



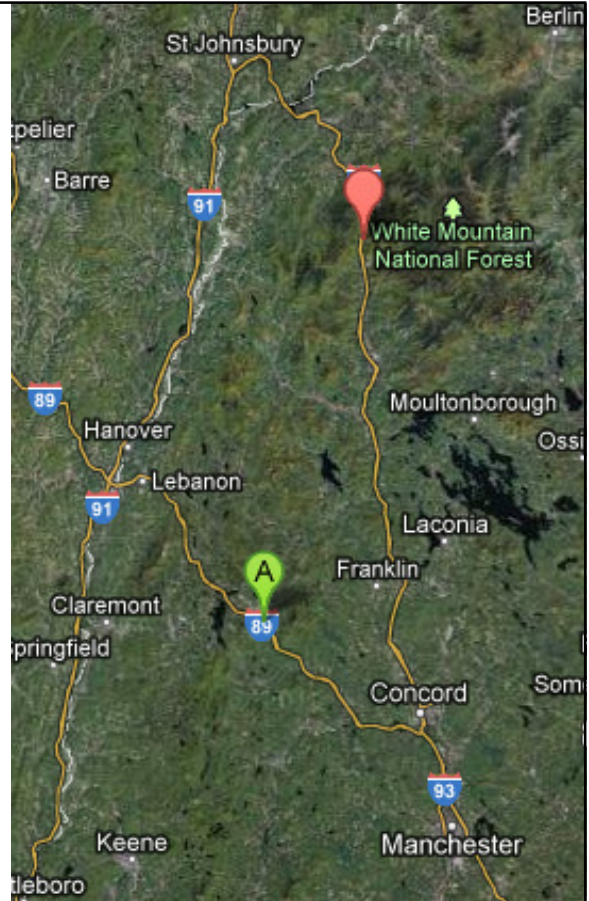
Forensic Analysis of a 22-Year Old 35% RAP Interstate Project

Jo Sias Daniel
Kelly Barry

*North Eastern States Materials Engineers' Association Meeting
October 23, 2013*

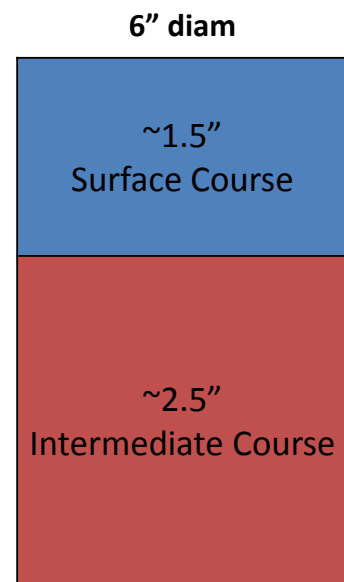
Field Sections

- Paved in 1987
- I-93 Travel & Shoulder
 - 20,000 ADT
 - 35% RAP Surface
 - 35% RAP Binder
- I-89 Travel & Shoulder
 - 36,000 ADT
 - 0% RAP Surface
 - 15% RAP Binder
- 19 mm max size
- AC-10 virgin binder
- Cores taken in 2010



Field Cores

- Cores cut for test specimens
 - 1.5” thick specimens
 - Surface layer
 - Intermediate layer
- Testing
 - IDT mode
 - Dynamic Modulus
 - Creep and Strength

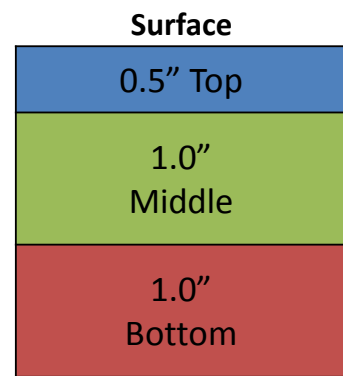


Air Voids

Pavement	Lane	Layer	Air Void
I-93	Travel	Surface	2.2%
		Intermed	5.1%
	Shoulder	Surface	3.8%
		Intermed	5.0%
I-89	Travel	Surface	4.0%
		Intermed	2.6%
	Shoulder	Surface	7.6%
		Intermed	5.1%

Binder Testing

- Extraction & Recovery by NHDOT
 - AASHTO T-164 & T-170
- Recover binder at 3 depths
 - Top & middle from surface
 - Except I89 Travel Lane
 - Bottom from intermediate
- Testing
 - DSR frequency sweep
 - BBR
 - DT

