

National Research Council

# STRATEGIC HIGHWAY RESEARCH PROGRAM



SPECIFIC PAVEMENT STUDIES  
CONSTRUCTION GUIDELINES FOR EXPERIMENT SPS-5,  
REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

STRATEGIC HIGHWAY RESEARCH PROGRAM  
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SPECIFIC PAVEMENT STUDIES  
CONSTRUCTION GUIDELINES FOR EXPERIMENT SPS-5,  
REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

INTRODUCTION

This report describes the guidelines for the construction of test sections for the Specific Pavement Studies' SPS-5 experiment, Rehabilitation of Asphalt Concrete Pavements. These guidelines have been developed by SHRP in cooperation with state and provincial highway agency personnel participating in various meetings, including a construction guidelines review meeting held in Tempe, Arizona, April 24 - 25, 1990. The recommendations of the participants from eleven states and provinces and the Federal Highway Administration and comments furnished by other highway agency personnel are incorporated in the guidelines outlined in this report. These guidelines will help participating highway agencies develop acceptable construction plans for test sections for this experiment.

The SPS-5 experiment, Rehabilitation of Asphalt Concrete Pavements, requires the construction of multiple test sections with similar details and materials at each of sixteen sites equally distributed in the four climatic regions. The experimental design and construction considerations for this experiment are described in the document, "Specific Pavement Studies: Experimental Design and Research Plan for Experiment SPS-5, "Rehabilitation of Asphalt Concrete Pavements," April 1989. The experiment has been developed as a coordinated national experiment to address the needs of the highway community at large and not only the participating highway agencies. Therefore, it is important to control construction uniformity at all test sites to reduce the influence of construction variability on test results. Consequently, the construction guidelines outlined in this report must be followed by all participating highway agencies to accomplish the desired objectives of the experiment.

## OBJECTIVE

The objective of this document is to provide guidelines for preparing and constructing SPS-5 test sections to maximize uniformity of these procedures across all projects. More specifically, the objectives are:

- To review the major construction features of the SPS-5 experiment test sections.
- To describe the details of the two major experimental levels of preparation of the test sections prior to construction (minimal and intensive).
- To provide specifications for materials to be used (aggregates, asphalts) and the mix design (virgin, recycled).
- To describe the construction operations (mix plant, hauling, placing, compaction) and as-built requirements (surface roughness).

In addition, special considerations related to friction courses, stripped surfaces, geometric corrections and treatments that should not be performed on the test sections are addressed in this document.

## TEST SECTIONS

The combinations of experimental factors for the eight SPS-5 test sections, designated Sections 2 through 9, are listed in Table 1. In addition, a control section which does not receive an overlay, designated Section 1, is included in the experiment. The test section numbers shown in this table are used to reference the test sections in the remainder of this document.

Typical cross sections illustrating the combinations of milling and overlay materials for the test sections are presented in Appendix A for illustrative purposes. The details of the cross sections at a test site will probably differ from those shown in Appendix A depending on the characteristics of the existing pavement structure. The participating highway agency must develop the typical sections for the proposed test site following the guidelines outlined in this document.

Table 2 presents a summary of the rehabilitation treatments that should be applied to each test section. The application of these treatments is described in more detail in the following sections of this report.

#### ACTIVITIES ON CONTROL SECTION

Repairs and other activities on the control test section should be limited to only those maintenance activities needed to keep the section in a safe and functional order. Although the project has fallen to a condition level requiring rehabilitation, overlay and extensive repairs on the control section must be avoided at the start of the study. The rate of change in the condition of the control section will be used as an indicator of the change expected on the other test sections had they not been rehabilitated. Also, the change in control section deflection over a short period of time (just before and after overlay) can be used as an indication of the climatic influence on the test sections had they not been overlaid.

When possible, agencies which use seal coats or part of the routine maintenance activities are requested to delay the application of a seal coat on the control section for at least one year from the start of the SPS-5 study. This will allow time for monitoring the change in the condition of the section during this period.

Maintenance activities should be performed on the control test section in accordance with the standard procedures of the agency. These procedures may differ from those described in this document for the overlaid test sections.

In general, maintenance treatments on the SPS-5 control section should be limited to those permitted in "Guidelines for Maintenance of General Pavement Studies' (GPS) Test Sections," SHRP-LTPP-OM-001, July 1988.

Table 1. SPS-5 Test section numbering scheme.

SPS-5 SECTION NO.	PREPARATION	OVERLAY MATERIAL	OVERLAY THICKNESS, inch
1	Routine Maintenance	No Overlay	—
2	Minimum	Recycled HMAC	2
3	Minimum	Recycled HMAC	5
4	Minimum	Virgin HMAC	5
5	Minimum	Virgin HMAC	2
6	Intensive	Virgin HMAC	2
7	Intensive	Virgin HMAC	5
8	Intensive	Recycled HMAC	5
9	Intensive	Recycled HMAC	2

Table 2. Summary of rehabilitation treatments for SPS-5 test sections

TEST SECTION DETAILS	SURFACE PREPARATION								
		Minimal				Intense			
Treatment Options									
Section Number	1	2	3	4	5	6	7	8	9
Overlay Thickness (in)	0	2	5	5	2	2	5	5	2
Overlay Material	-	R	R	V	V	V	V	R	R
Patching	X	X	X	X	X	P	P	P	P
Crack Sealing	X					P	P	P	P
Leveling		A	A	A	A				
Milling		F	F	F	F	X	X	X	X
Seal Coat	B								
<p>R - Recycled Hot Mixed Asphalt Concrete</p> <p>V - Virgin Hot Mixed Asphalt Concrete</p> <p>X - Perform</p> <p>A - If ruts are <math>\geq 1/2</math> inch</p> <p>B - Not permitted in first year of study</p> <p>P - Perform after milling as required</p> <p>F - Milling permitted only to remove open graded friction courses</p>									

## PAVEMENT PREPARATION

In the experimental design, preparation of the existing pavement prior to overlay is classed into two levels: minimal and intensive. This will help evaluate the effect of preparation intensity on the performance of the overlaid pavement. Milling of the surface is the primary difference between the minimal and intensive preparation levels in this experiment.

### Minimal Preparation

The "minimal" level of pavement preparation applies to test Sections 2 through 5 and consists primarily of patching of severely distressed areas and potholes, and placement of leveling course in ruts  $\geq 1/2$  inch deep. Under some circumstances, milling of an existing open graded friction course may be permitted. Edge drain installation or restoration, geometric corrections, seal coats (chip, fog, slurry) and use of geotextiles are not permitted as part of the minimal preparation.

Patching. The following guidelines should be observed for patching of the minimal preparation test sections:

- Localized failed areas which exhibit severe levels of fatigue cracking, potholes, deep depressions ( $\geq 1$  inch) and cracks  $> 0.75$  inch wide shall be repaired with patches.
- Deteriorated and loose material shall be removed to a depth and width necessary to reach sound material.
- The edges of the prepared patch<sup>area</sup> shall be near vertical.
- A tack coat shall be applied to the asphalt concrete surfaces of the prepared patch area.



- Dense graded Hot Mixed Asphalt Concrete (HMAC) patching mixture shall be used for all patches. The material should be placed in lifts and well compacted flush with the surface using either a vibratory plate compactor, roller compactor, or other mechanical compactor suitable for the size of the patch.
- Prior to opening a patch to traffic or placement of an overlay, the temperature of the compacted mix shall be allowed to drop sufficiently to avoid subsequent displacement, shoving or plastic deformations.

Crack Sealing. No crack sealing should be performed on the test sections immediately prior to overlay construction. Any crack sealing performed on a routine basis by maintenance crews should be performed far enough in advance of overlay placement so that the hot overlay material is not adversely affected by an interaction with the crack sealant.

Cracks which are wider than 0.75 inch shall be patched following the guidelines described in this document.

Leveling Course. An asphaltic concrete leveling course shall be placed in ruts greater than 1/2 inch deep prior to overlay. An HMAC material with a maximum 1/2 inch top size aggregate shall be used. This material shall be placed within the depressed rut areas, and not as a thin layer covering the entire surface of the test section, and shall be compacted with pneumatic roller equipment.

Milling. An existing thin (<1 inch) surface friction course on a test section may be removed by milling if prior experience with this material indicate that it is likely to experience stripping, create a weak or deleterious layer in the overlaid pavement structure, or adversely affect the performance of the overlay. The milling operation shall be performed to remove only the friction course. Agencies should contact SHRP if such test sections have significant transverse profile distortion (rutting) and require a significant amount of the dense graded asphalt concrete structural layer to be removed.

In general, milling operation should be performed on the minimal preparation test sections only when it is the agency's standard practice and the agency feels that it is extremely necessary. If required, milling operations should be performed according to the guidelines on milling described in the section of the report "Intensive Preparation", except that the mill depth must be adjusted to the condition of the test sections and the requirements desired above.

### Intensive Preparation

The "intensive" level of preparation applies to test Sections 6 through 9 and includes milling, patching of distressed areas and potholes, and crack sealing. The application of seal coats (chip, fog, slurry) and geotextiles are prohibited on these sections.

Milling. Milling of the pavement surface should be performed on all intensive preparation test sections (Sections 6 through 9) in accordance with the following guidelines:

- Milling shall be performed to a depth of 1 1/2 to 2 inches to remove oxidized or stripped material from the surface and correct transverse distortion due to rutting. This milling operation should be performed in addition to other milling that may be required to remove an existing surface friction course. The milled depth shall be selected so that the final surface is  $\geq$  1/2 inch above or below an interface between material layers.
- Milling equipment must be able to maintain an accurate depth of cut, profile and cross slope. The equipment must employ automatic profile controls to provide positive, definitive grade control. The cutting head shall have a minimum width of 6 feet and be capable of full drum width milling.

- The pavement surface shall be milled such that the transverse cross slope is restored to the initial specifications or that deemed acceptable by agency standards.
- The milling equipment should be operated to provide a uniform texture with no ridges or low spots and to minimize tearing or breaking of the underlying on adjacent pavement surfaces.
- Milled materials shall be loaded directly from the milling machine and removed.
- Full depth milling shall extend a minimum of 25 feet into the transition zones at the beginning and end of the test sections.
- The milled surface shall be cleaned with a power broom prior to any necessary repairs or placement of the tack coat.
- The depth of material removed by milling, excluding any surface friction courses removed, shall be replaced with an equal thickness of HMA overlay material. This material shall be a virgin mix on test Sections 6 and 7 and a recycled mix on test Sections 8 and 9. This depth of replacement material shall not be counted as a part of the overlay thickness specified for the experiment.
- Care shall be taken to insure proper compaction of the refill material in the milled area along the outside longitudinal edge. The roller should be placed so as to "pinch" the material along this edge. Care should be taken to maintain a sealed joint at this location.

Patching. In addition to the patching guidelines described in the section of the report "Minimal Preparation", the following guidelines should also be observed for the test section designated for intensive preparation (Sections 6 through 9):

- Full depth patching shall be performed after milling at locations with potholes, high severity cracking, and other severely distressed areas.
- The surface of the patch shall be level with the surrounding surface.
- Cracks > 3/4 inch wide that are still existing after milling shall be patched.

#### SPECIAL CONSIDERATIONS

The following treatments are specifically not to be performed on any of the test sections:

- Lane widening. Widening of the test lane will alter the characteristics and behavior or performance of the sections and thus "confound" the factors and effects being evaluated.
- Seal coats (Chip, fog, slurry). Seal coats are generally considered as preventive maintenance treatments designed to alter the rate of deterioration of the pavement. This factor is being evaluated in another study (SPS-3, Preventive Maintenance of Asphalt Pavements). Although some agencies place a seal coat as a part of the surface preparation process prior to overlay, it was recommended by the participants of the design workshop not to include seal coats as a factor in this experiment.
- Geotextiles. The use of geotextiles is not included as a factor in this experiment. Geotextiles may be used by participating agencies in supplemental test sections.
- Retro-fitted edge drains. Installation of edge drains are not permitted. Any existing edge drains shall not be excavated or restored.

- Lane addition. Addition of outside lanes are not permitted. The addition of lanes to the inside of the pavement may be permitted if their construction does not alter drainage characteristics across the existing pavement.
- Shoulder Construction. Addition of paved outside shoulders may be permitted provided that they are not integral with the study lane or effectively act as a widened lane.

The foregoing exclusions are not intended to lessen the importance of these treatments in asphalt pavement rehabilitation, but to enable a proper evaluation of the effects of the main study factors in a reasonable size experiment. The inclusion of such factors as geotextiles or lane widening in an uncontrolled basis would confound measurement of the main factor effects included in the study and diminish the results of this experiment. Further, the inclusion of such factors would require a larger size experiment to properly evaluate the effects of these factors on pavement performance.

