

DD-644

**WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
DESIGN DIRECTIVE**

DD – 644
ASPHALT PAVEMENT
July 1 October 13, 2016

Attached is the West Virginia Department of Transportation, Division of Highways policy on "Asphalt Pavement".

This Design Directive (DD) provides guidance on selecting *asphalt pavement* mix design methods and types of *asphalt pavement*. It also provides descriptions of situations that require polymer-modified asphalts, and methods for calculating quantities and types of materials that are to be used.

Attachment

ASPHALT PAVEMENT

TYPES OF ASPHALT PAVEMENT

Superpave Asphalt Pavement: “Superpave” stands for Superior Performing Asphalt Pavements. It represents an improved system for specifying the components of asphalt concrete, asphalt mixture design and analysis, and asphalt pavement performance prediction. The Strategic Highway Research Program (SHRP) developed the Superpave asphalt pavement mix design method in the early 1990’s.

Marshall Asphalt Pavement: Bruce Marshall developed the “Marshall” method of asphalt mix design in the late 1930’s for the Mississippi Highway Department. This method has been used by the WVDOT for at least the past 40 years and was the standard specification.

ASPHALT PAVEMENT MIX DESIGN TYPE SELECTION

Superpave asphalt pavement is to be used for the following type projects:

1. New construction of multilane divided highways where the mainline pavement is asphalt pavement.
2. Overlay or 3R type projects on existing multilane divided highways where the asphalt pavement overlay is 3 inches or more.
3. Overlay type projects on existing National Highway System (NHS) highways where the asphalt pavement overlay is 3 inches or more.
4. Projects on other highways where approved by the Deputy State Highway Engineer for Development or Operations.

Marshall asphalt pavement will be used on all other projects.

For resurfacing projects, polymer-modified asphalt (PMA) may be used in the Asphalt Pavement at the discretion of the District Engineer/Manager or the Director of the Engineering Division on projects where conventional asphalt pavement has exhibited severe rutting or shoving problems due to heavy traffic conditions, such as:

- (1) Intersections with very heavy truck traffic,
- (2) Truck climbing lanes and ramps,
- (3) For the surface lift of asphalt pavements in resurfacing projects where the design ESALS exceed 30,000,000,

Otherwise, PMA is required to be used in the following cases:

- (1) For the surface lift (at minimum) of asphalt pavement in new construction projects where the design ESALs exceed 30,000,000 (Refer to DD 646 – Pavement Design Guide) and the pavement system is being designed as a

- “perpetual” or “long life” system. Preferably PMA should be used in the top 4” of the pavement structure for a “perpetual” or “long life” pavement system,
- (2) For the surface lift on roadways facilitating access to industrial parks, warehouses, production facilities, etc.
 - (3) High Performance Thin Overlay (HPTO) asphalt pavement in accordance with Special Provision 496.

The specified binder grade shall be a PG 76-22 with polymer-modification. PMA can be used as a long term solution to severe rutting problems. Due to the significant additional cost of PMA, do not use it on any project without first repairing base failures and removing excessively rutted pavement. PMA should generally be used only in the skid surface mix (preferably a 12.5 mm mix), but may also be used in the underlying base course depending on the severity of the traffic conditions. Always use the preferred thickness from the Superpave asphalt pavement recommended lift thickness tables as a minimum thickness when using PMA. Any mix design to be used as a scratch course shall not be specified to use PMA.

Either Superpave or Marshall asphalt pavement should normally be used exclusively on a project. There will be no projects where both specifications are used, unless approved by the appropriate Deputy State Highway Engineer, or as hereinafter provided.

The Designer may consider using both Superpave and Marshall asphalt pavement when a large quantity of each type (>5000 tons of each type on a contract) could be specified in the same contract. This situation can occur when there is enough length of side roads to be paved in the contract to allow more than 5000 tons of Marshall mix to be used. Proper bid items and alternates for both types of asphalt pavement mix will then be included in the contract. Roadways that will be constructed of Marshall asphalt pavement will be indicated as such in the Asphalt Summary Table and on the typical sections for each roadway. If the designer does not desire Marshall asphalt pavement to be used, then no items and alternates for this mix will be indicated in the contract.