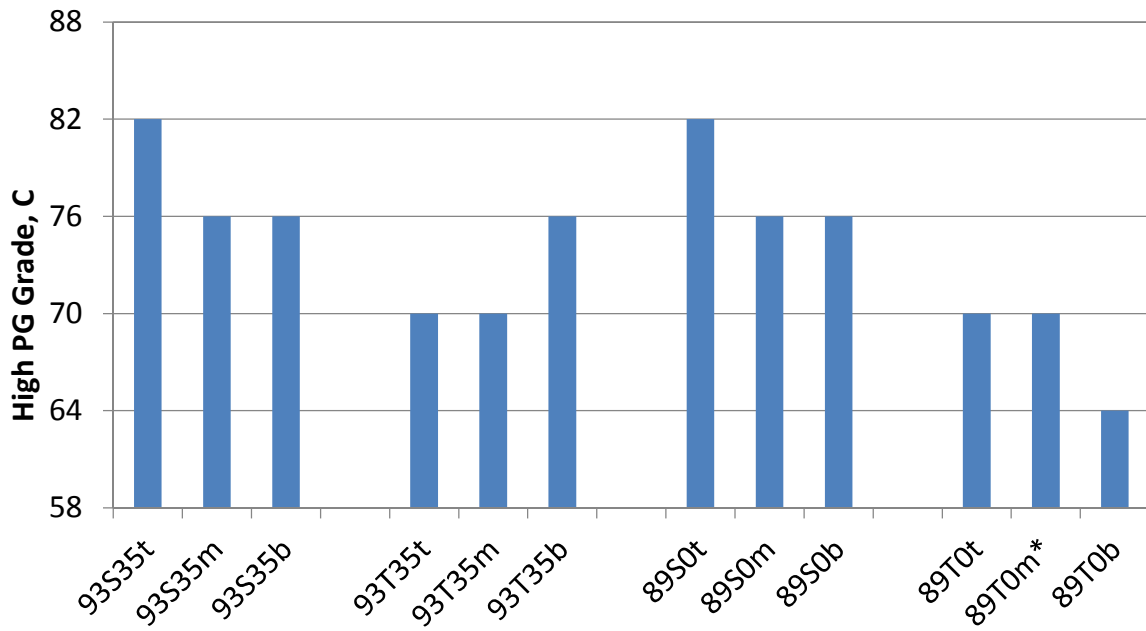


Project Objectives

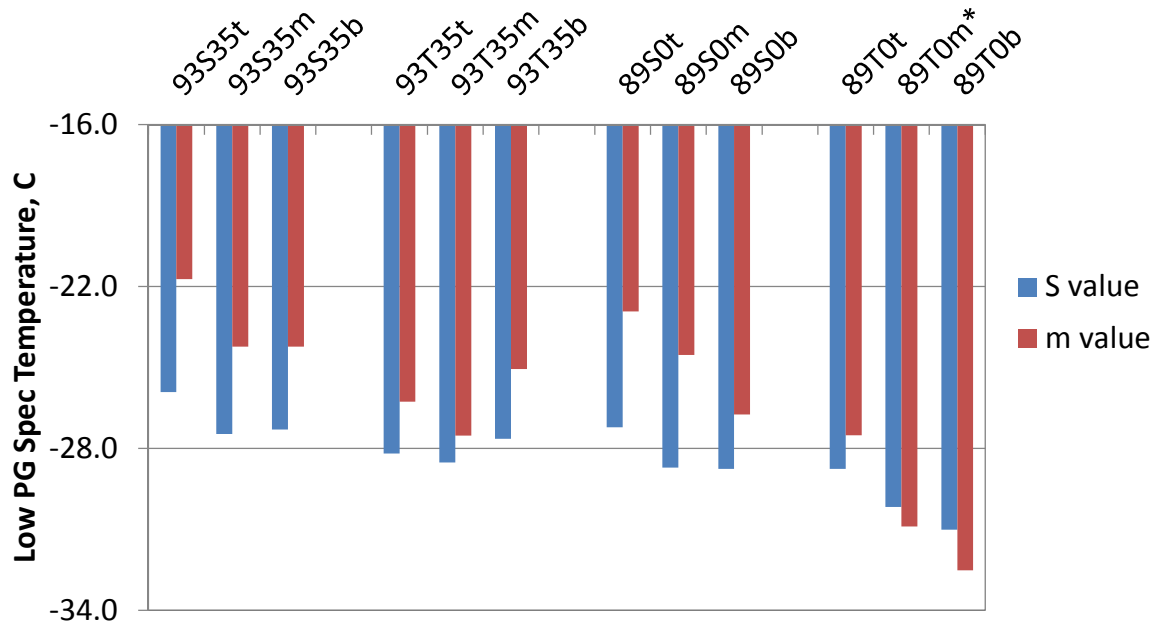
- Evaluate differences
 - High RAP and low/no RAP sections
 - Travel vs Shoulder
 - Pavement layer
- Recovered binder and mixture testing

