FDOT Accelerated Pavement Testing
AFD40(2) Web Update

June 2013

Topics

- APT facility
- Recently completed APT research
- Current APT research
- Concrete test road

Topics

- **APT facility**
- Recently completed research
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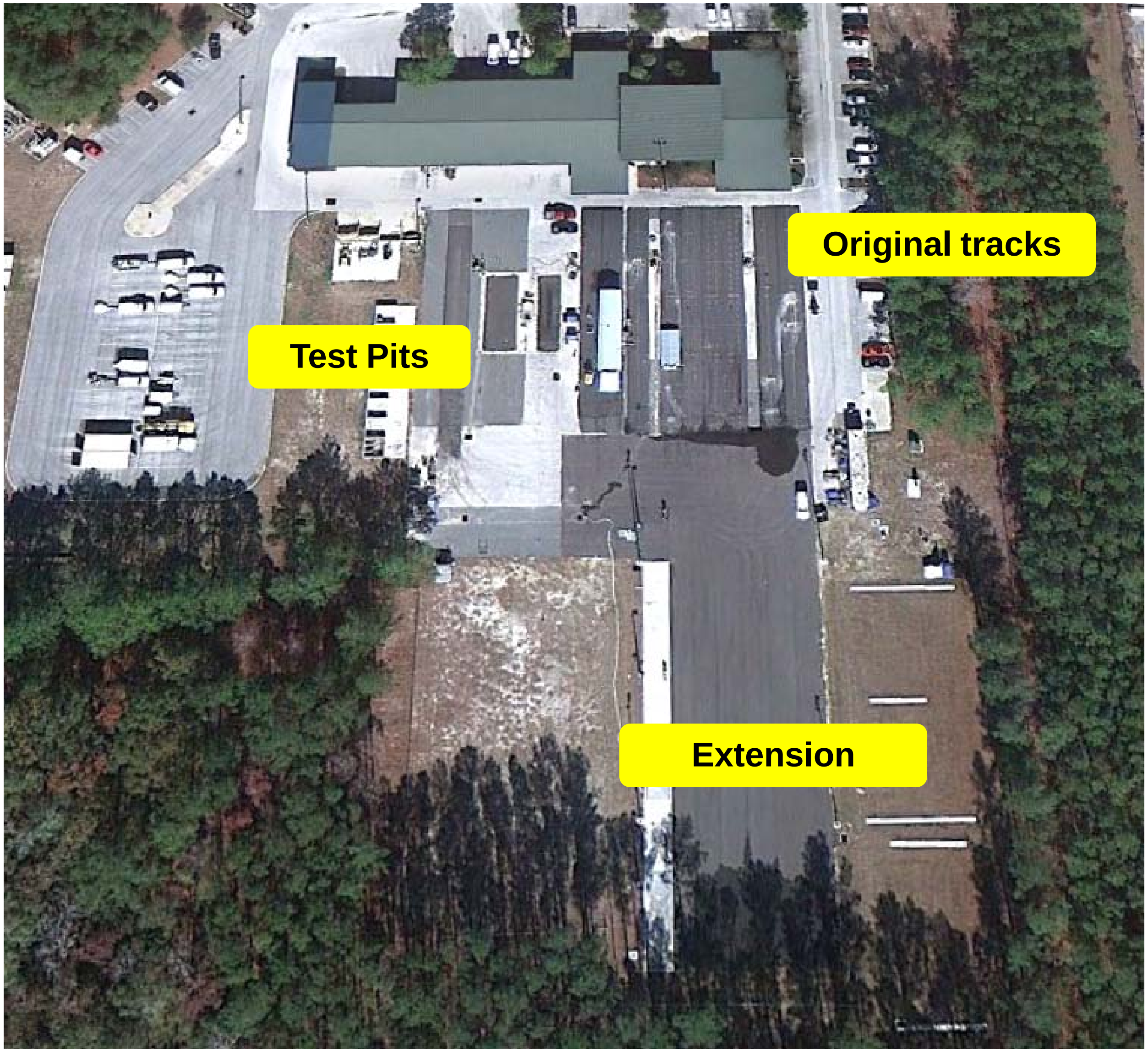
Accelerated Pavement Testing

- Initiated in 2000
- Housed at the State Materials Office in Gainesville
- Test site consists of eight 12 ft. linear tracks
  - ✓ Originally 150 ft. long
  - ✓ Seven tracks extended additional 300 ft. in 2011
- Two additional tracks include water table control
- Loading performed using a Heavy Vehicle Simulator (HVS)

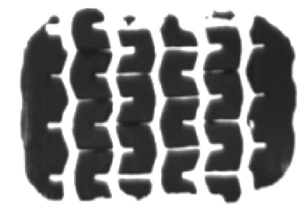
Test Track Aerial View



Heavy Vehicle Simulator

- Heavy Vehicle Simulator, Mark IV
  - ✓ Wheel speed up to 8 mph
  - ✓ Loading: 7 to 45 kips
  - ✓ Dual or single tires
  - ✓ Wander from 0 to 30 inches

Goodyear Unisteel G149 RSA, 11R22.5 (Dual Tire)



Goodyear G286 A SS, 425/65R22.5 (Super Single)

Michelin X One XDA-HT Plus, 445/50R22.5

Michelin X One XDA-HT Plus, 455/55R22.5

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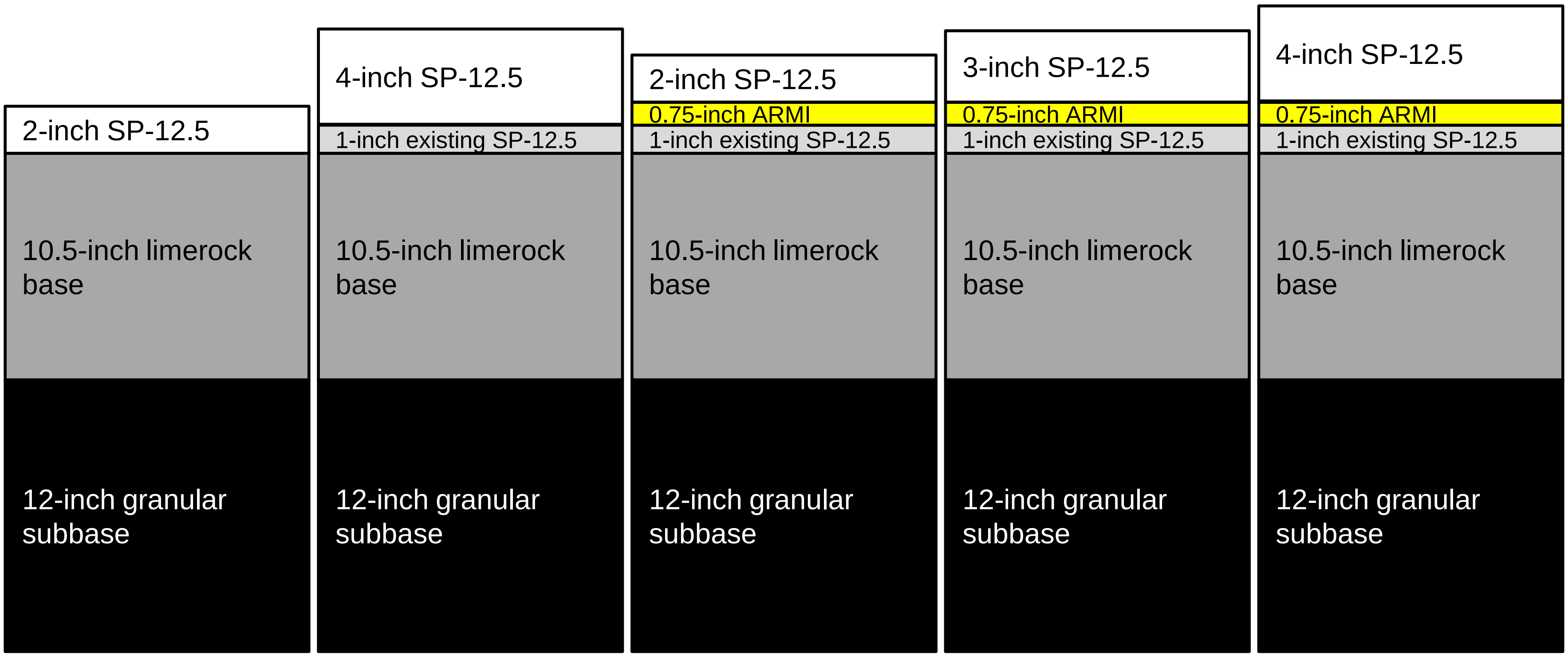
Effect of ARMI on Instability Rutting

- Asphalt Rubber Membrane Interlayer (ARMI)
  - ✓ Florida's primary reflection crack mitigation technique
  - ✓ Districts suspect ARMI may contribute to rutting

