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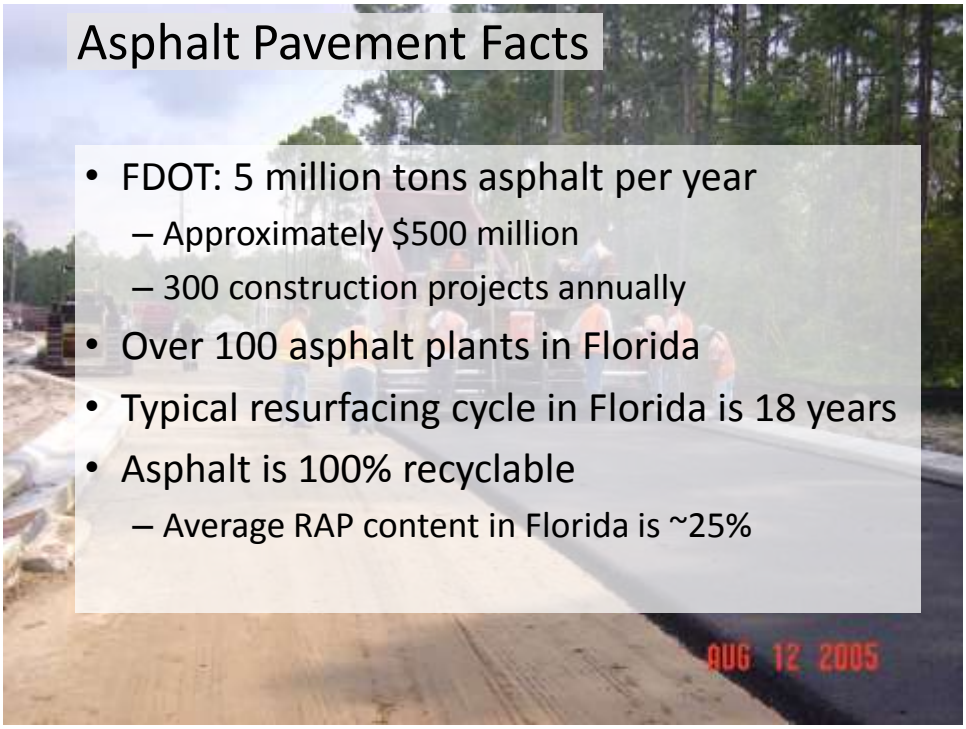
TRANSPORTATION

Asphalt Pavement Materials

Jim Musselman
State Bituminous Materials Engineer

STATE HIGHWAY SYSTEM

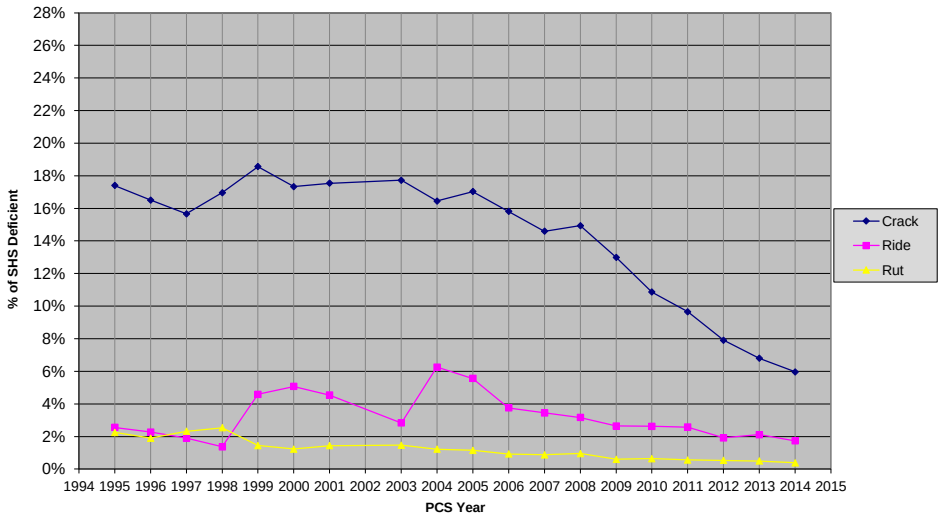
- 43,402 lane miles of roadway
  - 10% of the state roadway network
  - Carries more than 54% of all traffic in state
- 42,361 lane miles of asphalt (97.6%)
  - US average: 94%
  - 3,084 lane miles deficient (7.28%)
- 1,041 lane miles of concrete (2.4%)
  - 90 lane miles deficient (8.65%)



Asphalt Pavement Facts

- FDOT: 5 million tons asphalt per year
  - Approximately $500 million
  - 300 construction projects annually
- Over 100 asphalt plants in Florida
- Typical resurfacing cycle in Florida is 18 years
- Asphalt is 100% recyclable
  - Average RAP content in Florida is ~25%

Historical Statewide Performance



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Asphalt 101

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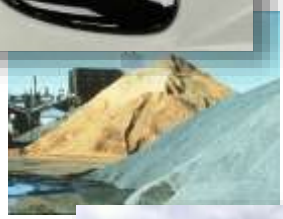
WHAT IS AN ASPHALT MIX?

