EAR
Workshop

Basics

Today's Topics

- HMA Basics
- Specification Overview
- Relationships between test data & performance
- What causes a failure?
- FDOT Pavement Performance
- EAR Process

HMA Basics

- Pavements
- Mix & Binder Types
- Asphalt Mix Basics (Volumetrics 101)

Typical Asphalt Pavement Structure

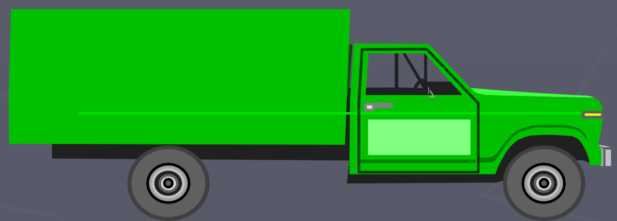
Mix Types

- Friction Courses
  - FC-9.5, FC-12.5, FC-5
- Structural Courses
  - SP-9.5, SP-12.5, SP-19.0
- Base Courses
  - B-12.5
- Other
  - Asphalt Treated Permeable Base (ATPB)
    - Used under PCC pavements

Structural Mixes

- Designated as Type SP
  - Superpave
- Purpose: load carrying portion of pavement
  - Layer coefficient 0.44
- Three nominal maximum aggregate sizes
  - 9.5 mm (SP-9.5)
  - 12.5 mm (SP-12.5)
  - 19.0 mm (SP-19.0)
- Five Traffic Levels (A-E)
  - Based on 18-kip Equivalent Single Axle Loads (ESAL's)
  - Low traffic = A, High traffic = E

ESAL Configuration Examples



67 kN
15,000 lb
0.48 ESAL

+

27 kN
6,000 lb
0.01 ESAL

= **0.49 ESALs**

151 kN
34,000 lb
1.10

+

151 kN
34,000 lb
1.10

+

54 kN
12,000lb
0.20

= 2.40 ESALs

Mix Types (Cont’d)

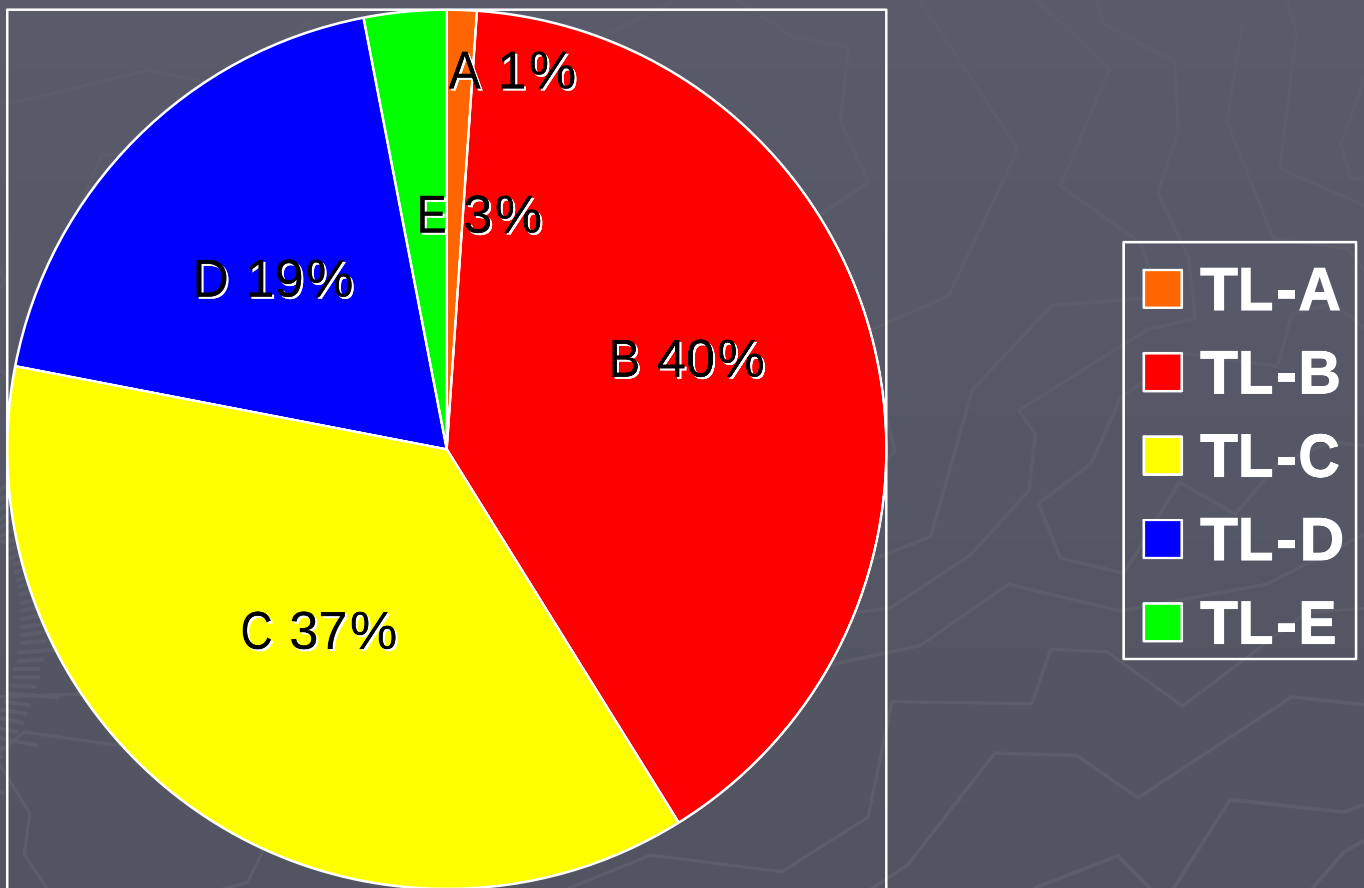
- Traffic Levels – Based on design life of the pavement:

A	<300,000 ESAL’s
B	300,000 – 3 million ESAL’s
C	3 million – 10 million ESAL’s
D	10 million – 30 million ESAL’s
E	>30 million ESAL’s

