Chapter 7
Pavement Rehabilitation

Pavement rehabilitation can be accomplished using a variety of methods. This section is intended to provide a general overview of rehabilitation methods available for pavements and is not intended as an exhaustive guide on how to accomplish this work. These rehabilitation methods are not applicable to every pavement surface and it is recommended that individuals with experience in pavement rehabilitation be contacted to determine the method most appropriate for the pavement in question.

This section presents information on asphalt pavement overlays and methods for surface preparation, including:

**Asphalt Pavement Overlays**
- Thin Asphalt Pavement Overlays
- Structural Asphalt Pavement Overlays

**Surface Preparations**
- Localized Surface Preparation
- Asphalt Pavement Cold Milling
- Concrete Pavement Preparation

The complete rehabilitation of a pavement will typically involve one or more of the above procedures. For example, it may be desirable to pulverize a concrete pavement prior to placing a structural overlay.

The asphalt pavement mixture salvaged from rehabilitation of existing pavements can and should be recycled into the new asphalt pavement mixture. This process is also discussed in this section.

**ASPHALT PAVEMENT OVERLAYS**

Asphalt pavement overlays are commonly used to restore an aged pavement to like-new condition. Asphalt pavement overlays can be placed with minor traffic disruptions during off-peak times and, when properly designed and constructed, will provide a smooth, durable surface for many years. The overlay thickness, which is related to its intended function, may be determined based on a number of analysis techniques, which are not discussed here.
Thin Asphalt Pavement Overlays
Thin asphalt pavement overlays, usually placed in thicknesses of 2 inches or less, are used to protect a deteriorated pavement, reduce roughness, improve ride quality, and/or restore skid resistance. When thin asphalt pavement overlays are used, it is important to ensure that 1) the maximum size of the aggregate is appropriate for the overlay thickness, 2) a proper tack coat is applied, 3) work is carried out in warm weather to obtain the desired level of compaction, and 4) good construction quality control is maintained.

Structural Asphalt Pavement Overlays
Structural overlays are used to increase or restore the structural integrity of a pavement. Structural overlays may be required when a dramatic increase in heavy truck traffic is experienced or when existing pavements are approaching the end of their designed service life. Overlays will increase pavement life, reduce routine maintenance costs, provide a smoother riding surface, and improve skid resistance.

Structural Asphalt Pavement Overlay Design with NDT
The design of an asphalt pavement overlay requires that the existing structure, including the subgrade, be evaluated. The “strength” of the existing pavement structure gives an indication of both the thickness and condition of the pavement layers. Strength variability along the road can be determined by periodic measurements (every 100 ft or so) along the length of the roadway.

Over the past 20 years, Non-Destructive Testing (NDT) has been used to calculate the overall strength of individual pavement layers. Ground Penetrating Radar (GPR) can be used along with NDT to estimate pavement section layer thickness.

Devices used for NDT are the plate-bearing test, Benkleman beam, Dynaflect, Roadrater and the Falling Weight Deflectometer (FWD). The last three create a deflection basin, which makes it possible to determine the strength of individual layers. The individual tests take a matter of minutes to run and record electronically, so that a number of tests can be run along a roadway in a reasonable length of time.

NDT can also be used to screen for localized weak areas in order to complete remedial repair work before construction begins.

SURFACE PREPARATION METHODS
To ensure good performance of an asphalt pavement overlay, the existing pavement surface must be properly prepared. In general, uncorrected problems in the existing pavement surface will become problems in the asphalt pavement overlay. The type and extent of surface preparation should be carefully matched to the existing pavement condition and the asphalt pavement overlay type.
Localized Surface Preparation

Localized surface preparation includes patching of deteriorated pavement areas and treatment of existing cracks.

Patching is one of the most common methods of repairing localized areas with intensive cracking (Alligator cracking) as a result of excessive loading or other factors. Patching may be either partial or full-depth.

Partial depth patching involves removal of only the surface layer and replacement with asphalt pavement. Full depth patching involves complete pavement removal down to stable material.

Regardless of the patch depth, it is important to remove the entire existing deteriorated pavement. Some areas of deterioration may not be visible on the surface but will become exposed during the removal process. In these cases, it is important to extend the patch boundaries to include these previously unseen areas of deterioration. Large cracks should be cleaned and filled with an asphalt pavement patching mixture.

