INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 23-06

June 19, 2023

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

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

SUBJECT: **Cross Slope Correction**

REVISES: ***Indiana Design Manual*** **Section 54-3.03(01)**
Indiana Design Manual **Section 55-4.05(04)**
Indiana Design Manual **Section 56-4.04(03)**
Indiana Design Manual **Section 603-2.04**
Indiana Design Manual **Section 607-1.0**

EFFECTIVE: **Lettings on or after September 1, 2023**

Where re-establishing an appropriate cross slope is needed, the work can include variable depth profile milling, a variable depth intermediate layer, or a combination thereof. An illustration of the methods to re-establish cross slope is included for reference at the end of the memo.

Variable Depth Profile Milling

Variable depth profile milling is the preferred method to correct pavement cross slope. This approach allows for the placement of uniform thickness intermediate and surface layers. The existing pavement section must be thick enough to accommodate the required milling depth and leave sufficient pavement thickness to support the new HMA material. The limits and associated milling depths should be shown on the typical sections.

Variable Depth Intermediate Layer

When variable depth profile milling is not feasible, a variable depth intermediate layer may be considered. There are limits to the amount of variability that is acceptable across the pavement section. The limits will determine whether QC/QA-HMA or HMA Wedge and Level material is used. QC/QA-HMA is the preferred pavement material.

QC/QA HMA**.** When variable depth QC/QA-HMA is specified, the difference between the pavement thickness at the crown and the thickness at the edge of pavement at any transverse section should not exceed the maximum particle size for a given HMA mixture designation.

Too much thickness variability within a single lift of pavement can lead to uneven compaction within the lift and be detrimental to pavement life. It can also increase the risk of the mixture failing acceptance testing by Percent Within Limits (PWL) in accordance with *Standard Specifications* Section 401.19(a). PWL evaluates the mixture on consistency as well as specification limits.

The maximum particle size is presented as Maximum Lift Thickness Variability in a new table added to IDM Section 603-2.04.

HMA Wedge and Level. A combination of variable depth profile milling and variable depth QC/QA-HMA should be considered before utilizing HMA Wedge and Level as an intermediate material.

When design or field conditions require a variable depth pavement that exceeds the maximum lift thickness variability for QC/QA-HMA, variable depth HMA Wedge and Level should be used. INDOT *Standard Specifications* Section 402.13 defines the lift thickness of wedge and level as follows: "The finished thickness of wedge and level mixtures shall be at least 1 1/2 times but not more than six times the maximum particle size as shown on the DMF. Feathering may be less than the minimum thickness requirements."

If wedge and level must be used, the smallest feasible mixture designation should be selected. This is typically a 9.5 mm mixture.

A uniform depth QC/QA HMA Surface or another type of surface treatment is required to be placed over the HMA Wedge and Level course.

IDM Revisions

The revised IDM sections are included for reference at the end of the memo.

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

IDM Revisions

Chapter 54

54-3.03(01) Cross slope, Lane and Shoulder Width [Rev. Jun. 2023]

Pavement cross slopes on a tangent section should be reviewed. Improving pavement cross slope, where required, may be completed through staged construction, e.g., combining milling with an acceptable variable-depth cross section of HMA Intermediate course in accordance with the INDOT *Standard Specifications* prior to placing a uniform-depth HMA Surface course. See Section 603-2.04 for additional variable depth guidance.

Each travel-lane or shoulder width not in accordance with Figure 54-2A should be evaluated for widening.

1. Travel Lane. The width of each travel lane or auxiliary lane should be 12 ft.

2. Shoulder. Existing shoulder widths may be retained if they are in accordance with the AASHTO Interstate System criteria in effect at the time of the route's original construction or inclusion into the Interstate system.

Chapter 55

55-4.05(04) Lane and Shoulder Cross Slopes [Rev. Jun. 2023]

Shoulder cross slopes on a horizontal curve should be in accordance with Section 43-3.06. The low-side shoulder should desirably be sloped as described in Section 43-3.06(02). At a minimum, the same cross slope on the shoulder should be kept in a tangent section.

