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PAVEMENT PATCHING GUIDELINES

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Development, and Technology
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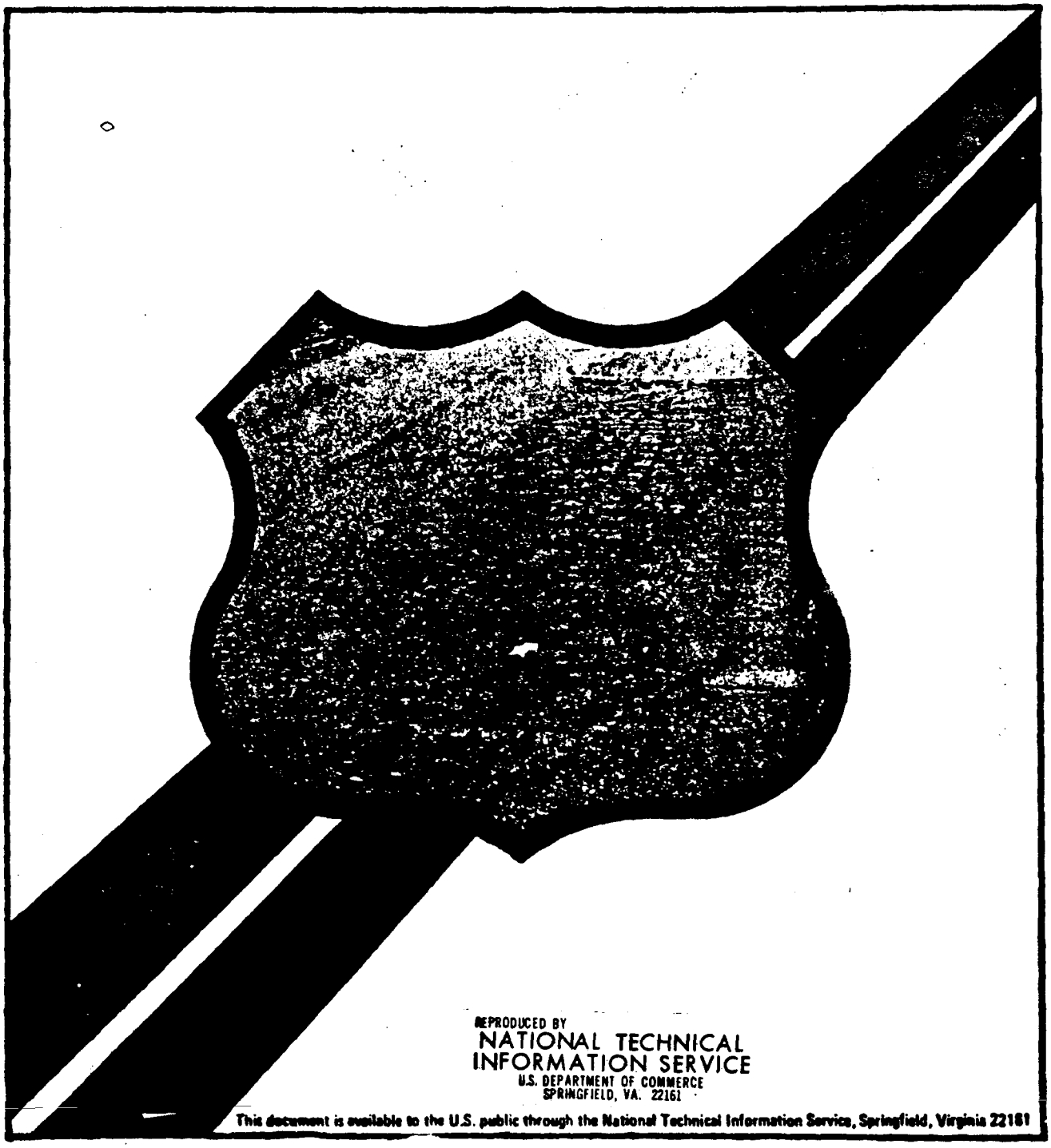
Administration**



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FOREWORD

This report provides pavement patching guidelines for both hot mix and cold mix materials. The report identifies techniques which will result in a permanent patch for hot and cold mixes and for a temporary emergency patch using a cold mix. The guidelines should be of interest to maintenance supervisors and foremen and to city and county engineers.

Research to identify, evaluate and promote new methods, materials and equipment for maintenance of highways is included in the Federally Coordinated Program of Highway Research and Development in Project 7A, "Improved Highway Maintenance Practices." Mr. Byron Lord is the Research Project Manager and Mr. Ernest Blais is the Implementation Manager.

A limited number of additional copies may be obtained from the Engineering and Highway Operations Implementation Division.

RJ Betsold

R. J. Betsold
Director, Office of Implementation

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16. Abstract

This report presents guidelines for pavement patching. "How to-do-it" recommendations are presented for constructing patches during cold weather (emergency basis), cold weather (routine basis), and warm weather (routine basis). Patching of flexible, rigid, and composite pavements is addressed. Recommended patching techniques include use of bituminous and portland cement patching materials. Pavement distress and causes are indexed to the recommended repair procedures.

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CHAPTER 1
INTRODUCTION

1.1 PURPOSE

These Guidelines have been prepared as a reference for highway maintenance personnel responsible for patching pavements. The Guidelines are intended as a reference to the patching crew foreman and roadway maintenance engineer. 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 SCOPE

The scope of these Guidelines includes patching of both flexible (asphalt concrete) and rigid (portland cement concrete) pavements. "How-to-do-it" recommendations are presented for constructing patches during the following conditions:

A. Cold Weather - emergency basis

B. Cold Weather - routine basis

C. Warm Weather - routine basis

For each condition suggested repair steps, material type and specifications, and maintenance performance standards are presented. Suggested generic specifications are presented in the Appendix of the Guidelines. Other chapters address examples and causes of pavement distress which require pavement patching, and managing pavement patching programs. Additional information concerning proprietary materials, State Specifications, and costs etc. may be obtained by writing to the Office of Implementation (HRT-10), 400 7th St. SW, Washington, D.C. 20590.

1.3 DEFINITIONS

The following definitions are presented for terms used in the Guidelines.

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).

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

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

Asphalt Cement - An ashpalt refined to be used in highway and airport paving.

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

Asphalt Emulsion - A fluid mix of asphalt cement and water. A liquid asphalt.

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.

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

Cutback Asphalt - An asphalt cement made liquid by addition of a petroleum solvent (naptha, kerosene, or diesel oil). A liquid asphalt.

1.3 DEFINITIONS continued

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

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

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

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

"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. (Appendix A contains data on generic cold mixes which have generally performed satisfactorily.)

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.

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.

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

CHAPTER 2
PAVEMENT FAILURES WHICH REQUIRE PATCHING

2.1 INTRODUCTION

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

Pavement distresses which usually require patching are identified in this chapter. Causes of the distress are listed along with the type of patch needed. The patch type is cross-referenced to those presented in Chapter 3. Pavements which have a high frequency of widespread distress need major repair such as an overlay or reconstruction.

2.2 ASPHALT PAVEMENT DISTRESS

2.2.1 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.

Cold weather

1. Routine patch with cold mix. (Paragraph 3.2.1)**, or
2. Emergency patch with select cold mix. (Paragraph 3.2.2)

Warm weather

1. Routine patch with hot mix. (Paragraph 3.2.3)

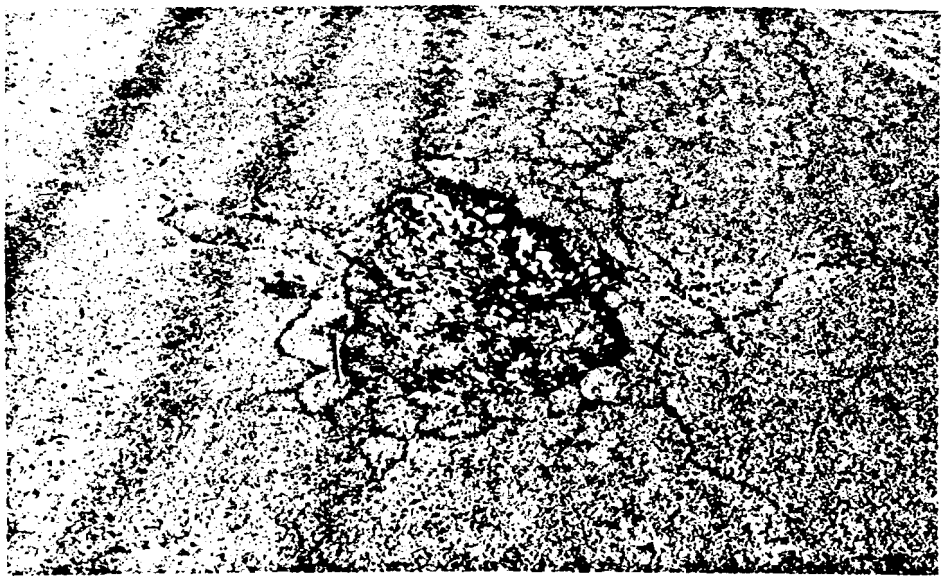


FIGURE 2.1 POTHOLES

**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.

2.2.2 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. (Paragraph 3.2.1), or
2. Emergency patch with select cold mix. (Paragraph 3.2.2)

Warm weather

1. Routine patch with hot mix. (Paragraph 3.2.3)

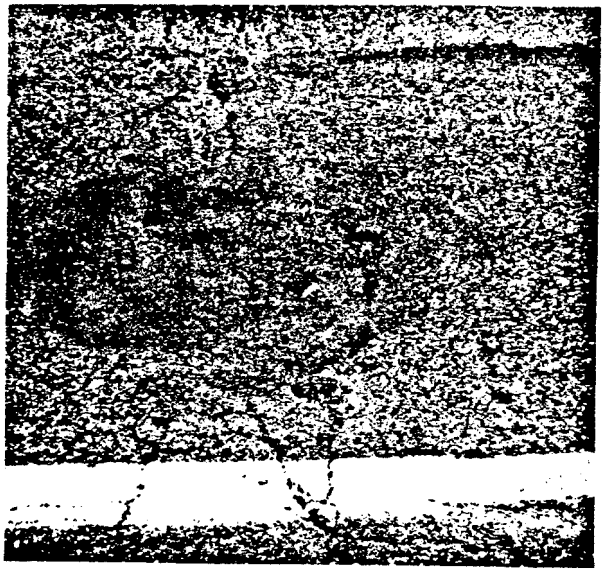


FIGURE 2.2 FAILED PATCH

2.2.3 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 (Paragraph 3.2.3) including removal and replacement of unstable base or subgrade as necessary.

FIGURE 2.3 ALLIGATOR CRACKING

2.2.4 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. (Paragraph 3 2.3)

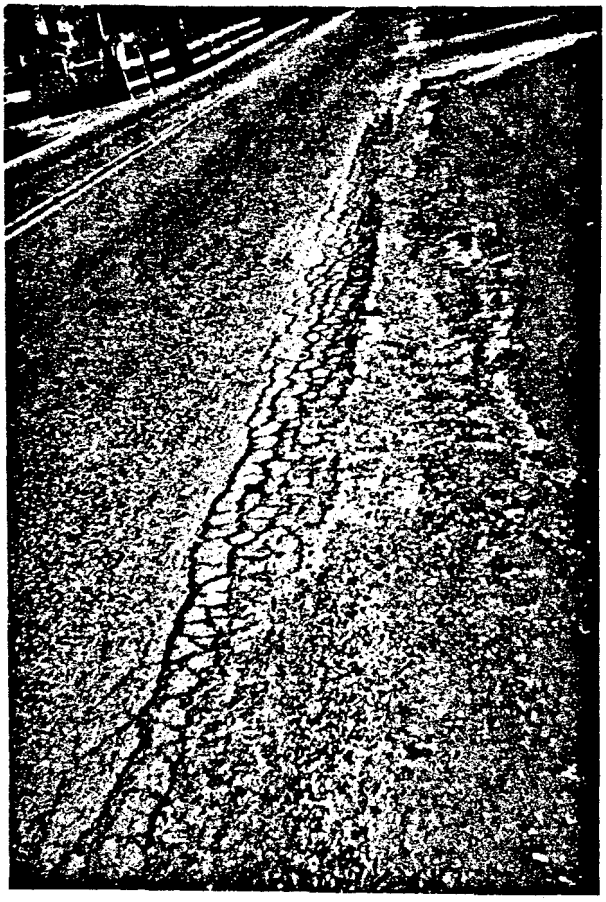


FIGURE 2.4 EDGE CRACKING

2.2.5 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. (Paragraph 3.2.5)

FIGURE 2.5 RUTTING

2.2.6 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,(Paragraph 3.2.5)

2.2.7 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 should be overlayed or have a surface treatment applied. Hot mix recycling may also be a viable option for 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, (Paragraph 3.2.6)