On overlay or 3R projects which require pavement and/or base failure repairs to be made before the overlay is placed, the designer shall indicate which mix type (Superpave or Marshall) is to be used for these repairs, and include proper bid items and quantities in the contract. If mix type substitutions are allowed by the designer, then alternate bid items and quantities will be included in the contract as shown in the example below. The pavement method design type, “HMA”, aggregate alternate, and mix type is indicated in the example below for illustrative purposes only.

Example:	AA1 401001-020 MARSHALL HMA BASE CRSE, SG, TY 2, TN (Pavement Repair)
	AA2 401001-021 MARSHALL HMA BASE CRSE, S, TY 2, TN (Pavement Repair)
	BB1 401001-042 SUPERPAVE HMA BASE CRSE, SG, TY 25, TN (Pavement Repair)
	BB2 401001-043 SUPERPAVE HMA BASE CRSE, S, TY 25, TN (Pavement Repair)

ASPHALT SPECIFICATION TYPE SELECTION

Section 410 of the Standard Specifications, *Asphalt Base and Wearing Courses, Percent Within Limits (PWL)* and the appropriate pay items will be used on the following type projects:

1. New Construction of multilane divided highways where the mainline pavement is asphalt pavement.
2. Overlay projects on existing multilane divided highways.
3. Projects on other highways where approved by the Deputy State Highway Engineer for Development or Operations.
- ~~4.~~

Section 401 and/or 402 and the appropriate pay items will be used on all other projects.

DETERMINATION OF “EQUIVALENT SINGLE AXLE LOAD” (ESAL) COUNT

The “ESAL Calculator” program shall be used to calculate the 20 year projected design ESALs for all projects unless one of the following applies.

1. The “ESAL Calculator” program produces a value exceeding 10,000,000.
2. When a traffic study has been performed. (i.e. When traffic movements or traffic counts are provided by the Traffic Modeling and Analysis Unit of the Planning Division.)
3. On roadway realignment projects that exceed 1000 feet of relocated roadway.
4. When there is an expected development in the area that may change or alter the nature or character of the expected traffic. (i.e. Shopping centers, schools, etc.)
5. The project is on the CRTS (Coal and Resource Transportation System).

The “ESAL Calculator” program can be obtained from the Technical Section of the Engineering Division or on the West Virginia Department of Transportation's web site at <http://www.transportation.wv.gov/highways/engineering/Pages/Manuals.aspx>, then under the “Paving” heading choose “ESAL Calculator”.

- A. When the “ESAL Calculator” program cannot be used to calculate the ESALs then the ESALs or the percentage of traffic in each of the 13 classes shall be obtained from the Traffic Modeling and Analysis Unit of the Planning Division. The designer is cautioned that the development of appropriate data to establish accurate ESAL counts may require significant lead time. The Traffic Modeling and Analysis Unit of the Planning Division should therefore be notified as early as possible so they may supply the information.

PLAN REQUIREMENTS

Projects using either Superpave or Marshall asphalt pavement will show the 20 year projected design ESALs on both the general notes sheet and the typical section sheet(s) showing the pavement details. This includes new construction, reconstruction, AND resurfacing projects (including ALL bridge replacement projects regardless of the length of pavement placed). The design ESALs shall be shown for the mainline and all other affected roadways where more than 500 feet of pavement is being placed.

A. Superpave Asphalt Pavement

The PG Binder grade will normally be one of the standard grades specified in Section 401.2 of the standard specifications. However, if a project requires the use of a nonstandard grade, the binder grade(s) shall be provided on both the general notes sheet and the typical section sheet(s) showing the pavement details.

B. Marshall Asphalt Pavement

Projects using Marshall asphalt pavement, including District-designed projects, will designate the use of “Medium Mix Design” or “Heavy Mix Design” as well as the design ESALs on both the general notes sheet and the typical section sheet(s) showing the pavement details. The designer should note that the terms “Medium” and “Heavy” refer to Equivalent Single Axle Loads (ESALs), and not to the quality of the asphalt pavement. After determining the ESALs by either using the ESAL Calculator or obtaining the value from the Planning Division, the mix design type shall be determined from the following criteria.

Medium Mix Design - This design is intended for use on local service roads or rural resurfacing projects with a 20-year projected design ESALs of less than 3,000,000.