The following are other special situations or treatments which need to be considered:

- Surface friction courses. Surface friction courses may be used on the test sections if required by the participating agency. In this case, the thickness of the friction course should be limited to 0.75 inch, and should not be considered as part of the thickness of the dense graded asphalt overlay specified for the test section.
- Stripped surfaces. If stripping is present on the control section, treatment with chip, fog, or slurry seals is permissible only if it is the standard practice of the agency for such conditions. If conditions permit, the application of a seal coat to the control sections should be delayed one year from the start of the SPS-5 study. Seal coats are not to be applied on test sections with a minimal level of preparation (Sections 2 through 5). Any severe ravelling associated with stripping

should be repaired with a surface patch on the minimal preparation test section. Any stripping of the pavement surface present on the intensive preparation test sections should be removed by the milling operation.

**ASPHALT CONCRETE MIX DESIGN**

The generic type of hot mixed asphalt concrete material used in the overlays is a main factor in this experiment. Mixtures composed of "virgin" (all new) materials and those containing a portion of recycled asphalt concrete materials are the two chosen levels for this factor.

It is not practical or feasible to specify either the same mix, mix design, or even mix design method for all test locations. To promote uniformity across test sites, design of the asphaltic concrete mixes shall be performed in compliance with the guidelines contained in the FHWA Technical Advisory T 5040.27, "Asphalt Concrete Mix Design and Field Control", March 10, 1988 with the mix design criteria revision to conform to the Asphalt Institute Manual, MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", 1988. A copy of these guidelines are reproduced in Appendix B of this report.

In accordance with the FHWA Technical Advisory and the Asphalt Institute Manual, both the virgin and recycled asphalt concrete mixtures should be designed to the following specifications:

Marshall -	Compaction blows	75
	Stability (Minimum)	1,800
	Flow	8 - 14
Hveem -	Stability (Minimum)	37
	Swell (Maximum)	0.30 in.
Air Voids -		3% - 5%

Agencies using non-standard Hveem or Marshall mix design procedures, should design the mixes to achieve design indices equivalent to those obtained using these standard procedures.

### Virgin Materials

The asphalt concrete designated as "virgin" shall employ new materials which have not been used in previous construction.

Aggregates. Aggregates used in the virgin mixes shall be new aggregates of the highest quality available to the agency. These aggregates shall conform to the following guidelines:

- A minimum of 60% of the crushed coarse aggregate (retained on #4 sieve) with two fractured faces.
- A minimum sand equivalent test of 45 as obtained following AASHTO T 176.
- A dense aggregate gradation.

Asphalt Cement. The asphalt grade and characteristics should be selected by the agency based on normal practice. Asphalt cements with low temperature susceptibility ( $PVN \geq -0.5$ ) are recommended.

Additives. Additives, such as lime, which are routinely used by an agency are permitted in the mix design. Experimental additives or modifiers should not be used in the test sections, but may be used in supplemental test sections.

### Recycled Materials

The asphaltic concrete mix containing recycled asphalt concrete materials shall conform to the following guidelines:

- A fixed 30% of recycled asphalt pavement (RAP) shall be used in the mixture.
- The RAP shall be free of organic or deleterious material.
- RAP containing poor quality aggregates with a history of stripping or high abrasion should not be used.
- All reclaimed coarse aggregate material shall have 100% passing the 1½ inch sieve and a maximum of 25% passing the 3/8 inch sieve.
- Reclaimed crushed fines shall have 100% passing the 3/4 inch sieve and no more than 25% retained on the 3/8 inch sieve.
- Measurement of the composition of the RAP including aggregate gradation, asphalt content, asphalt viscosity (@ 140° and 275° F), and penetration at 77° F should be performed for proper design of the recycled mix.
- New aggregates shall conform to the same specifications as the virgin mix.
- Only asphalt cement shall be added as a binder in the recycled mix.
- Asphalt cement obtained from the same source or supplier as that used in the virgin mix is recommended.
- The use of asphalts with low temperature susceptibility (PVN value  $\geq -0.5$ ) are recommended.
- Rejuvenating agents are not permitted in the recycled asphalt concrete mix.



## CONSTRUCTION OPERATIONS

Construction operations shall be performed in compliance with the guidelines outlined in the FHWA Technical Advisory T 5040.27 and the high quality construction practice employed by the participating agency. Adequate attention should be given to details and control of mix plant, hauling, placement and compaction operations on the test sections to prevent construction practices which are known to result in limited performance. In addition, care should be taken to ensure that the construction of the test sections is performed in a manner consistent with normal highway construction practice.

The following construction related guidelines shall be followed:

- Lift thicknesses shall be limited to a maximum depth of 3 inches.
- If a distinct surface course HMAC mix is used, its layer thickness shall be the same on all test sections (Sections 2 through 9).
- The asphalt concrete mix shall be placed only after the contractor has satisfactorily demonstrated proper placement and compaction procedures on non-test section locations.
- Longitudinal joints shall be located within 1 foot of the center of a lane or within 1 foot of the center of two adjacent lanes.
- All transverse ~~joints~~ construction joints shall be placed outside the test sections, e.g. within the transitions between test sections.
- The as-compacted thickness of the asphalt concrete overlay (surface plus binder course) in the test sections shall be constructed to within  $\pm 1/4$  inch of the values specified in the experiment design (i.e.  $2 \pm 1/4$  and  $5 \pm 1/4$  inch).

- The finished surface of the overlay should be smooth and provide an excellent ride level. As a target, the as-constructed surface should have a pro-rated profile index of less than 10 inches per mile as measured by a California type Profilograph and evaluated following California Test 526.

#### DEVIATIONS FROM GUIDELINES

An agency that desires to participate in the SPS-5 experiment but finds it necessary to deviate from some of the guidelines described in the report should review these deviations with the SHRP Regional Office or SHRP headquarters. SHRP will assess the implications of these deviations on the study objectives. If the implications of the non-compliance appear minimal, the deviations will be accepted, otherwise SHRP will suggest alternatives for consideration by the participating agency.

APPENDIX A

TYPICAL PAVEMENT SECTIONS  
FOR SPS-5 EXPERIMENT,  
REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

APPENDIX A - TYPICAL PAVEMENT SECTIONS FOR SPS-5 EXPERIMENT,  
REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

The typical cross sections presented in this document were developed for the hypothetical existing pavement structure shown in Figure A1. The depicted pavement structure is two lanes of a four lane divided highway structure with a crowned cross section. The pavement structure is assumed to consist of an untreated aggregate base, a plant mix bituminous base, and a hot mixed asphaltic concrete (HMAC) layer covered with a 1.5 inch surface course. Since no rehabilitation treatments will be applied to the control section at the start of the study, this figure also represents the cross section of the control section (Section 1).

The typical sections for the test sections with minimal surface preparation treatments are shown in Figures A2 through A5. These are the sections which are not milled. The specific layer combinations and thicknesses shown in these figures illustrate the expected test section cross sections. Participating agencies may alter some of the cross section details to meet local design and construction practice, but must stay within the limits defined in this document.

Section 2, shown in Figure A2, is the test section with a 2 in. thick recycled HMAC overlay. Because of the small thickness of this layer (<3.0 inch) the overlay is shown as composed entirely of a surface course mixture. A recycled HMAC binder course mixture topped with a surface treatment is shown for level up of the shoulders.

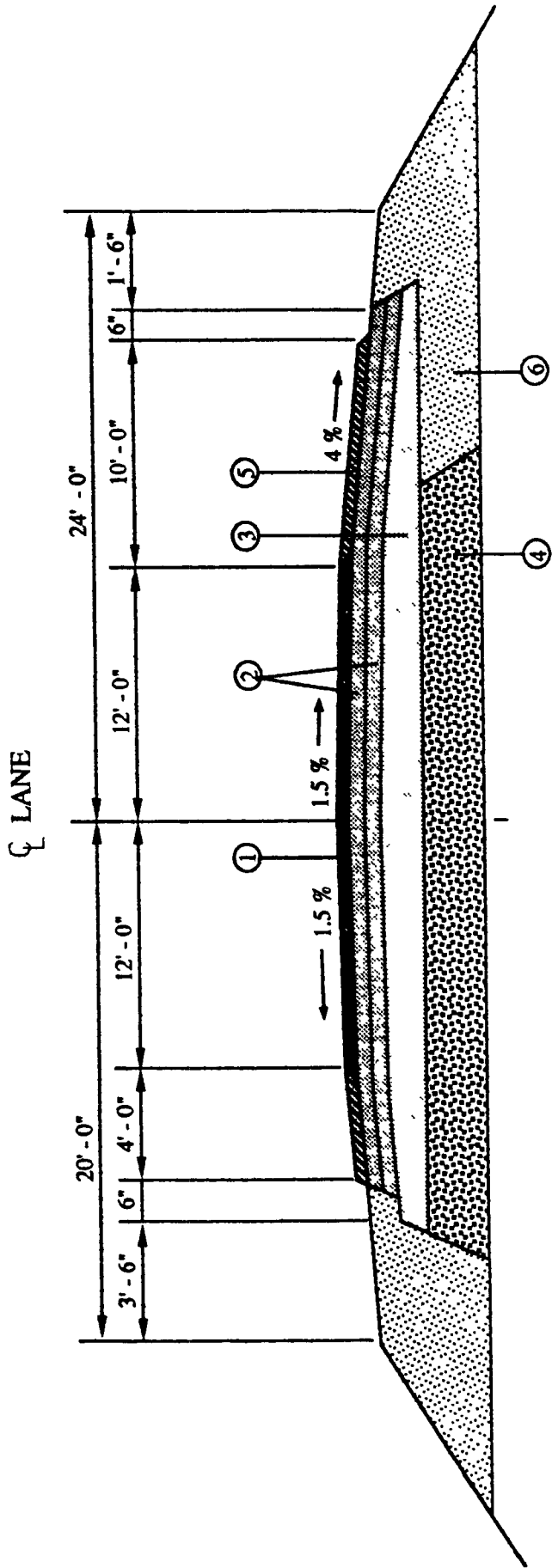
Figure A3 illustrates Section 3, the test section with a 5 in. thick recycled HMAC overlay. The AC overlay consists of a 2 in. recycled AC surface course and two 1½ in. thick lifts of recycled AC binder course. Three 1½ in. thick lifts of recycled AC binder course topped with a surface treatment are shown for the shoulders. Alternately, the two 1 1/2 in. thick lifts can be substituted with one 3 in. thick lift.

Sections 4 and 5 are similar to Sections 3 and 2, respectively, except that "virgin" HMAC materials are used in the overlay payment structure. Sections 4 and 5, shown in Figures A4 and A5, respectively.

Details of the shoulder joints for Sections 2 through 5 are shown in Figure A6.

Sections 6 through 9, shown in Figures A7 through A10, involve intensive surface preparation which require milling of 1 to 2 inch of the existing surface. For the study case, milling of 2 inches of the pavement surface is shown for these sections. On this hypothetical pavement section, the existing surface course and 1/2 inch of the binder course are removed. The milled area is replaced with an equal thickness (i.e. a 2 inch lift) of either recycled or virgin AC binder course material, depending on the test section. The details of the overlay placed on top of this lift are the same as those of the corresponding test sections not requiring milling.

Figure A11 presents the details of the shoulder joints for Sections 6 through 9.

