Structural Layer Coefficients

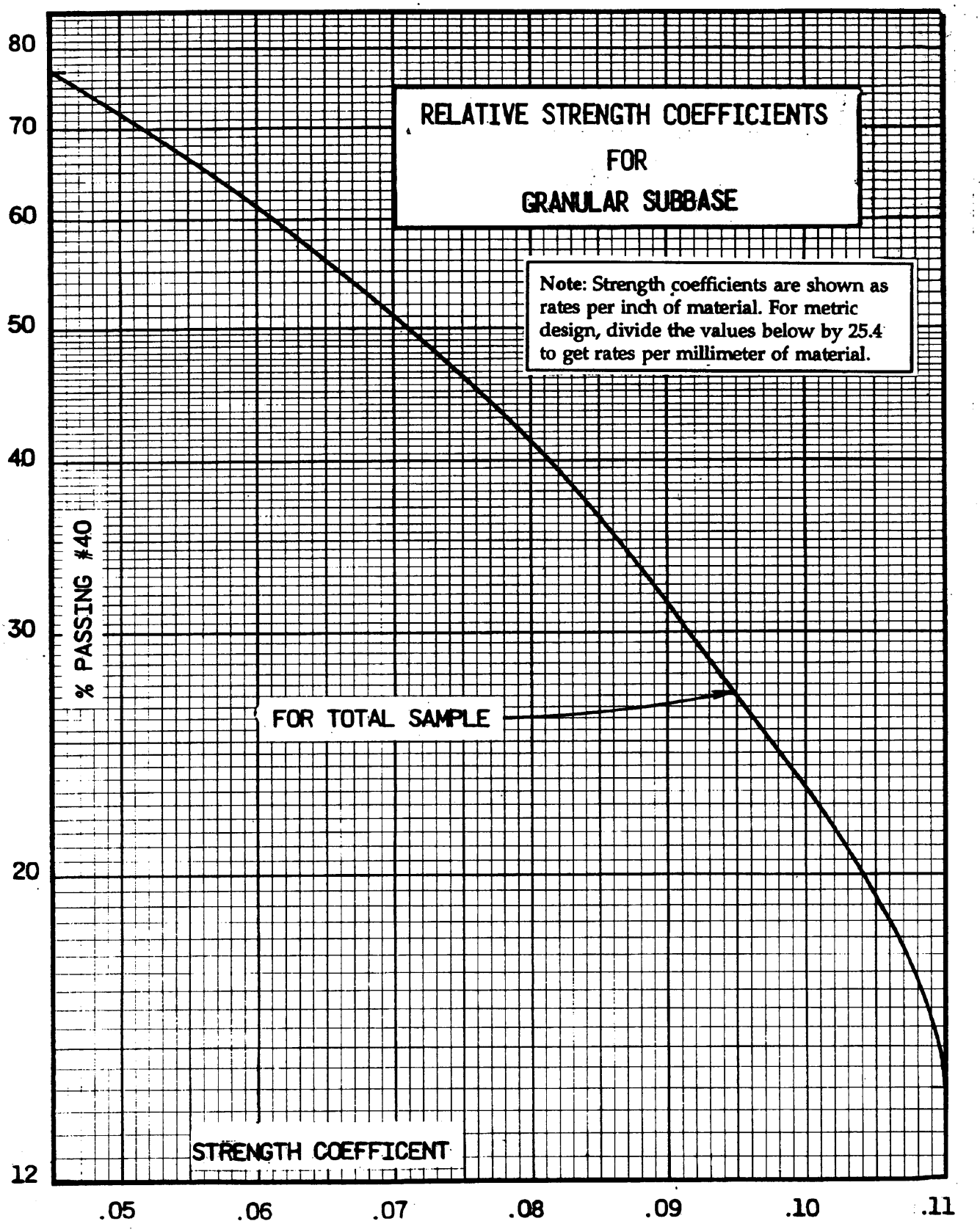
(For new or reconstructed pavements)

Structural Layer	Coefficient (English)
New HMA Pavement	0.44
HMA Pavement, Intact	0.10 – 0.44
Base Aggregate Dense	
crushed stone	0.14
crushed gravel	0.10
Base Aggregate Open Graded	
crushed stone	0.14
crushed gravel	0.10
Select Crushed Material	
crushed stone	0.14 *
crushed gravel	0.10 *
Subbase	See Attachment 5.2 **
Asphaltic Base	0.34
Concrete Base	0.40
Cement Stabilized Base Aggregate Open Graded	
crushed stone	0.14
crushed gravel	0.10
Asphalt Stabilized Base Aggregate Open Graded	
crushed stone	0.14
crushed gravel	0.10
Rubblized Concrete	0.20-0.24
Milled and Re-laid HMA Pavement	0.10-0.25
Pulverized HMA Pavement	0.10-0.25
Concrete Pavement, Intact	0.10-0.54
(if placing on HMA overlay)	0.10-0.44
Cold In-Place Recycling (CIR)	0.30-0.35
Cracked and Seated Concrete	0.20-0.40

