HIGHLY MODIFIED BINDERS FOR THIN LIFT AND MICRO SURFACING EMULSION APPLICATIONS

Midwest Preservation Partnership Meeting

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Chris Lubbers, Kraton Polymers, LLC




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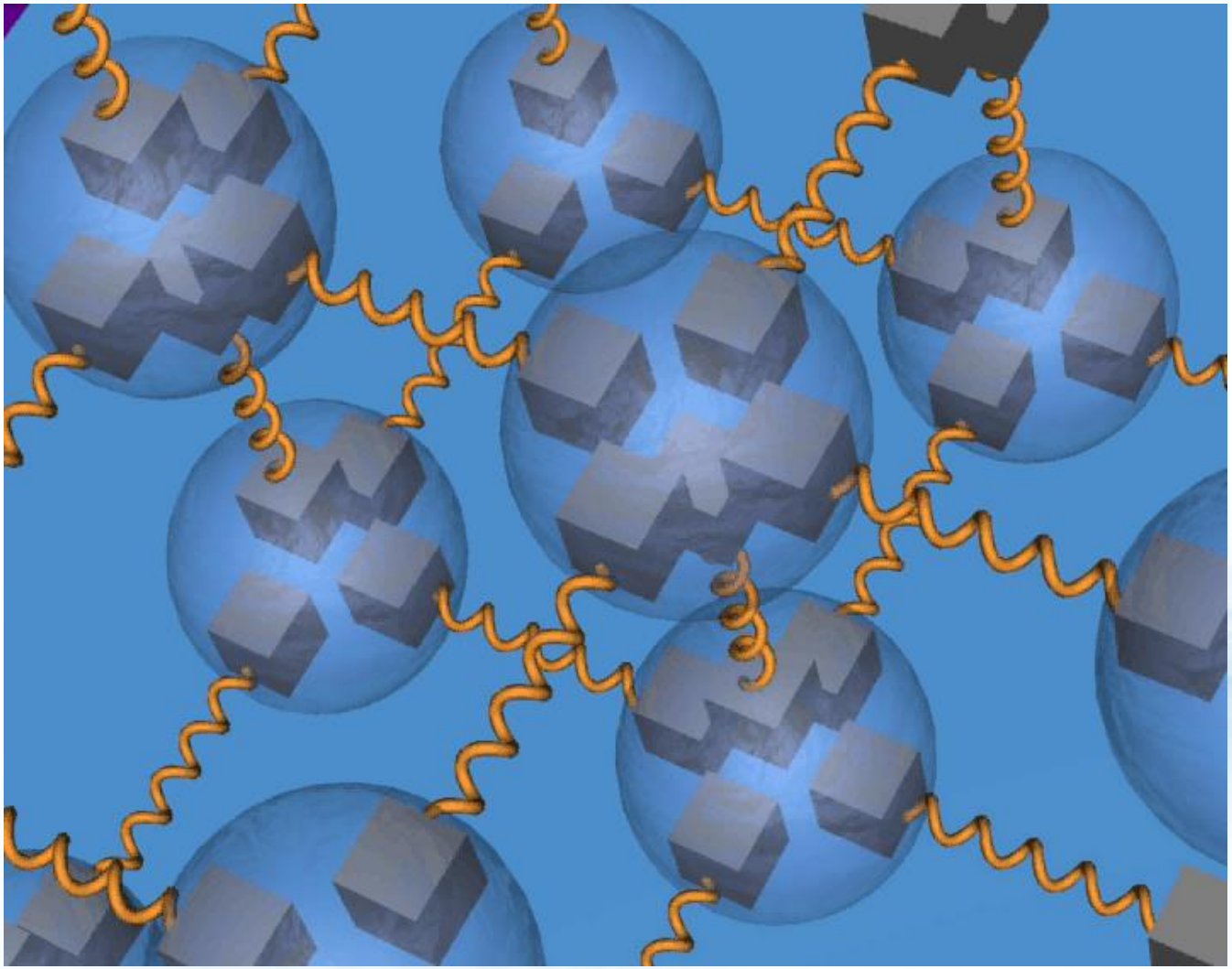
Giving Innovators Their Edge