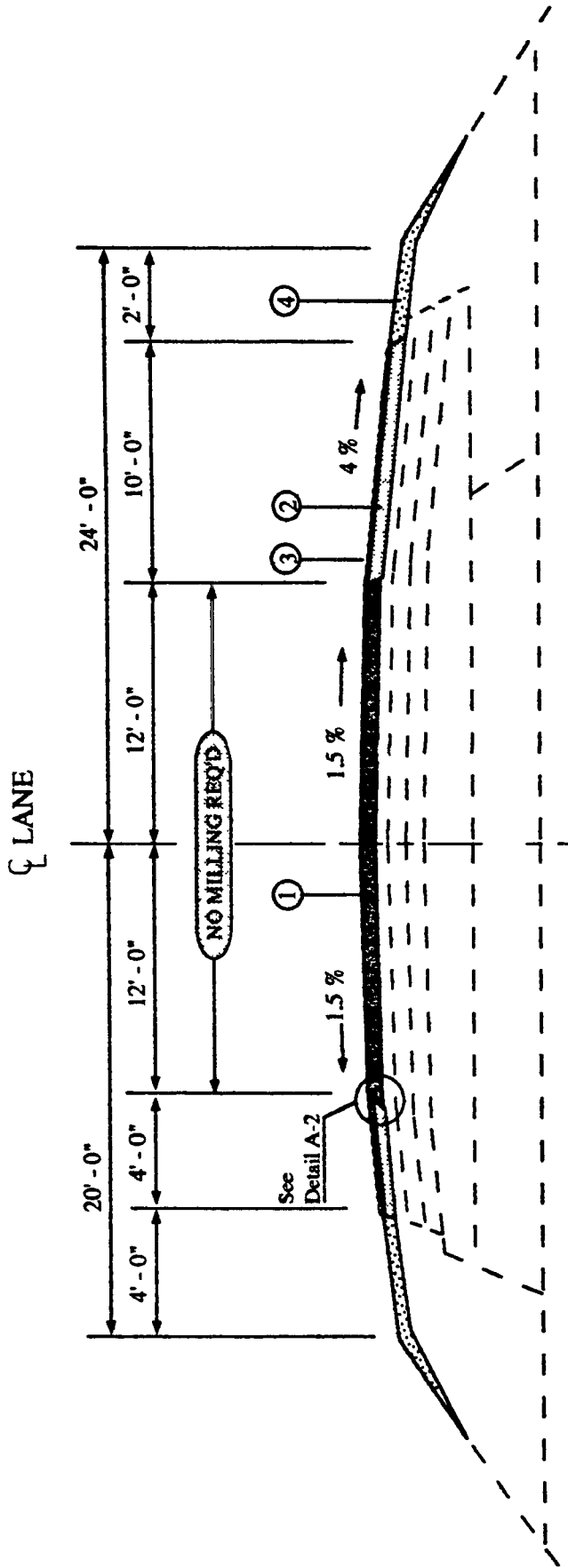


A-3

LEGEND

- (1.) 1 1/2" HMA Surface Course
- (2.) 4" HMA Surface Binder Course (2 @ 2")
- (3.) 4" Plant Mix Bituminous Base
- (4.) 6" Aggregate Base
- (5.) Double Bituminous Surface Treatment
- (6.) Select variable thickness granular fill

Figure A 1. SPS-5 section 1, control section - routine maintenance - no overlay.

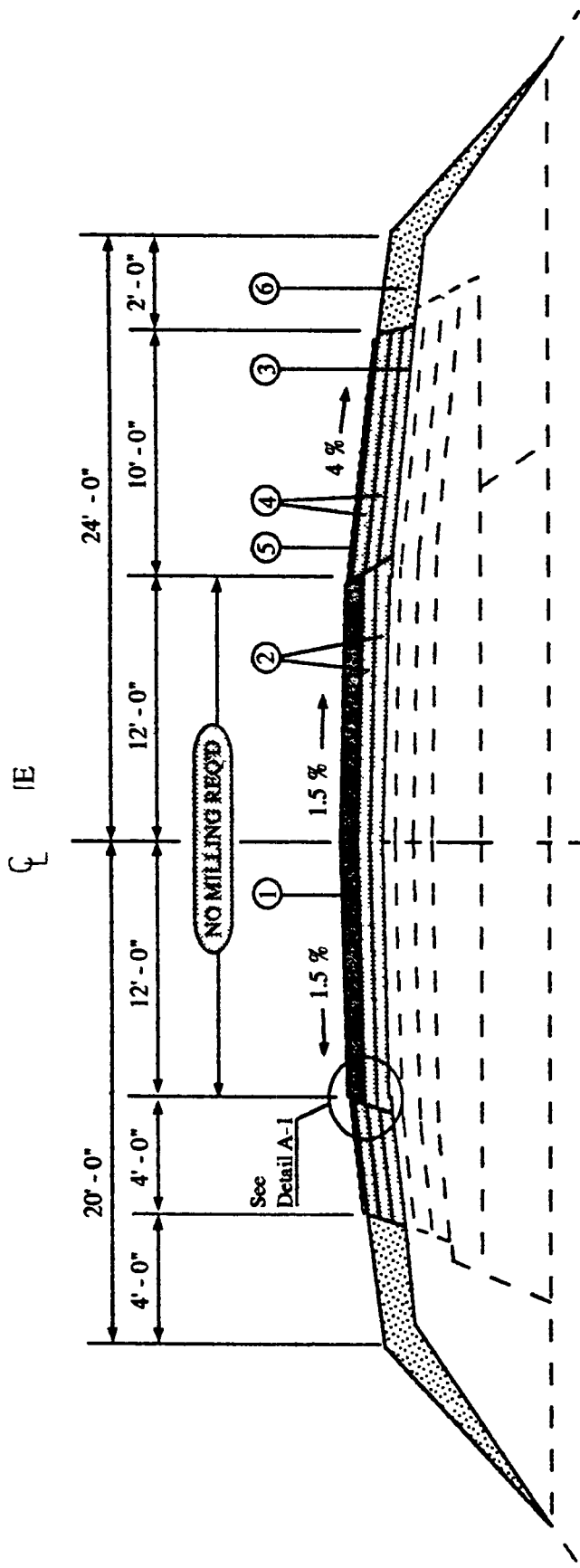


A-4

LEGEND

- (1.) 2" Recycled HMAC Surface Course
- (2.) 1 1/2" and variable depth Recycled HMAC Binder Course
- (3.) Single Bituminous Surface Treatment
- (4.) 1 1/2" and variable depth granular material
- - - - Existing pavement structure

Figure A 2 SPS-5 section 2, 2 inch recycled AC overlay, no milling.



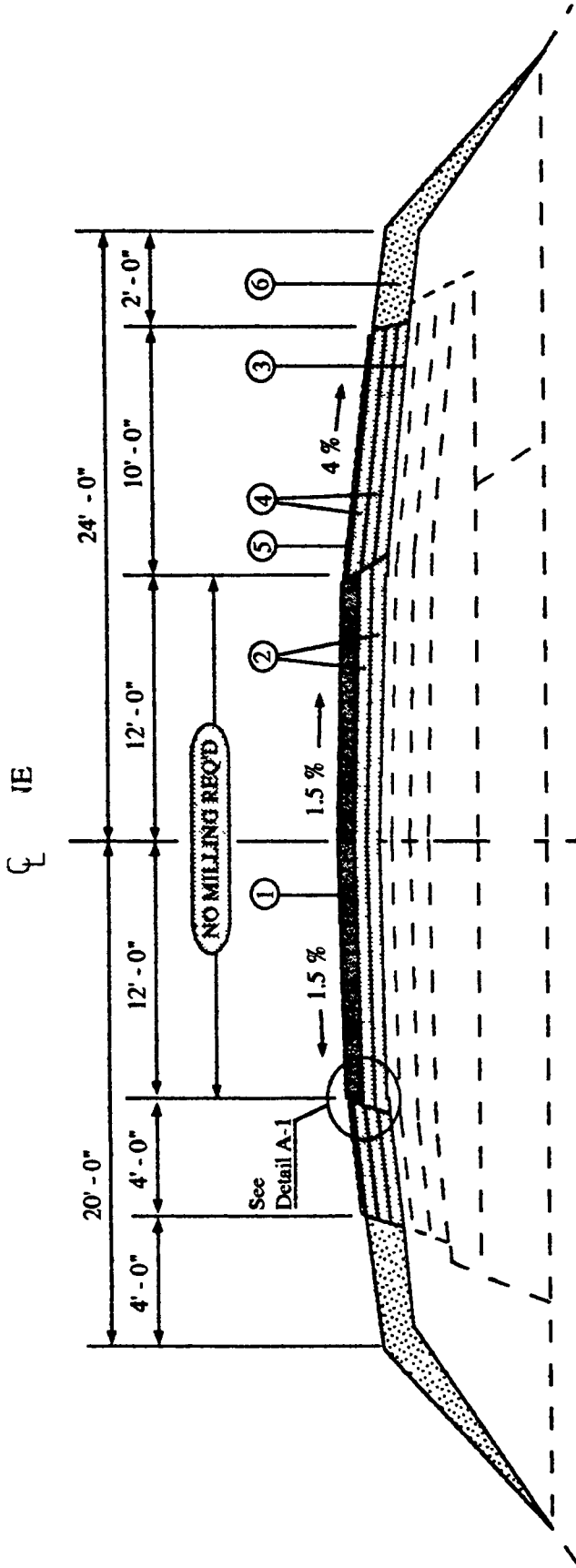
A-5

LEGEND

- (1.) 2" Recycled HMAC Surface Course
- (2.) 3" and variable depth Recycled HMAC Binder Course (2 @ 1 1/2")
- (3.) 1 1/2" and variable depth Recycled HMAC Binder Course
- (4.) 3" Recycled HMAC Binder Course (2 @ 1 1/2")
- (5.) Single Bituminous Surface Treatment
- (6.) 4 1/2" and variable depth granular material
- - - Existing pavement structure

Figure A 3 SPS-5 section 3, 5 inch recycled AC overlay, no milling.

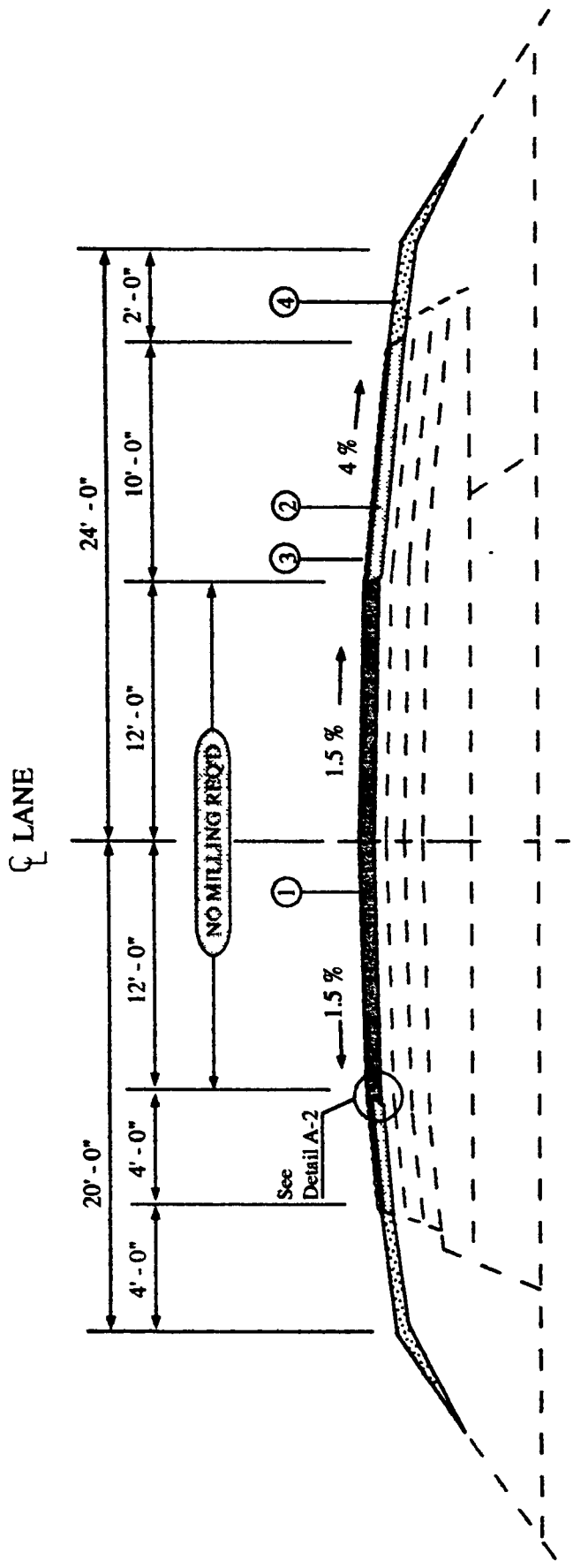




**LEGEND**

- (1.) 2" HMAC Surface Course
- (2.) 3" and variable depth HMAC Binder Course (2 @ 1 1/2")
- (3.) 1 1/2" and variable depth Hot Bituminous Pavement Binder Course
- (4.) 3" HMAC Binder Course (2 @ 1 1/2")
- (5.) Single Bituminous Surface Treatment
- (6.) 4 1/2" and variable depth granular material
- - - Existing pavement structure