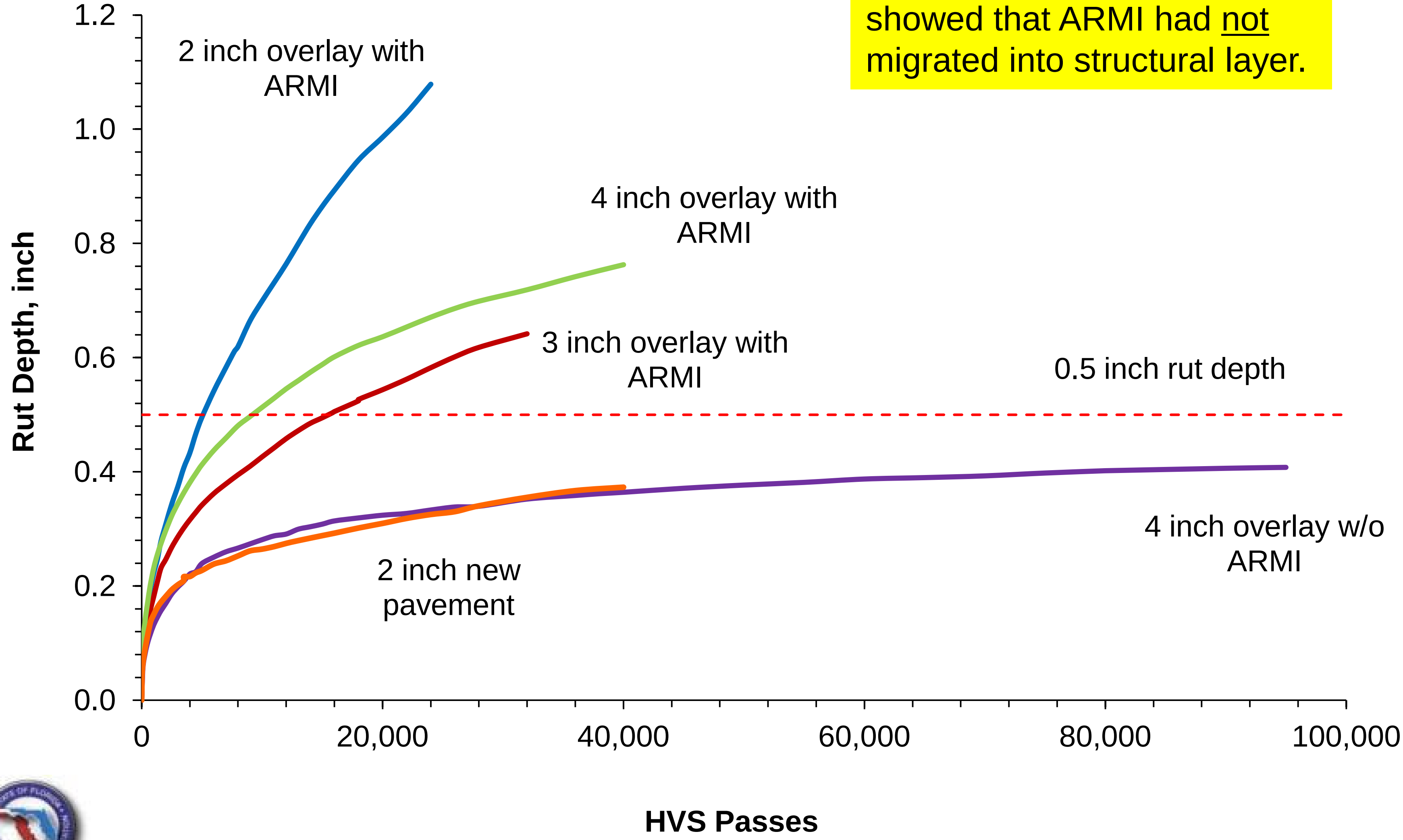
Pavement Structure

Control Sections *Experimental Sections*



Rut History

Lane slices indicated rutting confined to layers above the ARMI. Ignition tests on cores showed that ARMI had <u>not</u> migrated into structural layer.



Summary – ARMI Contribution to Instability Rutting

- An ARMI as deep as 4 inches contributed to instability rutting
  - ✓ Pavements with an ARMI rutted 20 to 50 times faster than those without an ARMI
  - ✓ FEA and lane slices indicated critical stress states above ARMI and at the tire edge
- Contracted research effort initiated to evaluate ARMI alternatives

Rut Resistance of Heavy Polymer Asphalt Binders

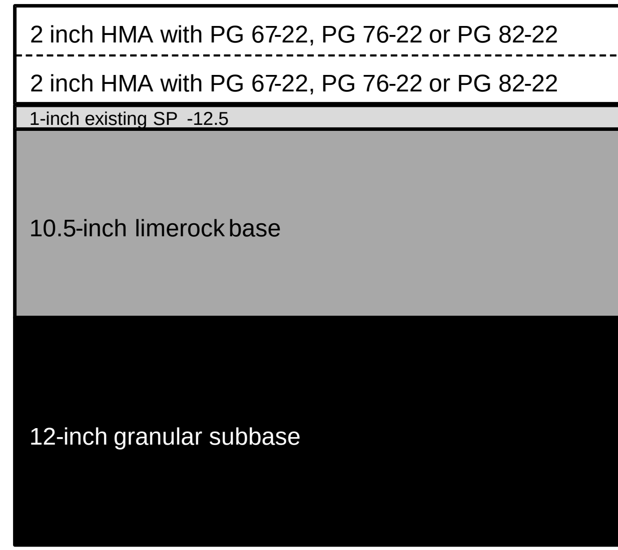
- 2001 APT evaluation of rutting resistance of a polymer modified PG 76-22 asphalt binder
  - ✓ Traffic level D roadways (10 to > 30 million ESALs) require PG 76-22 binder on final structural course
  - ✓ Traffic level E (≥ 30 million ESALs) require PG 76-22 binder in top two structural courses
  - ✓ Recommended for use at intersections or other facilities with slow moving & concentrated truck loads

Can We Add More Polymer?

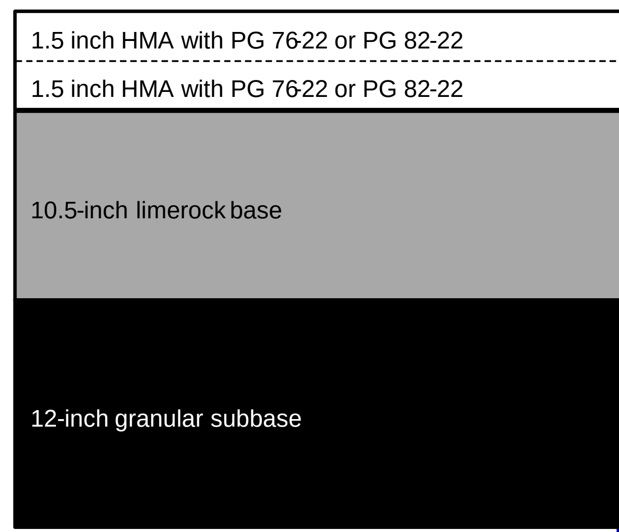
- Localized rutting failures still occur at some intersections and other facilities with low speed and concentrated truck traffic
- Recent studies have indicated a PG 82-22 asphalt binder could improve rut resistance
- Cost of adding polymer vs. PG 67-22 (Fall 2011):
  - ✓ PG 76-22 is approximately $250/liquid ton more
  - ✓ PG 82-22 is approximately $350/liquid ton more

Experiment Design (Rutting)

- Rutting
  - ✓ Three test track sections: two 2 inch lifts w/ PG 67-22, PG 76-22 & PG 82-22 binders
  - ✓ Loading performed at 120°F (50°C)

