MUNICIPAL ASPHALT PAVEMENT SOLUTIONS

ROSENBERG, TEXAS ★ MAY 7, 2025

PRESENTED BY:

TXAPA

Texas Asphalt Pavement Association

# Materials, Mix Types, and Binders

## Right Material, Right Place, Right Time

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# Topics

- Mix Types
  - Dense Graded Mixtures
  - Superpave Mixtures
  - Special Purpose Mixtures (SMA, PFC, TOM)
- General Mixture Characteristics
- Selection Considerations
  - Minimum lift Thickness
  - Effect of Certain Mixture Characteristics on Cost

# Mixture Considerations

## Choose the right mix for the right application.

- Performance
- Economy
- Design life
- Function
- Availability
- Existing surface condition


Texas Department of Transportation

# Material Selection Guide

## Bituminous Materials

TxDOT, Materials and Tests Division

# Types of Mix Gradations

Dense Graded (by far most common)

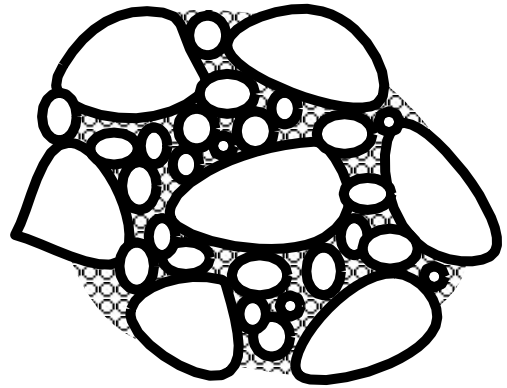
- All particle sizes represented
- Good interlock
- Low permeability

Gap Graded

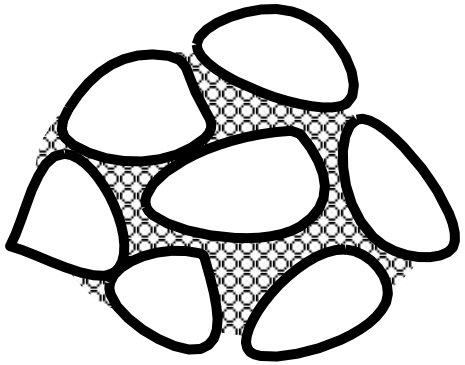
- Lacks intermediate sizes
- Good interlock
- Low permeability

Open Graded

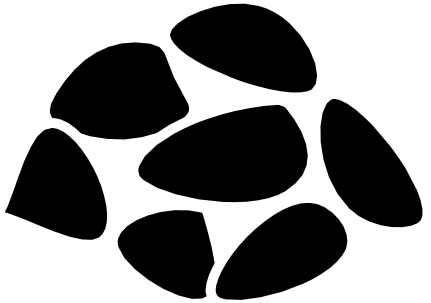
- Few points of contact
- Stone-on-stone contact
- High permeability



Dense Graded



Gap Graded



Open Graded

# Mix Type

**Dense Graded**

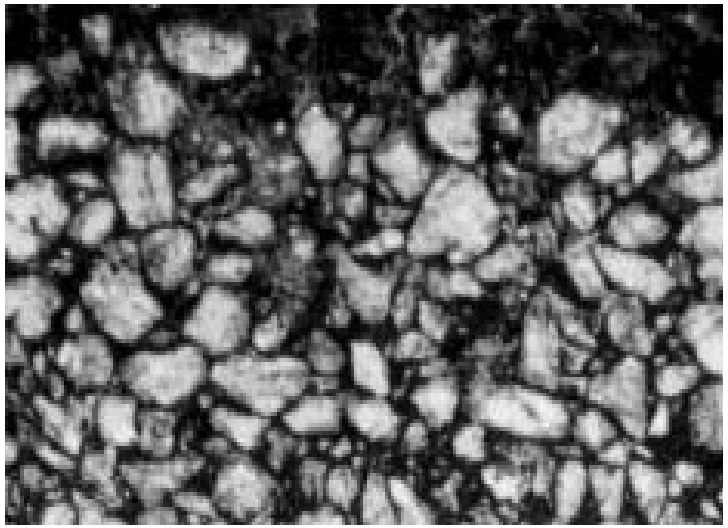
(DG-B, DG-C, DG-D, DG-E, Superpave)

