



UNH Research Update

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RAP ETG Meeting
May 11, 2011



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Projects

- Northeast High RAP Pooled Fund Study
- High RAP Case Studies
- Aging of RAP mixtures
- Shingles work



Northeast High RAP Pooled Fund Study Update



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Background

- 2009 extracted binder study on plant mixtures by NHDOT and Pike Industries, Inc.
- NEAUPG RAP Task Force developed scope of work for expanded mixture & binder testing study on plant produced mixtures ~\$750,000
- Scope of work to include 60 mixtures

Current Participants

- NHDOT lead agency
- States: MD, NH, NJ, NY, PA, RI, and VA (\$90k each over 3 years)
- FHWA at \$150k for NCSU work
- Research Team: UNH, Rutgers, UMass Dartmouth, NC State

High RAP Pooled Fund Study

- Producers have volunteered to produce mixtures at different RAP contents
- Mixtures sampled and taken to lab for testing
- SGC specimens compacted at time of production
- Data collected on plant operations, raw material info, placement location & conditions (field cores if possible)

Phase I: 2010-11

- 18 Mixtures
- Focus on evaluating effect of binder grade and plant type

Plant	NMAS (mm)	PG Grade	RAP Content (%)			
			0	20	30	40
Callanan NY (drum)	12.5	64-22	X	X	X	X
		58-28			X	X
Pike VT (batch)	9.5	58-28	X	X	X	X
		52-34	X	X	X	X
Pike NH (drum)	12.5	64-28	X	X	X	X

Phase I mixtures													
ID	Production Plant	Plant Type	PG grad	% ac	NMAS (mm)	% RAP	% ac of RAP	% ac Rep.	Dis. Tem	Com. Tem.	Gmm	VMA	VFA
NYb40	Callanan NY	Drum	58-28	5.2	12.5	40	4.9	37.69	330	275	2.540	12.70	88.36
NYb30	Callanan NY	Drum	58-28	5.2	12.5	30	4.93	28.44	305	275	2.539	13.70	81.12
NYd40	Callanan NY	Drum	64-22	5.2	12.5	40	4.9	37.69	330	290	2.546	12.53	87.90
NYd30	Callanan NY	Drum	64-22	5.2	12.5	30	4.93	28.44	305	290	2.543	12.96	85.08
NYd20	Callanan NY	Drum	64-22	5.2	12.5	20	4.95	19.04	320	290	2.528	14.09	79.86
NYd00	Callanan NY	Drum	64-22	5.2	12.5	0	--	0.00	310	290	2.530	12.64	89.32
VTa40	Pike VT	Batch	52-34	6.6	9.5	40	5.41	32.64	300	295	2.472	18.00	77.78
VTa30	Pike VT	Batch	52-34	6.6	9.5	30	5.41	24.74	320	320	2.466	17.72	82.51
VTa20	Pike VT	Batch	52-34	6.8	9.5	20	5.41	16.01	324	324	2.458	18.75	81.86
VTa00	Pike VT	Batch	52-34	6.7	9.5	0	--	0.00	340	340	2.465	20.23	76.28
VTe40	Pike VT	Batch	64-28	6.6	9.5	40	5.41	33.04	295	295	2.473	18.24	76.43
VTe30	Pike VT	Batch	64-28	6.6	9.5	30	5.41	24.55	322	310	2.464	19.10	75.91
VTe20	Pike VT	Batch	64-28	6.7	9.5	20	5.41	16.13	300	300	2.467	18.69	79.67
VTe00	Pike VT	Batch	64-28	6.5	9.5	0	--	0.00	330	300	2.482	20.33	71.48
NHe40	Pike NH	Drum	64-28	5.7	12.5	40	4.79	33.61	335	315	2.435	14.50	82.10
NHe30	Pike NH	Drum	64-28	5.7	12.5	30	4.79	25.21	335	315	2.434	14.40	81.30
NHe20	Pike NH	Drum	64-28	5.7	12.5	20	4.79	16.81	315	310	2.430	14.50	79.90
NHe00	Pike NH	Drum	64-28	5.7	12.5	0	--	0.00	330	300	2.419	14.90	74.80

Testing

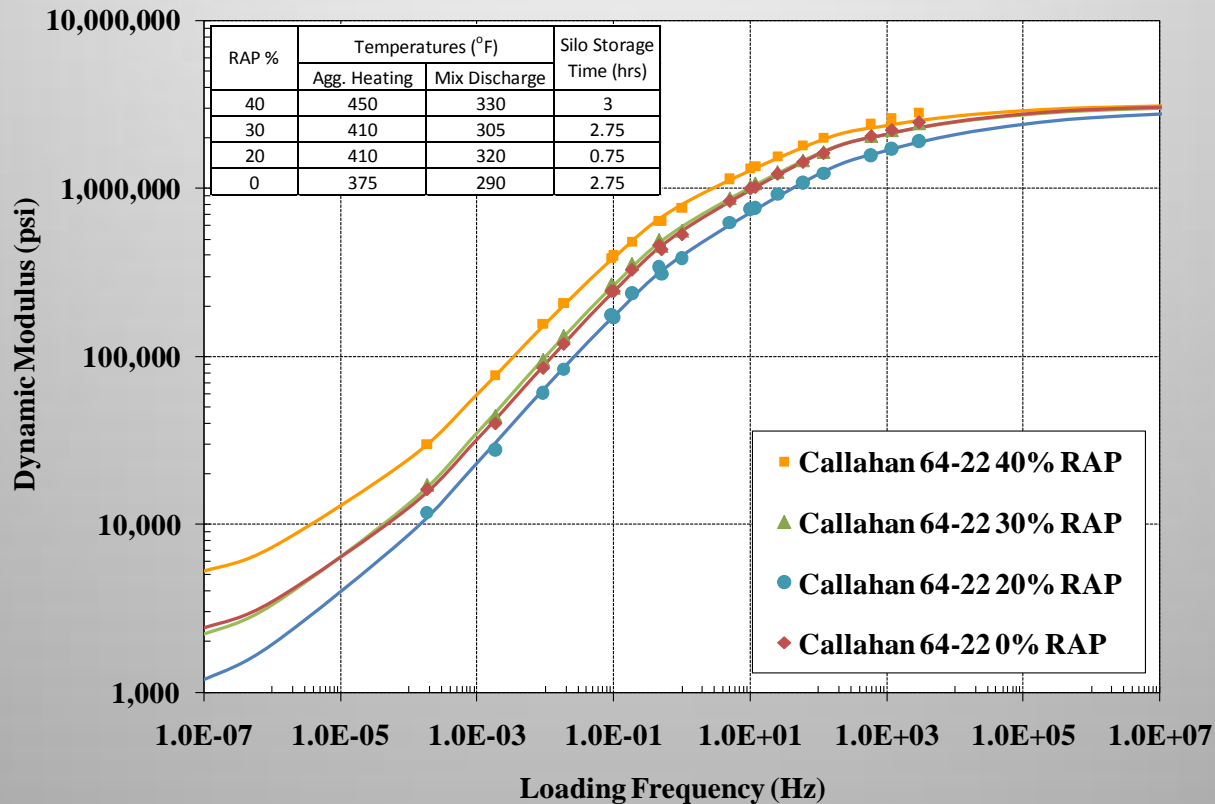
- Recovered & virgin binder
 - PG grade, master curves
 - CCT
 - ABCD
- Mixture
 - Complex Modulus
 - Hamburg & TSR
 - Low Temperature Creep & Strength
 - Fatigue (S-VECD protocol)
- Additional testing
 - Overlay tester
 - ACCD

Schedule/Progress

- Mixture testing started late 2010
- Extraction and recovery of binder has been completed
- Phase I testing will be completed over next few months
- Plan for Phase II to be developed this month
- Phase II mix production & testing 2011-2013