Restoring or improving the pavement cross slope is often cost effective, resulting in improved ride, safety, and drainage, and maintenance of roadway pavements. Improving pavement cross slope, where required, may be completed through staged construction, e.g., combining milling with an acceptable variable-depth cross section of HMA Intermediate course in accordance with the INDOT *Standard Specifications* prior to placing a uniform-depth HMA Surface course. See Section 603-2.04 for additional variable depth guidance.

Chapter 56
56-4.04(03) Cross Slopes [Rev. Jun. 2023]

1. Travel Lanes. Pavement cross slopes on a tangent section should be reviewed for each type of partial 3R treatment. Improving pavement cross slope, where required, may be completed through staged construction, e.g., combining surface milling with pavement core investigation with an acceptable variable-depth cross section of HMA Intermediate course in accordance with the INDOT *Standard Specifications* prior to placing a uniform-depth HMA Surface course. See Section 603-2.04 for additional variable depth guidance.

   A preventative-maintenance treatment is exempt from crown correction only if an existing rural-pavement cross slope is 2%, or if an existing urban-pavement cross slope is 1.5 to 3%. If the slope is outside this range, a combination of surface milling and a uniform-depth HMA Surface course should be used.

Chapter 603
603-2.04 Asphalt or PCCP Milling [Rev. Jun. 2023]

Asphalt or PCCP Milling is intended to remove material from an existing pavement to a specified average depth by milling the surface and creating a uniform profile. An average depth of milling should be specified depending on the condition of the pavement or project requirements.
Asphalt and PCCP milling maybe used in the following cases:

1. prior to placing an HMA or PCCP inlay;
2. to correct substandard cross slopes or crown conditions;
3. profile correction; or
4. to maintain vertical clearance or curb height.

In addition to the cases listed above, Asphalt Milling may be used for the removal of stripped or distressed asphalt. The average milling depth specified should be sufficient to accommodate the HMA inlay, or the removal of distressed materials, and to achieve the desired cross slope.

Cross Slope Correction – Variable Depth Profile Milling. Variable depth profile milling is the preferred method to correct pavement cross slope. This approach allows for the placement of uniform thickness intermediate and surface layers. The existing pavement section must be thick enough to accommodate the required milling depth and leave sufficient pavement thickness to support the new HMA material. The limits and associated milling depths should be shown on the typical sections.

Cross Slope Correction – Variable Depth Intermediate QC/QA-HMA. When variable depth profile milling is not feasible, a variable depth intermediate layer may be considered. There are limits to the amount of variability that is acceptable across the pavement section. The limits, as described below, will determine whether QC/QA-HMA or HMA Wedge and Level material is used. QC/QA-HMA is the preferred pavement material. When variable depth QC/QA-HMA or HMA Wedge and Level is used, the maximum and minimum lay rate and Mixture Designation (in mm) should be shown on the plans.

When variable depth QC/QA HMA is specified, the difference between the pavement thickness at the crown and the edge of pavement at any transverse section should not exceed the maximum particle size in the mixture (maximum lift thickness variability). The maximum lift thickness variability by mixture designation is shown in the table below. Too much thickness variability within a single lift of pavement can lead to uneven compaction within the lift. This can be detrimental to pavement life.

Mixture Designation	Maximum Lift Thickness Variability QC/QA-HMA (in.)
9.5 mm	0.5
12.5 mm	0.75
19.0 mm	1.0
25.0 mm	1.5

Cross Slope Correction – Variable Depth HMA Wedge and Level. A combination of variable depth profile milling and variable depth QC/QA HMA should be considered before utilizing a wedge and level course.

When design or field conditions require a variable depth pavement that exceeds the maximum lift thickness variability for QC/QA-HMA, HMA Wedge and Level should be specified. INDOT *Standard Specification* defines the lift thickness of wedge and level as follows: "The finished thickness of wedge and level mixtures shall be at least 1 1/2 times but not more than six times the maximum particle size as shown on the DMF. Feathering may be less than the minimum thickness requirements."

If wedge and level is specified, the smallest feasible mixture designation should be selected. This is typically a 9.5 mm mixture. A consistent depth QC/QA HMA Surface or another type of surface treatment is required to be placed over the HMA Wedge and Level course.

