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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
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.
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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):

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.


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.
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.
4. Slab Subsealing.
5. Diamond Grinding and Texturing.
6. Transverse and Longitudinal Grooving
7. Load Transfer Restoration.

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**
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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.
- 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 (½ inches) wide. Include a note on the plans effectively stating the following: "Clean joints and cracks greater than 10 mm (½ 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 (½ 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 (½ inch) before paving. Shim 600 mm (2 feet) longitudinally for every 6 mm (¼ 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
  - The presence of utilities precludes the use of cracking and seating, or
  - 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

**EXISTING**

- Asphalt Overlay (May or may not be present)
- Original Concrete Pavement (Deteriorated)
- Asphalt Shoulder
- Subbase

- Original Edge Drain System (Abandon or, if possible, connect to new)

**REMOVAL AND EXCAVATION**

- Any existing Asphalt Overlay Removed
- Original Concrete Pavement (Deteriorated)
- Asphalt Shoulder Removed
- Existing Subbase

- Excavate to required depth and parallel to finished pavement surface.

**LATERAL SUPPORT AND RUBBLIZATION**

- Rubblized Concrete
- Existing Subbase
- Crushed Stone Aggregate Subbase 2%
- Subgrade

- New Edge of Traveled Way
- 125 mm Dense Asphalt Base (Placed prior to rubblization)
- New Embankment

**OVERLAY AND SHOULDER PLACEMENT**

*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):
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


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.