- Blend of:
  - Asphalt binder (6%)
  - Aggregate (94%)
- Method of Design:
  - Hubbard Field (…1960's)
  - Marshall (1960's – 1998)
  - Superpave (1998 ….)
    - Want the mix to be strong, but crack resistant
- Produced through an asphalt plant



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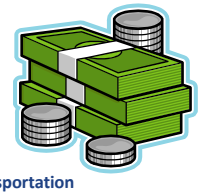
Asphalt Binders

- "Binds" the aggregate together
- Provides…..
  - lubrication for compaction
  - strength
  - durability
- The most expensive part of an asphalt mix



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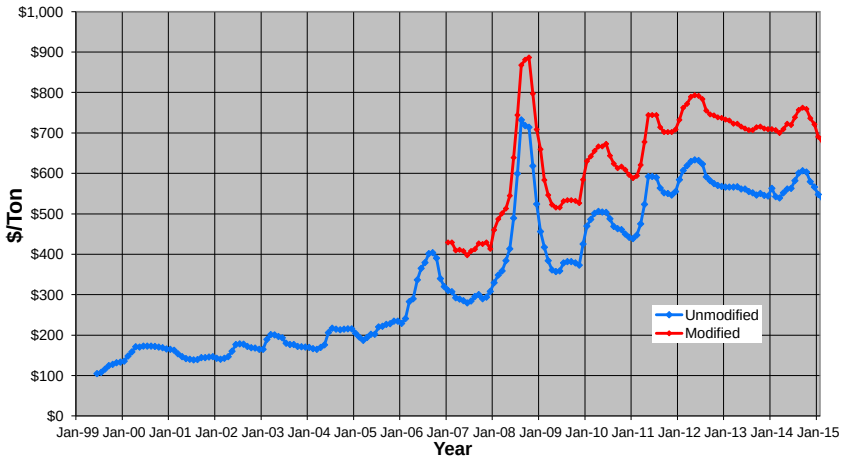
Cost of Asphalt Binder



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Where does asphalt come from?

Crude Oil

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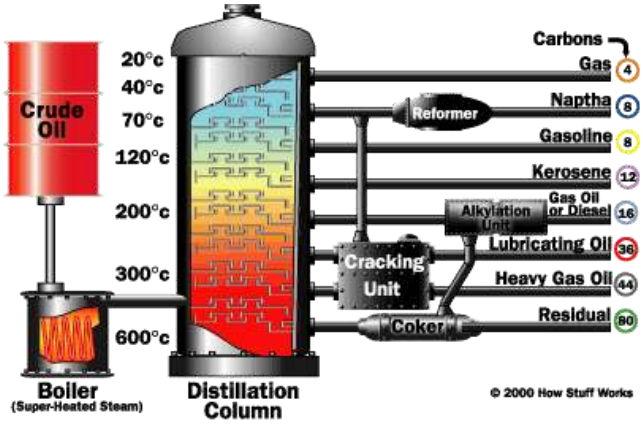
Crude Oil Transportation

Gulf Coast Oil and Natural Gas Operations

	Gulf of Mexico	Total U.S.	% from Gulf of Mexico
Oil production (million b/d)	1.5	5.5	27%
Natural Gas production (bcf/d)	10.6	52	20%
Refinery Capacity (million b/d)	8.1	17	48%
of which in LA and MS	*3.1*	*17*	*18%*
Crude Oil Imports (million b/d)	6.5	10.8	60%
of which into LA and MS ports	*2.5*	*10.8*	*23%*

Source: U.S. Energy Information Administration

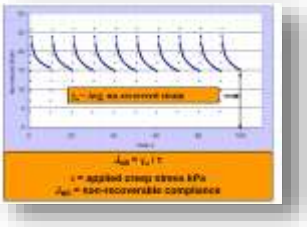
Oil Refining Process



Asphalt Binder

Essentially a waste product of the oil refining process…

….but is engineered to produce a strong and durable product.