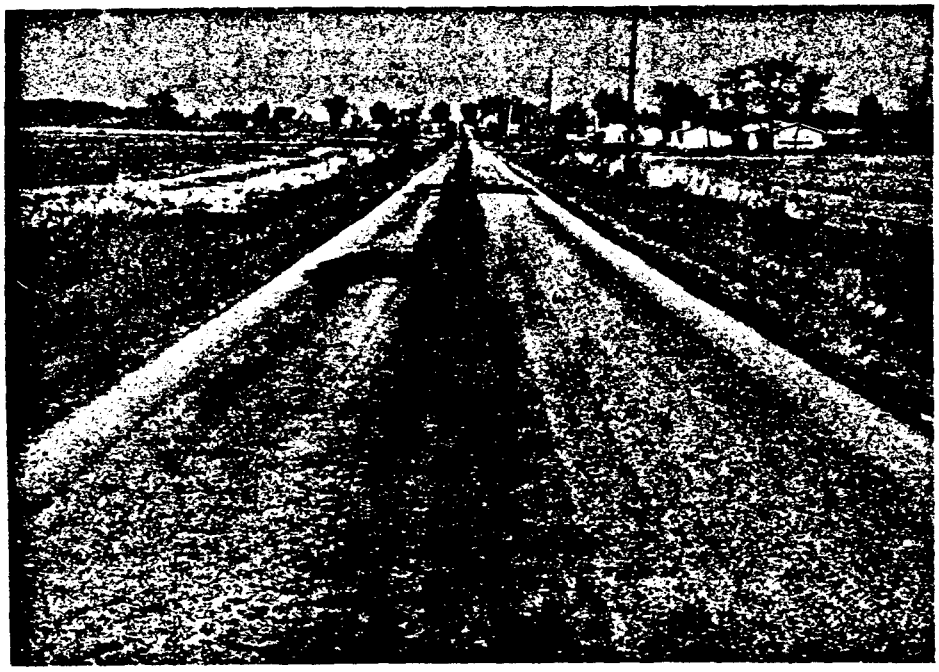


FIGURE 2.7 BLEEDING

2.2.8 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.(Paragraph 3.2.6)

FIGURE 2.8 RAVELING

2.3 COMPOSITE PAVEMENT DISTRESSES*

*Composite pavements have rigid bases (concrete or brick) and asphaltic surfaces.

Refer to Paragraph 2.2 for description, cause and patch repair of the following distress types:

Potholes

Failed Patch

Rutting

Settlement

Bleeding

Raveling

2.3.1 SURFACE DISINTEGRATION OR DEBONDING

Description: Loss of surface by debonding is the removal of the asphaltic surface layer from the underlying rigid layer. The problem is most common with thin asphalt surface layers (less than 2 inches).

Cause: Debonded areas are a type of pothole caused by freeze-thaw action or poor bonding of two pavement layers during construction.

Repair: Debonded areas are a severe pavement distress which should be repaired as soon as possible.

Cold weather

1. Routine patch with cold mix. (Paragraph 3.2.1), or
2. Emergency patch with select cold mix. (Paragraph 3.2.2)

Warm weather

1. Routine patch with hot mix. (Paragraph 3.2.3)

FIGURE 2.9 DEBONDING

2.3.2 SHATTERED SLAB

Description: Shattered slab is break up of the underlying rigid base made evident by surface reflection cracking and/or distortion. Reflection cracks in the asphaltic layer forming small rectangular areas may indicate that the underlying slab is broken up. Progressive deterioration will include distortion and pothole of the shattered area.

Cause: This distress is caused by poor base support, fatigue of concrete layer, or break up of the concrete due to D-cracking. (See description for joint spalling distress, Paragraph 2.4.2)

Repair: Shattered slab areas are severe distress if potholes or significant distortion has occurred and therefore should be repaired immediately. Otherwise shattered slab repair can be delayed until warm weather conditions.

Warm weather

1. Routine patch with hot mix. (Paragraph 3.2.3)

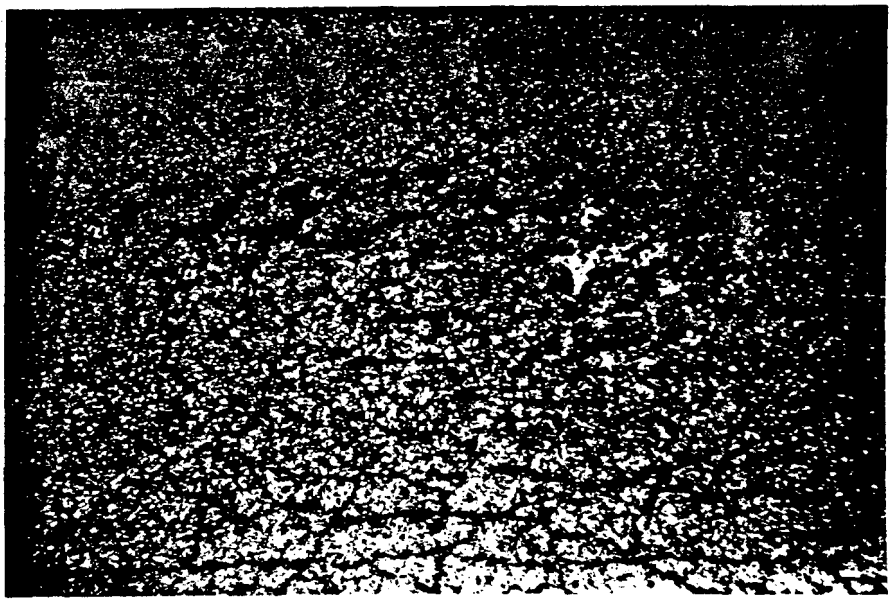


FIGURE 2.10 SHATTERED SLAB

2.4 CONCRETE PAVEMENT DISTRESSES

2.4.1 SURFACE POTHOLES

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

Cause: Potholes in concrete pavement are generally partial depth (1-3") and usually result from delamination or pop off of the concrete over rusted embedded steel.

Repair: Potholes in concrete pavement are usually small (less than the tire print area of about 6" diameter) and therefore repair can be delayed until warm weather. Large potholes should be repaired immediately.

Cold weather

1. Routine patch with cold mix. (Paragraph 3.2.1), or
2. Emergency patch with select cold mix. (Paragraph 3.2.2)

Warm weather

1. Routine patch with rapid set concrete. (Paragraph 3.2.4), or
2. Routine patch with hot mix. (Paragraph 3.2.3)

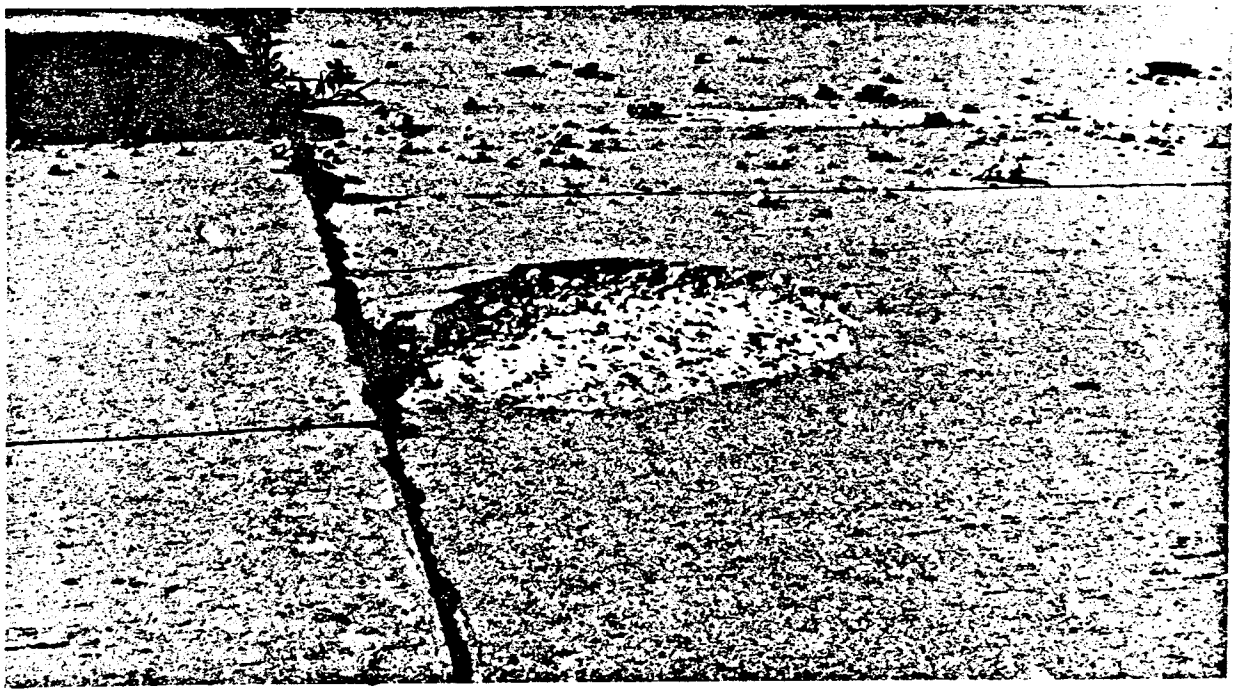


FIGURE 2.11 SURFACE POTHOLES

2.4.2 JOINT SPALLS

Description: Joint spalling is the break up or disintegration of the concrete at longitudinal or transverse pavement joints. A spall normally does not extend vertically through the slab but rather intersects the joint at an angle. Often joint spalling is the result of durability ("D") cracking of the pavement. Durability ("D") cracking is a series of fine crescent shaped cracks in the concrete surface which usually parallel a joint or major crack and curve across slab corners. Cracking pattern is normally concave in relation to slab corners or joints. Concrete may become saturated and eventually a dark-colored deposit may be visible near the hairline cracking. D-cracking can eventually lead to disintegration and spalling of the concrete near the joints or corners of the slab.

Causes: Joint spalling is usually the result of poor joint sealing which permitted incompressible material to enter the joint. Thermal slab expansion then crushes the concrete at the joint. D-crack spalling is the result of coarse aggregate fracture due to poor freeze-thaw durability of the aggregate.

Repair: Joint spalls in concrete pavement are usually small, except those which are D-crack initiated, and thus repair usually can be delayed until warm weather. Large spalls should be repaired immediately.