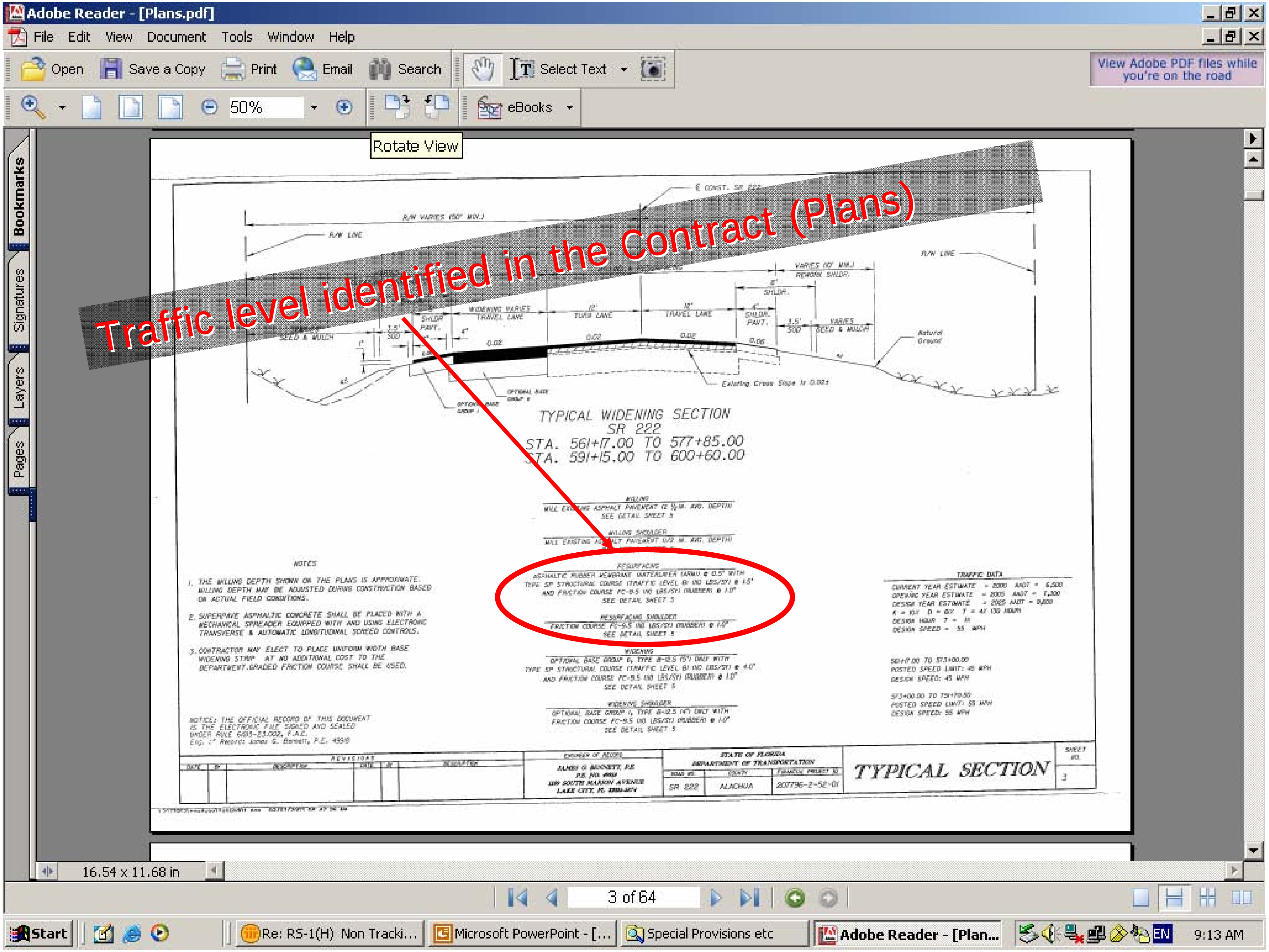
Traffic Levels A, B, C: Fine Graded

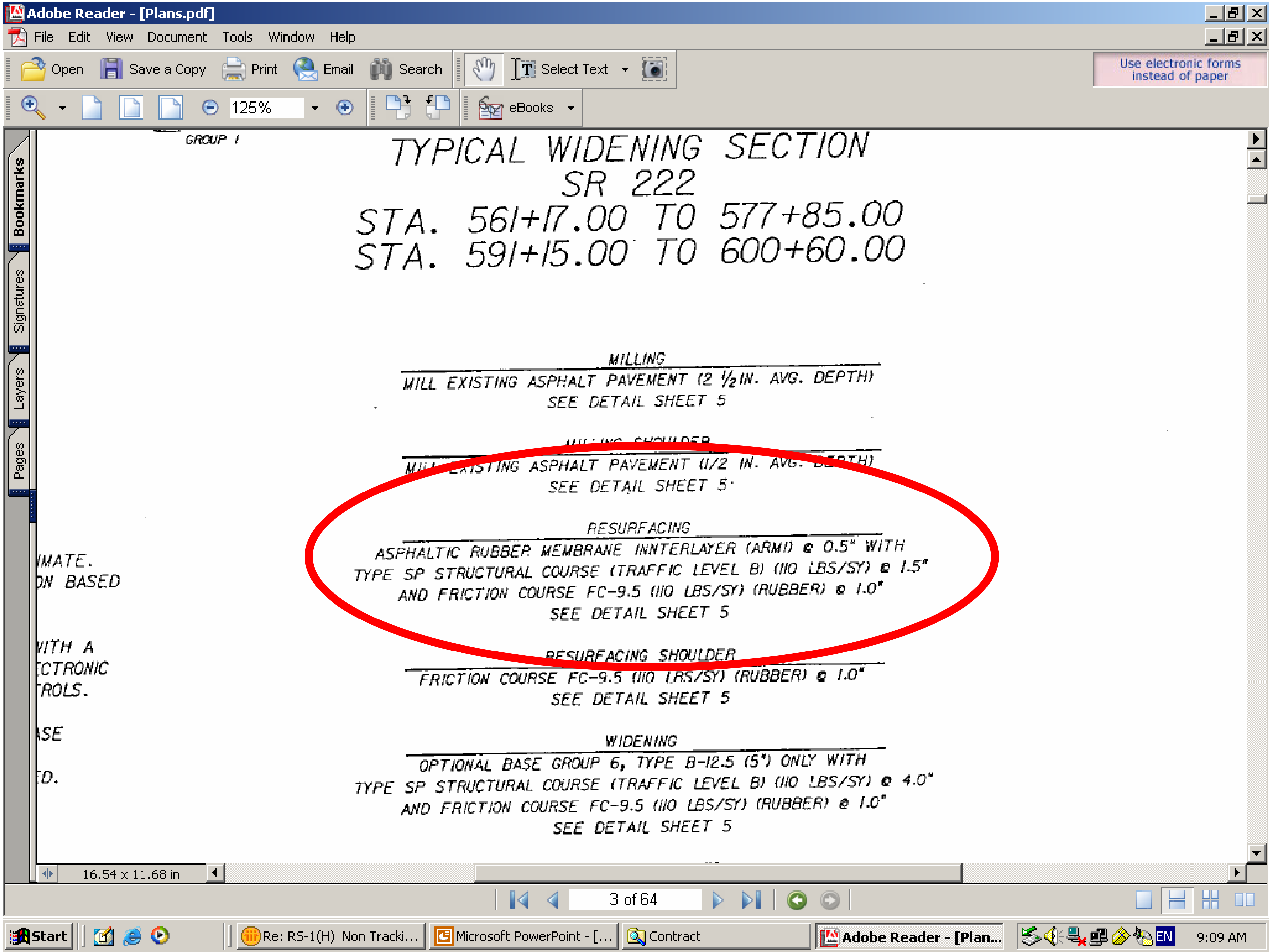
Traffic Levels D & E: Coarse Graded*

Traffic Distribution in Florida



Traffic level identified in the Contract (Plans)





GROUP I

TYPICAL WIDENING SECTION
SR 222
STA. 561+17.00 TO 577+85.00
STA. 591+15.00 TO 600+60.00

MILLING

MILL EXISTING ASPHALT PAVEMENT (2 ½ IN. AVG. DEPTH)
SEE DETAIL SHEET 5

MILLING SHOULDER

MILL EXISTING ASPHALT PAVEMENT (1/2 IN. AVG. DEPTH)
SEE DETAIL SHEET 5

RESURFACING

ASPHALTIC RUBBER MEMBRANE INNTERLAYER (ARMI) @ 0.5" WITH
TYPE SP STRUCTURAL COURSE (TRAFFIC LEVEL B) (110 LBS/SY) @ 1.5"
AND FRICTION COURSE FC-9.5 (110 LBS/SY) (RUBBER) @ 1.0"
SEE DETAIL SHEET 5

RESURFACING SHOULDER

FRICTION COURSE FC-9.5 (110 LBS/SY) (RUBBER) @ 1.0"
SEE DETAIL SHEET 5

WIDENING

OPTIONAL BASE GROUP 6, TYPE B-12.5 (5") ONLY WITH
TYPE SP STRUCTURAL COURSE (TRAFFIC LEVEL B) (110 LBS/SY) @ 4.0"
AND FRICTION COURSE FC-9.5 (110 LBS/SY) (RUBBER) @ 1.0"
SEE DETAIL SHEET 5