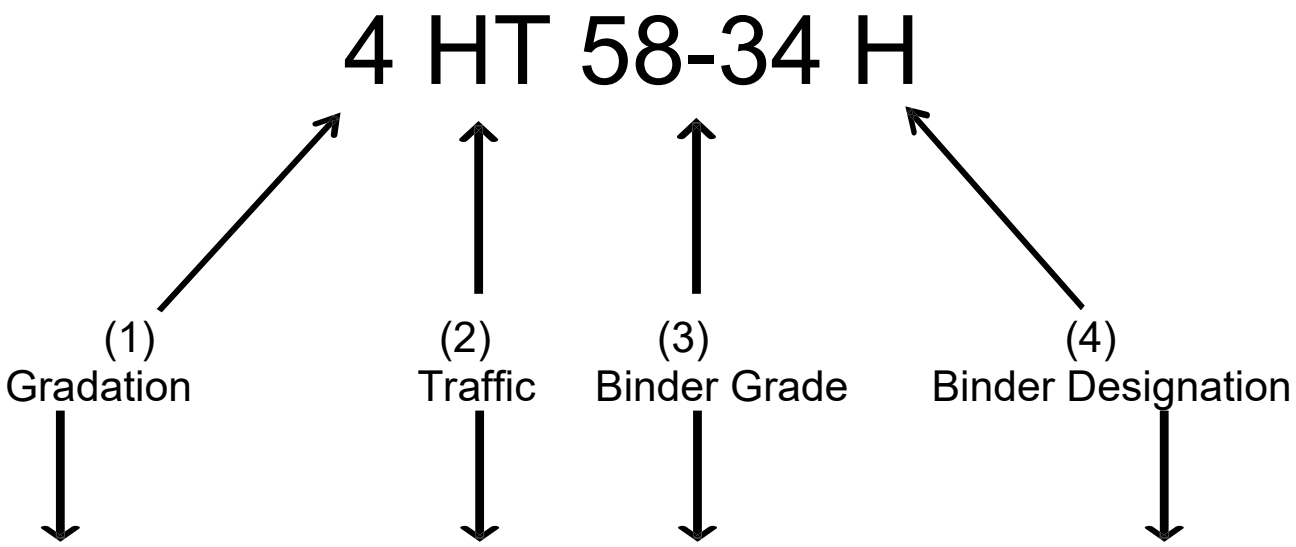
Notes:

* Do not count this material as part of the pavement structure if it is known it will be lost due to poor subgrades.

** Granular subbase may contribute a maximum of 10% of the design SN regardless of its strength coefficient or thickness used.


RELATIVE STRENGTH COEFFICIENTS
FOR
GRANULAR SUBBASE
Note: Strength coefficients are shown as rates per inch of material. For metric design, divide the values below by 25.4 to get rates per millimeter of material.
% PASSING #40
80
70
60
50
40
30
20
12
FOR TOTAL SAMPLE
STRENGTH COEFFICENT
.05
.06
.07
.08
.09
.10
.11

Step 1: Select Aggregate Gradation (Nmas) based on layer
Step 2: Select Traffic Classification based on 20-year design ESALs
Step 3: Select Asphaltic Binder Grade based on layer, project type and zone
Step 4: Select Asphaltic Binder Designation based on expected traffic levels



(1) Gradation	(2) Traffic Level		(3) Binder Grade		(4) Binder Designation
Upper Layer Options	**Class**	**ESALs**	**Upper Layer**		**Traffic Categories**
			Northern Zone	**Southern Zone**	
3 – 19.0 mm (crossovers) **4** – 12.5 mm **5** – 9.5 mm **6** – 4.75 mm	**LT**	≤ 1 million	**58-34** (New, Reconstruction, Pave. Replacement)	**58-28** (All Project Types)	**S** Standard (≤ 8 million ESALs)
	MT	1 million to ≤ 8 million	**58-28** (Other - Overlay, etc.)		**H** Heavy (8 million < ESALs ≤ 30 million OR design speeds between 15–45 mph)
Lower Layer Options	**HT**	> 8 million	**Lower Layer**		**V** Very Heavy (> 30 million ESALs OR traffic <15 mph)
			Northern Zone	**Southern Zone**	
2 – 25.0 mm **3** – 19.0 mm **4** – 12.5 mm **5** – 9.5 mm **6** – 4.75 mm	**SMA**	consider for > 2 million	**58-28** (All Project Types)	**58-28** (All Project Types)	**E** Extremely Heavy (> 30 million ESALs AND standing traffic)