Cold weather

1. Routine patch with cold mix. (Paragraph 3.2.1), or
2. Emergency patch with select cold mix. (Paragraph 3.2.2)

Warm weather

1. Routine patch with rapid set concrete. (Paragraph 3.2.4), or
2. Routine patch with hot mix. (Paragraph 3.2.3)

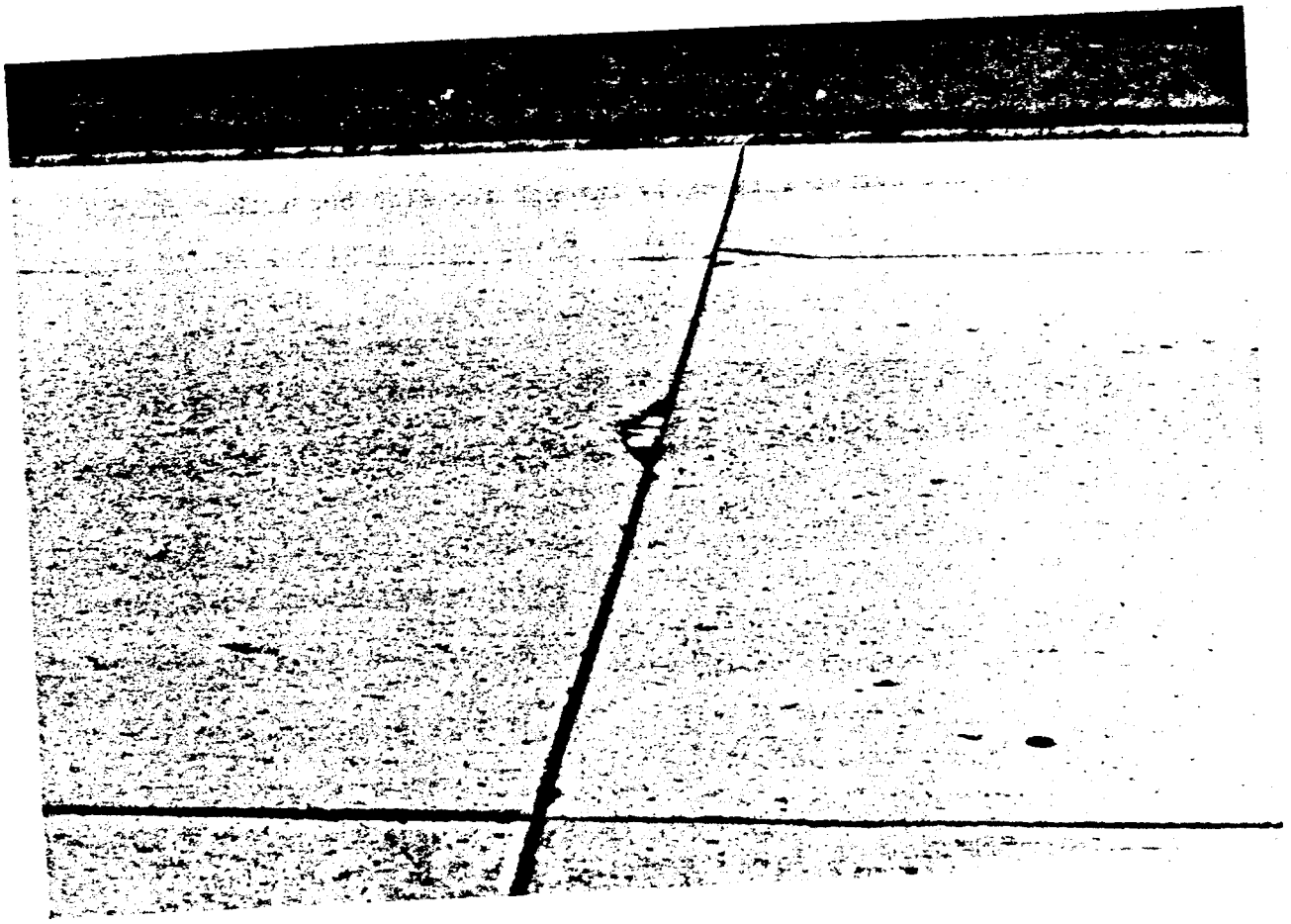


FIGURE 2.12.1 JOINT SPALLING

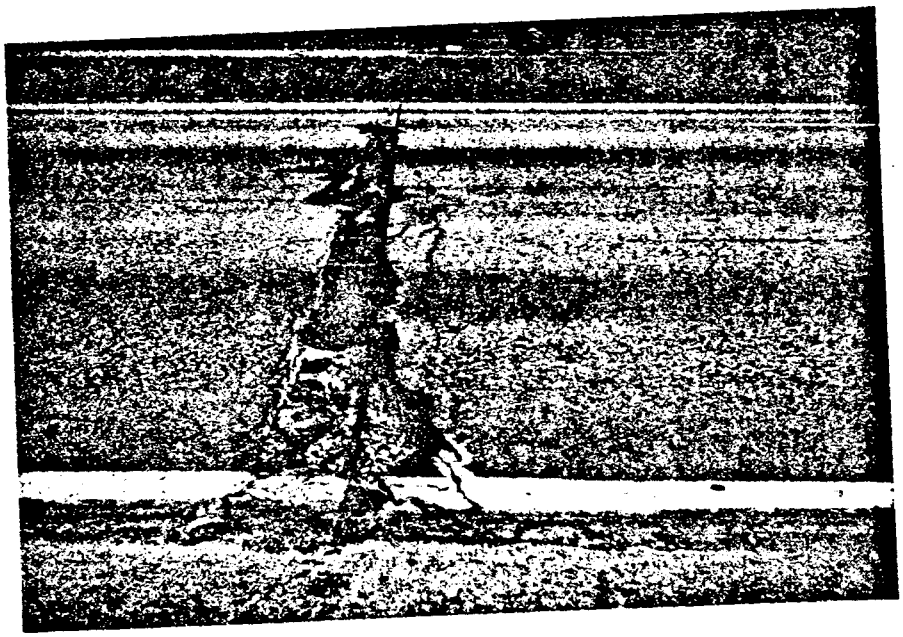


FIGURE 2.12.2 JOINT SPALLING "D" CRACKING

2.4.3 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. (Paragraph 3.2.1), or
2. Emergency patch with select cold mix. (Paragraph 3.2.2)

Warm weather

1. Routine patch with rapid set concrete. (Paragraph 3.2.4), or
2. Routine patch with hot mix. (Paragraph 3.2.3)

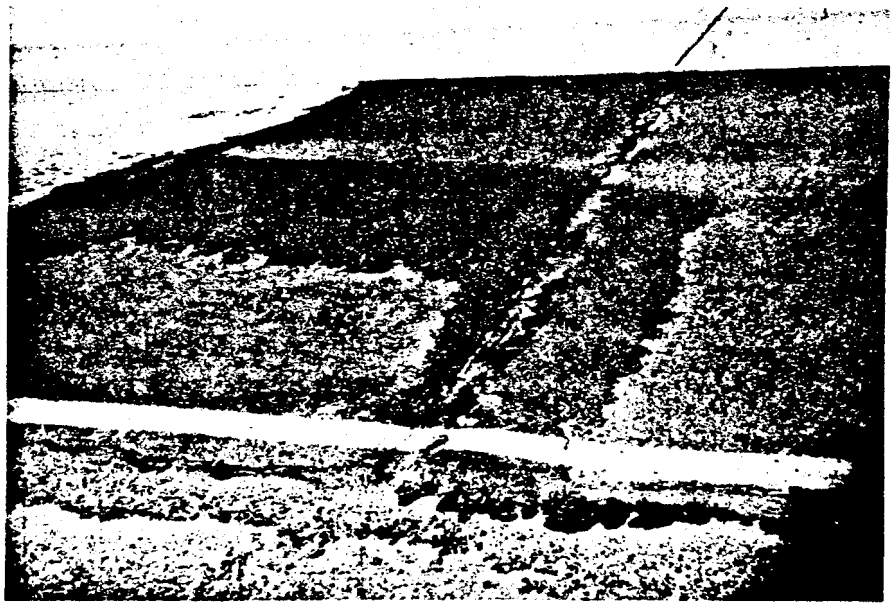


FIGURE 2.13 FAILED PATCH

2.4.4 SHATTERED SLAB

Description: Shattered slab is break up of the concrete slab into small rectangular pieces accompanied by faulting or settlement of the broken area.

Cause: This distress is caused by poor base support or fatigue of the concrete slab under heavy truck traffic.

Repair: Shattered slab repairs can normally be delayed until warm weather conditions.

Warm weather

1. Routine patch with rapid set concrete. (Paragraph 3.2.4),or
2. Routine patch with hot mix. (Paragraph 3.2.3)

FIGURE 2.14 SHATTERED SLAB

CHAPTER 3
SUGGESTED PATCH METHODS

3.1 INTRODUCTION

Interviews were conducted with various agencies and individuals responsible for pavement patching programs to obtain recommendations and guidance for repair technique and material selection. In addition, on-going and completed research studies about pavement patching were reviewed. The list of references are sources of pavement patching information.

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.

Six (6) patch repair techniques are present for the following environmental conditions:

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

(3.2.1) Routine patch with cold mix.

(3.2.2) Emergency or temporary patch with select cold mix. (temperature less than 32°F, 0°C with rain or snow)

Warm Weather (temperature greater than 50°F, 10°C)

(3.2.3) Routine patch with hot mix.

(3.2.4) Routine patch with rapid set concrete.

(3.2.5) Surface patch with hot mix.

(3.2.6) Bituminous surface treatment patch.

The following paragraphs present the recommended patch repair methods in detail. The repair techniques are cross referenced to the distress types presented in Chapter 2. Crew size, equipment, material, and suggested production rates 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 3.2.1, 3.2.3, and 3.2.4. However, all steps in the repair methods must be followed and carefully implemented.

3.2 REPAIR METHODS

3.2.1 ROUTINE PATCH WITH COLD MIX

Where Applicable:

Potholes (2.2.1)
Failed Patch (2.2.2), (2.4.3)
Surface Disintegration (2.3.1)
Surface Potholes (2.4.1)
Joint Spalls (2.4.2)

Manpower Required:

Foreman - 1
Dump Truck Driver - 1
Laborers - 3

Additional Support:

Safety Crew and equipment
Asphalt Mix heater (optional)

Material Required:

Cold mix or "select" cold mix (Appendix A).

Daily Production:

6 - 8 tons/day

Man-Hours per Unit:

5 - 6.0 Man-Hours/ton

Equipment Required:

Crew Cab Truck - 1
Dump Truck - 1
Vibratory Plate Compactor or Portable Roller - 1
Pavement Breaker and Power Source (Hydraulic, Pneumatic or Gas)- 1
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 S.F.).

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 3.1 ROUTINE PATCH WITH COLD MIX

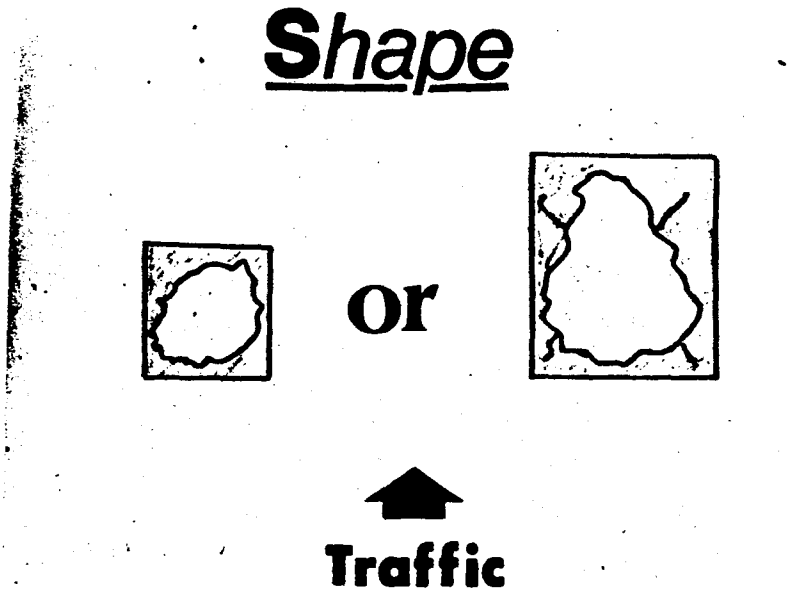


FIGURE 3.2 STEP 2. SHAPE HOLE

FIGURE 3.3 STEP 2. SHAPE HOLE

FIGURE 3.4 STEP 3. REMOVE MATERIAL

FIGURE 3.5 STEP 3. SWEEP CLEAN

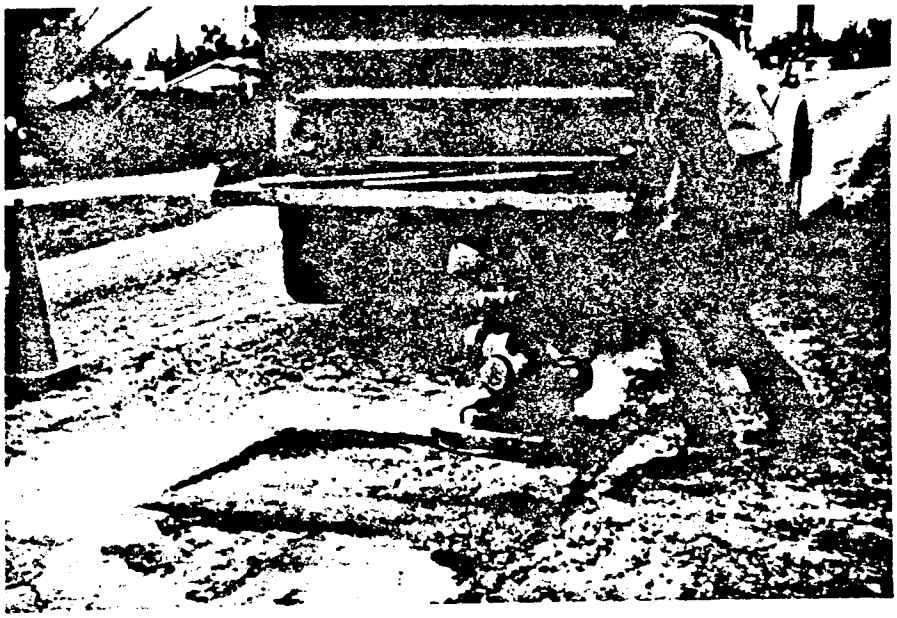


FIGURE 3.6 STEP 4. FILL AND COMPACT

3.2.2 EMERGENCY PATCH WITH COLD MIX

Where Applicable:

Potholes (2.2.1)
Failed Patch (2.2.2), (2.4.3)
Surface Dinintegration (2.3.1)
Surface Potholes (2.4.1)
Joint Spalls (2.4.2)

Daily Production:

7 - 10 tons/day

Man-Hours per Unit:

2.5 - 3.4 Man-Hours/ton

Manpower Required:

Dump Truck Driver - 1
Laborers - 2

Equipment Required:

Dump Truck - 1
Small tools including shovels, rakes, brooms and tamps.

Additional Support:

Safety crew and equipment

Material Required:

"Select" cold mix (Appendix A)

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 wheel of truck.