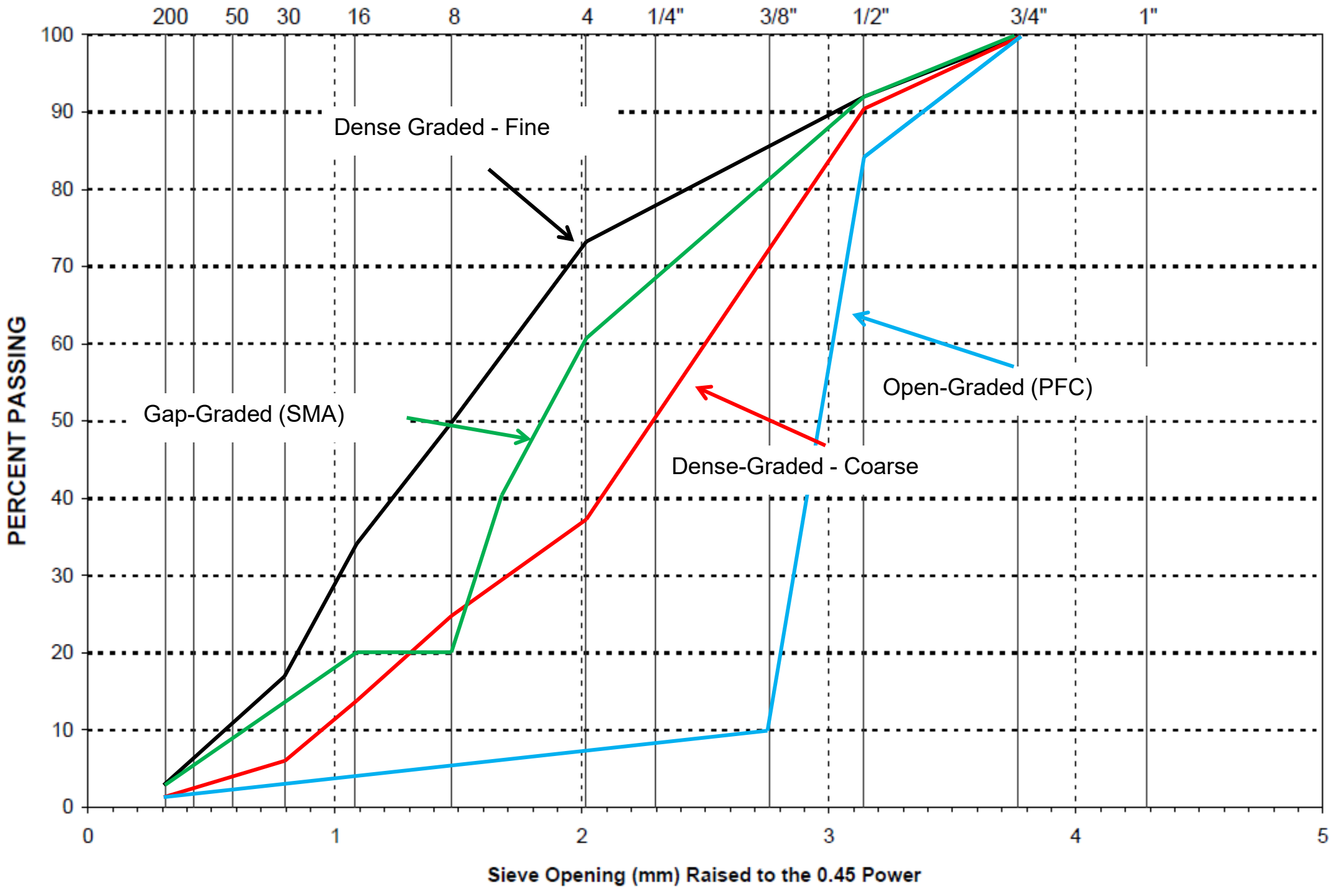
**Gap Graded**

(SMA, TOM, TBFC Types A, B, C)

**Open Graded**

(PFC, TBFC Types PFC-C, PFC-F)




200
50
30
16
8
4
1/4"
3/8"
1/2"
3/4"
1"
100
90
80
70
60
50
40
30
20
10
0
PERCENT PASSING
Dense Graded - Fine
Gap-Graded (SMA)
Open-Graded (PFC)
Dense-Graded - Coarse
0
1
2
3
4
5
Sieve Opening (mm) Raised to the 0.45 Power

# NMAS vs. MAS

**Nominal Maximum Aggregate Size (NMAS)**

- One sieve size larger than the first sieve to retain more than 10 percent

**Maximum Aggregate Size (MAS)**

- one sieve size larger than the NMAS

| Sieve Size | Percent Passing | |
|---|---|---|
| 3/4” | 100 | - MAS |
| 1/2” | 94 | - NMAS |
| 3/8” | 89 | *1st sieve to retain more than 10%* |
| No. 4 | 60 | |
| No. 8 | 35 | |
| No. 16 | 23 | |
| No. 30 | 13 | |
| No. 50 | 9 | |
| No. 100 | 6 | |
| No. 200 | 4.8 | |