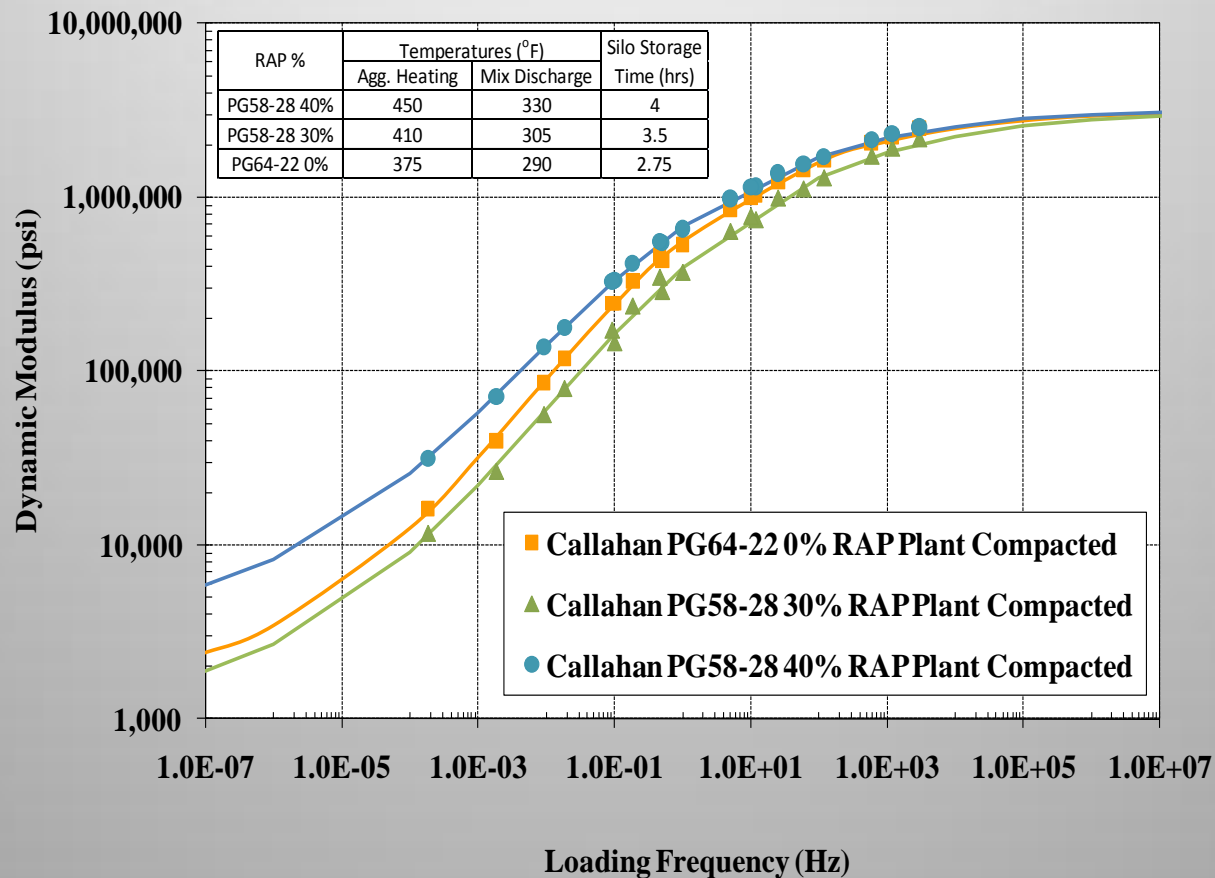
Results

Dynamic Modulus Master Curves NY Callahan PG 64-22 Lab Compacted Mixtures



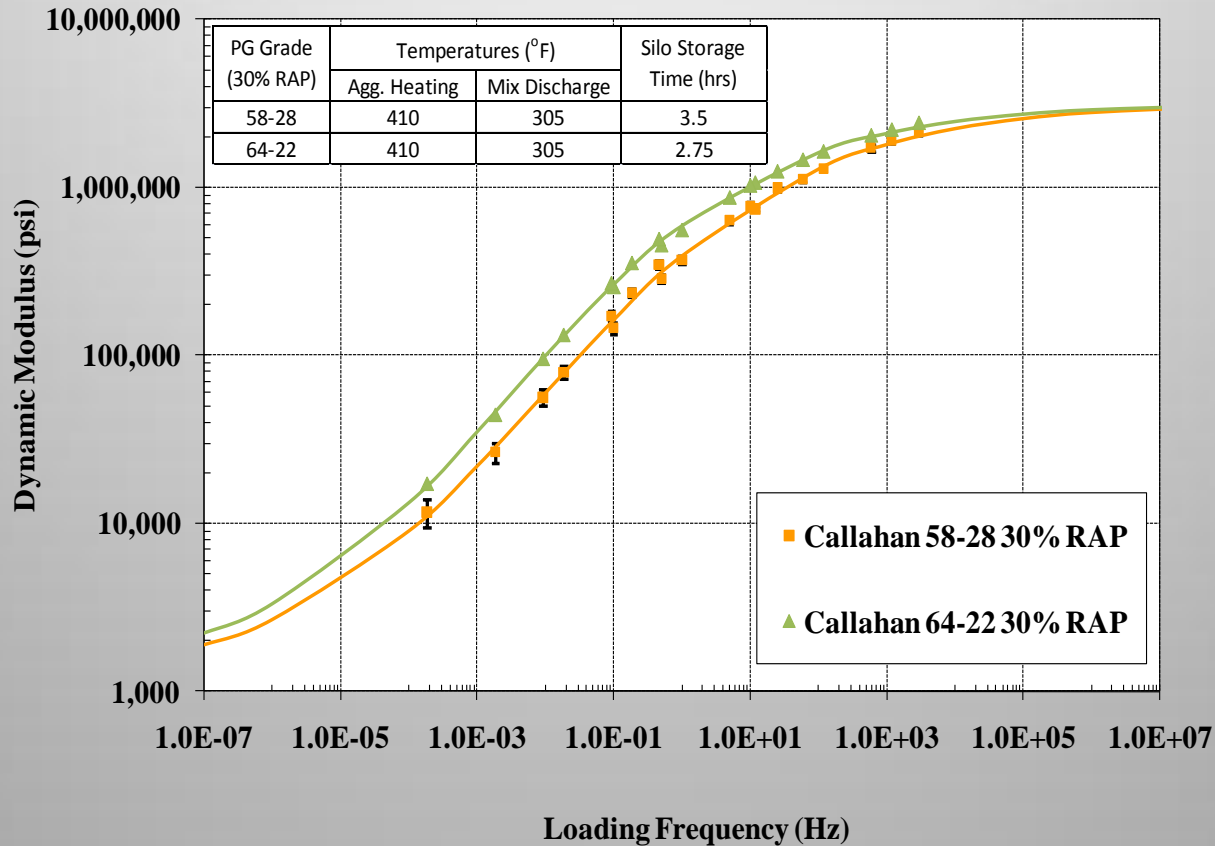
Results

Dynamic Modulus Master Curves NY Callanan PG 58-28 and Virgin PG 64-22 Plant Compacted Mixtures