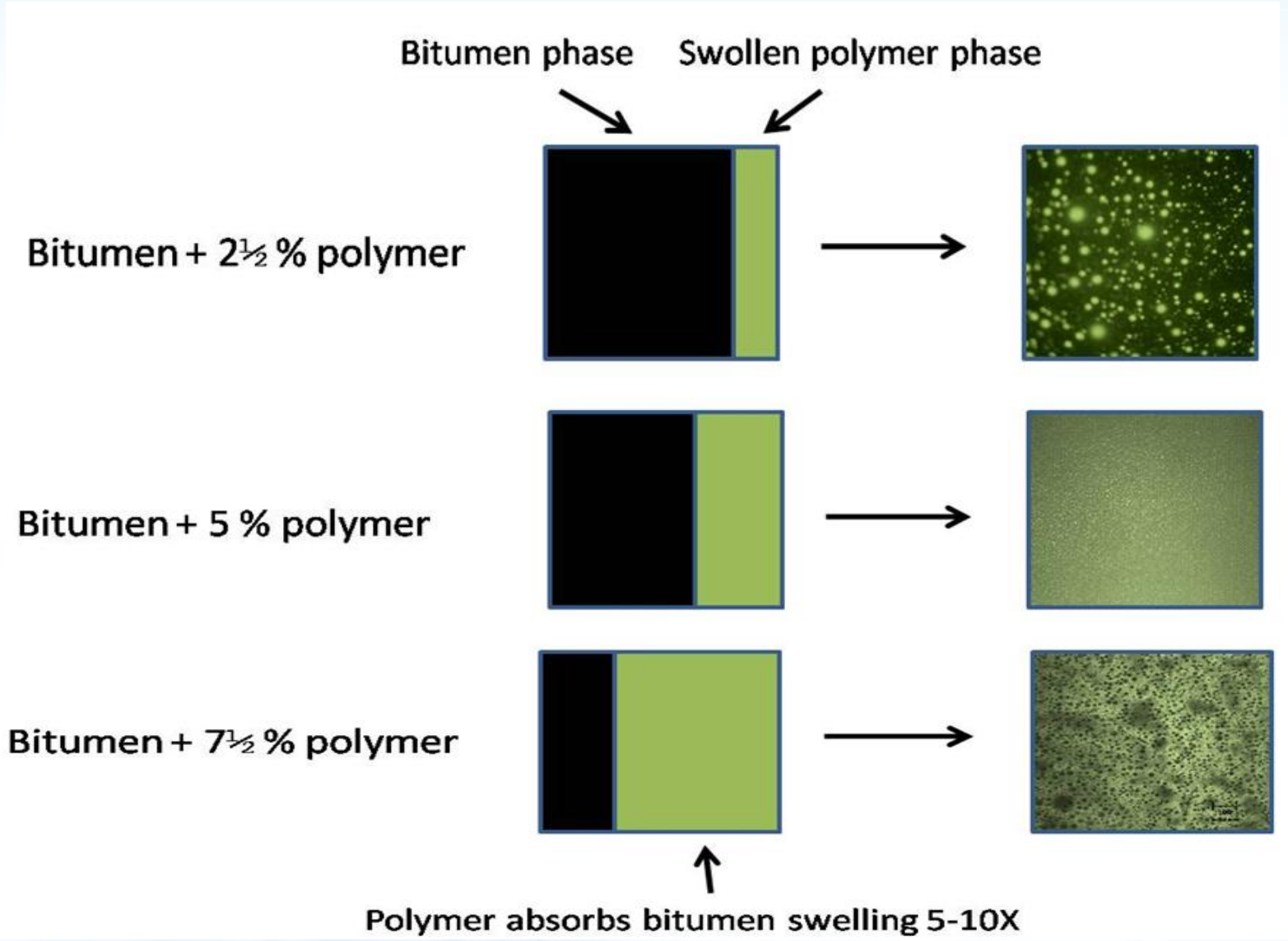
Outline

- How SBS Works in Bitumen
- Background of the Highly-Modified (HiMA) Binder Concept
- Pavement Trials – NCAT – Structural
- Pavement Trials – Thin Lift (AASHTO TSP2) + Micro Surfacing

