INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 23-02

May 12, 2023

TO: **All Design, Operations, and District Personnel, and Consultants**

FROM: ***/s/Kumar Dave***
Kumar Dave
Manager, Pavement Design Office
Highway Engineering Division

SUBJECT: **Void Reducing Asphalt Membrane for Asphalt Paving**

REVISES: ***Indiana Design Manual*** **Section 602-3.02**

EFFECTIVE: **For lettings on or after May 1, 2024**

Low asphalt pavement density and the intrusion of air and water in longitudinal joints, can accelerate pavement deterioration. Several paving techniques can be employed to alleviate the associated pavement distresses. These methods may not be cost effective. The application of hot applied polymer-modified asphalt also known as Void Reducing Asphalt Membrane (VRAM) has proven to be effective in retarding pavement deterioration. VRAM is applied under the longitudinal joint in new asphalt, and it migrates upward as the hot mix is installed on top of it. Therefore, VRAM fills the voids, reduces water intrusion, and protects the underlying pavement layers.

This technology is intended for use in roadways with higher ESAL category roads, and should be specified as follows:

1. On projects with more than 300 tons of ESAL category 4 HMA surface material used as a mainline pavement. For example: QC/QA-HMA, **4**, 76, SURFACE, 9.5 mm; and

2. On projects with more than 300 tons of SMA mixture surface used as a mainline pavement.

A VRAM project will incorporate RSP 401-R-750 "Void Reducing Asphalt Membrane for HMA" or 410-R-751 "Void Reducing Asphalt Membrane for SMA" as appropriate. The pay items 401-12439 "Void Reducing Asphalt Membrane for HMA" or 410-12466 "Void Reducing Asphalt Membrane for SMA" should be used for HMA and SMA mixtures, respectively.

The RSPs direct VRAM to be used where a longitudinal joint will be formed within the traveled way, between the traveled way and an auxiliary lane, between the traveled way and a paved shoulder, and between an auxiliary lane and a paved shoulder.

VRAM is placed before the HMA surface and replaces Hot Poured Joint Adhesive for the surface layer. In addition, Liquid Asphalt Sealant is not required when VRAM is used. Hot Poured Joint Adhesive for the intermediate layer should still be included in projects that contain VRAM.

The VRAM quantity is paid for by the linear foot can be estimated similarly to joint adhesive and as described in the RSPs. Consideration should be taken regarding potential bundled contracts as VRAM may not be appropriate on some roadways with small quantities of HMA surface mix.

This memo does not necessarily exclude other projects from using a VRAM if deemed appropriate by the District Pavement Asset Engineer or Asphalt Engineer, Division of Materials and Tests.

Questions regrading this design memo should be directed to Nick Cosenza, Senior Pavement Design Engineer at ncosenza@indot.in.gov

IDM Revisions

602-3.02 Asphalt Pavement [Rev. May. , 2023]

A new asphalt pavement typically consists of an HMA surface course, on an HMA intermediate course, on either an HMA base or a compacted aggregate base, directly on a prepared subgrade. An asphalt pavement overlay may consist of a single-lift HMA surface course or multiple HMA lifts on existing pavement.

See Section 602-3.05 for HMA pavement sections.

A drainage layer may be utilized at the bottom of a new asphalt pavement on top of a separation layer, in accordance with FHWA guidelines http://www.fhwa.dot.gov/pavement/pavedesign.cfm).

Lift or layer thicknesses are determined by the Nominal Maximum Aggregate Size, (NMAS) used in each mixture designation. See the Mixture Type Maximum Particle Size, and HMA Layer Thickness table below. A layer thickness is what a pavement designer designs for a certain mixture designation. A layer may have to be divided into two or more lifts to accomplish proper construction and compaction. A pavement designer must consider both the layer thickness and whether it needs to be divided into multiple lifts for constructability and compaction purposes.

Lay thicknesses play an important role in HMA construction quality control. Neither high lift thickness nor low lift thickness is desirable to achieve good compaction results. From a mechanistic point of view, the compaction pressure applied to the HMA layer is the highest at the top surface of the lift where the HMA materials directly contact the compacting roller. This compaction pressure decreases with depth, which means that if the lift thickness is too high, the required compaction pressure may not be applied to the materials at the bottom of the lift. On the other hand, since compaction is significantly affected by the lay down temperature, and the temperature decreases more quickly with thin HMA lifts, good compaction results cannot be achieved if the lift thickness is too low. In addition, there are many other factors that affect HMA compaction. Some of these factors are the nominal maximum aggregate size, aggregate gradation, and asphalt binder type. The *Standard Specifications* require that the finished thickness of any course should be at least 2 times but not more than 5 times the maximum particle size as shown on the Design Mix Formula (DMF). This requirement applies during construction; however, the pavement designer should design the lay thickness according to the research findings from *NCHRP Report 531*.