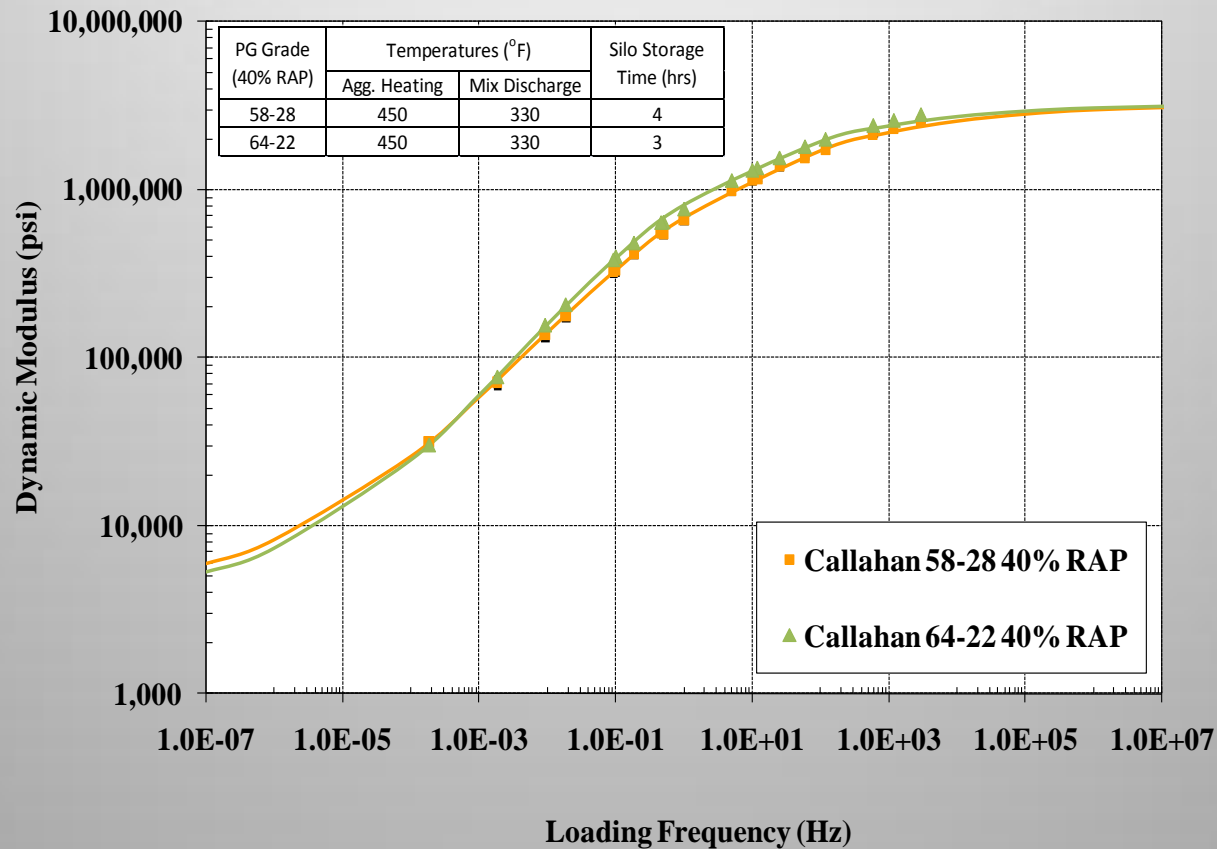
Results

Dynamic Modulus Master Curves NY Callahan 30% RAP Mixtures



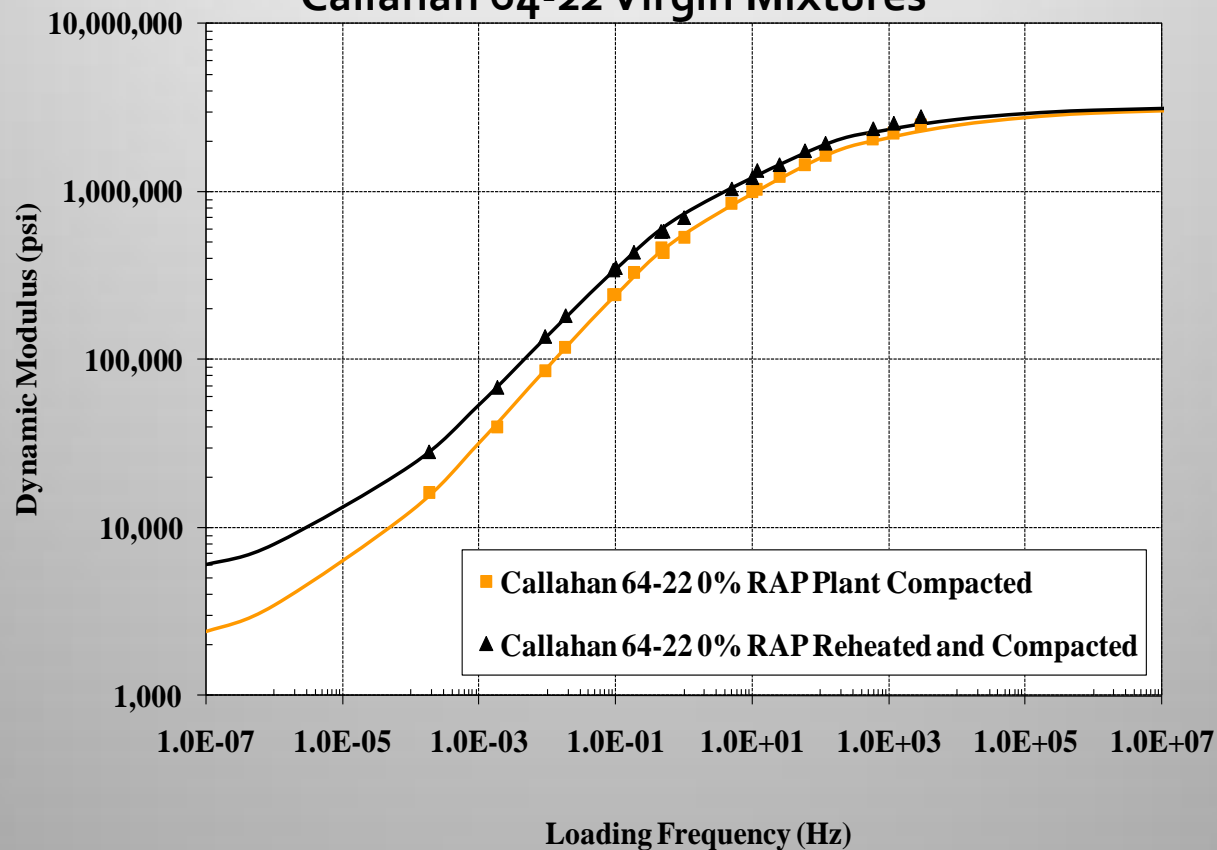
Results

Dynamic Modulus Master Curves NY Callahan 40% RAP Mixtures



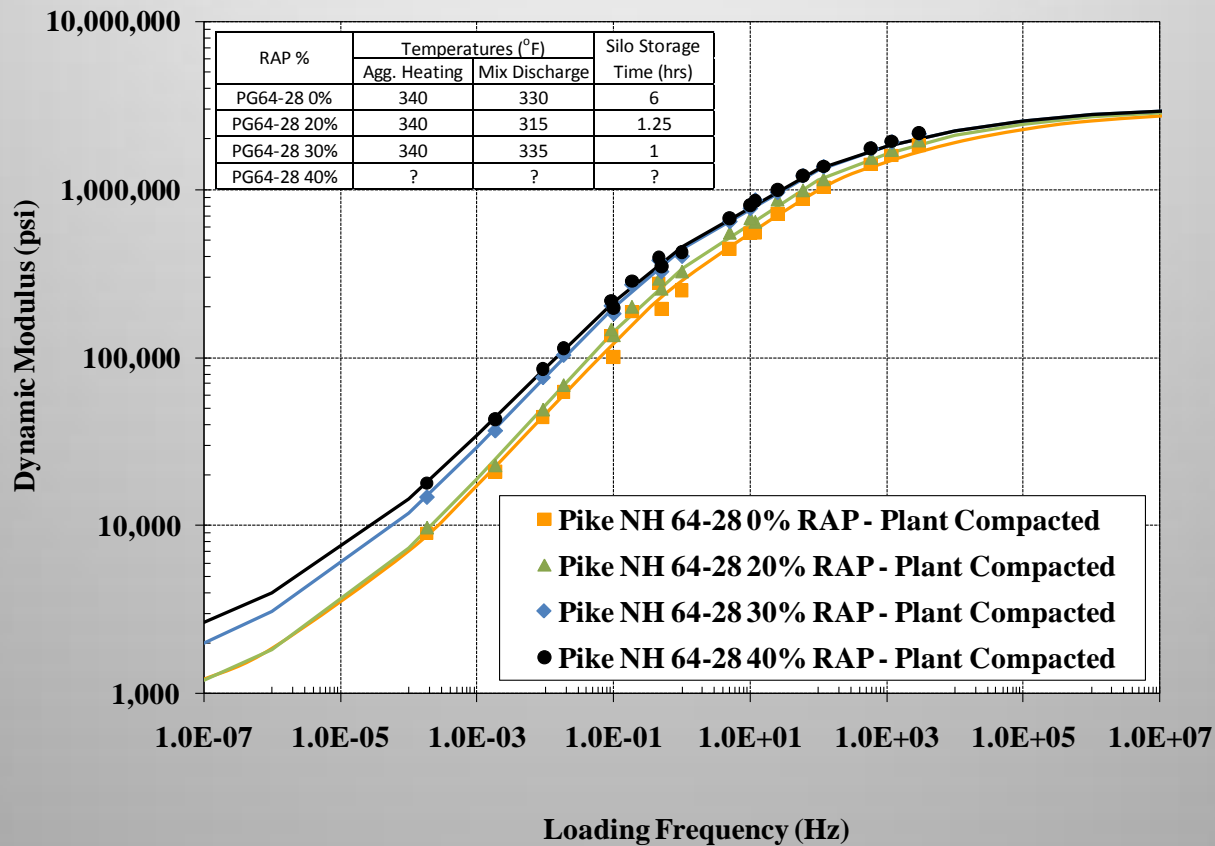
Results

Dynamic Modulus Master Curves
Comparison of Plant Compacted and Laboratory Compacted (Reheated)
Callahan 64-22 Virgin Mixtures



