A TRAINING GUIDE FOR
PAVEMENT MAINTENANCE PERSONNEL
in Indiana's Counties, Cities and Towns

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ACKNOWLEDGMENTS

Much of the material and pictures contained in these Guidelines came from the following publications:


1.1. Purpose of Guidelines

These Guidelines have been prepared as a reference for highway maintenance personnel responsible for patching pavements and are intended as a reference for the patching crew. The Guidelines are not intended to be a detailed reference describing the successes and failures of techniques and materials used by various agencies to construct pavement patches. The patching techniques and materials presented in these Guidelines are those which have been developed by research and successfully used by various agencies to patch highway pavements under various climatic or weather conditions.

1.2. Types of Common Pavement Problems

All pavements require maintenance, the main reason is that stresses producing minor defects are constantly working in all pavements. These stresses may be caused by change in temperature, or moisture content, by traffic, or by small movements in the underlying or adjacent earth. As a result, cracking, distortion, and disintegration occur in the pavement.

1.2.1. Cracking

Cracking can take place as alligator cracks, edge cracks, joint cracks, reflection cracks, or shrinkage cracks.

Figure 1.1: Alligator cracks are interconnected cracks forming a surface resembling an alligator skin.
Figure 1.2: Edge cracks are longitudinal cracks close to the edge of the pavement.

Figure 1.3: Joint cracks are longitudinal or transverse cracks formed due to separations between two paving lines or between two consecutive sections of the pavement.

Figure 1.4: Reflection cracks in the pavement reflect the crack pattern in the structure underneath.
1.2.2. **Shrinkage cracks** are interconnected cracks caused by volume changes in the asphalt mix or in the base or subgrade.

1.2.3. **Distortion** is any change in shape of the asphalt pavement. It can occur as channeling, shoving, corrugations, depressions, or upheaval.

![Figure 1.5. The distortion shown in this figure shows an unstable patch material which has flowed out of the patch requiring the dark replacement material to fill the void.](image)

![Figure 1.6. Depressions are localized low areas of limited size caused by heavy traffic settlement or due to poor construction methods.](image)
1.2.4. **Disintegration** is the breaking up of a pavement into small, loose fragments. It can occur as a pothole or raveling.

Figure 1.7: Potholes are bowl-shaped holes resulting from localized disintegration of the pavement.

Figure 1.8: Pothole formed in a pavement built over a rigid pavement.
1.2.5. **Combination of problems.** The distresses outlined above do not occur in an isolated manner, rather they are related to each other. They are produced by the same factors, or one distress creates the potential for the occurrence of another type of distress, e.g., cracking can develop potholes. This paper deals with potholes, their causes, and the methods for repairing them.

![Figure 1.9: Typical local street pothole.](image)

1.3. **Definitions**

Before proceeding further, let's review some definitions for terms used in the Guidelines.

1.3.1. **Coarse Aggregate** - Aggregate larger in size than the No. 8 (2.36 mm) sieve. Aggregates are further graded by an AASHTO size number with the lower number indicating the larger size. Exceptions are where two numbers are used (e.g. #89 being a blend of #8 and #9 aggregate).

1.3.2. **Fine Aggregate** - Aggregate smaller than the No. 8 (2.36 mm) sieve.

1.3.3. **Asphalt** - A dark brown to black cementing or bonding material which is a residual of petroleum refining.

1.3.4. **Asphalt Cement** - An asphalt refined to be used in highway and airport paving.

1.3.5. **Asphaltic Concrete (hot mixes)** - A hot mixture of asphalt cement and well-graded aggregate compacted to form a dense mass.

1.3.6. **Asphalt Emulsion** - A fluid mix of asphalt cement and water. A liquid asphalt. The abbreviation commonly used for these materials is "AE". AE-150 is a common asphalt emulsion.
1.3.7. Bonding Grout - A mixture of portland cement, fine aggregate, and water proportioned to give a thick paint-like consistency. Grout is applied to an existing portland cement concrete surface or edge to ensure bond between old material and new cement patch.