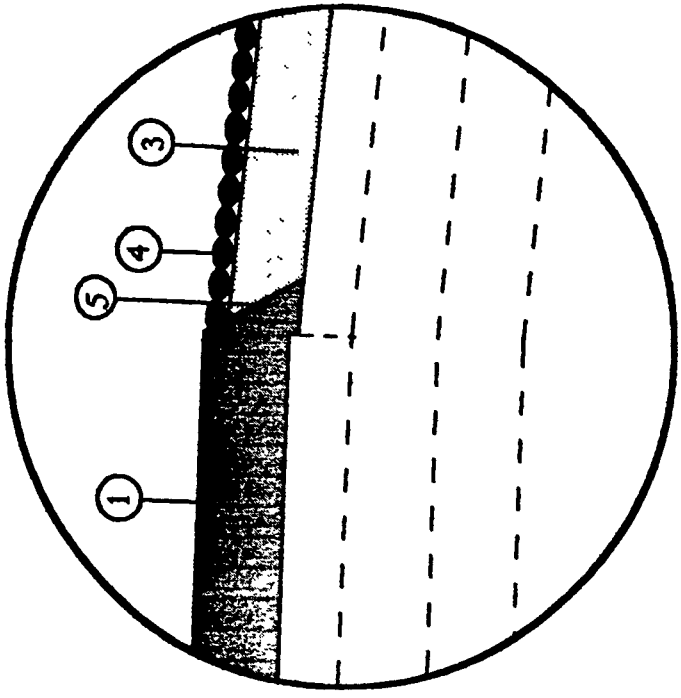
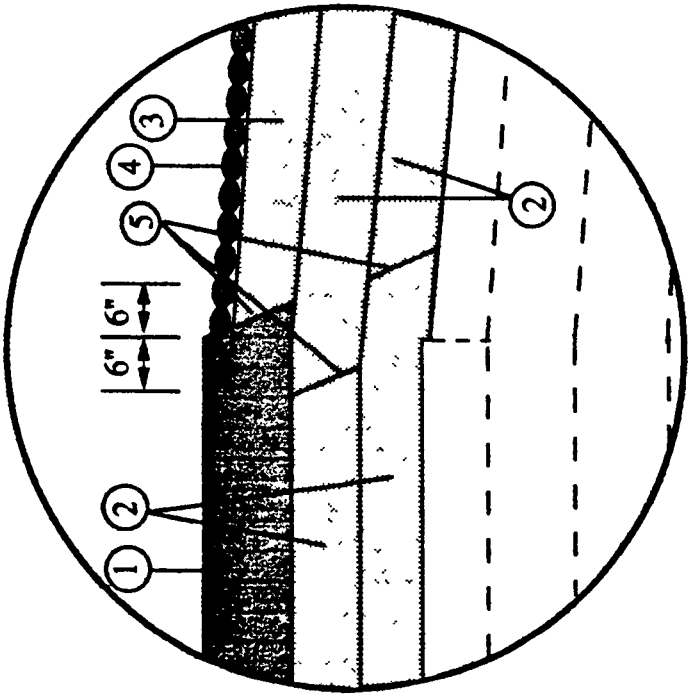
Figure A 4. SPS-5 section 4, 5 inch AC overlay, no milling.



LEGEND

- (1.) 2" HMAC Surface Course
- (2.) 1 1/2" and variable depth HMAC Binder Course
- (3.) Single Bituminous Surface Treatment
- (4.) 1 1/2" and variable depth granular material
- -- Existing pavement structure

Figure A 5. SPS-5 section 5, 2 inch AC overlay, no milling.



LEGEND

- ① 2" HMAC Surface Course
- ② 3" HMAC Binder Course (2 @ 1 1/2")
- ③ 1 1/2" HMAC Binder Course
- ④ Single Bituminous Surface Treatment
- ⑤ Angle of Repose Permitted
- Existing Pavement Structure

Figure A 6. Typical shoulder joint detail, non-milled sections.

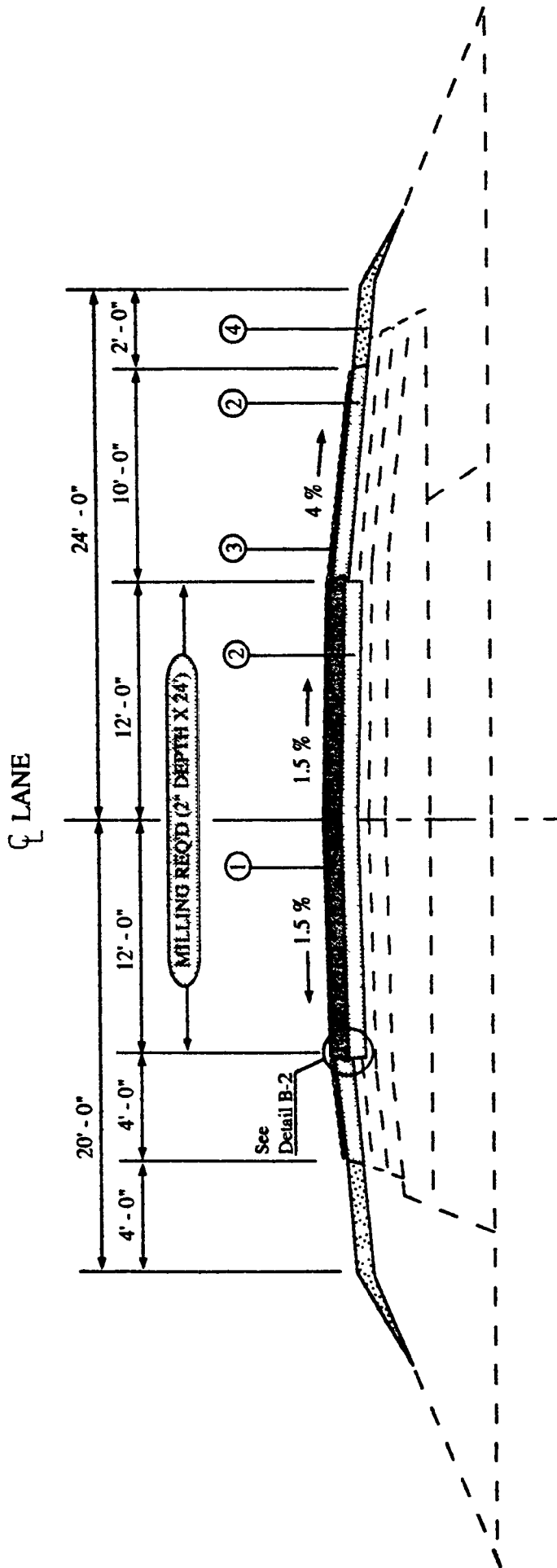


Figure A 7. SPS-5 section 6, 2 inch AC overlay with milling.

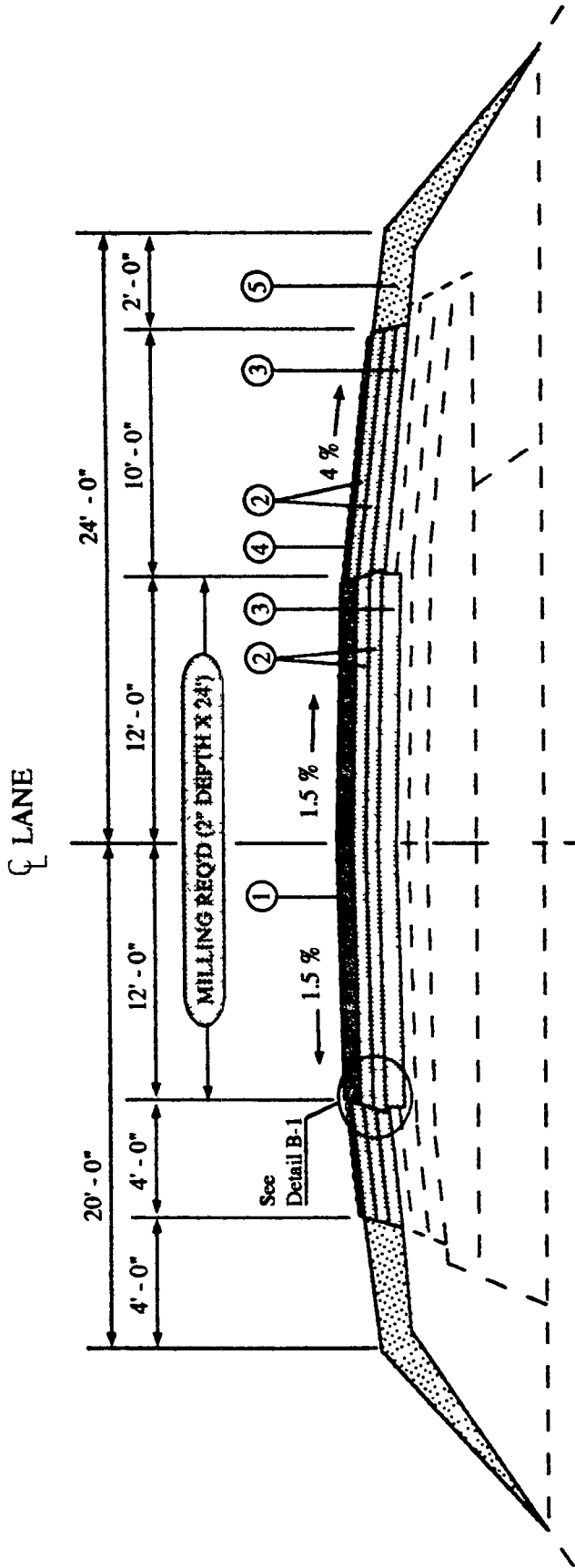
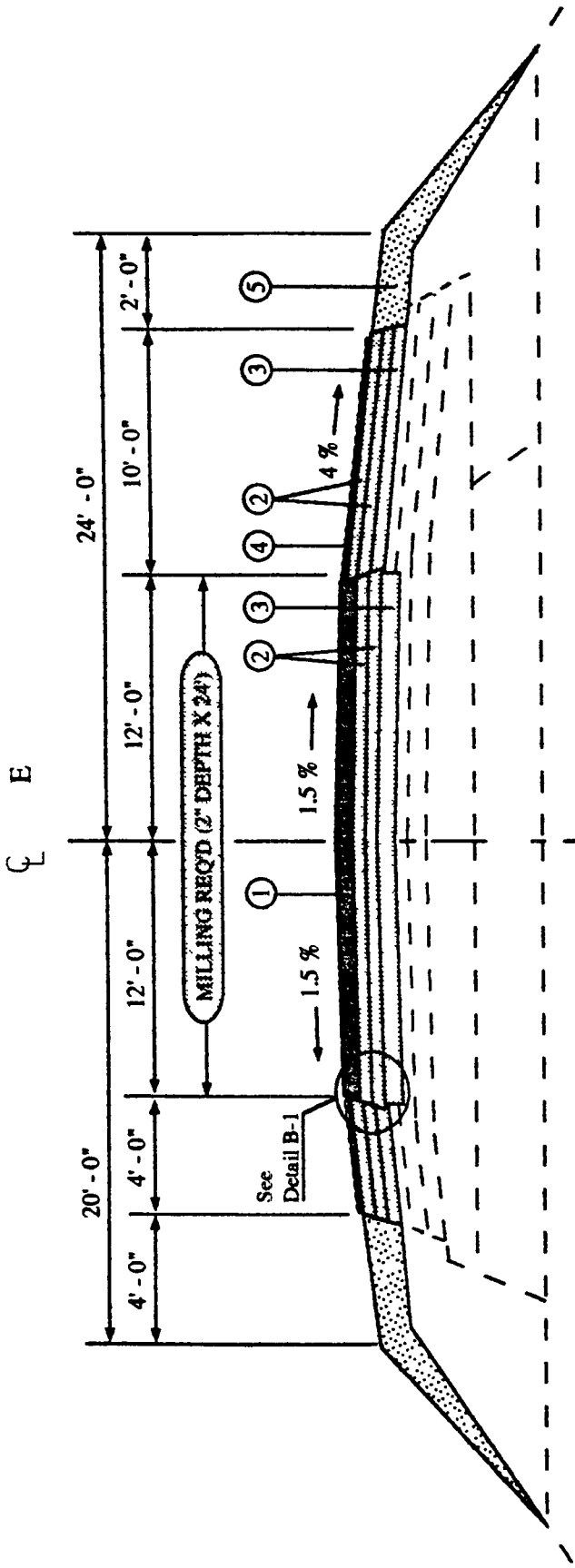


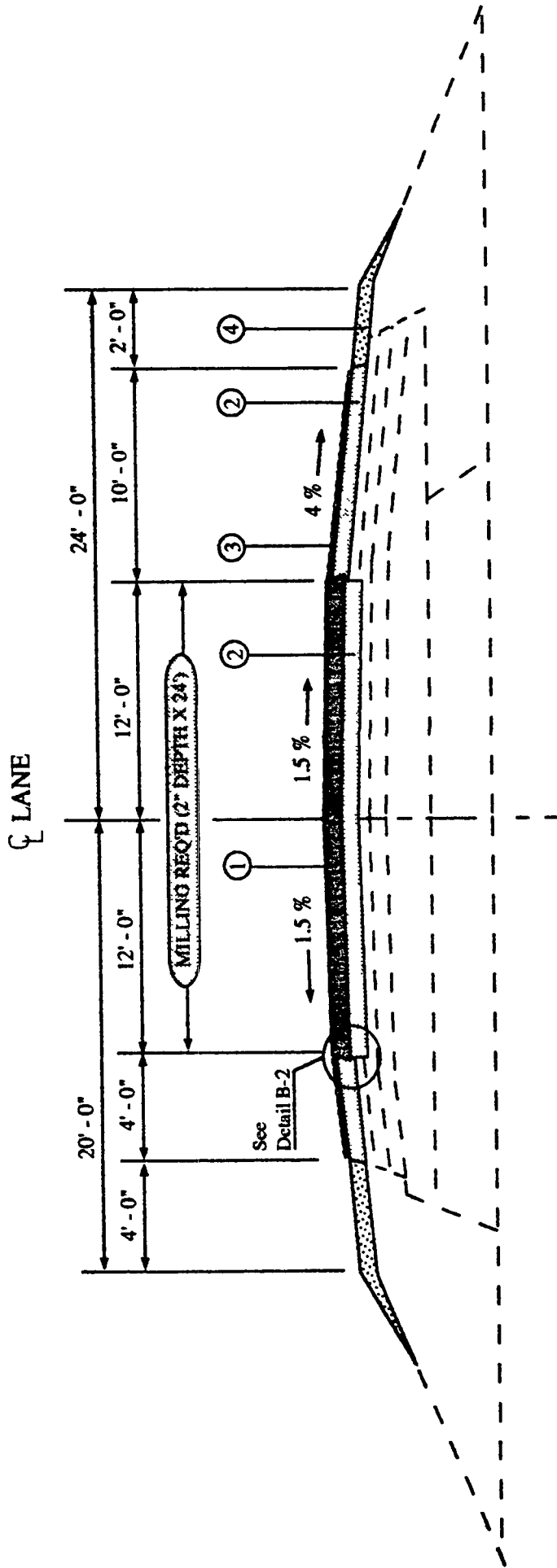
Figure A 8. SPS-5 section 7, 5 inch AC overlay with milling.