Asphalt Binder

- Grading system based on climate

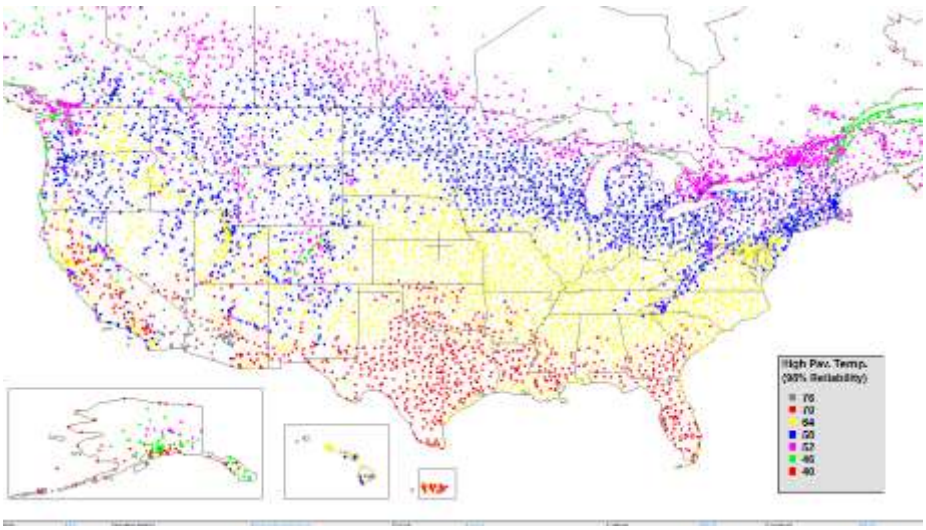
PG 67-22

Performance Grade

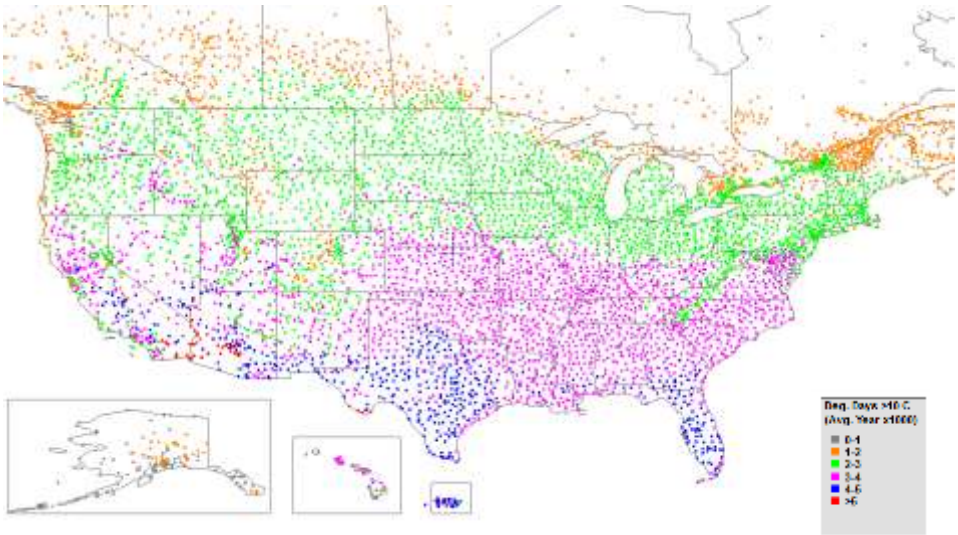
Average 7-day max pavement design temp

Min pavement design temp

High Temperature PG Grade



Degree Days >10°C (50°F)



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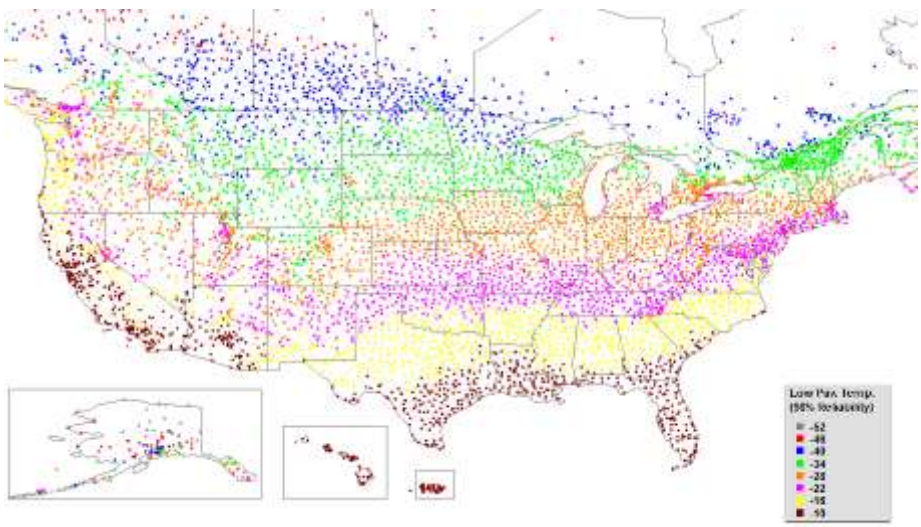
Low Temperature PG Grade