Heavy Mix Design - This design is intended for use on new construction projects and on projects with a 20 year projected design ESALs of equal to or greater than 3,000,000.

ESTIMATING QUANTITIES

A. Asphalt Pavement

The quantity for asphalt pavement shall be estimated at 1.980 ton/cy for stone and gravel mixes, 1.890 ton/cy for slag mixes and 2.10 ton/cy for steel slag mixes.

B. Patching and Leveling

The quantity for Patching and Leveling Course shall be estimated by multiplying the nominal depth of the irregularity to be repaired plus $\frac{3}{4}$ inch by the irregularity's surface area. Then the conversion rates of 1.980 ton/cy for stone and gravel mixes, 1.890 ton/cy for slag mixes and 2.10 ton/cy for steel slag mixes will be utilized.

C. Scratch Course

The quantity for Scratch Course shall be estimated at a thickness of one-half inch (0.028 ton/sy) for the entire area to be covered with Scratch Course.

D. Asphalt Material (Tack Coat)

The quantity for Asphalt Material (Tack Coat) shall be estimated as indicated in Table 408.11 in the latest issue of the Standard Specifications. No application rate will be shown on the typical sections.

E. Cover Aggregate

Cover aggregate will be used by the contractor when necessary as directed by the Project's Construction Engineer. The designer shall estimate this item at 10 to 15 lb/sy and include the cost in the unit bid price estimate for Item 408, Asphalt Material. No quantity is to be shown in the plans.

TYPE SELECTION**A. Patching and Leveling**

General: Patching and Leveling is to be placed at various locations throughout the project to remove irregularities in the existing pavement, such as dips, or to raise the outside edge of the existing pavement to provide a uniform template prior to placing a base or wearing course. Patching and Leveling shall not be specified as a continuous layer or course to be placed over the full width and length of the project.

Project Selection: Patching and Leveling should be used only in resurfacing or rehabilitation projects, not in the construction of new pavements. It shall be specified when the deviations in the existing pavement are 1 inch or greater in depth.

Typical Sections: Patching and Leveling shall be shown on the plan typical sections as a layer with thickness specified as "variable - 2" maximum lift thickness. No application rate shall be shown. Patching and Leveling thickness is not included in the structural design of the pavement.

B. Scratch Course

General: Scratch Course shall be specified when the deviations in the existing pavement are less than 1 inch in depth. Scratch Course can be placed over the entire project or to the limits established by the designer. If the Scratch Course is not to be placed over the full width of the project, it should be specified at least at a full lane width. Although Scratch Course can be placed over the complete project, it is not a constant thickness layer. The term "Scratch Course" comes from the method of placement of this item. The paving equipment is set to drag on or "scratch" the high areas of the existing pavement, only depositing material in the low areas; thereby creating a smooth surface on which to place the next layer of asphalt pavement. **If milling is performed on the project,**

Scratch Course ~~should not be necessary~~ shall not be used.

The Designer should specify Scratch Course in the contract if the overlay is the first overlay over an existing Portland Cement Concrete Pavement (PCCP), or if previous asphalt pavement overlays will be milled deep enough to expose the original PCCP. This will not include newly constructed PCCP or approach slabs.

Project Selection: Scratch Course is normally used in rehabilitation or resurfacing projects. Scratch Course may be specified to be placed on top of Type 1 or Type 37.5 Base Courses prior to placing the final wearing or skid course in new construction projects, if a Type 2 or a Type 19 Base Course is not used as the top lift of the base courses.

Typical Sections: Scratch Course shall be shown on the plan typical sections as a line without a thickness or application rate. Scratch Course is not included in the structural design of the pavement.

C. Base Courses

General: It is recommended that in multi lift pavements when Type 1 or Type 37.5 Base Course is used, the top lift of base course be a Type 2 or 19 to improve the smoothness of the finished pavement. This would eliminate the use of a Scratch Course prior to placing the final wearing or skid course.

1. Marshall Asphalt Pavement

- a. Type 1 Base Course shall be specified when the total base course thickness for new construction is greater than 3.25 inches. On resurfacing projects, Type 1 Base Course shall not be specified where temporary traffic control requirements prohibit an edge drop off of 3 inches.
- b. Type 2 Base Course shall be specified when the total base course thickness is less than or equal to 3.25 inches.