LEGEND

- (1.) 2" Recycled HMAC Surface Course
- (2.) 3" Recycled HMAC Binder Course (2 @ 1 1/2")
- (3.) 2" and variable depth Recycled HMAC Binder Course
- (4.) Single Bituminous Surface Treatment
- (5.) 5" and variable depth granular material
- - - - Existing pavement structure

Figure A.9. SPS-5 section 8, 5 inch recycled AC overlay with milling.

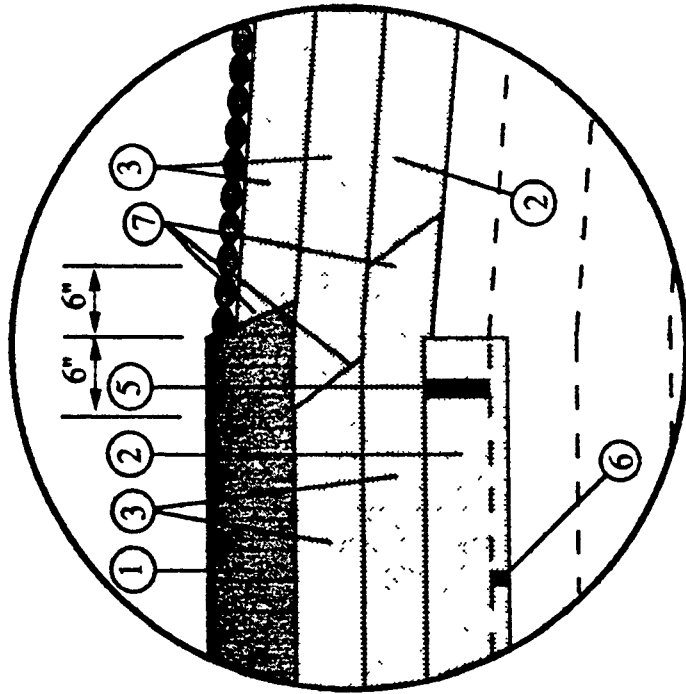


A-12

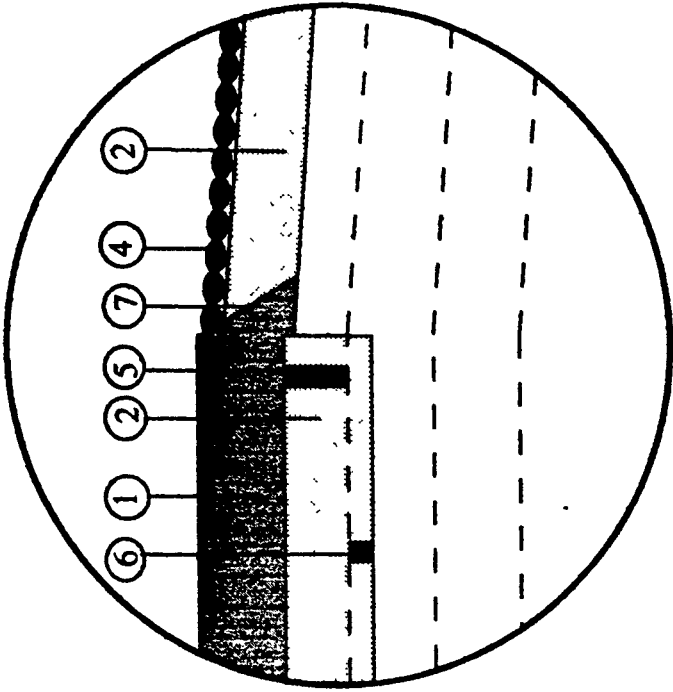
LEGEND

- (1.) 2" Recycled HMAC Surface Course
- (2.) 2" and variable depth Recycled HMAC Binder Course
- (3.) Single Bituminous Surface Treatment
- (4.) 2" and variable depth granular material
- Existing pavement structure

Figure A 10. SPS-5 section 9, 2 inch recycled AC overlay with milling.



Shoulder Detail B-1  
Milled Sections, 5" overlay



Shoulder Detail B-2  
Milled Sections, 2" overlay

LEGEND

- ① 2" HMA Surface Course
- ② 2" HMA Binder Course
- ③ 3" HMA Binder Course (2 @ 1 1/2")
- ④ Single Bituminous Surface Treatment
- ⑤ 1 1/2" Existing HMA Surface Course milled
- ⑥ Top 1/2" of Existing HMA Binder Course milled
- ⑦ Angle of Repose Permitted
- Existing Pavement Structure

Figure A 11. SPS-5 Typical shoulder joint detail, milled sections.



APPENDIX B

ASPHALT CONCRETE MIX DESIGN AND FIELD CONTROL

FHWA Technical Advisory T 50540.27

March 10, 1988



state-of-the-art in materials, mix design, plant operation, laydown and compaction, and other areas relating to quality hot-mix asphalt pavements.

#### 4. MATERIALS

- a. Aggregate is the granular material used in asphalt concrete mixtures which make up 90-95 percent of the mixture weight and provides most of the load bearing characteristics of the mix. Therefore, the quality and physical properties of the aggregates are critical to the pavement performance. The following is recommended:
- (1) Aggregates should be non-plastic. The presence of clay fines in an asphalt mix can result in problems with volume swell and adhesion of asphalt to the rock contributing to stripping problems. The minus #4 sieve material should have a minimum sand equivalent value of 45 using the test method described in the American Association of State Highway and Transportation Officials (AASHTO) specification (AASHTO T176).
  - (2) A limit should be placed on the amounts of deleterious materials permitted in the aggregates. Specifications should limit clay lumps and friable particles to a maximum of one percent.
  - (3) Durability or weathering resistance should be determined by sulfate soundness testing. Specifications should require a sodium or magnesium sulfate test using the limits described in the AASHTO specification M29.
  - (4) Aggregate resistance to abrasion should be determined. Specifications should require a Los Angeles abrasion loss of 45 percent or less (AASHTO T96).
  - (5) Friction between aggregate particles is dependent on aggregate surface roughness and area of contact. As surface friction increases, so does resistance of the mix to deformation. Specifications should require at least 60 percent of the plus #4 sieve material to have at least two mechanically induced fractured faces.
  - (6) The quality of natural sand varies considerably from one location to another. Since most natural sands are rounded and often contain a high percentage of undesirable materials, the amount of natural sand as a general rule should be limited to 15 to 20 percent for high volume pavements and 20 to 25 percent for medium and low volume pavements. These percentages may increase or decrease depending on quality of the natural sand and the types of traffic to which the pavement will be subjected.

- (7) For adequate control, aggregate gradations should be specified from the maximum particle size to the #200 sieve so each successive sieve opening is about 1/2 the previous sieve opening (for example, 1 inch, 1/2 inch, #4, #8, #16, #30, #50, #100, #200). The only accurate method to determine the amount of minus #200 sieve material is to perform a wash gradation in accordance with AASHTO T27 and AASHTO T11.
- (8) The ratio of dust (minus #200 sieve material) to asphalt cement, by mass, is critical. Asphalt concrete mixes should require a maximum dust asphalt ratio of 1.2 and a minimum of 0.6.
- (9) A tool which is very useful in evaluating aggregate gradations is the 0.45 power gradation chart. All mixes should be plotted on these charts as part of the mix design process (Attachment 1).
- (10) An aggregate's specific gravity and absorption characteristics are extremely important in proportioning and controlling the mixture. It is recommended that AASHTO T209 be used to determine the maximum specific gravity of asphalt concrete mixes. States not using AASHTO T209 should be aware of the difficulty of determining the theoretical maximum density using individual ingredient specific gravities and their percentages in the mixture. These difficulties will result in inaccuracies in determining the specific gravity of the mixture. These inaccuracies will carry through to the calculation of the densities in the compacted mat and may result in improperly compacted pavements. It is also necessary to determine the bulk dry specific gravity of the aggregate in order to determine the voids in the mineral aggregate (VMA).

The target value for VMA should be obtained through the proper distribution of aggregate gradation to provide adequate asphalt film thickness on each particle and accommodate the design air void system. In addition, tolerance used in construction quality control should be such that the mix designed is actually produced in the field.

- b. Asphalt grade and characteristics are critical to the performance of the asphalt pavement. The following is recommended:
  - (1) Grade(s) of asphalt cement used in hot-mix paving should be selected based on climatic conditions and past performance.

- (2) It is recommended that asphalt cement be accepted on certification by the supplier (along with the testing results) and State project verification samples. Acceptance procedures should provide information on the physical properties of the asphalt in a timely manner.
- (3) The physical properties of asphalt cement that are most important to hot-mix paving are shown below. Each State should obtain this information (by central laboratory or supplier tests) and should have specification requirement(s) for each property except specific gravity.
- (a) Penetration 77° F
  - (b) Viscosity 140° F
  - (c) Viscosity 275° F
  - (d) Ductility/Temperature
  - (e) Specific Gravity
  - (f) Solubility
  - (g) Thin Film Oven (TFO)/Rolling TFO; Loss on Heating
  - (h) Residue Ductility
  - (i) Residue Viscosity
  - (j) Low temperature cracking is related to the physical properties of the asphalt and may be increased by the presence of wax in the asphalt. The low temperature ductility test at 39.2° F (4° C) can indicate where this may be a problem. The test is performed at a pull speed of 1 cm/min. Typical specification requirements are:

AASHTO M226	Table 2
AC 2.5	50 + cm
AC 5	25 + cm
AC 10	15 + cm
AC 20	5 + cm

- (4) The temperature viscosity curves or absolute and kinematic viscosity information should be available at the mixing plant for each shipment of asphalt cement. This can identify a change in asphalt viscosity which necessitates a new mix design. Each State should provide temperature/viscosity information on the asphalt used in the laboratory mix design to the projects. Differences in the viscosity (as well as the penetration) of the asphalt from the asphalt used in the mix design may indicate the necessity to redesign the mix (Attachment 2).

5. MIX DESIGN

- a. Asphalt concrete mixes should be designed to meet the necessary criteria based on type of roadway, traffic volumes, intended use, i.e., overlay on rigid or flexible pavements, and the season of the year the construction would be performed. Each State's mix design criteria should be as follows.

