Polyphosphoric Acid Modified Asphalt in Conjunction with Lime as an Antistripping Agent

Performance of Asphalt Mixtures used in MN Road Pavement Test Track: Preliminary Results

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Overview

- Goal
- Polyphosphoric Acid (PPA)
- Test Track
- Mix Design
- Performance Data
  - Rutting
  - Field Mix
  - Lab Mix
- Conclusions

Project Goal

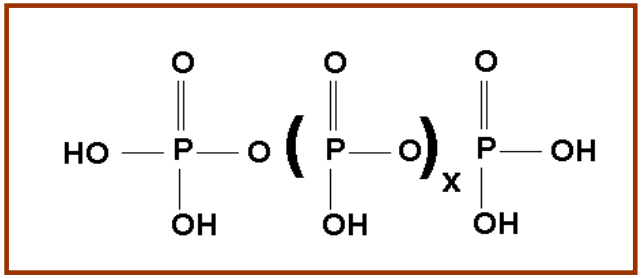
To evaluate the impact of lime used as an anti-strip additive in conjunction with PPA in modified asphalt.

History of PPA in Asphalt Pavement

- 35 years: Starting from Tosco-Lion, US Patent 3,751,278 (1973)
- 20+ Patents. Since 2000: 50+ Publications
  - Concerns: Amine, Lime Anti-Strip
- NCAT Test Track 2000, 2003 18 Test Sections, 10 M ESAL
  - SBS/PPA; Various aggregates; Amine or lime anti-strip
  - Improved rut depth, 1 fatigue crack, no moisture damage
- Asphalt Institute task group – ongoing
  - Identify roads with PPA & evaluate field performance
- PPA usage: 3.5 to 14% of the asphalt pavement in USA
  - Estimated 100 to 400 million ton of hot mix over last 5 years

Polyphosphoric Acid (PPA)

- PPA Chemical Attributes
  - Different from Orthophosphoric acid
  - No Free Water



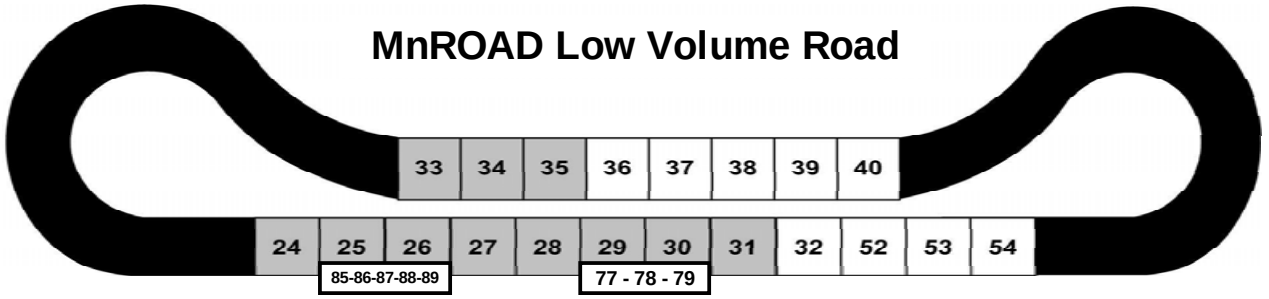
- Phosphate ester = compatible anti-strip
- Increases asphalt stiffness, Improves rutting resistance, expands PG range to meet Superpave specs
- Does not affect low-temperature grading
- In systems with polymers
  - Jointly with SBS, improves Jnr
  - Faster reaction time with reactive terpolymers (Elvaloy®)

PPA Modified Asphalt Study

- Joint effort of public agencies and private industry:
  - MNDOT, FHWA, Innophos, ICL-Performance Products, MTE, Paragon, Marathon, Dupont , WRI
- Test cell construction completed in fall of 2007, opened Nov 2007
- Performance to be assessed over 5 year period
- Today: Preliminary 8-month report

MnROAD
Minnesota Low Volume Road - Test Track

- 2 lane, 2.5 mile; 500 ft section; 18 wheel, 5 axle test vehicle
- 80 Klb and 120 Klb loads; presently 80 Klb only