For this example:

Gradation: 12.5 mm
Traffic Level: > 8 million ESALs
Binder Grade: upper layer, northern zone, reconstruction
Binder Designation: 8 million < ESALs ≤ 30 million

≤ 1 Mil ESALs				> 1 to ≤ 8 Mil ESALs				> 8 Mil ESALs				> 2 Mil ESALs			
Low Volume				Med Volume				High Volume				SMA			
3	LT	58-28	S	2	MT	58-28	S	2	HT	58-28	S	4	SMA	58-28	H
4	LT	58-28	S	3	MT	58-28	S	3	HT	58-28	S	5	SMA	58-28	H
5	LT	58-28	S	4	MT	58-28	S	4	HT	58-28	S	4	SMA	58-34	H
6	LT	58-28	S	5	MT	58-28	S	5	HT	58-28	S	5	SMA	58-34	H
3	LT	58-34	S	6	MT	58-28	S	6	HT	58-28	S	4	SMA	58-28	V
4	LT	58-34	S	2	MT	58-34	S	2	HT	58-34	S	5	SMA	58-28	V
5	LT	58-34	S	3	MT	58-34	S	3	HT	58-34	S	4	SMA	58-34	V
6	LT	58-34	S	4	MT	58-34	S	4	HT	58-34	S	5	SMA	58-34	V
4	LT	58-28	H	5	MT	58-34	S	5	HT	58-34	S	4	SMA	58-28	E
5	LT	58-28	H	6	MT	58-34	S	6	HT	58-34	S	5	SMA	58-28	E
				3	MT	58-28	V								
6	LT	58-28	H	4	MT	58-28	H	2	HT	58-28	H	4	SMA	58-34	E
4	LT	58-34	H	5	MT	58-28	H	3	HT	58-28	H	5	SMA	58-34	E
5	LT	58-34	H	6	MT	58-28	H	4	HT	58-28	H				
6	LT	58-34	H	4	MT	58-34	H	5	HT	58-28	H				
				5	MT	58-34	H	6	HT	58-28	H				
				6	MT	58-34	H	2	HT	58-34	H				
				3	MT	58-28	H								
				4	MT	58-28	V	3	HT	58-34	H				
				5	MT	58-28	V	4	HT	58-34	H				
				6	MT	58-28	V	5	HT	58-34	H				
				4	MT	58-34	V	6	HT	58-34	H				
				5	MT	58-34	V	4	HT	58-28	V				
				6	MT	58-34	V	5	HT	58-28	V				
								6	HT	58-28	V				
								4	HT	58-34	V				
								5	HT	58-34	V				
								6	HT	58-34	V				

Reasons you may not find specific mix types in the above table are summarized as follows:

- Gradation #2 (25mm) is not typically used for LT pavements.
- It is not typical to need anything greater than an S binder designation for LT pavements.
- It is uncommon to use a polymer modified binder (i.e., H and V binder designation) in the lower layers for LT or MT, which is the layer where one typically uses Gradation #2 or #3 (25mm or 19mm). It is up to region's

discretion.

- For HT pavements, there may be a need for H binder designation with Gradation #2 or #3 due to traffic loading, but typically there is no justification for a V binder designation with such gradations.
- SMA pavements are restricted to either gradation #4 or #5 (12.5mm or 9.5mm).

Key:

Gradation (NMAS)		Traffic Volume		Asphalt Binder		Binder Designation Level *	
1	37.5 mm	LT	Low Traffic	58-28	S	Standard
2	25.0 mm	MT	Medium Traffic	58-34	H	Heavy
3	19.0 mm	HT	High Traffic		V	Very Heavy
4	12.5 mm				E	Extremely Heavy
5	9.5 mm					
6	4.75 mm					

* See FDM 14-10-10.7.4 for additional details on Asphalt Binder Designation Selection.

Notes:

1. The final mix type should be one of those listed in the suite of choices shown above, unless otherwise designated in the approved Pavement Documentation for the project.
2. Bid Item numbers can be found beginning on the following pages.