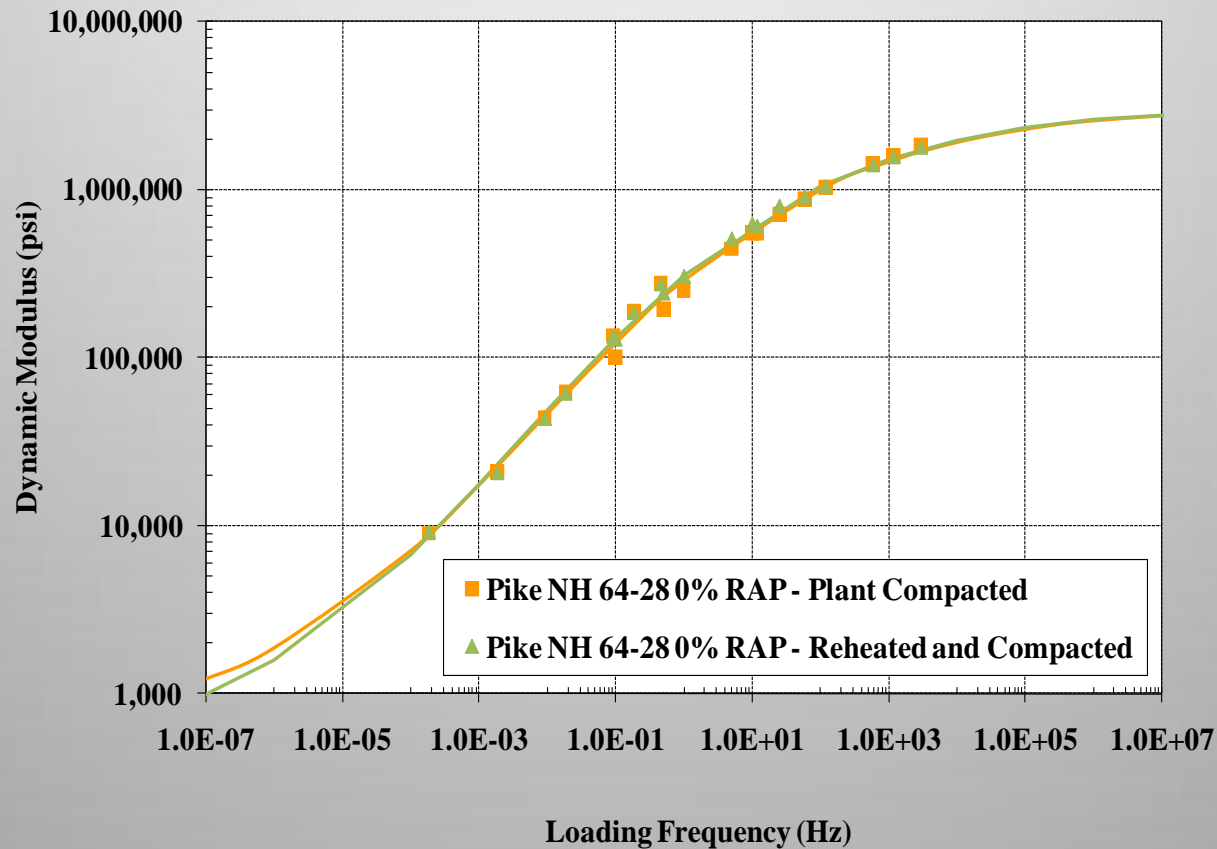
Results

Dynamic Modulus Master Curves Pike NH RAP Mixtures – Plant Compacted

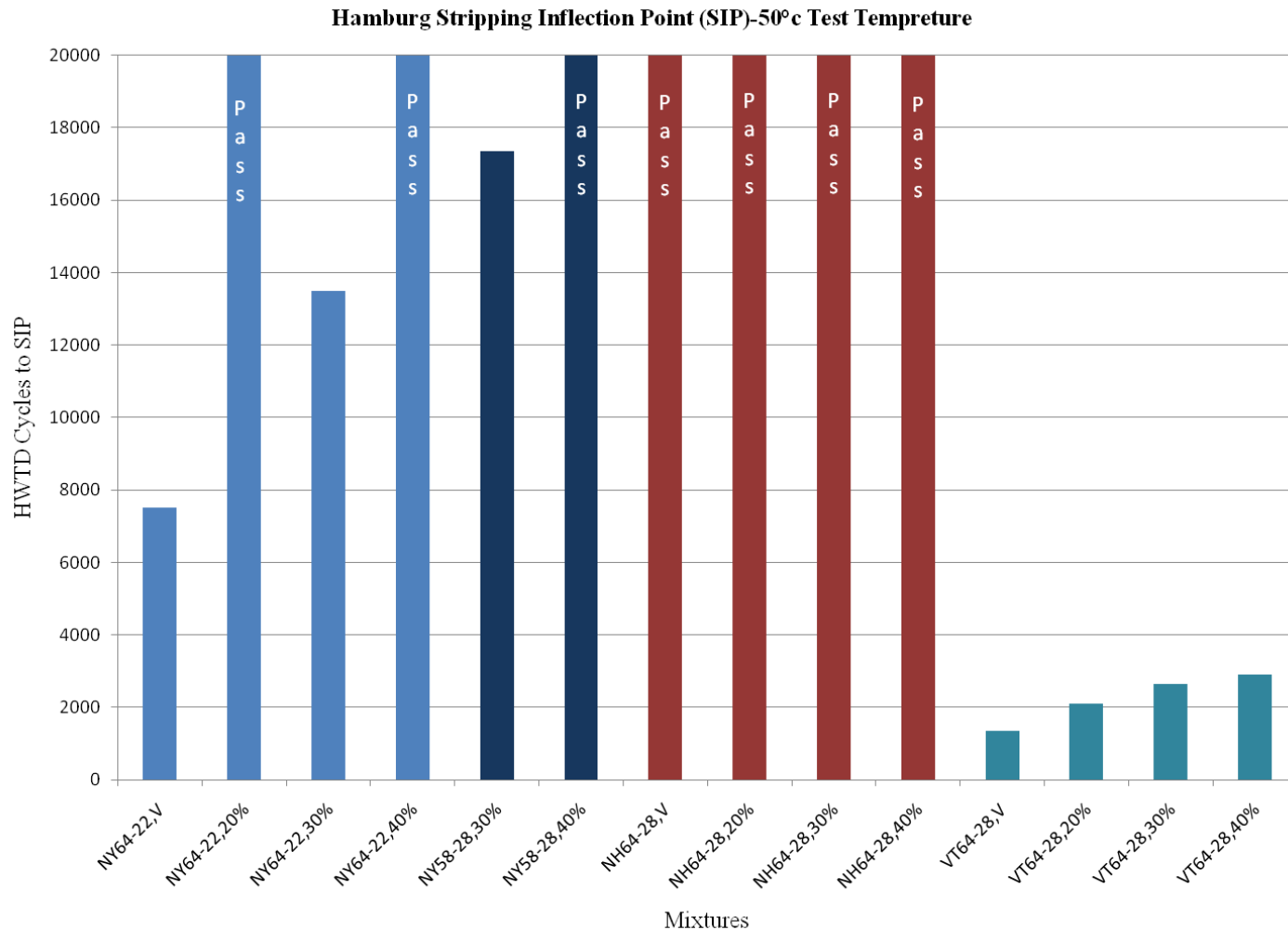


Results

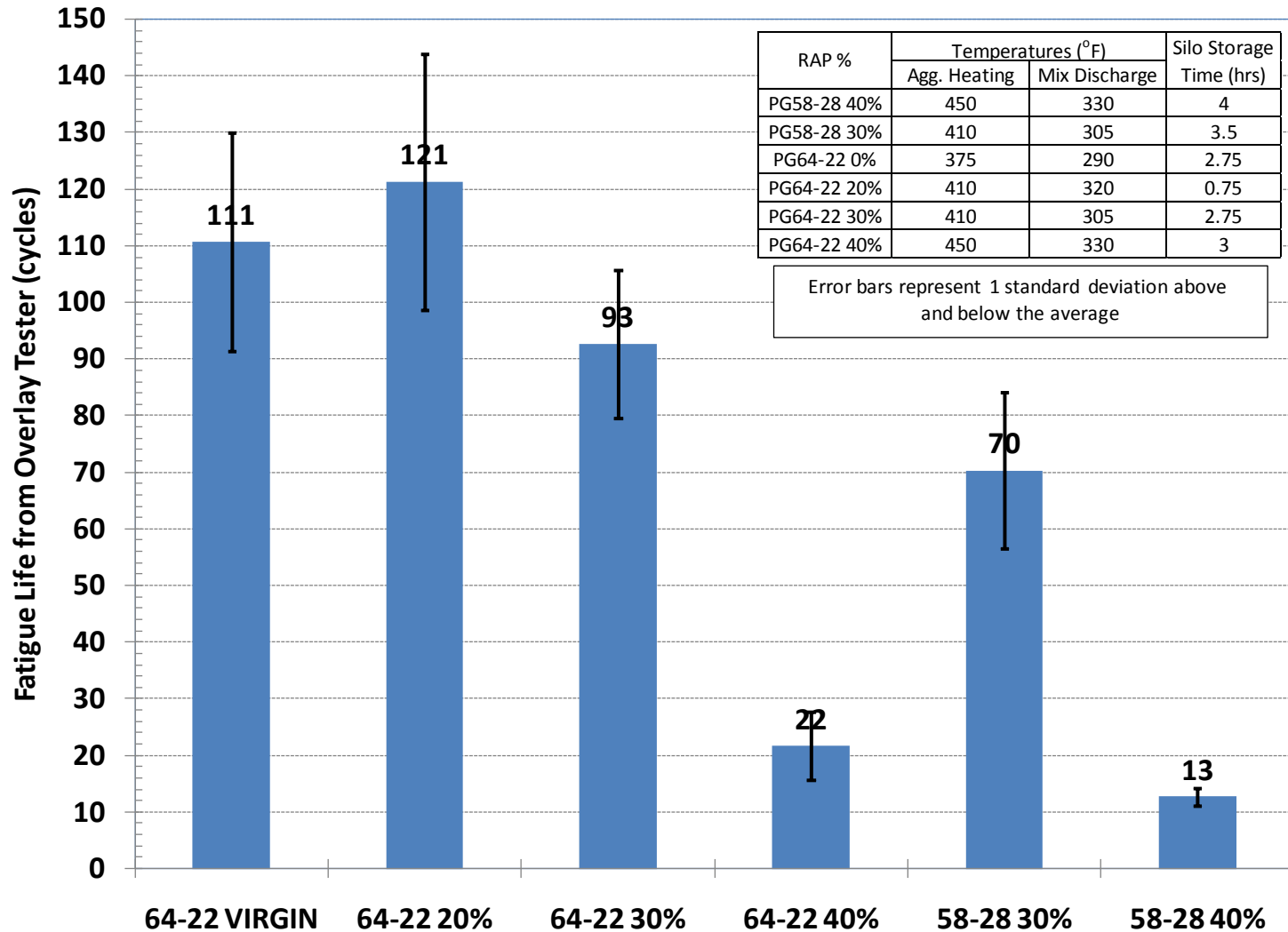
Dynamic Modulus Master Curves
Pike NH 0% RAP – Plant Compacted and Reheated Mixtures



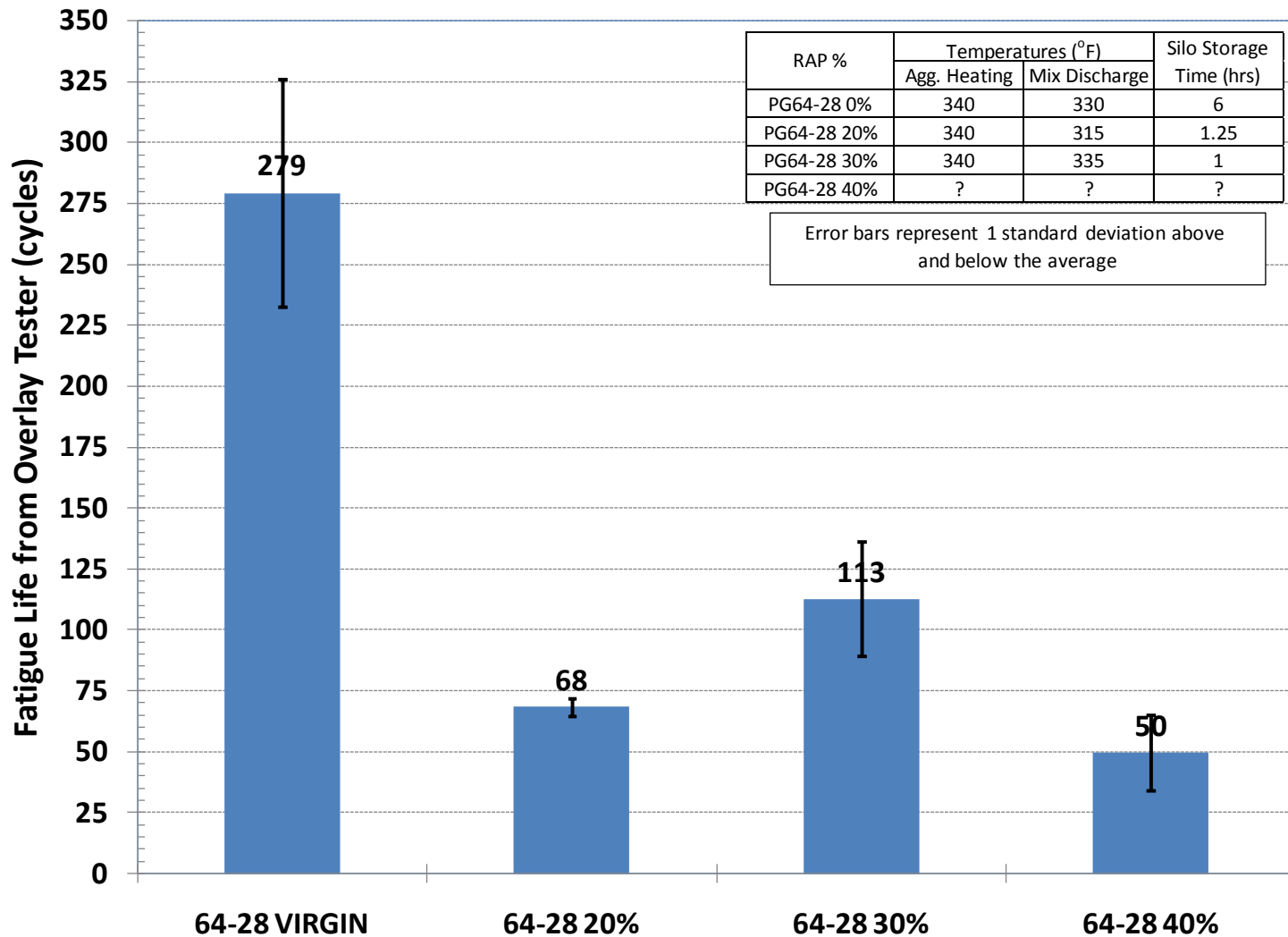
HWTD Results



Overlay Tester: NY Mixtures



Overlay Tester: NH Mixtures





High RAP Performance Case Studies



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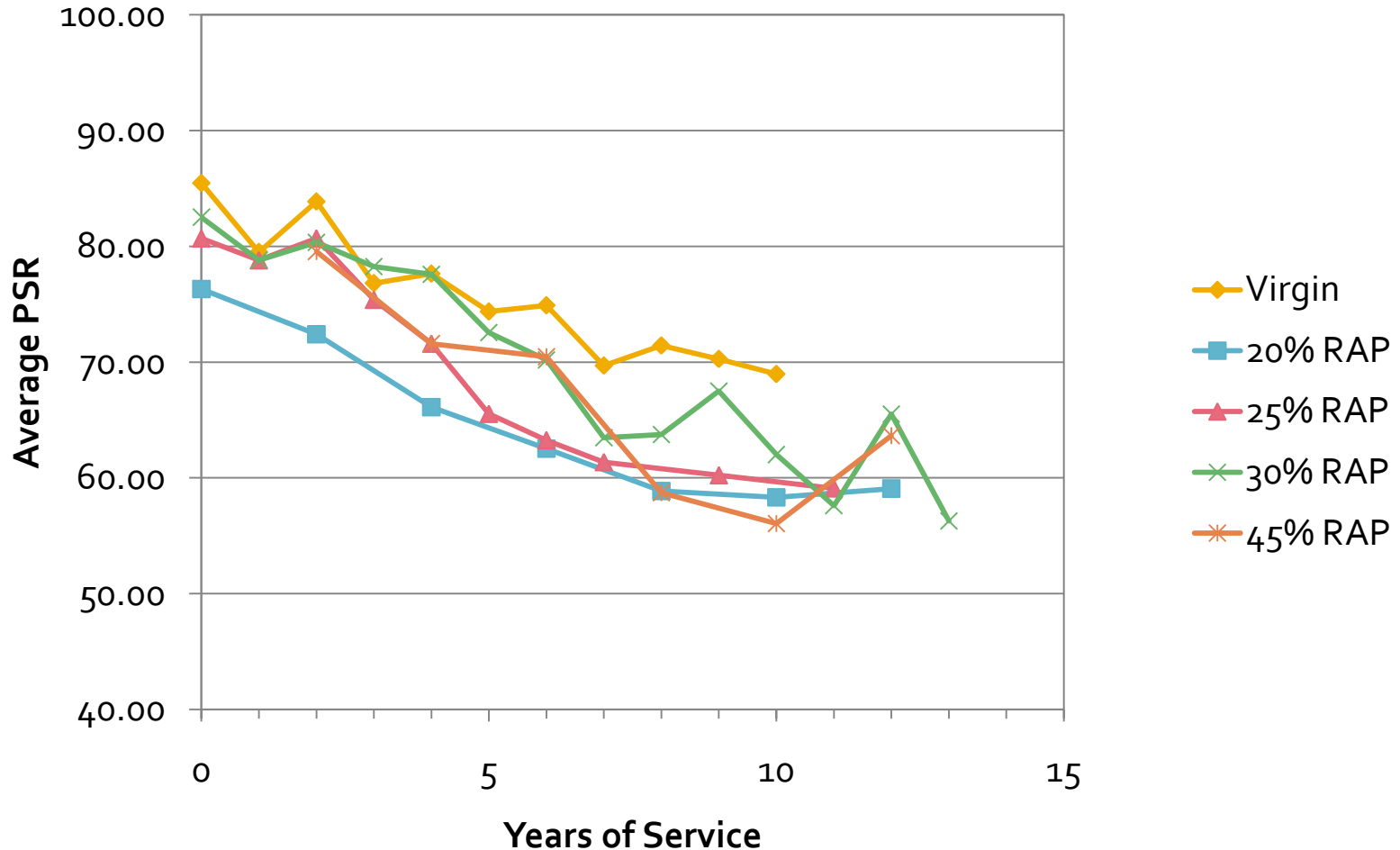
Background

