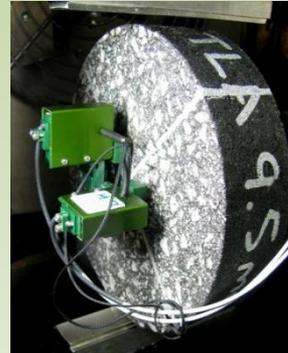




at AUBURN UNIVERSITY

Performance of High RAP Content Mixes at NCAT Test Track

Ray Brown



Outline of Presentation

- History of Test Track
- Significant Test Track Findings
- Performance of High RAP Mixes at Track

History of Test Track

- Original construction completed in 2000
- 1.7 miles long
- Located on 300 acres
- Loads applied with 4 fully loaded trucks
- Each cycle of tests is 3 years
- Speed---45 miles per hour
- 46 test sections
- Reconstructed in 2003, 2006, 2009, and 2012



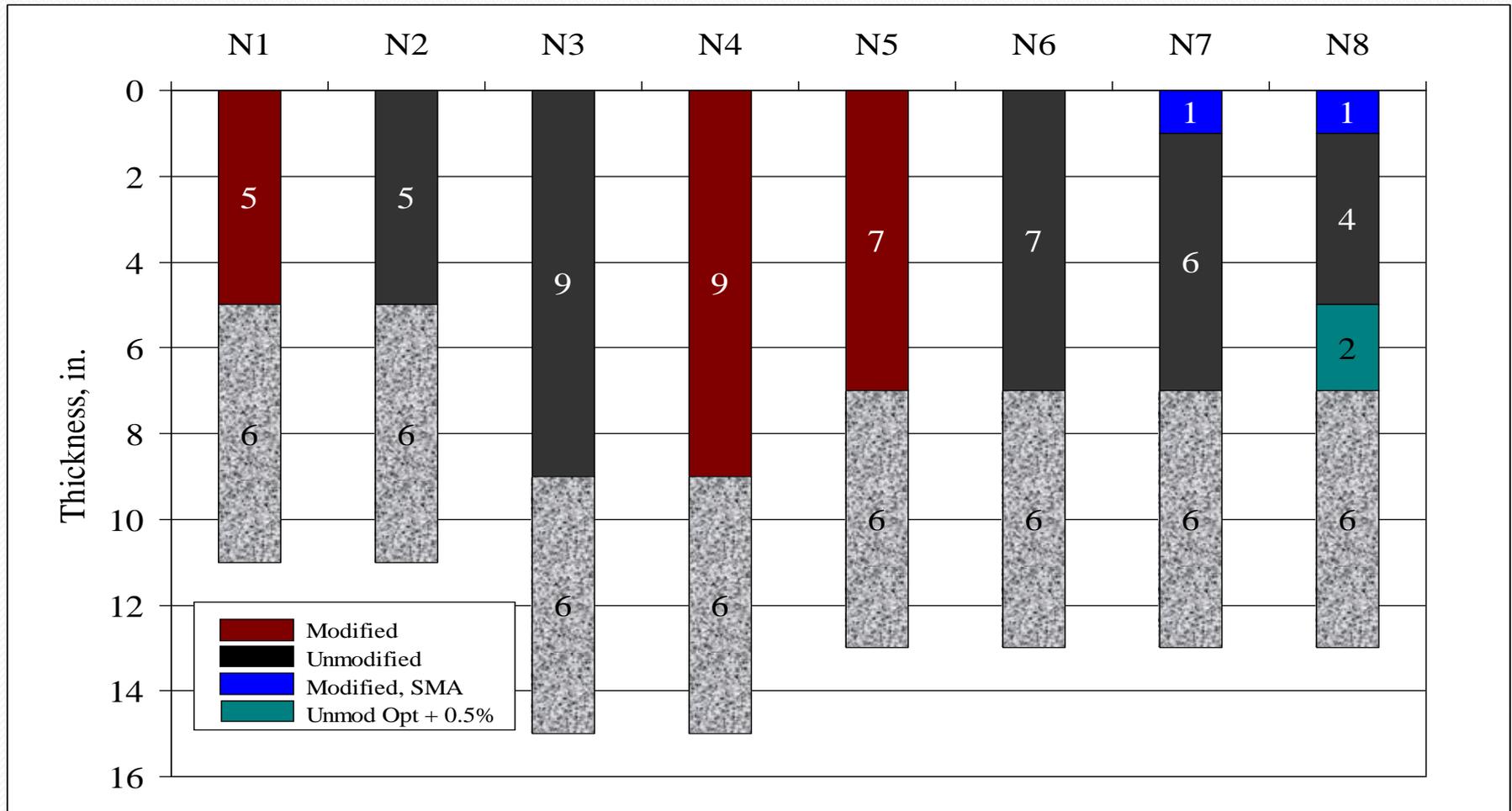
Building of Test Sections



Trucks



Typical Design of Experiment



Some Key Findings of Test Track

- Performance of fine-graded vs coarse-graded mixes. One DOT estimates that this saves them about \$3 million per year in aggregate costs
- Benefits of using bumped grades of asphalt. One state estimates that this results in savings of \$27 million annually
- Improved structural number for HMA resulting in use of thinner sections. Alabama estimates that this saves them \$40 million per year. Changed structural number from 0.44 to 0.54 as result of track results

Key Findings (Continued)

- Calibration of MEPDG
- One state was able to relax LA Abrasion requirements based on performance at the track
- Early performance or WMA was evaluated at the test track and shown to be good
- Good performance of high RAP mixtures

As a result of high price of asphalt we need to look at ways to reduce cost of mix

Increasing amount of RAP is one way to lower cost

Must use higher RAP in a way
that ensures good
performance

Reasons that amount of RAP used in HMA may be relatively low

- Availability of RAP
- Ability to control quality of mix
 - Moisture
 - Amount of material passing no. 200 sieve
 - Workability
 - RAP variability
- State DOT Specification requirements
- Requirement to test recovered binder---blending charts
- Concern with using RAP containing polymers

Some states are allowing more
RAP with Warm Mix Asphalt

More RAP allowed when
fractionation

When RAP used with WMA

- Improved workability
- Less aging during production
- Mixing efficiency????