BID ITEMS:

LT Pavement Types

460.5223	3 LT 58-28 S	TON
460.5224	4 LT 58-28 S	TON
460.5225	5 LT 58-28 S	TON
460.5226	6 LT 58-28 S	TON
460.5243	3 LT 58-34 S	TON
460.5244	4 LT 58-34 S	TON
460.5245	5 LT 58-34 S	TON
460.5246	6 LT 58-34 S	TON
460.5424	4 LT 58-28 H	TON
460.5425	5 LT 58-28 H	TON
460.5426	6 LT 58-28 H	TON
460.5444	4 LT 58-34 H	TON
460.5445	5 LT 58-34 H	TON
460.5446	6 LT 58-34 H	TON

MT Pavement Types

460.6222	2 MT 58-28 S	TON
460.6223	3 MT 58-28 S	TON
460.6224	4 MT 58-28 S	TON
460.6225	5 MT 58-28 S	TON
460.6226	6 MT 58-28 S	TON
460.6242	2 MT 58-34 S	TON
460.6243	3 MT 58-34 S	TON
460.6244	4 MT 58-34 S	TON
460.6245	5 MT 58-34 S	TON
460.6246	6 MT 58-34 S	TON
460.6423	3 MT 58-28 H	TON
460.6424	4 MT 58-28 H	TON
460.6425	5 MT 58-28 H	TON
460.6426	6 MT 58-28 H	TON
460.6444	4 MT 58-34 H	TON
460.6445	5 MT 58-34 H	TON
460.6446	6 MT 58-34 H	TON
460.6623	3 MT 58-28 V	TON
460.6624	4 MT 58-28 V	TON
460.6625	5 MT 58-28 V	TON
460.6626	6 MT 58-28 V	TON
460.6644	4 MT 58-34 V	TON
460.6645	5 MT 58-34 V	TON
460.6646	6 MT 58-34 V	TON

HT Pavement Types

460.7222	2 HT 58-28 S	TON
460.7223	3 HT 58-28 S	TON
460.7224	4 HT 58-28 S	TON
460.7225	5 HT 58-28 S	TON
460.7226	6 HT 58-28 S	TON
460.7242	2 HT 58-34 S	TON
460.7243	3 HT 58-34 S	TON

460.7244	4 HT 58-34 S	TON
460.7245	5 HT 58-34 S	TON
460.7246	6 HT 58-34 S	TON
460.7422	2 HT 58-28 H	TON
460.7423	3 HT 58-28 H	TON
460.7424	4 HT 58-28 H	TON
460.7425	5 HT 58-28 H	TON
460.7426	6 HT 58-28 H	TON
460.7442	2 HT 58-34 H	TON
460.7443	3 HT 58-34 H	TON
460.7444	4 HT 58-34 H	TON
460.7445	5 HT 58-34 H	TON
460.7446	6 HT 58-34 H	TON
460.7624	4 HT 58-28 V	TON
460.7625	5 HT 58-28 V	TON
460.7626	6 HT 58-28 V	TON
460.7644	4 HT 58-34 V	TON
460.7645	5 HT 58-34 V	TON
460.7646	6 HT 58-34 V	TON