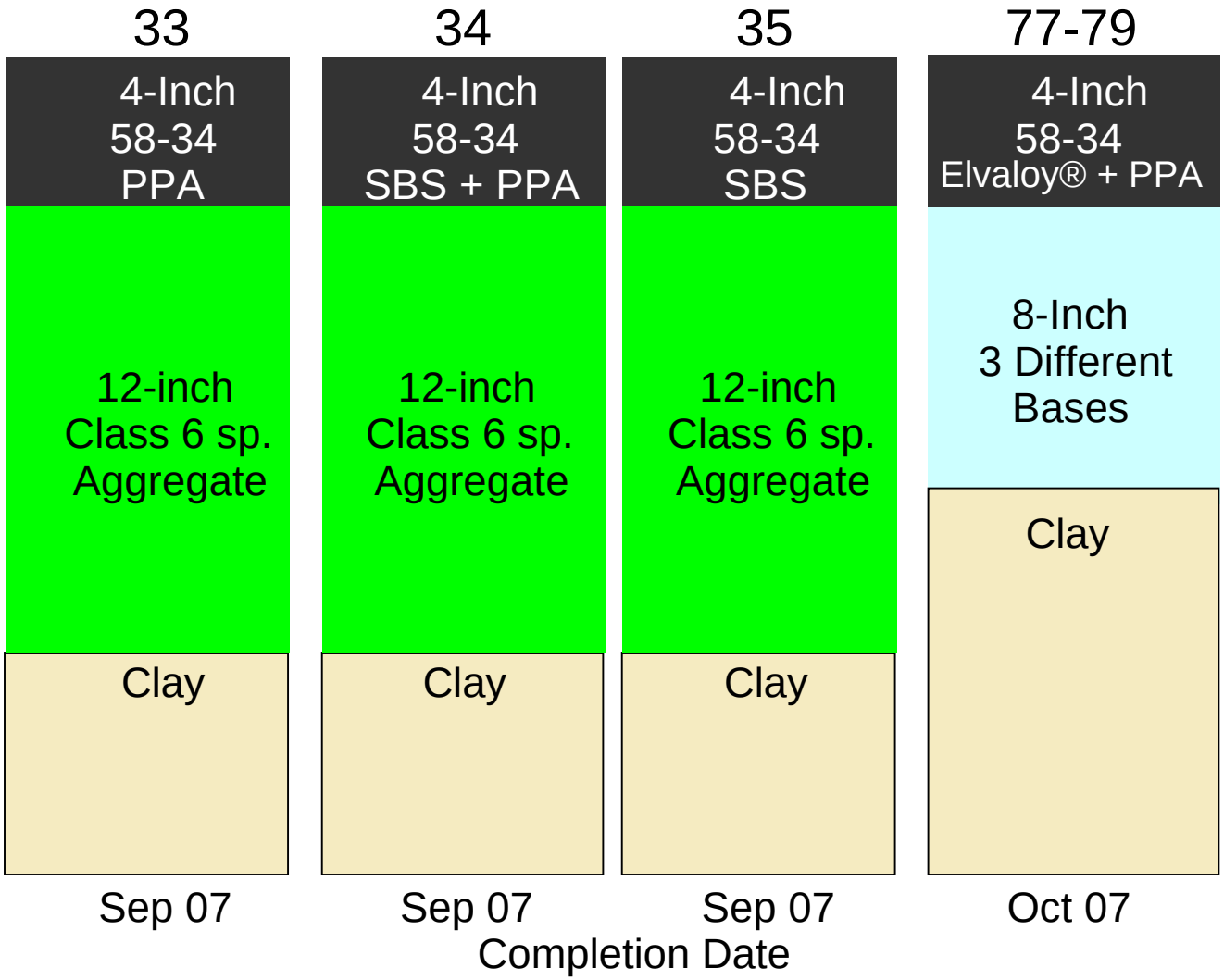
Mix Design

- Level 3 Superpave: (1 – 3 Million ESALs), N_{design} = 60
- PG 52-34 binder modified to PG 58-34
- Liquid Anti-Strip – Phosphate Ester
- 1% Hydrated Lime
- Granite Aggregate, 12.5 mm NMAS
  - Washed sand
- No Recycled Asphalt Pavement (RAP)

Test Matrix

Cell Number	33	34	35	77-79
PPA, Wt%	0.75	0.3		0.3
Polymer, Wt%	0.0	1.0	2.0	1.0
Polymer Type		SBS	SBS	Elvaloy®
True Grade, PG as shipped	62.1 - 35.7	62.5 - 35.5	62.1 - 34.8	62.7 - 35.1
Innovalt® W Anti-Strip, Wt%	0.5	0.5		0.5
Hydrated Lime, % Mix	1.0	1.0	1.0	1.0
Binder, % Mix	5.4	5.5	5.4	5.2
% Max Density	94.2	93.5	93.6	92.2
Air Voids, %	5.8	6.5	6.4	7.8

Cell Composition



Instrumentation

- Thermocouples
  - HMA + Base + Subgrade
- Strain Gauge
  - HMA/Base Interface
  - Longitudinal and Transverse
- Moisture Gauge
  - Base + Subgrade
- Dynamic Pressure Cell
  - Base/Subgrade Interface
- Falling Weight Deflectometer