Ste. 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 (3.2.1) 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 3.7 EMERGENCY PATCH WITH COLD MIX

3.2.3 ROUTINE PATCH WITH HOT MIX

Where Applicable:

Potholes (2.2.1)
Failed Patches (2.2.2), (2.4.3)
Alligator Cracking (2.2.3)
Edge Cracking (2.2.4)
Surface Disintegration (2.3.1)
Shattered Slab (2.3.2), (2.4.4)
Surface Potholes (2.4.1)
Joint Spalls (2.4.2)

Manpower Required:

Foreman	- 1
Dump Truck Driver	- 1
Laborers	- 3

Additional Support:

Safety Crew and equipment
Front end loader or backhoe (if needed)
Motor Grader and operator (if needed)
Concrete Saw (full depth composite or concrete pavement repair only)

Material Required:

Asphalt concrete hot mix
Liquid asphalt for tack

Daily Production:

8 - 10 tons/day

Man-Hours per Unit:

4 - 5 Man-Hours/ton

Equipment Required:

Crew Cab Truck	- 1
Dump Truck	- 1
Vibratory Plate Compactor or Portable Roller	- 1
Pavement Breaker and Power Source (Hydraulic, Pneumatic or Gas)	- 1
Asphalt Kettle	- 1

Small tools including shovels, rakes, brooms and tamps.

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 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 S.F.).

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 untable material should also be removed and replaced. New aggregate base or additional patching material should be used to make the thicker repair.

FIGURE 3.8 STEP 2. SWEEP CLEAN

FIGURE 3.9 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 3.10 ROUTINE PATCH WITH HOT MIX

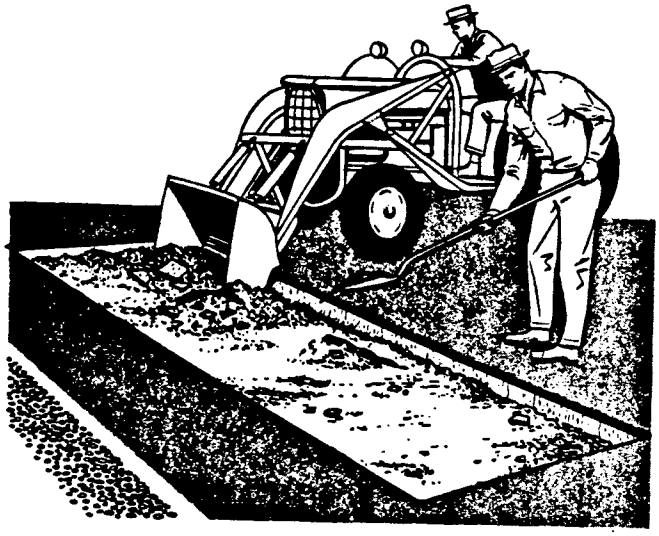


FIGURE 3.11 STEP 3. REMOVE MATERIAL

FIGURE 3.12 STEP 4. APPLY TACK COAT

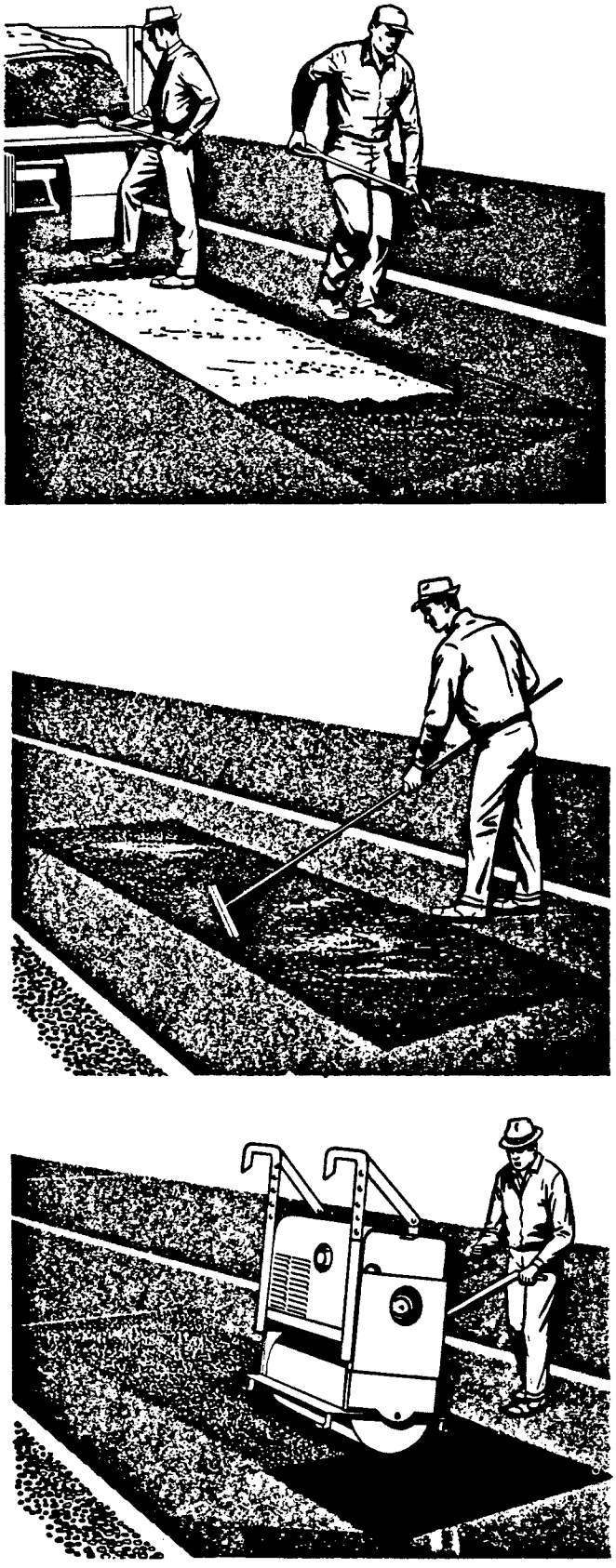
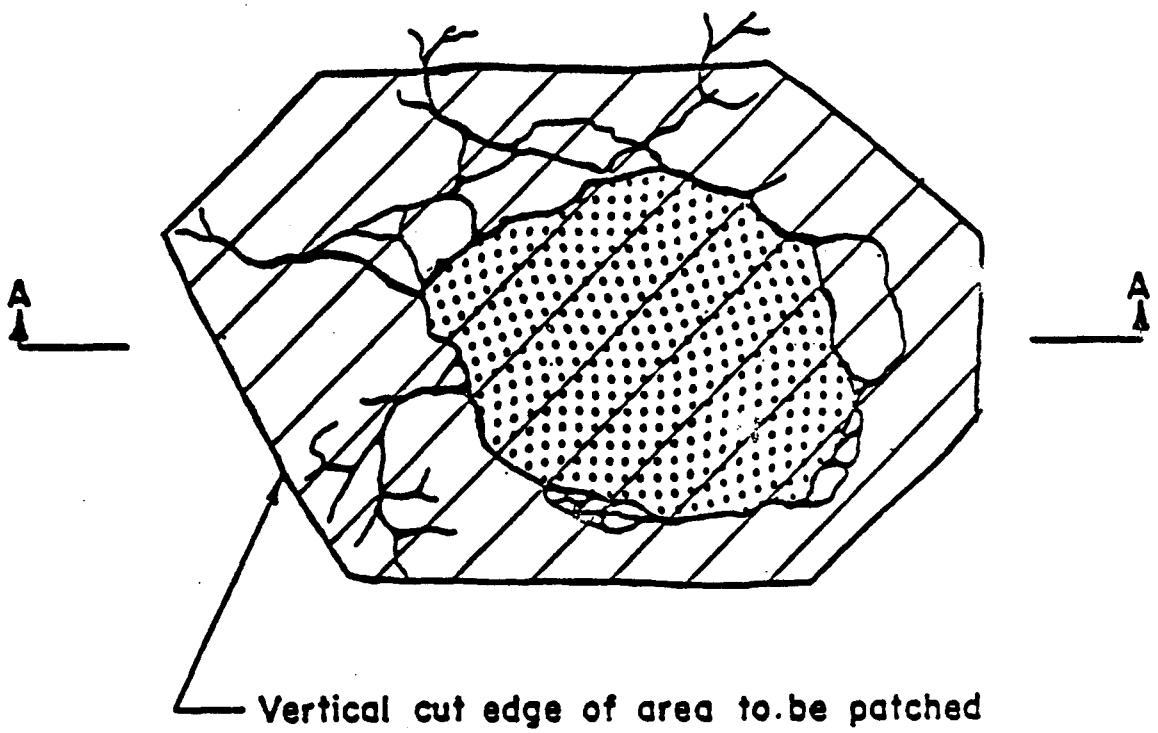


FIGURE 3.13 STEP 5. FILL, SPREAD, AND COMPACT



PLAN

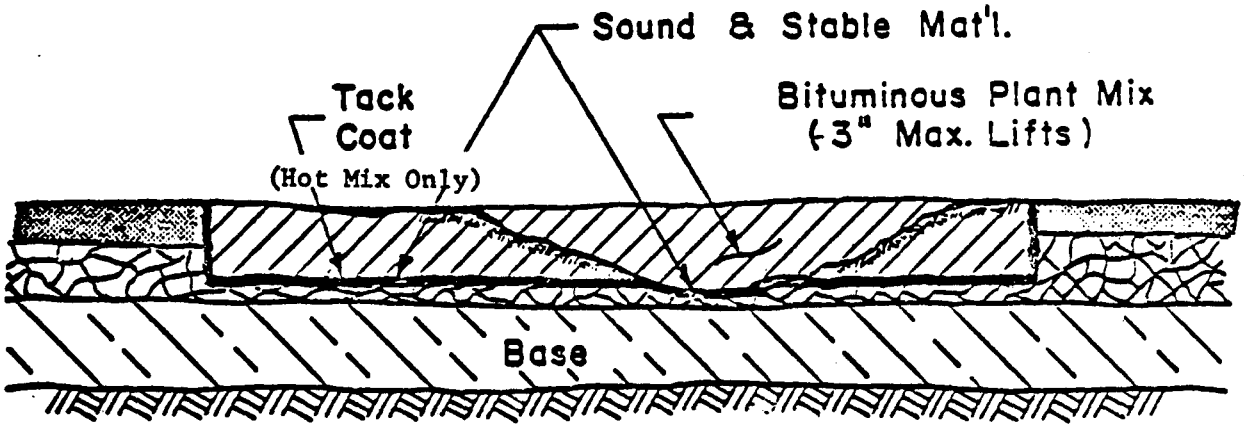


FIGURE 3.14 INTERIOR PATCH

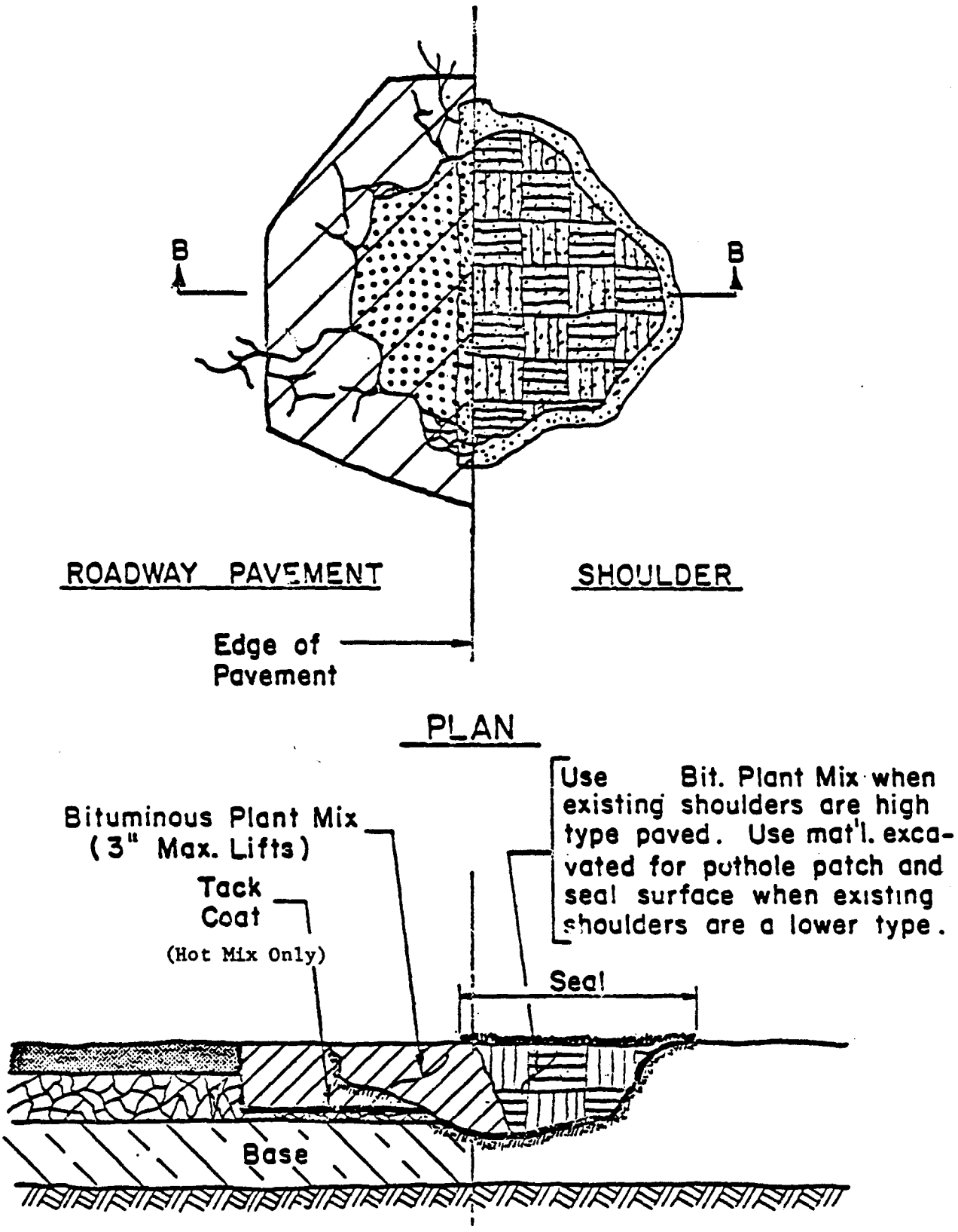


FIGURE 3.15 EDGE PATCH

3.2.4 ROUTINE PATCH WITH RAPID SET CONCRETE

Where Applicable:

Surface Potholes (2.4.1)
Joint Spalls (2.4.2)
Failed Patches (2.4.3)
Shattered Slab (2.4.4)

Daily Production:

8 - 10 Square Feet/day

Man-Hours per Unit:

3.2 - 4 Man-Hours/S.F.