Recommended Lift Thickness for Marshall Asphalt Pavement				
Mix Type	Aggregate Nominal Maximum Size	Minimum Lift Thickness	Maximum Lift Thickness	Preferred Thickness
2	0.75 inch (19 mm)	2.0 inches (50 mm)	3.0 inches (75 mm)	2.0 inches (50 mm)
1	1.5 inches (37.5 mm)	3.25 inches (82 mm)	5.0 inches (125 mm)	4.0 inches (100 mm)

2. Superpave Asphalt Pavement

- a. Type 37.5 Base Course shall be specified when the total base course thickness for new construction is greater than or equal to 4.5 inches. On resurfacing projects, Type 37.5 Base Course shall not be specified where temporary traffic control requirements prohibit an edge drop off of 3 inches.

- b. Type 19 or 25 Base Course shall be specified when the total base course thickness is less than 4.5 inches.

Recommended Lift Thickness for Superpave Asphalt Pavement					
Mix Type	Marshall Equivalent Designations	Aggregate Nominal Maximum Size	Minimum Lift Thickness	Maximum Lift Thickness	Preferred Thickness **
19	Base-2	0.75 inch (19 mm)	2.25 inches (56 mm)	3.5 inches (88 mm)	2.5 inches (63 mm)
25	Heavy Duty Base-2	1 inch (25 mm)	3.0 inches (75 mm)	4.0 inches (100 mm)	3.5 inches (88 mm)
37.5	Base-1	1.5 inches (37.5 mm)	4.5 inches (113 mm)	6.0 inches (150 mm)	5.0 inches (125 mm)

** Min. Thickness with Polymer Modified Binders

D. Wearing Courses

General: The wearing course is a single lift constant thickness course to be placed over the entire pavement surface. The wearing course is the riding surface on which traffic travels. Type 4 or Type 19 Wearing Course is intended for use in heavy truck traffic situations. On projects with a current ADT of 3000 or more vehicles per day, the wearing course shall be a skid resistant mix in accordance with Section 402 of the Standard Specifications. Only Type 1, Type 4, Type 9.5, Type 12.5 or Type 19 shall be specified as a skid resistant mix.

1. Marshall Asphalt Pavement

Recommended Lift Thickness for Marshall Asphalt Pavement				
Wearing or Skid Mix Type	Aggregate Nominal Maximum Size	Minimum Lift Thickness	Maximum Lift Thickness	Preferred Thickness
3	No. 4 (4.75 mm)	0.5 inch (12.5 mm)	0.75 inch (19 mm)	5/8 inch (16 mm)
1	3/8 inch (9.5 mm)	1.0 inch * (25 mm)	1.5 inches * (37.5 mm)	1.0 inch * (25 mm)
4	0.75 inch (19 mm)	2.0 inches (50 mm)	2.0 inches (50 mm)	2.0 inches (50 mm)

* 1½ inch (37.5 mm) thickness on resurfacing projects where the Wearing Course is the only asphalt pavement material being placed exclusive of Patching & Leveling and Scratch Courses.

2. Superpave Asphalt Pavement

Recommended Lift Thickness For Superpave Asphalt Pavement					
Wearing or Skid Mix Type	Marshall Equivalent Designations	Aggregate Nominal Maximum Size	Minimum Lift Thickness	Maximum Lift Thickness	Preferred Thickness **
4.75	Wearing-3	No. 4 (4.75 mm)	5/8 inches (14.25 mm)	1.0 inches (24 mm)	5/8 inches (16 mm)
9.5	Wearing-1	3/8 inch (9.5 mm)	1.5 inches * (37.5 mm)	2.0 inches * (50 mm)	1.5 inches * (37.5 mm)
12.5	Heavy Duty Wearing-1	½ inch (12.5 mm)	1.5 inches (37.5 mm)	2.5 inches (63 mm)	2.0 inches (50 mm)
19	Wearing-4	¾ inch (19 mm)	2.25 inches (56 mm)	3.5 inches (88 mm)	2.5 inches (63 mm)

* 1½ inch (37.5 mm) thickness on resurfacing projects where the Wearing Course is the only asphalt pavement material being placed exclusive of Patching & Leveling and Scratch Courses.