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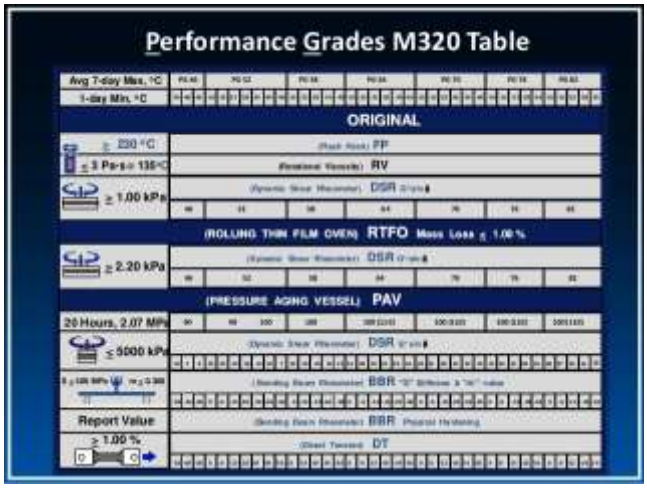
PG Specification: AASHTO M320



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Examples of PG Grading System

- Florida: PG 70-10 (158°F to 14°F)
- Minnesota: PG 58-34 (136°F to -29°F)
- Arizona: PG 76-22 (170°F to -8°F)

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Typical FDOT Asphalt Binders

- PG 67-22: Standard Paving Grade
- PG 52-28, PG 58-22 (for use with RAP)
- PG 76-22 (PMA)
  - Polymer Modified Asphalt
  - PG 67-22 base asphalt + ~ 2.5% polymer
- PG 76-22 (ARB):
  - Asphalt Rubber Binder
  - PG 67-22 base asphalt + minimum 7% GTR & polymer

BARGED FROM REFINERY TO TERMINAL

TERMINAL LOADING INTO TANKER

Binder Sources in Florida

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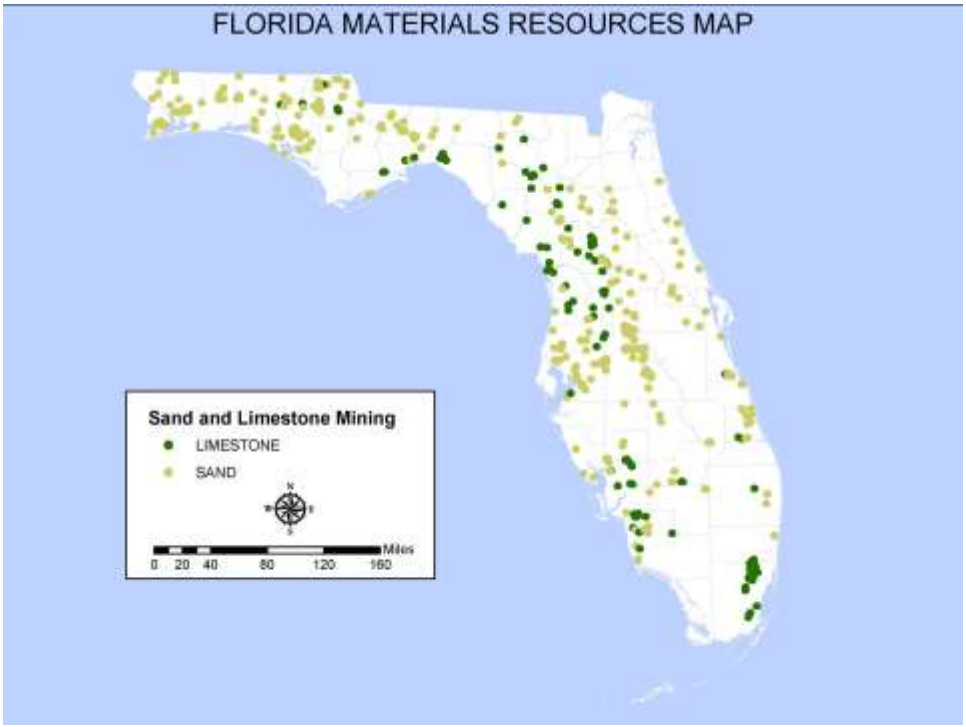
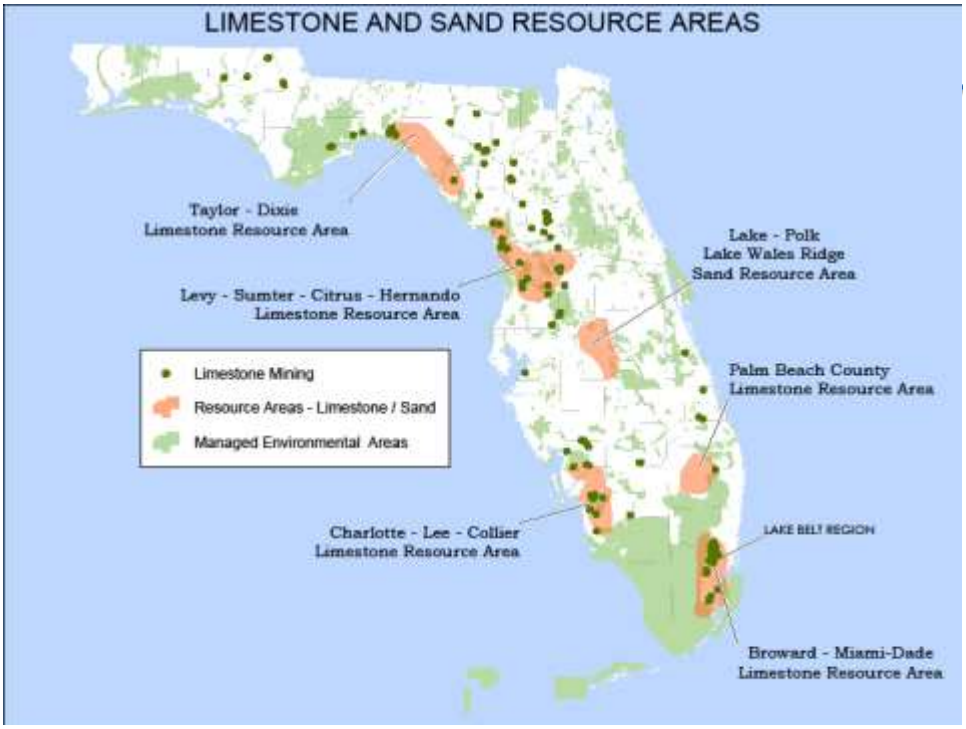
AGGREGATE