Manpower Required:

Foreman - 1
Dump Truck Driver - 1
Laborers - 2

Equipment Required:

Crew Cab Truck - 1
Dump Truck - 1
Portable Concrete Mixer - 1
Pavement Breaker and Power Source (Hydraulic, Pneumatic, or Gas) - 1
Concrete Saw - 1
Small tools including shovels, wheelbarrow, finishing tools, and brooms

Additional Support:

Safety crew and equipment for full depth slab replacement:

1. Front end loader or backhoe
2. Concrete mixer or delivery of ready mix concrete
3. Hand-operated vibrating screed

Material Required:

Rapid Set Concrete Patch Material
Bonding Grout (if needed)
Joint Seal Material

REPAIR PROCEDURE:

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

Step 2. Saw cut in a rectangular shape around perimeter of failed area into sound concrete. For partial depth repair sawcut should be 1" to 2" deep. Saw full depth for full depth replacement.

Step 3. Remove unsound concrete and reshape hole so that side faces at saw cuts are vertical. Remove down to sound concrete for partial depth repair (minimum of 1" depth). Removal should proceed from the failed area outward to the sawcut.

Step 4. Dry sweep or air blow patch surface clean of any loose material or dust.

Step 5. For partial depth repair, apply bonding grout by broom sweep onto dampened existing surfaces and vertical faces of the patch area.

The grout should consist of equal parts fine sand and cement and be mixed with water to a thick paint consistency. Use grout sparingly, only a thin coat is required. For proprietary materials, follow manufacturer's specifications regarding surface preparation.

Step 6. Fill hole with patching material and vibrate. For proprietary materials follow manufacturer's recommendations for placement of material. Partial depth patches across joints should have the joint formed full depth in the patch and filled with joint seal material.

Step 7. Strike off, finish, and texture patch surface to match adjoining pavement.

Step 8. Apply curing compound and do not open patch to traffic until adequate strength has been obtained. Manufacturer's product specifications usually contain compressive strength versus time information. If unavailable, this information should be based upon cylinder test samples cast and cured in the field during patch construction. Guidelines for adequate strength are:

Partial depth repair - 1000 psi. compression
Full depth repair - 3000 psi. compression

Step 9. Clean up area. Do not leave excess fill or excavated material on the pavement. Remove safety signs.

NOTE: Production rates shown are for partial depth repair. Production rates for full depth repair would be dependent upon availability of mechanical equipment for removal and placement of patching material, and use of ready-mix concrete.

STEP 1 - SET UP SAFETY CONTROL

STEP 2 - SAWCUT PATCH PERIMETER

STEP 3 - REMOVE MATERIAL

STEP 4 - SWEEP OR BLOW CLEAN

STEP 5 - APPLY BONDING GROUT (IF NEEDED)