Chapter 607

607-1.0 HMA PAVEMENT PAY ITEMS [Rev. Jun. 2023]

The INDOT *Standard Specifications* section 401 QC/QA-HMA pay item should use the format as follows:

QC/QA-HMA, _____,	_____,	_____,	_____ mm
	(ESAL Category)	(PG Binder)	(Course)	(Mixture Designation)

The ESAL categories can be found in Section 601-4.0, INDOT Pavement Philosophy.

EXAMPLE: The pay item QC/QA-HMA, 4, 76, Surface, 9.5 mm represents a QC/QA-HMA-mixture with between 10,000,000 and 30,000,000 ESALs, a PG 76 high-temperature binder, a Surface course, and a mixture designation size of 9.5 mm.

The project designer should use the pay-item descriptions shown in the INDOT *Standard Specifications* for QC/QA-HMA mixtures.

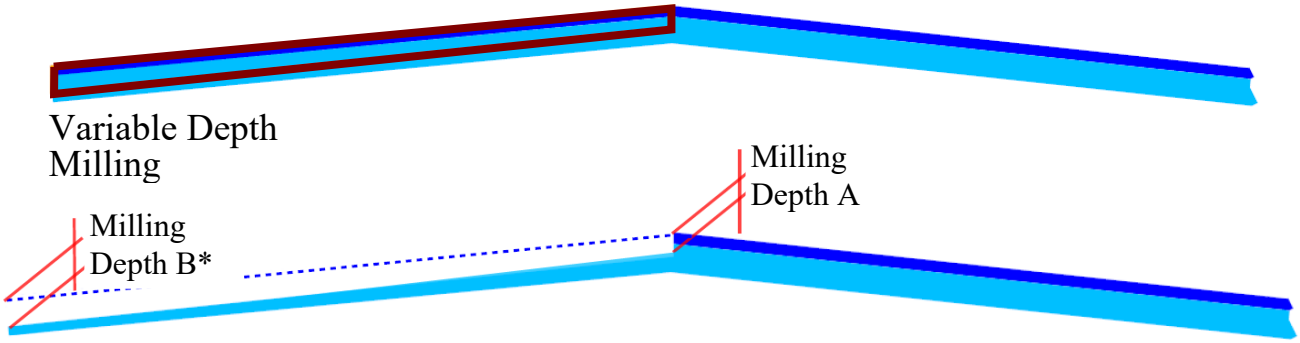
When Section 401 HMA is specified on mainline or shoulders and the original contract pay item quantities are less than 300 tons, acceptance will be based upon Type D certification

For Section 402 miscellaneous mixtures such as HMA Rumble Strips, HMA for Approaches, HMA for Temporary Pavement, HMA Wedge and Level, Widening with HMA, and HMA for Sidewalks, the project designer should specify the applicable pay item and mixtures as listed in the INDOT *Standard Specifications.*

Cross Slope Correction

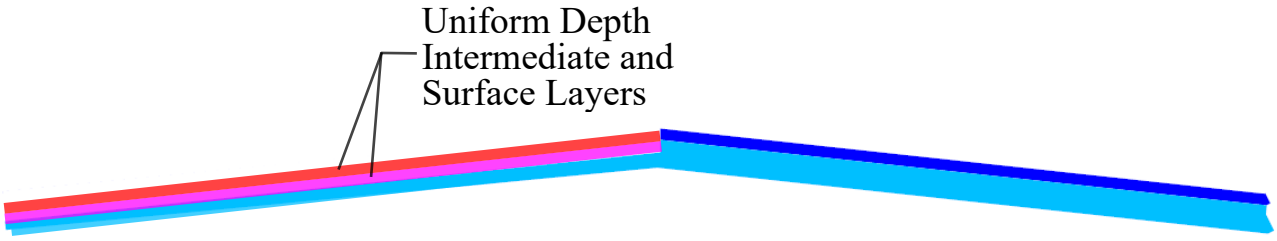
Variable Depth Milling (preferred)

