rectangular blocks ranging in size from 1 square foot to 20 square feet). The cracking (other) category does not include cracks in the wheelpaths (3 foot areas) or within 2 feet of the edges of the pavement. (Figure C8)

Possible Causes:

1. Shrinkage due to temperature changes and/or hardening of the asphalt.
2. Frost action.
3. Settlement or movement (does not apply to Block Cracking).
4. Poor construction practice in the fabrication of pavement joints.
5. Reflective cracks caused by cracks beneath the surface.

Severity Levels:

- Low** Single crack. This includes cracks that are effectively sealed.
- Medium** Multiple cracks that may be ravelled. This includes cracks that have been effectively sealed.
- High** Multiple cracks which have pieces broken or missing (potholes).

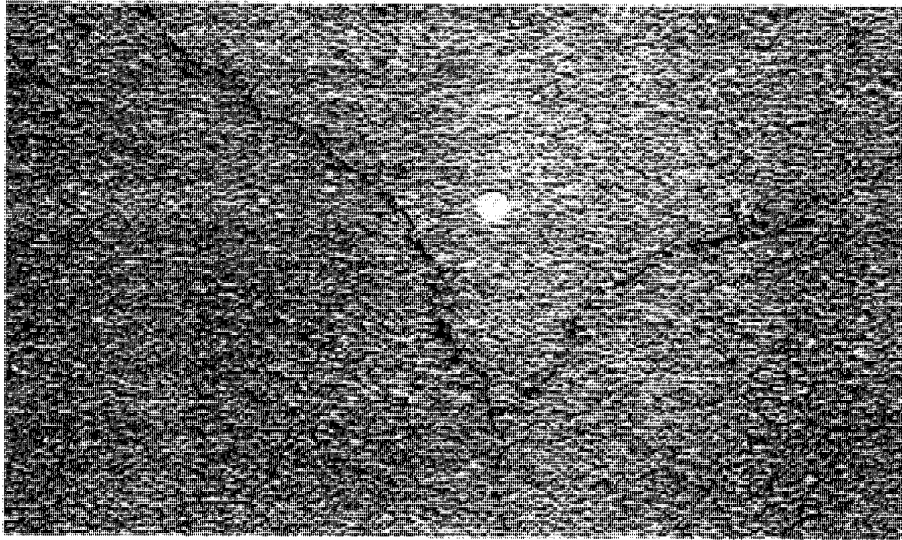
How to Measure:

Estimate the percentage of the 500 foot section affected. Measurement should be rated on the worst lane. If significant differences exist between lanes, it should be noted under remarks.

DISTRESS	SEVERITY	SECTION							EXTENT TOTAL		REMARKS
			(1)	(2)	(3)	(4)	(5)				
		Beginning	1000	1005	1010	1015	1020				
		Ending	1005	1010	1015	1020	1025				
		SUM	%								
CRACKING OTHER (%)	N	None	10	8				18	36		
	L	Single Crack		2	7	5	2	16	32		
	M	Multiple Cracks			3	4	7	14	28		
	H	Mult. Cracks w/Potholes				1	1	2	4		

$$\% = \frac{\text{Sum of Section Percentages}}{\text{Number of Sections Evaluated}} \times 10$$

Low



Medium



High



Figure C8 - Cracking (Other)

SLIPPAGE CRACKS

Description:

Slippage cracks are crescent or half-moon shaped cracks produced by vehicles breaking or turning their wheels causing the pavement surface to slide or deform. (Figure C9)

Possible Causes:

1. Poor bond between the surface and lower layer of the pavement.
2. Low stability mix can also contribute to debonding of pavement layers causing slippage cracks.

Severity Levels:

No degrees of severity are defined. Slippage cracks shall be noted whenever they are present.

How to Measure:

When slippage cracks are present note them with a checkmark.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
SLIPPAGE CRACKS ☒	N None		✓	✓		✓	✓	4 80	(3) 50' long-both
	P Present				✓			1 20	lanes-Int. Rte.4

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$

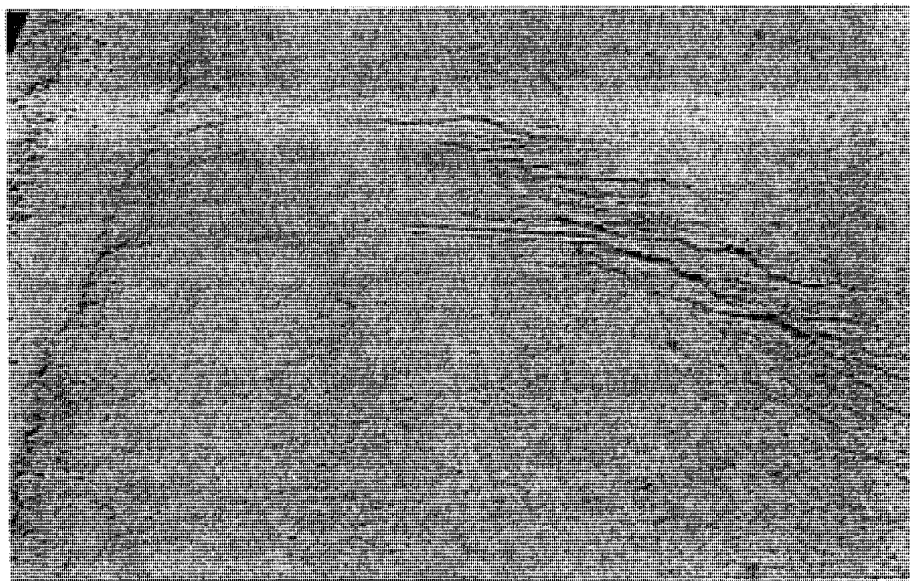


Figure C9 - Slippage Cracks

RAVELLING

Description:

Ravelling is the progressive deterioration of the pavement surface caused by the dislodging of aggregate particles. (Figure C10)

Possible Causes:

1. Poor quality mixture.
2. Traffic action on a weak surface.
3. Asphalt binder has hardened appreciably resulting in poor aggregate to asphalt adhesion.

Severity Levels:

No degrees of severity are defined. Ravelling should only be noted when there is an extensive loss of coarse aggregate.

How to Measure:

Estimate the percentage of the 500 foot section affected.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
RAVELLING (%)	N None		10	10	8	10	10	48 96	
	P Present				2			2 4	

$$\% = \frac{\text{Sum of Section Percentages}}{\text{Number of Sections Evaluated}} \times 10$$

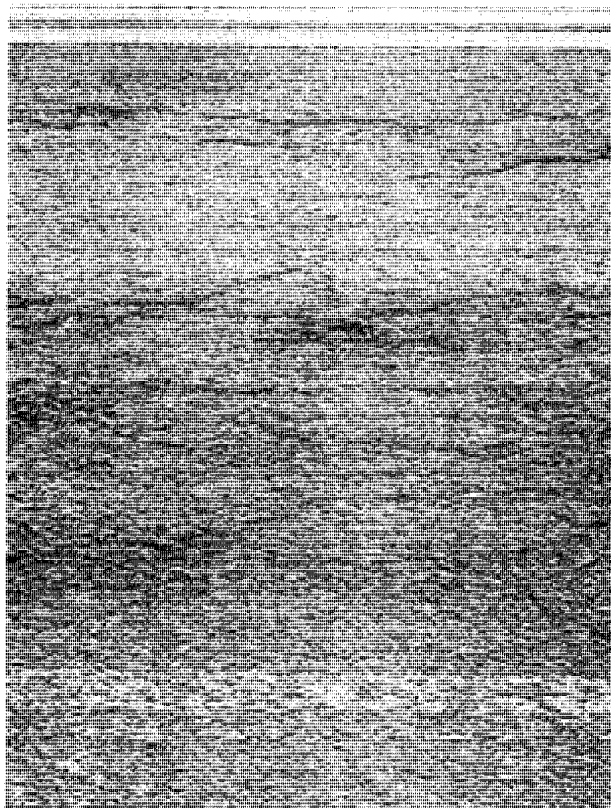


Figure C10 - Ravelling

WHEELPATH RUTTING

Description: Longitudinal surface depressions in the wheelpaths (approximately 3 feet wide per wheel path). Pavement uplift may occur along the sides of the rut. In many instances, ruts are not easily noticeable, therefore a measurement should always be taken. (Figure C11)

Possible Causes: Wheelpath rutting may be a load related failure of the pavement or merely result from pavement wear. Any one or combination of the following may result in wheelpath rutting.

1. Insufficient pavement thickness
2. Unstable base
3. Insufficient compaction during construction
4. Pavement wear or loss due to abrasive action of traffic

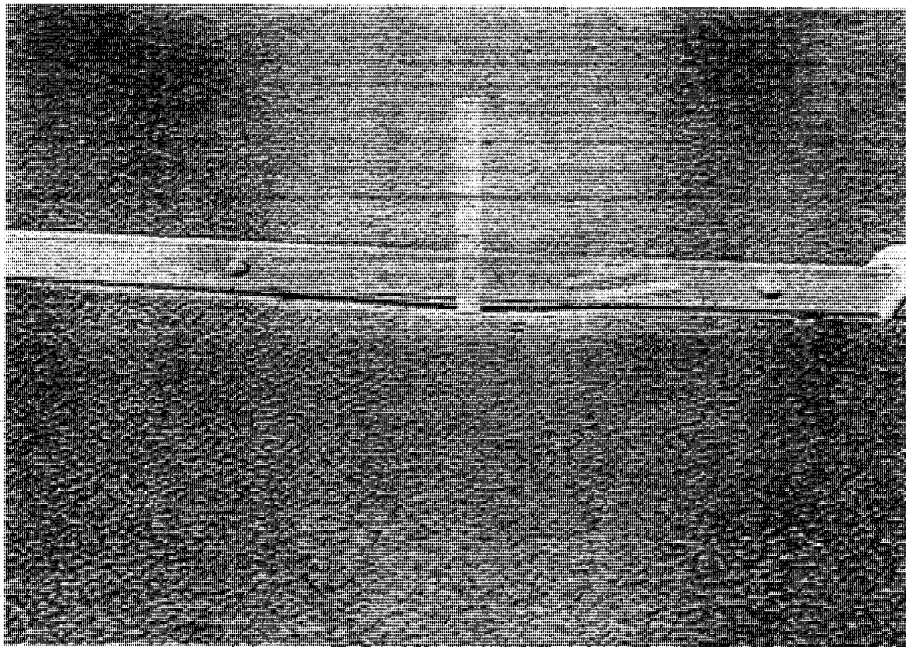
Severity Level:

Low	Average rut depth of less than 3/8 inch
Medium	Average rut depth of 3/8 - 3/4 inch
High	Average rut depth of greater than 3/4 inch

How to Measure: Measure depth to the nearest 1/8 inch, in right hand wheelpath, at one location during tenth mile detail survey. Checkmark category in which measurement falls.

DISTRESS	SEVERITY	SECTION								REMARKS
			(1)	(2)	(3)	(4)	(5)	EXTENT		
		Beginning	1000	1005	1010	1015	1020	TOTAL		
		Ending	1005	1010	1015	1020	1025	SUM	%	
WHEELPATH RUTTING (MEASURE) ☒	N	None	✓					1	20	
	L	< 3/8"		✓	✓		✓	3	60	
	M	3/8"-3/4"				✓		1	20	
	H	>3/4"						0	0	

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$



Medium

Figure C11 - Wheelpath Rutting

WIDENING DROPOFF

Description:

A widening dropoff is a difference in elevation across the longitudinal joint between the original pavement and the widening.
(Figure C12)

Possible Causes:

1. Consolidation of the widening due to traffic loadings.
2. Movement of the base underneath the widening.

Severity Levels:

Low	Dropoff is less than 3/8 inch
Medium	Dropoff is between 3/8 - 3/4 inch
High	Dropoff is greater than 3/4 inch

How to Measure:

Note presence in the 500 foot section.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
WIDENING DROPOFF (MEASURE) ☒	N None		✓	✓		✓	✓	4 80	
	L <3/8"				✓			1 20	
	M 3/8"-3/4"							0 0	
	H >3/4"							0 0	

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$

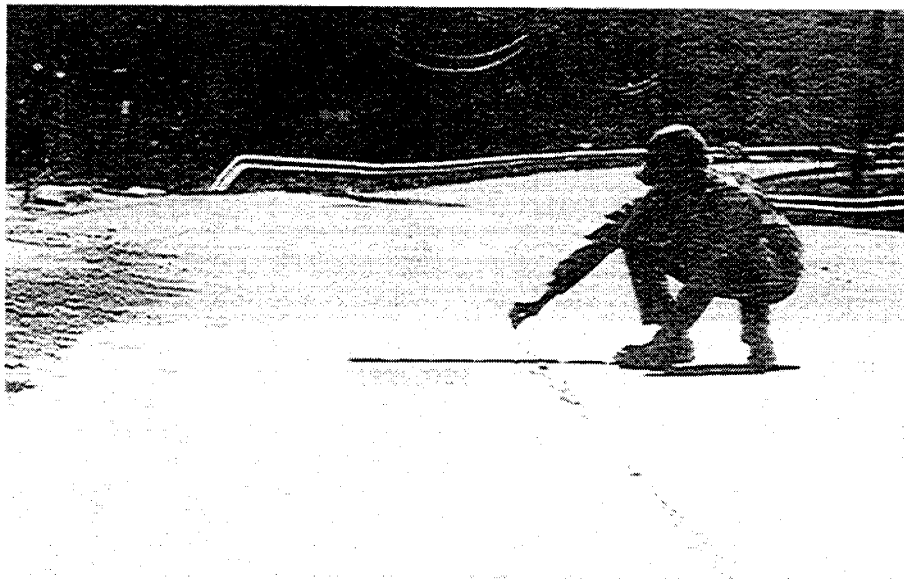


Figure C12 - Widening Dropoff

NYSDOT MATERIALS BUREAU

DISTRESS DATA FORM

Region 13 County Empire Route No. 101 Pin 1230.50 PAVEMENT FLEXIBLE ☒ FLEXIBLE/RIGID ☐
 Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction East
 Date Insp. 3/19/90 Inspectors B. Aware, D. Bond Sheet 1 of 4

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS	
			(1)	(2)	(3)	(4)	(5)	TOTAL		
		Beginning Ending	1000 1005	1005 1010	1010 1015	1015 1020	1020 1025	SUM		%
CORRUGATIONS (%)	N None		10	10	9	10	10	49	98	
	P Present				1			1	2	
SETTLEMENTS & HEAVES (#)	N None		✓		✓	✓	✓			
	P Present			II				2		
ASPHALT CONC. OVERLAY OR SPRAY PATCH (#)	N None		✓	✓		✓	✓			(3) 500' long-EB 1000' long both lanes
	G Good				II			2		
	F Fair									
	P Poor									
WHEELPATH CRACKING (%)	N None		6		1			7	14	
	L Single Crack		4	8	5	6	5	28	56	
	M Multiple Cracks			2	4	4	5	15	30	
	H Mult. Cracks w/Potholes							0	0	
FULL WIDTH TRANSVERSE CRACKING (#)	N None		✓							
	L Single Crack			III	II			5		
	M Multiple Cracks				IIII	IIII	IIII	14		
	H Mult. Cracks w/Potholes					II		2		
LONGITUDINAL CRACKING (%)	N None		10	10			2	22	44	
	L Single Crack				8	6	1	15	30	
	M Multiple Cracks				2	4	7	13	26	
	H Mult. Cracks w/Potholes							0	0	
EDGE CRACKING (%)	N None		10	10	4	2	3	29	58	
	L Single Crack				4	8	6	18	36	
	M Multiple Cracks				2		1	3	6	
	H Mult. Cracks w/Potholes							0	0	
CRACKING OTHER (%)	N None		10	8				18	36	
	L Single Crack			2	7	5	2	16	32	
	M Multiple Cracks				3	4	7	14	28	
	H Mult. Cracks w/Potholes					1	1	2	4	
SLIPPAGE CRACKS ☒	N None		✓	✓		✓	✓	4	80	(3) 50' long-both lanes-Int. Rte.4
	P Present				✓			1	20	
RAVELLING (%)	N None		10	10	8	10	10	48	96	
	P Present				2			2	4	
WHEELPATH RUTTING (MEASURE) ☒	N None		✓		✓		✓	1	20	
	L < 3/8"			✓	✓		✓	3	60	
	M 3/8"-3/4"					✓		1	20	
	H > 3/4"							0	0	
WIDENING DROPOFF (MEASURE) ☒	N None		✓	✓		✓	✓	4	80	
	L < 3/8"				✓			1	20	
	M 3/8"-3/4"							0	0	
	H > 3/4"							0	0	

SHOULDER SURVEY PERTINENT TO: BOTH ☐ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N None								
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
LANE/SOULDER SEPARATION (MEASURE) ☒	N None								
	L < 1/4"/Sealed								
	M 1/4"-1"								
	H > 1"								
LANE/SOULDER DROPOFF (MEASURE) ☒	N None								
	L < 1"								
	M 1"-2"								
	H > 2"								
SHOULDER DEFORMATION ☒	N None								
	P Present								

APPENDIX D

Distress Data Collection Procedures Shoulders

SHOULDER DETERIORATION

Description: Deterioration is characterized by surface and/or structural distress in paved shoulders only, causing cracking and/or potholes. (Figure D1)

Possible Causes: Deterioration of shoulders is generally caused by the same factors that deteriorate pavements. Refer to Wheelpath Cracking, Edge Cracking, Cracking (Other), and Ravelling.

Severity Levels:

- Low** Single crack (which may include some secondary cracking) at the pavement/shoulder joint.
- Medium** Multiple cracking at the pavement/shoulder joint and outside shoulder edge.
- High** Potholes, severe cracking over entire shoulder.

How to Measure: Generally, rate the right-hand shoulder. If a significant difference exists in left-hand shoulder, note under remarks. Checkmark the appropriate category.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
SHOULDER DETERIORATION ☒	N None		✓	✓	✓	✓		4 80	
	L Single Crack							0 0	
	M Multiple Cracks						✓	1 20	
	H Mult. Cracks w/Potholes							0 0	

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$

Low



Medium



High



Figure D1 - Shoulder Deterioration

LANE/SHOULDER SEPARATION

Description: Lane/Shoulder separation is a widening of the joint between the traffic lane and the shoulder which allows infiltration of water into the pavement and shoulder's base. (Figure D2)

Possible Causes:

1. Outward movement of the shoulder
2. Movement of the curb

Severity Levels: Severity level is determined by the width of the joint opening, or the opening between the pavement and curb.

Low Joint separation is less than 1/4 inch

Medium Joint separation is between 1/4 - 1 inch

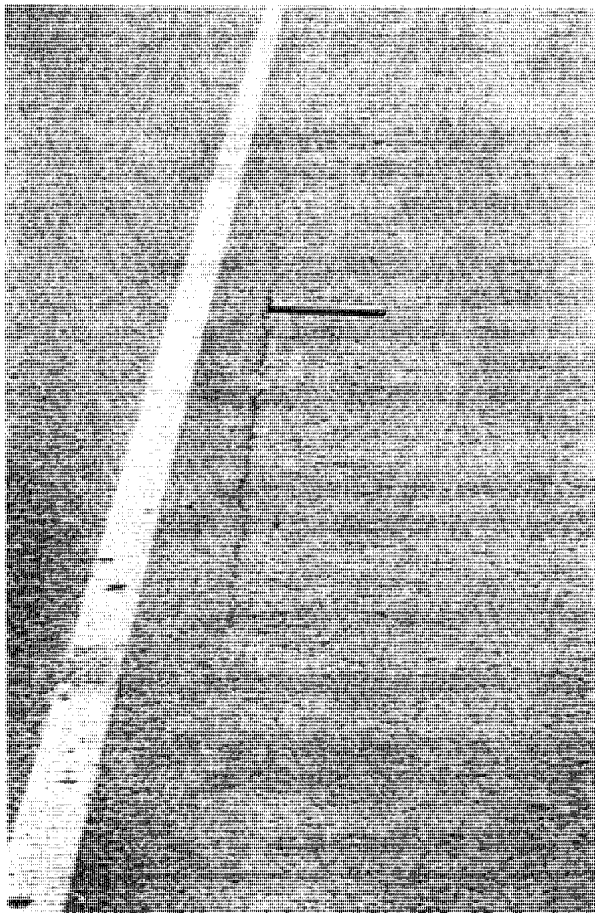
High Joint separation is greater than 1 inch

How to Measure: Generally, rate the right-hand shoulder. If a significant difference exists in left-hand shoulder, note under remarks. Checkmark the appropriate category.

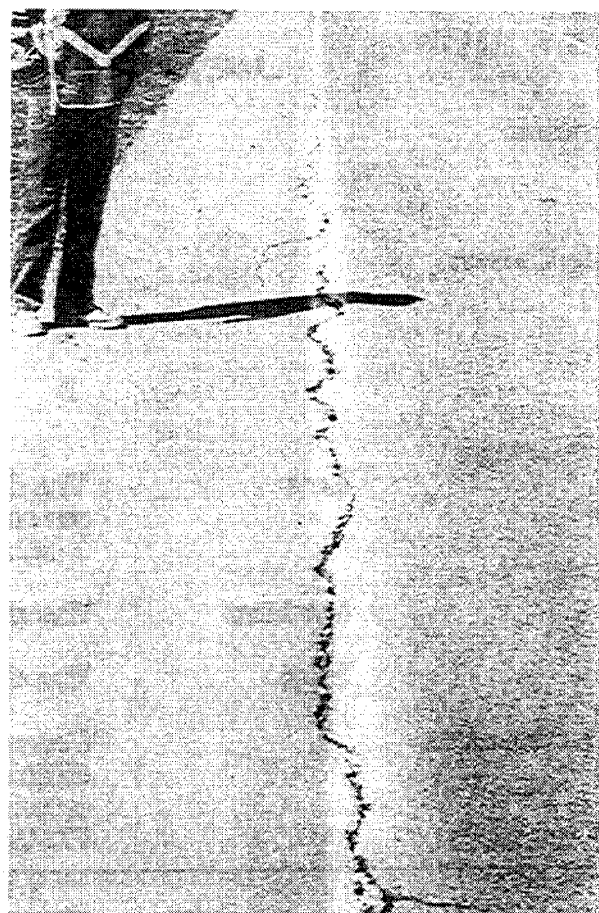
DISTRESS	SEVERITY	SECTION							EXTENT TOTAL		REMARKS
		(1)	(2)	(3)	(4)	(5)					
		Beginning	1000	1005	1010	1015	1020				
		Ending	1005	1010	1015	1020	1025	SUM	%		

LANE/SHOULDER SEPARATION (MEASURE) ☒	N	None						0	0	
	L	<1/4"/Sealed						0	0	
	M	1/4"-1"				✓	✓	2	40	
	H	>1"	✓	✓	✓			3	60	

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$



Low (AC Pavement)



High (AC Pavement)

**High
(PCC Pavement)**



Figure D2 - Lane/Shoulder Separation

LANE/SHOULDER DROPOFF

Description:

Lane/Shoulder dropoff is a difference in elevation between the pavement edge and the shoulder. (Figure D3)

Possible Causes:

1. Loss of underlying fines due to water pumping action.
2. Consolidation or settlement of the base material.
3. Loss of surface material on unpaved shoulders.

Severity Levels:

Low

The difference in elevation between the pavement edge and the shoulder is less than 1 inch.

Medium

The difference in elevation is 1 - 2 inches.

High

The difference in elevation is greater than 2 inches.

How to Measure:

Generally, rate the right-hand shoulder. If a difference exists in the left-hand shoulder, note under remarks.
Checkmark the appropriate category.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)		
		Beginning	1000	1005	1010	1015	1020	TOTAL	
		Ending	1005	1010	1015	1020	1025	SUM %	
LANE/SHOULDER DROPOFF (MEASURE) ☒	N None		✓	✓	✓			3 60	
	L < 1"							0 0	
	M 1" - 2"					✓	✓	2 40	
	H > 2"							0 0	

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$

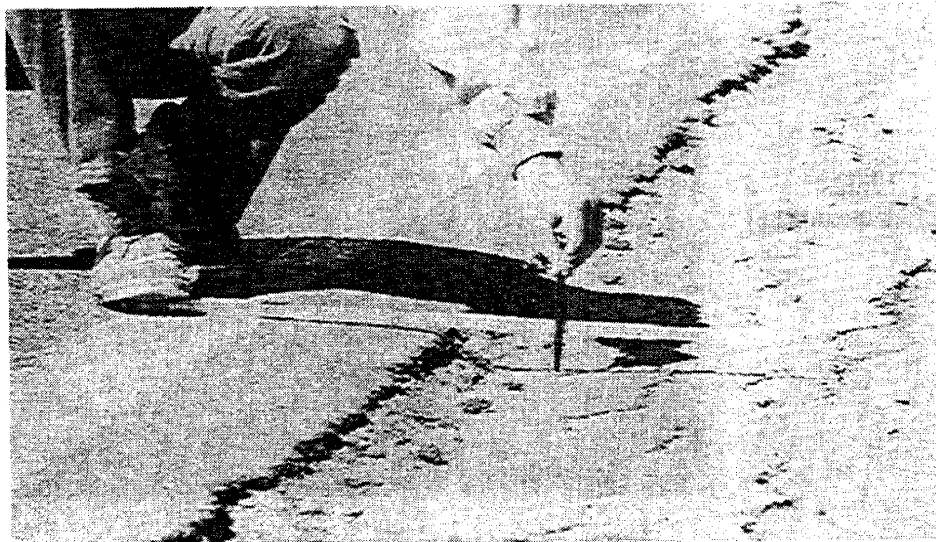


Figure D3

Lane/Shoulder Dropoff

SHOULDER DEFORMATION

Description:

Deformations are distortions in the shoulder cross section. This includes washouts, ruts, settlements, and heaves. (Figure D4)

Possible Causes:

1. Unstable base
2. Insufficient pavement thickness
3. Poor construction materials
4. Water intrusion

Severity Levels:

No degrees of severity are defined. Deformations should be noted when it is extensive enough to warrant complete shoulder rehabilitation.

How to Measure:

Generally, rate the righthand shoulder. If a difference exists in the lefthand shoulder, note under remarks. Checkmark the appropriate category.

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
			(1)	(2)	(3)	(4)	(5)	TOTAL	
		Beginning	1000	1005	1010	1015	1020		
		Ending	1005	1010	1015	1020	1025	SUM %	
SHOULDER DEFORMATION ☒	N None		✓	✓		✓	✓	4 80	
	P Present				✓			1 20	

$$\% = \frac{\text{Sum of Checkmarks}}{\text{Number of Sections Evaluated}} \times 100$$



Figure D4 - Shoulder Deformation

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N	None	✓	✓	✓	✓		4	80
	L	Single Crack						0	0
	M	Multiple Cracks					✓	1	20
	H	Mult. Cracks w/Potholes						0	0
LANE/SHOULDER SEPARATION (MEASURE) ☒	N	None						0	0
	L	< 1/4" / Sealed						0	0
	M	1/4" - 1"				✓	✓	2	40
	H	> 1"	✓	✓	✓			3	60
LANE/SHOULDER DROPOFF (MEASURE) ☒	N	None	✓	✓	✓			3	60
	L	< 1"						0	0
	M	1" - 2"				✓	✓	2	40
	H	> 2"						0	0
SHOULDER DEFORMATION ☒	N	None	✓	✓		✓	✓	4	80
	P	Present			✓			1	20

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 3 Project Development Process (Limited Revisions)

Revision 3

January 23, 2009

CHANGES TO CHAPTER 3

<u>Pages</u>	<u>Changes</u>
Contents	First page, title changed and number correction for Section 3.5, References. Second page, Appendix 3C now vacant. Third page, List of Figures and Tables included
3-7	Table 3-1, Preventive and Corrective Treatments (Single Course): added 2R under 'Safety Problem?', and 1R under 'Program./Project Type'. Table 3-1, Preventive and Corrective Treatments (Multiple Course) 2 nd row: removed references to SAFETRAK. Table 3-1, Reconstruction Treatments: added 4R under 'Program./Project Type'.
3-22	Section 3.3.2.2. Deleted references to SAFETRAK; added reference to EI 01-031.
3-25	Section 3.5. Corrected heading.

7/02/02

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Appendix 3B - Programmatic Quality Assurance Pavement Rehabilitation Treatment Selection Process, August 1994

Appendix 3C - Vacant (See HDM Ch 7)

Appendix 3D - Vacant (See HDM Ch 7)

Appendix 3E - Vacant (See HDM Ch 7)

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3.1 INTRODUCTION

This chapter references the manuals that contain the required procedures and documentation for the design of NYSDOT projects containing pavement work. Table 3-1, "NYSDOT Pavement Project Processing Summary," shows the relationships among pavement treatments, funding, processing, and implementation.

Most pertinent to a pavement project, the *Scoping Procedure Manual* (SPM) and the *Design Procedure Manual* (DPM) describe the steps that should be followed to produce a Scope Closure Document and Design Approval Document, obtain Design Approval, and continue processing a project through Plans, Specifications, and Estimate (PS&E).

Note that a project may include several pavement treatments and types. Therefore, multiple sections of this chapter and manual as well as the *Highway Design Manual* (HDM) may apply. For example, a project may include three different treatment segments:

- 0.5 km of pavement rehabilitation work using the 3R requirements in HDM, Chapter 7, Section 7.3, and Section 3.3.2 and Chapter 5 of this manual,
- 0.9 km of single course overlay using the 1R requirements in Section 3.3.2, Appendix 3D and Chapter 10 of this manual, and
- 1.8 km of pavement reconstruction using the reconstruction requirements in HDM, Chapter 2, and Chapters 2, 4, 5, and Section 3.3.1 of this manual.

When progressing projects with multiple pavement treatments, a single design approval document should be used by following the most stringent documentation requirements (e.g., Use a full design report rather than a full design report and an SSM/FDR. The DPM discusses the various types of design approval documents and their applicability.)

This chapter includes the project-level pavement treatment and type selection process, which describes specific procedures and identifies when further documentation is required (e.g., a Pavement Evaluation Treatment Selection Report (PETSR) and/or a Pavement Type Selection Analysis).

This chapter also discusses the requirements and guidance for single course overlays/inlays, pavement maintenance work, and short rigid or multicourse pavement work.

3.2 PROJECT DEVELOPMENT PROCESS OVERVIEW

Figure 3-1 illustrates the basic NYSDOT project development process. This process consists of four stages: Initiation, Scoping, Design, and Construction. A pavement design engineer may be involved in any of the first three stages from initiation through design. Brief descriptions of these stages are given below.

3.2.1 Project Initiation Stage

The Initial Project Proposal (IPP) is the initial planning and programming document by which projects are selected to achieve program goals. The IPP provides preliminary identification of a project's problems, the project objectives, the project elements to be investigated, schedule, and cost estimates. Upon approval of the IPP by the Regional Director, the project is ready from a program perspective to enter the scoping stage.

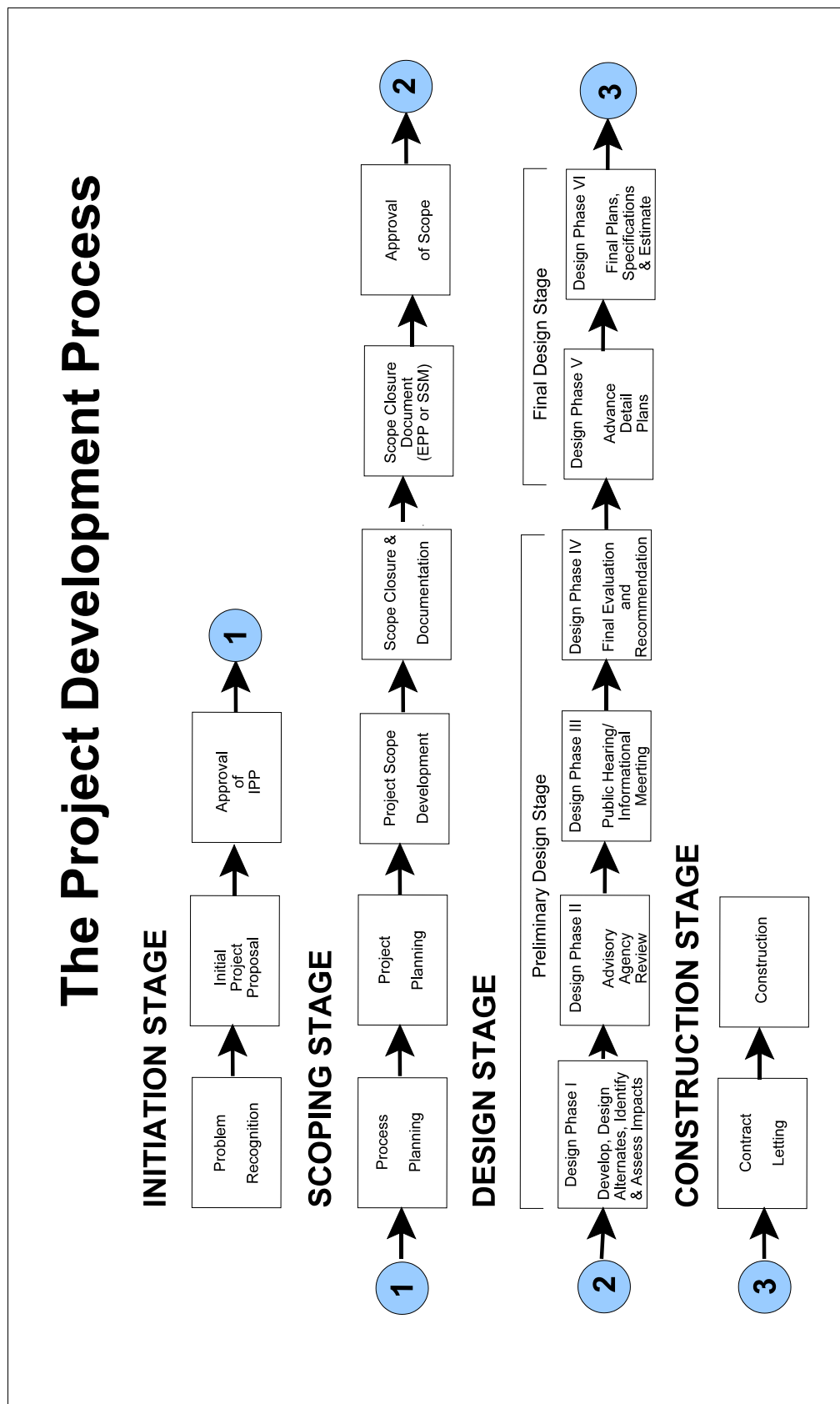
3.2.2 Scoping Stage

The purpose of the Scoping Stage is to identify the most likely solution(s) to the problems identified in the IPP and during the Scoping Stage. Figure 3-1 shows the sequence of work performed during this stage. Compliance with the *Scoping Procedure Manual* (SPM) is essential in order to efficiently define a project's scope and develop a scope closure document. The purpose of scoping is accomplished by the following basic activities:

- 1) Inventory existing conditions including doing a pavement evaluation and analysis
- 2) Identify future no-action conditions by doing traffic forecasting and analysis
- 3) Identify needs and problems
- 4) Define project objectives
- 5) Establish design criteria
- 6) Develop feasible alternative solutions to a planning-level of detail
- 7) Develop reasonable cost estimates
- 8) Identify social, economic, and environmental considerations, and possible impacts
- 9) Screen and identify feasible alternative solutions and reach a consensus

The minimum requirements for each project will vary depending on the level of pavement deterioration, accident history, capacity problems, etc. Appendix A, Guidelines for Preparing Expanded Project Proposals, of the SPM, includes procedures and guidelines to produce documentation (a scope closure document) for the Scoping Stage, in the form of either a Scope Summary Memorandum (SSM) or an Expanded Project Proposal (EPP). A detailed description of Project Identification (project type, project location/description, etc.), Project Evolution, Project Condition and Needs, and Project Objectives is given in Part III, Chapter II of Appendix A of the SPM.

Figure 3 - 1 The Project Development Process



The Project Condition and Needs section of Chapter II, Appendix A of the SPM also includes a section on Pavement and Shoulder Conditions. This section of a scope closure document summarizes the results of the Condition Report if one is required by Section 3.3.1 of this manual and the *Pavement Rehabilitation Manual - Volume I: Pavement Evaluation* (PRM, Vol.1) in Appendix 2A of this manual. The actual Condition Report should be included in the appendix of the scope closure document as a part of the Pavement Evaluation and Treatment Selection Report (PETSRS).

SPM, Appendix A, Part III, Chapter III, Alternatives discusses Design Criteria, Alternatives Considered, Feasible Alternative(s), and Project Cost and Estimates.

The design criteria established during the scoping stage guides the designer for subsequent design of proposed structures. The design criteria for the following critical design elements, as applicable, should be listed for new construction and reconstruction projects, 3R projects on the interstate and other freeways, and intersection improvement projects:

1. Design speed
2. Minimum lane width
3. Minimum shoulder width
4. Maximum grade
5. Maximum degree of curvature and maximum superelevation rate
6. Minimum stopping sight distance
7. Minimum lateral clearance
8. Minimum vertical clearance
9. Maximum pavement cross slope and rollover (between lanes and at pavement edge)
10. Minimum structural capacity
11. Level of Service (for interstate only)
12. Control of access (for interstate and other freeways only).

For further guidance on establishing design criteria refer to the *Highway Design Manual* (HDM), Chapter 2, Design Criteria.

SPM, Appendix A, Part III, Chapter III, Engineering Considerations of Alternative(s) also includes a section on Pavement. This section of a scope closure document summarizes the discussions and recommendations presented in the PETSRS and/or Pavement Type Selection Analysis, if one is required by Section 3.3.1 of this manual and the *Pavement Rehabilitation Manual - Volume II: Treatment Selection* (PRM, Vol.2) in Appendix 5A of this manual. If the project is not covered under Section 3.3.1 of this manual, a brief description of the proposed pavement rehabilitation treatment and/or pavement type is sufficient. Discuss pavement life cycle alternatives as required.

3.2.3 Design Stage

As shown in Figure 3-1, the Design Stage of a project consists of six design phases. The first four design phases make up the Preliminary Design Stage of a project and the last two design phases

make up the Final (or Detailed) Design Stage. NYSDOT's *Design Procedure Manual* (DPM) describes all these stages, including how to hold a public hearing or meeting, and what the format and content should be for a design approval document. The DPM ensures that NYSDOT projects are processed according to the appropriate policies, procedures and regulations.

Appendix B of the (DPM) discusses the format and content of design approval documents. Three parts of the format and content sections of a typical design approval document (Chapter II - Project Identification, Evolution, Condition and Needs, and Objectives; Chapter III - Alternatives; and the Technical Appendices) contain instructions on including pavement and shoulder conditions and engineering considerations of feasible design alternative(s). The design approval document is used to obtain Design Approval of the preferred treatment alternative (which will be advanced into detailed design) from the feasible treatment alternatives identified in the scoping document.

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3.3 PAVEMENT TREATMENT AND TYPE SELECTION PROCESS

Section 3.3 of the CPDM illustrates how Chapter 2 (Evaluation of Existing Pavements), Chapter 4 (New Construction/Reconstruction) and Chapter 5 (Rehabilitation) of the CPDM fit in with the Department's Pavement Management System (PMS). This Pavement Treatment and Type Selection Process is an essential element of the Department's PMS. The PMS includes standard processes for: network and project-level condition rating, project selection, pavement design, life cycle costing, selection of a treatment strategy and performance monitoring.

Table 3-1 "NYSDOT Pavement Project Processing Summary" shows the relationships among pavement treatment (with the pertinent CPDM chapter), funding, processing and implementation. It can be used as a guide or signpost to point the pavement designer in the right direction to find the applicable pavement treatment guidance (CPDM chapter), design process (DPM and CPDM), design standards (HDM and others) and implementation procedures.

Throughout this chapter additional guidance, such as the next paragraph, is labeled as **ADDITIONAL GUIDANCE** and italicized.

ADDITIONAL GUIDANCE: *The reader is referred to the PRM, Vol.2 (CPDM Chapter 5, Appendix 5A) for definitions of technical terms used in this section such as: pavement rehabilitation, pavement reconstruction, life cycle cost analysis, service life, analysis period, future treatment strategy time lines, etc. Definitions of terms related to the Scoping Stage of project development (e.g. Initial Project Proposal and Expanded Project Proposal) can be found in the NYSDOT Scoping Procedure Manual, while definitions of terms related to the Design Stage of project development (e.g., design approval document and Scope Summary Memorandum/Final Design Report) can be found in the NYSDOT Design Procedure Manual.*

3.3.1 Rigid or Multicourse Pavement Work Over 1.5 km

This section describes the process to be used (from the scoping stage to the final design stage) in selecting the pavement rehabilitation treatments and/or pavement type when designing rigid or multicourse pavement work over 1.5 km in length with pavement thicknesses greater than 50 mm. It describes specific design procedures and identifies when further documentation is required. (e.g., a *Pavement Evaluation Treatment Selection Report* (PETSr) and/or a *Pavement Type Selection Report*.)

This section lists the process steps to be followed in selection of a pavement treatment strategy. (i.e., the sequence of pavement rehabilitation treatments and/or pavement type when designing projects) The sequence includes the initial treatment as well as the necessary follow-up work over the analysis period of the pavement. Treatment selection shall emphasize lowest life cycle cost, but other factors such as: traffic, drainage characteristics, soil conditions, the environment, and design or construction constraints (e.g. bridge clearance or guide rail height) may contribute to the decision. Also, there are circumstances under which the pavement designer should consider

Table 3-1 NYSDOT Pavement Project Processing Summary (1/23/2009)

Pavement Treatment Based on CPDM (CPDM Chapter)	Federal- Aid or 100% State Funds	Safety Problem ?	Program/ Project Type	Work Type from Project & Program Mgmt. Info. System (PPMIS)	Process/ Procedures In Addition to CPDM Chapter 3	Primary Standards	Implementation *
Preventive Treatments (e.g., Joint filling/ Crack Sealing, and other nonoverlay** maintenance) (Chap. 3.3.2 & 10)	Federal-Aid or 100% State	N/A	Preventive Maintenance	Preventive Maintenance	Element-Specific (see PDM Appendix 7 and Pavement Preventive Maintenance Projects Second Working Draft	CPDM	Contract (see HDM Chap 21), State Forces, or Vendor in Place Paving (VPP)
Preventive and Corrective Treatments (e.g., Single Course Overlay**) (Chap. 3.3.2 & 10)	Federal-Aid or 100% State	Address with 1R (CPDM App. 3D), or progress a 3R, or Reconst. project	Preventive Maintenance (1R)	Preventive Maintenance (single course overlay), and Corrective Maintenance (hot in-place recycling 40 mm)	Element-Specific HDM Ch 7, PDM Appendix 7 and Pavement Preventive Maintenance Projects Second Working Draft	HDM Chapter 7	Contract (see HDM Chap 21), or VPP
Rehabilitation Treatments (e.g., Multicourse Overlay**) (Chap. 3.3.1 & 5)	Federal-Aid or 100% State	Yes or No	2R or 3R	Rehabilitation	PDM and HDM Ch 7	HDM Chapter 7	Contract (see HDM Chap 21)
Reconstruction Treatments (e.g., New Const. or Reconstruction) (Chap. 3.3.1, 4 & 5)	Federal-Aid or 100% State	Yes or No	New Construction or Reconstruction (4R)	New Construction and Reconstruction	PDM	HDM Chapter 2	Contract (see HDM Chap 21)

Notes: * State Forces can perform safety work (e.g., guide rail, signing, delineation, pavement markings, etc.), however, State Force work is not eligible for Federal-aid.

** "Mill and fill", hot in-place recycling and cold in-place recycling may also apply.

selecting a rehabilitation treatment or pavement type with the longest service life, or reconstruction, instead of a rehabilitation treatment with the minimum life cycle cost. These circumstances are discussed further in:

- The guidance following Step 7 in Section 3.3.1.2, Process Steps;
- In Section 3.3.1.3, Pavement Reconstruction Warrants; and
- In Appendix 3A.1, The AASHTO Pavement Type Selection Guidelines.

3.3.1.1 Applicability

Section 3.3.1 applies to the majority of projects, regardless of funding, that include rehabilitated, reconstructed or new pavement which meet the minimum thresholds below. However, this section does not apply to preventive maintenance work done by Department forces or preventive maintenance by contract projects such as Hot Mix Asphalt (HMA) single course overlays (50 mm maximum thickness), crack filling, and joint repairs. Process requirements for these projects are given in other sections of the CPDM (e.g., Section 3.3.2 and Chapter 10). It is important to note, however, that more extensive pavement maintenance projects (e.g., resurfacing projects with a pavement thickness greater than 50 mm) that also meet the thresholds described below, shall follow the process in this section. Applicability of Section 3.3.1 varies depending on the type of project, as shown below and in the flowchart, Appendix 3A.2, Figure 1, titled "Pavement Process (Section 3.3.1), Applicability - Major Process Requirements, and Minimum Service Life Requirements".

A. Applicability and Minimum Service Life Requirements for Pavement Rehabilitation/Reconstruction Projects

The requirements of this section apply to all pavement rehabilitation/reconstruction projects, including resurfacing projects greater than 50 mm thickness, on Rural Arterials and Urban Principal Arterials under NYSDOT jurisdiction (both Federal and State funded) that meet any of the following conditions:

- are more than 1.5 km long, excluding bridge length.
- include ramps where the sum of full width ramp length is greater than 1.5 km, excluding bridge length.
- have more than 1.5 km of work along one or both roadways of an intersection or interchange, excluding bridge length.

The 1.5 km lengths exclude bridge length. Routes classified as Rural Arterials include Interstates, other Principal Arterials, and Minor Arterials. Routes classified as Urban

Principal Arterials include Interstates, other Freeways and Expressways, and other Principal Arterials.

This section also establishes minimum service life requirements for pavement rehabilitation/reconstruction treatments. The minimum service life requirements are set forth below, and illustrated in Appendix 3A.2, Figure 1. These minimum service lives are not meant to override other Department policies that require a longer design life for a particular type of project. For example, the anticipated service lives given in the SPM, Appendix D, Design Traffic Forecast Policy, or the requirement given in Article 7, Section 12 of the State Constitution, that the period of a bond (currently 10 years) not exceed the probable life of the project being bonded, are not affected by this section.

Except for rural minor arterials, a minimum 8-year rehabilitation service life is required for these projects unless an exception is approved by the Regional Director prior to, or simultaneously with (when appropriate), Design Approval. Rural Minor Arterials have a minimum 5-year rehabilitation service life with no exceptions allowed.

ADDITIONAL GUIDANCE: *The above requirements only pertain to roadways under NYSDOT jurisdiction. However, any project using Federal-aid and meeting the thresholds above, regardless of jurisdiction, must meet the same service life requirements. Federal-aid pavement rehabilitation projects on highway classes not listed above must meet a minimum 5-year service life. Exceptions to the 8 year service life must be obtained from the Regional Director prior to or simultaneously with (when appropriate) Design Approval. There are no provisions for exceptions to a 5-year service life.*

B. Applicability of New/Reconstructed Pavement Projects

The Pavement Type Selection Analysis part of this process applies to the following types of projects on **all classes of highways regardless of jurisdiction**:

- All new/reconstructed pavement projects that are more than 1.5 continuous centerline kilometers long, excluding bridge length.
- Intersection/interchange projects where the length of new/reconstructed pavement along either roadway exceeds 1.5 km, excluding bridge length.
- Pavement widening projects where the widening involves adding one or more full lanes and the length of the widened section exceeds 1.5 km, excluding bridge length.

A Pavement Type Selection Analysis is not required for new/reconstructed ramps with design speeds less than 80 km/hr using conventional pavement design, since the ramp paving material is specified in HDM Section 6.04.06 and Section 4.4 of this manual.

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ADDITIONAL GUIDANCE: *Reconstruction is intentionally listed under both parts A and B of this section. The reason for this is that reconstruction is considered to be the ultimate rehabilitation treatment so it falls under the rehabilitation part of this process. However, since reconstruction involves new full depth pavement, a pavement type analysis (to compare asphalt and concrete) is also required similar to a new pavement.*

3.3.1.2 Process Steps

This section describes the steps in a pavement project covered by this section from the project scoping stage through to PS&E. Figure 2 (CPDM Appendix 3A.3) is a process flow chart which illustrates these steps. The intent of this section is to show where these pavement process steps fit into the existing Department design process. A description of the steps and responsibility for the steps is shown below.

It should be noted that while the Project Developer, usually Region Planning or Design, may be responsible for progressing the scope closure document (i.e., a Scope Summary Memorandum (SSM) or Expanded Project Proposal (EPP)), it is recommended, but not required, that the pavement evaluation, treatment selection, and treatment strategies be completed by the Regional Technical Services (RTS) Group, and the life cycle cost analysis and final treatment selection be completed by Design. This is recommended because in most Regions Technical Services has the pavement evaluation expertise, while Design is most familiar with and able to incorporate the effect a treatment would have on a project (e.g., a thick overlay may cause guide rail adjustment or bridge clearance problems increasing the costs of certain treatments). However, the actual assignment of these and other job responsibilities are left to the Regional Director. Other alternatives might include a team approach headed by the Project Developer or assignment of many of these tasks to a Pavement Management Group.

The Region, after selecting a project involving pavement for contract work using the Department's PMS network level conclusions and recommendations, input from Transportation Maintenance, Regional Planning, Program Management, and other sources, initiates the project via an IPP. Then the Project Developer/Designer incorporates the following steps into the Department's normal project development process (contained in the *Scoping Procedure Manual* (SPM) and *Design Procedure Manual* (DPM)).

A. Scoping

Steps (The step numbers are the same as shown in the Project-Level Pavement Design Process flowchart in Appendix 3A.3 of this manual.)

1. Project Developer and Designer

Make a preliminary field review of the project and consult and collaborate with Regional Technical Services, the Regional Pavement Management Group, or other group designated by the Regional Director. Based on field review, consultation, and the

CPDM, determine whether or not the project is a pavement rehabilitation/ reconstruction project that requires a pavement evaluation.

ADDITIONAL GUIDANCE: *A pavement evaluation is generally not required when reconstruction is necessary for reasons other than pavement distress (e.g., a realignment project). However, RTS should still provide a statement with the recommended treatment/ pavement type and future work strategy time line for all viable alternatives to the designer in process step 4. This information is still needed to enable the designer to prepare the life cycle cost analysis, to enable RTS to complete the "Pavement Evaluation and Treatment Selection Report", and for future use in a pavement treatment "tickler" file.*

2. Project Developer

If project meets the thresholds in the CPDM Section 3.3.1.1, requests pavement evaluation from RTS.

ADDITIONAL GUIDANCE: *A draft Pavement Evaluation and Treatment Selection Report is required for a pavement rehabilitation/reconstruction project that meets the applicability criteria in Section 3.3.1.1 before approval of the SSM or EPP.*

3. RTS

Collects data on pavement and shoulder distress, drainage, and subbase condition in accordance with PRM, Vol. 1 (in Appendix 2A of the CPDM) and prepares an inventory of distresses, as described in that volume.

4. RTS

Analyzes, compiles and interprets the distress data. The appropriate treatment(s) are then chosen from the PRM, Vol. 2 (in Appendix 5A of the CPDM), the traffic is checked, service lives determined, a future work strategy is constructed for each treatment and a written statement is prepared for the designer or the Regional Pavement Management Group containing the recommended treatment(s) and the rationale behind the recommendation. (See Process Step 12 in regard to matching treatment service lives to road history.)

Care should be taken in the determination of the Expected Service Lives (ESL) of the treatment(s) in the future work strategy. The ESL given in PRM, Vol. 2 are appropriate for highways with Average Annual Daily Traffic (AADT) counts of 12,000 to 35,000 with about 5% trucks. The ESL needs to be adjusted for highways with traffic outside these limits. Pages 7 and 8 of PRM, Vol. 2 provide guidance on the adjustment of the ESL. If the adjusted ESL is less than the minimum 8 years (requiring an exception approval in process Step 12), a different

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treatment with an adjusted ESL greater than, or equal to, 8 years should be considered.

ADDITIONAL GUIDANCE: *All pavement rehabilitation/reconstruction projects covered under this section are required to have a distress survey (see Additional Guidance under process Step 1 for exceptions to this requirement) conducted in accordance with the current edition of the PRM, Vol. 1 and one or more treatments with a future work strategy selected from the PRM, Vol. 2 that are appropriate for the pavement condition. However, alternative treatments, one of which must be reconstruction, and a life cycle cost analysis (LCCA) to compare treatments per PRM, Vol. 2, are only required under the following conditions:*

Conditions Requiring: Alternative Treatments, One of Which must Be Reconstruction, and a Life Cycle Cost Analysis (LCCA)

a. *Alternative treatments, one of which is reconstruction, are required when the initial treatment selection and treatment strategy involve:*

- *Treatments with large amounts of costly preparation work.*
- *Treatments with thick overlays which require changes in adjacent features such as curb, median barrier, drainage structures, and structures.*
- *Treatments whose future work strategies require frequent maintenance and future rehabilitation work.*

Comparison of reconstruction with the above types of treatments may not result in reconstruction being a cost-effective treatment. However, Section 3.3.1.3 Pavement Reconstruction Warrants contains guidance on when to select the reconstruction alternative, even if it is not the treatment with the lowest life cycle cost.

b. *The reconstruction alternatives should always be considered as a possibility in the Life Cycle Cost Analysis. The costs of reconstruction using both hot mix asphalt and portland cement concrete and their future work strategies should be compiled in each Region and used as a reference. These costs will be relatively constant, may be updated easily and used in many projects' analyses.*

c. *A Life Cycle Cost Analysis is required:*

- *When two or more alternate treatments with their future work strategies are selected.*
- *As part of the Pavement Type Selection Analysis when the recommended treatment is reconstruction.*

d. A Life Cycle Cost Analysis is not required for rehabilitation treatment comparison when:

- Only one treatment is appropriate (e.g., preventive maintenance).
- Reconstruction is necessary for reasons other than pavement distress, such as radical realignment or capacity improvements. (However, an LCCA and construction of future work strategy time lines are still required for pavement type comparison as part of the Pavement Type Selection Analysis.)

5. Designer

Reviews pavement evaluation and prepares the preliminary cost estimate for each alternative treatment strategy using the Preliminary Estimate Program (PEP) or the Price Estimating System (PES) or other acceptable method from the PRM, Vol. 2.

6. Designer

Identifies other factors affecting treatments and/or pavement types and performs an LCCA of alternative strategies using the economic analysis method shown in the PRM, Vol. 2.

ADDITIONAL GUIDANCE: *If the recommended treatment is reconstruction, a preliminary pavement type shall be selected during the scoping stage based on the LCCA. The Pavement Type Selection Analysis is not completed until the Preliminary Design Stage. An LCCA is also required at this stage for new construction to assist in the selection of a preliminary pavement type. Step 9 (below) includes additional guidance in performing the LCCA for new/reconstructed pavement projects.*

7. Designer

Completes draft of the "Pavement Evaluation and Treatment Selection Report" (PETSr) in accordance with the PRM, Vol. 2 incorporating:

- RTSs statement from process step 4;
- Other factors that may influence the decision (e.g., guide rail height, subbase problems, drainage problems, bridge clearance, constructibility, maintenance and protection of traffic, nighttime construction, pavement problems related to geometrics (e.g., grades, intersections), etc.);
- The time line(s) showing the future work strategy for all viable treatment/pavement type alternatives;
- The LCCA (if appropriate); and

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- The recommended treatment/pavement type to be used in subsequent estimates of the pavement costs for the project.

ADDITIONAL GUIDANCE: *The objective of the pavement design process is to select a pavement type and/or pavement treatment and a future treatment strategy as described in PRM, Vol. 2 which results in the wisest use of funds. On the other hand, there are circumstances under which the Region should consider selecting a rehabilitation treatment or pavement type with the longest service life instead of the minimum life cycle cost.*

Factors to Consider In Selecting a Pavement Treatment/Type With the Longest Service Life Instead of the Lowest Life Cycle Cost

- ***When the AADT exceeds 35,000 vehicles. PRM, Vol. 2 is based on research and experience with highways having an AADT in the range of 12,000-35,000. Therefore, when evaluating a facility with a greater volume of traffic, and the strategy with the lowest life cycle cost would have significant user delay costs associated with maintenance and protection of traffic, then a treatment strategy or pavement type that has the longest service life should be considered.***
- ***When a project meets the warrants for reconstruction discussed in CPDM Section 3.3.1.3.***

Therefore, when selecting a pavement type and/or pavement treatment, it is important to consider other factors such as those listed in Step 7. In those instances when the Region decides to implement a strategy that does not result in the lowest life cycle cost, or if the strategy includes nonstandard treatments or pavement designs, the rationale for such a decision must be documented in the PETSRS.

8. Project Developer or Designer

Secures approval of the scope closure document (SSM or EPP). If the project is being processed with a combined Scope Closure Document/Design Approval Document (SSM/FDR), checks the Estimated Service Life requirements in Step 12 and obtains Scope Approval and Design Approval, then skips to Step 15.

ADDITIONAL GUIDANCE: *The SSM or EPP should summarize the existing condition and the recommended treatment resulting from the PETSRS in the body of the SSM or EPP and include the draft PETSRS in the appendix. (Refer to the SPM and DPM for the format and content of SSMs, EPPs, and SSM/FDRs.)*

B. Design Phases I - IV

Steps9. Designer

For new/reconstructed pavement projects, confirms pavement type selection decision made in the Project Scoping Stage by performing the Pavement Type Selection Analysis in accordance with the "AASHTO Pavement Type Selection Guidelines" of the *AASHTO Guide for Design of Pavement Structures 1993* (a copy is included in the CPDM as Appendix 3A.1). It is important that all factors listed in Appendix 3A.1 that are relevant to the project be considered. The economic analysis (LCCA) should never be the sole determining factor in the pavement type selection decision. However, since the objective of this process is to encourage the wisest use of funds, the Pavement Type Selection Analysis shall contain the rationale behind selecting a pavement type not having the lowest life cycle cost.

ADDITIONAL GUIDANCE: *The LCCA for the pavement type analysis for a new pavement shall follow the method shown for the reconstruction strategy in the example contained in PRM, Vol. 2. Time lines showing future strategies with treatment service lives appropriate for the facility are to be shown for every viable pavement type.*

Department policy is to use a 4% discount rate. The benchmark analysis period for which all alternative pavement type strategies will be compared will consist of the life of the initial paving type that will last the longest, plus the life of one rehabilitation for that particular pavement type. Other proposed pavement types of lesser life should have as many rehabilitation treatments added as necessary to the basic service life in order to meet or exceed the benchmark analysis period. Salvage values should be included for the portion of these treatments that exceed the benchmark analysis period, in order to ensure that the LCCA is equivalent for the different pavement strategies.

10. Designer

Performs preliminary design including field review and additional data collection to determine actual quantities. Refines the cost estimate for the recommended pavement strategy using the PEP or PES program. Revises the PETSR if necessary to account for major changes (e.g. major quantity or cost changes or pavement condition changes caused by deterioration or maintenance performed since the condition survey).

11. Designer

Compares draft PETSR (from the Project Scoping Stage) to current PETSR to determine the significance of any quantity/cost change. If quantity/cost change is significant, or a lower level treatment (such as "Saw and Seal") was recommended in the Scoping Stage and it will be more than two years from the condition survey to

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construction, recycles to appropriate step and revises PETSRS, LCCA and/or recommended treatment as needed.

ADDITIONAL GUIDANCE: *It has been observed, that when there are more than two years between the condition survey and construction, continued deterioration of the highway during the design period may cause a higher level treatment to become the recommended or favored treatment (e.g., "HMA Overlay Preceded by Cracking and Sealing" vs. "Sawed and Sealed HMA Overlay"). However, if a higher level treatment is already recommended, and further deterioration will not affect the recommended treatment, this two year time limit does not apply. Examples of a higher level treatment would be reconstruction, HMA overlay preceded by rubblizing, or a 100 mm multiple course overlay.*

12. Designer

Inserts the PETSRS and/or the Pavement Type Selection Analysis into the appendix of the design approval document.

Includes in the body of the design approval document:

- a) A description of the existing pavement condition based on the distress survey.
- b) For pavement rehabilitation/reconstruction projects, a discussion of the road history and service life of previous treatments. The previous treatment service lives and future design traffic (AADT and percent trucks) should always be checked to determine if any adjustments need to be made to the expected service lives given for the proposed treatments in PRM, Vol. 2.
- c) The recommended pavement treatment and/or type.
- d) Justification for any recommended rehabilitation treatment that has an expected service life between 5 and 8 years.

Obtains/resolves comments on the design approval document from Main Office and Regional units in accordance with current design procedures as specified in the *Design Procedure Manual*.

Prior to, or concurrent with requesting Design Approval, obtains approval from the Regional Director for the use of a rehabilitation treatment with a service life between 5 and 8 years. The need for this approval hinges on the functional class of the road as outlined in Figure 1 (CPDM Appendix 3A.2).

Once this approval is obtained, requests Design Approval from the person authorized to grant Design Approval following current Department procedures. (See the *Design Procedure Manual*.)

ADDITIONAL GUIDANCE:

- (a) *FHWA, by memorandum dated March 25, 1992, authorized NYSDOT to grant exceptions to the 8-year expected service life on Federal-Aid projects. Approval of this exception has been delegated to the Regional Director. This means that the Regional Director grants all ESL exceptions regardless of fund source.*
- (b) *The memo requesting Design Approval shall include two sentences similar to those shown below. The first sentence, shall describe the recommended pavement type and/or pavement rehabilitation treatment. The second sentence is a statement that the project has complied with this process.*

Descriptive Sentence and Compliance Statement (in body of Design Approval Request Memo) -

“The recommended [insert name of the recommended pavement rehabilitation treatment and/or pavement type] is described in Appendix ___ of the attached report. This project has complied with the Pavement Treatment and Type Selection Process contained in the Comprehensive Pavement Design Manual.”

13. Design Approval Authority: Regional Director, Chief Engineer, or FHWA

Approves or disapproves the request for Design Approval including the statement of pavement process compliance.

14. Designer

If the design is disapproved because of the proposed pavement treatment and/or type, the project is recycled to the appropriate step and the PETSRS, LCCA, and/or recommended treatment are revised as needed. The Designer coordinates with the Project Manager to discuss impacts on the project's cost, scope, and schedule.

If the design is approved and receives the normal approvals and fund authorizations, the project proceeds to Advance Detail Design Phase V.

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C. Design Phase V

Steps15. Designer

Finalizes design and refines item costs/quantities using the Price Estimating System (PES).

Obtains/resolves comments on the Advance Detail Plans in accordance with current design procedures. (*See the Design Procedure Manual.*)

16. Designer

Checks back to the PETSR (from the Design Approval phase) to determine the significance of any quantity/cost change relating to the pavement. If quantity/cost change is significant, or a lower level treatment (such as "Saw and Seal") was recommended at Design Approval and it will be more than two years from the condition survey to construction, recycles to the appropriate step and revises the PETSR, LCCA, and/or recommended treatment as needed. (Refer to step 11 for guidance on this topic.) Coordinates with the Project Manager relative to the project's cost, scope and schedule (if necessary) and subsequently obtains approval of the pavement design modification from the authority granting Design Approval.

17. Designer

Prepares and transmits PS&E with process compliance statements in accordance with the latest procedures from the *Design Procedure Manual* and *Highway Design Manual*.

D. Future Steps

There are several steps shown on the flowcharts in Appendices 3A.2 and 3A.3 with dashed lines which are not specifically described in this section. Generally, these are future steps which show how this process is expected to link into the overall Pavement Management System. The steps are also shown to make the Regions aware that they should retain this data to be incorporated into a future Pavement Management Data Base.

3.3.1.3 Pavement Reconstruction Warrants

Using the current Life Cycle Cost analysis (LCCA) method contained in the PRM, Vol. 2 (Chapter 5), reconstruction can only rarely be shown to be the most cost-effective project-level alternative due to high initial costs, discounting future treatment costs, and the lack of a method to quantitatively assess user costs. Therefore, even when reconstruction is the preferred treatment alternative, unfavorable LCC analyses have hindered its selection. The ESAL-Based Pavement Design method discussed in Chapter 4 of the CPDM increases the costs of reconstruction and has exacerbated the problem.

The pavement treatment and type selection process discussed in CPDM Section 3.3.1 indicates that conditions exist that may drive treatment selection away from the least LCC alternative. It also discusses when reconstruction should be included as a treatment alternative and when LCC analyses should be conducted.

Pavement reconstruction should not be a commonly selected treatment alternative. In addition to the life cycle cost justification difficulty, NYSDOT pavements have not generally experienced structural failures that typically warrant reconstruction. This is especially true for pavements that have been designed and built with quality subbase and subgrade materials.

Nevertheless, situations do exist where pavement reconstruction is warranted. For example, pavements built directly on poor in situ soils (rather than on designed subbases and subgrades) are likely to fail, or to have failed, structurally. Also, badly deteriorated pavements, or poor pavements with other constraints that restrict the use of overlays, make reconstruction the only viable solution. Any of the following conditions warrant pavement reconstruction and eliminate other treatments from consideration:

1. The existing pavement has deteriorated beyond the conditions that warrant major rehabilitation (i.e., a structural overlay). It exhibits extensive and severe load-related distress and is structurally deficient for the anticipated future loadings due to inadequate drainage and nonstandard subbase and/or subgrade. The structural deficiency is such that an overlay would have a significantly shorter service life than expected.
2. The existing pavement condition warrants major rehabilitation, but it serves (or will serve) highly concentrated and channelized truck volumes and past performance has shown that asphalt concrete overlays will rut and shove, reducing the expected service life. In this situation the only viable alternative may be PCC pavement reconstruction. The Regional Materials Engineer should be consulted in this determination.
3. The existing pavement condition warrants major rehabilitation, but grade constraints restrict the placement of the required structural overlay thickness. This situation is typical of city or village streets that have been in place for several decades and repeatedly milled and overlaid to match curbs, gutters, sidewalks, intersections, etc. Continuation of the mill and overlay cycle, without providing the structurally required overlay thickness, will result in the overlay experiencing a significantly shorter service life than expected.

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4. The existing pavement section is nonuniform (either transversely or longitudinally), providing uneven structural support, poor cross-sectional drainage, and/or construction hardships. These situations result in costly, complex rehabilitation schemes; unpredictable future needs; and premature maintenance and/or rehabilitation needs. This situation is also typical of city or village streets and arterials where pavement widenings, curb replacement, closed drainage, utility cuts, and isolated repairs have resulted in a nonuniform pavement section.
5. Factors other than pavement condition may warrant reconstruction. These factors include nonstandard alignment, inadequate capacity, highway classification upgrade, safety concerns, regional socioeconomic development, long-term funding goals, and philosophies.

Issues discussed in condition 5 are beyond the scope of the CPDM. If the decision to reconstruct is based on one of these issues, there is no need to conduct a pavement distress evaluation or prepare a Pavement Evaluation and Treatment Selection Report (PETSR), although this decision still has to be explained in the body of both the Scope Closure Document and Design Approval Document. Also, a life cycle cost analysis would still be required as part of the Pavement Type Selection Analysis and to identify future maintenance and rehabilitation needs.

Situations discussed in conditions 1 through 4 require a PETSR. Rehabilitation treatments that will not achieve their expected service life due to pavement condition, structural deficiencies, or adjacent grade constraints should not be further considered in a life cycle cost analysis. If reconstruction is determined to be the only feasible alternative, conduct a life cycle cost analysis as part of the Pavement Type Selection Analysis and identify future maintenance and rehabilitation needs.

3.3.2 Pavement Maintenance and Short ($\leq$ 1.5 km), Rigid, or Multicourse Pavement Work

3.3.2.1 Pavement Maintenance Treatments

A formal pavement selection process as described in Section 3.3.1 of this chapter is not required. However, these projects are to be progressed in accordance with the Pavement Preventative Maintenance Projects Second Working Draft, dated February 12, 1993. A copy is attached to EI 99-001 in Appendix 3D of this chapter. Additional requirements apply as contained and referenced in this section and in the *Scoping Procedure Manual* (SPM) and *Design Procedure Manual* (DPM). Additionally, Chapter 10 of this manual contains information on the various maintenance treatments.

Pavement maintenance treatments let by the Department are processed in accordance with the SPM and DPM. Generally, federal-aid maintenance projects are NEPA Class II (and SEQR Type II) projects and are processed using the Element-Specific Procedures and a Simplified Design Approval Document in Appendix B of the DPM. Maintenance projects that are 100% State funded, are generally SEQR Type II projects which are processed using the SEQR Type II Procedures and a Simplified Design Approval Document, as found in the DPM. (Definitions for the terms NEPA Class II, SEQR Type II, and Element-Specific are given in the DPM.)

The Regional Maintenance Engineer should be contacted for the procedures, beyond those listed below, to process projects done by State forces or let by the Office of General Services.

A. Single Course Pavement Work

Single course pavement work is to be processed using the Pavement Preventative Maintenance Projects Second Working Draft, dated February 12, 1993. (A copy is attached to EI 99-001 in Appendix 3D of this chapter.) Additionally, EI 99-001, *1-R Requirements - Federal-Aid Single Course Overlay Maintenance Paving Projects*, describes the requirements and guidance for safety work on Federal-aid, single course overlay maintenance paving projects. Studies have shown that resurfacing projects with no safety work have a potential to increase run-off-the-road accidents. As a result, various types of safety work such as superelevation improvements, shoulder improvements, and edge of pavement drop-off remediation may be necessary, in order to minimize the public's exposure to existing or potential safety problems.

The Safety Appurtenance Program (SAFETAP) Guidelines provide similar guidance to EI 99-001 for safety work on 100% State Funded maintenance paving projects. However, all maintenance paving projects that meet the 1R requirements in EI 99-001 are eligible for 100% State as well as Federal funding. Therefore, use of the 1R requirements on all maintenance paving projects is recommended to allow greater flexibility in the fund source. The most recent version of the SAFETAP Guidelines is included as Appendix 3E to this chapter.

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B. Other Maintenance Work

Other pavement maintenance treatments may include microsurfacing, spot pavement repairs, chip sealing, quick-set slurry, and joint and crack sealing. Refer to Chapter 10 of this manual for information on these treatments.

Note that Engineering Instruction (EI) 97-030, *Pavement Preventive Maintenance Guidelines for Joint and Crack Sealing*, describes the process to be used to identify and schedule projects for sealing and to select appropriate sealing methods. It also includes general and specific guidelines of pavement sealing cycles based upon pavement type and age. EI 97-030 is included in the CPDM as Appendix 10A.

3.3.2.2 Short (≤ 1.5 km), Rigid, or Multicourse Pavement Work

Pavement work may include new construction, reconstruction, 3R, and 2R segments that are 1.5 km or less in length. The pavement work may be part of a bridge replacement project or a larger project with multiple treatments.

A formal pavement selection process as described in Section 3.3.1 of this chapter is not required. However, reasonable pavement treatment and type selections are necessary. Section 3.3.1 may be used as a guide to help select the pavement treatment and type.

The process for progressing these projects is contained in the SPM and DPM. The engineering considerations regarding this work are contained in the HDM, EI 01-031, and Chapters 4 and 5 of this manual.

3.4 PAVEMENT TREATMENT AND TYPE SELECTION QUALITY CONTROL AND QUALITY ASSURANCE

Under the Department Program and Project Management System (PPM) the Regional Offices are responsible for "quality control" while the Main Office (and FHWA for federally aided projects) is responsible for "quality assurance". The *Design Procedure Manual, Appendix I, Design Procedure Roles & Review Responsibilities* describes quality control and quality assurance relative to the entire design process.

For the purposes of the Pavement Design Process, quality control and quality assurance are defined in the following sections.

3.4.1 Quality Control

Under PPM, compliance with appropriate standards, policies, and procedures (i.e., quality control) is the responsibility of the Region. The following checklist can be used with the Pavement Design Process flowchart, in Appendix 3A.3, to enable easy monitoring of compliance with the pavement treatment and type selection process described in Section 3.3 of the CPDM.

Pavement Process Quality Control Checklist

At each control point in the project development process (e.g., SSM or EPP reviews, design approval document reviews, design approval, advance plan reviews and PS&E submission) the Project Developer, Job Managers, Project Manager, and group or person responsible for Regional quality control can use this checklist with the Pavement Design Process flowchart, in Appendix 3A.3, as tools to help determine if a project is ready to go to the next phase.

- ☐ The scope closure document (SSM or EPP) includes the draft PETSRS, when required, in the appendix to the SSM or EPP and includes summarized descriptions of the existing pavement condition and the recommended pavement rehabilitation treatment in the body of the SSM or EPP. (See Step 8 in Section 3.3.1.2, Process Steps.)
- ☐ The design approval document has similar requirements to the SSM or EPP and additionally includes the pavement treatment/type recommendation, and when appropriate, the Pavement Type Selection Analysis (in the appendix) or justification for treatments with 5-year to 8-year service lives. (See Step 12 in Section 3.3.1.2, Process Steps. Also, see the *Design Procedure Manual* for the format and content requirements of design approval documents.)
- ☐ The design approval request memorandum shall contain a description of the recommended pavement treatment/type and the process compliance statement. (See guidance following Step 12 in Section 3.3.1.2, Process Steps.)

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3.4.2 Quality Assurance

- FHWA - Quality assurance by FHWA is accomplished by statewide programmatic reviews as well as day-to-day project reviews when FHWA design-related approvals are required.
- NYSDOT - Generally, the quality assurance role of the Main Office in regard to the pavement design process is performed in conjunction with the quality assurance of other design processes. For example, the Design Quality Assurance Bureau and the Technical Services Division perform liaison and advisory reviews of current projects and revise pavement policies (such as the CPDM), standard sheets, and specifications as needed. In addition, a specific quality assurance effort regarding the pavement treatment selection process is described below.

The *Programmatic Quality Assurance - Pavement Rehabilitation Treatment Selection Process* (CPDM Appendix 3B) describes the processes used to: (1) monitor the quality and uniformity of project-level Pavement Evaluation and Treatment Selection Reports (PETSRS); (2) provide recommendations to the Regions to improve future PETSRS; and (3) identify and implement changes to improve the current procedures.

3.5 References

1. NYSDOT Design Procedure Manual, Design Division, Design Quality Assurance Bureau, January 9, 1999 as modified: July 1, 1999 (EB 99-056) and May 11, 1999 (EB 99-041).
2. NYSDOT Scoping Procedure Manual, Office of Planning and Program Management, Planning Division, April 1993. Modified in 1995, 1997, and 1998.
3. NYSDOT Highway Design Manual, Design Division, Design Quality Assurance Bureau, 1998 (contains Revisions 1 - 32).
4. "AASHTO Pavement Type Selection Guidelines", excerpt from AASHTO Guide for Design of Pavement Structures, 1993.

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**COMPREHENSIVE PAVEMENT
DESIGN MANUAL**

Chapter 3: Appendix 3A

**Rigid and Multicourse Pavement Work
Over 1.5 km in Length**

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COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 3: Appendix 3A.1

Pavement Type Selection Guidelines

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APPENDIX B

PAVEMENT TYPE SELECTION GUIDELINES

B.1 GENERAL

The highway engineer or administrator does not have at his disposal an absolute or undisputable method for determining the type of pavement which should be selected for a given set of conditions. However, the selection of pavement type should be an integral part of any pavement management program.

The selection of pavement type is not an exact science but one in which the highway engineer or administrator must make a judgement on many varying factors such as traffic, soils, weather, materials, construction, maintenance, and environment. The pavement type selection may be dictated by an overriding consideration for one or more of these factors.

The selection process may be facilitated by comparison of alternate structural designs for one or more pavement types using theoretical or empirically derived methods. However, such methods are not so precise as to guarantee a certain level of performance from any one alternate or comparable service for all alternates.

Also, comparative cost estimates can be applied to alternate pavement designs to aid in the decision-making process. The cost for the service of the pavement would include not only the initial cost but also subsequent cost to maintain the service level desired. It should be recognized that such procedures are not precise since reliable data for maintenance, subsequent stages for construction, or corrective work and salvage value are not always available, and it is usually necessary to project costs to some future point in time. Also, economic analyses are generally altruistic in that they do not consider the present or future financial capabilities of the contracting agency.

Even if structural design and cost comparative procedures were perfected, they would not by their nature encompass all factors which should be considered in pavement type determination. Such a determination should properly be one of professional engineering judgement based on the consideration and evaluation of all factors applicable to a given highway section.

The factors which may have some influence in the decisionmaking process are discussed below. They are

generally applicable to both new and reconstructed pavements. One group includes those factors which may have major influence and may dictate the pavement type in some instances. Some of the major factors are also incorporated in the basic design procedures and influence the structural requirements of the pavement design or subgrade and embankment treatments. In such cases they are assigned an economic value for comparative purposes. The second group includes those factors which have a lesser influence and are usually taken into account when there are no overriding considerations or one type is not clearly superior from an economic standpoint. A flow chart of pavement selection procedure incorporating the major and secondary factors is shown in Figure B.1.

B.2 PRINCIPAL FACTORS

1. Traffic

While the total volume of traffic affects the geometric requirements of the highway, the percentage of commercial traffic and frequency of heavy load applications generally have the major effect on the structural design of the pavement.

Traffic forecasts for design purposes have generally projected normal growth in the immediate corridor with an appropriate allowance for changes in land use and potential commercial and industrial development. However, experience over the past several decades has shown that the construction of new major highway facilities diverts large amounts of heavy traffic from other routes in a broad traffic corridor. This, coupled with a decline in the quantity of railroad services, has resulted in a considerable underestimation of traffic growth, particularly commercial traffic. Also, the future availability and cost of motor fuels could result in increased legal loads to which pavement structures could be subjected during their design period.

For these reasons, pavement designs for major facilities should incorporate an appropriate mar-

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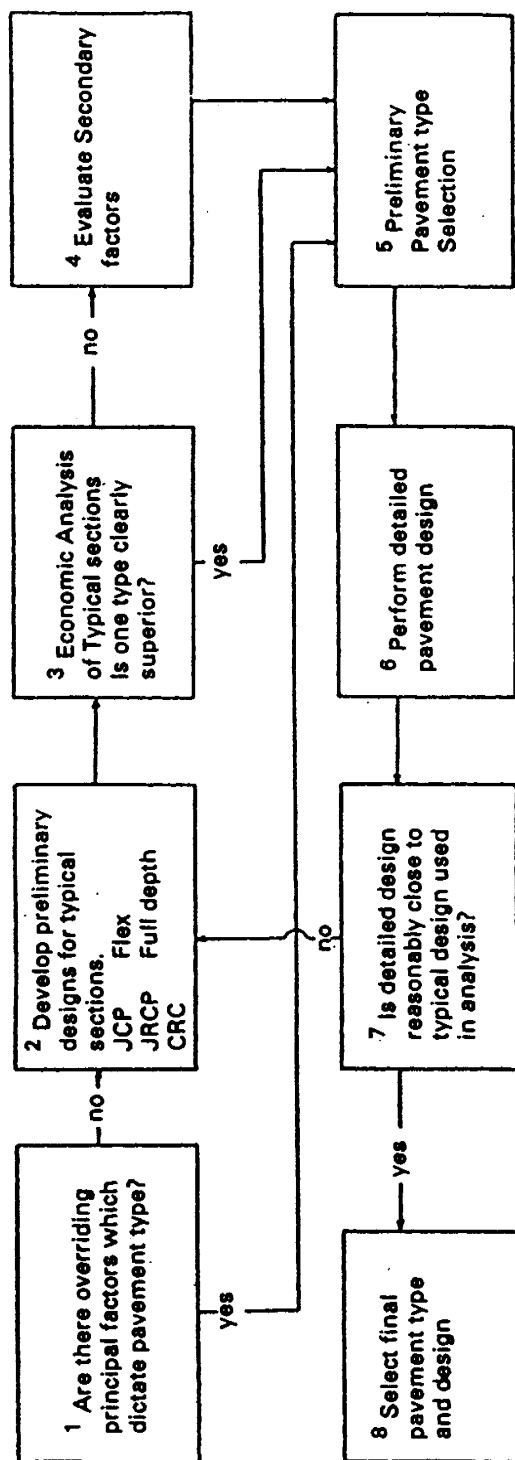


Figure B.1. Pavement Type Selection Process

gin of safety in the traffic factor. Agencies may choose to establish minimum structural requirements for all alternate pavement types to ensure adequate performance and service life for major facilities. Alternate strategies, or combinations of initial design, rehabilitation and maintenance, can be developed to provide equivalent service over a given period of time although the initial designs are not equivalent. For heavily traveled facilities in congested locations, the need to minimize the disruptions and hazards to traffic may dictate the selection of those strategies having long initial service life with little maintenance or rehabilitation regardless of relative economics.

2. Soils Characteristics

The load-carrying capability of a native soil, which forms the subgrade for the pavement structure, is of paramount importance in pavement performance. Even in given limited areas the inherent qualities of such native soils are far from uniform, and they are further subjected to variations by the influence of weather.

The characteristics of native soils not only directly affect the pavement structure design but may, in certain cases, dictate the type of pavement economically justified for a given location. As an example, problem soils that change volume with time frequently require stage construction to provide an acceptable riding surface.

3. Weather

Weather affects subgrade as well as the pavement wearing course. The amount of rainfall, snow and ice, and frost penetration will seasonally influence the bearing capacity of subgrade materials. Moisture, freezing and thawing, and winter clearing operations will affect pavement wearing surfaces as to performance and maintenance costs. These surfaces, in turn, will have some effect on the ease of winter clearing operations due to differences in thermal absorption or to the ability of the pavement to resist damage from snow and ice control equipment or materials.

In drawing upon the performance record of pavements elsewhere, it is most important to take

into consideration the conditions pertaining to the particular climatic belt.

4. Construction Considerations

Stage construction of the pavement structure may dictate the type of pavement selected. Other considerations such as speed of construction, accommodating traffic during construction, safety to traffic during construction, ease of replacement, anticipated future widening, seasons of the year when construction must be accomplished, and perhaps others may have a strong influence on paving type selections in specific cases.

5. Recycling

The opportunity to recycle material from an existing pavement structure or other sources may dictate the use of one pavement type. Future recycling opportunities may also be considered.

6. Cost Comparison

Where there are no overriding factors and several alternate pavement types would serve satisfactorily, cost comparison can be used to assist in determining pavement type.

Unavoidably, there will be instances where financial circumstances are such as to make first costs the dominate factor in selection, even though higher maintenance or repair costs may be involved at a later date. Where circumstances permit, a more realistic measure is cost on the basis of service life or service rendered by a pavement structure. Such costs should include the initial construction cost, the cost of subsequent stages or corrective work, anticipated life, maintenance costs, and salvage value. Costs to road users during periods of reconstruction or maintenance operations are also appropriate for consideration. Although pavement structures are based on an initial design period, few are abandoned at the end of that period and continue to serve as part of the future pavement structure. For this reason, the analysis period should be of sufficient duration to include a representative reconstruction of all pavement types.

B.3 SECONDARY FACTORS

1. Performance of Similar Pavements in the Area

To a large degree, the experience and judgment of the highway engineer is based on the performance of pavements in the immediate area of his jurisdiction. Past performance is a valuable guide, provided there is good correlation between conditions and service requirements between the reference pavements and the designs under study. Caution must be urged against reliance on short-term performance records, and on those long-term records of pavements which may have been subjected to much lighter loadings for a large portion of their present life. The need for periodic re-analysis of performance is apparent.

2. Adjacent Existing Pavements

Provided there is no radical change in conditions, the choice of paving type on a highway may be influenced by adjacent existing sections which have given adequate service. The resultant continuity of pavement type will also simplify maintenance operations.

3. Conservation of Materials and Energy

Pavement selection may be influenced by the pavement type which contains less of a scarce critical material or the type whose material production, transportation, and placement requires less energy consumption.

4. Availability of Local Materials or Contractor Capabilities

The availability and adaptability of local material may influence the selection of pavement type. Also, the availability of commercially produced mixes and the equipment capabilities of area contractors may influence the selection of pavement type, particularly on small projects.

5. Traffic Safety

The particular characteristics of a wearing course surface, the need for delineation through pavement and shoulder contrast, reflectivity under highway lighting, and the maintenance of a nonskid surface as affected by the available materials may each influence the paving type selection in specific locations.

6. Incorporation of Experimental Features

In some instances, the performance of new materials or design concepts must be determined by field testing under actual construction, environmental, or traffic conditions. Where the material or concept is adaptable to only one paving type, the incorporation of such experimental features may dictate pavement type selection.

7. Stimulation of Competition

It is desirable that monopoly situations be avoided, and that improvement in products and methods be encouraged through continued and healthy competition among industries involved in the production of paving materials.

Where alternative pavement designs have comparable initial costs, including the attendant costs of earthwork, drainage facilities, and other appurtenances, and provide comparable service life or life-cycle cost, the highway agency may elect to take alternate bids to stimulate competition and obtain lower prices. If this procedure is used, it is essential that good engineering practices and product improvement are not abandoned for the purpose of making cost more competitive.

Where several materials will adequately serve as a component within the pavement structure, such as a subbase or a base course, contractors should be permitted the option of using any of the approved materials.

8. Municipal Preference, Participating Local Government Preference and Recognition of Local Industry

While these considerations seem outside the realm of the highway engineer, they cannot always be ignored by the highway administrator,

especially if all other factors involved are indecisive as to the pavement type to select.

B.4 CONCLUSION

In the foregoing, there have been listed and discussed those factors and considerations which influ-

ence, to various degrees, the determination of paving types. This has brought to the fore the need, in certain areas, for the development of basic information that is not available at present. It has also served to point out, in general, that conditions are so variable and influences sufficiently different from locality to locality to necessitate a study of individual projects in most instances.

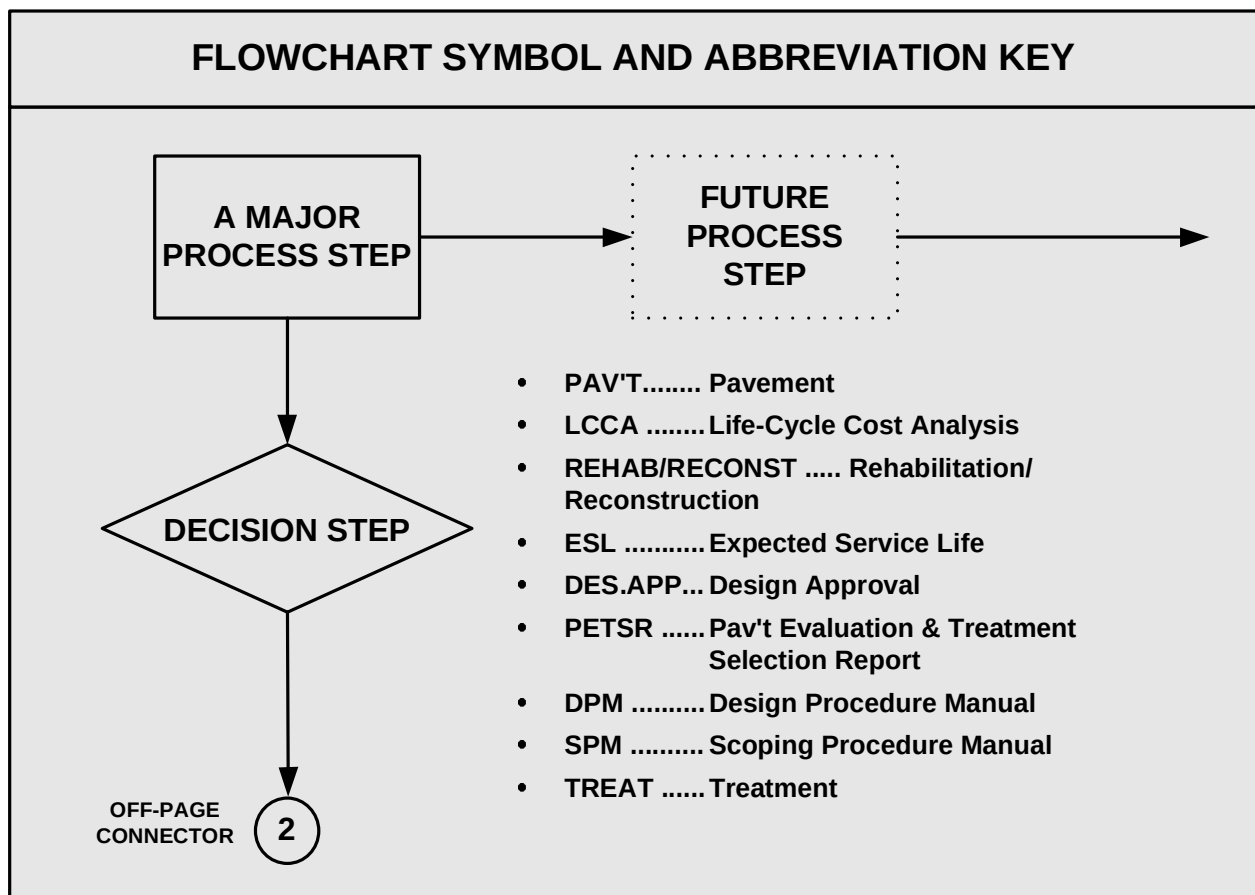
COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 3: Appendix 3A.2

Pavement Process (Section 3.3.1) Applicability, Major Process Requirements, and Minimum Service Life Requirements

6/30/00

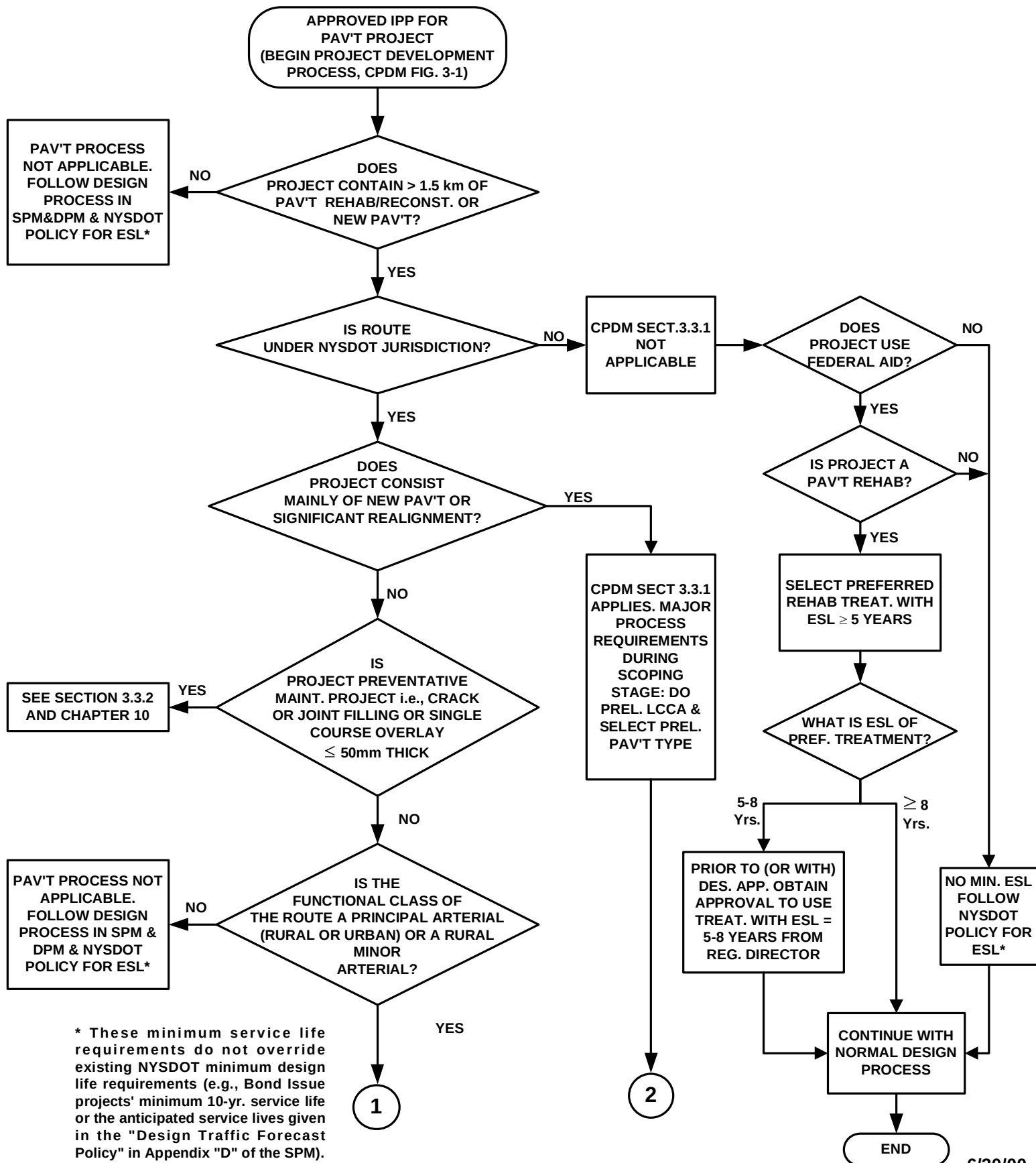
PAVEMENT PROCESS (SECTION 3.3.1) APPLICABILITY, MAJOR PROCESS REQUIREMENTS, AND MINIMUM SERVICE LIFE REQUIREMENTS *



6/30/00

PAVEMENT PROCESS (SECTION 3.3.1) APPLICABILITY, MAJOR PROCESS REQUIREMENTS, AND MINIMUM SERVICE LIFE REQUIREMENTS *

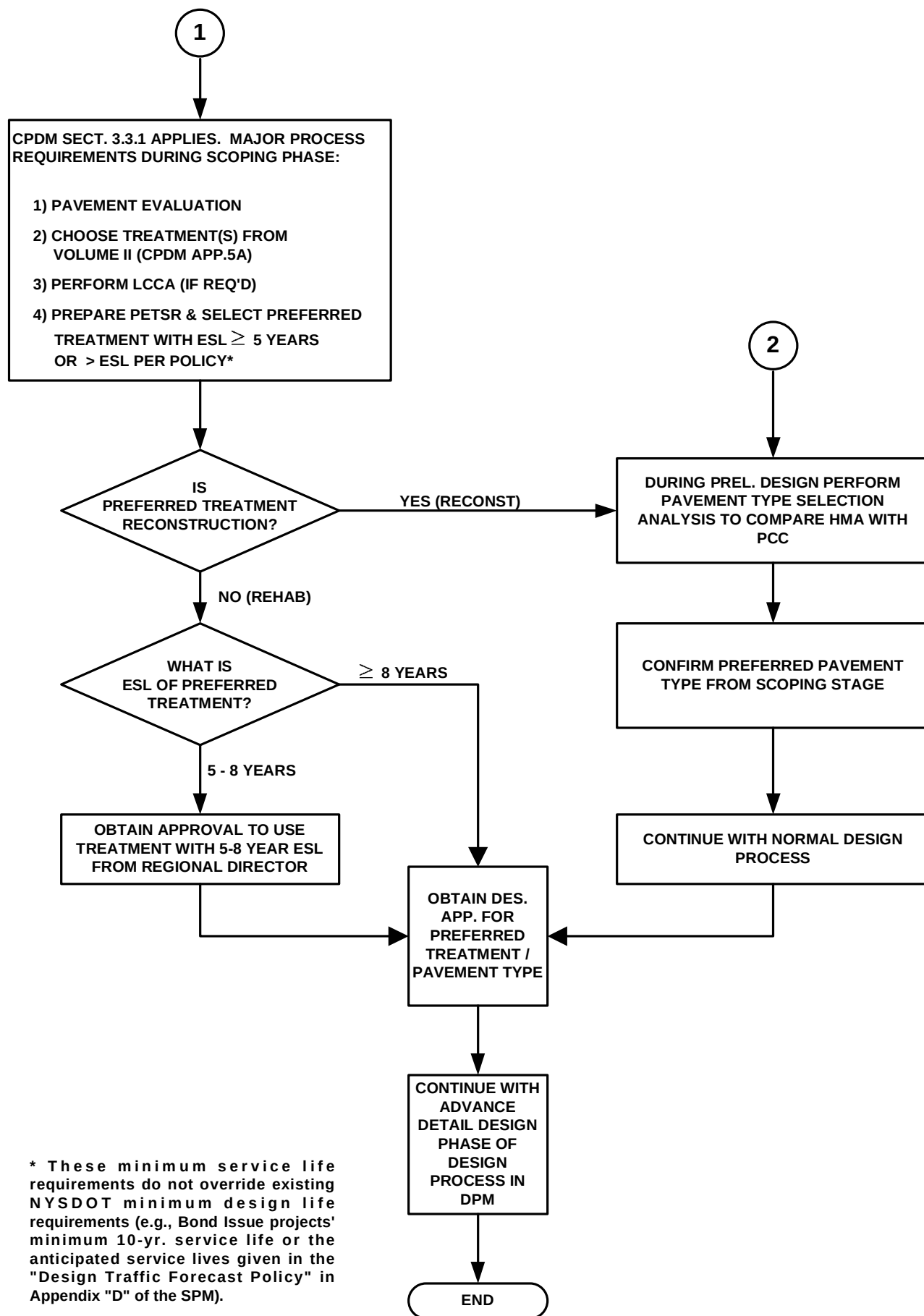
CPDM APPENDIX 3A.2
FIGURE 1 - PAGE 2 OF 3



6/30/00

PAVEMENT PROCESS (SECTION 3.3.1) APPLICABILITY, MAJOR PROCESS REQUIREMENTS, AND MINIMUM SERVICE LIFE REQUIREMENTS *

CPDM APPENDIX 3A.2
FIGURE 1 - PAGE 3 OF 3



6/30/00

COMPREHENSIVE PAVEMENT DESIGN MANUAL

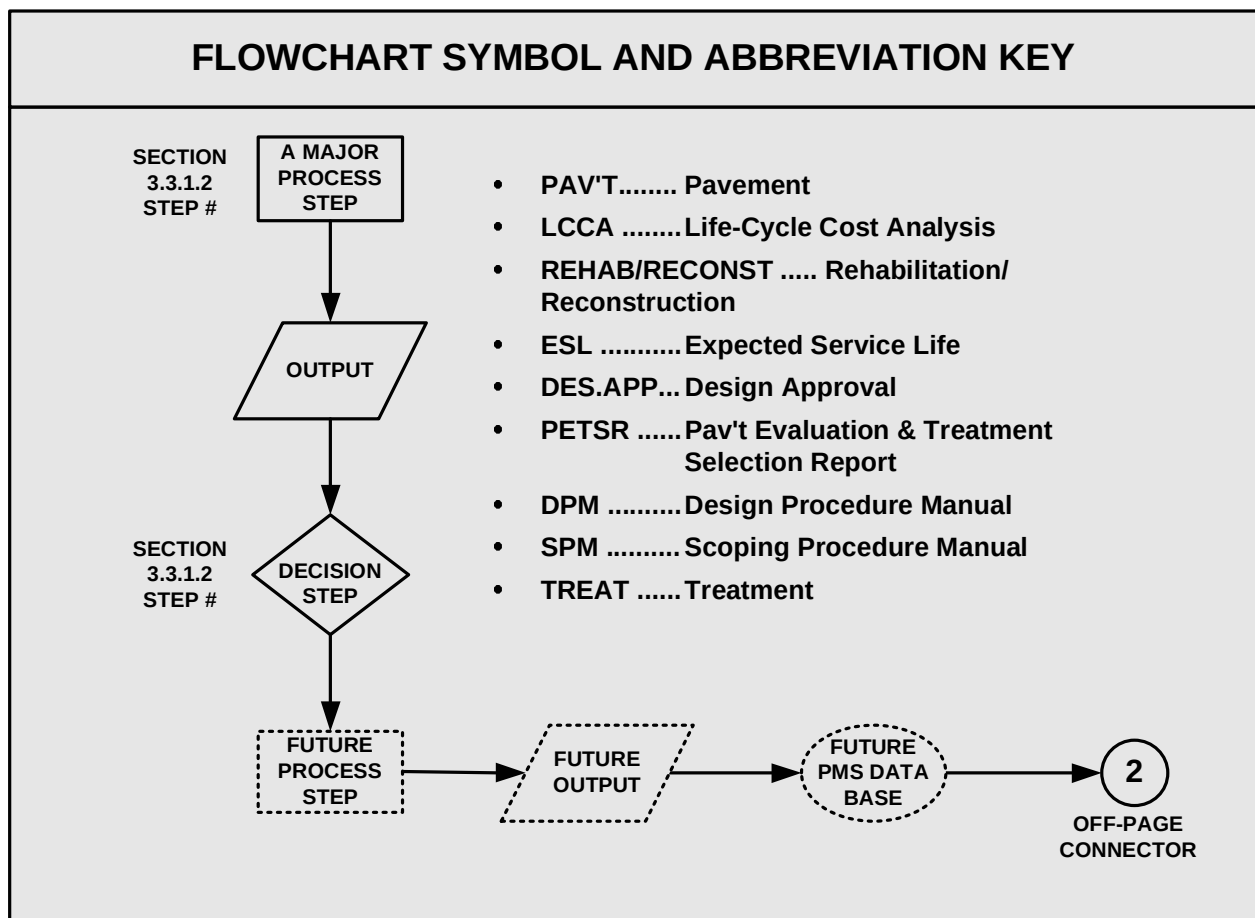
Chapter 3: Appendix 3A.3

Project-Level Pavement Design Process (Section 3.3.1)

6/30/00

PROJECT - LEVEL PAVEMENT DESIGN PROCESS

(See Section 3.3.1.2 for Full Process Step Description & Guidance)

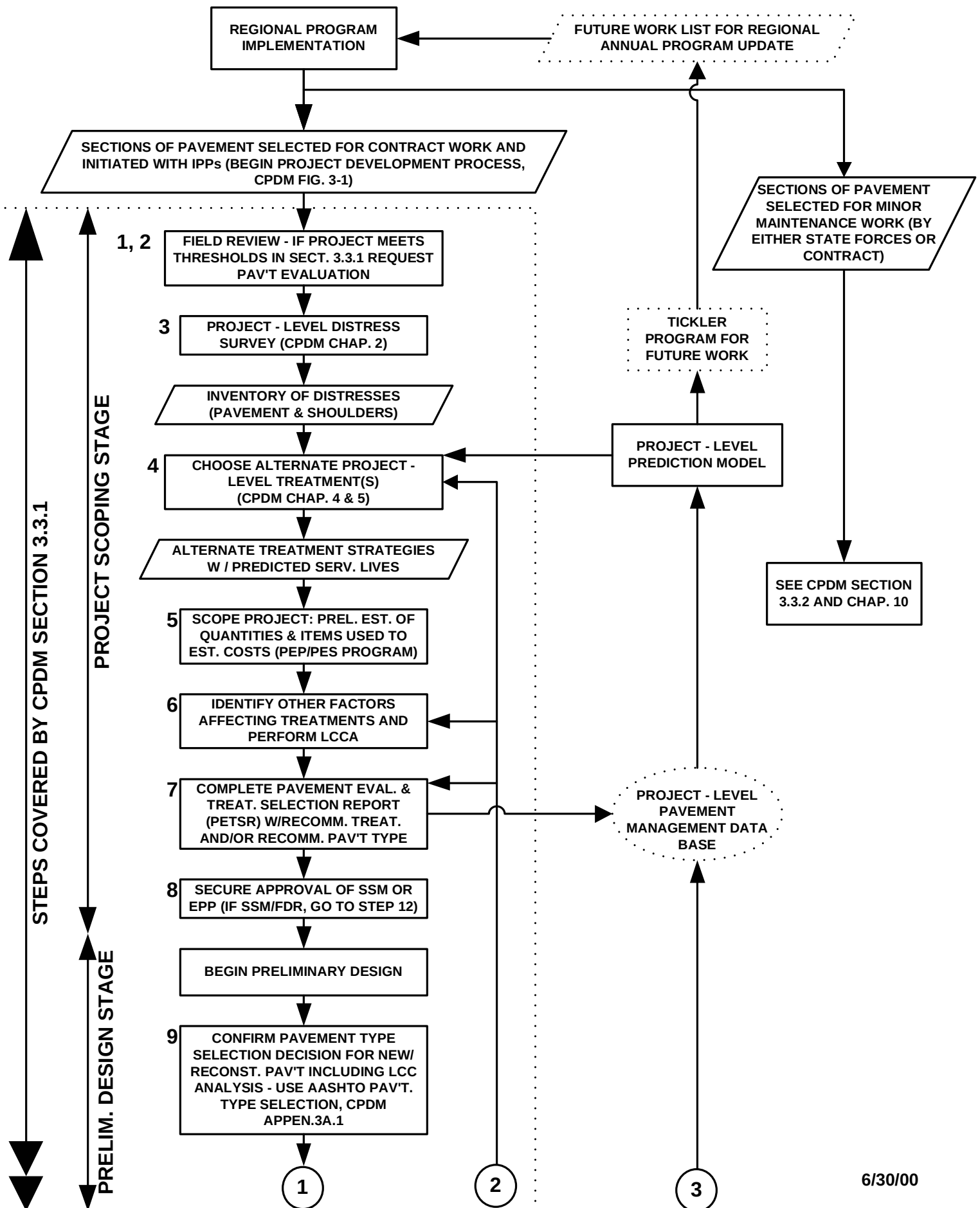


PROJECT - LEVEL PAVEMENT DESIGN PROCESS

(See Section 3.3.1.2 for Full Process Step Description & Guidance)

CPDM APPENDIX 3A.3

FIGURE 2 - PAGE 2 OF 3

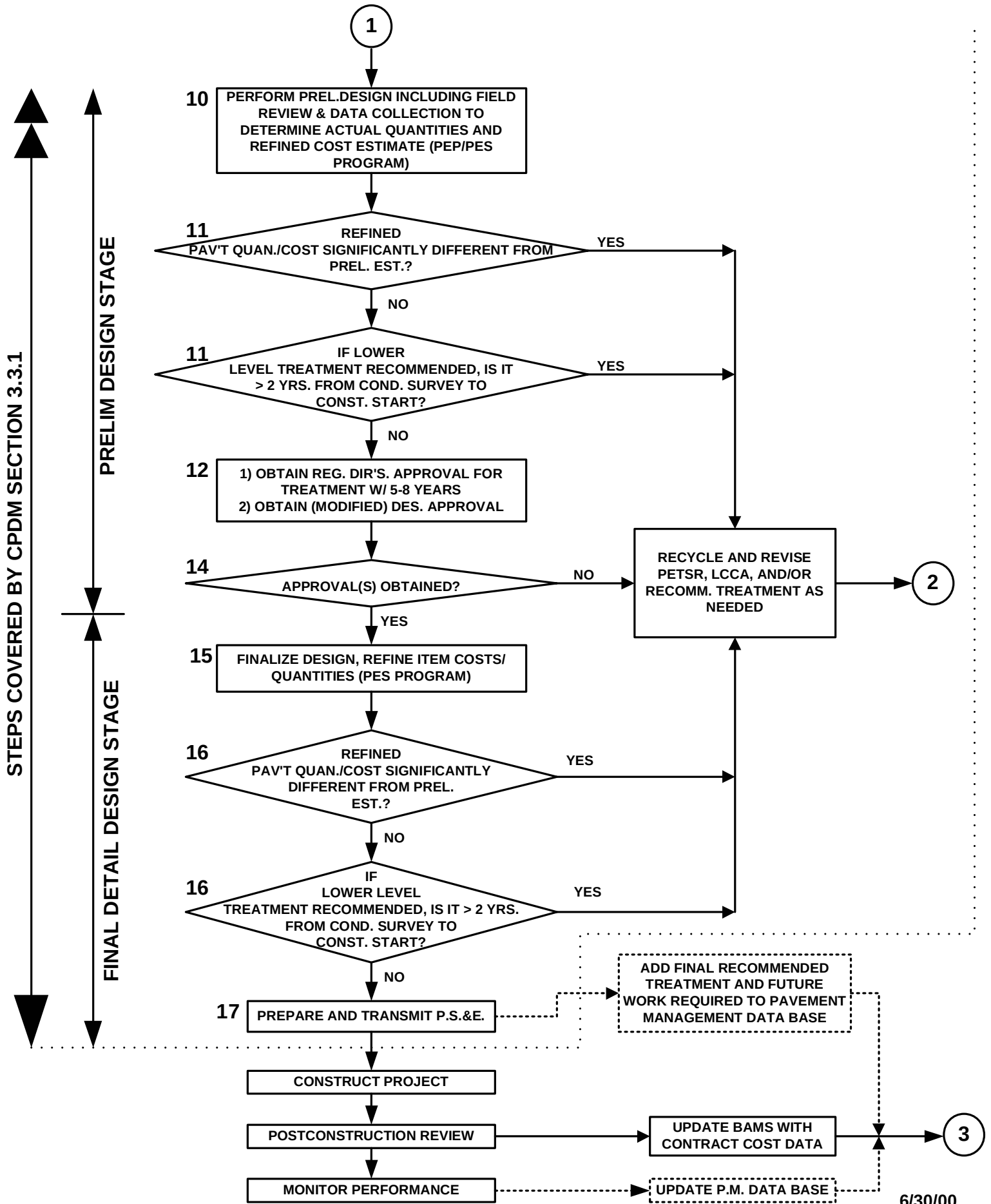


6/30/00

PROJECT - LEVEL PAVEMENT DESIGN PROCESS

(See Section 3.3.1.2 for Full Process Step Description & Guidance)

CPDM APPENDIX 3A.3
FIGURE 2 - PAGE 3 OF 3



**COMPREHENSIVE PAVEMENT
DESIGN MANUAL**

Chapter 3: Appendix 3B

**Programmatic Quality Assurance
Pavement Rehabilitation Treatment
Selection Process, August 1994**

6/30/00

**PROGRAMMATIC QUALITY ASSURANCE
PAVEMENT REHABILITATION TREATMENT SELECTION PROCESS**

**PREPARED BY THE OPERATIONAL GOAL COMMITTEE
FOR
TECHNICAL SERVICES OPERATIONAL GOAL 93-3**

**AUGUST 1994
REVISED MAY 2000**

JUNE 30, 2000

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ACKNOWLEDGMENTS

Those participating in the preparation of this Technical Service Goal 93-3, Programmatic Quality Assurance - Pavement Rehabilitation Treatment Selection Process, were:

William Snyder	Materials Bureau
Mike Brinkman	Materials Bureau
Pete Melas	Region 1 Materials
Andy Williams	Region 6 Design
Tim Giblin	Region 9 Design
Chris Badour	Region 10 Tech Services
Carol Hennessy	DQAB

I. INTRODUCTION

The purpose of this goal is to develop a process to monitor the quality and uniformity of project level Pavement Evaluations and Treatment Selection Reports (PETSR's), to provide recommendations to the regions to improve future PETSRs, and to identify and implement changes to improve the current procedures.