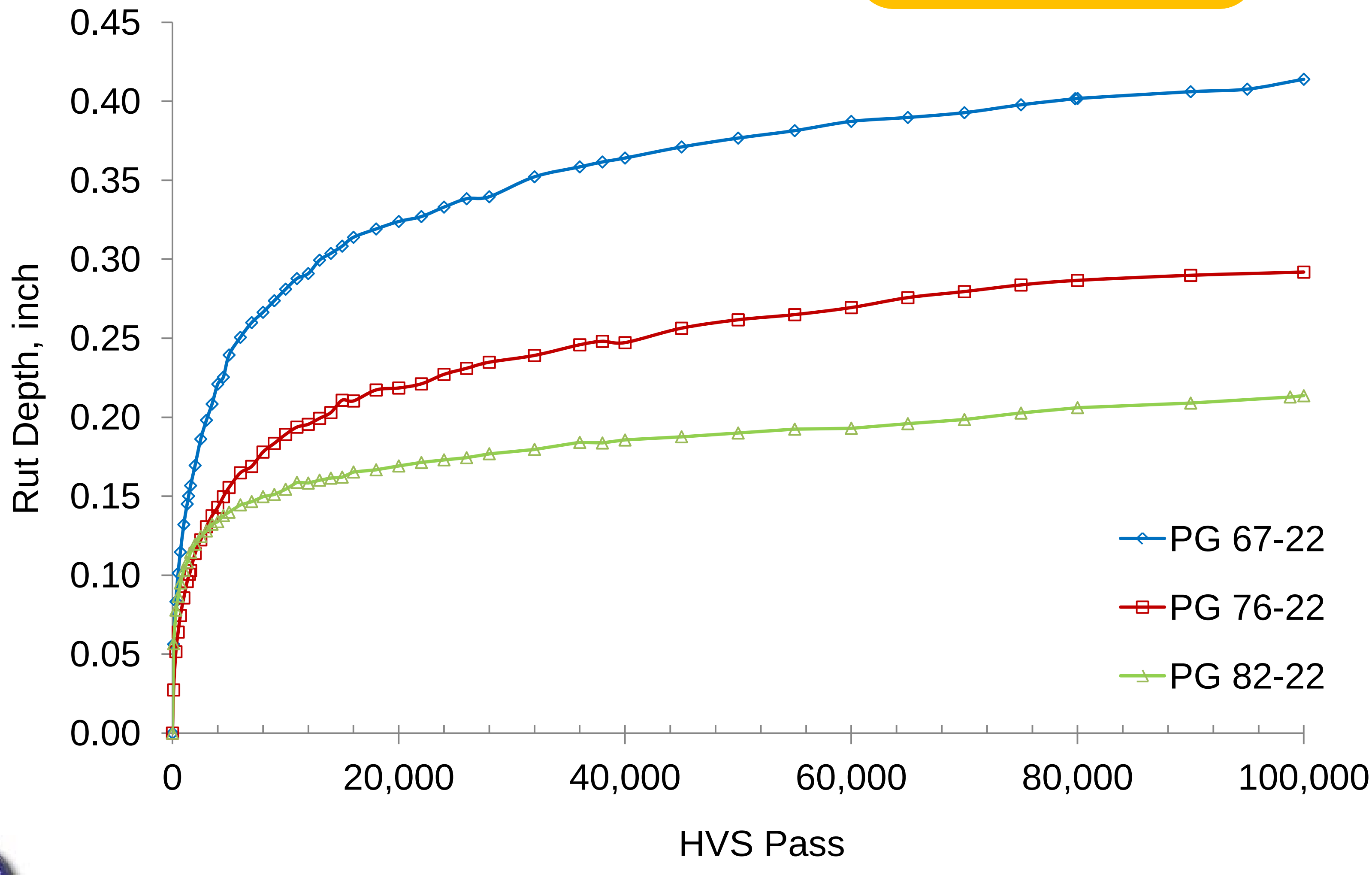


- Fatigue
  - ✓ Two test pit sections: two 1.5 inch lifts w/ PG 76-22 & PG 82-22 asphalt binders
  - ✓ Loading performed at ambient temperature



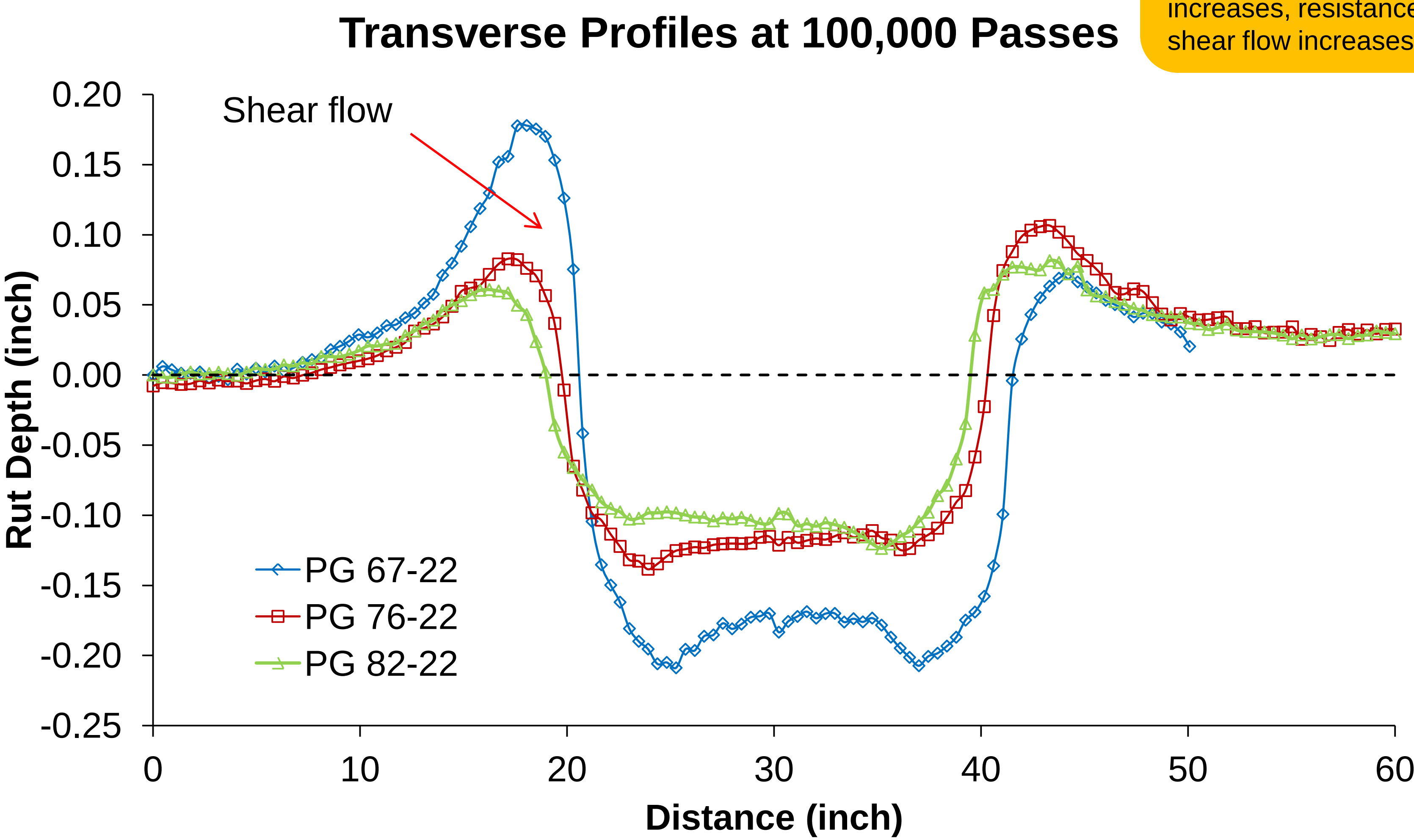
Rut History

As the amount of polymer increases, rut accumulation decreases

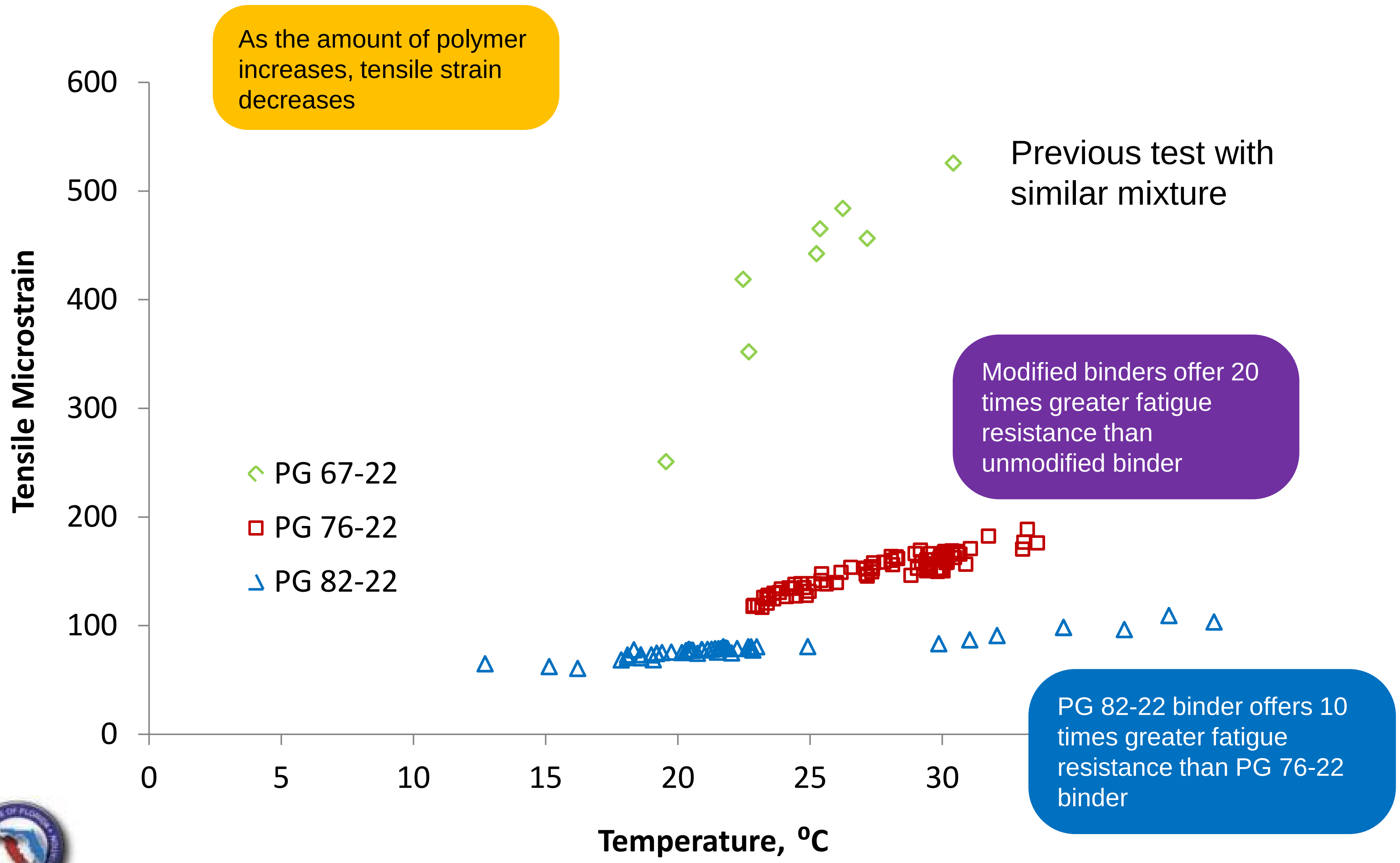


Shear Flow

As the amount of polymer increases, resistance to shear flow increases



Tensile Strain



Summary & Conclusions

- APT study showed that PG 82-22 binder increased rutting and fatigue resistance
- To date, two projects have been constructed with PG 82-22 binder (planning a third)
  - ✓ All have a history of significant rutting

