



# **Asphalt Modifiers: Warm Mix, Polyphosphoric Acid, and Polymers**

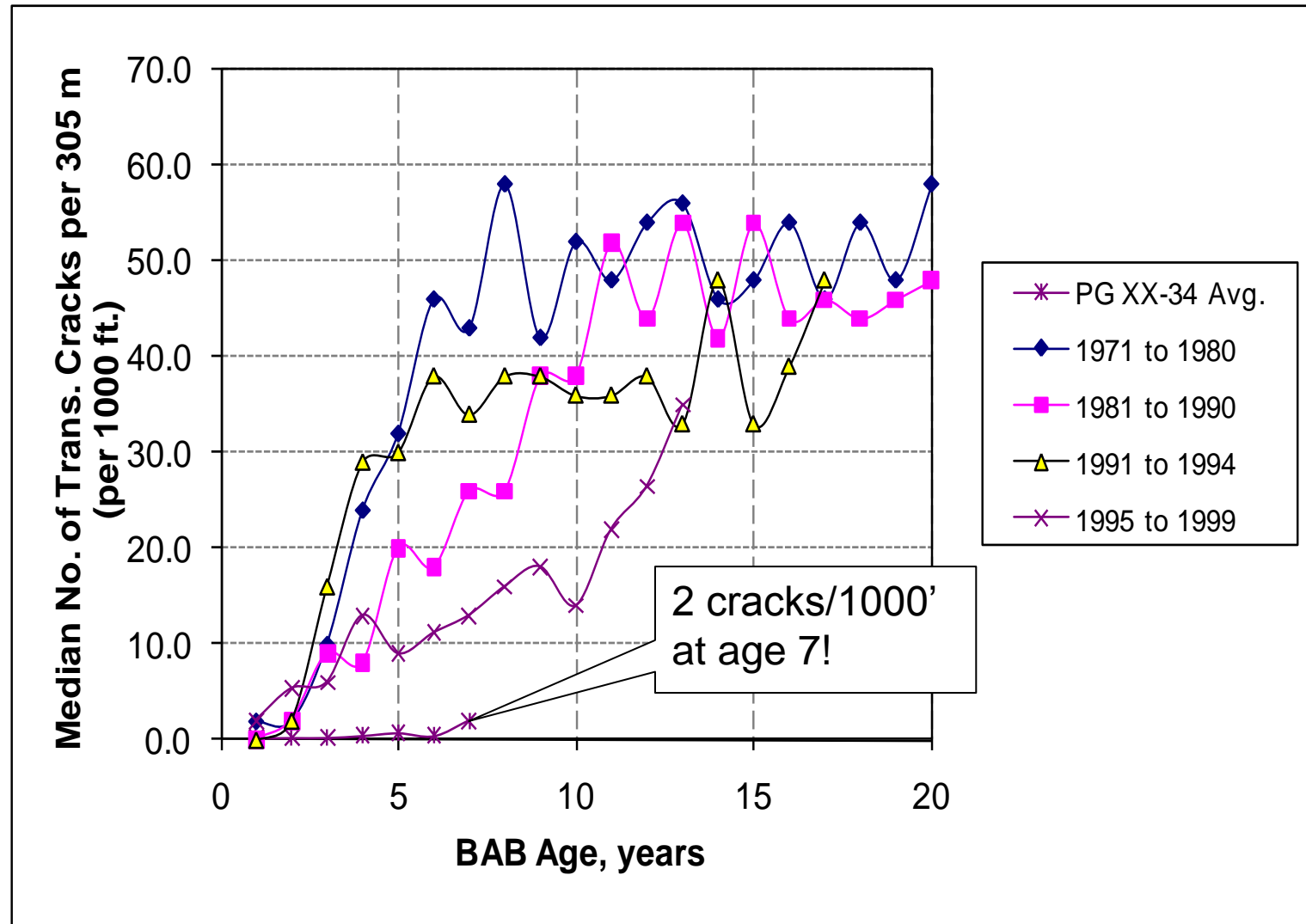
*Tim Clyne, MnDOT  
MnROAD Research Conference  
October 4, 2011*