1.3.8. Cold Mix - A mixture of an aggregate and a liquid asphalt (cutback or emulsion or an asphaltic cement with a petroleum liquifier) placed at atmospheric temperature.

1.3.9. Cutback Asphalt - An asphalt cement made liquid by addition of a petroleum solvent (naptha, kerosene, or diesel oil). A liquid asphalt. The abbreviation for these materials is "RC" for rapid curing, "MC" for medium curing, and "SC" for slow curing. An MC-70 is sometimes used for spot patching.

1.3.10. Liquid Asphalts - An asphalt cement made liquid by the blending of petroleum solvent or water.

1.3.11. Overlay - One or more courses of hot mix or asphalt concrete placed over an existing pavement to increase its load carrying capacity.

1.3.12. Patching - Removal and replacement of a defect (or covering defect) to repair the deficiency and prevent further deterioration.

1.3.13. Rapid Set Concrete Patch - A concrete patch material which gains strength more rapidly than normal (Type I) portland cement concrete.

1.3.14. "Select" Cold Mix - A cold mix produced by either generic specification or by a proprietary process which has been developed specifically for cold weather pavement patching.

1.3.15. Surface Treatment - Applying asphalt materials to any type of base or pavement surface followed by a cover of aggregate that produces an increase in thickness of less than one inch.

1.3.16. Seal Coat - A thin asphalt surface treatment used to waterproof and improve the texture of an asphalt concrete's wearing surface. Seal coats may or may not be covered with aggregate, depending on purposes.

1.3.17. Tack Coat - A very light application of liquid asphalt applied to an existing surface or edge to ensure a bond between the existing material and the new material.
2.1. Occurrence of Potholes

Potholes are found principally on local roads and streets, rather than on highways where they are less numerous. One reason for this, is that on local roads and streets, underground utilities exist under the pavement. There are also pavement openings, and surface access castings for manholes that cause difficulties in the maintenance of the road. Another reason is that state highways receive regular and planned maintenance, while in the case of local roads, many times, maintenance is performed only when distresses reach a crisis state.

2.2. Conditions Causing Potholes

Potholes result when certain conditions of the pavement make it susceptible to disintegration. These conditions are the following:
1. Weakness in the pavement.
2. Weakness in the base and/or subbase.
3. Poor drainage combined with freezing and thawing.
4. Combination of the above causes.

2.3. Types of Failure

These conditions of the pavement result in the occurrence of potholes which are developed by two principal mechanisms: Fatigue failure and Raveling failure.

Figure 2.1: Pothole Formation Cycle
2.3.1. Fatigue Failure

Fatigue failure results from excessive flexing of the pavement when there is water in the base course and traffic loads are applied. Water from poor drainage or meltwater formed during spring thaw, weakens the soil under the pavement which flexes up and down under loads causing cracking and disintegration.

2.3.2. Raveling Failure

Failure due to raveling occurs when water washes away the adhesive asphalt film that holds the aggregate particles together and traffic action disintegrates the pavement. This occurs when water has a chance to penetrate into a pavement of low density or into a pavement with cracks or openings. The potential for development of potholes by raveling can be anticipated by finding locations that remain damp or wet-looking, when the rest of the pavement had dried out after a rainstorm.

2.3.3. Common Causes of Fatigue and Raveling Failure

The mechanisms fatigue failure and raveling failure produce potholes when conditions of the pavement are weak enough so that disintegration occurs.

2.4. Pavements Susceptible to Failure

2.4.1. Pavement Weakness

Weakness in the pavement caused by:

1. **Too little asphalt content.** With actual asphalt content less than that required for satisfactory performance.
2. **Too little or too much fine aggregates.** When the actual amount of fines used in the asphalt mix is different from that called for, in the mix design.
3. **Inadequate compaction.** When the compaction obtained during construction is lower than the minimum required.