Property	Heavy Traffic Design (>1,000,000 ESAL*)	Medium Traffic Design (10,000-1,000,000 ESAL)	Light Traffic Design (<10,000 ESAL)
<b>Marshall</b>			
Compaction Blows	<u>75</u>	<u>50</u>	<u>35</u>
Stability (min.)	<u><del>1,500</del> 1,800**</u>	<u><del>750</del> 1,200**</u>	<u><del>500</del> 750**</u>
Flow	<u><del>8-16</del> 14**</u>	<u><del>8-18</del> 16**</u>	<u><del>8-20</del> 18**</u>
<b>Hveem</b>			
Stability (min.)	<u>37</u>	<u>35</u>	<u>30</u>
Swell (max)**	<u>0.030 in.</u>	<u>0.030 in.</u>	<u>0.030 in.</u>
<b>Void Analysis</b>			
Air Voids	<u>3-5</u>	<u>3-5</u>	<u>3-5</u>

\* Equivalent Single Axle Load

\*\* Revised to conform to the Asphalt Institute MS-2, Table III-2, 1988

MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE (VMA)

Nominal Maximum Particle Size U.S.A. Standard Sieve Designation	Minimum Voids in Mineral Aggregate Percent
No. 16	23.5
No. 8	21
No. 4	18
3/8 in.	16
1/2 in.	15
3/4 in.	14
1 in.	13
1-1/2 in.	12
2 in.	11.5
2-1/2 in.	11

- b. Standard mix design procedures (Marshall, Hveem) have been developed and adopted by AASHTO, however, some States have modified these procedures for their own use. Any modification from the standard procedure should be supported by correlation testing for reasonable conformity to the design values obtained using the standard mix design procedures.
- c. Stripping in the asphalt pavements is not a new phenomenon, although the attention to it has intensified in recent years. Moisture susceptibility testing should be a part of every State's mix design procedure. The "Effect of Water on Compacted Bituminous Mixtures" (immersion compression test) (AASHTO T165) and "Resistance of Compacted Bituminous Mixture to Moisture Induced Damage" (AASHTO T283) are currently the only stripping test procedures which have been adopted by AASHTO. The AASHTO T283, commonly known as the Lottman Test, requires that the test specimens be compacted so as to have an air void content of  $7 \pm 1$  percent, while AASHTO T165 does not. This air void content is what one would expect in the mat after construction compaction. There is considerable research underway on developing better tests for determining moisture damage susceptibility of the aggregate asphalt mixtures. One of the most promising test procedures is that developed by Tunnickliff and Root as reported in the National Cooperative Highway Research Program (NCHRP) Report 274. This test is similar to AASHTO T283, but it takes less time to perform. In the majority of cases hydrated lime and portland cement have proven to be the most effective anti-stripping additives.

- d. The determination of air voids in the laboratory mix is a critical step in designing and controlling asphalt hot-mix. In order to determine air voids, the theoretical maximum density or the maximum specific gravity of the mix must be determined. This can be accomplished by using the "Maximum Specific Gravity of Bituminous Paving Mixtures" (Rice Vacuum Saturation) (AASHTO T209).
- e. Proper mix design procedures require that each mix be designed using all of the actual ingredient materials including all additives which will be used on the project.
- f. The complete information on the mix design should be sent to the plant. The following information should be included in the mix design report and sent to the plant.
  - (1) Ingredient materials sources
  - (2) Ingredient materials properties including:
    - (a) Specific gravities
    - (b) L. A. Abrasion
    - (c) Sand equivalent
    - (d) Plastic Index
    - (e) Absorption
    - (f) Asphalt temperature/viscosity curves or values
  - (3) Mix temperature and tolerances
  - (4) Mix design test property curves
  - (5) Target asphalt content and tolerances
  - (6) Target gradations for each sieve and tolerances
  - (7) Plot of gradation on the 0.45 power gradation chart, and
  - (8) Target density



- g. Formal procedures should be established to require that changes to mix designs be approved by the same personnel or office that developed the original mix design.
- h. After start-up, the resulting mixture should be tested to verify that it meets all of the design criteria.

## 6. PLANT OPERATIONS

- a. In order to assure proper operation, an asphalt plant must be calibrated and inspected. Plant approval should be required and should cover each item on the asphalt plant checklist (Attachment 3).
- b. To avoid or mitigate unburned fuel oil contamination of the asphalt mixture, the use of propane, butane, natural gas, coal or No. 1 or No. 2 fuel oils is recommended.
- c. If the asphalt cement is overheated or otherwise aged excessively, the viscosity of the recovered asphalt will exceed that of the original asphalt by more than four times. However, if the viscosity of the recovered asphalt is less or even equal to the original viscosity, it has probably been contaminated with unburned fuel oil.
- d. For drum mixer and screenless batch plants there should be three separate graded stockpiles for surface courses and four for binder and base courses. Each stockpile should contain between 15 to 50 percent by weight of the aggregate size in the mix design. The plus #4 sieve aggregate stockpile should be constructed in lifts not exceeding 3 feet to a maximum height of 12 feet. There should be enough material in the stockpiles for at least 5 days of production. The plant should be equipped with a minimum of four cold feed bins with positive separation.
- e. Control testing of gradation and asphalt content should be conducted to assure a quality and consistent mixture. In many States, the contractor or supplier is required to do this testing.
- f. Acceptance testing should be conducted for gradation and asphalt content of the final mixture.
- g. The plotting of control and acceptance test results for gradation, asphalt content, and density on control charts at the plant provides for easy and effective analysis of test results and plant control.

- h. The moisture content of the aggregate must be determined for proper control of drum mixer plants. The asphalt content is determined by the total weight of the material that passes over the weigh bridge with the correction made for moisture. Sufficient aggregate moisture contents need to be performed throughout the day to avoid deviations in the desired asphalt content.
- i. Moisture contents of asphalt mixtures is also important. The extraction and nuclear asphalt content gauge procedures will count moisture as asphalt. For this reason, a moisture correction should be made. In addition, high moisture contents in asphalt mixtures can lead to compaction difficulty due to the cooling of the mix caused by evaporation of the moisture. This is particularly important with drum mixer mixes which require moisture for the mixing process. Some States specify a maximum moisture content behind the paver. A recommended maximum moisture content behind the paver is 0.5 percent.

#### 7. LAYDOWN AND COMPACTION

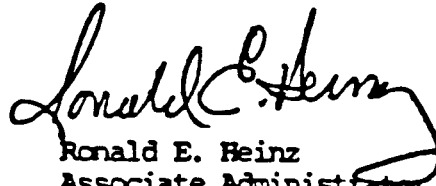
- a. Prior to paving start-up, equipment should be checked to assure its suitability and proper function. Project equipment approval should include the items shown on the project inspection checklist (Attachment 4).
- b. Paving start-up should begin with a test strip section. This will allow for minor problems to be solved, establishment of roller patterns and number of passes, and will assure that proper placement and compaction can be attained.
- c. In order to assure proper placement and compaction, it is essential that the mat be placed hot. Establishment of and compliance with the following items should be included; minimum mix, underlying pavement, and ambient temperatures. Cold weather and early or late season paving should be avoided. The practice of raising the temperature of the mixture to combat the cold conditions should not be permitted, as this will contribute to excessive aging of the asphalt cement.
- d. The use of a pneumatic roller in the compaction process is strongly encouraged. When used in the intermediate rolling it will knead and seal the mat surface and aid in preventing the intrusion of surface water into the pavement layers. It will also contribute to the compaction of the mat.

- e. Density requirements should be established to result in an air void system in the mat of 6-8 percent immediately after construction. This allows for the inherent additional densification under traffic to an ultimate air void content of about 3-5 percent. Density acceptance specifications should require a percentage of maximum density as determined by AASHTO T209. A percentage of test strip density or Marshall laboratory density can be used provided each is related to the maximum density. The specified density should be attained before the mat temperature drops below 175° F.
- f. Density measurement should be accurate, taken frequently, and the results made available quickly for each day of production. Density should be determined by test cores, or by properly calibrated nuclear test gauges. Specifications should require several tests to be averaged to determine density results for acceptance.
- g. Successive hot-mix courses should not be placed while previous layers are wet. To avoid, or minimize the penetration of water into base and binder courses, paving operations should be scheduled so that the surface layer(s) is placed within a reasonable period after these courses are constructed. To the greatest extent possible, construction should be planned to avoid the necessity of leaving layers uncovered during wet seasons of the year.

#### 8. MISCELLANEOUS

- a. Some States have established procedures to accept out-of-specification material and pavement with a reduction in price. These procedures include definition of lot size/production time, tolerances, and pay factor reductions for ingredient materials, combined mixture properties, pavement density, pavement smoothness, and lift thickness.
- b. Prior to the start of production and placement operations, a preplacement conference, including all the paving participants, should be held. This conference would define duties and responsibilities for each phase of the operation as well as problem solving procedures.
- c. During start-up it is very effective to have a construction and/or materials specialist at the project site to assist in identifying and solving any problem that develops.

- d. Because asphalt hot-mix pavement construction is complex, it requires that each person involved understand his/her function thoroughly. It is also helpful if each person has a basic understanding of each of the many phases involved. It is recommended that States develop or use existing training to address these phases of asphalt paving.



Ronald E. Heinz  
Associate Administrator for  
Engineering and Program Development

4 Attachments

## AGGREGATE GRADATION

It has long been established that gradation of the aggregate is one of the factors that must be carefully considered in the design of asphalt paving mixtures, especially for heavy duty highways. The purpose in establishing and controlling aggregate gradation is to provide sufficient voids in the asphalt aggregate mixture to accommodate the proper asphalt film thickness on each particle and provide the design air void system to allow for thermal expansion of the asphalt within the mix. Minimum voids in the mineral aggregate (VMA) requirements have been established and vary with the top aggregate size.

Traditionally, gradation requirements are so broad that they permit the use of paving mixtures ranging from coarse to fine and to either low or high stability. To further complicate matters, different combinations of sieve sizes are specified to control specific grading ranges. Standardization of sieve sizes and aggregate gradations, which has often been suggested, is not likely to occur because of the practice of using locally available materials to the extent possible.

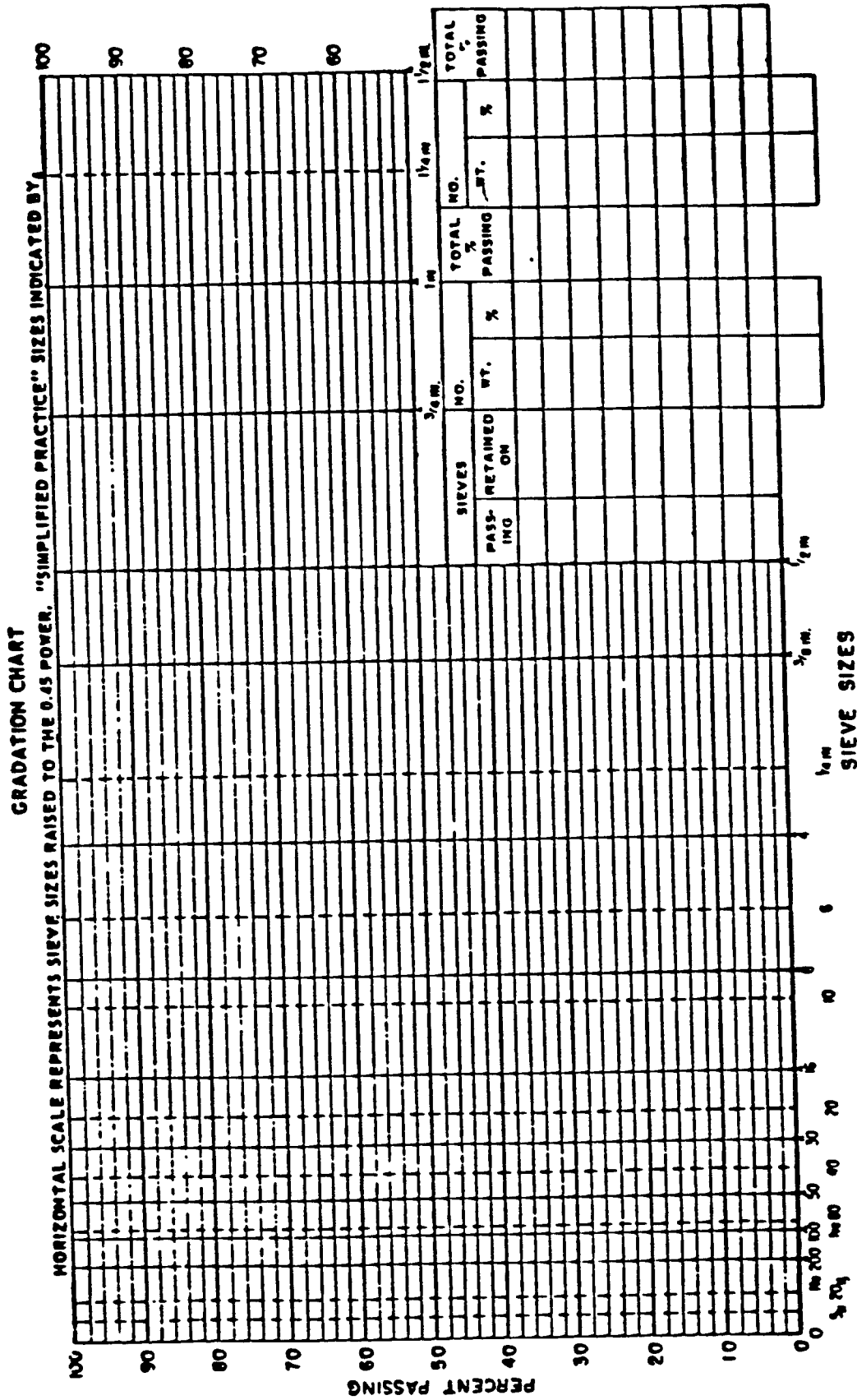
In the early 1960's, the Bureau of Public Roads introduced a gradation chart (Figure #1) which is especially useful in evaluating aggregate gradations. The chart uses a horizontal scale which represents sieve size openings in microns raised to the 0.45 power and a vertical scale in percent passing. The advantage in using this chart is that, for all practical purposes, all straight lines plotted from the lower left corner of the chart, upward and toward the right to any specific nominal maximum particle size, represent maximum density gradations. The nominal maximum particle sieve size is the largest sieve size listed in the applicable specification upon which any material is permitted to be retained. An example is shown in Figure #2.