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Gradation Types

- Coarse mixes – Predominantly coarse aggregate
  - Gradation below restricted zone
  - Higher density requirement
  - Greater likelihood of being permeable
  - Placed thicker
- Fine mixes – Predominantly fine aggregate
  - Gradation above restricted zone
  - Similar to old FDOT Type S mixes
- Shown on the mix design

http://secure.sm.dot.state.fl.us/bituminous/superpave/3001-4000/3009A.pdf - Microsoft Internet Explorer

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
STATEMENT OF SOURCE OF MATERIALS AND JOB MIX FORMULA FOR BITUMINOUS CONCRETE

SUBMIT TO THE STATE MATERIALS ENGINEER, CENTRAL BITUMINOUS LABORATORY, 2006 NORTHEAST WALDO ROAD., GAINESVILLE, FLA. 32609

Contractor: Orlando Paving Company Address: 8150 Apopka Blvd., Apopka, FL 32703

Phone No.: (407) 290-9327 Fax No.: (407) 290-5068 E-mail: cmoorefield@hubbard.com

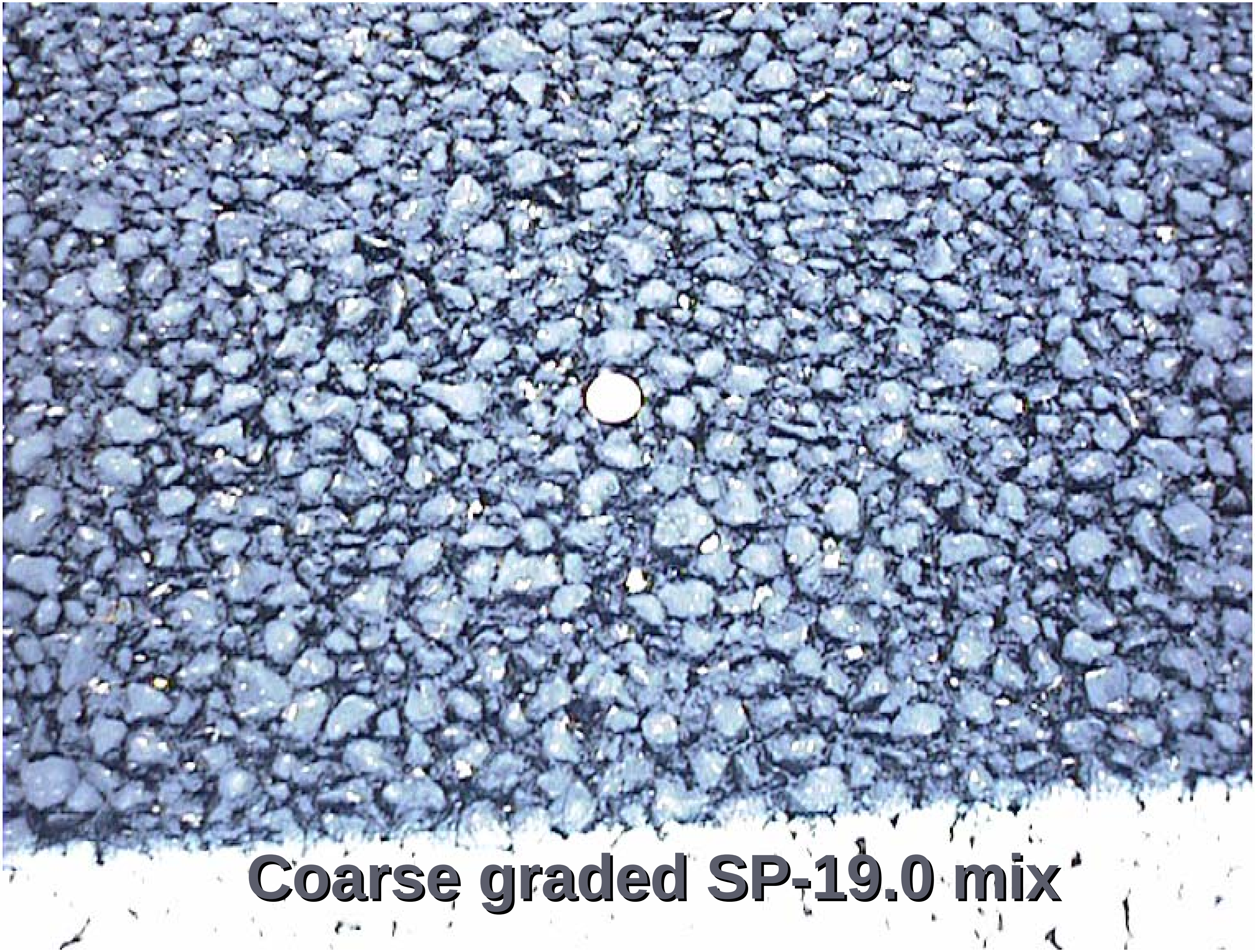
Submitted By: Orlando Paving Company Type Mix: Fine SP-12.5 Recycle Intended Use of Mix: Structural

Design Traffic Level: C Gyrations @ N des: 75

TYPE MATERIAL	F.D.O.T. CODE	PRODUCER	PIT NO.	DATE SAMPLED
1. Crushed R. A. P.	2-00	Orlando Paving Company	A0531	06 / 01 / 2001
2. S-1-A Stone	42	Florida Rock Industries	TM-469 87-049	06 / 01 / 2001
3. FC-3 Stone	55	Rinker Materials Corp.	TM-447 87-090	06 / 01 / 2001
4. W-12 Screenings	21	Rinker Materials Corp.	TM-447 GA-178	06 / 01 / 2001
5.				
6.				

1 of 2


Fine graded SP-12.5 mix



Coarse graded SP-19.0 mix

Friction Courses

- Designated as FC
- Purpose: Provide a pavement surface with good frictional characteristics
- Required on all jobs with:
  - AADT >3,000
  - Design Speed >35 mph
- Use polish resistant aggregate
  - Oolitic limestone (Miami-Dade County)
  - Granite (Georgia & Nova Scotia)
- Also use asphalt rubber binder (ARB)

Friction Courses

- Fine Graded Friction Courses:
  - Good microtexture
    - Function of the aggregate
  - Two Nominal Maximum Aggregate Sizes:
    - FC-9.5 (Placed 1” thick)
    - FC-12.5 (Placed 1 ½” thick)
      - Formerly called FC-6
  - Standardized at Traffic Level C
  - Layer coefficient: 0.44
  - 100% oolite or 60% granite
  - ARB-5 (PG 67-22 w/5% GTR)

Friction Courses

- Open-Graded Friction Courses:
  - Required on high speed multi-lane facilities
    - Design Speed >50 mph
  - Good macrotexture
    - Function of surface texture
    - “Minimize” hydroplaning
  - FC-5
  - Layer coefficient: 0.00
  - 100% granite or 100% oolite
  - ARB-12 (PG 67-22 w/12% GTR)
  - Stabilizing fibers
  - Granite: hydrated lime


FC-5 Nassau County

Close-up FC-5 Macrotexture

Base Courses

- Designated as Type B
- One NMAS:
  - B-12.5
- Superpave
  - Standardized as Traffic Level B
  - Layer coefficient: 0.20
- May substitute an SP-12.5
  - It’s basically the same mix

Asphalt Treated Permeable Base (APTB)

- No. 57 or 67 Stone
  - ¾” aggregate
- Approximately 2 – 3% PG 67-22
- Very porous/very open
- Used under PCC pavements