# NMAS Considerations

- Larger NMAS mixes *may* have a higher load-bearing capacity
- Larger NMAS mixes are less aesthetically pleasing than smaller NMAS mixes
- Larger NMAS mixes are inherently less expensive
- Larger NMAS mixes need to be laid in thicker lifts
- Use them in the lowest lifts of thicker pavement sections

# Dense Graded Mixtures

- TxDOT Specifications (Item 340 & 341)
  - Item 340 not present in 2024 TxDOT specs
  - 341 M Municipalities Specification
- Applications
  - Workhorse mix
  - New construction or overlays
  - High to low volume traffic*
  - Any layer*

* Use appropriate binder grade and aggregate qualities

# Dense Graded Mixtures

- Advantages
  - Low cost
  - Readily available
  - Broad contractor familiarity
  - QC/QA Specification (341),
  - 341 M Municipalities Specification
- Used Throughout Texas
  - Superpave Gyratory Press
  - No longer can use the Texas Gyratory Press

# Superpave Mixtures

- TxDOT Specification (Item 344)
- Applications
  - Dense graded
  - Different compactor
  - High to low-volume roads
  - Any pavement layer (surface, intermediate, base)
  - New construction and overlay
  - Aggregate quality depends upon the layer and traffic

# Superpave Mixtures

- Advantages
  - Ability to adjust binder content by $N_{des}$
  - More asphalt, more crack resistant
  - Not prone to rutting
- Higher in-place density requirements

# Special Purpose Mixtures

**Stone Matrix Asphalt (SMA)**

- TxDOT Specification (Item 346)
  - Gap-graded mixture; contains PG 76-22 plus fibers and mineral filler to prevent binder drain-down
  - Stone-on-stone design resists rutting
  - Polymer binder and high mastic resists cracking
  - Higher cost, but longer service life
  - Macrotexture provides good skid resistance
- Applications
  - Surface layer or intermediate topped by PFC
  - Premium mix intended for high volume roads

Superpave SMA

# Special Purpose Mixtures

**Permeable Friction Course (PFC)**

- TxDOT Specification (Item 342)
  - Open-graded mixture; contains PG 76-22 plus fibers to prevent binder drain-down
  - Intentionally permeable; reduces potential for hydroplaning, water spray, and headlight glare
  - Reduces roadway noise; A-R used for even greater noise reduction
  - Higher cost, used as a safety consideration
  - Macrotexture provides good skid resistance
  - Uses SAC A aggregate
- Applications
  - Surface layer over SMA or dense-graded mix