Flat Cross Slope



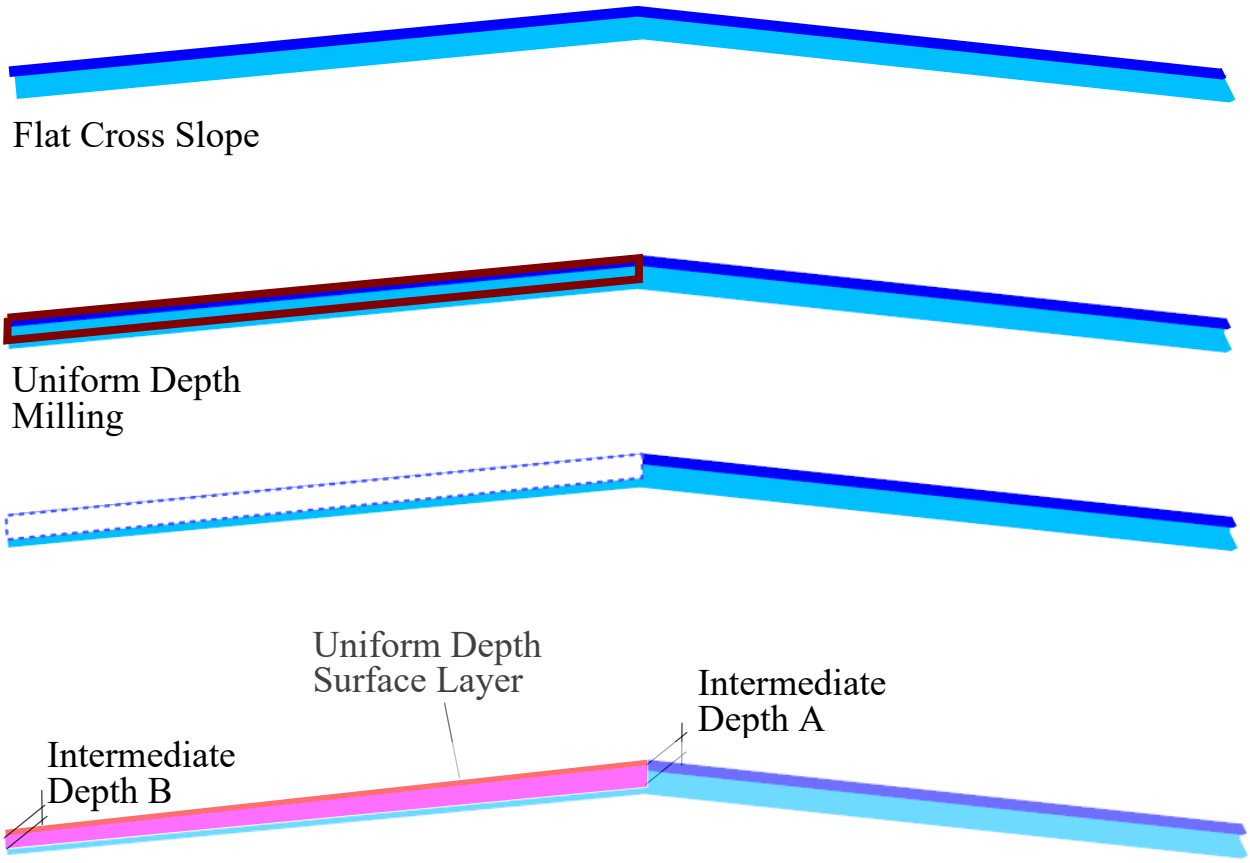
Milling Depth B > Milling Depth A

*There must be sufficient pavement thickness
to accommodate deeper milling at edge of pavement



Cross Slope Correction

Variable Depth Intermediate Layer



Difference in Intermediate Pavement Thickness	Variable Depth Intermediate Layer	Surface Layer
Depth A – Depth B ≤ Maximum Lift Thickness Variability	QC/QA-HMA	QC/QA-HMA
Depth A – Depth B > Maximum Lift Thickness Variability	HMA Wedge and Level*	QC/QA-HMA

*A combination of variable depth profile milling and variable depth QC/QA-HMA should be considered before utilizing HMA Wedge and Level

Mixture Designation	Maximum Lift Thickness Variability QC/QA-HMA (in.)
9.5 mm	0.5
12.5 mm	0.75
19.0 mm	1.0
25.0 mm	1.5