Binder Types

Superpave Asphalt Binders

- Grading system based on climate

PG 67-22

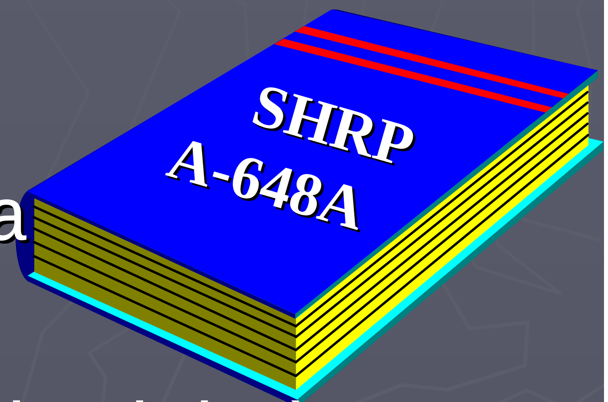
Performance Grade

Average 7-day max pavement design temp

Min pavement design temp

Developed from Air Temperatures (over 20 year period)

- Superpave Weather Database
  - 6500 stations in U.S. and Canada
- Annual air temperatures
  - hottest seven-day temp (avg and std dev)
  - coldest temp (avg and std dev)
- Found on LTPP Website



LTPPBind - Internet Explorer Provided by Cox High Speed Internet

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Address http://www.tfhrc.gov/pavement/ltpp/ltppbind.htm

U.S. Department of Transportation
Federal Highway Administration

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LTPP

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LTPP Customer Survey

LTPPBind

LTPPBind is a Windows-based software program developed by LTPP to help highway agencies select the most suitable and cost-effective Superpave asphalt binder Performance Grade (PG) for a particular site. Based on the original binder selection software SHRPBind, LTPPBind features a database of high and low air temperatures (minimum, mean, maximum, standard deviation, and number of years) for U.S. and Canadian weather stations, along with several modifications that provide users with the ability to:

- Select PGs based on actual temperature conditions at their site and at the level of risk designated by their highway agency.
- Use either the original SHRP or LTPP's revised temperature models for determining a site's binder PG.
- Adjust PG selection for different levels of traffic loading and speed.

LTPP's revised temperature models that form the basis for LTPPBind were developed via an LTPP data analysis project. The research report from the project is entitled, *LTPP Seasonal Asphalt Concrete Pavement Temperature Models* (FHWA-RD-97-103). To view an abstract on this publication or for information on