The gradations depicted in Figure #3 and #4 are exaggerated to illustrate the points being made. By using the chart, aggregate gradations can be related to maximum density gradation and used to predict if the mixture will be fine or coarse textured as shown in Figure #3.

Soon after the chart was developed, it was used to study gradations of aggregate from several mixtures that had been reported as having unsatisfactory compaction characteristics. These mixtures could not be compacted in the normal manner because they were slow in developing sufficient stability to withstand the weight of the rolling equipment. Such mixtures can be called "tender mixes." This study identified a consistent gradation pattern in these mixes as is illustrated in Figure #4.

Most notable is the hump in the curve near the #40 sieve and the flat slope between the #40 sieve and the #8 sieve. This indicates a deficiency of material in the #40 to #8 sieve range and an excess of material passing the #40 sieve. Mixtures with an aggregate exhibiting this gradation characteristic are susceptible to being tender, particularly if the fines are composed of natural sand.

As part of the bituminous mix design process, the aggregate gradation should be plotted on the 0.45 power gradation chart.



GPO 882-015

Figure 41

### 0.45 Power Gradation Chart

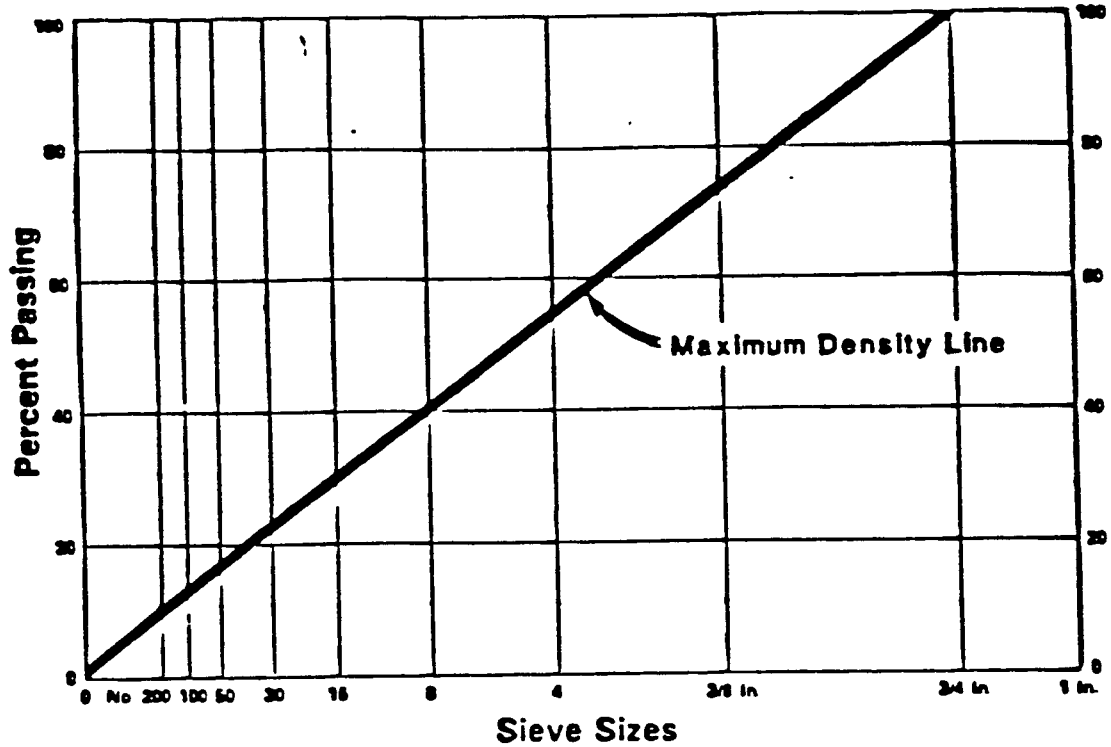


Figure 2

### 0.45 Power Gradation Chart

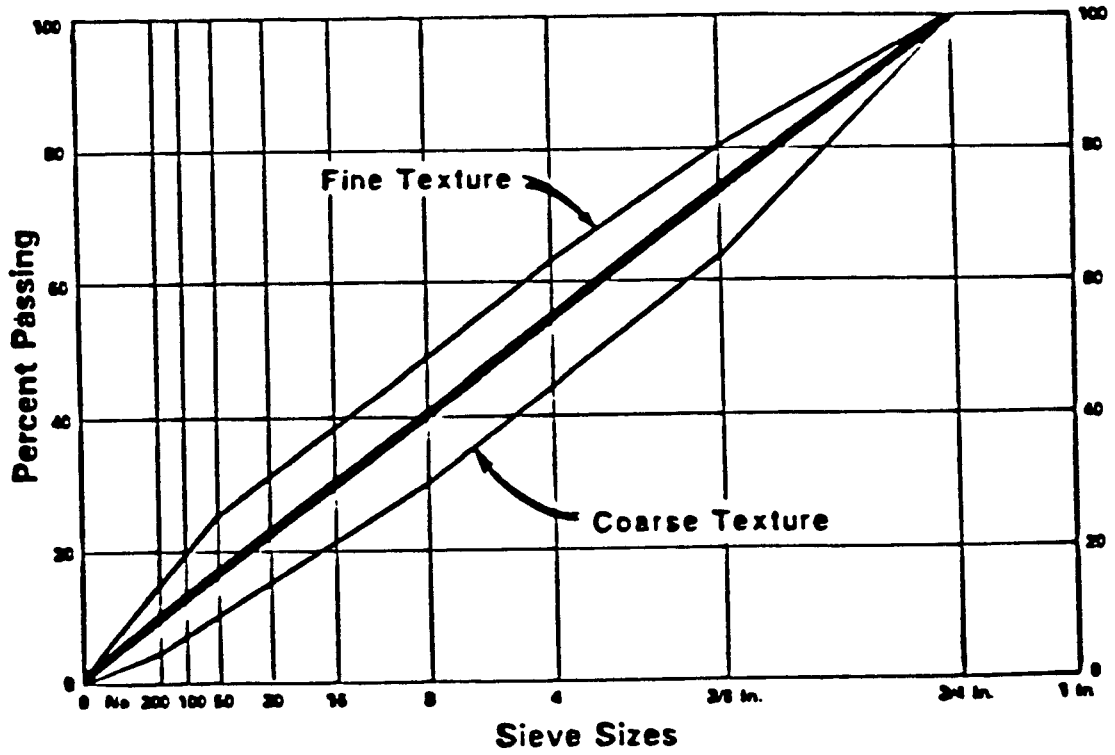


Figure 3

### 0.45 Power Gradation Chart

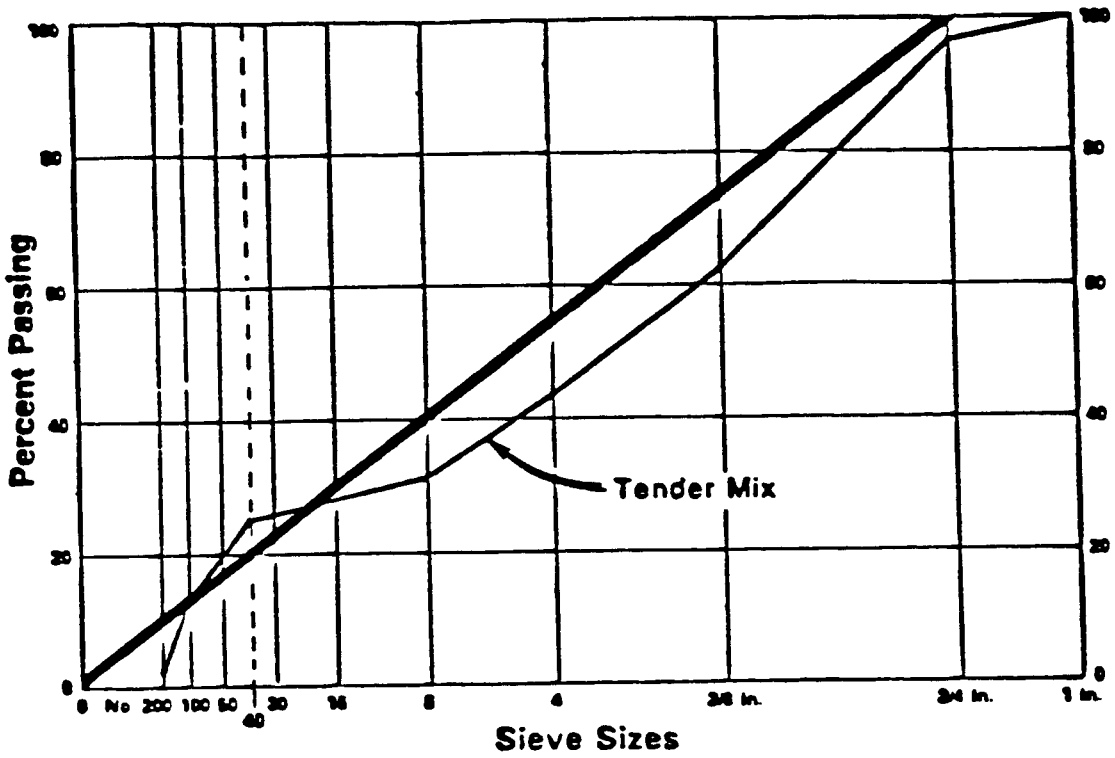


Figure #4



## ASPHALT VISCOSITY

Each particular asphalt has a unique temperature-viscosity relationship. This relationship is sometimes described as temperature susceptibility. This temperature-viscosity relationship can be plotted on a modified semi-log chart as shown on the attached chart. These charts are very useful in determining the optimum mixing and compacting temperature of a particular asphalt. Past research has identified the optimum mixing temperature as that corresponding to a viscosity of  $170 \pm 20$  centistokes, and the optimum compaction temperature as that corresponding to a viscosity of  $280 \pm 30$  centistokes for laboratory mix design. The optimum mixing temperature should be identified for the asphalt used in the mix design and included in the mix design report which is sent to the production plant.

Prior to the oil embargo, there was a relatively fixed distribution system for crude oil. This allowed for a relatively uniform asphalt cement from each refinery. Highway agencies became familiar with the handling and performance characteristics of those asphalt cements. As a result of the embargo, a new variable distribution system is in place which allows shifting and blending of crude oils resulting in production of asphalt cements with very different temperature viscosity characteristics.

The attached chart will allow plotting the temperature-viscosity curve for the asphalts used in a State or a particular asphalt from a project. If the kinematic viscosity (275° F) of the asphalt being used changes from the kinematic viscosity of the asphalt used in the mix design by a factor of more than about two, a new mix design should be required.



MODEL CHECK LIST FOR  
ASPHALT PLANT

COMPANY \_\_\_\_\_

LOCATION \_\_\_\_\_ INSPECTED BY \_\_\_\_\_ DATE \_\_\_\_\_

TYPE PLANT AND MANUFACTURER NAME \_\_\_\_\_

MAXIMUM BATCH \_\_\_\_\_ LBS.

RATED TONS PER HOUR \_\_\_\_\_

PROJECT NO. \_\_\_\_\_ COUNTY \_\_\_\_\_

I. Stockpiles

1. Properly separated.
2. Material segregated.
3. Has contractor submitted and received approval of intended materials sources and job mix formula?
4. Is area clean and properly kept?

II. General Requires for all Plants

1. Are tanks for storage of asphalt cement equipped for heating the material under effective and positive control at all times?
2. Are tanks or storage material properly heated?
3. Is a circulating system for the asphalt cement of adequate capacity to provide proper and continuous circulation between storage tank and proportioning units during the entire operating period?
4. Is the discharge end of the asphalt cement circulating pipe kept below the surface of the material in the storage tank?
5. Are all pipe links and fittings steamed, oil jacketed, or otherwise properly insulated to prevent heat loss?
6. Is storage tank capacity such as to ensure continuous operation of the plant and uniform temperature of the asphalt cement when it is mixed with the aggregate?
7. Are tanks accurately calibrated to 100 gallons (378.5 L) and accessible for measuring the volume of the asphalt cement?
8. Is a sampling outlet provided in the asphalt feed lines?
9. Is a drainage receptacle provided for flushing the outlet prior to sampling?

