Structural Layer Coefficients

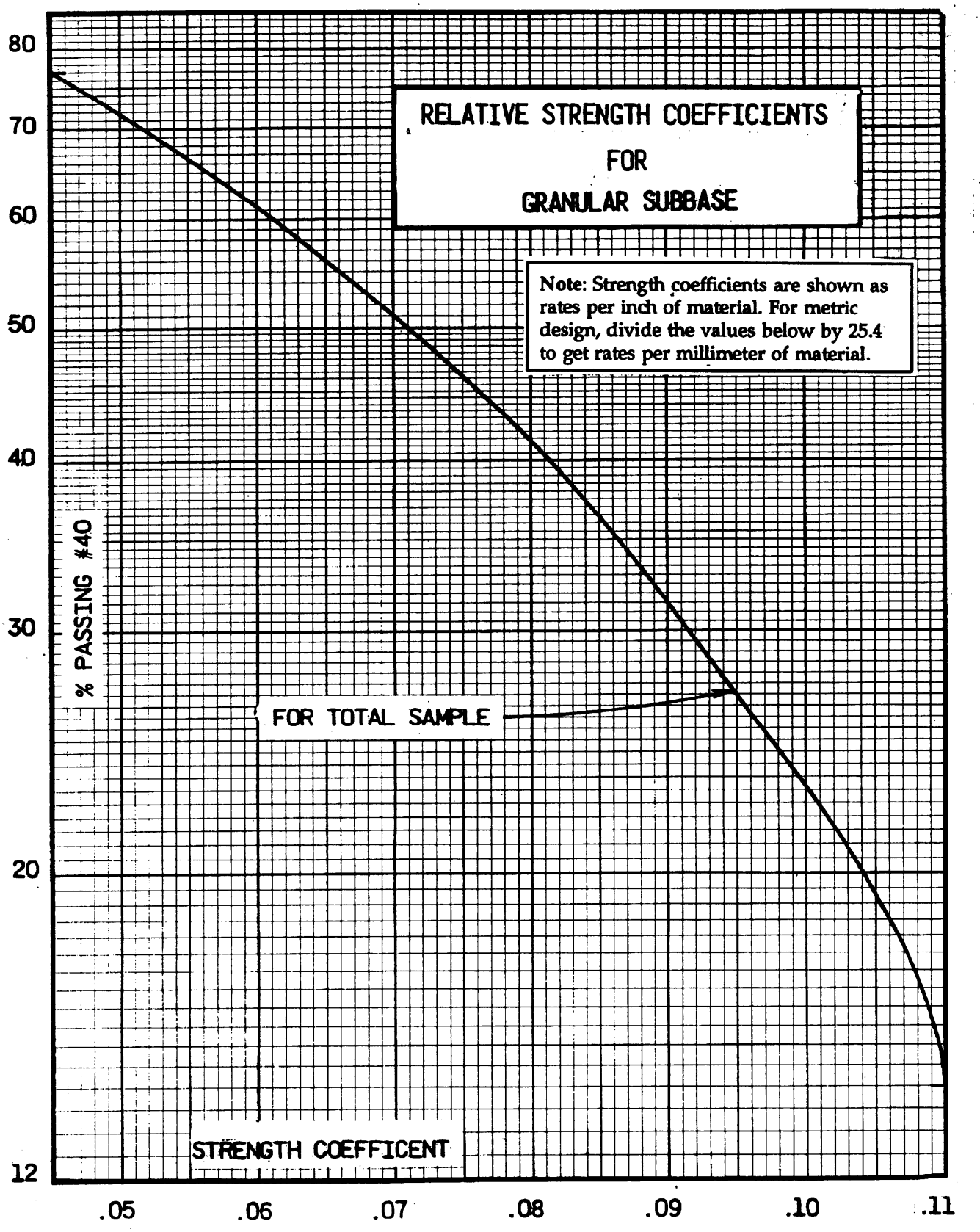
(For new or reconstructed pavements)