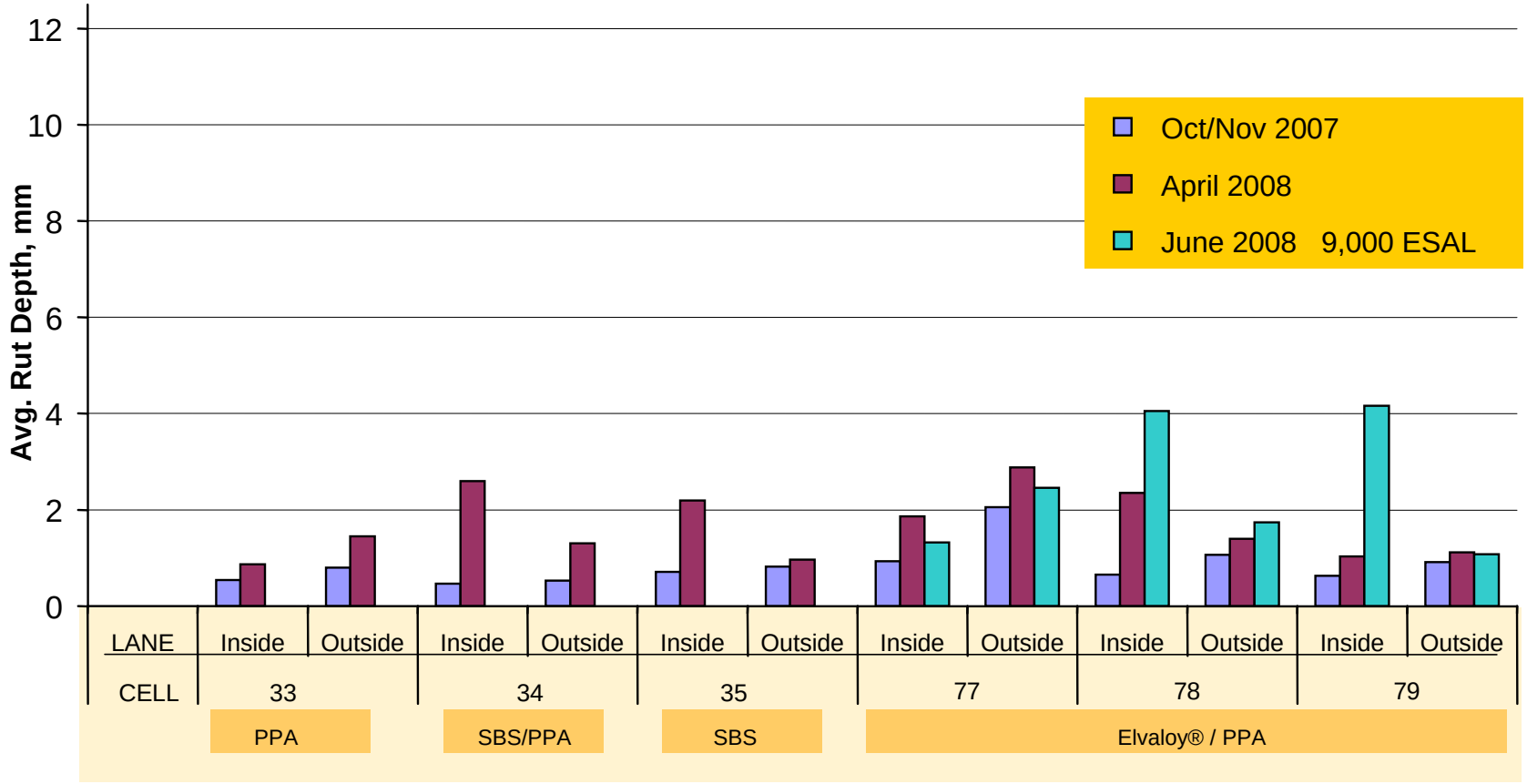
Monitoring

- Environmental Conditions
- Rutting
- Fatigue
- Moisture Damage
- Low-Temperature Cracking
- Friction, Surface Texture, Noise