2.4.2. Base/Subbase Weakness

Weakness of base and/or subbase caused by:

1. **Improper material.** When the material used in the construction of the base and/or subbase is inadequate. This results from presence of too many fines, or inappropriate particle size distribution.
2. **Improper compaction.** When compaction of base obtained during construction is not larger or equal to that assumed in the design. Inadequate compaction is produced when low energy is applied during compaction, or when the moisture content or the particle size distribution of the material are inappropriate.
2.4.3. Inadequate Drainage

Poor drainage. Poor drainage occurs in the asphalt pavement when the surface water is not drained away by curbs or ditches. Subsurface water, or seepage from the earth can also cause serious problems.

2.4.4. Simultaneous Conditions

Some of the conditions indicated before can occur simultaneously. For example, improper compaction of subbase with poor drainage, etc.
3.1. General Consequences

The presence of potholes in pavements make the driving conditions dangerous or uncomfortable, in addition to producing deterioration of vehicles. Potholes also permit the entrance of water into the pavement causing progressive and very rapid deterioration of the road.

Figure 3.1: Road conditions directly affect users' costs.

Figure 3.2: Waste of fuel and frequent repairs in cars are higher in pavements with potholes.
CHAPTER 4
GENERAL PRINCIPLES OF POTHOLE REPAIR

4.1. Two General Approaches

In the next section we will outline and discuss some specific guidelines for some specific problems. First, let's review some general principles that should apply to almost all "pothole" type pavement repair.

The problem of potholes can be solved in two manners:
1. by preventing them from occurring, or
2. by repairing or rehabilitating the pavement once potholes have occurred.

4.2. Prevention

Prevention is obtained by avoiding the occurrences of the conditions that make the pavement susceptible to pothole formation. During construction, the following precautions should be considered:

1. Provide a good asphalt mixture with the amount of materials in accordance with the mix design.
2. Provide proper thickness and compaction of the asphalt surface.
3. Build specified base, subbase, and subgrade with appropriate materials and compacted at the specified unit weight. Check particle size distribution and moisture content before compacting, and apply not less than the minimum energy of compaction.
4. Provide appropriate ditches or curbs, filters and drains for pavement section including subgrade. Build appropriate transverse slope to drain surface water.
5. Seal cracks and openings in the pavement. This can be obtained with what is called "Spot Patching" which consists of applying an asphalt material over the pavement and covering it with aggregate. The asphalt can be an MC-70, AE-90, or AE-150. The aggregate for covering can be an IDOH size #11 or smaller stone, or sand. This method, in addition to sealing the cracks in the pavements, makes the roadbed waterproof, and improves the texture of the asphalt wearing surface.
4.3. Repair

Repair is performed to bring the damaged pavement to serviceable conditions. Repair can be temporary (Emergency repair), or permanent.

4.3.1. Emergency Repair

Emergency repair is achieved by the following steps:

1. **Cleaning** out the repair area of loose material and water.
2. **Heating and softening** of asphalt surrounding the distressed area (if possible).
3. **Filling** the repair area with a "cold" patching mix at temperatures above freezing.
4. **Good compaction of material** -- (extremely important).

4.3.2. Permanent Repair

Permanent repair is obtained as follows:

1. Consider characteristics of the area to be repaired. If poor drainage or weak subgrade is the cause, try to improve drainage.
2. **Removing of loose material and cutting.** Remove the surface and base of the pavement to obtain firm support. Make a rectangular cut with faces vertical and straight, extending some distance into the good pavement outside the damaged area.
3. **Cleaning.** Cleaning all the cut as well as possible. Use a blow pipe if available.
4. **Tacking.** Apply a tack coat to the vertical faces of cut. Rapid curing asphalt material is commonly used, and should be applied with a good sprayer. The purpose is to ensure adhesion of the patch to the existing pavement. (Some organizations find that tacking is not necessary with the materials and methods they use.)
5. **Filling.** Fill the hole with asphalt mix.
6. **Compaction.** Compact the material properly. If repair area is more than 4 inches deep, compaction in layers is more appropriate. Compaction should be performed with the more suitable equipment available for the size of the job. Hand tamping can be effective if a heavy tamper with a small contact area is used. It should leave an imprint in the compacted patch material. Thinner layers are desirable when hand patching or lighter weight mechanical compactors are used. A vibratory plate is usually recommended for small patches while a roller is usually required for larger jobs.