Asphalt Pavement Cold Milling

Cold milling is the process of removing a desired thickness of pavement with a specially designed milling machine. A milling machine has a revolving drum mounted with carbide bits. These bits strike the pavement surface and remove the material (concrete or asphalt) to a predetermined depth. Pavement can be removed to any desired thickness.

Milling provides a level, textured surface, which has good skid resistance and provides an excellent bond with an overlay. Most pavement distortions, such as rutting, bumps and shoving, can be removed through milling without harming the underlying material. Milling makes it possible to maintain the original pavement elevations and drainage patterns. By removing material at the surface, no adjustments are required in the elevation at manholes, curbs and gutters, storm sewer inlets and other connecting pavement surfaces.

CONCRETE PAVEMENT PREPARATION

Rehabilitation of existing pavements is the greatest pavement priority facing local, state and federal transportation agencies. Fracturing concrete pavement in place and then surfacing with asphalt pavement has been used successfully in Minnesota and nationally to provide a long-term and economical solution to the pavement rehabilitation problem and help reduce reflective cracking.
The objective of the Crack and Seat technique is to greatly reduce reflective cracking in the asphalt pavement surfacing by reducing the effective slab length of the concrete pavement and is applicable to jointed plain concrete pavements (JPCP). The objective of Break and Seat is essentially the same, however more fracture energy is required as this is used on jointed reinforced concrete pavements (JRCP). Rubblization is applicable to all concrete pavement types and reduces the concrete panel to fragments that provide a strong foundation and eliminate or significantly reduce reflective cracks. Since Crack and Seat and Rubblization are more common in Minnesota, they are discussed further below. More information is also available on the National Asphalt Pavement Association (NAPA) web site.

**Crack and Seat**

A concrete pavement that has good drainage and is still relatively sound can be salvaged through cracking and seating and then surfacing with an asphalt pavement. This option for rehabilitation is designed to reduce reflective cracking by decreasing the slab size of the concrete. Proper cracking and seating will greatly reduce reflective cracking. If reflective cracks should appear, they usually will be small, tight cracks that can be easily maintained.

With this method of rehabilitation, the concrete is cracked at 24- to 30-inch intervals with heavy drop hammer equipment to create a uniform pattern of cracking. Next, the cracked concrete pavement is seated with a rubber-tired roller of at least 35 tons. This seating action by the roller pushes down any pieces of concrete that might be over a void in the subbase. After the cracking and seating steps are completed, a 3-to 5-inch asphalt pavement surface is placed directly on the cracked and seated concrete. This method of recycling has been used for more than 30 years in many states; the first project in Minnesota using this technique was in 1959.

This method offers the following benefits:

1. Delays occurrence and reduces severity of reflective cracking.
2. Extends pavement service life.
3. Reduces maintenance costs.
4. Improves riding smoothness.
5. Is more cost-effective than removal and replacement.
6. Causes minimal disruption to traffic.

The procedural steps of the crack and seat process are:

1. Install necessary drainage.
2. Remove any existing overlay.
3. Saw cut the full thickness of the pavement adjacent to sections to remain in place.
4. Crack the concrete slabs.
5. Seat cracked slabs.
6. Remove and patch soft areas.
7. Sweep clean.
8. Place tack coat.
9. Place asphalt pavement.
Rubblization

The rubblization of concrete pavements before surfacing with an asphalt pavement means the complete destruction of the concrete slab and of all concrete slab action. With this technique the concrete-to-steel bond is broken on all reinforced concrete pavements. The rubblization process effectively reduces the existing slab to a stable and strong in-place crushed aggregate base.

The benefits of this method are:

1. Eliminates or significantly reduces reflective cracking.
2. Provides a sound base.
3. Extends pavement service life.
4. Reduces maintenance costs.
5. Improves riding smoothness.
6. Is more cost-effective than removal and replacement.
7. Can be constructed one lane at a time, eliminating the need to divert traffic.

