53-4.08 Superpave Design Guidelines

These guidelines apply to all bituminous concrete construction. Although the guidelines may list all of the available options allowed in Superpave, the District Materials Engineer should always be consulted for the determination of each aspect of the Superpave criteria.

Superpave, the final product of the Strategic Highway Research Program (SHRP), was developed as a system for specifying asphalt materials. It stands for Superior Performing Asphalt Pavements and represents a basis for specifying component materials, designing and analyzing bituminous concrete mixture designs, and predicting pavement performance. It is an improvement over previous mixture designs because Superpave designs mixtures for specific locations, climate, and traffic.

The Special Provision, “Superpave Bituminous Concrete Mixtures”, must always be used in conjunction with the Special Provision, “Quality Control/Quality Assurance of Bituminous Concrete Mixtures.” If reclaimed asphalt pavement (RAP) is to be allowed in the Superpave mixture, insert the Special Provision, “RAP for Use in Bituminous Concrete Mixtures.”
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Figure 53-4M was designed to accommodate Superpave mixtures and is required to be completed and inserted into the General Notes of the project plans.

The following mixture requirements are applicable for this project:

Location(s):	
Mixture Use(s):	
PG:	
RAP %: (Max)**	
Design Air Voids:	
Mixture Composition: (Gradation Mixture)	
Friction Aggregate:	
Mixture Weight:	

** *Note: If > 15% RAP is used, the District Materials Engineer may require the use of a softer grade of asphalt.*

SUPERPAVE MIXTURE REQUIREMENTS

Figure 53-4M

Use the following guidelines to complete the table in Figure 53-4M:

1. Location(s): Specify, by route number or stationing, the location(s) where the mix will be placed.

2. Mixture Use(s): Corresponds to the generic description of the mixture(s) (i.e., surface course, level binder, base course, shoulders, etc.). On full-depth projects, specify the lift (e.g., “full-depth, lower binder”, “full-depth, top binder”, or “full-depth, surface”).

3. PG: In Superpave designs, the asphalt cement is referred to as binder. Specify the Performance-Graded (PG) binder for the mixture, including polymer modified asphalt cement (e.g., PG64-28, SBR or SBS-PG64-28, PG70-22, SBR or SBS-PG70-22). Obtain the required PG binder designation from the District Materials Engineer. For additional information on PG binders and AC equivalents, see Section 53-4.02(c).

4. RAP%: Specify the maximum RAP percentage allowed in the mixture (e.g., 0%, 10%, 15%, 25%, etc.). RAP is not allowed in any mixtures that contain polymers. For additional information on RAP, see Section 53-4.08(d).

5. Design Air Voids: Specify the target air void content for the mixture. For example, Superpave may require “4.0% @ N_{design} = 50”, “4.0% @ N_{design} = 70”, etc. All Superpave projects, with the exception of some shoulder and low ESAL (< 0.3 million) mixtures, will

require 4.0% air voids; however, the N_{design} number will change. The target air voids for base course, stabilized subbase, shoulders and low ESAL mixtures will be included in the corresponding special provision. Obtain the N_{design} number from the District Materials Engineer.

6. Mixture Composition: Specify the aggregate gradation for the mixture design:

   a. Gradation Selection. Specify the aggregate gradation for Superpave design applications:

      - IL-25.0 – coarse binder (i.e., Mixture A).
      - IL-19.0 – binder (i.e., Mixture B).
      - IL-19.0L – low volume binder.
      - IL-12.5 – surface or level binder.
      - IL-9.5 – surface or level binder.
      - IL-9.5L – low volume surface.

   b. Surface Mixture. The gradation designation indicates the nominal maximum aggregate size in mm. When specifying a surface mixture, list both IL-12.5 and IL-9.5 for the mixture composition. The actual mixture composition used for the project is the contractor's option.

   c. Binder/Level Binder Mixtures. Binder mixtures have a larger top size aggregate, are placed in thicker lifts, and are used for structural purposes. IL-19.0, IL-19.0L and IL-25.0 mixtures are binder mixtures. Level binder mixtures have a smaller top size aggregate, are generally placed in thinner lifts, and are used for leveling purposes. IL-9.5 and IL-12.5 mixtures are level binder mixtures.