- To compare the long term performance of RAP pavements to virgin pavements using several case studies
- Started from April 2009 RAP ETG
- Funded through the RMRC
- Project Completed
 - Evan Anderson thesis
 - paper to be submitted

List of Case Studies

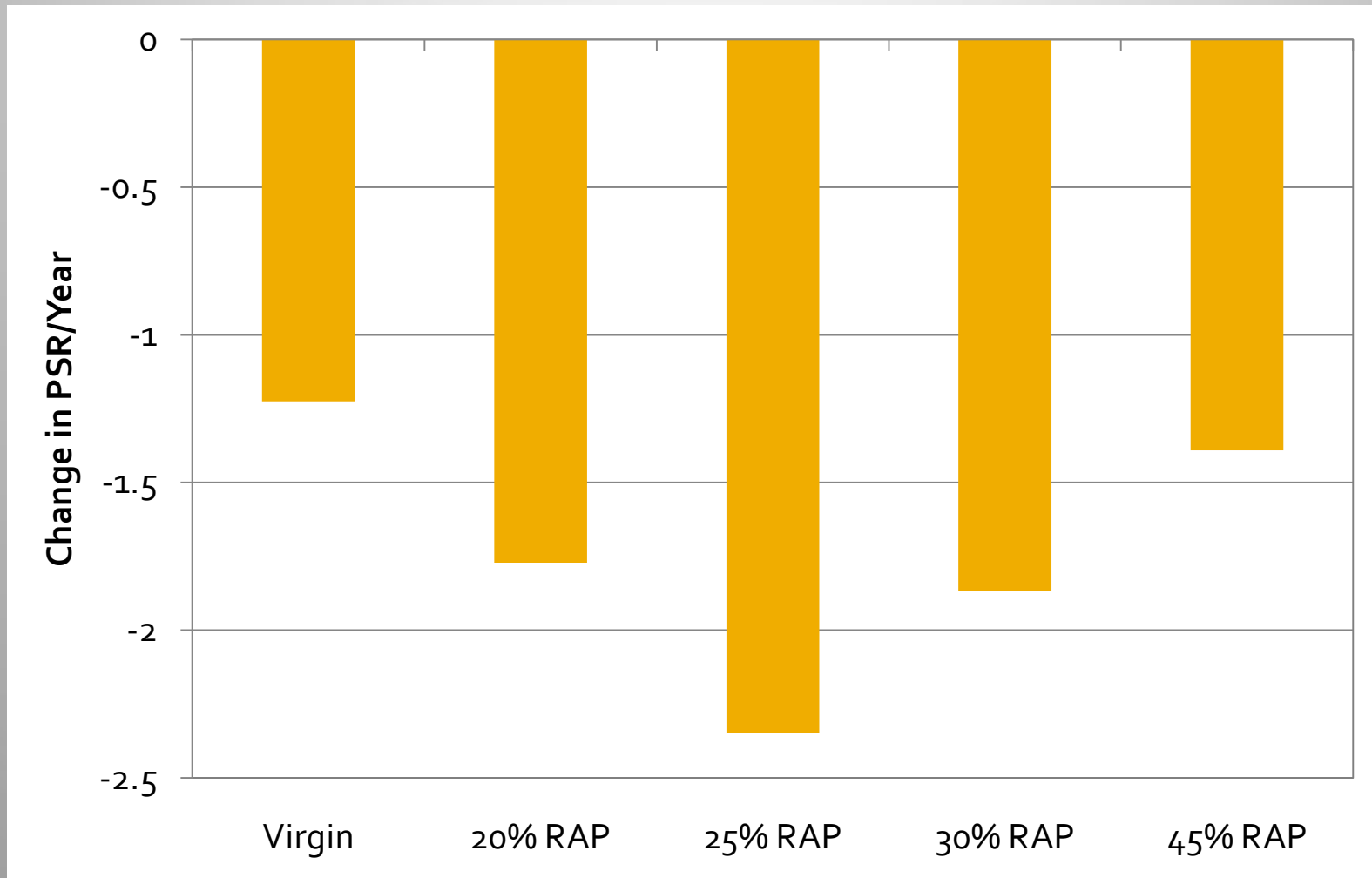
- Washington, I-90
 - Renslow to Ryegrass
 - Akima River to W. Ellensberg
- Durango, CO
- Willow, AK
- London, Ontario - Highway 401
- Connecticut – Rt. 2
- Woodstock-Lincoln, NH
- Wyoming
 - I-90
 - I-25
 - US-85
 - I-80
- Arizona
 - SR-73
 - US-180
 - US-191
- Florida
- Boston-Logan Airport

Wyoming Average PSR

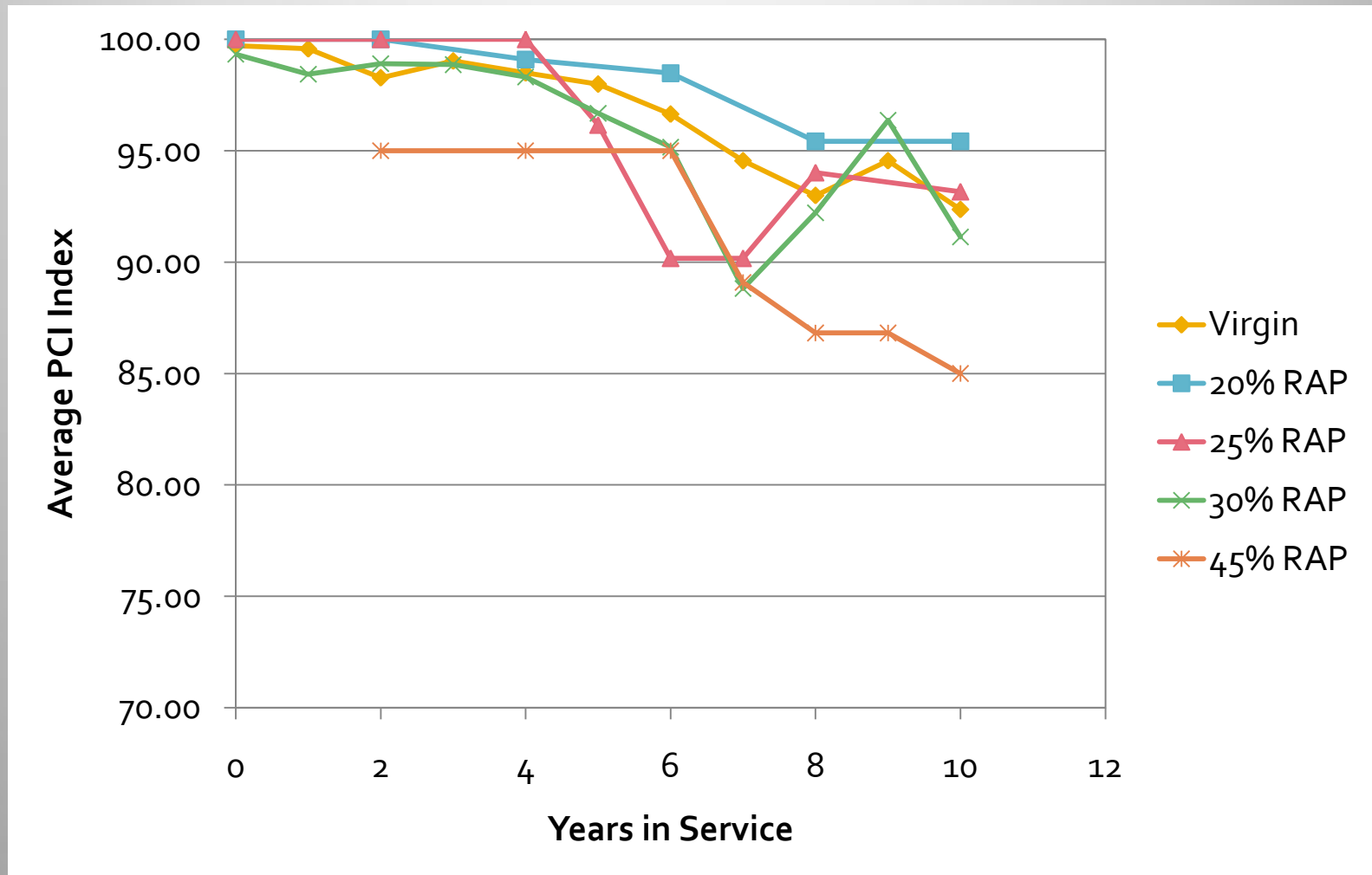


Note: 25% and 45% RAP levels only represented by one section each.