Cell 34 SBS/PPA July 2008

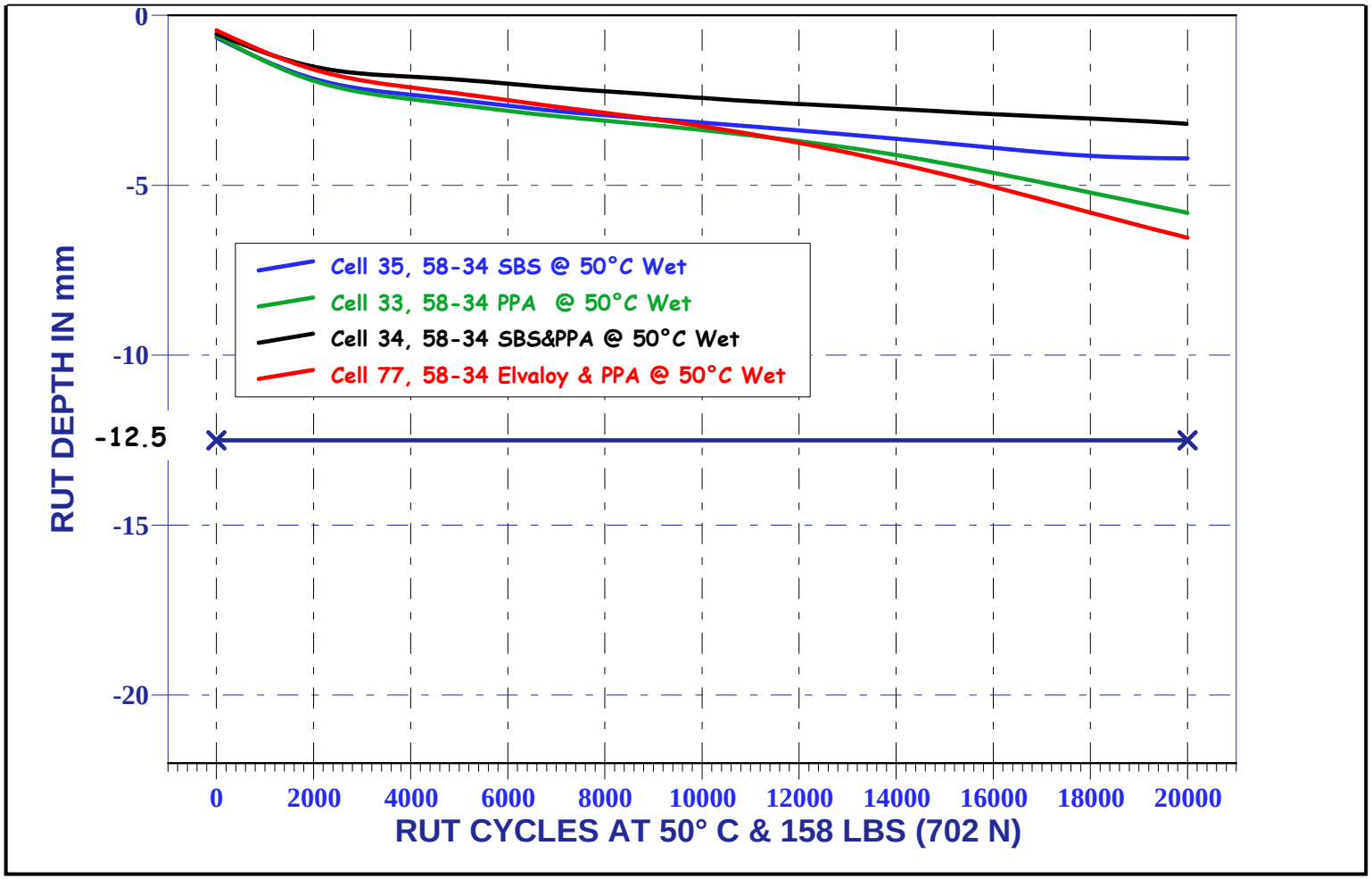
Cell 34 SBS/PPA July 2008

Rut Depth at MnROAD - Field Data
Advanced Laser Profile System (ALPS)



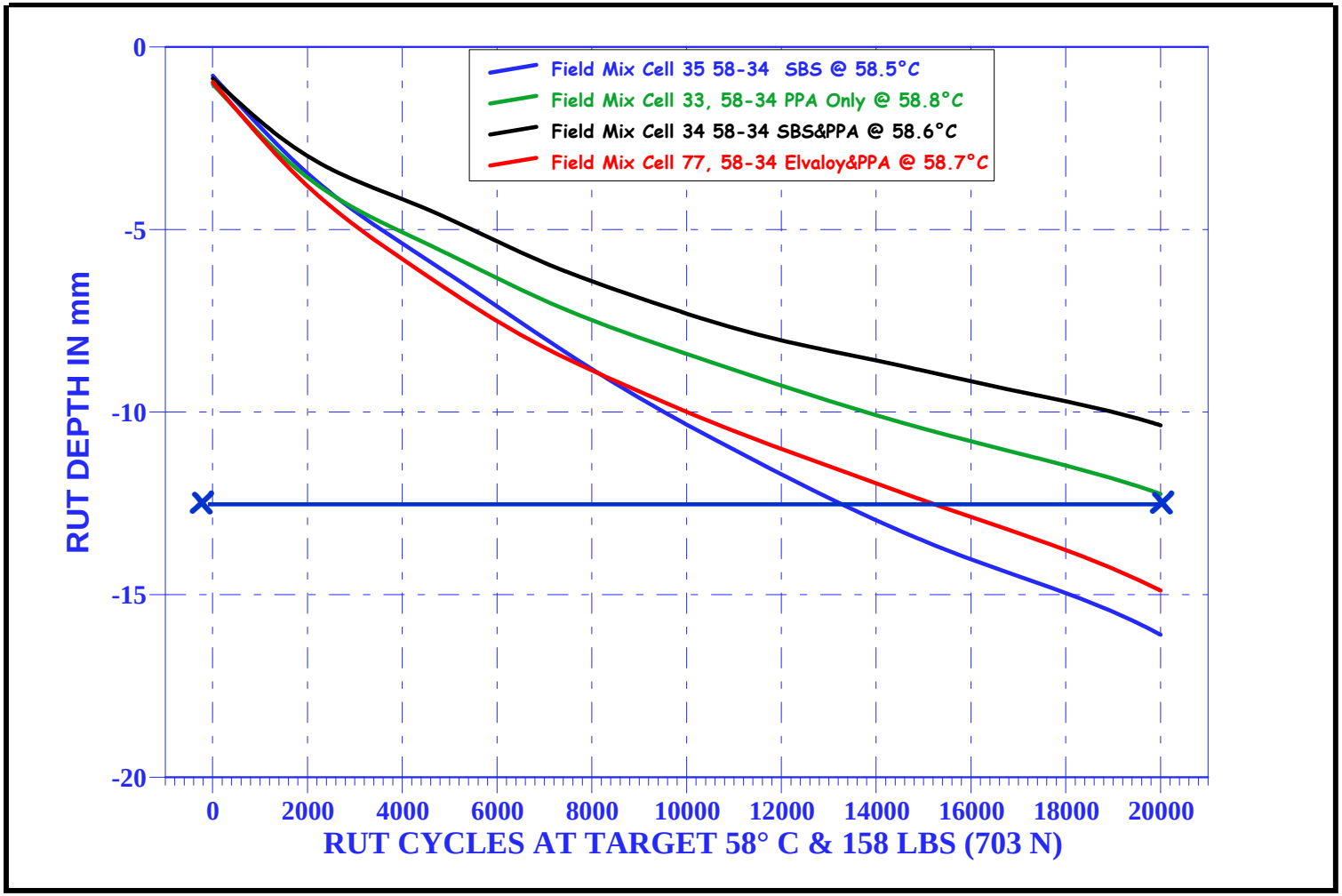
Early field data demonstrate minimal rutting at 9,000 ESAL.