**COMPACTION IS ESSENTIAL**
CHAPTER 5
SPECIFIC PAVEMENT FAILURES AND PATCHING GUIDELINES

5.1. Introduction

Highway pavements are exposed to a variety of traffic and thermal loading conditions (stresses due to temperature changes). After time or repeated applications, these loadings produce distress (cracking, ruts, distortion, etc.) in the pavement. Further progression of the distress often results in a pavement failure, requiring repair with a patch to return the pavement to an acceptable, safe condition.

Specific types of pavement distresses which usually require patching are identified in this chapter. Causes of the distress are listed along with the type of patch needed. Each patch type is followed by reference to guidelines for installing that type of patch and these guidelines are presented in the next chapter.
5.2. Asphalt Pavement Distress

5.2.1. Potholes

Description: Potholes are bowl shaped voids or depressions in the pavement surface.

Cause: Potholes are localized failure areas which are usually caused by weak base or subgrade layers due to poor drainage, or too thin an asphalt surface.

Repair: Potholes are a severe pavement distress which should be repaired as soon as possible. Permanent repairs can be made during cold, wet weather as well as during the warmer weather.

For success, good procedures must be followed. The "emergency" practice of simply filling a wet pothole with patch material and leaving it is a waste of time, effort and money.

Cold Weather
1. Routine patch with cold mix. (Section 6.21.1)**, or
2. Emergency patch with select cold mix. (Section 6.2.2).

Warm Weather
1. Routine patch with hot mix. (Section 6.2.3).

**Routine patching is the preferred technique. However, during adverse cold weather (temp. 40°F), it may not be feasible to use routine procedures. Emergency patches should be used only if it is not practical to utilize the routine procedures.
5.2.2. Failed Patch

Description: Patching is the replacement of original pavement area with either bituminous or concrete material. Deteriorated patches may exhibit disintegration, distortion, cracking, spalling or delamination between the patch and the original surface.

Cause: Patch failure is usually a result of poor installation techniques, inferior materials, or failure of the surrounding or underlying pavement.

Repair: Failed patches are a severe pavement distress if potholes have started to form in the patch and therefore should be repaired immediately. Otherwise failed patch repair can usually be delayed until warm weather conditions.

Cold Weather
1. Routine patch with cold mix. (Section 6.2.1), or
2. Emergency patch with select cold mix. (Section 6.2.2).

Warm Weather
1. Routine patch with hot mix. (Section 6.2.3).

Figure 5.2: Failed Patch
5.2.3. Alligator Cracking

Description: Alligator cracks are numerous, short length interconnecting cracks forming small blocks which resemble the skin of an alligator or a chicken wire pattern.

Cause: Alligator cracks result from excessive deflection of the asphalt concrete layer. The common cause of this failure is a spongy subgrade or unstable base material resulting from saturation of the base or subgrade. It often occurs in isolated locations where subgrades or bases become unstable or where traffic is concentrated such as entrances in large parking lots.

Repair: Areas of alligator cracking will deteriorate rapidly under traffic into other types of deficiencies such as potholes. Areas of alligator cracking should be repaired during warm weather. Severity is such that immediate repair is not necessary. However, repairs should not be deferred too long, since further damage may result.

Warm Weather
1. Routine patch with hot mix (Section 6.2.3) including removal and replacement of unstable base or subgrade as necessary.

Figure 5.3: Alligator Cracking
5.2.4. Edge Cracking

Description: Edge cracks are longitudinal or crescent shaped cracks usually within 1 foot of the outer pavement edge.

Cause: Edge cracks are caused by insufficient support of the pavement edge. They can result from lateral movement of an unstable shoulder or vertical movement in the subgrade due to poor drainage, shrinkage, or subgrade settlement.