SMA Pavement Types

460.8424	4 SMA 58-28 H	TON
460.8425	5 SMA 58-28 H	TON
460.8444	4 SMA 58-34 H	TON
460.8445	5 SMA 58-34 H	TON
460.8624	4 SMA 58-28 V	TON
460.8625	5 SMA 58-28 V	TON
460.8644	4 SMA 58-34 V	TON
460.8645	5 SMA 58-34 V	TON
460.8824	4 SMA 58-28 E	TON
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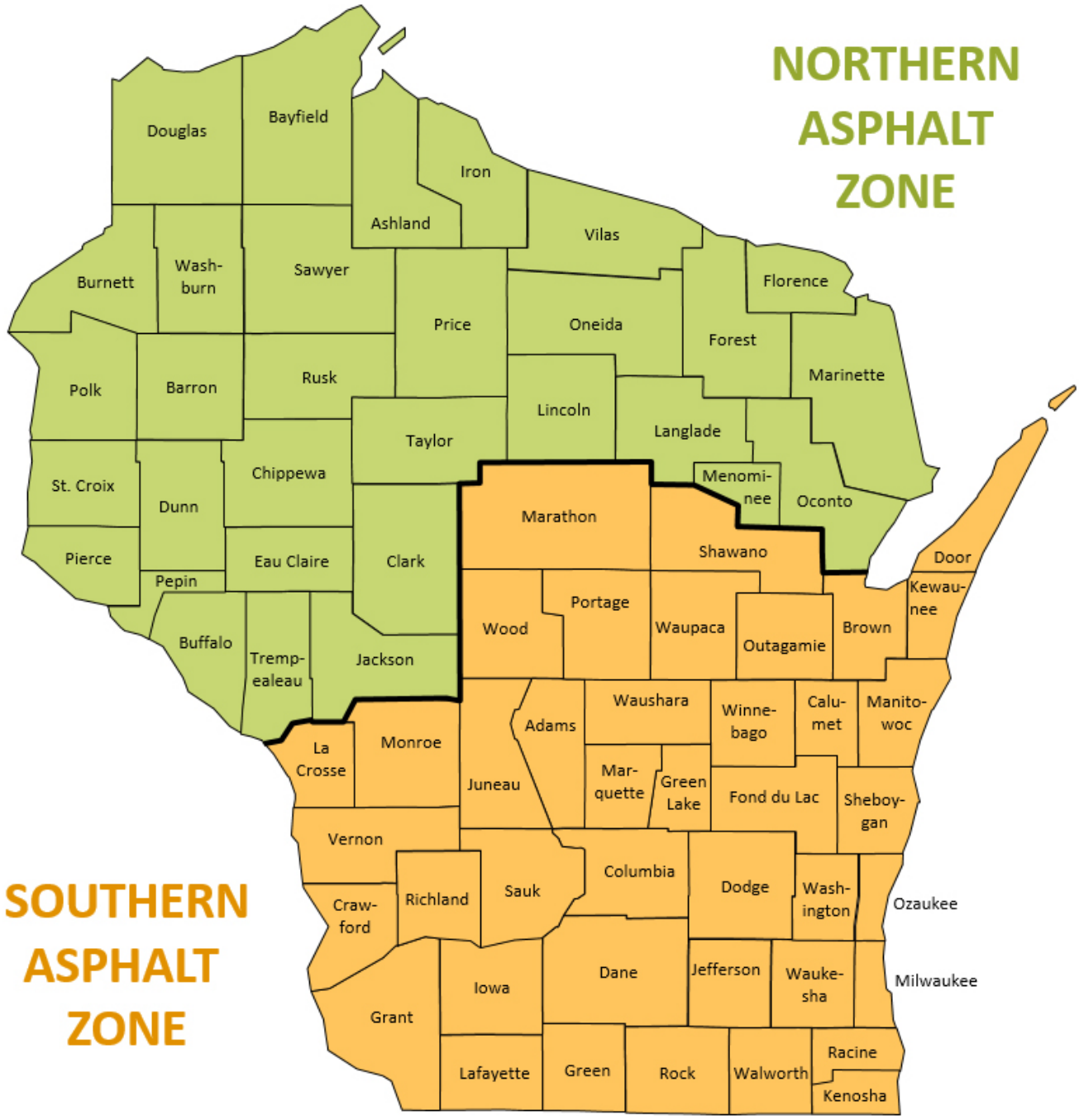
460.8844	4 SMA 58-34 E	TON
460.8845	5 SMA 58-34 E	TON



The Northern Asphalt Zone includes the following counties:

Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Florence, Forest, Iron, Jackson, Langlade, Lincoln, Marinette, Menominee, Oconto, Oneida, Pepin, Pierce, Polk, Price, Rusk, Saint Croix, Sawyer, Taylor, Trempealeau, Vilas, and Washburn.

The Southern Asphalt Zone includes the following counties:

Adams, Brown, Calumet, Columbia, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Juneau, Kenosha, Kewaunee, La Crosse, Lafayette, Manitowoc, Marathon, Marquette, Milwaukee, Monroe, Outagamie, Ozaukee, Portage, Racine, Richland, Rock, Sauk, Shawano, Sheboygan, Vernon, Walworth, Washington, Waukesha, Waupaca, Waushara, Winnebago, and Wood.

HMA Mix Type Examples

(FDM 14-10-10.7 is used to determine the asphalt mix to be used for a project.)

Example 1: A 4" thick HMA pavement is needed for an overlay of a concrete pavement on a 4 lane, rural divided highway in Barron County. The traffic forecast is for 9,000,000 ESALs in the design timeline. The highway is high speed divided highway with a posted speed limit of 65 mph.

Step 1: Gradation (following FDM 14-10-10.7.1)

Using the layer thickness guidelines as defined in Standard Spec 460.3.2, the following options are available.