# Presentation Topics

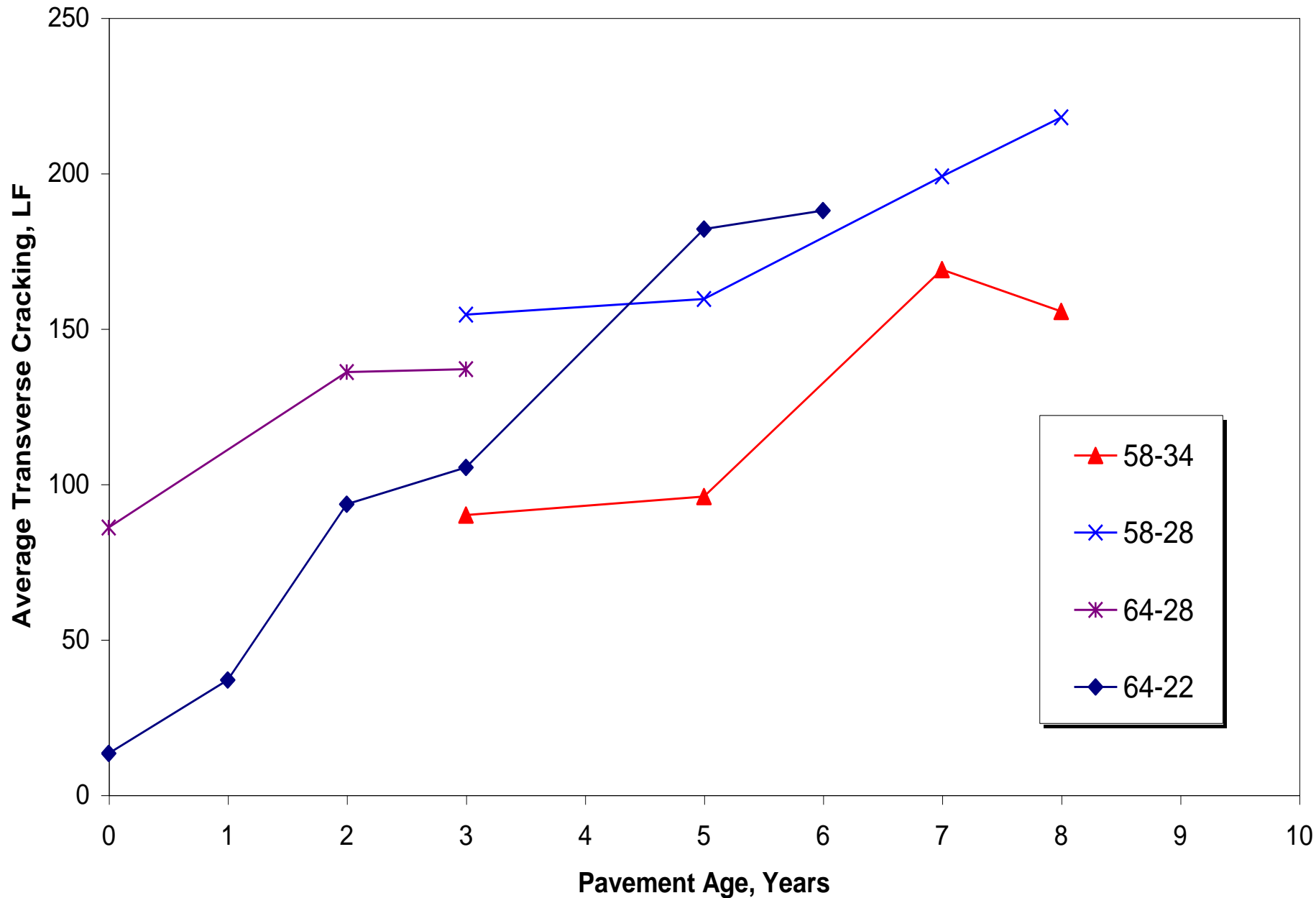
- Intro to Binder Modification
- Types of modification used at MnROAD
  - Dry Additives (Mineral Fillers)
  - Polymers
    - SBS, Elvaloy
  - Polyphosphoric Acid
  - Warm Mix Asphalt
- Pavement Lab & Field Performance
- Summary & Conclusions



# Why Modified Asphalt?



# Bituminous over Concrete



# Basics of Binder Modification

- Start with soft binder grade
  - Low temperature
- Add modifier to increase high temperature grade
  - Without compromising low temperature grade

PG 49-34 → PG 64-34



# Types of Modification at MnROAD

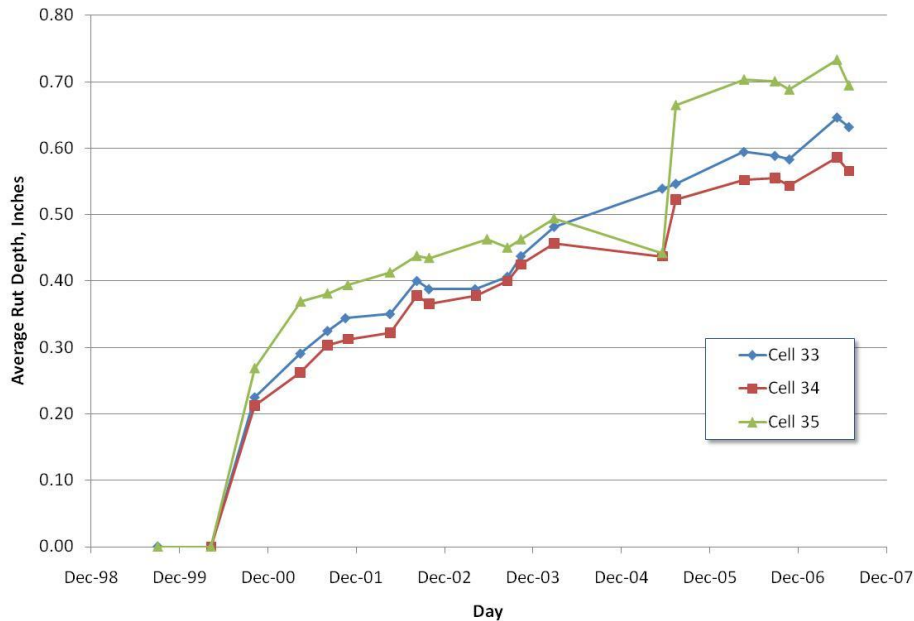
- ❑ Dry Additive
  - ❑ PG 52-34 (2006)
- ❑ Polymers
  - ❑ SBS
  - ❑ Elvaloy
  - ❑ PG 58-34, 64-34, 70-28 (1999, 2004, 2007, 2008, 2010)
- ❑ Polyphosphoric Acid
  - ❑ PG 58-34 (2007)
- ❑ Warm Mix Asphalt
  - ❑ Evotherm 3G
  - ❑ PG 58-34 (2008)