Repair: Edge cracked areas will deteriorate under traffic into other types of deficiencies such as potholes. Repair of edge cracked areas should be scheduled as routine warm weather pavement maintenance.

Warm Weather
1. Routine patch with hot mix. (Section 6.2.3)
5.2.5. Rutting

Description: Ruts are vertical depressions in the pavement surface along the wheel tracks. In severe cases, pavement uplift may occur along the sides of the rut, but in most instances only a depression is noticeable.

Cause: Rutting is caused by consolidation or lateral movement of any or all pavement layers, including subgrade, under traffic. This permanent deformation of the pavement creates hazardous wet weather driving conditions and can eventually result in major structural failure of the pavement.

Repair: Severe wheeltrack ruts (depth in excess of 1-1/2") should be repaired during warm weather with surface patches.

Warm Weather
1. Surface patch with hot mix. (Section 6.2.4).

Figure 5.5: Rutting
5.2.6. Bleeding

Description: Bleeding or flushing is the presence of free asphalt cement binder on the pavement surface.

Cause: Bleeding is caused by excess amount of bituminous binder in the mixture and/or low air void content. Bleeding is most common in surface treatments where excess tack coat was used or cover aggregate has been abraded away by traffic.

Repair: Bleeding is a serious distress, if widespread, because of its adverse affect upon skid resistance. Areas of widespread bleeding. Isolated areas of bleeding can also be corrected with a surface treatment patch or placement of sand or other absorptive aggregate over the areas of bleeding.

Warm Weather
1. Surface Treatment patch. (Section 6.2.5).

Figure 5.7: Bleeding
5.2.8. Raveling

Description: Disintegration of the pavement from the surface downward through the loss of aggregate particles.

Cause: Raveling may occur as a result of asphalt binder aging, poor mixture quality, segregation, or insufficient compaction. Stripping of the aggregate from the asphalt cement in a moist environment by traffic can also cause raveling.

Repair: Raveled areas should be repaired with surface treatment patches.

Warm Weather
1. Surface treatment patch. (Section 6.2.5).

Figure 5.8: Raveling

5.2.9. Settlement

Description: Settlement is a dip or depression in the longitudinal profile of the pavement surface. Settlement should not be confused with wheeltrack rutting or potholes, which are also a depression of the roadway profile.

Cause: Settlement is usually caused by consolidation of underlying subgrade or embankment materials.

Repair: Severe settlement areas (depth in excess of 4") should be repaired during warm weather with surface patches.

Warm Weather
1. Surface patch with hot mix. (Section 6.2.4).
CHAPTER 6
SUGGESTED PATCH GUIDELINES

6.1. Introduction

It is evident that different patch repair materials are required during cold weather conditions (temperature less than 50°F, 10°C) from those of warm weather. Also adverse cold weather conditions such as rain, snow, or freezing conditions (temperature less than 32°F, 0°C) are not conducive to efficient, effective patch installation. Those patches which cannot be delayed till more favorable conditions occur, should be repaired using the emergency patch procedures.

6.2. Five Patch Repair Techniques

Five (5) bituminous patch repair techniques are present for the following environmental conditions:

6.2.1. Cold Weather (Temperature less than 50°F, 10°C)

1. (6.2.1) Routine patch with cold mix.
2. (6.2.2) Emergency or temporary patch with select cold mix. (temperature less than 32°F, 0°C with rain or snow).

6.2.2. Warm Weather (Temperature greater than 50°F, 0°C)

3. (6.2.3) Routine patch with hot mix.
4. (6.2.4) Surface patch with hot mix.
5. (6.2.5) Bituminous surface treatment patch.

6.3. Detailed Patch Repair Methods

The following paragraphs present the recommended patch repair methods in detail. The repair techniques are cross referenced to the distress types previously presented in Chapter 5. Some rough guidelines on equipment, suggested production rates man-hours and support are presented. Availability of manpower and equipment will limit some agencies' ability to implement some of the recommended repair methods. It is hoped that these agencies will attempt to utilize the recommended methods wherever possible, even on a limited basis.