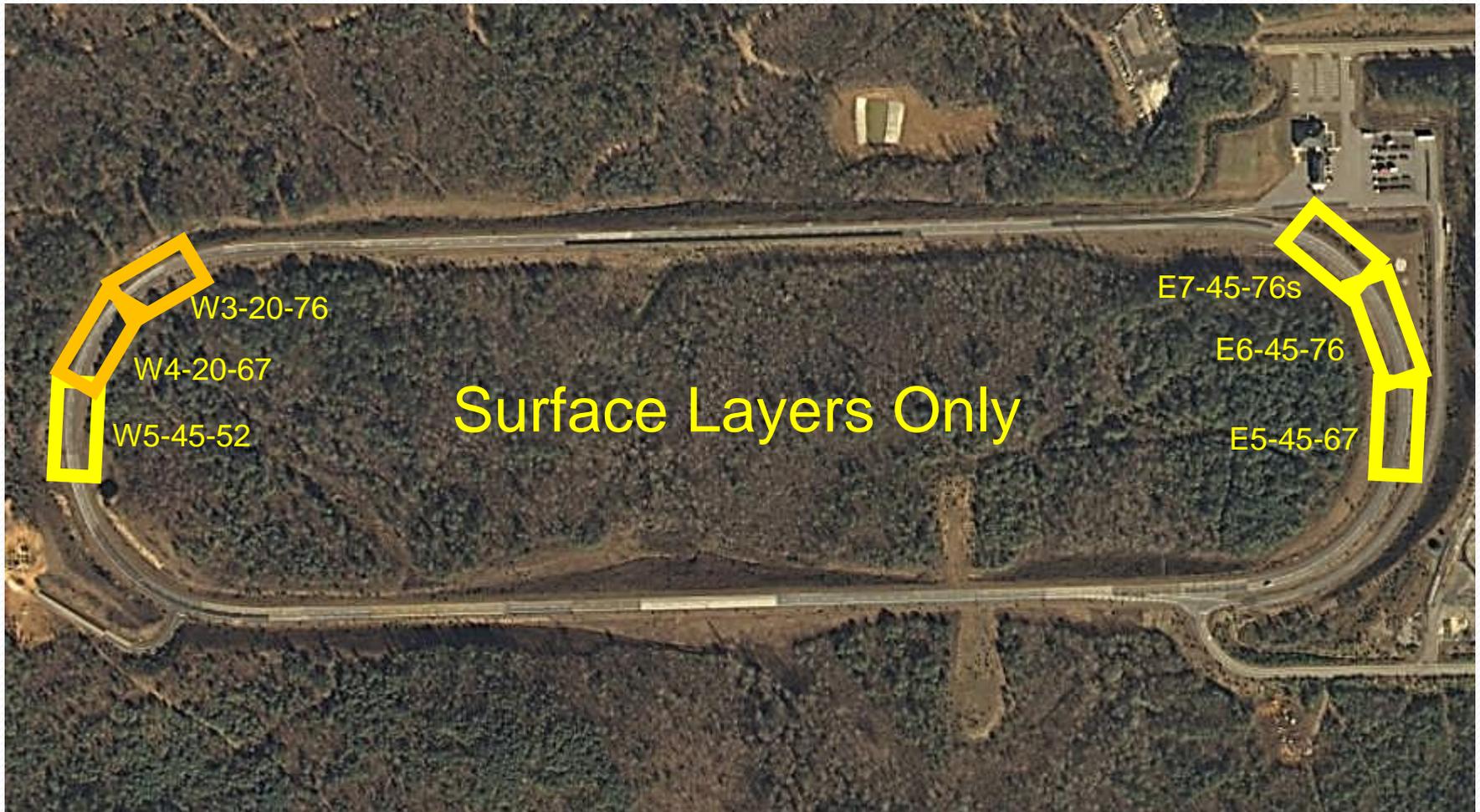
WMA with High RAP



Typical Effect of RAP Percentage on PG grade

RAP, %	True Recovered PG Grade
0	70-27
25	78-24
50	90-19

Performance of mixes at the test track

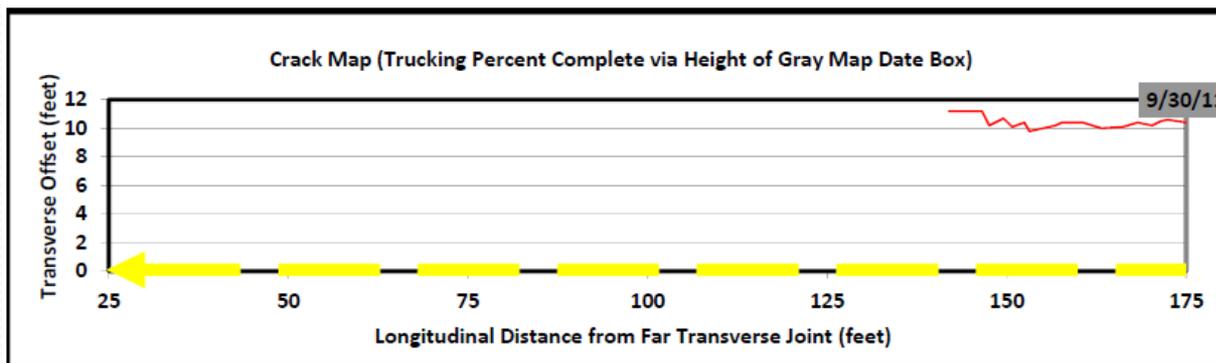
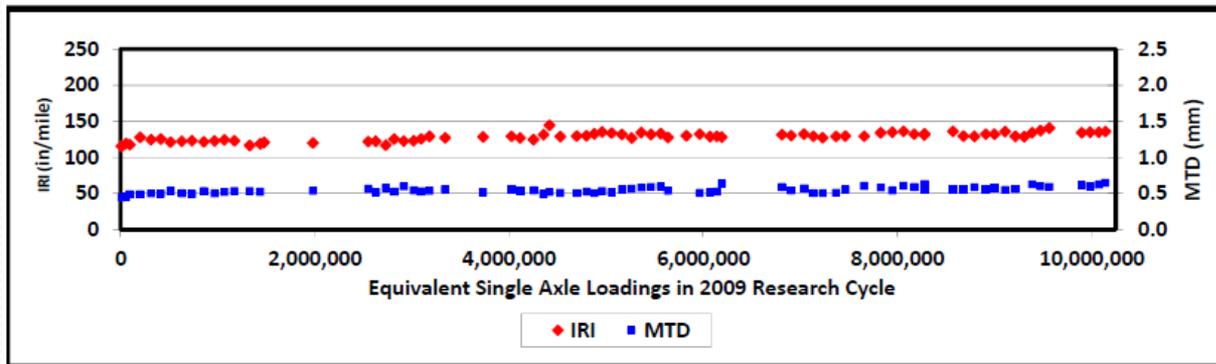
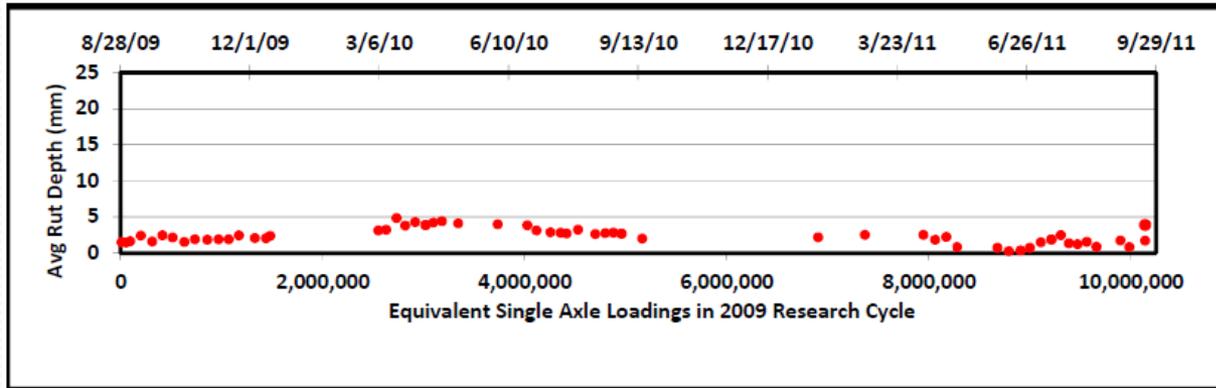


