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January 23, 2024

Mr. Don Davis
Federal Highway Administration
100 W. Capitol Street
Jackson, MS 39269

SUBJECT: Pavement Design Procedures

Mr. Davis:

Attached for your review and approval are the revised MDOT pavement design procedures. The Pavement Committee has approved these new procedures. If you approve, please sign and return.

If any additional information is needed, please advise.

Sincerely,

Earl Glenn

Earl Glenn, P.E.
Deputy Executive Director/Chief Engineer

Attachment

Pc: Assistant Chief Engineer – Field Operations (Bass)
Director of Preconstruction - Engineering (Frederick)
Director of Preconstruction – Program Management (Loflin)
Materials Division Engineer (Sullivan)
Construction Division Engineer (Martin)
Maintenance Division Engineer (Patterson)
Roadway Design Division Engineer (Nail)
Research Division Engineer (Smith)
Pavement Engineer (Subedi)
District Engineers
Central Files

APPROVED: SCOT BURRELL EHRGOTT Digitally signed by SCOT BURRELL EHRGOTT Date: 2024.02.15 15:25:36 -06'00'
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MDOT PAVEMENT DESIGN PROCEDURES

01/23/2024

This document contains the procedures involved with the pavement design process for MDOT projects. Pavement shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-efficient manner. Any deviations from the procedures described herein should be documented in the District's pavement design recommendation.

Below is a list of acronyms for common terms used throughout this document:

CBR – California Bearing Ratio
ST – Standard Type Asphalt Mixture
MT – Medium Type Asphalt Mixture
HT – High Type Asphalt Mixture
SMA – Stone Matrix Asphalt
OGFC – Open Graded Friction Course
ESAL – Equivalent Single Axle Load
FWD – Falling Weight Deflectometer
LCCA – Life-Cycle Cost Analysis

Earthwork Recommendation:

For projects that are expected to result in a significant amount of earthwork, the District should prepare a soil profile and make recommendations in accordance with SOP Number TMD-20-14-00-000. The Roadway Design Division Engineer or his designee should provide a set of conceptual plans (approximately thirty percent (30%) complete) to the District Office in order for this work to commence.

Pavement Design Process:

Pavement designs should be provided for the following types of projects with approval from the Chief Engineer via the Pavement Committee:

1. Any project involving the placement of pavement (travel lane or shoulder) of any thickness on interstate or four-lane highways [exclusive of OGFC rehabilitation/replacement projects]
2. Any project that exceeds a single-lift overlay (excluding trench widening) or milling and replacing one lift. An additional intermediate lift (excluding a wedge, crown correction lift) that extends through the length of the project is considered an additional lift.

Prior to beginning the development of final construction plans, Planning Division should provide updated traffic data at the request of the District Materials Engineer or the Pavement Engineer. Using this traffic data, the District Materials Engineer in coordination with the Pavement Engineer should then prepare the draft pavement design in accordance with the procedures set forth herein.

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Rigid (Concrete) Pavement:

Depending on soil conditions and other constraints, new sections of pavement for divided highways may include concrete pavement. Thicknesses for the concrete pavement will be established using AASHTO guidelines.

Below is a list of criteria for concrete pavement design:

1. Concrete pavement should be designed with a thirty-five (35) year design life.
2. Concrete pavement will have a minimum thickness of ten (10) inches.
3. All concrete pavement will be jointed plain concrete pavement with doweled joints.
4. All sections of concrete pavement will be constructed over a minimum two-inch (2″) layer of flexible pavement and either: (A) a treated base course or (B) a crushed stone base course.

Flexible (Asphalt) Pavement (Including New Construction & Rehabilitation):

For asphalt pavement designs, the Pavement Engineer should request an asphalt pavement recommendation from the District Materials Engineer. A current set of plans should be included in this request.