FLORIDA MATERIALS RESOURCES MAP
Sand and Limestone Mining
LIMESTONE
SAND
N
W
E
S
Miles
0 20 40 80 120 160



AGGREGATE SOURCES USED IN ASPHALT

- Aggregate mines
- Aggregate terminals

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Mines
Plantation
Fort Lauderdale
Weston
Davie
Cooper City
Pembroke Pines
Hollywood
Miramar
Miami Gardens
North Miami Beach
Opa-locka
North Miami
Hialeah
Miami Beach
Miami
Tamiami
Coral Terrace
Coral Gables
Kendale Lakes
The Hammocks
Kendall

Reclaimed Asphalt Pavement (RAP)

BENEFITS OF USING RAP

- Conserves resources
- Allows milling without generating waste
- Eliminates a potential waste material
- *Saves money*

Some Historical Data….

- FDOT usage since 1980:
  - 150 million tons HMA
  - 33 million tons RAP
- Resource savings from RAP usage:
  - 31.7 million tons aggregate
  - 1.7 million tons asphalt binder

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Fiscal Year 14/15

- 4.9 million tons of HMA
  - 85% of all mixes contain RAP
  - 940,000 tons of RAP used
    - 893,000 tons aggregate reclaimed
    - 47,000 tons asphalt binder reclaimed
- Current Materials Costs:
  - Aggregate: 20 – 30 $/ton
    - Potential savings $22 million
  - Binder: >$550/ton
    - Potential savings $26 million

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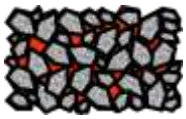
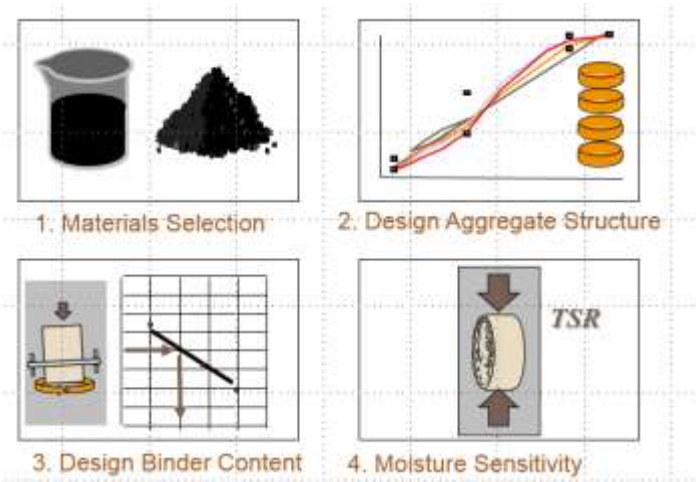
Asphalt Mix Design