# 1999 Superpave Study

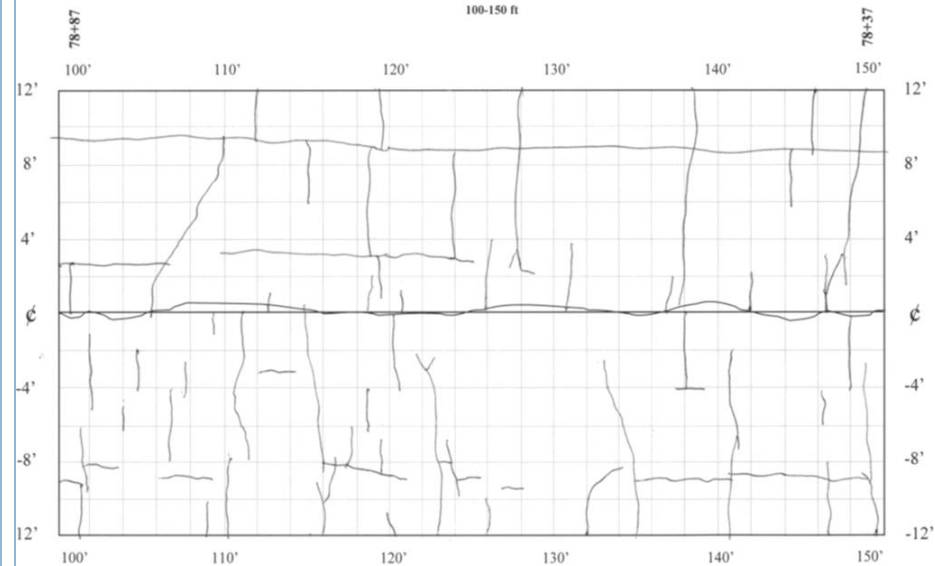
- PG 58-28, 58-34, 58-40
- Slightly different rutting performance
- Vastly different cracking performance

Superpave Rutting Performance



CELL 35

100-150 ft



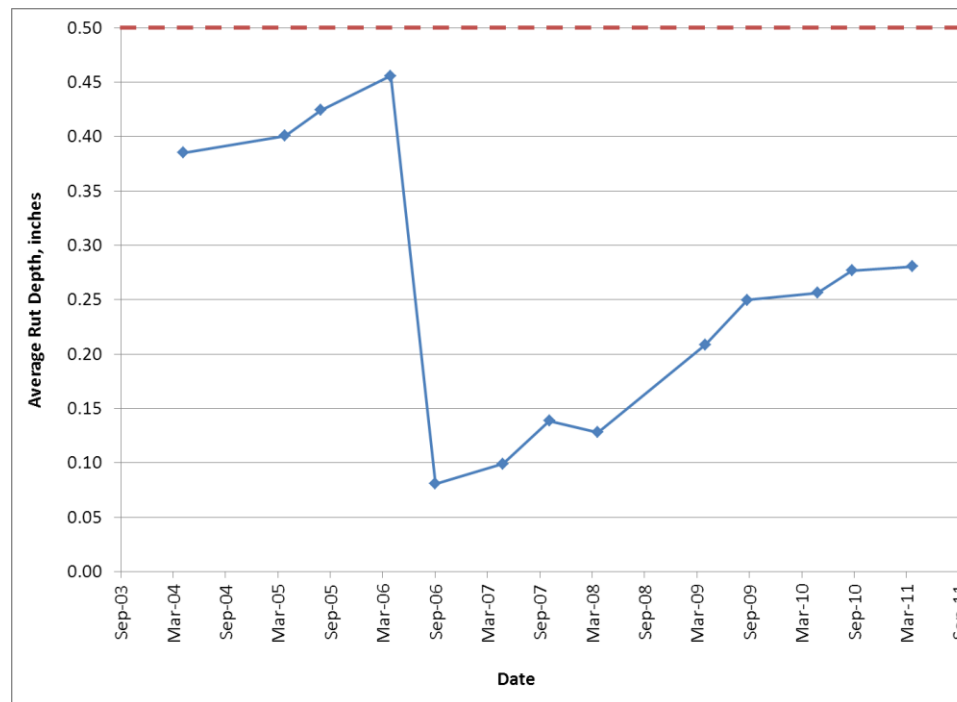
# 2006 PG 52-34 on Mainline

- ❑ Major cracking in driving lane due to instrumentation and age
- ❑ 6" HMA + 33" Class 4
- ❑ 1.5" Mill & Inlay
- ❑ PG 52-34, Level 2 Superpave, no RAP



# Amazing Performance

- ❑ 3.6 Million ESALs after 5 years
- ❑ Cracking returned, but low severity
- ❑ Minimal rutting