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
Cold In-Place Recycling (CIR)	0.30-0.35

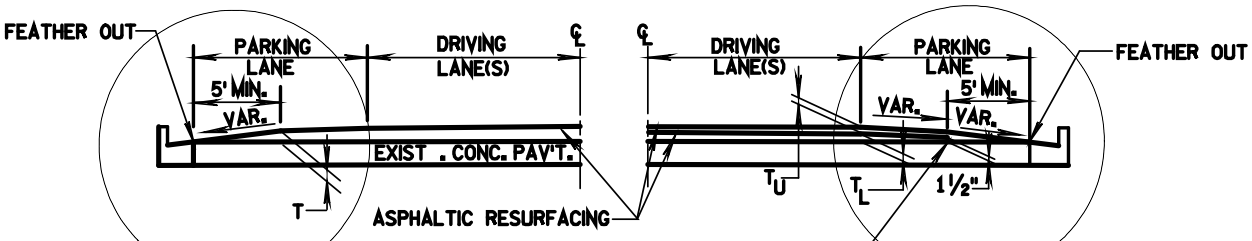
Notes:

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

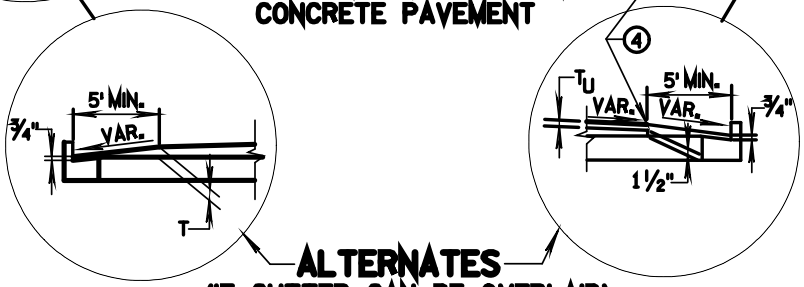
** Granular subbase may contribute a maximum of 10% of the design SN regardless of its strength coefficient or thickness used.


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

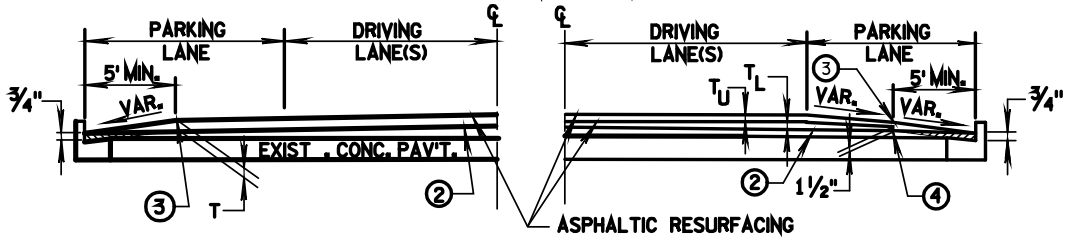
EDGE JOINTS



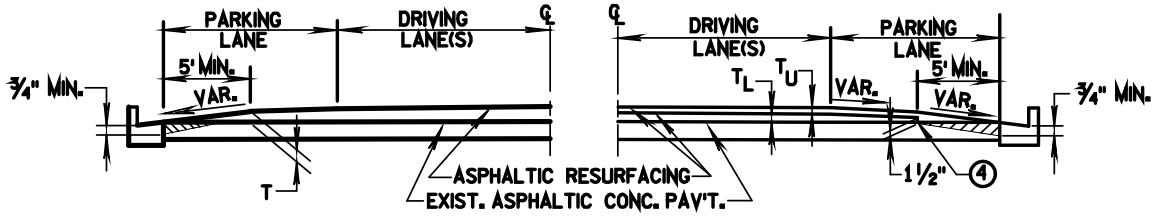
RESURFACING OVER EXISTING CONCRETE PAVEMENT



ALTERNATES
(IF GUTTER CAN BE OVERLAID)