Topics

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- **Current research**
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Current APT Projects

- Asphalt rubber (AR) binder
- 4.75-mm mixture
- Cooperative research projects
  - ✓ Tire study TPF-5(197)
  - ✓ Fiber Reinforced Polymer (FRP) bridge deck

PG 76-22 Asphalt Rubber (AR)

- **Background:** PG 76-22 binder required on final structural course of Traffic level D mixes and top two structural courses of Traffic Level E mixes
- **Objective:** Extend use of ground tire rubber (GTR) to structural course and provide alternative to SBS polymer
- Minimum 7% GTR (may contain SBS polymer)

Test & Method	Conditions	Spec Min/Max Value
Solubility, AASHTO T 44	In Trichloroethylene	Not Applicable for PG 76-22AR
Separation Test, ASTM D7173 & Softening Point, ASTM D36/D36M	163 ± 5^{0}C	Max 7^{0}F between top & bottom portions of tube sample
Multiple Stress Creep Recovery, AASHTO MP 19-10 & AASHTO TP 70-11	76^{0}C	1. Max $J_{nr3.2}$ 1.0kPa^{-1} Max J_{nrdiff} 75% 2. Meet requirements in Fig X2.1

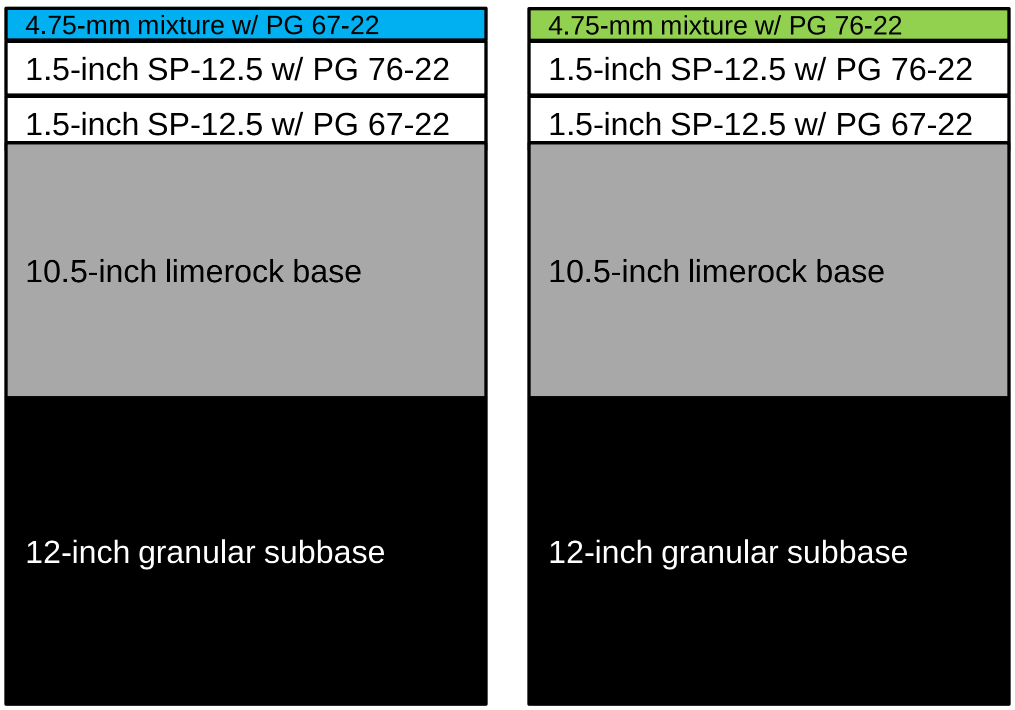
PG 76-22 AR Study Test Sections

PG 76-22 PM (Control)	*ARB-5*	*Blend of GTR and Polymer PG76-22 ARB*	*PG76-22 ARB*
1.5-inch SP-12.5	1.5-inch SP-12.5	1.5-inch SP-12.5	1.5-inch SP-12.5
1.5-inch SP-12.5	1.5-inch SP-12.5	1.5-inch SP-12.5	1.5-inch SP-12.5
1-inch existing SP-12.5	1-inch existing SP-12.5	1-inch existing SP-12.5	1-inch existing SP-12.5
10.5-inch limerock base	10.5-inch limerock base	10.5-inch limerock base	10.5-inch limerock base
12-inch granular subbase	12-inch granular subbase	12-inch granular subbase	12-inch granular subbase
		(two binder suppliers)	*(two binder suppliers)*

4.75 mm Mixture

- **Objective:** Study use of 4.75 mm mixture for preservation treatment on low-volume roadways and overbuild layer

4.75-mm w/ PG 67-22 *4.75-mm w/ PG 76-22*



4.75-mm thickness ranges from ½ to 1 inch

Wide-Base Tire Study

- TPF-5(197), The Impact of Wide-Base Tires on Pavement – A National Study
- **Objective:** Quantify the impact of WBT on pavement damage utilizing advanced theoretical modeling and validate results using full-scale testing
- **Scope:**
  - ✓ Tire Contact stress measurements (WBT & DTA)
  - ✓ APT of pavement sections
  - ✓ FEM modeling of pavement loading
  - ✓ Calculation of pavement damage

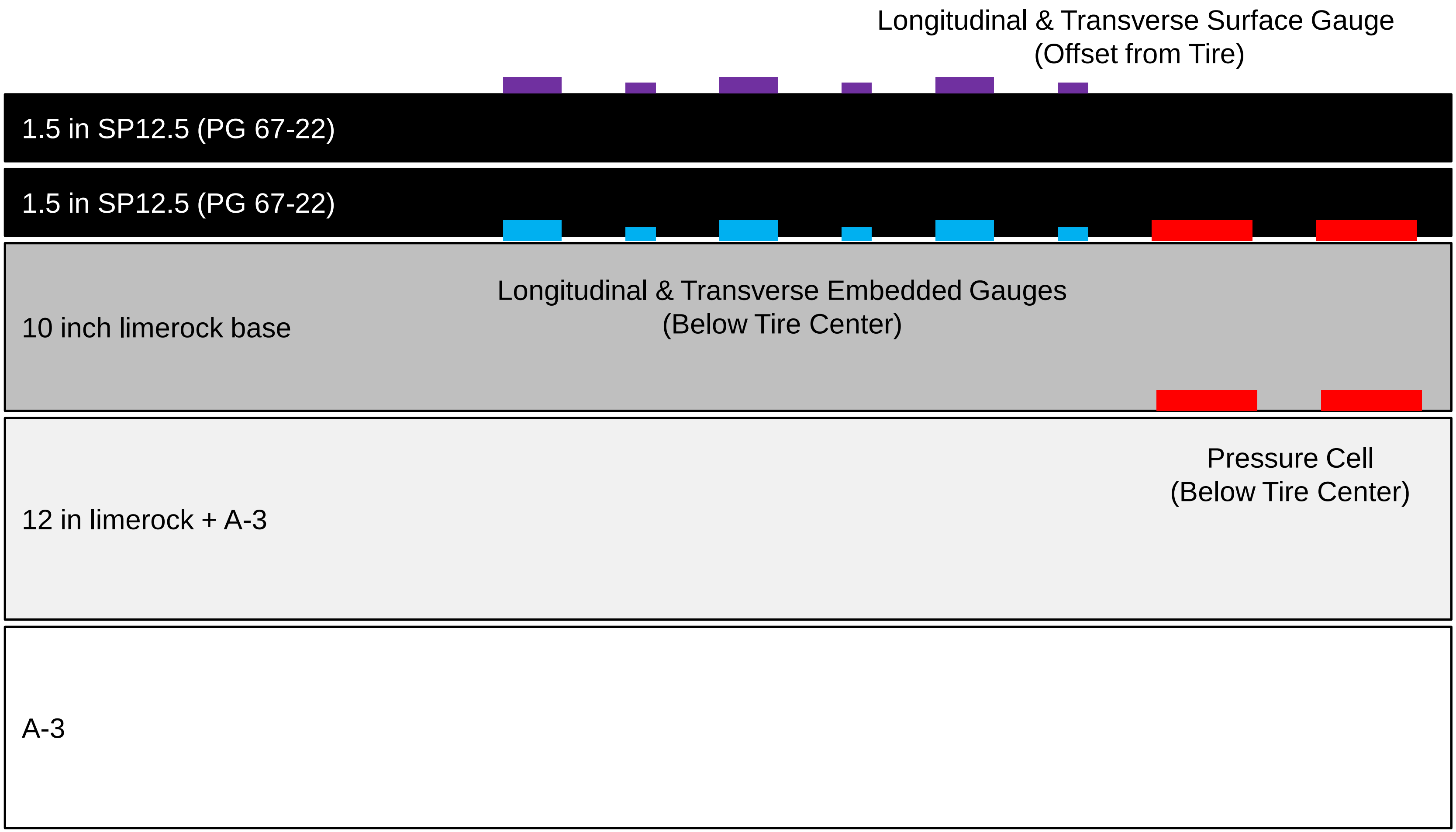
Wide-Base Tire Study

- University of Illinois, Principal Investigator
- Contact stress measurements, CSIR
- APT
  - ✓ FDOT
  - ✓ UC-Davis
  - ✓ Ohio University
- Modeling effort
  - ✓ University of Illinois
  - ✓ Delft University of Technology