Over the next five years, the Department anticipates spending more than \$ 3.8 billion on capital projects primarily to improve pavement conditions. Engineering Instruction 92-015 established the policy and procedures for the "Project Level Pavement Selection Process" to maximize these expenditures and their impact on pavement performance. It also implemented Pavement Rehabilitation Manual Volume I, Pavement Evaluation, and Volume II, Treatment Selection. Given the magnitude of capital project pavement rehabilitation spending, it is imperative to establish a Quality Assurance Program to ensure consistent PETSR development. The goal of the Quality Assurance Program is meant to ensure that all Regions are in compliance with EI 92-015 and Volumes I and II of the Pavement Rehabilitation Manual.

The goal team developed a proposed quality assurance process for the PETSRs. The team recommends that the Assistant Commissioner for the Office of Engineering and Chief Engineer establish a PETSR Quality Review Committee with representatives

from the Design Quality Assurance Bureau and the Materials Bureau to implement the quality assurance process. The proposed process and program area responsibilities are outlined in this report.

II. GENERAL

To begin this Quality Assurance Process the QA Committee will request that the Regional Design Engineer submit a list of all pavement rehabilitation projects which have received their design approval within the past year and are greater than one mile in length. The listing must also identify those projects which have a pavement evaluation, treatment selection and life cycle cost analysis completed in accordance with the Pavement Rehabilitation Manual, Volume 1 and 2. Reasons should be provided for any projects not having a complete pavement evaluation report. In addition, to check the completeness of the regions' pavement rehabilitation project listing, it will be compared to the Comprehensive Project Report #1 issued monthly by the Program and Project Management Division. The QA Committee will then select one of these projects identified as having a complete PETSR and request that the completed Design Approval Document and completed PETSR be submitted for review. It is essential that the project meet that criteria specified in EI 92-015.

A Quality Assurance checklist has been developed to identify specific components of a PETSR. Regional PETSR's will be compared to the checklist to identify specific

components and deficiencies that need to be addressed. The checklist follows the format identified in the Pavement Rehabilitation Manual, Volume II, Part 4: Model Pavement Evaluation Report. The review will identify the differences between the intended format and content detailed in the "checklist" and the actual format and content used by each Region. At the request of the QA Committee the project pavement site will be visited by the Materials Bureau to determine if the distresses are properly documented and appropriate treatments selected. A Quality Assurance Report (QAR) will be prepared by the QA Committee to clearly identify the results of the PETSRS review. The QAR report will be returned to the respective Regional Design Engineer and copies to Materials, Soils and Maintenance Engineers and will be categorized as:

- 1) The report is within substantial compliance. No additional work is recommended.
- 2) If deficiencies are found, the QAR will identify problem areas and make recommendations to correct and comply with the QA standards.

The QA Committee review may identify needed improvements to Department policy and standards for the pavement selection process. These improvements when warranted will be implemented by Engineering Instruction.

III. PROGRAM RESPONSIBILITIES

The Materials Bureau developed the Pavement Rehabilitation Manual, Volume I and Volume II, and is responsible for any future revisions. Engineering Instruction 92-015 was prepared by the Design Quality Assurance Bureau and they are responsible for any future revisions of that document. Regional responsibilities to accomplish the PETSRS vary from region to region. The majority of the regions assign pavement evaluation and initial treatment selections to the Regional Materials Engineer and the Life Cycle Cost Analysis and final treatment selection to Regional Design. This is consistent with recommended responsibilities identified in EI 92-015. However, some regions effectively utilize other groups, such as Planning to collect distress data, and Regional Materials Engineer and/or Regional Technical Services to complete the L.C.C.A.

Since so many different groups are involved in preparing the contents of the PETSRS, the QA Committee will request that the Regional Design Engineer coordinate and submit the pavement rehabilitation project listing as described under Section II. The Regional Design Engineer will also later submit at the request of the QA Committee a complete PETSRS for QA Committee review.

The QA Committee is responsible for performing Quality Assurance reviews of PETSRSs. These QA reviews will look at: whether PETSRS's are being done on

appropriate projects, accuracy of distress survey data, completeness of the PETSR, and the rationale leading to the selected treatment. These QA procedures are new and subject to review and changes are expected. Updating will depend on feedback from the user. Accordingly, users are encouraged to share their views with the QA Committee.

IV SAMPLING PROCEDURES

Since it is not feasible to critique every PETSR, a biennial random sampling by the QA Committee will be used in this Quality Assurance Program. The following actions will be required to select the PETSR's for review.

- 1) The QA Committee will complete two or three reviews each year to maintain the statewide review every five years. To accomplish this, every April the QA Committee will request from the Regional Design Engineer in two regions a list of qualifying pavement rehabilitation projects that have a complete PETSR. The following four years two regions will be asked for a similar list. The QA Committee will randomly select one of these projects from each region for the purpose of critiquing the PETSR. The Regional Design Engineer will be responsible for submitting the selected report.

- 2) The QA Committee will select one of the listed projects, identified as having a complete pavement evaluation report, for the purpose of critiquing the PETSRS. The Regional Design Engineer will be responsible for submitting the selected report.
- 3) The QA Committee will review the regional list and comment on whether PETSRS are being done on appropriate projects. Then using the QA checklist, they will critique each Regional PETSRS for completeness and accuracy.
- 4) To minimize the impact of the QA program on Department staff each Region will be critiqued every 5 years.
- 5) To minimize the impact of the QA program on Department staff, each Region will be critiqued on a biennial basis. The first year 5 or 6 regions will be selected. The following year the remaining regions will be evaluated in the same manner, with the same pattern continuing into the future.

V. QUALITY ASSURANCE REVIEW

As the first step in the Quality Assurance review, the QA Committee will review the regional list and comment on whether PETSR's are being done on appropriate projects.

The PETSR is a detailed technical decision-making document. The purpose of a PETSR is to provide decision-makers with specific information to properly plan and design pavement rehabilitation projects. The PETSR must provide sufficient data and the data must be properly analyzed to enable reviewers and decision-makers a clear understanding of the problem(s) and needs to be addressed. The final result will be the selection of the most cost effective and appropriate treatment. If the least life cycle cost alternative is not chosen it must be clearly justified and documented by supporting information. The extent of the data collection must be thorough enough to minimize major changes in project scope and costs during later phases of the project's development.

The QA Committee will also review the discussion of the recommended alternative in the Design Approval Document (DAD) to determine if the DAD accurately reflects the PETSR recommendations. If it does not the DAD should provide an explanation.

A QA "checklist" has been developed to critique the PETSR's. The checklist is a general outline of a PETSR. The checklist is subdivided into five major sections.

Each section identifies information required of a PETSRS. The appendices in this manual include exhibits of the QA checklist, a completed PETSRS, and an accompanying QAR example. The regions may find the QA checklist helpful in establishing the correct format and content in their preparation of future PETSRSs.

As previously stated, the QA Committee is responsible for the PETSRS Quality Assurance. Quality Assurance will include: project reviews; continuous evaluation and updating of policy, procedures and standards; compliance to these policies, procedures, and standards.

VI. QUALITY ASSURANCE CHECKLIST

The following is a description of the Quality Assurance Checklist content that is needed to properly complete a PETSRS. The QA checklist is subdivided into the following five categories which are consistent with the example report shown in the Pavement Rehabilitation Manual, Volume II, Part 4: Model Pavement Evaluation Report.

1) - BACKGROUND INFORMATION (NARRATIVE)

This section provides a narrative summary of the information identified on the BR-46: "NYSDOT Materials Bureau Pavement Evaluation Report - Project Information".

a) Are project description & limits included?

The project description and limits should be described in narrative format. If different physical characteristics exists, multiple pavement evaluation sections may be warranted.

b) Are original contract date(s) provided?

This provides the age of the original pavement section.

c) Are additional contract dates listed?

This provides an indication of service life of past treatments. This should be reviewed along with service life information in the Pavement Rehabilitation Manual, Volume II in determining service life of future treatments.

d) Are observed maintenance activities listed?

As with 1-c above this provides valuable input in assigning service life of future treatments.

2) - DATA COLLECTION

a) Is there a drive-through description provided?

A primary purpose of the drive-through is to determine if distresses are relatively consistent throughout the project limits. This provides information to determine if multiple evaluation sections are required.

b) Does distress or physical characteristics warrant multiple sections (BR-46)?

Changes in the level of distress or physical changes within the project

limits may require multiple evaluation sections.

c) Are distress data sheets complete?

The extent and severity of distress is to be collected at tenth mile increments per half mile pavement segment, resulting in a 20 percent sampling frequency.

d) Are distresses properly summarized?

The distresses should be summarized on a project basis. If multiple evaluation sections are used to separately analyze different portions of a project, then each should be summarized separately.

e) Is distress narrative included?

The distress data collected on the BR-47 and BR-48 should be summarized and described in a narrative format. Photographs are not required in Volume I, but may be beneficial in describing a dominant distress severity.

3) - INPUT FROM OTHERS

a) Resident Engineer's concerns

b) Regional Soils Engineer's concerns

c) Regional Materials Engineer's concerns

Contact with each of the above groups is imperative and their concerns must be noted and accounted for. If any of the above have no input it should be noted that they were contacted and had no input.

4) - TREATMENT ALTERNATIVES

a) Are all appropriate options listed?

All appropriate treatment options identified in the Pavement Rehabilitation Manual, Volume II should be identified and the pros and cons of each given.

b) Are reasons for eliminating options given?

Only those treatments which appear viable after discussion need be considered in the L.C.C.A.

c) Is time line provided? (service life, maintenance needs, future treatments given)?

Include the corresponding service life for each selected option and all future maintenance activities over the service life of the pavement for each appropriate treatment option.

d) Is a life cycle cost analysis summary included?

Unit cost and quantities should be tabulated and time lines of service life and future pavement needs should be graphically shown. The Present Worth approach described in the Pavement Rehabilitation Manual, Volume II should be followed.

e) Is recommended alternative provided?

A recommended alternative must be provided and justification given if the recommended treatment does not have the lowest L.C.C.A. or the treatment alternative is not one listed in the Pavement Rehabilitation Manual, Volume II.

- f) If the recommended alternative is reconstruction, is a Pavement Type Selection Analysis included in the PETSr?**

The costs of reconstruction using both asphalt cement concrete and portland cement concrete and their future work strategies should be identified and pavement type selection made using criteria identified in EI 92-015 Appendix B.

5) - APPENDIX ITEMS

- a) BR 46**
- b) BR 47 AND/OR BR 48**
- c) Initial and future treatment cost tables**
- d) Life Cycle Cost Analysis**
- e) Core report**

Each of the above items are required documents of a PETSr as identified in the Pavement Rehabilitation Manual, Volume II. They should be included in the appendix and referenced in the narrative portion of the PETSr. It should be noted that a L.C.C.A. is not always required on a project as described in Engineering Instruction 92-015, Project Scoping Phase, step 4d on page 8 of 17. See that EI for further guidance.

VII. QUALITY ASSURANCE REPORT

Once the QA Committee has completed its review of each region's PETSR a field evaluation will be scheduled. Materials Bureau personnel at the request of the QA Committee will field evaluate the pavement to ensure the distress is correctly documented and the selected treatment is appropriate. Once the field evaluation has been completed, the QA Committee will prepare a written evaluation report that will critique both the written report and the field evaluation. The purpose of the Quality Assurance Report is to provide feedback and input to each region so that both quality and uniformity are achieved statewide.

As stated, the QA report format will be in one of two formats:

- 1) The region will be notified that their report is within substantial compliance of the intended guidelines. No additional requirements or work needs to be done by the region at this time. Comments may be provided for recommended improvements.
- 2) A region will be notified that deficiencies have been noted. The region will be given suggestions on how to correct the problem so that future PETSRs will meet Department standards. Incorporating the suggestions into the subject PETSR is at the option of the region. The

review may identify training needs, which will be recommended to the region and provided as needed.

VIII ANNUAL PROGRAM REVIEW REPORT

At the end of each year the QA Committee will prepare a summary report for the Deputy Chief Engineer in Facilities Design and Technical Services to identify compliance, common problems, and recommendations to improve the Pavement Rehabilitation Treatment Selection Process.

APPENDIX A
of
PROGRAMMATIC QUALITY ASSURANCE
PAVEMENT REHABILITATION TREATMENT SELECTION PROCESS

**NEW YORK STATE DEPARTMENT OF TRANSPORTATION
PAVEMENT EVALUATION QUALITY ASSURANCE CHECKLIST**

PIN _____ PROJECT DESCRIPTION _____

REVIEWED BY _____ DATE _____

Item	Completeness		Comments Attached
	Yes	No	
1) BACKGROUND INFORMATION (NARRATIVE)			
a) ARE PROJECT DESCRIPTION & LIMITS INCLUDED?			
b) ARE ORIGINAL CONTRACT DATE(S) PROVIDED?			
c) ARE ADDITIONAL CONTRACT DATE(S) LISTED?			
d) ARE OBSERVED MAINTENANCE ACTIVITIES LISTED?			
2) DATA COLLECTION			
a) IS THERE A DRIVE THROUGH DESCRIPTION PROVIDED?			
b) ARE MULTIPLE SECTIONS (BR-46's) INCLUDED? (If required, due to physical or distress characteristics).			
c) ARE DISTRESS DATA SHEETS COMPLETE?			
d) ARE DISTRESSES PROPERLY SUMMARIZED?			
e) IS DISTRESS NARRATIVE INCLUDED?			
3) INPUT FROM OTHERS			
a) RESIDENT ENGINEER'S CONCERNS			
b) REGIONAL SOILS ENGINEER'S CONCERNS			
c) REGIONAL MATERIALS ENGINEER'S CONCERNS			
4) TREATMENT ALTERNATIVES			
a) ARE ALL APPROPRIATE OPTIONS LISTED?			
b) ARE REASONS FOR ELIMINATING OPTIONS GIVEN?			
c) IS TIME LINE PROVIDED INCLUDING: SERVICE LIFE, MAINTENANCE NEEDS, FUTURE TREATMENTS?			
d) IS A LIFE CYCLE COST ANALYSIS SUMMARY INCLUDED?			
e) IS RECOMMENDED ALTERNATIVE PROVIDED?			
f) IF THE RECOMMENDED ALTERNATIVE IS RECONSTRUCTION, IS A PAVEMENT TYPE SELECTION ANALYSIS INCLUDED?			
5) APPENDIX ITEMS			
a) BR 46			
b) BR 47 AND/OR BR 48			
c) INITIAL AND FUTURE TREATMENT COST TABLES			
d) LIFE CYCLE COST ANALYSIS			
e) CORE REPORT			

APPENDIX B

of

**PROGRAMMATIC QUALITY ASSURANCE
PAVEMENT REHABILITATION TREATMENT SELECTION PROCESS**

PAVEMENT EVALUATION REPORT

**STATE ROUTE 248
SH 8265, CANISTEO-WHITEVILLE, PTS. 6 & 7
TOWN OF WEST UNION
STEUBEN COUNTY**

MM 248-6402-1000 to 248-6402-1060

PIN 6048.13

**PREPARED BY
NEW YORK STATE DEPARTMENT OF TRANSPORTATION
REGION 6 PLANNING & PROGRAM MANAGEMENT UNIT
AUGUST 1993**

GENERAL INFORMATION

The project is located on State Route 248 in the Town of West Union, Steuben County. Route 248 is classified as a Major Collector (S6401) and is maintained by the State of New York. The project begins at the Allegany County Line at Reference Mile Marker 248-6402-1000 and extends northeast to Rexville at Reference Mile Marker 248-6402-1060. The total project length is 6.0 miles. See the location map in the Appendix.

The section of Route 248 involved in this project is an undivided composite pavement consisting of two 9' wide lanes with 4' wide gravel/dirt shoulders on both sides of the highway.

Original construction took place in 1928, with the 6.0 miles constructed as a 18' wide, 8" thick, reinforced portland cement concrete pavement.

In 1953 under contract RC 52-94, 4.15 miles of the road was overlayed with 3" of bituminous material. The remainder of the project was overlayed with 2½" of bituminous material between the years of 1956 and 1962.

Since then, only maintenance procedures have been carried out on the 4.5 miles of pavement.

EXISTING PAVEMENT CONDITION

The overall condition of the 6.0 miles of pavement is poor. This section of State Route 248 was rated a 4, with general alligator cracking and widening drop-off, by the 1993 Highway Condition Field Survey.

The major pavement distresses indicated on the "Distress Data Forms", see the Appendix, are frequent settlement heaves, medium to high severity longitudinal, transverse, wheelpath, other and edge cracking. Two other concerns are the light severity of widening drop-off and the potholes that are noted throughout the length of the project.

Less severe pavement distresses that are present include wheelpath rutting, slippage cracks, ravelling and lane/shoulder drop-off.

There are sixteen areas along the edge of pavement that were noted as being repaired with approximately 400' - 900' long patches of asphalt concrete. Thirteen patches are in poor condition and three are rated as fair. There also were numerous pothole patches in many areas of the project especially from RMM 1006 to 1009 and from RMM 1042 to 1057.

The shoulders are in fair condition and show low to medium severity of lane/shoulder drop-off. The existing shoulders are composed of gravel and dirt only.

CORE REPORT INFORMATION

As this pavement evaluation was being completed, the Regional Materials Unit took some pavement cores to determine the full depth condition of the existing pavement. A copy of the Core Report is included in the Appendix.

To summarize, the cores generally show about 7" of blacktop over an old 8" portland cement concrete pavement. All the cores found the blacktop to have an intact upper section with the lower layers showing loose stone. The old concrete pavement is in fair to poor condition. There are no paved shoulders within the limits of the project.

ALTERNATIVES NOT CHOSEN

In addition to the alternatives detailed in this report, several others were investigated. None of these alternatives would provide a long term solution to the problems encountered in the project area and, therefore, were not progressed further in this report. The following is a list of them:

1. Two Course, 2½" AC Overlay.. The pavement condition is in too poor a condition to make this a feasible alternative.
2. Two Course, 4" AC Overlay. The poor condition of the pavement and the pavement failure areas make this alternative not feasible.

ALTERNATIVES

- 1) TOTAL RECONSTRUCTION (6.0 MI)

This alternative proposes the complete reconstruction of the project area. Work includes the removal and disposal of the existing portland cement pavement and its overlay material, existing shoulder removal, placement of new subbase, new 6½" asphalt pavement, new underdrain, and new shoulders.

- 2) RECONSTRUCTION AREAS (.9 MI) AND 5½" OF AC OVERLAY (5.1 MI)

This alternative is comprised of two different types of work. The first consists of the reconstruction of the pavement in several different areas, adding up to a total of .9 miles. This will include the removal and disposal of the existing Asphalt Concrete and the Portland Cement Concrete Pavement, placement of 12" of subbase material, underdrain as necessary followed by placement of a 6½" Asphalt Concrete (AC) pavement section. The overlaid section would include cleaning, and filling all cracks and pavement/shoulder joints, placing T&L as required (approximately a 3" course), placing underdrain as necessary, then placing a 2½" AC pavement section. All the shoulders and the guiderail on the project will be replaced and various drainage work, including culvert repairs/replacements and ditch work, will also be completed.

COST ANALYSIS

A cost analysis of the two alternative rehabilitation procedures was prepared based on estimated costs of items pertaining to the roadway itself, see the Appendix. A present worth comparison of the two alternatives over a 30 year life cycle was used. Initial rehabilitation as well as predicted future maintenance and rehabilitation procedures were included.

PROPOSED REHABILITATION RECOMMENDATION

Based on the condition of the highway as discussed in this report and the core information from the Regional Materials Unit, the reconstruction of areas and the placement of 5½" of AC on the remaining portions, referred to as Alternative 2 in this report, is the most viable alternative. The initial and annual costs of this alternative are lower than the total reconstruction alternative. We, therefore, recommend that the alternative that reconstructs several sections of the pavement and then strengthens and overlays the remaining portions, be utilized on this project.

This recommendation should be reviewed during the design phase of this project, once more information is uncovered such as survey, etc., to ensure that it still is the most appropriate treatment.

APPENDIX

1. Project Location Map
2. Project Information
3. Materials Engineer Memo & Core Report
4. Summary of Distress
5. Distress Data Forms
6. Pavement Patches Information
7. Cost Analysis
8. Life Cycle Charts & Analysis

PAVEMENT EVALUATION REPORT
NEW YORK STATE DEPARTMENT OF TRANSPORTATION
PROJECT INFORMATION

General

Region: 6 County: Steuben Route No: 248 PIN: 6048.13
Project Identification: Canistota-Whitesville, Pts. 6 & 7
Begin RM: 248-6402-1000 End RM: 248-6402-1060 Total Length: 6.0 CL miles
Original Contract Date(s): 1926-28
Latest Pavement Rehabilitation Date(s): 1953 (RC 52-94), 1956 (Retread C3),
1960 (ACRICE), 1962 (ACIACD)

Roadway Features

Roadway: Divided _____ Non-Divided X
Median: Flush _____ Raised _____ Concrete Med. Barrier _____
Curbs: Mountable _____ Non-Mountable _____
AC _____ PCC _____ Stone _____

Pavement:

Lanes: No. 2 Width(s) 9'
Type: Reinforced PCC _____ Non-Reinforced PCC _____
AC _____ AC over PCC X
Thickness (nominal): Total 15" (AC 7" PCC 8")
Reinforced and Non-Reinforced PCC Pavements Only:
Slab Length: _____
Load Transfer Type: Dowels X 2 Component _____
Transverse Joints: Contraction _____ Expansion _____

Subbase:

Type: Gravel Thickness (nominal): 9"

Shoulders:

Type: AC _____ PCC _____ Gravel/Earth X Thickness _____
AC or Surface Treatment/Stabilized Gravel _____ Thickness _____
Width: Both 4' Driving Lane _____ Passing Lane _____

Drainage:

Type: Open System X Closed System _____

Related Pavement Data

Traffic AADT (Range) 275 Date 1992 # Trucks 17
Sufficiency Score 4 GA, WD Date 1993

Prepared By: Reg. Planning & Program Mgmt.

Date: 8/93

MEMORANDUM

DEPARTMENT OF TRANSPORTATION

TO: A. H. Williams, Planning, R-6

FROM: H. J. Clark, Regional Materials Engineer, R-6 *H. J. Clark*

SUBJECT: Rte. 248 Cores, S.H. 8265, Steuben County
PIN 6048.13.101

DATE: July 20, 1993

As requested, we cored the section of Rte. 248 in Rexville, Steuben County. Attached is a core report of our findings for this section of roadway.

Our cores generally show about 7" of blacktop over an old 8" portland cement concrete pavement.

All ten cores showed the blacktop to have an intact upper section of hot-mix asphalt, with a very old 6F top course. The lower layers in all cases are deteriorated (now loose stone) which were probably penetration macadam or open base or binder.

The old concrete pavement is in fair to poor condition, since only two of the ten concrete cores were intact. The rest were broken into 2 or 3 pieces except for Core #6 which was rubble (many pieces).

Your memo of June 11, 1993 asked for shoulder cores in addition to pavement cores. There are no paved shoulders anywhere within the mile marker limits you gave us.

I hope these cores help you and Design in your work on this project.

HJC

Attachment

cc: Don Matula
R. L. Hollenbeck, Regional Design Engr.
S. B. Moores, Design

7/20/93

Core Report
Region 6 Materials

Page 1

Rte. 248

Cored 6/16/93

S.H. 8255

History:

Proj.
Proj.
Proj.

Core No.	Location	Dir.	Core Description	
1 MM	1060	SB	3.25" bt 3 layers; 2" rubl, 6" br	
			3.3" Blacktop	-----+
			2.8" Det Pen Mac	+ <--- Core layers
			8.0" Broken Conc	-----+
			14.0" total thickness	
			6F	Pavement <--- Description
2 MM	1053	SB	4.5"bt, 1.5"det pen mac, 8" br conc	
			4.5" Blacktop	-----+
			1.5" Det Pen Mac	+ <--- Core layers
			8.0" Broken Conc	-----+
			14.0" total thickness	
			6F	Pavement <--- Description
3 MM	1043	SB	4.5"bt, 2.5"det pen mac, 8" br conc	
			4.5" Blacktop	-----+
			2.5" Det Pen Mac	+ <--- Core layers
			8.0" Broken Conc	-----+
			15.0" total thickness	
			6F	Pavement <--- Description
4 MM	1024	SB	5"bt, 2"det pen mac, 8" broken conc	
			5.0" Blacktop	-----+
			2.0" Det Pen Mac	+ <--- Core layers
			8.0" Broken Conc	-----+
			15.0" total thickness	
			6F	Pavement <--- Description
5 MM	1016	SB	1.8"bt, 5.2"det pen mac, 8" br conc	
			1.8" Blacktop	-----+
			5.2" Det Pen Mac	+ <--- Core layers
			8.0" Broken Conc	-----+
			15.0" total thickness	
			6F	Pavement <--- Description

7/20/93

Core Report
Region 6 Materials

Page 7

Rte. 248
History:

Cored 6/16/93

S.H. 8265

Proj.
Proj.
Proj.

Core No.	Location	Dir.	Core Description	
6 MM	1001	NB	4.5"bt, 2.5"det pen mac, 8" br conc	
			4.5" Blacktop	-----+
			2.5" Det Pen Mac	+ <--- Core layers
			8.0" Conc rubble	-----+
			15.0" total thickness	
			6F	Pavement <--- Description
7 MM	1008	NB	5"bt, 2"det pen mac, 8" broken conc	
			5.0" Blacktop	-----+
			2.0" Det Pen Mac	+ <--- Core layers
			8.0" Broken Conc	-----+
			15.0" total thickness	
			6F	Pavement <--- Description
8 MM	1033	NB	4.5"bt, 2.5"det pen mac, 8" br conc	
			4.5" Blacktop	-----+
			2.5" Det Pen Mac	+ <--- Core layers
			8.0" Concrete	-----+
			15.0" total thickness	
			6F	Pavement <--- Description
9 MM	1036	NB	4.5"bt, 3"det pen mac, 7.5" br conc	
			4.5" Blacktop	-----+
			3.0" Det Pen Mac	+ <--- Core layers
			7.5" Concrete	-----+
			15.0" total thickness	
			6F	Pavement <--- Description
10 MM	1041	NB	4.5"bt, 3"det pen mac, 7.5" br conc	
			4.5" Blacktop	-----+
			3.0" Det Pen Mac	+ <--- Core layers
			7.5" Conc pieces	-----+
			15.0" total thickness	
			6F	Pavement <--- Description

PIN 6048.13
SR 248
REXVILLE TO ALLEGANY COUNTY LINE
TOWN OF WEST UNION
STROBEN COUNTY
RMM 248-6402-1000 to 1060

SUMMARY OF DISTRESS

Based on Full Project Length (6.0 Miles)

Corrugations	Present on 20% of the Project
Settlement or Heaves	46 throughout Length of Project
AC Overlay/Patch	13 Large Patches Rated "Poor" 3 Large Patches Rated "Fair" Numerous Small Pothole Patches Throughout

Based on (12) 1/10 mile sections

	<u>None</u>	<u>Light Single Crack</u>	<u>Medium Multiple Cracks</u>	<u>Heavy Mult. Cracks/ Potholes</u>
Wheelpath Cracking	39%	12%	43%	6%
Transverse Cracking	--	86 each	42 each	5 each
Longitudinal Cracking	12%	12%	55%	21%
Edge Cracking	1%	13%	66%	20%
Cracking Other	26%	56%	13%	5%

Slippage Cracks 83% None, 17% Present

Ravelling 66% None, 34% Present

Wheelpath Rutting	--	84%	16%	--

Widening Dropoff	16%	84%	--	--

Shoulder Deterioration	100%	--	--	--

Lane/Shoulder Separation	100%	--	--	--

Lane/Shoulder Dropoff	--	67%	33%	--

Shoulder Deformation	100% None

DISTRESS DATA FORM

Region 6 County SEAGEN Route No. 248 Pin 6043.13.01 PAVEMENT FLEXIBLE ☒
 Number of Lanes 7 Survey Segment to 7 Lane(s) Direction A/R S FLEXIBLE/RIGID ☐
 Date Insp. 1/11/02 Inspector LARRY AMMON : DAVE SALT Sheet 1 of 3

DISTRESS	SEVERITY	SECTION					EXTENT TOTAL	REMARKS	
		(1)	(2)	(3)	(4)	(5)			
		Beginning Elev	1000	1005	1010	1015			1020
CORRUGATIONS (1)	N None		7	7	7	7	7	40	20
	P Present		1	1	3	7	2	10	20
SETTLEMENTS & HEAVES (2)	N None							0	
	P Present		111	1111	111	11	1111	17	
ASPHALT CONC. OVERLAY OR SPRAY PATCH (3)	N None								
	G Good								
	F Fair								
	P Poor								
WHEELPATH CRACKING (4)	N None			5	6	7	7	10	21
	L Single Crack			1	7	1	1	5	10
	M Multiple Cracks		10	3	2	2	1	13	36
	H Mult. Cracks w/Potholes			1				1	2
FULL WIDTH TRANSVERSE CRACKING (5)	N None							0	
	L Single Crack		1111	1111111	1111111	111111	1111111	40	
	M Multiple Cracks		111111	11111111	111111	11		26	
	H Mult. Cracks w/Potholes		111		11			4	
LONGITUDINAL CRACKING (6)	N None					4	3	7	14
	L Single Crack		2		2	3	5	12	24
	M Multiple Cracks		4	10	4	2	2	22	44
	H Mult. Cracks w/Potholes		4		4	1		9	18
EDGE CRACKING (7)	N None							0	0
	L Single Crack			3	4		2	9	18
	M Multiple Cracks		9	3		10	6	26	52
	H Mult. Cracks w/Potholes		2	5	6		2	15	30
CRACKING OTHER (8)	N None				2	7	7	16	32
	L Single Crack		3	8	8	3	3	25	50
	M Multiple Cracks		7	2				5	10
	H Mult. Cracks w/Potholes		4					4	8
SURFACE CRACKS (9)	N None		✓	✓	✓	✓	✓	5	100
	P Present							0	
RAVELLING (10)	N None		5	6	7	9	8	35	70
	P Present		7	4	3	1	2	15	30
WHEELPATH RUTTING (MEASURE) (11)	N None							0	0
	L < 3/8"		✓	✓	✓	✓	✓	5	100
	M 3/8" - 3/4"							0	0
	H > 3/4"							0	0
WOENING DROPOFF (MEASURE) (12)	N None							0	0
	L < 3/8"		✓	✓	✓	✓	✓	5	100
	M 3/8" - 3/4"							0	0
	H > 3/4"							0	0

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION (13)	N None	✓	✓	✓	✓	✓	5	100	GRAVEL
	L Single Crack								Shoulders
	M Multiple Cracks								
	H Mult. Cracks w/Potholes								
LANE/SOULDER SEPARATION (MEASURE) (14)	N None	✓	✓	✓	✓	✓	5	100	
	L < 1/4" Sealed								
	M 1/4" - 1"								
	H > 1"								
LANE/SOULDER DROPOFF (MEASURE) (15)	N None								
	L < 1"	✓	✓	✓			3	60	
	M 1" - 2"				✓	✓	2	40	
	H > 2"								
SHOULDER DEFORMATION (16)	N None	✓	✓	✓	✓	✓	5	100	
	P Present								

Figure 3

DISTRESS DATA FORM

Region 6 County STONEMAN Route No. 248 Pin 6042.17.101
 Number of Lanes 7 Survey Pertinent to 2 Lane(s) Direction NES
 Date Insp. 6/11/03 Inspector L. AMMON 1 SALSMAN Sheet 2 of 3

PAVEMENT

FLEXIBLE ☒RIGID ☐

DISTRESS	SEVERITY	SECTION					SUM	REMARKS
		(1)	(2)	(3)	(4)	(5)		
		Beginning 1025	1030	1035	1040	1045		
CORRUGATIONS (A)	N None						141	021
	P Present	2	2	1	2	1	9	18
SETTLEMENTS & HEAVES (B)	N None						0	0
	P Present						21	0
ASPHALT CONC. OVERLAY OR SPRAY PATCH (B)	N None							
	G Good							
	F Fair							
	P Poor							
WHEELPATH CRACKING (C)	N None	4	2	7	2	1	14	26
	L Single Crack	2	1	1	2	2	5	16
	M Multiple Cracks	4	1	2	6	5	23	46
	H Mult. Cracks w/ Patching		1				1	2
FULL WIDTH TRANSVERSE CRACKING (D)	N None						0	0
	L Single Crack						38	0
	M Multiple Cracks						11	0
	H Mult. Cracks w/ Patching						1	0
LONGITUDINAL CRACKING (E)	N None	6				1	7	14
	L Single Crack	2				1	3	6
	M Multiple Cracks	2	10	10	8	2	32	64
	H Mult. Cracks w/ Patching				2	6	8	16
EDGE CRACKING (F)	N None		1				1	2
	L Single Crack	1	1	2	2	1	7	14
	M Multiple Cracks	8	7	8	7	8	38	76
	H Mult. Cracks w/ Patching	1	1		1	1	4	8
CRACKING OTHER (G)	N None	3	3	2	2	1	13	26
	L Single Crack	8	7	6	5	5	31	62
	M Multiple Cracks		1	2	2	2	7	14
	H Mult. Cracks w/ Patching						0	0
SURFACE CRACKS (H)	N None	✓	✓	✓		✓	4	10
	P Present				✓		1	20
RAVELLING (I)	N None	6	6	7	5	2	32	64
	P Present	4	4	3	5	2	18	36
WHEELPATH RUTTING (MEASURE) (J)	N None						0	0
	L < 3/8"		✓	✓	✓	✓	4	80
	M 3/8"-3/4"	✓					1	20
	H > 3/4"						0	0
WOENING DROPOFF (MEASURE) (K)	N None						0	0
	L < 1/8"	✓	✓	✓	✓	✓	5	100
	M 1/8"-3/4"						0	0
	H > 3/4"						0	0

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION (L)	N None	✓	✓	✓	✓	✓	5	100	NO AUSE Shoulder
	L Single Crack								
	M Multiple Cracks								
	H Mult. Cracks w/ Patching								
LANE/SOULDER SEPARATION (MEASURE) (M)	N None	✓	✓	✓	✓	✓	5	100	
	L < 1/4" Sealed								
	M 1/4"-1"								
	H > 1"								
LANE/SOULDER DROPOFF (MEASURE) (N)	N None								
	L < 1"	✓		✓	✓		3	60	
	M 1"-2"		✓			✓	2	40	
	H > 2"								
SHOULDER DEFORMATION (O)	N None	✓	✓	✓	✓	✓	5	100	
	P Present								

Figure 3

DISTRESS DATA FORM

Region 6 County STEARNS Route No. 242 Pin 6048.13.101 PAVEMENT FLEXIBLE
 Number of Lanes 2 Survey Pertinent to 2 Lane(s) Direction N65 FLEXIBLE/RIGID ☐
 Date Insp. 6/11/07 Inspector L. AMMONI & D. SALTMAN Sheet 3 of 3

DISTRESS	SEVERITY	SECTION					TOTAL	REMARKS
		(1)	(2)	(3)	(4)	(5)		
		Beginning	Ending	Beginning	Ending	Beginning		
CORRUPTIONS (2)	N None						15 75	76 30
	P Present						5 25	24 20
SETTLEMENTS & HEAVES (2)	N None						0 -	0 -
	P Present						5 -	46 -
ASPHALT CONC. OVERLAY OR SPRAY PATCH (8)	N None							
	G Good							
	P Poor							
WHEELPATH CRACKING (2)	N None						3 15	47 30
	L Single Crack						1 5	14 12
	M Multiple Cracks						10 50	51 43
	H MULT. CRACKS w/Potholes						6 30	8 6
FULL WIDTH TRANSVERSE CRACKING (2)	N None						0 -	0 -
	L Single Crack						9 -	86 -
	M Multiple Cracks						5 -	42 -
	H MULT. CRACKS w/Potholes						0 -	5 -
LONGITUDINAL CRACKING (2)	N None						0 -	14 12
	L Single Crack						0 -	15 12
	M Multiple Cracks						12 60	66 55
	H MULT. CRACKS w/Potholes						4 40	25 2
EDGE CRACKING (2)	N None						0 -	1 1
	L Single Crack						0 -	16 13
	M Multiple Cracks						15 75	77 66
	H MULT. CRACKS w/Potholes						5 25	24 20
CRACKING OTHER (2)	N None						3 10	31 26
	L Single Crack						11 55	67 56
	M Multiple Cracks						4 20	16 13
	H MULT. CRACKS w/Potholes						3 15	7 5
SURFACE CRACKS (2)	N None						1 50	10 87
	P Present						1 50	2 17
RAVELLING (2)	N None						12 60	70 66
	P Present						3 40	41 34
WHEELPATH RUTTING (MEASURE) (2)	N None						0 -	0 0
	L < 3/8"						2 100	11 84
	M 3/8" - 3/4"						0 -	1 1.6
	H > 3/4"						0 -	0 0
WIDENING DROPOFF (MEASURE) (2)	N None						1 50	1 1.6
	L < 3/8"						1 50	11 34
	M 3/8" - 3/4"						0 -	0 0
	H > 3/4"						0 -	0 0

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION (2)	N None						2 100	12 100
	L Single Crack						0 -	- -
	M Multiple Cracks						0 -	- -
	H MULT. CRACKS w/Potholes						0 -	- -
LANE/SHOULDER SEPARATION (MEASURE) (2)	N None						2 100	12 100
	L < 1/4" / Sealed						0 -	- -
	M 1/4" - 1"						0 -	- -
	H > 1"						0 -	- -
LANE/SHOULDER DROPOFF (MEASURE) (2)	N None						0 -	- -
	L < 1"						2 100	8 67
	M 1" - 2"						0 -	4 33
	H > 2"						0 -	- -
SHOULDER DEFORMATION (2)	N None						2 100	12 100
	P Present						0 -	- -

Figure 3

PIN 6048.13
SR 248
REXVILLE TO ALLEGANY COUNTY LINE
TOWN OF WEST UNION
STEEBEN COUNTY
RMM 248-6402-1000 to 1060
PAVEMENT PATCHES

<u>RMM</u>	<u>Lane</u>	<u>Length</u>	<u>Condition</u>	<u>Location</u>
1000 - 1002	SB	900'	Poor	Edge
1002 - 1004	NB	950'	Poor/Fair	Edge
1006 - 1009	Numerous Pothole Patches			
1009 - 1010	NB	400'	Poor	Edge
1012 - 1013	SB	400'	Poor	Edge
1014 - 1016	SB	750'	Poor	Edge
1016 - 1018	SB	900'	Poor	Edge
1019 - 1020	SB	500'	Fair	Edge
1021 - 1023	SB	700'	Poor	Edge
1026 - 1027	NB	500'	Fair	Edge
1027 - 1028	SB	300'	Poor	Edge
1028 - 1029	SB	150'	Poor	Edge
1032 - 1035	SB	1400'	Poor	Edge
1037 - 1038	NB	300'	Fair	Edge
1041 - 1042	SB	400'	Poor	Edge
1042 - 1057	Numerous Pothole Patches			
1057 - 1058	Both	500'	Poor	Edges & Center
1059 - 1060	SB	1000'	Poor	Edge

Summary:

13 Poor Large Patches
3 Fair Large Patches
Numerous Pothole Patches Throughout

COST ANALYSIS

The following section includes cost estimates for the Reconstruction Alternative and the Reconstruction Areas with Strengthening and Overlay Alternative. These estimates are based on a one-mile long section consisting of an 18' pavement and two 4' shoulders. The estimates do not contain various items that are not core pavement items. This would include guiderail, drainage (culverts and underdrain) and several others that will be necessary to complete the project. The overhead factor is 10% for PE and 12% for CI for a total of 22%.

Total Reconstruction of Pavement

(6.0 miles in Alternative 1 and 0.9 miles in Alternative 2)

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/ Unit</u>	<u>Quantity/ Mile</u>	<u>Cost</u>
203.02	Unclass. Evacuation	CY	6.00	15,253	91,518
203.03	Embankment	CY	5.00	2,542	12,710
15203.51	Clean, Grade, Reshape Ditch	LF	7.00	10,560	73,920
303.01	Opt. Flexible Shoulder	SY	7.00	4,693	32,851
06304.06	Subbase Course	CY	25.00	5,084	127,100
403.11	AC - Base Course	Ton	35.00	2,352	82,320
403.13	AC - Binder Course	Ton	35.00	891	31,185
403.1701	AC - Top Course	Ton	38.00	855	32,490
685.---	Pav't Markings	LF	0.75	21,120	15,840
---	ETC Trailer, Phone, Computer, etc.	LS	10,000	1	10,000
Subtotal					\$509,934
Mobil (4%), M&PoffT (5%), Survey (2%), Cont. (25%) = 36%					<u>183,576</u>
Subtotal					693,510
PE (10%), CI (12%) = 22%					<u>152,572</u>
Total Cost/Mile =					\$846,082

Strengthening Course (3") and 2 1/2" AC Overlay (5.1 Miles)

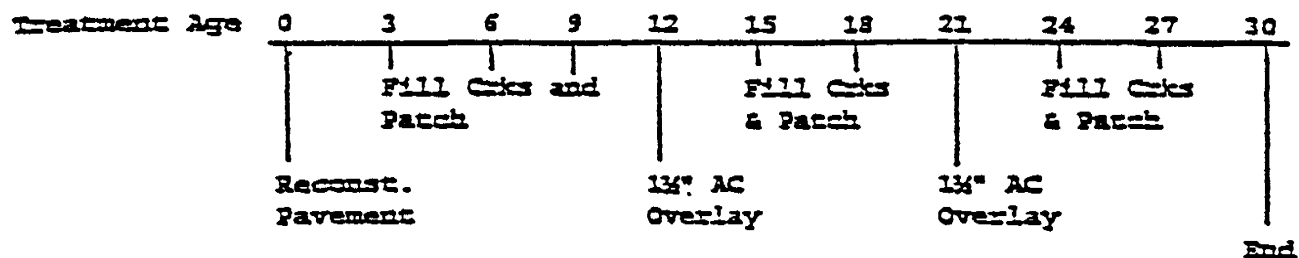
<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/ Unit</u>	<u>Quantity/ Mile</u>	<u>Cost</u>
15203.51	Clean, Grade, Reshape Ditch	LF	7.00	10,560	73,920
303.01	Opt. Flexible Shoulder	SY	7.00	4,693	32,851
403.13	AC - Binder Course	Ton	35.00	891	31,185
403.1701	AC - Top Course	Ton	38.00	855	32,490
403.21	AC - T&L Course	Ton	35.00	1,782	62,370
18403.7502	Clean, Fill and Seal Joints and Cracks	Gal.	10.00	974	9,740
407.0101	Tack Coat	Gal.	2.00	528	1,056
633.0202	Clean Pavement	SY	0.10	10,560	1,056
685.---	Pav't Markings	LF	0.75	21,120	15,840
---	ETC Trailer, Phone, Computer, etc.	LS	10,000	1	10,000
Subtotal					\$270,508
Mobil (4%), M&PoffT (5%), Survey (2%), Cont. (25%) = 36%					<u>97,383</u>
Subtotal					367,891
PE (10%), CI (12%) = 22%					<u>80,936</u>
Total Cost/Mile =					\$448,827

2 1/2" AC Overlay

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/ Unit</u>	<u>Quantity/ Mile</u>	<u>Cost</u>
403.13	AC - Binder Course	Ton	35.00	1.287	45,045
403.1901	AC - Top Course	Ton	38.00	855	32,490
403.21	AC - T&L Course	Ton	35.00	411	14,385
18403.7502	Clean, Fill, & Seal Joints & Cracks	Gal	10.00	519	5,190
407.0101	Tack Coat	Gal	2.00	763	1,526
633.0202	Clean Pavement	SY	0.10	15,253	1,525
685.---	Pavement Markings	LF	0.75	21,120	15,840
---	KIC Trailer, Phone, Computer, etc.	LS	10,000	1	10,000
				Subtotal	126,001
	Mobil (4%), M&Poft (5%), Survey (2%), Cont. (25%) = 36%				<u>45,360</u>
				Subtotal	\$171,361
	FE (10%), CI (12%) = 22%				<u>37,699</u>
				Total Cost/Mile =	\$209,060

LIFE CYCLE CHART

Complete Reconstruction Alternative



No Salvage Value

Description	Year (n)	Present Cost	Present Worth Factor	Present Worth
Reconst. Pavement	0	846,082	1.0000	846,082
Fill Cracks & Patch	3	9,682	0.8890	8,607
Fill Cracks & Patch	6	9,682	0.7903	7,652
Fill Cracks & Patch	9	9,682	0.7026	6,803
1 1/2" AC Overlay	12	119,320	0.6246	74,527
Fill Cracks & Patch	15	9,682	0.5553	5,376
Fill Cracks & Patch	18	9,682	0.4936	4,779
1 1/2" AC Overlay	21	119,320	0.4388	52,358
Fill Cracks & Patch	24	9,682	0.3901	3,777
Fill Cracks & Patch	27	9,682	0.3468	3,358
		\$1,152,496		\$1,013,319
No Salvage Value		<u>0</u>		<u>0</u>
		\$1,152,496		\$1,013,319

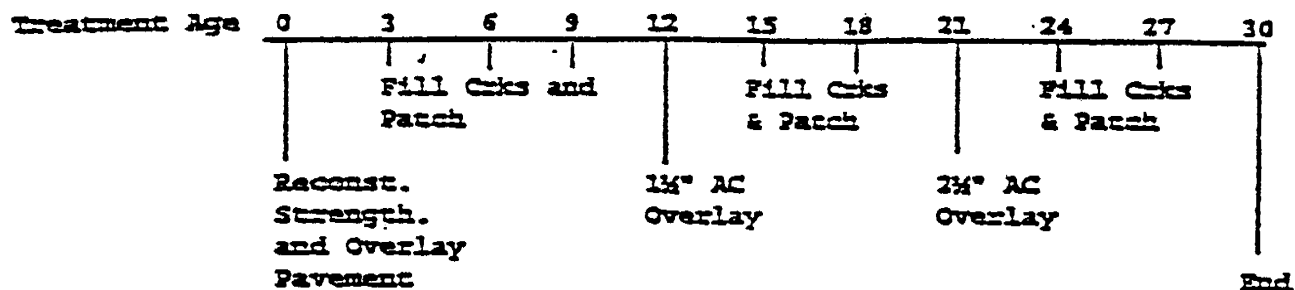
Initial Cost Per Mile = \$ 846,082
 Total Present Cost Per Mile = \$1,152,496
 Total Present Worth Per Mile = \$1,013,319

Annual Cost = Present Worth x (A/P, 4%, 30 years)
 = \$1,013,319 x 0.0578
 = \$ 58,570

Annual Cost of Project - \$58,570 x 6.0 miles = \$ 351,420

LIFE CYCLE CHART

Reconstruction Areas and Strengthening with Overlay Alternative



Salvage Value: 2 1/2" AC Overlay = 1 Yr.

Description	Year (n)	Present Cost	Present Worth Factor	Present Worth
Reconstruct Areas Strengthening & Overlay	0	508,415	1.0000	508,415
Fill Cracks & Patch	3	9,682	0.8890	8,607
Fill Cracks & Patch	6	9,682	0.7903	7,652
Fill Cracks & Patch	9	9,682	0.7026	6,803
1 1/2" AC Overlay	12	119,320	0.6246	74,527
Fill Cracks & Patch	15	9,682	0.5553	5,376
Fill Cracks & Patch	18	9,682	0.4936	4,779
2 1/2" AC Overlay	21	209,060	0.4388	91,736
Fill Cracks & Patch	24	9,682	0.3901	3,777
Fill Cracks & Patch	27	9,682	0.3468	3,358
		\$ 904,569		\$ 715,030
2 1/2" AC Overlay, 1 Yr. Salvage =		<u>-20,906</u>	0.3083	<u>-6,445</u>
		\$ 883,663		\$ 708,585

Initial Cost Per Mile = \$ 508,415
 Total Present Cost Per Mile = \$ 883,663
 Total Present Worth Per Mile = \$ 708,585

Annual Cost = Present Worth x (A/P, 4%, 30 years)
 = \$708,585 x 0.0578
 = \$ 40,956

Annual Cost of Project - \$40,956 x 6.0 miles = \$ 245,736

APPENDIX C
of
PROGRAMMATIC QUALITY ASSURANCE
PAVEMENT REHABILITATION TREATMENT SELECTION PROCESS



**MEMORANDUM
DEPARTMENT OF TRANSPORTATION**

TO: Regional Design Engineer, R - ____

FROM: QA COMMITTEE

SUBJECT: PAVEMENT EVALUATION AND TREATMENT SELECTION REPORT
ROUTE 248 STEUBEN COUNTY, PIN 6048.13

DATE: April 1, 1994

My staff has completed its review of your Region's pavement evaluation and treatment selection report for the subject project. This review was conducted as part of the Department's Programmatic Quality Assurance Program for the Pavement Rehabilitation Treatment Selection Process.

Your report is well prepared, in light of the newness of the pavement evaluation and treatment selection process. A field project review by my staff of this roadway shows that the distress was accurately documented and the selected treatments although not complete were appropriate. Several comments/recommendations were provided that we believe will further improve your preparation of pavement evaluation and treatment selection reports.

Should you have any questions regarding this review, they should be directed to Mike Brinkman of my staff at 518-457-5956.

WJB/MJB
FILE: 16.2
Attach.

c: Regional Materials Engineer
Regional Soils Engineer
Regional Maintenance Engineer

EXAMPLE ONLY

**NEW YORK STATE DEPARTMENT OF TRANSPORTATION
PAVEMENT EVALUATION QUALITY ASSURANCE CHECKLIST**

PIN

6048.13

PROJECT DESCRIPTION

S.R. 248

REVIEWED BY

M. J. BRINKMAN

CANISTEO - WHITESVILLE - STEUBEN CO.

DATE

1-25-94

Item	Complete		Comments Attached
	Yes	No	
1) BACKGROUND INFORMATION (NARRATIVE)			
a) ARE PROJECT DESCRIPTION & LIMITS INCLUDED?	✓		✓
b) ARE ORIGINAL CONTRACT DATE(S) PROVIDED?	✓		
c) ARE ADDITIONAL CONTRACT DATE(S) LISTED?	✓		✓
d) ARE OBSERVED MAINTENANCE ACTIVITIES LISTED?		✓	✓
2) DATA COLLECTION			
a) IS THERE A DRIVE THROUGH DESCRIPTION PROVIDED?	✓		
b) ARE MULTIPLE SECTIONS (BR-46's) INCLUDED? (If required, due to physical or distress characteristics).			
c) ARE DISTRESS DATA SHEETS COMPLETE?	✓		
d) ARE DISTRESSES PROPERLY SUMMARIZED?	✓		✓
e) IS DISTRESS NARRATIVE INCLUDED?	✓		
3) INPUT FROM OTHERS			
a) RESIDENT ENGINEER'S CONCERNS		✓	✓
b) REGIONAL SOILS ENGINEER'S CONCERNS		✓	✓
c) REGIONAL MATERIALS ENGINEER'S CONCERNS	✓		
4) TREATMENT ALTERNATIVES			
a) ARE ALL APPROPRIATE OPTIONS LISTED?		✓	✓
b) ARE REASONS FOR ELIMINATING OPTIONS GIVEN?	✓		
c) IS TIME LINE PROVIDED INCLUDING: SERVICE LIFE, MAINTENANCE NEEDS, FUTURE TREATMENTS?	✓		✓
d) IS A LIFE CYCLE COST ANALYSIS SUMMARY INCLUDED?	✓		✓
e) IS RECOMMENDED ALTERNATIVE PROVIDED?	✓		
f) IF THE RECOMMENDED ALTERNATIVE IS RECONSTRUCTION, IS A PAVEMENT TYPE SELECTION ANALYSIS INCLUDED?			
5) APPENDIX ITEMS			
a) BR 46	✓		
b) BR 47 AND/OR BR 48	✓		
c) INITIAL AND FUTURE TREATMENT COST TABLES	✓		
d) LIFE CYCLE COST ANALYSIS	✓		
e) CORE REPORT	✓		

**CHECKLIST
SECTION**

**PETSR COMMENTS
P.J.N. 6048.13**

- 1a) There is an apparent conflict between the original 18' wide pavement description and the Distress Data Form which identifies Widening Dropoff distress. Any widening that occurred should be detailed in the project description.
- 1c&d) The PETSR offers a concise history of the roadway which is useful in establishing the material make-up of the roadway and assist in selecting the appropriate treatment alternative. However, it should be noted that there appears to be a discrepancy between past "contract work" and core reports. Historical records indicate AC overlay thickness should be 2 1/2" to 3". Core reports identifies 7" of AC. This indicates significant maintenance work was performed. This should be addressed by reviewing Residency records. Timing of maintenance overlays would probably be helpful in estimating service lives of future treatments.
- 2d) Data collection is thorough , neat and accurate, however when completing the "Distress Summary Form" it is only necessary to summarize the extent of distress encountered on the final page of the report. It is not necessary to summarize each individual Distress Form.
- Location and spacing of full-depth removal areas identified for Alternative 2 may influence costs. A table detailing the reference marker location of full depth repairs would be helpful.
- 3a&b) No reference is made in the report that either the Resident Engineer or the Soils Engineer were contacted . Either one could have significant input, as discussed in Comment 1c, that could assist in determining treatment alternatives. It is imperative that all the appropriate personnel be contacted for their input. These contacts should be noted in the report. If they were contacted and had no significant input this should also be noted in the report.
- 4a) Although the report lists several treatment alternatives it is felt that two additional treatment alternatives should have been considered. Based on the recorded distress the alternative of removing the existing overlay, followed by crack and seating with a multiple course overlay could be appropriate.

The second alternative worth considering is rubblizing. Review of the PETSR shows that the 18' wide original pavement had been previously

widened and the widening is exhibiting light severity dropoff distress. Rubblizing is a viable alternative when pavement widening is present or required. This issue should have been discussed.

- 4c) For each initial treatment selected, the timelines show 12 years to the first overlay. The Pavement Rehabilitation Manual, Volume 2, identifies a 15 year service life for these treatments and these are based on AADT's of 12,000 to 35,000 with about 5% trucks. Since the AADT for Route 248 is only 275 we would expect a longer rather than shorter service life.

Also, when service lives other than those identified in Volume 2 are selected they should be justified. For example, service performance of past contract and maintenance treatments on the existing roadway would be very beneficial in establishing treatment service lives.

- 4d) Cost calculations for areas of full depth replacement described in the PETSR as Alternative 2 appears to have been estimated as if the reconstruction was a continuous run, when in fact they will be scattered along the length of the project. This could significantly increase the cost of the project.

**COMPREHENSIVE PAVEMENT
DESIGN MANUAL**

**Chapter 3: Appendix 3C
Vacant (See HDM Ch 7)**

January 23, 2009

**COMPREHENSIVE PAVEMENT
DESIGN MANUAL**

**Chapter 3: Appendix 3D
Vacant (See HDM Ch 7)**

January 23, 2009

**COMPREHENSIVE PAVEMENT
DESIGN MANUAL**

Chapter 3: Appendix 3E

Vacant (See HDM Ch 7)

January 23, 2009

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 4 - New Construction/Reconstruction (Limited Revisions)

Revision 1

July 2, 2002

CHANGES TO CHAPTER 4

<u>Pages</u>	<u>Changes</u>
Contents	List of Figures and Tables included.
4-3	Table 4-1. 'Percent Trucks' column math symbols were clarified.
4-6	Section 4.5.1.1.A, second and third paragraphs. Updated references to Chapter 6.
4-12	Figure 4-2. Deleted reference to Asphalt Treated Permeable Base (ATPB). Enlarged figure for clarity.
4-13	Table 4.4. 'ESAL' column math symbols were clarified.
4-15	Figure 4-3. Specifically reference Asphalt Treated Permeable Base (ATPB). Enlarged figure for clarity.
4-16	Table 4.5. 'ESAL' column math symbols were clarified. Table 4.5. First row of 'Total HMA Thickness' column in all cases updated to agree with new Chapter 6 guidance.

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CHAPTER 4 NEW CONSTRUCTION/RECONSTRUCTION

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4.1 INTRODUCTION

This chapter describes the methods of selecting pavement thickness for new construction and reconstruction projects. Pavement design procedures are classified herein as conventional (Section 4.4) or as equivalent single axle load ESAL-based (Section 4.5), which was formerly issued as the *New York State Thickness Design Manual for New and Reconstructed Pavements* dated October 31, 1994.

4.2 PAVEMENT TYPE SELECTION

Each new construction or reconstruction project should be evaluated to determine the most appropriate type of pavement. The current pavement selection method, Pavement Type Selection Analysis, uses several factors for comparing suitable options, and is outlined in Chapter 3 of this manual. The method examines the project's life-cycle cost rather than only the first cost.

4.3 PAVEMENT DESIGN PROCEDURE DETERMINATION

Projects over 1.5 km in length, exclusive of bridges, should be designed in accordance with the ESAL-based design procedures given in Section 4.5. New pavement projects less than 1.5 km in length may be exempted by the Regional Design Engineer and may be designed in accordance with the conventional design procedures in Section 4.4.

Widening projects should use a pavement section that is consistent with the existing pavement design. Typically, this means that the thickness of each layer of the widened section should match the existing pavement. When the existing pavement layers are exceedingly thick, there may be a structural problem with the existing pavement. Refer to Chapter 2 of this manual for more information. It is also important that the effectiveness and continuity of any existing drainage layers be maintained or enhanced. The goal is to develop a widened section that responds the same to frost, traffic loads and other effects as the existing section does. See Chapter 5 of this manual for additional information about lane additions and widenings.

4.4 CONVENTIONAL PAVEMENT DESIGN

Conventional pavement design is based on both the amount of traffic volume and the percentage of trucks. Table 4-1 gives the pavement thicknesses that should be used for given traffic volumes.

Conventional Portland Cement Concrete (PCC) pavement should be built with 5.5 m long, unreinforced slabs when used on new construction projects. Designers working with older roads should be aware that some PCC pavements were built with reinforced 18 m (60-foot) and even 30 m (100-foot) slabs. When placed adjacent to existing slabs, the new pavement should match the existing pavement cross section, and the transverse joints should be made at the same locations as the existing joints. Refer to Standard Sheet M502-1 for reinforcement details and Chapter 8 of this manual for joint design. For PCC design, the first two slabs following the departure bridge approach slab should be reinforced PCC.

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4.4.1 Conventional Pavement Design Procedure

1. Obtain the Annual Average Daily Traffic (AADT) and the Percent Trucks for the project from the Highway Sufficiency Ratings or from the Regional Planning Office.
2. If the project is an Interstate highway refer to the minimum requirements outlined below.
3. Determine the pavement thickness from Table 4-1.
4. If the pavement is hot mix asphalt (HMA) determine the SUPERPAVE top, binder, and base course items as given in Chapter 6 of this manual.
5. Determine the shoulder design based on guidelines in Chapter 7 in this manual.
6. Determine the drainage design, if needed, based on guidelines in Chapter 9 in this manual.

4.4.2 Interstate Highway Conventional Pavement Requirements

For the Interstate system, the following are minimum requirements for conventional pavement design.

1. The minimum PCC pavement thickness is 225 mm.
2. If HMA pavement is selected, use ≥ 10 % truck traffic for the pavement design.
3. The joint between PCC mainlines and HMA ramps should be at the first transverse joint beyond the separation of mainline and ramp pavements. The change in pavement type should be at right angles to the ramp.
4. If an interchange ramp is to be built of HMA pavement it should have a minimum combined thickness for top, binder and base courses of 155 mm. The ramp pavement thicknesses should also satisfy the values shown in Table 4-1. When selecting pavement thickness or type (HMA or PCC) for ramps, consideration should be given to heavy truck destination points in the immediate vicinity, such as truck terminals or refueling areas, and the pavement thickness increased accordingly.
5. PCC pavement may be used on high speed ramps 80 km/h or greater, to preserve continuity with a PCC paved mainline. PCC pavement should be used on lower speed ramps less than 80 km/h, when shoving of the HMA pavement is anticipated.

Table 4-1 Conventional Pavement Thickness Guide

Annual Average Daily Traffic AADT ¹	Percent Trucks	Subbase Course (all Pavements)	Portland Cement Concrete Pavement	Hot Mix Asphalt Pavement	
				Base Course	Top & Binder Courses Combined ²
Over 10,000 Vehicles	10 % or more	300 mm	250 mm	150 mm	90 mm
	less than 10 %			125 mm	
6,000 to 10,000	10 % or more	300 mm	225 mm	125 mm	90 mm
	less than 10 %			100 mm	
4,000 to 5,999	All	300 mm	Not Applicable	75 mm	90 mm
Under 4,000 Vehicles	All	300 mm	Not Applicable	75 mm	80 mm

¹ See Section 4.5.1.1.B for AADT definition.

² This is for SUPERPAVE HMA - see Chapter 6 of this manual for individual course thicknesses.

4.5 ESAL-BASED PAVEMENT DESIGN

ESAL-based pavement design is based on the *American Association of State Highway and Transportation Officials (AASHTO) 1993 Guide for the Design of Pavement Structures*, referred to in this manual as the *1993 AASHTO Pavement Design Manual*. Equivalent single axle loads (ESAL) are used for determining pavement thickness and the design relies on using a treated open-graded permeable base layer with continuous edge drains in the pavement structure to provide positive drainage.

The key input variable in the ESAL-based design process is the anticipated amount of heavy truck traffic. The truck traffic is measured and converted to a number of 80 kN ESALs. Section 4.5.1 provides the steps for calculating ESALs using available NYSDOT traffic data.

The *1993 AASHTO Pavement Design Manual* provides a reasonable methodology in designing for adequate structural capacity of the pavement structure. However, it neglects to account for lack of uniform support in the subgrade due to nonuniform, frost-susceptible soils, or to provide adequate support for construction equipment due to unstable subgrade soils. Numerous subgrade improvement methods have been used by NYSDOT in the past to account for these situations.

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For PCC pavements the *1993 AASHTO Pavement Design Manual* method was modified for NYS conditions. A mechanistic-empirical design procedure (M-E procedure) was used to predict pavement performance. A nondimensional performance model for New York State was developed using pavement response to the combined effects of temperature and traffic loading, calibrated with actual pavement performance and 90 % reliability. Miner's hypothesis was used to sum the damage caused by traffic and environmental loading. Pavement response was determined with actual physical dimensions, material properties, soil support, temperature gradients, and traffic from New York State DOT pavements.

The M-E procedure uses principles of engineering mechanics to calculate pavement response and relate them to rates of deterioration. Therefore, once the M-E procedure has been calibrated with serviceability vs. time histories of pavement structures, developing possible pavement performance for conditions outside the study area by calculating stresses is feasible. The PCC thicknesses for Table 4-4 were developed using the M-E procedure.

For flexible (HMA) pavements, the other input variable is the load carrying capability of the materials below the pavement or the Subgrade Resilient Modulus (M_r). This modulus is dependent on the characteristics of the underlying soil. The value of the modulus for given locations may be obtained from the Regional Geotechnical Engineer. The HMA thicknesses for Table 4-5 were derived from the *1993 AASHTO Pavement Design Manual* and include the overall HMA thickness exclusive of the permeable base layer.

ESAL-based pavement is designed to be a long lasting, low maintenance, smooth riding pavement system. Major component differences compared to conventional pavement designs account for increased pavement life as follows:

1. Thicker PCC pavement slabs (up to 325 mm thick).
2. Thicker flexible pavement subbase course(s) (up to 900 mm thick).
3. Locating the longitudinal joint between shoulders and driving lane 0.6 m outside of the travel lane.
4. Subsurface pavement drainage via a 100 mm thick treated permeable base with continuous edge drains outletting approximately every 75 m.
5. Subbase is considered impermeable, so water drains through permeable base layer and does not penetrate subbase.

Currently in New York State, pavements are designed for a 50-year life. The 50-year life expectancy is based on observations of the longevity of European pavements and our own history of pavements in New York State. Our first ESAL-based pavements were built in 1993, and have performed quite well since then. This longer 50-year design life is predicated on the structural integrity of the pavement structure as a whole. A flexible pavement obviously will require some kind of rehabilitation (probably periodic thin overlays or recycling of the existing asphalt due to the aging process) during this 50-year period. This should be incorporated into the life-cycle cost analyses. Rigid pavements will require preventive maintenance and minor rehabilitation (such as joint resealing and surface grinding to restore friction) during the 50-year design life.

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4.5.1 ESAL Calculation

ESALs, or 80-kN Equivalent Single Axle Loads, is an important input parameter for the pavement thickness design tables. Traffic on a pavement structure includes numerous types of vehicles with varying weights and axle configurations (mixed traffic). The anticipated traffic damage over a pavement's entire design life from all load combinations must be converted to a fixed traffic factor or an ESAL, to be incorporated into the design equations from the *1993 AASHTO Pavement Design Manual*.

NYSDOT uses the AASHTO "simple" method for obtaining ESALs for pavement design. This method uses a Truck Equivalency Factor to account for all trucks using the pavement (FHWA Vehicle Classes 4 through 13). FHWA's 13 category vehicle classification system, also known as FHWA scheme F, categorizes vehicles according to axle geometry and vehicle type. The classification system assigns motorcycles to class 1, with the classes representing progressively heavier vehicles up to class 13 for trucks with 7 axles or more and multiple trailers. Class 4 vehicles are buses. Class 5 vehicles are 2 axle, 6 tire single unit trucks. Vehicles with heavier axle loads do exponentially more damage to the pavement structure and this loading damage accumulates over the design life of the pavement. Lighter vehicles (motorcycles, passenger cars, etc.) make little contribution to damaging the pavement structure.

ESALs are a measurement of load repetitions which accumulate and cause pavement damage. The pavement thickness is designed for the projected number of ESALs over the pavement's design life. ESALs calculated for PCC pavements are not the same as those calculated for HMA pavement due to the Truck Equivalency Factor. For the same road section, ESALs calculated for rigid pavement are about 40 % greater than ESALs calculated for flexible pavement.

AASHTO has another procedure, the "rigorous" method, which calculates site specific equivalency factors for each vehicle classification. Presently there is not sufficient data to use the "rigorous" method and only the "simple" method is used to calculate ESALs.

4.5.1.1 Inputs for ESAL Calculation

Most inputs for ESAL calculation are found in the NYSDOT Highway Sufficiency Ratings, which is arranged by New York State route number, county, and reference marker number. If the data in the Highway Sufficiency Ratings is more than 3 years old, contact the Regional Planning Office for a classification count and the percentage of heavy trucks. Contact the Regional Planning Group, the Main Office Data Services Bureau, or the Geotechnical Engineering Bureau with questions about traffic information or data. All traffic inputs are described in the following pages.

F. Pavement Design Life

As defined by AASHTO, this is the initial performance period of the pavement structure in years. The design life is the useful life of the pavement structure and drainage system after

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which time the road may need total reconstruction from the subbase up. **For ESAL-based pavement design, use 50 years as the design life to calculate the ESAL value to determine the total thickness of the pavement, exclusive of the permeable base and subbase layers.** Paragraphs B through H in Section 4.5.1.1 provide guidance on calculating the site-specific 50-year ESAL value. For PCC pavements, use the 50-year ESAL value to determine the slab thickness from Table 4-4. For HMA pavements, use the 50-year ESAL value to determine the total HMA thickness (combined thickness of base, binder, and top courses) from Table 4-5.

CAUTION: Design life should not be confused with the service life of pavements as explained in the *Pavement Rehabilitation Manual, Volume II, Treatment Selection*, (Appendix 5A of this manual). **For HMA designs**, calculate the 20-year ESAL count to determine the aggregate size and pay item of each course (see Chapter 6, HMA Item Selection Guidelines) using the following specific values, as well as the appropriate values from paragraphs B through F in Section 4.5.1.1:

- Annual Truck Weight Growth Rate = 0.5%
- Annual Truck Volume Growth Rate = 2.0%
- Percent Trucks in Design Lane: 1 lane = 100; 2 lanes = 85; 3 lanes = 70; 4 lanes = 60.

The sum of all HMA course thicknesses should equal or exceed the total HMA thickness required by Table 4-5 based on the 50-year ESAL value. See Chapter 6, Special Note Development, for the wording of the special note required in the proposal, which conveys to the Contractor the Performance Graded Binder (PGB) grade and the 20-year ESAL level.

G. Initial AADT (Average Annual Daily Traffic)

This is the 24-hour two-way vehicle count in all lanes for a pavement structure when opened to traffic. Choose the highest AADT value provided in the Highway Sufficiency Ratings within the project limits.

H. Percent Heavy Trucks (FHWA Class 4 or Greater)

This is the percentage of vehicles in the average daily traffic flow that are in FHWA Class 4 or higher. This percentage is assumed to remain constant over the design life unless other information is available, such as a proposed new truck route or a new business requiring a lot of trucking, in which case the percentage should be modified.

I. Percent Trucks in Design Direction

This is a directional distribution factor applied to the two-way AADT to account for any variations in truck traffic volumes or truck weights by direction. Normally, this factor is

50 percent, but in special cases where one direction of travel has either larger traffic volume or heavier vehicles, this factor may increase. Request a classification count for a specific site for a more accurate directional distribution factor.

J. Percent Trucks in Design Lane

This is a lane distribution factor which accounts for the percentage of trucks in the design lane. On a multilane roadway, truck traffic will be found in all lanes, but only the lane with the majority of truck traffic is called the "design lane". The design lane is typically the driving lane or the right lane and the pavement design for the other lanes is based on this lane. Table 4-2 lists the distribution factors for Percent Truck in Design Lane which the *1993 AASHTO Pavement Design Guide* recommends. The designer may wish to refine these values by requesting a classification count.

Table 4-2 Percent Trucks in Design Lane

Number Of Lanes In Each Direction	Percent Of Trucks In Design Lane
1	100
2	80-100
3	60-80
4	50-75

F. Truck Equivalency Factor (ESALs/Truck)

This is a weighted average which represents the number of 80-kN ESAL applications caused by a single passage of an average heavy vehicle. Equivalency factors may vary by as much as a factor of 2, depending on local industry, highway classification, and pavement type. The factors listed in Table 4-3 should generally be used unless the Regional Planning Office indicates that local truck traffic warrants adjusting the factors. These factors are based on weight data obtained from the limited number of weigh-in-motion sites in New York State and may be recalculated in the future when more data becomes available.

Table 4-3 Truck Equivalency Factor For ESAL Calculation

FHWA Vehicle Classifications	Flexible Pavement (HMA)	Rigid Pavement (PCC)
4 - 13	1.35	1.85

G. Annual Truck Volume Growth Rate

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Expressed as a percent, this is used to specify the anticipated annual growth rate of the truck traffic volume compounded over a pavement's design life. Because this rate is compounded, the ESALs accrue quickly over 50 years, so the designer should be careful when selecting a value. Typical values are between 0 % and 2 % per year. The annual traffic volume growth rate for the general traffic stream may be used if no values are available for trucks alone. These growth rates are calculated every year based on the previous 15 years of traffic volume and are tabulated by Region and functional class. Contact the Regional Planning Group for the annual truck volume growth rate. When no other information is available use a rate of 1%.

H. Annual Truck Weight Growth Rate

The Annual Truck Weight Growth Rate is a factor which accounts for the increase in truck weights over time. It is expressed as a percentage and typically ranges from 0 % to 4% per year. A high growth rate can cause a dramatic increase of ESALs over the life of the pavement structure. NYSDOT does not currently have enough data to predict the increase of truck weights. When no other information is available use a rate of 0.5 %.

4.5.1.2 ESAL Calculation Worksheet

Use the work sheet below to calculate the total ESAL count using AASHTO's "simple" method for a compound traffic volume growth rate. This ESAL count is used to find the pavement thickness and for SUPERPAVE calculations. Contact the Pavement Design Services Group of the Geotechnical Engineering Bureau for an electronic spreadsheet of this worksheet or download the spreadsheet located on the Intradot: CADD Innovation Section/Quattro Pro File Exchange/esal vx.wb3.

Figure 4-1 ESAL Calculation Worksheet for the "Simple" Method

Input Parameters:	
1. Design Life =	_____ years
2. Initial AADT =	_____ vehicles
3. Percent Heavy Truck (Class 4 or greater) =	_____ %
4. Percent Trucks in Design Direction =	_____ %
5. Percent Trucks in Design Lane =	_____ %
6. Truck Equivalency Factor =	_____
7. Annual Truck Volume Growth Rate =	_____ %
8. Annual Truck Weight Growth Rate =	_____ %
Traffic Analysis for Pavement Design:	
9. Traffic Volume Growth Factor	
$[1 + \text{Item 7}]^{(\text{Item 1} - 1)}$ =	_____
10. Truck Growth Factor	
$[1 + \text{Item 8}]^{(\text{Item 1} - 1)}$ =	_____
11. Design Year AADT	
Item 2 x Item 9 =	_____
12. Average AADT	
$(\text{Item 2} + \text{Item 11}) / 2$ =	_____
13. Design Year Truck Factor	
Item 6 x Item 10 =	_____
14. Average Truck Factor	
$(\text{Item 6} + \text{Item 13}) / 2$ =	_____
15. AADT in One Direction	
Item 12 x Item 4 =	_____
16. Truck AADT in One Direction	
Item 15 x Item 3 =	_____
17. Daily 80 kN (18 kip) ESAL Count	
Item 16 x Item 14 =	_____
18. Total 80 kN (18 kip) ESAL Count	
Item 17 x 365 x Item 1 x Item 5 =	_____

4.5.2 PCC Pavement

The design of PCC pavement in New York State is based on a mechanistic-empirical approach as described in Section 4.5. This design method should be used in close conjunction with Chapter 8 of this manual, PCC Standard Sheets M502 series, and Section 502 of the NYSDOT Standard Specifications.

4.5.2.1 PCC Pavement Design Procedure

The steps for designing an ESAL-based PCC pavement are as follows:

1. Divide the project into different sections depending on traffic volumes and driving lane widths.
2. Calculate ESALs - see Section 4.5.1.
3. Determine the type of shoulders to be used - see Chapter 7 of this manual. Note one side of the road may have a PCC shoulder and other side an HMA shoulder.
4. Determine the driving lane slab width - see Section 4.5.2.2 below.
5. Determine pavement thickness from Table 4-4 below based on ESALs and lane width.
6. Determine the maximum tie bar spacing based on the number of lanes, whether it is a shoulder/lane joint, and either PCC or HMA shoulders from the Longitudinal Tie Bar Maximum Spacing Table in Standard Sheet M502-11. If the number of lanes changes then the tie bar spacing should change.
7. Determine dowel bar diameter based on pavement thickness from the Transverse Dowel Bar Diameter Table in Standard Sheet M502-11.
8. Select a drainage system, including the type of permeable drainage layer, and outletting protocol as shown in Section 9.3 of this manual. Where drainage outletting is difficult see Section 9.2.1 of this manual.
9. Layout the transverse and longitudinal joints according to instructions in PCC Standard Sheet M502-11. If there will be utility structures in the lanes, follow the utility isolation and joint layout instructions in PCC Standard Sheet M502-17. Questions regarding transverse and longitudinal joints should be addressed to the Field Engineering 2 Section of the Main Office Materials Bureau.

4.5.2.2 PCC Pavement Driving Lane Slab Width and Length

The recommended driving lane slab width is 4.2 m, which amounts to a standard 3.6 m lane plus a 0.6 m extension onto the shoulder. For a 2-lane highway (one lane in each direction), both lanes should have a 4.2 m slab width. With multilane highways, the 4.2 m slab width should only be used for the right hand outside lane and not for the center or left lanes. This is because there is more traffic in the right hand lane (especially truck traffic), so this lane gets the most damage. The joint at the pavement edge, between the driving lane and the shoulder, deteriorates quicker than the other joints, since traffic runs close to or over the joint. The wide slab (4.2 m) spreads the load over a larger area and moves the pavement edge onto the shoulder, reducing the stresses and thus the distress at the edge of the pavement. To account for the large magnitude of stresses at the pavement edge, narrow slabs (3.6 m) must be thicker than wide slabs (4.2 m). A wide thin slab can handle a similar number of load applications as a narrow thick slab.

Sometimes it is not possible to construct a wide driving lane slab (4.2 m), so a standard slab width (3.6 m) is used. If this occurs for transitions to exit and entrance ramps, where the driving lane changes to a middle or center lane, do not change the slab thickness, keep it the same as the rest of the project. Ramps have less ESALs than the highway mainline. For other cases, contact the Field Engineering 1 Section of the Main Office Materials Bureau to assist with the design, since the slab length may have to be changed to compensate for the slab width change.

For typical applications, the driving lane slab should be longitudinally tied to the shoulder slab, whether it is a 4.2 m or 3.6 m wide slab. Although for special cases untied shoulders and HMA shoulders may be used, they may cause premature deterioration of both the shoulder and the driving lane compared with the tied shoulder case. Chapter 8 of this manual discusses when untied longitudinal joints are appropriate. The PCC thicknesses in Table 4-4 are valid for tied or untied shoulders and either PCC or HMA shoulders.

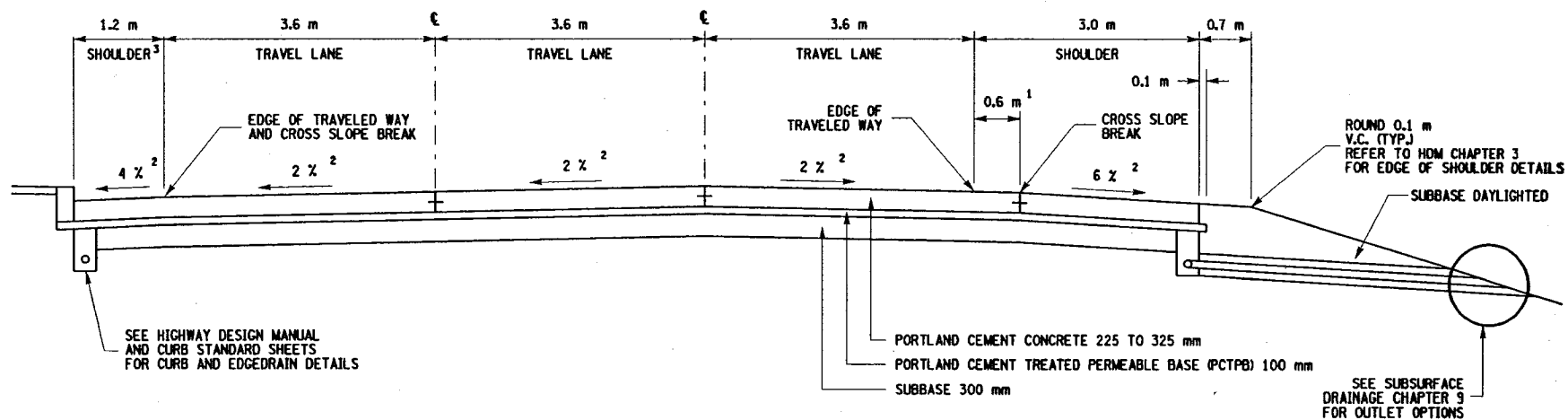
The shoulder and the abutting travel lane may be placed in a single pour as discussed in Section 7.3 of this manual. The typical slab length is 5.5 m, but this may be reduced to a minimum of 3.5 m to satisfy site conditions such as utilities or interruptions in the pavement. The slab aspect ratio (width/length) must conform to that shown on Standard Sheet M502-17, Note 3a. The maximum slab width and length are both 5.5 m.

4.5.2.3 Typical PCC Pavement Section

A typical PCC pavement section is shown in Figure 4-2. This typical section is shown for reference purposes for the text only. Refer to Standard Sheet M502-11 and HDM Chapter 3 for further details and guidance on the development of typical sections.

FIGURE 4-2

TYPICAL PORTLAND CEMENT CONCRETE PAVEMENT SECTION



THE DIMENSIONS SHOWN ARE TYPICAL ONLY AND THE DETAILS ARE SHOWN TO GIVE THE DESIGNER AN IDEA OF WHAT THE OVERALL SECTION LOOKS LIKE.

1. THE DRIVING LANE SLAB WIDTH IS 4.2 m, OF WHICH 3.6 m IS THE TRAVEL LANE AND 0.6 m IS PART OF THE SHOULDER.
2. REFER TO THE HIGHWAY DESIGN MANUAL, CHAPTERS 2 AND 3, FOR THE PROPER CROSS SLOPE AND FURTHER GUIDANCE ON THE DEVELOPMENT OF TYPICAL SECTIONS.
3. IN THIS CASE THE SHOULDER (1.2 m) AND THE TRAVEL LANE (3.6 m) ARE POURED AS ONE SLAB WITH NO LONGITUDINAL JOINT IN BETWEEN THEM. SEE SHOULDER CHAPTER 7 FOR MORE INFORMATION.

4.5.2.3 PCC Pavement Thickness

The pavement thickness for all adjacent lanes is dependent on the amount of traffic (ESALs) and the driving lane slab width, and is given in Table 4-4 below. Use a minimum slab thickness of 250 mm for all interstate highways.

Table 4-4 PCC Thickness Table

80-kN ESALs	PCC Slab Thickness 4.2 m driving lane slab width	PCC Slab Thickness 3.6 m driving lane slab width
millions	mm	mm
ESALs $\leq$ 22	225	225
22 < ESALs $\leq$ 36	225	250
36 < ESALs $\leq$ 65	225	275
65 < ESALs $\leq$ 100	250	300
100 < ESALs $\leq$ 165	275	325
165 < ESALs $\leq$ 250	300	325 ¹
250 < ESALs $\leq$ 400	325	325 ¹

¹ For ESALs over 165 million, 3.6 m untied slabs may not be used for the right hand driving lane. Use either 3.6 m tied slabs, 4.2 m untied slabs, or 4.2 m tied slabs.

4.5.3 HMA Pavement

ESAL-based design of HMA pavement is based on the SUPERPAVE system in New York State. This section describes the steps for designing a full depth HMA pavement for new construction/reconstruction and provides the overall asphalt thickness of the pavement and subgrade. Chapter 6 of this manual, provides guidance on determining the thickness of the individual SUPERPAVE HMA courses that make up the overall asphalt pavement thickness.

4.5.3.1 HMA Pavement Design Procedure

The steps for designing an ESAL-based HMA pavement are as follows:

1. Divide the project into different sections depending on significant traffic volume differences and complete the following steps for each section.
2. Calculate ESALs - see Section 4.5.1.
3. Determine the type of shoulders to be used - see Chapter 7 of this manual.
4. Determine the subgrade resilient modulus, M_r - see Section 6.6.2 of this manual for a description of M_r and contact the Regional Geotechnical Engineer for an M_r value.
5. Determine pavement thickness from Table 4-5 based on ESALs.
6. Select a drainage system, including the type of permeable drainage layer, and outletting protocol as shown in Section 9.3 of this manual. Where drainage outletting is difficult see Section 9.2.1 of this manual.
7. Select the individual SUPERPAVE top, binder, and base course items according to the Item Selection Guidelines in Chapter 6 of this manual.

Questions regarding HMA pavement design should be addressed to the Field Engineering 2 Section of the Main Office Materials Bureau.

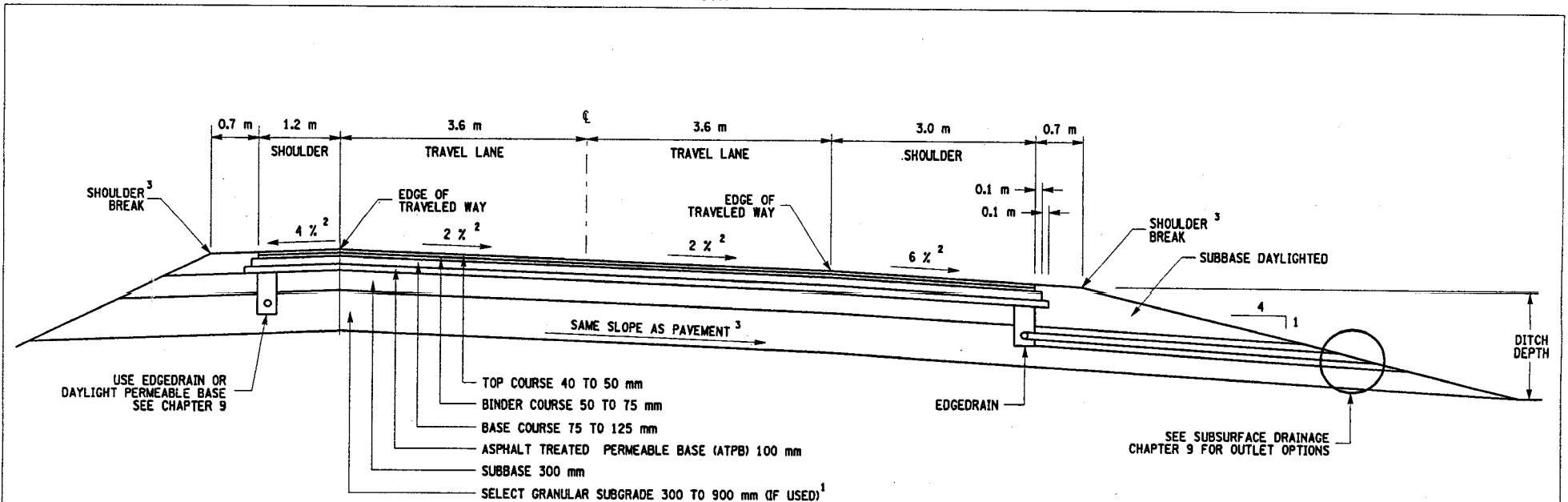
When Select Granular Subgrade is utilized, the lateral limit shall be at daylight on embankment slopes or at the extension of the ditch backslope in cut sections. The thickness shall be held constant under the traveled way. The bottom of the Select Granular Subgrade should be parallel to the bottom of the subbase as shown in Figure 3-3 of HDM Chapter 3.

4.5.3.2 Typical HMA Pavement Section

A typical HMA pavement section is shown in Figure 4-3. This section is shown for reference purposes for the text only. The HDM Chapter 3 contains guidance on the development of typical sections.

FIGURE 4-3

TYPICAL HOT MIX ASPHALT PAVEMENT SECTION



THE DIMENSIONS SHOWN ARE TYPICAL ONLY AND THE DETAILS ARE SHOWN TO GIVE THE DESIGNER AN IDEA OF WHAT OVERALL SECTION LOOKS LIKE.

1. SEE CHAPTER 6 FOR MORE INFORMATION OR CONTACT REGIONAL GEOTECHNICAL ENGINEER FOR NECESSITY AND THICKNESS OF SELECT GRANULAR SUBGRADE. DAYLIGHT SELECT GRANULAR SUBGRADE ONTO EMBANKMENT SLOPES OR AT THE EXTENSION OF THE DITCH BACKSLOPE IN CUT SECTIONS.
2. REFER TO THE HIGHWAY DESIGN MANUAL, CHAPTERS 2 AND 3, FOR THE PROPER CROSS SLOPE AND FURTHER DEVELOPMENT OF TYPICAL SECTIONS.
3. REFER TO THE HIGHWAY DESIGN MANUAL, CHAPTER 3, FOR SUBGRADE GRADE CHANGES AND EDGE OF SHOULDER DETAILS.

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4.5.3.3 HMA Pavement Thickness

The pavement thickness for all lanes is dependent on the subgrade resilient modulus, M_r , and the amount of traffic in the driving lane (ESALs) and is given in Table 4-5 below. Contact the Regional Geotechnical Engineer to obtain the M_r design value, and also when site conditions would make it difficult to provide the required subbase course and/or select granular subgrade layer thicknesses.

Table 4-5 HMA Thickness Table

$M_r = 28 \text{ MPa}$		
80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ 2	165	0
$2 < \text{ESALs} \leq 4$	175	0
$4 < \text{ESALs} \leq 8$	200	0
$8 < \text{ESALs} \leq 13$	225	0
$13 < \text{ESALs} \leq 23$	250	0
$23 < \text{ESALs} \leq 45$	250	150
$45 < \text{ESALs} \leq 80$	250	300
$80 < \text{ESALs} \leq 140$	250	450
$140 < \text{ESALs} \leq 300$	250	600

$M_r = 34 \text{ MPa}$		
80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ 4	165	0
$4 < \text{ESALs} \leq 7$	175	0
$7 < \text{ESALs} \leq 13$	200	0
$13 < \text{ESALs} \leq 23$	225	0
$23 < \text{ESALs} \leq 40$	250	0
$40 < \text{ESALs} \leq 70$	250	150
$70 < \text{ESALs} \leq 130$	250	300
$130 < \text{ESALs} \leq 235$	250	450
$235 < \text{ESALs} \leq 300$	250	600

$M_r = 41 \text{ MPa}$		
80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ 6	165	0
$6 < \text{ESALs} \leq 11$	175	0
$11 < \text{ESALs} \leq 20$	200	0
$20 < \text{ESALs} \leq 35$	225	0
$35 < \text{ESALs} \leq 60$	250	0
$60 < \text{ESALs} \leq 110$	250	150
$110 < \text{ESALs} \leq 200$	250	300
$200 < \text{ESALs} \leq 300$	250	450

$M_r = 48 \text{ MPa}$		
80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ 8	165	0
$8 < \text{ESALs} \leq 16$	175	0
$16 < \text{ESALs} \leq 30$	200	0
$30 < \text{ESALs} \leq 50$	225	0
$50 < \text{ESALs} \leq 85$	250	0
$85 < \text{ESALs} \leq 160$	250	150
$160 < \text{ESALs} \leq 300$	250	300

$M_r = 55 \text{ MPa}$		
80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ 12	165	0
$12 < \text{ESALs} \leq 20$	175	0
$20 < \text{ESALs} \leq 40$	200	0
$40 < \text{ESALs} \leq 65$	225	0
$65 < \text{ESALs} \leq 115$	250	0
$115 < \text{ESALs} \leq 215$	250	150
$215 < \text{ESALs} \leq 300$	250	300

$M_r = 62 \text{ MPa}$		
80 kN ESALs over Design Life	Total HMA Thickness	Select Granular Subgrade Thickness
millions	mm	mm
ESALs ≤ 15	165	0
$15 < \text{ESALs} \leq 30$	175	0
$30 < \text{ESALs} \leq 50$	200	0
$50 < \text{ESALs} \leq 90$	225	0
$90 < \text{ESALs} \leq 150$	250	0
$150 < \text{ESALs} \leq 300$	250	150

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COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 5 - Rehabilitation (Limited Revisions)

Revision 1

July 2, 2002

CHANGES TO CHAPTER 5

<u>Pages</u>	<u>Changes</u>
Contents	List of Figures and Tables included.
5-1	Section 5.1.1, last sentence. Corrected internal cross-references.
5-3	Table 5-1, second row. Sawed and Sealed: added HMA strengthening course, to correct previous omission. Table 5-1, first column. Rephrased to emphasize pre-treatment, and whether single course or multiple course.
5-4	Table 5-1, first column. Rephrased to emphasize pre-treatment, and whether single course or multiple course.
5-5	Section 5.2.1, first paragraph. Revised number of steps to 17, and added cross reference to Section 3.3.1, to correct previous error.
5-6	Section 5.2.1, Item 9. In first sentence added phrase “and document the treatment selection”. In last sentence, added specific cross reference to Section 3.3.
5-7	Section 5.3, third paragraph. Inserted ‘Transverse and Longitudinal Grooving’ as Item 6 and adjusted remaining list, to correct previous omission.
5-8	Section 5.3.1, first paragraph. Referred designer to Regional Materials Engineer for latest guidance on Concrete Pavement Restoration (CPR) techniques.
5-22	Section 5.4.2.1, third and fourth paragraphs. Updated references to Chapter 6.
5-23	Section 5.4.2.2. In item 1 under ‘Construction Considerations’, revised reference to be compatible with Standard Specifications issued January 2, 2002.

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5.1 INTRODUCTION

5.1.1 General

The main purpose of this chapter is to provide design guidance for major rehabilitation activities. It is to be used in conjunction with Appendix 5A (*Pavement Rehabilitation Manual - Volume II: Treatment Selection* (PRM, Vol.2)), Appendix 5B (*Pavement Restoration Techniques:2000*), special specifications, standard sheets to prepare the PS&E for a pavement rehabilitation project.

The term “rehabilitation” encompasses the following activities: resurfacing, restoration, recycling, and reconstruction. Major rehabilitation activities are viewed as any work that is undertaken to significantly extend the service life of an existing pavement. The selection of a rehabilitation alternative is a major step in any pavement rehabilitation project. This chapter describes the procedure for treatment selection and guidelines as described in detail in the PRM, Vol. 2. Additional treatments not currently included in PRM Vol. 2 include Ultra-thin Whitetopping (UTW) and Microsurfacing. See Sections 5.4.2.5 and 10.2.3, respectively. Note: Chapter 3 of this manual describes the overall Pavement Treatment Selection Process relative to the Department Project Development Process. The project fund source and type of treatment selected may trigger other procedure and documentation requirements which may increase overall design time (see Table 3-1 in Chapter 3 of this manual).

Pavement restoration techniques are also discussed in this chapter. These techniques include full- and partial-depth pavement repairs, joint and crack sealing, slab subsealing, diamond grinding and texturing, load transfer restoration, edge-of-shoulder rutting, and rapid setting PCC pavement repairs.

Treatments with overlays are divided into three groups: overlays on rigid pavements, overlays on flexible pavements and overlays on flexible-over-rigid pavements. The treatment guidelines including conditions for use, constructibility, performance, expected failure modes and expected service life pertaining to each treatment are discussed in the PRM, Vol. 2 (Appendix 5A of this manual). The Pavement Restoration Techniques: 2000 (Appendix 5B of this manual) provides a summary guide of state-of-the-art techniques and treatments used for pavement maintenance, rehabilitation, and reconstruction including references to current specifications.

The Sections 5.1 and 5.5 briefly discuss overlay thickness design and lane additions and widenings.

5.1.2 Overlay Thickness Design

The PRM, Vol. 2 (CPDM Chapter 5, Appendix 5A) presents thickness dimensions for overlays for each rehabilitation alternative based on past research and current performance experience. It is appropriate for highways with Average Annual Daily Traffic (AADTs) of 12,000 to 35,000 with about

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5 percent trucks. Thicknesses should be adjusted for highways with traffic outside these limits. In such cases, the AASHTO Guide for Design of Pavement Structures, 1993 Edition may be used for overlay design.

5.1.2.1 HMA Overlay Thicknesses

Table 5-1 gives thickness dimensions for each rehabilitation alternative associated with flexible and flexible-over-rigid pavements. This table supersedes the thickness dimensions related to flexible and flexible-over-rigid pavements presented in PRM, Vol. 2. These thicknesses are developed to accommodate SUPERPAVE HMA lift thicknesses. The total thickness for overlays placed on HMA surfaced pavements ranges from 40 to 205 mm. On PCC pavements, overlay thicknesses range from 75 to 180 mm. Overlay thickness depends on the load carrying capacity of the existing pavement and the type, severity, and extent of distresses present. Note that thick overlays may present problems with overhead clearances and, in developed areas, with driveways, cross streets, manhole rim elevations, drain inlets, curb heights, and other appurtenances. The designer should be aware that, in addition to the normal milling and filling operations for such cases, other techniques, such as microsurfacing, and particularly reconstruction (Chapter 4 of this manual) may warrant consideration. Chapter 3 of this manual also includes warrants for reconstruction.

5.1.2.2 PCC Overlay Thicknesses

The PRM, Vol. 2 gives thickness dimensions for each rehabilitation alternative associated with rigid pavements. The thickness of ultra-thin whitetopping placed on HMA pavements is usually 100 mm or less (see Section 5.4.2.5). Refer to the PRM, Vol. 2 for additional guidance.

Table 5-1 HMA Overlay Thicknesses For Flexible and Flexible-Over-Rigid Pavement Rehabilitation

Treatment as it appears in <u>Pavement Rehabilitation Manual Volume II: Treatment Selection</u>	Pavement Layer Type (Nominal Aggregate Size)	Layer Thickness
Saw and Sealed HMA Overlay (≥ 90 mm)	HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	50 mm or 65 mm 40 mm
Sawed and Sealed HMA Overlay (≥ 130 mm)	HMA strengthening course HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	≥ 40 mm 50mm or 65 mm 40 mm
HMA Overlay (≥ 140 mm) Preceded by Cracking and Seating	Initial HMA course, Binder (19.0 mm or 25.0 mm) HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	50mm or 65 mm 50mm or 65 mm 40 mm
HMA Overlay (≥ 165 mm) Preceded by Rubblizing	HMA Base HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	75 mm 50mm or 65 mm 40 mm
Two Course Overlay (≥ 90 mm)	HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	50mm or 65 mm 40 mm
Cold Milling with Single Course Overlay (≥ 80 mm)	HMA inlay course HMA Top (9.5 mm or 12.5 mm)	≥ 40 mm 40 mm
Hot In-Place Recycle with Single Course Overlay (≥ 90 mm)	Hot in-place recycle HMA Top (9.5 mm or 12.5 mm)	50mm or 65 mm 40 mm
Cold In-Place Recycle with Single-Course Overlay (≥ 115 mm)	Cold in-place recycle HMA Top (9.5 mm or 12.5 mm)	75 - 100 mm 40 mm
Multiple-course Overlay (≥ 130 mm)	HMA strengthening course HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	≥ 40 mm 50mm or 65 mm 40 mm

Cold Milling with Multiple-Course Overlay (≥ 230 mm)	HMA inlay and/or strengthening course Multiple courses required for lifts HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	≥ 40 mm > 100 mm 50mm or 65 mm 40 mm

Table 5-1 HMA Overlay Thicknesses For Flexible and Flexible-Over-Rigid Pavement Rehabilitation (Continued)

Treatment as it appears in <u>Pavement Rehabilitation Manual Volume II: Treatment Selection</u>	Pavement Layer Type (Nominal Aggregate Size)	Layer Thickness
Cold In-Place Recycle with Multiple Course Overlay (≥ 165 mm)	Cold in-place recycle HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	75 - 100 mm 50mm or 65 mm 40 mm
Remove Flexible Overlay, Crack and Seat with Multiple Course Overlay (≥ 130 mm)	Initial HMA course HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	≥ 40 mm 50mm or 65 mm 40 mm
Remove Flexible Overlay, Rubblize with Multiple Course Overlay (≥ 165 mm)	HMA Base HMA Binder (19.0 mm or 25.0 mm) HMA Top (9.5 mm or 12.5 mm)	75 mm 50mm or 65 mm 40 mm

5.2 SELECTION OF REHABILITATION ALTERNATIVES

Several alternative rehabilitation measures are available for repairing a pavement in need of rehabilitation. The first step in rehabilitation design, therefore, is to determine which alternative provides a cost-effective design within the constraints of a given project. The following four major types of rehabilitation alternatives should be considered for every project:

- Restoration - The work required to return the existing pavement structure to a suitable condition for satisfactory performance, without immediately placing an overlay.
- Recycling - The reuse of existing surface, base, or subbase materials to improve structural and durability integrity. New material is commonly added to the existing materials to improve their strength and durability performance.
- Resurfacing - Overlays or the addition of paving layers to provide additional structure or improved serviceability.
- Reconstruction - Complete removal of the existing pavement section and replacement with a new pavement section.

Based on the results of a pavement evaluation, the designer may wish to consider preventive maintenance treatments. The preventive maintenance treatments are discussed in Chapters 3 and 10 of this manual. Therefore, no guidance is presented in this chapter relative to the use of thin asphalt overlays (50 mm or less), overlays of short (spot) length, pavement patching, pothole repairs, routine sealing of cracks and joints, miscellaneous repair of minor pavement failures, slab sealing, or any other work designed to preserve the existing pavement system.

Chapter 4 of this manual covers the pavement reconstruction in detail and is not discussed in this chapter. This chapter addresses three major rehabilitation activities: Restoration, Resurfacing (Overlays), and Recycling.

Some of the rehabilitation methods other than overlay are used/required as preoverlay treatments in major rehabilitation work.

5.2.1 Procedure for Treatment Selection

Section 3.3, Chapter 3 of this manual discusses the activities related to the process of pavement treatment selection (steps 1 through 17) performed by the project developer or designer. For timing and to determine what projects require alternate treatment strategies refer to Section 3.3.1 of this manual. The general procedure for treatment selection includes the following steps (also see Appendix 5A, PRM, Vol. 2, page 4):

1. Review the Pavement Evaluation and Treatment Selection Report, PETSRSR, generated by following procedures in PRM, Vol. 1 (Appendix 2A: Chapter 2).

2. Solicit information from Regional and/or Main Office units that could influence treatment selection.
3. Select appropriate initial treatment alternatives based on pavement condition and the treatment guidelines presented in PRM, Vol. 2 (Appendix 5A of the CPDM).
4. Eliminate any initial alternatives that are inappropriate due to design, construction, or other constraints.
5. Develop a treatment strategy for each alternative using an Expected Service Life of the initial treatment and projected future treatments.
6. Determine costs of all initial and future treatments using average weighted bid prices or estimates for new items.
7. Compare total costs of the alternative strategies, using the LCCA analysis methods presented in PRM, Vol. 2 (Appendix 5A of the CPDM). (Note: If one of the alternative treatments is reconstruction, a pavement type selection analysis is required. Chapter 3 of this manual discusses preparation and timing of the analysis while Chapter 4 discusses design of the reconstructed pavement.)
8. Perform a "Sensitivity Analysis" if desirable using the procedure described in page 133 of PRM, Vol. 2 (in Appendix 5A of the CPDM).
9. Select the best treatment strategy based on cost and other factors, and document the treatment selection in the project's design approval document. Many projects also require that treatment selection for a project be documented in a Pavement Evaluation and Treatment Selection Report (PETSR). (Note: Refer to Appendix B of the Design Procedure Manual for the format and content of design approval documents and Chapter 3, Section 3.3 of this manual to determine when a PETSR is required.)
10. Design the selected treatment with references to appropriate CPDM chapters, appendices, standard sheets, and NYS Standard Specifications.
11. Document pavement performance to improve future strategy development.

5.2.2 Treatment Guidelines and Typical Sections

PRM, Vol. 2 (Appendix 5A of the CPDM) describes how to prepare a PETSR while Chapter 3 of this manual shows when it should be prepared. It provides a compilation of Department pavement rehabilitation treatments, ranging from preventive maintenance to total reconstruction. Included are guidelines maximizing each treatment's effectiveness based on pavement distress levels, and typical section drawings listing work items necessary for success of each treatment. Each pavement treatment is presented in the following format:

1. Conditions For Use.
2. Constructibility.
3. Performance.

4. Expected Failure Modes.
5. Expected Service Life.

Expected Service Lives (ESL) have been estimated for all treatments based on current experience and engineering judgement. The ESL given in PRM, Vol. 2 are ONLY appropriate for highways with Average Annual Daily Traffic counts (AADT) of 12,000 to 35,000 with about 5 percent trucks. Expected Service Lives should be adjusted for highways with traffic outside these limits.

Users of PRM, Vol. 2 of this manual are cautioned that selection of a rehabilitation strategy should not be based on existing pavement condition alone. Other less obvious deficiencies, such as unfavorable soil conditions and inadequate drainage characteristics, may have a profound effect on strategy selection and project scope. Also, design and/or construction constraints and maintenance concerns and capabilities must be considered during the selection process.

This chapter provides additional guidance to the pavement designers in relation to each pavement treatment presented in PRM, Vol. 2 (Appendix 5A of the CPDM).

5.3 PAVEMENT RESTORATION TECHNIQUES

When evaluating the feasibility and effectiveness of pavement restoration techniques, several factors must be considered, including the surface distress, structural condition, and functional condition of existing pavement. These factors are discussed in Chapter 2 of this manual.

Appendix 5B provides a listing of pavement restoration techniques based on the Department's experience to date. It is a summary of current state-of-the-art techniques and treatments used for pavement maintenance, rehabilitation, and reconstruction. The purpose of the listing is to provide a "catalog" of treatments, useful background information, and policy for the use of these techniques.

This section provides additional guidance in the following pavement restoration techniques practiced statewide:

1. Full-Depth PCC Pavement Repairs.
2. Partial-Depth Pavement Repair.
3. Joint and Crack Sealing.
4. Slab Subsealing.
5. Diamond Grinding and Texturing.
6. Transverse and Longitudinal Grooving
7. Load Transfer Restoration.
8. Edge-of-Shoulder Rutting/Rutting Mitigation.
9. Rapid Setting PCC Pavements Repairs.

Several of these techniques can also be used in conjunction with an overlay as preoverlay treatments to ensure better performance.

5.3.1 Full-Depth PCC Pavement Repairs

Full-depth PCC repairs are required at areas of poor support, at high severity cracks, and at structurally deficient joints. Areas of poor subbase support typically contain broken slabs which act as independent pieces and tend to rock under traffic loads. High-severity cracks are open, spalled, and/or faulted transverse cracks. Structurally deficient joints are those that have experienced medium to high-severity faulting, infrequent differential settlements, corner breaks or blowups. Areas identified for full-depth repairs usually require repairs to the subbase and/or subgrade. The Regional Geotechnical Engineer should be consulted to determine required depth of repairs and suitable replacement material during design and construction. Detailed repair techniques are provided on current version of Concrete Pavement Restoration (CPR) Standard Sheets (contact the Regional Materials Engineer for guidance).

PCC should be used as a pavement replacement material on moderate and high volume roads or if the removal area is less than 5 m long. HMA may be used as a replacement material on low volume roads or if the removal area is longer than 5 m. Full-depth HMA repairs less than 5 m long tend to "hump" as adjacent PCC slabs move into pressure relief areas created by PCC removal. Experience indicates that HMA repairs longer than 5 m result in a less objectionable hump. Refer to Appendix 5B for appropriate specification item number.

5.3.2 Partial-Depth Pavement Repair

Partial-depth repair is the removal of small, shallow areas of deteriorated PCC and replacement with a suitable repair material. Make partial-depth repairs in areas where slab deterioration is located primarily in the upper one-third of the slab. Detailed partial-depth repair techniques will be provided in CPR Standard Sheets. Contact the Materials Bureau for guidance on partial depth repair techniques. Refer to Appendix 5B for appropriate specification item number.

5.3.3 Joint and Crack Sealing

Joint and crack sealing operations are commonly performed before placing an overlay. These activities reduce the amount of moisture that can infiltrate a pavement structure, thereby reducing moisture-related distresses such as pumping. They also prevent the intrusion of incompressible materials into joints and cracks, thus preventing pressure-related distresses such as spalling.

On PCC pavements, sealing operations may be performed at both joints and cracks. Most sealing operations on PCC pavements are conducted at transverse joints, although longitudinal joints are also sometimes sealed. Resealing joints is necessary when the existing sealant deteriorates to the extent that incompressible materials and water can infiltrate the pavement structure. If the underlying pavement layers have been damaged by excessive moisture intrusion, the cost-effectiveness of a sealing operation may be diminished. Most cracks less than 20 mm (0.75 in) wide are recommended for sealing. However, hairline cracks less than 3 mm (0.125 in) wide are not recommended for sealing.

Sealing operations on HMA pavements address various forms of cracking, such as thermal cracking, reflection cracking, block cracking, and alligator cracking. However, crack sealing is most

effective when conducted on pavements exhibiting little structural deterioration. HMA pavements displaying extensive alligator cracking or severe crack deterioration are candidates for more rigorous rehabilitation alternatives. HMA pavements with block cracking and most types of linear

cracking are better candidates for crack sealing. Generally, cracks less than 3 mm (0.125 in) wide are not recommended for crack sealing. However, most cracks between 3 and 25 mm (0.125 and 1 in) wide are recommended for crack sealing, provided there is limited secondary cracking. Cracks greater than 25 mm (1 in) wide should be patched using standard patching materials and procedures.

For recommended sealing materials refer to joint and crack sealing using silicone (Approved List) and ASTM D3405 (Approved List). For sealing procedures refer to Appendix 5B for appropriate item numbers.

5.3.4 **Slab Subsealing**

Slab subsealing is an effective repair measure for PCC pavements that exhibit a loss of support. The technique to determine whether loss of support has occurred beneath a PCC surface is described in PRM, Vol. 1 (Appendix 2A of the CPDM).

Slab subsealing, also referred to as pressure grouting, stabilization, and undersealing, is the pressure injection of material beneath a pavement slab and/or stabilized subbase to fill voids, in order to reduce deflections and subsequent pumping action. The most commonly used materials for slab stabilization are pozzolanic-cement grout and limestone-cement. Slab stabilization should be performed only at joints and working cracks exhibiting loss of support. To prevent the recurrence of loss of support, other rehabilitation techniques are often performed together with slab stabilization. For example, improving subdrainage, sealing existing joints and cracks, and installing load transfer devices all help prevent the recurrence of support loss.

5.3.5 **Diamond Grinding and Texturing**

The main purpose of diamond grinding is to correct surface irregularities, reestablish skid resistance, and to correct cross slope. Structural distress (e.g., pumping, loss of support, corner breaks, working transverse cracks, and shattered slabs) require repair before grinding. Diamond grinding is not suitable for pavements with widespread distress related to concrete durability, such as D-cracking and reactive aggregate distress.

This work involves diamond grinding the entire surface (full grinding) or a portion of the surface (partial grinding) of existing PCC pavement at locations indicated on the plans. Grinding should be done utilizing power-driven diamond blades mounted on a self-propelled machine that has been designed for grinding pavements. The machine should be capable of grinding the surface without causing spalls at cracks, joints, or other locations.

Diamond grinding is performed in a longitudinal direction in the areas designated on the plans. Grinding begins and ends at lines perpendicular to the pavement centerline. "Space cutting" is permitted provided results are satisfactory to the Engineer. Space cutting is defined as a wider

spacing of saw blades for an initial pass in deep grinding areas followed by a final pass meeting the requirements below. Refer to Appendix 5B for appropriate specification item number.