Lower Layer: 3 (19.0 mm) or 4 (12.5 mm)

Upper Layer: 4 (12.5 mm) or 5 (9.5 mm)

Depending on which surface material is chosen with the minimum layer thickness guidelines, the pavement designer has four options:

1) 2.25" thick lower layer (Gradation 3) with a 1.75" thick upper layer (Gradation 4)
2) 2.5" thick lower layer (Gradation 3) with a 1.5" thick upper layer (Gradation 5)
3) 2.0" thick lower layer (Gradation 4) with 2.0" thick upper layer (Gradation 4)
4) 2.5" thick lower layer (Gradation 4) with 1.5" thick upper layer (Gradation 5)

In this case, the pavement designer has several options, but it is generally agreed that the above gradations are listed in order of most to least cost-effective, with larger gradations more economical. Knowing that the facility is a high-speed highway, and that the concrete being overlaid is in relatively good shape, with little heaving or patching necessary, the designer chooses to use Option 1 with Gradation 3 in the lower layer and Gradation 4 in the upper layer. If the pavement would have needed wedging, cross slope correction, or other repairs to try and restore a proper profile, use of Gradation 4 in the lower layer may have been justified.

We are left with the following:

Gradation: Lower = 3, Upper = 4

Step 2: Traffic Category (following FDM 14-10-10.7.2)

With 9,000,000 ESALs being expected during the pavement design life, an HT is selected. An SMA could have also been selected if there is a high volume of trucks on the pavement for the design period.

Step 3: Select the Asphalt Binder - Temperature (following FDM 14-10-10.7.3)

Since the project is in Barron County, which is in the Northern Asphalt Zone, the base binder selection is normally a 58-34, but because this pavement is an overlay, the use of 58-28 is allowed.

Step 4: Select the Asphalt Binder – Designation (following FDM 14-10-10.7.4)

One can see from the table of allowed designs (Attachment 10.4) that gradations 3 and 4 with 58-28 binder can be selected at the designation level of S or H for the HT category. Since there is little stopping and starting, and the speed is high, standard (S) would normally be specified and is reasonable for lower layers. However, in a traffic category like HT, there are benefits in specifying polymer modified asphalts to resist rutting of the pavement. Also, polymer modified asphalts have generally shown to be more resistant to thermal cracking, which is more prevalent in the northern part of the state. The pavement designer encouraged the use of a heavy grade (H) binder in this case due to the advantages mentioned.

Conclusion. The resulting mixes for this project are as follows:

Lower Layer: 3 HT 58-28 S

Upper Layer: 4 HT 58-28 H

Example 2: A roundabout is being built in Jefferson County at the intersection of two state highways. Traffic for the E-W and N-S roads approaching the roundabout is approximately 1,000,000 and 1,500,000 ESALs, respectively. The pavement design calls for 8" of HMA on top of the base aggregate.

Step 1: Gradation (following FDM 14-10-10.7.1)

Using the layer thickness guidelines as defined in standard spec 460.3.2, the following options are available.

Lower Layers: 2 (25.0 mm) or 3 (19.0 mm)

Upper Layer: 4 (12.5 mm) or 5 (9.5 mm)

Given the total 8" pavement thickness required, a pavement engineer has many gradation choices. In an effort to minimize the number of mix designs, the pavement engineer would usually call for 2 layers of a single gradation for construction of the lower layer. With that in mind, the pavement designer has three options:

1) Two 3.25" thick lower layers (Gradation 2) with a 1.5" thick upper layer (Gradation 5)
2) Two 3.0" thick lower layer (Gradation 3) with a 2.0" thick upper layer (Gradation 4)
3) Two 3.0" thick lower layer (Gradation 3) with 2.0" thick upper layer (Gradation 5)

It can be seen that selection of Gradation 2 for the lower layers limits the choices for the upper layer due to the increased minimum thickness required for the lower layers.

The pavement engineer may rely on past experience with various mix designs and material costs within their region to differentiate between Options 1 and 2 in this case (both are acceptable). Let's assume the engineer chooses Option 2 resulting in two 3.0" layers of Gradation 3 (19.0 mm) for the lower layers, and a 2.0" layer of Gradation 4 (12.5 mm) for the surface.

Gradation: Lower Layers = 3, Upper Layer = 4

Step 2: Traffic (following FDM 14-10-10.7.2)

With the legs of the roundabout providing approximately 1,000,000 and 1,500,000 ESALs, nearly 3 million ESALs are anticipated in the circular roadway which corresponds to a MT design. Following FDM 14-10-35.3.3 the mixture type level needs to be increased by one level for roundabout intersections and therefore a HT pavement is chosen.

Step 3: Asphalt Binder – Temperature (following FDM 14-10-10.7.3)

Since the project is in Jefferson County, in the Southern Asphalt Zone, a PG 58-28 is selected.