The procedural steps in the rubblization process are:

1. Install necessary drainage.
2. Remove any existing overlay.
3. Saw cut the full thickness of the pavement adjacent to sections to remain in place.
4. Rubblize the concrete pavement.
5. Cut off any exposed steel reinforcement.
6. Remove any loose patching material, joint fillers, expansion material, or similar from the rubblized surface.
7. Compact the rubblized concrete pavement.
8. Place asphalt pavement.
Sawcut Joints

On PCC rehabilitation projects, sawing the asphalt pavement overlay over the underlying PCC joints will extend the overlay's service life. Unless special procedures, such as crack/break and seat or pulverization, are used to prepare the existing PCC pavement, the joints will eventually reflect through the asphalt overlay. These cracks can occur within a short time, depending on factors such as the thickness of the overlay, volume of traffic, and conditions of the environment. Reflective cracking is caused by the underlying joints moving because of temperature and moisture changes, warping of the slab, and loading conditions that result in tensile, shear, and flexural forces greater than the strength of the pavement. This results in a crack in the overlay above the underlying joint.

Primary candidates for sawing of overlays over joints in the underlying PCC pavements are those overlays that have not lost structural integrity at the joints. Examples are overlays that are intended to increase structural capacity, correct skid resistance, prevent further scaling, or reduce noise.

To be effective, the sawcut in the overlay should be directly over the underlying joint. A maximum tolerance of 1 inch is required.

Reference marks that will not be obliterated during the overlay operation must be established at the underlying joint. The underlying joint must also be thoroughly cleaned and filled before overlaying.

Benefits

Sawcut of the asphalt overlay is an effective technique to reduce the detrimental effect of uncontrolled reflective cracking over the underlying PCC joints. The sawcut and seal technique establishes a weakened plane joint in the overlay directly above the joint, and it can then be effectively sealed and maintained.

The technique of sawcut joints offers the following benefits:

1. Controls reflective cracking.
2. Provides maintainable joints.
3. Extends service life.
4. Controls maintenance costs.
5. Adjoining surface will be stronger than at the natural crack.
7. Smoother riding pavement.
The procedural steps in the process are:

1. Locate and reference existing joints in the underlying slab.
2. Thoroughly clean and fill joints.
3. Place overlay.
4. Sawcut directly over the referenced joint.

**RECYCLING ASPHALT PAVEMENTS**

As natural resources become more scarce and more costly to obtain, their rehabilitation and re-use becomes more important. Asphalt cement and aggregates used in asphalt pavement roadway construction constitute a sizable public investment. They represent two very important natural resources whose value as construction materials is recoverable. This ability to recycle has enormous implications not only for the conservation of valuable resources, but also for energy savings and total economic benefits.

Recycling asphalt pavements can be accomplished through removal and transport to another location for crushing and reprocessing, through cold milling the surface, or through conventional removal, with crushing, reprocessing, laydown, and rolling accomplished on the site.

Recycling involves reprocessing the salvaged materials, plus the addition of virgin asphalt and new aggregates. In a hot mix process, a special drum for mixing is used to comply with environmental requirements. The mixture produced is a fully recycled product containing 10-50 percent recycled asphalt pavement (RAP).

**Asphalt Pavement Recycling Advantages**

Recycling asphalt pavement offers the following benefits:

1. Cost savings.
2. Savings of aggregate and asphalt cement materials, which are non-renewable resources.
3. Structural improvements can be realized with little or no change in pavement thickness.
4. Surface and base distortion problems may be corrected.
5. Base preparation and shoulder work are reduced.
**FDR and SFDR**

Full depth reclamation (FDR) and stabilized full depth reclamation (SFDR) of an in-place asphalt pavement have been defined as a recycling method where all of the asphalt pavement section and a predetermined amount of underlying materials are reclaimed in-place to produce a stabilized base course. Different types of additives, such as asphalt emulsions and chemical agents such as calcium chloride, portland cement, fly ash and lime, can be added to obtain an improved base. The five main steps in this process are pulverization, introduction of additive, shaping of the mixed material, compaction, and application of a surface or a wearing course. If the in-place material is not sufficient to provide the desired depth of the treated base, new materials may be imported and included in the processing. This method of recycling is normally performed to a depth of 4 to 12 in.

**CIR**

Cold in-place recycling (CIR) grinds off the top 2 to 6 inches of old asphalt pavement, crushes and screens it to size, mixes it with an asphalt recycling agent and sometimes other additives, then paves it on the same roadway. Topped with an asphalt overlay, the CIR lift can remove deep cracks to form a rut resistant base at a cost-effective price. It has been used when defects in the old pavement do not run the full depth of the old pavement, yet are too deep to be corrected with mill-and-fill or hot-in-place recycling. It should not be used when pavements have structural, drainage or base deficiencies. Deep failures should be addressed individually.