III. Anti-Strip and Other Additive Systems

1. Is anti-strip material added at plant site?
2. If anti-strip material is added at plant site, does the anti-strip system meet specifications?
3. If other approved additives are used, are they handled in accordance with an established procedure?

IV. Cold Feed System

1. Number of cold bins. \_\_\_\_\_
2. Does plant have mechanical or electrical means for uniformly feeding the aggregates into the dryer?
3. Does cold feed have a synchronized proportioning method when blending aggregates from two or more bins?
4. If mineral filler is required, is a separate bin provided?
5. Is the feeder for mineral filler furnished with the feeder drive positively interlocked and synchronized with the aggregate feeds?

V. Drier

1. Number of driers. \_\_\_\_\_
2. Is a drier of satisfactory design provided?

VI. Dust Collectors and Emission Controls

1. What type dust collector is provided?
2. Can the material collected in the dust collector be wasted or any part or all of the material be returned to the aggregate mixture?
3. Does the plant meet applicable limitations on emissions?
4. Has company received a permit to operate from EPA?

VII. Thermometric Equipment

1. Is a recording pyrometer or armored thermometer located in the asphalt cement feed line near the discharge end at the mixer unit?
2. Is the plant equipped with recording pyrometers, or armored thermometers or other approved thermometric instruments at the discharge end of the drier?
3. Has accuracy of pyrometers or thermometers been checked?

VIII. Surge and Storage Bins

1. Is plant equipped with surge or storage bins?
2. What type bin? Surge or storage?
3. Is unit enclosed, insulated, weather proof?
4. Is unit equipped with material level indicator?
5. Is the indicator visible from plant operator or weigh master's station?
6. Does unit have approved thermometric instrument so placed to indicate automatically the temperature of mixture at discharge?

7. Is conveyer system covered and insulated (if necessary) so as to prevent excessive loss of heat during transfer of material from mixing plant to storage bin?
8. Does storage bin have acceptable heating system?
9. Has surge or storage bin received prior evaluation and approval before using?

**IX. Safety and Inspection Provisions**

1. Are gears, pulleys, chains, sprockets, and other dangerous moving parts thoroughly protected?
2. Is an unobstructed and adequately guarded passage provided and maintained in and around the truck loading space for visual inspection purposes?
3. Does plant have adequate and safe stairways or guarded ladders to plant units such as mixer platforms, control platforms, hot storage bins, asphalt storage tanks, etc. where inspections are required?
4. Is an inspection platform provided with a safe stairway for sampling the asphalt mixture from loaded trucks?

**X. Truck Scales**

1. Are scales capable of weighing the entire vehicle at one time?
2. Do scales have digital printing recorder or automatic weight printer?
3. Have scales been checked and certified by a reputable scale company in the presence of an authorized representative of the highway department?
4. Date checked \_\_\_\_\_ Agency Name \_\_\_\_\_
5. Is copy of certification available?
6. Remarks \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**XI. Transportation Equipment**

1. Are truck bodies clean, tight, and in good condition?
2. Do trucks have covers to protect material from unfavorable weather conditions?
3. Is soapy water or other approved products available for coating truck bodies to prevent material from sticking? Diesel fuel should not be used.
4. Type of material used. \_\_\_\_\_

**XII. Provisions for Testing**

1. Does size and location of laboratory comply with specifications?
2. Is laboratory properly equipped?
3. Is laboratory acceptable?

**SPECIAL REQUIREMENTS FOR BATCH PLANTS**

**XIII. Weigh Box or Hopper**

1. Is weigh box large enough to hold full batch?
2. Does gate close tightly so that material cannot leak into the mixer while a batch is being weighed?

**XIV. Aggregate Scales**

1. Are scales equipped with adjustable pointers or markers for marking the weight of each material to be weighed into the batch?
2. Are ten 50-lb. (22.7 kg) weights available for checking scales?
3. Has accuracy of weights been checked?
4. Have scales been checked and certified by a reputable scales company in the presence of an authorized representative of the highway department?

Date checked \_\_\_\_\_ Agency Name \_\_\_\_\_

Is copy of certification available? \_\_\_\_\_

Remarks \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5. If the plant is equipped with beam type scales, are the scales equipped with a device to indicate at least the last 200 lb. (97 kg) of the required load?

**XV. Asphalt Cement Bucket**

1. Is bucket large enough to handle a batch in a single weighing so that the asphalt material will not overflow, splash or spill?
2. Is the bucket steamed, or oil-jacketed or equipped with properly insulated electric heating units?
3. Is the bucket equipped to deliver the asphalt material over the full length of the mixer?

XVI. Asphalt Cement Scales

1. Have scales been checked and certified by a reputable scale company in the presence of an authorized representative of the highway department?  
Date checked \_\_\_\_\_ Agency Name \_\_\_\_\_  
Is copy of certification available?  
Remarks \_\_\_\_\_
2. Are scales equipped with a device to indicate at least the last 20 lb. (9.1 kg) of the approaching total load?

XVII. Screens

1. Condition of screens. Satisfactory \_\_\_\_\_ Unsatisfactory \_\_\_\_\_
2. Do the plant screens have adequate capacity and size range to properly separate all the aggregate into sizes required for proportioning so that they may be recombined consistently?

XVIII. Hot Bins

1. Number of bins? \_\_\_\_\_
2. Are bins properly partitioned?
3. Are bins equipped with overflow pipes?
4. Will gates cut off quickly and completely?
5. Can samples be obtained from bins?
6. Are bins equipped with device to indicate the position of aggregate at the lower quarter point?

XIX. Asphalt Control

1. Are means provided for checking the quantity or rate of flow of asphalt material?
2. Time required to add asphalt material into pugmill.

XX. Mixer Unit for Batch Method

1. Is the plant equipped with an approved twin pugmill batch mixer that will produce a uniform mixture?
2. Can the mixer blades be adjusted to ensure proper and efficient mixing?
3. Are the mixer blades in satisfactory condition?
4. What is the clearance of the mixer blades? \_\_\_\_\_ in.
5. Does the mixer gate close tight enough to prevent leakage?
6. Does the mixer discharge the mixture without appreciable segregation?
7. Is the mixer equipped with time lock?
8. Does timer lock the weigh box gate until the mixing cycle is completed?

9. Will timer control dry and wet mixing time?
10. Can timer be set in 5 second intervals throughout the designated mixing cycles?
11. Can timer be locked to prevent tampering?
12. Is a mechanical batch counter installed as part of the timing device?

**XXI. Automation of Batching**

1. If the plant is fully automated, is an automatic weighing, cycling and monitoring system installed as part of the batching equipment?
2. Is the automatic proportioning system capable of weighing the materials within  $\pm 2$  percent of the total sum of the batch sizes?

SPECIAL REQUIREMENT FOR DRUM MIXERS

**XXII. Aggregate Delivery System**

1. Number of cold feed bins?
2. Are cold feed bins equipped with devices to indicate when the level of the aggregate in each bin is below the quarter point?
3. Does the cold feed have an automatic shut-off system that activates when any individual feeder is interrupted?
4. Are provisions available for conveniently sampling the full flow of material from each cold feed and the total cold feed?
5. Is the total feed weighed continuously?
6. Are there provisions for automatically correcting the wet aggregate weight to dry aggregate weight?
7. Is the flow of aggregate dry weight displayed digitally in appropriate units of weight and time and totaled?
8. Are means provided for diverting aggregate delivery into trucks, front-end loaders, or other containers for checking accuracy of aggregate delivery system?
9. Is plant equipped with a scalping screen for aggregate prior to entering the conveyor weigh belt?

**XXIII. Asphalt Cement Delivery System**

1. Are satisfactory means provided to introduce the proper amount of asphalt material into the mix?
2. Does the delivery system for metering the asphalt material prove accurate within  $\pm 1$  percent?
3. Does the asphalt material delivery interlock with aggregate weight control?
4. Is the asphalt material flow displayed in appropriate units of volume or weight and time and totaled?
5. Can the asphalt material be diverted into distributor trucks or other containers for checking accuracy of delivery systems?



XXIV. Drum Mixer

1. Is the drum mixer capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the specifications, and capable of producing a uniform mix?
2. Does plant have provisions for diverting mixes at start-up and shutdowns or where mixing is not complete or uniform?

XXV. Is plant approved for use?  
If not, explain what needs to be corrected. (Show Item Number)

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## PROJECT INSPECTION CHECKLIST

### Compaction of Foundation

1. Have all courses of the foundation been compacted to required density?

### Old Asphalt Pavement

1. Have all potholes been patched?
2. Have all necessary patches been made?
3. Have all loose material and "fat" patches been removed?
4. Have all depressions been filled and compacted?
5. Has fog seal been used on surface that has deteriorated from oxidation?
6. Has an emulsified asphalt slurry seal been applied on old surfaces with extensive cracking?

### Rigid Type Pavement

1. Has pavement been under sealed where necessary?
2. Has premolded joint material and crack filler been cleaned out?
3. Have all "fat" patches been removed?
4. Has badly broken pavement been removed and patched?
5. Have all depressions been filled and compacted?

### Incidental Tools

1. Do incidental tools comply with specifications? \_\_\_\_\_
2. Are all necessary tools on job before work begins?

### The Engineer and the Contractor

1. Have the engineer and inspectors held a preliminary conference with the appropriate contractor personnel?
2. Has continuity of operations been planned?
3. Has the number of pavers to be used been determined?
4. Have the number and type of rollers to be used been determined?
5. Has the number of trucks to be used been determined?
6. Has the width of spread in successive layers been planned?
7. Is it understood who is to issue and who is to receive instructions?
8. Have weighing procedures and the number of load tickets to be prepared been determined?
9. Have procedures for investigation of mix been agreed upon?
10. Has method of handling traffic been established?

### **Preparation of Surface**

- 1. Have all surfaces that will come into contact with the asphalt mix been cleaned and coated with asphalt?**
- 2. Has a uniform tack coat of correct quantity been applied?**

### **Asphalt Distributor**

- 1. Does the asphalt distributor comply with specifications?**
- 2. Are the heaters and pump in good working condition?**
- 3. Have all gauges and measuring devices such as the bitumeter, tachometer, and measuring stick been calibrated?**
- 4. Are spray bars and nozzles unclogged and set for proper application of asphalt?**

### **Hauling Equipment**

- 1. Are truck beds smooth and free from holds and depressions?**
- 2. Do trucks comply with specifications?**
- 3. Are trucks equipped with properly attached tarpaulins?**
- 4. For cold weather or long hauls, are truck beds insulated?**
- 5. When unloading, do trucks and paver operate together without interference?**
- 6. Is the method of coating of contact surfaces of truck beds agreed upon?**

### **Paver**

- 1. Does the paver comply with specifications?**
- 2. Is the governor on the engine operating properly?**
- 3. Are the slat feeders, the hopper gates, and spreader screws in good condition and adjustment?**
- 4. Are the crawlers adjusted properly?**
- 5. Do the pneumatic tires contain correct and uniform air pressure?**
- 6. Is the screed heater working properly?**
- 7. Are the tamper bars free of excessive wear?**
- 8. Are the tamper bars correctly adjusted for stroke?**
- 9. Are the tamper bars correctly adjusted for clearance between the back of the bar and the nose of the screed plate?**
- 10. Are the surfaces of the screed plates true and in good condition?**
- 11. Are mat thickness and crown controls in good condition and adjustment?**
- 12. Are screed vibrators in good condition and adjustment?**
- 13. Is the oscillating screed in proper position with respect to the vibrating compactor?**
- 14. Is the automatic screed control in adjustment and is the correct sensor attached.**

### Spreading

1. Are the required number of pavers on job?
2. Is the mix of uniform texture?
3. Is the general appearance of the mix satisfactory?
4. Is the temperature of the mix uniform and satisfactory?
5. Does the mix satisfy the spreading requirements?
6. Has proper paver speed been determined?
7. Is the surface smoothness tolerance being checked and adhered to?
8. Is the depth of spread checked frequently?
9. Has the daily spread been checked?

### Rolling

1. Are the required number of rollers on the job?
2. Is proper rolling procedure being followed?
3. Is the proper rolling pattern being followed?
4. Are joints and edges being rolled properly?

### Miscellaneous

1. Are all surface irregularities being properly corrected?
2. Is efficient control of traffic being maintained?
3. Are sufficient samples being taken?
4. Are samples representative?
5. Have assistant inspectors been properly instructed?
6. Are inspection duties properly apportioned among assistants?
7. Are records complete and up-to-date?
8. Are safety measures being observed?
9. Has final clean-up and inspection been made?