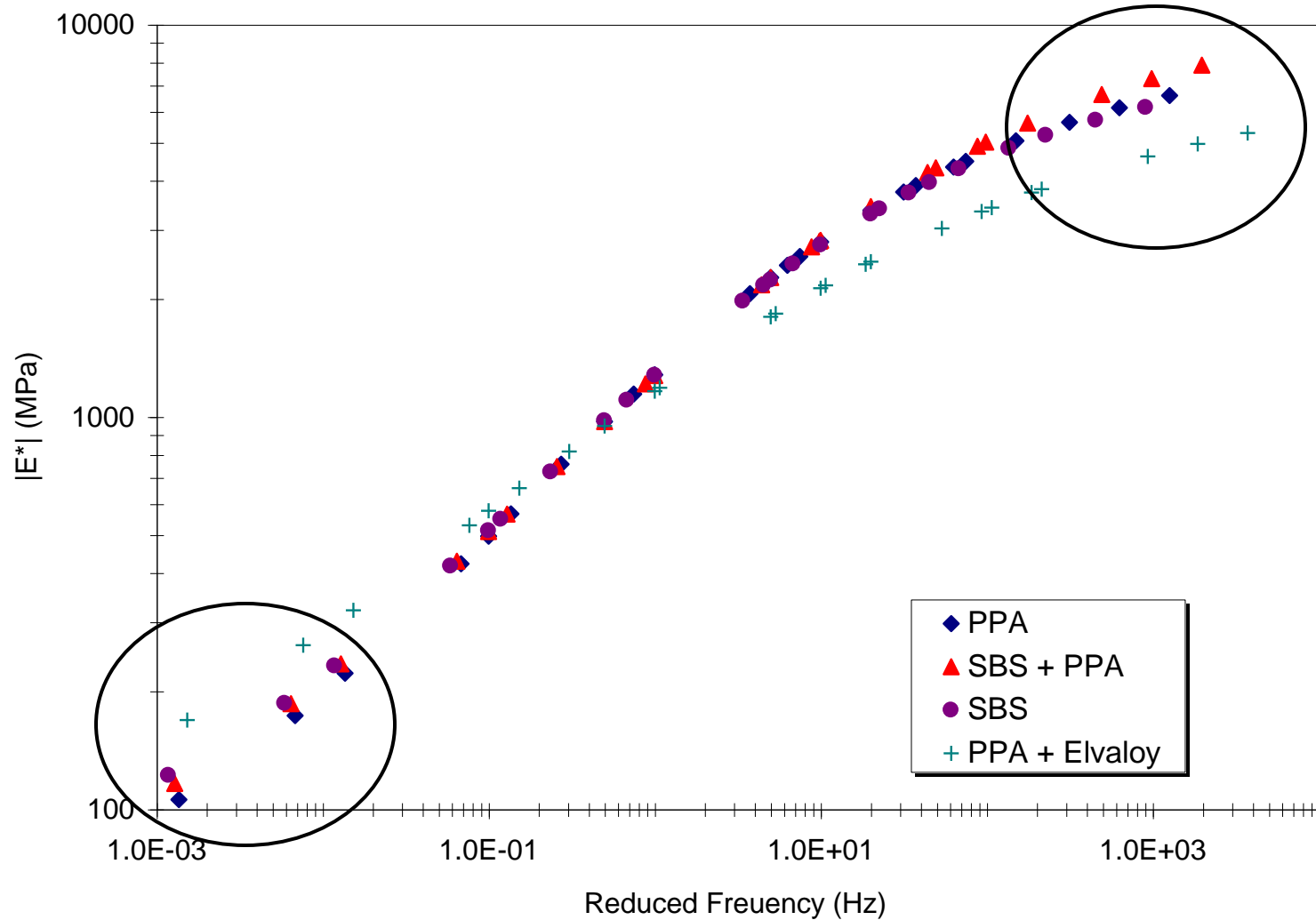


# Polyphosphoric Acid Study

- ❑ Field validation of previous FHWA (and other) laboratory work
- ❑ More cost-effective than polymers
- ❑ FHWA, Innophos, ICL Performance Products, Mathy Construction, Marathon, Paragon, Dupont, Western Research Institute
- ❑ Four different PPA binders (PG58-34):
  - ❑ PPA
  - ❑ PPA + SBS
  - ❑ PPA + Elvaloy
  - ❑ SBS