State-of-art review has shown that permanent pavement patches can be constructed during both cold and warm weather on a routine basis using the techniques presented in paragraphs 6.2.1, 6.2.3 and 6.2.4 if, all steps in the repair methods are followed and carefully implemented.
6.4. Repair Methods

6.4.1. Routine Patch with Cold Mix

Where Applicable: Potholes (5.2.1)  
Failed Patch (5.2.2)

Daily Production: 6-8 tons/day

Additional Support: Safety equipment  
Asphalt Mix heater (optional)

Man-Hours per Unit: 5-6.0 Man-Hours/ton

Equipment Required: Truck  
Compaction Equipment  
Pavement Cutting Equipment  
Small tools including shovels, rakes, brooms, and tamps.

Repair Procedure

Step 1. Set up sign and other safety control devices.

Step 2. Reshape hole by cutting into square or rectangular shape, and cut side faces vertically. Reshape downward to solid material and around hole to sound pavement. Cutting and removal should proceed from the failure outward to good pavement to ease cutting and removal effort.

Step 3. Remove all loose material and thoroughly sweep the hole area clean of mud and standing water.

Step 4. Fill hole and compact in lifts no more than 3" thick. Final uncompacted lift should be 1/2" to 1" above adjoining pavement so that after compaction the patch is level with the original pavement. Each lift should be thoroughly compacted with a plate compactor or roller. Experience has shown that 15 to 20 passes with a vibratory roller is necessary to insure good compaction. Hand tamp should be used only for small holes (less than 1 square foot) or when heavier compaction equipment is not available.

Step 5. Clean up area. Do not leave excess fill or removal material on the pavement. Remove safety signs.

NOTE: If available, a portable storage unit capable of heating the cold mix to 160°F should be used. Heating cold mix will ease needed compaction efforts to achieve maximum mix density.
STEP 1 - SET UP SAFETY CONTROL

STEP 2 - RESHAPE MECHANICALLY AND CUT HOLE

STEP 3 - REMOVE MATERIAL AND SWEEP CLEAN

STEP 4 - FILL AND MECHANICALLY COMPACT

STEP 5 - CLEAN UP

Figure 6.1: Routine patch with cold mix summary (Section 6.2.1)
Figure 6.2: Step 2. Shape Hole

Figure 6.3: Step 2. Shape Hole
Figure 6.4: Step 3. Remove Material

Figure 6.5: Step 3. Sweep Clean
6.4.2. Emergency Patch with Cold Mix

Where Applicable: Potholes (5.2.1) Failed Patch (5.2.2)

Daily Production: 7-10 tons/day

Man-House per Unit: 2.5-3.4 Man-Hours/ton

Equipment Required: Dump truck
Small tools including shovels, rakes, brooms and tamps.

Repair Procedure

Step 1. Set up signs and other safety control devices.
Step 2. Broom sweep away loose material and standing water.
Step 3. Fill hole and compact with hand tamp or repeated passes of wheel of truck.
Step 4. Clean up area. Do not leave excess fill or removal material on the pavement. Remove safety signs.

NOTE: This procedure will likely yield a short-term patch repair. It is preferable to use the routine procedure (6.2.1) unless weather conditions are adverse.
STEP 1 - SET UP SAFETY CONTROL

STEP 2 - BROOM SWEEP LOOSE MATERIAL AND WATER

STEP 3 - FILL AND MANUALLY COMPACT

STEP 4 - CLEAN UP

Figure 6.7: Emergency patch with cold mix summary (Section 6.2.2)
Figure 6.8: Emergency patch with cold mix