7. Friction Aggregate: Specify the aggregate to be used to meet surface course friction requirements (i.e., Mixture C, Mixture D, Mixture E, Mixture F). Because there are no friction requirements for binder courses, leave this entry blank when specifying binder courses. Refer to Section 53-4.08(e) for additional information.

8. Mixture Weight: Specify the unit weight used to determine the plan quantities for bituminous concrete surface course. Use 112.0 lb/sq yd/in thickness as the unit weight for typical standard mixes. For a specialty mix design, such as those with steel slag or a stone matrix asphalt (SMA), which only allow one specific coarse aggregate, the designer should consult the District Materials Engineer to determine the anticipated unit weight.

53-4.08(a) ESAL Calculation

In Superpave designs, use Section 54-2.01(c) to calculate ESALs for the design lane. To select the PG binder and design compactive effort (N_{design}), the ESAL value, equivalent to the Traffic Factor (TF), is calculated according to the equations in Figure 54-5B. For Superpave

designs, use a Design Period (DP) of 20 years. In this application, the calculation is purely to determine the mixture design parameters; actual pavement/thickness design may require a different design period and/or TF calculation. Minimum structural design traffic levels should be ignored for Superpave mixture design purposes.

It is recommended that each district designate a single individual to coordinate ESAL calculations. In instances where major routes cross district borders, it is recommended that the ESAL counts be confirmed between districts.

53-4.08(b) Design Compactive Effort

In the past, the laboratory compactive effort was defined by Class I and Type (i.e., Type 1, Type 2, Type 3). Now, with Superpave, the design compactive effort is expressed as an N_{design} number, which is selected based on the estimated 20-year ESAL loading of the traffic lane.

Figure 53-4N lists the design compactive effort (N_{design}) required for the different levels of traffic loading and describes the typical roadway application. These are guidelines. Consult the District Materials Engineer for the appropriate N_{design} value.

53-4.08(c) Binder/Asphalt Cement

Performance-Graded (PG) binders will now be specified in place of viscosity grades of asphalt cement (i.e., AC-10, AC-20). This does not mean the asphalt cement will be polymer modified; rather, the specification defines the asphalt cement based on the climate and pavement temperatures for which it is expected to serve. In Superpave, "binder" refers to the asphalt cement, not the "binder layer". Consider the following:

1. Polymer Modified Performance-Graded Binders. Where polymer modifiers are required, designate "SBS or SBR" in front of the PG binder requirements in the General Notes table. The following grades of asphalt cement must be polymer modified: PG70-28, PG76-22, and PG76-28. When specifying PG64-28 or PG70-22, check with the District Materials Engineer to verify the use of polymer, because these grades can be manufactured and applied without being polymer modified.

2. Applications. Figure 53-4O lists the common allowable PG binders, the previous asphalt cement equivalent, and possible applications.

3. Binder Selection. Based on Design ESALs and the Traffic Load Rate, the PG binder may be "bumped" to a higher binder grade. The binder selection options provided in Figures 53-4P and 53-4Q are based on the recommendations of the Illinois-Modified AASHTO MP-2 provisional standard in the *Manual of Test Procedures for Materials*.

Design ESALs (millions) (20-yr. Design)	N_{ini} [1]	N_{des} [1]	N_{max} [1]	TYPICAL ROADWAY APPLICATION
< 0.3	5	30	42	Roadways with very light traffic volume such as local roads, county roads, and city streets where truck traffic is prohibited or at a very minimal level. (Considered local in nature; not regional, intrastate, or interstate.) Special purpose roadways serving recreational sites or areas may also be applicable.
0.3 to 3	6	50	74	Includes many collector roads or access streets. Medium-trafficked city streets and the majority of county roadways.
3 to 10	7	70	107	Includes many two-lane, multi-lane, divided, and partially or completely controlled access roadways. Among these are medium-to-highly trafficked streets, many state routes, US highways, and some rural interstates.
10 to 30	8	90	141	May include the previous class of roadways which have a high amount of truck traffic.
> 30	8	105	167	Includes US Interstates, both urban and rural in nature. Special applications such as truck-weighing stations or truck-climbing lanes on two-lane roadways may also be applicable to this level.