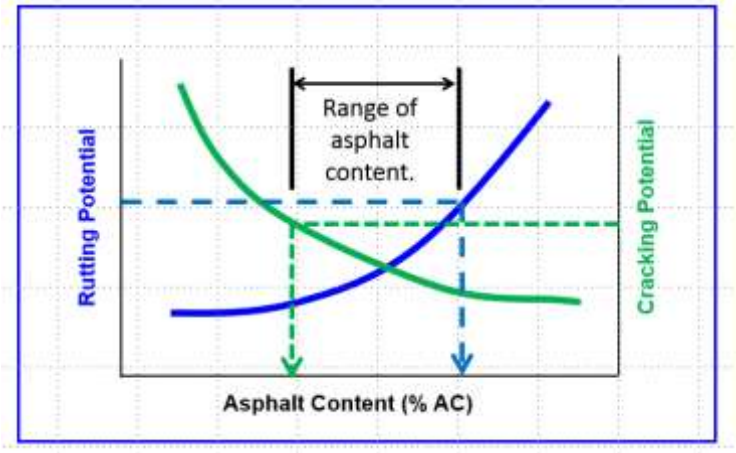
- "Recipe" containing the types and proportions of aggregate and asphalt binder
- FDOT uses the Superpave Mix Design System
  - Mixes are designed & tested based on the traffic level for the project
  - Mixes have to meet established specification criteria
    - To assure good performance



Mix Design Steps



Simplified Mix Design Philosophy



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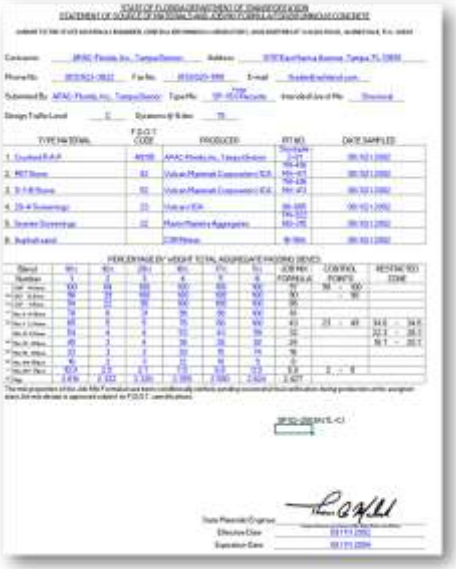
ASPHALT MIX DESIGN



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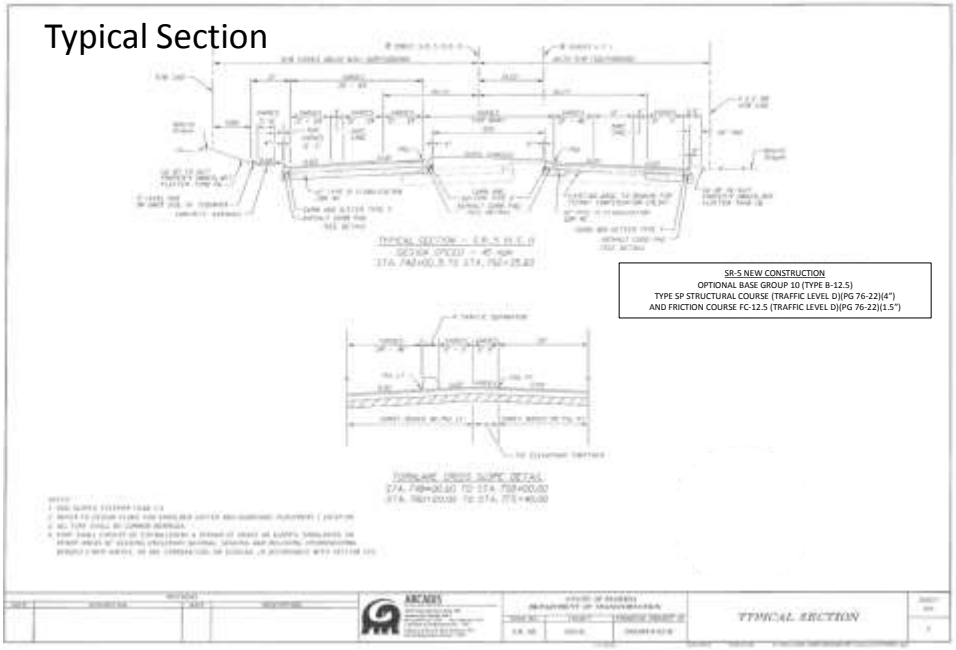
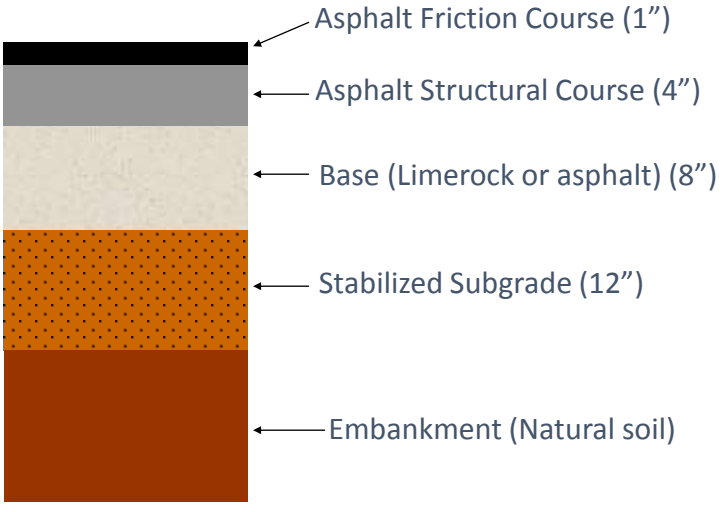
Typical Section