5.3.6 **Transverse and Longitudinal Grooving**

Both these techniques are used to reduce hydroplaning on tangents and curved sections lacking adequate macrotexture but where microtexture is satisfactory. See Appendix 5B for information on both these techniques.

5.3.7 Load Transfer Restoration

The ability of a joint or crack to transfer loads is a major factor in the structural performance of PCC pavement. The consequences of poor load transfer are a loss in serviceability due to pumping, faulting, and corner breaks. The measurement of load transfer should be a standard part of any PCC pavement evaluation. Load transfer efficiency across a joint or crack is normally defined as the ratio of deflection of the unloaded side of the joint or crack to the deflection of the loaded side. If complete load transfer exists, the ratio will be 1.0 (or 100 percent), and if no load transfer exists, the ratio will be 0.0 (or 0 percent). Load transfer is measured using the deflection testing method (see Section 2.3.2 of this manual). Contact the Geotechnical Engineering Bureau for information concerning load transfer testing.

Dowelled joints normally exhibit very good load transfer (i.e. between 70 and 100 percent). However, repeated heavy loads can cause the dowel sockets to deteriorate, resulting in looseness of the dowels, faulted and spalled joints, and loss of load transfer. Jointed Plain Concrete Pavement (JPCP) designs without dowels usually have poor load transfer. Load transfer should be measured during cooler periods, normally in the early morning. Load transfer is often lowest in the outer wheel path and, since most loads will pass over this area, it should be measured at this point.

Load transfer restoration should be considered for all transverse joints and cracks that exhibit measured deflection load transfer between 0 and 50 percent. This applies to JPCP with or without asphalt concrete overlays. Dowels placed in slots cut in the pavement are effective in restoring load transfer across transverse joints or cracks. The diameter of the dowels and the number placed in the outer wheel path have a major influence on the prevention of faulting. Dowels should be 450 mm (18 in) long and at least 32 mm (1.25 in) in diameter. Chapter 8 of this manual offers additional guidance on dowel size and length.

The successful installation of load transfer devices requires sound concrete adjacent to the joint or crack. If the concrete is deteriorated, full-depth repair is more appropriate than load transfer restoration. Joints or cracks having high deflections must be subsealed before load transfer devices are installed. The cause of joint distress should be determined and the deficiencies should be corrected before performing load transfer restoration work. Additional work to be detailed in the plans prior to load transfer restoration may include subsealing to fill voids in the pavement foundation, grinding to eliminate faulting, and spall repairs. The NYSDOT CPR Standard sheet will provide a detailed procedure to install the dowels and joint forming medium. Refer to Appendix 5B for appropriate specification item number. Contact the Materials Bureau for additional information.

5.3.8 Edge-of-Shoulder Rutting/Rutting Mitigation

Rutting problems may develop at the edge of shoulder in areas where shoulders are not wide enough to accommodate vehicles. Rutting problems are particularly likely to develop in residential areas where ditches are absent or minimal and topsoil extends close to the road. When such roads are to be reconstructed, care should be taken to ensure that steps have been taken to minimize the frequency of vehicles driving off of the shoulder and/or that the material immediately adjacent to the shoulder has reasonably good strength to resist the development of ruts. (Note: parkways which have grass shoulders that experienced rutting may require special treatment. Consult the Regional Environmental Contact.)

The treatment of the area from a depth of 150 mm up to the surface should depend on the anticipated potential for rutting. If there is judged to be little potential for rutting and the abutting property owners indicate a desire to extend their lawn up to the edge of the shoulder, designers may indicate the placement of topsoil, provided that is consistent with Regional policy/practice. If there is the potential for rutting, the normal treatment should be to place subbase material to a thickness of 150 mm adjacent to the shoulder. While limits may vary depending on the job, normal practice would be to indicate payment limits with a depth of 150 mm and a width of 600 mm. In areas that experienced severe rutting prior to construction and where the same potential is expected to exist after construction, consideration may be given to using reclaimed asphalt material in this same shoulder backup area. For reference, refer to Special Specification, *Shoulder Backup for Newly Placed Shoulders - Reclaimed Bituminous Material Option*.

The highway cross-section needs to be developed to eliminate drop-offs at the edge of paved areas. Edge drop-offs are undesirable, no matter how they develop, because they inhibit safe vehicle recovery maneuvers. Edge drop-offs commonly occur on the inside of sharp horizontal curves, near intersections and commercial driveways, and where shoulders are either narrow, unpaved, or only partially paved. Edge drop-offs may be prevented or eliminated by:

1. Widening the inside travel lane along sharp horizontal curves (described in Section 7.3.10.7 of HDM).
2. Widening or adding a paved shoulder. A full depth shoulder may also be considered (discussed in Chapter 7, Section 7.3 and 7.5 of this manual).
3. Adding turning lanes or acceleration lanes at intersections or commercial driveways.
4. Providing a stabilized wedge of material at the edge of the paved shoulder to reduce wheel rutting.

Since the usable shoulder width must be flush with the traveled way, no edge drop-off is permitted between the traveled way and shoulder. Where edge drop-offs will remain at the outside edge of fully paved shoulders, the edge is to be sloped at 45 degrees or less where vehicles could exit and return to the roadway. Additionally, the maximum height should desirably be limited to 40 mm or less to help accommodate motorcycles and trucks and shall not be over 60 mm (for reference see the TRB State of the Art Report No. 6, 1987).

5.3.9 Rapid Setting PCC Pavement Repairs

Surface Preparation for Rapid Setting Concrete Pavement Repairs, and *Furnish and Placement of Rapid Setting Concrete Pavement Repairs*, are used in association with the following pavement conditions:

- The use of these items should be limited.
- Restrict to concrete pavements in good to excellent condition.
- In association with a joint resealing rehabilitation strategy.
- For partial-depth repair of spalled or deteriorated areas of PCC pavements that are not receiving an overlay, and where extended life and durability are required. Present estimates for the life of these materials is approximately 5-7 years depending on traffic volumes. These items would not normally be used for short-term solutions or pavements that cannot utilize the life extension benefits possible with these materials. Due to the high cost associated with these items, the designer should consider other alternates for large spall areas or where a substantial volume of deteriorated concrete is to be removed and replaced.

Due to the high cost associated with repairing PCC pavements, a point is reached where either an overlay or pavement replacement become economically feasible. Life cycle cost analysis in the form of present worth costs is a sound and accepted method for comparing viable alternates. PRM, Vol. 2 (Appendix 5A of this manual) contains a method for Present Worth Life Cycle Cost Analysis that should be used when comparing pavement treatment alternatives. Chapter 3 of this manual contains guidance on when more than one alternative treatment should be considered and warrants for reconstruction.

Due to the relatively high cost of these items, designer estimated quantities for repair should be adequately developed in order to minimize contract overruns or underruns. The specifications require that repair areas should be of rectangular and approach square dimensions when feasible. Long narrow patch areas tend to develop shrinkage cracks. It is understood that long narrow patches are inevitable, particularly at joint areas. Minimum patch depth is 25 mm for §721-20, *Rapid Setting Polymer Concrete*, and 50 mm for §701-09, *Rapid Setting Concrete Repair Material (Normal Weather)*.

The minimum aggregate extension rate for §701-09 *Rapid Setting Concrete Repair Material (Normal Weather)*, is 60% by weight of the dry prepackaged material, which yields 0.017 m²/ 22 kg of prepackaged material (1294 kg of dry prepackaged §701-09 per m²). The minimum aggregate extension of §721-20, *Rapid Setting Polymer Concrete*, is 75 % which yields 0.018 m²/ 22 kg of dry prepackaged material (1222 kg of dry prepackaged §721-20 per m²). Refer to Appendix 5B for appropriate specification item number.

5.4 TREATMENTS WITH OVERLAYS

Overlays of existing pavements are the most common rehabilitation techniques. Overhead clearance requirements and the effects on bridges, curbs, sidewalks, guide rail, driveways, manholes, crossroads, drop inlets, etc., should be checked any time overlays are proposed.

For isolated clearance problems, such as a bridge underpass, the optimum solution is pavement removal and reconstruction in the vicinity of the structure to accommodate the required clearances. In areas with numerous driveways, cross streets, manholes, drain inlets, curb reveal needs, and other appurtenances, the best solution may be reconstruction. Milling and using a thinner overlay is not normally recommended because it will not achieve the intended service life. Locations that were previously overlaid and require resurfacing for functional reasons, rather than structural, may be appropriate for milling and inlaying to accommodate clearance limitations.

Overlay projects should not reduce the effective height of curbs to less than 100 mm when their design height is 150 mm, or less than 75 mm when their design height is 100 mm. To avoid reducing the effective curb heights, the project may (1) mill down the existing pavement before placing the overlay, (2) reset the curbs, or (3) taper the overlay thickness down towards the curb, provided rollover and cross slope limitations are not exceeded.

While most overlays will use HMA applied to either flexible or rigid pavements, PCC may also be used as an overlay material. An unbonded concrete overlay and ultrathin Whitetopping can be used. Overlay techniques and their conditions for use are catalogued in the PRM, Vol. 2 which is included as Appendix 5A to this chapter. Contact the Materials Bureau for additional information.

The success of any overlay requires proper repair and preparation of the existing pavement. In general, pre-overlay repairs consist of improving or restoring drainage, removing and replacing areas of poor support within the pavement subbase or subgrade, and repairing surface defects to provide a stable platform. Section 5.3 describes the majority of these preoverlay treatments for both HMA and PCC pavements. Additional guidance is available in Appendix 5A of this chapter.

This section discusses overlays on three existing pavement types: rigid, flexible, and flexible-over-rigid.

5.4.1 Overlays on Rigid Pavement

For existing PCC (rigid) pavements, repairing surface defects may include milling and patching spalled areas, shimming faults, removing cracked slabs (if the pavement is not to be cracked and seated or rubblized), and cleaning and sealing joints and cracks. The PRM, Vol. 2 describes the conditions for use for joint and crack sealing.

Overlays on PCC pavements tend to crack above locations of existing cracks and transverse joints which are locations of thermal expansion and contraction. This is known as reflection cracking. If unaccounted for, reflection cracks will occur shortly after the overlay is placed. Subsequent deterioration of these cracks will then lead to premature overlay failure. The following three techniques are used to control reflection cracks in PCC pavements:

1. Sawing and sealing joints in overlays (see Section 5.4.1.2).
2. Cracking and seating (see Section 5.4.1.3).
3. Rubblizing (see Section 5.4.1.4).

Pavement Rehabilitation Manual: Volume II - Treatment Selection (Appendix 5A of this manual) discusses the following rehabilitation alternatives on PCC pavements:

1. Joint and Crack Sealing with Spall Repair and Full-Depth Segment Replacement
2. Sawed and Sealed HMA Overlay
3. HMA Overlay Preceded by Cracking and Seating
4. HMA Overlay Preceded by Rubblizing

5.4.1.1 Joint and Crack Sealing with Spall Repair and Full-Depth Segment Replacement

The special specification, *Repair of Spalled Areas, Joints and/or Cracks in Portland Cement Concrete Pavement*, should be used to mill loose concrete from the surface of pavement slabs, and to mill off deteriorated asphalt concrete patches. In both cases, the removal of loose or delaminated material from the surface and replacement with an asphalt patch will provide a stable paving platform for subsequent asphalt courses. When using this item, designers should be aware that the maximum depth of milling is 90 mm. If loose, delaminated, or broken pieces of concrete remain below this depth, it is recommended that full-depth pavement repairs be made.

For spalled areas in PCC pavements to be repaired correctly, a milling machine should be used to remove loose concrete. The minimum width milling machine commonly available to contractors is 300 mm. The only way the contractor could create a recess narrower than 300 mm would be by removing teeth from the mandrel of the milling machine or by using chipping hammers. Either of these two alternatives lowers production rates and increases the unit cost of each item. When confronted with this situation, contractors usually have opted to use the fully equipped 300 mm mandrel sacrificing payment for production and adjusting the unit bid price accordingly.

When using this technique, 300 mm is the minimum allowable repair width. This requirement will benefit the Department as well as the contractor by minimizing disputes and in the case of HMA overlay allows for slightly better compaction. It is anticipated that there will be no change in cost or perhaps a slight reduction in cost to the Department.

The designer should detail on the plans the location and extent of all material to be removed by the contractor as determined by a detailed on-site inspection. The designer should also note that the actual quantities may change during construction as ordered by the engineer in charge.

5.4.1.2 Sawed and Sealed HMA Overlay

HMA overlays on existing PCC pavement will develop reflection cracking. One method of control is through the sawing and sealing of joints in the overlay over the existing joints and cracks. When properly done, sawing and sealing results in the formation of a controlled reflection crack through

the weakened plane created by the sawcut, which reduces spalling of the crack and provides a maintainable and aesthetically acceptable reflection crack. It is absolutely critical that the sawcut be placed immediately above the existing joint or crack, as a deviation of even 25 mm can lead to a secondary crack forming adjacent to the sawed joint resulting in spalling.

Sawing and sealing should be used when the majority of thermal expansion and contraction within the PCC pavement will continue to occur at the transverse joints. (This will typically be the case when there are no more than infrequent medium and high-severity slab cracks.) Using this technique, a saw cut is made in the overlay directly over the underlying transverse joint or mid slab crack. This confines reflection crack development to the saw cut. A reservoir is made using the saw cut. Sealant is then placed within the reservoir. This results in an easily maintained, effectively sealed joint which minimizes secondary cracking and the intrusion of water and incompressible fines into the pavement structure.

Use of this technique means conceding the fact that reflective cracking will occur. By sawing the joints, the cracks that are produced are straight and sealed to help retard the infiltration of moisture or incompressible materials into the pavement structure. Refer to Appendix 5B for appropriate specification item number.

5.4.1.3 HMA Overlay Preceded by Cracking and Seating

The design considerations for a cracking and seating project are as follows:

1. The following should be considered when selecting Cracking and Seating for a project:

- Cracking and seating is appropriate when the majority of the thermal movement within the existing PCC pavement occurs at transverse slab cracks, rather than at designed transverse joints. When this is the case, the locations and amounts of movement within the slabs are unpredictable. An overlay applied to such a pavement would crack above the movement locations. By deliberately cracking the pavement slabs, the crack and seat technique shortens the effective slab lengths. Since thermal movement is directly proportional to slab length, the effectively shortened slabs will individually experience less thermal movement. This redistribution of thermal stresses will reduce the likelihood and rate of reflection crack occurrence in the HMA overlay.
- Where a PCC pavement is cracked and deteriorated to a point that the other leading feasible rehabilitation alternative is reconstruction, cracking and seating may be an appropriate alternative. In the crack and seat operation, a pavement breaker is used to crack the pavement and a 50 ton roller used to seat it. The seated pavement should be overlaid with a minimum 125 mm of HMA. Underground utilities may preclude this option.
- If the existing pavement has frequent and extensive transverse joint spalls requiring full lane width milling, consider rubblizing the pavement or including additional full-depth sawcuts to provide pressure relief within the pavement. In previous cracking and seating projects, blowups occurred at transverse joints that were milled full lane width because the thinner PCC pavement section (that resulted from milling) was not capable of withstanding forces that developed when slabs expanded during the cracking operation.

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- Removing badly cracked slabs and cleaning joints and cracks also provides pressure relief within the pavement. Enough pressure reliefs should be provided to prevent blowups without additional sawcuts.
- The presence of utilities and drainage structures may preclude the use of cracking and seating.

Consult the Regional Materials Engineer to determine the appropriateness of cracking and seating, as well as the need for other techniques to address pressure relief and reflection crack control.

2. Include pay items within contract documents for the following:

- Milling existing asphalt overlays. Complete this work in accordance with §490, Cold Milling.
- Installing underdrains. Consult the Regional Geotechnical Engineer for appropriate pay items and locations. Drains must have a positive outlet.
- Cleaning joints and cracks greater than 10 mm ($\frac{3}{8}$ inches) wide. Include a note on the plans effectively stating the following: "Clean joints and cracks greater than 10 mm ($\frac{3}{8}$ inches) wide in accordance with item, *Cleaning and Filling Joints and Cracks*. Leave cleaned joints and cracks unfilled during cracking and seating. Re-clean and fill joints and cracks greater than 10 mm ($\frac{3}{8}$ inches) wide in accordance with the above item as close to paving as practical."
- Sawcutting concrete pavement.
- Excavating the pavement and repairing the subbase/subgrade. Consult the Regional Materials and Geotechnical Engineers to determine the need for this work.
- Repairing spalls. Use a pay item such as Item 18502.4467, Repair of Spalled Areas, Joints, and/or Cracks in PCC Pavement. Consult the Regional Materials Engineer to determine the need for this item.
- Cleaning existing pavement and/or shoulders (see Appendix 5B for item number).
- Tack coat (see Appendix 5B for item number).

3. Include details for the following operations:

- Shimming faults and ruts. Include a note effectively stating "Shim any fault greater than 13 mm ($\frac{1}{2}$ inch) before paving. Shim 600 mm (2 feet) longitudinally for every 6 mm ($\frac{1}{4}$ inch) of fault."
- Reconstructing shoulders. Consult the Regional Geotechnical Engineer to determine course types and thicknesses.

Include HMA quantities for these operations in their respective items. Refer to Appendix 5B for item numbers.

5.4.1.4 HMA Overlay Preceded by Rubblizing

The design considerations for a rubblizing project are as follows:

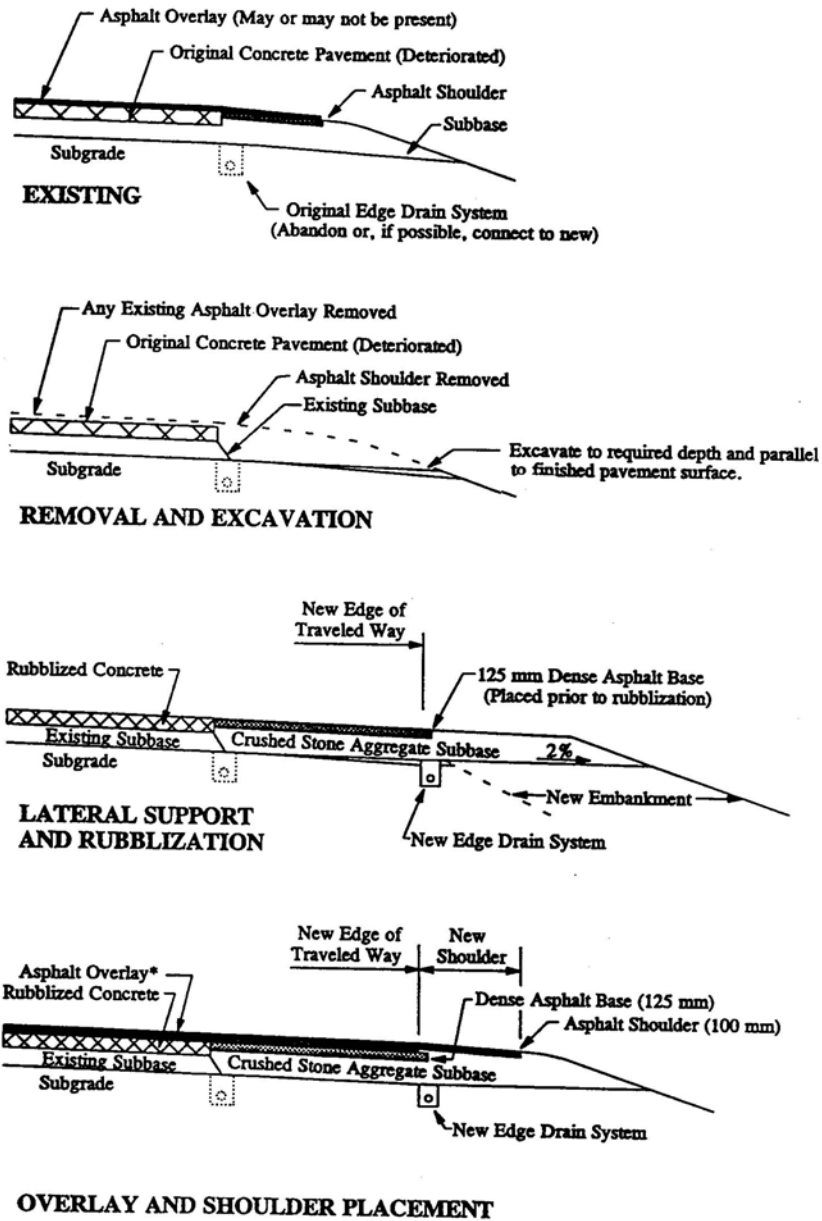
1. It is essential to consult the Regional Geotechnical Engineer to ensure proper subsurface conditions exist before a rubblizing contract is progressed. If the material beneath the existing portland cement concrete (PCC) pavement is not strong or stable enough to support the rubblizing operation, or the water table is located near the subbase, conditions will arise that are expensive to address (see Figure 1).
2. Rubblizing is appropriate under the following conditions:
 - A significant amount of thermal movement within the PCC pavement occurs at transverse slab cracks, rather than at transverse joints, and
 - i. The presence of utilities precludes the use of cracking and seating, or
 - ii. A flexible pavement widening is to be constructed adjacent to the existing pavement.

Generally, when more than 25 percent of the pavement slabs have open cracks, a significant amount of thermal movement is occurring at the cracks. If less than 25 percent of the pavement slabs have open cracks, rubblizing is generally not appropriate unless one or more of the following conditions exist.

- The pavement has extensive and severe full-depth spalling at joints and cracks. This spalling typically results from an adverse reaction between concrete mix components, not from reinforcing steel located too close to the surface. It is so pervasive that using spall repair items becomes cost prohibitive. This condition may exist with any severity and frequency of cracking.
- A combination of distresses exists that precludes the use of Cracking and Seating or Sawing and Sealing. This combination may include high severity joint faulting, separated transverse or longitudinal joints, and extensive spalling.

Consult the Regional Materials Engineer to ensure the appropriate pavement distresses exist to warrant the use of this item.

Figure 5-1. Rubblizing and Widening Details



*Overlay to be 75 mm of dense base, 40 mm of binder, and 40 mm of top

3. Include pay items within contract documents for the following:
- Installing underdrains. Consult the Regional Geotechnical Engineer for appropriate pay items, placement depth, and outlet locations. Drains must be located on both sides and along the entire length of the pavement to be rubblized. Provide positive outlets at maximum increments of 90 m (300 feet). Increments of 25 - 30 m (75 - 100 feet) are highly desirable.
 - Milling existing asphalt overlays, if applicable. Complete this work in accordance with §490, Cold Milling.
 - Sawcutting concrete pavement, if applicable. Longitudinal joint ties must be severed where rubblized pavement abuts PCC pavement to remain intact.
4. Include pay items and a detail for excavating the pavement and repairing the subbase/subgrade. These should be included even if the Regional Geotechnical Engineer indicates good subbase and subgrade conditions generally exist. This is because isolated areas of poor support are likely to exist within a rubblizing job. It is not practical to assess the entire subsurface to identify each area, so the plans should be prepared to address these areas as they are encountered in the field. For estimating purposes, it is reasonable to assume 5 percent of the rubblized area will need to be excavated, undercut, and replaced. This assumption may be revised as a region gains experience with the technique.

Consult the Regional Geotechnical Engineer to determine the excavation depth and replacement materials. Among the items likely to be recommended by the Regional Geotechnical Engineer for subgrade undercuts are items *Geotextile Undercut*, and *Select Granular Subgrade*.

When selecting an item to replace excavated subbase, consider drainage, material availability, and costs. The following items may also be recommended by the Regional Geotechnical Engineer (see Appendix 5B for item number):

- Crushed Stone Aggregate Subbase Course
- Subbase Course, Type 2
- Subbase Course, Type 4
- Subbase Course Type 1

If Crushed Stone Aggregate Subbase Course is used to replace excavated subbase, provide additional positive drainage outlets within the material placement limits.

When selecting an item to replace excavated rubblized PCC, it is important to consider providing permeable material to ensure water is allowed to escape the rubblized layer. Rubblized PCC is considered more permeable than standard subbases. Therefore, a dam may be created in the rubblized layer if a standard subbase is used as a replacement material for rubblized PCC. Replace excavated PCC pavement with the following items, in order of preference (see Appendix 5B for item number):

- Asphalt Concrete - Type 2 Base Course
- Crushed Stone Aggregate Subbase Course

5. Include a detail for constructing widenings, if applicable. Refer to Figure 5-1 and Sections 4.3 and 5.5 of this manual for details. It is highly desirable to place a permeable yet stable material that extends from the existing pavement structure to the ultimate drain location. This material must be at least as deep as the existing subbase. Use Crushed Stone Aggregate Subbase Course, if available, as a subbase in the widened area. If this material is not available, consult the Regional Geotechnical and Materials Engineers for an acceptable replacement.

The widening must be constructed to the existing pavement elevation before rubblizing. The top 125 mm (5 inches) of the widening must be item, *Asphalt Concrete - Type 1 Base Course*, when it is brought to the existing pavement elevation. This surface may then support the rubblizing equipment or maintain traffic.

6. Include a detail for reconstructing shoulders, if applicable. Construct shoulders to the existing pavement elevation before rubblizing. If a shoulder will be used to maintain traffic, the top 125 mm (5 inches) of the shoulder must be item, *Asphalt Concrete - Type 1 Base Course*, when it is brought to the existing pavement elevation. See Chapter 7 of this manual for details.

If a shoulder is not needed to maintain traffic, consult the Regional Materials Engineer for items used to prepare or re-establish shoulder cross slope, if necessary. In this case, the first 1 m (40 inches) adjacent to the lane\shoulder interface needs to be shaped before rubblizing to provide a level operating surface for the equipment. Continue overlay courses across the shoulder width when paving. In any case, ensure the design allows water to escape the pavement structure.

7. If applicable, include a detail to remove curbs within 1 m (40 inches) of the lane\shoulder interface before rubblizing. This will provide a level operating surface for the equipment. Install underdrains and construct this area to the existing pavement elevation as described in 5 or 6 above depending on its ultimate use. If curbs are to be replaced, construct this area to the existing pavement elevation using any granular material as a temporary measure to support the equipment. After rubblizing, remove the granular material as required to replace the curb and place widening or shoulder courses if needed.
8. The rubblizing item cost is likely to decrease if the Contractor is allowed to rubblize with few interruptions. Consider this in the maintenance and protection of traffic plan. Where possible, completely detour traffic from the pavement or to the opposite lanes of a divided highway.

5.4.2 **Overlays on Flexible Pavement**

Pavement Rehabilitation Manual: Volume II - Treatment Selection (Appendix 5A of this manual) discusses the following rehabilitation alternatives on HMA pavements:

1. HMA Overlay
2. Cold Milling with HMA Overlay
3. Cold In-Place Recycling with HMA Overlay
4. Hot In-Place Recycling with HMA Overlay
5. Ultra-thin Whitetopping

The following sections provide design guidance for overlays over HMA pavement. The details and treatment guidelines for both corrective maintenance and rehabilitation overlap can be found in PRM, Vol. 2.

Repairing surface defects in HMA surfaced pavements may include hot in-place recycling, cold in-place recycling, milling the entire surface (or selected areas only), shimming wheel ruts, and cleaning and filling joints and cracks.

Particular attention should be paid to the details of the terminations of the overlays. Since asphalt will ravel if tapered to a feathered edge, the preferred practice is to cut a recess (rebate) into the existing pavement to permit placement of the top course to a thickness of at least 25 mm. Rebate depths of up to 65 mm may be used to accommodate more than one layer of asphalt. The removal of the rebate should be scheduled to minimize the amount of time that it must be left open to traffic. For deeper rebates which will carry traffic prior to final paving, temporary asphalt wedges should be placed to reduce the severity of the bump effect between the rebate and the existing pavement. Because of potential compaction complications and maintenance and protection of traffic conflicts, rebates should generally not be deeper than 65 mm. Standard Sheet M403-1, Detail of Asphalt Overlay Splice, illustrates the standard method of terminating an HMA overlay. Between the rebate and the full overlay thickness, an area of truing and leveling (T&L) is used as a means of terminating lower lifts of the overlay. The use of T&L and the tapered geometry shown is intended to (1) simplify the calculation of payment quantities and to (2) recognize the greater labor involved in placing the asphalt in this location. In practice, the T&L should be the same material as that used in the adjacent lifts. Also, the T&L should not be thinned to a feather edge as it is likely to be a coarser material that could ravel quickly and become a nuisance to temporary traffic. More than one T&L wedge may be shown if it is necessary to terminate more than one asphalt layer outside the rebate.

5.4.2.1 HMA Overlay

An HMA overlay is a feasible rehabilitation alternative for an HMA pavement unless the condition of the existing pavement warrants substantial removal and replacement. All areas of high-severity alligator cracking must be repaired. (Note: The areas to be repaired should have been roughly estimated in the Pavement Condition Report. Then field reviews should be performed to determine the location and extent so that the work can be shown in the typical sections and details). The repair must include removal of any soft subsurface material. High-severity linear cracks should be patched. Some method of reflection crack control is recommended for transverse cracks that experience substantial opening and closing. Rutting is removed by milling or placement of a leveling course.

Refer to Table 5-1 under Section 5.1 of this chapter for HMA overlay thickness and PRM, Vol. 2 for PCC overlay thickness. If overlay thickness is less than 50 mm, refer to Chapter 10 of this manual for treatment types and related guidance.

Immediately before placing an HMA overlay, the existing pavement and shoulder surfaces should be cleaned and tack coated to bond the overlay to the existing surface. Tack coats are to be specified and shown on the typical section drawings between every lift of HMA with the exception of the surface of permeable base material. The normal application rates are between 0.14 and 0.32 L/m². See Chapter 6, Tack Coat, for more information.

Before placing the overlay, truing and leveling is to be used at spot locations to remove irregularities in the old pavement, and fill and patch holes. However, truing and leveling is not to be used over substantial lengths of the project to effectively increase the overall maximum overlay thickness or add a second pavement course. See Chapter 6, Truing and Leveling, for more information.

5.4.2.2 Cold Milling with HMA Overlay

Removal of the existing surface course to the depth of the proposed inlay, allows for the remediation of surface distresses such as rutting due to a soft mix. Milling also allows the curb reveal and guide rail heights to remain constant before and after the overlay. The inlay material may be any appropriate top course HMA mixture. The specific mix type and compaction requirements vary depending on the traffic loading. Contact your Regional Materials Engineer for support. Refer to Table 5-1 under Section 5.1 for thickness information. The information in this section supersedes the information in PRM, Vol. 2. Where there is a conflict with the PRM, Vol. 2 this section takes precedence.

There are no traffic restrictions for cold milling with HMA overlay.

Conditions for Use

Distress of a candidate pavement should be limited to:

1. Low to medium severity cracking.
2. Infrequent corrugations, settlements, heaves, or slippage cracks.
3. Medium-severity wheel path rutting and/or widening drop-off
4. Medium to high severity raveling.

Advantages

1. Allows for correction of cross-slope.
2. Requires no truing and leveling.
3. Maintains current elevations.
4. Can be done on mainline only.
5. No need to remove pavement markings.
6. Traffic can be allowed on milled pavement before inlay is placed.

Disadvantages

1. Millings must be disposed or recycled.
2. Milling around utility structures may require a separate operation.

Construction Considerations

Weather and seasonal limitations apply as follows:

1. Seasonal limitations governed by §402-3.01 of the Standard Specifications.
2. Minimum temperature 10°C.

No pavement preparation is required prior to cold milling.

Constructing a cold milling with HMA overlay consists of the following procedures.

1. Mill the existing surface course to the design depth.
2. Prepare the milled surface for an HMA inlay (see 10.2.5.4).
3. Apply a tack coat to the milled surface
4. Place the HMA inlay.
5. Place the HMA top course.
6. Traffic is allowed as soon as mat cools enough to support the loading.
7. Apply permanent markings.

Expected Failure Modes

1. Reflective cracking.
2. Low temperature cracking.
3. Rutting or shoving at intersections.
4. Potholes.
5. Raveling.

Expected Service Life

The expected service life of cold milling with a single course HMA overlay is 10 to 12 years.

Designer Information

Separate pay items for Production Cold Milling and Miscellaneous Cold Milling for both HMA (bituminous) and portland cement concrete surfaces are provided in Standard Specification 490. There are no differences in specification requirements between Production Cold Milling and Miscellaneous Cold Milling.

The separate pay items are intended to be used on large, high production milling operations when markedly different milling rates exist and the cost of milling varies appreciably between milled areas.

Consider Production Cold Milling to include the following characteristics.

1. More than 12,500 square meters of continuous or nearly continuous milling.

2. Large milling machines (having drum widths 2 meters or greater in width) would be suitable for the work.

Production milling of pavements, shoulders or medians is a continuous or nearly continuous operation and the contractors usually provide a large milling machine with a cutting drum of 2 meters or wider in width. Milling the approaches of intersecting streets with these large machines is often difficult and costly due to the machine's size, restricted work space and the backing and maneuvering required to mill the short sections of pavement. It is recommended that a miscellaneous cold milling item be utilized at these intersection areas so that the bid prices will better reflect the work involved. If the milling required on an intersecting street exceeds 625 square meters or the milling extends back more than 75 meters from the edge of the mainline milling, it is suggested the area be included under the production milling item.

Contractors usually provide a smaller milling machine behind a large machine to mill along curbs, around manholes etc. This work is considered part of the production milling item.

Miscellaneous Cold Milling is intended to be utilized by the designer for milling operations other than what would be considered production milling. It includes but is not necessarily limited to project milling quantities less than 12,500 square meters, intermittent milling of surfaces, repair areas, pavement and median inlays, elimination of bumps, vertical lane tapers for ending overlays, intersections and areas restricted due to space or traffic.

Both Production Cold Milling and Miscellaneous Cold Milling will require plan details showing areas to be milled, depth of removal, slope or whatever is necessary to effect the design or repair.

A payment limit will have to be indicated on the plans between Production Cold Milling and Miscellaneous Cold Milling areas when they abut.

Pavements having slope changes, superelevation and/or grade changes established by milling may require a reference elevation string line located near the edge of the work area. The designer should consider the necessity of such a reference elevation and indicate on the plans the location(s) where it will be required. The specification provides for the use of such a reference string line when indicated on the plans.

5.4.2.3 Cold In-Place Recycling with HMA Overlay

Cold in-place recycling (CIPR) is the process of milling the existing pavement to a depth of 75 or 100 mm, mixing the reclaimed material with virgin stone and asphalt emulsion and paving the mixture back in place with conventional paving equipment. The recycled mat is allowed to cure for at least 7 days before being overlaid with HMA. The information in this section supersedes the information in PRM, Vol. 2. Where there is a conflict with the PRM, Vol. 2 this section takes precedence.

CIPR rejuvenates the existing pavement, and repairs all cracks and surface distresses. When medium severity cracking is present, but the drainage and pavement structure are sound, CIPR offers a cost-effective means of improving the pavement condition. Because the cracking is

repaired, not just sealed, to a depth up to 100 mm, the appearance of reflection cracking is delayed.

The recycling depth is most dependent on the depth of existing pavement. After milling there must be at least 25 mm of asphalt remaining above the underlying subbase or PCC pavement. It may be necessary to reduce the mill depth for areas over culverts or other utilities (i.e., manholes, drop inlets (D.I.)).

If the paving width and the milling width are the same, the pavement thickness will increase slightly due to the addition of virgin stone. If rail height or curb reveal is critical, there are two common ways of accounting for this increased volume. The paver can be set so that the final compacted layer will be the same height as the mill depth. The excess material is discarded each day. If the pavement has shoulders that are distressed, the shoulder material can be milled out and discarded. The CIPR mill depth can be set to 100 mm, and the recycled material can be paved over the entire width of mainline and shoulders at a compacted depth of 75 mm (refer to Appendix 5B for specification item number). This method is dependent on the ratio of the lane width to shoulder width, and the amount of virgin stone added.

Compaction of the recycled mixture requires vibratory, and pneumatic tire rollers. A cold emulsion mix is weakest during the first few days after it is placed, but it must support traffic while it cures. If the mix is compacted properly this should not present a problem. If the mix is not compacted properly or too much emulsion is added, the mix may rut or shove under traffic. Unless the deformations are severe, further compaction during the cure period should eliminate the problem.

Asphalt shoulders may be recycled at the same time as the mainline pavement. However, it is essential that the shoulders meet the same minimum criteria required for the main line pavement. The minimum shoulder depth must be at least 25 mm greater than the recycle depth. Insufficient depth will result in subbase material being incorporated into the recycled pavement. This may lead to increased quantities of emulsion and decreased pavement performance. The shoulders must be in fair condition. Severe alligator cracking reduces the milling machine's ability to grind the shoulder material to the appropriate size, leading to oversized pieces of Recycled Asphalt Pavement (RAP) being included in the pavement.

If the shoulders cannot be recycled with the pavement, they can be boxed out and replaced before or after recycling. Replacing the shoulders before recycling aids in compacting the recycled mat. Another option may be to remove the shoulders to the depth of 100 mm, mill the pavement to 100 mm and pave the recycled mat over mainline and shoulders in a 75 mm lift (refer to Appendix 5B for specification item number). This can only be done if the pavement is thick enough to recycle 100 mm and the shoulders are less than 1/3 the width of the mainline. The OGS contract for CIPR contains provisions for payment of all of these techniques.

Heavy truck traffic may cause shoving in the recycled mix at controlled (stop sign or signal) intersections. Consider stopping the CIPR at least 150 m before controlled intersections depending on the amount and type of truck traffic. Contact your Regional Materials Engineer for assistance in determining CIPR limits around intersections.

Conditions For Use

Distress of candidate pavements should be limited to:

1. Medium severity cracking
2. High severity rutting and/or widening drop off
3. Corrugations, slippage cracking and raveling
4. Infrequent settlements, heaves, and/or high severity cracking.

Other required pavement conditions include:

1. Thickness of asphalt concrete at least 25 mm greater than mill depth.
2. Adequate drainage.
3. No evidence of severe stripping.
4. Few manholes or other utilities.
5. Continuous sections to be recycled, at least 1 km.
6. Condition of shoulders. Contact the Materials Bureau for support.

Traffic restrictions apply as follows.

1. Less than 4000 AADT per lane.
2. Less than 10% trucks.

Advantages

1. Can be constructed one lane at a time without matching lanes before opening to traffic.
2. Allows for correction of cross-slope.
3. Can be done on mainline only.
4. Mainline and shoulders can be done simultaneously.
5. Requires no crack sealing or rut filling.
6. No need to remove pavement markings.

Disadvantages

1. Contact with manholes, drainage inlets, and underlying concrete will damage equipment.
2. When lane width is less than 3.7 m, may move crown of road.
3. Requires at least 7 days to cure before placing overlay.

Construction Considerations

Weather and seasonal limitations apply as follows.

1. Earliest day of application, May 15.
2. Minimum temperature 10°C.

Constructing a CIPR pavement consists of the following procedures.

1. Clean the pavement.
2. Lay out virgin stone on the pavement ahead of the recycling train.
3. The mat is milled to the design depth, mixed with virgin stone and emulsion, and paved.
4. Compact with vibratory and static steel drums, and pneumatic tire rollers.

5. Fog seal may be applied at the recycler's discretion.
6. Apply temporary pavement markings and traffic immediately after compaction.
7. Allow the mat to cure for at least 7 days.
8. Apply tack coat.
9. The HMA overlay is placed.

Expected Failure Modes

1. Rutting or shoving at intersections.
2. Low temperature cracking.
3. Potholes.
4. Raveling.

Expected Service Life

The expected service life of CIPR is 10 to 15 years.

5.4.2.4 Hot In-Place Recycling with HMA Overlay

Hot in-place recycling (HIPR) involves in-place recycling of 50 mm or 65 mm of existing pavement in a simultaneous multistep process of heating, scarifying, remixing with a virgin asphalt concrete, reshaping, and compacting the asphalt surface. HIPR can be used to correct surface distresses and improve pavement mix characteristics including aggregate gradation, friction characteristics, and asphalt binder content and properties. When HIPR is selected, the contractor is given the option to cold mill the existing pavement, remove the milled material, and replace it with virgin hot mix asphalt (cold mill with inlay) instead of HIPR. The option includes tack coat as part of the process. The depth, width and location must be the same for both HIPR and cold mill with inlay option.

HIPR has been used as a stress-relieving interlayer between the old surface and an overlay to reduce the recurrence of existing crack patterns in the new overlay. The process is useful when it is desired to limit final pavement elevation.

Before a project is selected for HIPR, the Regional Materials Engineer must be contacted to determine that no structural, moisture, or soil problems exist in the pavement structure. Pavement samples must be obtained and evaluated for aggregate gradation and durability, asphalt binder content, and asphalt binder viscosity/penetration as required. The Materials Engineer will determine the depth of HIPR (maximum 65 mm), type and amount of virgin material to be added, and other factors relative to the use of this process. Pavements with stripping, delaminations within or just below the recycled depth, and free water present in the delaminations are not good HIPR candidates.

If HIPR is an option, the Designer must compute quantities for both options and have bid items for both options on separate HC201 proposal bid sheets. A note on the bid sheets will read: "If you bid the pay items on this page do not bid those on the next page"... "If you bid the pay items on this page do not bid those on the preceding page." Additionally, a special proposal note titled "Virgin Asphalt Concrete Admixture and Asphalt Concrete Inlay Mix Type" is required. The note will

specify the mix properties of the virgin asphalt mix added for HIPR, as well as the mix type required for a cold mill with inlay.

Refer to PRM, Vol. 2 for treatment guidelines and Appendix 5B for specification item number.

5.4.2.5 Ultra-thin Whitetopping

Ultra-thin Whitetopping (UTW) is a process where a layer of fiber-reinforced concrete, usually 100 mm (4 in.) thick or less is placed over a prepared surface of distressed asphalt. The resulting composite pavement delivers the long life and performance characteristics of PCC pavement. It should be considered on ramps and intersection where rutting and shoving of the asphalt pavement is a persistent problem. Contact the Materials Bureau for additional information. Two characteristics of a UTW pavement are: (1) a substantial degree of bond is obtained between the concrete overlay and the existing asphalt pavement, and (2) joint spacings are much shorter than normal.

Usually, UTW is applied where a substantial thickness of asphalt exists, such as full-depth pavements or where multiple asphalt overlays were placed over time. NYSDOT constructed an UTW pilot project on the Route 7 westbound ramp to Route 9 in Albany County. The expected service life of UTW is 10 to 15 years depending on the AADT and percent of truck traffic.

5.4.3 Overlays on Flexible-Over-Rigid Pavement

Pavement Rehabilitation Manual: Volume II - Treatment Selection (Appendix 5A of this manual) discusses the following rehabilitation alternatives on HMA/PCC pavements:

1. HMA Overlay
2. Cold Milling with HMA Overlay
3. Cold In-Place Recycling with HMA Overlay
4. Hot In-Place Recycling with HMA Overlay
5. Remove Existing HMA Overlay, Crack and Seat with HMA Overlay
6. Remove Existing HMA Overlay, Rubblize with HMA Overlay

For each rehabilitation alternative, Treatment Guidelines including conditions for use, constructibility, performance, expected failure modes and expected service life are discussed in detail. A Typical Section is also presented for easy reference. Additional guidance for designers are presented below.

5.4.3.1 HMA Overlay

An HMA overlay is a feasible rehabilitation alternative for an HMA/PCC pavement unless the condition of the existing pavement dictates substantial removal and replacement. When another HMA overlay of an existing HMA/JPCP is being considered, the causes of the deterioration in the existing pavement should be carefully investigated. If the PCC slab is sound and in good condition but the existing HMA layer is badly rutted or otherwise deteriorated, the HMA should be removed.

In HMA/JPCP, medium- and high-severity reflection cracks in the HMA surface are evidence of working cracks, deteriorated joints, or failed repairs in the PCC slab. In these cases consider removing the HMA overlay and perform full-depth repairs on the distressed PCC pavement. Coring should be conducted at areas of localized distress to determine whether the distresses are caused by a problem in the HMA mix or deterioration in the PCC (e.g., D-cracking). In the latter case, the PCC may be deteriorated to a greater extent than is evident at the HMA surface.

In general, an asphalt overlay placed on top of a PCC pavement will crack above areas of thermal movement in the underlying PCC pavement. Thermal expansion and contraction in the PCC pavement usually occurs at transverse joints and slab cracks. The severity of cracking in the asphalt overlay is related to the amount of movement and distress exhibited by the PCC pavement.

Any asphalt overlay placed on top of an existing overlay above a PCC pavement should be sawed and sealed if the existing overlay was previously sawed and sealed, or if the existing overlay exhibits consistent reflective cracking at transverse joints. This technique has been very successful when applied to HMA overlays of jointed PCC pavements when the sawcut matches the joint or straight crack within 25 mm (1 in.). See Section 5.4.1.4 for further details.

5.4.3.2 Cold Milling with HMA Overlay

Milling the cracked HMA overlay will delay the onset of reflection cracks. Typically, the PCC pavement below an asphalt overlay will not require milling unless the PCC pavement has been subjected to D-cracking. D-cracking can be identified through coring. Most cracking at longitudinal joints results from deterioration of the cold joint created when paving the asphalt overlay. After cold milling, if the PCC pavement exhibits D-cracking an HMA overlay is not recommended. See Section 5.4.2.2 and PRM, Vol. 2 for further details.

5.4.3.3 Cold In-Place Recycle with HMA Overlay

See Section 5.4.2.3 and PRM, Vol. 2 for details.

5.4.3.4 Hot In-Place Recycle with HMA Overlay

See Section 5.4.2.4 and PRM, Vol. 2 for details.

5.4.3.5 Remove Existing HMA Overlay, Crack and Seat with HMA Overlay

See Section 5.4.1.4 and PRM, Vol. 2 for details.

5.4.3.6 Remove Existing HMA Overlay, Rubblize with HMA Overlay

See Section 5.4.1.5 and PRM, Vol. 2 for details.

5.5 LANE ADDITIONS AND WIDENINGS

Once it has been determined that a project requires lane widening or additions, the designer must consult the Regional Geotechnical Engineer to review the existing subsurface conditions and provide recommendations for an embankment foundation, drainage provisions, and subgrade sufficient to support the pavement structure. Widening projects should use a pavement section that is consistent with the existing pavement design. Refer to Chapter 4 for pavement type selection. (Note: Chapter 3 requires a lane addition that adds one or more lanes that are more than 1.5 km long to be treated as a reconstruction project which requires a pavement type selection analysis and may require a PETSr). The top surface of the subbase of the widening should be no higher than the top surface of the existing pavement. At a minimum, a subbase material similar to the existing subbase should be used under the widened pavement. To better ensure adequate drainage, however, it is preferred practice to use the open graded subbase, crushed stone aggregate subbase course.

Where it is decided that an edge drain system should be installed, the area outside the drains may be constructed of normal embankment materials, although subbase is preferred as shown in Figure 5-1 (Section 5.4.1.4). Where no edgedrains are to be provided, the subbase should be carried to daylight and the bottom surface should slope to drain without pockets that might pond water and contribute to frost heave.

Where slopes are cut, the Regional Geotechnical Engineer should be consulted for recommendations on interceptor ditches, slope geometry and treatment, and catchment areas.

When a concrete lane is to be added adjacent to an existing concrete lane (see Section 4.3 for additional information):

- Any damaged concrete should be milled out and repaired prior to placing the new concrete slab.
- Holes should be drilled into the existing slab in accordance with the design guidance for longitudinal joint ties contained in M502 PCC Standard Sheets.
- The subbase should be brought to a properly prepared surface to permit pouring of a concrete slab matching the thickness of the existing slab.
- The longitudinal joint ties should be grouted into the existing slab.
- The new slab should be poured with transverse joints matching the locations of the existing transverse joints.
- The longitudinal joints should be properly sealed to prevent intrusion of incompressible material.

Details for concrete lane additions/widenings that are not covered by the Standard Specifications or Standard Sheets (e.g., construction of unusual transverse or longitudinal joints) should be explained in special details and specifications as necessary.

If HMA widening is to be constructed, the subbase should be brought to the appropriate surface, the edges of the existing HMA courses should be cleaned or saw cut to provide a sound interface, and a tack coat should be applied prior to placing the new asphalt.

For additional technical guidance regarding lane additions refer to Chapters 4 and 7.

5.6 REFERENCES

1. **Transportation Research Board State-of-the-Art Report**, No. 6, 1987, National Research Council, Washington, D.C.
2. **Guidelines For Use of HMA Overlays to Rehabilitate PCC Pavements**, Pavement Consultancy Services, National Asphalt Pavement Association, Series 117, 1994.
3. **Whitetopping - State of the Practice**, Engineering Bulletin, American Concrete Pavement Association.
4. **AASHTO Guide For Design of Pavement Structures**, Published by the American Association of State Highway and Transportation Officials, 1993, Washington D.C.
5. **Concrete Pavement Restoration (CPR) Standard Sheets**, New York State Department of Transportation.
6. **Standard Sheet M403-1, "Detail of Asphalt Overlay Splice."** New York State Department of Transportation.

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 5: Appendix 5A

Pavement Rehabilitation Manual

Volume II: Treatment Selection

6/30/00



Pavement Rehabilitation Manual

VOLUME II: TREATMENT SELECTION



**MATERIALS BUREAU
NEW YORK STATE DEPARTMENT OF TRANSPORTATION**

PAVEMENT REHABILITATION MANUAL

VOLUME II: TREATMENT SELECTION

M.A.P. Code 7.42-4-4

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**New York State Department of Transportation
Albany, New York 12232**

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William J. Cuerdon
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Daniel K. Fregoe
William M. McCarty
Richard H. Obuchowski
Linda M. Ross
William A. Snyder

PART 1: INTRODUCTION

PART 1: INTRODUCTION

This book on selection of treatments is Volume II of the Materials Bureau's Pavement Rehabilitation Manual. It is to be used in conjunction with Volume I: Pavement Evaluation, published in June 1990 and revised in February 1992 and May 1993. Volume II shows how pavement and/or shoulder distress data, collected in accord with procedures outlined in Volume I, are used to select rehabilitation alternatives, develop strategies and life-cycle costs for those alternatives, and choose proper rehabilitation alternatives. This volume completes the Pavement Rehabilitation Manual. New developments and additions will be handled through the Department's Engineering Instruction process.

Part 2 ("Treatment Guidelines and Typical Sections") is a compilation of current Department pavement rehabilitation treatments, ranging from preventive maintenance to total reconstruction. Included are guidelines maximizing each treatment's effectiveness based on pavement condition (distress levels), and typical section drawings listing work items necessary for success of each treatment. Service lives have been estimated for all treatments based on current experience and engineering judgment. Refinements of these estimates may be necessary as treatment performance histories are developed.

Short isolated areas within a proposed project may exhibit pavement distresses dissimilar to those found on the project in general. It is thus likely that more than one pavement rehabilitation treatment will be required on a project.

Part 3 on life-cycle-cost analysis presents a methodology for comparing treatment costs, the goal being to select a present and future treatment strategy for a pavement with the wisest use of funds. Also included in this chapter are information sources for specification items and costs.

Volume II also contains as Part 4 a model report on pavement evaluation and treatment selection, to give the user an example of format and methodology.

With these "tools" the user can select alternatives and plan a treatment strategy for each alternative. These strategies can then be compared for cost effectiveness and final selection. Once completed, performance of the selected strategy should be followed to verify service life assumptions, learn the influence of variables, and refine the analysis for future rehabilitation strategies.

Users of this Manual are cautioned that selection of a rehabilitation strategy should not be based on existing pavement condition alone. Other less obvious deficiencies, such as unfavorable soil conditions and inadequate drainage characteristics, may have a profound effect on strategy selection and project scope. Also, design and/or construction constraints and maintenance concerns and capabilities must be considered during the selection process.

It is thus recommended that technical assistance be solicited from those regional and/or Main Office units having expertise in these areas during the selection process.

The general procedure for treatment selection includes ten steps:

1. Review the condition report generated by following procedures in Volume I: Pavement Evaluation.
2. Solicit information from regional and/or Main Office units that could influence treatment selection.
3. Select appropriate initial treatment alternatives based on pavement condition and the treatment guidelines presented here.
4. Eliminate any initial alternatives that are inappropriate due to design, construction, or other constraints.
5. Develop a treatment strategy for each alternative using expected service life of the initial treatment and projected future treatments.
6. Determine costs of all initial and future treatments using prices from past projects or estimates for new items.
7. Compare total costs of the alternative strategies, using the methods presented here.
8. Perform a "Sensitivity Analysis" if desirable.
9. Select the best treatment strategy based on cost and other factors.
10. Document pavement performance to improve future strategy development.

PART 2: TREATMENT GUIDELINES AND TYPICAL SECTIONS

Rigid Pavement

Flexible Pavement

Flexible-Over-Rigid Pavement

Pavement Widening

Flexible Shoulder

PART 2: TREATMENT GUIDELINES AND TYPICAL SECTIONS

This part of Volume II is divided into three sections representing three pavement types: rigid, flexible, and flexible-over-rigid. Each section is further divided into four categories for various pavement treatments: Preventive Maintenance, Corrective Maintenance, Pavement Rehabilitation, and Pavement Reconstruction. Finally, treatments for pavement widening and treatment categories for shoulder maintenance and repair are discussed.

1. Preventive Maintenance. Treatments undertaken in advance of a critical need or of accumulated deterioration to avoid such occurrences and reduce or arrest the rate of deterioration, thus, allowing roadway surfaces to achieve their desired service lives. As a secondary benefit, these treatments correct minor defects and may improve roadway strength, friction, rideability and/or appearance for up to 8 years.
2. Corrective Maintenance. Treatments correcting existing deficiencies, upgrading the roadway surface for up to 8 years or until other more-extensive treatments are needed.
3. Pavement Rehabilitation. Treatments intended to extend service life of a roadway surface 8 years or more. To be effective, treatment selection is critical and should be based on amount and severity of existing pavement distress.
4. Pavement Reconstruction. Treatments to be considered when condition of the existing pavement is such that it can no longer serve a useful purpose, when design constraints preclude rehabilitation, or when a life-cycle-cost analysis reveals that reconstruction is the most appropriate solution.

Each pavement treatment guideline is presented in the following format;

1. Conditions For Use
2. Constructability
3. Performance
4. Expected Failure Modes
5. Expected Service Life

Except for reconstruction treatments, a typical section drawing is shown for each pavement treatment, listing appropriate repair items necessary for developing treatment costs. For reconstruction treatments, the Department's standard typical sections should be used to develop costs.

"Expected Service Life" in these guidelines is based on past research and current performance experience. It is appropriate for highways with Average Annual Daily Traffic counts (AADTs) of 12,000 to 35,000 with about 5-percent trucks. Service life should be

adjusted for highways with traffic outside these limits. Some guidelines are meant only for low-volume roadways, as noted under "Conditions For Use."

The ideal method to change or correct service life is by referring to a pavement work history file. A uniform statewide work history file is being developed as part of the Department's Pavement Management Initiative. Lacking this, similar treatments on highways carrying similar traffic volumes should be observed to estimate service life. Pavement performance for the various treatments should be followed and added to a work history file for future decision-making. Service life adjustments should be made using as many facts as possible, following a logical process and saving the information for future use.

Pavement deterioration results from the environment and traffic, but some treatments are not expected to change significantly with traffic. For instance, sealed or filled joints or cracks should not change, as their performance is based on temperature-induced movement and not traffic. However, traffic and environment affect other treatments and adjustments in their service lives are appropriate.

Part 4 ("Model Pavement Evaluation Report") in this volume shows a service life adjustment. In this example, estimated service life was decreased when overlay treatment thickness was reduced.

Thickness dimensions for asphalt overlays in the guidelines are considered nominal. Minor adjustments to these thicknesses are appropriate when local practice and performance dictate. However, caution is advised in reducing thicknesses. A thickness found in the guidelines should always be used as a minimum on interstate system roadways.

RIGID PAVEMENT TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance

- Joint and Crack Filling
- Joint and Crack Sealing

Corrective Maintenance

- Joint and Crack Sealing With Spall Repair
- Joint and Crack Sealing With Spall Repair and Grinding
- Joint and Crack Sealing With Spall Repair, Grinding,
and Full-Depth Segment Replacement

Rehabilitation

- Joint and Crack Sealing With Spall Repair and Full-Depth Segment Replacement
- Bonded Concrete Overlay
- Sawed and Sealed Asphalt Concrete Overlay (3")
- Sawed and Sealed Asphalt Concrete Overlay (4")
- Asphalt Concrete Overlay (5") Preceded by Cracking and Seating
- Asphalt Concrete Overlay (6") Preceded by Rubblizing

Reconstruction

- Full-Depth Portland Cement or Asphalt Concrete

Joint and Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals or filler, or slab cracks never sealed or filled.
2. Medium-severity pavement/shoulder separation.
3. Other distresses at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Restricted by temperature and moisture.
 - b. Cracks must be clean for the filler to be effective.

Performance

1. Reduces incompressibles and water infiltration.
2. Helps to achieve desired pavement service life.

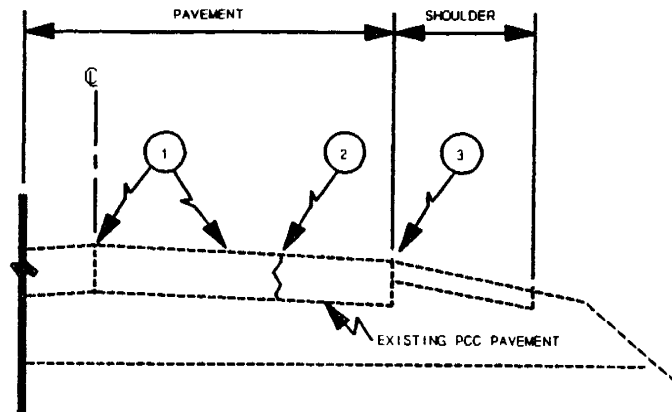
Expected Failure Modes

1. Fillers fail in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life

2 years

2. Typical Section



1. Clean and fill longitudinal and transverse joints.
2. Clean and fill slab cracks.
3. Clean and fill pavement/shoulder joint.
(See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Other distresses at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Restricted by temperature and moisture.
 - b. Requires intensive inspection.
 - c. Slab cracks difficult to follow for routing and sealing.

Performance

1. Retards development of spalls and faults from incompressibles and water infiltration.
2. Needed to achieve desired pavement service life.

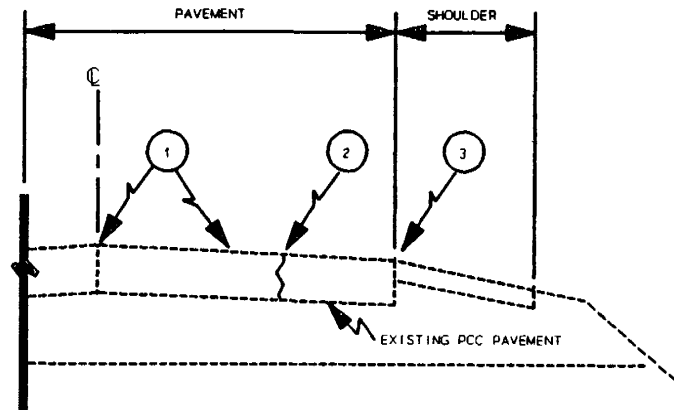
Expected Failure Modes

1. Seals fail in adhesion or cohesion.

Expected Service Life

8 years

2. Typical Section



1. Clean and seal longitudinal and transverse joints.
2. Rout, clean, and seal slab cracks.
3. Clean and fill pavement/shoulder joint.
(See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or scaling/non-joint spalling.
4. Other distresses at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Sealing disadvantages
 - a. Restricted by temperature and moisture.
 - b. Requires intensive inspection.
 - c. Slab cracks difficult to follow for routing and sealing.
3. Spall repair disadvantages
 - a. Restricted by temperature and moisture.
 - b. Sounding required to detect delaminations for spall repair.
 - c. Requires intensive preparation of the spalled area.

Performance

1. Sealing
 - a. Retards development of spalls and faults from incompressibles and water infiltration.
 - b. Needed to achieve desired pavement service life.
2. Spall repair
 - a. Restores ride by replacing lost material.
 - b. Needed to achieve desired pavement service life.

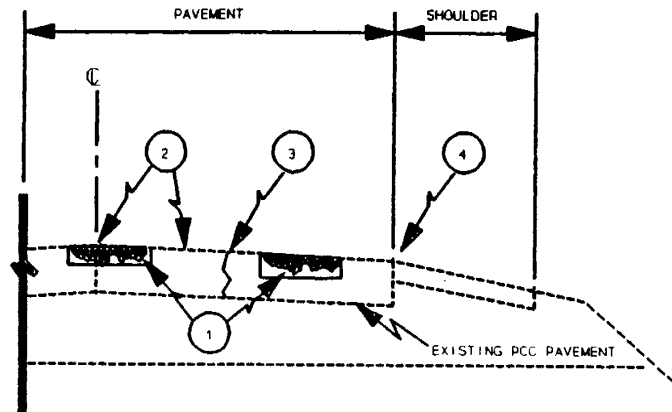
Expected Failure Modes

1. Sealing
 - a. Seals fail in adhesion or cohesion.
2. Spall repair
 - a. Loss of material due to cracking, delamination, or surrounding pavement failure.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years

2. Typical Section



1. Mill and patch spalls with rapid-setting concrete patching materials.
 2. Clean and seal longitudinal and transverse joints.
 3. Rout, clean, and seal slab cracks.
 4. Clean and fill pavement/shoulder joint.
- (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair and Grinding

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent medium-severity slab cracks.
3. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or scaling/non-joint spalling.
4. Medium-severity transverse joint faulting.
5. Other distresses at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Sealing disadvantages
 - a. Restricted by temperature and moisture.
 - b. Requires intensive inspection.
 - c. Slab cracks difficult to follow for routing and sealing.
3. Spall repair disadvantages
 - a. Restricted by temperature and moisture.
 - b. Sounding required to detect delaminations for spall repair.
 - c. Requires intensive preparation of the spalled area.
4. Grinding disadvantages
 - a. Side clearance of the machine limits grinding near existing features (i.e., curbs and barriers).
 - b. New joint seal reservoirs must be created.
 - c. High reinforcing mesh damages grinding equipment.

Performance

1. Sealing
 - a. Retards development of spalls and faults from incompressibles and water infiltration.
 - b. Needed to achieve desired pavement service life.
2. Spall repair
 - a. Restores ride by replacing lost material.
 - b. Needed to achieve desired pavement service life.
3. Grinding
 - a. Restores ride by removing faults (also improves pavement friction).

Expected Failure Modes

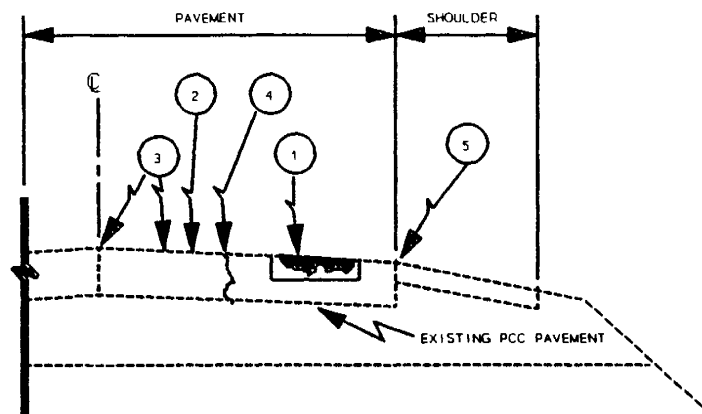
1. Sealing
 - a. Seals fail in adhesion or cohesion.

2. Spall repair
 - a. Loss of material due to cracking, delamination, or surrounding pavement failure.
3. Grinding
 - a. Traffic causes faults to return.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Grinding: 5 years

2. Typical Section



1. Mill and patch spalls with rapid-setting concrete patching materials.
 2. Grind faults.
 3. Clean and seal longitudinal and transverse joints.
 4. Rout, clean, and seal slab cracks.
 5. Clean and fill pavement/shoulder joint.
- (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair, Grinding, and Full-Depth Segment Replacement

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
 2. Infrequent high-severity slab cracks.
 3. Infrequent transverse and/or longitudinal joint separations.
 4. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or medium- and/or high-severity scaling/non-joint spalling.
 5. Medium-severity transverse joint faulting.
 6. Infrequent settlements, heaves, and/or blowups.
 7. Other distresses at the none or low-severity level.
- (Note: Distresses 2,3,4, and 6 are repaired with full-depth rapid-set cement concrete)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Sealing disadvantages
 - a. Restricted by temperature and moisture.
 - b. Requires intensive inspection.
 - c. Slab cracks difficult to follow for routing and sealing.
3. Spall repair disadvantages
 - a. Restricted by temperature and moisture.
 - b. Sounding required to detect delaminations for spall repair.
 - c. Requires intensive preparation of the spalled area.
4. Grinding disadvantages
 - a. Side clearance of the machine limits grinding near existing features (i.e., curbs and barriers).
 - b. New joint seal reservoirs must be created.
 - c. High reinforcing mesh damages grinding equipment.
5. Full-depth segment replacement disadvantages
 - a. Requires special preparation, equipment, and materials.

Performance

1. Sealing
 - a. Retards spall and fault development from incompressibles and water infiltration.
 - b. Needed to achieve desired pavement service life.
2. Spall repair
 - a. Restores ride by replacing lost material.
 - b. Needed to achieve desired pavement service life.
3. Grinding
 - a. Restores ride by removing faults (also improves pavement friction).

4. Full-depth segment replacement
 - a. Restores structural integrity by replacing cracked and displaced pavement.
 - b. Restores ride by replacing lost or displaced pavement.

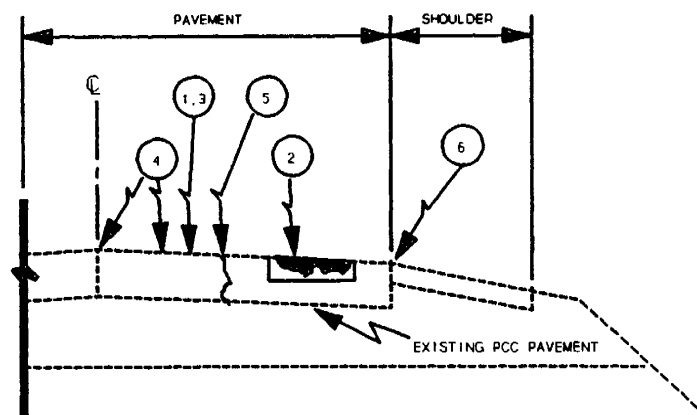
Expected Failure Modes

1. Sealing
 - a. Seals fail in adhesion or cohesion.
2. Spall repair
 - a. Loss of material due to cracking, delamination, or surrounding pavement failure.
3. Grinding
 - a. Traffic causes faults to return.
4. Full-depth segment replacement
 - a. Fails in the same manner as any portland cement concrete pavement.
 - b. Adjacent pavement failure may propagate into new segment.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Grinding: 5 years
4. Full-depth segment replacement: equals or exceeds service life of the existing pavement up to 30 years.

2. Typical Section



1. Full-depth segment replacement with cement concrete.
 2. Mill and patch spalls with rapid-setting concrete patching materials.
 3. Grind faults.
 4. Clean and seal longitudinal and transverse joints.
 5. Rout, clean, and seal slab cracks.
 6. Clean and fill pavement/shoulder joint.
- (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Joint and Crack Sealing With Spall Repair and Full-Depth Segment Replacement

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Infrequent high-severity slab cracks.
3. Infrequent transverse and/or longitudinal joint separations.
4. Medium-severity transverse joint spalling, longitudinal joint spalling, and/or medium- and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. Other distresses at the none or low-severity level.
(Note: Distresses 2, 3, 4, and 5 are repaired with full-depth rapid-setting cement concrete)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Sealing disadvantages
 - a. Restricted by temperature and moisture.
 - b. Requires intensive inspection.
 - c. Slab cracks difficult to follow for routing and sealing.
3. Spall repair disadvantages
 - a. Restricted by temperature and moisture.
 - b. Sounding required to detect delaminations for spall repair.
 - c. Requires intensive preparation of the spalled area.
4. Full-depth segment replacement disadvantages
 - a. Requires special preparation, equipment, and materials.

Performance

1. Sealing
 - a. Retards development of spalls and faults from incompressibles and water infiltration.
 - b. Needed to achieve desired pavement service life.
2. Spall repair
 - a. Restores ride by replacing lost material.
 - b. Needed to achieve desired pavement service life.
3. Full-depth segment replacement
 - a. Restores structural integrity by replacing cracked and displaced pavement.
 - b. Restores ride by replacing lost or displaced pavement.

Expected Failure Modes

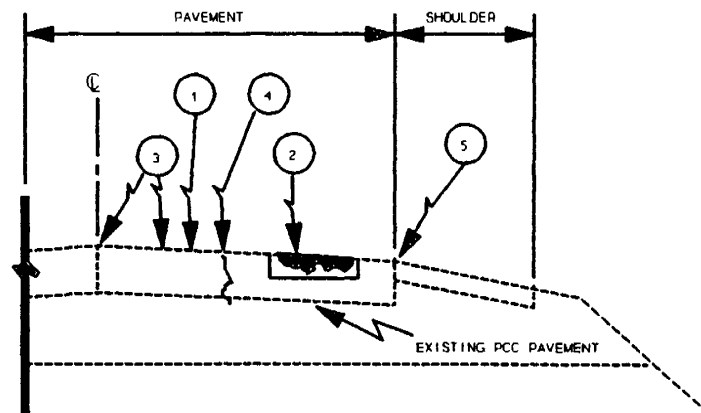
1. Sealing
 - a. Seals fail in adhesion or cohesion.

2. Spall repair
 - a. Loss of material due to cracking, delamination, or surrounding pavement failure.
3. Full-depth segment replacement
 - a. Fails in the same manner as any portland cement concrete pavement.
 - b. Adjacent pavement failure may propagate into new segment.

Expected Service Life

1. Joint/crack sealing: 8 years
2. Spall repair: 10 years
3. Full-depth segment replacement: equals or exceeds service life of the existing pavement up to 30 years.

2. Typical Section



1. Full-depth segment replacement with cement concrete.
 2. Mill and patch spalls with rapid-setting concrete patching materials.
 3. Clean and seal longitudinal and transverse joints.
 4. Rout, clean, and seal slab cracks.
 5. Clean and fill pavement/shoulder joint.
- (See Flexible Shoulder Treatment Guidelines and Typical Sections)

Bonded Concrete Overlay

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
 2. Infrequent medium- and high-severity slab cracks.
 3. Infrequent transverse and/or longitudinal joint separations.
 4. Medium- and/or high-severity transverse and/or longitudinal joint spalling and/or medium- and/or high-severity scaling/non-joint spalling.
 5. Infrequent settlements, heaves, and/or blowups.
 6. Medium- and/or high-severity wheelpath rutting.
 7. Other distresses at the none or low-severity level.
- (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement concrete)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Uses normal concrete paving techniques.
 - c. Rapid-strength-gaining concrete mixes are available.
2. Disadvantages
 - a. Overnight lane closures are required.
 - b. Achieving bond is critical.
 - c. Sandblast cleaning is required, dust control is difficult.
 - d. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Increased thickness adds structural capacity, if required.
3. Less susceptible to rutting than asphalt concrete overlay.

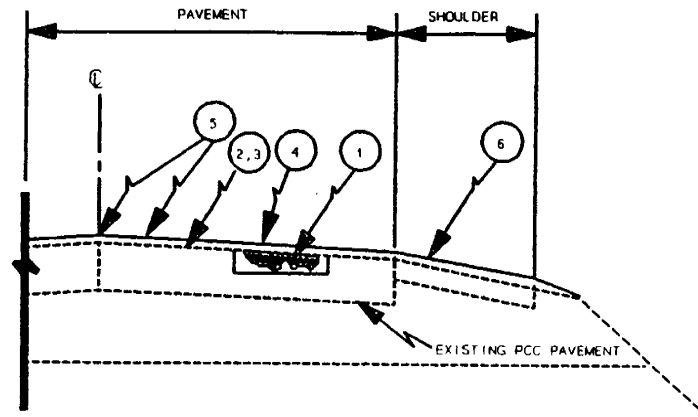
Expected Failure Modes

1. Sealer failure leading to spalls and blowups.
2. Underlying unrepaired cracks may reflect.

Expected Service Life

20 years with joint/crack resealing at 8-year intervals.

2. Typical Section



1. Mill out spalls.
2. Scarify 1/4", sandblast.
3. Clean pavement.
4. 3" cement concrete bonded overlay.
5. Saw and seal concrete over existing joints.
6. Asphalt concrete or cement concrete shoulder.

Sawed and Sealed Asphalt Concrete Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
 2. Infrequent medium- and/or high-severity slab cracks.
 3. Infrequent transverse and/or longitudinal joint separations.
 4. Medium-severity transverse and/or longitudinal joint spalling and/or medium-severity scaling/non-joint spalling.
 5. Infrequent settlements, heaves, and/or blowups.
 6. Medium- and/or high-severity wheelpath rutting.
 7. Other distresses are at the none or low-severity level.
- (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement or asphalt concrete)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Sawcuts must be properly located over underlying transverse joints.
 - b. Sealers must be installed properly.
 - c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
 - a. Restores ride, friction, and cross-slope.
2. Saw and seal
 - a. Controls reflection cracking.
 - b. Seals keep water out of the pavement structure, preventing further joint distress.
 - c. Seal must be maintained to achieve desired overlay service life.
3. Full-depth repairs
 - a. Restore structural integrity.
 - b. Needed to achieve desired overlay service life.

Expected Failure Modes

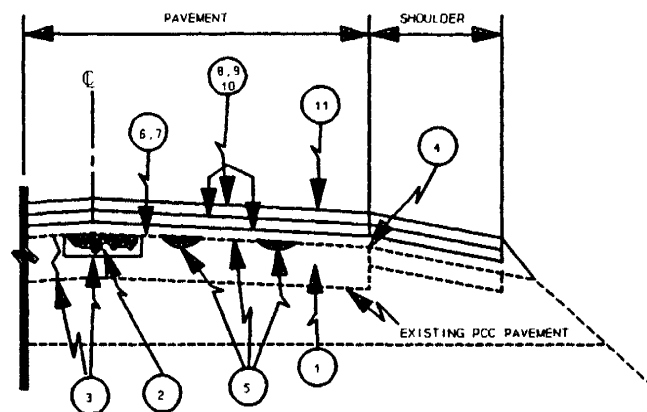
1. Asphalt concrete overlay
 - a. Oxidation, ravelling, and/or rutting.
 - b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
2. Saw and seal
 - a. Failure to maintain the seal may lead to multiple cracks and potholes at transverse joints.

3. Full-depth repairs
 - a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.

Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Sawed and sealed joints: 8 years
3. Full-depth asphalt concrete repairs: life of the overlay with bump milling at 5-year intervals
4. Full-depth cement concrete repairs: 30 years

2. Typical Section



1. Full-depth segment replacement with cement or asphalt concrete.
2. Mill and patch spalls with rapid-setting cement or asphalt concrete.
3. Clean and fill joints and cracks.
4. Clean and fill pavement/shoulder joint.
5. Shim faults and wheel ruts.
6. Clean pavement.
7. Tack coat.
8. Asphalt concrete truing-and-leveling.
9. Asphalt concrete binder (1-1/2").
10. Asphalt concrete top (1-1/2").
11. Saw and seal new surface over existing transverse joints.

Sawed and Sealed Asphalt Concrete Overlay (4")

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
 2. Infrequent medium- and/or high-severity slab cracks.
 3. Infrequent transverse and/or longitudinal joint separations.
 4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
 5. Infrequent settlements, heaves, and/or blowups.
 6. Medium-severity transverse joint faulting.
 7. High-severity wheelpath rutting.
- (Note: Distresses 2, 3, and 5 are repaired with full-depth rapid-setting cement or asphalt concrete)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closure not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Sawcuts must be properly located over transverse joints.
 - b. Sealers must be installed properly.
 - c. 4" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
 - a. Restores ride, friction, and cross-slope.
 - b. Increased thickness bridges patched spalls.
 - c. Multiple-course placement results in smoother ride.
2. Saw and seal
 - a. Controls reflection cracking.
 - b. Sealers keep water out of the pavement structure, preventing further joint distress.
 - c. Seal must be maintained to achieve desired overlay service life.
3. Full-depth repairs
 - a. Restore structural integrity.
 - b. Needed to achieve desired overlay service life.

Expected Failure Modes

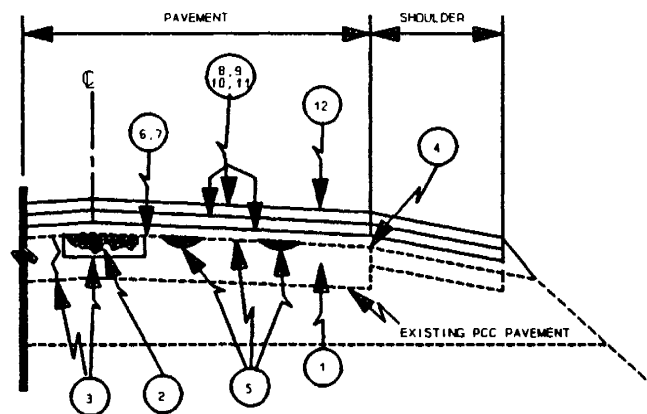
1. Asphalt concrete overlay
 - a. Oxidation, ravelling, and/or rutting.
 - b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
2. Saw and seal
 - a. Failure to maintain the seal may lead to multiple cracks and potholes at transverse joints.

3. Full-depth repairs
 - a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.

Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Sawed and sealed joints: 8 years
3. Full-depth asphalt concrete repairs: life of the overlay with bump milling at 5-year intervals
4. Full-depth cement concrete repairs: 30 years

2. Typical Section



1. Full-depth segment replacement with cement or asphalt concrete.
2. Mill and patch spalls with rapid-setting cement or asphalt concrete.
3. Clean and fill joints and cracks.
4. Clean and fill pavement/shoulder joint.
5. Shim faults and wheel ruts.
6. Clean pavement.
7. Tack coat.
8. Asphalt concrete truing-and-leveling.
9. Initial asphalt course, asphalt concrete top (1").
10. Asphalt concrete binder (1-1/2").
11. Asphalt concrete top (1-1/2").
12. Saw and seal new surface over existing transverse joints.

Asphalt Concrete Overlay (5") Preceded by Cracking and Seating

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
 2. Medium- and/or high-severity slab cracks.
 3. Infrequent transverse and/or longitudinal joint separations.
 4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
 5. Infrequent settlements, heaves, and/or blowups.
 6. High-severity transverse joint faulting.
 7. High-severity wheelpath rutting.
- (Note: Distresses 3 and 5 are repaired with full-depth asphalt concrete)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Traffic can be maintained on the cracked and seated portland cement concrete pavement.
 - d. Common rehabilitation technique.
2. Disadvantages
 - a. Cracking and seating may create additional unexpected spalls.
 - b. Has potential to disrupt culverts and underground utilities.
 - c. 5" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
 - a. Restores ride, friction, and cross-slope.
 - b. Increased thickness adds structural capacity and bridges patched spalls.
2. Crack and seat
 - a. Minimizes reflection cracking.
 - b. Reduction of reflection cracks keeps water from pavement structure.
 - c. Crack filling may be necessary to achieve desired overlay service life.
3. Full-depth repairs
 - a. Restore structural integrity.
 - b. Needed to achieve desired overlay service life.

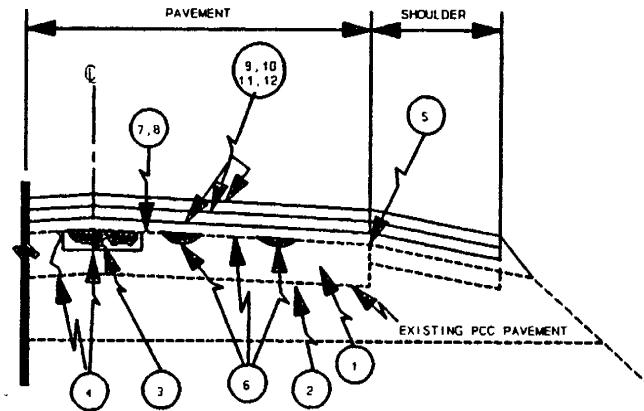
Expected Failure Modes

1. Asphalt concrete overlay
 - a. Oxidation, ravelling, and/or rutting.
 - b. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
 - c. Failure to maintain reflection cracks may lead to multiple cracks and potholes.
2. Full-depth repairs
 - a. Asphalt concrete repairs are more likely to rut, shove, and/or heave causing bumps.
 - b. Undowelled cement concrete repairs may heave causing bumps.

Expected Service Life

1. Asphalt concrete overlay: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Full-depth repairs: life of the overlay with bump milling as necessary.

2. Typical Section



1. Full-depth segment replacement with cement or asphalt concrete.
2. Crack and seat existing pavement.
3. Mill and patch spalls with asphalt concrete.
4. Clean and fill joints and cracks.
5. Clean and fill pavement/shoulder joint.
6. Shim faults and wheel ruts.
7. Clean pavement.
8. Tack coat.
9. Asphalt concrete truing-and-leveling.
10. Initial asphalt concrete course, asphalt concrete binder (2").
11. Asphalt concrete binder (1-1/2").
12. Asphalt concrete top (1-1/2").

Asphalt Concrete Overlay (6") Preceded by Rubblizing

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Separated transverse and/or longitudinal joints.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Infrequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
8. Widening is contemplated.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Does not damage utilities.
 - c. Compaction and overlay use standard techniques.
 - d. Spall repair and full-depth replacement are not necessary.
 - e. Pavement widening, shoulder replacement, and filling depressions can be accomplished with crushed stone.
2. Disadvantages
 - a. Traffic cannot be maintained on a rubblized surface until the initial asphalt concrete course is placed.
 - b. Positive drainage is required.
 - c. 6" thickness may be a problem for vertical clearance and appurtenances.
 - d. Most roadway features will require adjustment.
 - e. Rubblizing equipment cannot get closer than 3 ft to curbs.

Performance

1. Restores ride, friction, and cross-slope.
2. Eliminates reflection cracks.
3. Absence of reflection cracks keep water from the pavement structure.
4. Rubblized pavement provides a drainage layer.

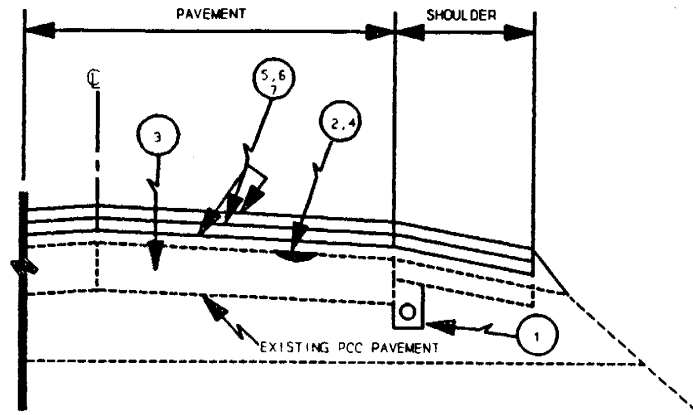
Expected Failure Modes

1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life

- 15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Install edge drain.*
2. Remove asphalt patches and/or overlays.
3. Rubblize and compact existing pavement.**
4. Patch depressions with crushed stone.
5. Asphalt concrete base (3").
6. Asphalt concrete binder (1-1/2").
7. Asphalt concrete top (1-1/2").

* An alternative to edge drain installation is a daylighted crushed stone shoulder replacing the existing shoulder.

** Pavement may also be widened with crushed stone matching the thickness of the rubblized pavement.

Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Failed joint seals.
2. Medium- and/or high-severity slab cracks.
3. Separated transverse and/or longitudinal joints.
4. High-severity transverse and/or longitudinal joint spalling and/or high-severity scaling/non-joint spalling.
5. Frequent settlements, heaves, and/or blowups.
6. High-severity transverse joint faulting.
7. High-severity wheelpath rutting.
8. Widening is contemplated.
9. Realignment is contemplated.
10. Existing profile must be maintained.
11. Extensive utility replacement is necessary.

Constructability

1. Advantages
 - a. Uses standard techniques.
 - b. Rapid-strength-gaining cement concrete mixes are available.
 - c. Traffic can be maintained on the initial courses of asphalt concrete.
2. Disadvantages
 - a. Overnight and/or long-term lane closures are required for cement concrete pavement.
 - b. Must remove and dispose of existing pavement.

Performance

1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes

1. Asphalt concrete pavement
 - a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.
2. Portland cement concrete pavement
 - a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life

1. Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.

FLEXIBLE PAVEMENT TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance

- Crack Sealing
- Crack Filling
- Single-Course Overlay (1" to 1-1/2")

Corrective Maintenance

- Single-Course Overlay (1" to 1-1/2")
- Hot In-Place Recycle (1" to 1-1/2")
- Cold Milling and Replacement (1" to 1-1/2")

Rehabilitation

- Two-Course Overlay (3")
- Cold Milling With Single-Course Overlay ($\geq 3"$)
- Hot In-Place Recycle With Single-Course Overlay (3")
- Cold In-Place Recycle With Single-Course Overlay (4-1/2")
- Multiple-Course Overlay ($\geq 4"$)
- Cold Milling With Multiple-Course Overlay ($\geq 4"$)
- Cold In-Place Recycle With Multiple-Course Overlay (6")

Reconstruction

- Asphalt Concrete Pavement Construction Above Existing Grade
- Full-Depth Portland Cement or Asphalt Concrete

Crack Sealing

1. Treatment Guidelines

Conditions For Use

1. Failed seals or full-width transverse cracks were never sealed.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Requires intensive inspection.

Performance

1. Seals out water and incompressibles.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

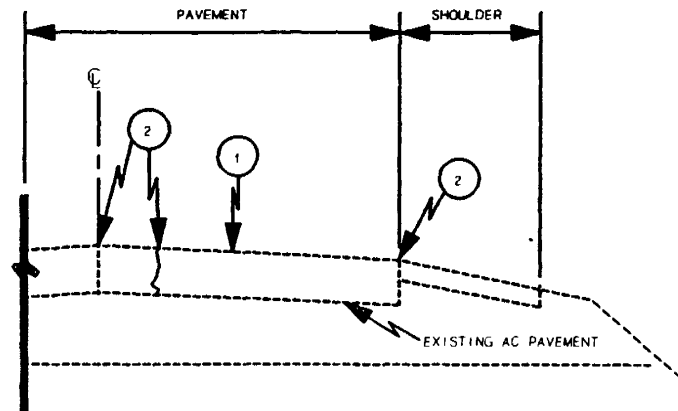
Expected Failure Modes

1. Sealer fails in adhesion or cohesion.

Expected Service Life

5 years

2. Typical Section



1. Rout, clean, and seal transverse cracks.
2. Clean and fill cracks and pavement/shoulder joint.

Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed seals or filler or cracks were never filled.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, and/or medium-severity cracking.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Cracks must be clean for the filler to be effective.

Performance

1. Reduces incompressible and water infiltration.
2. Retards the development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

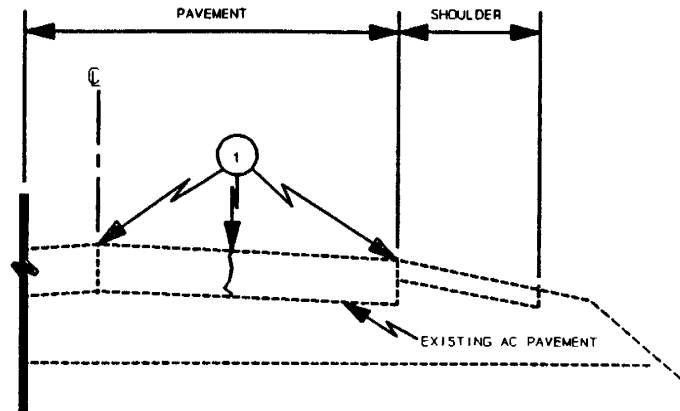
Expected Failure Modes

1. Filler fails in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life

2 years

2. Typical Section



1. Clean and fill cracks and pavement/shoulder joint.

Note: The crack filling operations in wheelpaths will be limited to a single intermittent (not to exceed 20 feet) longitudinal crack. Multiple cracks and alligator cracking in the wheelpaths shall not be filled. Spray patch (surface treatment), micro-surfacing, armor coat, or other similar treatments shall be used as a preventive maintenance treatment in these instances.

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent ravelling, and/or medium-severity cracking.
3. Low-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common maintenance technique.
2. Disadvantages
 - a. Crack filling is required to achieve service life.

Performance

1. Restores ride and friction.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

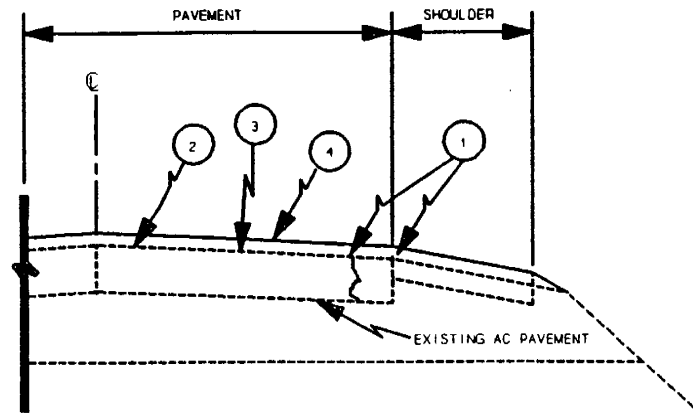
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Clean and fill cracks and pavement/shoulder joint.
2. Clean pavement.
3. Tack coat.
4. Asphalt concrete top course (1" to 1-1/2").

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Medium-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Crack filling, shimming wheel ruts are required to achieve service life.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

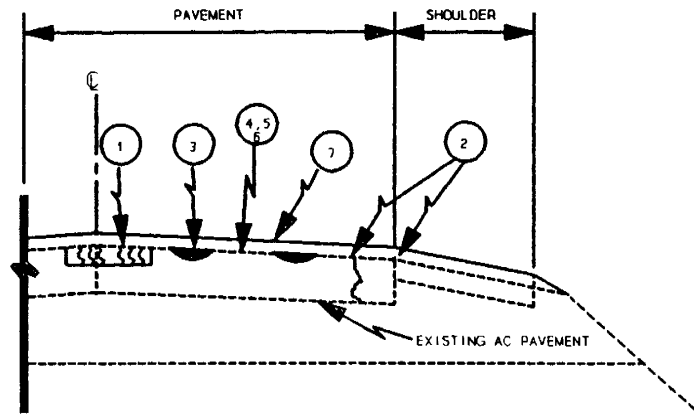
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat
6. Truing-and-leveling
7. Asphalt concrete top course (1" to 1-1/2").

Hot In-Place Recycle (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations may be present.
5. Low or medium-severity wheelpath rutting and/or widening dropoff.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
 - d. Maintains existing profile.
2. Disadvantages
 - a. Manholes or drainage inlets will damage recycling equipment.
 - b. Smoke emissions may prohibit use in residential areas.
 - c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint.
3. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

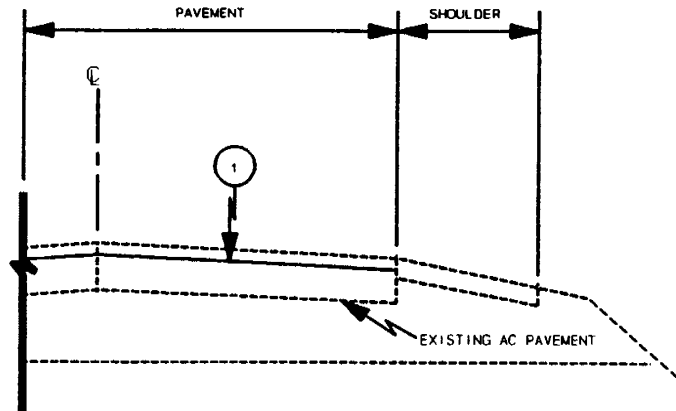
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Hot in-place surface recycling (1" to 1-1/2").

Cold Milling and Replacement (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Corrugations may be present.
4. Low- or medium-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Maintains existing profile.
 - d. Requires no truing-and-leveling.
2. Disadvantages
 - a. Millings must be disposed or recycled.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

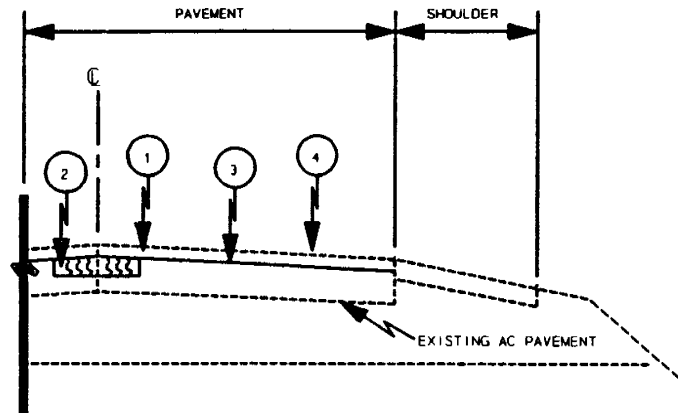
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold mill existing pavement surface (1" to 1-1/2").
2. Mill and patch high-severity cracks and ravelled and/or stripped areas with asphalt concrete.
3. Tack coat.
4. Asphalt concrete top course (1" to 1-1/2").

Two-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closure not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Crack filling, shimming wheel ruts, and truing-and-leveling are required to achieve service life.
 - b. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

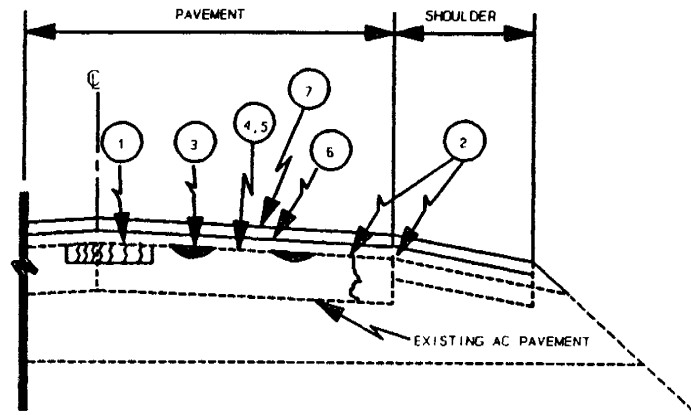
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete binder course (1-1/2").
7. Asphalt concrete top course (1-1/2").

Cold Milling With Single-Course Overlay ($\geq 3"$)

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Minimal increase in profile elevation.
 - d. Requires no truing-and-leveling.
2. Disadvantages
 - a. Millings must be disposed or recycled.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks.

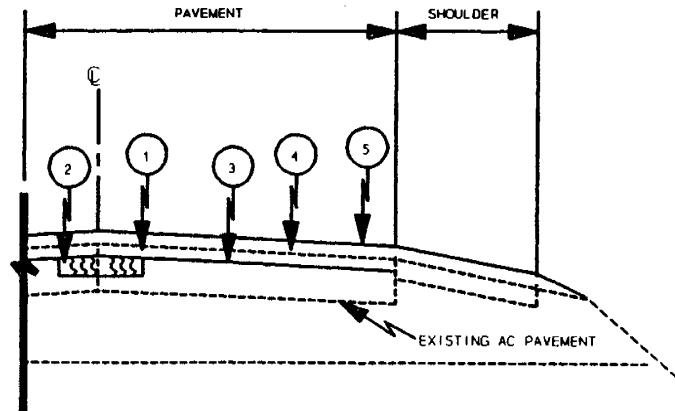
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold mill existing pavement surface ($\geq 1\text{-}1/2''$).
2. Mill and patch high-severity cracks and ravelled and/or stripped areas with asphalt concrete.
3. Tack coat.
4. Asphalt concrete inlay course ($\geq 1\text{-}1/2''$).
5. Asphalt concrete top course ($1\text{-}1/2''$).

Hot In-Place Recycle With Single-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations, slippage cracks, and ravelling may be present.
5. High-severity wheelpath rutting and/or widening dropoff may be present.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
2. Disadvantages
 - a. Manholes or drainage inlets will damage recycling equipment.
 - b. Smoke emissions may prohibit use in residential areas.
 - c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint in the recycled layer.
3. Adds structural capacity.
4. Maintenance required early in overlay life to fill or seal reflective cracks.

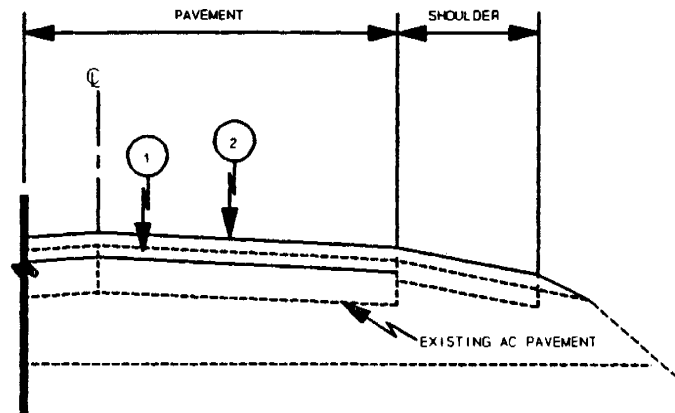
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Hot in-place recycle (1-1/2").
2. Asphalt concrete top course (1-1/2").

Cold In-Place Recycle With Single-Course Overlay (4-1/2")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.
5. Pavement core evaluation must meet warrants for recycling.
6. Pavement must have less than 4000 AADT per lane.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no crack sealing or shimming wheel ruts.
2. Disadvantages
 - a. Manholes or drainage inlets will damage recycling equipment.
 - b. Truing-and-leveling may be required.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

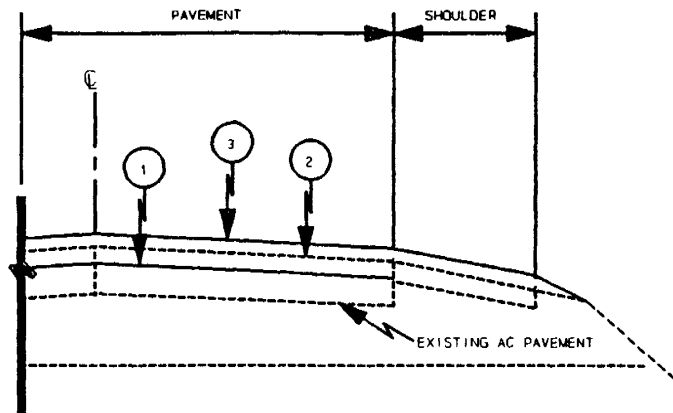
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete top course (1-1/2").

Multiple-Course Overlay ($\geq 4"$)

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Crack filling, shimming wheel ruts, and truing-and-leveling are required.
 - b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

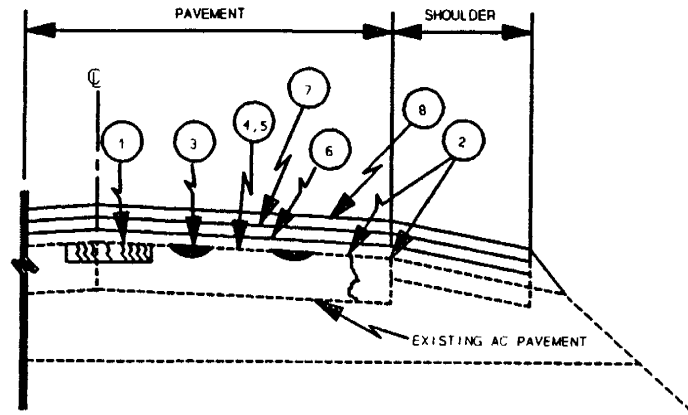
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling.
6. Asphalt concrete strengthening course (1" to 4").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Cold Milling With Multiple-Course Overlay ($\geq 4"$)

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no truing-and-leveling.
2. Disadvantages
 - a. Must dispose of millings.
 - b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

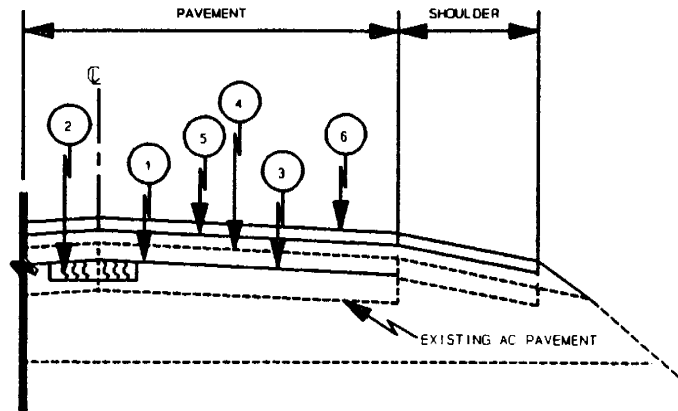
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold mill existing pavement surface (≥ 1 ").
2. Mill and patch ravelled and/or stripped areas with asphalt concrete.
3. Tack coat.
4. Asphalt concrete inlay and/or strengthening course (≥ 1 "), multiple courses required for lifts > 4 ".
5. Asphalt concrete binder course ($1\frac{1}{2}$ ").
6. Asphalt concrete top course ($1\frac{1}{2}$ ").

Cold In-Place Recycle With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.
4. Pavement core evaluation should meet warrants for recycling.
5. Pavement must have less than 4000 AADT per lane.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no crack sealing or shimming wheel ruts.
2. Disadvantages
 - a. Manholes or drainage inlets will damage the recycling equipment.
 - b. Truing-and-leveling may be required.
 - c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

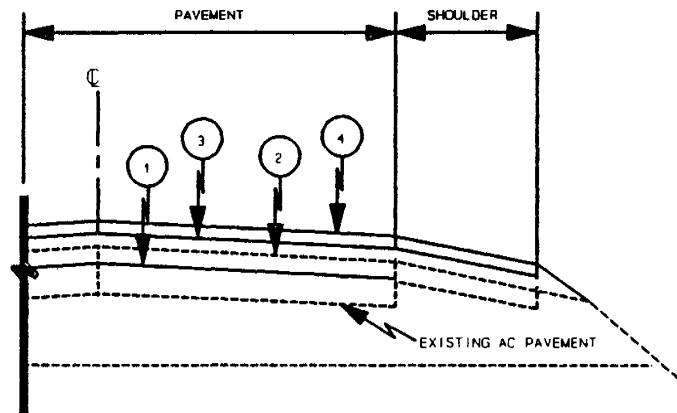
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete binder course (1-1/2").
4. Asphalt concrete top course (1-1/2").

Asphalt Concrete Pavement Construction Above Existing Grade

1. Treatment Guidelines

Conditions For Use

1. Corrugations, slippage cracks, and ravelling may be present.
2. Other distresses may be high-severity.
3. Existing pavement has low grade line with frost heaves and/or drainage problems over a substantial portion of its length.

Constructability

1. Advantages
 - a. Uses standard techniques.
 - b. Traffic can be maintained on initial courses of asphalt concrete.
2. Disadvantages
 - a. Overnight lane closures may be required.
 - b. Traffic has to be maintained on gravel fill.
 - c. Higher grade line may be difficult to transition into existing facilities.

Performance

1. Ride, friction, and structural capacity of a new pavement are realized.
2. Better drainage and mitigation of frost problems are achieved.
3. Cracks must be maintained to achieve the desired pavement service life.

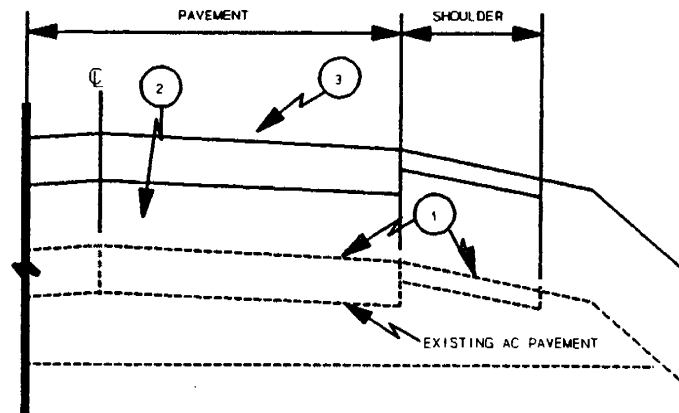
Expected Failure Modes

1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life

- 15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Scarify existing pavement and shoulder.
2. Construct and compact new fill and subbase.
3. Construct new pavement and shoulder.

Note: If distance between bottom of the new pavement and surface of the old is less than 12", then the old pavement should be removed.

Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Corrugations, slippage cracks, and ravelling may be present.
2. Infrequent settlements and heaves.
3. Other distresses may be high-severity.
4. Widening is contemplated.
5. Realignment is contemplated.
6. Existing profile must be maintained.
7. Extensive utility replacement is necessary.

Constructability

1. Advantages
 - a. Uses standard techniques.
 - b. Rapid-strength-gaining cement concrete mixes are available.
 - c. Traffic can be maintained on initial courses of asphalt concrete.
2. Disadvantages
 - a. Overnight and/or long-term lane closures are required for cement concrete pavement.
 - b. Must remove and dispose of the existing pavement.

Performance

1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve desired pavement service life.

Expected Failure Modes

1. Asphalt concrete pavement
 - a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.
2. Portland cement concrete pavement
 - a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life

1. Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.
2. Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.

FLEXIBLE-OVER-RIGID PAVEMENT TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance

- Joint and/or Crack Sealing
- Joint and/or Crack Filling
- Single-Course Overlay (1" to 1-1/2")

Corrective Maintenance

- Mill and Patch Joints and/or Cracks
- Single-Course Overlay (1" to 1-1/2")
- Hot In-Place Recycle (1" to 1-1/2")
- Cold Milling and Replacement (1" to 1-1/2")

Rehabilitation

- Two-Course Overlay (3")
- Cold Milling With Single-Course Overlay ($\geq 3"$)
- Hot In-Place Recycle With Single-Course Overlay (3")
- Cold In-Place Recycle With Single-Course Overlay (4-1/2")
- Multiple-Course Overlay ($\geq 4"$)
- Cold Milling With Multiple-Course Overlay ($\geq 4"$)
- Cold In-Place Recycle With Multiple-Course Overlay (6")
- Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5")
- Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6")

Reconstruction

- Full-Depth Portland Cement or Asphalt Concrete

Joint and/or Crack Sealing

1. Treatment Guidelines

Conditions For Use

1. Failed seals or full-width transverse cracks were never sealed.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Requires intensive inspection.

Performance

1. Seals out water and incompressibles.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

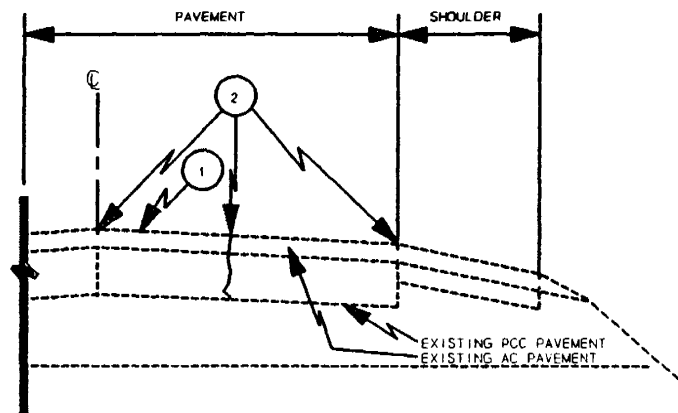
Expected Failure Modes

1. Sealer fails in adhesion or cohesion.

Expected Service Life

5 years

2. Typical Section



1. Rout, clean, and seal sawed-and-sealed transverse joints and/or full-width transverse cracks.
2. Clean and fill cracks and pavement/shoulder joint.

Joint and/or Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed seals or filler or low-severity cracks were never filled.
2. Cracks are at the low-severity level.
3. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, and/or medium-severity cracking.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Joints and cracks must be clean for the filler to be effective.

Performance

1. Reduces incompressibles and water infiltration.
2. Retards development of additional cracks and potholes.
3. Needed to achieve desired pavement service life.

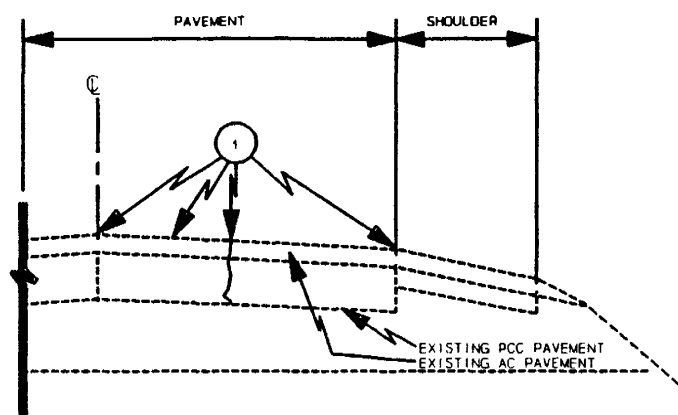
Expected Failure Modes

1. Filler fails in adhesion or cohesion.
2. Wear by traffic.

Expected Service Life

2 years

2. Typical Section



1. Clean and fill sawed-and-sealed transverse joints, cracks, and pavement/shoulder joint.

Note: The crack filling operations in wheelpaths will be limited to a single intermittent (not to exceed 20 feet) longitudinal crack. Multiple cracks and alligator cracking in the wheelpaths shall not be filled. Spray patch (surface treatment), micro-surfacing, armor coat, or other similar treatments shall be used as a preventive maintenance treatment in these instances.

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent ravelling, and/or medium-severity cracking.
3. Low-severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common maintenance technique.
2. Disadvantages
 - a. Crack filling, is required to achieve service life.

Performance

1. Restores ride and friction.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

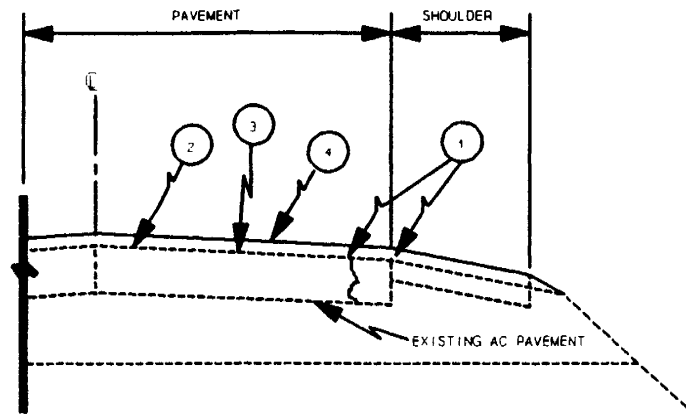
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years.