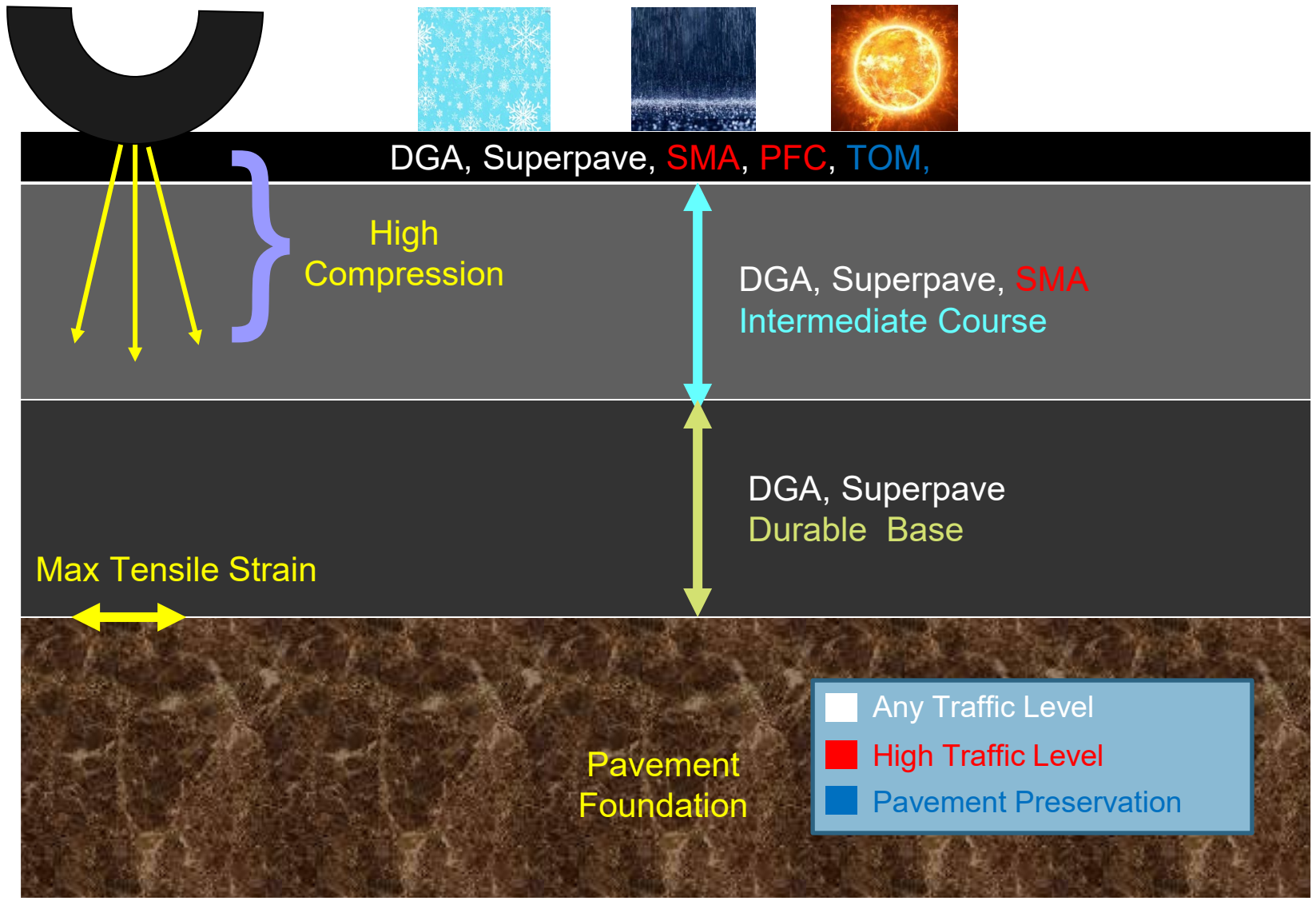
# Special Purpose Mixtures

## Thin Overlay Mix (TOM)

- TxDOT Specification (Item 347)
  - Gap-graded mixture, 3/8” NMAS; contains high % of PG 76-22 for excellent durability & flexibility and SAC A aggregate, can spec coarse or fine
  - No recycled materials allowed (RAP or RAS)
  - Used with polymer-modified emulsion tack coat to improve bonding
  - Higher cost per ton, but placed in thinner lift
- Applications
  - Pavement preservation treatment
  - Used when crack resistance is needed
  - Thin surface layer (1/2” to 1")
  - Existing surface must be structurally sound

# Where mixes are used

- Constructability (All layers)
- Durability (All layers)
- Fatigue Resistance (Lowest layer)
- Rut Resistance (Upper/Intermediate layers)
- Safety (Surface layer)
- Noise Mitigation (Surface layer)



# Make sure to specify an appropriate lift thickness relative to the NMAS

Dense Graded

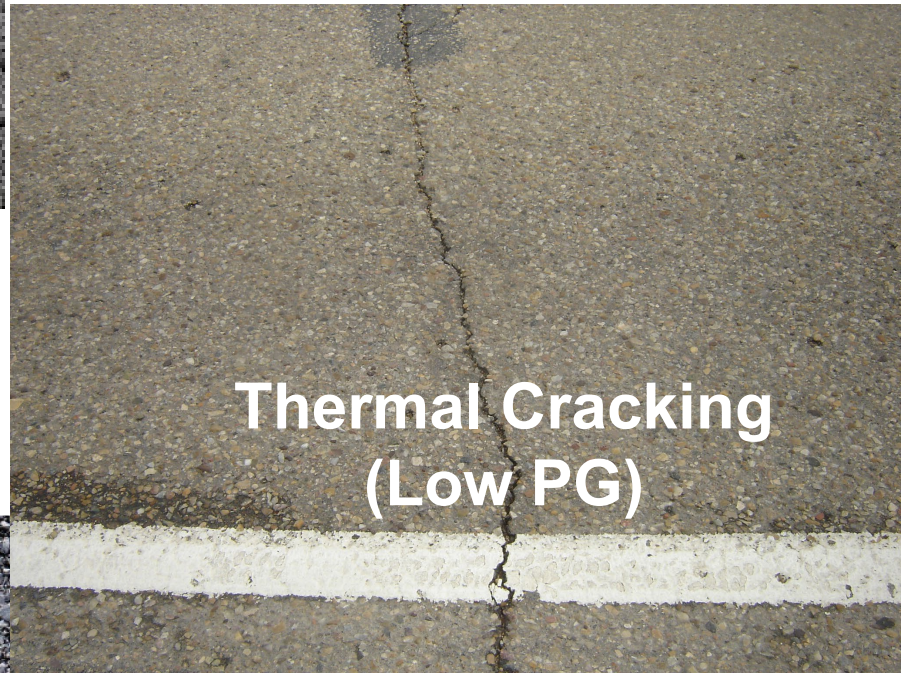
- Fine - 3X NMAS min
- Coarse – 4X NMAS min