Upon receiving the request, the District Materials Engineer should submit a pavement recommendation that includes the following information:

1. Asphalt pavement design
2. Description of existing pavement structure
3. Rehabilitation strategy
4. FWD survey, if applicable
5. Core analysis
6. Shoulder design
7. Chemical treatment of the subgrade
8. Pavement layer diagram depicting existing pavement and new construction (examples given on page 9), if applicable
9. Bridge end pavement diagram (examples given on page 10), if applicable
10. Temporary pavement design, if applicable
11. Confirmation that the proposed vertical clearance at all underpasses throughout the project has been checked and meets the minimum 16-foot clearance.
12. Any additional information that is unique to the specific project

The District Materials Engineer should examine the soil profile and, if applicable, the earthwork recommendation. The District Materials Engineer should input the design traffic data and the estimated design CBR into current pavement design software located at: http://mdotatwork/Division_Default.aspx?whatDiv=Roadway%20Design to determine the structural requirements (see Structure Coefficients). The current year of the traffic data should be set at the year the project is expected to be completed and open to traffic.

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Design Life:

All asphalt pavement structures and rehabilitation structures should be designed based on the following design life:

All Interstate Routes	20 Years
Urban Routes (Non-Interstate)	20 Years
All Other Routes	10 Years
Temporary Connections or Detours	Projected Life, not less than 1 Year

Lift Thicknesses:

All layers of asphalt pavement should meet the following lift thicknesses:

Mixture Type	Minimum Lift Thickness (Inches)	Maximum Lift Thickness (Inches)
OGFC	1	1
Ultra-Thin*	½	1
4.75 mm	½	¾
9.5 mm	1	1-½
12.5 mm**	1-½	2-½
19 mm	2-¼	3-½
25 mm	3	4

* An Ultra-Thin lift should not be used as a surface treatment on high-speed/high-volume routes.

** A 2¼ inch lift or greater should not be used as the final riding surface.

The maximum allowable temporary pavement edge drop-off without any protection is 2-¼ inches.

Where two lifts or less of asphalt pavement will be constructed, excluding curb and gutter sections, a safety edge will be constructed on all lifts of newly placed pavement. Where three lifts or more of asphalt pavement will be constructed, excluding curb and gutter sections, a safety edge will be constructed only on the top two lifts of newly placed pavement. On roadways with narrow traveled way and/or narrow shoulders, it is preferred that a minimum of 1-foot trench widening be added prior to adding the safety edge. However, if conditions prevent adding the trench widening, the safety edge should be added on top of the gravel shoulder.

All interstate routes should have an OGFC included in the pavement design for the travel lanes. However, the OGFC lift may be noted in the pavement recommendation as being placed in a future project.

More than one (1) lift of 9.5 mm asphalt pavement should be avoided. More than two (2) lifts of 12.5 mm asphalt pavement should be avoided whenever practical.

On pavement designs that include multiple lifts of 19 mm asphalt pavement with different thicknesses, the thicker lift is recommended to be at the bottom, as allowed by the lift thicknesses shown on the previous page.

Structure Coefficients:

Course	Coefficient (Per Inch)
OGFC	0.15
SMA	0.54
All Other Asphalt Mixtures	0.44
Cement Treated Granular Material Base	0.20
Crushed Stone or Crushed Concrete Base	0.14
Rubblization of Concrete Pavement	0.25
Untreated Granular Material	0.10

Below are examples of asphalt pavement designs:

1.5″	Asphalt Pavement, HT (9.5 mm Mixture)	(1 @ 1.5″)
2.0″	Asphalt Pavement, HT (12.5 mm Mixture)	(1 @ 2.0″)
3.0″	Asphalt Pavement, HT (19 mm Mixture)	(1 @ 3.0″)
6.0″	Crushed Stone/Concrete w/Geotextile Type V (Non-woven)	
12.5″	Structure Thickness	
6.5″	Shoulder Granular Material (*Class/Group*)	

1.5″	Asphalt Pavement, HT (9.5 mm Mixture)	(1 @ 1.5″)
2.0″	Asphalt Pavement, HT (12.5 mm Mixture)	(1 @ 2.0″)
2.5″	Asphalt Pavement, HT (19mm Mixture)	(1 @ 2.5″)
3.5″	Asphalt Pavement, ST (19 mm Mixture)	(1 @ 3.5″)
6.0″	Cement Treated Granular Material (*Class/Group*)	
15.5″	Structure Thickness	
6.0″	Chemically Treated Subgrade	
9.5″	Shoulder Granular Material (*Class/Group*)	