2. Typical Section



1. Clean and fill cracks and pavement/shoulder joint.
2. Clean pavement.
3. Tack coat.
4. Asphalt concrete top course (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints that have performed as intended (no secondary cracking), then the new overlay should be sawed and sealed.

Mill and Patch Joints and/or Cracks

1. Treatment Guidelines

Conditions For Use

1. High-severity full-width transverse and/or longitudinal cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, and/or ravelling.
3. Other distresses are generally at the none or low-severity level.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
2. Disadvantages
 - a. Careful inspection required to match existing pavement elevation.

Performance

1. May improve ride.
2. Prevents water infiltration.
3. Extends pavement service life.

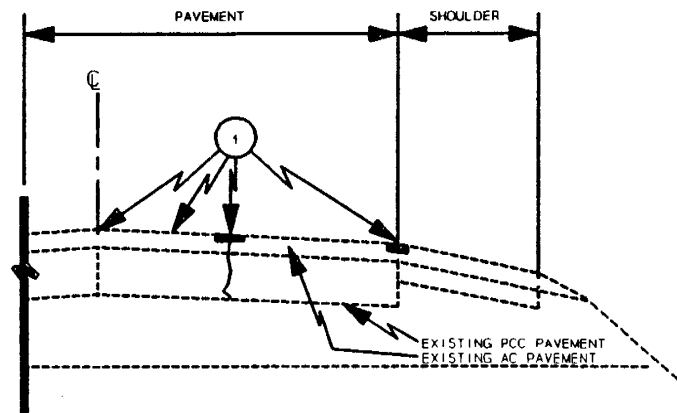
Expected Failure Modes

1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

5 years

2. Typical Section



1. Mill high-severity cracks. Tack-coat horizontal and vertical faces and place asphalt concrete patch.

Single-Course Overlay (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, ravelling, medium and/or high- severity cracking.
3. Medium severity wheelpath rutting and/or widening dropoff.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common rehabilitation techniques.
2. Disadvantages
 - a. Crack filling and shimming wheel ruts are required to achieve service life.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

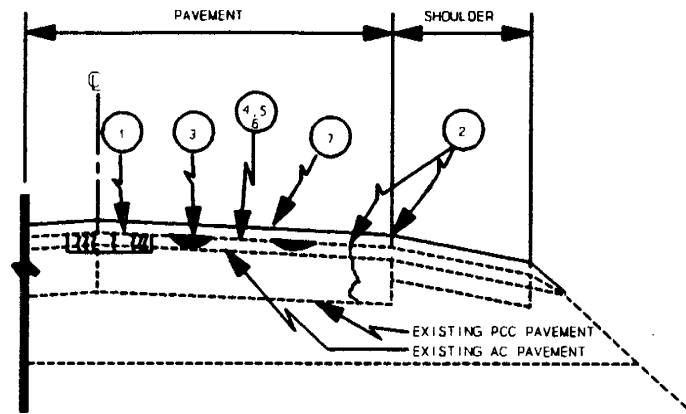
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed joints: 8 years

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat.
6. Truing-and-leveling.
7. Asphalt concrete top course (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints that have performed as intended (no secondary cracking), then the new overlay should be sawed and sealed.

Hot In-Place Recycle (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlements, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations may be present.
5. Low- or medium-severity wheelpath rutting and/or widening dropoff.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
 - d. Maintains existing profile.
2. Disadvantages
 - a. Manholes or drainage inlets will damage recycling equipment.
 - b. Smoke emissions may prohibit use in residential areas.
 - c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, and cross-slope.
2. Improves the longitudinal construction joint.
3. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

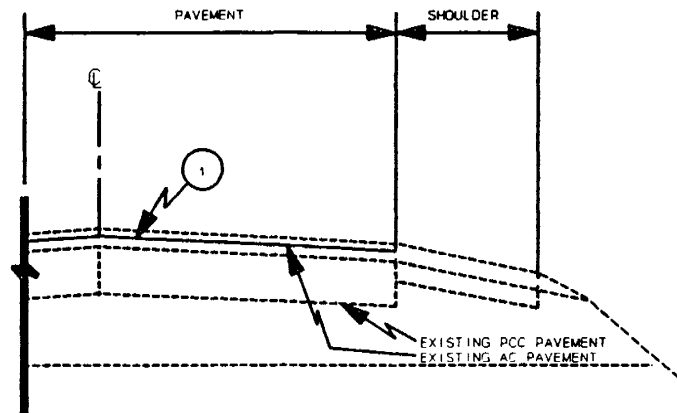
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and other cracks filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Hot in-place recycling (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from the underlying transverse joints, then new overlay should be sawed and sealed.

Cold Milling and Replacement (1" to 1-1/2")

1. Treatment Guidelines

Conditions For Use

1. Low-severity cracking.
2. Infrequent settlement, heaves, slippage cracks, ravelling, medium and/or high-severity cracking.
3. Corrugations may be present.
4. Low- or medium-severity wheelpath rutting and/or widening dropoff.
5. May not be appropriate if the remaining asphalt concrete thickness after milling is too thin or otherwise unsuitable to remain.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Maintains existing profile.
 - d. Requires no truing-and-leveling.
2. Disadvantages
 - a. Must dispose of the millings.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks. Full-width transverse cracks are sealed after first year, others filled after second year.

Expected Failure Modes

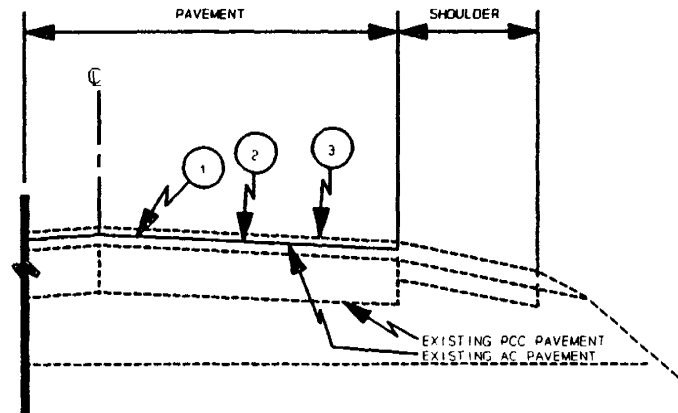
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 8 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Cold mill existing pavement surface (1" to 1-1/2").
2. Tack coat.
3. Asphalt concrete top course (1" to 1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Two-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Crack filling, shimming wheel ruts, and truing-and-leveling are required to achieve service life.
 - b. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

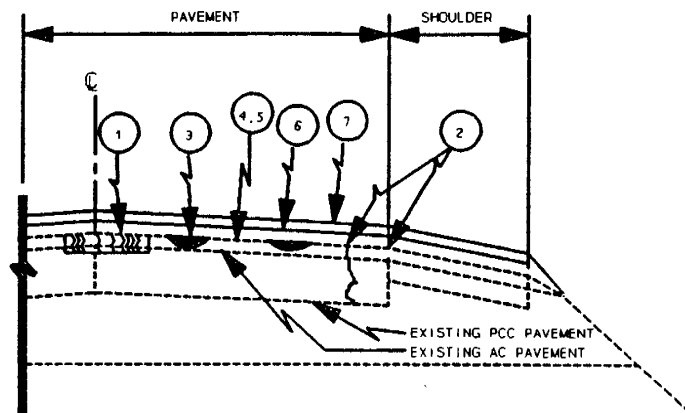
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete binder course (1-1/2").
7. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold Milling With Single-Course Overlay ($\geq 3"$)

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High-severity wheelpath rutting and/or widening dropoff may be present.
5. May not be appropriate if the remaining asphalt concrete thickness is too thin or otherwise unsuitable to remain.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Minimal increase in profile elevation.
 - d. Requires no truing-and-leveling.
2. Disadvantages
 - a. Must dispose of the millings.

Performance

1. Restores ride, friction, and cross-slope.
2. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

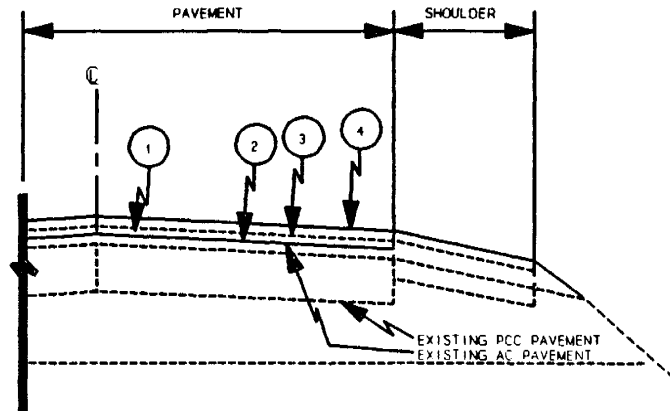
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Cold mill existing pavement surface ($\geq 1\frac{1}{2}$ ").
2. Tack coat.
3. Asphalt concrete inlay course ($\geq 1\frac{1}{2}$ ").
4. Asphalt concrete top course ($1\frac{1}{2}$ ").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Hot In-Place Recycle With Single-Course Overlay (3")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Infrequent or no overlay patches.
4. Corrugations, slippage cracks, and ravelling may be present.
5. High-severity wheelpath rutting and/or widening dropoff may be present.
6. Pavement core evaluation must meet warrants for recycling.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no tack coat, crack sealing, shimming wheel ruts, or truing-and-leveling.
2. Disadvantages
 - a. Manholes or drainage inlets will damage recycling equipment.
 - b. Smoke emissions may prohibit use in residential areas.
 - c. Requires some virgin asphalt concrete.

Performance

1. Restores ride, friction, cross-slope.
2. Improves longitudinal construction joint in the recycled layer.
3. Adds structural capacity.
4. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

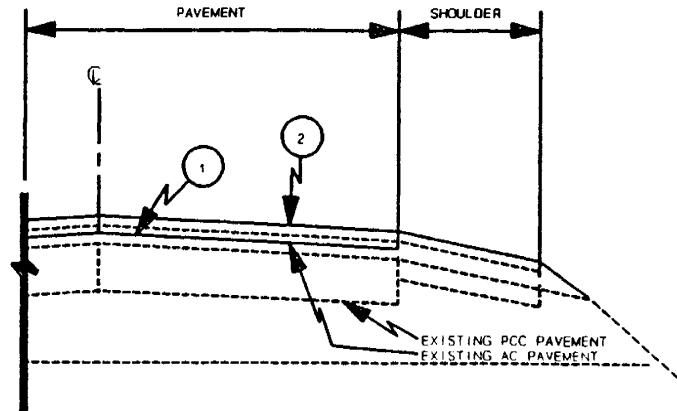
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Hot in-place recycling (1-1/2").
2. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold In-Place Recycle With Single-Course Overlay (4-1/2")

1. Treatment Guidelines

Conditions For Use

1. Medium-severity cracking.
2. Infrequent settlements, heaves, and/or high-severity cracking.
3. Corrugations, slippage cracks, and ravelling may be present.
4. High severity wheelpath rutting and/or widening dropoff may be present.
5. Pavement core evaluation must meet warrants for recycling.
6. Pavement must have less than 4000 AADT per lane.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no crack sealing or shimming wheel ruts.
2. Disadvantages
 - a. Manholes or drainage units will damage recycling equipment.
 - b. Truing-and-leveling may be required.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

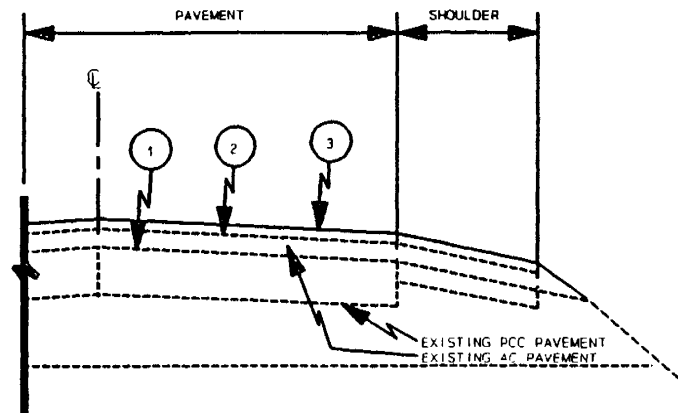
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Multiple-Course Overlay ($\geq 4"$)

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Requires crack filling, shimming wheel ruts, and truing-and-leveling.
 - b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

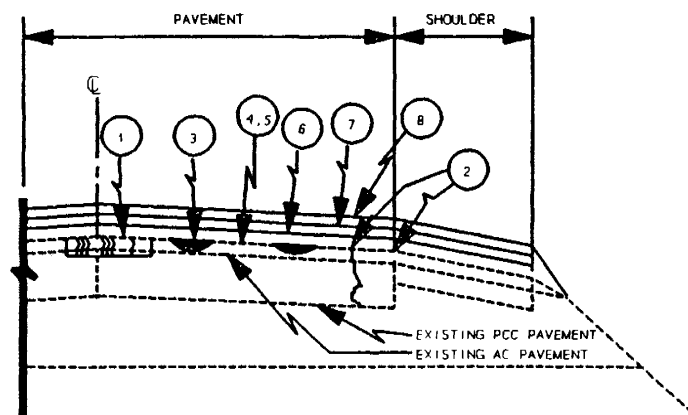
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Mill and patch high-severity cracks with asphalt concrete.
2. Clean and fill cracks and pavement/shoulder joint.
3. Shim wheel ruts.
4. Clean pavement.
5. Tack coat, truing-and-leveling course.
6. Asphalt concrete strengthening course (1" to 4").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold Milling With Multiple-Course Overlay ($\geq 4"$)

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no truing-and-leveling.
2. Disadvantages
 - a. Must dispose of millings.
 - b. Overlay thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, and cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

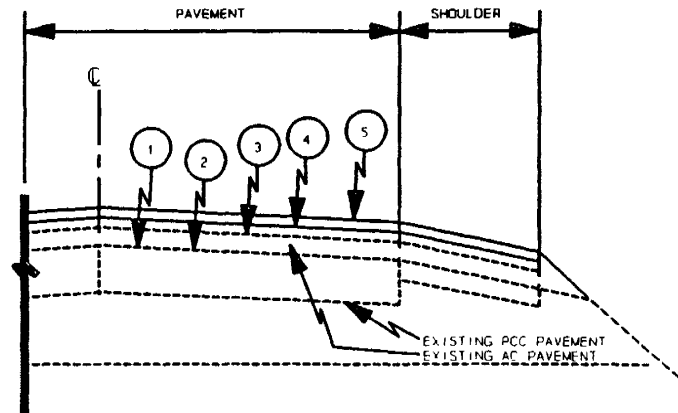
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Cold mill existing pavement surface (≥ 1 ").
2. Tack coat.
3. Asphalt concrete inlay and/or strengthening course (≥ 1 "), multiple-course required for lifts > 4 ".
4. Asphalt concrete binder course ($1\text{--}1\frac{1}{2}$ ").
5. Asphalt concrete top course ($1\text{--}1\frac{1}{2}$ ").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Cold In-Place Recycle With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use

1. Infrequent settlements and heaves.
2. Corrugations, slippage cracks, and ravelling may be present.
3. Other distresses may be high-severity.
4. Pavement core evaluation should meet warrants for recycling.
5. Pavement must have less than 4000 AADT per lane.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Overnight lane closures not required.
 - c. Requires no crack sealing or shimming wheel ruts.
2. Disadvantages
 - a. Manholes or drainage inlets will damage recycling equipment.
 - b. Truing-and-leveling may be required.
 - c. 3" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Restores ride, friction, cross-slope.
2. Adds structural capacity.
3. Maintenance required early in overlay life to fill or seal reflective cracks.

Expected Failure Modes

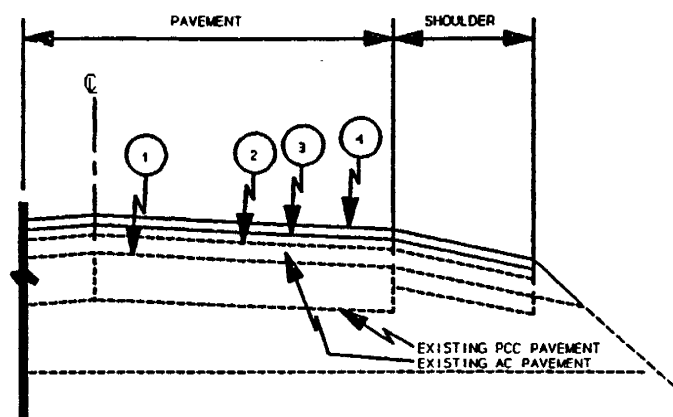
1. Reflective cracking, oxidation, cracking, potholes, ravelling, and rutting.

Expected Service Life

Asphalt overlay: 15 years with full-width transverse crack sealing at 5-year intervals and others filled at 2-year intervals.

Sawed and sealed transverse joints: 8 years

2. Typical Section



1. Cold in-place recycle (3").
2. Tack coat, truing-and-leveling.
3. Asphalt concrete binder course (1-1/2").
4. Asphalt concrete top course (1-1/2").

Note: If existing overlay has sawed-and-sealed transverse joints, or full-width transverse cracks have reflected through existing overlay from underlying transverse joints, then new overlay should be sawed and sealed.

Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5")

1. Treatment Guidelines

Conditions For Use

1. Medium- and/or high-severity full-width transverse, longitudinal, and edge cracking.
2. Infrequent settlements, heaves, blowups.
3. Slab cracks and/or infrequent separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
4. Corrugations, slippage cracks, and ravelling may be present.
5. Utilities not present.

(Note: Distresses in 2 are repaired by replacing segments with asphalt concrete before overlay.)

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Traffic can be maintained on the cracked-and-seated portland cement concrete pavement.
 - c. Common rehabilitation technique.
2. Disadvantages
 - a. Cracking and seating may create additional unexpected spalls.
 - b. Has potential to disrupt culverts and underground utilities.
 - c. 5" thickness may be a problem for vertical clearance and appurtenances.

Performance

1. Asphalt concrete overlay
 - a. Restores ride, friction, cross-slope.
 - b. Increased thickness adds structural capacity and bridges patched spalls.
2. Crack and seat
 - a. Minimizes reflection cracking.
 - b. Absence of reflection cracks keeps water from pavement structure.
 - c. Crack filling may be necessary to achieve desired overlay service life.

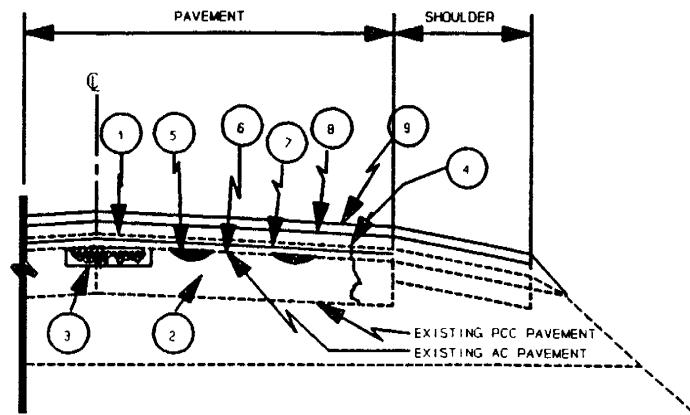
Expected Failure Modes

1. Oxidation, ravelling, and/or rutting.
2. Multiple cracks and potholes at longitudinal and pavement/shoulder joints.
3. Failure to maintain reflection cracks may lead to multiple cracks and potholes.
4. Full-depth asphalt concrete repairs may rut, shove, and heave causing local premature failure.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Remove existing asphalt concrete overlay.
2. Crack and seat existing concrete pavement.
3. Mill and patch spalls with asphalt concrete.
4. Clean and fill joints and cracks.
5. Shim faults and wheel ruts.
6. Clean pavement, tack coat, truing-and-leveling.
7. Initial asphalt concrete course (2").
8. Asphalt concrete binder course (1-1/2").
9. Asphalt concrete top course (1-1/2").

Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6")

1. Treatment Guidelines

Conditions For Use

1. Medium- and/or high severity full-width transverse, longitudinal, and edge cracking.
2. Corrugations, settlements, heaves, slippage cracks, and ravelling may be present.
3. Slab cracks and/or separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
4. Utilities are present.
5. Widening is contemplated.

Constructability

1. Advantages
 - a. Can be done one lane at a time.
 - b. Does not damage utilities.
 - c. Compaction and overlay use standard techniques.
 - d. Spall repair and full-depth replacement are not necessary.
 - e. Pavement widening, shoulder replacement, and filling depressions can be accomplished with crushed stone that is compatible with rubblized pavement.
2. Disadvantages
 - a. Traffic cannot be maintained on a rubblized surface until the initial asphalt concrete course is placed.
 - b. Positive drainage is required.
 - c. 6" thickness may be a problem for vertical clearance and appurtenances.
 - d. Most roadway features will require adjustment.
 - e. Lane closure may be required for extended periods.
 - f. Rubblizing equipment cannot get closer than 3 ft to curbs.

Performance

1. Restores ride, friction, cross-slope.
2. Eliminates reflection cracks.
3. Absence of reflection cracks keeps water from the pavement structure.
4. Rubblized pavement provides a drainage layer.

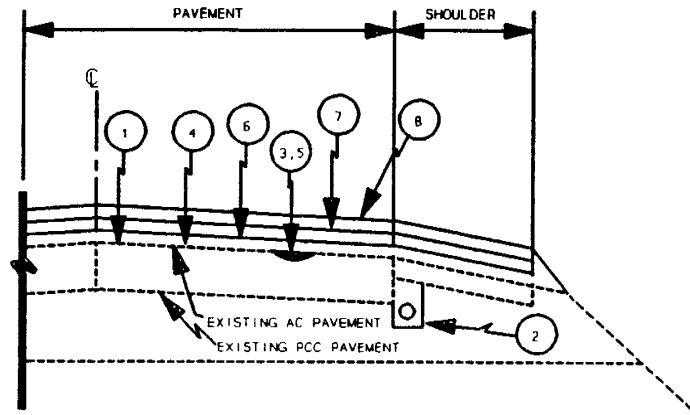
Expected Failure Modes

1. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.

Expected Service Life

- 15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Remove existing asphalt concrete overlay.
2. Install underdrain.
3. Remove asphalt patches.
4. Rubblize and compact existing concrete pavement.
5. Patch depressions with crushed stone.
6. Initial asphalt course: asphalt concrete base (3").
7. Asphalt concrete binder course (1-1/2").
8. Asphalt concrete top course (1-1/2").

Note: An alternative to underdrain installation is a daylighted crushed stone shoulder replacing the existing shoulder.

Full-Depth Portland Cement or Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Medium- and/or high-severity full-width transverse, longitudinal, and edge cracking.
2. Slab cracks and/or a significant number of separated transverse and/or longitudinal joints have reflected through the flexible overlay and caused medium- and high-severity cracks.
3. Blowups, settlements, and/or heaves may exist.
4. Widening is contemplated.
5. Realignment is contemplated.
6. Existing profile must be maintained.
7. Extensive utility replacement is necessary.

Constructability

1. Advantages
 - a. Uses standard techniques.
 - b. Rapid-strength-gaining cement concrete mixes are available.
 - c. Interim traffic can be maintained on the initial courses of asphalt concrete.
2. Disadvantages
 - a. Overnight and/or long-term lane closures are required for cement concrete pavement.
 - b. Must remove and dispose of the existing pavement.

Performance

1. Ride, friction, and structural capacity of a new pavement is realized.
2. Joints and/or cracks must be maintained to achieve the desired pavement service life.

Expected Failure Modes

1. Asphalt concrete pavement
 - a. Oxidation, ravelling, thermal cracking, wheelpath cracking, and/or rutting.
2. Portland cement concrete pavement
 - a. Joint seal failure, joint spalling, blowups, and/or fatigue cracking.

Expected Service Life

Asphalt concrete pavement: 15 years with full-width transverse crack sealing at 5-year intervals.

Portland cement concrete pavement: 30 years with joint resealing at 8-year intervals.

RIGID, FLEXIBLE, OR FLEXIBLE-OVER-RIGID PAVEMENT WIDENING TREATMENT GUIDELINES AND TYPICAL SECTIONS

Portland Cement Concrete

Asphalt Concrete

Portland Cement Concrete

1. Treatment Guidelines

Conditions For Use

1. Settlements, heaves, blowups, and slab cracking do not exist or have been repaired by full-depth segment replacement.
2. Other distresses are at the none or low-severity level.
3. Cores of existing concrete pavement show no cracking or mortar deterioration and adequate compressive strength. Cores are necessary at the widening edge to ensure that longitudinal joint ties will bond and tie.

Constructability

1. Advantages
 - a. No overnight lane closures required, if excavation amount equals replacement within the work day and rapid-setting concrete is used.
 - b. Common construction materials and techniques.
2. Disadvantages
 - a. Drill for longitudinal tie holes needs a 3-ft wide excavation to operate.

Performance

1. Matching thickness, widening will provide structural capacity similar to the existing pavement.
2. Joint sealing needed to achieve widening service life.

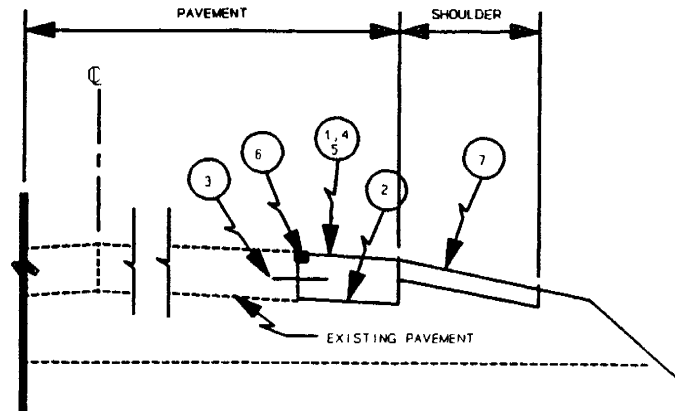
Expected Failure Modes

1. Sealing
 - a. Seals fail in adhesion or cohesion.
2. Widening
 - a. Fails in same manner as any cement concrete pavement.

Expected Service Life

1. Joint sealing: 8 years
2. Widening: equals or exceeds existing pavement service life up to 30 years.

2. Typical Section



1. Excavate and remove existing shoulder, widen embankment and subbase, etc.
2. Replace disturbed subbase and compact.
3. Drill holes and install longitudinal joint ties.
4. Place transverse load-transfer devices.
5. Place new concrete.
6. Construct and seal longitudinal and transverse joints.
7. Construct new shoulder.

Note: If flexible-over-rigid pavement is being widened, the cement concrete and asphalt concrete pavements are matched in thickness. Joints in the asphalt concrete are sealed in the same manner as those in the existing pavement.

Asphalt Concrete

1. Treatment Guidelines

Conditions For Use

1. Settlements and heaves do not exist or have been replaced.
2. Full-width transverse cracking or edge cracking do not exist.
3. Cores of existing overlaid cement concrete pavement show cracking, mortar deterioration, or low compressive strength.
4. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
 - a. No overnight lane closures required, if excavation amount equals replacement within the workday.
 - b. Common construction materials and techniques.
2. Disadvantages
 - a. Narrow-width widening difficult to compact.

Performance

1. Widening has structural capacity similar to the existing pavement, when pavement and subbase thicknesses are matched.
2. Longitudinal joint between the widening and existing pavement must be sealed to achieve expected service life.

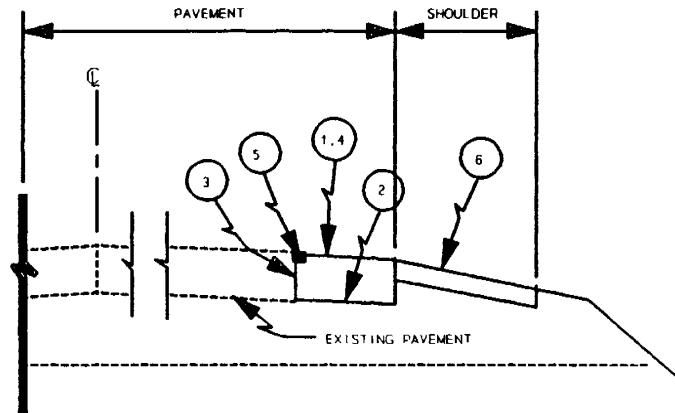
Expected Failure Modes

1. Seals fail in adhesion or cohesion.
2. Pavement/widening longitudinal joint separation.
3. Water infiltration weakens subbase, causing widening dropoff, multiple cracking, and potholes.
4. Fails in same manner as any flexible pavement.

Expected Service Life

15 years with full-width transverse crack sealing at 5-year intervals.

2. Typical Section



1. Excavate and remove existing shoulder, widen embankment and subbase, etc.
2. Replace disturbed subbase and compact.
3. Tack-coat existing pavement edge.
4. Place and compact asphalt concrete.
5. Rout and seal longitudinal joint.
6. Construct new shoulder.

Note: If no subbase exists, a minimum 8" subbase should be placed under the new widening. If open base is encountered in the existing pavement, widen only with open base.

FLEXIBLE SHOULDER TREATMENT GUIDELINES AND TYPICAL SECTIONS

Preventive Maintenance

- Pavement/Shoulder Joint and/or Crack Filling
- Surface Treatment

Corrective Maintenance

- Asphalt Concrete Wedging
- Surface Treatment

Rehabilitation

- Single- or Multiple-Course Asphalt Overlay

Reconstruction

- Shoulder Replacement With Cement Concrete, Asphalt Concrete, or Bituminous-Stabilized Gravel

Pavement/Shoulder Joint and/or Crack Filling

1. Treatment Guidelines

Conditions For Use

1. Failed filler, or joints and cracks never filled.
2. Pavement/shoulder separation is at the medium-severity level.
3. Deterioration, consisting of a single crack, is at the low-severity level.
4. Other distresses are at the none or low-severity level or are infrequent.

Constructability

1. Advantages
 - a. Overnight lane closure not required.

Performance

1. Prevents water infiltration from weakening the base, thus retarding development of additional distress.

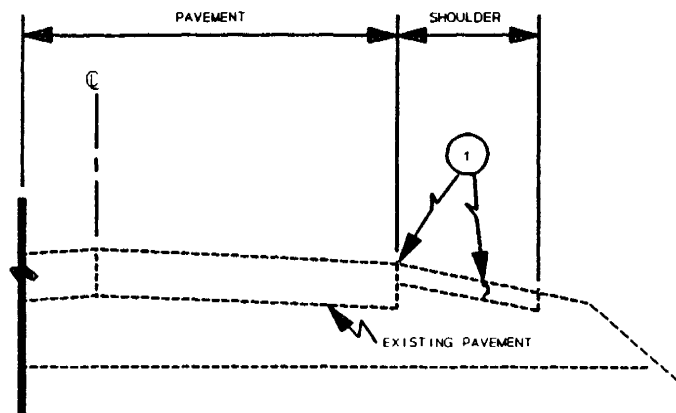
Expected Failure Modes

1. Filler fails in cohesion or adhesion.

Expected Service Life

2 years

2. Typical Section



1. Clean and fill cracks and pavement/shoulder joint.

Surface Treatment

1. Treatment Guidelines

Conditions For Use

1. Multiple-crack deterioration at the medium-severity level.
2. Low-severity pavement/shoulder separation may also be present.
3. Other distresses are at the none or low-severity level.

Constructability

1. Advantages
 - a. Overnight lane closures not required.
 - b. Can be done by closing only one traffic lane.
2. Disadvantages
 - a. Difficult working next to barrier or guiderail.
 - b. Shoulder should be wedged and patched as needed before surface treatment.

Performance

1. Retards deterioration.

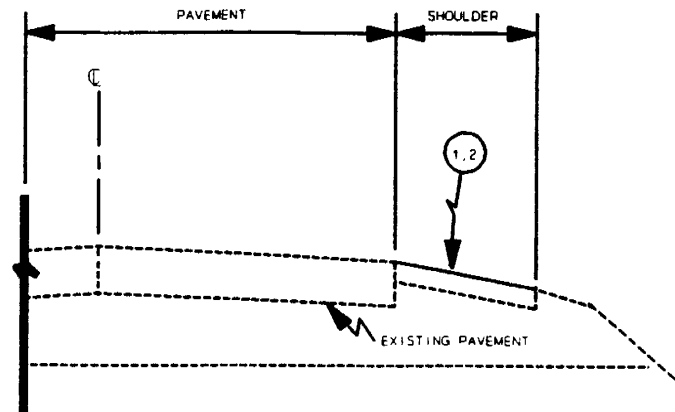
Expected Failure Modes

1. Cracking, separation, surface oxidation, stone loss from plows and ravelling.

Expected Service Life

5 years

2. Typical Section



1. Clean shoulder.
2. Single surface treatment.

Asphalt Concrete Wedging

1. Treatment Guidelines

Conditions For Use

1. Medium or high-severity lane shoulder dropoff.
2. Other distresses at the none or low-severity level.

Constructability

1. Advantages
 - a. Overnight lane closures not required.
 - b. Can be done by closing only one traffic lane.
2. Disadvantages
 - a. Pavement edge profile difficult to match.
 - b. Compaction difficult due to roller bridging.

Performance

1. Eliminates pavement edge hazard.

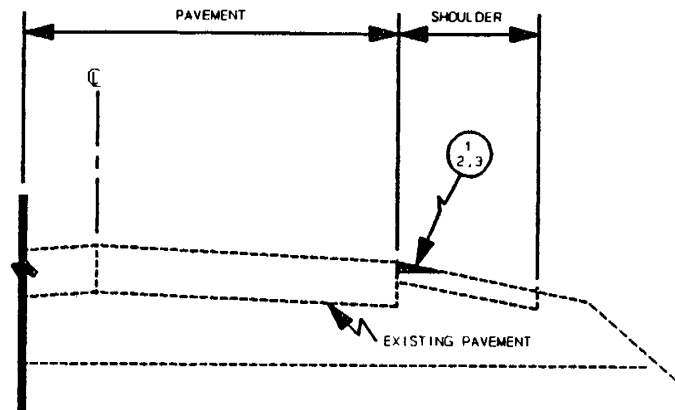
Expected Failure Modes

1. Cracking, separation, and ravelling.

Expected Service Life

3 years

2. Typical Section



1. Clean shoulder.
2. Tack coat.
3. Asphalt concrete wedging.

Surface Treatment

1. Treatment Guidelines

Conditions For Use

1. Multiple-crack deterioration at the medium-severity level.
2. Pavement/shoulder separation and dropoff may also be present.
3. Shoulder deformation is in the none category.

Constructability

1. Advantages
 - a. Overnight lane closures not required.
 - b. Can be done by closing only one traffic lane.
2. Disadvantages
 - a. Difficult working next to barrier or guiderail.
 - b. Shoulder should be wedged and patched as needed before surface treatment.

Performance

1. Retards deterioration.

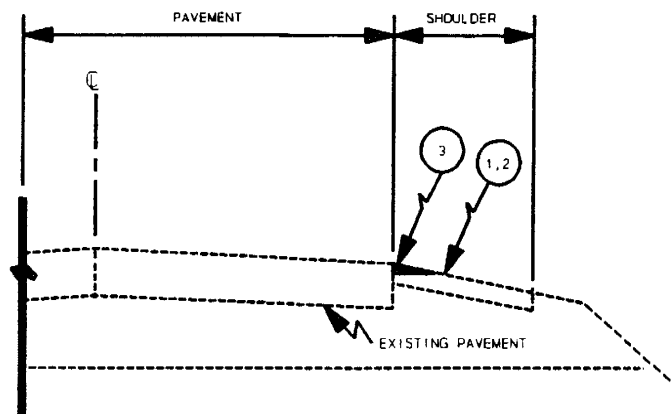
Expected Failure Modes

1. Cracking, separation, surface oxidation, stone loss from plows and ravelling.

Expected Service Life

5 years

2. Typical Section



1. Clean shoulder.
2. Single surface treatment.
3. Requires asphalt concrete wedging and/or patching as a pretreatment.

Single- or Multiple-Course Asphalt Overlay

1. Treatment Guidelines

Conditions For Use

1. Roadway condition dictates an asphalt overlay. Shoulder may be repaired by carrying same-thickness overlay across it, or reconstructing the shoulder. Shoulder condition dictates this choice.

Constructability

1. Advantages
 - a. Overnight lane closures not required.
 - b. Can be done at same time with same items as roadway paving.

Performance

1. Depends on overlay thickness and condition of existing shoulder.

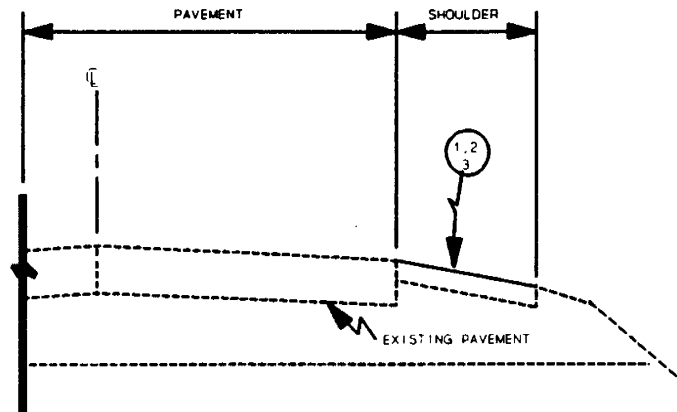
Expected Failure Modes

1. Asphalt oxidation, ravelling, and pavement/shoulder joint cracking.

Expected Service Life

1. Single course: 8 years
2. Multiple course: 15 years

2. Typical Section



1. Clean shoulder.
2. Tack coat.
3. Single- or multiple-course asphalt overlay.

Note: May require asphalt concrete wedging as a pretreatment.

Shoulder Replacement With Cement Concrete, Asphalt Concrete, or Bituminous-Stabilized Gravel

1. Treatment Guidelines

Conditions For Use

1. High-severity deterioration consisting of multiple cracks and potholes.
2. General shoulder deformation present.

Constructability

1. Advantage
 - a. Common construction technique.

Performance

1. Provides life of a new shoulder.

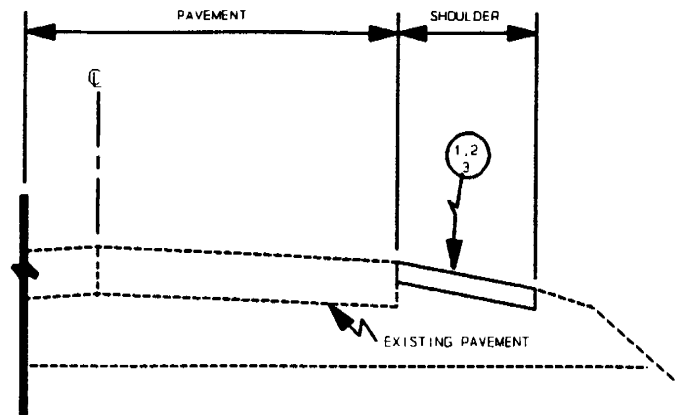
Expected Failure Modes

1. Cement concrete (only adjacent to concrete pavement)
 - a. Pavement/shoulder joint sealant failure, water infiltration, and cracking.
2. Asphalt concrete or bituminous-stabilized gravel with asphalt concrete top course
 - a. Asphalt oxidation, ravelling, cracking, separation, and dropoff.

Expected Service Life

1. Cement concrete: 30 years
2. Asphalt concrete: 15 years
3. Bituminous stabilized gravel with asphalt concrete top course: 15 years

2. Typical Section



1. Reconstruct with portland cement concrete (if adjacent pavement is concrete, then concrete shoulder tapers from 9" to 6").
2. Reconstruct with asphalt concrete (3" or 4").
3. Reconstruct with bituminous-stabilized gravel (3") and asphalt concrete top course (1").

PART 3: LIFE-CYCLE-COST ANALYSIS

Once initial treatment alternatives have been identified, one must choose among them. One method used to determine the most cost-effective is a life-cycle-cost (LCC) analysis. LCC can be defined as all Department costs necessary to provide a serviceable pavement over a particular analysis period. Its components include current treatment costs; the cost, timing, and service lives of future maintenance and rehabilitation treatments; the time value of money; and the residual or salvage value.

An LCC analysis will identify the least expensive alternative over time. It should be emphasized that this is only one step in the decision-making process. Budgetary constraints, non-pavement construction needs, and heavy traffic volumes also may influence treatment selection.

An LCC analysis has the following steps:

1. Identify all appropriate initial treatment alternatives.
2. Determine the analysis period and treatment strategy for each alternative.
3. Calculate the cost of each treatment strategy.
4. Compare treatment strategies using the Present Worth method.
5. Perform a sensitivity analysis.
6. Select the best treatment strategy based on LCC and other factors.

Identify Initial Treatment Alternatives

Distress Data Forms, completed according to the procedures described in this Manual's Volume I, must be reviewed. Distress information in those forms is compared with the "Conditions For Use" in Part 2 ("Treatment Guidelines and Typical Sections") of this Manual. A treatment is identified as an alternative if information in the Distress Data Form and Conditions For Use are similar. Some treatments may be eliminated due to specific characteristics of the project. Regional or Main Office Soil Mechanics Bureau and Materials Bureau personnel should be consulted.

Conditions For Use cannot include all possible combinations of distresses encountered in the field. Actual distress types and severities may apply to Conditions For Use of several treatments. When this occurs, all treatments in question should be considered as alternatives. All Conditions For Use do not have to be met for a treatment to be considered as an alternative. Similarly, a treatment may be an appropriate alternative even if the recorded distress data slightly exceed the Conditions For Use. Conditions For Use simply represent an approximate distress condition under which a particular treatment is considered effective.

For example, consider the pavement in Area I of the Model Pavement Evaluation (Part 4). The Distress Data Form for this pavement is found on page B-3. It shows that the primary pavement distresses encountered are full-width transverse and longitudinal cracking of medium and high severity. As noted in the "Remarks" column, these cracks appear over underlying PCC joints. The shoulders exhibit medium-severity lane/shoulder separation and low- to medium-severity lane/shoulder dropoff.

The Distress Data Form information is then compared with the "Conditions For Use" of treatments listed in the flexible/rigid treatment guidelines. Several treatments have Conditions For Use similar to the recorded distress data: Mill and Patch Joints and/or Cracks, Two-Course Overlay (3"), Cold Milling and Replacement (≥ 3 "), Hot In-Place Recycle with Single-Course Overlay (2-1/2"), Cold In-Place Recycle with Single-Course Overlay (4-1/2"), Cold In-Place Recycle with Multiple-Course Overlay (6"), Multiple-Course Overlay (≥ 4 "), and Cold Milling with Multiple-Course Overlay (≥ 4 "). Treatments involving cold milling and recycling were eliminated because the overlay was in good condition except over PCC joints. Complete removal was thus considered unnecessary. The Materials Engineer cored the pavement and determined that mix properties of the existing overlay were acceptable for an overlay base. By itself, Mill and Patch Joints and/or Cracks was not considered an alternative because the overlay had exceeded its expected service life. However, this treatment would be (and in this example is) appropriate for use in conjunction with another rehabilitation treatment. By process of elimination, the preferred alternatives were Two-Course Overlay (3") and Multiple-Course Overlay (≥ 4 ").

Determine The Analysis Period And Treatment Strategy For Each Alternative

The analysis period is the time over which costs of alternative treatment strategies are compared. A treatment strategy consists of the initial treatment alternative and its expected future maintenance and rehabilitation needs. The period must be long enough to include the entire service life of at least one rehabilitation treatment.

Expected future maintenance and rehabilitation needs must be considered when developing an analysis period. Typically, several preventive maintenance treatments and one or two rehabilitation treatments are included in an analysis period. One rehabilitation treatment should be scheduled at or near the end of the initial treatment's service life. Preventive maintenance should be scheduled at regular intervals before rehabilitation, and during the service life of the rehabilitation treatment. Preventive maintenance timing is based on that service life.

For example, again consider Area I of the Model Pavement Evaluation. The initial treatment alternatives identified are Two-Course Overlay (3") and Multiple-Course Overlay (≥ 4 "). Based on experience, the evaluation's author chose the following future treatment sequences, where "year" is the total years after overlay:

Two-Course Overlay (3")

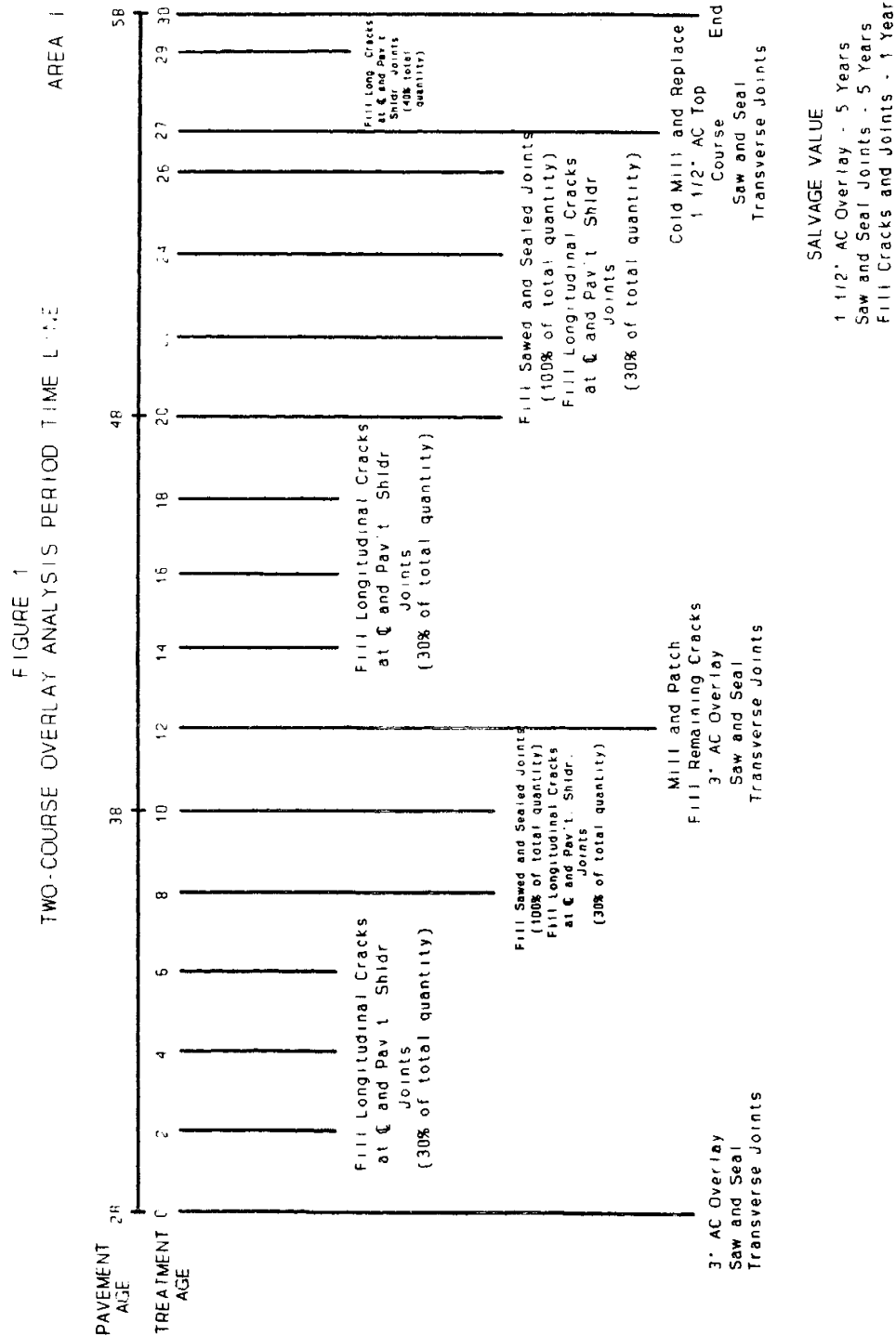
<u>Year</u>	<u>Activity</u>
2	Fill longitudinal cracks at centerline and pavement/shoulder joint (30% of total).
4	Same as year 2
6	Same as year 2
8	Fill sawed and sealed joints (100% of total), longitudinal cracks at centerline, and pavement/shoulder joint (30% of total).
10	Same as year 8
12	Mill and patch, fill remaining cracks, two-course overlay (3"), saw and seal transverse joints.
14	Same as year 2
16	Same as year 2
18	Same as year 2
20	Same as year 8
22	Same as year 8
24	Same as year 8
26	Same as year 8
27	Cold mill and replace 1-1/2" AC top course, saw and seal transverse joints.
29	Fill longitudinal cracks at centerline and pavement/shoulder joint (40% of total).
30	End

Multiple-Course Overlay (≥4")

<u>Year</u>	<u>Activity</u>
2	Fill longitudinal cracks at centerline and pavement/shoulder joint (20% of total).
4	Same as year 2
6	Same as year 2
8	Fill sawed and sealed joints (100% of total), longitudinal cracks at centerline, and pavement/shoulder joint (20% of total).
10	Same as year 8
12	Same as year 8
14	Same as year 8
15	Mill and patch, fill remaining cracks, two-course overlay (3"), saw and seal transverse joints.
17	Fill longitudinal cracks at centerline and pavement/shoulder joint (30% of total).
19	Same as year 17
21	Same as year 17
23	Fill sawed and sealed joints (100% of total), longitudinal cracks at centerline, and pavement/shoulder joint (20% of total).
25	Same as year 23
27	Same as year 23
29	Same as year 23
30	End

The author believes the multiple-course overlay will last slightly longer than the two-course overlay; respective service lives of 15 and 12 years were assigned. Also, more maintenance is anticipated for the thinner overlay before future rehabilitation. The preventive maintenance treatment of filling longitudinal cracks is completed every 2 years on both overlays, but more is required on the two-course overlay. The author also considered the recommended 8-year service life of sawed-and-sealed transverse joints in asphalt concrete overlays over portland cement concrete pavement. These joints are filled as part of preventive maintenance treatment beginning after 8 years and until rehabilitation.

The author predicted that at the ends of their service lives both overlay alternatives would require a two-course overlay as a rehabilitation treatment. A service life of 15 years is assigned to the two-course overlay rehabilitation treatment in both alternatives. The same service life was assigned because it was believed that the initial treatments would be in about the same condition at the end of their respective service lives. Identical preventive maintenance sequences are assumed after rehabilitation: fill cracks at 2-year intervals and fill sawed-and-sealed joints at 2-year intervals after 8 years.



The minimum analysis period is the longest expected service life of the initial treatment and one rehabilitation treatment for each alternative treatment strategy considered. In this case the multiple-course overlay with one rehabilitation treatment has an expected service life of 30 years, with 27 years for the two-course overlay with one rehabilitation treatment. The minimum analysis period for these alternatives thus is 30 years. To make the analysis periods of the alternatives equal, another treatment must be applied to the two-course overlay after 27 years. Cold Milling and Replacement (1-1/2") was chosen. It is very possible that this will not be the required treatment in 27 years, but it is included to help make a better current decision by accounting reasonably for an anticipated future need. A pavement evaluation before rehabilitation in the 12th year will more accurately predict treatment needs after 27 years.

Cold Milling and Replacement (1-1/2") has an expected service life of 8 years. After 30 years only 3 years of service life have been used, with 5 years remaining. Similarly, Sawed and Sealed Joints (8-year service life) and Filling Cracks and Joints (2-year service life) have 5 and 1 years of unused service life remaining, respectively. In the multiple-course overlay treatment strategy, only Filling Cracks and Joints has remaining service life (1 of 2 years). Remaining service lives will be accounted for as residual or salvage value when costs are calculated.

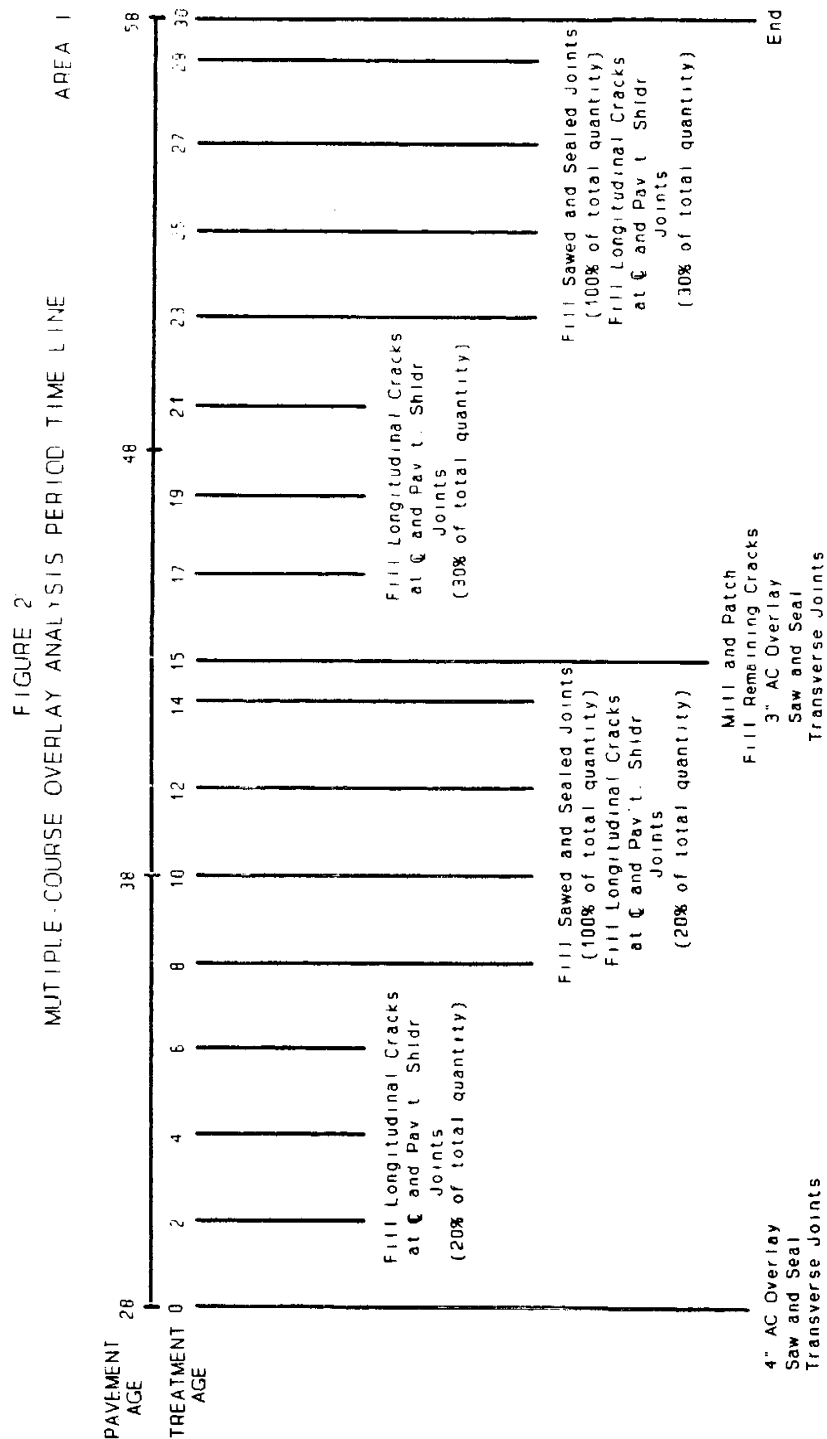
When treatment strategy alternatives have been decided, they are placed on an analysis period time-line, as shown in Figures 1 and 2. It is beyond the scope of this Manual to prescribe a standard maintenance and rehabilitation sequence for each initial treatment. Regional preferences, site-specific factors, work history, climate, and traffic affect type and timing of future treatments. Sound, consistent future treatment strategies can be developed using individual and regional experience and the treatment service lives given in Part 2 (Treatment Guidelines) of this manual. Service lives given are not absolute and may be varied based on local experience.

A pavement's actual future needs may not coincide with the predicted future strategy. Anticipating future treatments serves two purposes: planning work needs within a pavement management system, and helping the user choose the most cost-effective initial treatment alternative. The more accurately that future needs are predicted, the better both purposes are served. After initial treatments, actual maintenance and rehabilitation needs should be compared to what was predicted. Comparisons of this type allow refinement of treatment strategies and more cost-effective decision-making. Readers are encouraged to develop their own sound treatment strategies and time-lines based on their experience.

It is possible that only one initial treatment alternative will be identified based on information in the Distress Data Form. A future treatment strategy should still be developed to plan work needs. This would also allow comparisons of predicted and actual needs to aid in developing future strategies on other projects.

Calculate Cost Of Each Treatment Strategy Alternative

After all treatments within each treatment strategy have been identified and located on the appropriate time-line, current cost of each must be determined. This may be estimated by either of two methods accounting for quantities and prices of all items required to complete the treatment. Regions normally use the Preliminary Estimating Program (PEP), generally



SALVAGE VALUE
Fill Cracks and Joints - 1 Year

the responsibility of the Regional Estimating Engineer, and its "operations breakdown" concept. The second option is to determine quantities and costs of all specific items required to complete the treatment. In either case, regional planners/designers should estimate the cost of each treatment separately, using the same method as for other regional projects.

For an example, consider the 3" and 4" AC overlays described earlier. Tables 1 and 2 give respective overlay costs calculated by determining quantities and costs of the required items. These tables contain item numbers, brief item descriptions, pay units, unit costs, per-mile quantities, and individual item costs (unit costs x per-mile quantities). Total item cost is the sum of individual item costs. Required items for treatments are found in Part 2 ("Treatment Guidelines and Typical Sections"). The Department's Standard Specifications: Construction and Materials and a listing titled "Pavement Restoration Techniques," which is issued as an Engineering Instruction, may also be helpful in identifying necessary items. Item costs may be obtained from the Department's Weighted Average Bid Prices or the Bid Analysis Management System (BAMS). Per-mile quantities calculations are based on types and amounts of distresses recorded on the Distress Data Forms.

Overhead factors are then applied to the total item cost. These consist of variable percentages for surveying, maintenance and protection of traffic, mobilization, preliminary engineering, and construction inspection. When calculating costs for surveying, maintenance and protection of traffic, and mobilization the percentages are compounded. Percentages for preliminary engineering and construction inspection are not compounded in the total cost computation. The method used to apply these factors can be found in Tables 3 and 4. Note that no factors are used for contingencies, as information from the pavement evaluation eliminates the need for this estimate.

Tables 3 and 4 contain PEP output sheets for the same alternatives. Note that general operations are identified, not specific items. For example, the operation "Pavement-Existing, Overlay" automatically provides for asphalt concrete, tack coat, and cleaning existing pavement. Similarly, to approximate the cost of edge drains, the operation "Underdrain" provides trench/culvert excavation, piping, and filter. Item-specific operations, such as Shoulder Backup or AC and PCC Joint Repair, not noted in the standard PEP format may be added as "Lump Sum Specials" or "Regional Specials." All items listed in Part 2 of this Manual ("Treatment Guidelines and Typical Sections") must be accounted for in either general operations or lump sum or regional specials.

The PEP calculates operation costs based on a region's historical costs for items included in the specified operations. Further, when the Summary Options Sheet (part of PEP) is selected, costs (based on default percentages) may be added for survey, maintenance and protection of traffic, mobilization, contingencies, preliminary engineering, construction inspection, etc. All costs selected by the program, including those percentages for Survey, etc., may be adjusted based on planner/designer/estimator judgment and experience.

Total costs used in this example do not reflect such items as non-pavement excavation, clearing, sidewalks, curbs, guiderails, drainage units, signing, landscaping, etc. These non-pavement items are considered equal for these alternatives. It is commonly acceptable to exclude equal, non-pavement items from a LCC analysis. In some analyses, however, some non-pavement items may not be equal for the alternatives considered. When this is the case,

TABLE 1: COSTS OF AREA I, TWO-COURSE OVERLAY SPECIFIC ITEMS

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
203.02	Shoulder Excavation	C.Y.	\$ 6.00	1,760	\$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	293	4,102
403.13	Dense Binder (1 1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1 1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal (deep sawcuts may not be required)	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks. (this item may not be required)	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					271,116
Overhead Factors (Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%) (See Tables 3 and 4 for calculations)					<u>92,613</u>
Total Cost/Mile					363,729
Total Cost Area I					\$727,458

TABLE 2: COSTS OF AREA I, MULTIPLE-COURSE OVERLAY SPECIFIC ITEMS

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
203.02	Shoulder Excavation	C.Y.	\$ 6.00	1,760	\$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	391	5,474
403.13	Dense Binder (1 1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1 1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
403.21	Truing & Leveling (1") (pav't & shldrs.)	Ton	34.00	1,117	37,978
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks. (this item may not be required)	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					310,466
Overhead Factors (Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%) (See Tsbles 3 and 4 for calculations)					<u>106,055</u>
Total Cost/Mile					416,521
Total Cost Area I					\$833,042

TABLE 3: COSTS OF TWO-COURSE OVERLAY OPERATIONS

PRELIMINARY ESTIMATE PROGRAM								
PROJECT IDENTIFICATION NUMBER: 1234.57				PRESENT COST		PREPARED BY: _____		
PROJECT ESTIMATE PHASE:				\$ 303,126.97		DATE: _____		
TYPE OF CONSTRUCTION: 1- R-P TWO COURSE OVERLAY						CHECKED BY: _____		
						DATE: _____		
=====								
PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.57						DATE: 08/22/91		
PROJECT DESCRIPTION TWO COURSE OVERLAY						TIME: 11:06:47 PAGE 1		
=====								
OPERATION	QUANTITY	UNIT	COST	BREAKDOWN	UNIT	REFNO.	PRICE	FACTOR
=====								
EARTHWORK								
=====								
EARTHWORK EXCAVATION - EARTH	1760.0	CY	10560.00	UNCL EXCAVATION	CY	1	6.00	1.00000
=====								
PAVEMENT EXISTING								
=====								
PAVEMENT-EXISTING OVERLAY A THICKNESS:	21120.0 3.0	SY IN	118970.65	ASPH CONC TOP C TACK COAT CLEAN EXIST PAV	T GAL SY	13 15 103	34.50 2.00 0.06	0.05288 0.05 1.00
SAW & SEAL AC OVERLAY	2640.0	LF	13200.00	SAW &SEAL JTS I	LF	11	5.00	1.00000
CLEAN JOINTS 633.05 METHOD (LS FOR PROJECT) **DETERMINED BY PROJECT TYPE** ENTER DOLLAR AM'T.	3696.0	LS	3696.00					
=====								
DRAINAGE								
=====								
EDGE DRAINAGE (EACH SIDE) (6" UNDERDRAIN PIPE RUNS)	10500.0	LF	61600.60	TRENCH/CULVERT OPTIONAL UNDRDR	CY LF	8 27	17.00 3.00	0.16667 1.00
=====								
PAVEMENT MARKINGS								
=====								
EPOXY- LINES (CONC PAVT ONLY)	11880.0	LF	3564.00	WET EPOXY REFLE	LF	161	0.30	1.00000
=====								
SPECIALS								
=====								
SPECIALS SHOULDER BACKUP (15304.0117)	4102.0	LS	4102.00					
AC & PCC JT. REPAIR (18403.88)	55440.0	LS	55440.00					
=====								

TABLE 3 (cont.)

DATE: 08/22/91

TIME: 11:06:53

PAGE 2

PROJECT COST BREAKDOWN

PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.57
PROJECT DESCRIPTION: TWO COURSE OVERLAY

OPERATION	QUANTITY	COST
TOTAL COST OF ALL OPERATIONS		\$ 271,133.25
SURVEY 2-3%		\$ 0.00
MAINTENANCE OF TRAFFIC 5-10%	7.5 %	\$ 20,334.99
SUBTOTAL		\$ 291,468.24
MOBILIZATION	4.0 %	\$ 11,658.73
SUBTOTAL		\$ 303,126.97
CONTINGENCIES - PIR 25% I-20%, IV-15%, 75%-10%		\$ 0.00
PRESENT CONSTRUCTION COST		\$ 303,126.97

08/22/91

SUMMARY OF PROJECT COSTS

P.I.N. : 1234.57 PROGRAMMED AMOUNT: \$ 400,000.00
PROJECT DESC. : TWO COURSE OVERLAY
PROJECT PHASE:

PRESENT COSTS

CURRENT ESTIMATED COST: \$ 303,126.97

WORK NOT INCLUDED IN CURRENT CONSTRUCTION COST

RAILROAD FORCE ACCOUNT WORK: \$ 0.00
UTILITIES: \$ 0.00
AUTHORITY WORK: \$ 0.00
OTHER: \$ 0.00
OTHER: \$ 0.00

CONSTRUCTION COST (SUM OF THE ABOVE): \$ 303,126.97

PRELIMINARY ENGINEERING @ 8.00% OF CURRENT EST. COST: \$ 24,250.16
CONSTRUCTION INSPECTION @ 12.00% OF CURRENT EST. COST: \$ 36,375.24
RIGHT-OF-WAY ACQUISITION: \$ 0.00

TOTAL CURRENT PROJECT COST: \$ 363,752.37

TABLE 4: COSTS OF MULTIPLE-COURSE OVERLAY OPERATIONS

PRELIMINARY ESTIMATE PROGRAM								
PROJECT IDENTIFICATION NUMBER: 1234.56				PRESENT COST		PREPARED BY: _____		
PROJECT ESTIMATE PHASE:				\$ 347,113.64		DATE: _____		
TYPE OF CONSTRUCTION: 1- R-P MULTIPLE COURSE OVERLAY						CHECKED BY: _____		
						DATE: _____		
PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.56								
PROJECT DESCRIPTION MULTIPLE COURSE OVERLAY						DATE: 08/22/91		PAGE 1
OPERATION		QUANTITY	UNIT	COST	BREAKDOWN	UNIT	REFNO.	PRICE FACTOR
EARTHWORK								
EARTHWORK EXCAVATION - EARTH		1760.0	CY	10560.00	UNCL EXCAVATION	CY	1	6.00 1.00000
PAVEMENT EXISTING								
PAVEMENT-EXISTING OVERLAY A THICKNESS:		21120.0 3.0	SY IN	118970.65	ASPH CONC TOP C TACK COAT CLEAN EXIST PAV	T GAL SY	13 15 103	34.50 2.00 0.06 0.05288 0.05 1.00
SAW & SEAL AC OVERLAY		2640.0	LF	13200.00	SAW &SEAL JTS I	LF	11	5.00 1.00000
CLEAN JOINTS 633.05 METHOD (LS FOR PROJECT) **DETERMINED BY PROJECT TYPE** ENTER DOLLAR AM'T.		3696.0	LS	3696.00				
TRUEING & LEVELING THICKNESS:		21120.0 1.0	SY IN	37972.07	ASPH CONC TOP C	T	13	34.00 0.05288
DRAINAGE								
EDGE DRAINAGE (EACH SIDE) (6" UNDERDRAIN PIPE RUNS)		10560.0	LF	61600.60	TRENCH/CULVERT OPTIONAL UNDRDR	CY LF	8 27	17.00 3.00 0.16667 1.00
PAVEMENT MARKINGS								
EPOXY- LINES (CONC PAVT ONLY)		11880.0	LF	3564.00	WHT EPOXY REFLE	LF	161	0.30 1.00000
SPECIALS								
SPECIALS SHOULDER BACKUP (15304.0117)		5474.0	LS	5474.00				
AC & PCC JT. REPAIR (18403.88)		55440.0	LS	55440.00				

TABLE 4 (cont.)

DATE: 08/22/91

TIME: 11:04:19

PAGE 2

PROJECT COST BREAKDOWN

PRINT OUT OF PRELIMINARY ESTIMATE FOR PIN NO. 1234.56
 PROJECT DESCRIPTION: MULTIPLE COURSE OVERLAY

OPERATION	QUANTITY	COST
TOTAL COST OF ALL OPERATIONS		\$ 310,477.32
SURVEY 2-3%		\$ 0.00
MAINTENANCE OF TRAFFIC 5-10%	7.5 %	\$ 23,285.80
SUBTOTAL		\$ 333,763.12
MOBILIZATION	4.0 %	\$ 13,350.52
SUBTOTAL		\$ 347,113.64
CONTINGENCIES - PIR 25% I-20%, IV-15%, 75%-10%		\$ 0.00
PRESENT CONSTRUCTION COST		\$ 347,113.64

08/22/91

SUMMARY OF PROJECT COSTS

P.I.N. : 1234.56 PROGRAMMED AMOUNT: \$ 400,000.00
 PROJECT DESC. : MULTIPLE COURSE OVERLAY
 PROJECT PHASE:

PRESENT COSTS

CURRENT ESTIMATED COST: \$ 347,113.64

WORK NOT INCLUDED IN CURRENT CONSTRUCTION COST

RAILROAD FORCE ACCOUNT WORK:	\$ 0.00
UTILITIES:	\$ 0.00
AUTHORITY WORK:	\$ 0.00
OTHER:	\$ 0.00
OTHER:	\$ 0.00

CONSTRUCTION COST (SUM OF THE ABOVE): \$ 347,113.64

PRELIMINARY ENGINEERING @ 8.00% OF CURRENT EST. COST: \$ 27,769.09
 CONSTRUCTION INSPECTION @ 12.00% OF CURRENT EST. COST: \$ 41,653.64
 RIGHT-OF-WAY ACQUISITION: \$ 0.00

TOTAL CURRENT PROJECT COST: \$ 416,536.37

those items must be included in the appropriate alternative. For example, consider a LCC analysis comparing Full-Depth Segment Replacement of PCC pavement and 5" Asphalt Concrete Overlay Preceded By Cracking and Sealing. In the latter alternative, it may be necessary to include raising the guiderail, curbs, and sidewalks. For the final estimate of a chosen alternative, all items/operations must be considered.

Future treatment costs are determined in the same manner as initial treatment cost. Again, the cost of each future treatment is estimated as a separate project. Pages C-4 through C-5 tabulate future treatment costs for the 3" AC Overlay. These costs were determined by calculating quantities based on types and amounts of distresses recorded in the Distress Data Forms. Note that several treatments applied at different times are identical. Only one calculation is required for each identical treatment. Pages C-6 through C-8 tabulate future treatment costs for the 4" AC Overlay.

Salvage values are determined by multiplying the ratio of unused to expected service life by cost of the treatment. For example, a 1-1/2" AC Course applied during year 27 of the two-course overlay treatment strategy has a salvage value: 5 years remaining life/8 year expected life x the cost of 1-1/2" of AC, or

$$5/8 \times \$324,688 = \$202,930.$$

As total costs for initial and future treatments are determined, they are placed in the Present Cost columns of tabulations similar to Tables 5 and 6. In these tables each treatment is briefly described, the year applied is noted, and also the Present Cost of each treatment. (Present Worth will be discussed next.) The sum of the Present Costs gives Total Present Cost for the treatment strategy. Salvage values are considered negative values when calculating Total Present Cost.

Compare Treatment Strategies Using The Present Worth Method

Present Worth of a treatment strategy may be thought of as the amount of money that would have to be invested now to fund future treatments when necessary. To account for the time-value of money, the Present Worth Method of LCC discounts future treatment costs to their worth in today's dollars. The rate at which future treatments are discounted, or "discount rate," is the difference between return on public investments (interest) and inflation. Returns on public investment result from improved infrastructure, employment, sales, income and sales taxes, and benefits to local economies. Relationships among these factors are complex. Studies show that over time the discount rate is about 4 percent. Department policy is to use a discount rate of 4 percent.

The Present Worth Method discounts future treatment costs to their worth in today's dollars by multiplying Present Cost of each treatment by a Present Worth Factor (PWF). A PWF is equal to $1/(1+i)^n$, where i is the discount rate and n is the year the treatment is applied. $(P/F, i, n)$ is standard notation for the PWF. In Tables 5 and 6, PWFs are calculated for a discount rate of 4 percent. For example, PWF for a treatment applied in the 15th year is

$$(P/F, 4\%, 15) = 1/(1+.04)^{15} = 0.5553.$$

PWFs for each year a treatment is applied are found in the Present Worth Factor columns

of Tables 5 and 6. Present Worths of treatments are obtained by multiplying Present Cost of the treatment and the PWF for the year the treatment is applied. The two-course overlay applied in the 15th year in Table 6 has a Present Worth of

$$\$529,234 \times 0.5553 = \$293,884.$$

Present Worths are summed to obtain a Total Present Worth. Present Worths of salvage values are considered negative values when calculating Total Present Worth. PWF for all salvage values is determined for the last year in the analysis period. In this example,

$$(P/F, 4\%, 30) = 1/(1 + .04)^{30} = 0.3083.$$

PWFs may be calculated or obtained from Table 7, where values are calculated for a 4-percent discount rate. The treatment strategy with the smallest Total Present Worth is the most cost-effective.

Perform A Sensitivity Analysis

This is performed to determine how sensitive a LCC analysis is to a particular variable. Treatment service lives, treatment timing, future treatment strategies, and item costs may be varied for a sensitivity analysis. A sensitivity analysis is basically a recalculation of LCCs with one changing variable. If one variable is changed and the subsequent LCC analysis shows that the same treatment strategy continues to be the most cost-effective, the LCC analysis is not sensitive to that variable. This means the decision is more likely to be correct. If changing one variable makes another treatment strategy more cost-effective, the LCC analysis is sensitive to that variable. More effort should be given to determining the exact value or nature of a variable if an LCC analysis is sensitive to it.

Select The Best Treatment Strategy

Use results of the LCC analysis and other factors to select a treatment strategy for design and construction.

TABLE 5: COSTS OF AREA I, TWO-COURSE OVERLAY TREATMENT STRATEGY

<u>Description</u>	<u>Year (n)</u>	<u>Present Cost</u>	<u>Present Worth Factor (P/F, 4%, n)</u>	<u>Present Worth</u>
3" AC Overlay	0	\$727,458	1.0000	\$727,458
Fill Longitudinal Cracks/Joints	2	1,560	.9246	1,442
Fill Longitudinal Cracks/Joints	4	1,560	.8548	1,333
Fill Longitudinal Cracks/Joints	6	1,560	.7903	1,233
Fill Longitudinal Cracks/Joints	8	2,424	.7307	1,771
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	10	2,424	.6756	1,638
Fill Sawed & Sealed Joints				
3" AC Overlay	12	529,234	.6246	330,560
Fill Longitudinal Cracks/Joints	14	1,560	.5775	901
Fill Longitudinal Cracks/Joints	16	1,560	.5339	833
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Fill Longitudinal Cracks/Joints	20	2,424	.4564	1,106
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	22	2,424	.4220	1,023
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	24	2,424	.3901	946
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	26	2,424	.3607	874
Fill Sawed & Sealed Joints				
1-1/2" AC Overlay	27	324,688	.3468	112,602
Fill Longitudinal Cracks/Joints	29	2,070	.3207	664
Subtotal		1,607,354		1,185,154
1-1/2" AC Overlay, Sawed & Sealed Jts.		-202,930	.3083	-62,563
5-Yr Salvage Value				
Fill Longitudinal Cracks/Joints,		-1,035	.3083	-319
1-Yr Salvage Value				
Total		\$1,403,389		\$1,122,272

TABLE 6: COSTS OF AREA I, MULTIPLE-COURSE OVERLAY TREATMENT STRATEGY

<u>Description</u>	<u>Year (n)</u>	<u>Present Cost</u>	<u>Present Worth Factor (P/F, 4%, n)</u>	<u>Present Worth</u>
4" AC Overlay	0	\$833,042	1.0000	\$833,042
Fill Longitudinal Cracks/Joints	2	1,048	.9246	969
Fill Longitudinal Cracks/Joints	4	1,048	.8548	896
Fill Longitudinal Cracks/Joints	6	1,048	.7903	828
Fill Longitudinal Cracks/Joints	8	1,914	.7307	1,399
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	10	1,914	.6756	1,293
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	12	1,914	.6246	1,195
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	14	1,914	.5775	1,105
Fill Sawed & Sealed Joints				
3" AC Overlay	15	529,234	.5553	293,884
Fill Longitudinal Cracks/Joints	17	1,560	.5134	801
Fill Longitudinal Cracks/Joints	19	1,560	.4746	740
Fill Longitudinal Cracks/Joints	21	1,560	.4388	685
Fill Longitudinal Cracks/Joints	23	2,424	.4057	983
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	25	2,424	.3751	909
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	27	2,424	.3468	841
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	29	2,424	.3207	777
Fill Sawed & Sealed Joints				
Subtotal		1,387,452		1,140,347
Fill Longitudinal Cracks/Joints, Fill Sawed & Sealed Joints		-1,212	.3083	-374
1-Yr Salvage Value				
Total		\$1,386,240		\$1,139,973

TABLE 7: PRESENT WORTH FACTORS (P/F,4%,n)

<u>Year (n)</u>	<u>PWF</u>	<u>Year (n)</u>	<u>PWF</u>
0	1.0000	26	0.3607
1	0.9615	27	0.3468
2	0.9246	28	0.3335
3	0.8890	29	0.3207
4	0.8548	30	0.3083
5	0.8219	31	0.2965
6	0.7903	32	0.2851
7	0.7599	33	0.2741
8	0.7307	34	0.2636
9	0.7026	35	0.2534
10	0.6756	36	0.2437
11	0.6496	37	0.2343
12	0.6246	38	0.2253
13	0.6006	39	0.2166
14	0.5775	40	0.2083
15	0.5553	41	0.2003
16	0.5339	42	0.1926
17	0.5134	43	0.1852
18	0.4936	44	0.1780
19	0.4746	45	0.1712
20	0.4564	46	0.1646
21	0.4388	47	0.1583
22	0.4220	48	0.1522
23	0.4057	49	0.1463
24	0.3901	50	0.1407
25	0.3751	51	0.1353

PART 4: MODEL PAVEMENT EVALUATION REPORT

PART 4: MODEL PAVEMENT EVALUATION REPORT

The following model pavement evaluation report was created to show three areas exhibiting considerable differences in pavement distress, design requirements, and/or design constraints. Its purpose is to show the reader a variety of situations that could be encountered in developing various treatment strategies. Generally, existing pavement distress is not as diverse as shown here. It is thus unlikely that actual reports will have to be as voluminous as this example.

This model report also contains background information concerning probable causes of distress. This is not required in pavement evaluation reports unless the author feels its inclusion is critical to those reviewing the rehabilitation analysis and treatment selection strategies. For the reader's convenience, the information considered to be background in the model report has been *italicized*.

The model report is included in this volume of the Manual as an example of format and methodology. Format and methodology, however, should not be confused with writing style nor should the reader feel it necessary to adopt the author's style. Rather, the reader is encouraged to use and develop his own style.

Pavement evaluation reports, however, should contain information under each of the following general headings;

1. Background
2. Data Collection And Reduction
3. Field Observations
4. Other Investigations (if applicable, this includes coring, discussion with others and information from them etc.)
5. Alternative Selection
6. Rehabilitation, Future Treatment, and Life-Cycle Costs (Time Lines and Cost Summaries)
7. Analysis Summary
8. Recommendations
9. Appendices
 - A. Project Information Form (BR-46)
 - B. Distress Data Forms (BR-47 and/or BR-48)
 - C. Alternative Cost Estimates: Area I
 - D. Alternative Cost Estimates: Area II
 - E. Alternative Cost Estimates: Area III

PAVEMENT EVALUATION REPORT

PIN 9040.90

ROUTE 66, SOMEWHERE TO NOWHERE

BUSH COUNTY

BACKGROUND

This project is a 7-mile two-lane facility originally constructed in 1963 under Contract FAC 62-10. From the southern end, the highway goes through a relatively flat wooded area with scattered residences for the first 2 miles. The next 3 miles pass through farmland comprised of rolling hills. The final 2 miles are within the Village of Nowhere.

The pavement is mesh-reinforced portland cement concrete slabs separated at 60-ft intervals by transverse contraction joints. Both the longitudinal and transverse joints were sawed and then sealed with preformed neoprene extrusions. Two-piece malleable-iron load-transfer devices were used as transverse joint supports. In the rural areas, 6-ft shoulders were provided. In the village 3-ft wide concrete gutters beyond the 6-ft shoulders direct runoff to a closed drainage system.

In 1985, the southernmost 2 miles were overlaid by state maintenance forces with a 1-in. AC armor coat to alleviate a rideability problem caused by a combination of transverse-joint faulting and D-crack-related joint spalling. Other maintenance efforts have included blowup and spall repair with AC patches, crack filling with hot-poured rubber asphalt, and wedging and surface treating of shoulders. For additional details see the Project Information Form (Appendix A).

In the rural areas, the existing pavement and shoulders are to be rehabilitated. In the village, parking lanes and curbs will be added, existing sidewalks replaced, and the existing closed drainage system will be modified and upgraded.

DATA COLLECTION AND REDUCTION

During the initial drive-through, it was determined that there was enough difference within the project limits to collect and evaluate pavement distress data in three separate areas. From south to north, these are:

Area I: The first 2 miles through wooded flatland.

Area II: 3 miles through farmland.

Area III: The final 2 miles within the Village of Nowhere.

The second drive-through located specific areas of isolated distress. These were recorded and appear under the first three headings of the Distress Data Forms (Appendix B).

After the second drive-through, detailed distress data were collected at 1/10-mile sections in each half-mile segment of the project. These data appear under the remaining headings of the Distress Data Forms (Appendix B). As can be seen, these data were totaled, and where appropriate expressed as percentages. This information, as well as that from isolated distress areas, was then analyzed and used to select and develop cost estimates for the rehabilitation alternatives presented later in this report.

The following describes existing distresses as observed in the three areas. Distress is discussed in the same order that it appears on the forms.

FIELD OBSERVATIONS IN AREA I

The asphalt concrete overlay, placed by state maintenance forces 6 years ago, exhibits multiple cracking and some material loss (potholes) over transverse joints of the underlying portland cement concrete pavement. *Most likely, single cracks appeared in the overlay during the winter following placement, the result of thermal contraction in underlying slabs. Additional crack development and material loss took place over time because of existing D-cracking in the underlying pavement, deicing chemical and water penetration, aggregate stripping, and the action of traffic.*

Multiple cracking is also present over the longitudinal joint of the underlying portland cement concrete pavement. *Probably, initial cracks developed because of the inherent weakness built into an overlay when asphalt concrete is placed lane-at-a-time (cold joints). Subsequent cracks developed for the same reasons previously stated.*

Minor wheelpath rutting was the only other pavement deficiency found in Area I, *the result of overlay consolidation from repetitive traffic loading.*

Shoulders in Area I exhibit multiple cracking and some potholing. Separation between the pavement and shoulder has allowed runoff to penetrate and wash away some fines, weakening subsurface gravel courses. This has caused some settlement (lane/shoulder dropoff), secondary cracking, and surface potholing. Traffic encroachment has aggravated this situation. However, no isolated areas of shoulder deformation were found.

FIELD OBSERVATIONS IN AREA II

Settlements were found at five locations, four over existing cross-culverts and one at a structure approach. *Most likely, they resulted from differential compaction that occurred during construction.*

Four full-width blowups and one partial-width blowup have also occurred in the area. *These are the result of transverse joint sealer failure and subsequent joint and crack infiltration of incompressible material.*

Maintenance forces have patched the settlements and blowups with asphalt concrete to restore the original profile and cross-slope and to improve rideability.

The preformed neoprene used to seal transverse and longitudinal joints exhibits compression set. Beneath the sealers, joints are filled with incompressible material. *Historically, extrusions of this vintage have failed after 2 to 3 years of service. Consequently, joints have been unsealed for sometime.*

Generally, transverse joint faulting in this area is between 3/8 and 3/4 in. *indicating that the two-piece malleable-iron load-transfer devices have experienced section loss from corrosion and wear. Joint-support-device degradation is triggered when joint seals fail, allowing ingress of corrosive deicing chemicals. Pavement rideability is considered objectionable if transverse joint faulting is 1/4 in. or more.*

Transverse joint separation has occurred at transverse joints near blowups. *When blowups occur, joints open as adjacent pavement slabs move toward the stress-relieved area. This provides additional space for incompressible accumulation, renewed stress buildup, and potential for future blowups.*

Almost all transverse and longitudinal joint distress (spalling) encountered can be attributed to D-cracking, *a condition associated with using a coarse aggregate sensitive to freeze-thaw damage. Joints are particularly vulnerable because additional faces are exposed that can absorb free moisture.* Spalls have been repaired with asphalt concrete patches by state maintenance forces.

Longitudinal joint separation has occurred between pavement lanes on both sides of the partial-width blowup found in Section 4. Subsequent migration of pavement slabs toward the blowup in the affected lane has sheared off longitudinal joint ties between lanes, as shown by misalignment of transverse joints. Free from the restraint of ties, accumulation of incompressible material within the joint is forcing the adjacent lanes apart.

There is a significant number of slab cracks within the area. *Slab cracks develop for many reasons. Those appearing early in service life of a pavement can usually be traced to a flaw in construction. Those developing later usually are caused by loss of subbase support. Regardless of their origin, cracks disrupt the normally predictable expansion and contraction characteristics of slabs and opening and closing of joints.* State maintenance forces have filled these cracks with asphalt, in an attempt to discourage infiltration.

Rut measurements in the wheelpaths indicate that loss of mortar and fine aggregate in the surface has been minimal. Consequently, disruption of cross-slope drainage is insignificant.

Non-joint spalling consists of surface popouts, *the result of D-cracking in the absorptive coarse aggregate within the concrete matrix.*

Shoulder deterioration is similar to that found in Area I, exhibiting multiple cracking throughout, with some potholing in Section 4. The separation between shoulder and pavement is allowing runoff penetration to subsurface courses and shoulders have subsided. Deformation has also occurred in Sections 3 and 5 near cross-culverts.

FIELD OBSERVATIONS IN AREA III

Within the village, settlements were found over underlying cross-culverts and at utility cuts made since the pavement was built. These were patched with asphalt concrete to restore the pavement's profile and rideability, but most exhibit distortion, rutting, and/or ravelling.

Four partial-width and four full-width blowups have also occurred, *the result of sealer failure and joint infiltration.* Those too were patched with asphalt concrete and are exhibiting distress similar to that found in the settlement patches. No paver-laid asphalt concrete overlay patches were found.

Many of the original preformed neoprene sealers have been lost from the joints, which are filled with incompressible material. The extrusions remaining have failed in compression set and are allowing infiltration of fines and water.

Transverse joint faulting is objectionable because of load-transfer device disengagement, corrosion, and wear.

Transverse joint separation has occurred adjoining blowups. Pavement migration at partial-width blowups has caused misalignment of transverse joints in affected areas.

Most existing transverse joint distress (spalling) can be attributed to D-cracking, *a consequence of using absorptive aggregate in the concrete*. Spalls have been patched with asphalt concrete, but new spalls have developed around the patches, reducing their effectiveness. Longitudinal joint distress (spalling) is also D-crack related.

Longitudinal joint separation has occurred between lanes in the immediate vicinity of partial-width blowups. Here, longitudinal joint ties have sheared because of slab migration. Joint infiltration is forcing the lanes apart.

Most pavement slabs in the area contain working cracks, *indicating abnormal slab expansion and contraction and unpredictable joint movement*. State maintenance forces have attempted to delay infiltration as remnants of asphalt filler were found in the cracks.

Although some surface mortar loss and large-aggregate polishing has occurred, measurements show minimal wheelpath rutting. Consequently, cross-slope drainage has not been seriously affected.

Most non-joint spalling recorded consists of surface popouts, *the result of freeze-thaw damage of the larger absorptive aggregate in the concrete*. The remainder resulted from corroding wire mesh placed too close to the surface when the pavement was constructed.

Shoulder condition in this area is similar to that found in Areas I and II. Runoff is penetrating to subsurface layers through the separation between the pavement and shoulder, causing multiple cracking and dropoff. Vehicular encroachment is aggravating the situation. However, no shoulder deformation was found.

OTHER INVESTIGATIONS

Following the pavement evaluation, the Bush County Resident Engineer was contacted to determine what level of maintenance is needed on the existing facility and to learn of any particular problems he may have experienced that were not evident during the field evaluation. This indicated the following:

1. Efforts to maintain the highway have progressively increased in recent years. Despite this effort, pavement and shoulder condition continues to decline.
2. Continuous effort is now required to patch new spalls that are developing as a result of D-cracking and to replace older patches that have failed.
3. Annual crack sealing and shoulder repair is needed but cannot be done with the limited resources available.
4. Minor frost heaves have occurred in shoulders in Areas II and III.

The Regional Soils Engineer has inspected the road and recommends that the existing shoulders in Areas I and II be removed and replaced. He also suggests that underdrain be installed in all three areas to ensure positive drainage and reduce frost heave susceptibility.

Pavement cores were taken in Area I to determine the extent of D-crack-related distress beneath the existing overlay. As the field observations had indicated, structural damage was confined to PCC in the immediate vicinity of underlying joints. Consequently, this deficiency should be addressed during development of a rehabilitation strategy.

Subsequent tests of the AC from cores showed satisfactory mix properties. The existing overlay thus could be recycled or left in place and used as a base for an overlay.

ALTERNATIVE SELECTION

AREA I

Multiple reflection cracking over underlying D-cracked joints is the only distress form of any consequence that has developed in the existing overlay since it was placed 6 years ago. It thus appears that for the most part structural integrity of the underlying portland cement concrete and subbase courses are adequate. There is, some doubt however, of structural adequacy in the immediate vicinity of underlying joints that have deteriorated from the effects of D-cracking. It is thus apparent that the rehabilitation strategy selected must include corrective measures to forestall the effects of D-cracking in the underlying concrete.

Given these conditions, it is apparent that some of the rehabilitation strategies available are not appropriate and can be eliminated from the selection process:

1. Do Nothing. Since the level of service continues to decline despite increasing maintenance efforts, this option is unacceptable.
2. Single-Course Overlay (1-1/2"). Expected service life of this rehabilitation strategy (8 years) is significantly less than desired.
3. Hot or Cold Recycling or Cold Milling and Replacement. Except for areas in the immediate vicinity of underlying PCC joints, the existing overlay is in good condition. Damaged areas can be removed and repaired and the remainder of the overlay left in place to be used as a base for a new overlay. These strategies thus are not appropriate.
4. Remove Flexible Overlay, Crack and Seat With Multiple-Course Overlay (5"). This technique is used when normal (thermally induced) expansion and contraction of pavement slabs is interrupted by slab cracks, rendering transverse joint movement unpredictable. In this pavement, the distress survey revealed that reflection cracks appear only over underlying transverse joints, indicating that normal movement is still occurring. The crack-and-seat strategy thus is not appropriate.
5. Remove Flexible Overlay, Rubblize With Multiple-Course Overlay (6"). This strategy is used in situations suitable for cracking and seating, but presence of underground utilities precludes use of the crack-and-seat method. Rubblizing thus is not appropriate for the given condition.

6. Reconstruct. Despite existing distress, structural capacity of the pavement is still adequate, capable of providing satisfactory service for years to come. This remaining service life would be lost if the pavement were reconstructed. Consequently, this rehabilitation strategy would not now be cost-effective.

Two rehabilitation strategies are appropriate (provided reflective cracking in the overlay and D-cracking at underlying joints are addressed):

1. Two-Course Overlay (3"). For this strategy to succeed, areas affected by reflective cracking and D-cracking have to be removed and replaced with AC patches. This can be accomplished with Item 18403.88 (Repair Defective AC Overlay And PCC At Underlying PCC Joints). Patches will improve structural integrity of the affected areas and provide a uniform base for the new resurfacing. Sawing and sealing over underlying joints will control thermally induced reflective cracks occurring in the new overlay. Continued D-cracking in the underlying PCC however, could shorten the expected service life of this alternative.
2. Multiple-Course Overlay (4"). Again, Item 18403.88 must be used to ensure the success of this strategy, which is more expensive. However, the additional thickness will add strength to the section and help delay the effects of D-cracking deterioration that will continue in the underlying PCC. Consequently, the predicted service life of this alternative is expected to be somewhat longer than the two-course overlay.

AREA II

Transverse joint faulting *the result of load-transfer-device failure* and transverse joint spalling *the result of D-cracking* are the primary distresses responsible for objectionable rideability of this pavement. Slab cracking is most likely the result of loss of subbase support beneath transverse joints and subsequent pavement deflection from traffic loading. Generally, however, the pavement and its foundation still appear to possess sufficient strength to be used as a base.

Given these conditions, the following available rehabilitation strategies are not appropriate and can be eliminated from the selection process:

1. Do Nothing. The magnitude of existing distress is such that state maintenance forces can no longer maintain an acceptable level of service. This alternative thus is not appropriate.
2. Concrete Pavement Restoration (CPR). This technique is appropriate for portland cement concrete pavements exhibiting low levels of distress. CPR techniques include joint resealing, fault grinding, permanent patching and segment replacement. Since distress levels are relatively high, CPR would not be cost-effective.
3. Sawed and Sealed Asphalt Concrete Overlay (3"). This strategy is used when movement from thermal expansion and contraction is still occurring in most PCC transverse joints. Sawing and sealing transverse joints in an asphalt overlay directly over underlying PCC joints confines reflective cracks to the sawcuts, minimizing secondary cracking and preventing intrusion of water and debris into the pavement structure. Slab cracks disrupt this scenario. Cracked slabs thus should be removed

and replaced in conjunction with this strategy; the more slab replacements required, the less attractive this alternative becomes. In this area, most slabs are cracked, and this strategy thus would not be cost-effective.

4. Sawed and Sealed Asphalt Concrete Overlay (4"). Warrants for this rehabilitation strategy are the same as for the previous one, the only difference being that the thicker overlay provides greater structural strength to the pavement section. Consequently, this alternative is not appropriate, as slab cracking is extensive.
5. Asphalt Concrete Overlay (6") Preceded By Rubblizing. Warrants for this strategy currently limit its use to severely distressed PCC pavement in urban settings where presence of underground utilities precludes use of the crack-and-seat option, and/or where pavement is to be widened. Since this area falls outside these parameters, this strategy is not appropriate.

The following rehabilitation strategies are appropriate:

1. Asphalt Concrete Overlay (5") Preceded By Cracking and Seating. This is appropriate when normal, thermally induced expansion and contraction of pavement slabs is interrupted by slab cracks, rendering transverse joint movement unpredictable. In this area, however, other distresses have to be addressed for this alternative to be effective. These include D-crack related joint spalling and transverse joint faulting. The former can be corrected using Item 18502.4466 (Repair Of Spalled Areas, Joints And/Or Cracks In Portland Cement Concrete Pavement). The latter can be corrected by wedging faults with asphalt concrete patches before overlay placement. Both will help provide a stable, uniform base on which to place and compact the new overlay courses. The 5-in. overlay will strengthen the highway section and forestall the effects of D-cracking in the underlying PCC pavement.
2. Reconstruct. Based on the amount and severity of distress in this area, this is another option worth consideration. With routine maintenance, a new full-depth asphalt concrete pavement could provide adequate service for 15 years before further rehabilitation would be required. Thirty years of service could be attained from a new portland cement concrete pavement before further rehabilitation would be necessary, provided isolated slab distresses are repaired and periodic maintenance is performed during that period.

AREA III

Rideability of the pavement within the village is objectionable because of faulting and spalling at transverse joints and cracks. *As previously stated, these deficiencies result from load-transfer-device failure and D-cracking.* Noted distress also disrupts the pavement's drainage characteristics, impeding efficiency of the existing drainage system. As is, the pavement is no longer serviceable. However, it and its supporting foundation are still suitable for use as a base.

Given these conditions, some rehabilitation strategies available obviously are not appropriate and can be eliminated:

1. Do Nothing. With limited resources at their disposal, state maintenance

forces have been unable to maintain a satisfactory level of service within the village. Consequently, this alternative is unacceptable.

2. Concrete Pavement Restoration (CPR). This alternative is appropriate for portland cement concrete pavements exhibiting low distress levels. Existing levels are such that this strategy would not be cost-effective.
3. Sawed-and-Sealed Asphalt Concrete Overlay (3"). Many slabs in this area contain cracks that have disrupted normal thermally induced movement occurring at transverse joints. Sawing and sealing over existing joints thus would be ineffective. Based on existing distress levels, it is also apparent that the pavement is structurally inadequate and should be restored. This cannot be achieved with 3 in. of AC. Consequently, this strategy is not appropriate.
4. Sawed and Sealed Asphalt Concrete Overlay (4"). This alternative would improve structural strength of the existing pavement section, but does not address unpredictability of thermal movement associated with slab cracking. It thus is not appropriate.
5. Asphalt Concrete Overlay (5") Preceded By Cracking and Sealing. This rehabilitation strategy is appropriate given the amount and severity of existing distress, but presence of underground utilities near the pavement preclude its use.

The following rehabilitation strategies are appropriate;

1. Asphalt Concrete Overlay (6") Preceded By Rubblizing. This is particularly useful when utilities are located under a severely distressed portland cement concrete pavement. Rubblizing fragments the pavement in place without damaging utilities. It is also useful when pavement is to be widened. Here the rubblized pavement is supplemented with crushed stone and both materials are compacted with a vibratory roller for use as a base for a new pavement. Consequently, this alternative is ideally suited for the given conditions.
2. Reconstruct. Condition of the existing pavement is such that this is worth consideration. It is also compatible with plans to add parking lanes within the village. Further, the existing pavement can be removed and replaced without damaging underground utilities. Provided periodic maintenance, a new full-depth AC pavement could provide 15 years of service before further rehabilitation would be needed. With isolated slab distress repair and routine maintenance, 30 years of service could be expected from a new PCC pavement before further rehabilitation.

REHABILITATION, FUTURE TREATMENT, AND LIFE-CYCLE COSTS

REHABILITATION COSTS

Since cost is an important consideration in the rehabilitation selection process, cost estimates for each of the selected alternatives were prepared and are presented in Appendices C (Area I), D (Area II), and E (Area III). Quantities included in the computations are for a roadway section consisting of two 12-ft wide travel lanes and either two 6-ft wide shoulders or two 8-ft wide parking lanes. Estimates do not include items beyond these limits nor items for drainage adjustments/improvements within those limits (except for edge drains). Inclusion of these items will of course increase costs of the alternatives, but they do not

influence selection because these items are common to all the alternatives.

FUTURE TREATMENT COSTS

Cost estimates for the predicted maintenance needs of each of the selected alternatives also appear in Appendices C, D, and E, following the alternative cost estimates.

LIFE-CYCLE COSTS

Following are life-cycle time lines which combine initial rehabilitation and predicted future treatment costs for each of the selected alternatives in each area.

ANALYSIS SUMMARY

AREA I

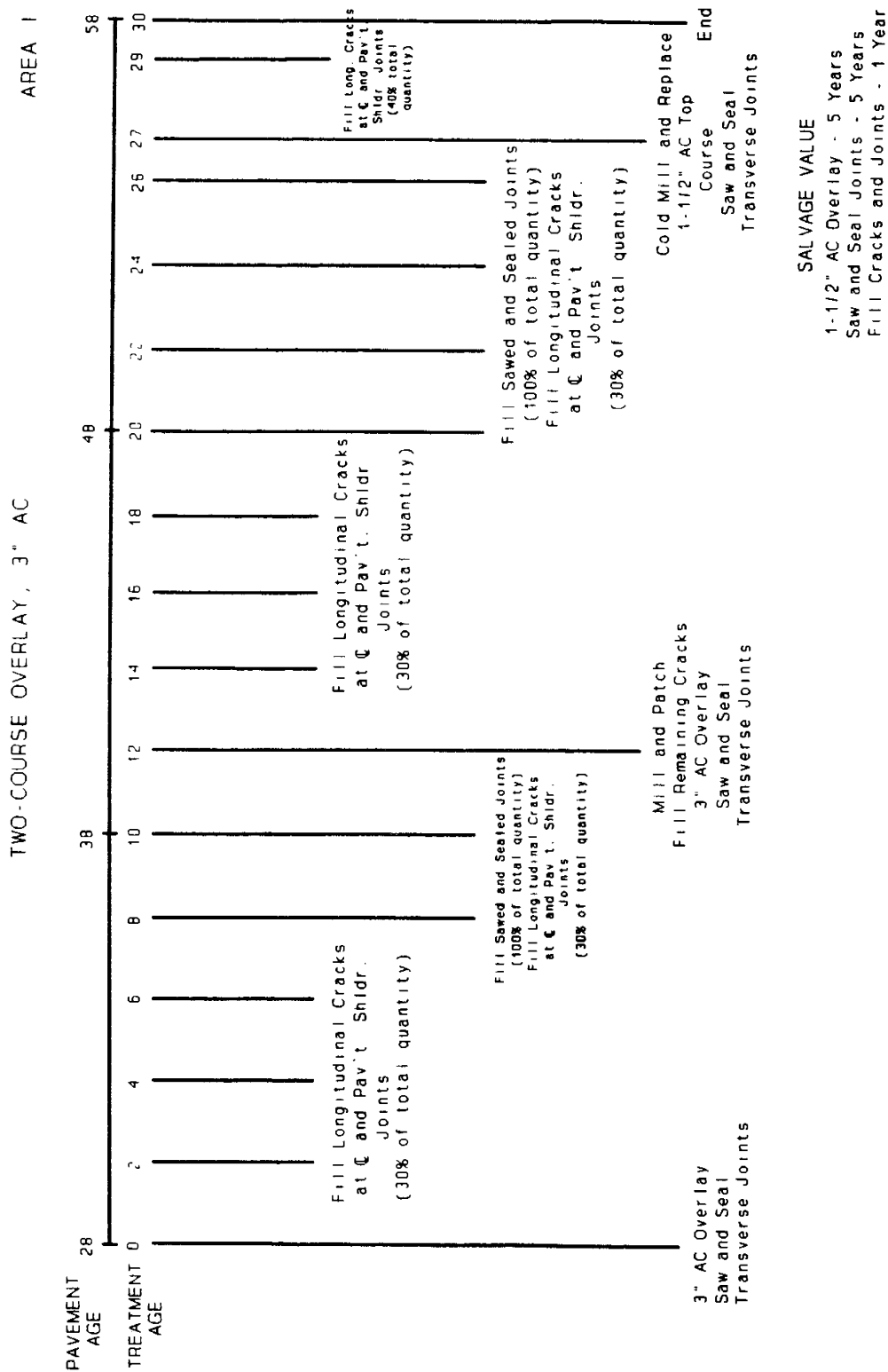
As would be expected, the cost analysis shows that initial cost of rehabilitating Area I with a 3-in. AC overlay is less than with a 4-in. AC overlay. Even when future maintenance needs over the 30-year life cycle period are considered, the thinner overlay still appears to enjoy an economic advantage, as its present worth cost is less than its thicker counterpart.

AREAS II AND III

The cost analysis reveals that the crack-and-seat and rubblize alternatives are initially cheaper than the reconstruction alternatives. Further, maintenance needs of these alternatives over the 45-year life-cycle-analysis period are comparable to those of the reconstruction alternatives. These alternatives also conserve natural resources in that they use materials already in place rather than removing them to disposal areas.

RECOMMENDATIONS

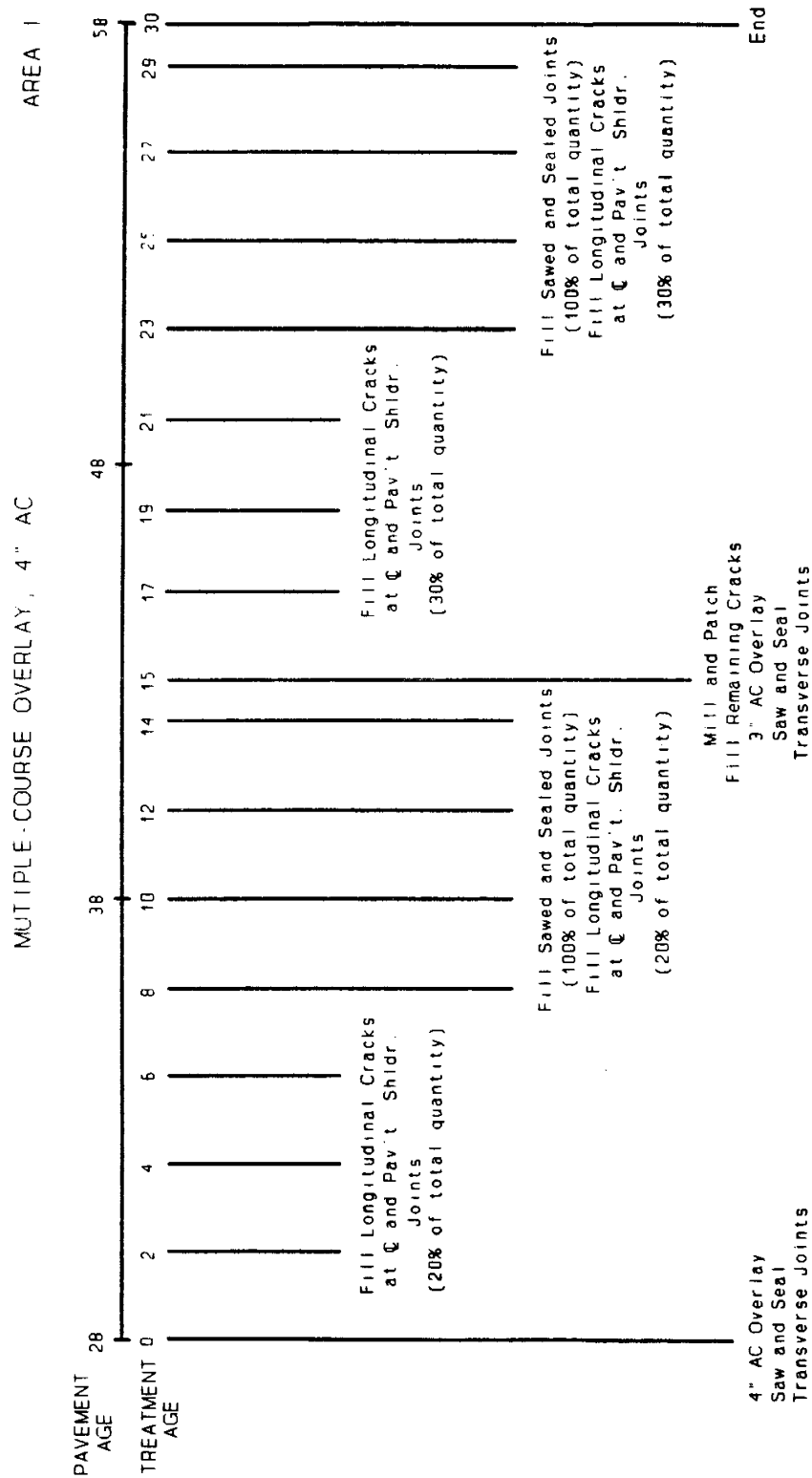
Based on the findings of this pavement evaluation and analysis, it is recommended that Area I be rehabilitated with a 3-in. sawed-and-sealed AC overlay. Rehabilitation of Area II should be accomplished by cracking and seating the existing PCC pavement before resurfacing it with a 5-in. thick AC overlay. In Area III, it is recommended that the existing PCC pavement be rubblized before being overlaid with 6-in. of AC resurfacing. For these selected alternatives to achieve their desired service lives, it is further recommended that anticipated maintenance needs described in the life-cycle-cost analysis for each alternative be scheduled as shown, unless otherwise adjusted as a result of future observations and/or performance.