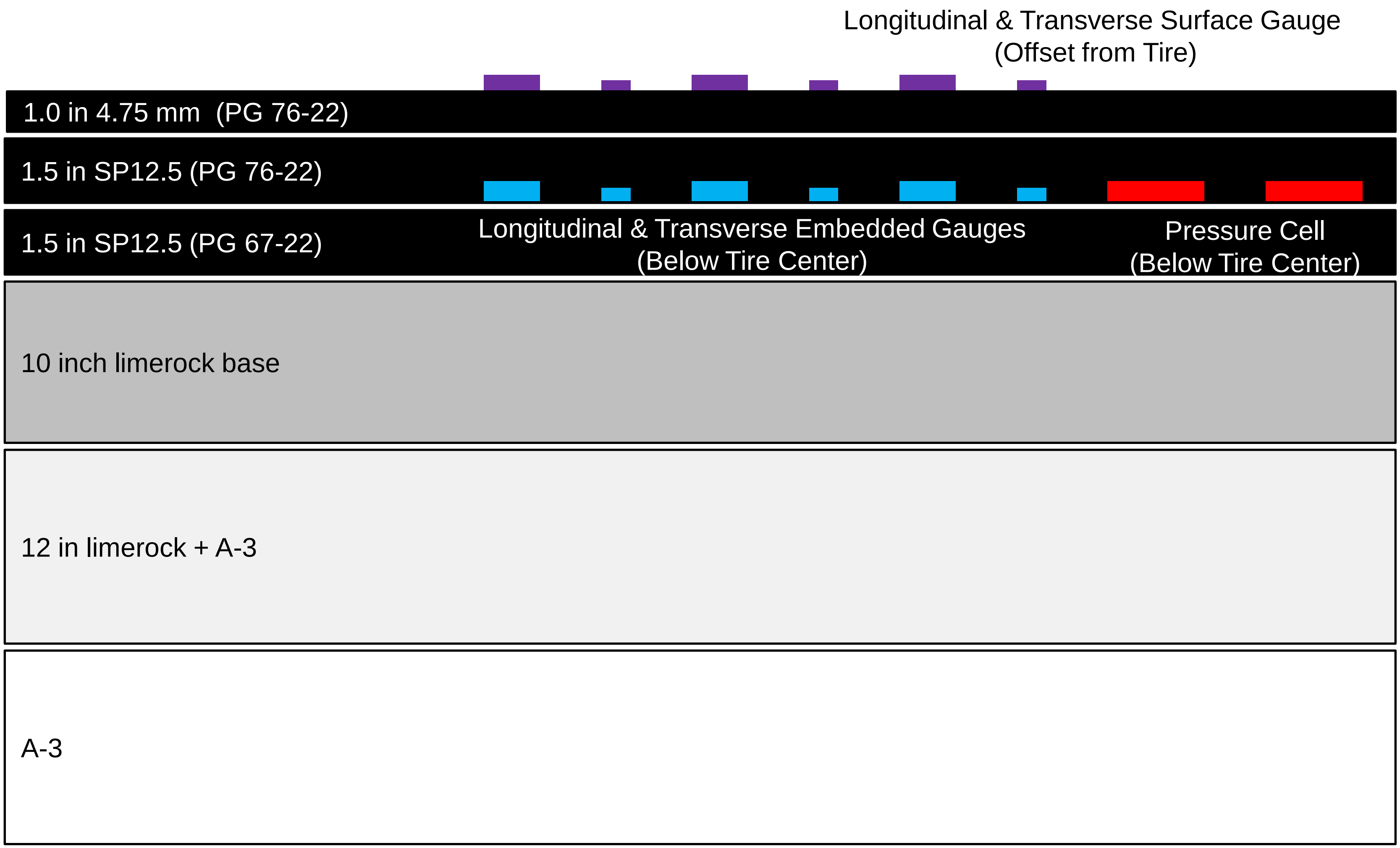
Test Section Design

Test Pit	Test Track
	1.0 in 4.75 mm (PG 76-22)
1.5 in SP12.5 (PG 67-22)	1.5 in SP12.5 (PG 76-22)
1.5 in SP12.5 (PG 67-22)	1.5 in SP12.5 (PG 67-22)
10 inch limerock base	10 inch limerock base
12 inch limerock + A-3	12 inch limerock + A-3
A-3	A-3

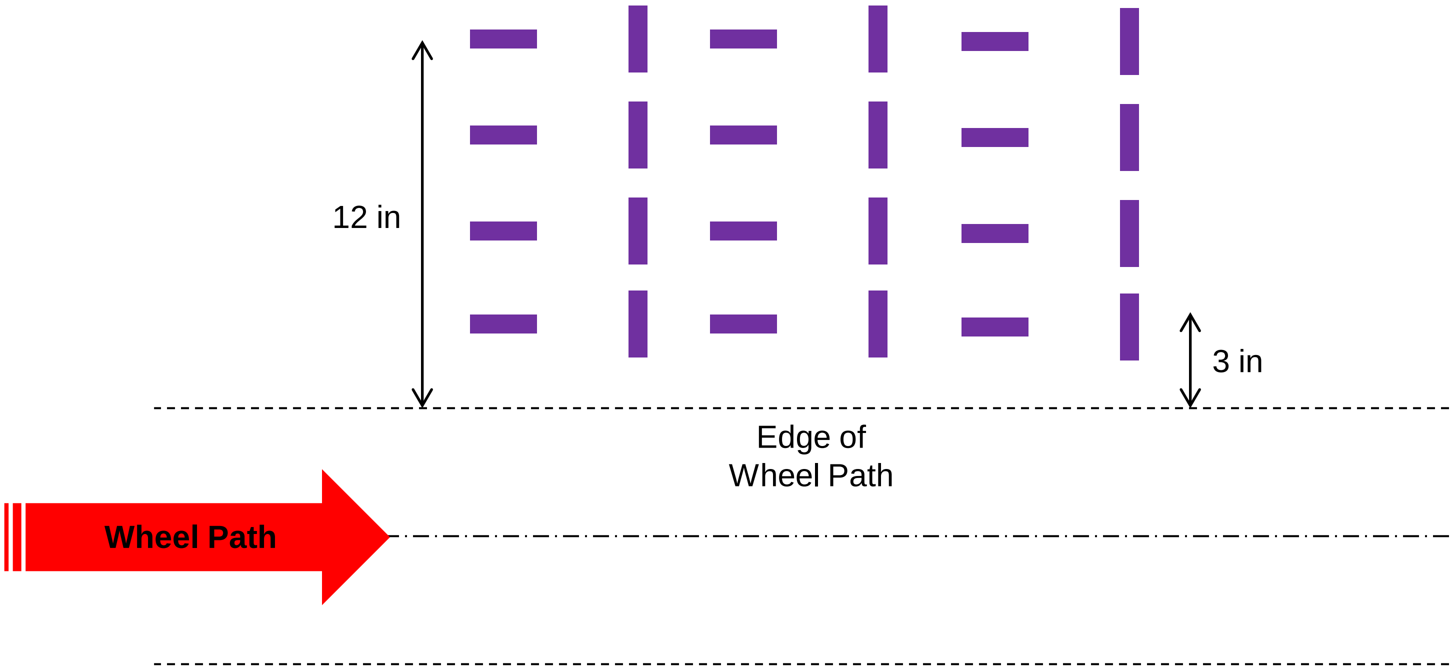
Test Pit Instrumentation



Test Track Instrumentation

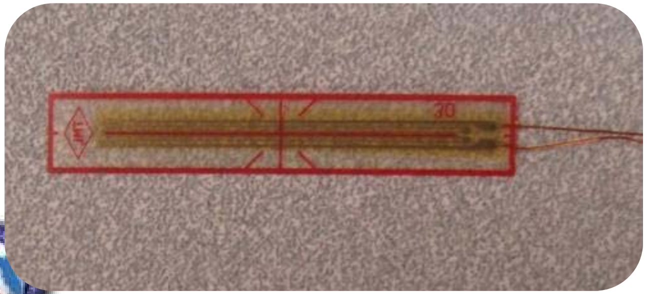


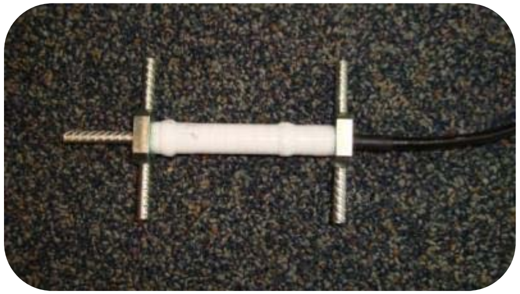
Surface Strain Gauges



Instrumentation Summary

Sensor Type	Number of Sensors per Test Section	Model	Vertical Location	Offset from Wheel Path
Surface strain gauge	24	Tokyo Sokki PFL-30-11-5L	HMA surface	Transverse and longitudinal orientations at various offsets from wheel path edge
Asphalt strain gauge	6	Tokyo Sokki KM-100HAS	Bottom of new HMA	Transverse and longitudinal orientations below tire center
Pressure cell	2	RST Instruments LPTPC09-S	Bottom of new HMA	Below tire center
Pressure cell (Test Pit only)	2	Geokon 3500	Bottom of base	Below tire center