Typical Roadway Structure



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FDOT 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

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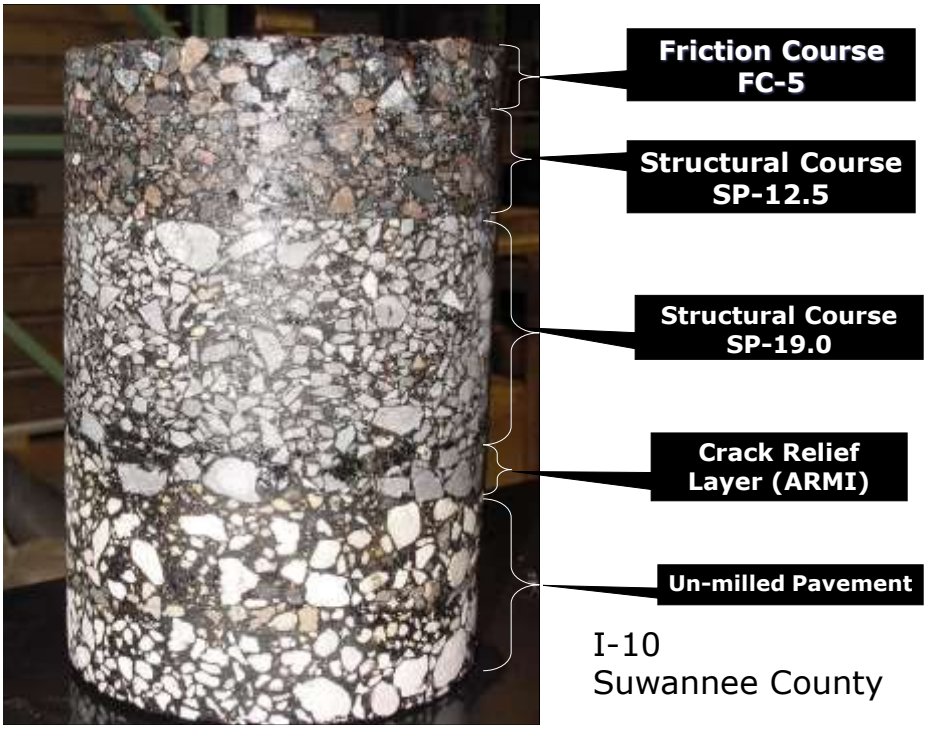

I-10
Suwannee County

Mix Types – Structural Courses (SP)

- Purpose: Load carrying portion of pavement
  - Structural layer coefficient 0.44
- Three 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 Design Life 18-kip Equivalent Single Axle Loads (ESAL's)
  - Low traffic = A, High traffic = E

Traffic Levels

- Generally, higher traffic levels…
  - Stronger mix
    - Higher quality aggregate
    - Stiffer asphalt binder
      - Less asphalt binder
  - More difficult to build
  - Greater cost
- Higher traffic level is not necessarily better
  - Put the right mix in the right place

Traffic Level A: <300,000 ESAL's

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Traffic Level B: 300,000 to 3,000,000 ESAL's

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Traffic Level C: 3,000,000 to 10,000,000 ESAL's

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Traffic Level D: 10,000,000 to 30,000,000 ESAL's

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Traffic Level E: >30,000,000 ESAL's

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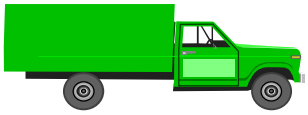
ESAL Configuration Examples