AREA I

TWO-COURSE OVERLAY, 3" AC

<u>Description</u>	<u>Year (n)</u>	<u>Present Cost</u>	<u>Present Worth Factor (P/F, 4%, n)</u>	<u>Present Worth</u>
3" AC Overlay	0	\$727,458	1.0000	\$727,458
Fill Longitudinal Cracks/Joints	2	1,560	.9246	1,442
Fill Longitudinal Cracks/Joints	4	1,560	.8548	1,333
Fill Longitudinal Cracks/Joints	6	1,560	.7903	1,233
Fill Longitudinal Cracks/Joints	8	2,424	.7307	1,771
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	10	2,424	.6756	1,638
Fill Sawed & Sealed Joints				
3" AC Overlay	12	529,234	.6246	330,560
Fill Longitudinal Cracks/Joints	14	1,560	.5775	901
Fill Longitudinal Cracks/Joints	16	1,560	.5339	833
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Fill Longitudinal Cracks/Joints	20	2,424	.4564	1,106
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	22	2,424	.4220	1,023
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	24	2,424	.3901	946
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	26	2,424	.3607	874
Fill Sawed & Sealed Joints				
1-1/2 Inch AC Overlay	27	324,688	.3468	112,602
Fill Longitudinal Cracks/Joints	29	<u>2,070</u>	.3207	<u>664</u>
Sub-Total		1,607,354		1,185,154
1-1/2" AC Overlay, Sawed & Sealed Jts.		-202,930	.3083	-62,563
5 Yrs. Salvage Value				
Fill Longitudinal Cracks/Joints,		<u>-1,035</u>	.3083	<u>-319</u>
1 Yr. Salvage Value				
Total		\$1,403,389		\$1,122,272



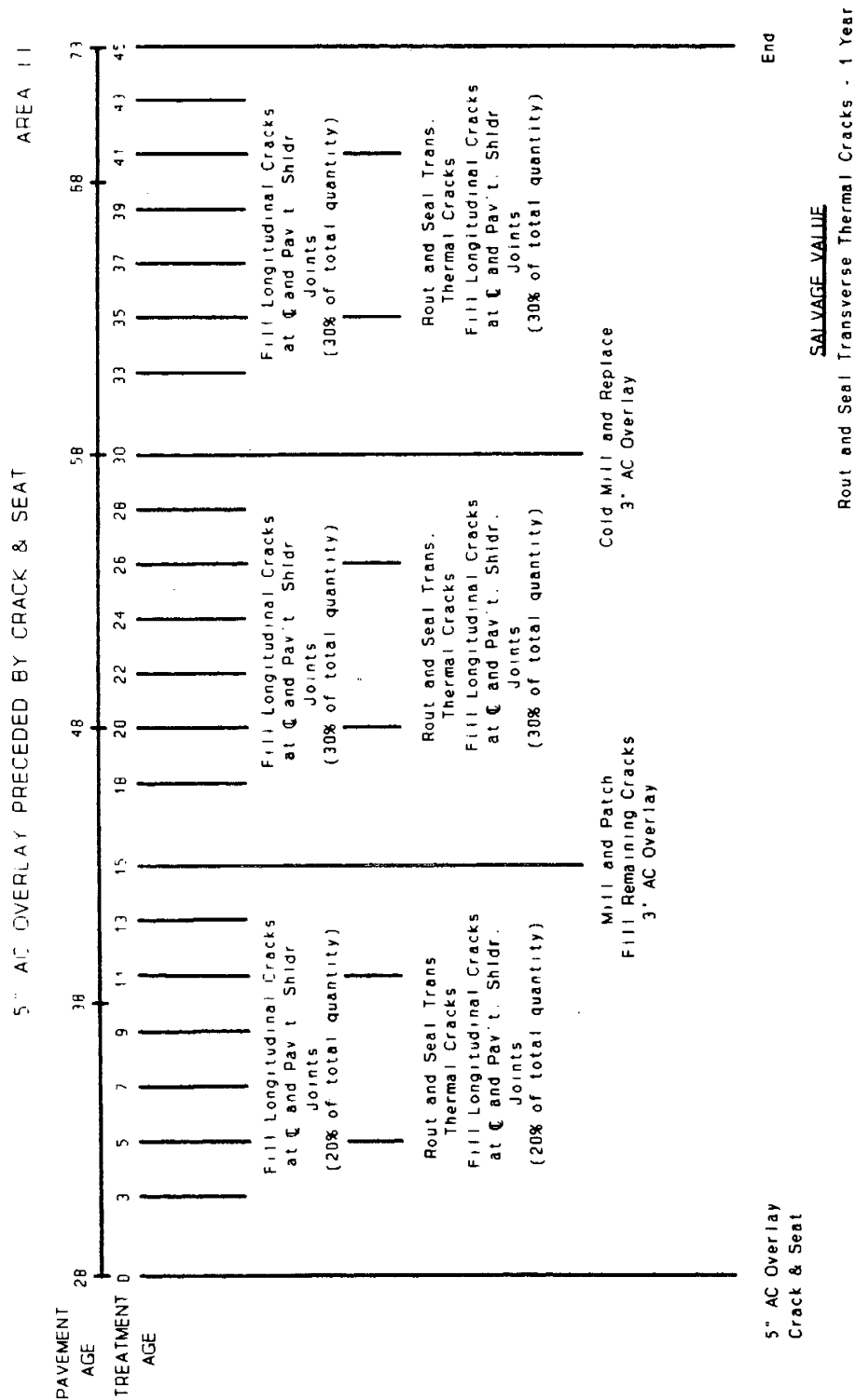
SALVAGE VALUE

Fill Cracks and Joints - 1 Year

AREA I

MULTIPLE COURSE OVERLAY, 4" AC

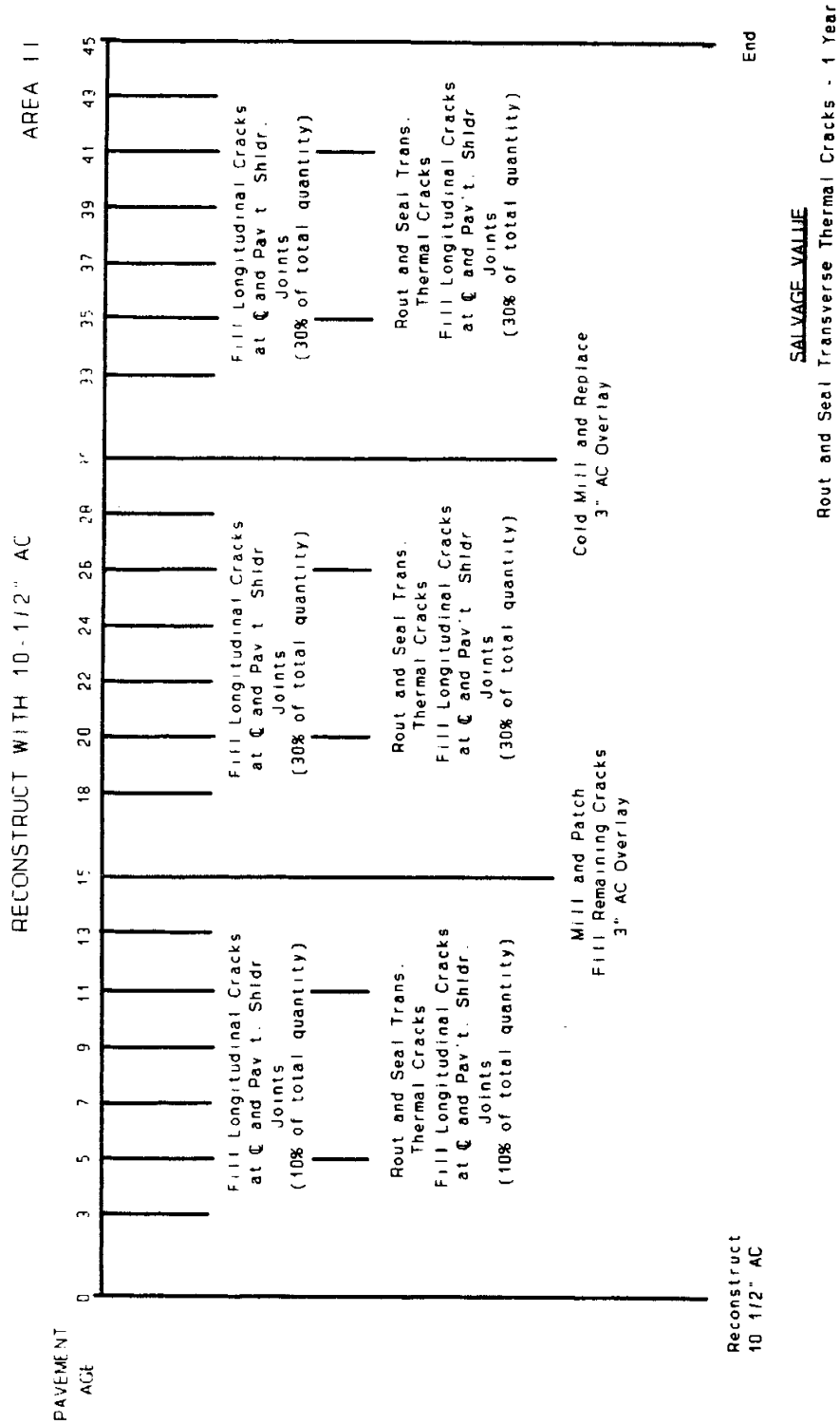
<u>Description</u>	<u>Year (n)</u>	<u>Present Cost</u>	<u>Present Worth Factor (P/F, 4%, n)</u>	<u>Present Worth</u>
4" AC Overlay	0	\$833,042	1.0000	\$833,042
Fill Longitudinal Cracks/Joints	2	1,048	.9246	969
Fill Longitudinal Cracks/Joints	4	1,048	.8548	896
Fill Longitudinal Cracks/Joints	6	1,048	.7903	828
Fill Longitudinal Cracks/Joints	8	1,914	.7307	1,399
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	10	1,914	.6756	1,293
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	12	1,914	.6246	1,195
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	14	1,914	.5775	1,105
Fill Sawed & Sealed Joints				
3" AC Overlay	15	529,234	.5553	293,884
Fill Longitudinal Cracks/Joints	17	1,560	.5134	801
Fill Longitudinal Cracks/Joints	19	1,560	.4746	740
Fill Longitudinal Cracks/Joints	21	1,560	.4388	685
Fill Longitudinal Cracks/Joints	23	2,424	.4057	983
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	25	2,424	.3751	909
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	27	2,424	.3468	841
Fill Sawed & Sealed Joints				
Fill Longitudinal Cracks/Joints	29	2,424	.3207	777
Fill Sawed & Sealed Joints				
Sub-Total		1,387,452		1,140,347
Fill Longitudinal Cracks/Joints,		-1,212	.3083	-374
Fill Sawed & Sealed Joints				
1 Yr. Salvage Value				
Total		\$1,386,240		\$1,139,973



AREA II

5" AC OVERLAY PRECEDED BY CRACK & SEAT

<u>Description</u>	<u>Year</u> <u>(n)</u>	<u>Present</u> <u>Cost</u>	<u>Present</u> <u>Worth Factor</u> <u>(P/F, 4%, n)</u>	<u>Present</u> <u>Worth</u>
5" AC Overlay	0	\$1,279,395	1.0000	\$1,279,395
Fill Longitudinal Cracks/Joints	3	1,572	.8890	1,398
Fill Longitudinal Cracks/Joints	5	18,012	.8219	14,804
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	7	1,572	.7599	1,195
Fill Longitudinal Cracks/Joints	9	1,572	.7026	1,104
Fill Longitudinal Cracks/Joints	11	18,012	.6496	11,701
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	13	1,572	.6006	944
3" AC Overlay	15	594,018	.5553	329,858
Fill Longitudinal Cracks/Joints	18	2,340	.4936	1,155
Fill Longitudinal Cracks/Joints	20	18,780	.4564	8,571
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	22	2,340	.4220	987
Fill Longitudinal Cracks/Joints	24	2,340	.3901	913
Fill Longitudinal Cracks/Joints	26	18,780	.3607	6,774
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	28	2,340	.3335	780
3" AC Overlay	30	748,122	.3083	230,646
Fill Longitudinal Cracks/Joints	33	2,340	.2741	641
Fill Longitudinal Cracks/Joints	35	18,780	.2534	4,759
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	37	2,340	.2343	548
Fill Longitudinal Cracks/Joints	39	2,340	.2166	507
Fill Longitudinal Cracks/Joints	41	18,780	.2003	3,762
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	43	<u>2,340</u>	.1852	<u>433</u>
Sub-Total		2,757,687		1,900,875
Rout & Seal Trans. Thermal Cracks		<u>-3,288</u>	.1712	<u>-563</u>
1 Yr. Salvage Value				
Total		\$2,754,399		\$1,900,312



AREA II

RECONSTRUCT WITH 10-1/2" AC

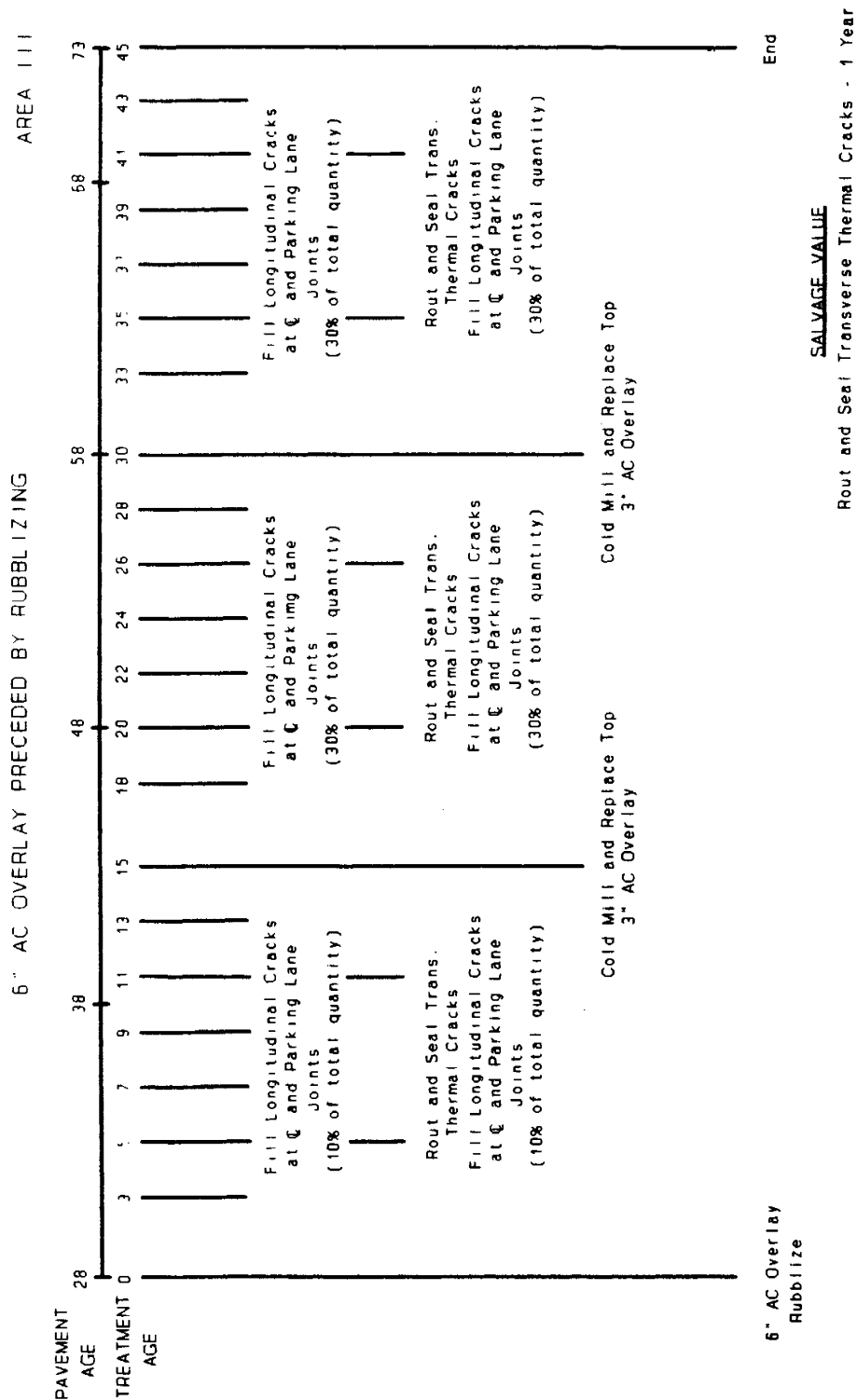
<u>Description</u>	<u>Year</u> <u>(n)</u>	<u>Present</u> <u>Cost</u>	<u>Present</u> <u>Worth Factor</u> <u>(P/F, 4%, n)</u>	<u>Present</u> <u>Worth</u>
Reconstruct 10-1/2" AC	0	\$2,214,270	1.0000	\$2,214,270
Fill Longitudinal Cracks/Joints	3	786	.8890	699
Fill Longitudinal Cracks/Joints	5	17,226	.8219	14,158
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	7	786	.7599	597
Fill Longitudinal Cracks/Joints	9	786	.7026	552
Fill Longitudinal Cracks/Joints	11	17,226	.6496	11,190
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	13	786	.6006	472
3" AC Overlay	15	594,021	.5553	329,860
Fill Longitudinal Cracks/Joints	18	2,340	.4936	1,155
Fill Longitudinal Cracks/Joints	20	18,780	.4564	8,571
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	22	2,340	.4220	987
Fill Longitudinal Cracks/Joints	24	2,340	.3901	913
Fill Longitudinal Cracks/Joints	26	18,780	.3607	6,774
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	28	2,340	.3335	780
3" AC Overlay	30	748,122	.3083	230,646
Fill Longitudinal Cracks/Joints	33	2,340	.2741	641
Fill Longitudinal Cracks/Joints	35	18,780	.2534	4,759
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	37	2,340	.2343	548
Fill Longitudinal Cracks/Joints	39	2,340	.2166	507
Fill Longitudinal Cracks/Joints	41	18,780	.2003	3,762
Rout & Seal Trans. Thermal Cracks				
Fill Longitudinal Cracks/Joints	43	2,340	.1852	433
Sub-Total		3,687,849		2,832,274
Rout & Seal Trans. Thermal Cracks				
1 Yr. Salvage Value		-3,288	.1712	-563
Total		\$3,684,561		\$2,831,711



AREA II

RECONSTRUCT WITH 9" PCC

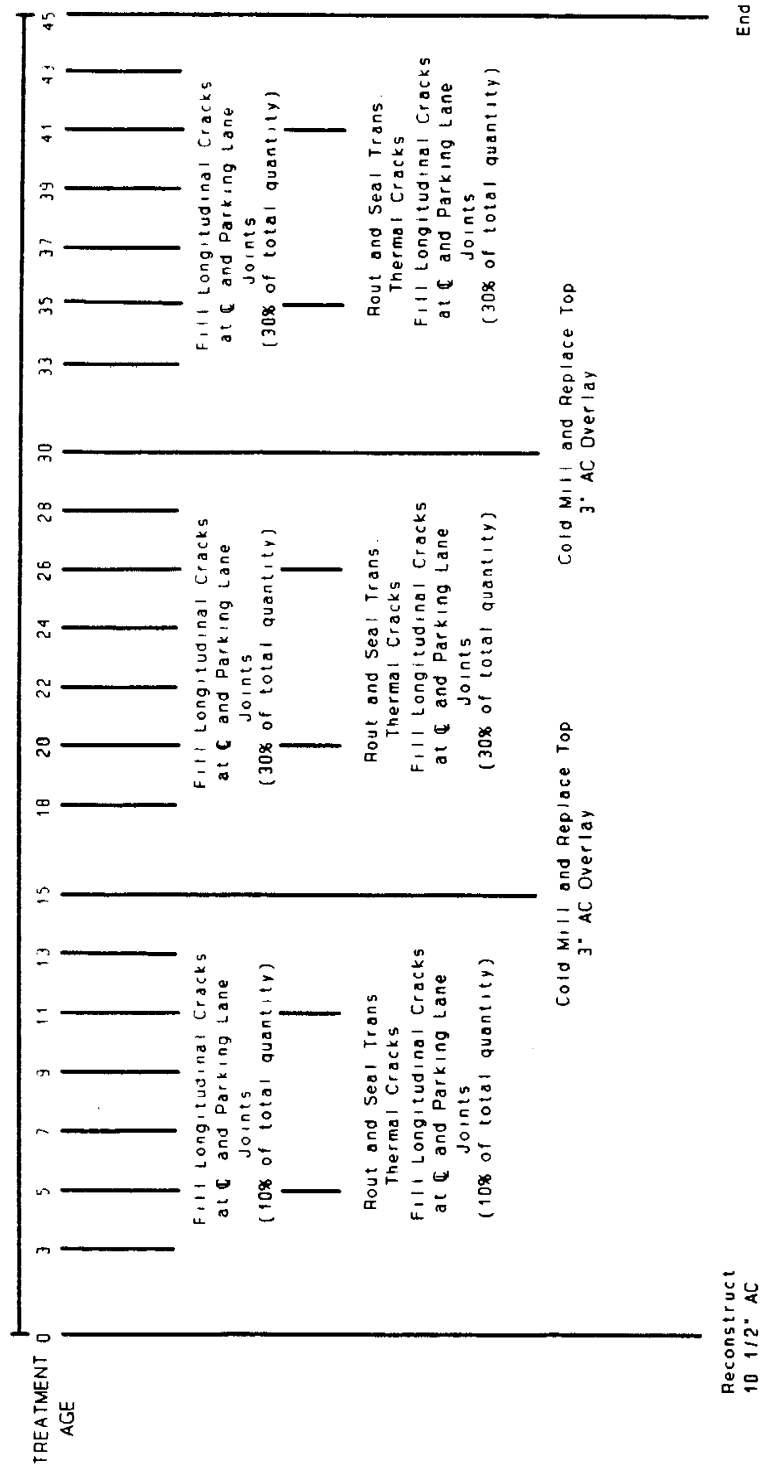
<u>Description</u>	<u>Year (n)</u>	<u>Present Cost</u>	<u>Present Worth Factor (P/F, 4%, n)</u>	<u>Present Worth</u>
Reconstruct 9" PCC	0	\$2,841,444	1.0000	\$2,841,444
Fill Pavement Shoulder Joints	2	6,228	.9246	5,758
Fill Pavement Shoulder Joints	4	6,228	.8548	5,324
Fill Pavement Shoulder Joints	6	6,228	.7903	4,922
Seal Longitudinal and Transverse Joints and Cracks	8	143,220	.7307	104,651
Fill Pavement Shoulder Joints				
Fill Pavement Shoulder Joints	10	6,228	.6756	4,208
Fill Pavement Shoulder Joints	12	6,228	.6246	3,890
Fill Pavement Shoulder Joints	14	6,228	.5775	3,597
Repair Pavement/Shoulders	15	427,680	.5553	237,491
Seal Longitudinal and Transverse Joints and Cracks				
Fill Pavement Shoulder Joints	17	6,228	.5134	3,197
Fill Pavement Shoulder Joints	19	6,228	.4746	2,956
Fill Pavement Shoulder Joints	21	6,228	.4388	2,733
Seal Longitudinal and Transverse Joints and Cracks	23	143,220	.4057	58,104
Fill Pavement Shoulder Joints				
Fill Pavement Shoulder Joints	25	6,228	.3751	2,336
Fill Pavement Shoulder Joints	27	6,228	.3468	2,160
Fill Pavement Shoulder Joints	29	6,228	.3207	1,997
3" AC Overlay	30	870,507	.3083	268,377
Fill Longitudinal Cracks/Joints	32	2,340	.2851	667
Fill Longitudinal Cracks/Joints	34	2,340	.2636	617
Fill Longitudinal Cracks/Joints	36	2,340	.2437	570
Fill Sawed and Sealed Joints	38	6,231	.2253	1,404
Fill Longitudinal Cracks/Joints				
Fill Sawed and Sealed Joints	40	6,231	.2083	1,298
Fill Longitudinal Cracks/Joints				
Fill Sawed and Sealed Joints	42	6,231	.1926	1,200
Fill Longitudinal Cracks/Joints				
Fill Sawed and Sealed Joints	44	6,231	.1780	1,109
Fill Longitudinal Cracks/Joints				
Sub-Total		<u>4,532,751</u>		<u>3,560,010</u>
Fill Sawed & Sealed Joints				
Longitudinal Cracks/Joints - 1 Yr.		<u>-3,116</u>	.1712	<u>-533</u>
Salvage Value				
Total		\$4,529,635		\$3,559,477



AREA III

6" AC OVERLAY PRECEDED BY RUBBLIZING

<u>Description</u>	<u>Year</u> <u>(n)</u>	<u>Present</u> <u>Cost</u>	<u>Present</u> <u>Worth Factor</u> <u>(P/F, 4%, n)</u>	<u>Present</u> <u>Worth</u>
6" AC Overlay	0	\$1,276,460	1.0000	\$1,276,460
Fill Longitudinal Cracks/Joints	3	524	.8890	466
Rout & Seal Trans. Thermal Cracks	5	12,700	.8219	10,438
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	7	524	.7599	398
Fill Longitudinal Cracks/Joints	9	524	.7026	368
Rout & Seal Trans. Thermal Cracks	11	12,700	.6496	8,250
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	13	524	.6006	315
3" AC Overlay	15	557,618	.5553	309,645
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Rout & Seal Trans. Thermal Cracks	20	13,736	.4564	6,269
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	22	1,560	.4220	658
Fill Longitudinal Cracks/Joints	24	1,560	.3901	609
Rout & Seal Trans. Thermal Cracks	26	13,736	.3607	4,955
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	28	1,560	.3335	520
3" AC Overlay	30	557,618	.3083	171,914
Fill Longitudinal Cracks/Joints	33	1,560	.2741	428
Rout & Seal Trans. Thermal Cracks	35	13,736	.2534	3,481
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	37	1,560	.2343	366
Fill Longitudinal Cracks/Joints	39	1,560	.2166	338
Rout & Seal Trans. Thermal Cracks	41	13,736	.2003	2,751
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	43	<u>1,560</u>	.1852	<u>289</u>
Sub-Total		2,486,616		1,799,688
Rout & Seal Trans. Thermal Cracks				
1 Yr. Salvage Value		<u>-2,435</u>	.1712	<u>-417</u>
Total		\$2,484,181		\$1,799,271

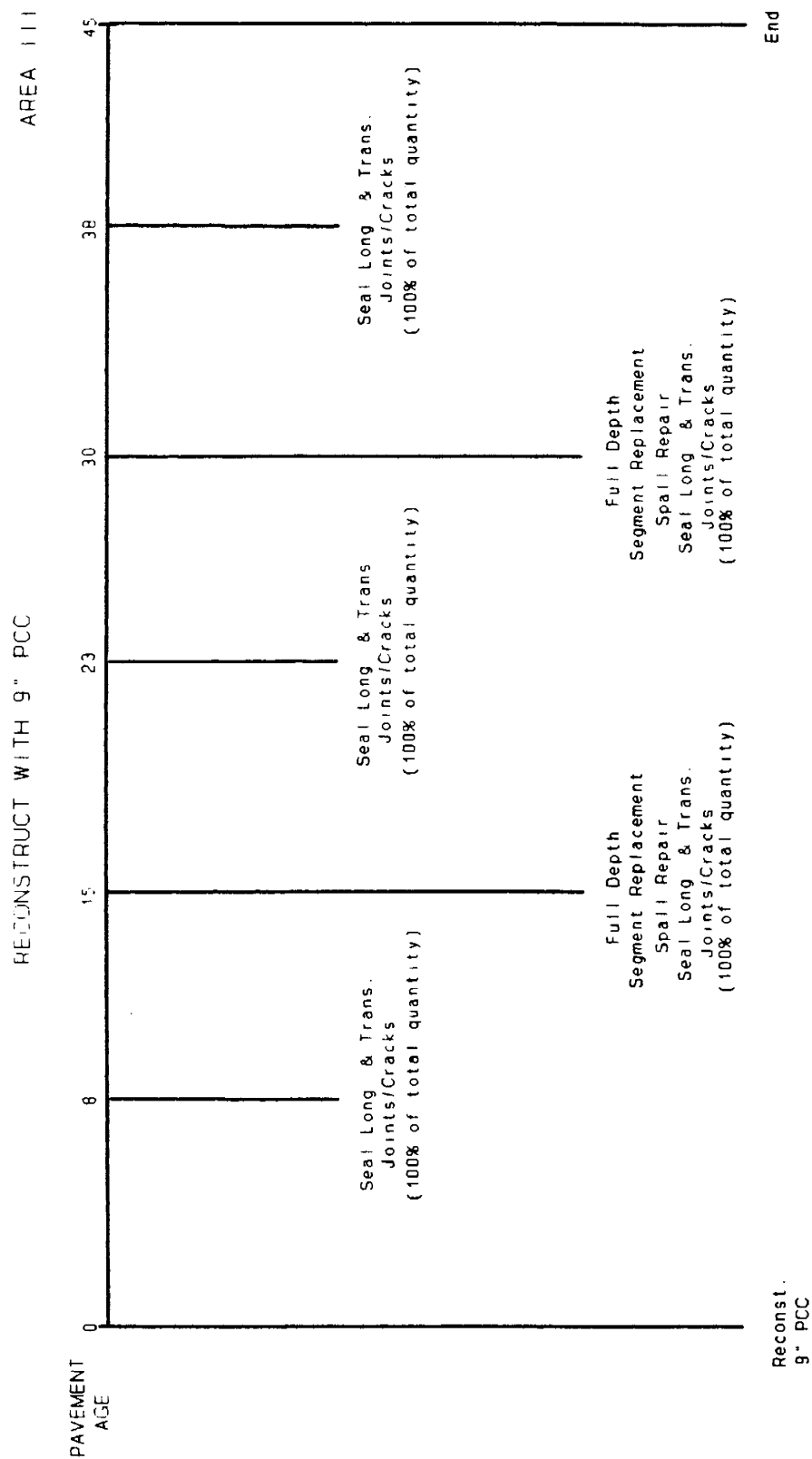


SALVAGE VALUE	
Route and Seal	Transverse Thermal Cracks - 1 Year
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
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97	97
98	98
99	99
100	100

AREA III

RECONSTRUCT WITH 10-1/2" AC

<u>Description</u>	<u>Year (n)</u>	<u>Present Cost</u>	<u>Present Worth Factor (P/F, 4%, n)</u>	<u>Present Worth</u>
Reconstruct 10-1/2" AC	0	\$1,894,940	1.0000	\$1,894,940
Fill Longitudinal Cracks/Joints	3	524	.8890	466
Rout & Seal Trans. Thermal Cracks	5	12,700	.8219	10,438
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	7	524	.7599	398
Fill Longitudinal Cracks/Joints	9	524	.7026	368
Rout & Seal Trans. Thermal Cracks	11	12,700	.6496	8,250
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	13	524	.6006	315
3" AC Overlay	15	557,618	.5553	309,645
Fill Longitudinal Cracks/Joints	18	1,560	.4936	770
Rout & Seal Trans. Thermal Cracks	20	13,736	.4564	6,2696
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	22	1,560	.4220	658
Fill Longitudinal Cracks/Joints	24	1,560	.3901	609
Rout & Seal Trans. Thermal Cracks	26	13,736	.3607	4,955
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	28	1,560	.3335	520
3" AC Overlay	30	557,618	.3083	171,914
Fill Longitudinal Cracks/Joints	33	1,560	.2741	428
Rout & Seal Trans. Thermal Cracks	35	13,736	.2534	3,481
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	37	1,560	.2343	366
Fill Longitudinal Cracks/Joints	39	1,560	.2166	338
Rout & Seal Trans. Thermal Cracks	41	13,736	.2003	2,751
Fill Longitudinal Cracks/Joints				
Fill Longitudinal Cracks/Joints	43	<u>1,560</u>	.1852	<u>289</u>
Sub-Total		3,105,096		2,418,168
Rout & Seal Trans. Thermal Cracks				
1 Yr. Salvage Value		<u>-2,435</u>	.1712	<u>-417</u>
Total		\$3,102,661		\$2,417,751



AREA III

RECONSTRUCT WITH 9" PCC

<u>Description</u>	<u>Year</u> <u>(n)</u>	<u>Present</u> <u>Cost</u>	<u>Present</u> <u>Worth Factor</u> <u>(P/F. 4%, n)</u>	<u>Present</u> <u>Worth</u>
Reconstruct 9" PCC	0	\$2,779,170	1.0000	\$2,779,170
Seal Long. & Trans. Joints/Cracks	8	209,108	.7307	152,795
Pavement Repair & Jt. Sealing	15	335,840	.5553	186,492
Seal Long. & Trans. Joints/Cracks	23	209,108	.4057	84,835
Pavt. Repair & Jt. Sealing	30	501,224	.3083	154,527
Seal Long. & Trans. Joints/Cracks	38	<u>209,108</u>	.2253	<u>47,112</u>
	Total	\$4,243,558		\$3,404,931

APPENDIX A

Project Information Form

PAVEMENT EVALUATION REPORT

PROJECT INFORMATION

General

Region: 12 County: Bush Route No.: 66 PIN 9040.90Project Identification: Somewhere to NowhereBegin RM 66-8101-3980 End RM 66-8101-4050 Total Length: 7 milesOriginal Contract Date(s): 1962 (Contract No. FAC 62-10)Latest Pavement Rehabilitation Date(s): Southernmost two miles overlaid
by state maintenance forces in 1985

Roadway Features

Roadway: Divided _____ Non-Divided X
Median: Flush _____ Raised _____ Concrete Median Barrier _____
Curbs: Mountable _____ Non-Mountable _____
AC _____ PCC _____ Stone _____

Pavement:

Lanes: No. 2 Width(s) 12'
Type: Reinforced PCC X(5mi) Non-Reinforced PCC _____
AC _____ AC over PCC X(2mi)
Thickness (normal): Total _____ (AC 1" PCC 9")
Reinforced and Non-Reinforced PCC Pavements only:
Slab Length 60'
Load Transfer Type: Dowels _____ 2 Component X
Transverse Joints: Contraction X Expansion _____

Subbase:

Type: Gravel Thickness (nominal): 12"

Shoulders:

Type: AC _____ PCC _____ Gravel X Thickness 3"
AC or Surface Treatment/Stabilized Gravel X Thickness 1"
Width: Both 6' Driving Lane _____ Passing Lane _____

Drainage:

Type: Open System X(5mi) Closed System X(2mi)

Related Pavement Data

Traffic AADT (Range) 12,000-14,000 Date 1988 % Trucks 5
Sufficiency Rating Surface Score 5-7 Date 1989Prepared By Dusty Rhodes Date 9/90

APPENDIX B
Distress Data Forms
Areas I - III

DISTRESS DATA FORM

Region 13 County Bush Route No. 66 Pin 9040.90 PAVEMENT FLEXIBLE ☐
 Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction North FLEXIBLE/RIGID ☒
 Date Insp. 9/25/90 Inspectors B. Careful, B. Aware Sheet 1 of 4

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
		Beginning Ending	(1)	(2)	(3)	(4)	SUM	%	
			3980 3985	3985 3990	3990 3995	3995 4000			
CORRUGATIONS (%)	N None		10	10	10	10	40	100	
	P Present						0	0	
SETTLEMENTS & HEAVES (#)	N None		✓	✓	✓	✓	0		
	P Present						0		
ASPHALT CONC. OVERLAY OR SPRAY PATCH (#)	N None		✓	✓	✓	✓	0		
	G Good						0		
	F Fair						0		
	P Poor						0		
WHEELPATH CRACKING (%)	N None		10	10	10	10	40	100	
	L Single Crack						0	0	
	M Multiple Cracks						0	0	
	H Mult. Cracks w/Potholes						0	0	
FULL WIDTH TRANSVERSE CRACKING (#)	N None						0		Cracking appears over underlying PCC joints
	L Single Crack						0		
	M Multiple Cracks	III II	III	III I	III III	26			
	H Mult. Cracks w/Potholes	II	III	III	I	10			
LONGITUDINAL CRACKING (%)	N None						0	0	Cracking appears over underlying PCC joints
	L Single Crack						0	0	
	M Multiple Cracks	8	8	7	7	30	75		
	H Mult. Cracks w/Potholes	2	2	3	3	10	25		
EDGE CRACKING (%)	N None		10	10	10	10	40	100	
	L Single Crack						0	0	
	M Multiple Cracks						0	0	
	H Mult. Cracks w/Potholes						0	0	
CRACKING OTHER (%)	N None		10	10	10	10	40	100	
	L Single Crack						0	0	
	M Multiple Cracks						0	0	
	H Mult. Cracks w/Potholes						0	0	
SLIPPAGE CRACKS ☒	N None		✓	✓	✓	✓	4	100	
	P Present						0	0	
RAVELLING (%)	N None		10	10	10	10	40	100	
	P Present						0	0	
WHEELPATH RUTTING (MEASURE) ☒	N None						0	0	
	L < 3/8"		✓	✓	✓	✓	4	100	
	M 3/8"-3/4"						0	0	
	H > 3/4"						0	0	
WIDENING DROPOFF (MEASURE) ☒	N None		✓	✓	✓	✓	4	100	
	L < 3/8"						0	0	
	M 3/8"-3/4"						0	0	
	H > 3/4"						0	0	

 SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N None					0	0	
	L Single Crack					0	0	
	M Multiple Cracks	✓			✓	2	50	
	H Mult. Cracks w/Potholes		✓	✓		2	50	
LANE/SOULDER SEPARATION (MEASURE) ☒	N None					0	0	
	L < 1/4"/Sealed					0	0	
	M 1/4"-1"	✓	✓	✓	✓	4	100	
	H > 1"					0	0	
LANE/SOULDER DROPOFF (MEASURE) ☒	N None					0	0	
	L < 1"	✓			✓	2	50	
	M 1"-2"		✓	✓		2	50	
	H > 2"					0	0	
SHOULDER DEFORMATION ☒	N None	✓	✓	✓	✓	4	100	
	P Present					0	0	

DISTRESS DATA FORM

Region 12 County Bush Route No. 66 Pin 9040.90
 Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction North
 Date Insp. 9/25/90 Inspectors B. Careful, B. Alert Sheet 1 of 1

PAVEMENT
RIGID ☒

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS
		Beginning Ending	(1) 4000 4005	(2) 4005 4010	(3) 4010 4015	(4) 4015 4020	(5) 4020 4025	TOTAL SUM %	
SETTLEMENTS & HEAVES (#)	N None		✓	✓					(3)(5) over culverts
	P Present				II	I	II	5	(4) struct. approach
BLOWUPS (#)	Partial Width			I				1	
	Full Width		II			I	I	4	
ASPHALT CONC. OVERLAY PATCHING (#)	N None		✓	✓					(3)(5) all four
	G Good							0	approx. 120 ft.
	F Fair				II		II	4	long over cross-
	P Poor							0	culverts - 2 lanes
JOINT SEALER FAILURE ☒	N None							0 0	original preformed
	F Failed		✓	✓	✓	✓	✓	5 100	neoprene sealer
TRANSVERSE JOINT FAULTING (MEASURE) ☒	N None							0 0	
	L < 3/8"		✓					1 20	
	M 3/8"-3/4"			✓	✓	✓	✓	4 80	
	H > 3/4"							0 0	
TRANSVERSE JOINT SEPARATION (#)			III I			II		8 18	near blowups
TRANSVERSE JOINT DISTRESS (# JOINTS)	N No Spalls		II		I		II	5 11	(1)-(5) "D" Crack
	L Minor 3" max. Width			III	I	II	II	8 18	related
	M Occs. > 3" Width		III	III	III	III	I	18 40	
	H Many > 3" Width		III	III	II	II	III	14 31	
LONGITUDINAL JOINT SEPARATION (#)					III I			6 15	near blowups
LONGITUDINAL JOINT DISTRESS (# SLABS)	N No Spalls				II		II	4 10	(1)-(5) "D" Crack
	L Minor 2" max. Width		III	II	II	II	II	11 28	related
	M Occs. > 2" Width		III	III	III	III	I	19 47	
	H Many > 2" Width		I	I		I	III	6 15	
SLAB CRACKING (# SLABS)	N None		I	III	III	I	II	11 28	
	L Non-working		II	I		II		5 12	
	M Working		II	II	II	III	III	14 35	
	H Working, Spalled, Faulted		III	II	II		III	10 25	
WHEELPATH RUTTING (MEASURE) ☒	N None		✓			✓		2 40	
	L < 3/8"			✓	✓		✓	3 60	
	M 3/8"-3/4"							0 0	
	H > 3/4"							0 0	
SCALING/ NON-JOINT SPALLING (# SLABS)	N None		III II	III	III III	III I	III III	34 85	
	L Low		I	III		I		5 13	
	M Medium					I		1 2	
	H High							0 0	

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N None						0 0
	L Single Crack						0 0
	M Multiple Cracks	✓	✓	✓		✓	4 80
	H Mult. Cracks w/Potholes				✓		1 20
LANE/SHOULDER SEPARATION (MEASURE) ☒	N None						0 0
	L < 1/4"/Sealed						0 0
	M 1/4"-1"	✓	✓	✓	✓		4 80
	H > 1"					✓	1 20
LANE/SHOULDER DROPOFF (MEASURE) ☒	N None						0 0
	L < 1"	✓	✓	✓	✓	✓	5 100
	M 1"-2"						0 0
	H > 2"						0 0
SHOULDER DEFORMATION ☒	N None	✓	✓		✓		3 60
	P Present			✓		✓	2 40

DISTRESS DATA FORM

Region 12 County Bush Route No. 66 Pin 9040.90PAVEMENT
RIGID ☒Number of Lanes 2 Survey Pertinent to 2 Lane(s) All Direction NorthDate Insp. 9/25/90 Inspectors B. Careful, B. Alert Sheet 1 of 1

DISTRESS	SEVERITY	SECTION					EXTENT		REMARKS	
			(1)	(2)	(3)	(4)	(5)	TOTAL		
		Beginning Ending	4030 4035	4035 4040	4040 4045	4045 4050		SUM		%
SETTLEMENTS & HEAVES (#)	N None				✓				Settlements at X-drains, util. cuts	
	P Present		III			III		16		
BLOWUPS (#)	Partial Width		II		II			4		
	Full Width			II		II		4		
ASPHALT CONC. OVERLAY PATCHING (#)	N None							0		
	G Good							0		
	F Fair		II	II	I	III		9		
	P Poor		III	III	I	III		15		
JOINT SEALER FAILURE ☒	N None							0	original preformed neoprene sealer	
	F Failed		✓	✓	✓	✓		4		
TRANSVERSE JOINT FAULTING (MEASURE) ☒	N None							0		
	L <3/8"							0		
	M 3/8"-3/4"		✓	✓	✓	✓		4		
	H >3/4"							0		
TRANSVERSE JOINT SEPARATION (#)			III	III	III	III		20	56	near blowups
TRANSVERSE JOINT DISTRESS (# JOINTS)	N No Spalls					I		1	3	(1)-(4) "D" Crack related
	L Minor 3" max. Width		III		II	I		6	17	
	M Occs. >3" Width		III	III	III	II		14	39	
	H Many >3" Width		II	III	III	III		15	41	
LONGITUDINAL JOINT SEPARATION (#)			III		III			8	20	
LONGITUDINAL JOINT DISTRESS (# SLABS)	N No Spalls							0	0	(1)-(4) "D" Crack related
	L Minor 2" max. Width		III	II	III	II		11	34	
	M Occs. >2" Width		III	III	III	III		18	56	
	H Many >2" Width					III		3	10	
SLAB CRACKING (# SLABS)	N None		I					1	4	Cracks contain remnants of asphalt filler incompressibles
	L Non-working		II	II	I	II		7	22	
	M Working		III	III	III	I		12	37	
	H Working, Spalled, Faulted		I	III	III	III		12	37	
WHEELPATH RUTTING (MEASURE) ☒	N None							0	0	
	L < 3/8"		✓	✓	✓	✓		4	100	
	M 3/8"-3/4"							0	0	
	H >3/4"							0	0	
SCALING/ NON-JOINT SPALLING (# SLABS)	N None		III	III	III	III		15	47	Spalling caused from high mesh popouts
	L Low		III	III	III	II		14	44	
	M Medium				I	II		3	9	
	H High							0	0	

SHOULDER SURVEY PERTINENT TO: BOTH ☒ RIGHT ☐ LEFT ☐

SHOULDER DETERIORATION ☒	N None						0	0		
	L Single Crack						0	0		
	M Multiple Cracks		✓	✓		✓		3		75
	H Mult. Cracks w/Potholes				✓			1		25
LANE/SHOULDER SEPARATION (MEASURE) ☒	N None						0	0		
	L <1/4"/Sealed						0	0		
	M 1/4"-1"		✓	✓	✓	✓		4		100
	H >1"							0		0
LANE/SHOULDER DROPOFF (MEASURE) ☒	N None						0	0		
	L < 1"		✓	✓	✓	✓		4		100
	M 1"-2"							0		0
	H >2"							0		0
SHOULDER DEFORMATION ☒	N None		✓	✓	✓	✓		4	100	
	P Present							0	0	

APPENDIX C

Alternative Cost Estimates: Area I

AREA I

TWO-COURSE OVERLAY, 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
203.02	Shoulder Excavation	C.Y.	\$ 6.00	1,760	\$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	293	4,102
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal (deep saw cuts may not be required)	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks. (this item may not be required)	L.S. (L.F.)	0.50 (L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					271,116
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>92,613</u>
Total Cost/Mile					363,729
Total Cost Area I					\$727,458

AREA I

FUTURE TREATMENT COSTS
AFTER 2, 4, 6, 14, 16 & 18 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
Total Item Cost					595
Overhead Factors: Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area I					\$1,560

AREA I

FUTURE TREATMENT COSTS
AFTER 8, 10, 20, 22, 24 & 26 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	185	\$925
	Fill Sawed & Sealed Transverse Joints				
Total Item Cost					925
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					287
Total Cost/Mile					1,212
Total Cost Area I					\$2,424

AREA I

FUTURE TREATMENT COSTS AFTER 12 YEARS
TWO-COURSE OVERLAY, 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
15304.0117	Shoulder Backup	C.Y.	14.00	293	\$ 4,102
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.7502	Fill Longitudinal Cracks & Joints.	Gal.	5.00	396	1,980
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal Trans. Jts. (deep saw cuts may not be required)	L.F.	5.00	2,640	13,200
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
Total Item Cost					197,240
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					67,377
Total Cost/Mile					264,617
Total Cost Area I					\$529,234

AREA I

FUTURE TREATMENT COSTS AFTER 27 YEARS
SINGLE-COURSE OVERLAY, 1-1/2" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	\$58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
490.10	Cold Milling (1-1/2") (pav't & shldrs.)	S.Y.	2.00	21,120	42,240
18502.2599	Saw & Seal Trans. Jts.	L.F.	5.00	2,640	13,200
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					121,008
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>41,336</u>
Total Cost/Mile					162,344
Total Cost Area I					\$324,688

AREA I

FUTURE TREATMENT COSTS
AFTER 29 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	158	\$790
Total Item Cost					790
Overhead Factors:					<u>245</u>
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					
Total Cost/Mile					1,035
Total Cost Area I					\$2,070

AREA I

MULTIPLE-COURSE OVERLAY, 4" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
203.02	Shoulder Excavation	C.Y.	\$ 6.00	1,760	\$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	391	5,474
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
403.21	Truing & Leveling (1") (pav't & shldrs.)	Ton	34.00	1,117	37,978
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal	L.F.	5.00	2,640	13,200
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks. (this item may not be required)	L.S.(L.F.)	0.50(L.F.)	7,392	3,696
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					310,466
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>106,055</u>
Total Cost/Mile					416,521
Total Cost Area I					\$833,042

AREA I

FUTURE TREATMENT COSTS
AFTER 2, 4 & 6 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	80	\$400
Total Item Cost					<u>400</u>
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>124</u>
Total Cost/Mile					524
Total Cost Area I					\$1,048

AREA I

FUTURE TREATMENT COSTS
AFTER 8, 10, 12 & 14 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	146	\$730
	Fill Sawed & Sealed Transverse Joints				
Total Item Cost					730
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					227
Total Cost/Mile					957
Total Cost Area I					\$1,914

AREA I

FUTURE TREATMENT COSTS AFTER 15 YEARS
MULTIPLE-COURSE OVERLAY, 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
15304.0117	Shoulder Backup	C.Y.	14.00	293	\$ 4,102
403.13	Dense Binder (1-1/2") (pav't. & shldrs.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2") (pav't. & shldrs.)	Ton	35.00	1,675	58,625
18403.7502	Fill Longitudinal Cracks & Joints.	Gal.	5.00	396	1,980
18403.88	AC & PCC Jt. Repair	S.Y.	45.00	1,232	55,440
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal Trans. Jts. (deep saw cuts may not be required)	L.F.	5.00	2,640	13,200
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	3,564
Total Item Cost					197,240
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					67,377
Total Cost/Mile					264,617
Total Cost Area I					\$529,234

AREA I

FUTURE TREATMENT COSTS
AFTER 17, 19 & 21 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
Total Item Cost					595
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area I					\$1,560

AREA I

FUTURE TREATMENT COSTS
AFTER 23, 25, 27 & 29 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	185	\$925
	Fill Sawed & Sealed Transverse Joints				
Total Item Cost					925
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>287</u>
Total Cost/Mile					1,212
Total Cost Area I					\$2,424

APPENDIX D

Alternative Cost Estimates: Area II

AREA II

5" AC OVERLAY PRECEDED BY CRACK & SEAT

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
202.20	Remove AC Overlay (Settlement Areas)	S.Y.	\$ 4.00	1,280	\$ 5,120
203.02	Shoulder Excavation (Includes Blowup Removal)	C.Y.	6.00	1,770	10,620
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
18203.9904	Crack & Seat PCC	Ln.Mi.	6000.00	2	12,000
15304.0117	Shoulder Backup	C.Y.	14.00	469	6,566
403.13	Dense Binder (3-1/2") (Includes Blowup Repair)	Ton	34.00	3,906	132,804
403.15	Shim Faults	Ton	100.00	6	600
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.4466	Spall Repair	S.F.	7.00	2,800	19,600
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18633.07	Clean & Fill Jts./Crks.	L.S.(L.F.)	0.50(L.F.)	6,800	3,400
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					317,878

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12% 108,587

Total Cost/Mile 426,465

Total Cost Area II \$1,279,395

AREA II

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	80	\$400
Total Item Cost					400

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12% 124

Total Cost/Mile 524

Total Cost Area II \$1,572

AREA II

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	80	\$400
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
Total Item Cost					4,582
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,422</u>
Total Cost/Mile					6,004
Total Cost Area II					\$18,012

AREA II

FUTURE TREATMENT COSTS AFTER 15 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
15304.0117	Shoulder Backup	C.Y.	14.00	293	\$ 4,102
403.13	Dense Binder (1-1/2")	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
18403.7502	Fill Cracks	Gal.	5.00	396	1,980
	Mill & Patch	S.Y.	45.00	422	18,990
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					147,590
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>50,416</u>
Total Cost/Mile					198,006
Total Cost Area II					\$594,018

AREA II

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
Total Item Cost					595
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area II					\$2,340

AREA II

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
Total Item Cost					4,777
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,483</u>
Total Cost/Mile					6,260
Total Cost Area II					\$18,780

AREA II

FUTURE TREATMENT COSTS AFTER 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
403.13	Dense Binder (1-1/2")	Ton	\$34.00	1,675	\$56,950
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
490.10	Cold Milling (3") (pav't. & shldrs.)	S.Y.	3.00	21,120	63,360
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					185,878
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>63,496</u>
Total Cost/Mile					249,374
Total Cost Area II					\$748,122

AREA II

RECONSTRUCT WITH 10-1/2" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
01202.97	Pavement Removal	S.Y.	\$ 10.00	14,080	\$140,800
203.02	Shoulder Excavation	C.Y.	6.00	1,760	10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,467	24,939
403.11	Dense Base (7")	Ton	34.00	5,182	176,188
403.13	Dense Binder	Ton	34.00	2.077	70,618
	(2" pav't.) & (1-1/2" Shldr.)				
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
	(pav't. & shldrs.)				
17605.2402	Edgedrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>

Total Item Cost 516,974

Overhead Factors:

Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12% 221,116

Total Cost/Mile 738,090

Total Cost Area II \$2,214,270

AREA II

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	40	\$200

Total Item Cost 200

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12% 62

Total Cost/Mile 262

Total Cost Area II \$786

AREA II

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	40	\$200
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
Total Item Cost					4,382
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,360</u>
Total Cost/Mile					5,742
Total Cost Area II					\$17,226

AREA II

FUTURE TREATMENT COSTS AFTER 15 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
15304.0117	Shoulder Backup	C.Y.	14.00	293	\$ 4,102
403.13	Dense Binder (1-1/2")	Ton	34.00	1,675	56,950
403.1701	Top Course (1-1/2")	Ton	35.00	1,675	58,625
18403.7502	Fill Cracks	Gal.	5.00	396	1,980
-	Mill & Patch	S.Y.	45.00	422	18,990
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					147,590
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>50,417</u>
Total Cost/Mile					198,007
Total Cost Area II					\$594,021

AREA II

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
Total Item Cost					<u>595</u>
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area II					\$2,340

AREA II

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	1,901	4,182
Total Item Cost					<u>4,777</u>
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,483</u>
Total Cost/Mile					6,260
Total Cost Area II					\$18,780

AREA II

FUTURE TREATMENT COSTS AFTER 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
403.13	Dense Binder (1 1/2")	Ton	\$34.00	1,675	\$56,950
403.1701	Top Course (1 1/2")	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
490.10	Cold Milling (3") (pav't. & shldrs.)	S.Y.	3.00	21,120	63,360
18633.06	Clean Pav't/Shldrs.	S.Y.	0.06	21,120	1,267
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					185,878
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>63,496</u>
Total Cost/Mile					249,374
Total Cost Area II					\$748,122

AREA II

RECONSTRUCT WITH 9" PCC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
01202.97	Pavement Removal	S.Y.	\$ 10.00	14,080	\$140,800
203.02	Shoulder Excavation	C.Y.	6.00	1,760	10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,173	19,941
403.13	Dense Binder (for 3" shldr.)	Ton	34.00	1,117	37,978
502.06	Cement Conc. Pav't.	C.Y.	80.00	3,250	281,600
502.20	Trans. Jt. Supports	L.F.	8.00	6,336	50,688
502.30	Long. Jt. Ties	EA.	4.00	1,320	5,280
18502.44201	Const. & Seal Jts.	L.F.	7.00	11,616	81,312
17605.2402	Edgedrains	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>

Total Item Cost 663,403

Overhead Factors:

Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12% 283,745

Total Cost/Mile 947,148

Total Cost Area II \$2,841,444

AREA II

FUTURE TREATMENT COSTS

AFTER 2, 4, 6, 10, 12, 14, 17, 19, 21, 25, 27 & 29 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7503	Fill Shldr. Jts.	Gal.	\$12.00	132	\$1,584

Total Item Cost 1,584

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12% 492

Total Cost/Mile 2,076

Total Cost Area II \$6,228

AREA II

FUTURE TREATMENT COSTS
AFTER 8 & 23 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18502.70200	Reseal Trans. Jts.	L.F.	\$3.00	6,336	\$19,008
18502.7401	Reseal Long. Jts.	L.F.	3.00	5,280	15,840
18403.7503	Fill Shldr. Jts.	Gal.	12.00	132	<u>1,584</u>
Total Item Cost					36,432
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>11,308</u>
Total Cost/Mile					47,740
Total Cost Area II					\$143,220

AREA II

FUTURE TREATMENT COSTS AFTER 15 YEARS

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
203.02	Shoulder Excavation	C.Y.	\$ 6.00	587	\$ 3,522
01203.02998	Pav't Lift Out	S.Y.	20.00	214	4,280
403.13	Dense Binder (for 3" shldr.)	Ton	34.00	1,117	37,978
18502.0701	Surface Prep.	S.F.	25.00	200	5,000
18502.0702	RS Pav't. Repair	LB.	1.50	4,168	6,252
502.11	Metal Reinf.	S.Y.	5.50	214	1,177
502.20	Trans. Jt. Supp.	L.F.	8.00	192	1,536
10502.6088	Conc. Repair	C.Y.	150.00	54	8,100
18502.70200	Reseal Trans. Jts.	L.F.	3.00	6,144	18,432
18502.7101	Saw & Seal Jts.	L.F.	5.00	272	1,360
18502.7401	Reseal Long. Jts.	L.F.	3.00	5,200	15,600
18502.7601	Seal Pav't. Cracks	L.F.	3.00	144	432
586.01	Drill & Grout Rebars	L.F.	18.00	144	<u>2,592</u>
Total Item Cost					106,261
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>36,299</u>
Total Cost/Mile					142,560
Total Cost Area II					\$427,680

AREA II

FUTURE TREATMENT COSTS AFTER 30 YEARS
3" SAWED & SEALED AC OVERLAY

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
203.02	Shoulder Excavation	C.Y.	\$ 6.00	1,760	\$ 10,560
203.07	Select Gran. Fill	C.Y.	17.00	1,760	29,920
15304.0117	Shoulder Backup	C.Y.	14.00	293	4,102
403.13	Dense Binder (1 1/2") (pav't. & shldr.)	Ton	34.00	1,675	56,950
403.1701	Top Course (1 1/2") (pav't. & shldr.)	Ton	35.00	1,675	58,625
407.0101	Tack Coat	Gal.	2.00	1,056	2,112
18502.2599	Saw & Seal	L.F.	5.00	7,920	39,600
18502.4466	Spall Repair	S.F.	7.00	600	4,200
18633.06	Clean Pav't.	S.Y.	0.06	14,080	845
18633.07	Clean & Fill Jts./Crks.	L.S.(L.F.)	0.50(L.F.)	11,616	5,808
18685.06	Pav't Marking	L.F.	0.30	11,880	<u>3,564</u>
Total Item Cost					216,286
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>73,883</u>
Total Cost/Mile					290,169
Total Cost Area II					\$870,507

AREA II

FUTURE TREATMENT COSTS
AFTER 32, 34 & 36 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
Total Item Cost					<u>595</u>
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area II					\$2,340

AREA II

FUTURE TREATMENT COSTS
AFTER 38, 40, 42 & 44 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints Fill Sawed & Sealed Transverse Joints	Gal.	\$5.00	317	\$1,585

				Total Item Cost	1,585
Overhead Factors:					
	Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%				<u>492</u>
				Total Cost/Mile	2,077
				Total Cost Area II	\$6,231

APPENDIX E

Alternative Cost Estimates: Area III

AREA III

6" AC OVERLAY PRECEDED BY RUBBLIZING

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
202.20	Remove AC Overlay (settlement areas)	S.Y.	\$ 4.00	214	\$ 856
203.02	Shldr. & Gutter Excav. (includes blowups)	C.Y.	6.00	2,654	15,924
206.02	Trench & Culvert Excav.	C.Y.	13.00	587	7,631
304.03	Subbase Course (crushed stone)	C.Y.	20.00	2,654	53,080
403.13	Dense Binder (4-1/2")	Ton	34.00	5,584	189,856
403.1701	Top Course (1-1/2")	Ton	35.00	1,861	65,135
18502.7590	Rubblize PCC	S.Y.	5.00	14,080	70,400
605.0901	Underdrain Filter	C.Y.	30.00	587	17,610
605.1701	Underdrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	17,512	<u>5,254</u>

Total Item Cost 457,426

Overhead Factors:

Prelim. Engr. 8%, Mobil. 4%, M&PT 7.5%, Survey 4%, Const. Insp. 12% 180,804

Total Cost/Mile 638,230

Total Cost Area III \$1,276,460

Note: Curb construction, sidewalk replacement, drainage adjustments and connections, and other incidental construction items are not included in this estimate. These additions will of course increase the overhead and total cost. However, cost increases as a result of these additions will be comparable for each of the selected alternatives. Therefore, their inclusion does not influence alternative comparison.

AREA III

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	40	\$200
Total Item Cost					200
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>62</u>
Total Cost/Mile					262
Total Cost Area III					\$524

AREA III

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	40	\$200
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
Total Item Cost					4,846
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,504</u>
Total Cost/Mile					6,350
Total Cost Area III					\$12,700

AREA III

FUTURE TREATMENT COSTS AFTER 15 & 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
403.13	Dense Binder (1 1/2")	Ton	\$34.00	1,861	\$63,274
403.1701	Top Course (1 1/2")	Ton	35.00	1,861	65,135
407.0101	Tack Coat	Gal.	2.00	1,173	2,346
490.10	Cold Milling (3")	S.Y.	3.00	23,467	70,401
18633.06	Clean Pav't.	S.Y.	0.06	23,467	1,408
18685.06	Pav't Marking	L.F.	0.30	17,512	<u>5,254</u>
Total Item Cost					207,818
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>70,991</u>
Total Cost/Mile					278,809
Total Cost Area III					\$557,618

AREA III

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	<u>\$595</u>
Total Item Cost					595
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area III					\$1,560

AREA III

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
				Total Item Cost	5,241
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,627</u>
				Total Cost/Mile	6,868
				Total Cost Area III	\$13,736

AREA III

RECONSTRUCT WITH 10-1/2" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
01202.97	Pavement Removal	S.Y.	\$ 10.00	14,080	\$140,800
203.02	Shldr. Gutter Excav.	C.Y.	6.00	2,640	15,840
206.02	Trench & Culvert Excav.	C.Y.	13.00	587	7,631
403.11	Dense Base (7")	Ton	34.00	8,685	295,290
403.13	Dense Binder (2")	Ton	34.00	2,482	84,388
403.1701	Top Course (1 1/2")	Ton	35.00	1,861	65,135
605.0901	Underdrain Filter	C.Y.	30.00	587	17,610
605.1701	Underdrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	17,512	<u>5,254</u>

Total Item Cost 663,628

Overhead Factors:

Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12% 283,842

Total Cost/Mile 947,470

Total Cost Area III \$1,894,940

NOTE: Curb construction, sidewalk replacement, drainage adjustments and connections, and other incidental construction items are not included in this estimate. These additions will of course increase the overhead and total cost. However, cost increases as a result of these additions will be comparable for each of the selected alternatives. Therefore, their inclusion does not influence alternative comparison.

AREA III

FUTURE TREATMENT COSTS
AFTER 3, 7, 9 & 13 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	40	\$200

Total Item Cost 200

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12% 62

Total Cost/Mile 262

Total Cost Area III \$524

AREA III

FUTURE TREATMENT COSTS
AFTER 5 & 11 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	40	\$200
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
Total Item Cost					4,846
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,504</u>
Total Cost/Mile					6,350
Total Cost Area III					\$12,700

AREA III

FUTURE TREATMENT COSTS AFTER 15 & 30 YEARS
MULTIPLE-COURSE OVERLAY 3" AC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
403.13	Dense Binder (1 1/2")	Ton	\$34.00	1,861	\$63,274
403.1701	Top Course (1 1/2")	Ton	35.00	1,861	65,135
407.0101	Tack Coat	Gal.	2.00	1,173	2,346
490.10	Cold Milling (3")	S.Y.	3.00	23,467	70,401
18633.06	Clean Pav't.	S.Y.	0.06	23,467	1,408
18685.06	Pav't Marking	L.F.	0.30	17,512	<u>5,254</u>
Total Item Cost					207,818
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>70,991</u>
Total Cost/Mile					278,809
Total Cost Area III					\$557,618

AREA III

FUTURE TREATMENT COSTS
AFTER 18, 22, 24, 28, 33, 37, 39 & 43 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
Total Item Cost					595
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>185</u>
Total Cost/Mile					780
Total Cost Area III					\$1,560

AREA III

FUTURE TREATMENT COSTS
AFTER 20, 26, 35 & 41 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18403.7502	Fill Longitudinal Cracks & Joints	Gal.	\$5.00	119	\$595
18403.7504	Rout & Seal Thermal Cracks	L.F.	2.20	2,112	4,646
Total Item Cost					5,241
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12%					<u>1,627</u>
Total Cost/Mile					6,868
Total Cost Area III					\$13,736

AREA III

RECONSTRUCT WITH 9" PCC

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
01202.97	Pavement Removal	S.Y.	\$ 10.00	14,080	\$140,800
203.02	Shldr. Gutter Excav.	C.Y.	6.00	2,640	15,840
206.02	Trench & Culvert Excav.	C.Y.	13.00	587	7,631
502.06	Cement Conc. Pav't.	C.Y.	80.00	5,867	469,360
502.20	Trans. Jt. Supports	L.F.	8.00	10,560	84,480
502.30	Long. Jt. Ties	EA.	4.00	3,960	15,840
18502.4420	Const. & Seal Joints	L.F.	7.00	26,400	184,800
605.0901	Underdrain Filter	C.Y.	30.00	587	17,610
605.1701	Underdrain	L.F.	3.00	10,560	31,680
18685.06	Pav't Marking	L.F.	0.30	17,512	<u>5,254</u>

Total Item Cost 973,295

Overhead Factors:

Prelim. Engr. 8%, Mobil. 4%, M&PT 10%, Survey 4%, Const. Insp. 12% 416,290

Total Cost/Mile 1,389,585

Total Cost Area III \$2,779,170

Note: Curb construction, sidewalk replacement, drainage adjustments and connections, and other incidental construction items are not included in this estimate. These additions will of course increase the overhead and total cost. However, cost increases as a result of these additions will be comparable for each of the selected alternatives. Therefore, their inclusion does not influence alternative comparison.

AREA III

FUTURE TREATMENT COSTS
AFTER 8, 23 & 38 YRS.

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
18502.7401	Reseal Long. Jts.	L.F.	\$3.00	15,780	\$47,340
18502.70200	Reseal Trans. Jts.	L.F.	3.00	10,416	31,248
18502.7601	Seal Pav't. Cracks	L.F.	3.00	400	<u>1,200</u>

Total Item Cost 79,788

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 5%, Const. Insp. 12% 24,766

Total Cost/Mile 104,554

Total Cost Area III \$209,108

AREA III

FUTURE TREATMENT COSTS AFTER 15 YEARS

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
01203.02998	Pav't Lift Out	S.Y.	20.00	320	\$6,400
18502.0701	Surface Prep.	S.F.	25.00	300	7,500
18502.0702	RS Pav't. Repair	LB.	1.50	6,250	9,376
502.11	Metal Reinf.	S.Y.	5.50	320	1,760
502.20	Trans. Jt. Supp.	L.F.	8.00	288	2,304
10502.6088	Conc. Repair	C.Y.	150.00	80	12,000
18502.70200	Reseal Trans. Jts.	L.F.	3.00	10,272	30,816
18502.7101	Saw & Seal Jts.	L.F.	5.00	768	3,840
18502.7401	Reseal Long. Jts.	L.F.	3.00	15,360	46,080
18502.7601	Seal Pav't. Cracks	L.F.	3.00	400	1,200
586.01	Drill & Grout Rebars	L.F.	18.00	216	<u>3,888</u>

Total Item Cost 125,164

Overhead Factors:

Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12% 42,756

Total Cost/Mile 167,920

Total Cost Area III \$335,840

AREA III

FUTURE TREATMENT COSTS AFTER 30 YEARS

<u>Item No.</u>	<u>Description</u>	<u>Unit</u>	<u>Cost/Unit</u>	<u>Qty./Mile</u>	<u>Cost</u>
01203.02998	Pav't Lift Out	S.Y.	20.00	640	\$12,800
18502.0701	Surface Prep.	S.F.	25.00	900	22,500
18502.0702	RS Pav't. Repair	LB.	1.50	18,750	28,125
502.11	Metal Reinf.	S.Y.	5.50	640	3,520
502.20	Trans. Jt. Supp.	L.F.	8.00	576	4,608
10502.6088	Conc. Repair	C.Y.	150.00	160	24,000
18502.70200	Reseal Trans. Jts.	L.F.	3.00	9,984	29,952
18502.7101	Saw & Seal Jts.	L.F.	5.00	1,536	7,680
18502.7401	Reseal Long. Jts.	L.F.	3.00	14,880	44,640
18502.7601	Seal Pav't. Cracks	L.F.	3.00	400	1,200
586.01	Drill & Grout Rebars	L.F.	18.00	432	<u>7,776</u>
Total Item Cost					186,801
Overhead Factors:					
Preliminary Engr. 8%, Mobil. 4%, M&PT 7.5%, Const. Insp. 12%					<u>63,811</u>
Total Cost/Mile					250,612
Total Cost Area III					\$501,224

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 5: Appendix 5B

Pavement Restoration Techniques: 2000

6/30/00

PAVEMENT RESTORATION TECHNIQUES: 2000

(FIRST PUBLISHED IN DECEMBER 1982 AND REVISED IN MARCH 1984)

(REVISED IN APRIL 1988 AND JUNE 2000)

Prepared By

FACILITIES DESIGN DIVISION
AND
TECHNICAL SERVICES DIVISION

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVE.
ALBANY, NEW YORK 12232

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INTRODUCTION

This updates the report entitled PAVEMENT RESTORATION TECHNIQUES which was published by the Technical Services Division in December 1982 and revised in March 1984, April 1988 and August 2000. Outdated or unused techniques have been removed while new techniques have been added to the list of restoration techniques available. It is a summary guide of state-of-the-art techniques and treatments used for pavement maintenance, rehabilitation and reconstruction.

Some treatments described in this report can be accomplished with standard items, while others require the use of items considered by the Department to be either experimental or project specials. These special items may not be identified in Pavement Rehabilitation Manual (PRM), Vol. II. It is expected that many of these non-standard items will be included as standards after more experience is gained with their use. In the meantime, the proposed use of techniques not found in PRM, Vol. II should be standard for use through the Design Quality Assurance Bureau (DQAB). DQAB should contact the Materials Bureau to verify the proposed use is appropriate for the subject project. A summary of the condition of the pavement and an explanation of why the item is required should be included.

Portland cement concrete (PCC) and Hot Mix Asphalt (HMA) pavements require various treatments to maintain, rehabilitate, or reconstruct the pavement depending upon the condition of the pavement and the level of service desired. Many standard types of treatments are currently in use and many more are in various stages of development. This summary is a listing of treatments based on the Department's experience to date. The purpose of this listing is to provide a "catalog" of treatments, useful background information and policy for the use of these techniques. Designers should use this information when considering various alternates for pavement restoration techniques.

To select the proper treatment, a Pavement Evaluation and Treatment Selection Report should be prepared in accordance with Chapters 2 and 5 of this manual and the Project Level Pavement Design Process found in Chapter 3 of this manual.

Information presented on PCC and HMA pavements includes 1) treatment (including specification numbers), 2) application, 3) remarks (including experience information and estimated service life, ESL). For PCC pavements overlaid with asphalt concrete, the pavement can be generally considered as an HMA pavement. However, special considerations may have to be made.

This report provides a listing of pavement restoration techniques based on the Departments experience to date. Its purpose is to provide State of the Art information in one place with capsuled background information and the Department policy for the use of these repair procedures. You will note a column captioned "Status", Remarks, Estimated Service Life (ESL). ESL has been included where appropriate. It is our best estimate of how long a technique or repair will last before requiring major work or reconstruction. ESL was included in order to assist designers when comparing alternatives. If your experience and/or local conditions indicate a different ESL is more appropriate, a statement explaining this difference should be incorporated in the project's Pavement Evaluation and Treatment Selection Report.

Remarks provided in the listing are based on current statewide experience. Costs should be reviewed for each project.

Technical Services Division personnel are available to provide additional information on any listed treatment(s).

PORTLAND CEMENT CONCRETE PAVEMENT

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Resealing transverse joints in portland cement concrete pavement, 19 m pavement slabs-silicone sealant, Item 18502.701002M, 18502.702002M <i>Resealing protects load transfer devices (LTDs), forestalls infiltration of incompressible material and water.</i>	Use on resealing contracts where existing sealers have failed and the existing pavement will not be resurfaced.	Statewide standard. Resealing is done by contract. For warrants and/or guidelines see EI 97-030 ESL: 8 years.
Resealing transverse joints in portland cement concrete pavement, 3.5 thru 6 m pavement slabs-silicone sealant, Item 18502.702002M, <i>Resealing protects LTDs, forestalls infiltration of incompressible material and water.</i>	Use on resealing contract where existing sealers have failed and the existing pavement will not be resurfaced.	Statewide standard. Resealing is done by contract. For warrants and/or guidelines see EI 97-030 ESL: 8 years.
Resealing longitudinal joints in portland cement concrete pavement, Item 18502.7041M <i>Resealing protects tie bars from corrosion, forestalls infiltration of incompressible material and water.</i>	Use on resealing contracts where existing sealers have failed and the existing pavement will not be resurfaced.	Statewide standard. Resealing is done by contract. For warrants and/or guidelines see EI 97-030 ESL: 8 years.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Sealing cracks in portland cement concrete pavement-silicone sealant, Item 18502.7601M. <i>Appropriate where the existing pavement will not be resurfaced.</i>	Use to seal cracks that have opened sufficiently to receive water and fines.	Statewide standard. Resealing is done by contract. For warrants and/or guidelines see EI 97-030 ESL: 8 years.
Diamond grinding and texturing of concrete pavement, Item 18502.5010M <i>This item consists of diamond grinding the entire lane(s) to remove faulted joints.</i>	Use where faulted joints have become objectionable (greater than 4 mm). Wheeltrack ruts can be removed and pavement cross slope changed. Pavement friction is increased due to texture left after grinding.	Statewide standard. With approximately 2000 trucks/day faulting will recur at a rate of 1 mm per year. ESL: Objectionable faulting 5 mm will recur within 5 years under the above traffic conditions if load transfer is not restored.
Production cold milling of portland cement concrete pavement, Item 490.20. <i>Provides shaping and removal of existing PCC pavement surfaces.</i>	Use on large, high production milling operations of more than 15,000 sq. yds. where continuous or near continuous milling is anticipated and where larger milling machines (6 ft diam. width and larger) are suitable.	Statewide standard. Equipment readily available. See EI 89-8.
Miscellaneous cold milling of portland cement concrete, Item 490.40. <i>Provides shaping and removal of existing PCC pavement surfaces.</i>	Use where milling is limited, intermittent and/or restricted in area, generally less than 15,000 sq. yds.	Statewide standard. Equipment readily available. See EI 89-8.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Pressure relief joints in existing cement concrete pavement, Item 15502.4598M. <i>Pressure relief is provided by full depth asphalt concrete.</i>	Use to stabilize a pavement (that is particularly prone to blowups) prior to resurfacing. Use to replace existing expansion joints at bridge approach slabs either side of a structure.	<u>PAVEMENT</u> Use has declined in recent years as the full depth AC pressure relief joints have a tendency to bump, rut and/or shove from thermal expansion and traffic after 5 years. Maintenance is then required to repair the deficiency and restore rideability. <u>STRUCTURES</u> The expansion joint between the pavement and approach slab is replaced with a 5 ft wide pressure relief joint. As with pavement, maintenance is required.
Surface preparation for rapid setting concrete pavement repairs, Item 18502.0707 M.	Use for partial depth repair of spalled or deteriorated areas of PCC pavements not receiving an overlay. Curing time to traffic use, 1 hour.	Statewide standard. See EI 93-016 ESL: 10 years.
Furnish and placement of rapid setting concrete pavement repairs, Item 18502.0708 M.	Partial depth repairs.	Statewide standard. See EI 93-016 ESL: 10 years

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Cement concrete for pavement repairs, Item 18502.6028 M. <i>After removal, a calcium chloride accelerated portland cement concrete is placed in the prepared void.</i>	Use for full depth removal and replacement of concrete pavement segments. Curing time to traffic use, 4 hours. The existing pavement is removed, steel dowels are installed in holes drilled in the existing slabs, an expansion joint load transfer device is placed where necessary and the accelerated concrete is placed.	Statewide standard. Sawcutting, excavation, drilling, dowels, and load transfer devices are paid for separately. ESL: Equal to the service life of the existing pavement up to 30 years. EI 99-010
Dowel retrofit load transfer devices for transverse joints in PCC pavement, Item 04502.8008 M. <i>Standard epoxy coated dowels are placed in sawcut slots across joint and bonded in place with polymer concrete.</i>	Use to reestablish load transfer at transverse cracks. Joints must have no or low-severity spalling.	Experimental feature. Usage minimal due to candidate pavement's poor condition and relatively high cost of the item.
Cracking and seating existing concrete pavement, Item 18502.6596 M. <i>A pavement breaker and 50 ton roller are used to crack and seat the pavement.</i>	Use to retard transverse joint reflection cracks and slab cracks through an asphalt overlay. Use where PCCP is deteriorated to the point that the only other feasible rehabilitation alternative is reconstruction. A crack and seated PCCP should be overlaid with a minimum of 125 mm of HMA.	Statewide standard. For warrants and guidelines see EI 96-029

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Rubblizing existing portland cement concrete pavement, Item 18502.7596 M. <i>A resonant frequency machine is used to rubblize pavement to aggregate size particles.</i>	Use where PCCP deterioration is similar to that warranting cracking and seating but where widening, longitudinal and/or transverse joint separation or the presence of underground utilities nullifies the crack and seat alternative.	Project special. For warrants and guidelines see EI 96-030.
Groove PCC pavement, Item 15502.5001. <i>Longitudinal grooving.</i>	Use to reduce wet weather hydroplaning on tangents and curved sections lacking adequate macrotexture but where microtexture is satisfactory.	Statewide standard. Longitudinal grooves cost less than transverse grooves and can be placed with less traffic disruption. ESL: Varies depending on traffic and concrete properties. For further information contact the Materials Bureau.
Transverse grooving of PCC pavement, Item 18502.5002.	Use to reduce wet weather hydroplaning on tangents and curved sections lacking adequate macrotexture but where microtexture is satisfactory.	Project special. Transverse grooves improve drainage in flat sections by taking advantage of existing pavement cross-slope and channeling water to the pavement edge. May be advantageous to use in place of longitudinal grooving when a contract also calls for transverse grooving of structural slabs. ESL: Varies depending on traffic and concrete properties. For further information contact the Materials Bureau.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Ultra-thin-whitetopping PCC pavement inlay <i>A minimum of a 100 mm of fiber reinforced PCC pavement is placed over a minimum 75 mm of non-distressed asphalt.</i>	Use to repair HMA that is rutted or corrugated due to shoving. Especially useful in intersections and ramps.	Experimental feature. Several Regional Specifications exist. Contact the Materials Office for assistance.
Unbonded PCC pavement overlay. <i>A minimum 225 mm reinforced concrete pavement with load transfer is constructed over a bond breaker Item 304.12 minimum loose lift thickness over the existing pavement.</i>	Use to overlay an extensively deteriorated PCCP. A bond breaker is used to prevent reflection cracks.	Experimental feature. No recent experience in N.Y. For details contact the Materials Bureau. ESL: Same as new concrete pavement, 30 years.
Repair of spalled areas, joints and/or cracks in portland cement concrete pavement, Item 18502.4467 M.	Asphalt concrete is used to repair partial depth spalls occurring at joints or in slabs prior to HMA resurfacing. Deteriorated PCC is removed by milling or other means prior to HMA patching.	Statewide standard. For warrants and guidelines see EI 93-028.
HMA overlay over PCCP. 90 mm minimum thickness. Various standard items. <i>A 50 mm thickness of dense binder and 40 mm thickness of top course is placed on a patched, filled, tack coated and leveled pavement.</i>	Use to overlay a moderately deteriorated PCCP.	Statewide standard. ESL: 18 years.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Sawing and sealing joints in bituminous concrete overlays, Item 18403.2502 M. <i>Reservoirs and deeper sawcuts are constructed and sealed over existing transverse joints to control and seal reflection cracks.</i>	Use for first time overlays, where existing transverse joints are well defined, to control reflection cracks.	Statewide standard. Reflective cracking is controlled. Deterioration at joint areas is minimized and delayed. As a result, overlay service life is achieved.
Additional depth sawing and sealing bituminous concrete pavement joints, Item 18502.2599 M. <i>Additional depth sawcutting, through the new and existing HMA overlays, acts as a control joint.</i>	Use in second overlay over PCC pavement where the first overlay has developed reflective cracks.	Statewide standard. For further information contact the Materials Bureau.
Full depth PCC slab replacement with dense graded asphalt concrete base or binder and top, Items 403.11 or 403.13 and 403.1701. <i>Structurally unsound PCCP slabs or segments are replaced full depth with new dense HMA prior to resurfacing.</i>	Use as an alternative to PCC replacement on moderate to low volume roadways where this less expensive repair will perform adequately. This repair is not recommended where high volumes of trucks can cause shoving, poor rideability and requires corrective maintenance after a few years.	Statewide standard. For this treatment to be cost effective the cause of the problem must be corrected. ESL: 2 years with AADT of 100,000 +. 5 years with AADT of 40,000.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Full depth PCC slab replacement with cement concrete pavement, reinforced Class F, Item 502.05. <i>Structurally unsound PCCP slabs are replaced full depth with new reinforced PCCP slabs.</i>	Use where individual pavement slabs have failed because of localized failure. Curing time to traffic use, 72 hours.	Statewide standard. For this treatment to be cost effective the cause of the problem must be corrected. For assistance contact the Materials Bureaus. ESL: Equal to the service life of the existing pavement up to 30 years.
Modified Class F reinforced concrete for pavement repairs, Item 01502.6088. <i>Class F concrete curing is accelerated with heated mix water and insulation.</i>	Use where individual pavement slabs have failed because of localized failure. Curing time to traffic use, 24 hours.	Statewide standard. For this treatment to be cost effective the cause of the problem must be corrected. For assistance contact the Soil Mechanics and Materials Bureaus. ESL: Equal to the service life of the existing pavement up to 30 years.
PCCP Reconstruction. Various standard items. <u>Remove and replace entire pavement.</u>	Use for complete replacement of the existing pavement in kind or as a flexible pavement.	Statewide standard. ESL: PCCP - 30 years. HMAP - 18 year.

HOT MIX ASPHALT PAVEMENT

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Hot Mix Asphalt (HMA) overlay. Various standard items.	<u>STRUCTURAL</u> Single or multiple layer(s) of sufficient thickness to provide adequate increase in total pavement thickness for design traffic. <u>RIDE/PREVENTIVE MAINTENANCE</u> Single or multiple layer(s) to restore acceptable ride, cover minor cracking, raveling, etc.	Statewide standard. Contact Geotechnical Engineering and Materials Bureaus for assistance in thickness design and corrections necessary prior to resurfacing. ESL: 18 years.
Superpave Item 18403.XXYZQR.	See previous entry.	Statewide standard. These Superpave items were developed to address pavement rutting, fatigue and low temperature cracking on high volume roadways. Superpave mixes have been used since 1996 statewide. Specifications were issued by EI 98-41 and ED 99-001. For warrants and guidelines for use see Chapter 6 of the CPDM. For further information contact the Materials Bureau.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Asphalt concrete Type 10FX open graded surface course, Item 15403.200401 M	Use to reduce wet weather hydroplaning in areas with a history of abnormally high skidding accidents.	Statewide standard. For warrants and guidelines see Chapter 6. For further information contact the Materials Bureau.
Hot In-place Recycling,	Use to hot in-place recycle existing asphalt pavement. Self contained multi-step process of heating, scarifying, remixing, reshaping and compacting asphalt pavement. Recycles top 25 mm - 40 mm of existing pavement as a binder course or wearing course.	Project special. For further information contact the Materials Bureau.
Cold In-place Recycling, Item 51405.0201	Use to recycle and reshape the existing surface of low volume roads. Recycled material must be covered with a new wearing course.	Project special. ESL: 15 years. For further information contact the Materials Bureau.
Hot Mix Asphalt concrete pavement replacement and/or reconstruction. Various items.	Full depth patches, replacement of short sections, complete pavement reconstruction. Multiple layers of sufficient thickness to provide adequate total pavement thickness for design traffic.	Statewide standard. ESL: 15 years for reconstruction.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Microsurfacing	Thin preventive maintenance surface treatment used to seal the pavement, reducing oxidation and weathering of the existing surface. Roadway can be opened to traffic within one hour under most conditions. Can also be used to fill wheel ruts and to restore pavement friction properties.	Statewide standard. For assistance and item numbers contact the Regional Materials Engineer. ESL: 5 - 8 years
Quick Set Slurry	Thin preventive maintenance surface treatment used to seal the pavement, reducing oxidation and weathering of the existing surface. Only for low traffic volume roadways. Roadway can usually be opened to traffic within 3 hours.	Statewide standard For assistance and item numbers contact the Regional Materials Engineer. ESL: 3 - 5 years
Sealing cracks in asphalt concrete pavement, ASTM D3405, Items can be found in EI 97-030. <i>Sealing is a preventive maintenance operation that forestalls infiltration of incompressible material and water.</i>	Use to seal thermal cracks that have opened sufficiently to receive water and fines.	Statewide standard. Sealing is primarily done by contract but may be done by highway maintenance forces. For warrants and/or guidelines see EI 97-030. ESL: 5 years.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Repair defective HMA overlay & PCC at underlying PCC joints, Item 18403.88.	Use to remove and repair deteriorated and unsound HMA overlay and PCC in vicinity of PCC pavement joints prior to overlay. Purpose - To extend or achieve service life of overlay.	Statewide standard.
Superpave HMA with Ice retardant additive	Use to reduce ice and snow related accidents in abnormally high accident areas.	Proprietary justification. For further information contact the Materials Bureau. For warrants and/or guidelines.
Production cold milling of HMA pavement, Item 490.10.	Provides shaping and removal of existing HMA pavement surfaces. Use on large, high production milling operations of more than 12,500 m ² where continuous or near continuous milling is anticipated and where larger milling machines (1.83 m diam. width and larger) are suitable. Reclaimed material may be recyclable.	Statewide standard. Equipment readily available. See EI 89-8.
Miscellaneous cold milling of HMA pavement, Item 490.30.	Provides shaping and removal of existing HMA pavement surfaces. Use where milling is limited, intermittent and/or restricted in area, generally less than 12,500 m ² . Reclaimed material may be recyclable.	Statewide standard. Equipment readily available. See EI 89-8.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Removing old HMA overlay, Item 202.20.	Use for complete removal of an overlay.	Statewide standard. Usually accomplished with a front end loader. If suitable, reclaimed material may be crushed and recycled.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Unclassified excavation and disposal, Item 203.02.	Use to completely remove a pavement.	Statewide standard. If suitable the reclaimed material may be crushed and recycled. For further information contact the Geotechnical Engineering Bureau (GEB).
Sealing cracks in PCC pavements using silicone. Item 18403.7508 M and 18403.7507 M.	Used to seal cracks where existing sealers have failed or where cracks are otherwise unsealed.	Statewide standard. Maintenance sealing done by contract. For warrants and/or guidelines see EI 97-030. ESL: Similar to resealing transverse and longitudinal joints in PCC pavement, see below.
Resealing transverse and longitudinal joints in PCC pavements using D3405 for longitudinal joints only and silicone. Items 18502.701002 M 18502.702002 M 18502.7401 M	Used to reseal transverse and longitudinal joints in PCC pavements.	Statewide standard. Resealing done by contract. For warrants and/or guidelines, see EI 97-030. ESL: Transverse - 8 yrs. Longitudinal - 16 yrs.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Filling shoulder joint between portland cement concrete pavement and asphalt concrete shoulders, Item 18403.7507 M and 18403.7508 M. <i>Filling is a preventive maintenance operation that forestalls infiltration of incompressible material and water.</i>	Use to fill the separation that develops between the pavement and shoulder.	Statewide standard. Filling is primarily done by highway maintenance forces but may be done by contract. For warrants and/or guidelines see EI 97 - 030. ESL: 2 years.
Tack coat, Item 407.01 M. <i>A diluted emulsified asphalt cement for bonding new asphalt concrete layers to existing surfaces.</i>	Use on portland cement concrete pavement surfaces, asphalt pavements with a milled surface, an aged asphalt pavement as long as the existing surface is not excessively flushed and between all layers of HMA pavement. Do not use on the surface of permeable base material. Tack coats should only be applied to clean dry surfaces.	Statewide standard. The diluted emulsion is not a stable material. It requires agitation to maintain homogeneity. Application rates are critical. See EI 2000 - XX. No suitable substitute to the diluted emulsion has been found. Good results when handled properly. See Construction Manual P. 407-1.
Precast Concrete Headwall for 100 mm Lateral Outlet Pipes Item 18605.2502 M	Use for protection of 100 mm lateral outlet pipes for edgedrains. Follow guidelines in Chapter 9 of this manual for when to use.	Statewide standard

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Perforated Corrugated Polyethylene Underdrain Tubing Item 605.15xx M	Used as underdrain/edgedrain pipe for longitudinal drains on typical runs - usually 100 mm or 150 mm pipe are used.	Statewide standard.
Perforated Polyvinyl Chloride Underdrain Pipe Item 605.16xx M	Used as underdrain/edgedrain pipe for longitudinal drains on flat runs and used for lateral outlets when stiffer pipe not available.	Refer to Standard Contract Pay Item Catalog for full Item number and full description.
Prefabricated geocomposite edge drain, Item 17605.2410 M and Item 17605.2411 M.	Use to provide drainage at the edge of existing PCCP. Untried on HMAP at this printing. For assistance contact the Geotechnical Engineering Bureau.	Project special. Requires GEB approval via DQAB. (See EI 01-002) See Chapter 9 of this manual for details. Appropriate for existing PCCP to be resurfaced. This item should not be placed below a widening interface.
Underdrain Filter Type I Item 605.0901 M Type II Item 605.1001 M Type III Item 605.1101 M	Used as drainage stone for edgedrain and underdrain systems. Type I or II are typically used. Type I is preferred but Type II should be used if in direct contact with fine-grained subgrade.	Statewide standard.
Underdrain Video Inspection Item 17605.99 M	Used to inspect edgedrains and underdrains after construction for quality control. May be used for maintenance purposes also.	This specification has only been used on a limited basis. Video inspection is recommended if proper drainage is crucial for the project. Consult Regional Geotechnical Engineer for appropriateness. Contracts with less than 20 outlets are exempt from video inspection.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Asphalt Treated Permeable Base Course Item 18403.100201 M	Used as a drainage layer for asphalt and concrete pavements. Care should be taken to prevent contamination or damage due to placement or traffic.	Statewide standard Construction traffic not permitted on except for equipment required to place the subsequent layer.
Hot Mix Asphalt - Type 2 Base Course Item 403.12 M	Can be used as a drainage layer for asphalt and concrete pavements when lane is necessary for temporary traffic control.	Used when asphalt or cement-treated permeable base can not be used due to traffic constraints.
Cement Treated Permeable Base Course Item 18502.03 M	Used as a drainage layer for concrete pavements only. Care should be taken to prevent contamination or damage due to placement or traffic.	Statewide standard Construction traffic not permitted on except for equipment required to place the subsequent layer.
Crushed Aggregate Subbase Course Item 17304.98 M	Used as a drainage layer for asphalt and concrete pavements when necessary to pave right away and a treated permeable base can not be used.	Special projects only. Consult Regional Geotechnical Engineer for appropriateness.
Subbase Course Type 1 Item 304.02 M Type 2 Item 304.03 M Type 3 Item 304.04 M Type 4 Item 304.05 M Optional Type Item 304.06 M	Typical items specified for subbase course.	Each Region may have a specific item that is readily available. Consult the Regional Geotechnical Engineer for appropriate item to use.

TREATMENT	APPLICATION	STATUS, REMARKS & ESTIMATED SERVICE LIFE (ESL)
Subbase Course Type 1011-2 Item 17304.101199 M	Subbase item allowing recycled bituminous material. Region 10 generally does not allow recycled bituminous material under HMA pavement.	Written for statewide use but utilized exclusively in Regions 10 and 11.
Select Granular Subgrade Item 203.20	Used for planned undercuts to prevent frost damage or for soft subgrades.	Paid for by fill compacted. Consult Regional Geotechnical Engineer for undercut areas.
Crushed stone weep, Item 17203.9902.	Use to provide drainage at the edge of pavement. For assistance contact the Regional Soils Engineer.	Project special. Appropriate for steep grades and at sags of vertical curves.
Cleaning existing pavement and/or shoulders, Item 18633.06.	Use to clean the existing pavement and shoulders surfaces prior to tack coating and resurfacing.	Project special. These items supplement air blasting with mechanical cleaning.
Cleaning and filling joints and cracks, Item 18633.07.	Use to clean and fill joints and cracks in an existing pavement prior to tack coating and resurfacing with asphalt concrete.	When it is determined that air blasting will not accomplish the intended purpose.
Cleaning and filling pavement/shoulder joints, Item 18633.08.	Use to clean and fill the longitudinal interface between the existing pavement and shoulder prior to tack coating and resurfacing with asphalt concrete.	They are especially useful in portland cement concrete pavements that were originally sealed with preformed neoprene extrusions, which should be removed from joints prior to resurfacing.

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 6 - Materials

Revision 2

February 12, 2008

CHANGES TO CHAPTER 6

Pages

Changes

Contents

Appendix 6A added.

6-5 to 6-6

Section 6.2.5, Table 6-4 Performance Graded Binder Selection. The definitions of downstate and upstate previously provided in Table 6-4 have been revised as follows:

- Upstate – All other counties not listed under Downstate
- Downstate - Orange, Putnam, Rockland, Westchester, Nassau, Suffolk Counties and City of New York

In addition, Table 6-4, was revised to create two new tables (Tables 6-4a and 6-4b). This was necessary to provide guidance on the use of standard and polymer modified PG binder grades. Table 6-4a, Performance Graded Binder Selection – Standard Grades, provides guidance for the standard grades while Table 6-4b, Performance Graded Binder – Polymer Modified, provides guidance for the use of polymer modified binder. Project designers will select appropriate PG binder using these tables.

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Section 6.2.6 Special Note Development. In addition to the above changes, there are additional PG binder requirements that apply to both Upstate and Downstate that must be included as part of the Performance Grade (PG) Binder and Mix Level Special Note. It is important that correct information is included in the Special Note.

6-8 to 6-12

Pages issued to accommodate shifting of text. No technical changes.

Appendix 6A

- Example Note for Upstate Standard PG Binder (i.e., PG 64-22)
- Example Note for Upstate Polymer Modified PG Binders (i.e., PG 58-34, PG 64-28 and PG 64-22 with elastic recovery requirement)
- Example Note for Downstate Standard PG Binder (i.e., PG 70-22)
- Example Note for Downstate Polymer Modified PG Binder (i.e., PG 76-22 with elastic recovery requirement)

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6.1 INTRODUCTION

This chapter is a summary of current design related materials issues for Hot Mix Asphalt (HMA) layers and Portland Cement Concrete (PCC) pavements, permeable base, subbase, and selected subgrade layers. The HMA layers consist of top, binder, and base courses. A description of each specification related to each layer of material is presented in this chapter.

6.2 HOT MIX ASPHALT

6.2.1 Superpave

The majority of the roads maintained by New York State Department of Transportation are constructed with Hot Mix Asphalt (HMA). The standard method of designing HMA mixtures is the Superpave system (an acronym for SUPERior PERforming asphalt PAVEMENTs). HMA can be placed quickly and traffic can be restored in a short amount of time. Mill and fill operations make rehabilitation of HMA pavements quick and easy because the shoulders contain the same top layer thicknesses and can be milled at the same time. With proper maintenance, HMA pavements should have life spans of 15 to 18 years for thicker overlays and 8 to 10 years for single course overlays before rehabilitation, while the subbase and underdrain system should last 50 years.

The Superpave mixture design system and Performance Graded Binder (PG Binder) specifications were developed through research performed during the Strategic Highway Research Program. Superpave addresses the three principal distresses that plague HMA pavement: rutting, fatigue cracking, and low temperature cracking. Superpave is performance based; both the PG Binder specification and mixture design system identify the performance properties directly related to pavement durability. The requirements for each property are tailored to accommodate the diverse, but specific, climate and traffic conditions that pavements are exposed to at project sites across the State.

The objective of the Superpave mix design system is to define an economical blend of PG Binder and aggregate yielding a paving mixture having sufficient air voids, voids in the mineral aggregate (VMA), and voids filled with binder (VFB) that will perform satisfactorily over the pavement's service life. The Superpave system provides an objective measure of quality associated with the use of various materials.

6.2.2 ESAL Calculations

Refer to section 4.5.1 of this manual for the ESAL calculation except for the input parameters, since the recommended parameters in Section 4.5.1 are intended for structure selection and are generally overly conservative for mix design. Mix design ESALs should not be overestimated for the following reasons:

1. the aggregate properties and binder specified may be restrictive and costly, and
2. the pavement's anticipated service life may not be obtained if the predicted traffic is not present to provide reworking and compaction of the asphalt.

Therefore, when calculating ESALs for Superpave mix design, the following parameters should be used in the "simple" method for compound traffic growth as described in Chapter 4 of this manual.

<u>Criteria</u>	<u>Input Parameter</u>
Design Life	20 years
Percent of Trucks in Design Lane	1 lane = 100, 2 lanes = 85, 3 lanes = 70, 4 lanes = 60
Compound Truck Weight Growth Rate	0.5%
Compound Truck Volume Growth Rate	2%

When the difference between the calculated design ESALs and the next lower ESAL design level is less than 10% of the lower ESAL mix design level, consideration should be given to using the lower design level. For example, if the calculated ESALs are 10.3 million then a <10 million design level should be selected instead of the <30 million level. In addition, when the roadway does not include signalized intersections, or grades exceeding 4%, a lower ESAL design level may be selected. The Regional Materials Engineer should be consulted in these situations.

The ESAL calculations are not required for all Parkways where truck traffic is prohibited. For these roadways, a <3.0 million ESAL level will be specified in the special note (see Section 6.2.6 of this chapter).

6.2.3 HMA Item Selection Guidelines

Selection of the specific HMA item type will involve four decision steps as laid out moving from left to right in Tables 6-1 and 6-2. The decisions are as follows.

1. What is the project's Functional Classification as defined in the *Highway Sufficiency Rating* manual (see Table 6-3)?
2. If it has a Principal Arterial classification, does it have either full or partial control of access
3.
 - a. What is the traffic volume? "High volume" refers to 2 or 3 lane highways with design year two-way AADT over 8000, or for more than three lanes, with two-way AADT over 13,000. Low volume refers to highways with lower volumes for the specified number of lanes.
 - b. What is the project's location? For Tables 6-1 and 6-2, the City of New York, and the surrounding counties of Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk and Westchester are referred to as "downstate". All other areas are referred to as "upstate".
 - c. What is the 20-year ESAL count? Does the project involve HMA quantity of less than 2000 Mg of top course? (Regardless of the quantities of each of the layers below). Are the calculated ESALs less than 0.3 million? This will determine the aggregate size and the pay item.

Within each section of Tables 6-1 and 6-2, the subdivision of choices places the preferred, longer-lasting pavement option first.

Table 6-1 Pay Item Selection for Principal Arterials

7/02/02

Functional Classification	Control of Access	Traffic Volume ¹	Location ²	Estimated top course < 2000 Mg OR ESALs < 0.3 million	Hot Mix Asphalt Pay Item ^{3,4,5}
11 - Urban Principal Arterial Interstate	Full or Partial Control of Access	High or Low	Downstate		402.XX51QR (Top) 402.XX59QR (Binder) 402.XX69QR (Base)
			Upstate		402.XX52QR (Top) 402.XX59QR (Binder) 402.XX69QR (Base)
12 - Urban Principal Arterial Expressway	No Control of Access	High	Downstate	No	402.XX61QR (Top) 402.XX69QR (Base and Binder)
Yes				402.XX71QR (Top) 402.XX79QR (Base and Binder)	
01 - Rural Principal Arterial Interstate			Upstate	No	402.XX62QR (Top) 402.XX69QR (Base and Binder)
				Yes	402.XX72QR (Top) 402.XX79QR (Base and Binder)
02 - Rural Principal Arterial Other		Low	Upstate or Downstate	No	402.XX63QR (Top) 402.XX69QR (Base and Binder)
				Yes	402.XX73QR (Top) 402.XX79QR (Base and Binder)

1. "High Volume" refers to 2 or 3 lane highways with design year two-way AADT over 8,000, or for more than three lanes, with two-way AADT over 13,000. "Low Volume" refers to highways with lower volumes for the specified number of lanes.
2. The City of New York, and the surrounding counties of Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk, and Westchester are referred to as "downstate." All other areas are referred to as "upstate."
3. XX aggregate sizes may be 37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, or 9.5 mm.
4. Q has been reserved for Quality Payment Adjustments.
5. R has been reserved for Revision Number.

Table 6-2 Pay Item Selection for General Highways

Functional Classification	Traffic Volume ¹	Location ²	Estimated top course <2000 Mg OR ESALs < 0.3 million	Hot Mix Asphalt Pay Item ^{3,4,5}
16 - Urban Minor Arterial 17 - Urban Collector 19 - Urban Local 06 - Rural Minor Arterial 07 - Rural Major Collector 08 - Rural Minor Collector 09 - Rural Local	High	Downstate	No	402.XX61QR (Top) 402.XX69QR (Base and Binder)
			Yes	402.XX71QR (Top) 402.XX79QR (Base and Binder)
		Upstate	No	402.XX62QR (Top) 402.XX69QR (Base and Binder)
			Yes	402.XX72QR (Top) 402.XX79QR (Base and Binder)
	Low	Upstate or Downstate	No	402.XX63QR (Top) 402.XX69QR (Base and Binder)
			Yes	402.XX73QR (Top) 402.XX79QR (Base and Binder)

1. "High Volume" refers to 2 or 3 lane highways with design year two-way AADT over 8,000, or for more than three lanes, with two-way AADT over 13,000. "Low Volume" refers to highways with lower volumes for the specified number of lanes.
2. The City of New York, and the surrounding counties of Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk, and Westchester are referred to as "downstate." All other areas are referred to as "upstate."
3. XX aggregate sizes may be 37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, or 9.5 mm.
4. Q has been reserved for Quality payment Adjustments.
5. R has been reserved for Revision Number.

Table 6-3 Functional Classification Code Descriptions

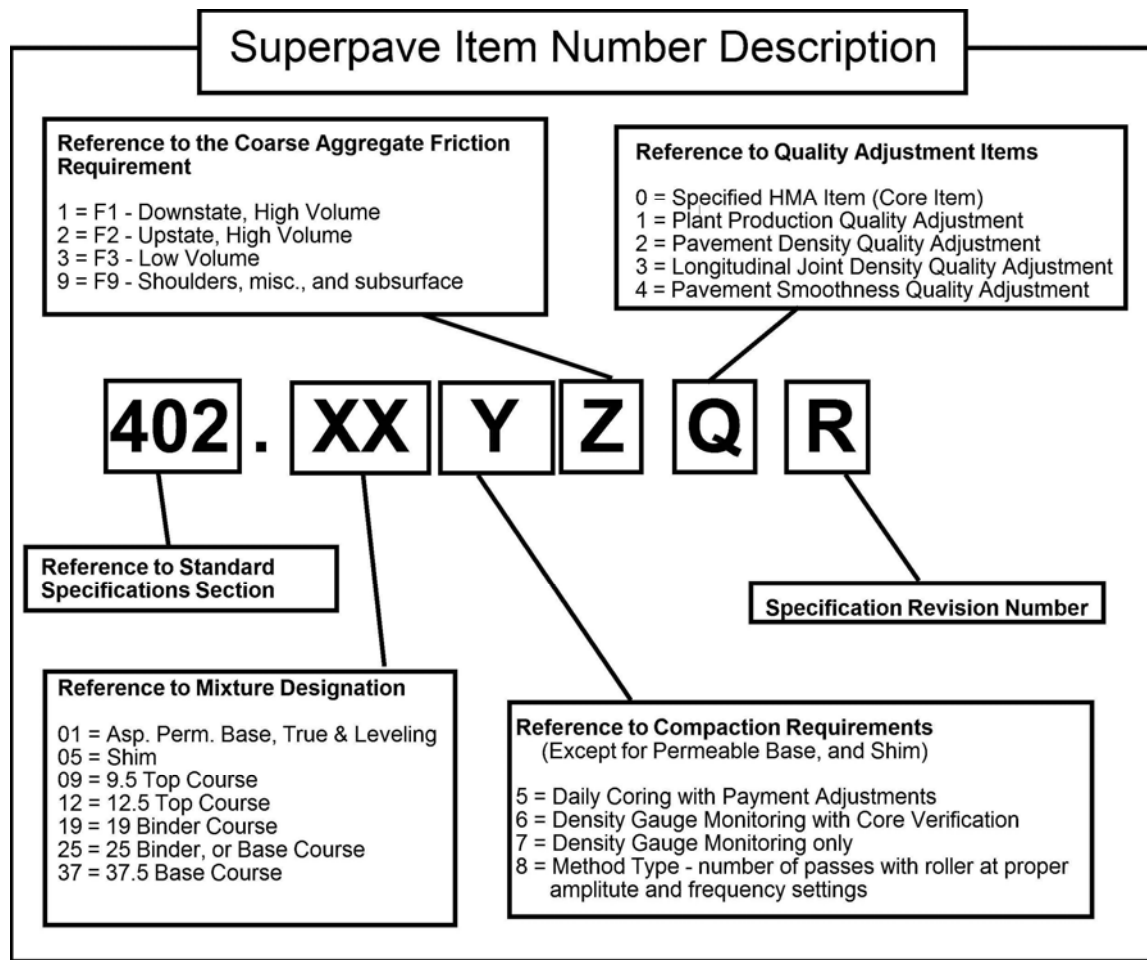
URBAN		RURAL	
Principal Arterial Interstate	11	Principal Arterial Interstate	01
Principal Arterial Expressway	12	Principal Arterial Other	02
Principal Arterial Other	14	Minor Arterial	06
Minor Arterial	16	Major Collector	07
Collector	17	Minor Collector	08
Local	19	Local	09

Source: Highway Sufficiency Manual

6.2.4 Interpreting HMA Item Numbers

HMA item numbers vary based upon nominal maximum aggregate size, compaction requirements, coarse aggregate friction requirements, quality adjustment items, and specification revision number except for Permeable Base, True & Leveling, and Shim courses. Figure 6-1 provides a description of how to interpret HMA item numbers.

Figure 6-1 Item Number Description



6.2.5 Performance Graded Binder Selection

The specific Performance Graded Binder (PG Binder) to be used should be selected using the guidance in this section and Section 6.2.6. The PG Binder, which is used to bind the aggregate together, is selected based on the traffic conditions and environment to which the binder will be subjected to maximize its performance. The environmental effects can be taken into account by looking at geographic location. The Regional Materials Engineer may be consulted prior to a PG Binder selection for assistance in the selection process.

a. Standard PG Binder Grades

Table 6-4a indicates the Standard PG binder grades. These grades should be specified for typical projects whether Upstate or Downstate.

Table 6-4a Performance Graded Binder Selection - Standard

Location	Location by Counties	Performance Grade (Spec Number)
Upstate	All Other Counties Not Listed Under Downstate	64-22 ¹ (702-6422)
Downstate	Orange, Putnam, Rockland, Westchester, Nassau, Suffolk Counties and City of New York	70-22 (702-7022)

1. For high volume roadways in Dutchess County, PG 70-22 or PG 76-22 may be specified with the concurrence of the Regional materials Engineer.

b. Polymer Modified PG Binder Grades

These PG binders are polymer modified and must meet minimum elastic recovery requirements. A Special Note for these binders, specifying elastic recovery requirements, must be included in the contract. Polymer modified binder grades should only be specified when the project warrants its use. Table 6-4b provides guidance for using these binders. The cost of HMA with polymer modified binder may be \$2.00 to \$5.00 per ton higher than HMA using a standard grade.

Table 6-4b Performance Graded Binder Selection – Polymer Modified

Conditions for Use	Location	Performance Grade (Spec Number) ¹
Cold temperature data warrants its use with the concurrence of the Regional Materials Engineer. Typically Adirondack Region.	Jefferson, Lewis, St. Lawrence, Franklin, Clinton, Essex, and the Northern Sections of Herkimer, Oswego, Hamilton, Warren, and Washington Counties	58-34 (702-5834)
Multiple course overlays, reconstruction, or new construction where cold temperature data warrants its use with the concurrence of the Regional Materials Engineer.	Upstate	64-28 (702-6428)
Multiple course overlays, reconstruction, new construction or roadway segments containing (a) grades in excess of 4.0% or (b) intersections that have traffic control signals (3 light signal) with the concurrence of the Region Materials Engineer.	Upstate	64-22 (702-6422)
Where the traffic level is greater than 30 million ESALs based on a 20-year design life or the roadway segment contains (a) grades in excess of 4.0% or (b) intersections that have traffic control signals (3 light signal).	Downstate	76-22 (702-7622)

1. Other PG binder grades may be specified in a given location with approval from the Regional Materials Engineer and the Materials Bureau.

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6.2.6 **Special Note Development**

The PG binder grade and the mixture's design level of "80 kN ESALs" must be conveyed by the designer to the Contractor in the form of a Special Note in the proposal. These notes are specific to the project location, either Upstate or Downstate. The note should read as follows:

PG binder requirements:

"Use a PG XX-XX meeting the requirements of AASHTO M320, Standard Specification for Performance Graded Asphalt Binder for the production of hot mix asphalt mixtures for this project."

XX-XX is the PG binder grade from the above tables.

In addition, include the following statement for Upstate projects:

"Use of polyphosphoric acid (PPA) to modify the PG binder properties is prohibited. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification."

For Downstate projects, include the following statement:

"Use of polyphosphoric acid (PPA) to modify the PG binder properties is prohibited for mixtures containing limestone, limestone as an aggregate blend component, limestone as a constituent in crushed gravel aggregate, or recycled asphalt pavement (RAP) that includes any limestone. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification."

Mixture design requirements:

"The mixture designs must be developed in accordance with the criteria specified in the HMA items that are appropriate for an "Estimated Traffic" level of YY Million ESALs."

YY is <0.3, <3, <10, <30, or ≥30 Million ESALs calculated as described in Section 4.5 of the CPDM. For Parkways, use <3 Million ESALs.

Example notes are provided in Appendix 6A.

6.2.7 **Gradation Considerations**

6.2.7.1 Base Course (402.37YZQR)

The nominal maximum aggregate size for HMA base course is 37.5 mm. When a thinner base course (75 mm or less) is required, the calculated ESALs are less than 3 million, or maintaining traffic on the base course is a concern, 25.0 mm nominal maximum aggregate size mixture may be used as a base course.

6.2.7.2 Binder Course (402.25YZQR, 402.19YZQR)

The choices for nominal maximum aggregate size for HMA binder course are 19.0 mm and 25.0 mm. The 19.0 mm size is preferred when the 20-year ESAL count is less than 10 million but it can also be used when pavement thickness prohibits the use of 25.0 mm size with the concurrence of the Regional Materials Engineer. In addition, 19.0 mm size should be used instead of 25.0 mm

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size when the binder layer will be left open to traffic through the winter season. The 25.0 mm size should be used for pavements with 20 year ESAL counts over 10 million. Larger aggregate sizes require greater lift thicknesses to ensure thorough compaction (refer to Table 6-6).

6.2.7.3 Top Course (402.12YZQR, 402.09YZQR)

The choices for nominal maximum aggregate size for HMA top course are 12.5 mm and 9.5 mm. Typically, the 12.5 mm mixture is more economical. In Regions where gravel aggregates are present or on urban projects where a lot of handwork is necessary, the use of a top course mix with a maximum nominal aggregate size of 9.5 mm may be specified. Designers should be aware of this issue and make sure that the Regional Materials Engineer is consulted to determine the appropriate gradation to specify.

6.2.8 **Compaction Monitoring**

Proper in-place density of HMA pavements is an essential component of pavement performance. NYSDOT uses four different compaction specifications to ensure proper density is achieved. The type of compaction specification depends first on the functional classification of the road, then the traffic volume, and last, the amount of material needed (less than 2000 Mg or not), or the calculated ESALs (less than 0.3 million or not).

On roadways with full or partial control of access, regardless of the traffic volume, location (upstate or downstate), the HMA quantity, the calculated ESALs, or vibratory sensitivity, the compaction would be determined by a direct method, such as coring, to verify the density. On urban roadways with no control of access, it is reasonable to use indirect methods, such as nuclear density gauge readings to evaluate density.

Since the method of monitoring the density is part of the specification for the item, the designer needs to include this decision in selecting which item to specify. See Tables 6-1 and 6-2 to select the appropriate item number except for 80 Series Compaction Method.

6.2.8.1 50 Series Compaction Method (402.XX5ZQR)

This method requires a Contractor takes cores daily to monitor pavement density. The results of these cores are used for incentive/disincentive payment. This compaction method should be specified on all full or partially controlled access roadways and applies only to Binder and Top courses.

6.2.8.2 60 Series Compaction Method (402.XX6ZQR)

This method requires a Contractor to monitor pavement density using a nuclear density gauge. The Project Target Density (PTD) for monitoring pavement density is established using pavement cores and gauge readings from a test section. This compaction method should be specified on all roadways that are not fully or partially controlled access or when the HMA quantity for the Top course is greater than or equal to 2000 Mg for the Top course layer. This method should be used for the Base, Binder, and Top courses.