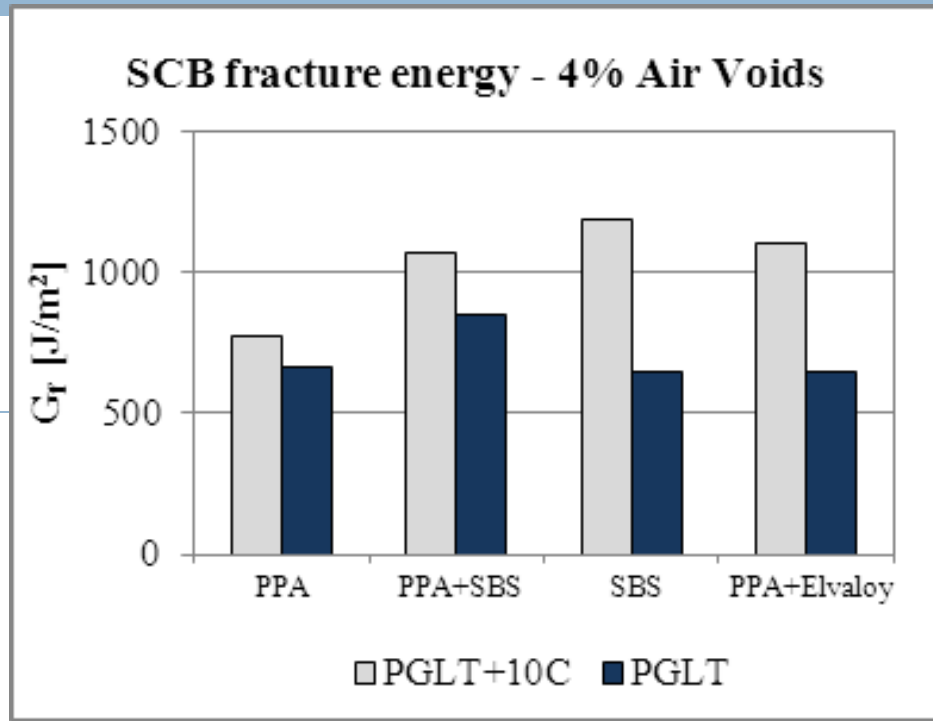
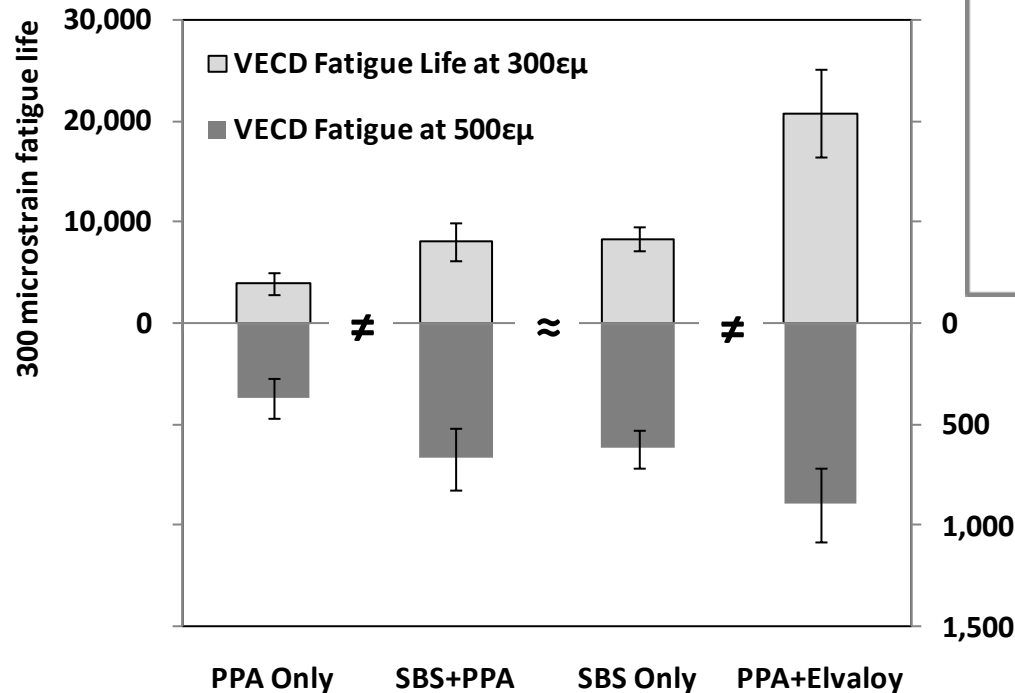