6.4.3. Routine Patch with Hot Mix

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<tr>
<th>Where Applicable:</th>
<th>Potholes (5.2.1)</th>
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<td></td>
<td>Failed Patches (5.2.2)</td>
</tr>
<tr>
<td></td>
<td>Alligator Cracking (5.2.3)</td>
</tr>
<tr>
<td></td>
<td>Edge Cracking (5.2.4)</td>
</tr>
<tr>
<td>Daily Production:</td>
<td>8-10 tons/day</td>
</tr>
<tr>
<td>Additional Support:</td>
<td>Safety equipment</td>
</tr>
<tr>
<td></td>
<td>Front end loader or backhoe (may be helpful)</td>
</tr>
<tr>
<td></td>
<td>Motor Grader and operator (may be helpful)</td>
</tr>
<tr>
<td>Man-Hours per Unit:</td>
<td>4-5 Man-Hours/ton</td>
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<tr>
<td>Equipment Required:</td>
<td>Dump truck</td>
</tr>
<tr>
<td></td>
<td>Compaction equipment</td>
</tr>
<tr>
<td></td>
<td>Pavement cutting equipment</td>
</tr>
<tr>
<td></td>
<td>Asphalt Kettle</td>
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<td></td>
<td>Small tools including shovels, rakes, brooms and tamps.</td>
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</table>
Repair Procedure:

Step 1. Set up signs and other safety control devices.

Step 2. Reshape hole or patch area by cutting into square or rectangular shape and cut side faces vertically. Reshape downward to solid material and around hole to sound pavement. Cutting and removal should proceed from the failed area outward to good pavement to ease cutting and removal effort. (See notes 1 and 2).

Step 3. Remove all loose material and thoroughly sweep the hole area clean of mud and standing water.

Step 4. Apply liquid asphalt tack to vertical faces and bottom of hole in a uniform manner. Do not puddle tack coat on bottom of hole. Clean No. 8 size aggregate should be placed in the bottom of the hole to absorb extra tack coat, if necessary.

Step 5. Fill hole and compact in lifts no more than 2" or 3" thick. Final uncompacted lift should be 1/2" to 1" above adjoining pavement so that after compaction the patch is level with the original pavement. Each lift should be thoroughly compacted with a plate compactor or roller. Experience has shown that 15 to 20 passes with a vibratory roller and mix temperature above 250°F (121°C) are necessary to ensure good compaction. Hand tamp should only be used for small areas (less than 1 square foot).

Step 6. Clean up area. Do not leave excess fill or excavated material on the pavement. Remove safety signs.

NOTE 1: For large areas of full depth patching, mechanical equipment should be used for removing broken pavement and spreading hot mix. Large patch areas are those requiring in excess of 1000 lbs. of patching material per 100 feet of 2-lane road. Production rate should be increased to 25-30 tons per day for mechanical removal and placement.

NOTE 2: Where unstable base or subgrade is encountered during pavement removal, the unstable material should also be removed and replaced. New aggregate base or additional patching material should be used to make the thicker repair.
Figure 6.9: Step 2. Sweep Clean

Figure 6.10: Step 3. Fill and Compact
STEP 1 - SET UP SAFETY CONTROL

STEP 2 - MECHANICALLY RESHAPE AND COMPACT HOLE

STEP 3 - REMOVE MATERIAL AND SWEEP CLEAN

STEP 4 - APPLY TACK COAT

STEP 5 - FILL AND MECHANICALLY COMPACT

STEP 6 - CLEAN UP

Figure 6.11: Routine patch with hot mix summary (Section 6.2.3)
Figure 6.12: Step 3. Remove material

Figure 6.13: Step 4. Apply tack coat
Figure 6.14: Step 5. Fill, spread and compact
Figure 6.15: Interior patch

Vertical cut edge of area to be patched

PLAN

Sound & Stable Mat'l.

Tack Coat
(Hot Mix Only)

Bituminous Plant Mix
(3" Max. Lifts)

Base
Figure 6.16: Edge patch

Bituminous Plant Mix (3" Max. Lifts)
Tack Coat
(Hot Mix Only)

Use Bit. Plant Mix when existing shoulders are high type paved. Use mat'l. excavated for pothole patch and seal surface when existing shoulders are a lower type.
6.4.4. Surface Patch with Hot Mix

Where Applicable:
- Rutting (5.2.5)
- Settlement (5.2.6)

Daily Production: 10-14 tons/day

Additional Support: Safety equipment

Man-Hours per Unit: 2.8-4.0 Man-Hours/ton

Equipment Required:
- Dump truck
- Compaction equipment
- Pavement breaking & cutting equipment
- Asphaltic Kettle
- Small tools including shovels, rakes, brooms and tamps.
- 6' Straightedge

Repair Procedure:

Step 1. Set up signs and other safety control devices.