MnROAD Field Mix
Hamburg Wet Rut Test @ 50°C



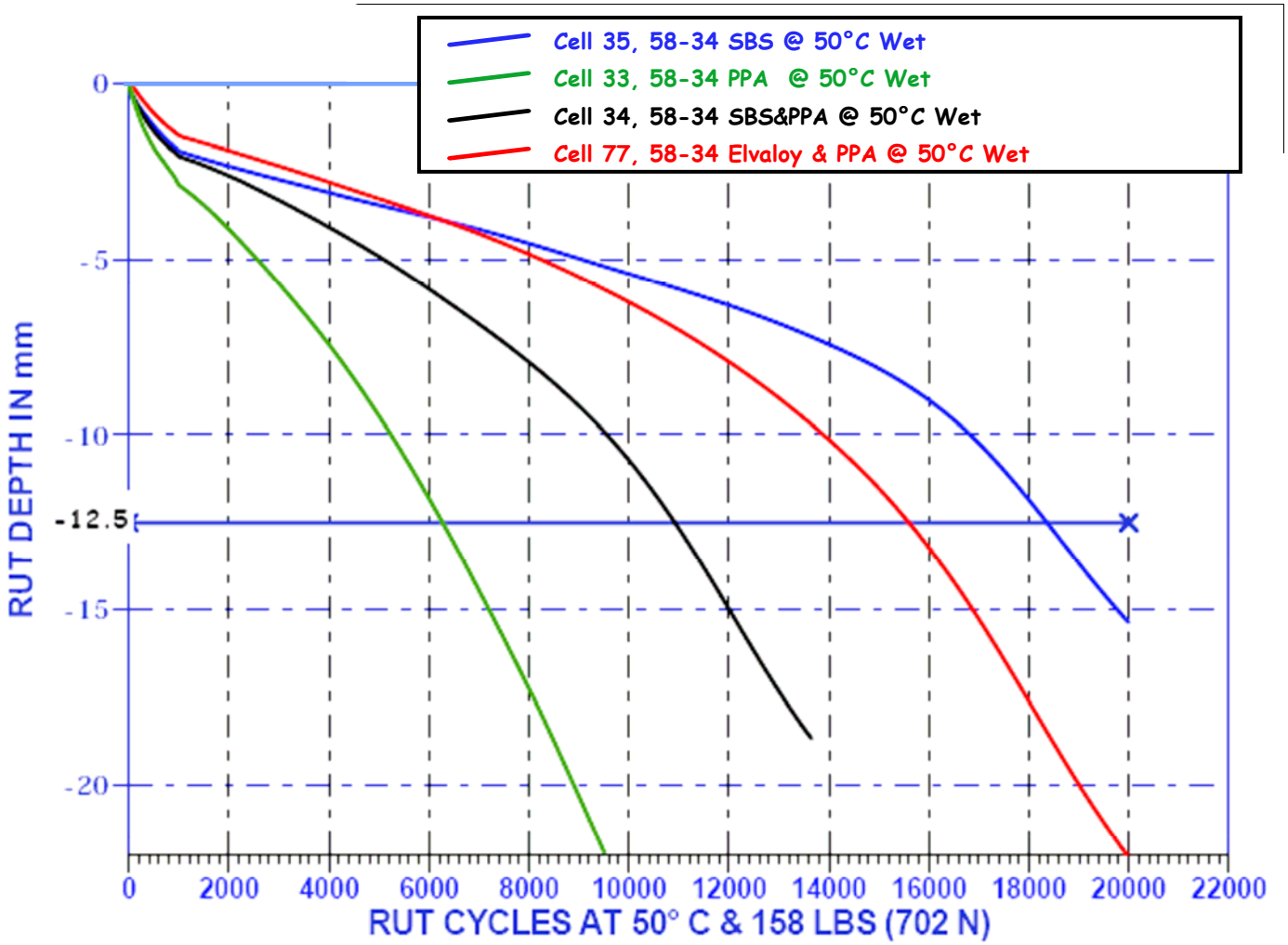
Field mix samples show excellent performance for all PPA treatments.