STEP 6 - FILL AND VIBRATE

STEP 7 - FINISH AND TEXTURE

STEP 8 - CURE

STEP 9 -CLEAN UP

FIGURE 3.16 ROUTINE PATCH WITH RAPID SET CONCRETE

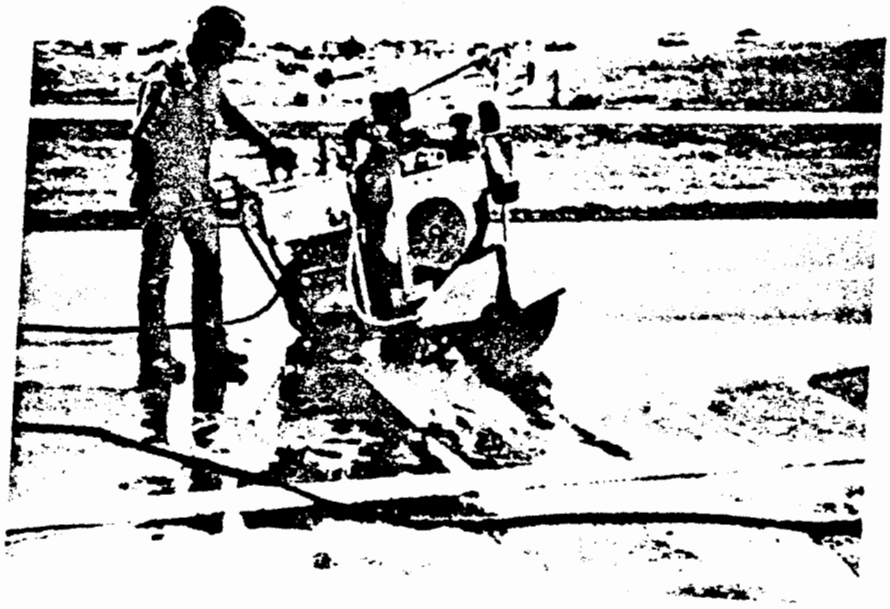


FIGURE 3.17 STEP 2. SAWCUT AREA

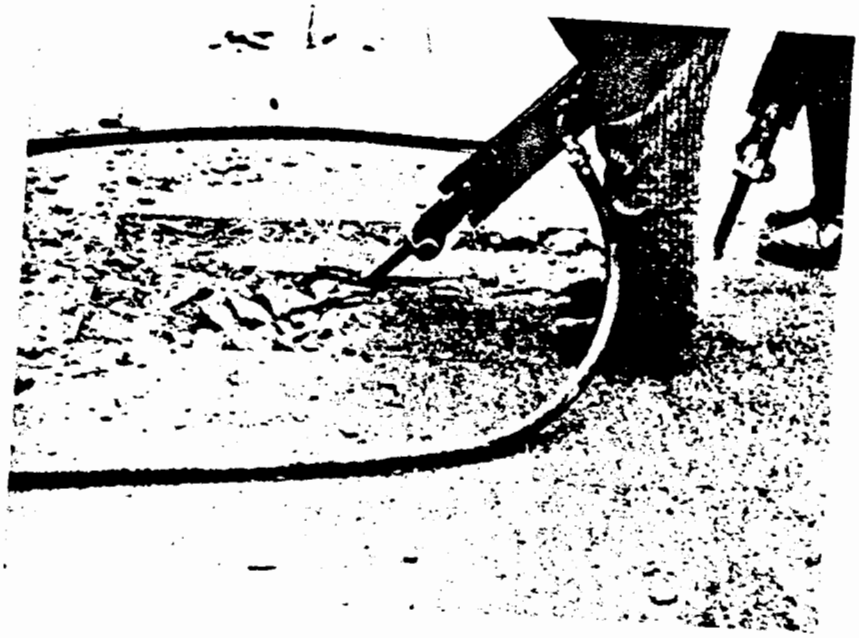


FIGURE 3.18 STEP 3. REMOVE UNSOUND CONCRETE

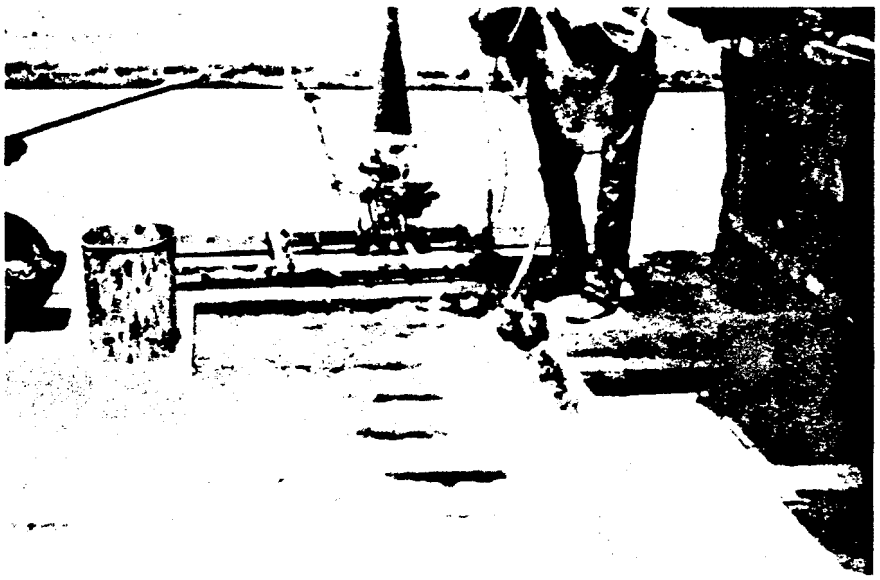


FIGURE 3.19 STEP 5. APPLY BONDING GROUT

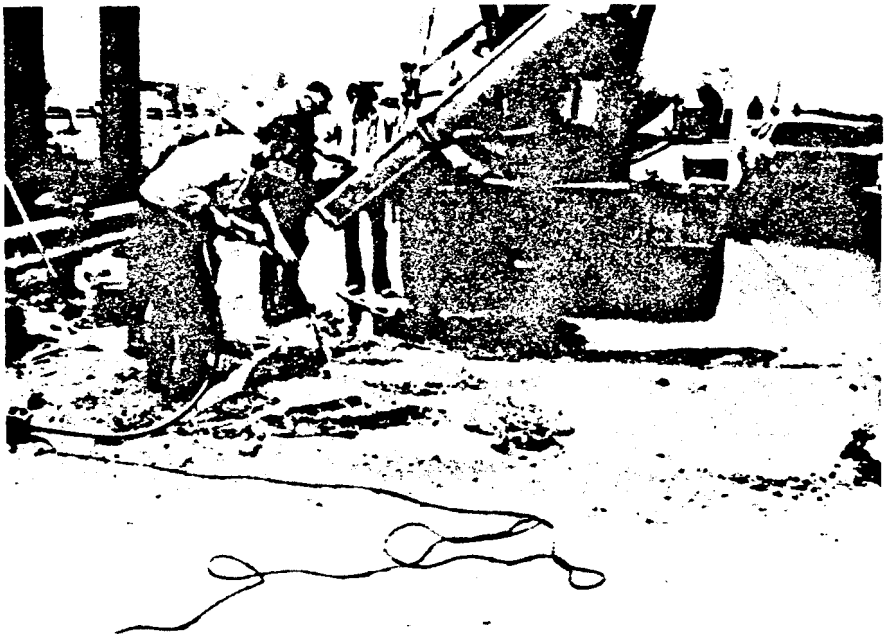


FIGURE 3.20 STEP 6. FILL HOLE AND VIBRATE

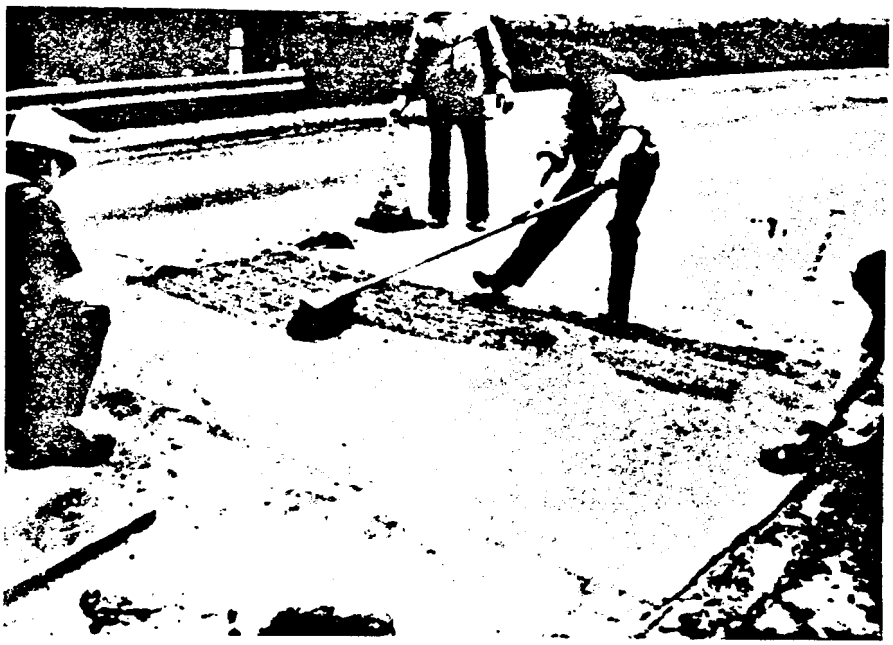


FIGURE 3.21 STEP 7. TEXTURE PATCH

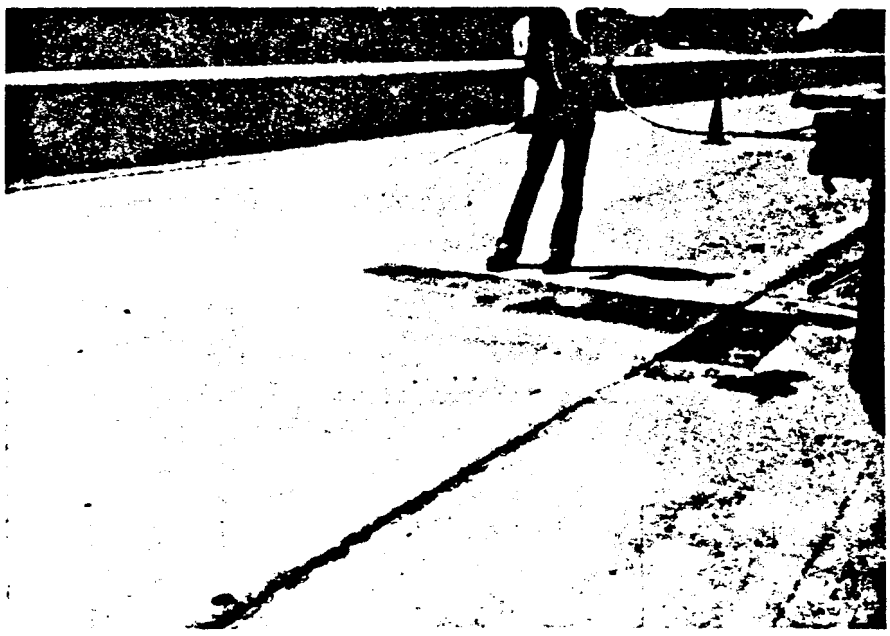


FIGURE 3.22 STEP 8. APPLY CURING COMPOUND

3.2.5 SURFACE PATCH WITH HOT MIX

Where Applicable:

Rutting (2.2.5)

Settlement (2.2.6), (2.4.5)

Manpower Required:

Foreman - 1

Dump Truck Driver - 1

Laborers - 3

Additional Support:

Safety Crew and equipment

Material Required:

Asphalt concrete hot mix

Liquid asphalt for tack

Daily Production:

10 - 14 tons/day

Man-Hours per Unit:

2.8 - 4.0 Man-Hours/ton

Equipment Required:

Crew Cab Truck - 1

Dump Truck - 1

Vibratory Plate Compactor or Portable Roller - 1

Pavement Breaker and Power Source (Hydraulic, Pneumatic or Gas) - 1

Asphalt Kettle - 1

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 3.23 SURFACE PATCH WITH HOT MIX

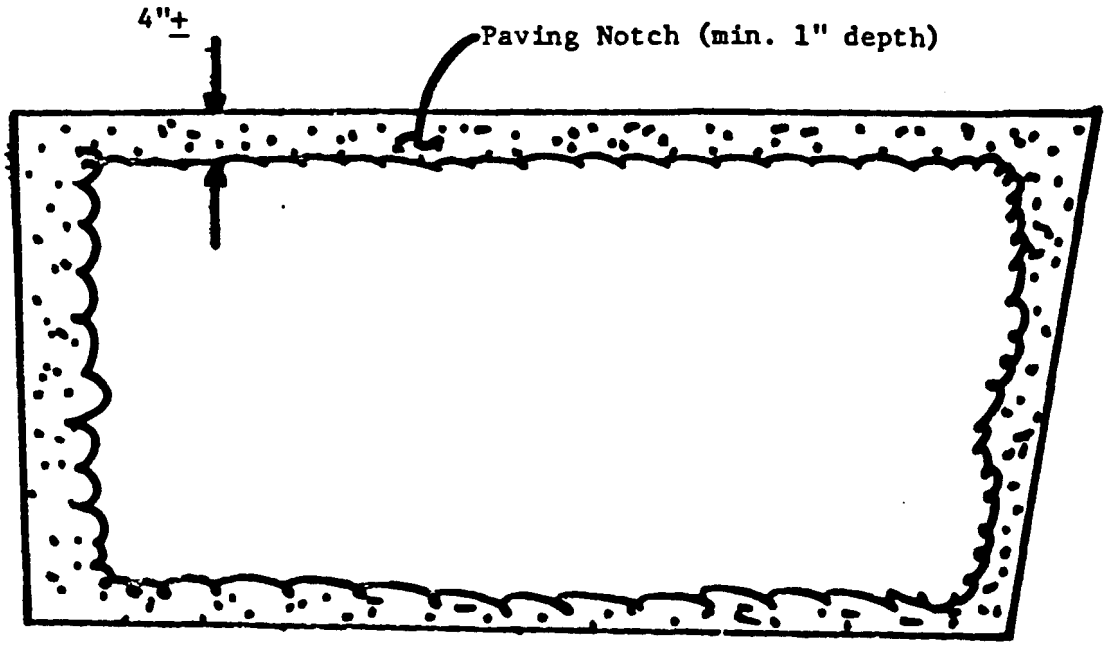


FIGURE 3.24 STEP 3. CUT PAVING NOTCH

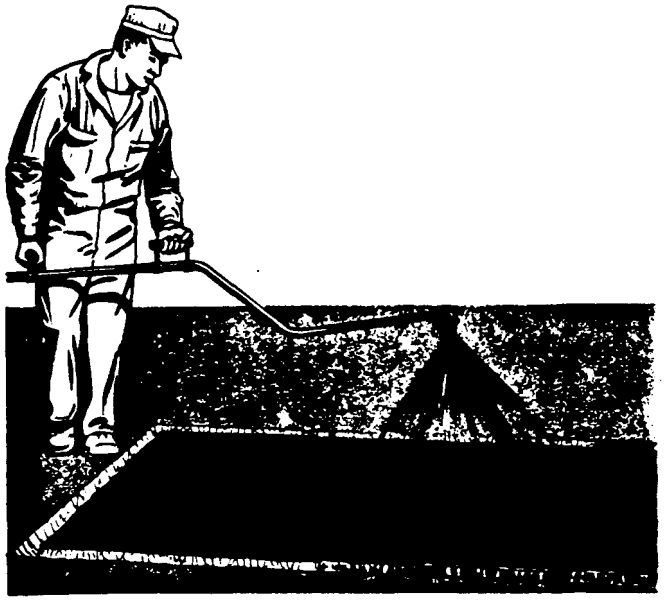


FIGURE 3.25 STEP 5. APPLY TACK COAT

FIGURE 3.26 STEP 6. FILL AND COMPACT

3.2.6 BITUMINOUS SURFACE TREATMENT PATCH

Where Applicable:

Bleeding (2.2.7)

Raveling (2.2.8)

Manpower Required:

Dump Truck Driver - 1

Equipment Operator - 1

Laborers - 2

Additional Support:

Safety crew and equipment

Material Required:

Liquid asphalt

Coarse aggregate (No. 8 size)

Daily Production:

12 - 15 tons of aggregate/day

Man-Hours per Unit:

2.1 - 2.7 Man-Hours/ton

Equipment Required:

Dump Truck - 2

Pneumatic tired roller (towed by dump truck) - 1

Asphalt Kettle - 1

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./S.Y. for areas of bleeding, and .15 to .25 gal./S.Y. 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 3.27 SURFACE TREATMENT PATCH

FIGURE 3.28 STEP 3. APPLY LIQUID ASPHALT

FIGURE 3.29 STEP 4. SPREAD AGGREGATE

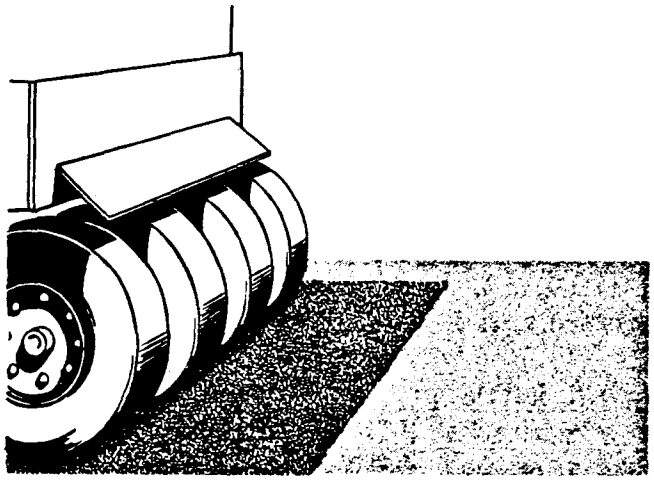


FIGURE 3.30 STEP 5. ROLL AGGREGATE

CHAPTER 4
MANAGING PAVEMENT PATCHING PROGRAMS

4.1 INTRODUCTION

Management of a pavement patching program requires skillful use of manpower, equipment and materials to meet an often unscheduled and unquantified work load. No accurate method has been developed to predict the frequency and occurrence of pavement patches on a system or city-wide basis. Therefore, a big element in any successful patching program is flexibility to respond to needs as they arise.

An effective pavement patching program needs to have defined management procedures regarding the following items:

4.2 IDENTIFYING NEED FOR REPAIR AND DISTRESS TYPE

Most agencies have supervisors or foremen responsible for traveling streets in an assigned area and noting locations of needed pavement patches. It is suggested that persons identifying patch locations also identify the pavement distress type using the descriptions presented in Chapter 2. A suggested patch repair order form is shown in Figure 4.1. Items 1 through 4 should be filled out by the field rater.

4.3 SELECTING AND SCHEDULING REPAIR

Scheduling patch repair should consider both the type and severity of the pavement. Three priority groups are suggested:

Priority 1 - Potholes of more than 6" diameter

Priority 2 - Potholes of less than 6" diameter

Priority 3 - Other pavement distresses which require patching as described in Chapter 3 (no potholes developed in distressed area)

Priority 1 potholes are large enough for a wheel to fall into and are therefore a safety hazard. Priority 1 patches should be installed as soon as possible. This may necessitate the use of emergency or temporary patches as presented in (3.2.2) during adverse cold weather conditions. Priority 2 patches should be made during weather conditions which permit routine repair while Priority 3 patches should be made during warm weather. Repair type should be based upon the information presented in Chapter 2 and the weather conditions at time of patching. Items 5 and 6 of Figure 4.1 should initially be assigned by the individual who observed the failure area or the foreman of the patching crew.

Priority and repair type assignment may also be reviewed by supervisory personnel in the office.

4.4 COMPLETE PATCH REPAIR AND MONITOR PRODUCTION

Patches should be installed in accordance with the procedures indicated in Chapter 3. Adequate reporting techniques should be implemented so that crew production rates can be compared with production standards. Needed adjustments to production standard or improvement in personnel performance can then be evaluated.

4.5 EVALUATE PATCH PERFORMANCE

Agencies should implement steps to evaluate and monitor performance of installed patches. Not all patches have to be evaluated. However, representative patches, especially those which were installed by techniques or with materials new to the agency, should be periodically evaluated. The evaluations would be valuable for selecting or developing future improvements in patch techniques or materials. Reference 13 contains a field rating procedure for evaluating patch performance based upon the occurrence of raveling, bleeding, cracking, rutting, and edge disintegration within the patch area. Figure 4.2 defines the patch distress types and severity lines considered by the rating procedure.

4.6 PERSONNEL TRAINING AND EQUIPMENT MAINTENANCE

Like all other construction activities efficient and effective pavement patch installation requires the use of good operable equipment and trained workers. Crew foremen should become familiar with the installation techniques outlined in the Guidelines and demonstrate them to workers. Annual or bi-annual workshops should be held to acquaint new personnel with the proper patch repair methods. Routine equipment maintenance programs should be established to insure that all patching crews have the required equipment noted in Chapter 3 in good working order. Equipment replacement and acquisition should also be a regular budget item.

4.7 CONCLUSION

It is recognized that some agencies will be unable to implement the recommended repair procedure because of required initial capital investment for equipment. However, the actual cost of a pavement patching program must consider more than just capital investment in equipment. A 1976 value engineering study by Louis O'Brien of Pennsylvania DOT (Ref 14) calculated that pothole repairs which did not follow standard procedure and did not include mechanical removal and compaction cost about $300/ton on an annual basis. Such patches

lasted about 1 month. Standard pothole repair procedures including mechanical removal and compaction (similar to 3.2.1) had an average annual cost of $60/ton and a minimum expected life of 12 months. These significant cost differences occur even though the production rate for the standard technique was only 6 ton/day versus 18 ton/day for the non-standard technique.