1.0″	Open Graded Friction Course, (9.5 mm Mixture)	(1 @ 1.0″)
1.5″	Stone Matrix Asphalt, (9.5 mm Mixture)	(1 @ 1.5″)
2.0″	Stone Matrix Asphalt, (12.5 mm Mixture)	(1 @ 2.0″)
2.5″	Asphalt Pavement, HT (19 mm Mixture)	(1 @ 2.5″)
3.5″	Asphalt Pavement, ST (19 mm Mixture)	(1 @ 3.5″)
6.0″	Cement Treated Granular Material (*Class/Group*)	
16.5″	Structure Thickness	
6.0″	Chemically Treated Subgrade	
10.5″	Shoulder Granular Material (*Class/Group*)	

Mix Type Designation/Modification:

The mix type designation map is located on Planning Division's intranet site at the following link: https://mdotatwork.mdot.state.ms.us/esal/. This map should be used to determine the type mix (ST, MT or HT) to be used on a particular project. The following guidelines were used in developing the map:

Number of ESAL's in the 10 Year Design Life	Mixture Type
Less than 1 million	ST
1 million to 3 million	MT
Greater than 3 million (non-interstate)*	HT
Interstate	SMA + OGFC

* For non-interstate routes, the top (2) lifts of asphalt may be HT Polymer Modified due to the traffic volume or a high percentage of heavy trucks. Use of HT Polymer Modified mixtures on non-interstate routes should be justified in the District's recommendation for review by the Pavement Committee.

Two (2) lifts of SMA and one (1) lift of OGFC should be included for interstate routes.

If a current traffic count shows the need for a higher mix designation than what is shown on the mix type designation map, then that mix designation takes precedence over what the map indicates.

For projects that include paving four (4) feet or less of the inside and/or outside shoulder, the same mix type and thickness of the travel lanes should be used for the paved sections of the shoulders. The paved shoulder should be placed in the same operation as the adjacent travel lane.

For projects that include paving more than four (4) feet of the inside and/or outside shoulder, a ST mix should typically be used. Higher performance mixes may need to be considered for certain conditions such as for accommodation of traffic during construction phasing operations. The paved shoulder should be placed in a separate operation from paving of the adjacent travel lanes. The thickness of the shoulders may vary for each project.

For pavement designs requiring four (4) or more lifts of asphalt pavement, the bottom lift should be an ST mix, regardless of the type of mix for the upper lifts.

Base Course:

Base granular material should be cement treated prior to the placement of pavement. Crushed stone may be used in lieu of cement-treated granular material where it is not feasible to treat the granular material, such as for temporary roadways or phased construction. Also, cement treatment may be waived for clay gravel (Granular Material with Classes 1-6, Group "D") in short sections of new pavement (typically less than 300 feet).

Cement treatment of the granular material should be included for the mainline and any interchange ramps and crossing routes. Cement treatment of the granular material should be omitted for crossovers, driveways, or local roads that are not part of an interchange.

If a crushed stone base is included and the subgrade will not be chemically treated, geotextile (Type V, non-woven) should be placed between the subgrade and the crushed stone. The minimum thickness of the crushed stone base should be six (6) inches; however, the District may recommend an additional thickness based on the existing soil conditions. Crushed stone base layers will be daylighted for drainage unless otherwise requested in the District's pavement recommendation.

Rate for Treatment of Base

The rate for soil cement treatment of the base course is four percent (4%) cement by weight. This rate is for the plan quantities only. The actual rate to be used should be determined during construction.