MnROAD Field Mix
Hamburg Dry Rut Test @ 58°C



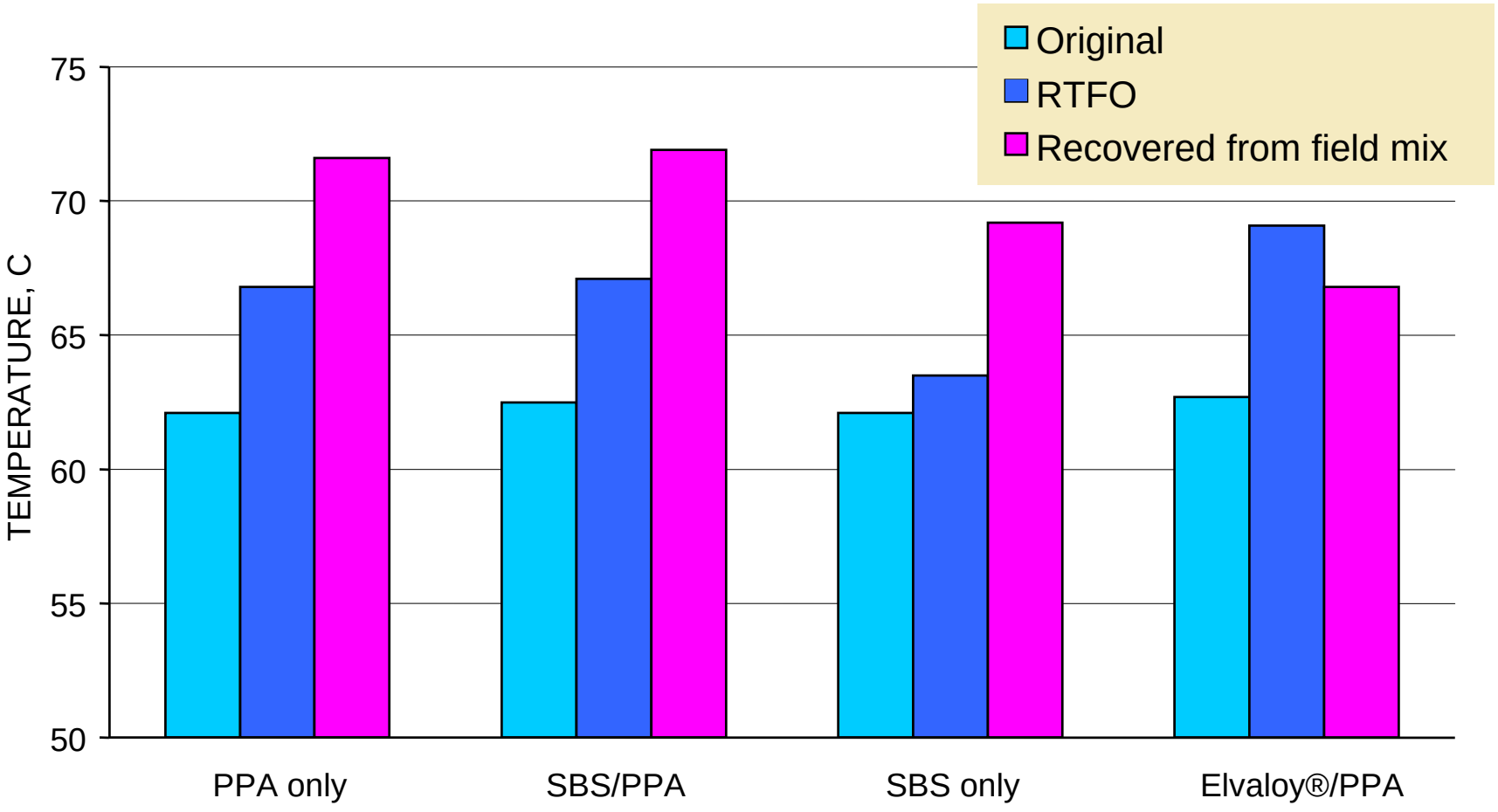
Field mix samples show good performance for all PPA treatments.

MnROAD LAB Mix
Hamburg Wet Rut Test @ 50°C



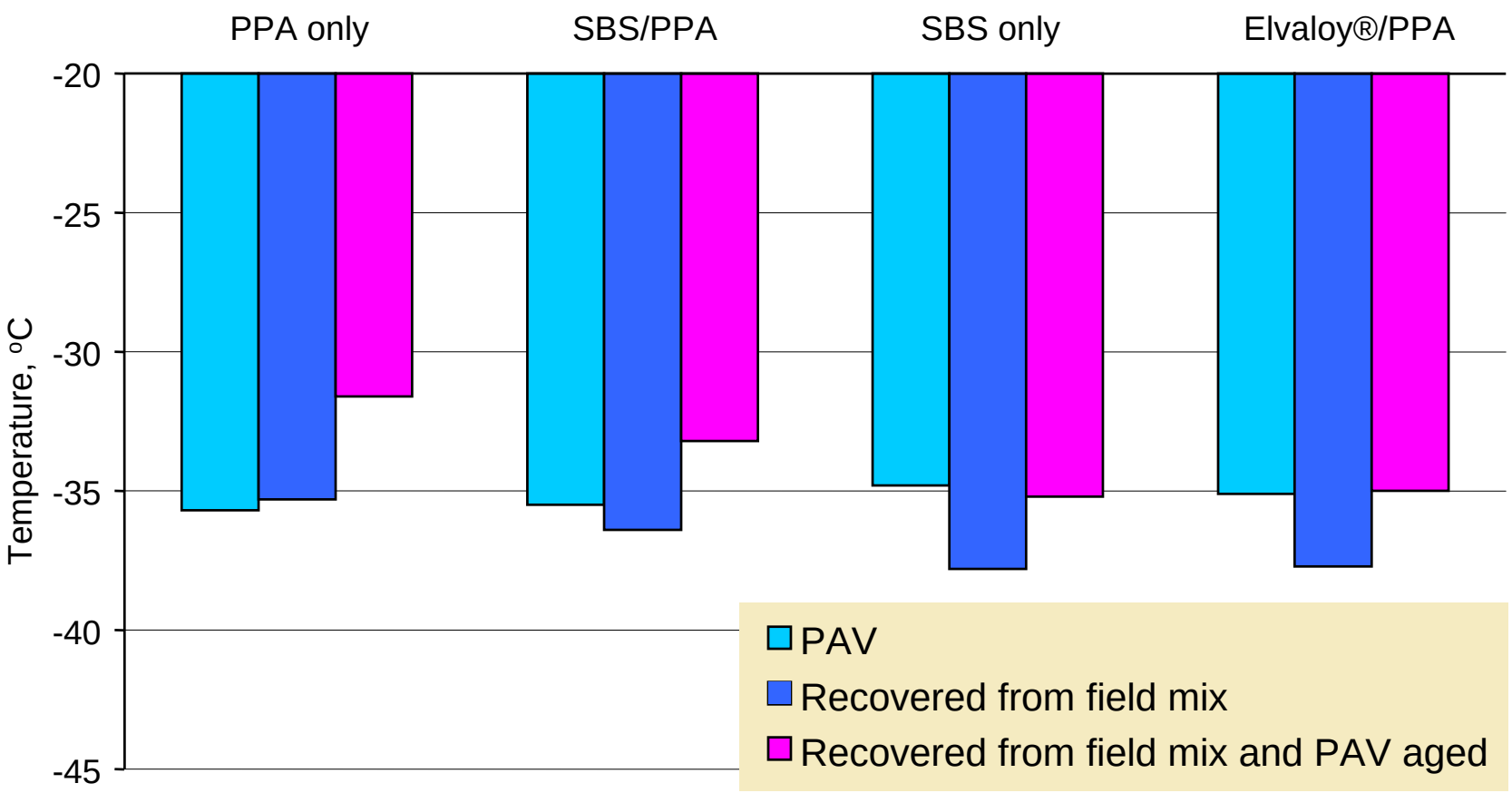
Tests of lab mix do not show what we are seeing in the field.