NCHRP Report 531 indicates that the HMA pavement density that can be obtained under normal rolling conditions is clearly related to the ratio of the layer thickness divided by NMAS of the HMA mixture. To achieve proper compaction, the thickness divided by NMAS ratio should be 4, or the thickness divided by Maximum Particle Size should be 3. The pavement designer should target lifts of 3 times the Maximum Particle Size and avoid designing to the minimum or maximum. Likewise, the pavement design should specify the smaller aggregate size for intermediate and base mixtures where given the choice. While this will require more binder, this makes for a more desirable pavement structure: better density, better stability, and less permeability. If the design layer thickness of a specific layer exceeds 5 times the Maximum Particle Size, then that specific layer should be laid in two lifts, e.g., 770 lb./yd² of Base, 19.0 mm should be laid in two lifts of 385 lb./yd² each lift.

MIXTURE TYPE, MAXIMUM PARTICLE SIZE AND HMA LAYER THICKNESS					
Mixture Type	Nominal Ma Aggregate Size	Maximum P Size (in.)	Minimum Layer Thicknes (in.)	Maximum Layer Thicknes (in.)	Target HMA Thickness (in.)
9.5 mm	0.375 (3/8)	0.5	1.0	2.0	1.5
12.5 mm	0.5	0.75	1.5	3.0	2 - 2.5
19.0 mm	0.75	1.0	2.0	4.0	2.5 - 3.5
25.0 mm	1.0	1.5	3.0	6.0	3.5 - 5.5

Thickness, maximum particle size, and PG Binder are determined based on various factors of the roadway being evaluated. The pavement designer may choose various maximum particle size and appropriate lay rates for surface, intermediate, and base courses based on design criteria and in accordance with *Standard Specifications* Section 400. The PG Binder grade is determined using LTPPBind software utilizing data from National Weather Service weather stations.

HMA pavement surfaces comprise the majority of pavements seen on Indiana's highway system. They are used on local roads, state routes, on the NHS, and interstate highways. INDOT's typical full-depth asphalt pavements are composed of a surface course, on an intermediate course, on a base course, on a drainage layer, on a separation layer on prepared subgrade, with underdrains and adequate support from foundation soils below. See Section 602-3.05 for HMA pavement sections.

Low asphalt pavement density and the intrusion of air and water in longitudinal joints, can accelerate pavement deterioration. Several paving techniques can be employed to alleviate the associated pavement distresses. These methods may not be cost effective. The application of hot applied polymer-modified asphalt also known as Void Reducing Asphalt Membrane (VRAM) has proven to be a cost-effective remedy in retarding pavement deterioration. VRAM is applied under the longitudinal joint in new asphalt, and it migrates upward as the hot mix is installed on top of it. Therefore, VRAM fills the voids, reduces water intrusion, and protects the underlying pavement layers.

This technology is intended for use in roadways with higher ESAL category roads, and should be specified as follows:

1. On projects with more than 300 tons of ESAL category 4 HMA surface material used as a mainline pavement. For example: QC/QA-HMA, **4**, 76, SURFACE, 9.5 mm; and

2. On projects with more than 300 tons of SMA mixture surface used as a mainline pavement.

VRAM should be used where a longitudinal joint will be formed within the traveled way, between the traveled way and an auxiliary lane, between the traveled way and a paved shoulder, and between an auxiliary lane and a paved shoulder.

VRAM is placed before the HMA surface and replaces Hot Poured Joint Adhesive for the surface layer. In addition, Liquid Asphalt Sealant is not required when VRAM is used. Hot Poured Joint Adhesive for the intermediate layer should still be included in projects that contain VRAM.

The VRAM for HMA and VRAM for SMA are paid for at the contract price per the linear foot for full width applications and at half the contract price for half width applications. Consideration should be taken regarding potential bundled contracts as VRAM may not be appropriate on some roadways with small quantities of HMA surface mix.