# Dynamic Modulus



# Lab Cracking Performance

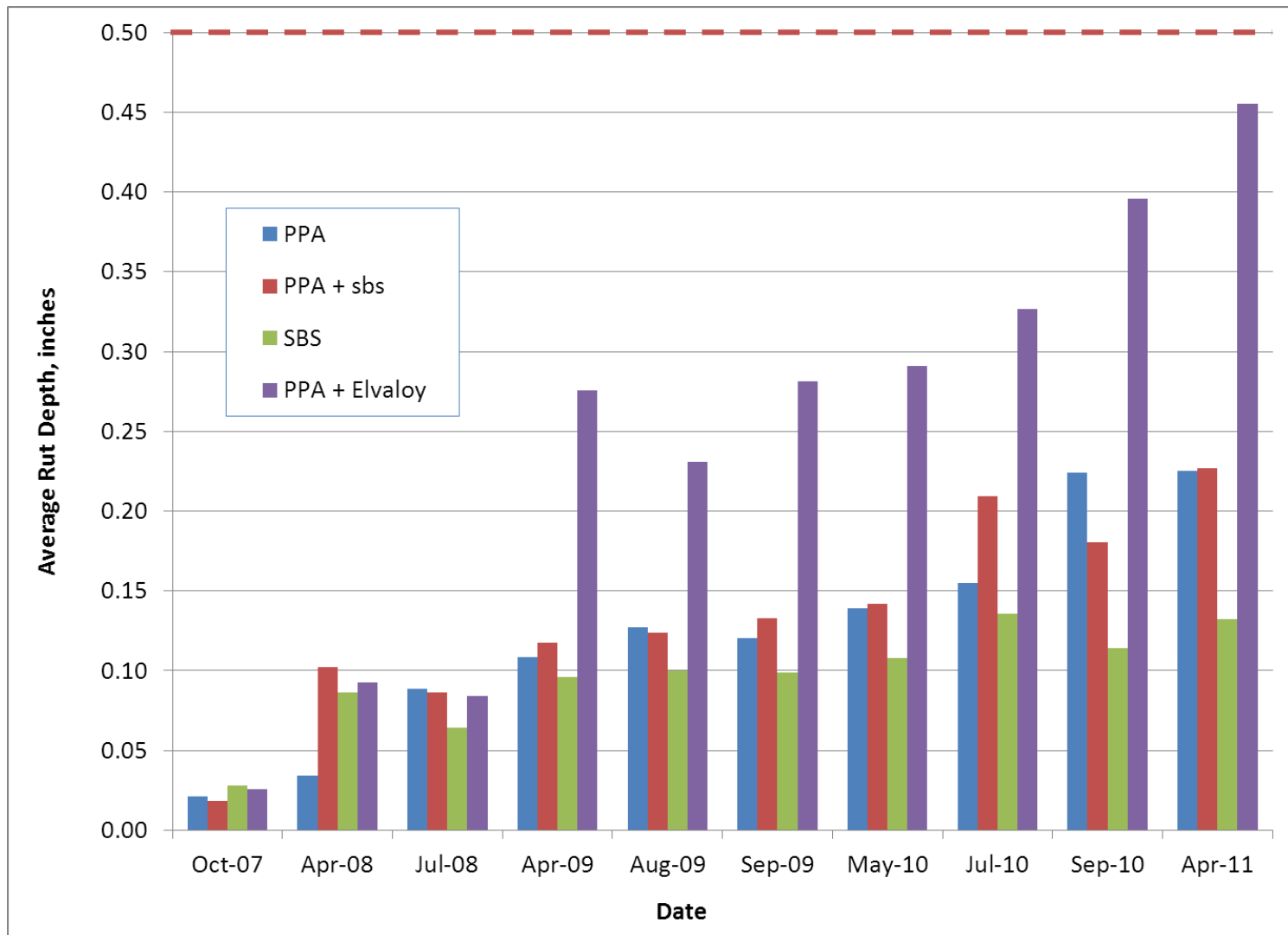
## Fatigue



## Fracture

500 microstrain fatigue life

# Field Rutting Data

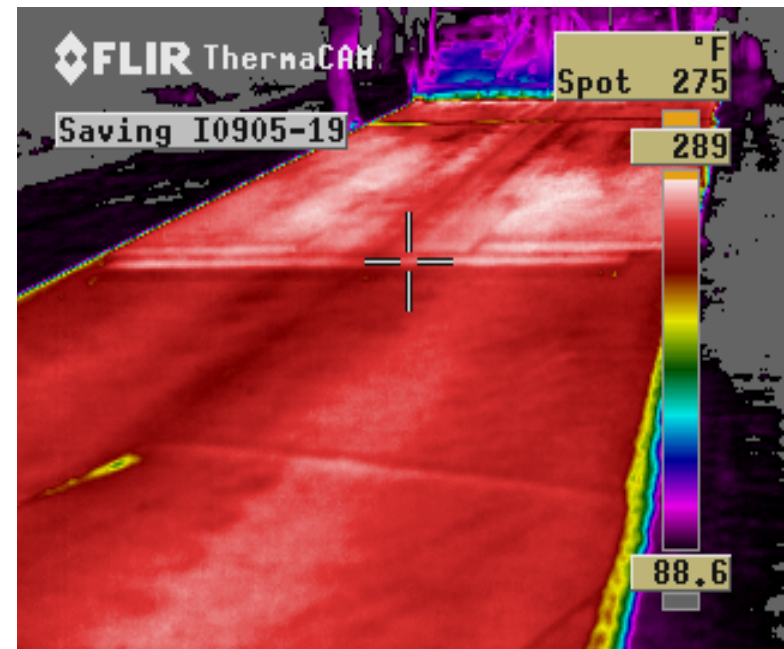


# PPA Project Status

- ❑ TRB Circular from 2009 Workshop
- ❑ Several published papers from study
  - ❑ TRB, AAPT, ASCE Journal, etc.
  - ❑ Numerous conference & workshop presentations
- ❑ Funding is complete
- ❑ Final report due in 2012
- ❑ PPA + Polymer generally performed better than either modifier alone
- ❑ **No Big Deal!**

# Warm Mix Asphalt

- ❑ 6 Cells on Mainline
- ❑ Control on LVR
- ❑ New construction (2008)
  