PATCH

REPAIR ORDER

1. Date:_____

2. Location:_____

3. Pavement Type:_____ Asphalt_____ Composite_____Concrete

4. Distress Type:

Asphalt	Composite	Concrete
( ) Pothole more than 6" in size	( ) Pothole more than 6" in size	( ) Pothole more than 6" in size
( ) Pothole less than 6" in size	( ) Pothole less than 6" in size	( ) Pothole less than 6" in size
( ) Failed Patch	( ) Failed Patch	( ) Failed Patch
( ) Alligator Cracking	( ) Surface Debond	( ) Joint Spall
( ) Edge Cracking	( ) Shattered Slab	( ) Shattered Slab
( ) Rutting	( ) Rutting	
( ) Settlement	( ) Settlement	
( ) Bleeding	( ) Bleeding	
( ) Raveling	( ) Raveling	

5. Repair Priority: ( ) Priority Group 1
( ) Priority Group 2
( ) Priority Group 3

6. Repair Type:_____

7. Date Patch Installed:_____

FIGURE 4.1

SUGGESTED DISTRESS
TYPE AND SEVERITY FOR
PATCH EVALUATION

DISTRESS TYPE: RAVELING

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

SEVERITY LEVEL
- Low - loss of aggregate is barely noticeable.
- Medium - surface has an open texture with considerable loss of fine aggregate and some loss of coarse aggregate.
- High - most of surface aggregate worn away or dislodged. Surface is rough and pitted.

DISTRESS TYPE: BLEEDING

DESCRIPTION: The presence of free asphalt binder on the pavement surface.

SEVERITY LEVEL: Only two severity levels are defined:
- Low and medium - both coarse aggregate and free bitumen are noticeable on the pavement surface.
- High - surface of patch appears black with little aggregate.

DISTRESS TYPE: CRACKING

DESCRIPTION: Cracking within the interior regions of the patch.
- Low - tight, hairline cracks with average crack width less than 1/8" with no spalling.
- Medium - cracks opened or spalled to a width between 1/8" and 3/8".
- High - cracks opened or spalled to widths of more than 3/8".

DISTRESS TYPE: EDGE DISINTEGRATION

DESCRIPTION: Cracking and/or spalling along the edges of the patch.

SEVERITY LEVEL:
- Low - tight cracks with little or no spalling.
- Medium - edge spalled up to 1" in width.
- High - edge spalled to greater than 1" in width.

FIGURE 4.2

DISTRESS TYPE: DISTORTION AND RUTTING

DESCRIPTION: Depression, upheaval, or shoving of the patching material. In severe cases cracking may occur around distorted areas.

SEVERITY LEVEL: Severity level is based upon the estimated vertical displacement of the patching material.

Low - displacement (rut or upheaval) less than 1/2".

Medium - displacement (rut or upheaval) between 1/2" and 1 1/2".

High - displacement (rut or upheaval) greater than 1 1/2".

FIGURE 4.2 (Cont.)

SELECTED REFERENCES
FOR
PAVEMENT PATCHING

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9. Hartvigas, L. "Patching Flexible and Rigid Pavements", Research Report 74 Engineering Research and Development Bureau, New York DOT, 1979.

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11. _____ "Patching Concrete Pavement", and "Maintenance of Joints and Cracks in Concrete Pavement", Concrete Information Pamphlets, Portland Cement Association, 1976.

12. _____ "Asphalt in Pavement Maintenance", MS-16, The Asphalt Institute.

13. Luther, M.S. and Majidzadeh, K. "A Field and Laboratory Evaluation of Pavement Patching Material", Current HPR Study, Ohio Department of Transportation.

14. O'Brien, L.G. "Value Engineering as Applied to Pothole Patching", Pennsylvania Department of Transportation, Harrisburg, PA 1976.

15. _____ Bulletin 25 "Specifications for Bituminous Materials", Pennsylvania Department of Transportation, Jan. 1981.

APPENDIX A

TYPICAL PATCHING MATERIAL SPECIFICATIONS

This Appendix presents typical specifications and information for generic materials. An extensive listing of materials and products is available. The data presented is for materials which have been widely and successfully used to construct pavement patches when placed using procedures similar to those recommended in Chapter 3.

TABLE A-1 TYPICAL REQUIREMENT FOR HOT MIX

Rev. May 20, 1977

SECTION 828 - HOT MIX ASPHALTIC CONCRETE MIXTURES

828.02 Dense Graded Intermediate and Surface Mixtures

JOB MIX FORMULA LIMITS

MIXTURE CONTROL TOLERANCES	ASPHALTIC CONCRETE	"B" MODIFIED	"E"	"F"	"H"
	ASPHALT CEMENT, VISCOSITY GRADE	AC-20	AC-20	AC-20	AC-20
	GRADING REQUIREMENTS				
± 7.0	% PASSING 1" SIEVE	100			
± 7.0	% PASSING 3/4" SIEVE	85-100	100		
± 6.1	% PASSING 1/2" SIEVE		85-100	100	100
± 5.6	% PASSING 3/8" SIEVE	60-80	70-85	90-100	90-100
± 5.7	% PASSING NO. 4 SIEVE			55-75	65-80
± 4.6	% PASSING NO. 8 SIEVE	42-46	44-48	44-50	48-55
± 3.8	% PASSING NO. 50 SIEVE		10-25	12-28	14-30
± 2.0	% PASSING NO. 200 SIEVE	2-10	2-10	2-12	2-12
	DESIGN REQUIREMENTS				
	RANGE FOR % AC	4.75-5.75	5.25-7.0	5.25-7.50	5.50-7.50
	FLOW, AASHTO T-245	8-16	8-16	8-16	8-16
	MINIMUM STABILITY BASED ON 50-BLOW MARSHALL AASHTO T-245	1300 lbs.	1300 lbs.	1300 lbs.	1300 lbs.
	DESIGN OPTIMUM AIR VOIDS (%)	4.5 ± .5	4.5 ± .5	4.5 ± .5	4.5 ± .5
	% AGGREGATE VOIDS FILLED WITH ASPHALT CEMENT	65-75	70-82	70-82	70-82
	% IMMERSION COMPRESSION RETAINED STABILITY AFTER 24 HOURS GHD-53	75	75	75	75
	% RETENTION OF COATING GHD-56	95	95	95	95

SOURCE: Ref. (2)

TABLE A-2 TACK AND SURFACE TREATMENT MATERIALS

I. TACK COAT

ACCEPTABLE BITUMINOUS MATERIAL

AC-10
AC-20
RC-70
RS-1, RS-2
SS-1
CRS-1
CRS-1

TEMPERATURE FOR APPLICATION

Material	RC-70	RS-1 CRS-; SS-1	CRS-2 RS-2	Asphalt Cement
Temperature °F	105- 180	75- 130	110- 165	325- 375

II. SURFACE TREATMENT

Aggregate Size	Bituminous Material
6	AC-20 RS-2, CRS-2, RC-3000 CBAE-2, CBAE-3
7	AC-20 RS-2, CRS-2, RC-800 CBAE-2
89	AC-10 RS-2, CRS-2, RC-800 CBAE-2

SOURCE: Ref. (2)

TABLE A-3 - TYPICAL PORTLAND CEMENT PATCH MIXTURE

MIX DESIGN (PER C.Y.)

HIGH EARLY STRENGTH
PORTLAND CEMENT PATCHING MATERIAL

Cement Content = 658 lb. (Type III)

Calcium Chloride = 12 lb.

Water/Cement Ratio = .45 max.

% Entrained Air = 7% $\pm$ 1

Slump = 3" max.

Coarse Aggregate = Size No. 8 (AASHTO M-43)

Fine Aggregate = natural sand

NOTE: Mixture design selected to permit patch opening in 4 to 6 hours. Compressive strength of 2000 psi (4 to 6 hours) and 5000 psi at 28 day.

"SELECT"

COLD MIX SPECIFICATIONS

"SELECT"
BITUMINOUS STOCKPILE PATCHING MATERIAL

DESCRIPTION - The material shall consist of plant mixed stockpile patching bituminous mixture composed of mineral aggregate coated with bituminous material. The material shall be capable of being stocked for at least six months without stripping and shall be workable at all times.

Patching material stocked by the contractor on his property may be rejected, at anytime during the six-month period if, in the opinion of the Engineer, the patching material has stripped (more than 10% uncoated particles) or otherwise become unfit for use.

When the patching material has been delivered directly to a stockpile before Engineer approval, it will be the contractor's responsibility to remove any unacceptable material within two weeks of notification.

This material is intended for patching holes up to 3 inches deep. For holes deeper than 3 inches, this material will be compacted in layers, each layer not exceeding 3 inches.

MATERIALS - The materials and their use shall meet the applicable requirements of AASHTO M81, M82, M140, or M208.

(a) Bituminous Materials. The listed bituminous materials shall be used. For proper mixing, the bituminous materials shall be heated.

CLASS OF MATERIAL	TYPE OF MATERIAL
MC-400	Cut-back Petroleum Asphalt
MC-800	Cut-back Petroleum Asphalt
ME-400	Emulsified Cut-back Asphalt
ME-800	Emulsified Cut-back Asphalt
E-10	Emulsified Asphalt
E-12	Cationic Emulsified Asphalt
RT-4-C	Tar Cut-back
RT-6-C	Tar Cut-back

Bituminous Materials MC-400, ME-400 and RT-4-C shall be used between November 1 and March 1. Bituminous Materials MC-800, ME-800, and RT-6-C shall be used between March 1 and October 31. Bituminous Materials E-10 and E-12 can be used throughout the year.

Bituminous Materials MC-400, MC-800, ME-400, and ME-800 shall be Treated Bituminous Materials meeting the applicable requirements of the Appendix to

Reference 15 (Wet Coating Test, Static Immersion Test and Stripping Test) using the job aggregate. Bituminous Materials E-10 and E-12 shall pass the dry and wet stone coating test on the job aggregate.

The contractor shall furnish the sample of the job aggregate to the bituminous supplier for the coating and stripping tests specified in Reference 15 and obtain a certificate that the bituminous material has been treated to suit the job aggregate. This certificate shall be produced when required by the Engineer.

(b) Composition of Mixtures. The percent of asphalt residue and the percent passing the No. 8 sieve shall be approved by the Engineer. The contractor shall furnish the mixed material within the gradation limits specified in Table A.

TABLE A-A
Composition of Mixtures
(Total Percent by Weight Passing Square Openings
Based on Laboratory Sieve Tests)

Passing Sieve	Percent Passing
3/8"	100
#4	40-100
#8	20-50*
#200	0-2

*If the material passing #4 sieve is between 85 to 100, the material passing #8 sieve shall be 15-40 percent.

The quantity of bituminous material in the mix shall be such that the minimum requirements on the percent residue specified in Table B are met.

TABLE A-B
Minimum Asphalt or Tar Residue for J.M.F. Design

Aggregate Type	Percent Water Absorption (Coarse Aggregate)	Percent Aspahlt or Tar Residue, Min. Design J.M.F.
Stone and Gravel	Less than 1.0	4.5
Stone and Gravel	1.1 to 1.5	5.0
Stone and Gravel	1.6 to 2.0	5.5
Stone and Gravel	2.1 to 2.5	6.0
Stone and Gravel	2.6 to 3.0	6.5
Slag	Less than 4.0	7.0
Slag	4.1 to 5.0	8.0
Slag	5.1 to 6.0	9.0
Slag	6.1 to 7.0	10.0

Based on the characteristics of the aggregate and the performance of the mix, the engineer can specify percent asphalt or tar residue higher than the minimum values given in Table B. These minimum residue values are based on a material of which 25 percent passes the #8 sieve. A finer mix may require more bituminous material due to the increased surface area of the aggregates. Normally, 0.1 percent additional bitumen residue may be required for each percent passing the #8 sieve over 25 percent.

The contractor shall furnish the mixed material within the limits specified in Table A and Table B of this section, except, the asphalt residue shall not be deficient by more than 0.5 percent and the No. 8 sieve shall not vary more than ±5 percent from the JMF values approved by the engineer.

CONSTRUCTION REQUIREMENTS

Preparation of Mixtures. All mineral aggregates and bituminous material shall be proportioned by weight or by volume.

The mixture shall be such that it may be stocked, handled, placed and finished without stripping of the bituminous material from the aggregate. To help prevent stripping, the mixed material shall be stocked no higher than 4 feet for the first 48 hours.

The mineral aggregate shall be clean and surface dry prior to mixing. The temperatures of the bituminous material, aggregate and the resulting mixture shall be maintained as follows:

Type of Bituminous Material	Termperature Range °F		
	Aggregate	Bituminous Material	Mixture
MC-400	40-150	135-180	-
MC-800	40-150	165-205	-
ME-400	40-150	175 max.	-
ME-800	40-150	175 max.	-
E-10 and E-12	Appropriate for specified mix temp.	140-175	190-250
RT-4-C	100-200	130-150	100-190
RT-6-C	100-200	130-175	100-190

When E-10 or E-12 Emulsified Asphalt are used, the temperature requirements on the aggregate and then mixture can be waived by the engineer, if it is demonstrated that the mix can be prepared with unheated aggregate without any coating or stripping problems, during production and stockpiling.