Binder Testing & Results

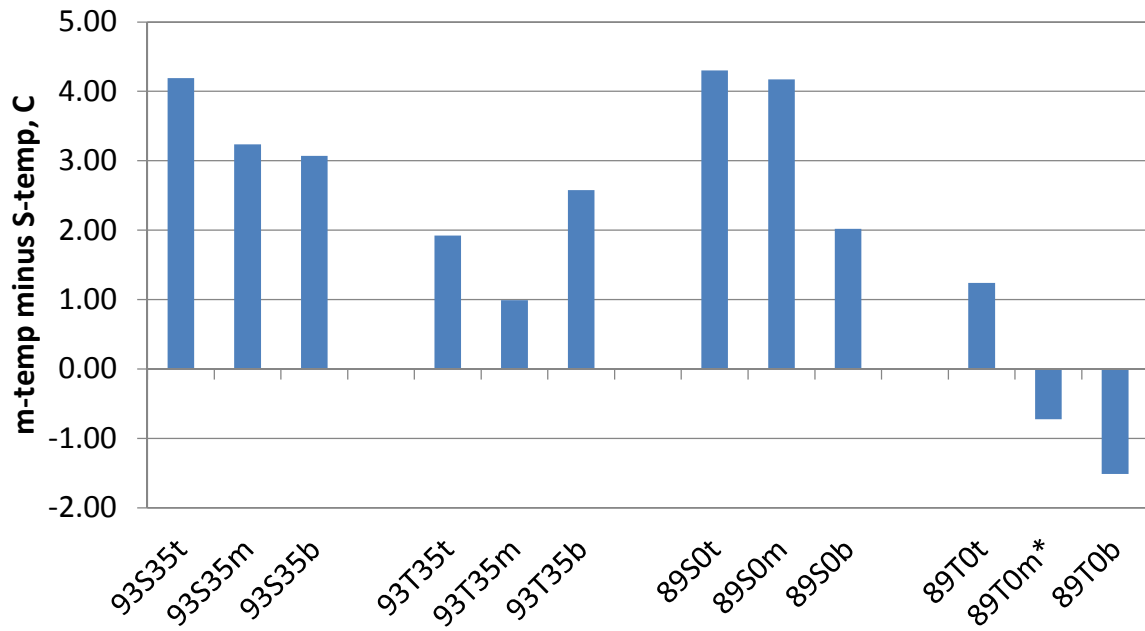
High Temperature Grade



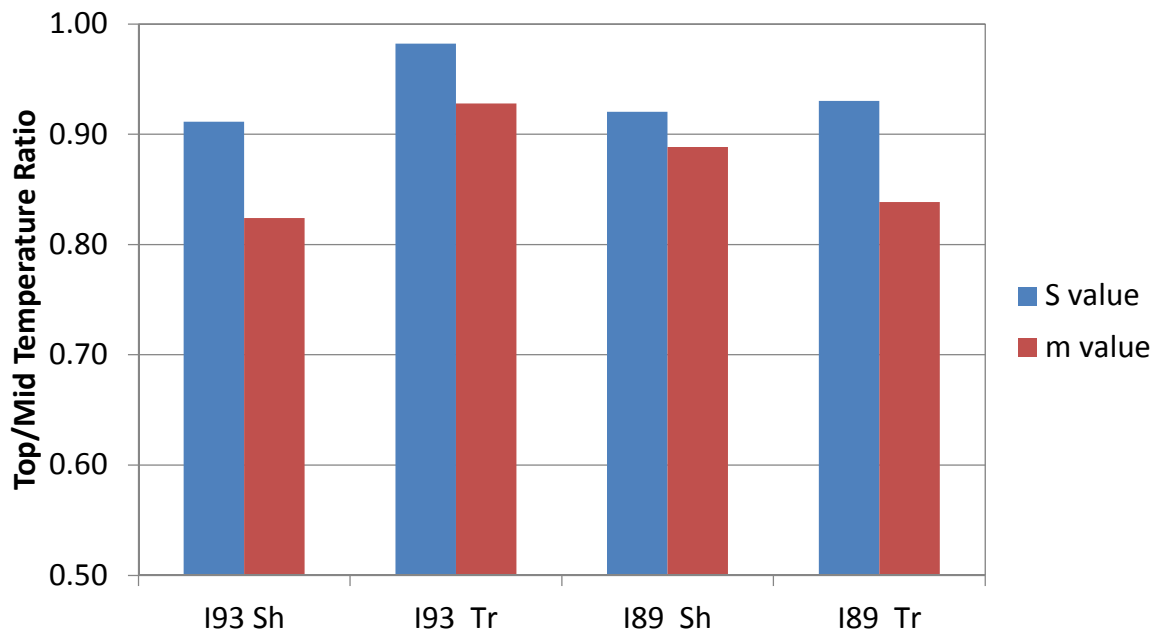
Low Temperature Grade



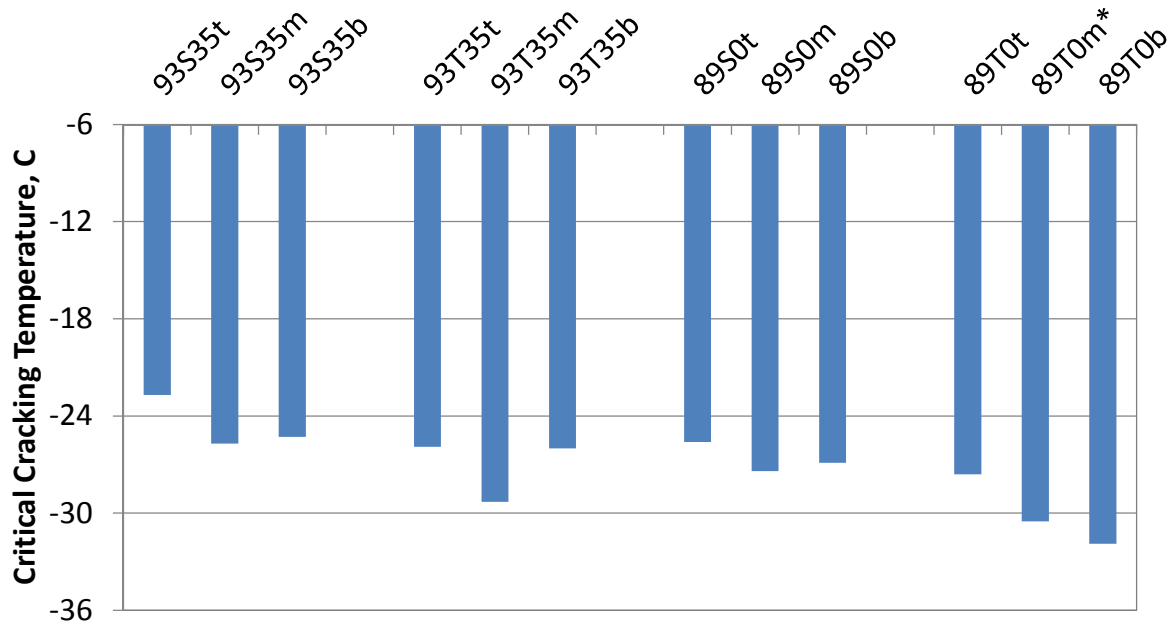
Difference between m-temp and S-temp



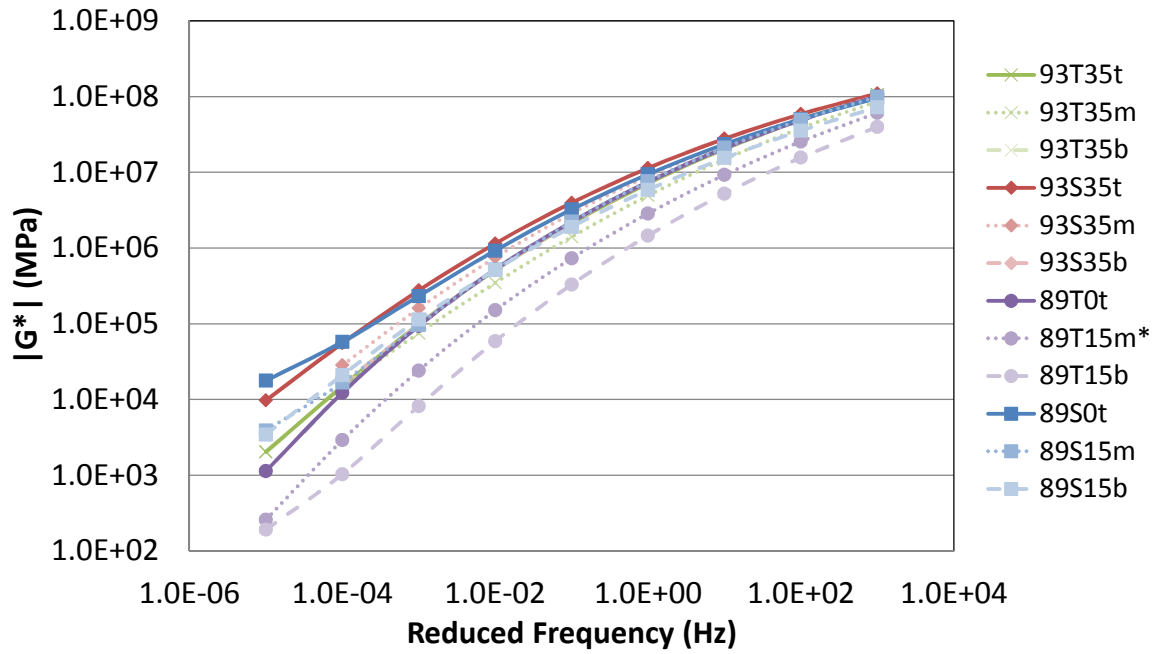
Top/Mid Temperature Ratio



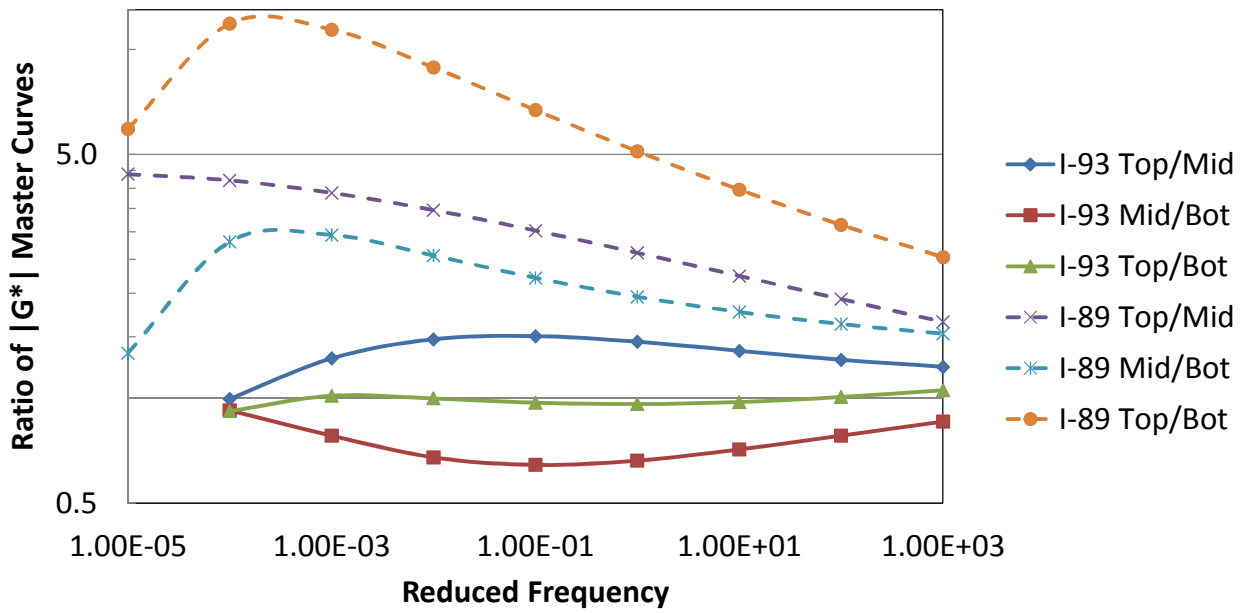
Critical Cracking Temperature



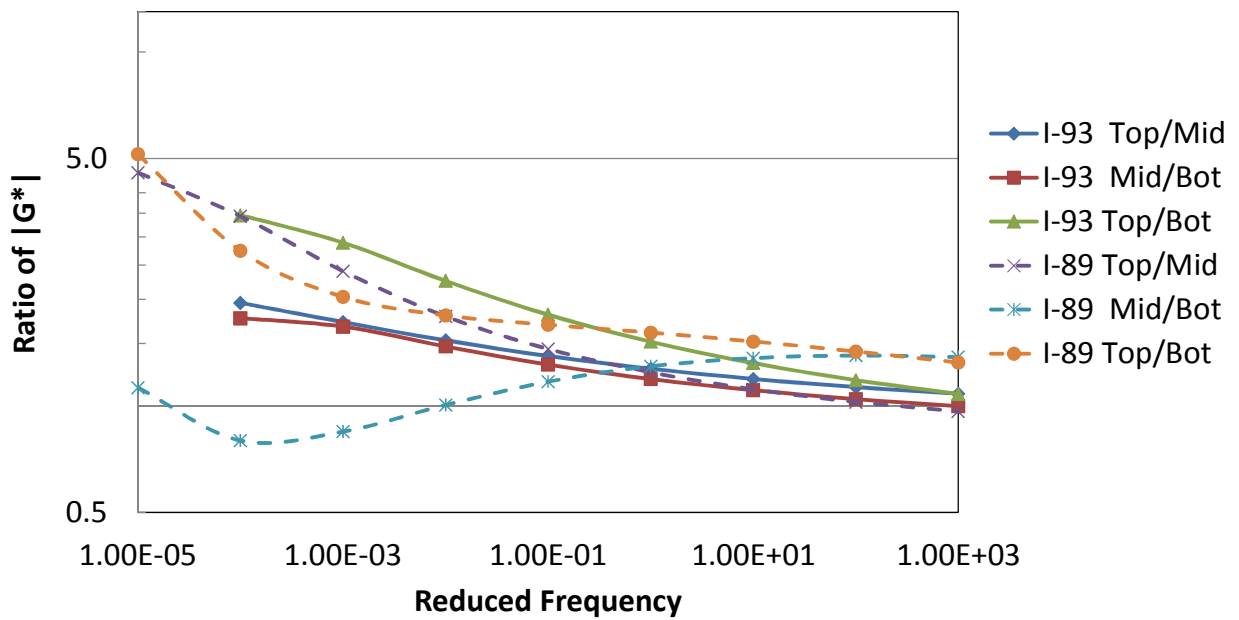