15,000 lb 0.48 ESAL + 6,000 lb 0.01 ESAL = 0.49 ESALs

34,000 lb 1.10 + 34,000 lb 1.10 + 12,000lb 0.20 = 2.40 ESALs

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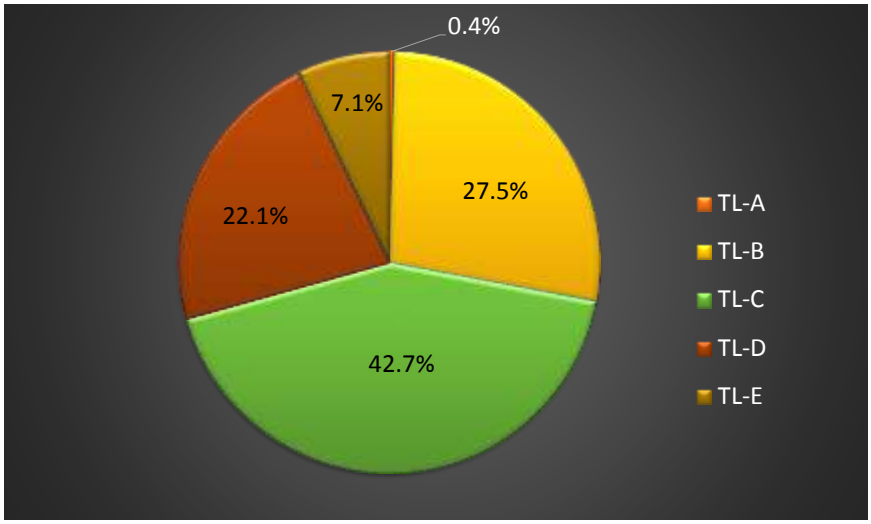
Traffic Distribution



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Friction Courses

- 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 (Alabama, Georgia & Nova Scotia)

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Friction Courses

- Dense Graded Friction Courses:
  - Uses microtexture of the aggregate to provide friction
  - Aggregate:
    - 100% oolitic limestone, or
    - Minimum of 60% granite
  - Two aggregate sizes:
    - 9.5 mm (FC-9.5) – Placed 1” thick
    - 12.5 mm (FC-12.5) – Placed 1 ½” thick
  - Layer coefficient 0.44
  - PG 76-22 (ARB) or PG 76-22 (PMA)

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Oolitic limestone

Granite

Friction Courses

- Open-Graded Friction Courses:
  - Required on high speed multi-lane facilities
    - Design Speed ≥ 50 mph
  - Uses macrotexture and microtexture to provide friction
    - Primarily a function of surface texture
    - Minimize hydroplaning and excessive splash and spray
  - Layer Coefficient: 0.00
  - FC-5
  - Aggregate: Either 100% granite or 100% oolite
  - Binder: PG 76-22 (ARB) or PG 76-22 (PMA)
  - Stabilizing fibers to prevent binder draindown during construction
  - Granite: Must use hydrated lime to prevent stripping

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Base Courses

- B-12.5
- Superpave
  - Traffic Level B
- Layer Coefficient 0.30
- May substitute an SP-12.5 during construction
  - It's basically the same mix

Asphalt Treated Permeable Base (ATPB)

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

Asphalt Plants

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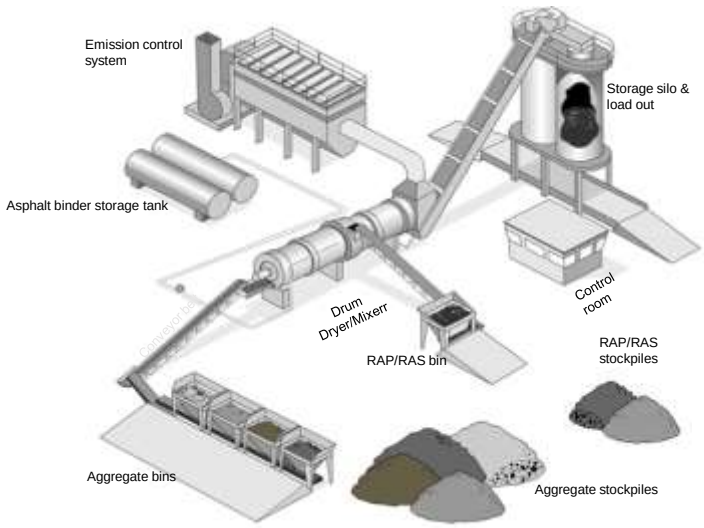
Continuous-Flow Drum Plant



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Aggregate Transport to Drum

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Liquid Asphalt Transport to Drum

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Counter-flow Drum

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Emission Control Systems

Transport of Hot Mix to Silo

Paving Operations

Milling and Resurfacing

Tacking between layers

Compaction
APR 13 2006

Placing second structural layer
JUN 16 2006

Placing Friction Course
MAY 26 2005

CATERPILLAR
Compaction

THANK YOU… QUESTIONS?

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