High-Temperature PG Grade



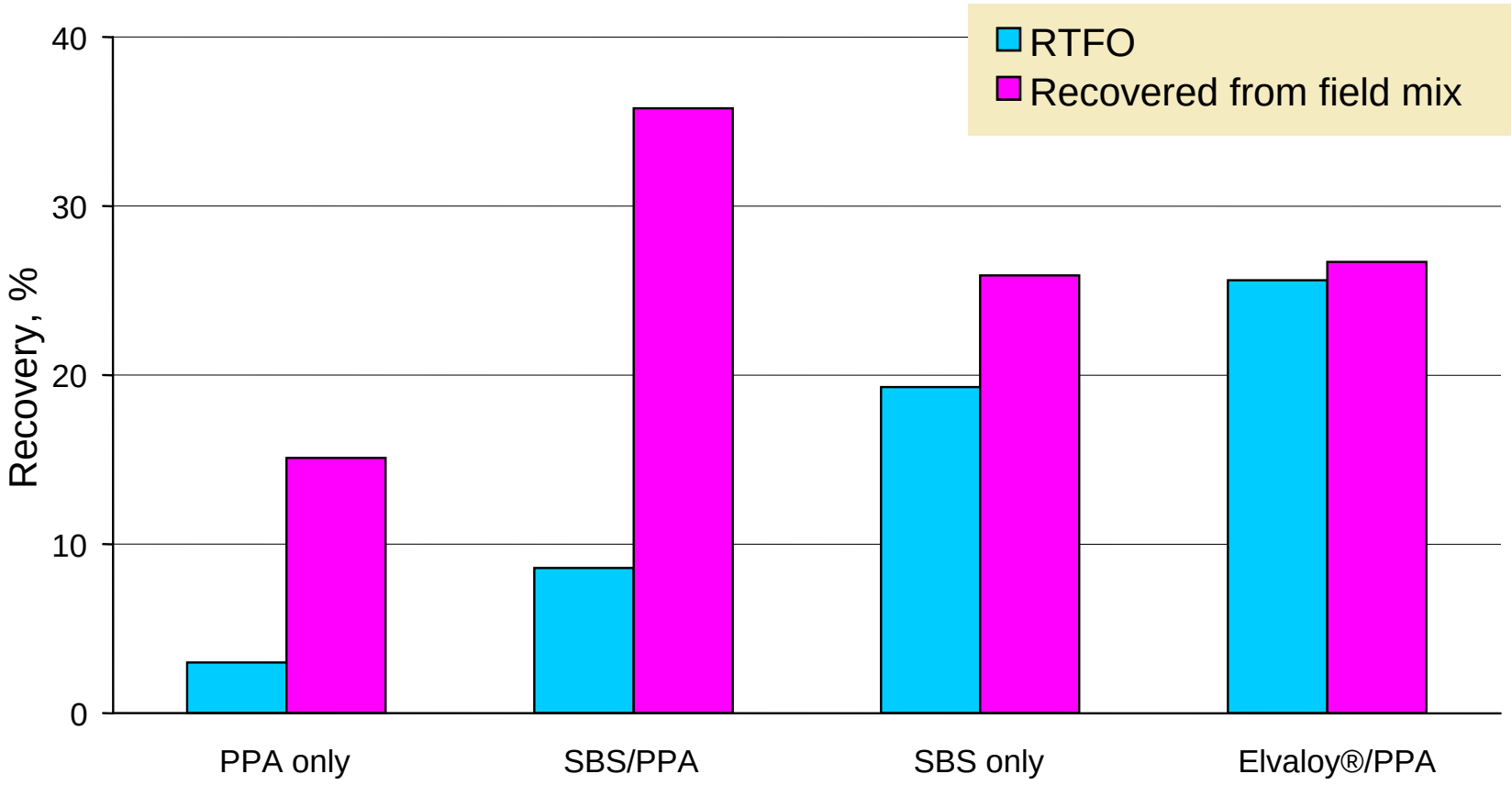
Field-aged samples perform differently than lab-aged samples.