Table 13
Compacted Lift Thickness and Required Core Height

| Mixture Type | Compacted Lift Thickness Guidelines | | Min Untrimmed Core Height Eligible for Testing (in.) |
|---|---|---|---|
| | Min (in.) | Max (in.) | |
| DG-B | 2.50 | 5.00 | 1.75 |
| DG-C | 2.00 | 4.00 | 1.50 |
| DG-D | 1.50 | 3.00 | 1.25 |
| DG-F | 1.25 | 2.50 | 1.25 |

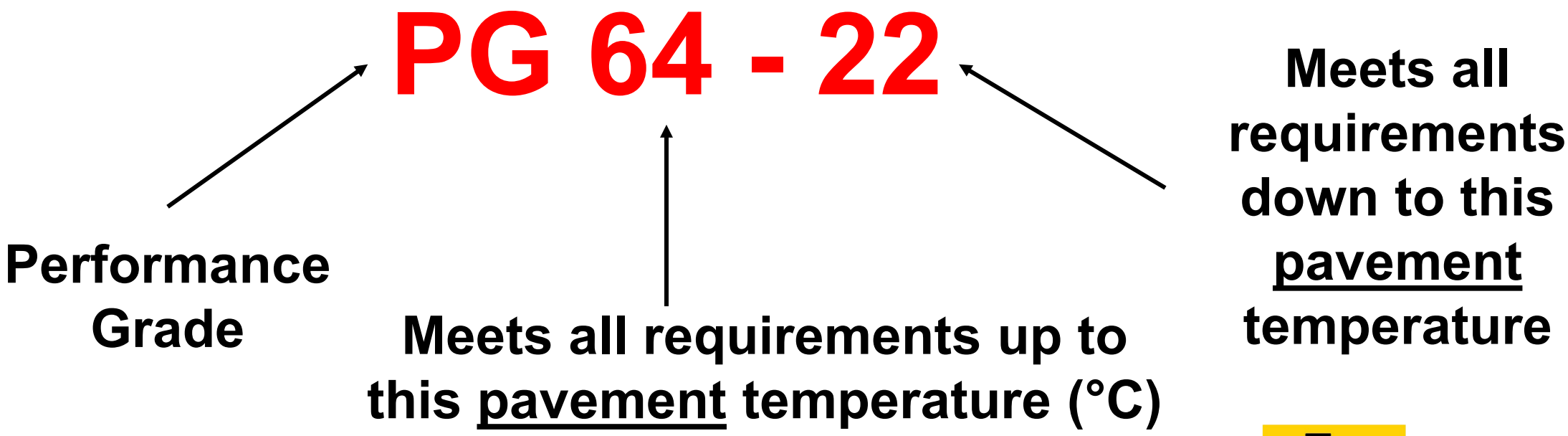
# Asphalt binders are specified to provide resistance to:



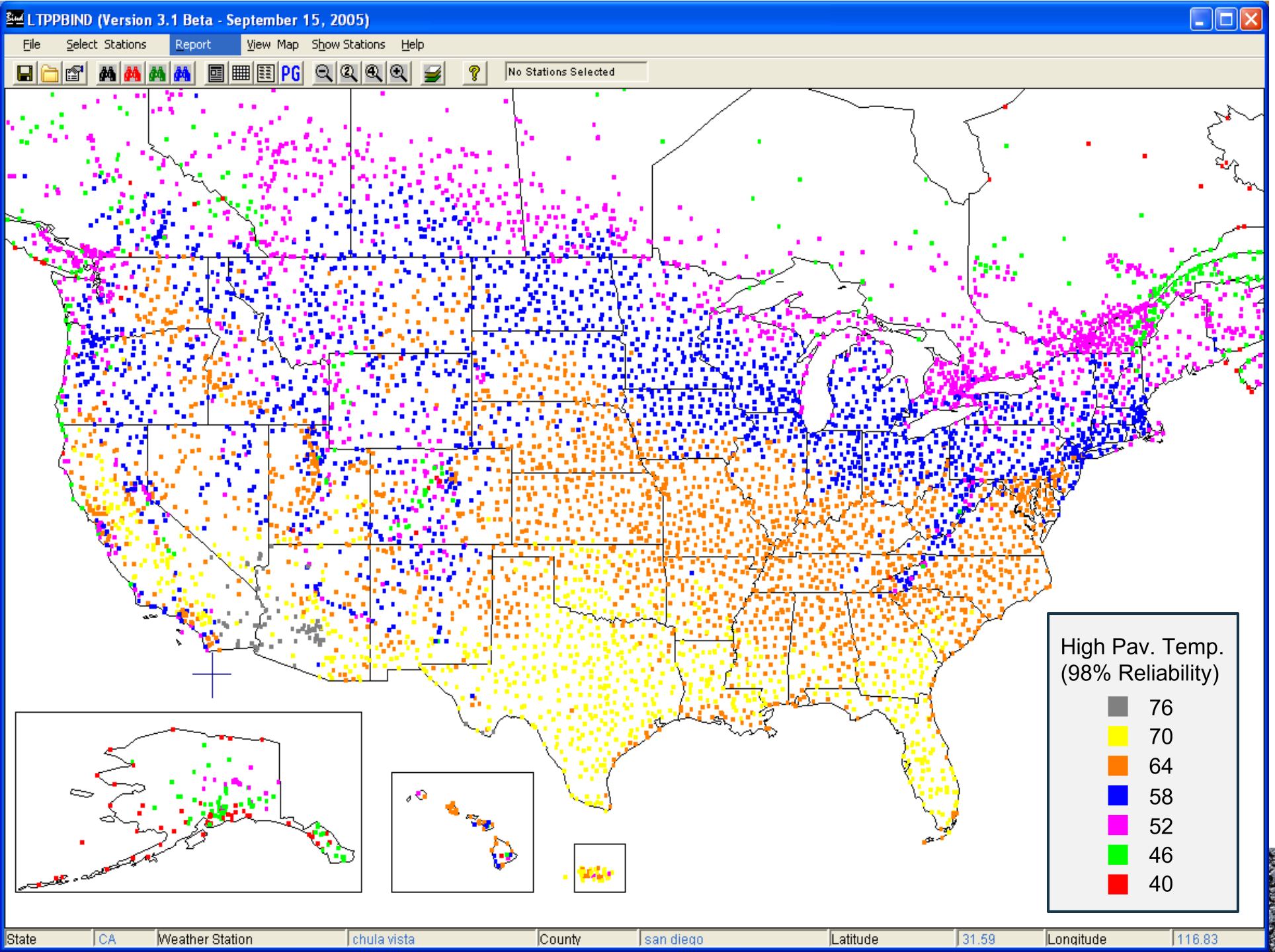



# Superpave Asphalt Binder Specification

**The grading system allows binder selection based on the local climatic conditions.**

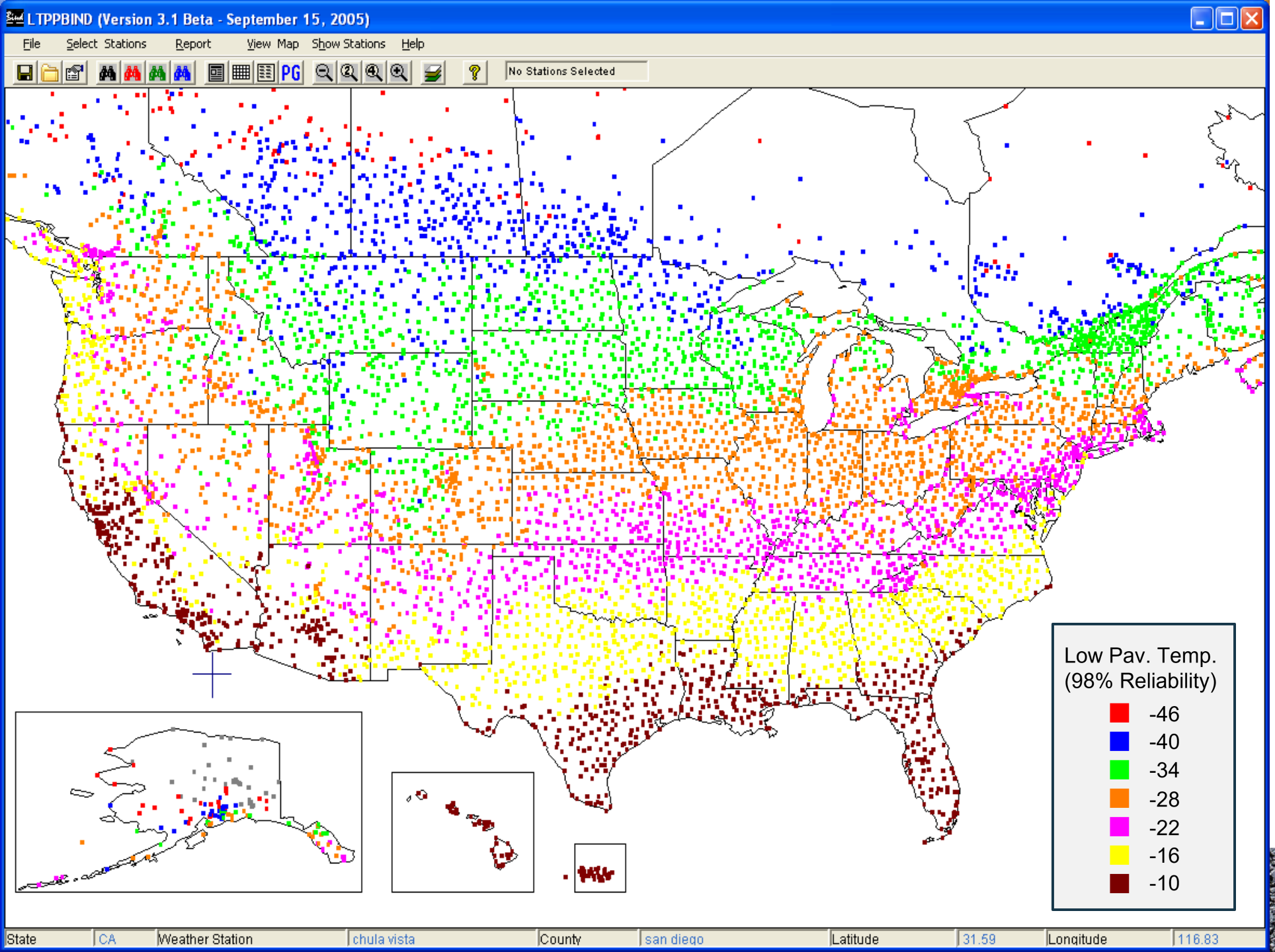



Note: These grades are specified in ***6°C increments***




# LTPP High Temp Grade Map

TxDOT specifies PG 64 & PG 70 environmental high grades, but may specify as low as PG 58 and as high as PG 82




# LTPP Low Temp Grade Map

TxDOT specifies PG -22, PG -28, and PG -34 environmental low grades, but may specify as low as PG -16

# Asphalt Binder Grades in Texas

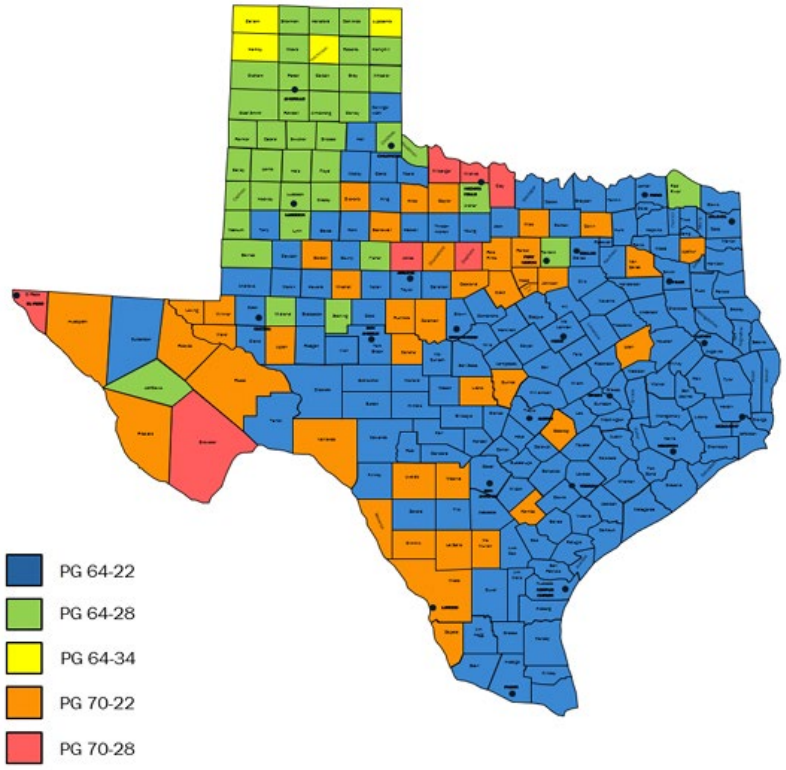



Figure 2.1
Recommended Climate-Based PG Binder Grade – 98% Confidence

These recommended grades are based on climate *only*.

Lower “high temperature” grades may be specified to balance the stiffer recycled binder in RAP or RAS.

Higher “high temperature” grades may be specified to stiffen mixes subject to high traffic or low speeds.

The “low temperature” grades may also be lowered to balance stiffer recycled binder in RAP or RAS.

# Aggregates for HMA

- Ideal Aggregate:
  - Gradation with sufficient voids to allow room for AC
  - Angular, uniform shape
  - Low porosity
  - Low absorption
  - Clean
  - Rough surface texture
  - Hydrophobic (water-hating)

# TxDOT Surface Aggregate Classification

- Crushing Requirement: 85%, 2 or more faces


- SAC A – Friction – Surface Only
  - Insolubility to Acid
  - 25% loss on Mag Sulfate
- SAC B – Surface – Intermediate - Base
  - 30% loss on Mag Sulfate