Test Section W-3

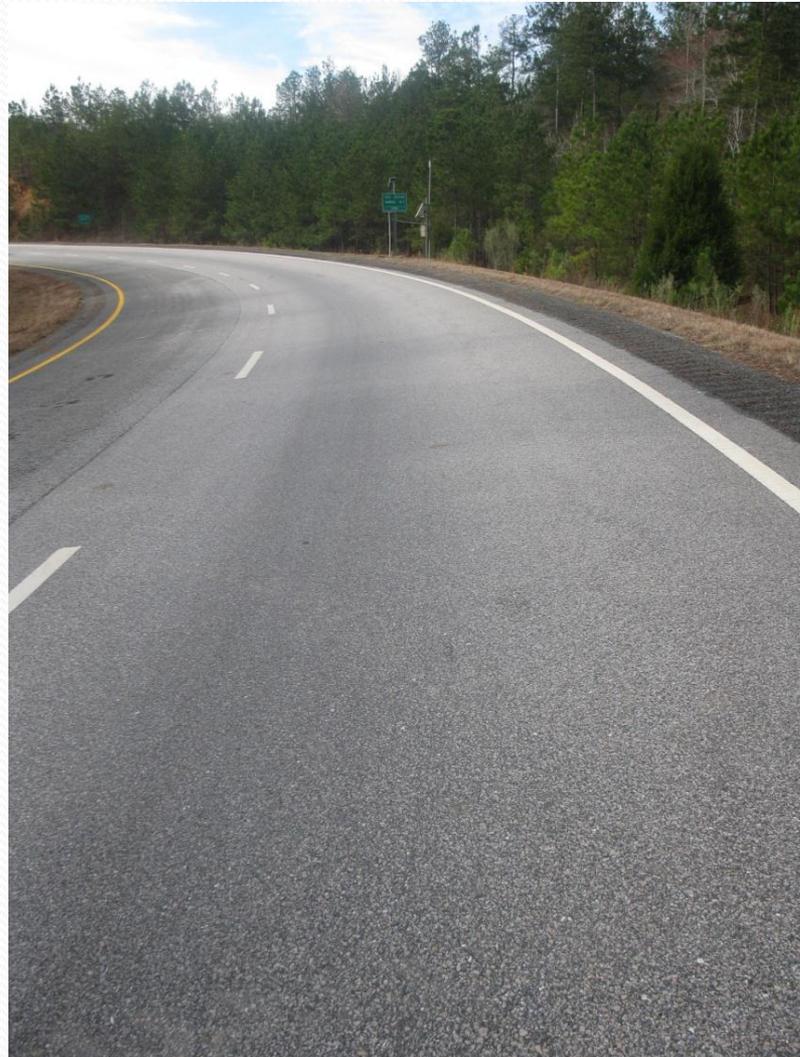
W-3 Summary of Mix

- Compactive Effort: 60 gyrations
- Binder Performance Grade: 76-22
- Modifier Type: SBS
- Mix: 20% RAP
- Constructed in 2006