** Minimum Thickness with Polymer Modified Binders

E. Prime Coat and Asphalt Material (Tack Coat)

Prime Coat (Item 409) is discontinued.

Asphalt Material (Tack Coat) (Item 408) shall be specified for placement on all existing pavement prior to placing asphalt pavement. This item shall also be specified for placement on new asphalt pavement when traffic must be maintained on each layer of asphalt pavement during construction for periods of time in excess of 2 weeks.

F. Milling existing pavement surfaces

~~When milling is specified by the contract, the thickness of milling specified by the Designer should be at least ¼" into the layer just below the layer(s) being removed. The intent is to mill off entire layers, and not leave any partial layers. If partial layers are to remain in place, the thickness to remain should be at least one and one half times the nominal diameter of the aggregate of the existing asphalt pavement course being removed.~~

Commented [VLA1]: Moved, no change

Milling is used to remove surface distresses, create a better bond for an overlay, restore cross slope, and maintain vertical geometric properties, such as bridge clearance, guardrail height, and grade with gutter area. *Milling of Asphalt Pavement Surfaces*, Section 415 of the Standard Specifications, contains three types of milling: Standard Milling, Fine Milling, and Micromilling. These are differentiated primarily by the carbide tooth spacing, typically 15, 8, and 5 mm respectively, resulting in finer textured surfaces. These milling types specify the final surface texture prior to any overlay.

1. Standard Milling ~~shall be~~ used as the default milling of asphalt pavement. It is intended to be used when the Division plans to remove existing asphalt pavement without a high level of profile and slope control.

2. Fine Milling ~~shall be~~ used when the Division intends to overlay the milled surface with a thin lift asphalt course. It shall also be used when the contract contains pay items from Section 410 of the Standard Specifications, *Asphalt Base and Wearing Courses, Percent Within Limits (PWL)*. It is intended be used when control of the profile and slope of the milled surface is important.
3. Micromilling ~~shall be~~ used for smoothness correction, skid correction, bump and/or grade corrections on existing or newly paved surfaces. This milling is typically less than an inch. It is not intended to be used when standard overlays are to be used.

When milling is specified by the contract, the thickness of milling specified by the Designer should be at least ¼" into the layer just below the layer(s) being removed. The intent is to mill off entire layers, and not leave any partial layers. If partial layers are to remain in place, the thickness to remain should be at least one and one-half times the nominal diameter of the aggregate of the existing asphalt pavement course being removed.

SPECIAL SITUATIONS

General: The Specifications have been written to account for the majority of the situations that would occur during construction. However, there are always special situations that require the designers' attention.

Specification requirements should only be altered after careful consideration and when, in the opinion of the designer, there is no practical way for the work to be performed in accordance with the specifications. Additional notes that modify existing specifications shall not be used without the approval of the Engineering Division or the District Engineer.

Compaction. The specification density requirement in the latest issue of the Standard Specifications shall not be modified when asphalt pavement is placed at normal paving widths. It is possible that asphalt pavement will be placed in certain areas of the project where densities of this magnitude cannot be obtained. These areas usually have an irregular shape, which will not allow the proper use of compaction equipment. Listed below is a situation where the density specification may be modified by plan note and the plan note to be used.

Situation	Plan Note
Concrete pavement repair *	Compaction testing shall be in accordance with the Lot-by-Lot method and the rollerpass method shall not be used for acceptance testing for compaction. The engineer may reduce the target density requirement if the contractor has made every reasonable effort at obtaining the required density.

* If the proper density is not obtained during placement, traffic will continue to compact the asphalt pavement in the pavement repair area, causing additional settlement. This will be very

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noticeable because the surrounding overlay will be placed on the existing concrete pavement, which is rigid and will not settle.

The designer is encouraged to use concrete to repair an existing concrete pavement.

Surface Tolerance: To comply with the specifications, projects receiving 3 inches or more of asphalt pavement must meet a smoothness requirement. It is possible that asphalt pavement will be placed on certain projects or in certain areas of a project where this specification cannot be met. Listed below is a situation where the surface tolerance specification may be modified by plan note and the plan note to be used.

Situation	Plan Note
Urban projects with numerous side streets where traffic must cross through the paving operation.	The first three paragraphs of Section 401.7.2 shall not apply to this project.