Shortcuts

LTPPBind Product Brief

LTPPBind PowerPoint Presentation

Download LTPPBind

Back to Products

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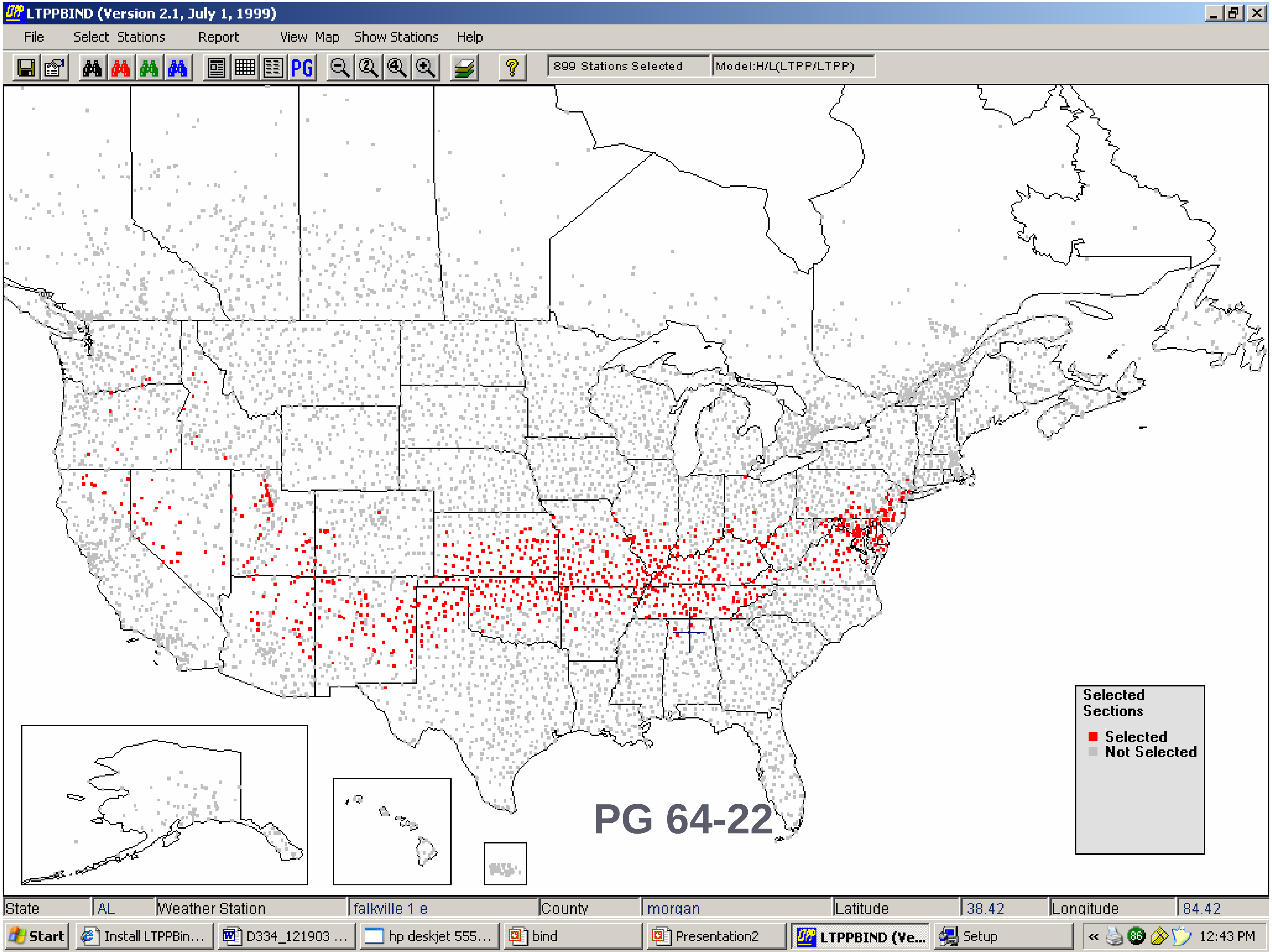
LTPPBIND (Version 2.1, July 1, 1999)
File
Select Stations
Report
View Map
Show Stations
Help
PG
899 Stations Selected
Model:H/L(LTPP/LTPP)
PG 64-22
Selected Sections
Selected
Not Selected
State
AL
Weather Station
falkville 1 e
County
morgan
Latitude
38.42
Longitude
84.42
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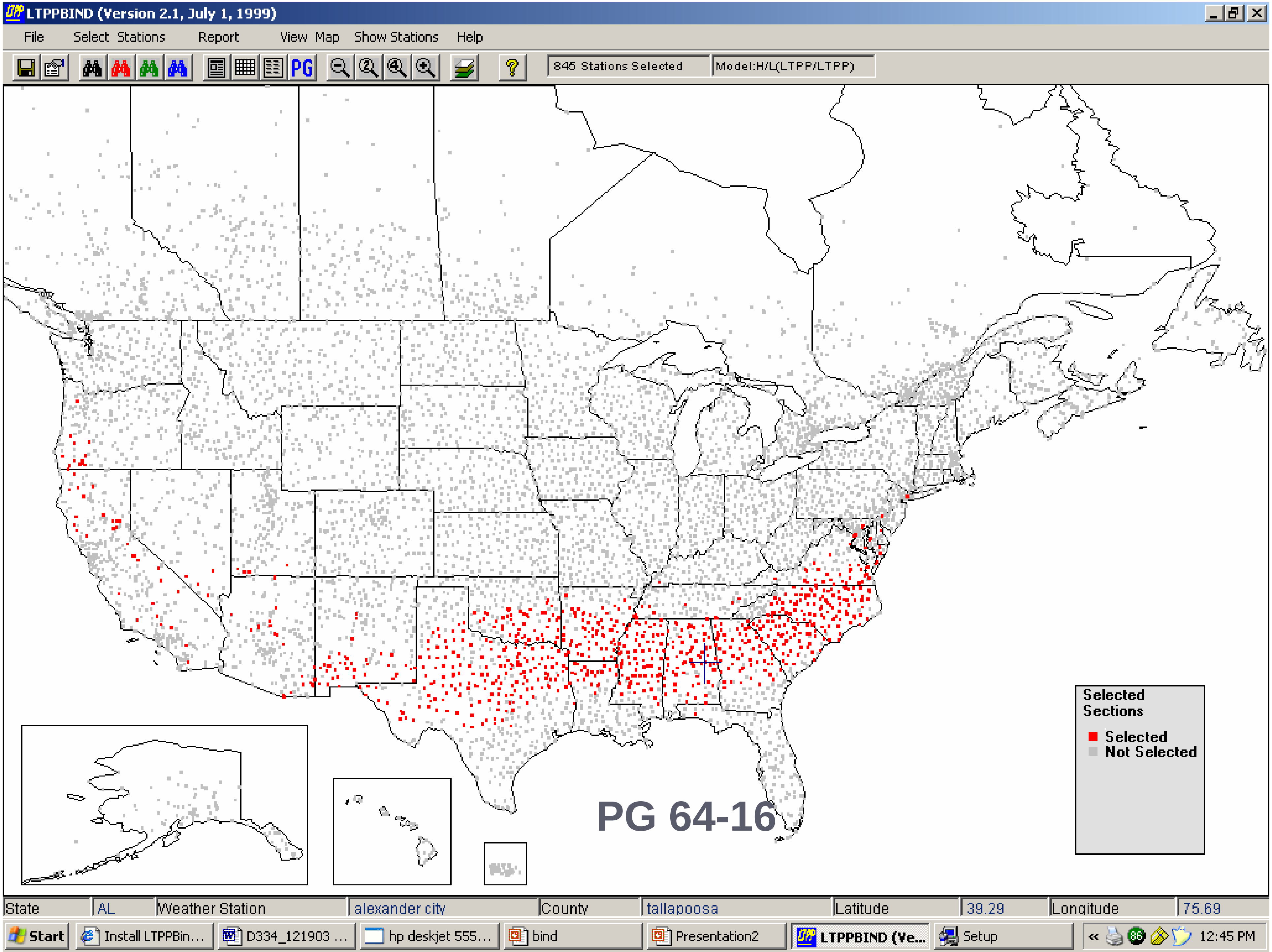
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File
Select Stations
Report
View Map
Show Stations
Help
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Model:H/L(LTPP/LTPP)
Selected Sections
Selected
Not Selected
PG 64-16
State
AL
Weather Station
alexander city
County
tallapoosa
Latitude
39.29
Longitude
75.69
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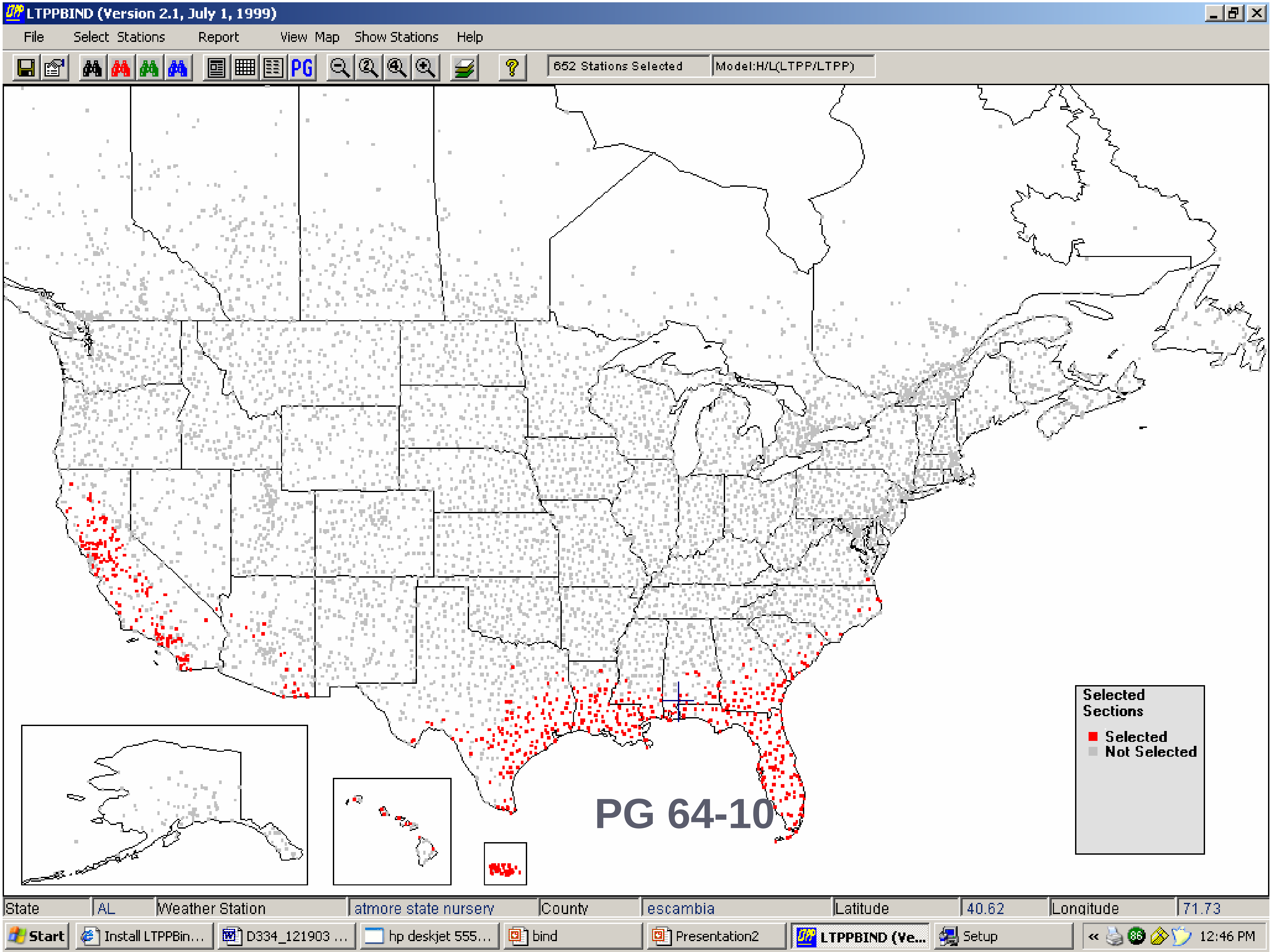
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File
Select Stations
Report
View Map
Show Stations
Help
652 Stations Selected
Model:H/L(LTPP/LTPP)
PG 64-10
Selected Sections
Selected
Not Selected
State
AL
Weather Station
atmore state nursery
County
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Latitude
40.62
Longitude
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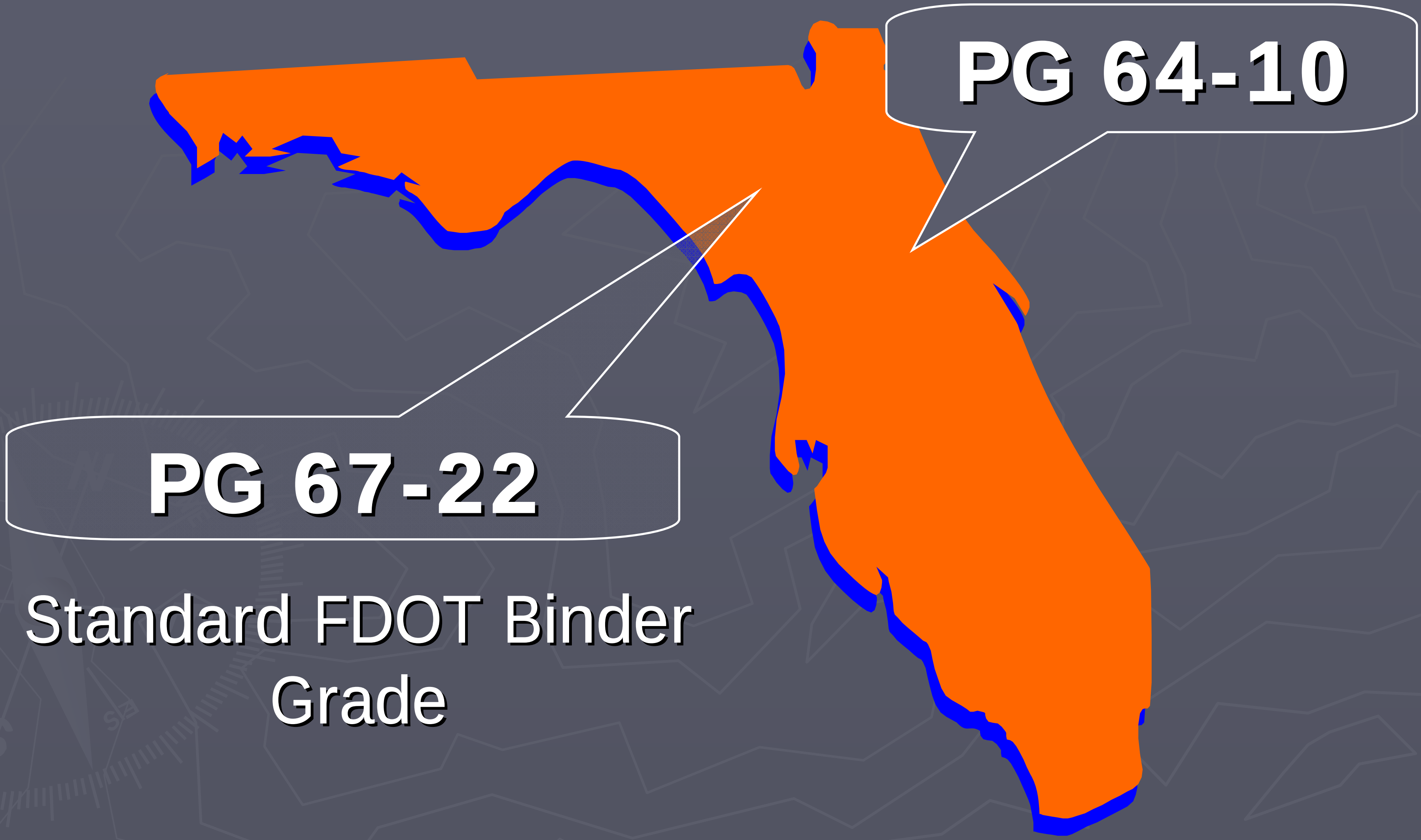
LTPP Binder Grade in Florida