G* Master Curves



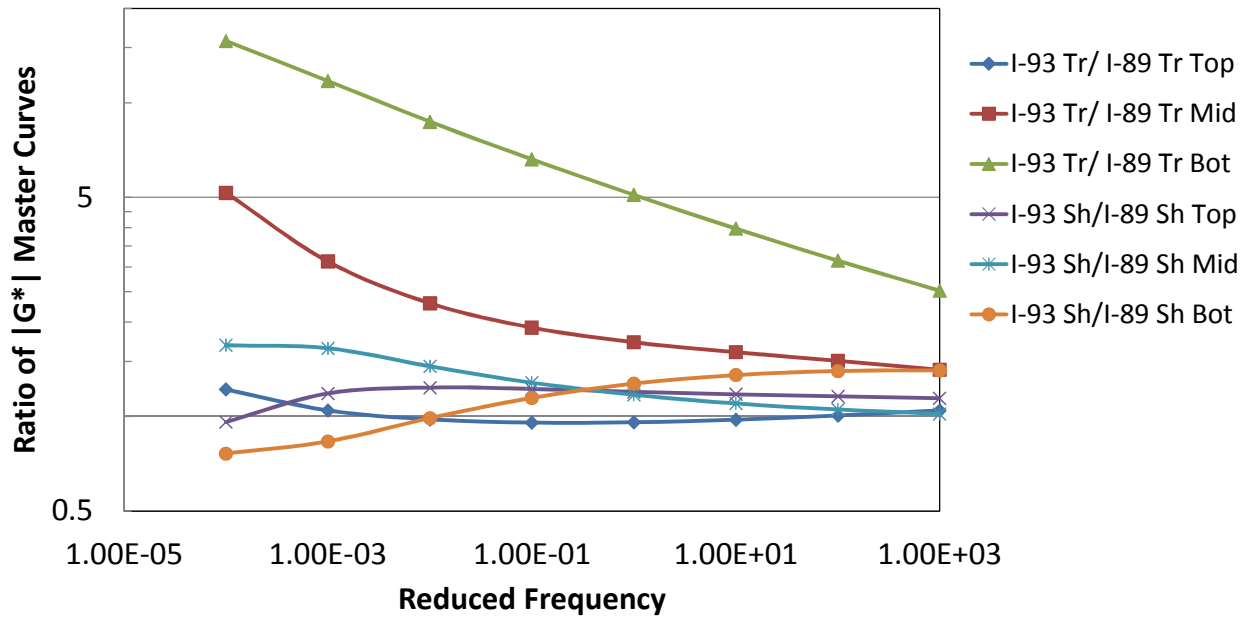
Travel Lane G* Ratios with Depth



Shoulder G* Ratios with Depth

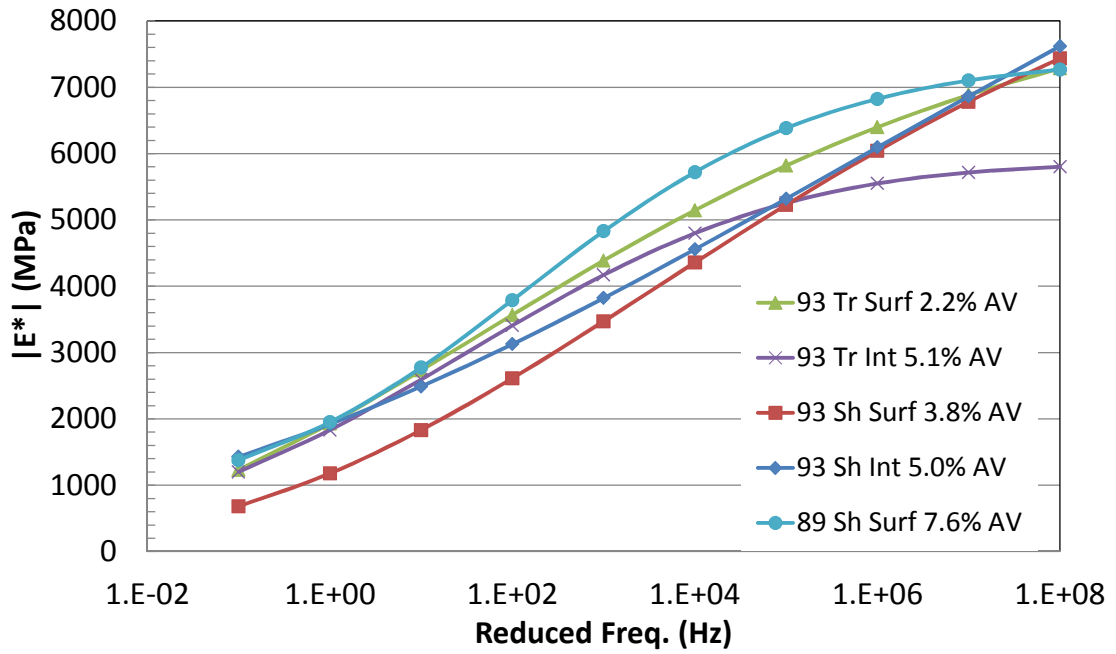


RAP Level G* Ratios with Depth

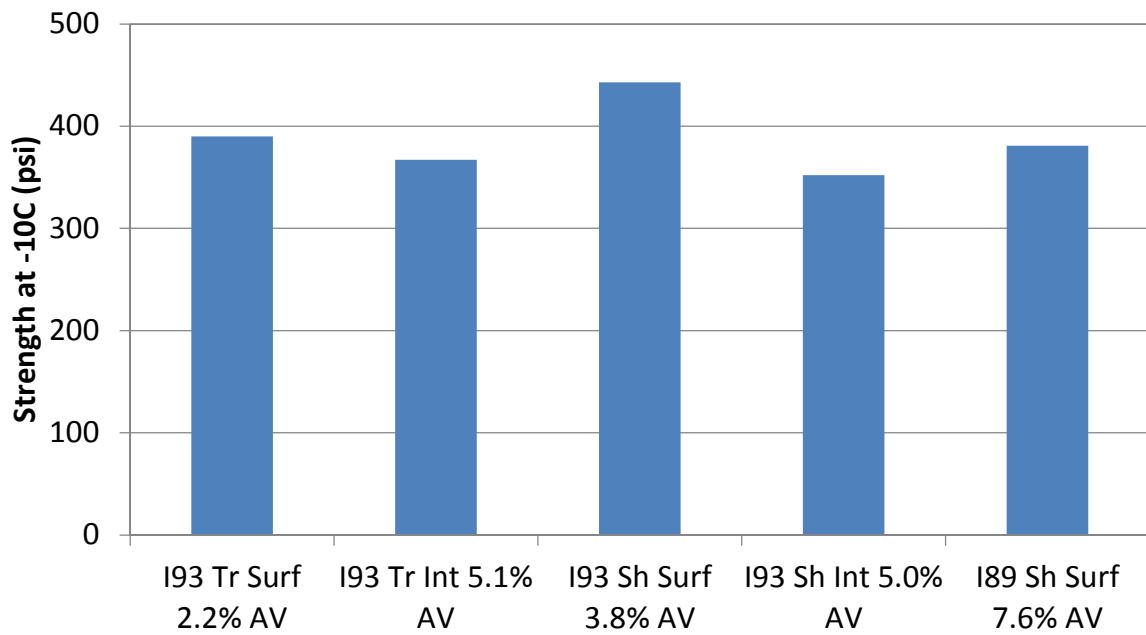


Mixture Testing & Results

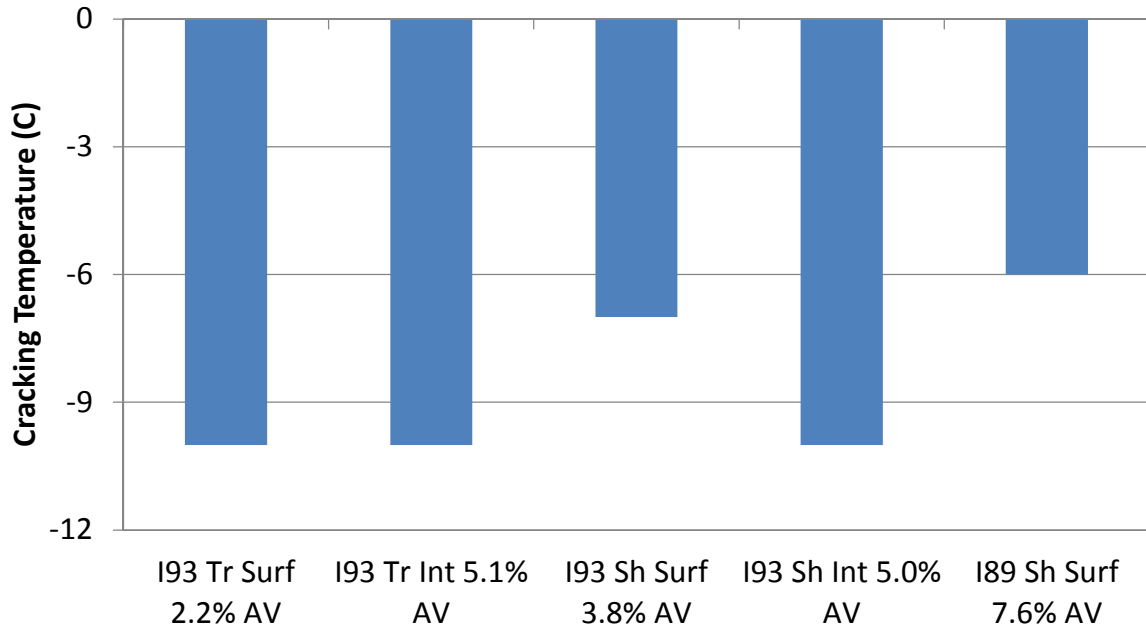
Dynamic Modulus Master Curves



Low Temperature Strength



Mix Cracking Temperature



Summary and Conclusions

Summary of Binder Results