6.2.8.3 70 Series Compaction Method (402.XX7ZQR)

This method requires a Contractor to monitor pavement density using a nuclear density gauge. The PTD for monitoring pavement density is established by peaking the nuclear gauge on a test section. This compaction method should be used for the Base, Binder, Top, and True & Leveling courses. The criteria for specifying this method is when:

- the HMA quantity for the Top course is less than 2000 Mg regardless of other layer quantities or,
- a nominal thickness for True and Leveling course is specified in the contract documents or
- when the calculated ESALs are <0.3 million.

6.2.8.4 80 Series Compaction Method (402.XX8ZQR)

This method requires a Contractor to compact the pavement by applying the number of passes specified in Table 402-5 of Section 402 of the Standard Specifications. The items for this method are not shown in Tables 6.1 and 6.2. However, this method should be specified for miscellaneous placements, shoulders, bridge approaches (regardless of the project location), True & Leveling, Shim, etc., where the distance of HMA placement does not permit the construction of a test section. All item numbers for this compaction method will be 402.XX8ZQR.

6.2.9 **Friction Aggregate Requirements**

HMA pavement friction is controlled primarily by the coarse aggregate component of the surface course. Department specifications allow only those coarse aggregate types found to provide design friction under design traffic conditions.

6.2.9.1 Mainline Pavement Surface Layer

The friction aggregate requirements for HMA pavements are dependent on each project's specific design parameters. Friction requirements are designated by the fourth digit of the pay item extension. Depending on a project's design parameters coarse aggregate in the surface course, HMA must meet F1, F2 or F3 requirements. Use Tables 6.1 and 6.2 to select the proper aggregate requirements for each project. For short placements using 80 series item numbers, i.e., bridge approaches, an appropriate fourth digit designating proper friction must be selected. The aggregate requirements for the entire project are dictated by that segment within the project with the most stringent requirements.

6.2.9.2 Flexible Shoulders, Miscellaneous Placements and Subsurface Layers

HMA for flexible shoulders, miscellaneous placements: driveways, culvert inverts, etc., and subsurface layers require coarse aggregate meeting F9 requirements. F9 requirements are specified by placing a 9 in the fourth digit of the pay item extension, see Figure 6.1.

6.2.10 **Quality Adjustment Items**

NYSDOT began making payment adjustments for the quality of HMA in 1990 for in-place density and in 1996 for plant production. These payment adjustments were based on the density of the finished pavement and/or the production quality of HMA material. For Portland Cement Concrete (PCC), NYSDOT began making payment adjustment on pavement smoothness beginning 2001. The payment adjustment will be made by *Quality Adjustment Factors* using a pay unit called a

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Quality Unit.

All the quality units are paid at a predetermined Index Price. The HMA Index Prices have been created based on HMA weighted average bid prices. One index price is used for all HMA quality adjustment items in a contract and applies for the duration of the contract. Index prices will be established and updated by an Engineering Bulletin annually and preprinted in the contract documents.

In order to simplify the Contractor's accounting procedures, separate quality payment items were created for each of the possible quality payment adjustments: plant production, pavement density, longitudinal joint density (future), and pavement smoothness (future). All quality adjustments will be paid under the appropriate quality adjustment item number in the contract documents and are listed in Table 6-5. To estimate the quality units for each quality payment item, the following formula should be used:

$$\text{Quality Units} = (\text{Max. Quality Adjustment Factor} - 1.00) \times \text{Appropriate HMA Tons}$$

Currently, the maximum QAF for both plant production and pavement density is 1.05.

Table 6-5 Description of Quality Adjustment Items

Quality Adjustment Items		Apply Quality Adjustments to the following Items:
402.____1_ M =	Plant Production Quality Adjustment ¹	All asphalt items paid by the metric ton <u>except</u> for ice retardant asphalt.
402.____2_ M =	Pavement Density Quality Adjustment	Only apply to Superpave 50 series items. ²
402.____3_ M =	Longitudinal Joint Density Quality Adjustment	Not for general use at this time. ²
402.____4_ M =	Pavement Smoothness Quality Adjustment	Not for general use at this time. ³

1. The Quality Units for plant production adjustments are computed from the total tonnage of HMA in the contract.

2. The Quality Units for pavement density and longitudinal joint density adjustments are computed from the top and binder course tonnage on the traveled lanes and ramps longer than 400 m. Shoulders, tapers, maintenance crossovers, etc., are not subject to QAFs. When calculating the tonnage eligible for quality adjustment, refer to the core item's Method of Measurement.

3. The Quality Units for pavement smoothness adjustments are computed from the top course tonnage on the traveled lanes and ramps longer than 400 m. Shoulders, tapers, maintenance crossovers, etc., are not subject to QAFs. When calculating the tonnage eligible for quality adjustment, refer to the core item's Method of Measurement.

6.2.11 Lift Thickness Limitations

In general, minimum lift thicknesses are established by the nominal maximum size of the aggregate that is to be compacted. Maximum lift thicknesses are set to ensure that the full thickness of the lift is adequately compacted. If the required course thickness of a given item exceeds the maximum permissible lift thickness, then multiple lifts are to be used to obtain the required course thickness. Table 6-6 lists the minimum and maximum lift thicknesses for the various nominal maximum aggregate sizes. Note that the lift thickness for multiple lifts is to be 2/12/08

indicated on the typical section drawings for the project.

Table 6-6 Limits on Permissible Lift Thicknesses

Maximum Nominal Aggregate Size (mm)	Minimum Lift Thickness (mm)	Maximum Lift Thickness (mm)
37.5	75	125
25.0	65	100
19.0	50	75
12.5	40	50
9.5	40	50

6.2.12 Truing and Leveling (402.01Y901, where Y =7 or 8)

Truing and Leveling (T&L) should be used at spot locations to remove irregularities in the old pavement, fill and patch holes, correct variations in banked pavement, establish pavement crowns, establish the proper cross-slope and grade and for the terminations of the overlay as noted in section 5.4.2 of this manual. When a T&L course is required, it should be indicated on the typical sections in the plans with a specific aggregate size mixture since there is no specific T&L material. When a mixture is not specified, the selection of the appropriate mixture will be left to the discretion of the Contractor depending on the thickness needed for the T&L course. This course will be of variable thickness and its material composition will be adjusted in accordance with the thickness required.

When choosing compaction method for T&L, the item with 70 Series method should be used when a nominal thickness to be placed is specified in the contract. However, a T&L item with 80 Series method should be used when T&L is specified to correct the grade and slope of the pavement section. These items are recommended to be used for all Functional Classifications and require aggregates meeting F9 requirements.

Note that T&L is not to be used as a substitute for a lift of an overlay by specifying full width applications of a given minimum thickness. When corrections are needed over the length of the project, an "initial asphalt paving" course of the minimum thickness and the appropriate type to correct the transverse slope is to be specified.

6.2.13 Vibratory Compaction Procedure

When the HMA is compacted using vibratory compaction equipment, there is a potential for damage to sensitive structures, such as weak, old masonry structures that are in close proximity to the work or underlying utilities, etc. To determine if an area may have structures or utilities that could be damaged by vibratory compaction, the State Highway Maintenance supervisors, utility companies, and local highway maintenance officials should be consulted. When a section within the project limits is vibratory sensitive and has the potential of damage, it should be compacted using non-vibratory (static) compaction equipment. In that case, the limits of this section should be indicated in the plans. When the entire project is vibratory sensitive, a Special Note should be included in the proposal indicating that vibratory compaction should not be used for the project.

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6.2.14 **Handwork**

When a project requires the HMA mixture to be placed with a lot of handwork, consideration should be given to the use of 9.5 mm mixture with the concurrence of the Regional Materials Engineer. The 9.5 mm mixture is suited for this purpose because of a smaller stone size and generally, a well-graded aggregate mixture. In addition, this mixture can easily be placed and compacted with hand tampers or other small compaction equipments.

6.2.15 **Tack Coat**

In the past, tack coat was used only when HMA was placed on existing Portland Cement Concrete (PCC), on milled surfaces or on existing HMA pavement. Experience has shown it is also beneficial to use tack coat between lifts of new HMA. Tack coat enhances the bond between HMA lifts. This is particularly important for HMA mixtures which have lower binder contents than previously used. Contact surfaces between all HMA pavement lifts will therefore be tack coated in accordance with Section 407 - Tack Coat prior to placing HMA mixture. The only exception to this is the surface of permeable base course. The application rates in Table 6-7 should be used to estimate the quantity of tack coat required.

Table 6-7 Tack Coat Application Rates

Surface Type	Application Rate(L/m²)
New Hot Mix Asphalt	0.14 - 0.18
Milled Surfaces	0.21 - 0.25
Existing Hot Mix Asphalt	0.21 - 0.25
Portland Cement Concrete	0.17 - 0.30
Vertical Surfaces (curbs, concrete drainage structures and appurtenances)	0.27 - 0.32

6.3 PORTLAND CEMENT CONCRETE

The majority of NYSDOT's Interstate system was constructed from 1960 through the mid 70's using PCC. Most of those pavements have outlived their intended service lives and many have been overlaid with HMA. Since the mid 80's through the early 90's, there had been a limited amount of new PCC pavement placed. These pavements were designed and built using shorter, 6.1 m unreinforced slabs.

The current PCC pavement design for new pavements is a Jointed Plain Concrete Pavement (JPCP) with 5.0 m typical slab lengths, edge drains, and a cement treated permeable base drainage layer. These pavements are typically constructed with Class C concrete, although Class F concrete or High Early Strength concrete may be specified. Details about PCC materials and construction are found in the Standard Specifications and the M502 Standard Sheets.

The following guidelines should be used when designing a PCC pavement:

6.3.1 Project Selection

When constructing or reconstructing roads projected to carry high traffic volumes and/or high equivalent single axle loads (ESALs) consider PCC pavements. PCC pavement construction atop rubblized PCC pavement is also governed by Section 502.

6.3.2 Thickness Selection

For pavement layer thicknesses, refer to Chapter 4 of this manual. The layer thicknesses must be shown in the plans.

6.3.3 Pavement Hardware

The type, size, and spacing of longitudinal joint ties, transverse joint supports (dowels), reinforcing mesh, and reinforcing steel are depicted in the M502 Series Standard Sheets for Portland Cement Concrete Pavements.

6.3.4 Projections Into The Pavement

Whenever possible, drainage structures, utilities, and other projections into the pavement should be moved from travel lanes and into medians, shoulders, sidewalks, or other areas not routinely exposed to traffic. Such projections into the pavement:

- Reduce the concrete cross section, thereby decreasing structural capacity.
- Introduce complex joint layouts, irregular slabs, or high-cost heavily reinforced slabs.
- Require significant effort to properly consolidate the concrete and isolate the structure.
- Present weakened planes in plastic concrete which may initiate uncontrolled cracking.
- Interrupt paving.
- Result in bumps.

If projections must be placed in travel lanes:

- Space them such that reasonable transverse joint layouts may be accommodated. In general, space projections such that their midpoints are at least 3.5 m apart longitudinally. This

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includes projections in different lanes. That is, to accommodate reasonable transverse joint layouts, assume all projections that occur across multiple lanes occur only in one lane. This one lane then controls transverse joint locations across multiple lanes.

- Center any portion of a projection that protrudes into the permeable base or PCC between longitudinal joints. If centering between longitudinal joints is not possible, locate the structure such that any portion that protrudes into the permeable base or PCC is at least 300 mm from any longitudinal joint. Avoid placing projections in the wheel paths or on longitudinal joints.
- Set the projection to a depth such that at least 100 mm of subbase can be placed between the top masonry surface of the projection and the bottom of the permeable base or the PCC slab isolating the projection.

6.3.5 **Joint Layout**

The need to provide a complete joint layout in the plans varies with project complexity. Generally, it is not practical to provide a complete joint layout in the plans because moving one joint during construction alters the layout significantly. It is recommended that the longitudinal joint locations be included in the plans if there are multiple maintenance and protection of traffic (M&PT) stages. Separate sheets devoted solely to joint layout, showing the longitudinal joint locations and projections within 250 mm of the bottom of the PCC slabs, are helpful to both the Contractor and Engineer when laying out joints at the project.

It is highly preferable to align longitudinal joints between travel lanes with the final longitudinal pavement markings. The Contractor is required to submit the final joint layout based on construction staging and the locations of projections, tapers, irregular areas, etc. The joint layout is subject to the Engineer's approval. Guidance for joint layout is found in Standard Sheets M502-17.

For PCC intersections, a proposed joint layout should be included in the plans to provide the Contractor with a reasonable expectation of the work required. Intersection joint layouts are typically complex because of projections and intersecting centerlines. In the plans, reference Note 1 on Standard Sheet M502-17, Utility Isolation and Joint Layout - General Notes, to inform the Contractor that the joint layout is proposed only, and they are responsible for developing the final joint layout. The Field Engineering II Section of the Materials Bureau is available to assist in developing the proposed joint layout.

When designing a PCC intersection, extend the PCC limits to the point where hot mix asphalt (HMA) rutting and shoving are likely to begin.

6.3.6 **Slab Geometry**

Show the typical slab length and width in the plans. The Standard Sheets depict slab lengths (transverse joint spacings) between 3.5 m - 5.5 m to allow flexibility during construction to accommodate utilities, drainage structures, and other projections into the pavement. For travel lanes, a typical slab length of 5.0 m is recommended for typical 3.6 m or 4.2 m slab widths, resulting in width-to-length ratios of 0.72 and 0.84, respectively.

Consult Standard Sheet M502-11 for slab lengths associated with non-typical slab widths. A recommended maximum slab length at any location is the minimum slab width at that location divided by 0.70. A recommended minimum slab length is the maximum slab width divided by 1.33. Furthermore, if the project is designed without widened outer slabs, tied PCC shoulders, tied

gutters, or tied curbs, then a combination of shorter slab lengths and/or thicker slabs may be required. Consult the Materials Bureau.

6.3.7 **Work Zones**

Whenever possible, remove traffic from the facility under construction or make work zones as large as possible. Large work zones foster smoother, longer lasting, and less costly pavements by:

- Allowing the use of high-quality, high-volume paving equipment.
- Minimizing short or irregular placements.
- Enhancing concrete delivery which reduces truck rejection, joint construction, and sub-optimal joint configurations.

6.3.8 **Class F and High-Early-Strength (HES) Concrete**

Include an item for Class F concrete if the project is likely to contain short or closure placements that need to be opened to traffic more quickly than a Class C concrete allows. Class F concrete is typically opened to traffic 3 days after placement, while Class C concrete is typically opened 10 days after placement. If an even higher early strength concrete is required to expedite construction, select one of the HES pay item numbers. If an HES pay item is selected for a location, the contract documents should also include a work zone closure time frame for that location. The Contractor will design the HES mix based on the assigned closure time frame and the work required. When selecting a work zone closure time frame, consider HES mixes to be capable of developing the strength required for traffic opening 12 hours after placement, however, 18-hour mixes are preferable. Select joint filling items where HES concrete items are specified.

6.3.9 **Concrete Compressive Strength Determination**

Consult the Regional Materials Engineer to determine if compressive strength testing should be performed by the Regional Materials staff, rather than by the Contractor. If the Regional Materials Engineer elects to perform the testing, include a special note in the contract documents. This note is included in the appendix of this chapter and must include the Regional Materials Engineer's address.

6.3.10 **Smoothness Requirements**

If a high level of smoothness is desired, consult the Materials Bureau for the recommended smoothness level and select one of the profilographed items. Select a Level 1 item for projects with sizable work zones and few or no projections into travel lanes. As a minimum, interstate and expressways should be built to Level 2 smoothness requirements. Deceleration or acceleration lanes tied to the main line pavement should have the same smoothness requirement as the main line pavement. After separation from the pavement, PCC ramps, when selected, can also be constructed using a profilograph item depending on geometrics, speed, and work zone availability.

Select unprofilographed items for low-speed roads, city streets, intersections, or tied PCC shoulders. The portion of the shoulder placed as part of a widened driving lane should have the same smoothness requirement as the travel lane. Profilographed and unprofilographed work limits can be included in the same project. For example, the "legs" of an intersection built to a grade line can be profilographed, but the transitions between different grade lines, or over the crown of the intersection, can be unprofilographed.

If a profilographed item is selected, include the corresponding pay item for the Smoothness Adjustment Factor in the contract documents. Quality Unit is the pay unit for the Smoothness Adjustment Factor. To estimate the quantity of Quality Units of profilographed items, use the following formula

$$\text{Estimated Quality Units} = (\text{Max. Quality Adjustment Factor} - 1.00) \times \text{volume (m}^3\text{) of profilographed PCC}$$

Currently, the maximum QAF for PCC smoothness is 1.05.

At this time, an Index Price for Quality Units has not been generated. Consult the Materials Bureau to establish an Index Price for Quality Units, which will be preprinted in the contract documents.

6.3.11 Diamond Grinding Slurry Removal

Include a note or table in the contract documents indicating where diamond grinding slurry must be removed from the project. Slurry must not be deposited on business or residential property or into:

- Closed drainage systems.
- Occupied travel lanes.
- Wetlands, streams, estuaries, or sensitive environmental resources.
- Areas where it will become a public nuisance.

6.3.12 Shoulder Type Selection

Use tied PCC shoulders or tied PCC curbs and/or gutters if the outer slabs cannot be widened 600 mm beyond the travel lane width as depicted in the Standard Sheets. If the outer slabs can be widened 600 mm, there are advantages to using full-depth HMA shoulders. HMA shoulders:

- Are typically less costly for initial construction.
- Result in less full depth PCC removal and replacement costs on future Concrete Pavement Restoration (CPR) projects.
- Will not crack due to poor width-to-length ratios (e.g., 1.2 m wide inside PCC shoulders with 5.0 m lengths result in a very slender 0.24 ratio).
- Can simplify construction, particularly when projections are in the shoulder.

Tied PCC shoulders used to maintain traffic during construction should be constructed with transverse joint supports.

6.3.13 Ramp Type Selection

After a ramp diverges from the mainline pavement, treat it as a separate design. Consider the anticipated traffic volume and geometrics when deciding between full-depth PCC or HMA ramps.

6.3.14 Joint Sealing or Joint Filling

Select an item to either seal pavement joints or fill pavement joints. At this time, the issue of whether to use a high quality joint sealant (neoprene compression or silicone sealant) or a lower quality joint filler (ASTM D3405) is debated nationwide. A body of research is gaining acceptance

that indicates the cost of initially sealing joints and maintaining a high quality seal over the pavement service life is unjustified.

Historically, NYSDOT has sealed pavement joints. However, considering NYSDOT's new pavement design which incorporates a permeable base and short slab lengths, the recent trend has been to fill joints because:

- A properly sealed joint will better keep water and debris out of the joint.
- Sealing is more expensive than filling.
- Upon material failure, a filled joint will collect less debris because it is narrower.
- A filled joint is quieter because it is narrower.
- A filled joint can be widened and sealed at a later date.
- When a previously sealed joint is resealed, noise from "tire slapping" increases.
- Filling joints expedites construction.
- If a Region is unlikely to close a heavily trafficked road to reseal, select filling.
- Select filling wherever an HES item is specified.

Consult the Materials Bureau for guidance.

6.4 PERMEABLE BASE

The permeable base course is intended to quickly remove water that infiltrates the pavement to an edge drain system, thus preventing the lower pavement layers from becoming saturated and losing strength (which reduces pavement life). It is a free-draining layer, capable of draining both surface water and preventing water accumulation from the subbase below. Water drains through it as fast as it enters in, retarded only by the cross-slope and any obstructions. There are two types of treated permeable bases: Asphalt Treated Permeable Base (ATPB) or Portland Cement Treated Permeable Base (PCTPB). ATPB is used only with HMA pavements and PCTPB is used only with PCC pavements. Treated permeable bases should be used in all cases. Refer to Chapter 9 of this manual for further discussion of permeable base and Appendix 5B for a listing of current item numbers.

For constructibility reasons, the minimum thickness of permeable base is 100 mm.

6.4.1 Asphalt Treated Permeable Base (ATPB)

ATPB is a mixture of asphalt and coarse aggregate with less strength than HMA but providing structural support and permeability at the same time. Once the permeable base layer is placed and compacted, the surface must be protected from any damage or debris which may decrease the strength or permeability of the mixture.

There are two types of ATPB mixtures which can be specified. Type 1 Permeable Base should be specified when the project warrants the use of Asphalt Treated Permeable Base. This Permeable Base requires the layer to be cooled for at least 24 hours prior to overlaying with the subsequent layer. When the roadway must be opened to traffic immediately, Type 2 Permeable Base should be specified so subsequent layer can be placed immediately for traffic to run on it.

6.4.2 **Portland Cement Treated Permeable Base (PCTPB)**

PCTPB is a lean, concrete cement mixture. Care should be taken when placing PCTPB in forms since the paste from the PCC above will run down the form and cover the face of the PCTPB. PCC paste will also intrude into the PCTPB, fill the voids in the top 25 to 50 mm, weakening the PCC above, and leaving only 50 to 75 mm of drainable PCTPB layer.

6.5 SUBBASE COURSE

Subbase course is used to provide support for PCC slabs and as a structural component for HMA pavements. The ideal subbase is strong, uniform, and free draining. Strength is derived from the gradation of the material and its placement. Uniformity is provided by stockpiling subbase material. The free draining characteristic depends on the percentage of fine particles (fines). Unfortunately, a granular material derives more of its strength by packing the voids with fines. Because of the allowance of up to 10% fines, the subbase is considered an impermeable layer, not free draining.

Section 304 of the Standard Specifications describes the material requirements for subbase course. The most commonly used subbase used is Type 2, followed by Optional Type and Type 4. Several special specifications allow the use of reclaimed bituminous pavement and/or shoulder material in the subbase. Subbase Course, Type 1011 is used in Regions 10 and 11 and allows the use of locally available materials in subbase construction. Consult the Regional Geotechnical Engineer for questions concerning using special subbase specifications. The subbase layer is typically 300 mm thick.

6.6 SUBGRADE

6.6.1 **Subgrade Improvements**

The purpose of the subgrade area is to provide a uniform, stable platform on which to place the pavement structure and to minimize differential frost heaves. The subgrade area is generally defined as that portion of an embankment situated above either (1) a line located 0.6 m below the subgrade surface and extended to the intersection with the embankment side slopes, or (2) the embankment foundation, whichever is higher (refer to NYSDOT Standard Specification book subsection 203-1.05.) This area excludes any material placed under another specification, particles greater than 150 mm, or unsuitable material.

Methods to improve the subgrade area are as follows:

1. Reduce the amount of water in the subgrade area. Improve drainage by creating roadside ditches to a depth of 1.2 m, measured from the pavement edge to the ditch flow line. Underdrains and crushed stone trenches may be used to lower the water table in cut sections, see Chapter 9 of this manual for more information. Also note when modifying a ditch cross section it is important to consider the traversability of the section relative to the design clear zone. See HDM Chapter 10.
2. Minimize differential frost heaves or increase load-bearing capacity. The most common method is to remove unsuitable (organic) or unstable (saturated) materials and replace them with select granular subgrade material. Item 203.20 M Select Granular Subgrade of the

Standard Specifications is typically used.

Subbase material alone or in combination with a geotextile may also replace removed material. Rock should be fragmented and drained. Transition sections at culverts and in boulder removal areas are also used to provide uniformity.

3. Stabilize subgrade. Stabilize the subgrade with rollers that are 27 to 45 metric ton proof-roller-type compactors (refer to NYSDOT Standard Specifications Subsection 203-3.13 and 203-3.14.) Mix in-situ material to break up stratified layers into more uniform material. Clayey soils can be stabilized by adding lime.

The designer should always contact the Regional Geotechnical Engineer for subgrade improvement recommendations.

6.6.2 Subgrade Resilient Modulus - M_r

The subgrade resilient modulus, M_r , is a measure of the stiffness of the subbase and subgrade soils. It is a necessary component for determining the pavement thicknesses of HMA pavements. See section 4.5.3 of this manual. The higher the M_r , the stronger the subgrade soil, and the better support it will provide to the pavement.

The designer should contact the Regional Geotechnical Engineer to obtain a value for the subgrade resilient modulus, M_r . For reconstruction projects, M_r values can be determined by either taking soil samples (by comparing blow counts with visual descriptions) or Falling Weight Deflectometer (FWD) testing along the proposed project route. FWD testing is conducted by the Geotechnical Engineering Bureau. For new projects or widenings, M_r values can be found by taking soil samples.

M_r values below 28 MPa (4,000 psi) may signify a fine-grained soil. Poorly drained soils will also have lower M_r values. M_r values below 21 MPa (3,000 psi) indicate soft soil, probably with poor drainage, and offers weak subgrade support. M_r values from 34 to 48 MPa (5,000 to 7,000 psi) are characteristic of fine to medium-grained soil and are typical values for most NYS roadway subgrades.

EXAMPLE SPECIAL NOTE FOR UPSTATE STANDARD PG BINDER**SPECIAL NOTE****PG BINDER AND MIX DESIGN LEVEL**

Requirements of this note apply to all Section 402 Hot Mix Asphalt (HMA) items in this contract.

PG BINDER

Use a PG 64-22 meeting the requirements of AASHTO M320, Standard Specification for Performance Graded Asphalt Binder for the production of HMA mixtures for this project.

Use of polyphosphoric acid (PPA) to modify the PG binder properties is prohibited. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification.

MIX DESIGN

The mixture designs must be developed in accordance with the criteria specified in the HMA items that are appropriate for an "Estimated Traffic" level of YY Million ESALs.

EXAMPLE SPECIAL NOTE FOR UPSTATE POLYMER MODIFIED PG BINDERS**SPECIAL NOTE****PG BINDER AND MIX DESIGN LEVEL**

Requirements of this note apply to all Section 402 Hot Mix Asphalt (HMA) items in this contract.

PG BINDER

Use a polymer modified Performance Graded (PG) Binder PG XX-XX for the production of HMA mixtures for this project. The PG Binder shall meet the requirements of AASHTO M320, Standard Specification for Performance Graded Asphalt Binder and **Elastic Recovery** requirements as shown in the table below:

TEST ON THE ROLLING THIN FILM OVEN (RTFO) BINDER SAMPLE

Test	Requirements
Elastic Recovery using ASTM D6084-04, Testing Procedure A, at 25°C	60% minimum

Use of polyphosphoric acid (PPA) to modify the PG binder properties is prohibited. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification.

MIX DESIGN

The mixture designs must be developed in accordance with the criteria specified in the HMA items that are appropriate for an "Estimated Traffic" level of YY "Million ESALs."

Note: The PG binder for this project will be modified using polymer additives to meet the requirements stated above. Handling of the HMA shall be discussed at pre-construction and pre-paving meetings.

EXAMPLE SPECIAL NOTE FOR DOWNSTATE STANDARD PG BINDER**SPECIAL NOTE****PG BINDER AND MIX DESIGN LEVEL**

Requirements of this note apply to all Section 402 Hot Mix Asphalt (HMA) items in this contract.

PG BINDER

Use a PG 70-22 meeting the requirements of AASHTO M320, Standard Specification for Performance Graded Asphalt Binder for the production of HMA mixtures for this project.

Use of polyphosphoric acid (PPA) to modify the PG binder properties is prohibited for mixtures containing limestone, limestone as an aggregate blend component, limestone as a constituent in crushed gravel aggregate, or recycled asphalt pavement (RAP) that includes any limestone. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification.

MIX DESIGN

The mixture designs must be developed in accordance with the criteria specified in the HMA items that are appropriate for an "Estimated Traffic" level of YY Million ESALs.

EXAMPLE SPECIAL NOTE FOR DOWNSTATE POLYMER MODIFIED PG BINDER**SPECIAL NOTE****PG BINDER AND MIX DESIGN LEVEL**

Requirements of this note apply to all Section 402 Hot Mix Asphalt (HMA) items in this contract.

PG BINDER

Use a polymer modified Performance Graded (PG) Binder PG 76-22 for the production of HMA mixtures for this project. The PG Binder shall meet the requirements of AASHTO M320, Standard Specification for Performance Graded Asphalt Binder and **Elastic Recovery** requirements as shown in the table below:

TEST ON THE ROLLING THIN FILM OVEN (RTFO) BINDER SAMPLE

Test	Requirements
Elastic Recovery using ASTM D6084-04, Testing Procedure A, at 25°C	60% minimum

Use of polyphosphoric acid (PPA) to modify the PG binder properties is prohibited for mixtures containing limestone, limestone as an aggregate blend component, limestone as a constituent in crushed gravel aggregate, or recycled asphalt pavement (RAP) that includes any limestone. This prohibition also applies to the use of PPA as a cross-linking agent for polymer modification.

MIX DESIGN

The mixture designs must be developed in accordance with the criteria specified in the HMA items that are appropriate for an "Estimated Traffic" level of YY "Million ESALs."

Note: The PG binder for this project will be modified using polymer additives to meet the requirements stated above. Handling of the HMA shall be discussed at pre-construction and pre-paving meetings.

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 7 - Shoulders (Limited Revisions)

Revision 1

July 2, 2002

CHANGES TO CHAPTER 7

Pages Changes

Contents List of Figures and Tables included.

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7.1 INTRODUCTION

The shoulder is that portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles for emergency use. Parked traffic is estimated at 0.05 to 0.1 percent of mainline (traveled-way) traffic. The shoulder is generally referred to as the paved section next to the mainline.

Shoulders provide lateral support of the base and surface courses of the mainline, promote surface drainage, provide a temporary lane for occasional peak traffic use, and delineate the edge of the roadway. Some shoulders are used under peak traffic conditions or as alternate lanes during bridge or highway construction. All shoulders are used by maintenance traffic.

Shoulders should be durable, compatible with the adjacent mainline pavement, strong enough to handle heavy truck encroachment, endure maintenance traffic, and be on the same maintenance schedule as the mainline. They should provide lateral support for the mainline with either a maintainable joint at the mainline, or ideally, no joint next to the mainline.

7.2 MISCELLANEOUS SHOULDER FEATURES

Discussions of shoulder width, delineation, break, cross-slope, rollover limitations, and edge of shoulder treatment are covered in the Highway Design Manual, HDM.

Shoulder widths vary according to functional classification and traffic volumes. Refer to the HDM Section 2.7 for new construction/reconstruction projects, HDM Sections 7.2, 7.3 for reconstruction projects, and HDM Section 3.2.5 for additional width and lateral clearance information.

Delineation of the shoulder and rumble strips are discussed in HDM Section 3.2.5. The solid painted line defines the edge of pavement and the beginning of the shoulder.

The shoulder break is the intersection of the shoulder slope and the embankment slope or ditch slope plane. It is typically 0.7 m outside the edge of the paved shoulder. Shoulder breaks are discussed in HDM Section 3.2.12.

The cross-slope is the slope of the pavement towards the roadside. A cross-slope break (increase in cross-slope) at the shoulder is necessary to quickly drain off rain, snow and ice from the driving lanes. For PCC pavements with the 600 mm extension, the cross-slope break should be at the edge of the extension. For all other cases the cross-slope break should be at the edge of traveled way, (the edge of the driving lane.) Further information about mainline and shoulder cross-slopes, and roll over limitations is provided in HDM Section 3.2.5.

Edge of shoulder treatments are addressed in HDM Section 3.3.5, including standard edge of the shoulder details, and preventative treatments for edge of shoulder rutting problems and dropoffs.

Changes in the subgrade surface slope under the shoulder are discussed in HDM Section 3.2.4.6.

7.3 FULL-DEPTH SHOULDERS

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Full-depth shoulders have the same cross-section thicknesses and layer types as the adjacent travel lane, although Portland Cement Concrete (PCC) mainlines can use either full-depth PCC (Figure 7-1) or Hot Mix Asphalt (HMA) shoulders (Figure 7-2). When PCC driving lanes have a 600 mm slab extension into the shoulder, (refer to Section 4.5.2 of this manual), PCC/HMA shoulder combinations may be possible, as shown in Figure 7-2.

PCC shoulders are always full-depth. Full-depth shoulders should be used on new construction and reconstruction projects with PCC mainlines and for certain HMA mainlines as defined in Table 7-1.

Full-depth shoulders are designed to have the same 50-year design life as the mainline pavement,. They can also be rehabilitated at the same time as the mainline. Pavement edgedrains are typically placed under the outer edges of the shoulder, as shown in Figure 7-1.

HMA shoulders may be used for PCC mainlines when the HMA portion of the shoulder is wider than 1.2 m, (HMA shoulders less than 1.2 m wide are difficult to compact). When HMA shoulders are used, the PCC pavement thickness may increase. Refer to Section 4.5.2.3 of this manual for more information. PCC shoulders are preferred over HMA shoulders for PCC mainlines since they require less maintenance over the life of the pavement and will follow the same maintenance schedule as the mainline.

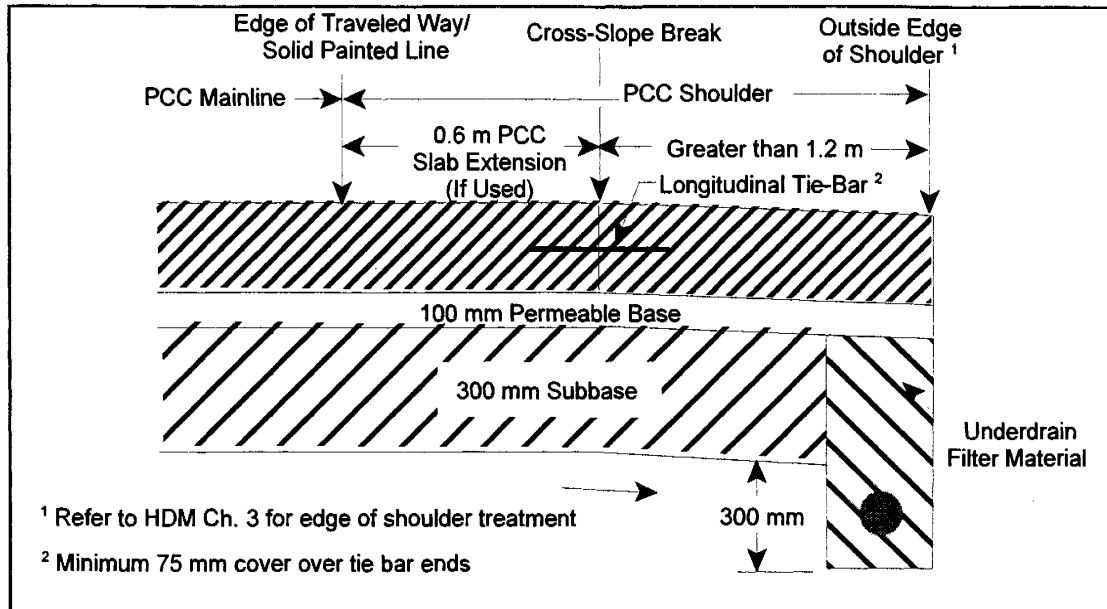
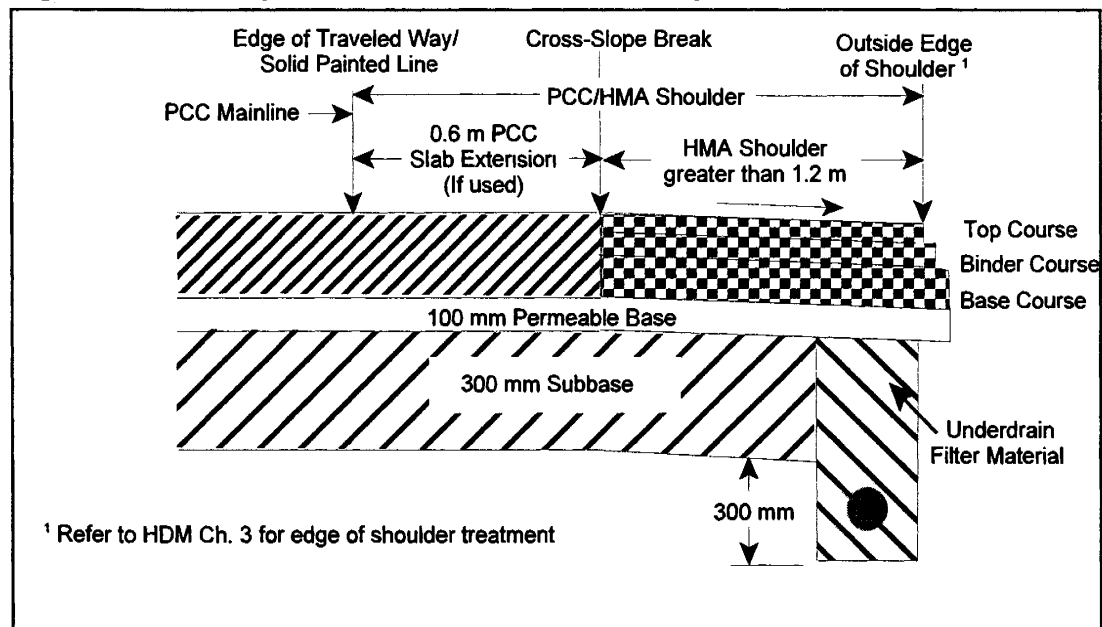
For PCC shoulders, the shoulder and the abutting travel lane may be placed in a single pour without a longitudinal joint, as shown in Figure 7-3. The maximum slab width should meet the geometric criteria of Standard Sheet M502-17, general note 3A, with a maximum combined slab width of 5.5 m. In this case, the cross-slope should change at the edge of traveled way. As noted on Standard Sheet M502-11, general note 6, this combination shoulder/travel lane is at the contractor's election. The shoulder cross-slope shall still be maintained consistent with the shoulder cross-slope requirements of the Highway Design Manual Chapters 2 and 3.

The item selection guidelines for HMA top, binder and base course is located in Chapter 6 of this manual. Note that the same binder and base courses are used for the mainline and shoulder, however the shoulder top course is paid under a different item number, which does have friction requirements. Current item numbers are located in Appendix 5B of this manual.

The edgedrain locations shown in the shoulder sections are for reference. Refer to Chapter 9 of this manual for information about subsurface drainage design.

Refer to Table 7-1 for guidance on when to use full-depth shoulders and Figures 7-1, 7-2, 7-3, and 7-4 for typical sections.

Table 7-1 provides designs based on specific criteria for new construction and reconstruction projects.

Figure 7-1 Full-Depth PCC Shoulder with Full-Depth PCC Mainline**Figure 7-2 Full-Depth HMA Shoulder with Full-Depth PCC Mainline**

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Figure 7-3 Full-Depth Combined PCC Shoulder and Mainline

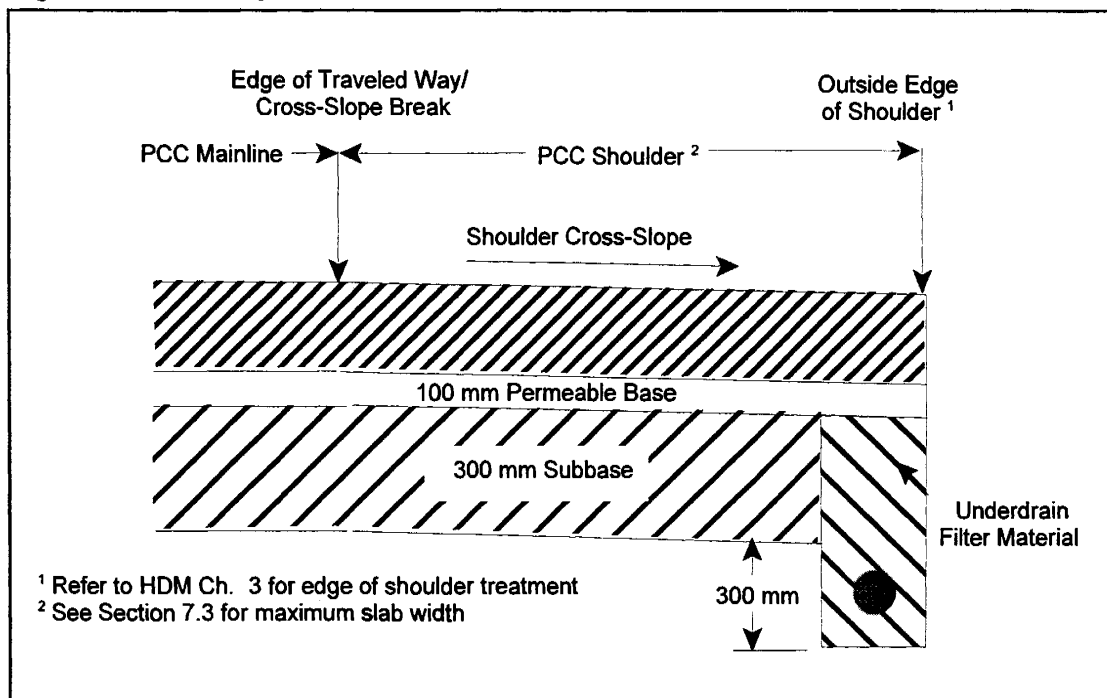
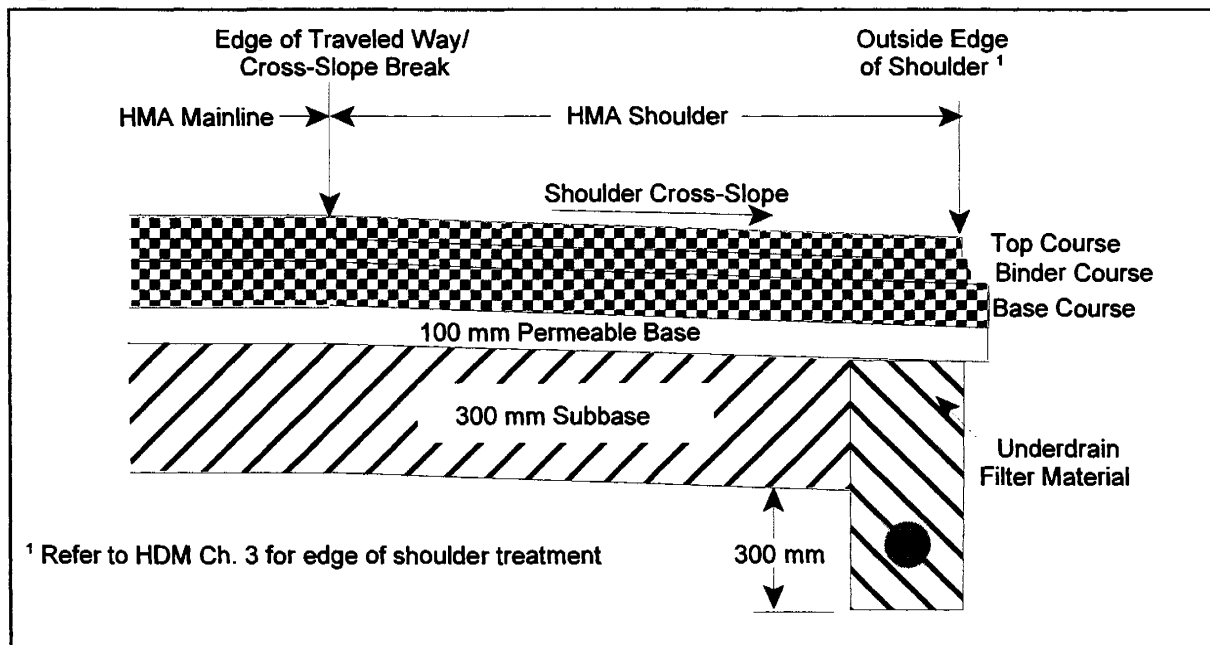


Figure 7-4 Full-Depth HMA Shoulder with Full-Depth HMA Mainline



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Table 7-1 Shoulder Design for New Construction/Reconstruction

CRITERIA	SHOULDER DESIGN
PCC mainline - shoulder widths greater than 1.2 m	Full-depth PCC shoulder - longitudinally tied joints, transverse load transfer dowels in 600 mm extension section of shoulder only, refer to Fig.7-1 <u>or</u> Full-depth HMA shoulder when the HMA portion is wider than 1.2 m (see <i>Section 7.2 for when to use PCC or HMA Shoulders</i>), refer to Fig. 7-2 <u>or</u> Full-depth PCC shoulder when the combined lane and shoulder width is 5.5 m or less - no longitudinal joint between mainline and shoulder, cross-slope break at edge of traveled way, refer to Fig.7-3
PCC mainline - shoulder widths 1.2 m or less	Full-depth PCC shoulder - no longitudinal joint between mainline and shoulder, cross-slope break at edge of traveled way, refer to Fig.7-3
PCC mainline - shoulder to be used as alternate lane during peak traffic conditions	Full-depth PCC shoulder - longitudinally tied joints and transverse load transfer dowels, see Fig.7-1

Refer to PCC Standard Sheets for further information.

HMA mainline - interstates & freeways	Full-depth HMA shoulder, refer to Fig.7-4
HMA ramp sections - interstates & freeways	Full-depth HMA shoulder, refer to Fig.7-4
HMA mainline - shoulder widths 1.2 m or less	Full-depth HMA shoulder, refer to Fig.7-4
HMA mainline - having an (AADT x % trucks)* greater than 600	Full-depth HMA shoulder, refer to Fig.7-4
HMA mainline - shoulder widths greater than 1.2 m and less than or equal to 1.8 m, and having an (AADT x % trucks)* between 250 and 600	Full-depth HMA shoulder, refer to Fig.7-4
HMA mainline - shoulder widths greater than 1.8 m and (AADT x % trucks)* between 250 and 600	Partial-depth HMA shoulder with 600 mm wide full-depth extension, top and binder courses match mainline course thicknesses, no permeable base in partial-depth section, refer to Fig.7-5
HMA mainline - shoulder widths greater than 1.2 m and (AADT x % trucks)* less than 250	Partial-depth HMA shoulder, top and binder courses match mainline course thicknesses, no permeable base in partial-depth section, refer to Fig.7-6

**AADT x % trucks: both values are found in the Highway Sufficiency Ratings Manual. Use values for the current available year. For example: a HMA mainline section with a shoulder width of 2.0 m, 3820 AADT, and 5% trucks. $AADT \times \% \text{ trucks} = 3820 \times 0.05 = 191$. Use the last choice, a partial-depth HMA shoulder with matching top and binder courses.*

7.4 PARTIAL-DEPTH SHOULDERS

Partial-depth shoulders are HMA shoulders that have an HMA thickness less than the mainline pavement thickness. Rehabilitated pavements and shoulder replacements for either HMA or PCC mainlines should use partial-depth HMA shoulders as shown in Table 7-2. New and reconstructed pavements may also use partial-depth HMA shoulders for certain cases as listed in Table 7-1. Partial-depth PCC shoulders are no longer used since they are not cost-effective for these cases. Partial-depth HMA shoulders replace Optional Flexible Shoulders (OFS.)

For new construction/reconstruction HMA and overlays, the shoulder top and binder course items and their thicknesses correspond to the mainline, allowing the shoulder and mainline to be milled and overlaid at the same time.

To account for heavy truck traffic on the shoulder of HMA pavements, the full-depth pavement section is extended 600 mm into the shoulder for new construction and reconstruction projects (refer to Figure 7-5.) The criteria to account for heavy truck traffic in this case is:

Annual Average Daily Traffic multiplied by Percent Truck Traffic or (AADT x % trucks).

Both AADT and % trucks are found in the Highway Sufficiency Ratings. If the Highway Sufficiency Ratings is not current (older than three years old), contact the Regional Planning Office for a classification count and the percentage heavy trucks. The upper criteria limit for using these full-depth pavement extensions is 600 (AADT x % trucks). This corresponds to approximately three million ESALS over 20 years and ten million ESALS over 50 years. For this case, the cross-slope break between the travel lane and the shoulder remains at the edge of traveled way (the edge of the driving lane). For HMA pavements when (AADT x % trucks) is over 600 use full-depth shoulders.

For ease of construction, the shoulder subbase layer for new construction and reconstruction projects is extended down to match the mainline subgrade surface (refer to Figure 7-6.) For rehabilitation and shoulder restoration projects the existing subbase layer is reused, unless the Regional Geotechnical Engineer recommends replacing all or part of the subbase layer.

The top course layer should be 40 mm thick comprised of either a 9.5 mm or 12.5 mm aggregate size HMA mixture. The binder course layer should be either 50 mm thick using a 19 mm aggregate size HMA mixture, or 65 mm thick using a 25 mm aggregate size HMA mixture. The item selection guidelines for HMA top, binder and base course is located in Chapter 6 of this manual. Note that the same top and binder courses are used for the mainline and shoulder, however the shoulder top course is paid under a different item number, which does have friction requirements. Current item numbers are located in Appendix 5B of this manual.

The edgedrain locations shown in Figures 7-5, 7-6 and 7-7 are for reference. Refer to Chapter 9 of this manual for information about subsurface drainage design.

Refer to Tables 7-1 and 7-2 for when to use partial-depth shoulders and Figures 7-5, 7-6 and 7-7 for typical sections.

Figure 7-5 Partial-Depth HMA Shoulder with 600 mm Full-Depth Extension with Permeable Base Layer

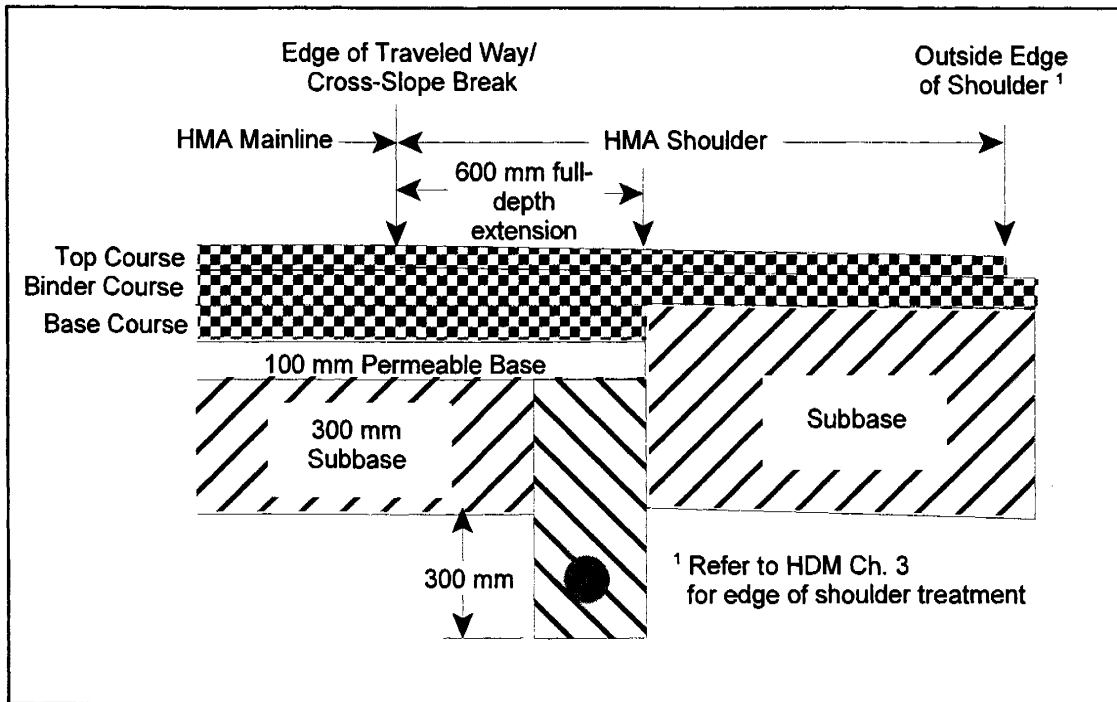
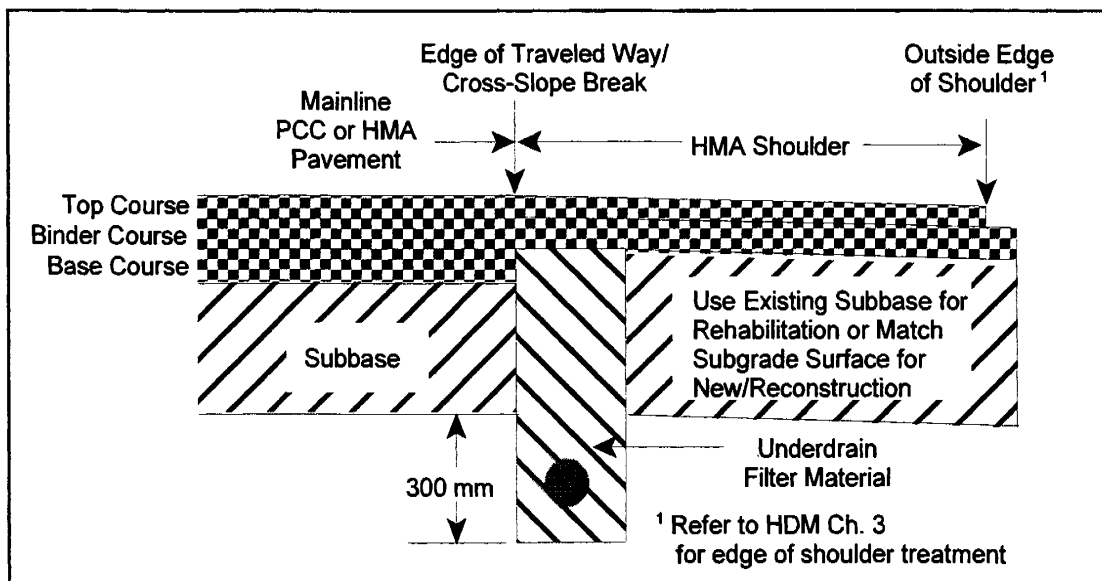
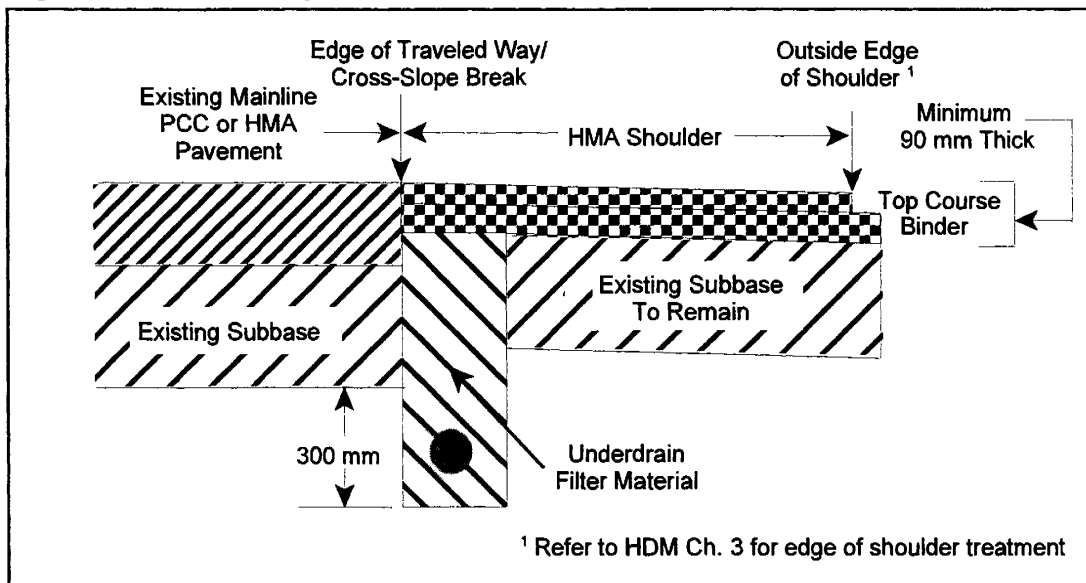


Figure 7-6 Partial-Depth HMA Shoulder for New/Reconstruction or Rehabilitation



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Figure 7-7 Partial-Depth HMA Shoulder for Shoulder Restoration

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Table 7-2 Shoulder Design for Rehabilitated Pavement or Shoulder Restoration

CRITERIA	SHOULDER DESIGN
PCC mainline - mainline <u>will</u> have localized CPR, existing shoulder is full-depth PCC	Localized CPR - Concrete Pavement Restoration
PCC mainline - mainline <u>will</u> have overlay	Partial-depth HMA shoulder, mainline overlay carries over to shoulder with same courses and thicknesses, (top course pay item for shoulder is different, see Section 7.4), refer to Fig. 7-6
PCC mainline - mainline <u>will not</u> have overlay	Partial-depth HMA shoulder, <u>minimum 90 mm combined thickness for top and binder courses</u> , refer to Fig. 7-7
PCC mainline - break & seat, crack & seat, or rubblize project	Partial-depth HMA shoulder, mainline overlay carries over to shoulder with same courses and thicknesses, (top course pay item for shoulder is different, see Section 7.4), refer to Fig. 7-6
HMA mainline - mainline <u>will not</u> have overlay	Partial-depth HMA shoulder, <u>minimum 90 mm combined thickness for top and binder courses</u> , refer to Fig. 7-7
HMA mainline - mainline <u>will</u> have overlay - all other cases	Partial-depth HMA shoulder, mainline overlay carries over to shoulder with same courses and thicknesses, (top course pay item for shoulder is different, see Section 7.4), refer to Fig. 7-6

7.5 HEAVILY TRAVELED SHOULDERS

Some localized shoulder areas are subjected to above normal traffic encroachment, such as across from entrances, inside curves of ramps, intersections, or opposite the leg of "T" intersections. To prevent premature damage to the shoulders, these locations, which might normally be partial-depth, should have full-depth shoulders.

Frequently, shoulders are used to carry traffic during staged construction, when the mainline is being worked on. This causes a great deal of distress to shoulders not designed for mainline traffic. This is exacerbated when the duration of the detour is necessarily long. If this case is anticipated, the entire shoulder should be full-depth.

Full-depth shoulders should also be used for ramps and intersections with safety widenings (see HDM Section 5.10.5.5 D) and should begin 6 m before the Point of Curve (P.C.) and terminate 3m beyond the Point of Tangent (P.T.). Where safety widening is not provided at an intersection, use full-depth shoulders 15 m in advance of the P.C. and end 3 m beyond the P.T.

Where right-turning traffic may illegally utilize the shoulder, full-depth shoulders should begin 50m in advance of the P.C. for the shoulder. Under adverse geometric conditions, where large vehicles will have trouble negotiating curves or corners without encroaching onto the shoulders, the designer should use truck templates to determine whether full-depth shoulders should extend beyond the limits given above.

Bus traffic on shoulders, particularly starting and stopping, can cause rutting and/or rolling of HMA pavements. Use full-depth shoulders where frequent bus traffic on the shoulder is anticipated. Consider using concrete stopping pads at designated transit stops. Consult local bus companies or transit authorities to assess current and projected areas of need.

7.6 OPTIONAL FLEXIBLE SHOULDERS (OFS)

NYSDOT's OFS, which are described in the 1995 Standard Specifications, are designed to be inexpensive, thin shoulders for low traffic volume roadways. OFS Options 1, 2, and 3 have only 25 mm of top course, with a choice to increase it to 40 mm, but decrease the base layer by 15 mm. This 15 mm increase is to allow for SUPERPAVE pavement (minimum 40 mm thick). However, OFS is too thin for milled-in audible rumble strips (minimum of 50 mm thick), does not lend itself to mill and fill resurfacing operations, and unless properly constructed, deteriorates quickly once it starts cracking.

Because of these reasons OFS is no longer recommended for use in NYSDOT projects, but may be suitable for use by other agencies.

7.7 REFERENCES

AASHTO Guide for Design of Pavement Structures, Washington D.C.: American Association of State Highway and Transportation Officials, 1993.

Deen, R.C, D.Q. Hunsucker, and G.W. Sharpe, **Design and Performance of Highway Shoulders**, Kentucky Transportation Research Program, University of Kentucky, March 1987.

Fambro, D.B., R.O. Rogness, and D.S. Turner, **Operational and Safety Effects of Driving on Paved Shoulders in Texas**, Research Report No. 265-2F, Texas Transportation Institute, January 1981.

Implementation of a New Shoulder Design Method in Ohio, (Unpublished), Ohio Department of Transportation, 1991.

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 8 - Pavement Joints (Limited Revisions)

Revision 1

July 2, 2002

CHANGES TO CHAPTER 8

<u>Pages</u>	<u>Changes</u>
8-3	Section 8.3. Revised reference to be compatible with Standard Specifications issued January 2, 2002.
8-4	Section 8.4. Revised reference to be compatible with Standard Specifications issued January 2, 2002.

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CHAPTER 8 PAVEMENT JOINTS

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8.1 INTRODUCTION

This chapter includes guidance on the design and placement of pavement joints for rigid and flexible pavements.

8.2 RIGID PAVEMENTS

8.2.1 Longitudinal Joints

8.2.1.1 Tied Longitudinal Joints

Longitudinal joints establish slab width and typically coincide with travel lanes. The driving lane/shoulder joint should be located 600 mm into the shoulder to improve lane load-carrying capabilities. Longitudinal joints are either sawed or formed. Pavements with sawed joints are placed simultaneously, while butt and warp joints are placed separately. Sawed joints are always tied and rely on a combination of aggregate interlock and steel longitudinal joint ties (tie bars) for load transfer. Tie bars are always epoxy coated deformed and provide some load transfer, but their primary function is to hold adjacent lanes together.

Formed joints may be either keyed or butt-type, and tied or untied. Keys in longitudinal joints provide load transfer between lanes. The assumption is that butt-type (keyless) joints have no aggregate interlocks, and load transfer is provided by tie bars and thus require closer tie spacings.

8.2.1.2 Untied Longitudinal Joints

Untied longitudinal joints are always keyed to provide load transfer, and should be used to isolate nonparallel, merging pavements. Also, independent transverse joint layouts can be used on opposite sides of untied longitudinal joints (transverse joints on one side of the untied longitudinal joint need not coincide with those on the other side). This occurs primarily at intersections and ramps. See M502 Standard Sheets for “key” details.

8.2.2 Transverse Joints

8.2.2.1 Expansion Joints.

Expansion joints are formed joints used to relieve tensile stress and establish slab length. A compressible material, such as premolded resilient joint filler, is typically the forming medium. As

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a formed joint, it requires no first stage saw cuts. Load transfer is provided entirely by dowels because forming precludes aggregate interlock. Expansion joints are used at intersections, reinforced slabs, and utility structures to prevent stress transmission from the pavement as it expands in hot weather. Expansion joints require smooth, round dowels coated with a bond-breaker. Expansion caps are placed on alternating dowel ends to accommodate slab expansion and contraction. Dowels must be carefully aligned to prevent joint lockups. Expansion joints generally require more long-term preventive maintenance and their use should thus be minimized (see Standard Sheet).

8.2.2.2 Contraction Joints.

Contraction joints are formed by saw cutting, producing a weakened plane within the PCC to induce a crack. They perform best when pavements are constructed at relatively high temperatures ($>20^{\circ}\text{C}$). When temperature drops, net shrinkage (contraction) occurs in PCC volume. Contraction joints provide relief as pavement expands on hot summer days. Like expansion joints, contraction joints require smooth, round dowels coated with a bond breaker and carefully aligned both vertically and horizontally to prevent joint lockups. They also establish slab length and accommodate slab expansion and contraction with changing temperature. Unlike expansion joints, contraction joints require timely sawing of the pavement to ensure that the pavement cracks at joint assemblies where intended. Contraction joints typically require both a first stage and second stage saw cut. See M502 Standard Sheets for joint spacing and details. Load transfer at contraction joints is provided by the dowel, aggregate interlock, and bearing support. To compensate for the lack of aggregate interlock in the winter, dowels are designed to provide complete load transfer. Shorter slabs result in less movement at each joint, reducing joint sealer stress and improving sealer performance.

8.2.3 Urban Considerations

In urban paving environments, the designer must deal not only with the normal problems encountered by PCC rural pavements, i.e., support condition, environment, and traffic loading, but also with interaction among utility structures, intersections, and space limitations. Ideally, utility structures should be separated from the pavement lanes, but that can rarely be accomplished. Utility structures that are not isolated from the rigid pavement lanes, develop higher stresses in the pavement. See M502 PCC Standard Sheet for specific details.

8.3 FLEXIBLE PAVEMENTS

8.3.1 Longitudinal Joints

The first signs of distress in a hot mix asphalt pavement occur at the weakest point in the pavement, usually the longitudinal joint. Construction of durable longitudinal joints is critical to a pavement's service life.

The optional methods for constructing longitudinal joints are butt joints and tapered wedge joints. When using either method, the standard specification states that placement of the surface course should be carefully planned to ensure that the longitudinal joints in the surface course will correspond with the edges of the proposed traffic lanes. Refer to Standard Specifications §402-3.09B for details of construction of butt and tapered joints.

The designer must include a special note in the project proposal that indicates if the longitudinal pavement joint can be left exposed to traffic overnight. This requirement will help the Contractor bid the contract accordingly. (Note: Refer to §619-3.01G3 for the case when the longitudinal joint is the lane/shoulder joint. The Contractor shall provide traffic protection in accordance with the provisions of Table 619-1 for drop-offs within three meters of the travel lanes, except bridge drop-offs or other drop-offs in excess of 1.8 m deep). If the designer anticipates the longitudinal pavement joint in excess of 30 meters can be left exposed to traffic overnight they should include maintenance and protection of traffic requirements to alert drivers of the uneven edge. As a minimum, W8-39, 'UNEVEN LANES' signs should be posted on both sides of the roadway at a maximum 300 meter spacing. Consideration should be given to include R4-10, 'STAY IN LANE' signs. The Regional Traffic and Safety Unit should be consulted. An exposed longitudinal pavement joint should not be allowed if it is expected that traffic will frequently change lanes. Under no circumstances can traffic be allowed to travel over a longitudinal pavement joint constructed as a butt joint. Minimizing damage to the shape of the joint (urban vs. rural projects) and the safety of the motoring public must be considered in the decision to allow an exposed longitudinal pavement joint. The following are examples of special notes for the designer to use:

- "During paving operations on this contract a longitudinal pavement joint length in excess of 30 meters at the end of the working day is prohibited."
- "Prior to paving operations on this contract, the contractor may request approval, in writing, to leave exposed a longitudinal pavement joint in excess of 30 meters at the end of the work day. Approval is contingent upon the use of Option B - Tapered Wedge Joint of Section 402-3.09 Joints, of the Standard Specifications. Maintenance and protection of traffic

requirements to provide adequate, advanced warning to motorists must be provided as detailed in these contract documents. As a minimum W8-39, 'UNEVEN LANES' signs must

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be posted on both sides of the roadway at a maximum 300 meter spacing. Paving operations must be planned so the edge is only exposed to traffic for one night and is not exposed over weekends or holidays. If the exposed edge becomes damaged or provides an unsafe condition for motorists, the approval to expose a longitudinal pavement joint in excess of 30 meters at the end of the work day will be rescinded."

8.4 REFERENCES

1. New York State Department of Transportation draft standard sheet Utility Isolation and Joint Layout General Notes, M502.
2. New York State Department of Transportation Standard Specifications - Section 402-3.09 and 619-3.01G3.

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 8: Appendix 8A

PCC Standard Sheets

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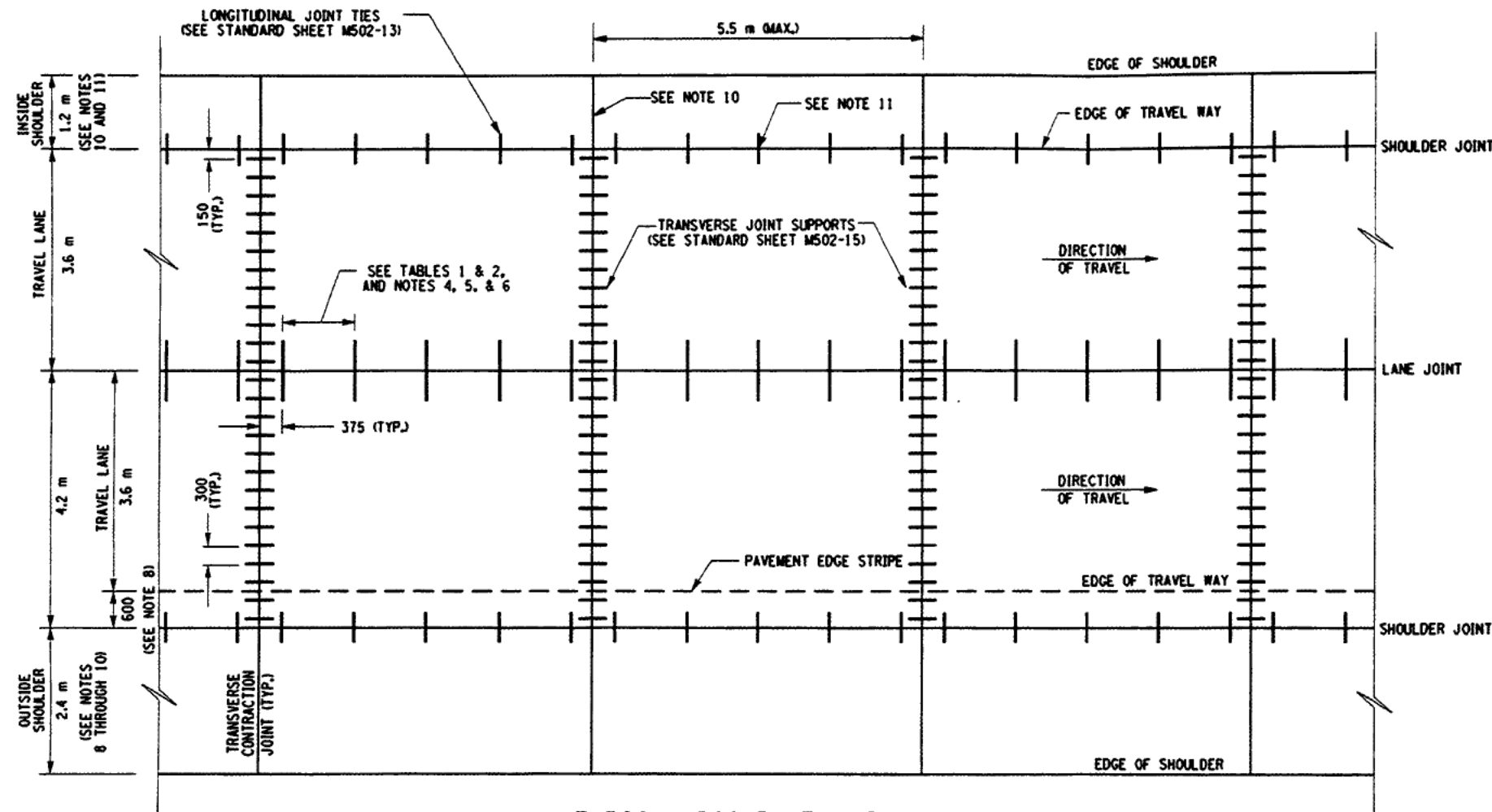
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TYPICAL PCC PAVEMENT PLAN

TABLE 1 - LONGITUDINAL JOINT TIE SPACING TIED PCC SHOULDERS								
SLAB THICKNESS (mm)	MAXIMUM SPACING (mm)							
	LANE JOINT (2 LANES)		LANE JOINT (3&4 LANES)		CENTER JOINT (4 LANES)		SHOULDER JOINT	
	WARP JOINT	BUTT JOINT	WARP JOINT	BUTT JOINT	WARP JOINT	BUTT JOINT	WARP JOINT	BUTT JOINT
225	1187	778	950	674	790	585	1187	778
250	1187	778	950	674	678	521	1187	778
275	1187	778	790	585	594	427	1187	778
300	950	674	790	585	528	427	1187	778
325	950	674	678	521	528	427	1187	778

• WARP JOINTS AND BUTT JOINTS ARE DEPICTED ON STANDARD SHEET M502-12

TABLE 2 - LONGITUDINAL JOINT TIE SPACING HOT MIX ASPHALT SHOULDERS						
SLAB THICKNESS (mm)	MAXIMUM SPACING (mm)					
	LANE JOINT (2 LANES)		LANE JOINT (3&4 LANES)		CENTER JOINT (4 LANES)	
	WARP JOINT	BUTT JOINT	WARP JOINT	BUTT JOINT	WARP JOINT	BUTT JOINT
225	1187	778	1187	778	950	674
250	1187	778	1187	778	790	585
275	1187	778	1187	778	678	521
300	1187	778	950	674	678	521
325	1187	778	950	674	594	427

• WARP JOINTS AND BUTT JOINTS ARE DEPICTED ON STANDARD SHEET M502-12

TABLE 3 - JOINT REINFORCEMENT		
PROPERTY	LONGITUDINAL JOINT TIES	TRANSVERSE JOINT DOWELS
MATERIAL	GRADE 420 STEEL	GRADE 420 STEEL
SURFACE	DEFORMED	PLAIN (SMOOTH)
COATING	EPOXY COATED	EPOXY COATED
DIAMETER	19 mm	VARIES (SEE TABLE 4)
STANDARD LENGTH	900 mm FOR LANE JOINTS 500 mm FOR SHOULDER JOINTS	460 mm (TRAVEL LANES ONLY)
SPACING	SEE TABLES 1 & 2 (& NOTES 4 - 6) (300 mm MIN. TO 1187 mm MAX.)	300 mm
PLACEMENT LOCATION	CENTERED ACROSS THE JOINT AND AT A DEPTH OF 1/2 THE SLAB THICKNESS	CENTERED ACROSS THE JOINT AND AT A DEPTH OF 1/2 THE SLAB THICKNESS
STANDARD JOINT OFFSET	375 mm (TYP.) FROM THE TRANSVERSE JOINT	150 mm (TYP.) FROM THE LONGITUDINAL JOINT

TABLE 4 DOWEL BAR DIAMETER	
SLAB THICKNESS (mm)	DOWEL DIAMETER (mm)
225-250	32
275	35
300	38
325	41

GENERAL NOTES:

- PAVEMENT LAYER THICKNESSES PER CONTRACT DOCUMENTS.
- MAXIMUM SLAB LENGTH IS 5.5 m. MINIMUM SLAB LENGTH IS 3.5 m. USE SLAB LENGTHS WITHIN THIS RANGE TO SATISFY SITE CONDITIONS. REFER TO STANDARD SHEET M502-17, NOTE 3, FOR ADDITIONAL GUIDANCE ON SLAB GEOMETRY.
- LANE AND SHOULDER WIDTHS AND CROSS SLOPES SHOWN ARE TYPICAL. THESE MAY VARY PER CONTRACT DOCUMENTS. REFER TO STANDARD SHEET M502-17, NOTE 3, FOR ADDITIONAL GUIDANCE ON SLAB GEOMETRY.
- THE REQUIRED NUMBER OF LONGITUDINAL JOINT TIES PER SLAB IS BASED ON THE SLAB LENGTH AND THE MAXIMUM SPACING, SEE TABLES 1 & 2.
- WHEN APPROVED BY THE ENGINEER, THE CONTRACTOR MAY USE SHORTER LONGITUDINAL JOINT TIES WITH A REDUCED MAXIMUM SPACING. THE CORRECTED MAXIMUM SPACING FOR THE SHORTER TIES IS CALCULATED AS FOLLOWS:
$$S_c = (S) \times (L_s/900)$$

EQUATION (1)

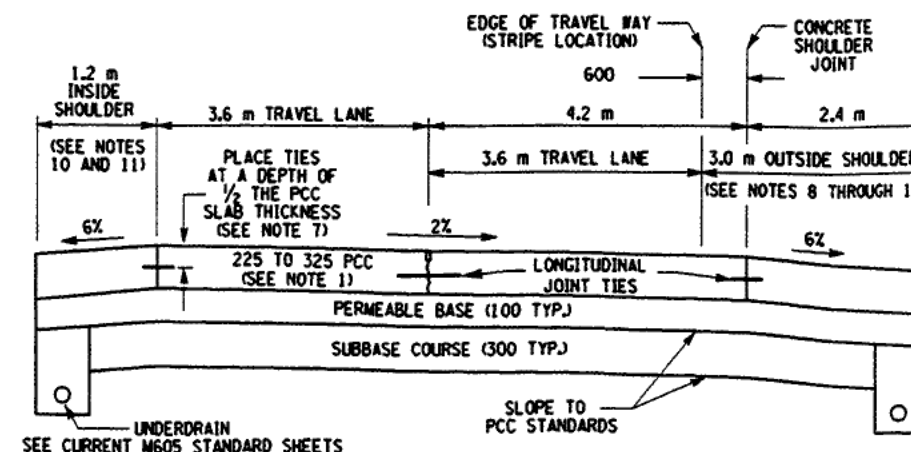
WHERE:
 S_c = CORRECTED MAXIMUM TIE SPACING (mm)
 S = MAXIMUM TIE SPACING FROM TABLES 1 & 2 (mm)
 L_s = LENGTH OF SHORTER TIES (mm)

MINIMUM TIE LENGTH IS 500 mm. MAXIMUM TIE LENGTH IS 900 mm. NO ADDITIONAL PAYMENT WILL BE MADE FOR THE ADDITIONAL NUMBER OF TIES.
- IN A FIXED FORM PAVING OPERATION, THE CONTRACTOR MAY DETERMINE THE REQUIRED MINIMUM NUMBER OF LONGITUDINAL JOINT TIES PER SLAB USING THE FOLLOWING:
$$N = \left\{ \frac{1000 (L - 0.75)}{S} \right\} + 1$$

EQUATION (2)

WHERE:
 N = NUMBER OF TIES PER SLAB (ROUNDED UP FOR DECIMAL VALUES GREATER THAN 0.2)
 L = SLAB LENGTH (m)
 S = MAXIMUM TIE BAR SPACING FROM TABLE 1 & 2 (OR S_c IF SHORTENED) (mm)

INSERT THE REQUIRED MINIMUM NUMBER OF TIES PER SLAB INTO THE FORM HOLES SUCH THAT THE TIES ARE REASONABLY DISTRIBUTED WITHIN THE SLAB. MINIMUM TIE SPACING IS 300 mm. MAXIMUM TIE SPACING IS FROM TABLES 1 & 2.
- WHEN LONGITUDINAL JOINT TIES ARE PLACED ACROSS A JOINT CONTAINING A BREAK IN CROSS SLOPE, ENSURE THAT THE TIE ENDS HAVE 75 mm MINIMUM COVER. TIES MAY BE BENT TO ACHIEVE MINIMUM COVER OR SHORTENED TIES MAY BE USED PER NOTE 5.
- CONSTRUCT THE LONGITUDINAL JOINT BETWEEN THE TRAVEL LANE AND THE OUTSIDE SHOULDER 600 mm OUTSIDE THE PAVEMENT EDGE STRIPE.
- REFER TO TABLE 2 FOR LONGITUDINAL JOINT TIE SPACING WHEN HOT MIX ASPHALT SHOULDERS ARE SPECIFIED. THE OUTSIDE SHOULDER MUST BE TIED PCC IF THE 600 mm TRAVEL LANE WIDENING CAN NOT BE ACHIEVED DUE TO PROJECT CONSTRAINTS.
- CONSTRUCT TRANSVERSE JOINTS ACROSS TIED PCC SHOULDERS. ALIGN TRANSVERSE JOINTS IN THE SHOULDER WITH TRANSVERSE JOINTS IN THE ADJACENT TRAVEL LANE. TRANSVERSE JOINT SUPPORTS ARE NOT REQUIRED IN TIED PCC SHOULDERS.
- THE INSIDE LONGITUDINAL JOINT CAN BE OMITTED IF THE CONTRACTOR ELECTS TO PLACE THE SHOULDER AND ADJACENT TRAVEL LANE IN A SINGLE PLACEMENT. THE MAXIMUM PLACEMENT WIDTH IS 5.5 m. REFER TO STANDARD SHEET M502-17, NOTE 3, FOR ADDITIONAL GUIDANCE ON SLAB GEOMETRY.
- CONSTRUCT ACCELERATION/DECELERATION LANES ABUTTING THE MAINLINE TO THE SAME STANDARD AS THE MAINLINE. SEPARATE DESIGNS BASED ON ANTICIPATED TRAFFIC VOLUMES MAY BE DEVELOPED FOR EACH RAMP AFTER DIVERGENCE FROM THE MAINLINE. PROVIDE REASONABLE TRANSITIONS TO DIFFERENT LAYER THICKNESSES AND PAVEMENT TYPES AS WELL AS CONSISTENT DRAINAGE BETWEEN THE DIFFERENT SECTIONS.

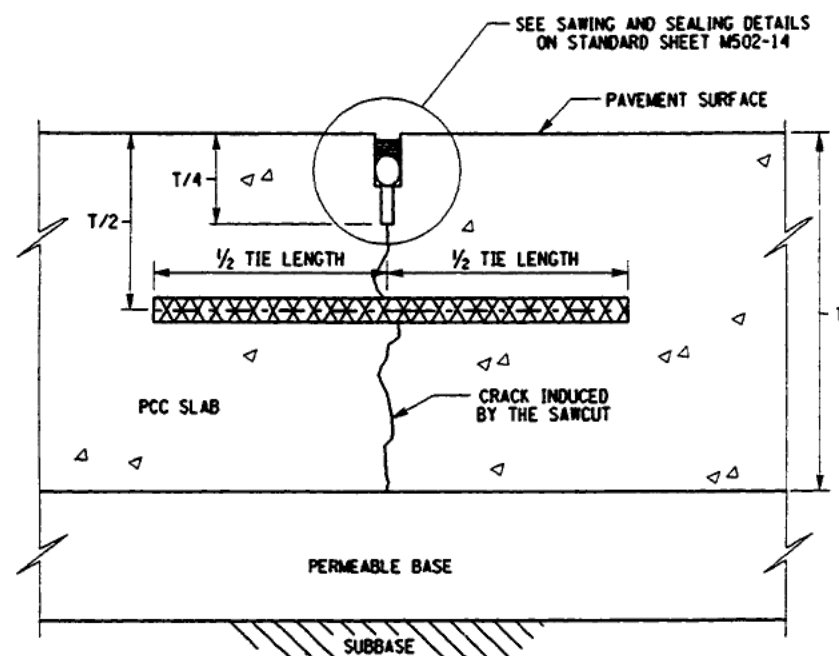


TYPICAL PCC PAVEMENT CROSS SECTION
(POINT OF VIEW IS IN DIRECTION OF TRAVEL)

SHEET NOTES:

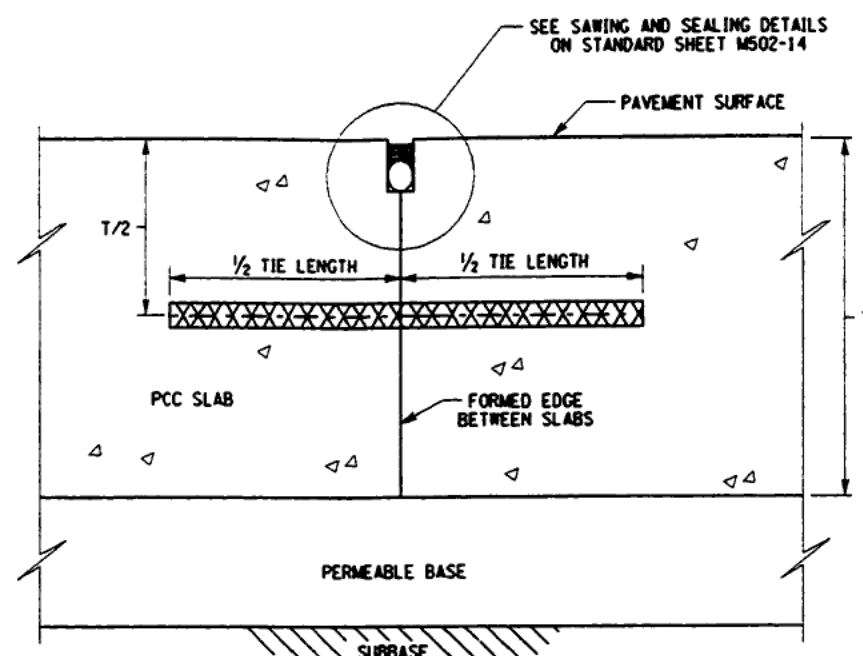
- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
TYPICAL PLAN, CROSS SECTION, AND JOINT LAYOUT	
APPROVED <i>Oct 16</i> 2000 <i>DESIGN CHIEF ENGINEER</i>	ISSUED UNDER EB 00-057 M502-11



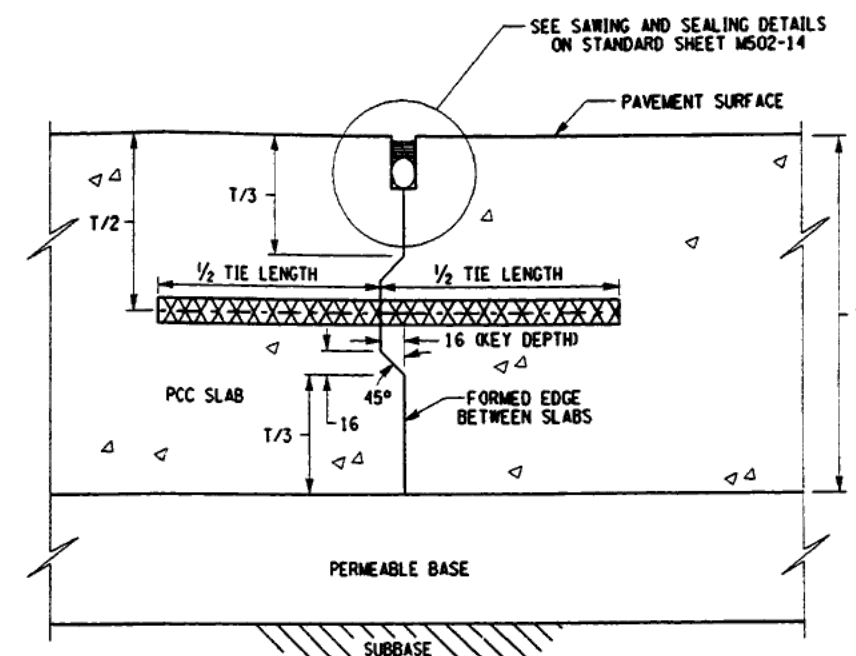
DETAIL 'A'

SAWED LONGITUDINAL JOINT
BETWEEN LANES PLACED SIMULTANEOUSLY
(WARP JOINT)



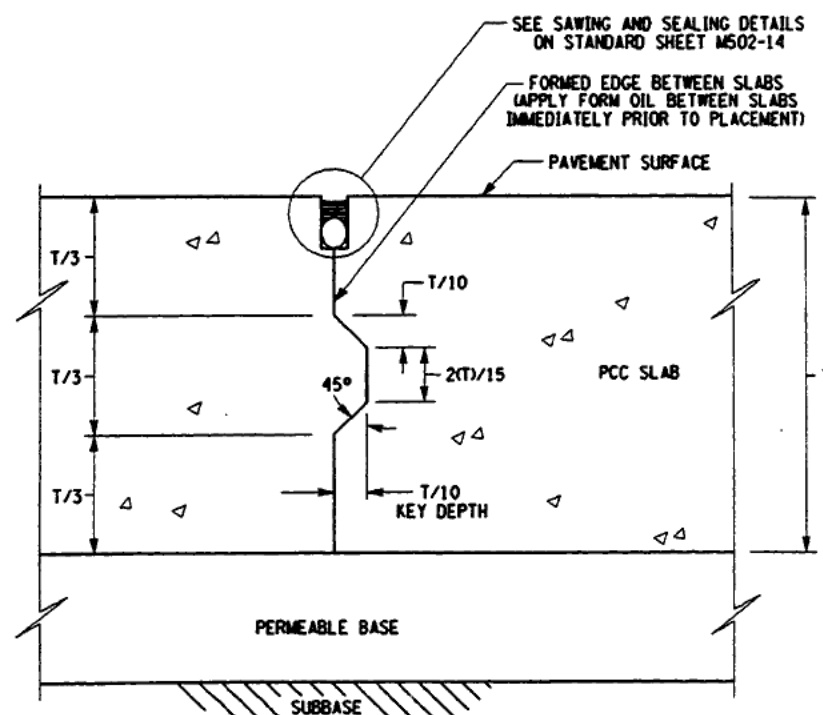
DETAIL 'B'

FORMED LONGITUDINAL JOINT
BETWEEN LANES PLACED SEPARATELY
(BUTT JOINT - SEE NOTE 2)



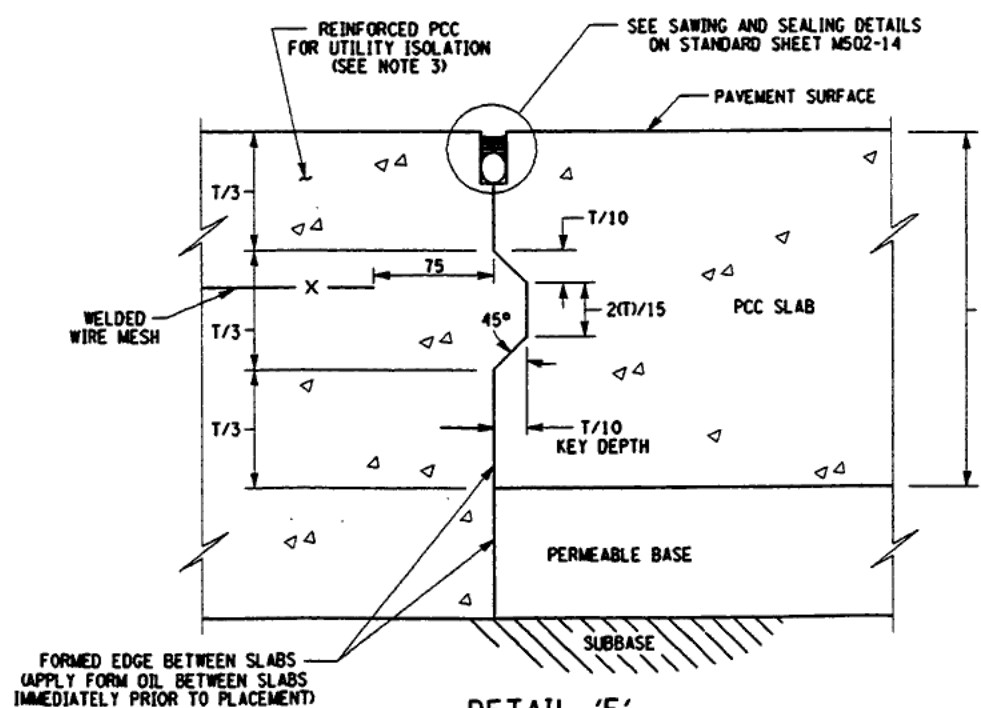
DETAIL 'C'

FORMED LONGITUDINAL JOINT
BETWEEN LANES PLACED SEPARATELY
(WARP JOINT)



DETAIL 'D'

UNTIED LONGITUDINAL JOINT
SHEAR KEY



UNTIED LONGITUDINAL JOINT SHEAR KEY FOR UTILITY ISOLATION

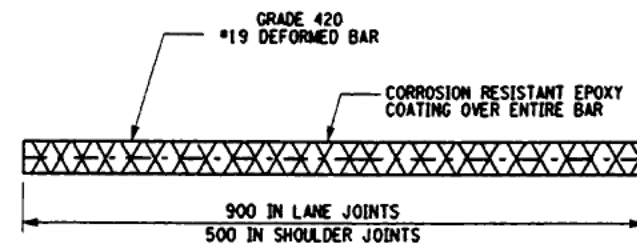
GENERAL NOTES :

1. PLACE THE FEMALE END OF THE KEY WAY FIRST.
2. BUTT JOINTS ARE ONLY USED BETWEEN LANES PLACED SEPARATELY IN A SLIP FORM PAVING OPERATION. IN THIS CASE, THE CONTRACTOR MAY USE EITHER A BUTT JOINT OR A KEYED WARP JOINT. THE ENGINEER MAY REQUIRE THE CONTRACTOR TO CONSTRUCT A BUTT JOINT IF THE KEYWAY CONCRETE CAN NOT BE ADEQUATELY CONSOLIDATED IN THE ENGINEERS OPINION. BUTT JOINTS MAY REQUIRE ADDITIONAL TIES. SEE TABLES 1 AND 2 ON STANDARD SHEET M502-11. IN A FIXED FORM PAVING OPERATION ALL TIED LONGITUDINAL JOINTS ARE WARP JOINTS.
3. REFER TO STANDARD SHEETS M502-17 THROUGH M502-24 FOR MORE DETAILED INFORMATION REGARDING ISOLATION PAVEMENT.
4. A TIED SHEAR KEY HAS A STANDARD KEY DEPTH OF 16 mm. WHILE AN UNTIED SHEAR KEY HAS A KEY DEPTH BASED ON THE PCC SLAB THICKNESS.
5. SLAB THICKNESS (T) PER CONTRACT DOCUMENTS.

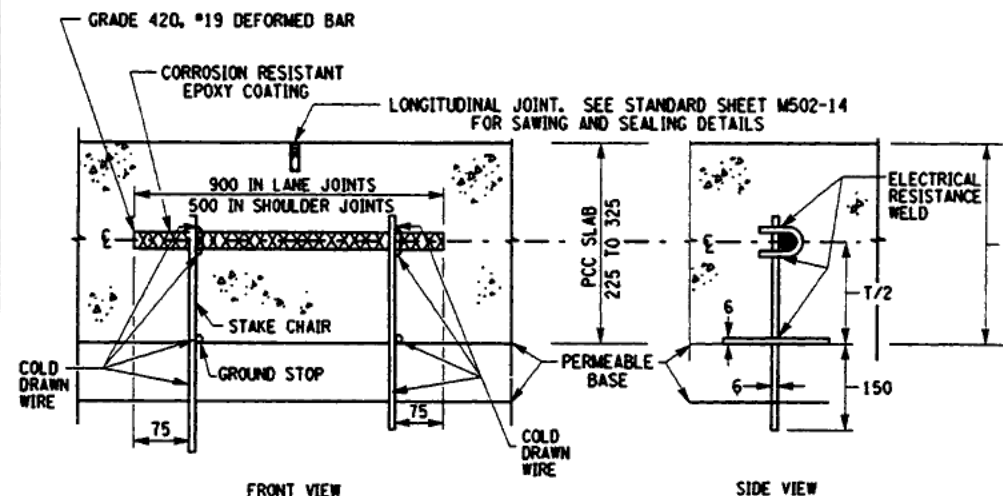
SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

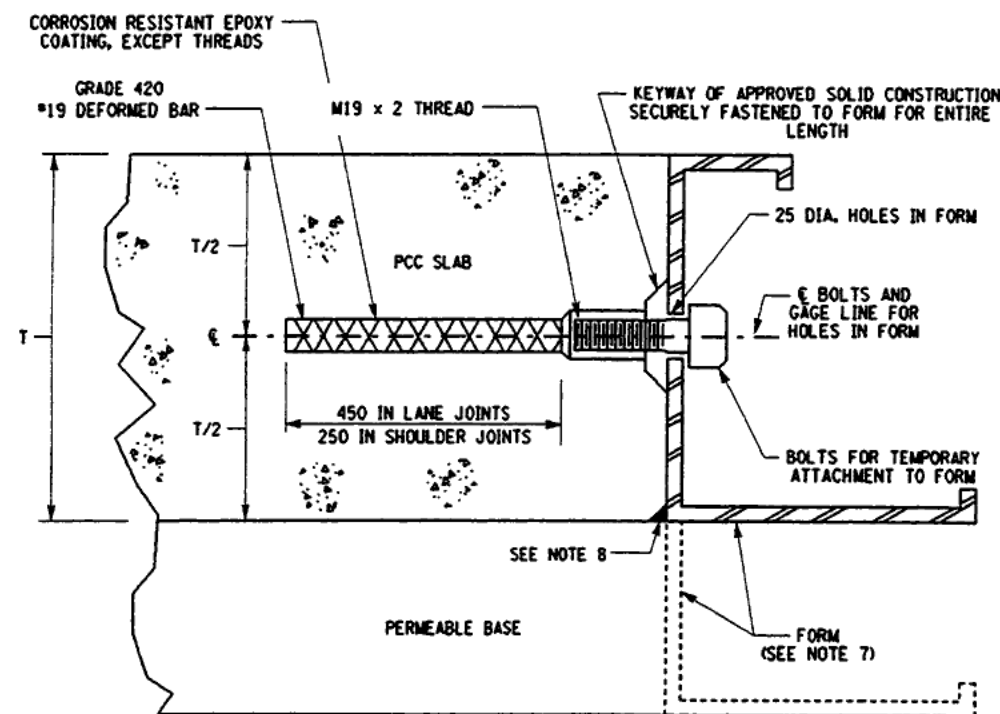
	STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION
	METRIC STANDARD SHEETS
LONGITUDINAL JOINTS	
APPROVED <i>Oct 16</i> . 2000 <i>[Signature]</i> DEPT. CHIEF ENGINEER DESIGN	ISSUED UNDER EB 00-057 M502-12



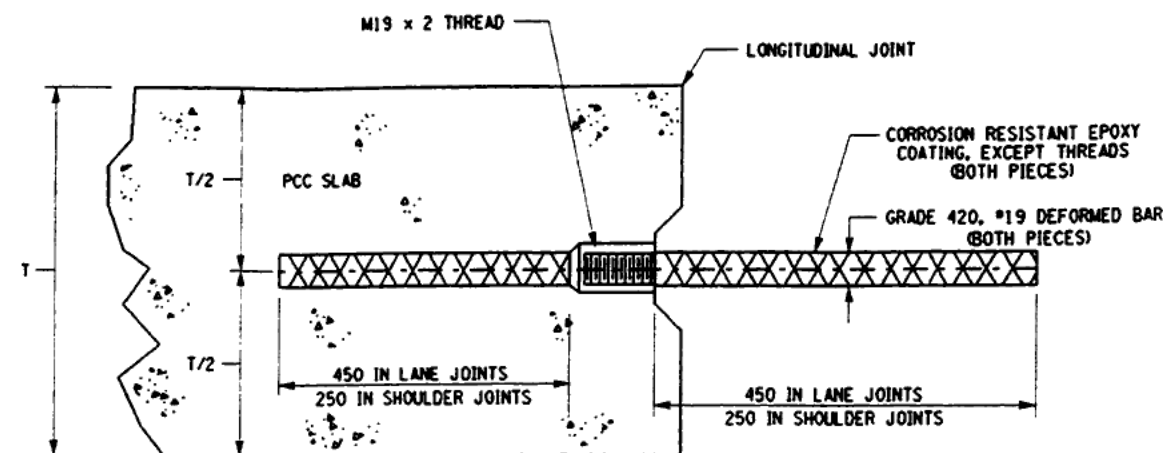
DROP IN TYPE



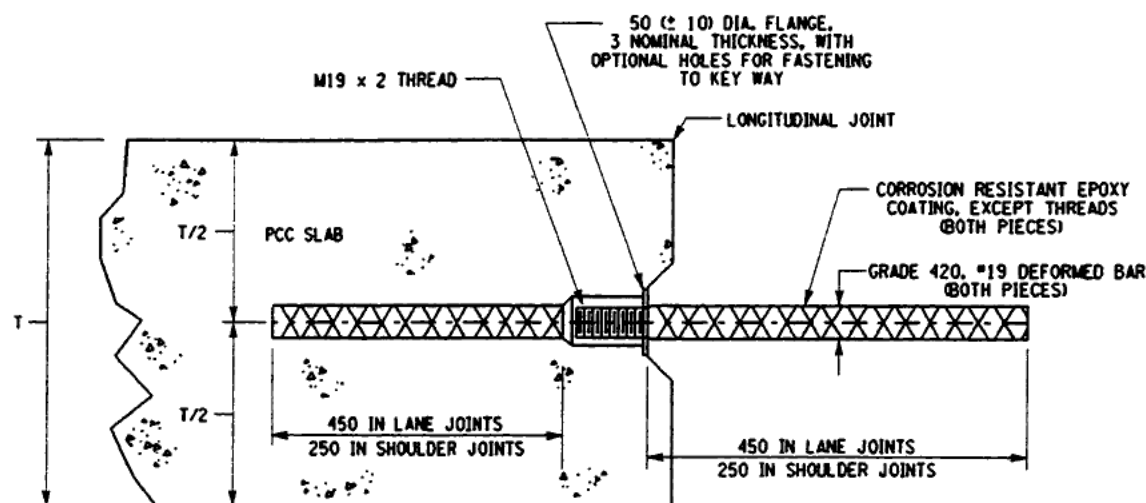
LONGITUDINAL JOINT TIE SUPPORTS
(SEE NOTE 5)



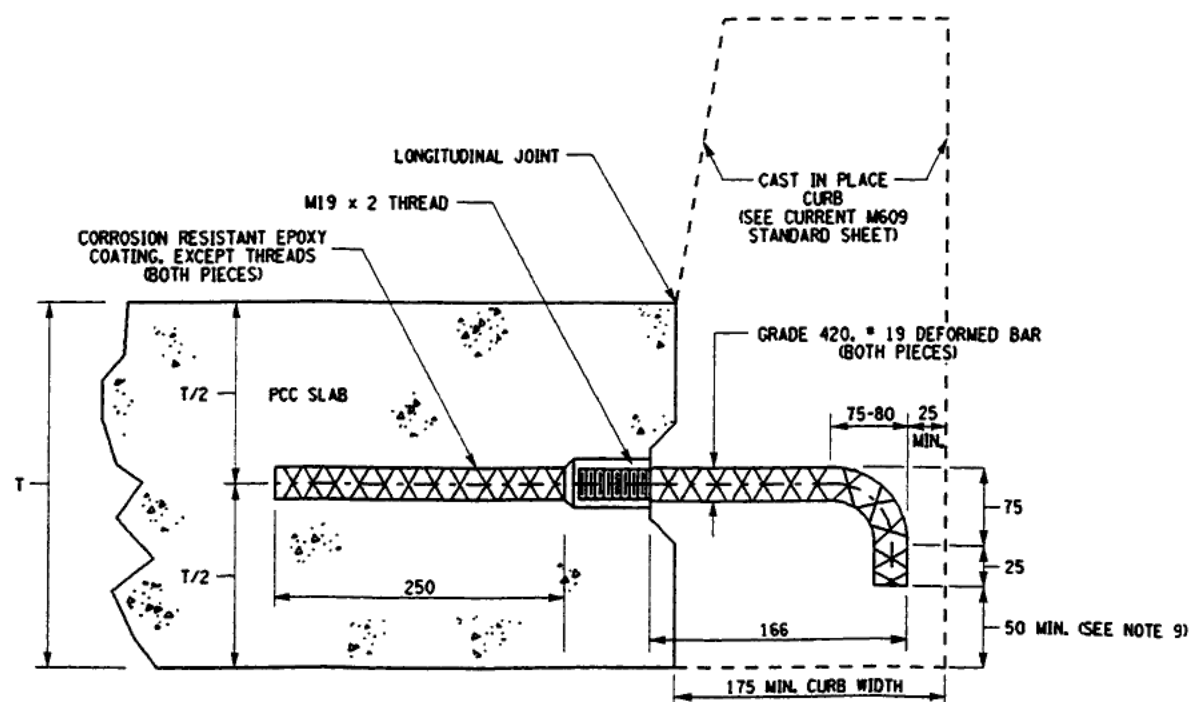
FIXED FORM PAVING



PUSH IN TYPE
(SEE NOTE 6)



PUSH IN TYPE WITH FLANGE
(SEE NOTE 6)



PUSH IN TYPE WITH HOOK (FOR CURB ONLY)
(SEE NOTE 6)

GENERAL NOTES :

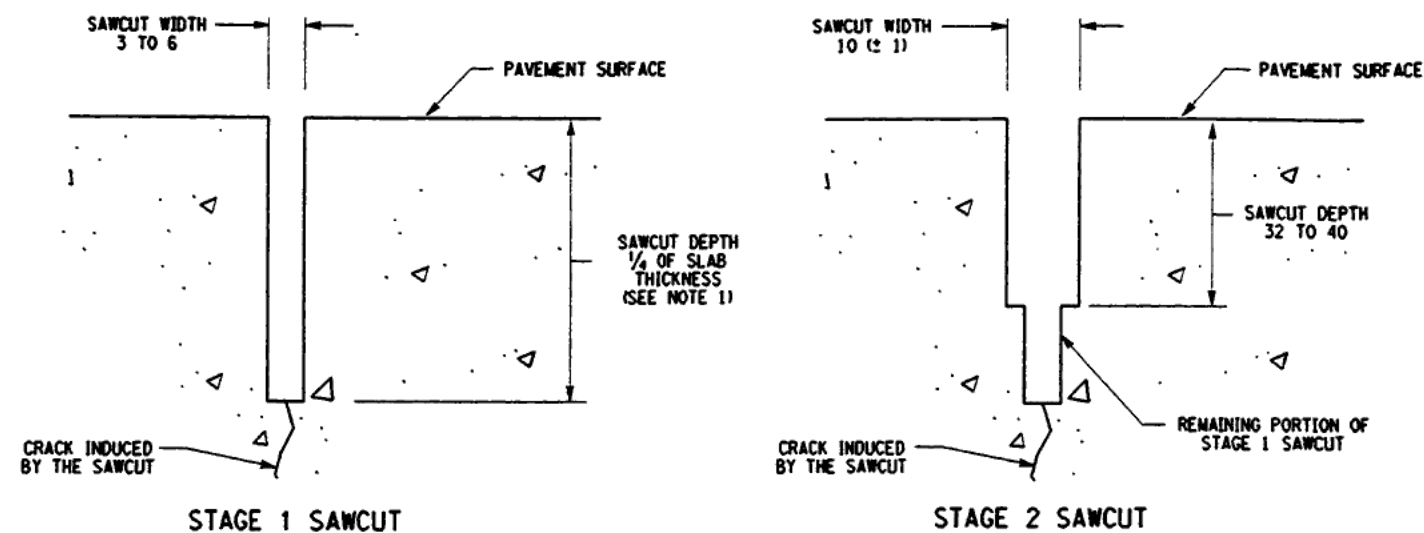
1. LONGITUDINAL JOINT TIES MUST MEET THE REQUIREMENTS OF §705-14. ALL THREADED TIE ENDS MUST HAVE 25mm (MIN.) OF THREADED LENGTH.
2. LONGITUDINAL JOINT TIES IN LANE JOINTS (BETWEEN TRAVEL LANES) ARE TYPICALLY 900 mm LONG. TIES IN SHOULDER JOINTS (BETWEEN TRAVEL LANE AND SHOULDER) ARE TYPICALLY 500 mm LONG. PUSH-IN TYPE TIES ARE MADE OF TWO PIECES TO ACHIEVE TOTAL TIE LENGTH OF 900 mm OR 500 mm.
3. FOR APPROVED CORROSION RESISTANT COATINGS, REFER TO §705-14. LONGITUDINAL JOINT TIES, AND ITS ASSOCIATED APPROVED LIST. CUT ENDS OF TIES DO NOT NEED TO BE COATED.
4. APPLY AN APPROVED CORROSION INHIBITIVE COATING TO THE MALE PORTION OF THE THREADED CONNECTIONS SUCH THAT AN UNBROKEN SEAL WITH THE EPOXY IS FORMED WHEN THE TWO PIECES ARE FIRMLY TIGHTENED. DO NOT DAMAGE THE EPOXY COATING WHEN TIGHTENING THE TWO PIECE TIES.
5. ALTERNATE TIE ASSEMBLY & ANCHORAGE METHODS ARE SUBJECT TO THE APPROVAL OF THE ENGINEER.
6. PUSH IN TYPE TIES FOR SLIP FORM PAVING REQUIRE A PLUG TO SEAL THE FEMALE THREADS AND KEEP THE CONNECTION CLEAN.
7. IT IS THE CONTRACTOR'S OPTION TO PLACE FIXED FORMS EITHER ATOP THE PERMEABLE BASE COURSE OR PLACE THE PERMEABLE BASE COURSE WITHIN THE FORMS.
8. WHEN FIXED FORM PAVING WITH THE PERMEABLE BASE COURSE WITHIN THE FORMS, APPLY A MASONRY CAULK BEAD TO THE TOP EDGE OF PERMEABLE BASE WHERE IT MEETS THE FORM TO PREVENT CEMENT PASTE INFILTRATION ALONG THE PERMEABLE BASE FACE. CAULK IS NOT NEEDED IF EDGE DRAIN IS PLACED INSIDE OF THE FORM. THERE ARE NO MATERIAL REQUIREMENTS FOR THE MASONRY CAULK.
9. MAXIMUM SPACING BETWEEN HOOK BARS IS 1187 mm. INSTALL HOOK BARS SUCH THAT THE END OF THE HOOK BARS ARE VERTICALLY ALIGNED BELOW THE STRAIGHT PORTION OF BAR. IF THE 50 mm MINIMUM CLEARANCE TO THE BOTTOM OF THE CURB DICTATES, THE HOOK MAY BE ROTATED UP TO 45 DEGREES TO THE SIDE.
10. REFER TO STANDARD SHEET M502-11 FOR TYPICAL TIE LAYOUT INFORMATION.
11. SLAB THICKNESS (T) PER CONTRACT DOCUMENTS.

SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

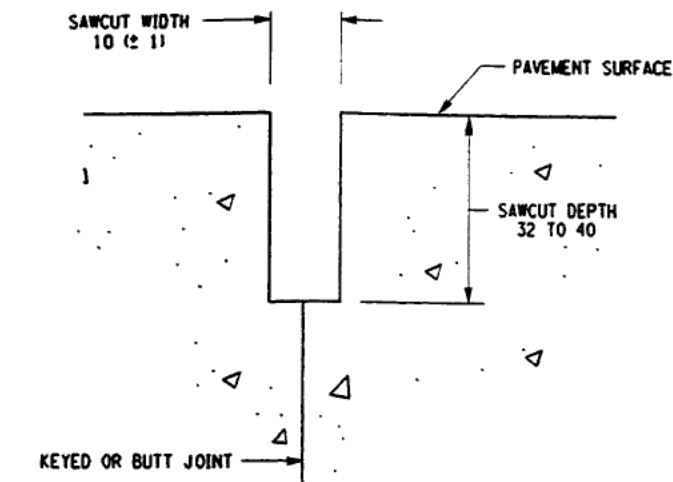
STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
LONGITUDINAL JOINT TIES	
APPROVED <i>Oct 16, 2000</i> DESIGN CHIEF ENGINEER	ISSUED UNDER EB 00-057 M502-13

LONGITUDINAL JOINT SAWCUTTING



DETAIL 'A'

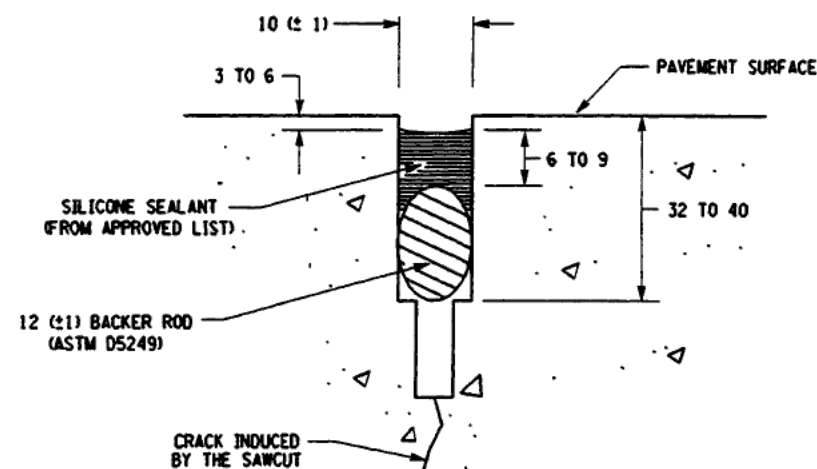
TWO STAGE SAWCUT BETWEEN LANES PLACED SIMULTANEOUSLY



DETAIL 'B'

SAWCUT BETWEEN LANES PLACED SEPARATELY

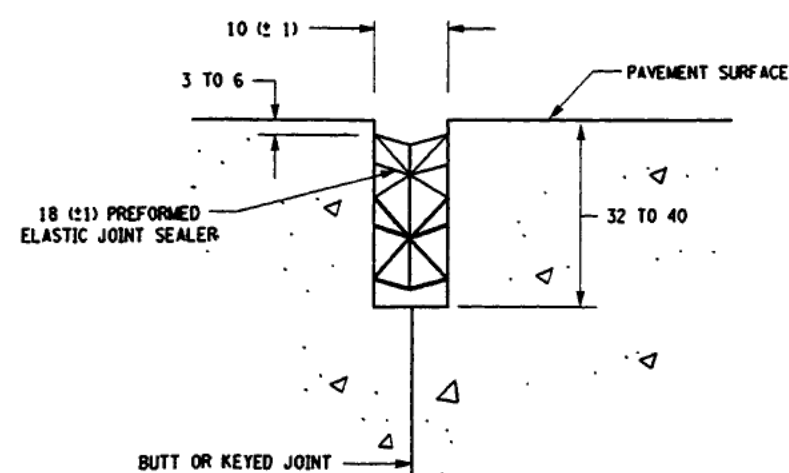
LONGITUDINAL JOINT SEALING



DETAIL 'C'

SILICONE SEAL OPTION

(SEE NOTE 3)



DETAIL 'D'

PREFORMED ELASTIC LONGITUDINAL JOINT SEALER OPTION (\$705-10)

(SEE NOTE 3)

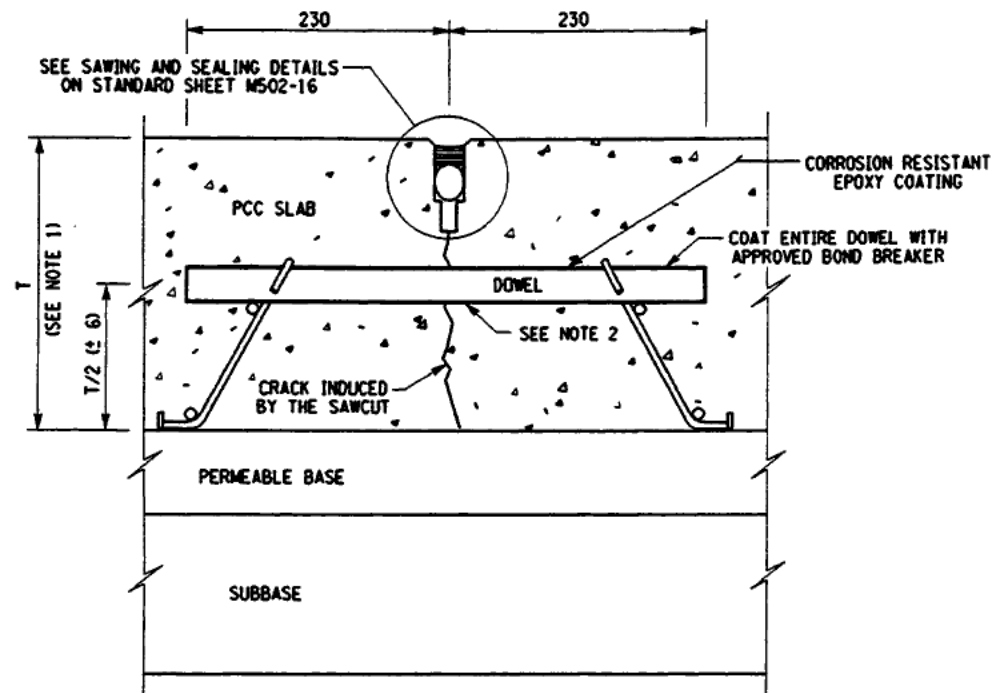
GENERAL NOTES:

1. PAVEMENT SLAB THICKNESS PER CONTRACT DOCUMENTS.
2. STAGE 1 SAWCUTS ARE NOT REQUIRED BETWEEN LANES PLACED SEPARATELY.
3. USE OF SILICONE OR PREFORMED ELASTIC LONGITUDINAL JOINT SEALER IS THE CONTRACTOR'S OPTION UNLESS MATERIAL TYPE IS SPECIFIED IN THE CONTRACT DOCUMENTS.

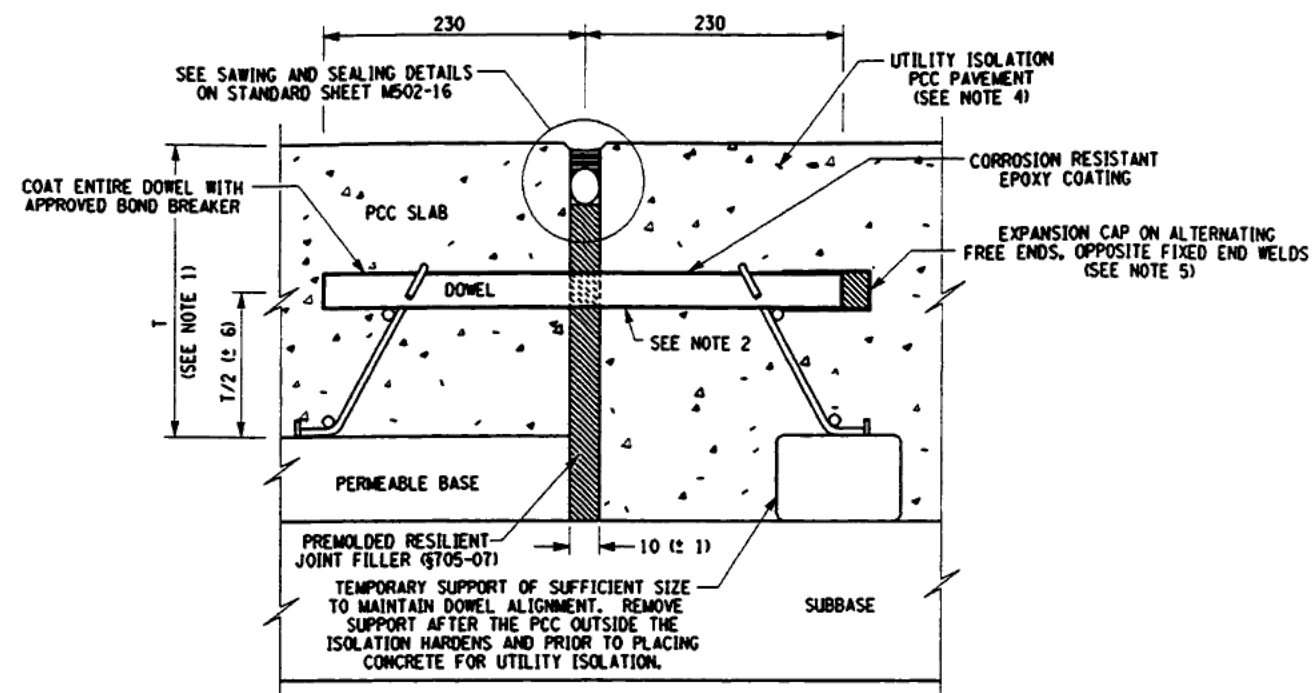
SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

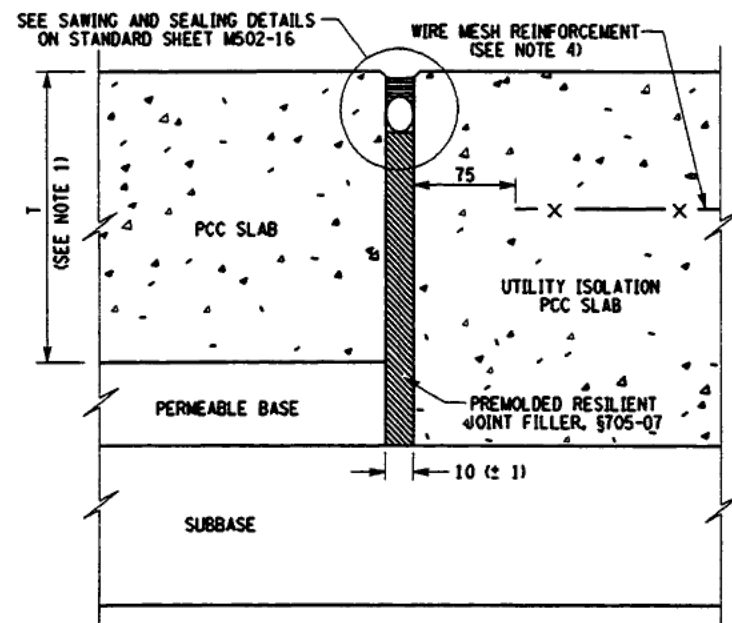
STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
LONGITUDINAL JOINT SAWING AND SEALING	
APPROVED <i>Oct 16, 2000</i> DESIGN CHIEF ENGINEER	ISSUED UNDER EB 00-057 M502-14



DETAIL 'A'
CONTRACTION JOINT



DETAIL 'B'
EXPANSION JOINT
UTILITY ISOLATION CONDITION SHOWN



DETAIL 'C'
ISOLATION JOINT
UTILITY ISOLATION CONDITION SHOWN
NOTE: AN ISOLATION JOINT CONTAINS NO LOAD TRANSFER DEVICE

GENERAL NOTES :

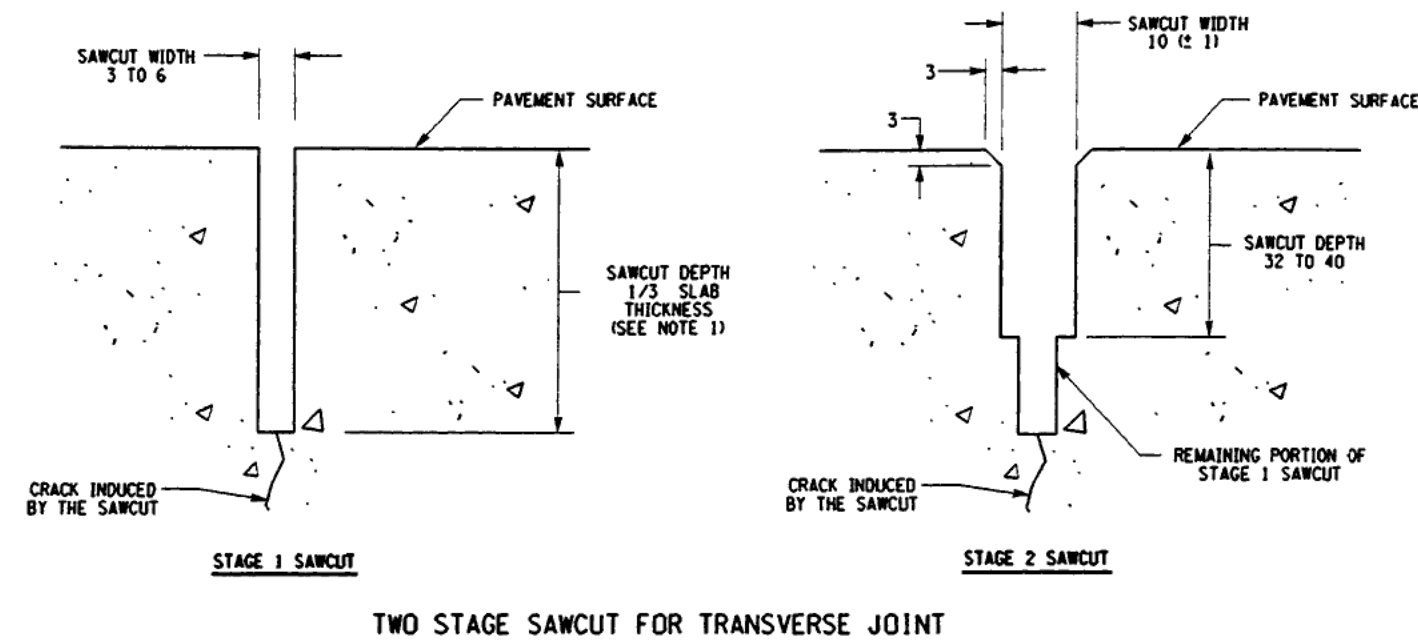
1. SLAB THICKNESS (T) PER CONTRACT DOCUMENTS.
2. SEE STANDARD SHEET M502-11 FOR DOWEL DIAMETER AND PLACEMENT INFORMATION.
3. TRANSVERSE JOINT SUPPORTS MUST MEET REQUIREMENTS OF NYS DOT SPECIFICATION 705-15.
4. UTILITY ISOLATION PCC PAVEMENT IS EITHER WIRE MESH REINFORCED OR HEAVILY REINFORCED. SEE STANDARD SHEETS M502-17 THROUGH M502-24 FOR ADDITIONAL DETAILS.
5. DO NOT TAP EXPANSION CAPS ONTO DOWELS.
6. FOR APPROVED CORROSION RESISTANT COATINGS, REFER TO 705-15, TRANSVERSE JOINT SUPPORTS, AND ITS ASSOCIATED APPROVED LIST. CUT ENDS OF DOWELS DO NOT NEED TO BE COATED.

SHEET NOTES :

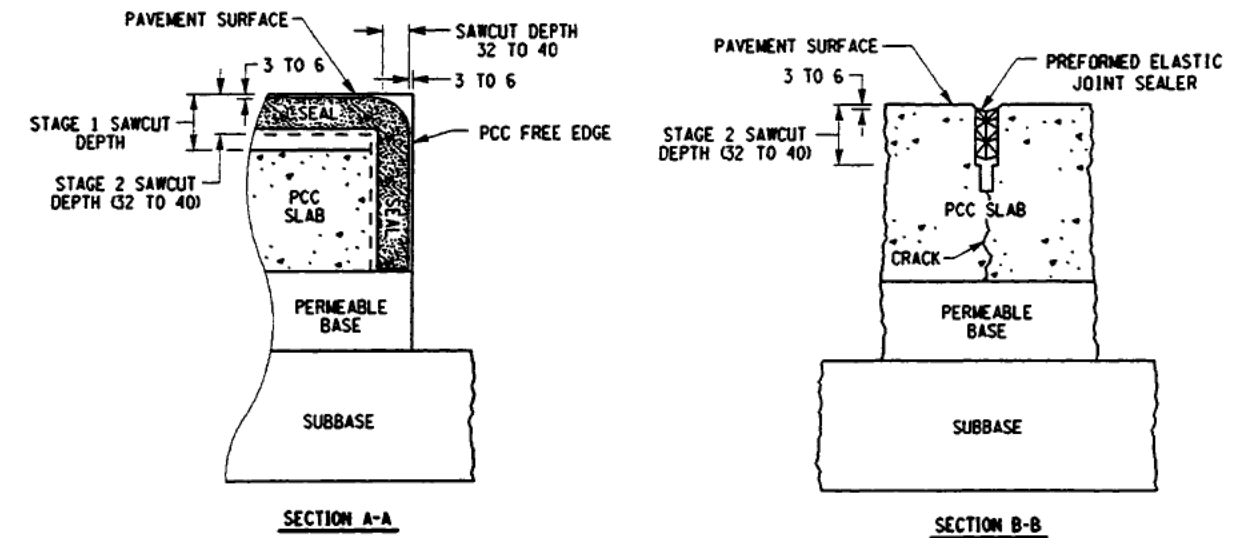
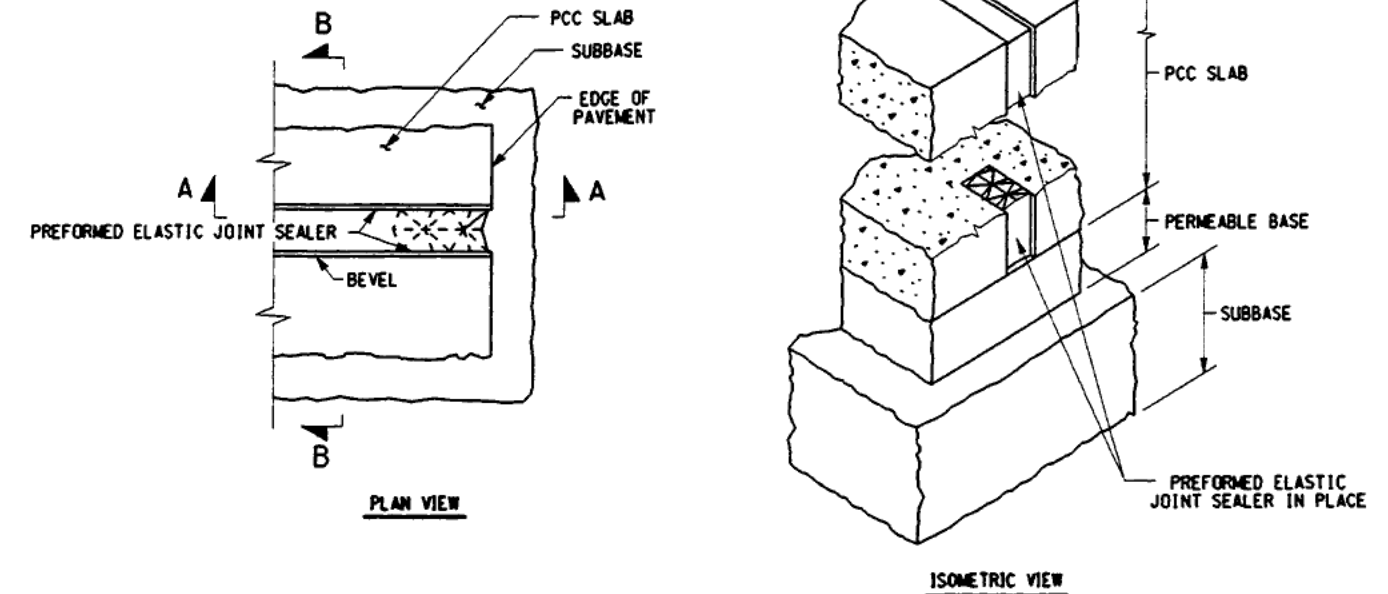
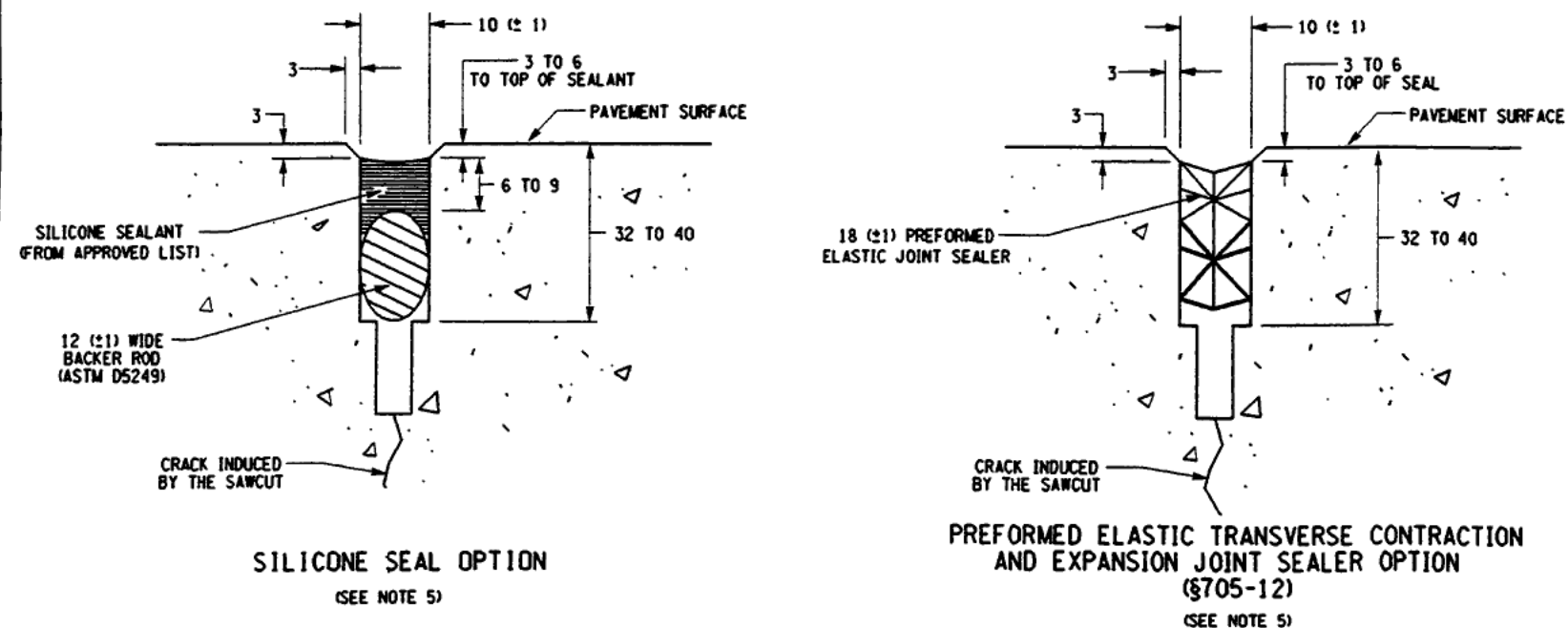
- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

	STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION
	METRIC STANDARD SHEETS
	TRANSVERSE JOINTS
APPROVED <i>Oct 16</i> . 2000 DEPUTY CHIEF ENGINEER DESIGN	ISSUED UNDER EB 00-057 M502-15

TRANSVERSE CONTRACTION JOINT SAWCUTTING



TRANSVERSE JOINT SEALING



PREFORMED ELASTIC JOINT SEALER INSTALLATION AT EDGE OF PAVEMENT (SAWCUT THE JOINT DOWN THE SIDE OF THE SLAB) (SEE NOTE 6)

GENERAL NOTES:

1. SLAB THICKNESS PER CONTRACT DOCUMENTS.
2. EXPANSION, CONTRACTION, AND ISOLATION JOINTS DO NOT REQUIRE STAGE 1 SAWCUTS.
3. PERFORM STAGE 2 SAWCUTS WITH BEVEL ON CONSTRUCTION JOINTS. SEAL CONSTRUCTION JOINTS EXACTLY LIKE CONTRACTION JOINTS.
4. ROUT AND BEVEL EXPANSION AND ISOLATION JOINTS TO THE STAGE 2 SAWCUT DIMENSIONS. SEAL EXPANSION AND ISOLATION JOINTS EXACTLY LIKE CONTRACTION JOINTS.
5. USE OF SILICONE OR PREFORMED ELASTIC JOINT SEALER IS THE CONTRACTOR'S OPTION UNLESS MATERIAL TYPE IS SPECIFIED IN THE CONTRACT DOCUMENTS.
6. THE STAGE 2 SAWCUT DOWN THE SIDE OF THE SLAB IS ONLY REQUIRED FOR THE PREFORMED ELASTIC SEALER OPTION, NOT THE SILICONE SEAL OPTION.
7. CONSTRUCT TRANSVERSE JOINTS ACROSS TIED PCC SHOULDERS. ALIGN TRANSVERSE JOINTS IN THE SHOULDER WITH TRANSVERSE JOINTS IN THE ADJACENT TRAVEL LANE. TRANSVERSE JOINT SUPPORTS ARE NOT REQUIRED IN TIED PCC SHOULDERS.

SHEET NOTES:

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
TRANSVERSE JOINT SAWING AND SEALING	
APPROVED <i>Oct 16, 2000</i> DEPT. CHIEF ENGINEER DESIGN	ISSUED UNDER EB 00-057 M502-16

UTILITY ISOLATION & JOINT LAYOUT

GENERAL NOTES :

1. THE CONTRACTOR IS RESPONSIBLE FOR THE FINAL JOINT LAYOUT BASED ON THE ACTUAL LOCATIONS OF UTILITIES AND DRAINAGE STRUCTURES WITHIN THE PAVEMENT AND CONSTRUCTION STAGING. THE CONTRACTOR MUST SUBMIT A PROPOSED JOINT LAYOUT TO THE ENGINEER AT LEAST 10 DAYS BEFORE PAVING BEGINS. THE CONTRACTOR WILL REVISE THE PLAN UNTIL IT MEETS THE ENGINEER'S APPROVAL. PAVING SHALL NOT BEGIN UNTIL THE JOINT LAYOUT IS APPROVED BY THE ENGINEER.
2. JOINT LAYOUT METHODOLOGY
 - A. LOCATE LONGITUDINAL JOINTS.
 - B. LOCATE UTILITIES AND DRAINAGE STRUCTURES. WHENEVER POSSIBLE, POSITION UTILITIES AND DRAINAGE STRUCTURES (OTHER THAN CATCH BASINS) SUCH THAT (1) THE STRUCTURES ARE BETWEEN WHEEL PATHS, AND (2) THE STRUCTURES ARE LONGITUDINALLY SPACED TO ALLOW OPTIMAL ISOLATION TECHNIQUES (REFER TO STANDARD SHEET M502-23, DETAILS A, C, D, & F).
 - C. SELECT A TELESCOPING CASTING OR THE MOST APPROPRIATE ISOLATION TECHNIQUE FOR EACH UTILITY, DRAINAGE STRUCTURE, AND/OR GROUP THEREOF AS DESCRIBED IN NOTE 5 AND THE 'TYPICAL UTILITY ISOLATION GUIDELINES' TABLE ON STANDARD SHEET M502-18.
 - D. LOCATE THE TRANSVERSE JOINTS AND UNTIED LONGITUDINAL (SHEAR KEY) JOINTS NEAR UTILITIES AND DRAINAGE STRUCTURES.
 - E. EQUALLY SPACE REMAINING TRANSVERSE JOINTS BETWEEN THOSE TRANSVERSE JOINTS PLACED IN CONJUNCTION WITH UTILITIES AND DRAINAGE STRUCTURES SUCH THAT THE DESIGN SLAB LENGTH IS ACHIEVED (3.5 m TO 5.5 m TYPICAL).
 - F. DESIGN AND LAYOUT THE LONGITUDINAL JOINT TIES AND TRANSVERSE JOINT SUPPORTS.
3. PCC SLAB ASPECT RATIO & SLAB GEOMETRY
 - A. THE ASPECT RATIO (W/L) IS THE RATIO OF SLAB WIDTH (W) TO SLAB LENGTH (L). FOR SLABS ROUTINELY EXPOSED TO TRAFFIC, CONSTRUCT SLABS MEETING THE FOLLOWING GEOMETRIC CRITERIA :
 1. $0.65 \leq W/L \leq 1.37$,
 2. $2.3 \text{ m} \leq W \leq 5.5 \text{ m}$, AND
 3. $3.5 \text{ m} \leq L \leq 5.5 \text{ m}$.
 - B. TYPICAL TRAVEL LANES WITHOUT UTILITIES HAVE INNER AND OUTER SLAB WIDTHS OF 3.6 m AND 4.2 m, RESPECTIVELY, WITH SLAB LENGTHS OF 5.5 m. THIS RESULTS IN ASPECT RATIOS OF 0.65 AND 0.76. THUS, FOR SLABS WITHOUT UTILITIES, THE ASPECT RATIO APPROACHES MINIMUM VALUES. FOR SLABS WITH UTILITIES OR DRAINAGE STRUCTURES, THE ASPECT RATIO APPROACHES MAXIMUM VALUES BECAUSE THESE SLABS HAVE REDUCED LENGTHS (REFER TO STANDARD SHEETS M502-19 THROUGH M502-23). THE GEOMETRIC CRITERIA IN NOTE 3A DO NOT APPLY TO HEAVILY REINFORCED SLABS DEPICTED ON STANDARD SHEET M502-24 OR TO CATCH BASIN ISOLATION SLABS DEPICTED ON STANDARD SHEETS M502-22 AND M502-23.
 - C. IF PROJECT CONSTRAINTS RESULT IN NARROWER TRAVEL LANES OR REDUCED SLAB LENGTHS FROM THOSE DEPICTED ON STANDARD SHEET M502-11, THE ASPECT RATIO REQUIREMENTS OF NOTE 3A MUST BE SATISFIED. IT IS HIGHLY PREFERABLE TO CONSTRUCT PCC SLABS SUCH THAT LONGITUDINAL JOINTS BETWEEN TRAVEL LANES ARE ALIGNED WITH PAVEMENT MARKINGS.
 - D. IF PROJECT CONSTRAINTS RESULT IN NARROWER PCC SHOULDERS THAN THOSE DEPICTED ON STANDARD SHEET M502-11, IT IS PREFERABLE TO CONSTRUCT THE SHOULDERS AND ADJACENT TRAVEL LANES SIMULTANEOUSLY, PROVIDED THE GEOMETRIC CRITERIA IN NOTE 3A ARE SATISFIED. NO LONGITUDINAL JOINT IS REQUIRED IN THIS CASE.
4. TRANSVERSE JOINT TYPE SELECTION
 - A. THERE ARE THREE BASIC TYPES OF TRANSVERSE JOINTS: CONTRACTION, CONSTRUCTION, AND EXPANSION. THESE JOINTS CONTROL CRACKING, ACCOMMODATE SLAB MOVEMENT, AND PROVIDE LOAD TRANSFER. IT IS ESSENTIAL TO PROPERLY COAT AND ALIGN DOWELS TO ALLOW FREE SLAB MOVEMENT. SEE STANDARD SHEETS M502-15 AND M502-16 FOR TRANSVERSE JOINT DETAILS.
 - B. GENERALLY, TRANSVERSE JOINTS EXTEND ACROSS THE FULL PAVEMENT WIDTH AND ARE ALIGNED PERPENDICULAR TO THE LONGITUDINAL JOINT. TRANSVERSE JOINT TYPE, LOCATION, AND/OR ALIGNMENT MAY CHANGE WHEN A TRANSVERSE JOINT INTERSECTS AN UNTIED LONGITUDINAL (SHEAR KEY) JOINT.
 - C. CONTRACTION JOINTS ARE BY FAR THE MOST COMMON TYPE OF TRANSVERSE JOINT. SPACE CONTRACTION JOINTS TO ACHIEVE 3.5 m TO 5.5 m SLAB LENGTHS.
 - D. CONSTRUCTION JOINTS ARE USED AT PAVING INTERRUPTIONS. THEY ARE AS WIDE AS THE CONCRETE PLACEMENT, TYPICALLY ONE OR TWO LANES, NOT NECESSARILY FULL WIDTH. ALIGN CONSTRUCTION JOINTS WITH ADJACENT TRANSVERSE JOINTS.
 - E. EXPANSION JOINTS SHOULD BE USED SPARINGLY. THEY ISOLATE AND PROTECT PAVEMENTS AND STRUCTURES FROM CONCRETE MOVEMENT AND VOLUME CHANGES. EXPANSION JOINTS ARE REQUIRED AT INTERSECTIONS AND ISOLATED UTILITIES EXPOSED TO TRAFFIC.
 - F. ISOLATION JOINTS ARE NOT CAPABLE OF TRANSFERING LOADS BECAUSE THEY DO NOT CONTAIN LOAD TRANSFER DEVICES. THEREFORE, THEY ARE ONLY USED TO ISOLATE UTILITIES AND DRAINAGE STRUCTURES IN AREAS NOT ROUTINELY EXPOSED TO TRAFFIC.

5. UTILITY AND DRAINAGE STRUCTURE ISOLATION

- A. FOLLOW THE 'TYPICAL UTILITY ISOLATION GUIDELINES' TABLE ON STANDARD SHEET M502-18 TO SELECT THE APPROPRIATE ISOLATION METHOD.
- B. WHEREVER POSSIBLE, USE TELESCOPING MANHOLE CASTINGS TO INTEGRALLY CAST THE UTILITIES INTO THE PCC SLAB. REFER TO CONDITIONS (A), (B), (K), AND (L) ON STANDARD SHEET M502-18.
- C. IF A TELESCOPING CASTING CAN NOT BE USED (SEE STANDARD SHEET M502-19, NOTE 2), USE A NON-TELESCOPING CASTING OR A SHALLOW UTILITY ISOLATION. REFER TO CONDITIONS (C), (E), (F), (H), AND (J) ON STANDARD SHEET M502-18.
- D. IF THE MASONRY PORTION OF SHALLOW UTILITIES OR UTILITIES WITH NON-TELESCOPING CASTINGS FALLS WITHIN 300 mm OF THE PROJECTED LONGITUDINAL JOINT, OFFSET THE LONGITUDINAL JOINT SUCH THAT A 300 mm CLEARANCE IS ACHIEVED BETWEEN THE MASONRY AND THE LONGITUDINAL JOINT. THE WIDENED SLAB CONTAINING THE STRUCTURE AND THE NARROWED ADJACENT SLAB MUST BOTH MEET THE GEOMETRIC REQUIREMENTS IN NOTE 3A. IF THESE REQUIREMENTS CAN NOT BE MET, OMIT THE OFFSET LONGITUDINAL JOINT AND ISOLATE THE STRUCTURE IN A SINGLE PLACEMENT THAT IS TWO SLABS WIDE. THIS PLACEMENT MUST ALSO MEET THE GEOMETRIC REQUIREMENTS IN NOTE 3A. REFER TO CONDITIONS (D) AND (G) ON STANDARD SHEET M502-18.
- E. WHEN MULTIPLE UTILITIES ARE LOCATED SUCH THAT INDIVIDUAL ISOLATION IS NOT POSSIBLE, ISOLATE THE ENTIRE GROUP OF UTILITIES IN A HEAVILY REINFORCED SLAB. REFER TO CONDITIONS (M) AND (N) ON STANDARD SHEET M502-18.
- F. WHEN UTILITIES AND/OR DRAINAGE STRUCTURES IN ADJACENT LANES PRECLUDE AN OPTIMAL SOLUTION FOR EACH STRUCTURE, THE ISOLATION METHODS SHALL BE PRIORITIZED AS FOLLOWS:
 1. STRUCTURES IN THE TRAVEL LANE CARRYING THE GREATEST NUMBER OF TRUCKS
 2. STRUCTURES IN OTHER TRAVEL LANES
 3. STRUCTURES IN PARKING LANES, SHOULDERS, GORE AREAS, AND OTHER NON-TRAVELED AREAS

6. CONSTRUCTION SEQUENCE AT ISOLATED UTILITIES AND DRAINAGE STRUCTURES

- A. FORM ISOLATION JOINT.
- B. CONSTRUCT THE PAVEMENT OUTSIDE THE ISOLATION JOINT.
- C. SAWCUT TRANSVERSE AND LONGITUDINAL JOINTS, FIRST STAGE.
- D. REMOVE ISOLATION FORM AND TEMPORARY SUPPORT.
- E. SAWCUT TRANSVERSE AND LONGITUDINAL JOINTS, SECOND STAGE.
- F. PLACE PREMOULDED RESILIENT JOINT FILLER AROUND THE INNER PERIPHERY OF THE ISOLATION.
- G. PLACE CONCRETE WITH REINFORCEMENT INSIDE THE ISOLATION.
- H. SAWCUT AND SEAL THE ISOLATION JOINT.
- I. SEAL TRANSVERSE AND LONGITUDINAL JOINTS.

NOTE: STEPS (C) AND (J) ABOVE MAY BE REVERSED.

JOINT DETAIL REFERENCE	
FEATURE	FOR DETAIL SEE STANDARD SHEET
TRANSVERSE CONTRACTION JOINT	M502-15, DETAIL 'A'
TRANSVERSE EXPANSION JOINT	M502-15, DETAIL 'B'
TRANSVERSE ISOLATION JOINT	M502-15, DETAIL 'C'
TIED LONGITUDINAL JOINT	M502-12, DETAILS 'A', 'B', AND 'C'
UNTIED LONGITUDINAL JOINT (SHEAR KEY)	M502-12, DETAILS 'D' AND 'E'

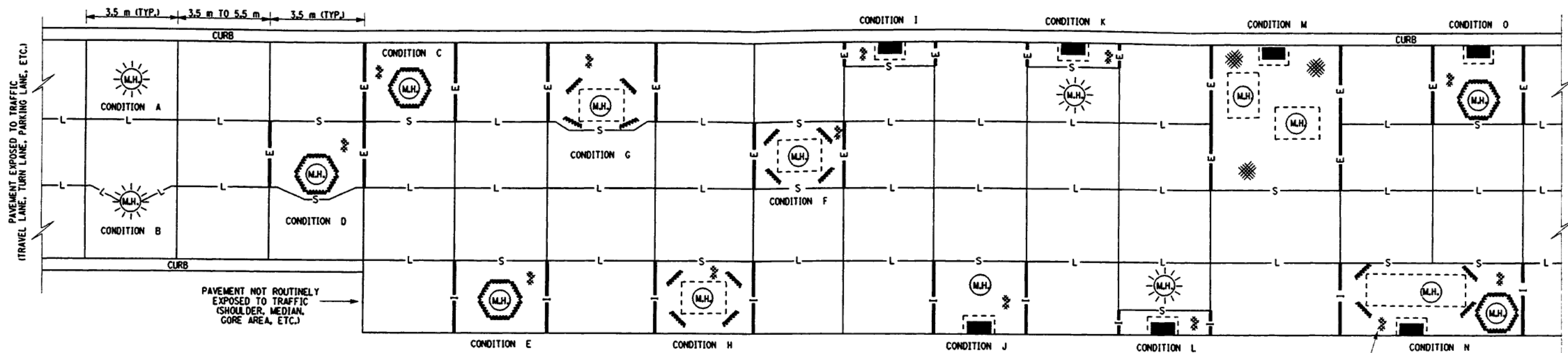
LEGEND FOR PLAN VIEW DETAILS ON STANDARD SHEETS M502-18 THROUGH M502-24

FEATURE	SYMBOL
TRANSVERSE CONTRACTION JOINT	—
TRANSVERSE EXPANSION JOINT	— E —
TRANSVERSE ISOLATION JOINT	— I —
TIED LONGITUDINAL JOINT	— L —
UNTIED LONGITUDINAL JOINT (SHEAR KEY)	— S —
NON-TELESCOPING MANHOLE CASTING	(M.H.)
TELESCOPING MANHOLE CASTING	(M.H.)
SHALLOW UTILITY (TOP OF STRUCTURE IS IN PCC PAVEMENT)	(M.H.) OR (M.H.)
DRAINAGE STRUCTURE ISOLATION (NOT EXPOSED TO TRAFFIC)	S
DRAINAGE STRUCTURE ISOLATION (EXPOSED TO TRAFFIC)	S
WIRE MESH REINFORCED SLAB	⊗
HEAVILY REINFORCED SLAB	⊗
LONGITUDINAL JOINT TIE OR DEFORMED REINFORCING BAR	—
TRANSVERSE JOINT DOWEL BAR	—

SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
UTILITY ISOLATION AND JOINT LAYOUT GENERAL NOTES	
APPROVED <i>Oct 16</i> , 2000 <i>Adrian</i> DEPUTY CHIEF ENGINEER (DESIGN)	ISSUED UNDER EB 00-057 M502-17



TYPICAL UTILITY ISOLATION PLAN

TYPICAL UTILITY ISOLATION GUIDELINES								
CONDITION	FEATURE	IS THE TOP OF THE MANHOLE STRUCTURE...			IS MANHOLE CASTING* WITHIN 300 mm OF A LONGITUDINAL JOINT? * SEE TABLE NOTES 1 & 2	WILL THE FEATURE BE EXPOSED TO TRAFFIC	MANHOLE CASTING TYPE	FOR MORE DETAILED REFERENCE SEE STANDARD SHEET
		≥ 400 mm BELOW ROADWAY SURFACE	< 400 mm BELOW ROADWAY SURFACE, BUT NOT WITHIN PCC SLAB	WITHIN PCC SLAB (SHALLOW)				
CONDITION A	MANHOLE	YES	--	--	NO	YES OR NO	TELESCOPING	M502-19, DETAIL 'A'
CONDITION B	MANHOLE	YES	--	--	YES	YES OR NO	TELESCOPING	M502-19, DETAILS 'B' & 'C'
CONDITION C	MANHOLE	--	YES	--	NO	YES	NON-TELESCOPING	M502-20, DETAIL 'A'
CONDITION D	MANHOLE	--	YES	--	YES	YES	NON-TELESCOPING	M502-20, DETAIL 'B'
CONDITION E	MANHOLE	--	YES	--	YES OR NO	NO	NON-TELESCOPING	M502-20, DETAIL 'A' & NOTE 8
CONDITION F	MANHOLE	--	--	YES	NO	YES	NON-TELESCOPING	M502-21, DETAIL 'A'
CONDITION G	MANHOLE	--	--	YES	YES	YES	NON-TELESCOPING	M502-21, DETAIL 'B'
CONDITION H	MANHOLE	--	--	YES	YES OR NO	NO	NON-TELESCOPING	M502-21, DETAIL 'A' & NOTE 8
CONDITION I	DRAINAGE STRUCTURE					YES	--	M502-22
CONDITION J	DRAINAGE STRUCTURE WITH NON-TELESCOPING MANHOLE IN PROXIMITY					NO	NON-TELESCOPING	M502-23, DETAILS 'D' THRU 'F' & NOTE 4
CONDITION K	DRAINAGE STRUCTURE WITH TELESCOPING MANHOLE IN PROXIMITY					YES	TELESCOPING	M502-23, DETAILS 'A' THRU 'C'
CONDITION L	DRAINAGE STRUCTURE WITH TELESCOPING MANHOLE IN PROXIMITY					NO	TELESCOPING	M502-23, DETAILS 'A' THRU 'C' & NOTE 4
CONDITION M	MULTIPLE DRAINAGE STRUCTURES / MANHOLES IN PROXIMITY					YES	NON-TELESCOPING	M502-24
CONDITION N	MULTIPLE DRAINAGE STRUCTURES / MANHOLES IN PROXIMITY					NO	NON-TELESCOPING	M502-24 & TABLE NOTE 3 BELOW
CONDITION O	DRAINAGE STRUCTURE WITH NON-TELESCOPING MANHOLE IN PROXIMITY					YES	NON-TELESCOPING	M502-23, DETAILS 'D' THRU 'F'

- TABLE NOTES :
1. WHEN THE PRECAST CONCRETE PAVERS OF A NON-TELESCOPING MANHOLE CASTING OR THE MASONRY PORTION OF A SHALLOW UTILITY IS WITHIN 300 mm OF A LONGITUDINAL JOINT, ISOLATE THE UTILITY AS SHOWN IN EITHER CONDITION D OR CONDITION G, RESPECTIVELY.
 2. FOR SHALLOW UTILITIES, THE 300 mm OFFSET CRITERIA IS BASED ON THE DISTANCE BETWEEN THE LONGITUDINAL JOINT AND THE MASONRY PORTION OF THE STRUCTURE, NOT THE CASTING (OR PRECAST CONCRETE PAVERS).
 3. PAVEMENT NOT ROUTINELY EXPOSED TO TRAFFIC IS NOT HEAVILY REINFORCED.

TELESCOPING MANHOLE SUBSTITUTIONS	
IF THE PROPER SIZE TELESCOPING MANHOLE CASTING IS NOT AVAILABLE USE A NON-TELESCOPING MANHOLE CASTING AND THE FOLLOWING ISOLATION METHOD :	
TELESCOPING MANHOLE CASTING RECOMMENDED FOR :	SUBSTITUTE NON-TELESCOPING MANHOLE CASTING AND USE ISOLATION METHOD :
CONDITION A	CONDITION C
CONDITION B	CONDITION D
CONDITION K	CONDITION O
CONDITION L	CONDITION J

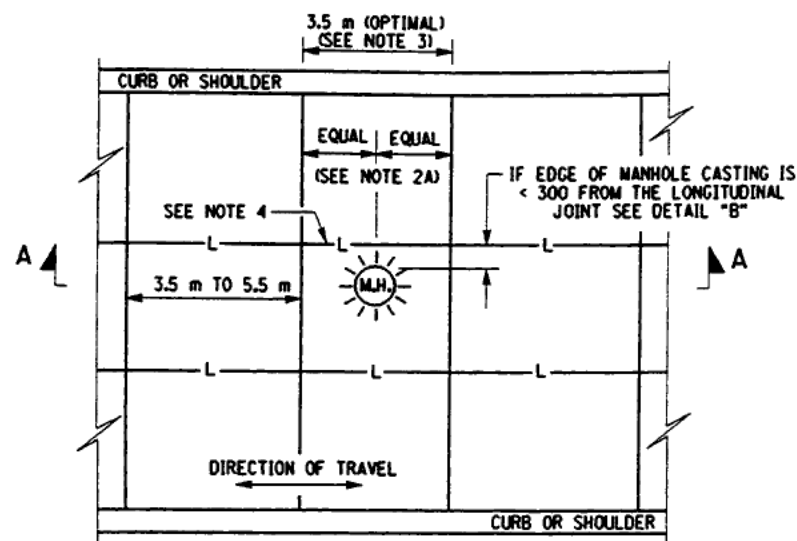
GENERAL NOTE :

1. SEE GENERAL NOTES AND LEGEND ON SHEET M502-17.

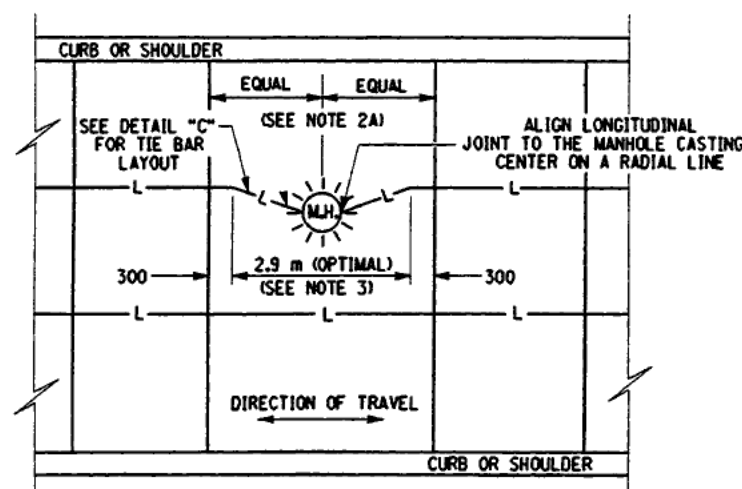
SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLS

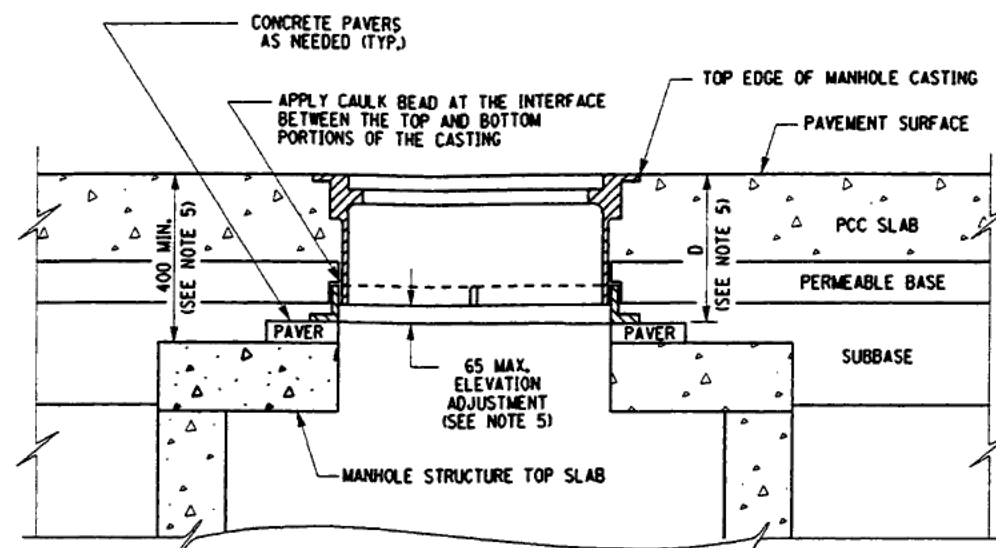
STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
UTILITY ISOLATION GUIDELINES	
APPROVED <i>Oct 16, 2000</i> <i>B. J. Clark</i> DEPUTY CHIEF ENGINEER (DESIGN)	ISSUED UNDER EB 00-057 M502-18



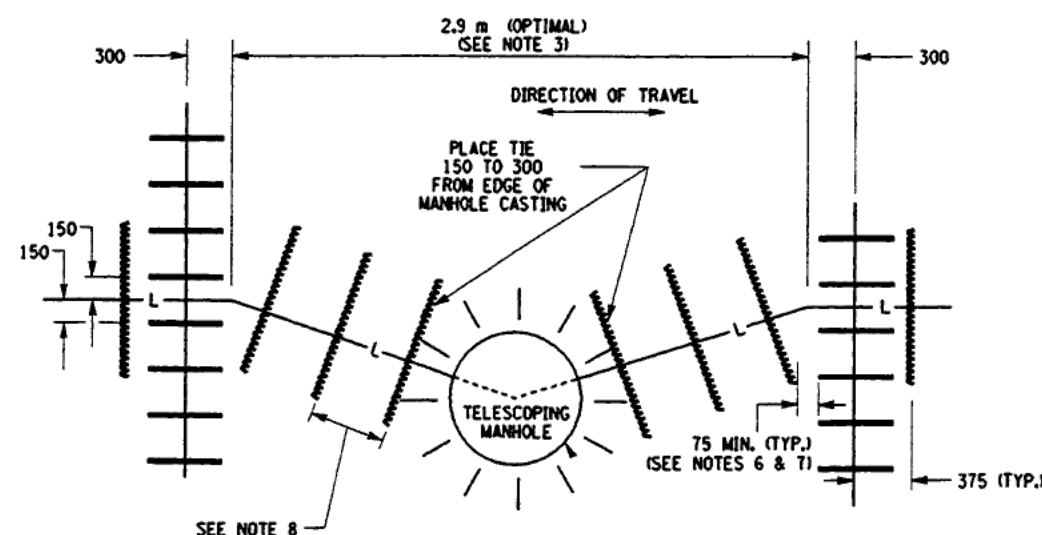
DETAIL 'A'
TYPICAL JOINT LAYOUT
TELESCOPING MANHOLE CASTING
VALID FOR EITHER EXPOSED OR NOT EXPOSED TO TRAFFIC CONDITIONS
PLAN VIEW
(CONDITION 'A' ON SHEET M502-18)



DETAIL 'B'
TELESCOPING MANHOLE CASTING
< 300 mm FROM A LONGITUDINAL JOINT
VALID FOR EITHER EXPOSED OR NOT EXPOSED TO TRAFFIC CONDITIONS
PLAN VIEW
(CONDITION 'B' ON SHEET M502-18)



SECTION A-A
TELESCOPING MANHOLE CASTING
(SEE NOTE 2)



DETAIL 'C'
JOINT AND TIE BAR LAYOUT
FOR TELESCOPING MANHOLE CASTING
< 300 mm FROM A LONGITUDINAL JOINT
VALID FOR EITHER EXPOSED OR NOT EXPOSED TO TRAFFIC CONDITIONS
PLAN VIEW
(CONDITION 'B' ON SHEET M502-18)

GENERAL NOTES :

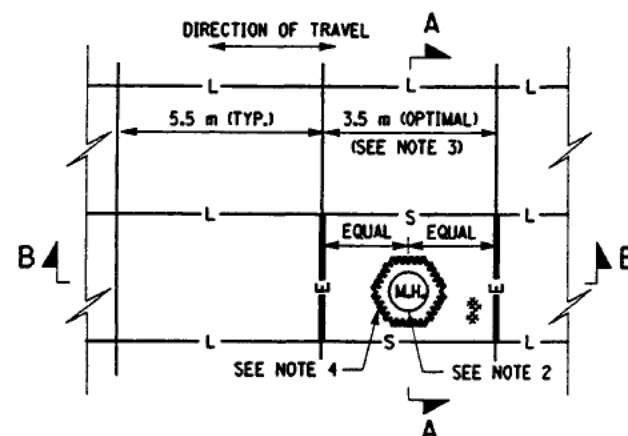
- SEE GENERAL NOTES AND LEGEND ON SHEET M502-17.
- THE USE OF TELESCOPING CASTINGS REQUIRE:
 - THE CASTING MUST BE CENTERED LONGITUDINALLY BETWEEN TRANSVERSE JOINTS (± 300 mm).
 - THE ROOF OF THE UTILITY STRUCTURE MUST BE A MINIMUM OF 400 mm BELOW THE PAVEMENT SURFACE.
 - THE CASTING TYPE AND SIZE MUST BE AVAILABLE WITH THE TELESCOPING FEATURE. SEE THE CURRENT M655 STANDARD SHEET.
- MAINTAIN 3.5 m SLAB LENGTHS. SLABS MAY BE LENGTHENED TO 5.5 m TO RESOLVE CONFLICTS WITH STRUCTURES IN ADJACENT LANES PROVIDED THE GEOMETRIC REQUIREMENTS IN STANDARD SHEET M502-17, NOTE 3A ARE SATISFIED. ADD A LAYER OF WIRE MESH IF THE SLAB(S) CONTAINING THE TELESCOPING CASTING EXCEEDS 4.0 m IN LENGTH. USE GALVANIZED WELDED WIRE MESH, MW 20, 100 mm x 100 mm. MAINTAIN A 75 mm CLEARANCE BETWEEN THE MESH AND ALL JOINTS, JOINT BARS, AND UTILITIES.
- IF THE MANHOLE CASTING INTERFERES WITH NORMAL LONGITUDINAL JOINT TIE SPACING, RELOCATE THE TIES OR BEND THE TIES WHEN APPROVED BY THE ENGINEER. THE SAME NUMBER OF TIES PER SLAB ARE REQUIRED AND THE DISTRIBUTION OF TIES TO EITHER SIDE OF THE CASTING SHOULD BE AS BALANCED AS POSSIBLE.
- THE "D" DIMENSION MUST BE BETWEEN 400 mm AND 430 mm. WHEN "D" IS GREATER THAN 430 mm, PRECAST CONCRETE PAVERS AND/OR ADJUSTMENT RINGS ARE REQUIRED. THE SLOT IN THE TELESCOPING MANHOLE CASTING PROVIDES 65 mm OF ELEVATION ADJUSTMENT TO MATCH THE PCC PAVEMENT FINISHED GRADE.
- MAINTAIN A 75 mm MINIMUM CLEARANCE BETWEEN THE LONGITUDINAL JOINT TIES AND THE TRANSVERSE JOINT SUPPORTS. TIES MAY BE BENT TO ACHIEVE THE CLEARANCE.
- IF THE SLAB DOES NOT REQUIRE TRANSVERSE JOINT SUPPORTS (EXAMPLE: SLAB IS PART OF THE SHOULDER THERE WILL BE NO CONFLICT WITH THE SKEWED LONGITUDINAL JOINT TIES. HOWEVER, THE MINIMUM DISTANCE BETWEEN THE TIES AND THE TRANSVERSE JOINT IS 75 mm. TIES MAY BE BENT TO ACHIEVE THE CLEARANCE.
- COMPUTE THE NUMBER OF TIES USING EQUATION (2) ON STANDARD SHEET M502-11. EVENLY SPACE HALF THE REQUIRED TIES ON EACH SIDE OF THE MANHOLE. IF AN ODD NUMBER OF TIES IS REQUIRED, ELIMINATE ONE TIE AND EVENLY SPACE THE TIES ON EACH SIDE OF THE MANHOLE.

SHEET NOTES :

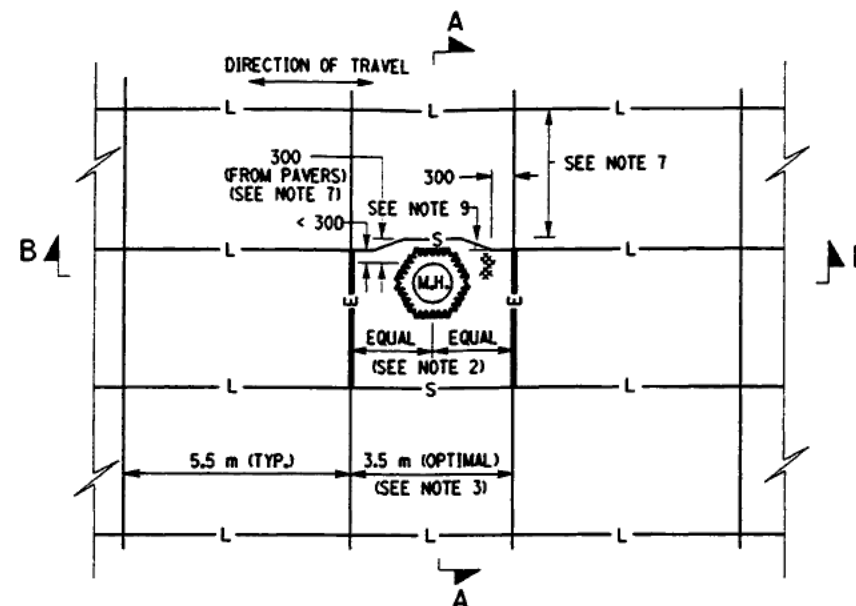
- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLOLOGY

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
TELESCOPING MANHOLE CASTING LAYOUT	
APPROVED <i>Oct 16, 2000</i> <i>[Signature]</i> DEPUTY CHIEF ENGINEER (DESIGN)	ISSUED UNDER EB 00-057 M502-19

NON-TELESCOPING MANHOLE CASTING



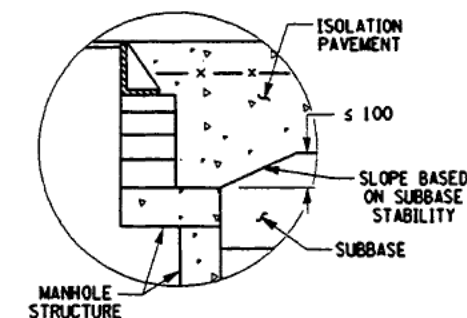
DETAIL 'A'
NON-TELESCOPING MANHOLE CASTING
EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 8)
PLAN VIEW
(CONDITIONS 'C' AND 'E' ON SHEET M502-18)



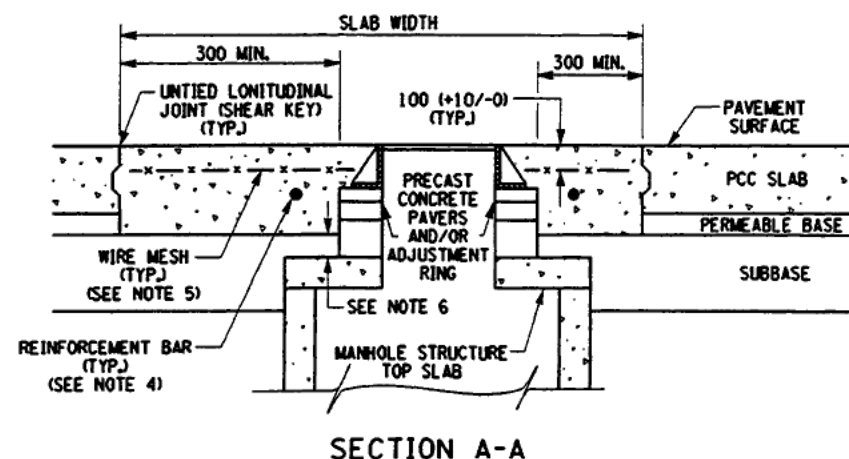
DETAIL 'B'
NON-TELESCOPING MANHOLE CASTING
< 300 mm OFFSET FROM A LONGITUDINAL JOINT
EXPOSED TO TRAFFIC CONDITIONS SHOWN (SEE NOTE 8)
PLAN VIEW
(CONDITION 'D' ON SHEET M502-18)

GENERAL NOTES:

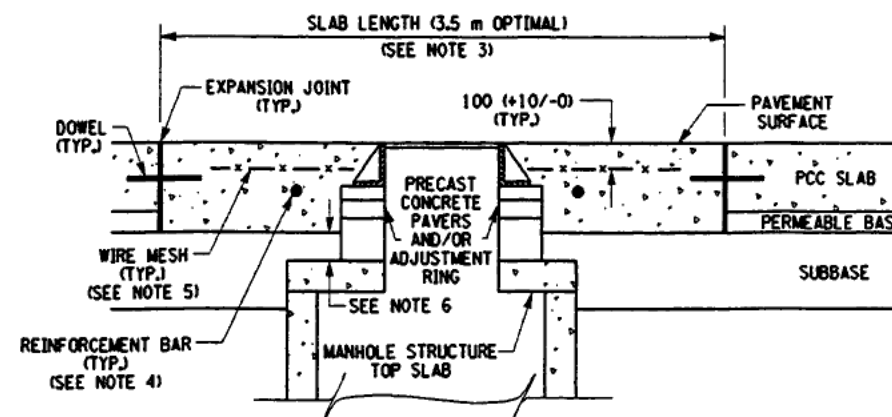
1. SEE GENERAL NOTES AND LEGEND ON SHEET M502-17.
2. CENTER THE MANHOLE CASTING LONGITUDINALLY BETWEEN THE TRANSVERSE JOINTS (≤ 300 mm).
3. MAINTAIN 3.5 m SLAB LENGTHS. SLABS MAY BE LENGTHENED TO 5.5 m TO RESOLVE CONFLICTS WITH STRUCTURES IN ADJACENT LANES PROVIDED THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A ARE SATISFIED.
4. USE #19, GRADE 420 STEEL, EPOXY COATED, DEFORMED BARS PLACED AT A DEPTH OF HALF THE ISOLATION SLAB THICKNESS FOR REINFORCEMENT. FOR RECTANGULAR STRUCTURES, PLACE A 900 mm LONG BAR AT EACH CORNER. FOR ROUND STRUCTURES, ENCIRCLE THE STRUCTURE WITH 6 BARS, OVERLAPPED A MINIMUM OF 75 mm. MAINTAIN A HORIZONTAL CLEARANCE OF 75 mm BETWEEN THE BARS AND THE JOINTS, JOINT BARS, AND UTILITIES. THE BARS MAY BE BENT TO ACHIEVE CLEARANCES.
5. USE GALVANIZED, WELDED WIRE MESH, MW 20, 100 mm X 100 mm. MAINTAIN A 75 mm CLEARANCE BETWEEN THE WIRE MESH AND ALL JOINTS, JOINT BARS, AND UTILITIES.
6. IF THERE IS 100 mm OR LESS BETWEEN THE BOTTOM OF THE ISOLATION SLAB AND THE TOP OF THE MANHOLE STRUCTURE, OMIT THE SUBBASE AND PLACE CONCRETE TO THE STRUCTURE. SEE DETAIL 'C'.
7. IF A UTILITY WITH A NON-TELESCOPING CASTING FALLS WITHIN 300 mm OF THE PROJECTED LONGITUDINAL JOINT, OFFSET THE LONGITUDINAL JOINT SUCH THAT A 300 mm CLEARANCE IS ACHIEVED BETWEEN THE MASONRY AND THE LONGITUDINAL JOINT. THE WIDENED SLAB CONTAINING THE STRUCTURE AND THE NARROWED ADJACENT SLAB MUST BOTH MEET THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A. IF THESE REQUIREMENTS CAN NOT BE MET, OMIT THE OFFSET LONGITUDINAL JOINT AND ISOLATE THE STRUCTURE IN A SINGLE PLACEMENT THAT IS TWO SLABS WIDE. THIS PLACEMENT MUST ALSO MEET THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A.
8. SUBSTITUTE ISOLATION JOINTS FOR EXPANSION JOINTS WHEN THE UTILITY OR DRAINAGE STRUCTURE TO BE ISOLATED IS NOT EXPOSED TO TRAFFIC, SUCH AS IN A SHOULDER, MEDIAN, OR GORE AREA.
9. FORM AS FLAT AN ANGLE AS POSSIBLE, WHILE MAINTAINING A 300 mm CLEARANCE BETWEEN THE LONGITUDINAL JOINT AND THE MASONRY OR PRECAST CONCRETE PAVERS, MAXIMUM ANGLE IS 30°.



DETAIL 'C'
ISOLATION PAVEMENT
WHEN ≤ 100 mm SUBBASE DEPTH
ABOVE STRUCTURE



SECTION A-A



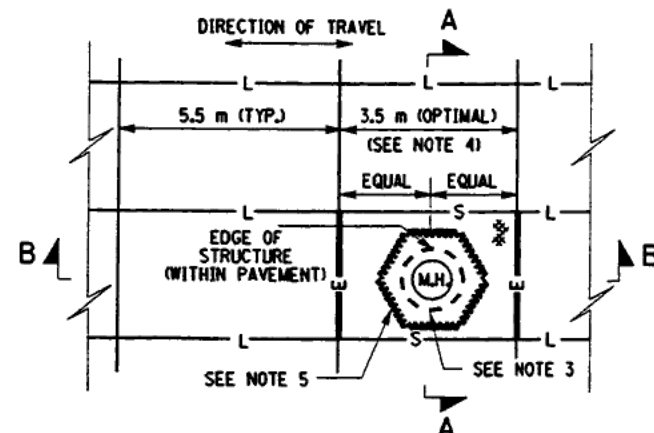
SECTION B-B

SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLOLOGY

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
NON-TELESCOPING MANHOLE CASTING ISOLATION	
APPROVED Oct 16, 2000 [Signature] DEPUTY CHIEF ENGINEER (DESIGN)	ISSUED UNDER EB 00-057 M502-20

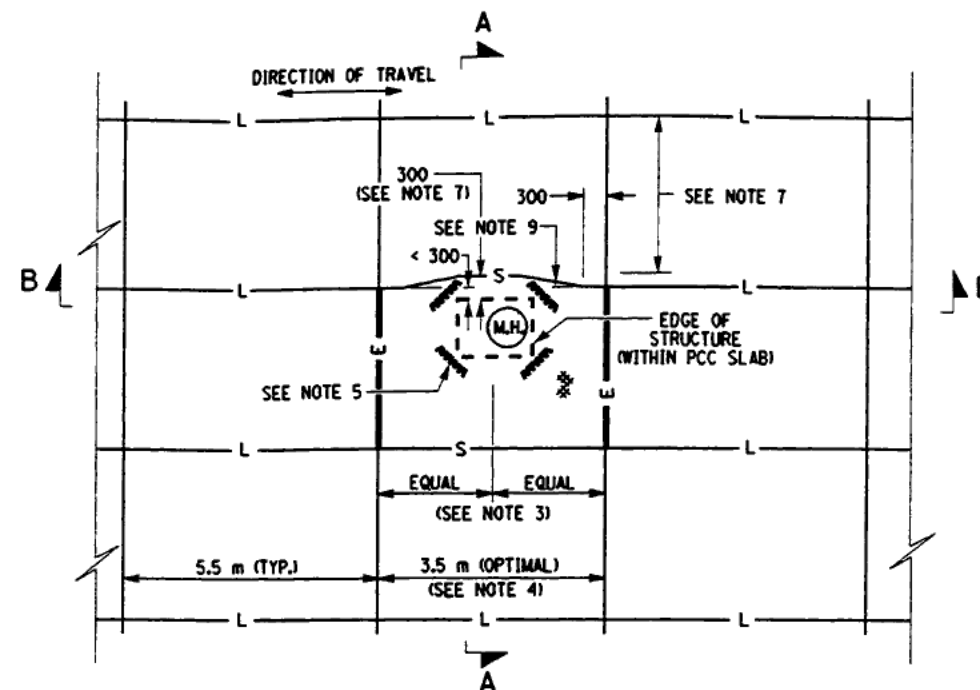
SHALLOW STRUCTURE



DETAIL 'A'

SHALLOW STRUCTURE

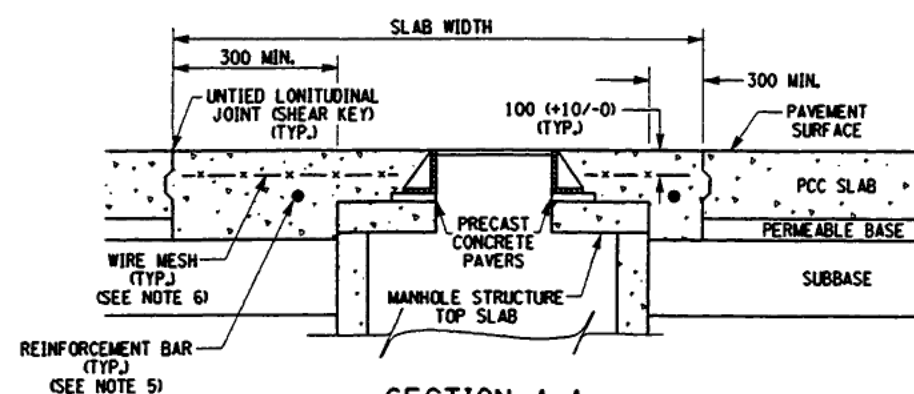
EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 8)
PLAN VIEW
(CONDITIONS 'F' & 'H' ON SHEET M502-18)



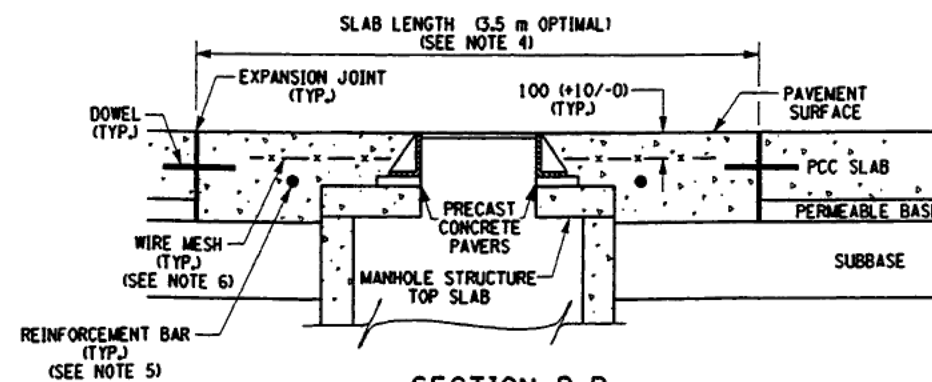
DETAIL 'B'

SHALLOW STRUCTURE < 300 mm FROM A LONGITUDINAL JOINT

EXPOSED TO TRAFFIC CONDITIONS SHOWN (SEE NOTE 8)
PLAN VIEW
(CONDITION 'G' ON SHEET M502-18)



SECTION A-A



SECTION B-B

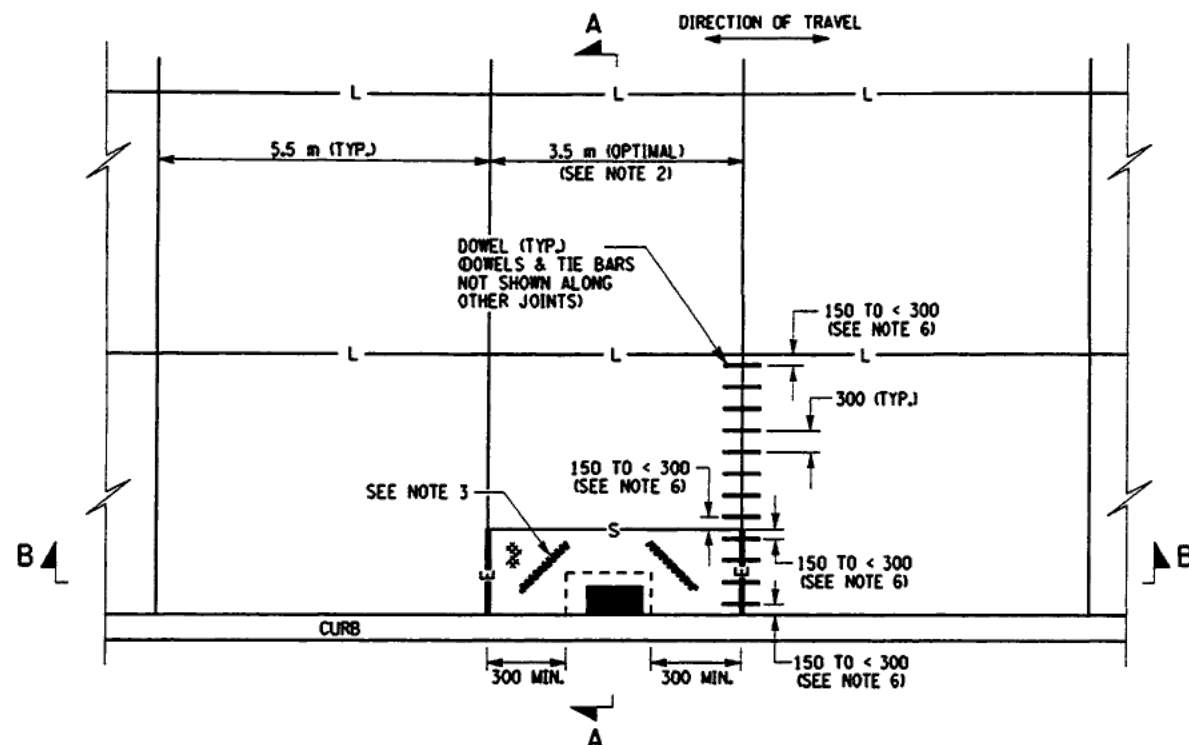
GENERAL NOTES:

1. SEE GENERAL NOTES AND LEGEND ON SHEET M502-17.
2. USE THESE DETAILS IF THE TOP OF THE STRUCTURE PROTRUDES INTO THE PCC SLAB. THESE DETAILS ARE VALID FOR EITHER ROUND OR RECTANGULAR MANHOLE STRUCTURES.
3. CENTER THE MASONRY PORTION OF THE STRUCTURE (NOT THE CASTING) LONGITUDINALLY BETWEEN THE TRANSVERSE JOINTS.
4. MAINTAIN 3.5 m SLAB LENGTH. SLABS MAY BE LENGTHENED TO 5.5 m TO RESOLVE CONFLICTS WITH STRUCTURE IN ADJACENT LANES PROVIDED THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A ARE SATISFIED.
5. USE #19, GRADE 420 STEEL, EPOXY COATED, DEFORMED BARS PLACED AT A DEPTH OF HALF THE ISOLATION SLAB THICKNESS FOR REINFORCEMENT. FOR RECTANGULAR STRUCTURES, PLACE A 900 mm LONG BAR AT EACH CORNER. FOR ROUND STRUCTURES, ENCIRCLE THE STRUCTURE WITH 6 BARS, OVERLAPPED A MINIMUM OF 75 mm. MAINTAIN A HORIZONTAL CLEARANCE OF 75 mm BETWEEN THE BARS AND THE JOINTS, JOINT BARS, AND UTILITIES. THE BARS MAY BE BENT TO ACHIEVE CLEARANCES.
6. USE GALVANIZED, WELDED WIRE MESH, MW20, 100 mm X 100 mm. MAINTAIN A 75 mm CLEARANCE BETWEEN THE WIRE MESH AND ALL JOINTS, JOINT BARS, AND UTILITIES.
7. IF THE MASONRY PORTION OF A SHALLOW UTILITY FALLS WITHIN 300 mm OF THE PROJECTED LONGITUDINAL JOINT, OFFSET THE LONGITUDINAL JOINT SUCH THAT A 300 mm CLEARANCE IS ACHIEVED BETWEEN THE MASONRY AND THE LONGITUDINAL JOINT. THE WIDENED SLAB CONTAINING THE STRUCTURE AND THE NARROWED ADJACENT SLAB MUST BOTH MEET THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A. IF THESE REQUIREMENTS CAN NOT BE MET, OMIT THE OFFSET LONGITUDINAL JOINT AND ISOLATE THE STRUCTURE IN A SINGLE PLACEMENT THAT IS TWO SLABS WIDE. THIS PLACEMENT MUST ALSO MEET THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A.
8. SUBSTITUTE ISOLATION JOINTS FOR EXPANSION JOINTS WHEN THE UTILITY OR DRAINAGE STRUCTURE TO BE ISOLATED IS NOT EXPOSED TO TRAFFIC, SUCH AS IN A SHOULDER, MEDIAN, OR GORE AREA.
9. FORM AS FLAT AN ANGLE AS POSSIBLE WHILE MAINTAINING A 300 mm CLEARANCE BETWEEN THE LONGITUDINAL JOINT AND THE MASONRY OR PRECAST CONCRETE PAVERS, MAXIMUM ANGLE IS 30°.

SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLOLOGY

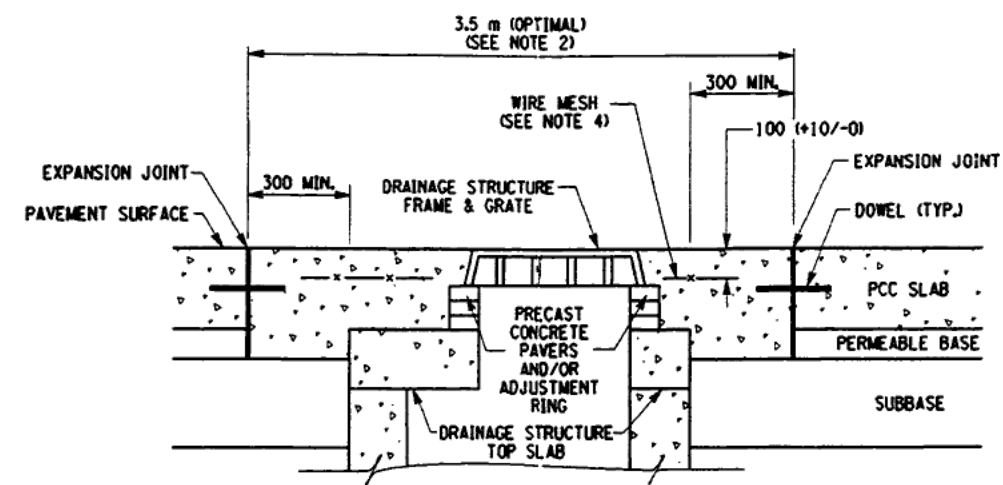
STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
SHALLOW STRUCTURE ISOLATION	
APPROVED <i>Oct 16</i> 2000 <i>[Signature]</i> DESIGN CHIEF ENGINEER	ISSUED UNDER EB 00-057 M502-21



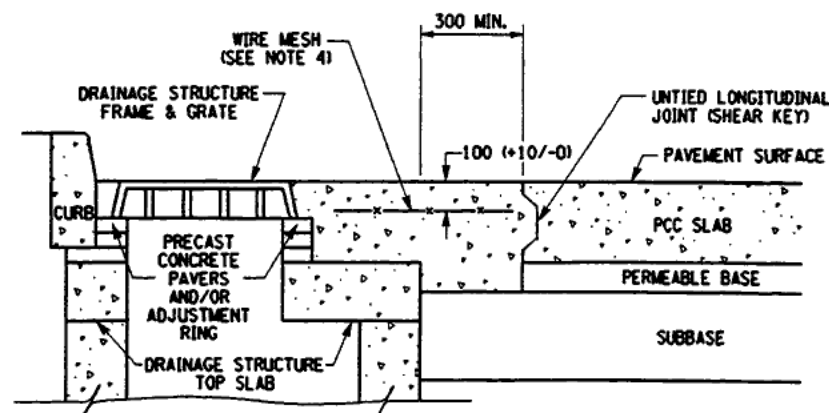
DETAIL 'A'

DRAINAGE STRUCTURE ISOLATION

EXPOSED TO TRAFFIC CONDITIONS SHOWN (SEE NOTE 5)
PLAN VIEW
(CONDITION '1' ON SHEET M502-18)



SECTION B-B



SECTION A-A

GENERAL NOTES :

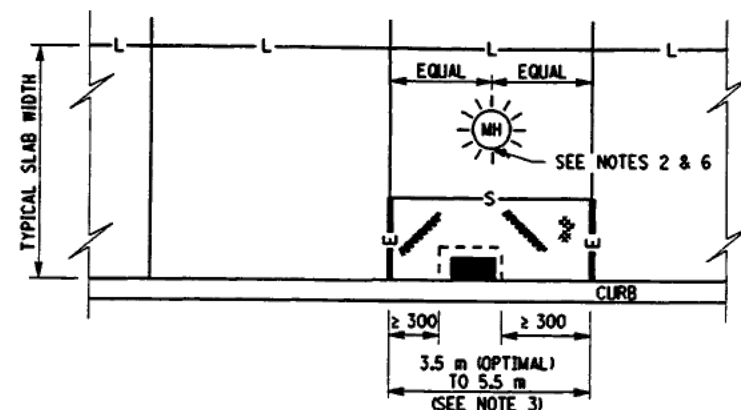
1. SEE GENERAL NOTES AND LEGEND ON SHEET M502-17.
2. MAINTAIN 3.5 m SLAB LENGTHS. SLABS MAY BE LENGTHENED TO 5.5 m TO RESOLVE CONFLICTS WITH STRUCTURES IN ADJACENT LANES, PROVIDED THE GEOMETRIC REQUIREMENTS ON STANDARD SHEET M502-17, NOTE 3A ARE SATISFIED. THE GEOMETRIC REQUIREMENTS OF STANDARD SHEET M502-17, NOTE 3A, DO NOT APPLY TO THE SLAB CONTAINING THE DRAINAGE STRUCTURE.
3. PLACE A 900 mm LONG, #19, GRADE 420 STEEL, EPOXY COATED, DEFORMED BAR AT BOTH CORNERS OF THE STRUCTURE AT A DEPTH OF HALF THE ISOLATION SLAB THICKNESS AS SHOWN IN DETAIL 'A'. MAINTAIN A MINIMUM 75 mm CLEARANCE BETWEEN THE BARS AND THE STRUCTURE, JOINTS, AND JOINT BARS. THE BARS MAY BE BENT TO ACHIEVE CLEARANCES.
4. USE GALVANIZED, WELDED WIRE MESH, MW20 - 100 mm X 100 mm. MAINTAIN A 75 mm CLEARANCE BETWEEN THE WIRE MESH AND ALL JOINTS, JOINT BARS, AND UTILITIES.
5. IF THE DRAINAGE STRUCTURE WILL NOT BE ROUTINELY EXPOSED TO TRAFFIC (FOR EXAMPLE: SHOULDER, GORE AREA, OR MEDIAN), REPLACE THE TRANSVERSE EXPANSION JOINTS WITH ISOLATION JOINTS.
6. EVENLY SPACE THE END DOWELS BETWEEN THE LONGITUDINAL JOINTS. DO NOT SPAN AN UNTIED LONGITUDINAL JOINT WITH A TRANSVERSE JOINT SUPPORT. USE SEPARATE SUPPORTS ON EITHER SIDE OF THE UNTIED LONGITUDINAL JOINT.

SHEET NOTES :

- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLOLOGY

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
DRAINAGE STRUCTURE ISOLATION	
APPROVED <i>Oct 16</i> . 2000 <i>JD</i> DEPUTY CHIEF ENGINEER DESIGN	ISSUED UNDER EB 00-057 M502-22

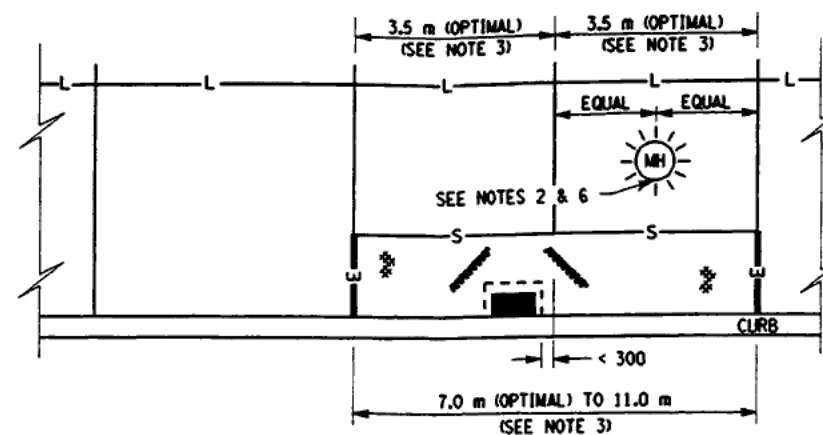
TELESCOPING MANHOLE CASTING (CONDITIONS 'K' & 'L' ON SHEET M502-18)



DETAIL 'A'

SINGLE SLAB ISOLATION

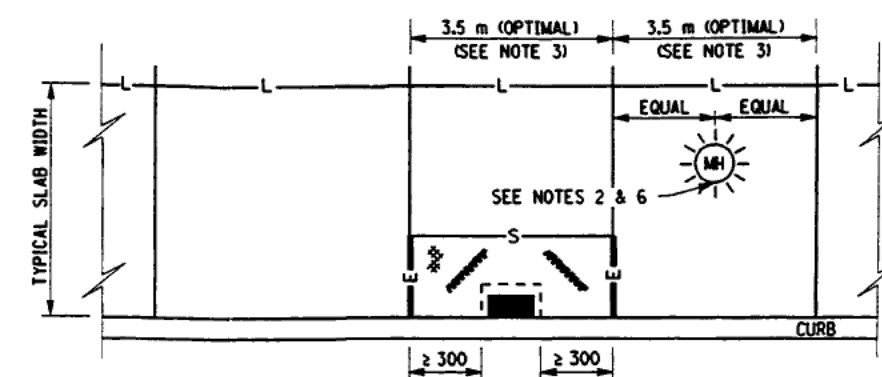
EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 4)



DETAIL 'B'

TWO SLAB ISOLATION

EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 4)

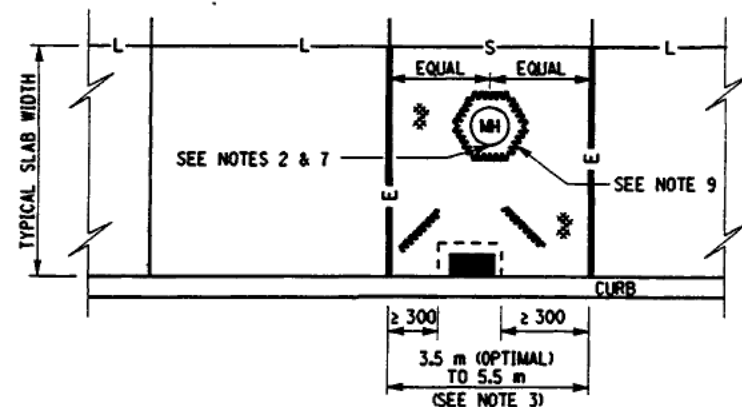


DETAIL 'C'

OFFSET SINGLE SLAB ISOLATION

EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 4)

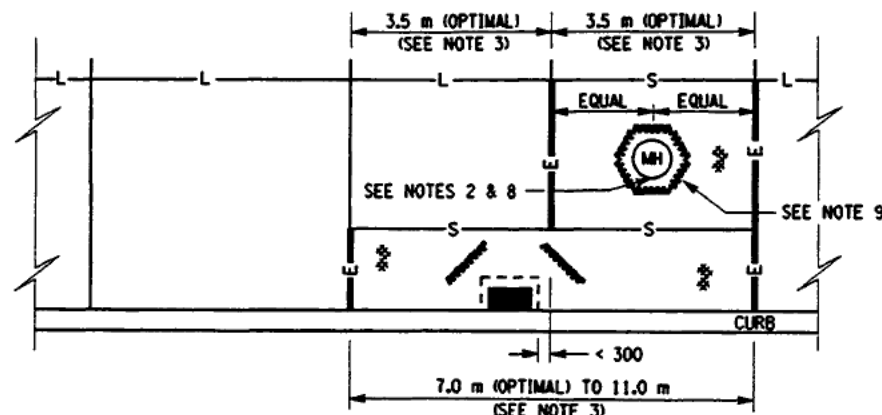
NON-TELESCOPING MANHOLE CASTING (CONDITIONS 'J' & 'O' ON SHEET M502-18)



DETAIL 'D'

SINGLE SLAB ISOLATION

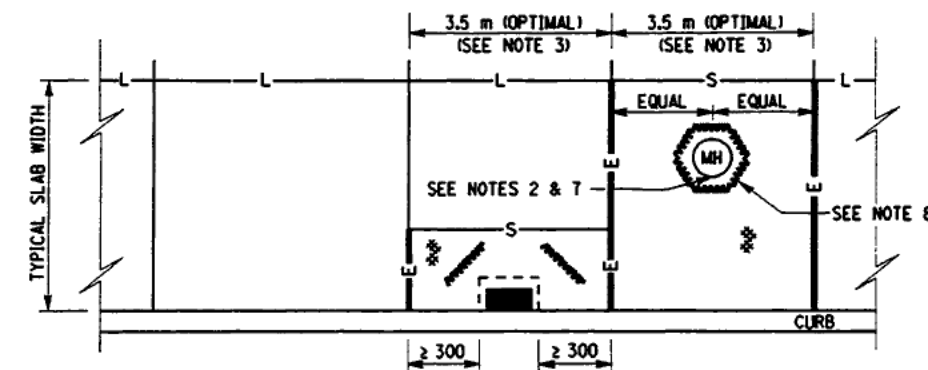
EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 4)



DETAIL 'E'

TWO SLAB ISOLATION

EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 4)



DETAIL 'F'

OFFSET SINGLE SLAB ISOLATION

EXPOSED TO TRAFFIC CONDITION SHOWN (SEE NOTE 4)

DETAIL SELECTION PROCESS :

FOR TELESCOPING MANHOLE CASTINGS, PROGRESS FROM DETAIL 'A' THROUGH DETAIL 'C' AS THE LONGITUDINAL DISTANCE BETWEEN THE MANHOLE CASTING AND THE DRAINAGE STRUCTURE INCREASES. FOR NON-TELESCOPING MANHOLE CASTINGS USE DETAILS 'D' THROUGH 'F'. DETAILS 'A' AND 'C' ARE THE OPTIMAL ISOLATION TECHNIQUES FOR TELESCOPING MANHOLE CASTINGS NEAR DRAINAGE STRUCTURES. DETAILS 'D' AND 'F' ARE THE OPTIMAL ISOLATION TECHNIQUES FOR NON-TELESCOPING MANHOLE CASTINGS NEAR DRAINAGE STRUCTURES.

DETAILS 'A' AND 'D' - SINGLE SLAB ISOLATION :

USE THESE DETAILS WHEN THE TRANSVERSE JOINTS SURROUNDING THE MANHOLE BOTH FALL A MINIMUM OF 300 mm OUTSIDE THE MASONRY PORTION OF THE DRAINAGE STRUCTURE.

DETAILS 'B' AND 'E' - TWO SLAB ISOLATION :

USE THESE DETAILS WHEN EITHER OF THE TRANSVERSE JOINTS SURROUNDING THE MANHOLE FALLS WITHIN 300 mm OF THE MASONRY PORTION OF THE DRAINAGE STRUCTURE.

DETAILS 'C' AND 'F' - OFFSET SINGLE SLAB ISOLATION :

USE THESE DETAILS WHEN:

- (1) THE TRANSVERSE JOINT BETWEEN THE MANHOLE AND DRAINAGE STRUCTURE FALLS A MINIMUM OF 300 mm OUTSIDE THE MASONRY PORTION OF THE DRAINAGE STRUCTURE AND
- (2) THE NEXT TRANSVERSE JOINT FALLS A MINIMUM OF 300 mm OUTSIDE THE OTHER SIDE OF THE MASONRY PORTION OF THE DRAINAGE STRUCTURE WHILE ACHIEVING A 3.5 m TO 5.5 m SLAB LENGTH.

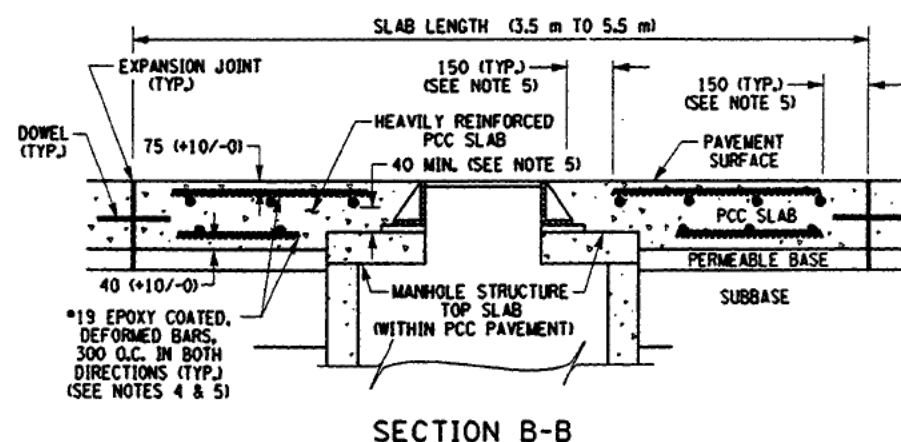
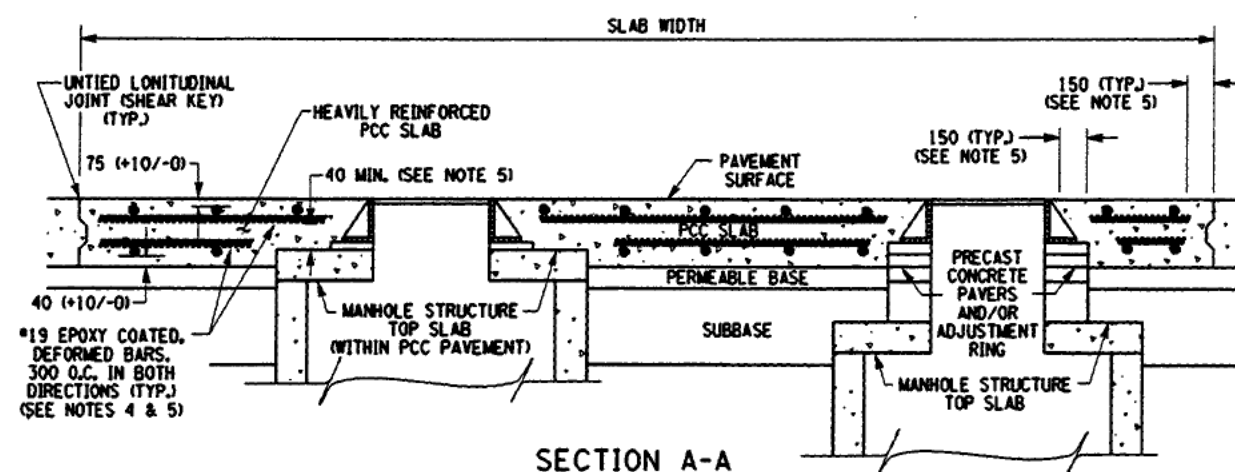
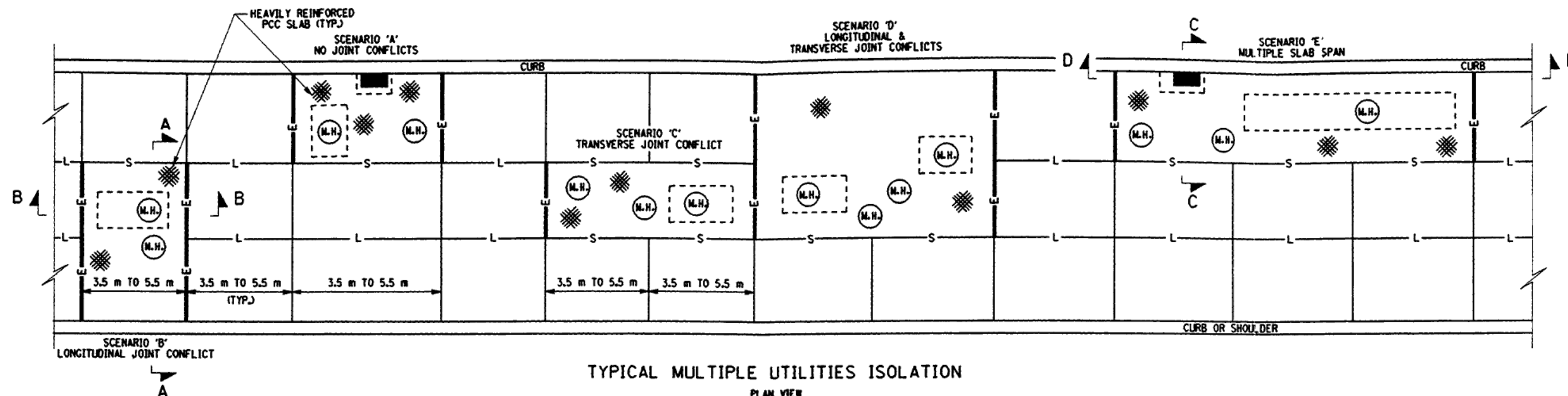
GENERAL NOTES:

1. SEE GENERAL NOTES AND LEGEND ON SHEET M502-17.
2. CENTER THE MANHOLE CASTING LONGITUDINALLY BETWEEN TRANSVERSE JOINTS (± 300 mm).
3. MAINTAIN 3.5 m SLAB LENGTHS. SLABS MAY BE LENGTHENED TO 5.5 m TO RESOLVE CONFLICTS WITH STRUCTURES IN ADJACENT LANES PROVIDED THE GEOMETRIC REQUIREMENTS IN STANDARD SHEET M502-17, NOTE 3A ARE SATISFIED. ADD A LAYER OF WIRE MESH IF THE SLAB(S) CONTAINING THE TELESCOPING CASTING EXCEEDS 4.0 m IN LENGTH. USE GALVANIZED WELDED WIRE MESH, MW20, 100 mm x 100 mm. MAINTAIN A 75 mm CLEARANCE BETWEEN THE MESH AND ALL JOINTS, JOINT BARS, AND UTILITIES. THE GEOMETRIC REQUIREMENTS OF STANDARD SHEET M502-17, NOTE 3A DO NOT APPLY TO THE SLAB CONTAINING THE DRAINAGE STRUCTURE.
4. SUBSTITUTE ISOLATION JOINTS FOR EXPANSION JOINTS IF THE UTILITY OR DRAINAGE STRUCTURE TO BE ISOLATED IS NOT EXPOSED TO TRAFFIC SUCH AS IN THE SHOULDER, MEDIAN, OR GORE AREA.
5. EVENLY SPACE THE END DOWELS BETWEEN THE LONGITUDINAL JOINTS. DO NOT SPAN AN UNTIED LONGITUDINAL JOINT WITH A TRANSVERSE JOINT SUPPORT. USE SEPARATE SUPPORTS ON EITHER SIDE OF THE UNTIED LONGITUDINAL JOINT.
6. IF A TELESCOPING MANHOLE CASTING FALLS WITHIN 300 mm OF A LONGITUDINAL JOINT, SKEW THE JOINT AS DEPICTED IN DETAILS 'B' AND 'C' ON STANDARD SHEET M502-19. IF THE SKEWED JOINT IS AN UNTIED LONGITUDINAL JOINT (SHEAR KEY), OMIT THE TIE BARS DEPICTED IN DETAIL 'C' ON STANDARD SHEET M502-19.
7. IF THE MASONRY PORTION OF A NON-TELESCOPING MANHOLE FALLS WITHIN 300 mm OF THE UNTIED LONGITUDINAL JOINT (SHEAR KEY), OFFSET THE LONGITUDINAL JOINT AS DEPICTED IN DETAIL 'B' ON STANDARD SHEET M502-20.
8. IF THE MASONRY PORTION OF A NON-TELESCOPING MANHOLE FALLS WITHIN 300 mm OF THE UNTIED LONGITUDINAL JOINT (SHEAR KEY) BETWEEN LANES, OFFSET THE LONGITUDINAL JOINT AS DEPICTED IN DETAIL 'B' ON STANDARD SHEET M502-20. IF THE MASONRY PORTION OF A NON-TELESCOPING MANHOLE FALLS WITHIN 300 mm OF THE UNTIED LONGITUDINAL JOINT (SHEAR KEY) IN FRONT OF THE DRAINAGE STRUCTURE, ELIMINATE THAT JOINT AND ISOLATE BOTH STRUCTURES IN A HEAVILY REINFORCED SLAB AS DEPICTED ON STANDARD SHEET M502-24.
9. SEE STANDARD SHEETS M502-19, M502-20, AND M502-22 FOR TELESCOPING MANHOLE CASTING, NON-TELESCOPING MANHOLE CASTING, AND DRAINAGE STRUCTURE CROSS SECTIONS AND REINFORCEMENT DETAILS, RESPECTIVELY.

SHEET NOTES :

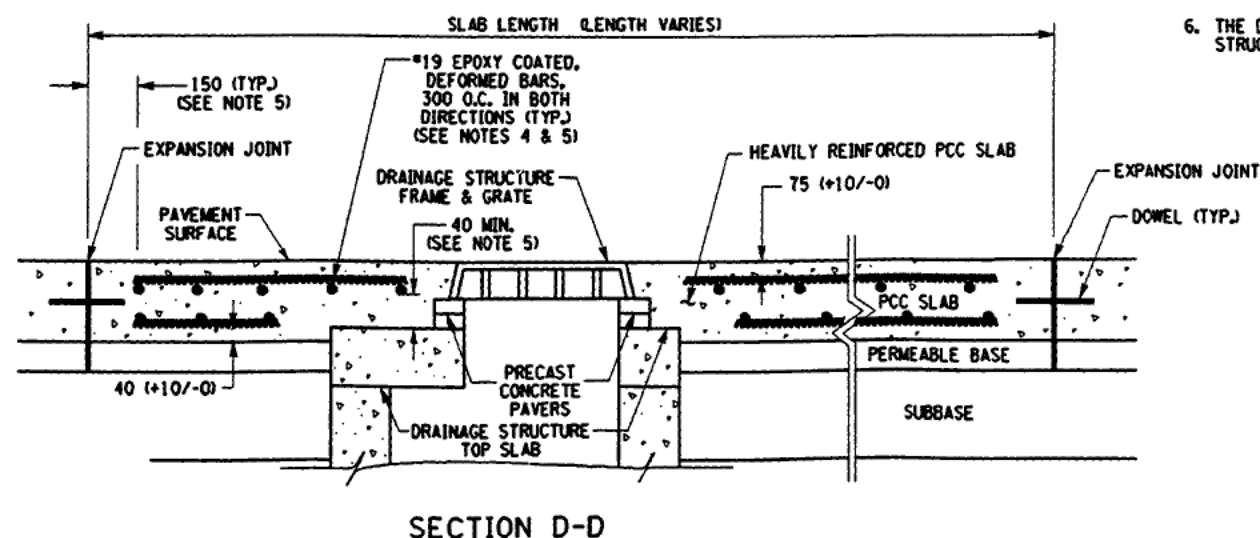
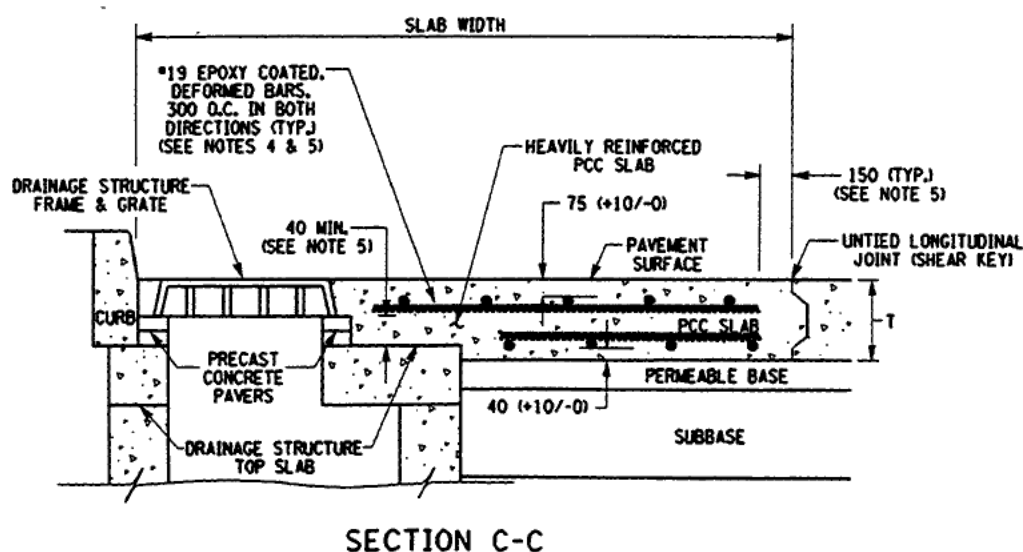
- 'PCC' STANDS FOR PORTLAND CEMENT CONCRETE
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLOLOGY

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
DRAINAGE STRUCTURE ISOLATION NEAR MANHOLE CASTINGS	
APPROVED <i>[Signature]</i> DESIGN CHIEF ENGINEER	ISSUED UNDER EB 00-057 M502-23



GENERAL NOTES:

- SEE GENERAL NOTES AND LEGEND ON SHEET M502-17. THE GEOMETRIC REQUIREMENTS OF STANDARD SHEET M502-17, NOTE 3A DO NOT APPLY TO HEAVILY REINFORCED SLABS.
- USE HEAVILY REINFORCED SLABS IN LANES EXPOSED TO TRAFFIC WHEN:
 - THE SLAB LENGTH REQUIRED TO ISOLATE A UTILITY (OR UTILITIES) IS GREATER THAN 5.5 m, OR
 - A SLAB LESS THAN 5.5 m LONG CONTAINS TWO OR MORE UTILITIES, EXCEPT FOR THE CONDITIONS DEPICTED ON STANDARD SHEET M502-23.
- CONSTRUCT HEAVILY REINFORCED SLABS SUCH THAT THE SLABS IN ADJACENT, UNREINFORCED LANES ARE BETWEEN 3.5 m TO 5.5 m LONG. ALIGN THE TRANSVERSE EXPANSION JOINTS THAT DEFINE THE HEAVILY REINFORCED SLAB WITH THE TRANSVERSE JOINTS IN THE ADJACENT LANE(S). TERMINATE TRANSVERSE JOINTS IN ADJACENT LANES AT THE UNTIED LONGITUDINAL (SHEAR KEY) JOINT IF THEY ARE LOCATED BETWEEN THE TRANSVERSE EXPANSION JOINTS DEFINING THE HEAVILY REINFORCED SLAB.
- IF A HEAVILY REINFORCED SLAB IS IN A LANE NOT ROUTINELY EXPOSED TO TRAFFIC, SUBSTITUTE TRANSVERSE ISOLATION JOINTS FOR TRANSVERSE EXPANSION JOINTS AND A SINGLE LAYER OF WIRE MESH REINFORCEMENT FOR THE REINFORCEMENT BARS. USE GALVANIZED, WELDED WIRE MESH, MW20, 100 mm X 100 mm. MAINTAIN A 75 mm CLEARANCE BETWEEN THE WIRE MESH AND ALL JOINTS, JOINT BARS, AND UTILITIES. PLACE THE WIRE MESH 100 mm FROM THE PAVEMENT SURFACE.
- MAINTAIN 150 mm CLEARANCE BETWEEN THE REINFORCEMENT BARS AND THE JOINTS, JOINT BARS, AND UTILITIES. MINIMUM VERTICAL CLEARANCE TO THE UTILITY STRUCTURES IS 40 mm.
- THE DETAILS ARE VALID FOR EITHER ROUND OR RECTANGULAR UTILITY STRUCTURES.

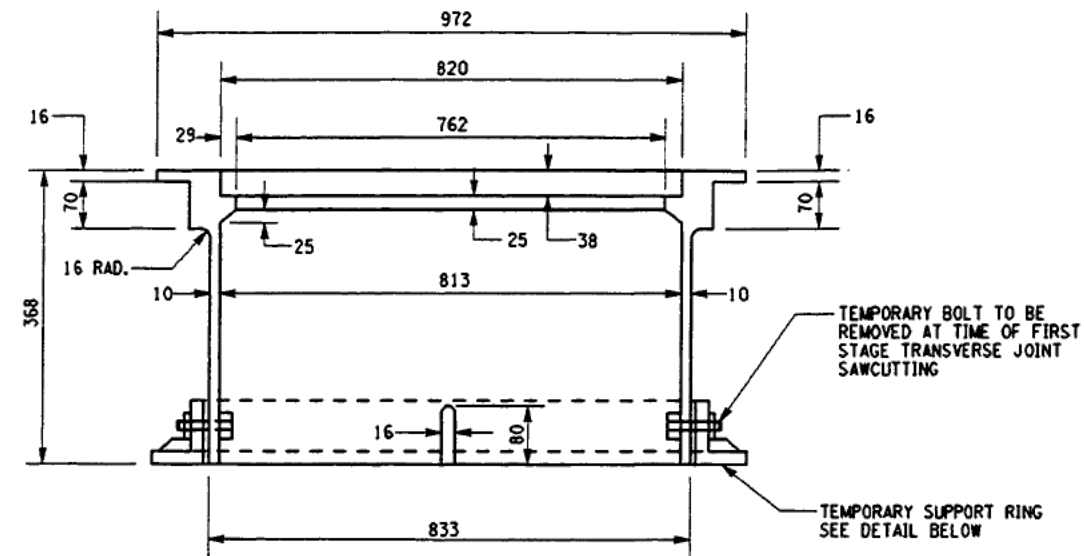


SHEET NOTES:

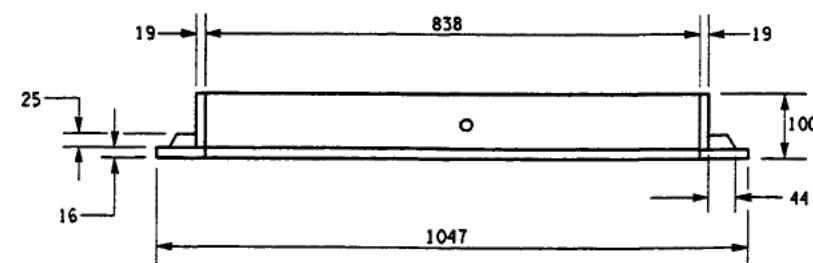
- "PCC" STANDS FOR PORTLAND CEMENT CONCRETE.
- ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED
- SEE LEGEND ON STANDARD SHEET M502-17 FOR PLAN VIEW DETAILS SYMBOLOGY

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
MULTIPLE UTILITIES ISOLATION	
APPROVED <i>Oct 16</i> 2000 <i>[Signature]</i> DEPUTY CHIEF ENGINEER (DESIGN)	ISSUED UNDER EB 00-05T M502-24

TELESCOPING CASTING DETAILS



TELESCOPING MANHOLE CASTING



TEMPORARY SUPPORT RING

GENERAL NOTES:

1. TELESCOPING CASTINGS MUST MEET THE REQUIREMENTS OF §655, FRAMES AND GRATES.
2. USE STANDARD COVERS FROM THE CURRENT M655 STANDARD SHEET.
3. THE USE OF TELESCOPING CASTINGS REQUIRE:
 - (A) THE CASTING MUST BE CENTERED LONGITUDINALLY BETWEEN TRANSVERSE JOINTS (± 300 mm).
 - (B) THE ROOF OF THE UTILITY STRUCTURE MUST BE A MINIMUM OF 400 mm BELOW THE PAVEMENT SURFACE.
 - (C) THE CASTING TYPE AND SIZE MUST BE AVAILABLE WITH THE TELESCOPING FEATURE. SEE THE CURRENT M655 STANDARD SHEET.
4. REFER TO THE CURRENT M502 STANDARD SHEETS FOR TELESCOPING CASTING PLACEMENT DETAILS.