[1] N_{ini} and N_{max} are for informational purposes only. It is recommended the air voids at N_{ini} be greater than 11 % to avoid mix tenderness. Also, air voids at N_{max} should be greater than 2% to prevent premature rutting.

DESIGN COMPACTIVE EFFORT FOR VARIOUS TRAFFIC CONDITIONS

Figure 53-4N

PG GRADE	PREVIOUS EQUIVALENT	APPLICATIONS
PG64-22	AC 20	Overlays Full-Depth Pavements
PG70-22 SBR or SBS-PG70-22	AC 40 or MAC 20	Overlays Full-Depth Pavements
SBR or SBS-PG76-22	MAC 20HD	Overlays Full-Depth Pavements
PG64-28 SBR or SBS-PG64-28	AC 20 or MAC 10	Full-Depth Pavements
SBR or SBS-PG70-28	MAC 10HD	Full-Depth Pavements
SBR or SBS-PG76-28	MAC 10HD+	Full-Depth Pavements
PG58-22	AC 10	Local Agencies
PG58-28	AC 7.5	RAP Mixtures
PG52-28	AC 5	Local Agencies RAP Mixtures
PG46-28	AC 2.5	Local Agencies

PG BINDER APPLICATIONS

Figure 53-4O

Illinois N_{design} Number	Design ESALs[1] (million)	PG Binder Grade[5] [7]		
		Traffic Load Rate		
		Standard[4]	Slow[3]	Standing[2]
30	< 0.3	PG58-22	PG64-22	PG64-22[6]
50	0.3 to < 3	PG64-22	PG70-22 SBR or SBS-PG70-22	SBS-PG76-22
70	3 to < 10	PG64-22	PG70-22 SBR or SBS-PG70-22	SBS-PG76-22
90	10 to < 30	PG64-22[6]	PG70-22 SBR or SBS-PG70-22	SBS-PG76-22
105	≥ 30	PG70-22 SBR or SBS-PG70-22	PG70-22 SBR or SBS-PG70-22	SBS-PG76-22

Notes:

1. *Design ESALs are the anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years and choose the appropriate N_{design} level.*

2. *Standing Traffic - where the average traffic speed is less than 12 mph.*

3. *Slow Traffic - where the average traffic speed ranges from 12 mph to 43 mph.*

4. *Standard Traffic - where the average traffic speed is greater than 43 mph.*

5. *The binder grade provided in the table is based on the recommendations given in Illinois-Modified AASHTO MP-2, Table 1, "Binder Selection on the Basis of Traffic Speed and Traffic Level."*

6. *Consideration should be given to increasing the high temperature grade by one grade equivalent.*

7. *Consider increasing the high temperature grade by one grade and/or use polymer modified binder within 2500 ft upstream of the exit terminal stub to 2500 ft downstream of the entrance stub at weigh stations.*

PG BINDER GRADE SELECTION – OVERLAYS
Figure 53-4P

APPLICATION	PG BINDER GRADE [5,6,7]		
	STANDARD[4]	SLOW[3] TRAFFIC OR HIGH[1] ESALS	STANDING[2] TRAFFIC
Districts 1 - 6			
Surface	SBR or SBS-PG64-28	SBR or SBS-PG70-28	SBR or SBS-PG76-28
Top Binder	SBR or SBS-PG64-28	SBR or SBS-PG70-28	SBR or SBS-PG76-28
Lower Binders	PG64-22	PG64-22	PG64-22
Districts 7-9			
Surface	PG64-22	SBR or SBS-PG70-22	SBR or SBS-PG76-22
Top Binder	PG64-22	SBR or SBS-PG70-22	SBR or SBS-PG76-22
Lower Binders	PG64-22	PG64-22	PG64-22