Test Section W-3



Test Section W-3



Test Section W-3

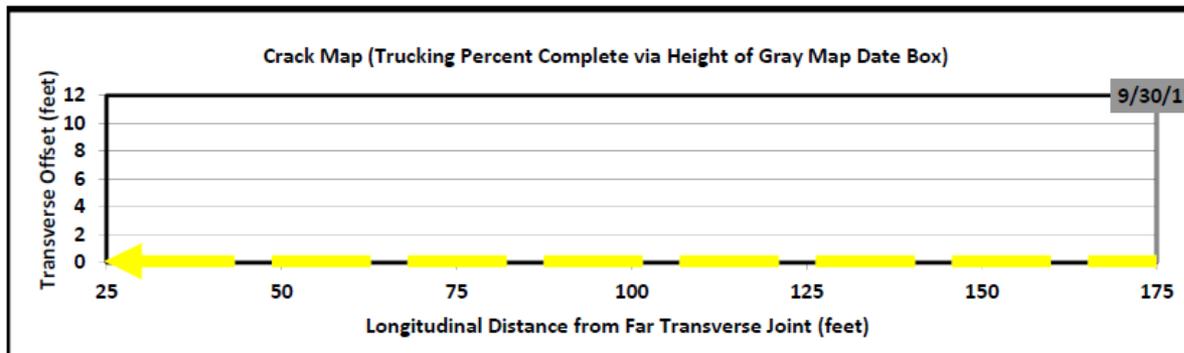
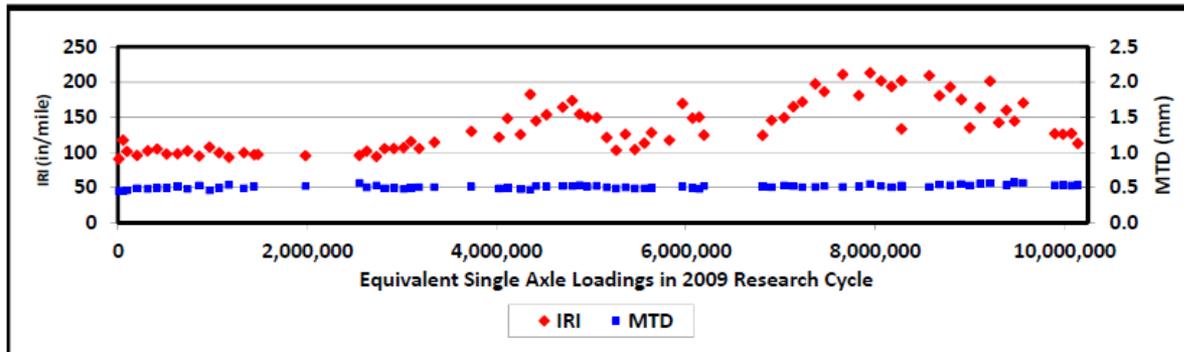
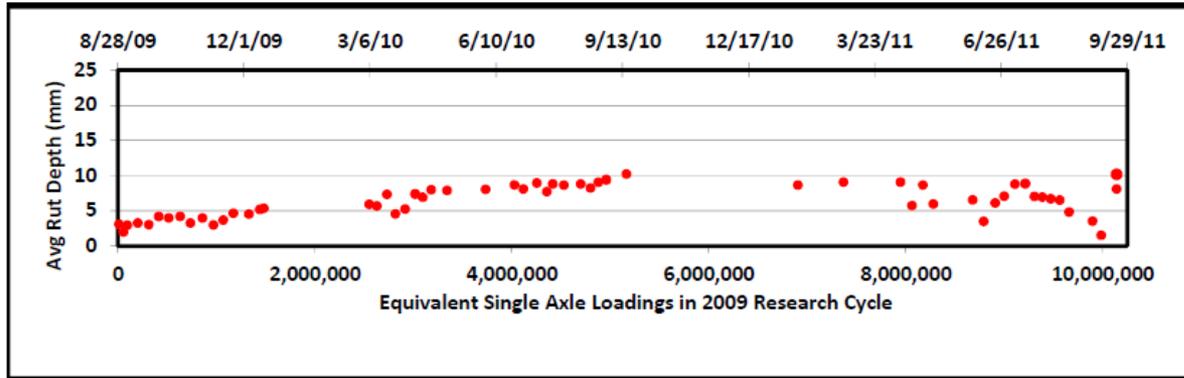




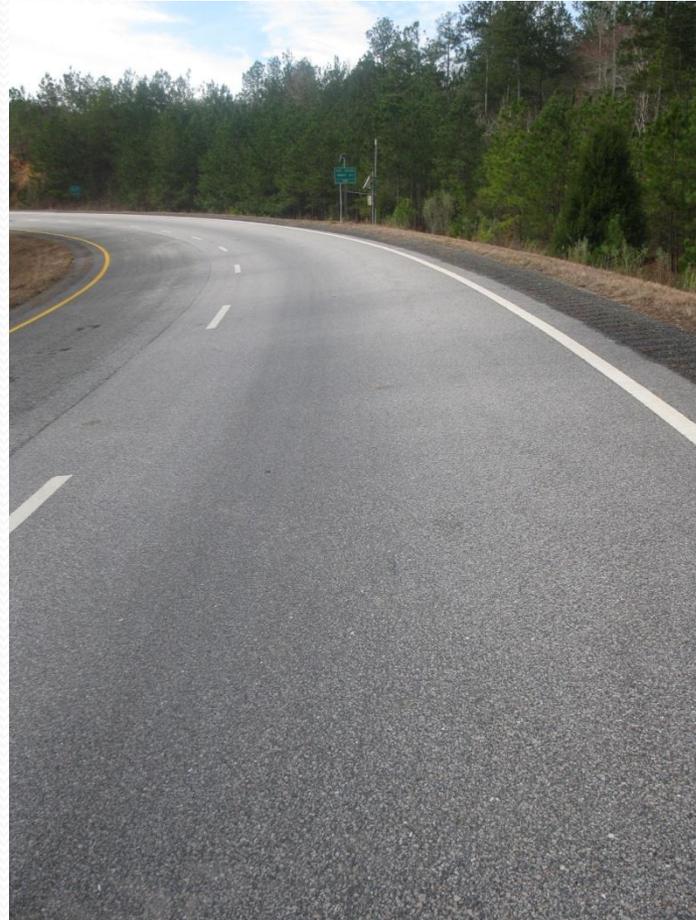
W-4 Summary of Mix

- Compactive Effort: 60 gyrations
- Binder Performance Grade: 67-22
- Mix: RAP 20%
- Constructed in 2006