Step 4: Asphalt Binder – Designation (following FDM 14-10-10.7.4)

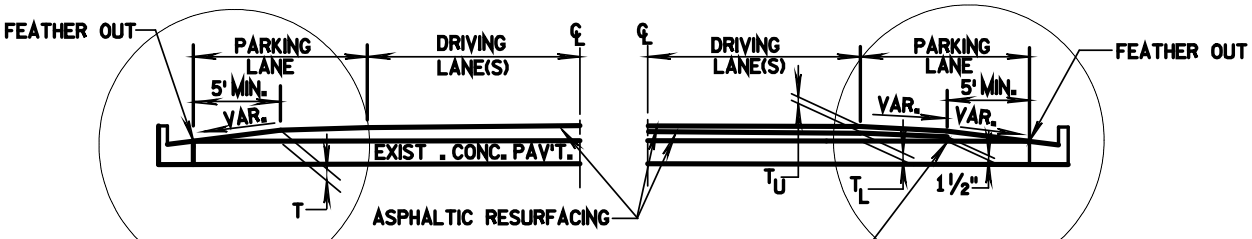
This kind of pavement sees significant turning, slowing and accelerating shearing motions. It would be classified as a lower speed where a polymer-modified asphalt would be appropriate. A move from S binder to H is required for the surface. In the lower layers, modification would not be necessary, as the surface is handling most of the stress from the vehicle movements, so S binder is acceptable in this case. (Per FDM 14-10-35.3.3 considering small tonnage of material being used usually for roundabout projects, it is recommended to use H binder in lower level as well if it has economic advantages.)

Conclusion: The resulting mixes for this project are as follows:

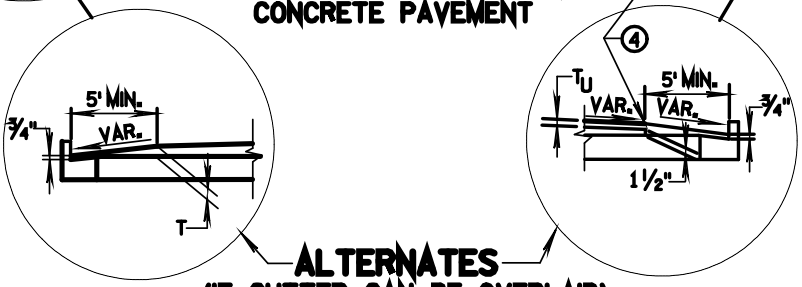
Lower Layers – 3 HT 58-28 S

Upper Layer – 4 HT 58-28 H

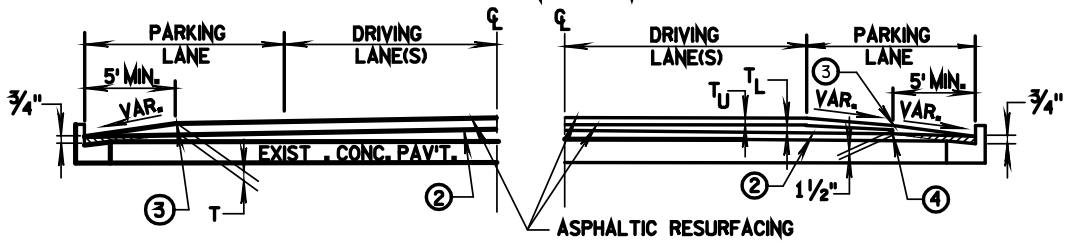
EDGE JOINTS



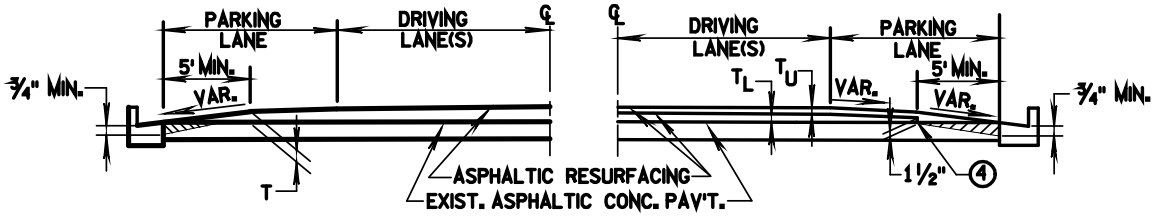
RESURFACING OVER EXISTING CONCRETE PAVEMENT



ALTERNATES
(IF GUTTER CAN BE OVERLAID)