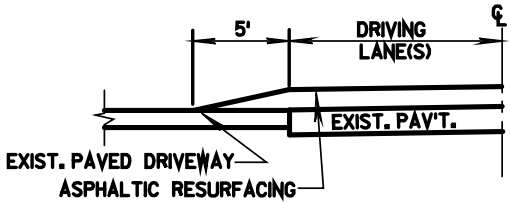


RESURFACING OVER PREVIOUS RESURFACING



RESURFACING OVER EXISTING ASPHALTIC CONCRETE PAVEMENT

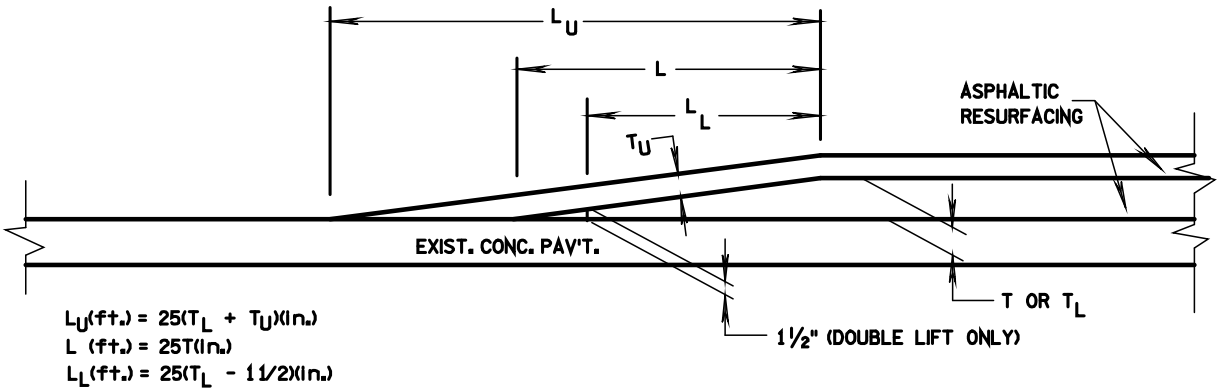
URBAN



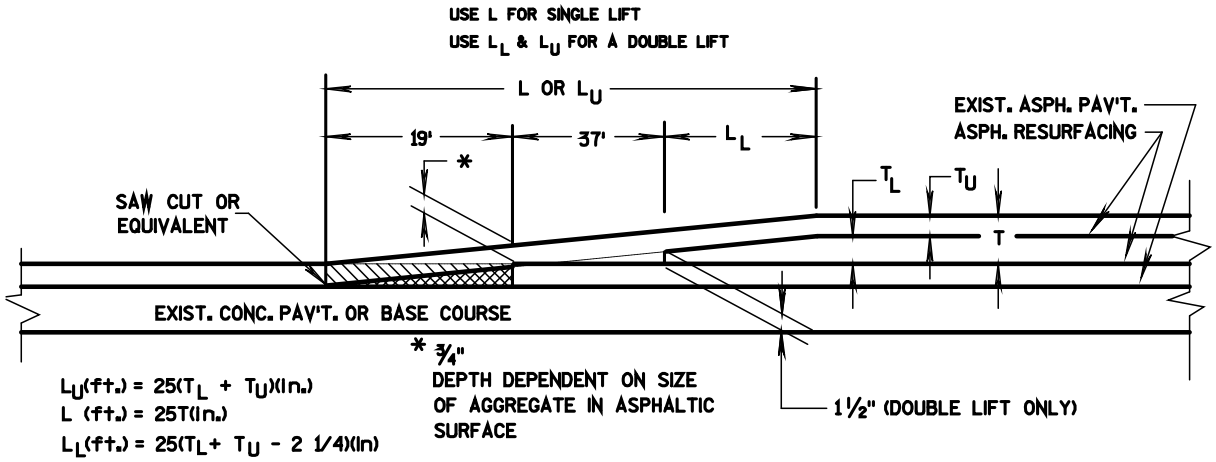
DRIVEWAYS
RURAL

SEE FIGURE 4 FOR NOTES AND LEGEND

END JOINTS

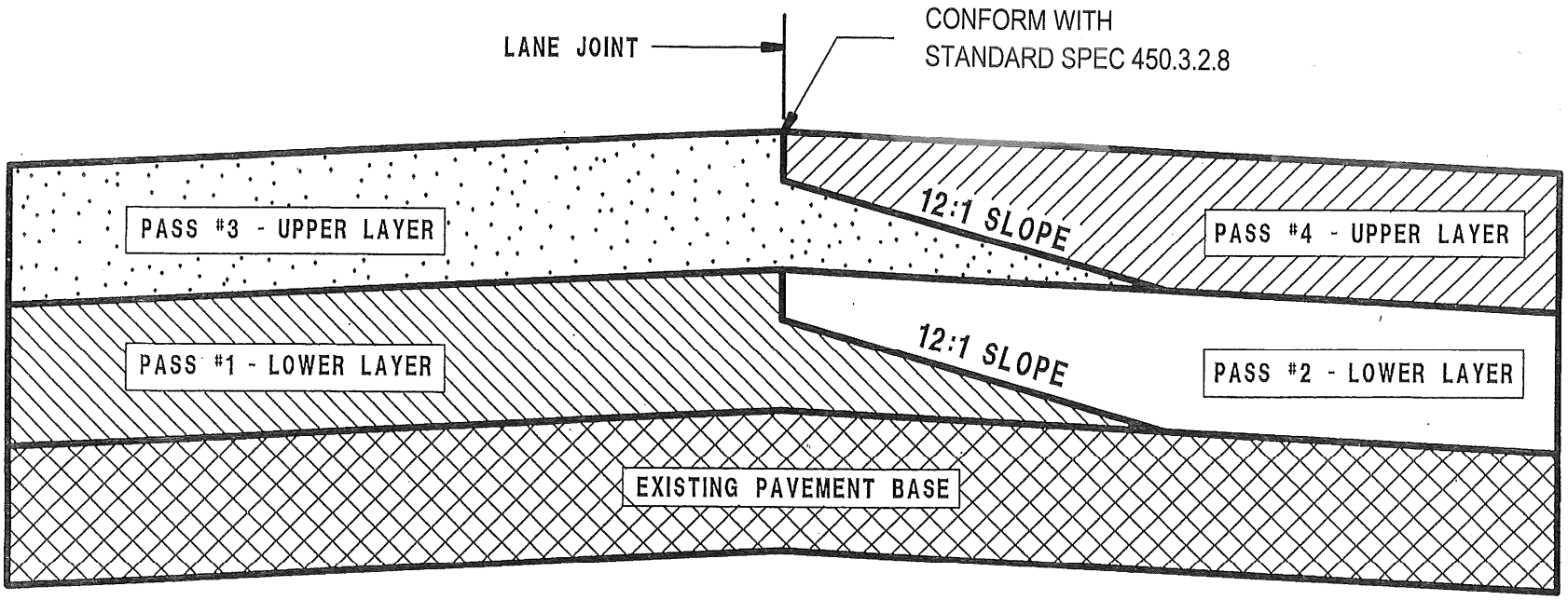


OVER EXISTING CONCRETE PAVEMENT
OVERLAP JOINT



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



(LOWER AND UPPER LAYERS)

TYPICAL PAVEMENT CROSS SECTION OF NOTCHED WEDGE LONGITUDINAL JOINTS

< 2 Mil ESALs			
Low Volume			
3	LT	58-34	S
4	LT	58-34	S
5	LT	58-34	S
3	LT	58-28	S
4	LT	58-28	S
5	LT	58-28	S

2 to <8 Mil ESALs			
Med Volume			
2	MT	58-34	S
3	MT	58-34	S
4	MT	58-34	S
5	MT	58-34	S
2	MT	58-28	S
3	MT	58-28	S
4	MT	58-28	S
5	MT	58-28	S
4	MT	58-34	H
5	MT	58-34	H
4	MT	58-28	H
5	MT	58-28	H