- ❑ Elvaloy
- ❑ PPA
- ❑ Evotherm 3G
  - ❑ Lubricator
  - ❑ Anti-strip



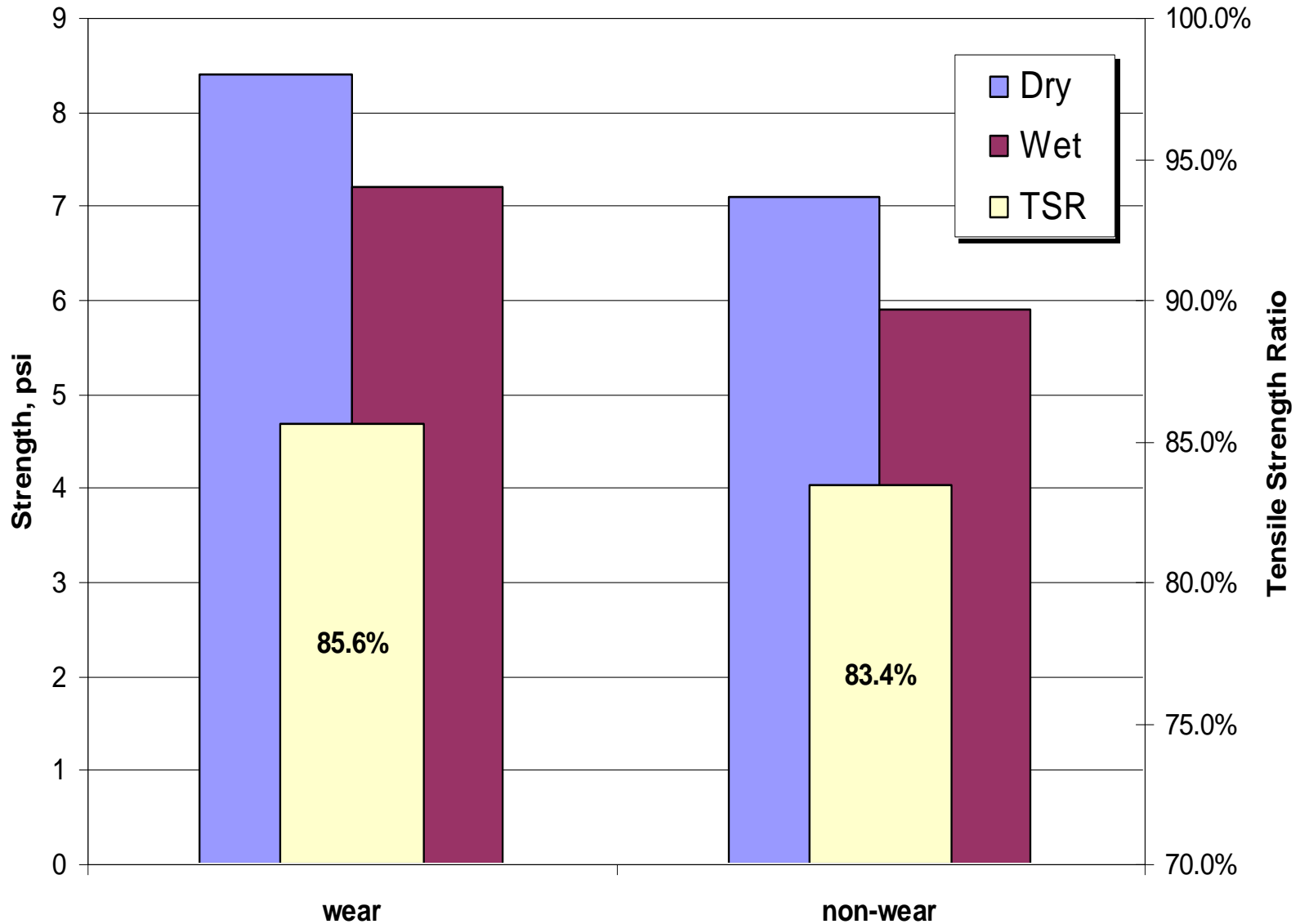
# Mix Design Requirements

- ❑ Wear and Non-Wear
- ❑ 12.5 mm NMAS
- ❑ Traffic Level 4
- ❑ PG 58-34
- ❑ 20% RAP from MnROAD
- ❑ No requirements for WMA technology
  - ❑ Hardrives chose REVIX (Evotherm 3G)

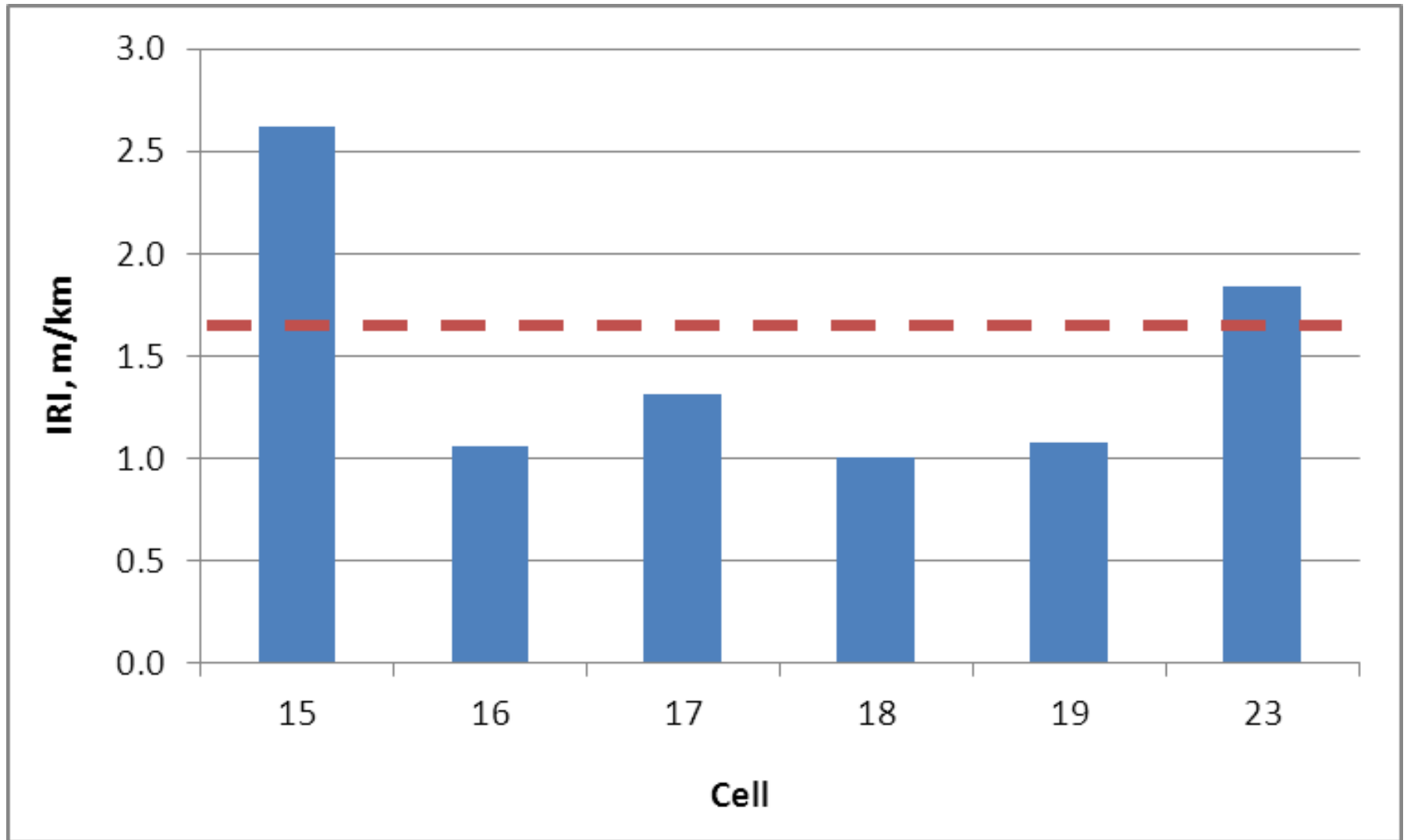
# Construction Lessons Learned

- ❑ More lab work needed at mix design to determine compaction temperature range
- ❑ Definite energy savings
- ❑ Appears as though fumes/emissions were less
- ❑ Equal density appears to be achievable with equal or less effort
- ❑ **No Big Deal!**