W-4 Performance



Test Section W-4

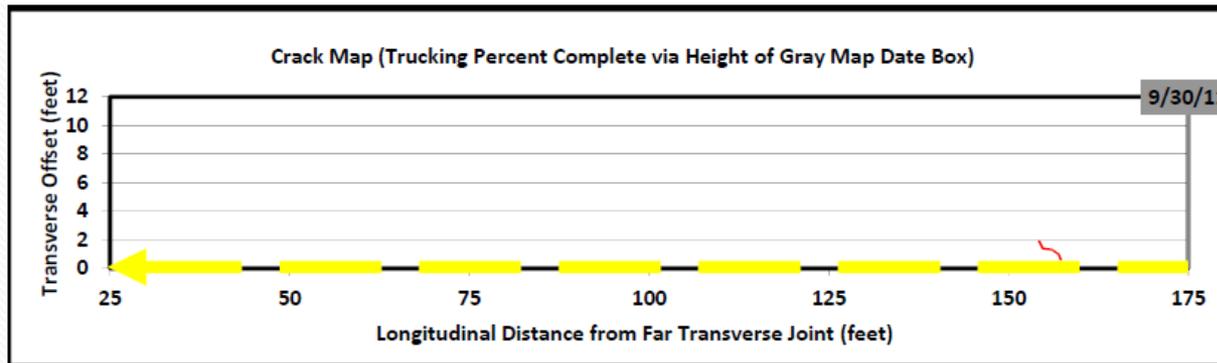
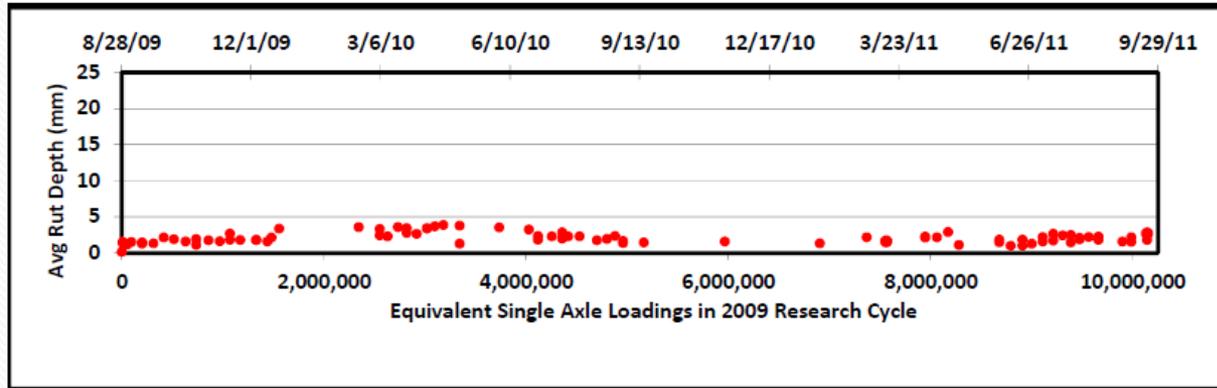




W-5 Mix Properties

- Compactive Effort: 60 gyrations
- Binder Performance Grade: RA500
- Mix: RAP 45% with RA500
- Constructed in 2006

W-5 Performance



Test Section W-5

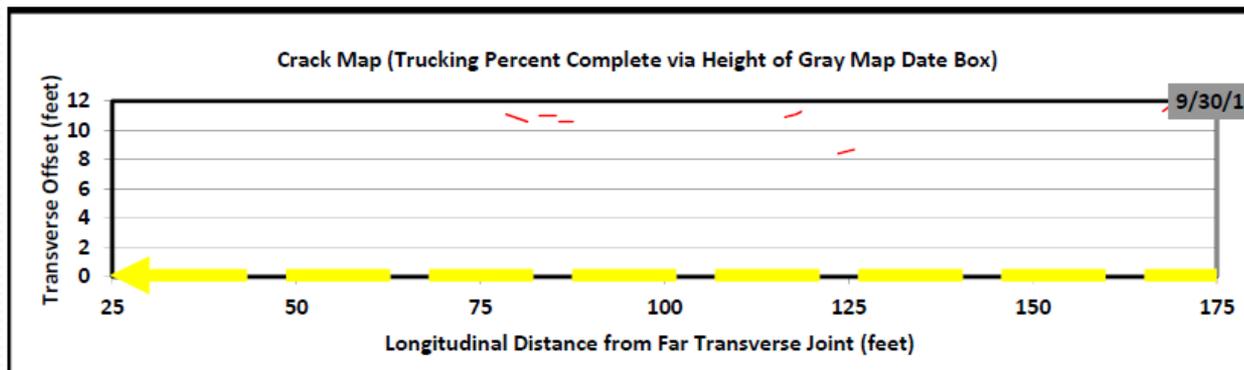
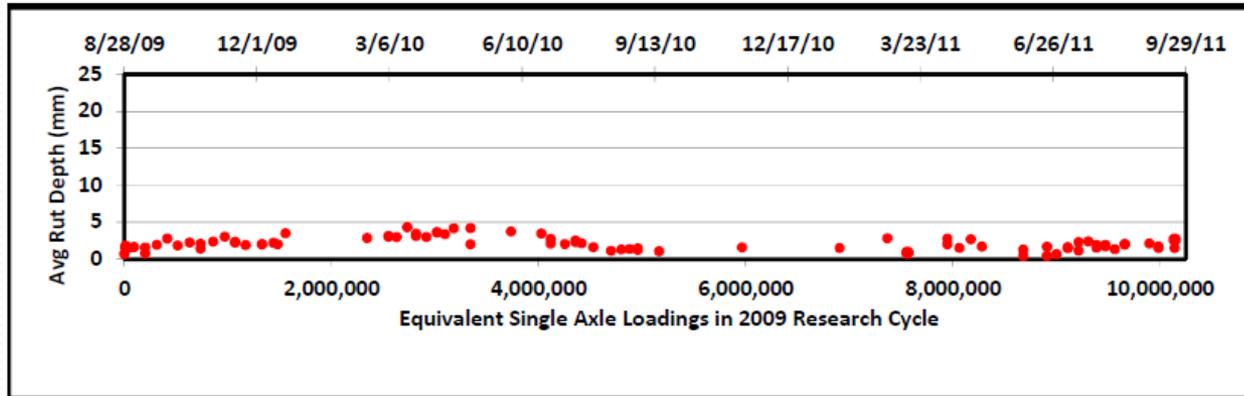




E-5 Description of Mix

- Compactive Effort: 60 gyrations
- Binder Performance Grade: 67-22
- Mix Type: RAP 45% with PG
- Constructed in 2006