Treatment of Subgrade:

To provide increased integrity of the subgrade, all paving projects should include chemical treatment of the subgrade unless a crushed stone base with geotextile is used prior to the placement of the pavement structure. Chemical treatment may be waived in the case of short lengths of new pavement (typically less than 300 feet) or local road relocations. Normally, based on soil conditions, the plans should include a combination of:

A) Lime Treatment – six-inch (6") depth, six percent (6%) by weight lime, Class "C" Application
B) Soil Cement Treatment – four percent (4%) cement by weight

Plan quantities should be based on an estimated percentage of each of the treatment methods. The District should recommend the type treatment to be used (example: fifty percent (50%) lime treatment and fifty percent (50%) cement treatment.

The treatment of the subgrade should not affect the pavement design or the design CBR. No structure value is added for chemical treatment of the subgrade.

Rates for Treatment of Subgrade

Lime Treatment – six percent (6%) lime by weight*
Cement Treatment – four percent (4%) cement by weight*

* These rates are for the plan quantities only. The actual rates to be used should be determined during construction.

Multi-Phase Paving:

The full pavement structure should be placed on long-term (greater than one (1) year) multi- phase projects in the interim phase(s). When the ultimate configuration is open to traffic, an additional lift (9.5 mm) should be placed on the added lanes.

Rehabilitation Procedures:

The District Office should also submit pavement recommendations for pavement rehabilitation projects. Each recommendation should include, but is not limited to:

1. Construction, rehabilitation, and maintenance history
2. Pavement condition/distress survey of the existing condition
3. Pavement safety issues
4. Analysis of pavement cores
5. Alternative rehabilitation strategies considered
6. FWD survey on full-depth asphalt pavement (interstate or selected projects only)

This recommendation should be reviewed by the MDOT Pavement Committee and submitted to the Chief Engineer or FHWA, as applicable, for approval.

The surface course centerline joints of asphalt pavements on interstate highways should be treated with sealant between adjacent lanes (including paved shoulders). The sealant should be applied against the vertical face of the first completed lane prior to the placement of the adjacent lane (or shoulder).

On all asphalt overlays of jointed concrete pavement that have not previously been overlaid, new joints should be sawed and sealed in the top lift of the new asphalt overlay section. The new joints in the asphalt overlay should line up with the joints in the existing concrete pavement. This procedure should also take place if all existing asphalt overlay is to be removed from a section of jointed concrete pavement.

The saw and seal procedure should not be included if the jointed concrete pavement is to be rubblized.

The placement of an OGFC lift over jointed concrete pavement that is to be overlaid should be evaluated on a case-by-case basis.

The saw and seal procedure should be excluded in an OGFC lift.

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Pavement Type Selection:

The type of pavement selected should be based on, but not limited to, traffic characteristics, structural requirements, soil conditions, and the estimated cost. For new pavement on divided routes, a LCCA of each alternate should be prepared in order to determine the costs of different alternates. If a LCCA is performed, it will not be the sole determining factor in the pavement type selection.

The LCCA for both pavement types should include the initial cost and the cost for expected rehabilitation within the analysis period. These strategies include, but are not limited to: milling, overlay, slab replacement, resealing of joints, shoulder rehabilitation, and rubblization. The LCCA should include a discount rate applied to all future costs and the anticipated salvage value/costs. Mobilization, maintenance of traffic, and engineering costs should also be included in the LCCA.

After reviewing the District's pavement design recommendation, the Pavement Engineer should prepare a draft pavement design. The draft pavement design should then be reviewed by the MDOT Pavement Committee, which is composed of:

1. Chief Engineer
2. Assistant Chief Engineer
3. Director of Preconstruction – Engineering
4. Director of Preconstruction – Program Management
5. Materials Division Engineer or designee
6. Roadway Design Division Engineer or designee
7. Pavement Design Engineer
8. Construction Division Engineer or designee
9. Maintenance Division Engineer or designee
10. Research Division Engineer or designee

Regular meetings of this committee are held on the second and fourth Tuesdays of every month. Representatives from the District are invited to attend these meetings or to participate via teleconference.

The type of pavement selected and the pavement design should be submitted for approval to the Federal Highway Administration (FHWA) (as required) or to the Assistant Chief Engineer – Field Operations for approval by the Chief Engineer.