The following two tests on the mixture, freshly prepared or taken from the stockpile, shall be performed by the contractor. The mixture shall be rejected if it fails these tests.

Water Resistance Test

Fifty grams of mixture, whether freshly prepared or taken from the stockpile, shall be heated at 250°F in a laboratory oven for one hour, cooled to 200°F in laboratory air and then placed in 400 ml. of boiling distilled water in a 600 ml. glass beaker and stirred with a glass rod at the rate of one revolution per second for 3 minutes. The water shall be decanted and the mix shall be spread on an absorbent paper for visual observation of the coating. The aggregate shall be at least 90% coated with a bituminous film.

Workability Test

Approximately five pounds of the mixture shall be cooled to 20°F in the laboratory. After cooling the mixture shall be capable of being broken up readily with a spatula having a blade length of approximately 8 inches. This test shall be performed when the mixture is produced or used between November 1 and March 1. If the mixture is not workable at 20°F, it shall be rejected and proper modification to the composition of the mixture (such as, increase in % bitumen residue or gradation changes) shall be made.

METHOD OF MEASUREMENT - The tonnage will be measured and determined from the actual plant batch reports as recorded by a representative of the Engineer assigned to do the work.

BASIS OF PAYMENT - The bituminous stockpile patching material will be paid for at the contract unit price per ton, f.o.b. the plant, at the work site or other destination as specified in the proposal.

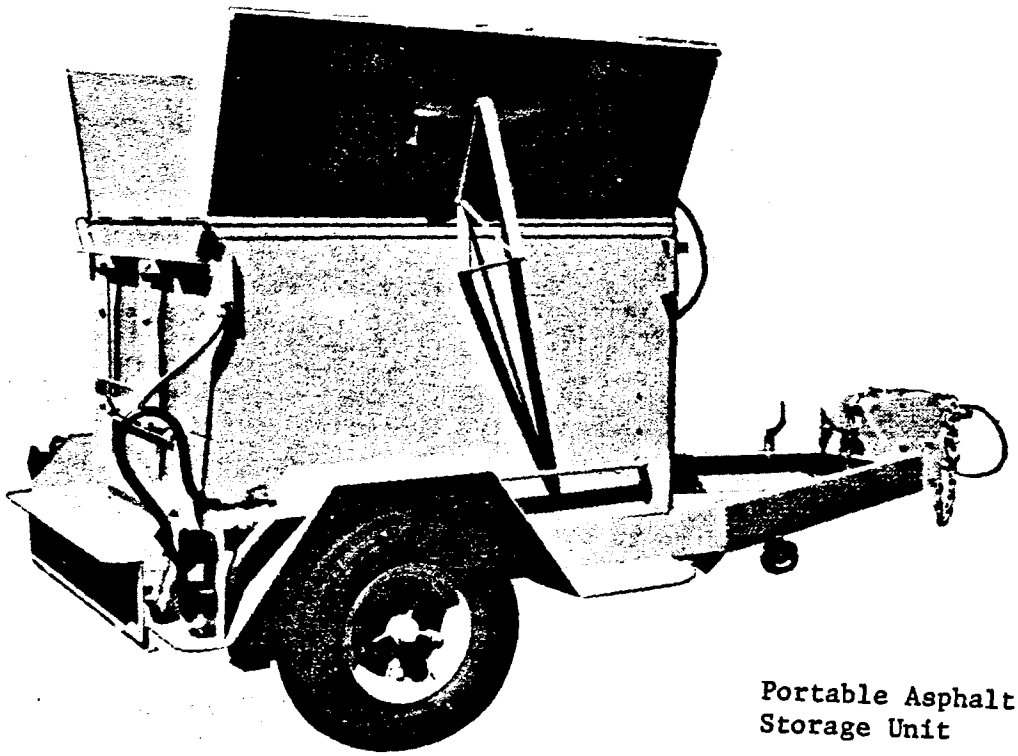
APPENDIX B

COMPACTION AND MATERIAL HEATING EQUIPMENT

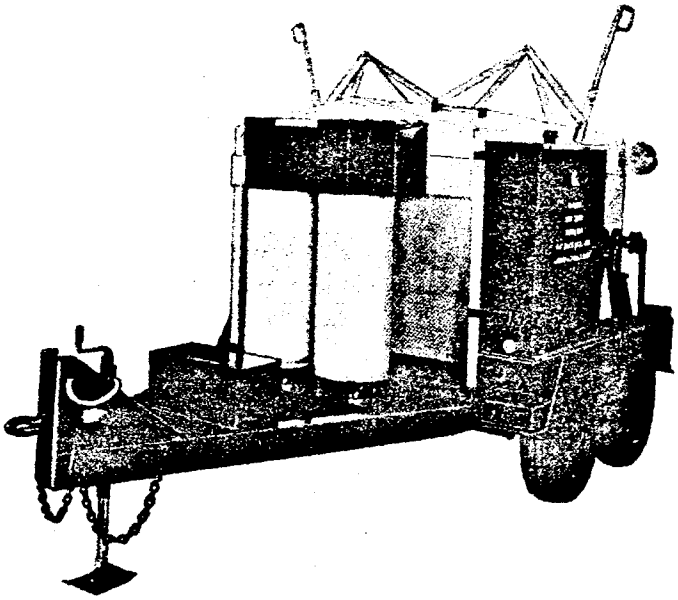
Research conducted by Pennsylvania DOT (Ref. 4) reccommended use of mechanical equipment for patching techniques similar to those presented in (3.2.2) and (3.2.3).

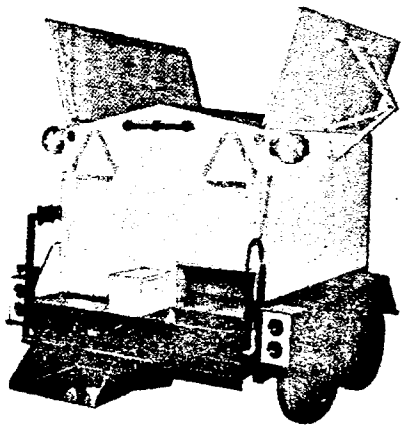
The Pennsylvania study gave the following guidelines when using these types of equipment:

1. 15 to 20 passes of the roller or plate compactor are required to achieve good compaction;
2. First couple of passes with the vibrating roller should be in the static mode;
3. Roller may need to be operated transverse to pavement to prevent budging on high wheel rut areas;
4. Plate compactor requires about 2 minutes of compaction per square yard of patch area;
5. During winter months, cold mix should be placed in heater storage units overnight, for installation during next day. Temperature of mix should not exceed 160°F.

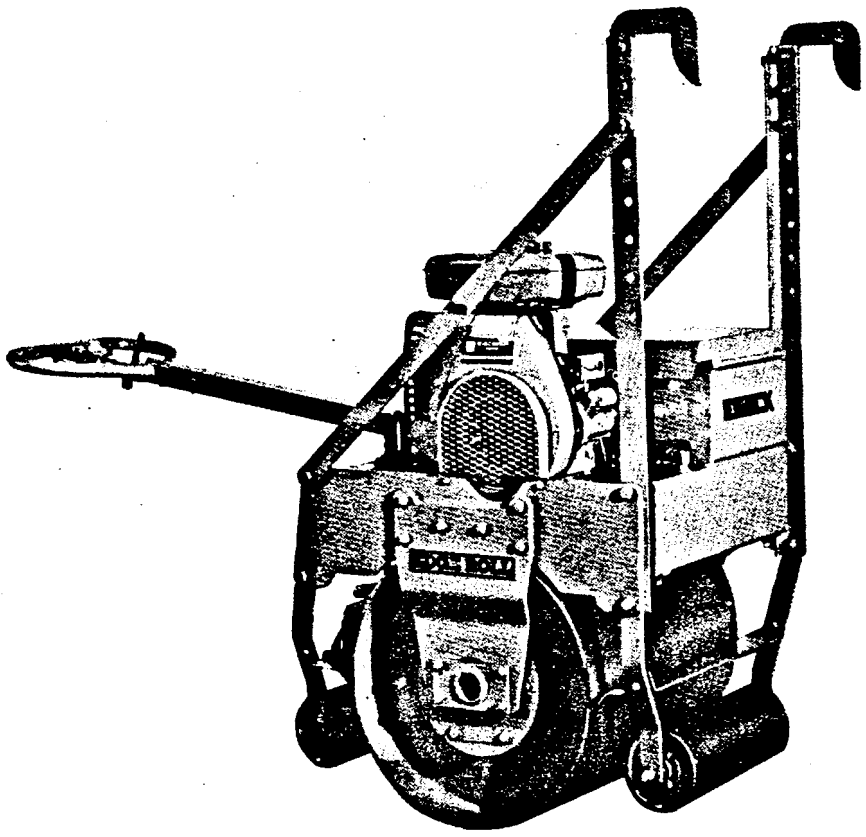


Portable Asphalt
Storage Unit



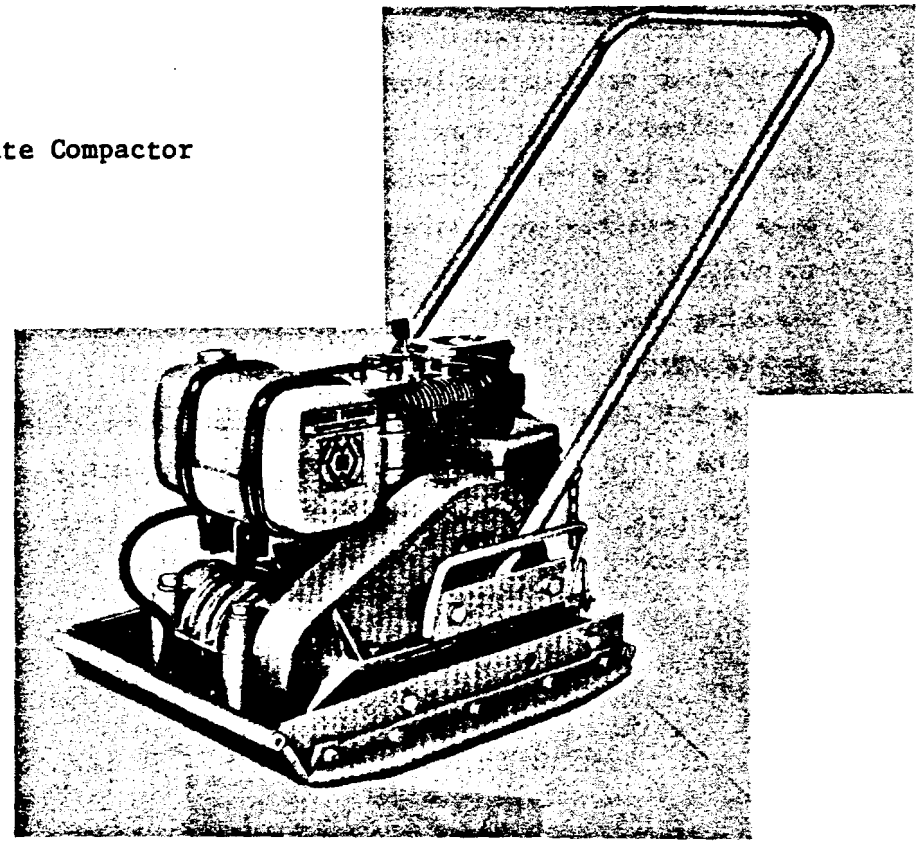


Portable Asphalt Storage
Unit



Vibrating Roller

Plate Compactor



APPENDIX C

SUGGESTED TRAFFIC CONTROL PRACTICES

This Appendix presents guidelines and suggested layout for traffic control devices.

General Guidelines:

1. All traffic control devices shall comply with the requirements set forth in the States current edition of the Manual of Uniform Traffic Control Devices, MUTCD.
2. Temporary type signs should be utilized only when work is in process. When not in use they should be removed, closed flat on ground, or reset facing away from traffic a desirable distance of 15' or more from traveled way.
3. All signs shall have reflective sheeting backgrounds.
4. When it becomes necessary to use equipment on the roadway while doing work on the shoulder or off the roadway, the signing shall be treated as work on the roadway.
5. The application of traffic control devices shown is to be considered as minimum. Additional devices may be used as required.
6. Open flame devices and lanterns using flammable fuel are not to be used unless an emergency has developed and they are the only devices available in a rural location. These devices shall be replaced as soon as possible with more effective lighting devices as recommended in MUTCD.
7. Flashing and steady burning warning lights shall be used as set forth in the MUTCD.
8. Figure C-1 shows suggested practice for short-time maintenance activities of 15 to 60 minutes duration. Figure C-2 is for maintenance operation in excess of 60 minutes on 2-lane roadways, with Figure C-3 applicable to multilane highways.

*U.S. GOVERNMENT PRINTING OFFICE : 1983 O-381-428/3020