Low-Temperature PG Grade



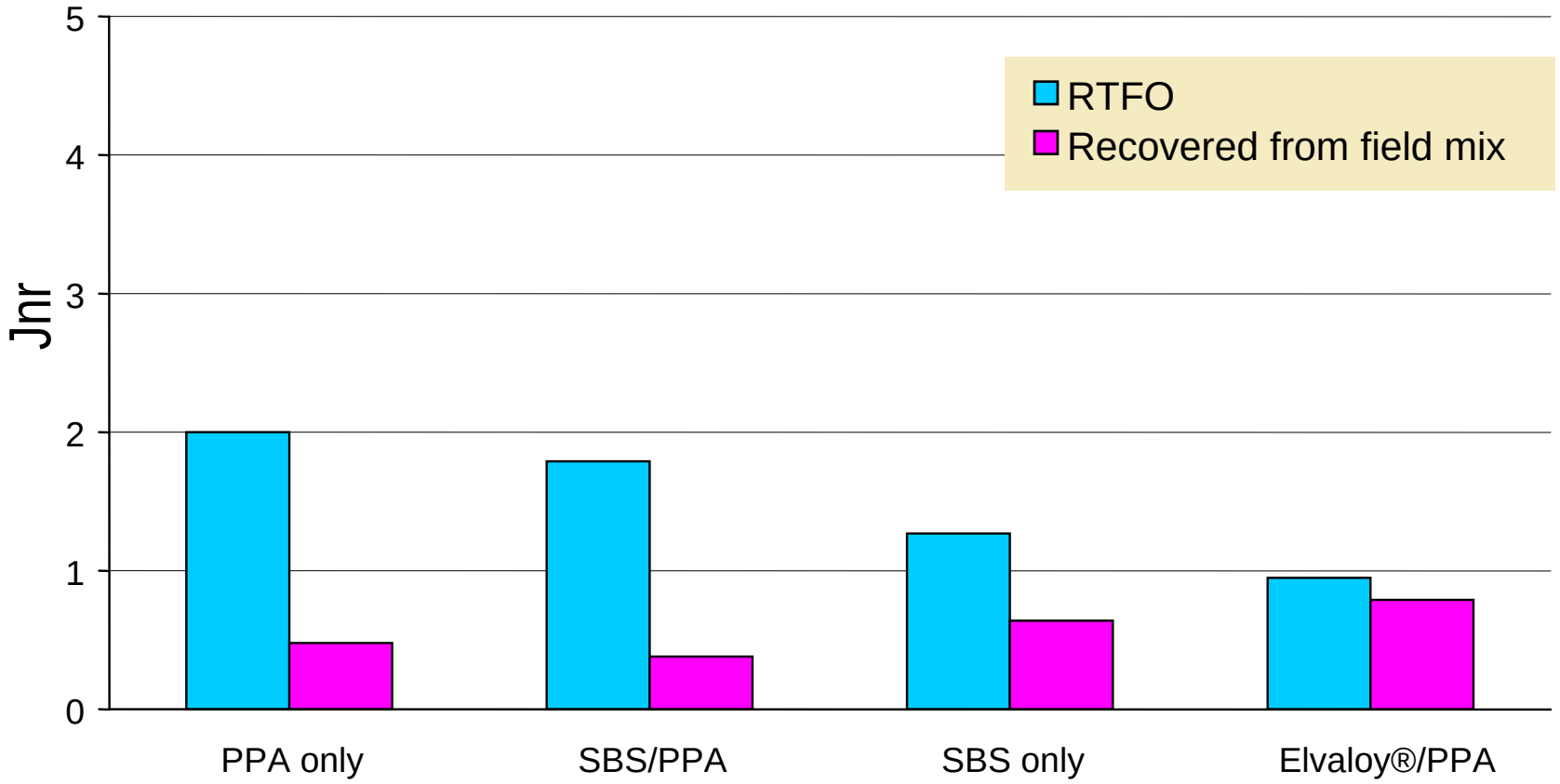
Field-aged samples perform the same as lab-aged samples.

MSCR @ 58°C, 3.2 kPa



Some field samples perform differently than lab aged samples.

Jnr Values @ 58°C, 3.2 kPa



- Field aged samples perform better than lab aged samples.
- SBS/PPA performed better than SBS or PPA alone.

Summary

- MnROAD cells with PPA performing well since construction in fall 2007
- Field HMA samples showed excellent rutting & stripping performance in Hamburg Wheel Rutting tests
- Lab mix preparations showed different performance profiles
- Polymer/PPA performed better than either modifier alone
- Cells will continue to be monitored for 5 years

Thanks for your attention

- Thanks to co-authors & co-contributors
- Thanks to Rene Maldonado, ICL-Performance Products

MnROAD LAB Mix – No Innovalt W® Anti-Strip Hamburg Wet Rut Test @ 50°C