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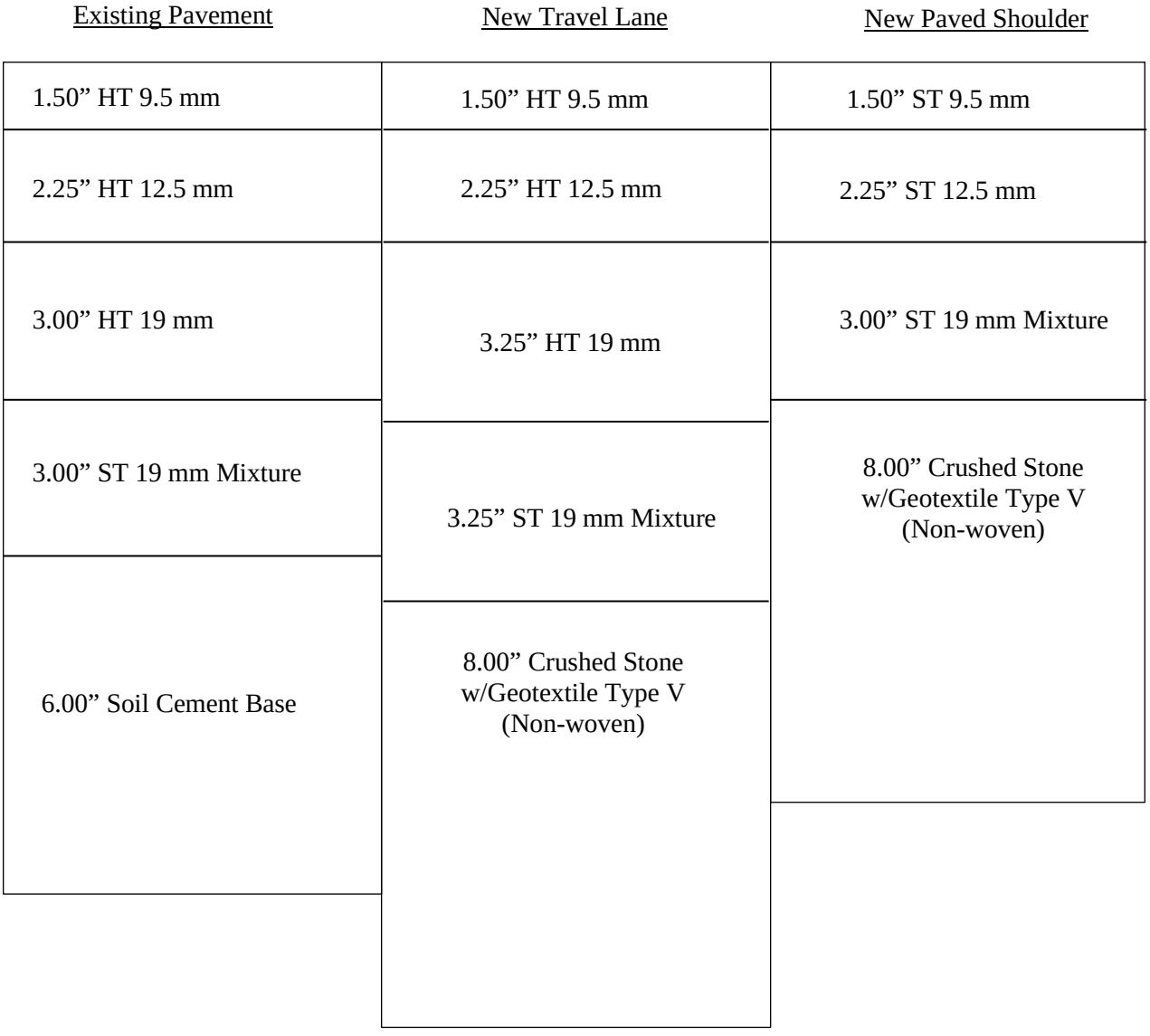
Pavement Layer Diagram Examples



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Bridge End Detail Examples