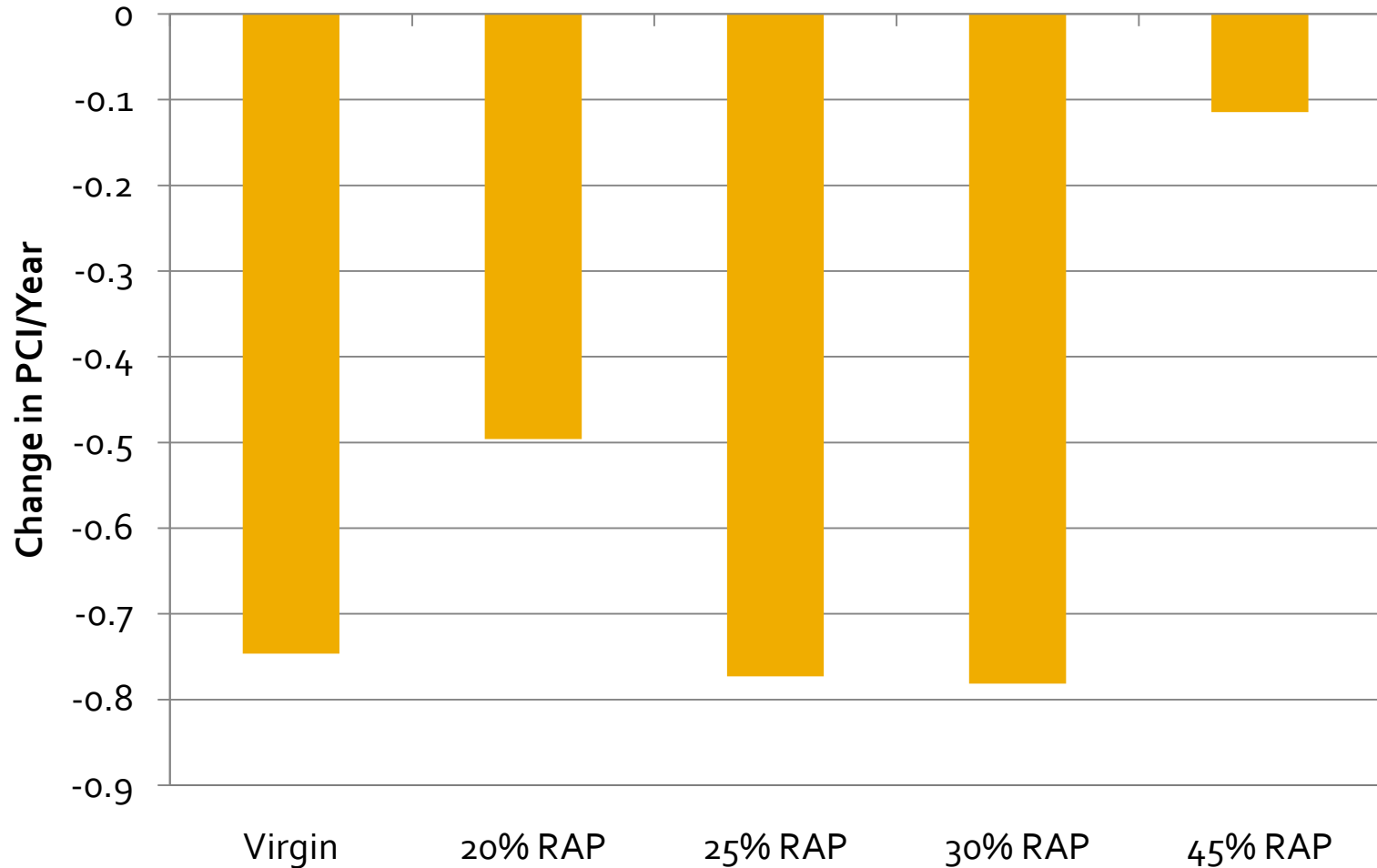
WY Average PSR Deterioration Rates



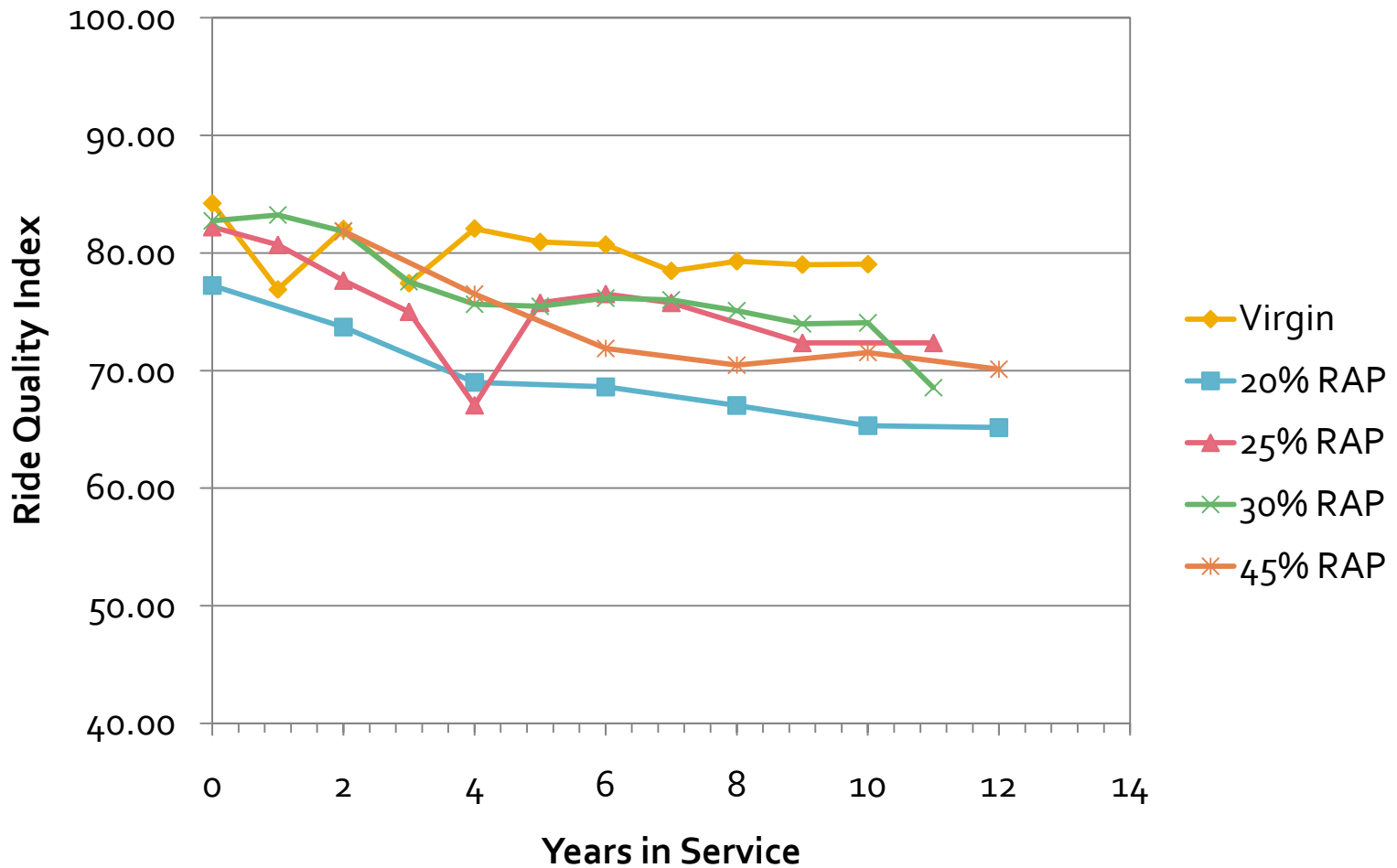
Wyoming Average PCI



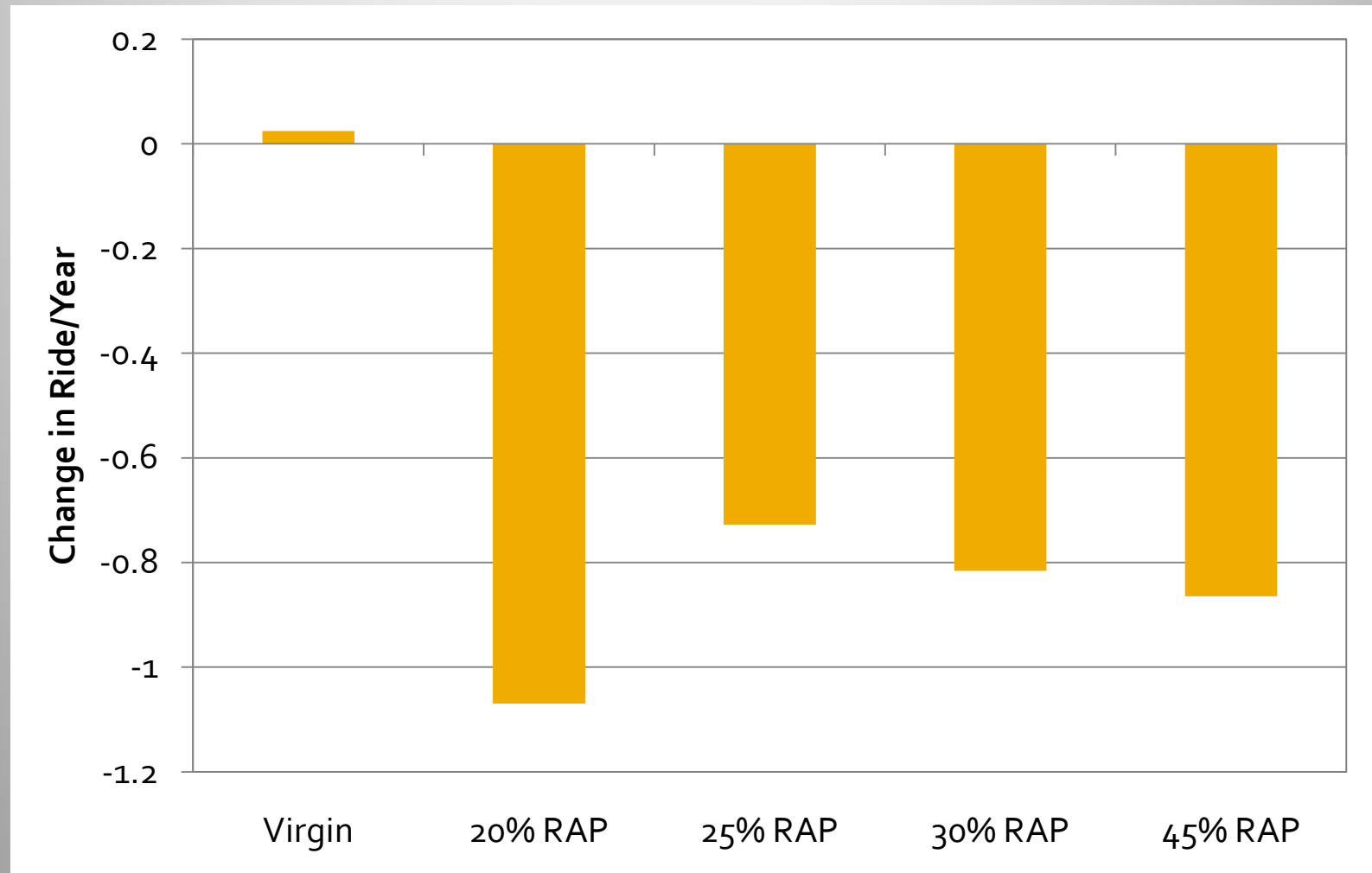
WY Average PCI Deterioration Rates



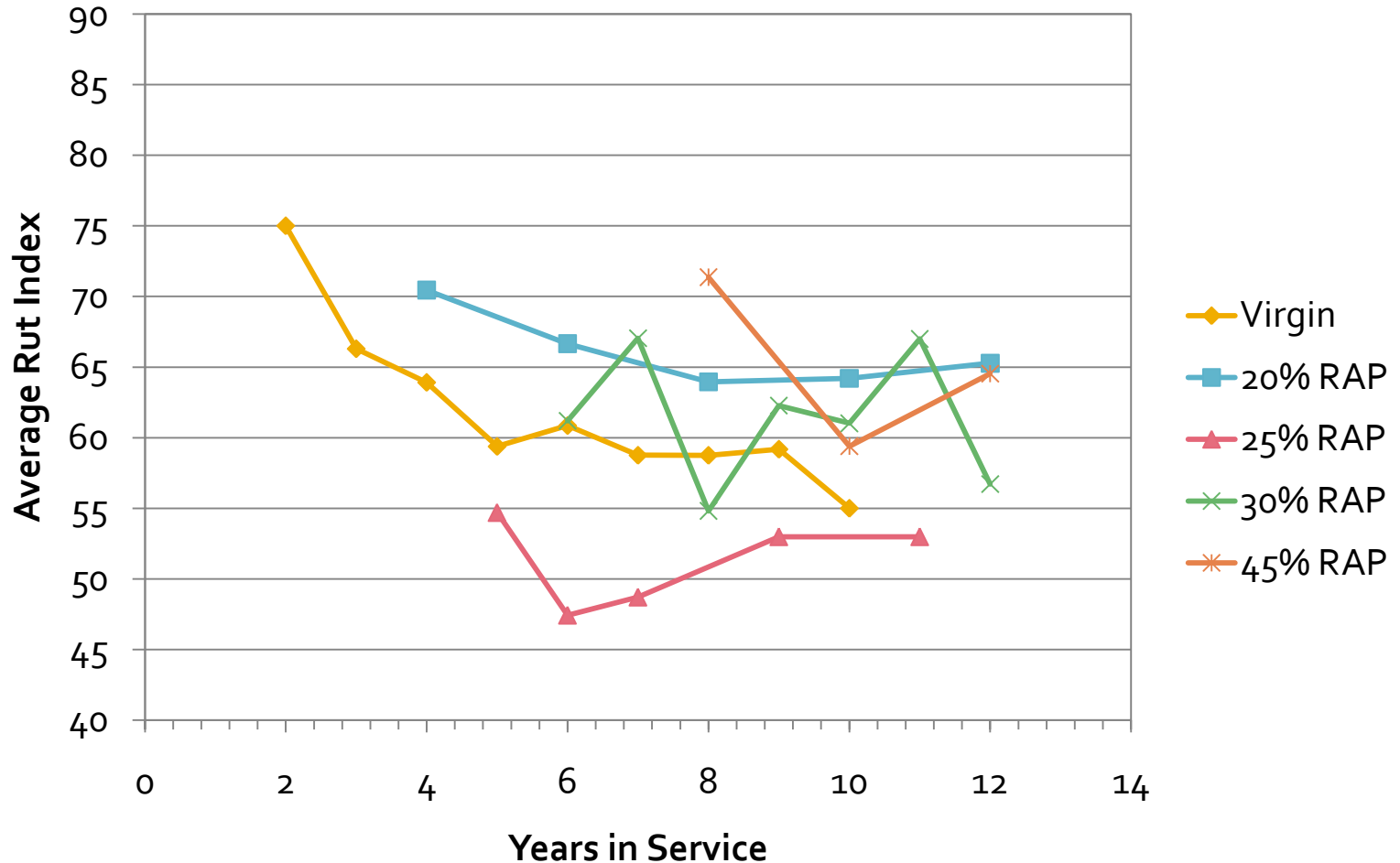
Wyoming Average Ride Quality



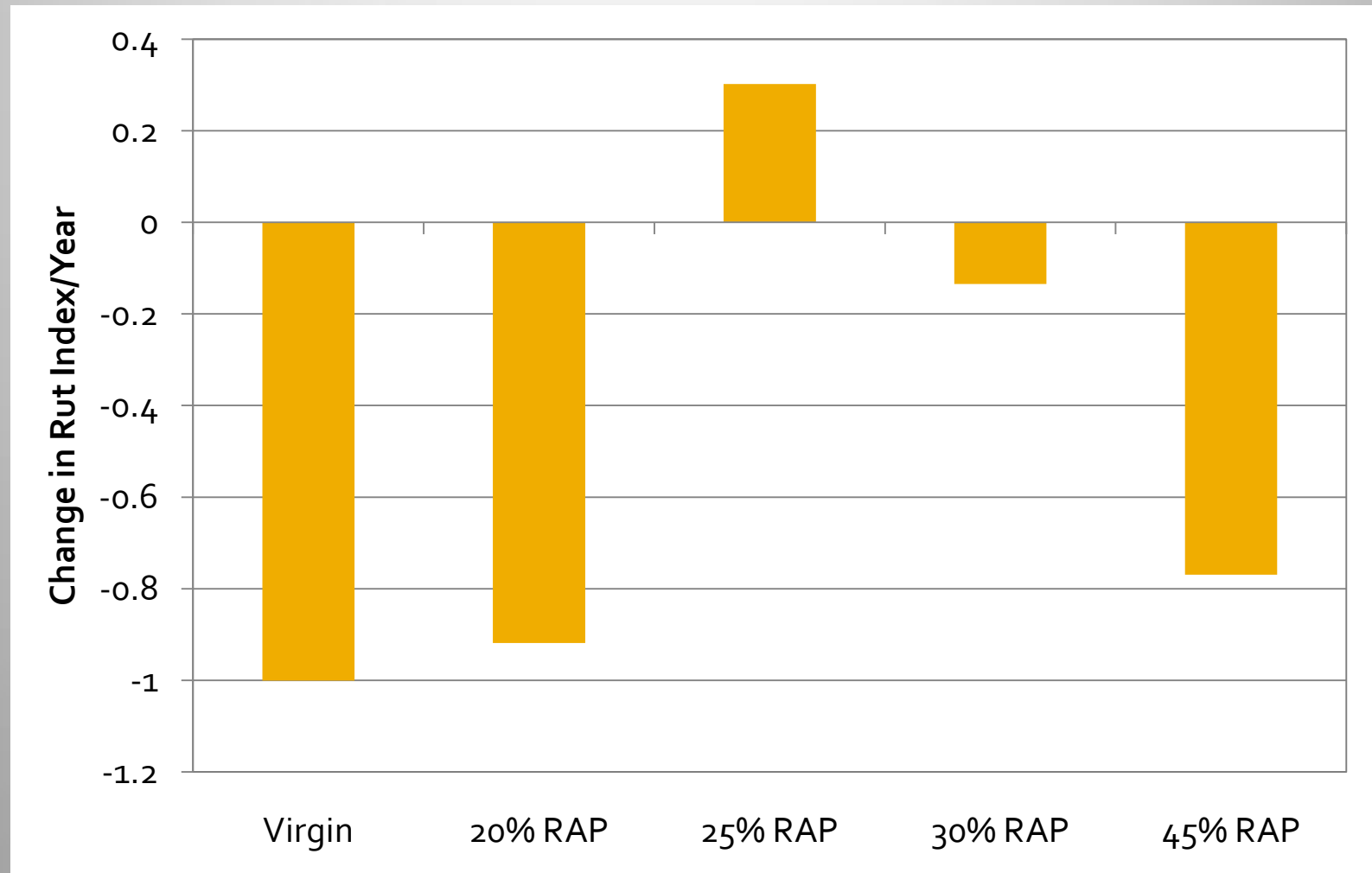
WY Avg. Ride Index Deterioration Rates



Wyoming Average Rut Index



WY Avg. Rut Index Deterioration Rates



Summary of Findings – WY

- Wyoming Index Statistics
 - RAP Sections not statistically different from one another, only 20% RAP sections PSR was statistically worse than virgin sections
- Wyoming Deterioration Rate Statistics
 - RAP sections deteriorate in ride quality significantly faster than virgin sections. 30% RAP PSR deteriorates significantly faster than virgin section.

Summary of Findings – Demo 39

- Washington, Renslow to Ryegrass
 - Comparable performance rating after 9 Years of available data
- Washington, Akima River to W. Ellensberg
 - Comparable performance rating after 6 years of available data
- Durango, CO
 - Similar levels of maintenance over 21 years
- Willow, AK
 - Provided level of performance typical to the region for 23 years

Summary of Findings - Arizona

- Arizona SR-73
 - Similar levels of performance and maintenance between RAP and virgin sections
- Arizona US-180
 - Smoother ride in RAP Section, higher maintenance costs for Virgin section
- Arizona US-191
 - Similar levels of performance between RAP and virgin sections

Summary of Findings

- London, Ontario - Highway 401
 - Slightly more rutting and smoother ride in RAP section, comparable performance
- Connecticut – Route 2
 - No significant rutting in any section, Underlying conditions control cracking, smoother ride in most RAP sections
- Woodstock-Lincoln, NH
 - Presence of RAP does not affect long term performance, Higher ride comfort in virgin sections

Summary of Findings

- Florida Recycled Projects
 - No statistical difference between amounts of RAP and life span except for the 45% RAP sections, which performed best
- Boston-Logan International Airport
 - Meets design life expectations for region



Aging of RAP Mixtures



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Aging of Recycled Asphalt Mixtures