NOTE: ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEET	
TELESCOPING MANHOLE CASTING & RING	
APPROVED <i>[Signature]</i> DEPUTY CHIEF ENGINEER DESIGN	ISSUED UNDER EB 00-057 M655-14

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 9 - Subsurface Pavement Drainage (Limited Revisions)

Revision 1

July 2, 2002

CHANGES TO CHAPTER 9

<u>Pages</u>	<u>Changes</u>
Contents	List of Figures and Tables included.
9-2	Section 9.2.1, fifth paragraph. Revised reference to Geotechnical Engineering Bureau Directive 124.1-4-2R.
9-5	Section 9.3, Item 1. Revised guidance on Permeable Base to eliminate Asphalt Treated Permeable Base (ATPB) as an option for use with PCC pavements.
9-6	Section 9.3, Item 2. Corrected description of edgedrain pipe for use where grade is less than 1% for extended lengths.

7/02/02

CHAPTER 9 SUBSURFACE PAVEMENT DRAINAGE

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9.1 INTRODUCTION

This chapter includes guidance on the design of edgedrain and underdrain systems to provide positive drainage for pavements. This chapter covers subsurface drainage systems only. For design information about surface drainage such as open channels, culverts, storm drainage systems, or hydrology, refer to Chapter 8 of the Highway Design Manual.

Pavement drainage is critical to pavement performance. The *NCHRP Synthesis 239, Pavement Subsurface Drainage Systems*, states that based on a national survey, drained and maintained pavements last up to twice as long as undrained pavements. It also found that maintenance and overlays do not greatly improve the life of pavements that do not have good subsurface drainage.

Because there is no way of stopping water from infiltrating the pavement surface, removal of that water is essential to extending the life of the pavement. The main purpose of subsurface drainage is to remove water as quickly as possible. When granular layers beneath a flexible pavement surface become saturated with water and are not allowed to drain, they become weak. Since the granular layer is a structural component of a flexible pavement system, this weakens the entire structure, causing higher than average damage from each vehicle load (i.e., premature failure). For rigid pavements, water trapped beneath slabs may lead to pumping at the joints and loss of material (voids) beneath the slab. This in turn may lead to loss of support and premature failure of the pavement.

This chapter supersedes conflicting information in the Highway Design Manual, which has not been altered at the time of this printing of this manual, specifically HDM Chapter 3, Sections 3.2.4.6, 3.3.5, and Chapter 9, Section 9.3.9.

9.2 BASIC PAVEMENT DRAINAGE GUIDELINES

9.2.1 Drainage Design Issues

Underdrains are perforated or porous pipes, installed in narrow trenches and surrounded by crushed stone or underdrain filter material that is both pervious to water and capable of protecting the pipe from infiltration by the surrounding soil. They are used to lower the groundwater level, drain slopes, prevent ground water from entering the pavement, and remove surface water that enters the pavement.

Edgedrains, on the other hand, primarily serve to remove surface water that enters the pavement. Often the terms underdrains and edgedrains are used interchangeably, since they both drain the pavement and are located at the edge of the pavement. The edgedrain systems discussed in this chapter mainly serve to remove surface water, but since they also drain the area below the subgrade surface they act as underdrains.

While edgedrains help to lower perched water tables below the pavement, they can also become storage zones for water if the water table is seasonally or annually high. Thus, a saturated edgedrain run provides a good source of water for frost lense formation below the pavement during the winter and spring months. For this reason, the edgedrain should only be placed at an elevation above the seasonally high water tables or the profile of the road should be raised. The typical depth

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of the edgedrain is 300 mm below the subbase, with the edgedrain pipe invert 200 mm below the subbase.

Edgedrains or underdrains may be installed without pipes, however the stone and pipe combination is preferred since it gives protection against the pipe becoming crushed during construction or clogged during use, since the water can freely flow through either the stone or the pipe. The outlet trench should always use a stone and pipe combination, so it will quickly disperse water from the edgedrain.

After a period of time the underdrain filter material (crushed stone) becomes a natural filter for the underdrain and a geotextile is not necessary. However, there may be instances where a geotextile should be used to wrap the underdrain or edgedrain trench, such as fine silty subgrade soil or other poor subgrade soil conditions. The designer should contact the Regional Geotechnical Engineer for guidance on selecting drainage geotextiles based on the current version of *Geotechnical Engineering Bureau Directive, 124.1-4-2R***, "Geosynthetic Acceptance and Quality Assurance Procedures" (see Geotechnical Engineering Bureau's Home Page). The Department's Approved List of Geosynthetics for Highway Construction (also on NYSDOT's WEB) contains a listing of the currently approved drainage geotextiles. More detailed design procedures are found in *FHWA Publication HI-95-038, Revised 1998, NHI Course No. 13213, Geosynthetic Design and Construction Guidelines - Participant Notebook*.

Because subbase material is well graded for maximum strength, it is considered to be impermeable compared to the permeable base layer, so water tends to accumulate on the subbase surface. Since a permeable base layer is used in new construction projects, all runoff that enters the pavement section should drain quickly to the edgedrain and then to the outlets. Water that cannot be absorbed into the subbase or exit through the edgedrains will pool in the permeable base layer or the bound layers above and become a bathtub section, causing premature road distress.

Locate outlets and shallow pipes well away from areas of expected future surface maintenance activities such as sign replacement and catch basin clean out or repair.

Information about drainage ditches is covered in HDM Chapters 3 and 8. If ditches and medians are too shallow to outlet the edgedrain system, or ditches do not exist, there are several outletting options which are listed below.

1. Storm water drainage system. In these cases subsurface drainage design should be coordinated with surface drainage design (Chapter 8, HDM). The storm water inlet must be low enough and large enough to accept the inflow of the edgedrain without backing up. FHWA recommends that the edgedrain inlet be at least 150 mm above the 10-year storm flow line in the drainage structure.
2. Dry well. Outlet to a dry well if a storm water system is not possible. The dry well is essentially another edgedrain system outside the pavement structure built to temporarily store and release water. The dry well is a trench 300 mm wide by a minimum of 900 mm deep. They are backfilled with underdrain filter material to within 150 mm of the surface (see Section 9.3, item 3), covered with a geotextile underdrain material, then backfill with excavated material. The drywell should always be outletted to a ditch or other outlet. Only use this option if the dry well is above the water table.
3. Raise the grade and create ditches. If practical, low lying sections and dips should be raised.

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4. Daylight the permeable base layer. If the road is built on an embankment with ditches, the permeable base layer may be daylighted. This should be done for cases when outletting is difficult, and maintenance is unlikely. Refer to Section 9.3, Permeable Base layer.
5. Do not use a drainage system. For sections where outletting is not possible and the road cannot be raised, no permeable base layer or edgedrain should be used. Water will saturate the edgedrain and drainage layer possibly creating frost lenses in the pavement during the winter and spring months. It is better to have no drainage than a bathtub section.

On steep downgrades or side hill locations where there could be a heavy flow of water through the pavement, either crossdrains or more closely spaced drainage outlets may be needed. Crossdrains may also be needed to support outlets at discontinuities in the roadway, such as bridges, culverts, and large utilities. Refer to Section 9.5 of this chapter for more information about crossdrains.

Outlet markers should be installed to designate the location of outlets for future maintenance cleanouts. If maintenance personnel cannot find the outlets, no maintenance can be performed. These markers may be: metal or plastic marker post placed on the slope at the outlet or placed clear of the shoulder; or special plant groupings placed above the outlet locations. These outlets should be located behind the design clear area, at the right of way line, or behind the guiderail. Refer to Appendix 5B for the current outlet marker specification to use (this specification may not be available at the time of this printing.)

9.2.2 Drainage Construction Issues

All drainage designs should be reviewed for constructibility. The following construction problems along with a suggested solution, should be considered when designing the drainage system:

- Poor grades can leave water pooled in the pipes (check drainage profiles).
- Guiderail and sign posts driven through drains (show guiderail and post locations on typical sections).
- Pipes and other parts of the system crushed and collapsed during construction (include video inspection).
- Inadequate or altered drainage outlet spacings (specify outlet spacing on plans).
- Bad or poor headwall connections (include outlet details as shown in Appendix 9A).
- Improper use of connectors such as T-connectors used on grades (include connection details as shown in Appendix 9A).
- High ditch lines that do not allow proper drainage from outlets (include outlet location table).
- Outlets that have been left out altogether (check outlet locations and include outlet location table).
- Deep ditch lines that drain well but are not traversable or trap vehicles (check HDM Ch.10 for typical section guidance).

Drainage inspection should be included on all projects. Once the pavement is finished, it will be difficult to repair or replace the drainage system and the pavement life may be reduced. Drainage inspection may include either using video inspection or simply pouring water on the drainage layer and checking the outflow. Video inspection involves sending a video probe into the outlet end and inspecting the edgedrain and outlet for discontinuities or problems. Refer to Appendix 5B for the

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current video inspection item and guidelines. The second method can be done by pouring a large volume of water (50 to 100 gallons) onto the permeable base, but must be specified in the specifications or noted in the plans.

Maintaining an open drainage aggregate is critical during the remaining construction period. A shovelful of fines can clog the drain. The drainage system should be protected from fouling until the pavement section is complete. If a contamination problem is anticipated, geotextile can be placed over the edgedrain to catch fines: this should be shown in the edgedrain details.

9.2.3 Drainage Maintenance Issues

A well designed and constructed drainage system will not perform properly without adequate maintenance. Realistically though, drainage systems will receive little or no maintenance over the life of the pavement, so they should be designed to last as long as possible and to be as maintenance free as practical. By the time pavement distress is identified, the subgrade and subbase usually have already failed and the problem cannot be corrected without removing the pavement. A poor design can be corrected during construction if a deficiency is recognized, but maintenance can seldom correct a poor design.

The combination of vegetative growth, debris, and fines discharging from the edgedrains can eventually plug the outlet pipe. Rodent nests, mowing clippings, and sediment collecting on rodent screens at the headwalls are common maintenance problems. However, outlets often cannot be located or maintained because they are hidden by vegetative growth. The use of outlet markers will alleviate this problem .

Inadequately designed outlet aprons will be rutted easier when mowers travel over them during saturated conditions, blocking the outlet. Some outlets are so plugged that water gushes from the pipes when the obstructions are removed. Therefore, make sure the outlets are adequately designed as shown in Appendix 9A.

When flexible tubing is used for edgedrains, the pipe will not be perfectly straight. The pipe may become clogged by sediment resulting in slow flow, clogged outlet conditions, or sags in the grade. If the grade is 1 percent or less, consider using solid walled edgedrain pipe. Refer to Section 9.3 for further guidelines and Appendix 5B for the current item number.

Maintaining drainage systems involves cleaning outlets, replacing rodent screens, flushing or replacing outlet pipes, repairing damage, and cleaning ditches. See Chapter 10 of this manual for more information about drainage maintenance.

9.3 NEW CONSTRUCTION EDGEDRAIN SYSTEMS

Subsurface pavement drainage is provided by a treated permeable base layer and continuous 100-mm diameter perforated underdrains with outlets every 75 m as shown in Fig. 9-1. This system handles any surface water that flows through cracks in the pavement. The system also helps to draw down high water tables in the subgrade area or under the pavement structure. Note that

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conventional pavement designs (non ESAL-based designs) do not normally have a permeable base layer.

Construction installation details for these edgedrain systems are shown in the draft *Standard Sheet M605-2, Edgedrain and Lateral Outlet Details*, which is shown in Appendix 9A. Many of these construction details are also repeated in Fig. 9-1.

Edgedrains should be placed continuously along both shoulders for all permeable base installations except in areas where the permeable base is daylighted (see Permeable Base Layer discussion below). If one shoulder is on a high side of the road, such as banked curves or ramps, edgedrains are not needed on the high side of the road. In those locations, the subbase and permeable base layers on the high side of the road should either slope towards the low side of the road, or be daylighted onto the banked curve.

Edgedrains and/or permeable base may not be necessary in locations that have well drained soil. Contact the Regional Geotechnical Engineer early in the project development (scoping stage) for evaluation of soil conditions and further edgedrain recommendations.

For pipe edgedrains the lateral outlets should be spaced approximately every 75 meters in accordance with draft Standard Sheet M605-2, Edgedrain and Lateral Outlet Details, in Appendix 9A. While adjustments may be made for local conflicts, the spacing should not exceed 90 meters. Where the roadway profile has less than a 1% grade, reduce the spacing to approximately 60 meters, with a maximum spacing of 75 meters. To facilitate the insertion of cleaning equipment, use 45° bends between the edgedrains and the straight lateral outlet runs.

The edgedrain system consists of the five elements shown in Figure 9-1 and discussed below:

1. Permeable Base Layer. This is a free-draining bound layer, capable of draining both surface water and preventing water accumulation from the subbase below. The flow of water through this layer is retarded only by the cross-slope and any obstructions. There are two types of bound permeable base: Asphalt Treated Permeable Base (ATPB) and Portland Cement Treated Permeable Base (PCTPB). ATPB is used only with HMA pavements. PCTPB is used only with PCC pavements, but is allowable under full depth HMA shoulders constructed adjacent to new PCC pavement. There may be cases where the Treated Permeable Base material cannot be placed either due to space limitations for the equipment or intrusion of utilities into the permeable layer. In these areas, an unbound material, such as open-graded subbase item or a crushed stone item may be substituted. Contact the Regional Geotechnical Engineer for further guidance.

Although limited construction traffic is allowed on the treated permeable base, it should not be used as a haul road. Care should be taken to prevent damage from vehicles turning and carrying in fines, overly heavy loads, or traffic too soon after rain.

Only in cases where no construction traffic is allowed on the completed permeable base layer, (side-load trucks), may an untreated permeable base course, such as an open subbase, be used (listed in Appendix 5B).

The permeable base layer may be daylighted at 3% to the slope face in cases where there is well drained subgrade (such as silty sand soil found in parts of Region 10), when outlets cannot

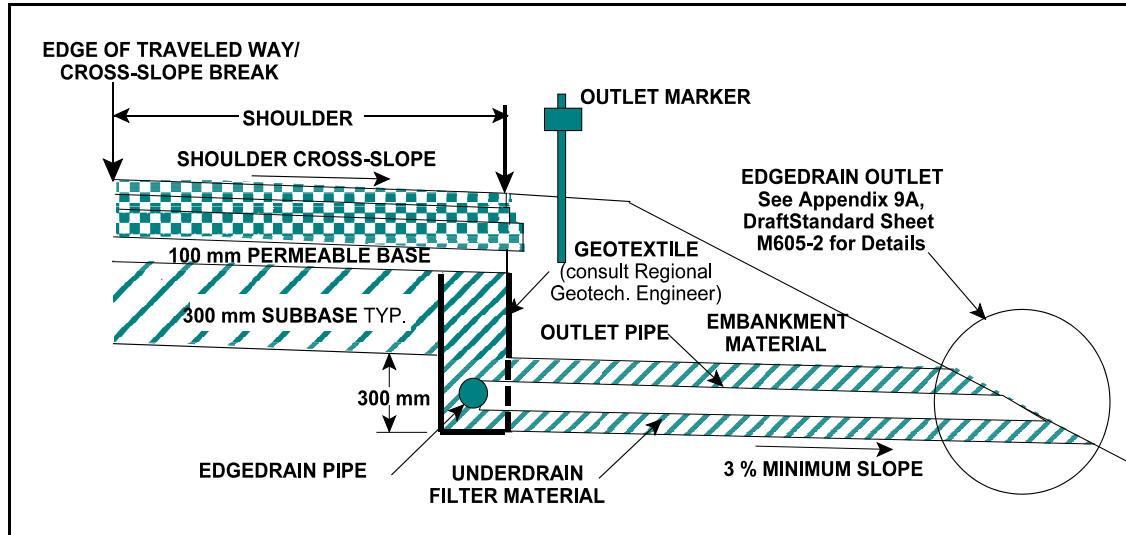
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be used, for flat grades (1% or less), or on the high side of a super-elevated section that is being drained to the high side. However, this should not be made the standard treatment since it is difficult to maintain a daylighted layer. If this is the case edgedrains and outlets are not needed. Make sure the bottom of the permeable layer is at least 600 mm above the ditch invert. This is to prevent silty material or storm water in ditches from entering the pavement structure and blinding the permeable base layer with topsoil and vegetation.

2. Edgedrain Pipe. This is a perforated pipe which carries the water to the outlets and is centered in the outlet trench, with the pipe invert 100 mm above the trench bottom. The pipe diameter is typically 100 mm in diameter although for certain high flow situations and combined edgedrain/drainage systems, a 150 mm pipe diameter may be necessary. Perforated corrugated polyethylene underdrain tubing or optional underdrain pipe are normally used. The pipe, along with the trench, should follow the longitudinal grade of the road. If the grade is 1% or less for extended lengths, consider using a rigid smooth-walled PVC underdrain pipe to promote faster drainage, and/or providing more outlets at closer spacing. Refer to Appendix 5B for the current item numbers.
3. Underdrain Filter Material. This material is placed around the edgedrain and outlet pipes in a 300 mm by 300 mm trench for 100 mm pipe or a 350 mm by 350 mm trench for 150 mm pipe. For excavation, use item 206.02 M, Trench and Culvert Excavation. For other pipe sizes use a trench 200 mm wider than the pipe diameter. When no pipe is used specify a minimum 300 mm wide trench. Type I or Type II Underdrain Filter is typically used. Type I is preferred, but Type II should be used if in direct contact with a fine-grained subgrade. To reduce the expense of stockpiling requirements crushed stone, screened gravel, crushed gravel or crushed slag may be used. Designate on the plans either combinations of size Nos. 1, 2, and 3 or specify Type CA-2 coarse aggregate. Recycled glass may also be used. Place the underdrain filter material around and over the underdrain pipe to such a depth that, after compaction, the filter material extends up to the bottom of the permeable base layer or to the top of the subbase layer. If geotextile is used (see Section 9.2.1), show the geotextile wrapped around the trench, but leave the trench exposed to the permeable base layer.
4. Outlet Pipe. This pipe is a double-wall, rigid, smooth perforated pipe that comes in straight lengths. It is better able to resist crushing from mowers and construction equipment than underdrain pipe or corrugated steel pipe. (See Appendix 5B for appropriate pipe item number, since the specification for this pipe may not be available at the time of printing of this manual.) The outlet pipe should be connected to the edgedrain with 45° fittings for future maintenance and to maximize the outlet slope. Slope the outlet pipe a minimum of 3% to the edgedrain outlet.

5. Edgedrain Outlet. The edgedrain can terminate into the following three different outlets. Other outlet types are feasible as long as they swiftly disperse the surface and subsurface water (see Section 9.2.1). Selection criteria is listed in the draft of Standard Sheet M605-2 found in Appendix 9A with the current item numbers listed in Appendix 5B. Outlet type and locations should be shown on the plans with edgedrain details and an edgedrain outlet location table. Outlet markers should be specified for the precast concrete headwall and stone trench options.

Figure 9-1 Typical Edgedrain Outlet



- a. Precast Concrete Headwall. The headwall is used in cases where: (1) the side slope is 1V on 4H or flatter, or (2) when the outlet invert is greater than 100 mm above the ditch invert, or (3) when a closed drainage system is not available. Headwalls should be set on a 100 mm bed of underdrain filter material, to provide an alternative drainage path should the pipe become clogged. The surface of the headwall should be slightly recessed below the surface of the embankment to minimize the chances of being struck by mowing equipment. The 100 mm pipe headwalls are small, they can be hand carried and maneuvered by two people. For pipe diameters greater than 100mm use the following outlet options.
- b. Stone Trench. If the side slope and invert conditions mentioned above are not met and there is no closed drainage system, use a stone trench outlet.
- c. Closed Drainage System. When a closed drainage system is available, it should be utilized. Most underdrain systems do not expel large quantities of water so the closed drainage system should handle this water flow. Water flow in underdrains is usually a delayed event after surface runoff is drained so there should be no capacity problems. Edgedrains and their outlet locations may vary to accommodate the closed drainage system, although outlet pipes should be sloped a minimum of 3% into the drainage structure (drop inlet, catch basin, etc.).

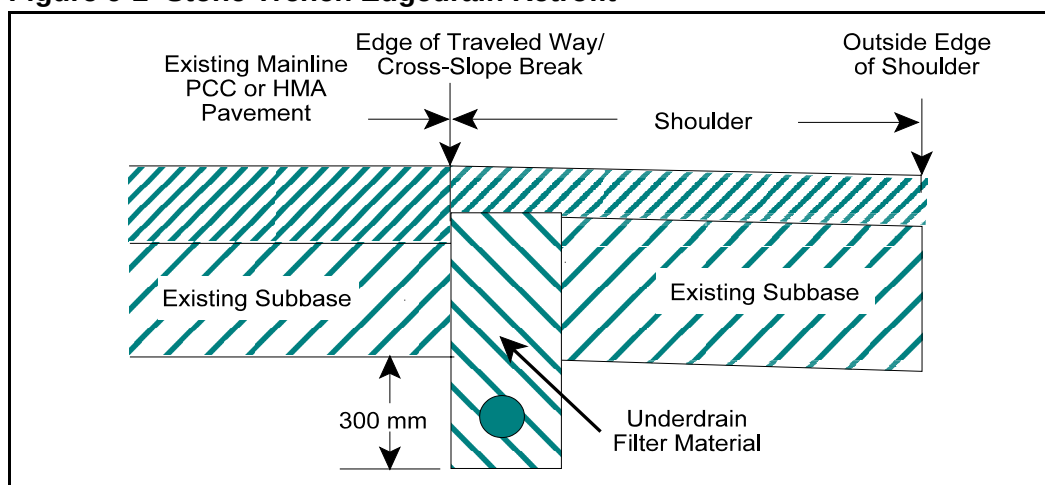
9.4 RETROFIT EDGEDRAIN SYSTEMS

Retrofit edgedrains are used for rehabilitation, restoration or maintenance projects that do not have existing functioning subsurface drainage systems. Retrofits are effective for pavement that is relatively young (<15 years old) and has signs of moisture damage, pavements in cut sections, and areas that have adequate ditch depth or means for outlet drainage. Unless guidance is given elsewhere, contact the Geotechnical Engineer to determine the need for an edgedrain system. For most retrofit applications the edgedrain is typically placed at the edge of the driving lane under the shoulder. Retrofit edgedrains generally do not use permeable base layers, unless they are retrofitting roads that have existing permeable base layers. Section 9.2, Drainage Guidelines, also applies to retrofit edgedrains. Use the outletting methods described in Section 9.3. The Stone Trench and Pipe Edgedrain is preferred since it has an estimated service life of 10 to 25 years, (compared with 5 to 10 years for a Prefabricated Geocomposite Edge Drain), it has greater hydraulic capacity and requires fewer outlets.

9.4.1 Conventional Stone Trench and Pipe Edgedrain

Generally the design requirements for these systems in terms of specifications, dimensioning, slope, and outlet spacing should follow those found in the new construction Section 9.3. This system is used for rubblized projects, crack & seat projects, and for other projects where drainage is needed. A typical stone trench and pipe retrofit design is shown in Figure 9-2. For maximum benefit, the trench should be below the subbase, (shown as 300 mm below subbase in Figure 9-2), however this may not always be practical. Follow the guidelines given in Note (4) of the Edgedrain Details in Appendix 9A for setting different edgedrain elevations. If the section is curbed, put the edgedrain in front of the curb as shown in Section 3.2.9, Curbs, in the HDM.

Figure 9-2 Stone Trench Edgedrain Retrofit



9.4.2 Prefabricated Geocomposite Edge Drain (PGED)

Prefabricated Geocomposite Edge Drain (PGED) has found many applications in NYS in recent years. The primary advantages over conventional pipe in stone edgedrains are speed and ease of installation, which minimize maintenance and protection of traffic. This equates to a much lower installed price. It has some disadvantages which make it a less useful choice in some applications. Therefore, the following usage policy has been formulated.

PGED should not be used in a series of short runs less than 90 m. The installation advantages overcome this disadvantage only when continuous long runs of the material are placeable. Occasional short runs may be necessary on a project, but the primary usage should be in long, multiple outlet runs.

PGED should not be used where there is a significant possibility of oversize material (plus 100 mm) to be excavated. Thus, very old pavements (built in the 1930s and 1940s) placed directly on subgrade must be approached with extreme caution. Even newer pavements (1970s) are often found to have material beneath the pavement which will not excavate well using a 100 mm wide trenching wheel.

PGED should not be used next to a pavement that is going to be rubblized. There is concern that the concrete fines created by the rubblizing process may blind the fabric on a PGED, while it would have less effect on the filter stone in a conventional drain. Also, the forces involved in rubblizing may damage the core and the capacity of the PGED.

PGED should not be installed adjacent to pumping concrete slabs that are not to be overlaid. The rocking motion of the slabs under traffic loads pumps fines into the drain, causing blinding of the fabric, resulting in premature failure.

When using PGED in an area of fine-grained subsoils, it is recommended that the underdrain filter material backfill option be specified. This is to prevent a possible blinding problem that may occur using existing material as backfill.

The underdrain filter material backfill option should be used next to flexible pavement. Inevitably, with a vertical excavation at the edge of pavement in an area requiring edgedrains (presumably wet), some sloughing and loss of material will occur from under the pavement. Flexible pavement will not bridge this loss of support. The underdrain filter material backfill placed on the pavement side should minimize concerns of this sort.

If underdrain filter material backfill is necessary with a PGED installation, then consideration should be given to using a conventional underdrain/edgedrain of stone filled trench and pipe. The designer should discuss the conditions and needs of the project with the Regional Geotechnical Engineer to determine the most appropriate treatment.

PGED with existing material backfill is most suited to rigid pavements with well controlled subbase (no oversize material) as long as the subgrade soils are not excessively fine-grained. This applies to a large number of highways built during the busy days of the 1960s and 1970s.

SUBSURFACE PAVEMENT DRAINAGE

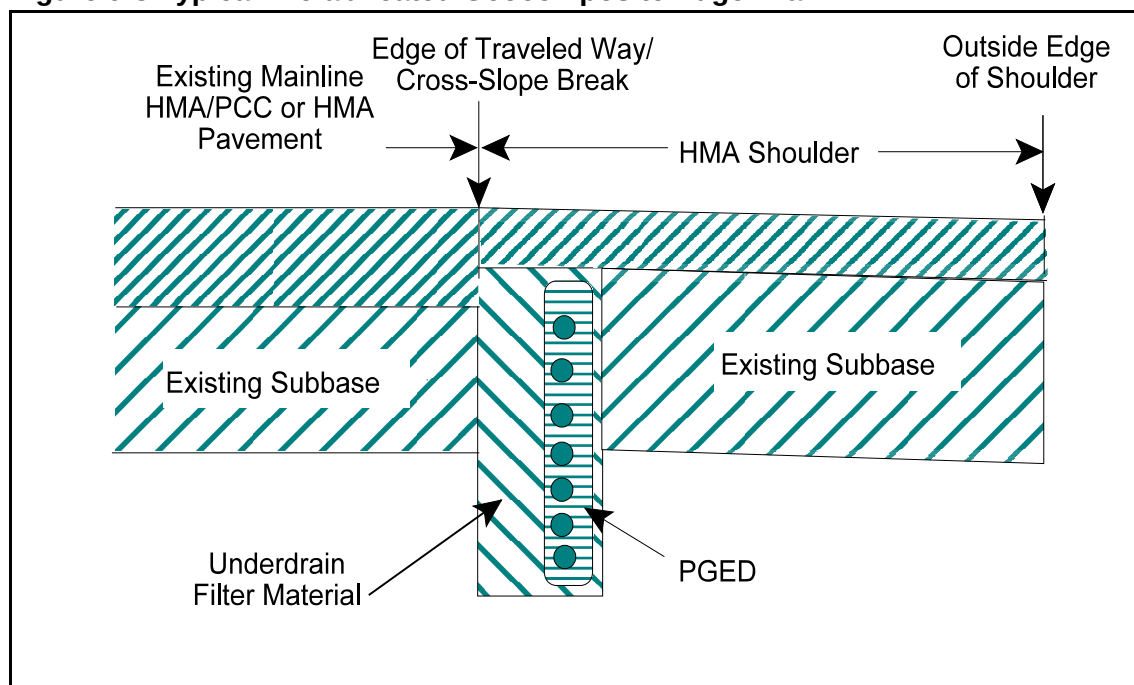
It should be realized that due to their depth and nature, PGEDs are not as effective at treating pavements with high subgrade water contents, frost problems, or pumping slabs that are not to be overlaid. PGEDs are best used next to pavements where the observed distresses are likely related to surface water penetrating the pavement and then not having an outlet. Any other applications must be carefully considered before use.

As always, any underdrain installation should be in contact with the water-bearing layer (bottom of subbase, bottom of pavement). Short curve radius situations (usually ramps) make this impossible as the ditching wheel cannot follow a tight radius and runs away from the edge of pavement.

As with any drain, PGEDs must be outletted. Outlet spacing should be no greater than 35 m and preferably less in flat (<1% grade) sections. Also, place an outlet at the bottom of any sag vertical curves. Use outlets shown in draft Standard Sheet M605-2, Edgedrain and Lateral Outlet Details, (in Appendix 9A), following the guidelines of Section 9.3 of this chapter.

Where existing material backfill is used, the PGED should be installed abutting the side of the trench closest to the centerline of pavement (the inside of the trench). Where underdrain filter material backfill is used, the PGED should be installed abutting the side of the trench farthest from the centerline of pavement (the outside of the trench) as shown in Figure 9-3. Refer to Appendix 5B for appropriate specification item number.

Figure 9-3 Typical Prefabricated Geocomposite Edge Drain

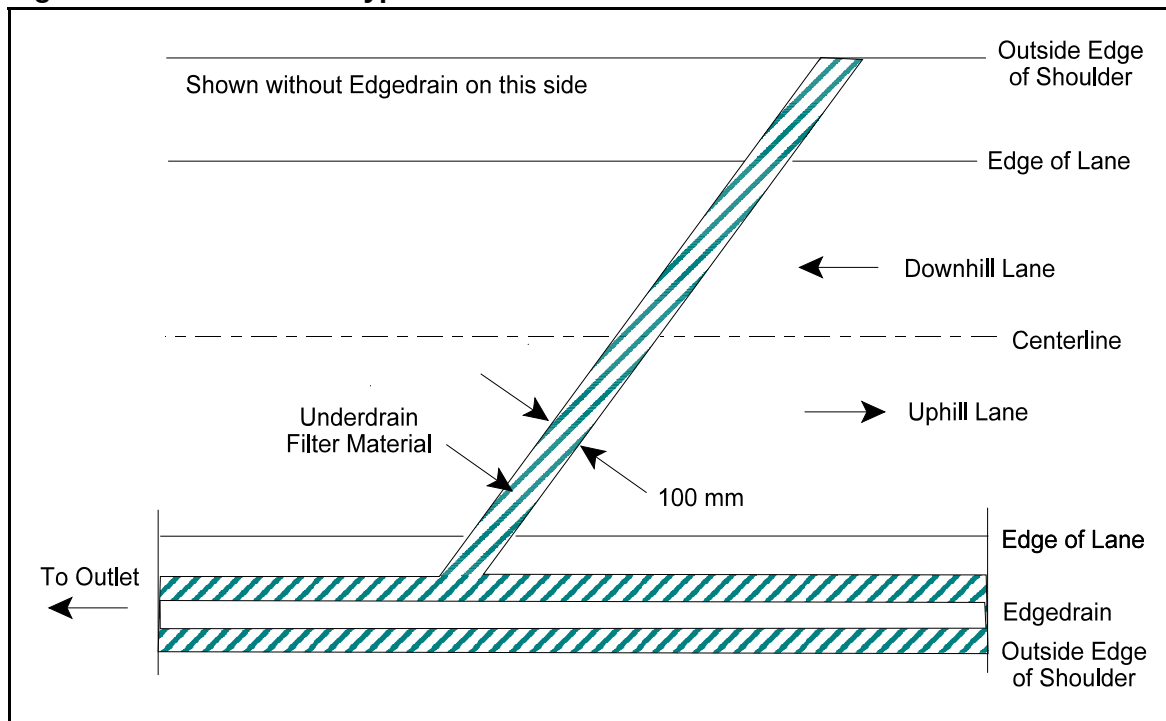


9.5 CROSSDRAINS

Crossdrains or weeps are narrow drains that run transversely or diagonally across the road. Crossdrains can alleviate problem downhill areas where water is seeping through the pavement or where there is an edgedrain only on one side of the road, or for sag areas to drain from one side to the other. They can be used in new construction or rehabilitation projects. Use of crossdrains, however, should be kept to a minimum since they are a discontinuity in an otherwise uniform pavement section.

The crossdrain should be a 100 mm wide vermeer cut trench, filled with underdrain filter material (see Section 9.3, item 3) and oriented to drain downhill (except in a sag where should be perpendicular to the centerline). This should handle most flow situations. If very heavy flows are expected or for new construction use a 100 mm pipe (see Section 9.3) in a 300 mm wide stone filled trench. In either case the trench should extend from 300 mm below the subbase layer to the top of the subbase layer and paved directly overtop. The downhill end of the crossdrain should extend to the edgedrain or may directly outlet, into a ditch, side slope, or into a closed drainage system as discussed in the Section 9.3. Extend the uphill end of the crossdrain to the outer edge of the shoulder or to the edgedrain, if available. Provide a location plan/chart and cross section detail showing the width and depth of the crossdrain in the plans. Appendix 5B has the latest item number for Crushed Stone Weep, which is used as a crossdrain. A typical crossdrain is shown in Figure 9-4.

Figure 9-4 Plan View of Typical Crossdrain



9.6 REFERENCES

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Drainage of Asphalt Pavement Structures, Asphalt Institute Manual Series No. 15, September 1984.

Participant's Manual on Construction of Portland Cement Concrete Pavements, Federal Highway Administration Publication No. FHWA-HI-96-027, U.S. Department of Transportation, October 1996.

Participant's Notebook on Drainable Pavement Systems, Demonstration Project 87, Federal Highway Administration Publication No. FHWA-SA-92-008, U.S. Department of Transportation, March 1992.

Pavement Notebook for FHWA Engineers, Federal Highway Administration Publication No. FHWA-PD-96-037, U.S. Department of Transportation, October 1996.

Pavement Subsurface Drainage Design, Participant Workbook, Federal Highway Administration Publication No. FHWA-NHI-99-030, ERES Consultants, April 1999.

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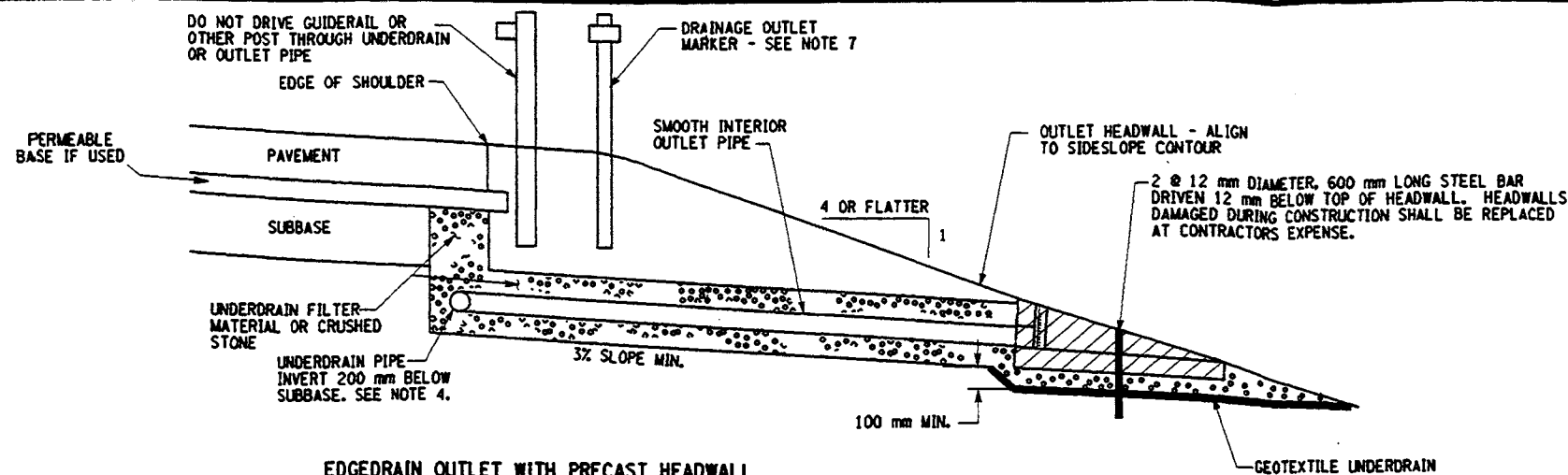
Yu, Thomas H., L. Khazanovich, S.P.Rao, M.I. Darter, H.V. Quintus, **Guidelines for Subsurface Drainage Based on Performance**, Final Report, ERES Consultants, Inc., prepared for National Cooperative Highway Research Program, August 1999.

APPENDIX 9A

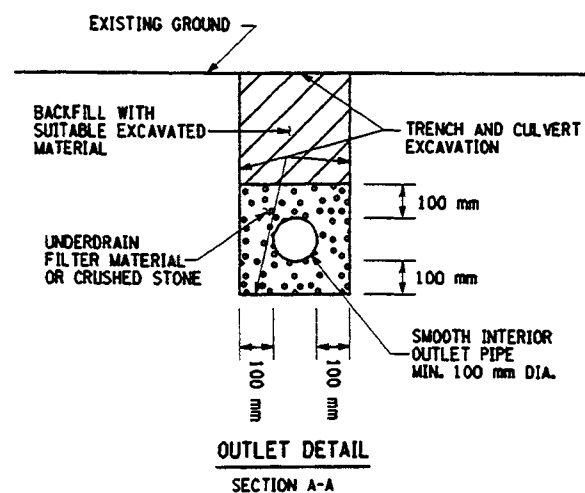
***Edgedrain and Lateral Outlet Details
(Draft Standard Sheet)***

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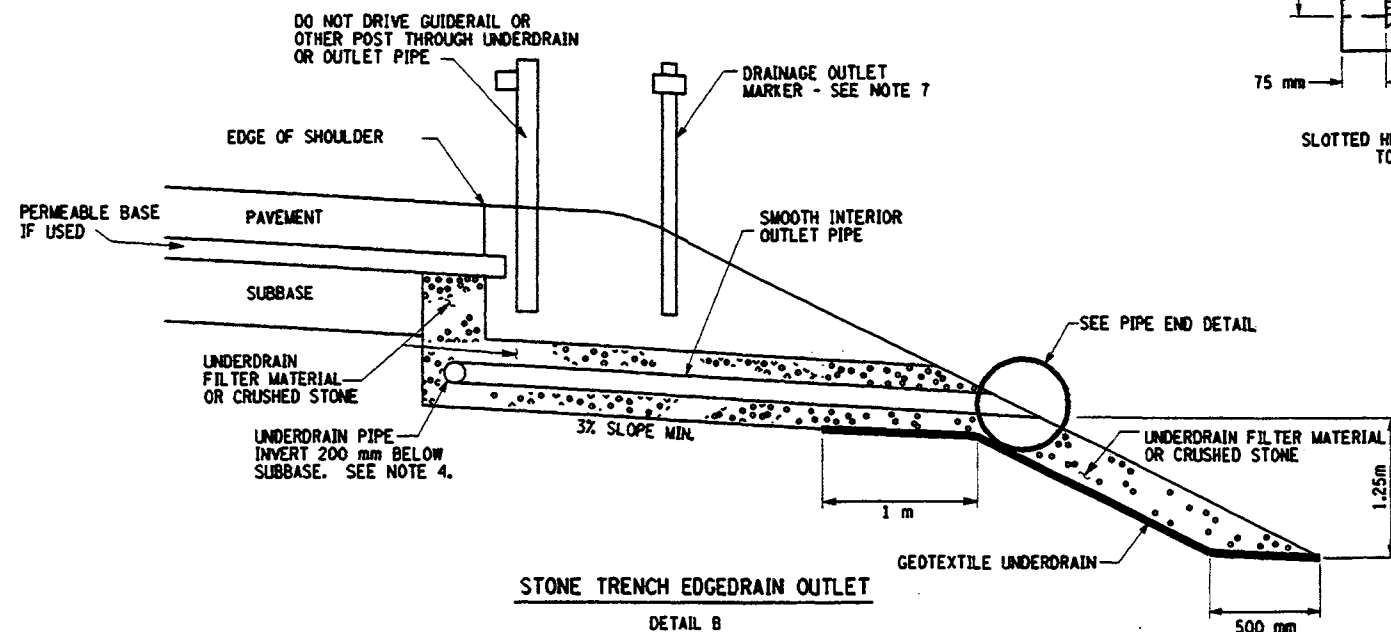
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CHECKED BY
DESIGNED BY
JOB MANAGER
DESIGN SUPERVISOR



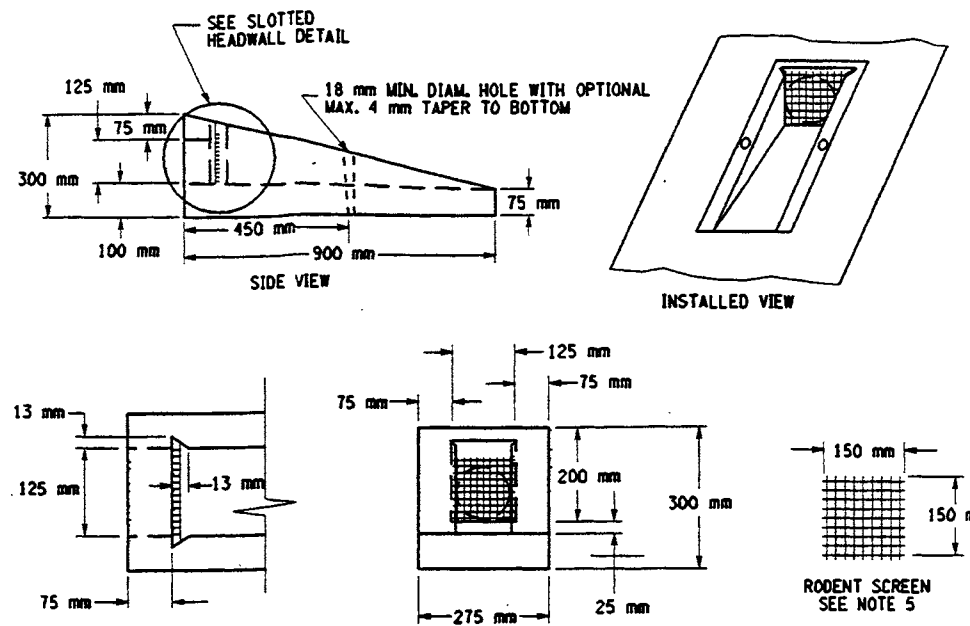
EDGEDRAIN OUTLET WITH PRECAST HEADWALL
DETAIL A



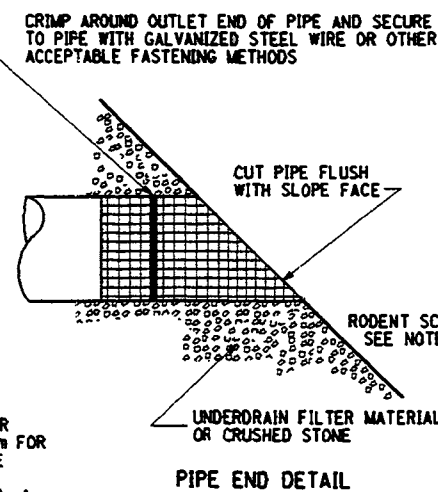
OUTLET DETAIL
SECTION A-A



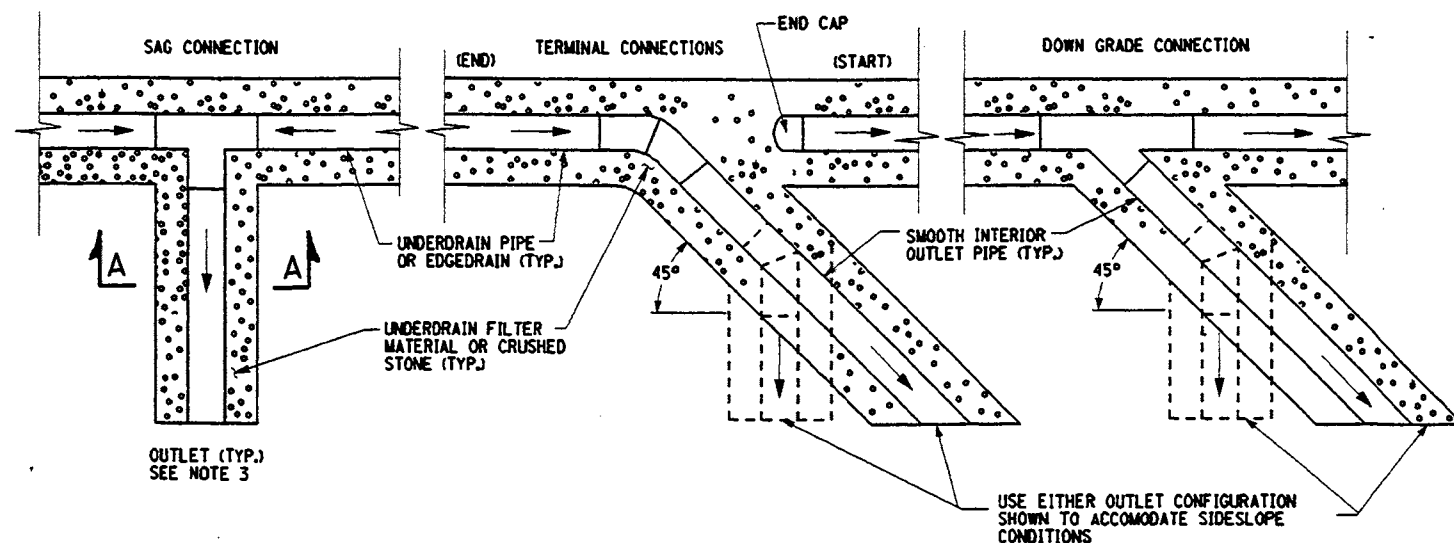
STONE TRENCH EDGEDRAIN OUTLET
DETAIL B



PRECAST CONCRETE OUTLET HEADWALL
FOR 100 mm PIPE



PIPE END DETAIL



LATERAL OUTLET CONNECTIONS
USE APPROPRIATE OUTLET CONNECTION
SEE NOTE 1

NOTES:

1. LATERAL OUTLETS SHALL BE 100 mm MINIMUM INSIDE DIAMETER SMOOTH INTERIOR PIPE PLACED APPROXIMATELY EVERY 75 m FOR PIPE EDGEDRAINS AND EVERY 40 m FOR PREFABRICATED GEOCOMPOSITE EDGEDRAINS (PGED). WHILE ADJUSTMENTS MAY BE MADE FOR LOCAL CONFLICTS, THE SPACING SHOULD NOT EXCEED 90 m FOR PIPE EDGEDRAINS AND 50 m FOR PGED. WHERE THE ROADWAY PROFILE HAS LESS THAN A 1% GRADE, THE SPACING SHOULD BE REDUCED TO APPROXIMATELY 60 m WITH A MAXIMUM OF 75 m FOR PIPE EDGEDRAINS AND 30 m TO 40 m FOR PGED, UNLESS OTHERWISE SPECIFIED.
2. SLOPE OUTLET PIPES A MINIMUM 3%.
3. A PRECAST UNDERDRAIN OUTLET HEADWALL AS SHOWN IN DETAIL A SHOULD BE USED UNLESS:
A. THE SIDESLOPE IS STEEPER THAN 1V ON 4H.
B. THE OUTLET PIPE INVERT IS LESS THAN 600 mm ABOVE THE DITCH INVERT.
C. THE ROADWAY INCORPORATES A CLOSED DRAINAGE SYSTEM. IN THIS CASE THE OUTLET SHOULD DRAIN INTO THE CLOSED DRAINAGE CATCH BASINS.
D. THE OUTLET PIPE DIAMETER IS LARGER THAN 100 mm.
WHEN THE PRECAST OUTLET HEADWALL IS NOT USED AND THE ROADWAY DOES NOT HAVE A CLOSED DRAINAGE SYSTEM, USE A STONE TRENCH EDGEDRAIN OUTLET AS SHOWN IN DETAIL B, UNLESS OTHERWISE SPECIFIED IN CONTRACT DOCUMENTS.
4. PREFERENCES IN SETTING EDGEDRAIN AND OUTLET ELEVATIONS:
A. SET THE UNDERDRAIN PIPE INVERT ELEVATION 200 mm BELOW THE BOTTOM OF SUBBASE WHEN OUTLET AND DITCH ELEVATIONS PROVIDE A MINIMUM 3% OUTLET GRADE WHILE MAINTAINING THE OUTLET PIPE INVERT A MINIMUM 600 mm ABOVE THE DITCH INVERT.
B. IF THIS IS NOT ACHIEVABLE, RAISE THE UNDERDRAIN PIPE INVERT A MAXIMUM 200 mm TO A LEVEL EQUAL TO THE BOTTOM OF SUBBASE AND ADD AN OUTLET AT THIS LOCATION TO ACCOMMODATE DRAINAGE.
C. IF A OR B IS NOT POSSIBLE, CONNECT OUTLET TO A CLOSED DRAINAGE SYSTEM IF AVAILABLE.
5. USE 16 GAUGE OR HEAVIER, #2 OR #3 WELDED WIRE MESH, MADE OF TYPE 304 STAINLESS STEEL OR CARBON STEEL WIRE HOT GALVANIZED IN ACCORDANCE WITH SECTION 709-07 OF THE STANDARD SPECIFICATIONS.
6. EDGEDRAIN LOCATION IS SHOWN AT OUTER EDGE OF SHOULDER, HOWEVER CONTRACT DOCUMENTS MAY SPECIFY THE EDGEDRAIN AT A DIFFERENT LOCATION RELATIVE TO THE EDGE OF SHOULDERS.
7. DRAINAGE OUTLET MARKERS SHOULD BE USED TO LOCATE ALL DRAINAGE OUTLETS EXCEPT THOSE INTO DRAINAGE STRUCTURES.

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
METRIC STANDARD SHEETS	
EDGEDRAIN AND LATERAL OUTLET DETAILS	
DRAFT	JUNE 30, 2000
DEPUTY CHIEF ENGINEER (DESIGN)	M605-X

COMPREHENSIVE PAVEMENT DESIGN MANUAL

Chapter 10 - Preventive Maintenance

Addition 2

April 2005

CHANGES TO CHAPTER 10

<u>Pages</u>	<u>Changes</u>
Title	Addition 2, April 2005
Contents	Section 10.2.7 is listed.
10-5	Section 10.2. Added bullet for "Heater Scarification of Hot Mix Asphalt (HMA) Pavement.
10-17c & 10-17d	Section 10.2.7. Added guidelines for "Heater Scarification of Hot Mix Asphalt (HMA) Pavement.

CHAPTER 10 PREVENTIVE MAINTENANCE

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10.1 INTRODUCTION

This chapter is to be used in conjunction with Chapter 2 Evaluation of Existing Pavements (which includes Volume 1 of the Pavement Rehabilitation Manual as Appendix 2A), to select preventive maintenance alternatives and determine the most cost-effective treatment to prevent pavement distress and increase pavement service life. This chapter does not compare one treatment to another; it provides information on each treatment type, so a decision to use a given treatment, or combination of treatments, can be made on an informed basis. The requirements in Chapter 3 of this manual, Section 3.3 - Pavement Treatment and Type Selection Process, must be used when considering the treatments in this chapter. Refer to Chapter 3 of this manual for additional requirements for preventive maintenance projects progressed under Element Specific, 1R, or SAFETAP.

Note: Due to the timeliness of application required for preventive maintenance to be effective, Regional Designers should contact the Regional Materials Engineer to discuss the proposed schedule for the project and the appropriateness of the treatment. The Regional Materials Engineer can also assist in providing the latest specification item numbers and other design information.

Life-cycle-cost analysis is not required to choose between the treatments described in this chapter. Preventive maintenance is part of the life-cycle of the pavement structure and all associated costs should be considered when determining the life-cycle-cost of pavement rehabilitation options. This chapter should be used as an aid in selecting the most appropriate, cost-effective treatment. Guidance for construction inspection can be found in other manuals. A list of suggested reference materials is given in the Appendix.

The estimated service lives included in this chapter are based on the assumption that the treatment is being applied to pavement in good condition with only low severity distress. The service life will decrease, as the level of pavement distress at the time of treatment application increases. Contact the Regional Pavement Engineer or Materials Engineer for assistance in determining the expected service life of specific projects.

Note: The service lives given in this chapter are for use on NYSDOT projects. The level of pavement distress constituting the end of a treatment's service life will vary between purchasing agencies. On low volume facilities, the service lives of these treatments may be considerably longer than the estimates given in this chapter.

This chapter does not provide estimated costs for any included treatments. Because many of these treatments are new, their costs are continually declining relative to more traditional treatments. A good estimate of cost can be determined by examining the Office of General Services contract award notices issued each year.

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10.1.1 Definition of Preventive Maintenance

Preventive maintenance is any planned activity performed in advance of a critical need for repair or accumulated deterioration so as to avoid such occurrences and reduce or arrest the rate of future deterioration. The activities may correct minor defects as a secondary benefit. Preventive maintenance activities extend a pavement service life, without significantly improving the pavement's structural capacity. The primary intent of a preventive maintenance treatment is not to correct specific pavement distress, but to delay the development of distress. To be successful, preventive maintenance must be undertaken when little distress is evident. "To be cost-effective, pavement preventive maintenance treatments should be applied before most engineers, or project decision makers, would normally consider their use" (Pavement Maintenance Effectiveness Preventive Maintenance Treatments Participants Handbook, FHWA-SA-96-027). Preventive maintenance activities should typically be initiated by the Resident Engineer.

10.1.2 Types of Preventive Maintenance Treatments

There are three general types of preventive maintenance treatments: nonstructural overlays, minor pavement repairs and drainage. Nonstructural overlays and recycling apply only to flexible pavements. Minor pavement repairs and drainage apply to all types of pavements.

Nonstructural overlays are thin (40-50 mm) overlays that provide no improvement to the pavement structure. These products can do nothing to improve unstable mats, or correct drainage problems, and provide very little correction to cross-slope. Those concerns must be addressed separately. **Nonstructural overlays cannot be applied to rigid pavements as preventive maintenance.**

Minor pavement repairs are any treatments performed to correct minor isolated flaws in a pavement prior to failure, to prevent failure from occurring. Minor pavement repairs include partial depth repairs in rigid pavements, crack sealing and joint sealing. Pothole repairs in flexible pavements are only performed after failure of the pavement structure and are therefore not preventive maintenance.

Drainage maintenance is any work performed to maintain the efficiency of the pavement drainage system including removing debris from under guide rail, cleaning edge drains, drain outlets, and culverts, and removing excess vegetation and debris from roadside ditches. Repairs to crushed drains can be preventive maintenance if the repair is performed before the damaged drain causes failure of the pavement structure.

10.1.3 Factors Affecting Performance

Deciding to invest in some type of preventive maintenance is often the simplest part of the decision-making process. Learning about the available preventive maintenance treatments, their

specifications, and trying to factor in all the variables affecting their performance in order to maximize the life of the treatment selected is the most difficult. Numerous variables affect the performance of any preventive maintenance treatment, including: workmanship, seasonal and weather variations, equipment condition, material quality, pavement condition, and traffic volume. Every effort should be made to control as many factors as possible to ensure proper performance of the chosen treatment.

The most common performance problems are related to time and money. Performance suffers when work is rushed in an attempt to maximize daily output, when opening to traffic is rushed, or when seasonal limits are pushed. It is best to be conservative when estimating the area to be treated, time required, quantities needed and dollars available. Follow proper inspection and quality assurance procedures during construction.

Equipment condition and the materials used are often two of the easiest factors to inspect, and the most critical to the treatment's performance. Making sure the equipment is in proper working order and verifying that proper materials are used will help obtain satisfactory performance.

One of the most often overlooked factors is pavement preparation. Each treatment may require a different level of preparation, but in all cases the resultant performance will be affected by this preparation. Proper inspection at this time will have a positive impact on the treatment's performance.

Combining treatments on a pavement may be the most effective preventive maintenance measure. However, something as simple as over applying crack sealant can cause serious performance problems with a nonstructural overlay. Being familiar with the different maintenance treatments and their sensitivities to one another will help minimize related performance problems.

10.1.4 Including Preventive Maintenance in a Pavement Management System

Having a well designed pavement management system in place and functioning is essential for the effective use of preventive maintenance. All roadways in a pavement management program must be systematically evaluated for level of service. This data must be compiled into a database from which typical times to initiation of distress, and times to failure can be estimated for each of the pavement types and traffic loading levels in the system. From this information, the proper preventive maintenance treatments and time of treatment can be selected for each pavement. Using the rating system of the Highway Sufficiency Ratings Manual (HSRM), preventive maintenance should usually be applied to flexible pavements rated 6 and higher and rigid pavements rated at 8 or higher.

Transportation Maintenance Resident Engineers are the Department's first line pavement managers. Their intimate knowledge of pavements in their residency is invaluable in carrying out pavement management strategies. As such, Resident Engineers are the primary decision makers

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for identifying and scheduling preventive maintenance projects.

Note: *Because these surface distress ratings in the HSRM are determined while surveying the pavement at the posted speed limits, they do not always provide the most accurate description of the pavement's condition and should not be relied upon exclusively.*

10.2 NONSTRUCTURAL OVERLAYS

Nonstructural overlays are asphalt surface courses designed to improve and protect the pavement, but offer no structural improvement to the pavement. The overlay treatments discussed in this section include:

- Single course surface treatment (chip seal)
- Quick-set slurry
- Micro-surfacing
- Paver-placed surface treatment
- Hot mix asphalt (HMA) (40 mm - 50 mm)
- 6.3 mm polymer-modified HMA
- Heater scarification of HMA pavement (surface preparation for overlay treatments)

Nonstructural overlays constitute preventive maintenance only when used on flexible pavements or rigid pavements that were previously overlaid with HMA. When used properly as preventive maintenance, these treatments prevent future cracking by delaying the aging process of the pavement. They can also correct minor flaws such as rutting, raveling, minor cracks, and reduced pavement friction. The advantages and disadvantages of each treatment are discussed in sections 10.2.1 through 10.2.7. When overlays are used directly on rigid pavements, they are classified either as corrective maintenance or pavement rehabilitation (see Chapter 5 of this manual).

The friction requirements given in the specification for each treatment, limit that treatment to certain types of traffic loadings. Certain products, because of their structure, can only be used on low-volume traffic roads and the friction aggregate requirements for these treatments reflect this limitation. The three types of traffic loadings used to specify friction aggregate in surface courses are described below. The specific traffic conditions under which each treatment can be used are described in the subsection for each treatment.

Low-Volume Traffic refers to 2- or 3-lane highways with a design-year, two-way AADT less than 8,000, or highways with more than 3 lanes and a design-year, two-way AADT less than 13,000.

Downstate High-Volume Traffic refers to 2- or 3-lane highways in the City of New York or the Counties of Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk, or Westchester with a design-year, two-way AADT of 8,000 or greater, or highways in these areas with more than 3 lanes and a design-year, two-way AADT of 13,000 or greater.

Upstate High-Volume Traffic refers to 2- or 3-lane highways in all other areas of the State with a design-year, two-way AADT of 8,000 or greater, or highways with more than 3 lanes and a design-year, two-way AADT of 13,000 or greater.

10.2.1 Single Course Surface Treatment (Chip Seal)

Single course surface treatment is a thin overlay consisting of a heavy asphalt emulsion application followed by a single layer of clean, uniformly sized coarse aggregate of size designation 1 ST, 6.3 mm crushed stone. Surface treatments are used on flexible pavements only. The emulsion is applied to the cleaned road surface, and immediately covered with the stone. The stone is placed, producing a dense one aggregate thick layer with no bald spots or bleeding areas. The stones are then oriented and seated with pneumatic tire rollers. The emulsion must be allowed to cure before the road can accept traffic.

Surface treatment will seal the pavement, reducing oxidation and weathering of the surface. The reduction in oxidation will allow the pavement to remain resilient to fatigue and low temperature cracking. Minor surface distresses such as raveling may also be corrected or prevented. The final thickness of a surface treatment is approximately 10 to 15 mm.

The Office of General Service's (OGS) contract for this item includes a one-year warranty. The contractor must repair any area retaining less than 90% of the aggregate before September of the following year, at no cost to the purchaser.

Due to the very coarse texture of this treatment, the quantity of striping material required to provide adequate visibility is greater than for other nonstructural overlays. When evaluating the use of this product, the increased striping costs should be considered.

The expected service life for surface treatment (chip seal) is 2 to 4 years.

10.2.1.1 Conditions for Use

Distress of candidate pavements should be limited to:

1. Low severity cracking, raveling, or rutting.
2. Infrequent corrugations, settlements, heaves, or slippage cracks.

Traffic restrictions for candidate pavements are:

1. **Low volume traffic** only.
2. Low to moderate truck traffic (< 10%).
3. Recommended for two lane roads with less than 2000 AADT and low truck traffic.

10.2.1.2 Advantages

1. Can be constructed one lane at a time without matching lanes before opening to traffic at the end of the day.
2. Minimal change to pavement elevation.

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3. Can be applied to mainline only with no elevation adjustment to the shoulders.
4. Can be applied on shoulders only with no elevation adjustment to the mainline.
5. One year warranty.

10.2.1.3 Disadvantages

1. Potential for loose stone (risk of damage to autos), may require multiple sweepings.
2. Provides no correction to cross-slope.
3. Thermoplastic and preformed markings will not adhere.
4. Requires long (length) lane closure.
5. Time to open to traffic is dependent on environmental conditions, and may be several hours.
6. Surface treatments can be susceptible to damage (stone loss) from snow removal equipment.
7. Short service life.
8. Cannot be constructed at night.

10.2.1.4 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Earliest date of application is May 1.
2. Latest day of application is the last Saturday in August.
3. Minimum pavement temperature is 10°C.
4. Cure time is dependant on environmental conditions, and is significantly affected by the amount of exposure to sunlight. The greater the exposure to sunlight, the less time is needed for curing at a given temperature.

Pavement preparation consists of the following procedures:

1. Perform necessary crack sealing.
2. Remove all epoxy, polyester, thermoplastic and preformed pavement markings.
3. Clean the pavement.

Constructing a surface treatment consists of the following procedures:

1. Apply the asphalt emulsion.
2. Apply the stone to the asphalt emulsion.
3. Compact the stone with pneumatic tire rollers.
4. Treatment is allowed to cure before opening it to traffic.
5. Permanent markings are applied after 24 hours of cure.

10.2.1.5 Expected Failure Modes

1. Loss of aggregate (stripping).
2. Flushing.
3. Potholes and raveling at reflective cracks.

10.2.2 **Quick-Set Slurry**

Quick-set slurry is a mixture of asphalt emulsion, aggregate, mineral filler and water. The slurry is continuously mixed and applied to the pavement in a single lift with specialized equipment. There are two aggregate gradations available: Type II and Type III. The aggregate used is size 2MS or 3MS, depending on the mixture type. No compaction is required for quick-set slurry, but the emulsion must be allowed to cure before opening to traffic, usually 2-3 hours.

Quick-set slurry will seal the pavement, reducing oxidation and weathering of the surface. The reduction in oxidation will allow the pavement to remain resilient to fatigue and low temperature cracking. Minor surface distresses such as raveling may also be corrected or prevented. The final thickness of a quick-set slurry is approximately 5 to 15 mm.

Crack sealing should be performed at least 3 months prior to the application of quick-set slurry. It is recommended that all necessary crack sealing be completed during the previous construction season.

Preformed temporary markings are not recommended for quick-set slurry. It is recommended that paint be used for all temporary markings. The overlay requires at least 7 days of curing before the application of any permanent pavement markings.

The expected service life for quick-set slurry is 3 to 5 years.

10.2.2.1 Conditions for Use

Distress of candidate pavements should be limited to:

1. Low severity cracking, raveling, or rutting.
2. Infrequent corrugations, settlements, heaves, or slippage cracks.

Traffic restrictions for candidate pavements are:

1. **Low volume** traffic only.
2. Low to moderate truck traffic (<10%).

10.2.2.2 Selecting Type II or Type III gradation

Type II contains mostly fine aggregate. A typical lift thickness for Type II is 5 to 10 mm. The thin lift does not allow for profile corrections. Type II is best suited for roads with few cracks, and little surface distress.

Type III is a coarser mix requiring a thicker lift. A typical lift thickness for Type III is 10 to 15 mm. The thicker lift allows for use on roads with slightly higher levels of distress. The coarser aggregate is also better suited for roadways approaching the maximum AADT for low volume traffic roads (defined in Section 10.2).

10.2.2.3 Advantages

1. Can be constructed one lane at a time without matching lanes before opening to traffic at the end of the day.
2. Can be used to treat the mainline with no elevation adjustment to the shoulders.
3. Can be used to treat the shoulders with no elevation adjustment to the mainline.
4. Can be applied to the mainline only without covering the edge of pavement markings.
5. Edges and transitions may be feathered out.
6. Minimal change to pavement elevation.
7. Single pass operation.

10.2.2.4 Disadvantages

1. Provides no correction to cross-slope.
2. Difficult to obtain proper surface texture with hand tools.
3. Requires at least 7 days for emulsion to fully cure before permanent markings can be applied.
4. Time to open to traffic is dependent on environmental conditions, and may be several hours.
5. Equipment cannot account for shoulder breaks.
6. Cannot be constructed at night.

10.2.2.5 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Seasonal limitations are governed by §402-3.01 of the Standard Specifications.
2. Minimum temperature is 10°C.
3. Cure time is dependant on environmental conditions, and is significantly affected by the amount of exposure to sunlight. The greater the exposure to sunlight, the less time is needed for curing at a given temperature.

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Pavement preparation consists of:

1. Crack sealing should be performed at least 3 months before application of quick-set slurry.
2. Perform all required rut filling.
3. Remove all thermoplastic, and preformed markings.
4. Abrade all epoxy and polyester markings to remove the glass beads and roughen the surface.
5. Clean the pavement.

Constructing a quick-set slurry overlay consists of:

1. Apply slurry.
2. Allow slurry to cure until stable enough to support traffic.
3. Apply temporary striping.
4. Open roadway to traffic.
5. Apply permanent striping after 7 days of cure (minimum).

10.2.2.6 Expected Failure Modes

1. Potholes and raveling at reflective cracks.
2. Abrasion at intersections.

10.2.3 **Micro-Surfacing**

Micro-surfacing is a mixture of polymer modified asphalt emulsion, aggregate, mineral filler, and water, that has a slurry consistency during mixing and application. The micro-surfacing is continuously mixed and applied with specialized equipment. There are two mix types available based on aggregate gradation: Type II micro-surfacing uses a 2MS aggregate gradation and Type III micro-surfacing uses a 3MS aggregate gradation. The aggregate gradation requirements are listed in §703-02 Coarse Aggregate of the Standard Specifications.

Micro-surfacing overlays are always applied in two passes. The first pass, often called the scratch course, is applied to even out surface irregularities and prepare the pavement for the surface course. The surface course is applied to provide a smooth wearing course. No compaction is required, however, the emulsion must be allowed to cure before traffic is applied. Micro-surfacing will accept traffic within 1 hour after application under most conditions.

Micro-surfacing will seal the pavement, reducing oxidation and weathering of the surface. The reduction in oxidation will allow the pavement to remain resilient to fatigue and low temperature cracking. Minor surface distresses such as raveling may also be prevented or corrected. The final thickness of micro-surfacing is approximately 10 to 20 mm depending on the mix type used and the design application rate.

Ruts up to 9 mm deep can be filled in one pass concurrent with the initial paving pass. For ruts deeper than 9 mm, the rut filling operation is performed separately using Type III micro-surfacing applied with a specialized applicator, and paid for under a separate item. The depth of ruts must be taken into account when determining the total quantity of material needed for a project. The filled ruts can be covered with any appropriate nonstructural overlay.

Crack sealing should be performed at least 3 months prior to the application of micro-surfacing. It is recommended that all necessary crack sealing be completed during the previous construction season.

Preformed temporary markings are not recommended for micro-surfacing. It is recommended that paint be used for all temporary markings. The overlay requires at least 7 days of curing before the application of any permanent pavement markings.

The expected service life for micro-surfacing is 5 to 8 years. No traffic restrictions apply for this treatment, but appropriate friction aggregate must be used for the traffic volume and location.

10.2.3.1 Conditions for Use

Distress of candidate pavements should be limited to:

1. Low severity cracking and raveling.
2. Infrequent corrugations, settlements, heaves, and slippage cracks.
3. Wheel path rutting up to 25 mm.

10.2.3.2 Selecting Type II or Type III Micro-surfacing

Type II contains mostly fine aggregate. The final thickness of two applications of Type II is approximately 10 mm to 15 mm. The fine aggregate results in a very smooth dense surface, excellent for urban applications, and moderate traffic volume highways. Type II cannot be used for filling ruts deeper than 9 mm.

Type III is a coarser mix, and provides a thicker surface course. The final thickness of two applications of Type III is approximately 15 mm to 20 mm. The coarser aggregate provides a slightly more aggressive surface texture. The thicker lifts provide improved durability. Type III is recommended for highways with high traffic volume, and/or high truck traffic.

10.2.3.3 Determining the Application Rate

A. Rut Fill

This quantity must be calculated for any candidate that exhibits rutting, regardless of whether the ruts will be filled and paid for under a separate item. Calculating the exact quantity of

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material needed to fill ruts is very difficult. The following table can be used to estimate the quantity of material needed. Adjustments to these quantities can be made based on experience.

Table 10-1 Estimated Quantities for Rut Filling

Average Rut Depth	Estimated Rut Fill Application Rate (kg/m ²)
0 to 12 mm	0 - 9
12 to 19 mm	9 - 14
19 to 25 mm	12 - 16
25 to 32 mm	13 - 17
32 to 40 mm	14 - 18

Multiply the estimated rut fill application rate by the total square meters of rutting (rut width x 2 x length x no. of lanes), to calculate the total mass of material needed. If the ruts are deeper than 9 mm, the quantity calculated above is bid under the Type III Rut Filling item. If the ruts are less than 9 mm deep, the quantity can be combined with the overlay quantity and bid under a single item.

B. Overlay

The application rate of the overlay depends on the level of distress and traffic conditions of the candidate. Typical application rates for Type II range from 14 to 22 kg/m². Typical application rates for Type III range from 20 to 32 kg/m². Micro-surfacing overlays are applied in at least 2 lifts. The rates provided here are totals for all lifts.

10.2.3.4 Advantages

1. Can be constructed one lane at a time without matching lanes before opening to traffic.
2. Can be applied to the mainline only with no elevation adjustment to the shoulders.
3. Can be applied to the shoulders only with no elevation adjustment to the mainline.
4. Can be applied to the mainline without covering the permanent edge of pavement markings.
5. Edges and transitions may be feathered out.
6. Minimal change to pavement elevation.
7. Can be used to fill rutting.
8. Open to traffic within one hour (advantage over chip seal and slurry seal).

10.2.3.5 Disadvantages

1. Two pass operation.
2. No correction for cross-slope.
3. Difficult to obtain proper surface texture with hand tools.
4. Requires at least 7 days for emulsion to fully cure before permanent markings can be applied.
5. Equipment cannot account for shoulder breaks.
6. Requires up to one hour before opening to traffic.

10.2.3.6 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Seasonal limitations are governed by §402-3.01 of the Standard Specifications.
2. Minimum temperature is 10°C.
3. Cure time is dependant on environmental conditions, and is affected by the amount of exposure to sunlight. The greater the exposure to sunlight, the less time is needed for curing at a given temperature.

Pavement preparation procedures consist of:

1. Perform all required crack sealing.
2. Remove all thermoplastic and preformed pavement markings.
3. Abrade all epoxy and polyester markings to remove the glass beads and roughen the surface.
4. Clean the pavement.

Constructing a micro-surfacing overlay consists of:

1. Apply rut fill course if needed.
2. Allow rut fill course to cure for 1 day.
3. Apply initial course.
4. Allow initial course to cure before traffic or the second course is allowed.
5. Apply surface course.
6. Allow surface course to cure until it is stable enough to support traffic.
7. Apply temporary markings.
8. Allow traffic on the pavement.
9. Cure continues for at least 7 days before the permanent markings are applied.

10.2.3.7 Expected Failure Modes

1. Potholes and raveling at reflective cracks.
2. Subject to abrasion at high traffic acceleration areas (vehicles accelerating at traffic signals).

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10.2.4 Paver Placed Surface Treatment

Paver placed surface treatment consists of a warm polymer-modified asphalt emulsion coat followed immediately with a thin hot mix asphalt (HMA) wearing course. A self-priming paver applies the warm emulsion coat directly in front of the paving screed. Three gradations are available for the HMA wearing course: Type A, B, or C. The nominal maximum aggregate sizes are 6.3 mm, 9.5 mm, and 12.5 mm for Types A, B, and C respectively. The HMA overlay is placed in 1 lift, having a final thickness of 1 to 1.5 times the diameter of the coarsest aggregate.

Paver placed surface treatment will seal the pavement, reducing oxidation and weathering of the surface. The reduction in oxidation will allow the pavement to remain resilient to fatigue and low temperature cracking. Surface distresses such as raveling and moderate rutting (defined in Chapter 2, Appendix 2A) may also be corrected. The final thickness of paver placed surface treatment is 12 mm for Type A, and 20 mm for Types B and C.

There are no traffic restrictions for paver placed surface treatment. The expected service life of paver placed surface treatment is 5 to 8 years.

10.2.4.1 Conditions for Use

Distress of candidate pavements should be limited to:

1. Low severity cracking, or raveling.
2. Infrequent corrugations, settlements, heaves or slippage cracks.
3. Medium severity rutting.

10.2.4.2 Selecting Type A, Type B, or Type C.

Type A is a 6.3 mm nominal maximum aggregate size mix. This mix is considered to be the lightest duty mix. Its fine surface texture is excellent for urban and suburban applications with light truck traffic. Type A is not recommended for highways that are borderline candidates for preventive maintenance. One of the coarser gradations should be used in those applications.

Type B is a 9.5 mm nominal maximum aggregate size mix. This mix is durable enough to handle moderate to heavy traffic and truck traffic on highways with moderate speeds. Type B can also be used in lighter duty applications if a slightly thicker lift is desired, or if more surface distress is present.

Type C is a 12.5 mm nominal maximum aggregate size mix and the most heavy-duty mix. Type C can be used for any application, regardless of traffic levels. This mix is recommended for high speed, high traffic applications, and for applications with moderate rutting.

10.2.4.3 Advantages

1. Can be constructed one lane at a time without matching lanes before opening to traffic.
2. Requires only a short, single lane, moving traffic closure.
3. Can correct wheel path rutting up to 13 mm with a single pass.
4. Can be opened to traffic immediately after rolling.
5. Minimal change in pavement elevation.
6. Can be applied to mainline only, with no adjustment to the shoulders.
7. Can reduce water spray from traffic on wet pavement.

10.2.4.4 Disadvantages

1. Minimum correction to cross-slope.
2. Edges and transitions cannot be feathered. Milling rebates may be required.
3. Self-priming paver cannot accommodate shoulder breaks.
4. Coarse surface texture reduces yield of marking paint.

10.2.4.5 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Seasonal limitations governed by §402-3.01 of the Standard Specifications.
2. Minimum temperature is 10°C.

Pavement preparation procedures consist of:

1. Perform all required crack sealing.
2. Remove all thermoplastic and preformed pavement markings.
3. Abrade all epoxy and polyester markings to remove the glass beads and roughen the surface.
4. Clean the pavement.

Constructing a paver placed surface treatment consists of:

1. Apply emulsion and HMA with a self priming paver.
2. Apply compaction.
3. Temporary pavement markings and traffic are allowed as soon as the surface temperature allows.
4. Apply permanent markings.

10.2.4.6 Expected Failure Modes

1. Potholes and raveling at reflective cracks.
2. Raveling.

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10.2.5 Hot Mix Asphalt, 40-50 mm

Hot mix asphalt (HMA) overlays may be any appropriate top course mixture. The specific mix type and compaction requirements will depend on the design traffic loading of the pavement. Contact the Regional Materials Engineer for support.

There are no traffic restrictions for HMA overlays; however, mixture selection is based on traffic loading. The expected service life of a 40-50 mm hot mix asphalt overlay is 5 to 8 years.

10.2.5.1 Conditions for Use

Distress of a candidate pavement should be limited to:

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, or raveling.

10.2.5.2 Advantages

1. Paver can adjust for shoulder break to allow paving of mainline and shoulders.
2. Allows for some correction of cross-slope.
3. Hand work is easier than with other overlays.
4. No need to remove epoxy pavement markings.

10.2.5.3 Disadvantages

1. Crack sealing and rut filling must be performed prior to construction to achieve service life.
2. Increases elevation of pavement, decreases curb reveal and guide rail height.
3. Must pave mainline and shoulders.
4. Need to remove preformed pavement markings.
5. Requires a relatively long paving train.
6. Usually requires a shoulder backup.

10.2.5.4 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Seasonal limitations governed by §402-3.01 of the Standard Specifications.
2. Minimum temperature is 8°C.

Pavement preparation consists of:

1. Perform all required crack sealing.
2. Remove all preformed pavement markings.
3. Clean the pavement.

Constructing a 40-50 mm HMA overlay consists of the following procedures:

1. Apply a tack coat.
2. Apply the HMA.
3. Compact the overlay.
4. Apply temporary markings after surface temperature drops.
5. Traffic is allowed as soon as mat cools enough to support the loading.
6. Apply permanent markings.

10.2.5.5 Expected Failure Modes

1. Reflective cracking.
2. Low temperature cracking.
3. Rutting or shoving at intersections.
4. Potholes.
5. Raveling.

10.2.6 6.3 mm Polymer-Modified HMA, 19-25 mm

A 6.3 mm polymer-modified HMA overlay is an appropriate top course mixture. There are no traffic restrictions for a 6.3 mm polymer-modified HMA overlay. The expected service life of a 19-25 mm thick 6.3 mm polymer-modified HMA is 5 to 8 years.

The specification requires the use of a Polymer-Modified PG Binder in the mixture and the use of a rapid setting asphalt emulsion as a tack coat, which will cause an increased cost per ton. Designers should estimate a cost of approximately 25% more per ton of mixture as compared to regular HMA mixtures.

Item number selection will depend on design traffic loading of the pavement. Use the table below to select the appropriate Item number for the anticipated traffic conditions. Contact the Regional Materials Engineer for support.

Anticipated Traffic Conditions ^{1,2}	Appropriate Item Number
Downstate High Volume	402.067101 18 M
Upstate High Volume	402.067201 18 M
Low Volume	402.067301 18 M

1. "High Volume" refers to 2- or 3-lane highways with design year two-way AADT over 8,000, or for more than three lanes, with two-way AADT over 13,000. "Low Volume" refers to highways with lower volumes for the specified number of lanes.
2. The City of New York and the surrounding counties of Dutchess, Nassau, Orange, Sullivan, Putnam, Rockland, Suffolk, and Westchester are referred to as "downstate." All other areas are referred to as "upstate."

10.2.6.1 Conditions for Use

Distress of a candidate pavement should be limited to:

1. Low-severity cracking.
2. Infrequent corrugations, settlements, heaves, slippage cracks, or raveling.

10.2.6.2 Advantages

1. Paver can adjust for shoulder break to allow paving of mainline and shoulders.
2. Hand work is easier than with other treatments.
3. No need to remove epoxy pavement markings.
4. Edges can be feathered.
5. Only a slight increase to the pavement elevation.

10.2.6.3 Disadvantages

1. Crack sealing and rut filling must be performed prior to construction to achieve service life.
2. Need to remove preformed pavement markings.
3. May requires a relatively long construction zone.
4. Transitions cannot be feathered. Milling rebates may be required.

10.2.6.4 Construction Considerations

Weather and seasonal limitations are governed by §402-3.01 of the Standard Specifications.

Pavement preparation consists of:

1. Perform all required crack sealing and rut filling.
2. Remove all preformed pavement markings.
3. Clean the pavement.

Constructing a 6.3 mm polymer-modified HMA overlay consists of the following procedures:

1. Apply a tack coat.
2. Apply the 6.3 mm polymer-modified HMA.
3. Compact the overlay.
4. Apply temporary markings after surface temperature drops.
5. Traffic is allowed as soon as mat cools enough to support the loading.
6. Apply permanent markings.

10.2.6.5 Expected Failure Modes

1. Reflective cracking.
2. Low temperature cracking.
3. Shoving at intersections.
4. Potholes.

10.2.7 Heater Scarification of Hot Mix Asphalt (HMA) Pavement

Heater scarification is an optional surface preparation technique to recycle and rehabilitate the top course of an existing asphalt pavement prior to a preventive maintenance overlay. It is a multi-step process, in which the existing asphalt pavement is heated and scarified with specialized equipment. Depth of the asphalt pavement to be scarified is usually between 25 mm and 50 mm. The only new material added to the pavement is an asphalt recycling agent which improves the properties of the aged asphalt. This mix is then reshaped and compacted back onto the roadway. A preventive maintenance treatment overlay is placed over the recycled pavement.

Heater scarification improves the existing pavement's ability to remain resilient to fatigue and low-temperature cracking. This process will help restore proper drainage by improving the pavement surface and cross-section deformed by rutting or traffic wear.

When used properly, heater scarification is expected to delay distress from the underlying pavement and extend the overlay's expected service life by an additional 2 years.

The specification requires the Contract documents to include the following:

- Descriptive notes of the core locations along with their test results for percent of recovered asphalt content, aggregate gradation, and original penetration value for each sample.
- The depth of existing HMA pavement depth to be scarified in millimeters. (Maximum allowable depth to be scarified is 50 mm).

In order to obtain this information, core samples have to be taken from the existing HMA pavement. The designer must coordinate with the Regional Materials Engineer to obtain these cores for testing. This test data will be used by the Contractor to determine the application rate of the recycling agent.

For bidding purposes, the estimated quantity of asphalt recycling agent will be 0.45 liters per square meter of heater scarified hot mix asphalt (HMA) pavement.

10.2.7.1 Conditions for Use

Distress of a candidate pavement should be limited to:

1. Low-severity cracking.
2. Structurally sound pavement with infrequent settlements, heaves, slippage cracks, raveling, medium- and/or high-severity cracking.
3. Corrugations.
4. Low- or medium-severity wheel path rutting and/or widening drop-off.
5. Pavement core evaluation must meet warrants for recycling.
6. If the pavement is rutted, the cause of the rutting must be evaluated to determine if rutting has ceased.

10.2.7.2 Advantages

1. Can be done one lane at a time.
2. Overnight lane closures not required.
3. Crack sealing, shimming wheel ruts, or truing and leveling (T&L) is not required.
4. Maintains existing profile.
5. Delays reflective cracking in overlay.

10.2.7.3 Disadvantages

1. Manholes or drainage inlets will damage recycling equipment.
2. Emissions may be objectionable in residential areas.
3. Extra caution must be used because high temperatures may damage vegetation close to road.
4. Must be overlaid with a preventive maintenance item.

10.2.7.4 Construction Considerations

Weather and seasonal limitations are governed by §402-3.01 of the Standard Specifications for minimal compacted lift thickness <50 mm.

Constructing an asphalt pavement using heater scarification consists of the following procedures:

1. Apply heat to the existing asphalt pavement.
2. Scarify the heated pavement with specialized equipment.
3. Add the asphalt recycling agent to the scarified pavement.
4. Reshape and compact the paved surface.
5. Apply temporary markings after surface temperature drops.
6. Traffic is allowed as soon as mat cools enough to support the loading.
7. The preventive maintenance overlay must be placed prior to the end of the paving season.

10.2.7.5 Expected Failure Modes

See expected failure mode of preventive maintenance overlay.

10.3 MINOR PAVEMENT REPAIRS

Minor pavement repairs are any work performed on a pavement to remediate specific, low-severity, or isolated distresses. The current Department treatments for minor repairs include:

- crack sealing(flexible pavement only)
- joint sealing (PCC pavements)
- partial depth spall repairs (PCC pavements)
- combinations of these treatments.

Early in a pavement's life, when low-severity or isolated distresses appear, these repairs may be performed to delay the need for more extensive maintenance or rehabilitation. As the pavement ages, the frequency and/or severity of the distress may increase, reducing the pavement's condition rating. These treatments can then be used to prepare the pavement for a nonstructural overlay (flexible pavements only). Minor repairs are just that, minor, and should not be used by themselves once medium-severity distress has occurred. If the application of these treatments is delayed until medium severity distress is present, their use is not preventive maintenance.

This chapter considers only flexible pavements and jointed *plain* (unreinforced) concrete pavements (JPCP). The vast majority of concrete pavements constructed by the Department have been jointed *reinforced* concrete pavement (JRCP); however, the age of these pavements places them beyond the scope of preventive maintenance. Corrosion in a JPCP slab is not a concern because it does not contain reinforcing steel. Also, cracks in JPCP constitute a pavement failure. For these two reasons, cracks in JPCP must be repaired by retrofitting the crack with dowel bars, turning the crack into a joint. Dowel bar retrofit is a concrete pavement rehabilitation (CPR) technique. Refer to Chapter 5 of this manual for further guidance on CPR. Preventive maintenance of JPCP is limited to resealing joints and partial depth spall repairs.

Project Selection

Resident Engineers are the primary decision makers for identifying and scheduling minor pavement repairs. They decide which roads need sealing, the appropriate sealing treatment, and the contract arrangements for completing the work. Parameters outlined in these guidelines will help with project selection and in choosing a sealing method. Deciding whether to seal cracks with State forces or by contract involves consideration of factors that vary with the residency. Some examples are workload, personnel skill level and experience, project location, volume of traffic, availability of competent contractors in the area, OGS contract availability, etc. The Regional Pavement Management Group may review the candidate projects, sealing methods, and contract type selected by the Resident Engineer for program and funding compatibility.

Briefly outlined below is a five-step procedure recommended for selecting projects to include in a pavement sealing program, and for designing their cost-effective treatments.

1. Maintain a database of pavement work histories. Minimum types of information to include are: pavement type, pavement location, the category of work, limits of work, and date of work. Basic pavement types are: full-depth PCC, full-depth HMA, and HMA overlays of PCC. The broad categories of work associated with each pavement type are: reconstruction, rehabilitation, corrective maintenance, and preventive maintenance. Joint and crack sealing are specified for each of these work categories. For a complete description of treatments and their timing, refer to the Pavement Rehabilitation Manuals, Volumes I and II, in Chapters 2 and 5 of this manual, respectively.
2. Identify candidate pavements. Do a sort on the database to produce a list of pavements that are candidates for sealing. Key criteria are pavement type, the category of work, and date of work.
3. Evaluate pavement condition. Pavement condition and the condition of previous work are important factors when deciding whether a sealing project is appropriate. Each pavement listed in the database sort requires a field investigation to evaluate its condition. For PCC pavements, the age of the pavement drives the scheduling of joint and crack sealing. Joint seals, however, need to be checked periodically for premature failure. For HMA pavements, cracks should ideally be sealed as soon as they appear; however, upon inspection, may have too few cracks for sealing by contract at the time. These pavements will need a field inspection again the following year to decide if distress levels are now appropriate for sealing. Severely distressed pavements are not good candidates for sealing. The purpose of crack sealing is to slow distress development, not correct it. Crack sealing is not a solution for making a seriously distressed pavement last through another winter. The Conditions for Use section under each treatment describes the level of cracking considered acceptable at the time of construction for the sealing of HMA pavements.
4. Select pavement sealing treatment and decide contract arrangements. The type, age, and physical condition of the pavement and previous work are important factors in designing and scheduling joint and crack sealing projects. Keep in mind that a pavement will continue to deteriorate after the field investigation until work is done to stop deterioration or improve condition. Some pavements may even fall apart over a winter to a point where they may no longer be good candidates for sealing. It is, therefore, important to schedule a project for work before the pavement distresses reach the upper levels considered acceptable for sealing.

Equally important is the remaining service life of the pavement, which must be greater than the expected life of the planned sealing treatment. Pavement sealing is not a good investment if the treatment outlasts the pavement.

Sealing specifications for HMA pavements offer choices in crack preparation and in the method of measurement for payment purposes. A rout and seal treatment may last five years compared to two years for a clean and seal treatment. Routing of the full-width

transverse cracks in HMA pavements is an effective treatment because thermal movement is greatest with this type of crack. Consider a rout and seal treatment if the remaining life of the pavement may exceed five years. The Regional Materials Engineer can help with an assessment of remaining pavement life.

Other factors important to each Region must be considered to complete the project. Some examples are, who will do the work (State forces or contractors) and the funding source.

5. Set priorities. Available resources may limit what work gets done and when. Following is a prioritized listing of the work categories considered cost-effective:
 - a. Resealing Joints (Transverse and Longitudinal) in PCC Pavement.
 - b. Sealing Cracks in PCC Pavement.
 - c. Filling PCC-Pavement/HMA-Shoulder Joints.
 - d. Routing and Sealing Cracks in HMA Pavement.
 - e. Cleaning and Sealing Cracks in HMA Pavement.

Regions may establish sub-priorities within the above categories of work to account for pavement age and traffic volume. Generally, sealing projects on young pavements with high traffic volumes (or many trucks) are very cost-effective.

There are no traffic restrictions for any of these treatments.

10.3.1 **Partial Depth Repairs of Jointed Plain Concrete Pavements**

Partial depth repair corrects localized surface distress, such as joint spalling located primarily in the upper one-third of a concrete pavement. Surface spalls can create a rough ride and accelerate development of further distress problems. Partial depth repairs replace unsound concrete, restore a smooth ride, deter further deterioration and provide suitable edges for effective joint and crack resealing.

Installing a partial depth repair involves determining the extent of the deterioration, removing the deteriorated concrete, thoroughly cleaning the repair area, placing the repair material, and reforming the joint.

Spalls that are smaller than 12 mm by 150 mm do not typically affect ride quality and do not require a partial depth repair.

Good judgement is essential in defining limits for partial depth repairs. Do not attempt to cut costs by limiting repair size, despite the expanse of deterioration. Such practice can reduce the repair's ability to extend pavement service life. It is important to remember that the majority of the cost is in repair preparation. Since the preparation effort is similar for smaller and larger repairs, smaller repairs do not significantly reduce costs.

Estimating the quantity of repair areas can be difficult. The area of deteriorated concrete is often much larger than the resulting surface distress. Extensive evaluation and conservative calculations are recommended when estimating quantities.

10.3.1.2 Conditions for Use

Spalls should be of 1 m² or less in area with the larger dimension no more than two times the smaller, and less than 100 mm deep.

10.3.1.3 Advantages

1. Overnight lane closures may not be required.
2. Small areas can be repaired with rapid setting products.
3. Heavy equipment not required.
4. Improves ride.

10.3.1.4 Disadvantages

1. Restricted by temperature and moisture.
2. Requires intensive preparation of the repair area.
3. Must strictly adhere to rapid setting repair material instructions.
4. Extended time for traffic control.

10.3.1.5 Construction Considerations

Weather seasonal limitations apply as follows:

1. Most concrete repair materials cannot be used below 10°C.
2. Repair materials require different curing techniques.

The surrounding pavement does not need to be prepared prior to removing the material from the repair area.

Constructing partial depth repairs consists of:

1. Saw cut the repair perimeter 20 mm deep with a diamond blade saw.
2. Remove the damaged concrete using 20 kg or lighter hammers and appropriate bits.
3. Blast clean the repair area.
4. Prepare the repair area as recommended by the repair material manufacturer.
5. Form adjacent joints.
6. Place, consolidate, and finish repair material.
7. Cure the repair for required period.
8. Allow traffic on repair after cure.
9. Clean and seal adjacent joints.

Common repair materials include:

1. Concrete Repair Materials (Item 701-04, Approved List)
2. Rapid Setting Concrete Repair Materials (Item 701-09, Approved List)
3. High Early Strength PCC Mixtures (Contact the Materials Bureau)
4. Specialty Cement Concrete Mixtures (Contact the Materials Bureau)
5. Rapid Setting Polymer Concrete (Item 721-20, Approved List)
6. Epoxy Repair Paste.

10.3.1.6 Expected Failure Modes

1. Bond failure between repair and pavement.
2. Cracking of repair.
3. Degradation of surrounding pavement (minimized by use of diamond blade).

10.3.2 **Resealing Joints in Jointed Plain Concrete Pavement**

Joint resealing is a cost-effective strategy for extending a pavement's service life. Resealing should be performed on joints that are in good condition. Partial depth repairs can be performed to allow the joint to accept sealant. For JPCP, the age of the pavement drives the scheduling of joint sealing. Joint seals, however, need to be checked periodically for premature failure.

Resealing joints reduces the accumulation of incompressible material in the joint. Incompressible material retained in rigid pavement joints or cracks can lead to spalls and/or blowups in hot weather.

Resealing joints, reduces the amount of surface water entering the subbase, slowing pavement deterioration and extending service life. Surface water infiltrating through the cracks and joints can penetrate into the base and subbase materials, causing a loss of strength in these materials. Load-related failures may result. This type of failure is not as critical for pavement designs using drainable base layers (ex. permeable base layer with edge drains).

Joint sealing provides no improvement to ride or drainage. If the quality of the ride has suffered due to cracking, failure has occurred, and it is too late for preventive maintenance.

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The expected service life of resealed joints in plain concrete pavement is 8 years.

10.3.2.1 Conditions for Use

The conditions for resealing transverse and longitudinal joints in PCC pavement are:

1. No sign of alkali silica reaction or D-cracking.
2. Low-severity spalling (spalls may be repaired before sealing).

The conditions for resealing longitudinal joints between PCC pavement and HMA shoulders are:

1. No alkali silica reaction or D-cracking.
2. Low-severity spalling (spalls may be repaired before sealing).
3. Low level shoulder distress.

10.3.2.2 Advantages

1. Overnight lane closures are not required.
2. Can seal widths up to 40 mm; however, the quality of the ride suffers when wider than 20 mm.

10.3.2.3 Disadvantages

The use of sealing materials is restricted by temperature and moisture.

10.3.2.4 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Dry weather is required for sealant to cure properly.
2. Air and pavement temperature should be in the middle of the annual temperature range.
3. Air temperature must be $> 5^{\circ}\text{C}$ above the dew point.
4. Summer application is preferred for resealing joints in PCC pavement.
5. Spring or fall application is preferred for sealing longitudinal joints between PCC pavement and HMA shoulders.

Joint preparation consists of:

1. Remove the old sealant.

2. Remove all debris from the joint.
3. Perform all necessary spall repairs.
4. Saw additional joint width if necessary.
5. Abrasive blast clean each wall of the sealant reservoir.
6. Air blast each wall of the sealant reservoir.
7. Dry the crack thoroughly (hot air lance may be used).
8. Place the backer rod to the proper depth.

The process for resealing joints in PCC pavements consists of:

1. Extrude sealant into the sealant reservoir such that the sealant is 3 mm below the surface of the pavement.
2. Silicone is the recommended sealant. ASTM D3405 is acceptable for longitudinal joints.
3. Tool the sealant if necessary.

The process for filling joints between PCC pavements and HMA shoulders is as follows:

1. Clean the joint with compressed air, hot air lance, or wire brush.
2. Pour the filler material into the joint (use backer rod if joint is wide).
3. Recommended material is ASTM D3405.
4. Squeegee the filler such that a band of filler 3 mm high and 100 mm wide is left over the pavement/shoulder joint. Be sure not to obscure pavement markings.

10.3.2.5 Expected Failure Modes

1. Bond failure between the sealant and pavement.
2. Failure of PCC at or near the interface with the sealant.

10.3.3 Sealing Cracks and Routing and Sealing Cracks in HMA Pavements

Surface water infiltrating through cracks can penetrate into the base and subbase materials, causing a loss of strength in these materials. Load-related failures may result. By sealing cracks, the amount of surface water entering the pavement is reduced, slowing deterioration and extending service life. Crack sealing provides no improvement to the quality of ride or drainage. If the quality of ride has suffered due to cracking, failure has occurred, and it is too late for preventive maintenance. Severely distressed pavements are **not** good candidates for sealing.

10.3.3.1 Sealing

Crack sealing is a cost-effective strategy for extending a pavement's service life. By sealing the pavement when cracks first appear, the pavement remains watertight slowing subsequent pavement deterioration. Crack sealing should be performed on cracks that are in good condition.

The objective of crack sealing is to prevent the formation of future cracks. In flexible pavements, the initial cracking is usually narrow with no surrounding distress. If this condition is not treated, the intrusion of water and incompressibles can lead to fatigue cracking and failure of the pavement structure. The expected service life of crack sealing is 2 years.

Crack sealing operations should not be scheduled within 1 year of an HMA overlay, or within 3 months of a quick-set slurry or micro-surfacing overlay.

10.3.3.2 Routing and Sealing

Routing of the full-width transverse cracks in HMA pavements is an effective treatment because thermal movement is greatest with this type of crack. The work consists of routing a sealant reservoir in well defined single cracks (a transverse thermal crack for example), cleaning the openings by high pressure air blasting and sealing. Consider a rout and seal treatment if the remaining life of the pavement may exceed 5 years. The Regional Materials Engineer or Regional Pavement Manager can help with an assessment of remaining pavement life. The expected service life of routing and sealing is 5 years.

10.3.3.3 Conditions for Use

1. Well defined and spaced cracks with little or no secondary cracking.
2. Average spacing no closer than 6 m between cracks.
3. Less than 25% of the crack's length should have secondary cracking.

10.3.3.4 Advantages

1. Overnight lane closures are not required.
2. Proper application delays need for more expensive overlays.

10.3.3.5 Disadvantages

1. Restricted by temperature and moisture.
2. Improper application will decrease effectiveness of subsequent treatments (overlays).

10.3.3.6 Construction Considerations

Weather and seasonal limitations apply as follows:

1. Dry weather is required for sealant to cure properly.

2. Air and pavement temperature should be in the middle of the annual temperature range.
3. Air temperature must be $> 5^{\circ}\text{C}$ above the dew point.
4. Spring and fall application is preferred.

Sealing or routing and sealing cracks consists of:

1. Rout the crack if performing rout and seal.
2. Thoroughly clean all debris from the crack.
3. Dry the crack thoroughly (hot air lance may be used).
4. Apply the sealant (ASTM D3405 from Approved List) into the crack or reservoir.
5. Squeegee the sealant to a thin film no wider than 50 mm and no thicker than 1 mm.

10.3.3.7 Expected Failure Modes

1. Bond failure between the sealant and the pavement.
2. Degradation of the HMA at or near the interface with the sealant.

10.4 DRAINAGE MAINTENANCE

It is widely known that a key element for successful pavement performance is a properly functioning drainage system. The most important function of the drainage system is to quickly rid water from the road surface plus inside the pavement, so proper maintenance means keeping existing edge drains, underdrains, outlet pipes, drainage structures and ditches clear and running.

By the time pavement distress is identified, the subgrade and subbase usually have already failed and the problem cannot be corrected without removing the pavement. Sealing the pavement is not effective in the long term without correcting drainage problems. Unfortunately, inadequate or nonexistent maintenance of drainage systems is a universal problem.

Maintaining the edge drain and underdrain outlets has become an even more critical factor with the newer pavement designs, which include a permeable base layer to collect and channel water to the edge drain. The new designs which are described in Chapter 9 of this manual, account for this by including more outlets and installing the outlets with 45° connections to enable inspection and clean-out. Also, precast concrete headwalls are specified for many of the outlet drains to prevent the pipe ends from collapsing and to help locate the outlets easily.

10.4.1 Inspect and Flush Out Clogged Drainage Systems

Lack of water flowing from a subsurface drain outlet often means that the drainage system is damaged, through improper installation or a crushed or plugged drain or outlet. If it is suspected there is a clogged drainage system, drainage inspection should be done by either pouring water on the pavement and checking the outflow, or using video inspection.

The first technique can be done by pouring a large volume of water (50 to 100 gallons) onto the pavement surface midway between outlets and verifying outflow: the more outflow and the sooner it exits the outlets the better. This should be done after a rainfall event, so the subgrade/subbase is saturated. If there is poor drainage, the system may be either clogged or the outlet pipe crushed. If it is a stone trench and pipe systems it may need to be flushed out. If the clogged system is a prefabricated geocomposite edge drain (PGED), portions of the system may have to be replaced.

Video inspection involves sending a video probe into the outlet end and inspecting the edge drain and outlet for discontinuities or problems. These inspections are mainly done for quality control during construction but may be used if there is reason to believe the system is not working properly. A specification for video inspection is listed in Appendix 5B of this manual.

If it is evident the edge drain or underdrain pipe has been crushed it should be repaired or a new outlet put in at this location.

If the drainage system is clogged with debris it should be flushed. Cleaning clogged drainage systems can be accomplished with sewer jets or water jets which discharge water from a large tank

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or an abundant water source into the outlet and through the drainage system.

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10.4.2 Inspect and Repair Outlet Openings

The combination of debris, vegetation and fines discharging from the edge drains may eventually plug the outlet pipe. Rodent nests, mowing clippings, and sediment collecting on rodent screens at the headwalls are common maintenance problems. Outlets often cannot be located because they are hidden by vegetative growth. Some outlets are so plugged that water gushes from the pipes when the obstructions are removed.

Visual inspection of the outlets should be done within two years of construction, and thereafter at sites which have had past problems. Debris and/or vegetation should be cleaned out of the outlet opening and rodent screens replaced. If the outlet pipe connections to headwalls or drainage structures are damaged they should be repaired or replaced. Damaged headwalls should either be repaired or replaced with an outlet pipe.

Outlet pipes that are crushed or damaged should be replaced. Replace the outlet pipe with a minimum length of 1.5 m of double-wall, perforated polyethylene pipe with a smooth interior and the same diameter as the existing outlet pipe (usually 100 mm or 150 mm.) This pipe comes in straight lengths and is better able to resist crushing from mowers and construction equipment than typical single-wall polyethylene underdrain pipe or steel corrugated pipe. Connect the new outlet pipe to the underdrain with standard fittings, slope the outlet pipe for positive flow, cut the end flush with the slope face and wrap the end with wire mesh (rodent barrier). Surround the outlet pipe with #2 and #3 crushed stone 300 mm wide by 300 mm or more deep, with the stone extending downslope 1 m.

Outlets should be located for future maintenance cleanouts with outlet markers. If the outlets can not be found, no maintenance can be performed. These outlet markers may be: paint marks on the paved shoulder or guide rail; special plant groupings placed above the outlet locations; or preferably, metal or plastic marker posts placed on the slope at the outlet or placed clear of the shoulder. Outlet markers should be placed outside the design clear area for the road or behind the guide rail. If the clear area for the road section is unknown, contact Regional Design for a recommended clear area.

10.4.3 Cleaning Ditches

A free-draining ditch is important for the drainage system. If ditches are filled with debris and/or vegetation to the point water is backing up or perhaps overflowing the roadway, they should be cleaned out to their original profile or enough to achieve positive drainage. Care should be taken when cleaning and reshaping ditches to use recommended ditch shapes from the AASHTO Roadside Design Guide, so they are traversable and won't channel a vehicle toward a hazard. Contact Regional Design for advice on ditch shapes, location, and clear area.

If the effective ditch depth needs to be increased due to poor drainage but digging out the ditch is not possible, one solution is to construct a stone trench consisting of an underdrain pipe wrapped

in crushed stone. Excavate the bottom of the existing ditch a minimum 300 mm wide and deep enough and long enough to achieve positive drainage or provide enough trench volume to accommodate normal drainage conditions, which may not always be possible. Use #2 and #3 crushed stone or underdrain filter material. For ditches within the clear zone of the roadway, cover the #2 and #3 crushed stones with geotextile fabric and 150 mm of soil. Note that this stone trench option may only be a temporary fix, since it might clog up with fines, and a permanent roadway or drainage rehabilitation may be needed.

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10.5 REFERENCES

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SHRP Studies in Preventive Maintenance Effectiveness (H-101)

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APPENDIX A

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Advice

Not every pavement manager, or maintenance engineer is familiar with every treatment described in this manual. Some project decision makers may be reluctant to select treatments with which they are not familiar. This manual is analogous to a mechanics toolbox. No mechanic would attempt to perform a repair armed only with an adjustable wrench and a screwdriver. Likewise, no treatment in this manual is the answer to every pavement. Even treatments as similar in performance as micro-surfacing and paver placed surface treatment have significant differences that may make either more desirable for a given pavement.

Detailed information on the treatments presented in this manual is available from many sources. If you are not familiar with a particular treatment, ask someone who is. Others in your program area, the Main Office Materials Bureau and Maintenance Division, Regional Materials Engineers and even the contractors themselves can be valuable sources of information. Other states have experience that can be accessed, and many government and industry organizations are accessible to answer your questions via the Internet. Travel to a project site in a neighboring area to see the operation in person. Occasionally training is offered on some of the treatments, participate whenever you can.

Industry Contacts**American Association of State Highway and Transportation Officials**

Lead States Program on Preventive Maintenance
444 North Capitol Street, NW
Suite 225
Washington, D.C. 20001
Phone: (202) 624-5800

Asphalt Emulsion Manufacturers Association

#3 Church Circle, Suite 250
Annapolis, MD 21401
Phone: (410) 267-0023

Asphalt Institute

Research Park Drive
P.O. Box 14052
Lexington, KY 40512-4052
Phone: (606) 288-4999

International Slurry Surfacing Association

1200 19th Street, N.W.
Suite 300
Washington, D.C. 20036-2422
Phone: (202) 857-1160

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CHAPTER HISTORIES

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TYPES OF REVISIONS

COMPLETE REVISION (Comp Rev)
CHAPTER ISSUED (Ch Iss)
CHAPTER DELETED (Ch Del)
LIMITED REVISION (Lim Rev)

CHAPTER RESCINDED (Ch Resc)
SECTION(S) RESCINDED (Sect Resc)
PARTIAL ISSUANCE (Part Iss)

CHAPT. NO.	EDITION OR REVISION NO.	ISSUE DATE	ISSUANCE, EFFECTIVE DATE	TYPE OF REVISION	REMARK
1 Introduction and Glossary	Orig. Edition	3/26/01	EB 01-017, 7/5/01	Ch Iss	First Issue
2 Evaluation of Existing Pavement	Orig. Edition	3/26/01	EB 01-017, 7/5/01	Ch Iss	First Issue
3 Project Development Process	Orig. Edition 1 3	3/26/01 7/15/02 2/6/09	EB 01-017, 7/5/01 EB 02-036, 7/15/02 EB 09-004, 7/1/09	Ch Iss Lim Rev Lim Rev	First Issue Appen. 3C, 3D, & 3E Rem., Table 3-1 Revised
4 New Construction/ Reconstruction	Orig. Edition 1	3/26/01 7/15/02	EB 01-017, 7/5/01 EB 02-036, 7/15/02	Ch Iss Lim Rev	First Issue
5 Rehabilitation	Orig. Edition 1	3/26/01 7/15/02	EB 01-017, 7/5/01 EB 02-036, 7/15/02	Ch Iss Lim Rev	First Issue
6 Materials	Orig. Edition 1 ---- 2	3/26/01 7/15/02 10/5/04 2/12/08	EB 01-017, 7/5/01 EB 02-036, 7/15/02 EB 04-045, 1/26/05 EB 08-008, 2/12/08	Ch Iss Comp Rev Lim Rev Lim Rev	First Issue Repl. Pgs 6-1 – 6-4 Repl. Pgs 6-5 – 6-12 & Appendix 6A
7 Shoulders	Orig. Edition 1	3/26/01 7/15/02	EB 01-017, 7/5/01 EB 02-036, 7/15/02	Ch Iss Lim Rev	First Issue Internal X-Ref Update
8 Pavement Joints	Orig. Edition 1	3/26/01 7/15/02	EB 01-017, 7/5/01 EB 02-036, 7/15/02	Ch Iss Lim Rev	First Issue
9 Subsurface Pavement Drainage	Orig. Edition 1	3/26/01 7/15/02	EB 01-017, 7/5/01 EB 02-036, 7/15/02	Ch Iss Lim Rev	First Issue
10 Preventive Maintenance	Orig. Edition 1 ---- 1, Addition 2	3/26/01 7/15/02 11/29/04 4/15/05	EB 01-017, 7/5/01 EB 02-036, 7/15/02 EB 04-047, 5/5/05 EB 05-026, 9/8/05	Ch Iss Comp Rev Lim Rev Lim Rev	First Issue