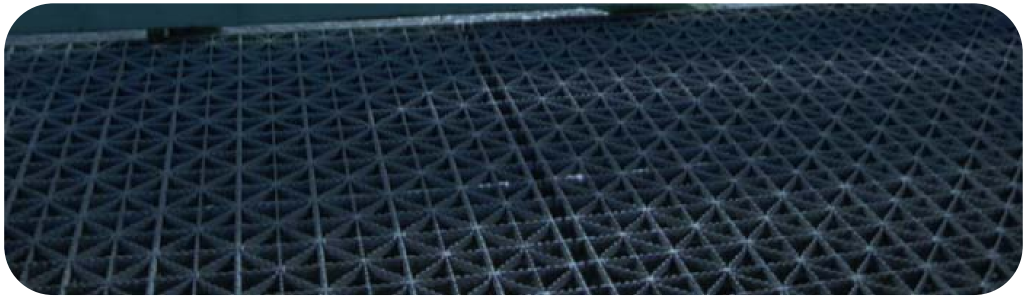
Test Pit Paving

HVS Test Matrix

Tire Type	Inflation Pressure (psi)	Tire Loading (kips)				
NGWB and Dual	80	6	8	10	14	18
NGWB and Dual	100	6	8	10	14	18
NGWB and Dual	110	6	8	10	14	18
NGWB and Dual	125	6	8	10	14	18
Dual Only	60/110	6	8	10	14	18
Dual Only	80/110	6	8	10	14	18
Tests at 25^{0}C, 40^{0}C, and 55^{0}C						

FRP Bridge Deck

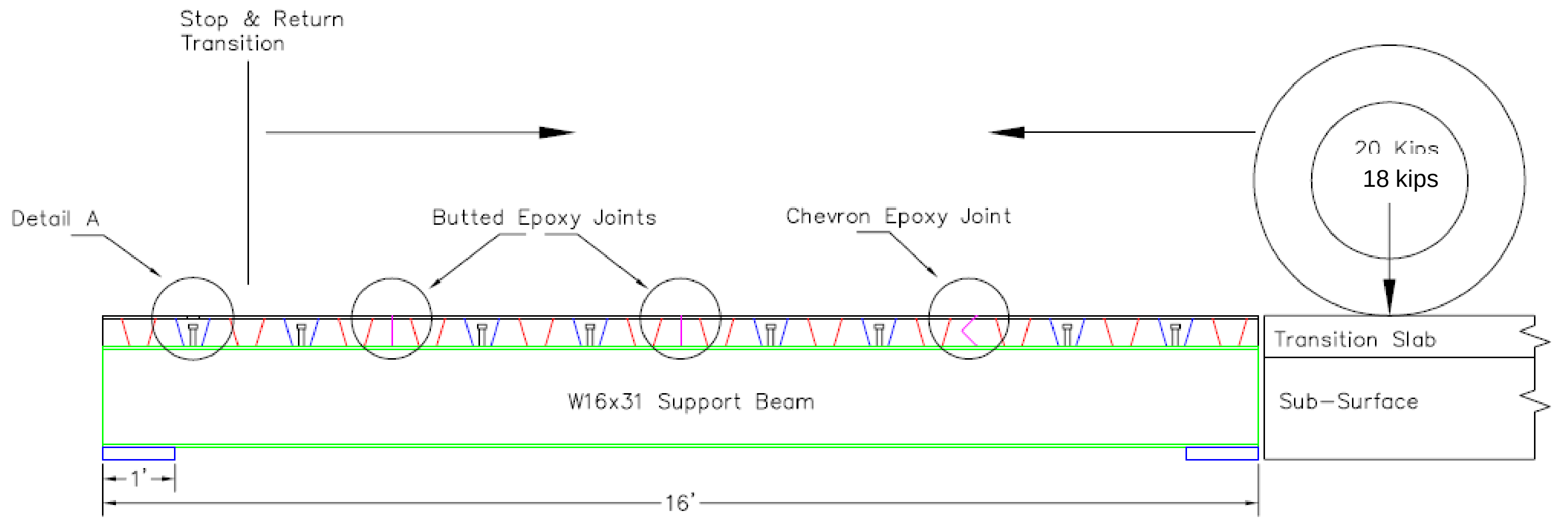
- **Objective:** Investigate alternative to open grid steel decks
  - ✓ Must have a solid riding surface, weigh less than 25 lb/ft^2, have a low profile (5 in depth), and low noise
- **Background:** Florida has the largest inventory of movable bridges in the US, most of which use open grid steel decks
  - ✓ High noise & vibration levels, costly maintenance



FRP Experimental Plan

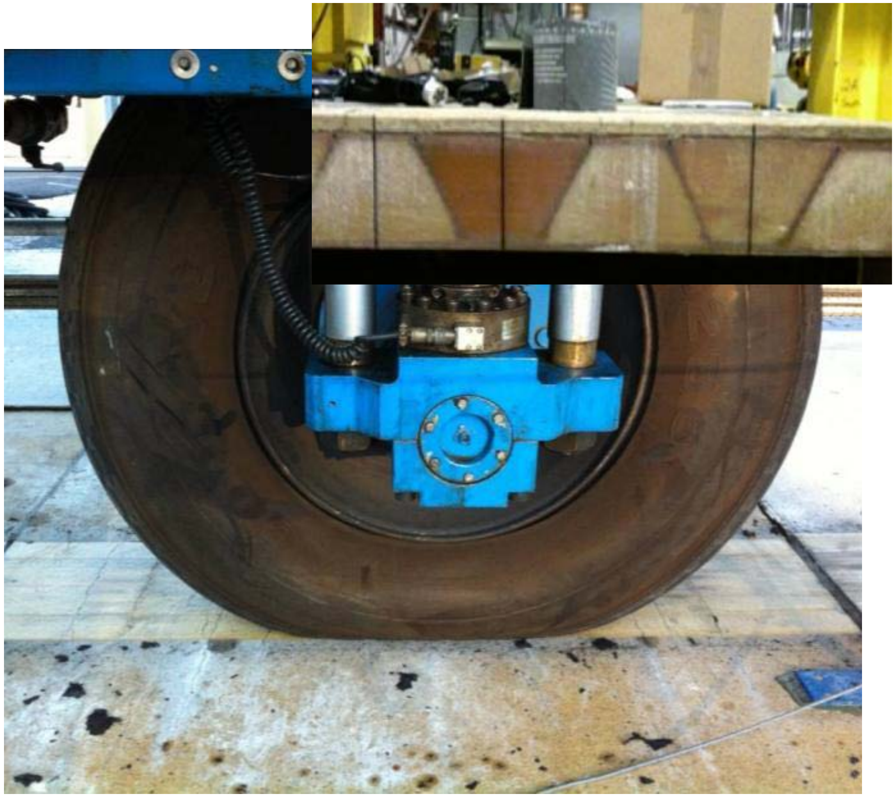
- 20 kip tire load with no wheel wander
- Three strain gauges placed on the underside of each panel below the wheel path (edge & mid-panel)
- Four 6 ft wide x 4 ft long x 5 inch thick panels joined by three different joint types
  - ✓ Joint 1 – Low stiffness butted epoxy joint
  - ✓ Joint 2 – High stiffness butted epoxy joint
  - ✓ Joint 3 – 45^0 chevron epoxy joint

FRP Bridge Deck



Preliminary Results

- Applied more than 300,000 passes
- Significant system deflection > 0.5 inches in center of deck
- Surface cracks initiated after < 5000 passes
- No catastrophic failures of joints or panels



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Why Build a Test Road?

- Provide a real-word testing ground
  - ✓ New construction, rehabilitation, and maintenance techniques
  - ✓ New materials and design methods
- Develop cost effective long-life concrete pavements specific for Florida environment
- Will be the only full scale concrete pavement test facility in the Southeast

Test Road Committee

- Pavement Management Office
- State Materials Office
- District representatives
- Concrete pavement industry
- Roadway design consultant

Test Road Location

- Northbound US 301 / SR 200
  - ✓ Minimal side streets
  - ✓ Minimal impact
  - ✓ Large truck volume
    - 30% trucks
    - 1 million ESALs/year

US-301 (Looking South)

What Will the Test Road Look Like?