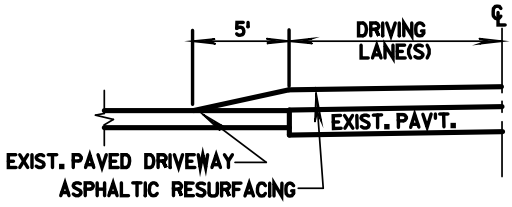


RESURFACING OVER PREVIOUS RESURFACING



RESURFACING OVER EXISTING ASPHALTIC CONCRETE PAVEMENT

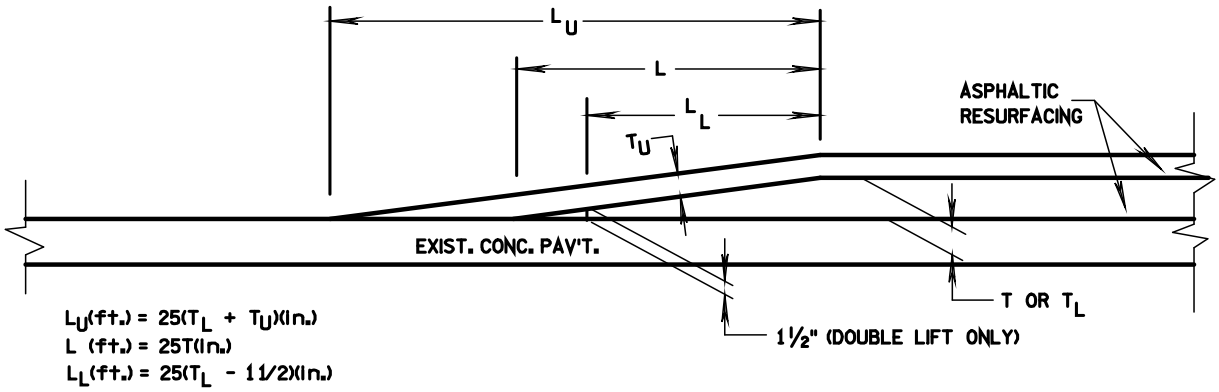
URBAN



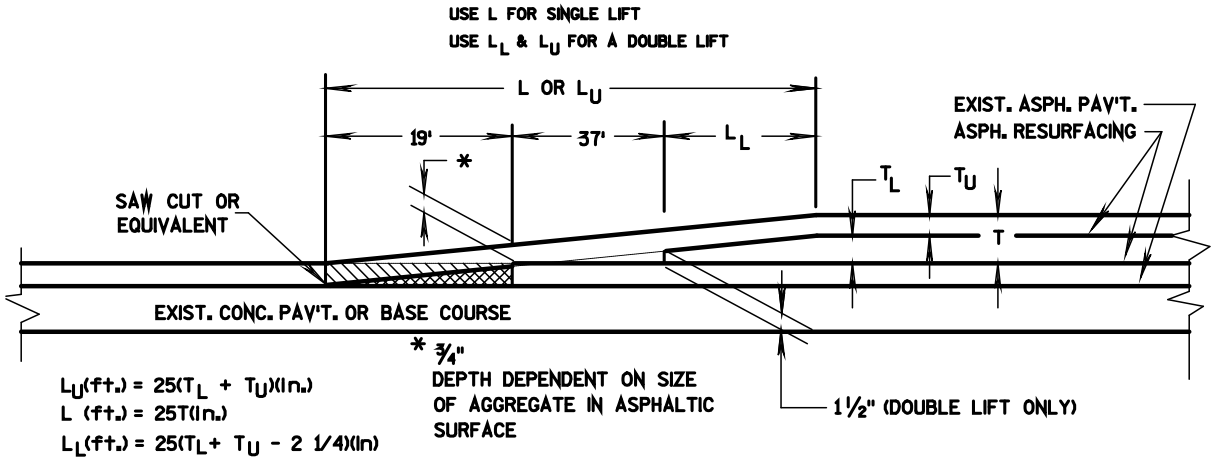
DRIVEWAYS
RURAL

SEE FIGURE 4 FOR NOTES AND LEGEND

END JOINTS



OVER EXISTING CONCRETE PAVEMENT
OVERLAP JOINT



OVER EXISTING ASPHALTIC PAVEMENT
OVERLAP JOINT, BUTTED

NOTES:	LEGEND:
← Existing asphaltic surfaces with excess crown or with parabolic crown should have the excess crown eliminated as required.	T = Plan thickness of single lift of asphaltic resurf.
↑ On roadways where previous resurfacing will cause the elevation at the edge of pavement to be less than two inches below the top of curb, consider reconstructing the curb or removing the previous resurfacing.	T_L = Plan thickness of lower layer
→ Vertical edges may be raked down at the option of the engineer.	T_U = Plan thickness of upper layer
	L = Length of wedge for single lift
	L_L = Length of lower wedge
	L_U = Length of upper wedge
	▧ Remove existing pavement
	▩ Wedge with surface material prior to placing surface course