Step 2. Establish patch limits by stretching masonline over depression and marking a line for paving notch around parameters of depression.

Step 3. Cut paving notch (minimum 1" deep by 4" wide) with mechanical pavement breaker/cutting equipment.

Step 4. Remove all loose material from paving notch, and sweep clean the notch and entire patch area.

Step 5. Apply liquid asphalt tack to notch and settlement area. Do not puddle tack coat.

Step 6. Fill settlement area and compact in depths no more than 3" thick. Final compacted depth should be 1/2" to 1" above surrounding pavement so that after compaction the patch is level with the original pavement. Each depth should be thoroughly compacted with plate compactor or roller. Experience has shown that 15 to 20 passes with a vibratory roller is necessary to insure good compaction. Check patch with straightedge for proper slope and eveness with surrounding pavement.

Step 7. Clean up area. Do not leave excess fill or excavated material on the pavement. Remove safety signs.
STEP 1 - SET UP SAFETY CONTROL

STEP 2 - MARK LIMITS OF SETTLEMENT AREA

STEP 3 - CUT PAVING NOTCH

STEP 4 - REMOVE NOTCH MATERIAL AND SWEEP CLEAN

STEP 5 - APPLY TACK COAT

STEP 6 - FILL AND MECHANICALLY COMPACT

STEP 7 - CLEAN UP

Figure 6.17: Surface patch with hot mix summary (Section 6.2.4)
Figure 6.18: Step 3. Cut paving notch

Figure 6.19: Step 5. Apply tack coat
Figure 6.20: Step 6. Fill and compact
6.4.5. Bituminous Surface Treatment Patch

Where Applicable:  
Bleeding (5.2.7)  
Raveling (5.2.8)

Daily Production:  
12-15 tons of aggregate/day

Additional Support:  
Safety equipment

Man-Hours per Unit:  
2.1-2.7 Man-Hours/ton

Material Required:  
Liquid asphalt  
Coarse aggregate (No. 8 size)

Equipment Required:  
Dump truck  
Pneumatic tired roller (towed by dump truck)  
Asphalt Kettle  
Small tools including shovels, rakes, brooms

Repair Procedure:

Step 1. Set up signs and other safety control devices.

Step 2. Sweep surface free of loose dirt and aggregate.

Step 3. Apply liquid asphalt on surface at least 6" beyond distressed area. Application rate should be .05 to .1 gal./square yard for areas of bleeding, and .15 to .25 gal./square yard for repair of ravelled areas.

Step 4. Immediately spread aggregate on asphalt. Use tail gate spreader box for large areas, and shovels for small areas.

Step 5. Roll aggregate with pneumatic-tired roller. Roller tire pressures should be about 100 psi. with rolling continued until aggregate is well seated in the liquid asphalt.

Step 6. If patch surface is still below that of good pavement, repeat steps 3 through 5 to apply second aggregate layer.

Step 7. Clean up area. Do not leave excess material on the pavement. Remove safety signs.
STEP 1 - SET UP SAFETY CONTROL

STEP 2 - SWEEP SURFACE CLEAN

STEP 3 - APPLY LIQUID ASPHALT

STEP 4 - SPREAD AGGREGATE

STEP 5 - ROLL AGGREGATE

STEP 6 - REPEAT STEPS 3 THROUGH 5 IF NEEDED

STEP 7 - CLEAN UP AREA

Figure 6.21: Surface treatment patch summary (Section 6.2.5)
Figure 6.22: Step 3. Apply liquid asphalt

Figure 6.23: Step 4. Spread aggregate

Figure 6.24: Step 5. Roll aggregate