- 2.5 mainline miles, parallel to existing NB lanes
  - ✓ Individual test sections will be 225 ft long
  - ✓ Test sections will be used to evaluate various design and construction features
- Live traffic will be diverted to the test road
  - ✓ Traffic will be classified & weighed
- Construction planned for 2015/16

What Will We Learn?

- Structural
  - ✓ Thickness, base types, recycled material
- Drainage
  - ✓ Edge drains, joint sealant
- Construction
  - ✓ Construction temperature, curing

Structural Evaluation

- Concrete thickness (8 -12 inches)
- Base type (ATPB, asphalt base, composite base)
- Recycled material (RAP as concrete aggregate)

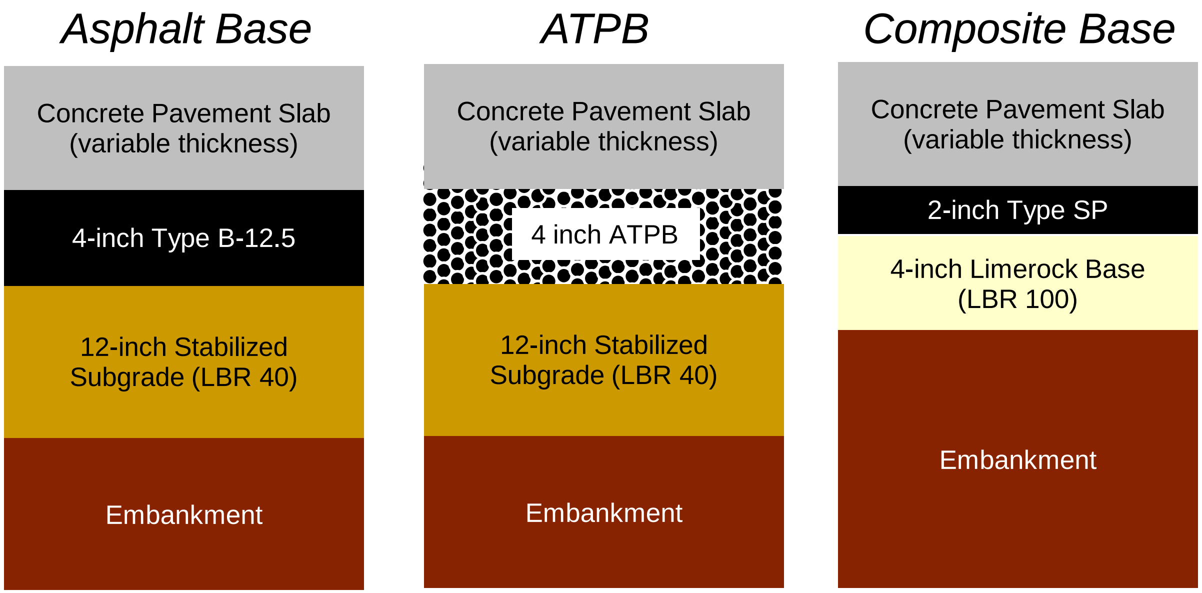
w/RAP Black Base	w/o RAP Black Base	w RAP Comp Base	w/o RAP Comp Base	w RAP Treat Perm	w/o RAP Treat Perm
w/RAP Black Base	w/o RAP Black Base	w RAP Comp Base	w/o RAP Comp Base	w RAP Treat Perm	w/o RAP Treat Perm

8 in thickness (light blue; top row)

12 in thickness (dark blue; bottom row)

4,400 ft. total

Pavement Structures

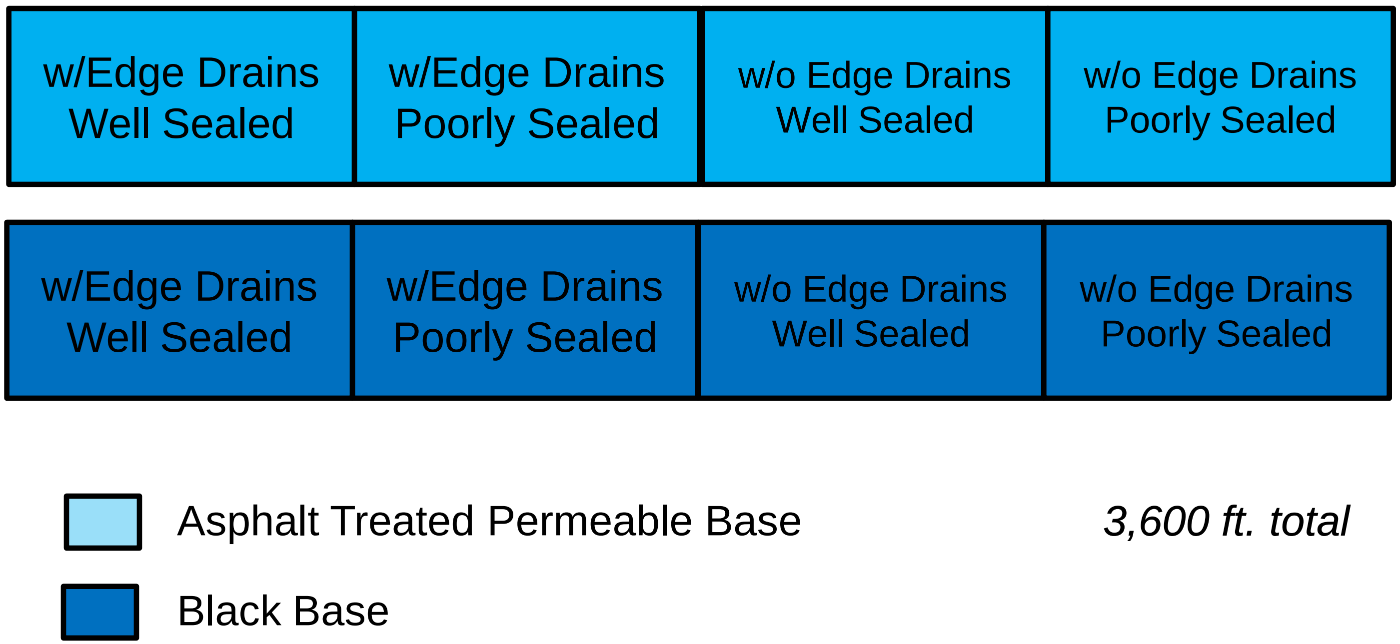


Structural Evaluation

Proposed Construction Sequence	Concrete Slab		Base Type	Drainage		Construction Effects	
	Thickness	with RAP		Edge Drain	Sealant Quality	Joint Spacing, ft.	Set Gradient, °F
1	8	Y	ATPB	Y	Good	15	NA
2	8	N	Black Base	Y	Good	15	NA
3	8	Y	Black Base	Y	Good	15	NA
4	8	N	ATPB	Y	Good	15	NA
5	8	N	Composite	Y	Good	15	NA
6	8	Y	Composite	Y	Good	15	NA
7	8	N	Black Base	Y	Good	15	NA
8	8	N	Composite	Y	Good	15	NA
9	8	Y	Composite	Y	Good	15	NA
10	8	Y	Black Base	Y	Good	15	NA
11	12	Y	ATPB	Y	Good	15	NA
12	12	N	ATPB	Y	Good	15	NA
13	12	N	Composite	Y	Good	15	NA
14	12	Y	Black Base	Y	Good	15	NA
15	12	N	Black Base	Y	Good	15	NA
16	12	Y	Composite	Y	Good	15	NA
17	12	Y	Black Base	Y	Good	15	NA
18	12	N	Composite	Y	Good	15	NA
19	12	N	Black Base	Y	Good	15	NA
20	12	Y	Composite	Y	Good	15	NA