Notes:

1. *High ESALs – where ESALs are > 30 million.*
2. *Standing Traffic - where the average traffic speed is less than 12 mph.*
3. *Slow Traffic - where the average traffic speed ranges from 12 mph to 43 mph.*
4. *Standard Traffic - where the average traffic speed is greater than 43 mph.*
5. *The binder grade provided in the table is based on the recommendations given in Illinois-Modified AASHTO MP-2, Table 1, "Binder Selection on the Basis of Traffic Speed and Traffic Level."*
6. *Consider increasing the high temperature grade by one grade for ESALs 10 to 30 million.*
7. *Consider increasing the high temperature grade by one grade and/or use polymer modified binder within 2500 ft upstream of the exit terminal stub to 2500 ft downstream of the entrance stub at weigh stations.*

PG BINDER GRADE SELECTION – FULL-DEPTH PAVEMENT

Figure 53-4Q

SUPERPAVE MIXTURES	MAXIMUM % RAP	
N_{design}	Binder/Leveling Binder	Surface
30	30	30
50	25	15
70	15	10
90	10	10
105	0	0

Note: RAP is not allowed in mixtures containing polymer modifiers. Designate 0% on the plans where SBR or SBS-PG binders are specified.

MAXIMUM RAP PERCENTAGES

Figure 53-4R

a. Overlays. Most overlays should use the grades shown in Figure 53-4P for a standard traffic level. Adjustments to this grade are dependent upon conditions such as slow moving traffic, high ESALs, or standing traffic. These modifications should be made according to Figure 53-4P for the corresponding N_{design} number and/or ESAL number. The appropriate binder grade should then be reported on the General Notes table of the plans.

b. Full-Depth. Full-depth pavements should be designed using the PG binders shown in Figure 53-4Q. The appropriate binder grade should be reported on the General Notes table of the project plans.

53-4.08(d) RAP

Use Figure 53-4R to determine the maximum allowable RAP percentage. Districts should specify the correct maximum RAP percentages on the General Notes table of the project plans.

53-4.08(e) Friction Aggregate

A Superpave bituminous concrete surface course must be specified for each rehabilitation/resurfacing project. The Illinois Wet-Pavement Crash Reduction Program (TRA-16), effective February 4, 2000, lists the selection criteria of the surface course material for construction and rehabilitation/resurfacing of pavements.

Before the appropriate mix is selected, determine whether or not the segment is a wet-pavement cluster site. If the segment is a wet-pavement cluster site, refer to "A Procedure for Identifying, Analyzing, and Improving Wet-Pavement Crash Locations Within Rehabilitation/ Resurfacing Projects," which is included in the "Illinois Safety Improvement Processes" maintained by the Bureau of Operations. This procedure discusses the available options for wet-pavement cluster sites.

It is not desirable to specify short, closely spaced segments of special high-quality friction mixes (i.e., patchwork surfacing). If a special high-quality friction mix treatment is required at more than one location on a project and the distance between locations is less than 1,000 ft, the gaps should also be treated with the special mix. Also, if the special treatment is required on more than 50 percent of the project, it should be used throughout the project.

For areas other than wet-pavement cluster sites, four surface course mixtures have been developed that will provide adequate skid resistance for various Average Daily Traffic (ADT) levels: Mixtures C, D, E, and F. Figure 53-4S designates the ADT levels allowable for each of the surface course mixtures.

NUMBER OF LANES	FRICTIONAL REQUIREMENTS (ADT)			
	Mixture C	Mixture D	Mixture E	Mixture F
≤ 2	≤ 5,000	> 5,000	N/A	N/A
4	≤ 5,000	5,001 to 25,000	25,001 to 100,000	> 100,000
≥ 6	N/A	5,001 to 60,000	60,001 to 100,000	> 100,000

Note: ADT levels are for the expected year of construction.

FRICTIONAL REQUIREMENTS FOR SURFACE MIXTURES

Figure 53-4S