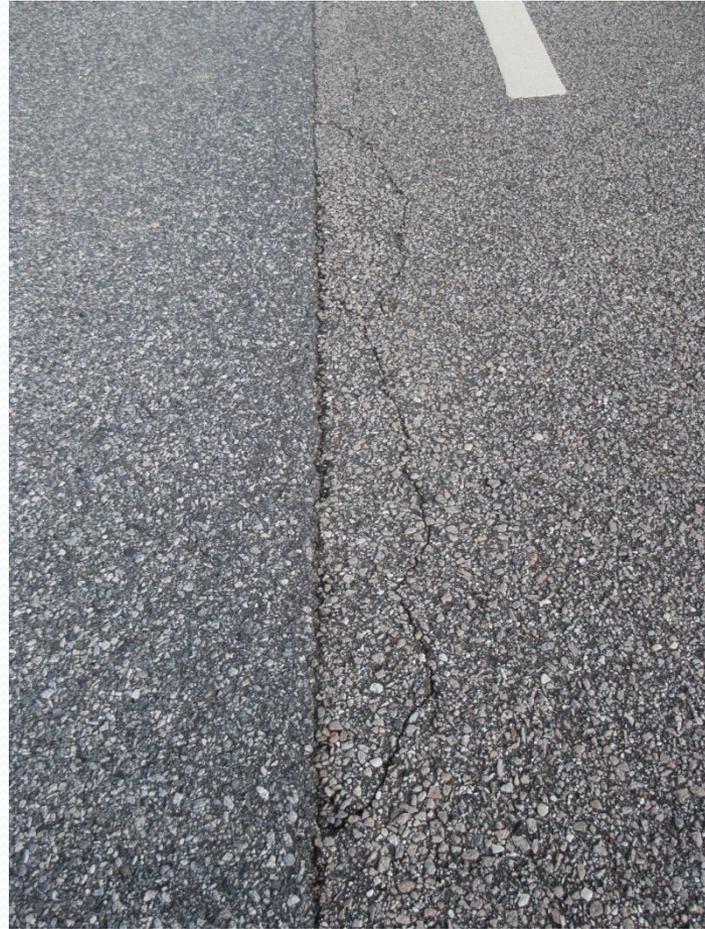
E-5 Performance



Test Section E-5



Test Section E-5

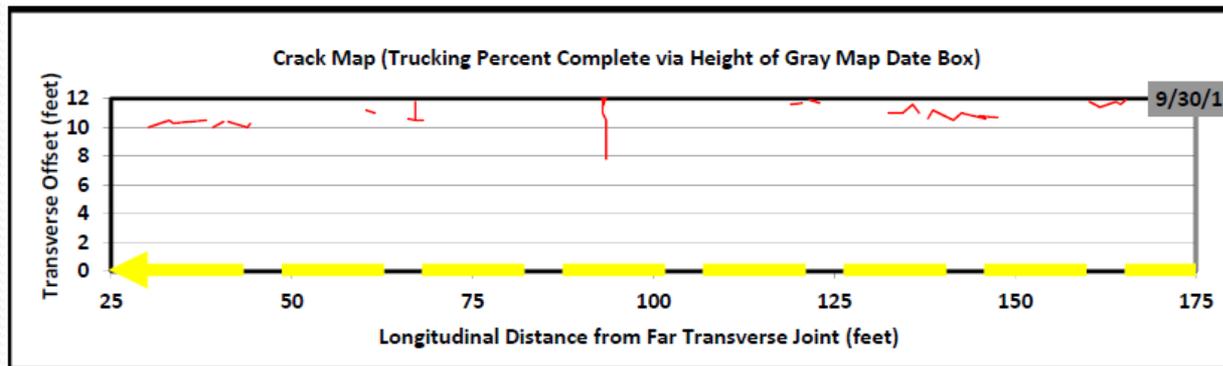
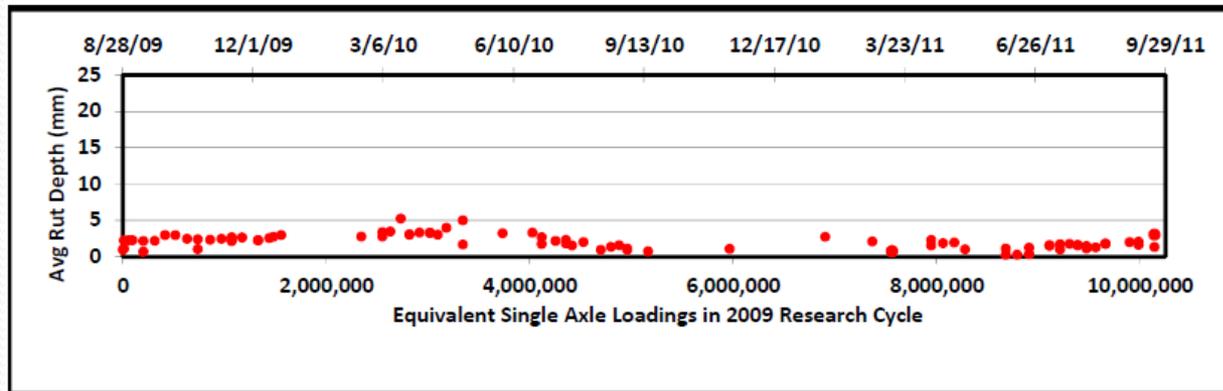




E-6 Test Section

- Compactive Effort: 60 gyrations
- Binder Performance Grade: 76-22
- Modifier Type: SBS
- Mix Description: RAP 45%
- Constructed in 2006