Project Objective

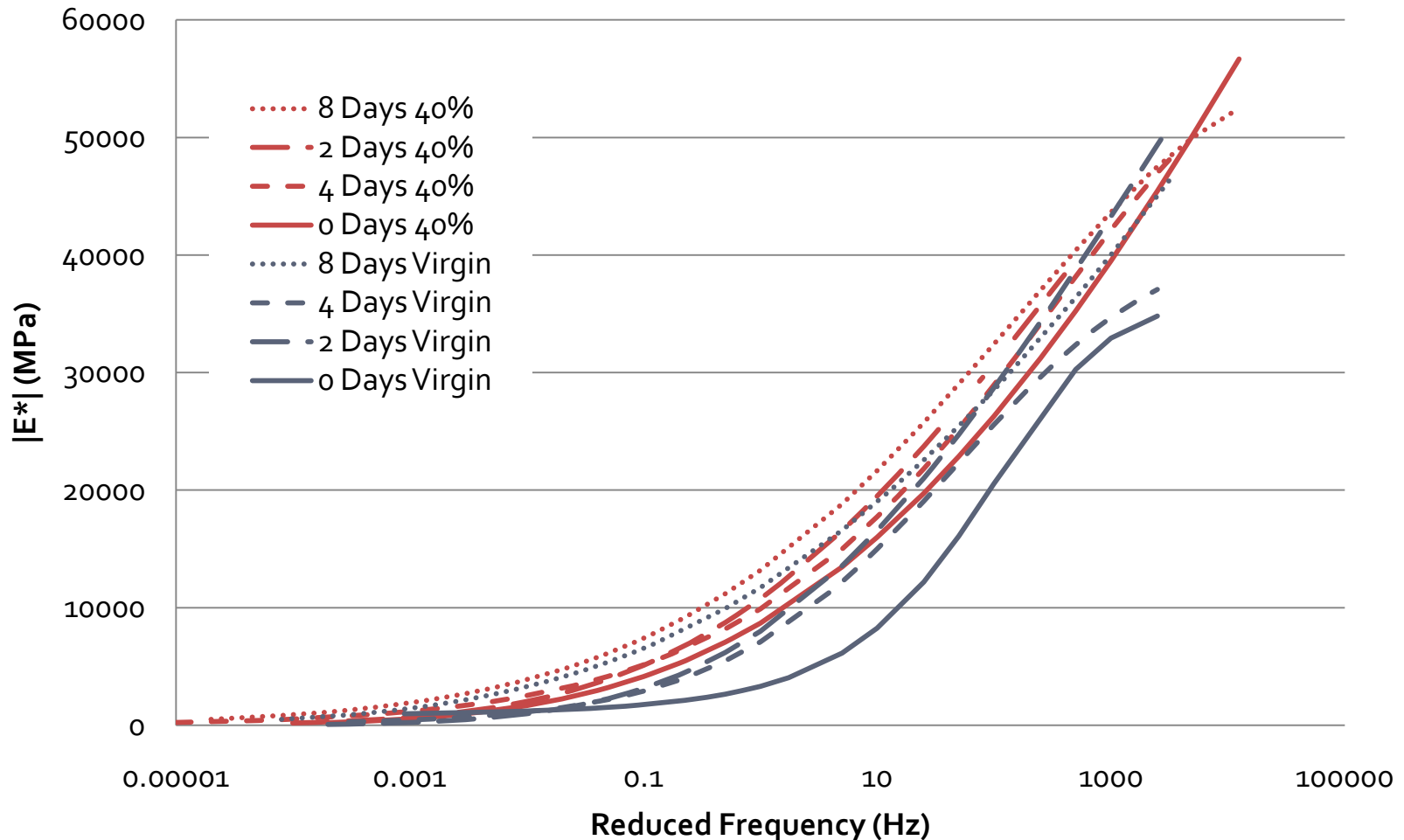
- The objective of this project is to evaluate how the properties of asphalt mixtures containing RAP and RAS change with aging as compared to a virgin mixture.
- Plant produced mixtures
 - 0, 20, 30, 40% RAP, one RAS mixture
- Specimens are aged to four different levels following existing SHRP recommendations for laboratory aging.

Performance Evaluation Testing

- All RAP specimens have been fabricated and aged
- Testing is in progress and includes:
 - Dynamic Modulus (AASHTO TP62)
 - Fatigue (S-VECD protocol)
 - Binder testing?

Performance Evaluation

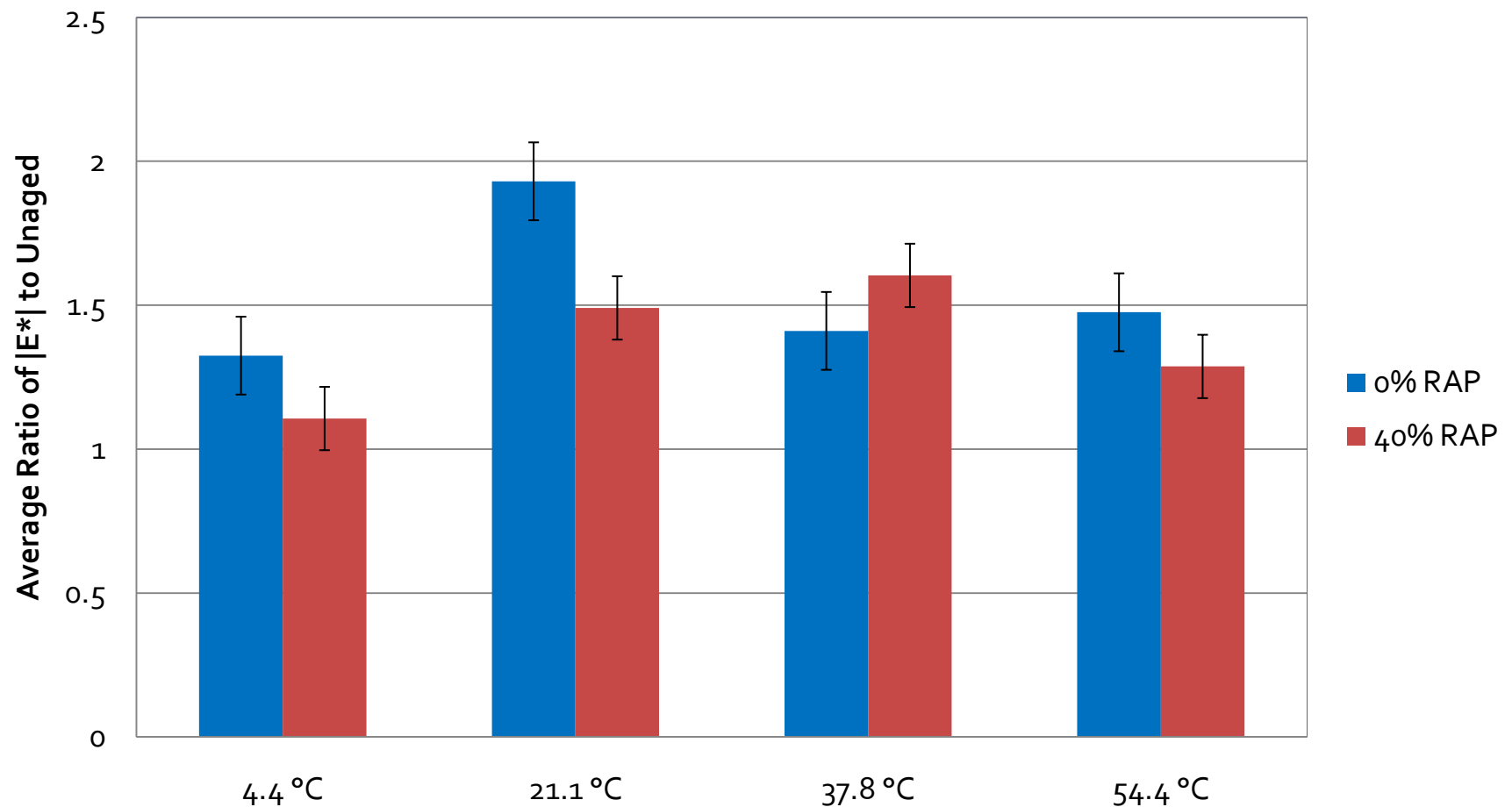
$|E^*|$ Master Curve Comparison



Performance Evaluation

$|E^*|$ Comparisons With Temperature

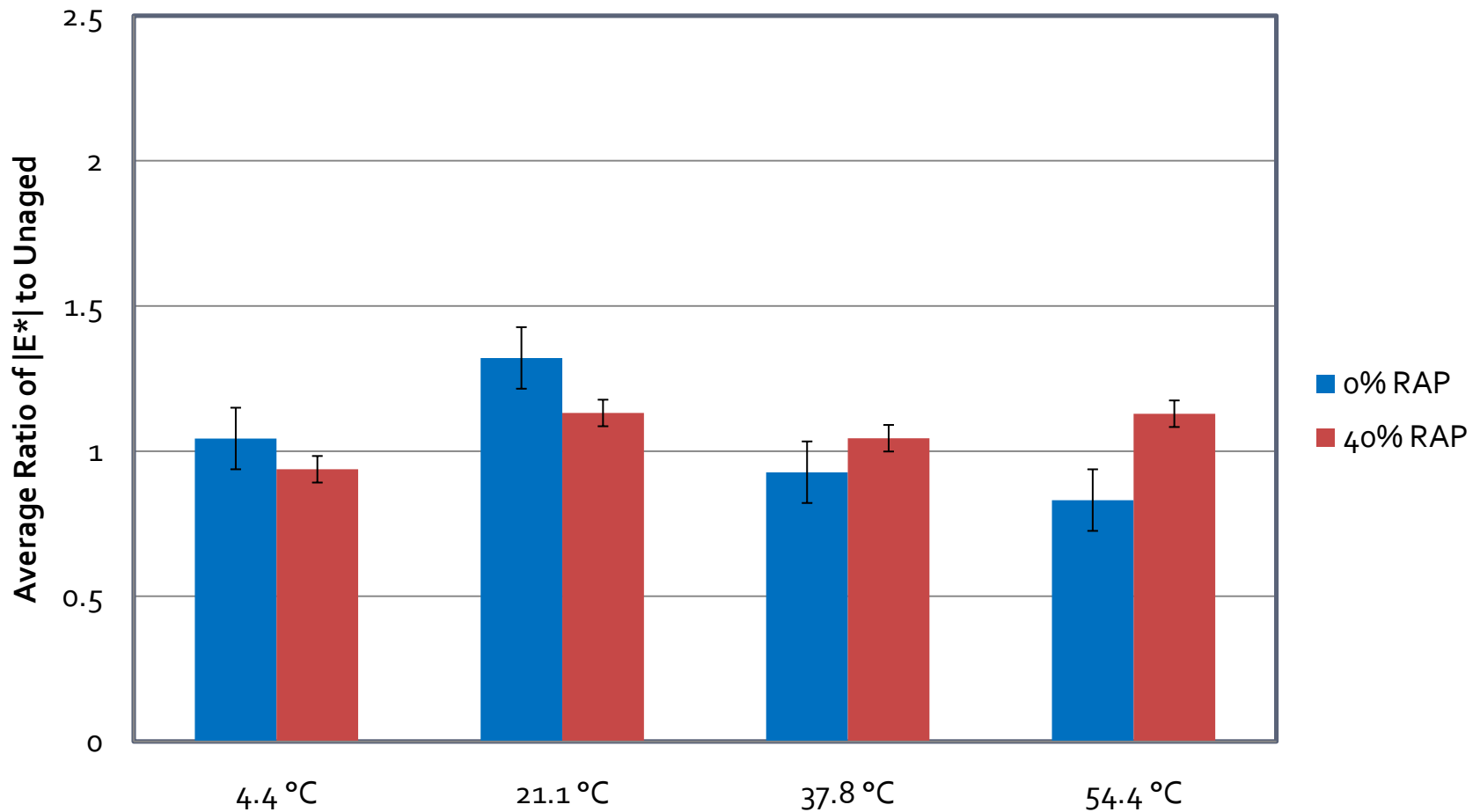
Average Ratio at 8 Days of Aging



Performance Evaluation

$|E^*|$ Comparisons With Temperature

Average Ratio at 4 Days of Aging





Shingles Research



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- RAP & RAS : AAPT 2011 paper
- RAS source
 - Post consumer
 - Manufacturer waste
 - Blend
- RAS amount
 - 3 levels of RAS



Questions?