Standard FDOT Binder Grade

Standard Binder Grades in Florida

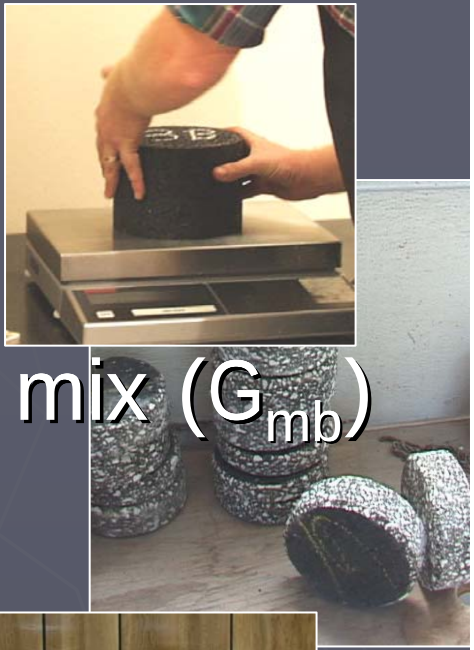
- PG 67-22 (AC-30)
  - Special grade used in southeastern US
- PG 64-22 (AC-20)
- RA (Recycling Agent)
  - If >30% RAP in mix
- PG 76-22 (AC-30 w/polymer)
  - Rutting concerns

Volumetrics

Basic Terminology

- Specific Gravity (G): G_{xy}
  - x: b = <u>b</u>inder
    s = <u>s</u>tone
    m = <u>m</u>ixture
  - y: b = <u>b</u>ulk
    e = <u>e</u>ffective
    a = <u>a</u>pparent
    m = <u>m</u>aximum
  - Example:
    G_{mm} = gravity, mixture, maximum
    (i.e., maximum gravity of the mixture)

HMA Basics



- Bulk specific gravity of compacted mix (G_{mb})
  - FM 1-T 166
  - Core, SGC specimen
- Maximum specific gravity (G_{mm})
  - FM 1-T 209
  - Loose (uncompacted) mixture

- Air voids (V_a)
- Voids in the mineral aggregate (VMA)

HMA Basics

- Air Voids
  - Calculated using G_{mm} & G_{mb}

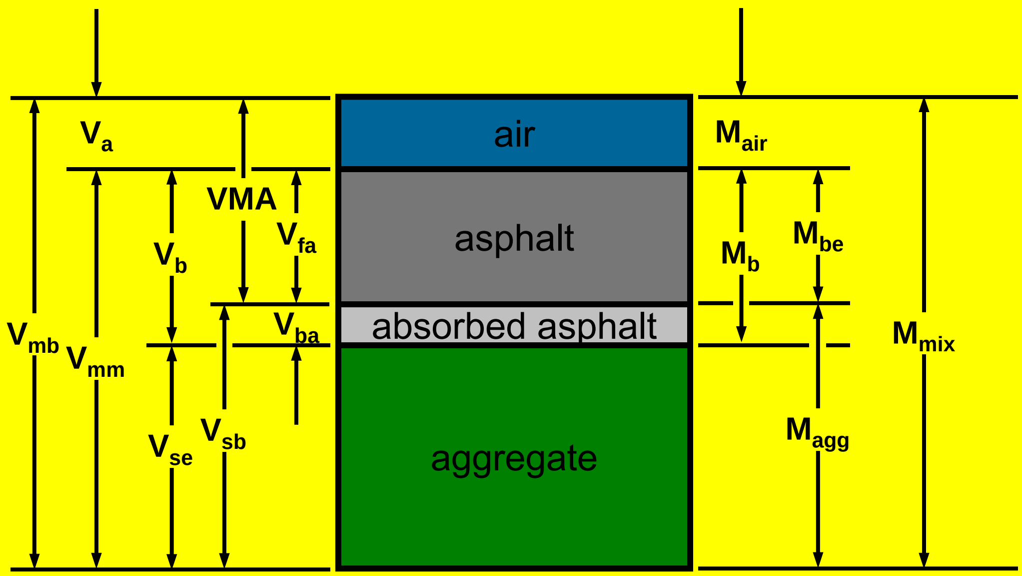
$$V_a = 100 * \left\{ \frac{G_{mm} - G_{mb}}{G_{mm}} \right\}$$