Drainage

- With and without edge drains
- Good and poorly sealed joints

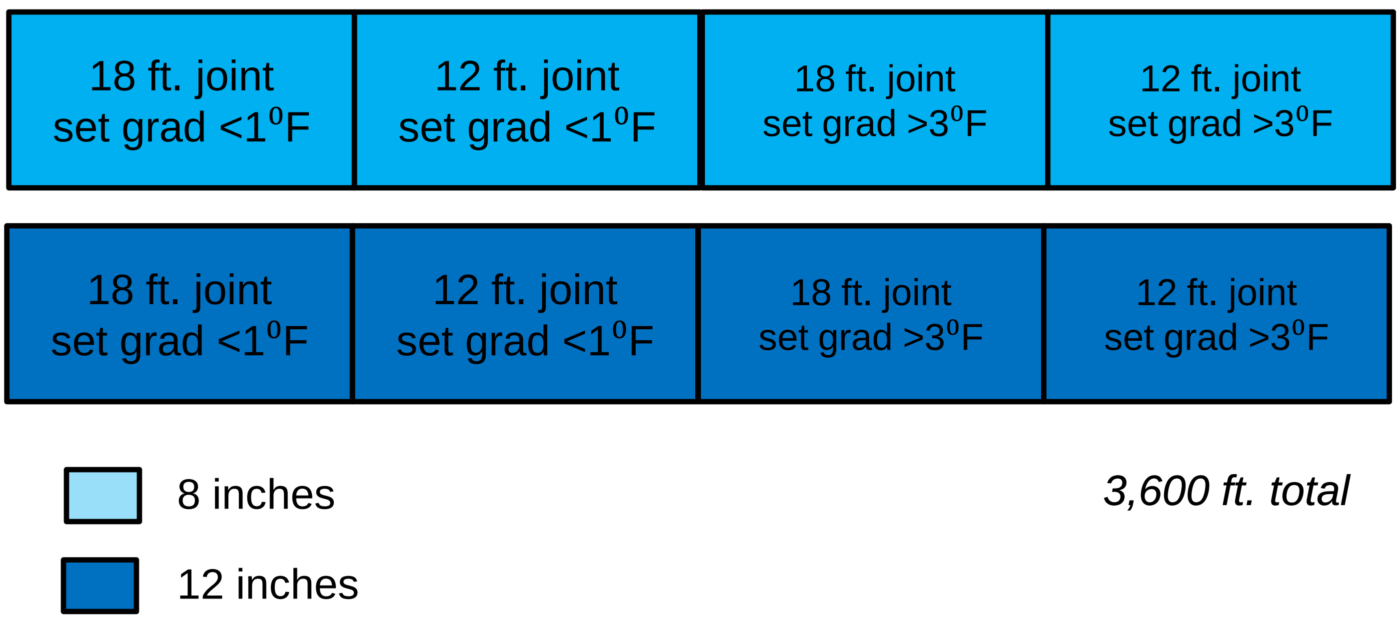


Drainage Evaluation

Proposed Construction Sequence	Concrete Slab		Base Type	Drainage		Construction Effects	
	Thickness	with RAP		Edge Drain	Sealant Quality	Joint Spacing, ft.	Set Gradient, °F
21	10	N	ATPB	Y	Good	15	NA
22	10	N	ATPB	N	Poor	15	NA
23	10	N	ATPB	N	Good	15	NA
24	10	N	ATPB	Y	Poor	15	NA
25	10	N	ATPB	N	Good	15	NA
26	10	N	ATPB	N	Poor	15	NA
27	10	N	ATPB	Y	Poor	15	NA
28	10	N	ATPB	Y	Good	15	NA
29	10	N	Black Base	Y	Poor	15	NA
30	10	N	Black Base	Y	Good	15	NA
31	10	N	Black Base	N	Poor	15	NA
32	10	N	Black Base	N	Good	15	NA
33	10	N	Black Base	Y	Good	15	NA
34	10	N	Black Base	N	Good	15	NA
35	10	N	Black Base	Y	Poor	15	NA
36	10	N	Black Base	N	Poor	15	NA

Construction Parameters

- Built-in slab shape due to construction temperature, shrinkage, creep, & curing
- Determines slab support conditions
- Critical to fatigue performance



Construction Effects

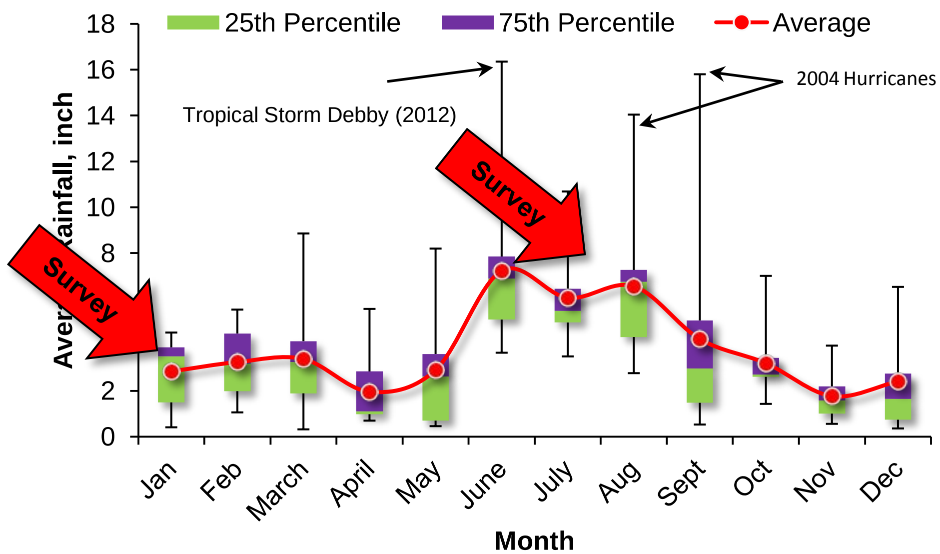
Proposed Construction Sequence	Concrete Slab		Base Type	Drainage		Construction Effects	
	Thickness	with RAP		Edge Drain	Sealant Quality	Joint Spacing, ft.	Set Gradient, °F
37	12	N	Black Base	Y	Good	12	<1
38	12	N	Black Base	Y	Good	12	>3
39	12	N	Black Base	Y	Good	18	<1
40	12	N	Black Base	Y	Good	18	>3
41	12	N	Black Base	Y	Good	12	>3
42	12	N	Black Base	Y	Good	18	>3
43	12	N	Black Base	Y	Good	12	<1
44	12	N	Black Base	Y	Good	18	<1
45	8	N	Black Base	Y	Good	12	>3
46	8	N	Black Base	Y	Good	18	<1
47	8	N	Black Base	Y	Good	18	>3
48	8	N	Black Base	Y	Good	12	<1
49	8	N	Black Base	Y	Good	12	>3
50	8	N	Black Base	Y	Good	18	<1
51	8	N	Black Base	Y	Good	12	<1
52	8	N	Black Base	Y	Good	18	>3

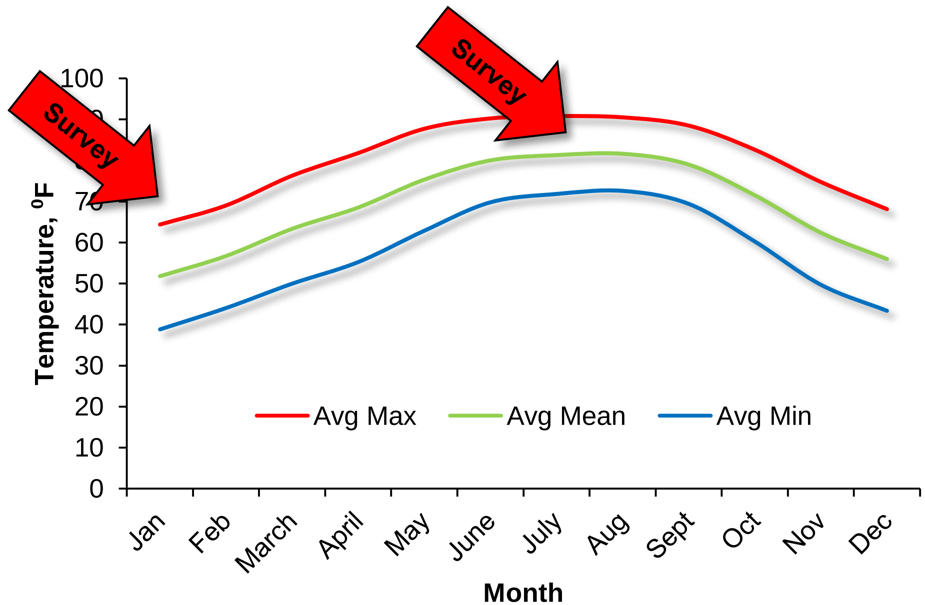
Test Road Performance

- The SMO will monitor performance throughout the year
  - ✓ Material sampling/characterization during construction
  - ✓ Nondestructive performance measurements
  - ✓ Coring & destructive measurements when necessary
- Embedded instrumentation will be used to measure pavement response
  - ✓ Traffic loads
  - ✓ Environmental loads

Performance Survey Frequency

- Several performance surveys conducted during the year
  - ✓ Seasonal extremes
  - ✓ Experimental objectives
- Traffic will be diverted from test road during survey





Performance Measurements

Smoothness / Faulting

Pavement Support

Manual Survey

Layer Thickness

Pavement Images

Friction

Instrumentation


- Dynamic measurements
  - ✓ Concrete strain
  - ✓ Soil pressure
  - ✓ Joint deflection
  - ✓ Pavement deformation

- Environmental measurements
  - ✓ Concrete & asphalt temp
  - ✓ Concrete strain
  - ✓ Concrete curl/warp
  - ✓ Soil moisture



Pavement Response Measurements

- Instrumentation will be specific to experimental objectives
- Dynamic measurements
  - ✓ Measured during performance survey using truck of known weight, speed, axle configuration, etc.
- Environmental measurements
  - ✓ Measured daily

Instrumentation Challenges

- 52 test sections
- Above ground DAQ cabinets will be required to be placed +100 feet from roadway edge
- Are fiber optic sensors a realistic option?
- Test road will be in service for +10 years
- Potential of damage from lightning?
- Sensor/wire management
- Off-site long-term data management & data retrieval

THANK YOU

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