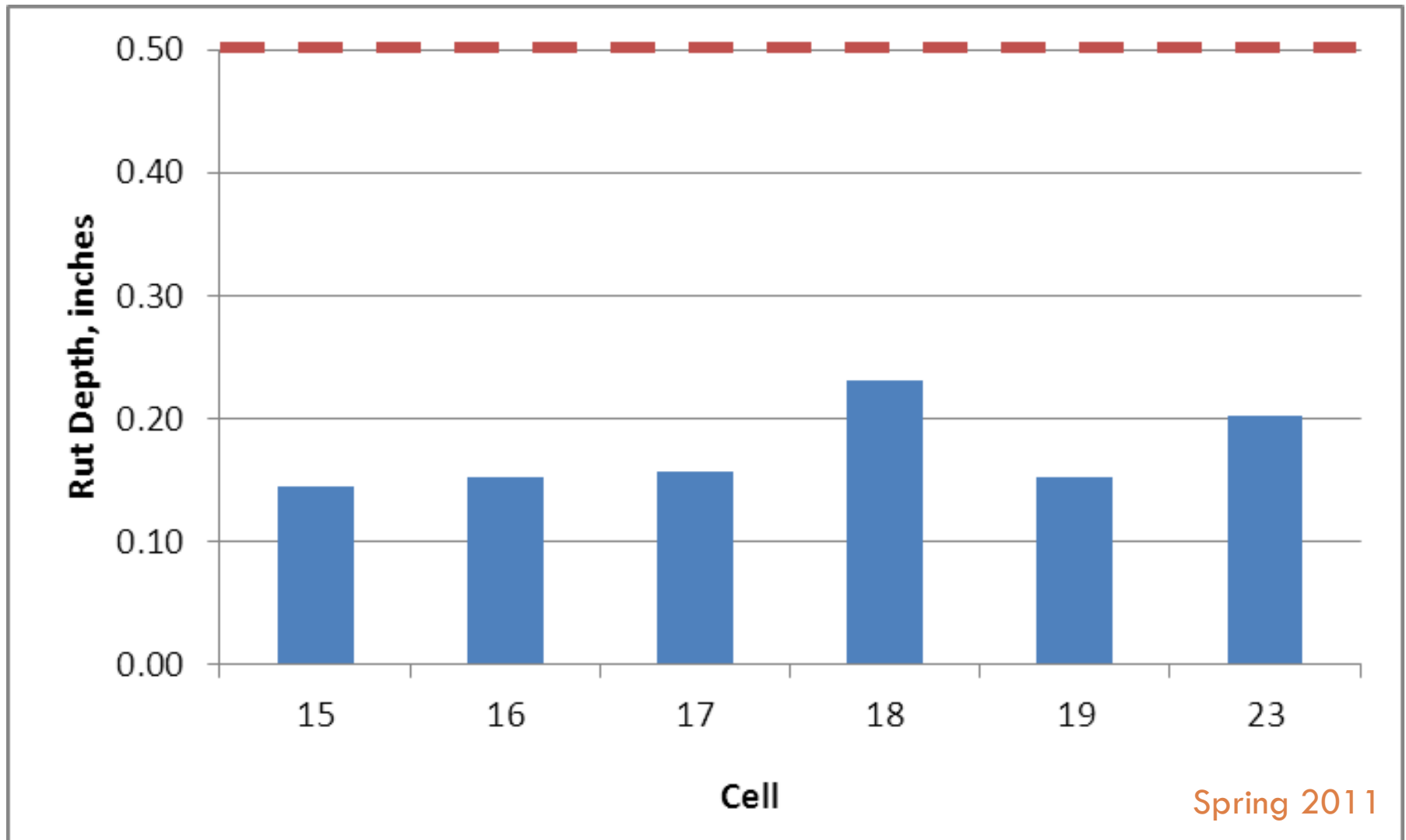
# Moisture Damage Potential



# WMA Ride Performance



# WMA Rutting Performance



# WMA Field Performance (2)

- ❑ 1 transverse crack in 5 test sections
  - ❑ Over instrumentation area (inadequate compaction)
- ❑ 25% reflective cracking on 3" WMA overlay
- ❑ So far, so good



# Great, But What Does It Cost?

Binder Grade	Price per Liquid Ton
PG 58-28	\$410
PG 64-28	\$530
PG 58-34	\$555
PG 64-34	\$585

# Summary

- ❑ Modified binders have shown excellent performance at MnROAD
  - ❑ Minimal cracking and rutting
  - ❑ Similar to MnDOT network performance
  - ❑ Better than neat binders
- ❑ SBS and Elvaloy provide great polymer modification
- ❑ PPA modification is an acceptable alternative at (generally) a lower cost
- ❑ Even dry additive works at times
- ❑ Life Cycle Cost?

# Thank You!



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