- High PG grades
 - similar between high RAP and low/no RAP
 - Shoulders stiffer than travel lanes (2 grades at top)
- Low PG grades & CCT
 - Most m-controlled
 - Shoulder stiffer than travel lanes - more with low/no RAP
 - Impact of RAP observed in travel lanes, not as large of a difference in shoulder lanes
- Master Curves
 - Larger differences with depth for low/no RAP
 - Little impact of RAP at surface

Summary of Mixture Results

- Only one virgin mixture, air void differences
- RAP mixes decrease in stiffness and strength with depth
- Mixed results comparing travel and shoulder
- Virgin mix stiffest, lowest strength, warmest cracking temperature

Overall Conclusions

- Binder data indicates there is difference in how RAP mixtures and low/no RAP mixtures age
- More uniform properties between layers and lanes in high RAP pavements
- Differences between RAP and low/no RAP are smaller at the surface and in shoulder
- Implications in terms of how properties/performance change over life of pavement

Future Work

- Include test sections of wider range of RAP contents
 - PG 58-28: 0%, 15%, 25% RAP
 - PG 52-34: 25%, 30%, 40% RAP
- Evaluate initial mixture and binder performance
- Evaluate mixture and binder performance at regular time intervals throughout pavement service life

Acknowledgements

- Kelly Barry
- NHDOT for providing support for this work and conducting the binder extraction and recoveries and testing
- UNH asphalt research team members:
Ashton Congalton, Dave Mensching,
Sonja Pape

Infrastructure and Climate Network (ICNet)

- www.theicnet.org
- Webinar series



**CLIMATIC CHANGE IMPACTS ON FUTURE
PAVEMENT PERFORMANCE AND
MAINTENANCE COSTS**

Wednesday October 30, 2013 at 2pm EDT