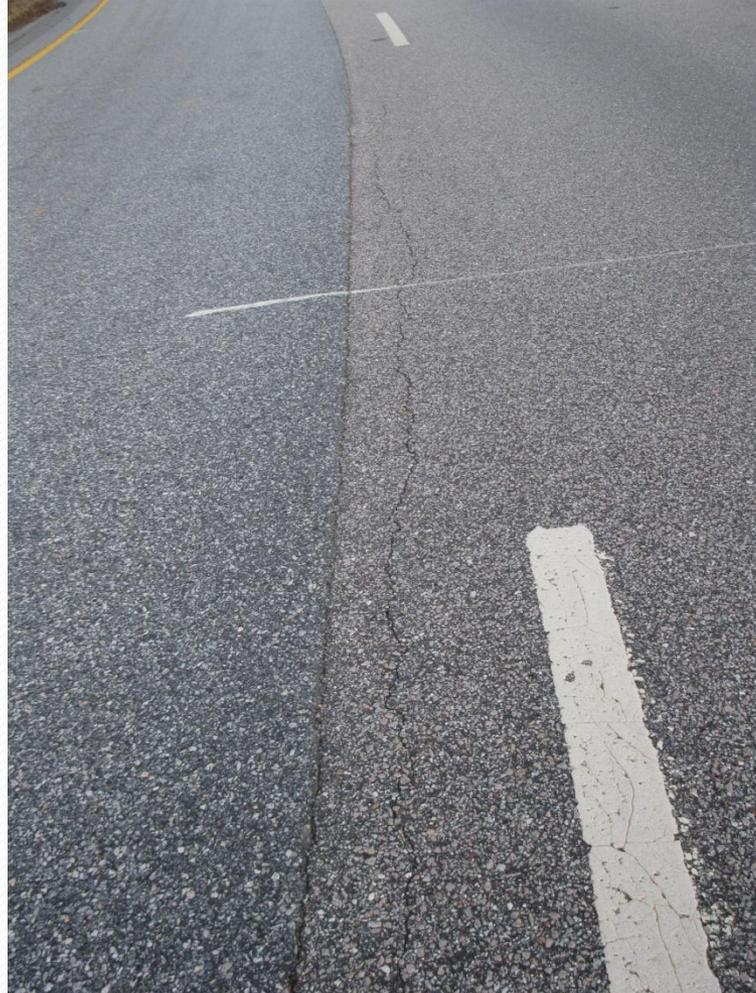
E-6 Performance



Test Section E-6



Test Section E-6



Test Section E-6



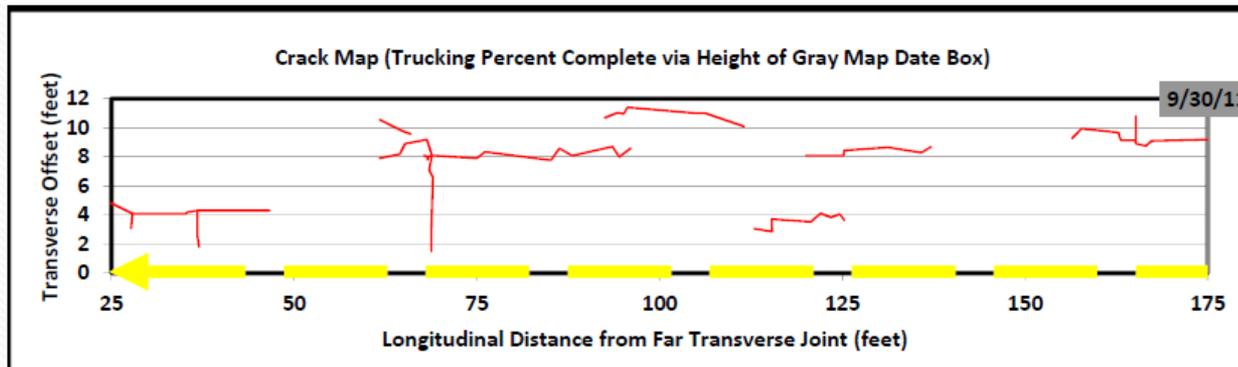
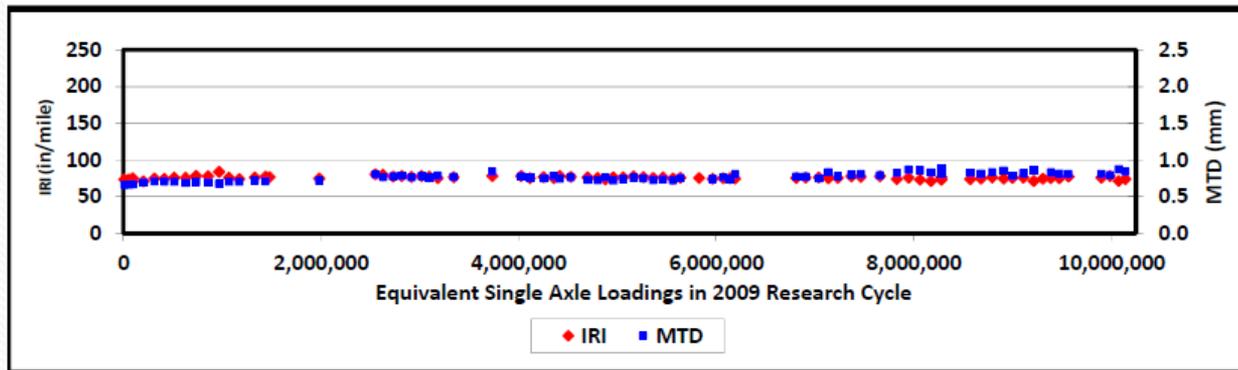
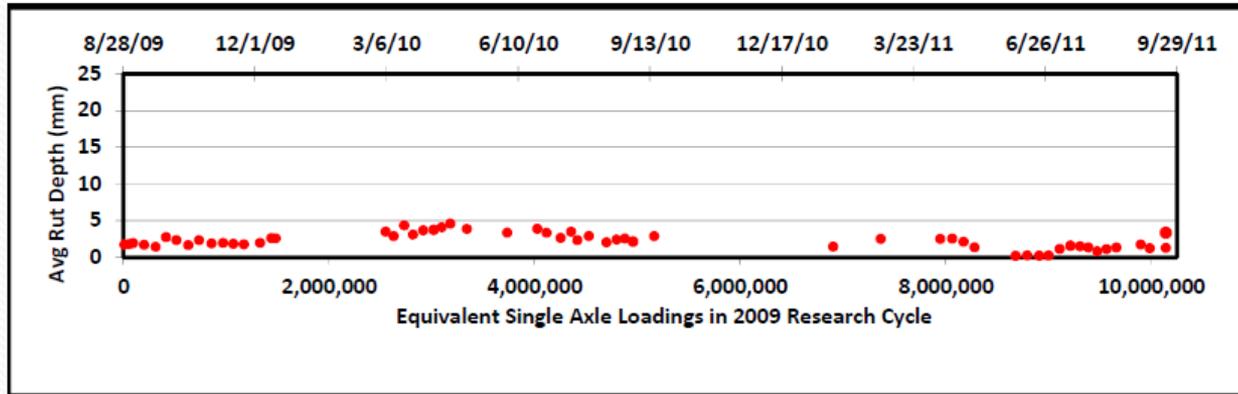
Test Section E-7