≥8 Mil ESALs			
High Volume			
2	HT	58-34	S
3	HT	58-34	S
4	HT	58-34	S
5	HT	58-34	S
2	HT	58-28	S
3	HT	58-28	S
4	HT	58-28	S
5	HT	58-28	S
2	HT	58-34	H
3	HT	58-34	H
4	HT	58-34	H
5	HT	58-34	H
2	HT	58-28	H
3	HT	58-28	H
4	HT	58-28	H
5	HT	58-28	H
4	HT	58-34	V
5	HT	58-34	V
4	HT	58-28	V
5	HT	58-28	V

≥5 Mil ESALs			
SMA			
4	SMA	58-34	H
5	SMA	58-34	H
4	SMA	58-28	H
5	SMA	58-28	H
4	SMA	58-34	V
5	SMA	58-34	V
4	SMA	58-28	V
5	SMA	58-28	V

*Gradation 2 not used for LT

*Lowest Designation used for LT so only S binders appear

*Heavy Designation not needed in Lower Layers, becomes Gradation dependent (Eliminate Grad. 2 & 3)

*Very Heavy Designation not needed in Lower Layers, becomes Gradation dependent (Eliminate Grad. 2 & 3)

*SMA restricted to Gradations 4 & 5

*Increased designation used with SMA so no S binders appear

KEY:

Gradations (NMAS)	
1	37.5 mm
2	25.0 mm
3	19.0 mm
4	12.5 mm
5	9.5 mm
6	4.75 mm

Traffic	
LT	Low Traffic Vol.
MT	Medium Traffic Vol.
HT	High Traffic Vol.

Asphalt Binder
58-28
58-34

Binder Designation Level	
S	Standard
H	Heavy
V	Very Heavy
E	Extremely Heavy

NOTE: 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.

(Bid Item numbers can be found beginning on the following page.)

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
460.5243	3 LT 58-34 S	TON
460.5244	4 LT 58-34 S	TON
460.5245	5 LT 58-34 S	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
460.6242	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
460.6424	4 MT 58-28 H	TON
460.6425	5 MT 58-28 H	TON
460.6444	4 MT 58-34 H	TON
460.6445	5 MT 58-34 H	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
460.7242	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
460.7422	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
460.7442	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
460.7624	4 HT 58-28 V	TON
460.7625	5 HT 58-28 V	TON
460.7644	4 HT 58-34 V	TON
460.7645	5 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

KEY:

Traffic Level		
LT	Low Traffic Vol.	460.5xxx
MT	Medium Traffic Vol.	460.6xxx
HT	High Traffic Vol.	460.7xxx
SMA		460.8xxx

Binder Designation Level		
S	Standard	460.x2xx
H	Heavy	460.x4xx
V	Very Heavy	460.x6xx
E	Extremely Heavy	460.x8xx

Asphalt Binder		
58-28		460.xx2x
58-34		460.xx4x

Gradations (NMAS)		
1	37.5 mm	460.xxx1
2	25 mm	460.xxx2
3	19 mm	460.xxx3
4	12.5 mm	460.xxx4
5	9.5 mm	460.xxx5
6	4.75 mm	460.xxx6

FDM 14-10 Sections 5.6 and 5.10 are used to determine the asphalt mix to be used for a Project. The following are examples.

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 14-10-5.9.1)

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 14-10-5.9.2)

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 14-10-5.9.3)

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 14-10-5.9.4)

One can see from the table of allowed designs (Attachment 5.6) 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 14-10-5.9.1)

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 14-10-5.9.2)

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. Therefore, an MT pavement is chosen.