- VMA
  - Void space in mix containing air or binder
    - $VMA = V_a + V_{be}$
  - Calculated using G_{mb}, P_s, & G_{sb}

$$VMA = 100 - \frac{G_{mb} * P_s}{G_{sb}}$$

ASPHALT MIXTURE VOLUMETRICS

COMPONENT DIAGRAM



EQUATIONS USED IN HMA VOLUMETRIC ANALYSIS

Bulk Specific Gravity of Aggregate

$$G_{sb} = \frac{P_1 + P_2 + \ldots + P_N}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \ldots + \frac{P_N}{G_N}}$$

where
G_{sb} = bulk specific gravity for the total aggregate
P_1, P_2, P_N = individual percentages by mass of aggregate
G_1, G_2, G_N = individual bulk specific gravities of aggregate

Effective Specific Gravity of Aggregate

$$G_{se} = \frac{P_{mm} - P_b}{\frac{P_{mm}}{G_{mm}} - \frac{P_b}{G_b}}$$

where
G_{se} = effective specific gravity of the aggregate
G_{mm} = maximum specific gravity
P_{mm} = percent by mass of total loose mixture = 100
P_b = asphalt content
G_b = specific gravity of asphalt

Maximum Specific Gravity of Mixtures with Different Asphalt Contents

$$G_{sb} = \frac{P_{mm}}{\frac{P_s}{G_{se}} + \frac{P_b}{G_b}}$$

where
G_{mm} = maximum specific gravity
P_{mm} = percent by mass of total loose mixture = 100
P_s = aggregate content, percent by total mass of mixture
P_b = asphalt content, percent by total mass of mixture
G_{se} = effective specific gravity of the aggregate
G_b = specific gravity of asphalt

Asphalt Absorption

$$P_{ba} = 100 \times \frac{G_{se} - G_{sb}}{G_{sb} G_{se}} \times G_b$$

where
P_{ba} = absorbed asphalt, percent by mass of aggregate
G_{se} = effective specific gravity of aggregate
G_{sb} = bulk specific gravity of aggregate
G_b = specific gravity of asphalt

Effective Asphalt Content of a Paving Mixture

$$P_{be} = P_b - \frac{P_{ba}}{100} \times P_s$$

where
P_{be} = effective asphalt content, percent by total mass of mixture
P_b = asphalt content, percent by total mass of mixture
P_{ba} = absorbed asphalt, percent by mass of aggregate
P_s = aggregate content, percent by total mass of mixture

Percent VMA in Compacted Paving Mixture

$$VMA = 100 - \frac{G_{mb} \times P_s}{G_{sb}}$$

where
VMA = voids in mineral aggregate (percent of bulk volume)
G_{sb} = bulk specific gravity of total aggregate
G_{mb} = bulk specific gravity of compacted mixture
P_s = aggregate content, percent by total mass of mixture

Percent Air Voids in Compacted Mixture

$$V_a = 100 \times \frac{G_{mm} - G_{mb}}{G_{mm}}$$

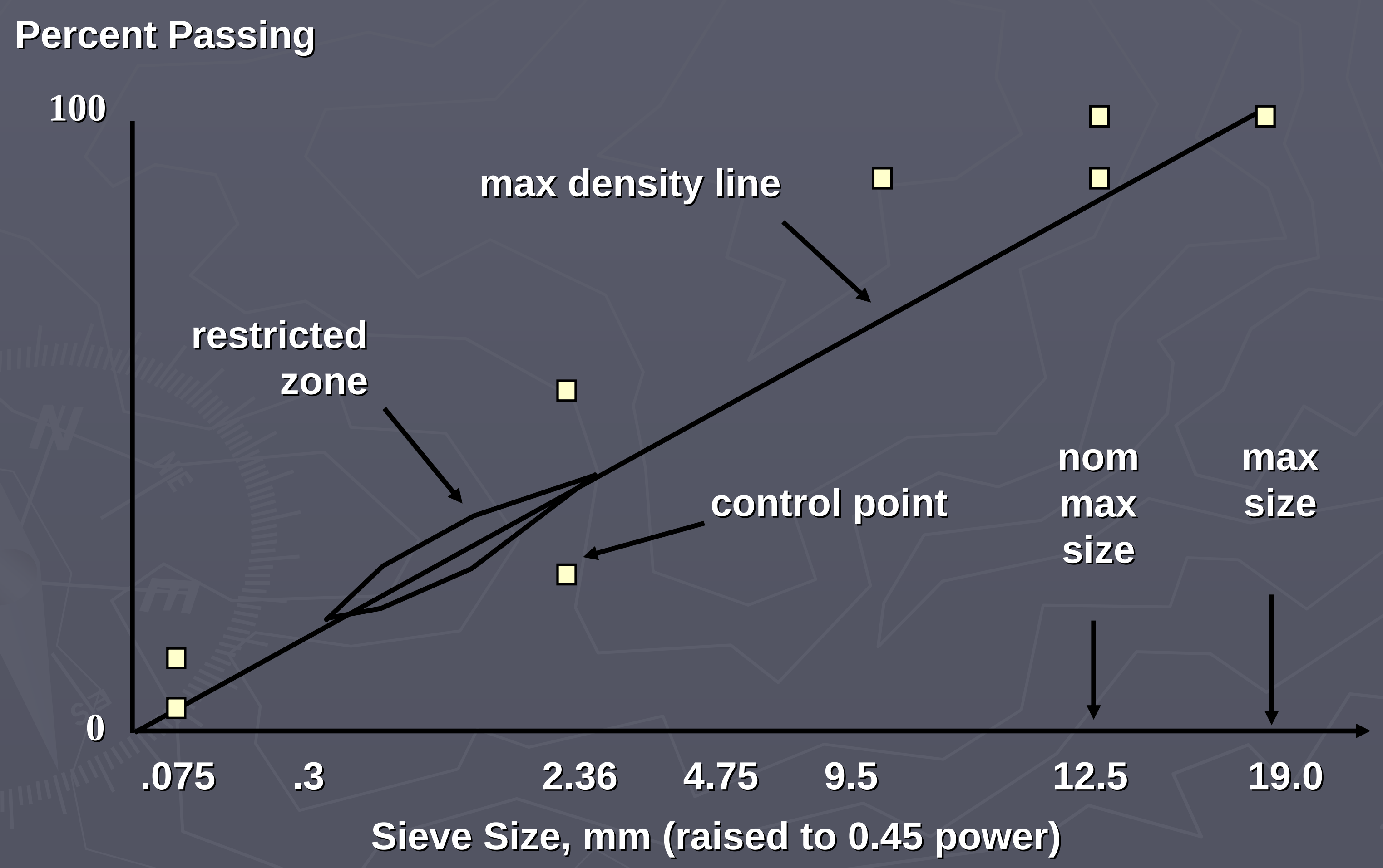
where
V_a = air voids in compacted mixture, percent of total volume
G_{mm} = maximum specific gravity
G_{mb} = bulk specific gravity of compacted mixture