E-7 Mix Description

- Compactive Effort: 60 gyrations
- Binder Performance Grade: 76-22
- Modifier Type: SBS and Sasobit
- Mix Type: RAP45
- Constructed in 2006

E-7 Performance



Test Section E-7



Test Section E-7

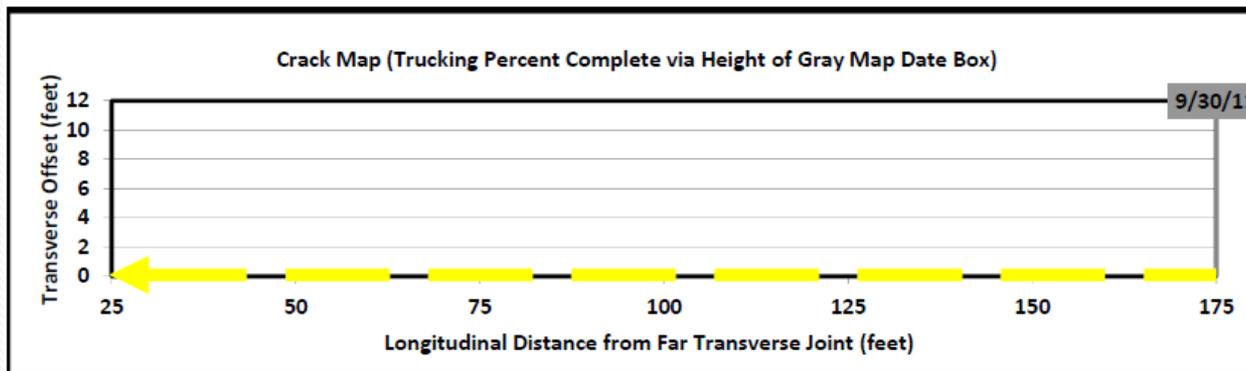
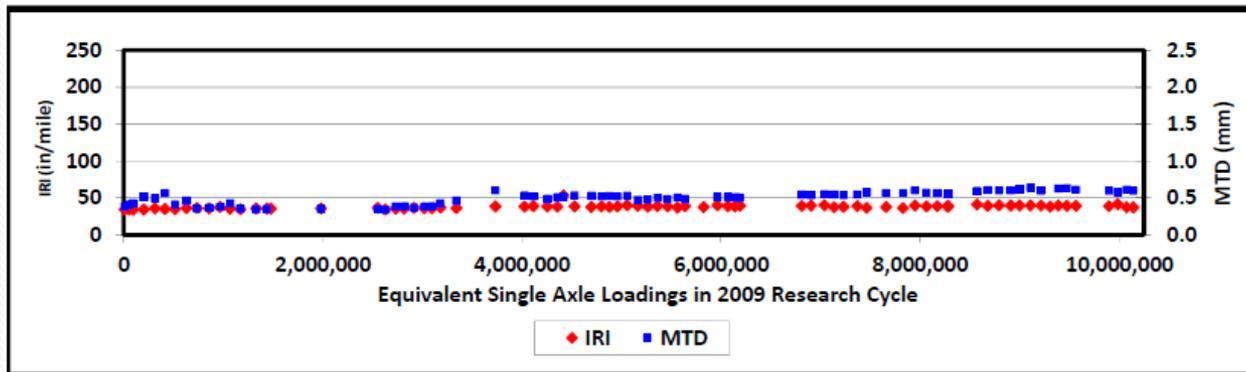
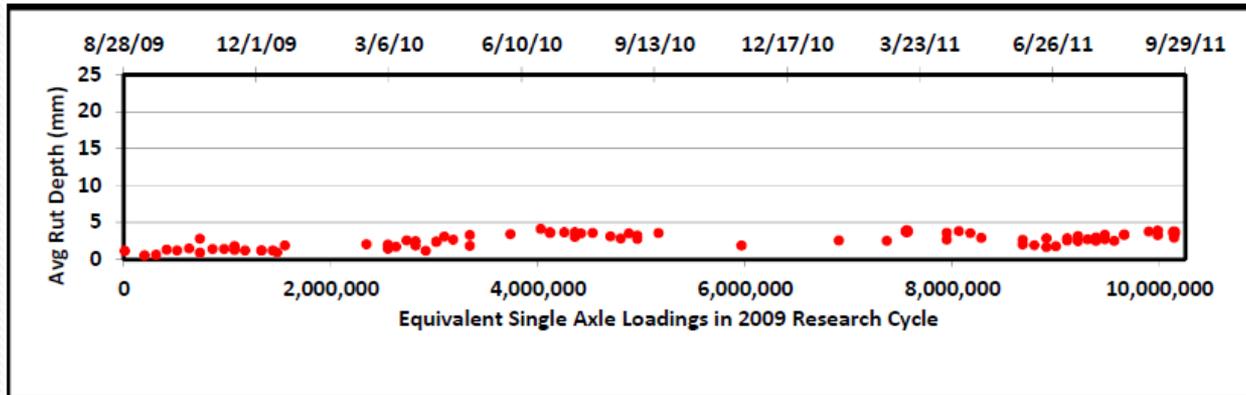




N-11 Mix Description

- Compactive Effort: 80 gyrations
- Binder Performance Grade: 67-22
- Mix Type: 50% RAP
- Gradation Type: 9.5mm NMAS
- Constructed in 2009

N-11 Performance



Test Section N-11



Summary of Performance of RAP Test Sections

Test Section No.	Year	Amt Of RAP, %	Virgin Grade Of Asphalt	IRI, inches/mile	Rutting, mm	Mean Texture depth, mm	Cracking, ft
W3	2006	20	76-22	140	3	0.6	35
W4	2006	20	67-22	175	9	0.5	0
W5	2006	45	RA 500	80	2	0.6	2
E5	2006	45	67-22	100	2	0.7	10
E6	2006	45	76-22	100	2	0.7	40
E7	2006	45	76-22	80	2	0.7	120
N11	2009	50	67-22	60	4	0.4	0

Conclusions

- High RAP mixes have provided good performance at the track
- Good performance occurred except in sections with very stiff asphalt binders
- Other sections had little or no cracking
- Need method to determine when the asphalt mixture is too stiff
- We need to begin to utilize higher RAP contents to reduce costs

Any Questions???