Step 3: Asphalt Binder – Temperature (following FDM 14-10-5.9.3)

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

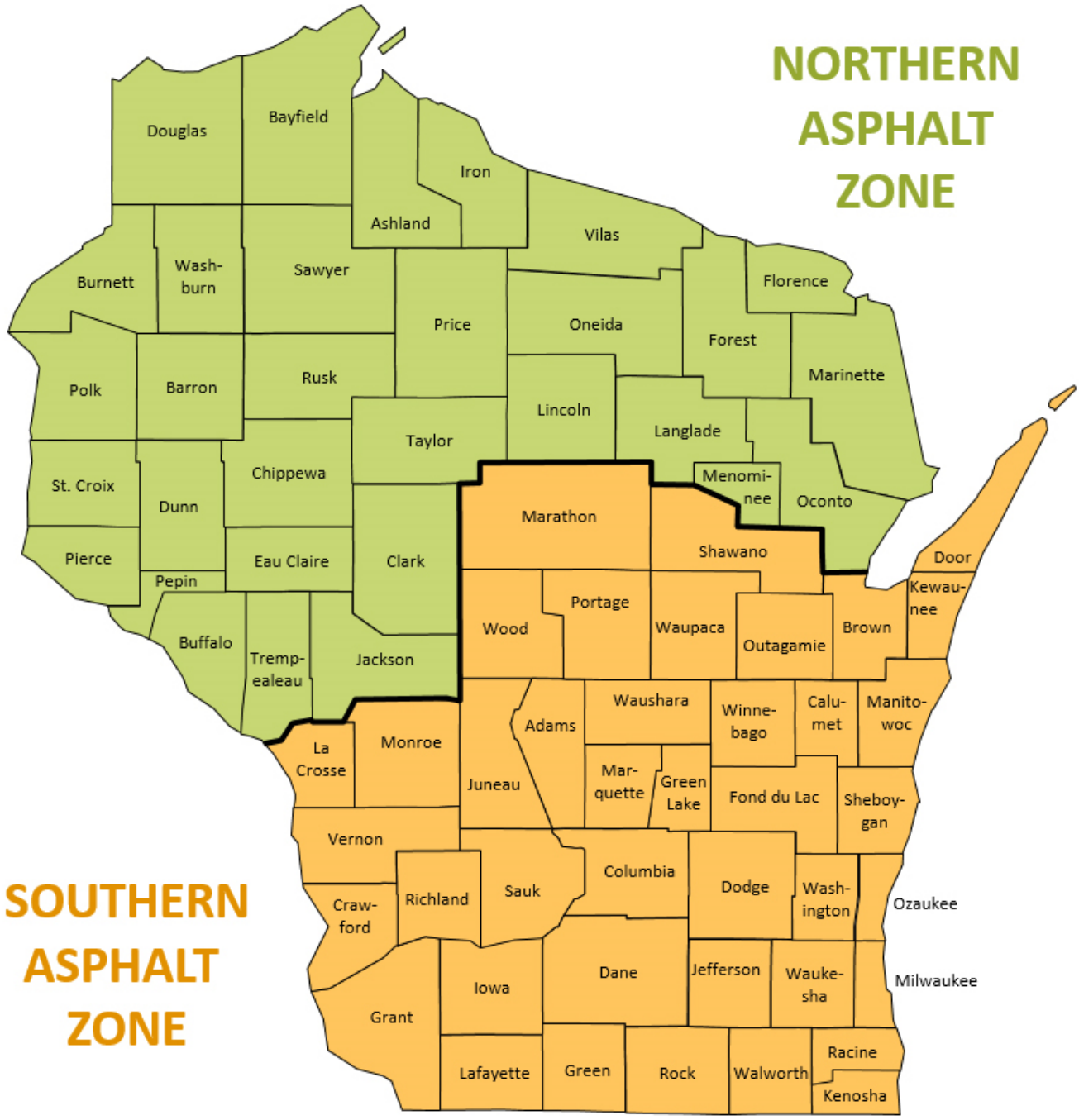
Step 4: Asphalt Binder – Designation (following FDM 14-10-5.9.4)

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.

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

Lower Layers – 3 MT 58-28 S

Upper Layer – 4 MT 58-28 H



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.