Percent VFA in Compacted Mixture

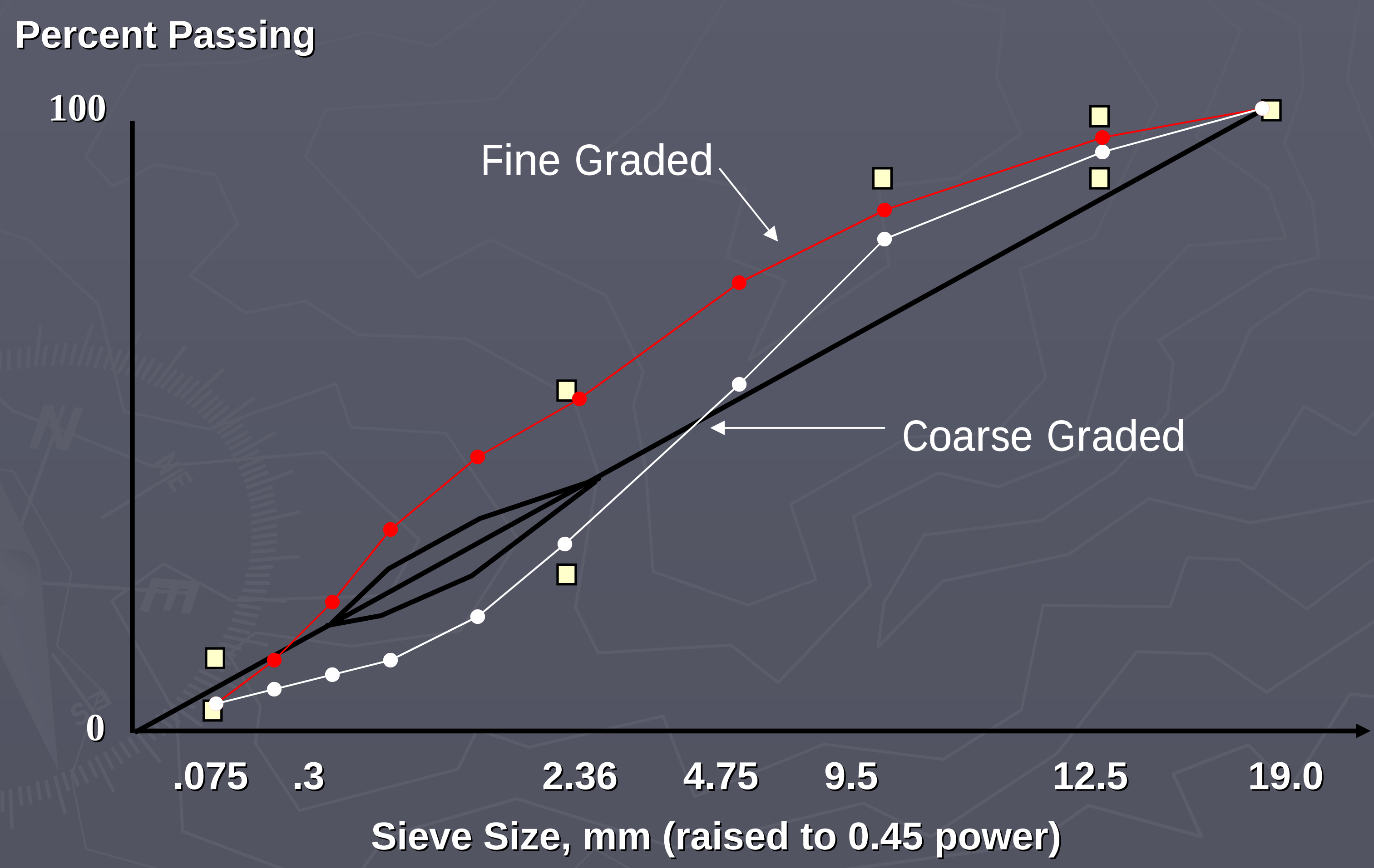
$$VFA = 100 \times \frac{VMA - V_a}{VMA}$$

where
VFA = voids filled with asphalt, percent of VMA
VMA = voids in mineral aggregate, percent of bulk volume
V_a = air voids in compacted mixture, percent of total volume

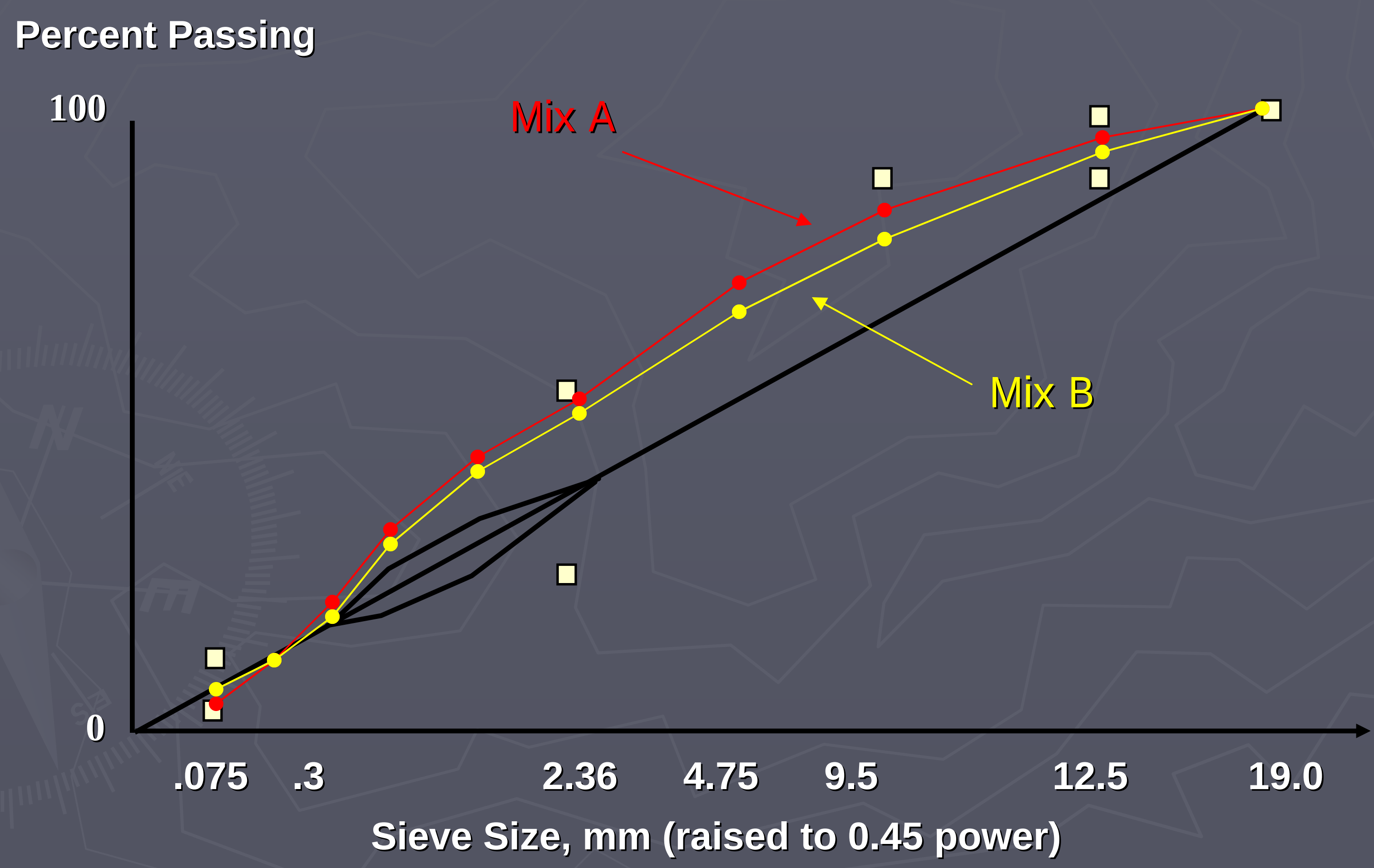
0.45 Power Curve



0.45 Power Curve



0.45 Power Curve



Summary

- Typical asphalt pavement structures
- Different asphalt mix types
- Asphalt binders
- Basic volumetrics

Questions?