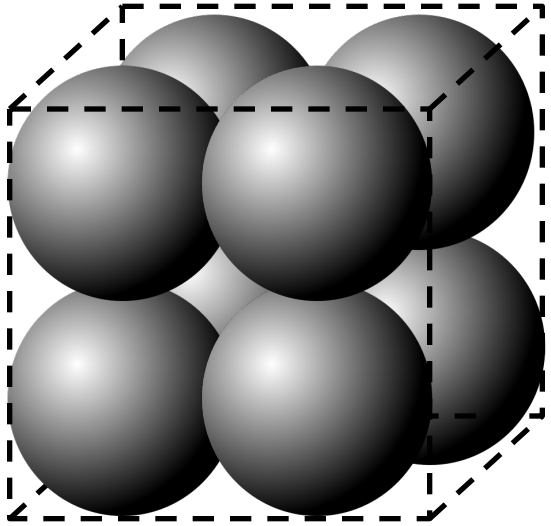
SAC = Surface Aggregate Classification

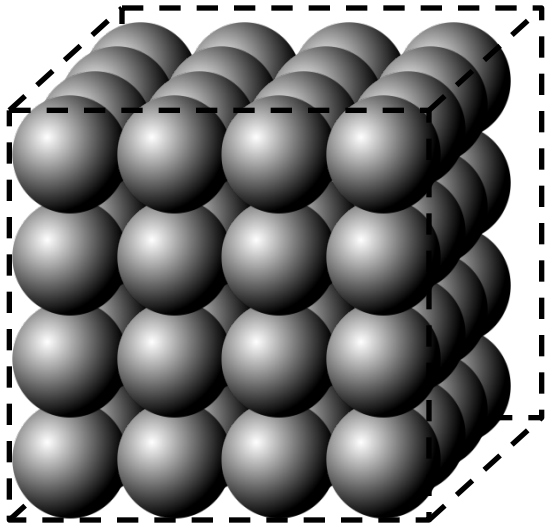
# Effect of Nominal Maximum Aggregate Size on Mix Cost

An important concept in mix design is that a minimum asphalt film thickness is required to properly coat and protect the aggregate particles.

The amount of asphalt binder needed to coat an aggregate particle to a certain film thickness is a function of the surface area of the aggregate.

# Effect of Nominal Maximum Aggregate Size on Mix Cost





**Surface area of a sphere = $4\pi r^2$**

## 8 - 1” Spheres

*Surface area per sphere = 3.14 $in^2$*

**Total Surface area = 25.1 $in^2$**

## 64 - 1/2” Spheres

*Surface area per sphere = 0.79 $in^2$*

**Total Surface area = 50.3 $in^2$**

# Effect of Nominal Maximum Aggregate Size on Mix Cost

Although not in the same ratio as the spheres, a given volume of large particles has a smaller surface area than the same volume of smaller particles.

A mix composed of smaller NMAS particles will inherently require more asphalt binder than a larger-sized mix.

**Because asphalt binder costs much more than aggregate, smaller NMAS mixes are inherently more expensive than larger-sized mixes.**

# Effect of Nominal Maximum Aggregate Size on Mix Cost

| | Asphalt Nominal Maximum Aggregate Size | | | |
|---|---|---|---|---|
| | **DG-F** | **DG-D** | **DG-C** | **DG-B** |
| Reasonable % AC | 5.5 | 5.1 | 4.5 | 4.1 |
| **Binder Cost** @ $600/ton | $33.00 | $30.60 | $27.00 | $24.60 |

# Effect of Binder Type Selection on Mix Cost

The binder type specified also affects the final cost of the mix.

Neat (unmodified) asphalts are the least expensive, while the polymer-modified grades cost more.

Most local government uses do not require the use of polymer-modified binders except in very high traffic areas.

# Effect of RAP Usage on Mix Cost

The *reasonable* use of RAP does not diminish the quality of the asphalt.

The amount of virgin binder and virgin aggregate and associated costs is lowered by the amount of binder and aggregate present in the RAP.

For lowest cost, permit RAP in quantities allowed by TxDOT specification.

# Effect of RAP Usage on Mix Cost

| | PG Binder Type |
|---|---|
| | PG 64-22 |
| Design % AC | 4.3 |
| 10% RAP savings | $3.53 |
| 20% RAP savings | $7.05 |
| 30% RAP savings | $10.58 |

** Assuming $720/ton binder cost (ODOT Price Index for PG 64-22 – June 2022), $15/ton aggregate cost, 5% binder in RAP, RAP valued at $15/ton*

# Summary

- Select the **Right Material** for the **Right Place** at the **Right Time**
- You want **Quality Pavements** that are:
  - *Durable*
  - *Strong*
  - *High Performing*
- Dense Graded and Superpave mixtures are the workhorses
- Select binders and aggregates to meet project needs
- Consider the effect on cost of mix NMAS, binder type, and %RAP

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# QUESTIONS?

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