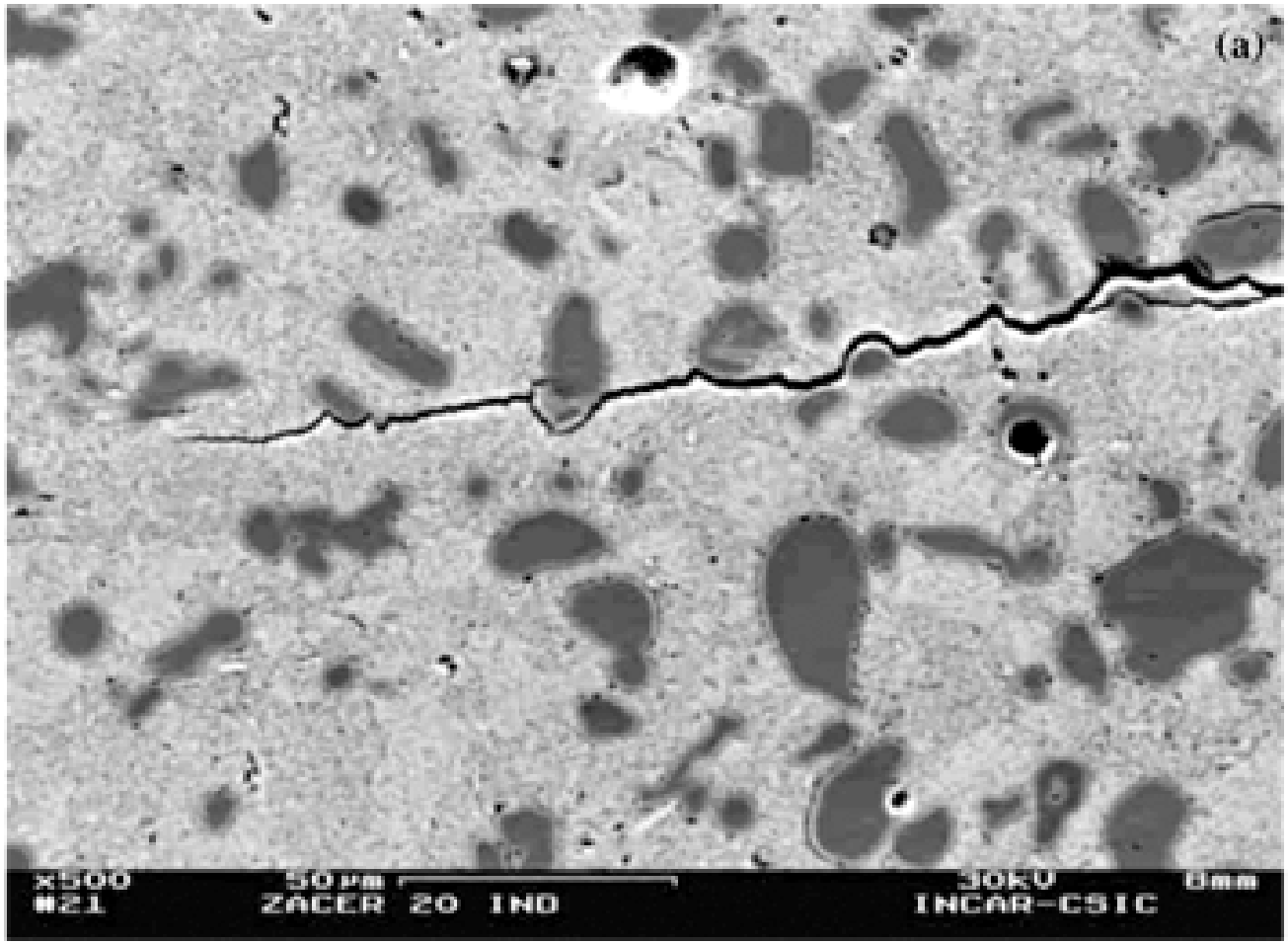
SBS in Bitumen



Phase Morphology

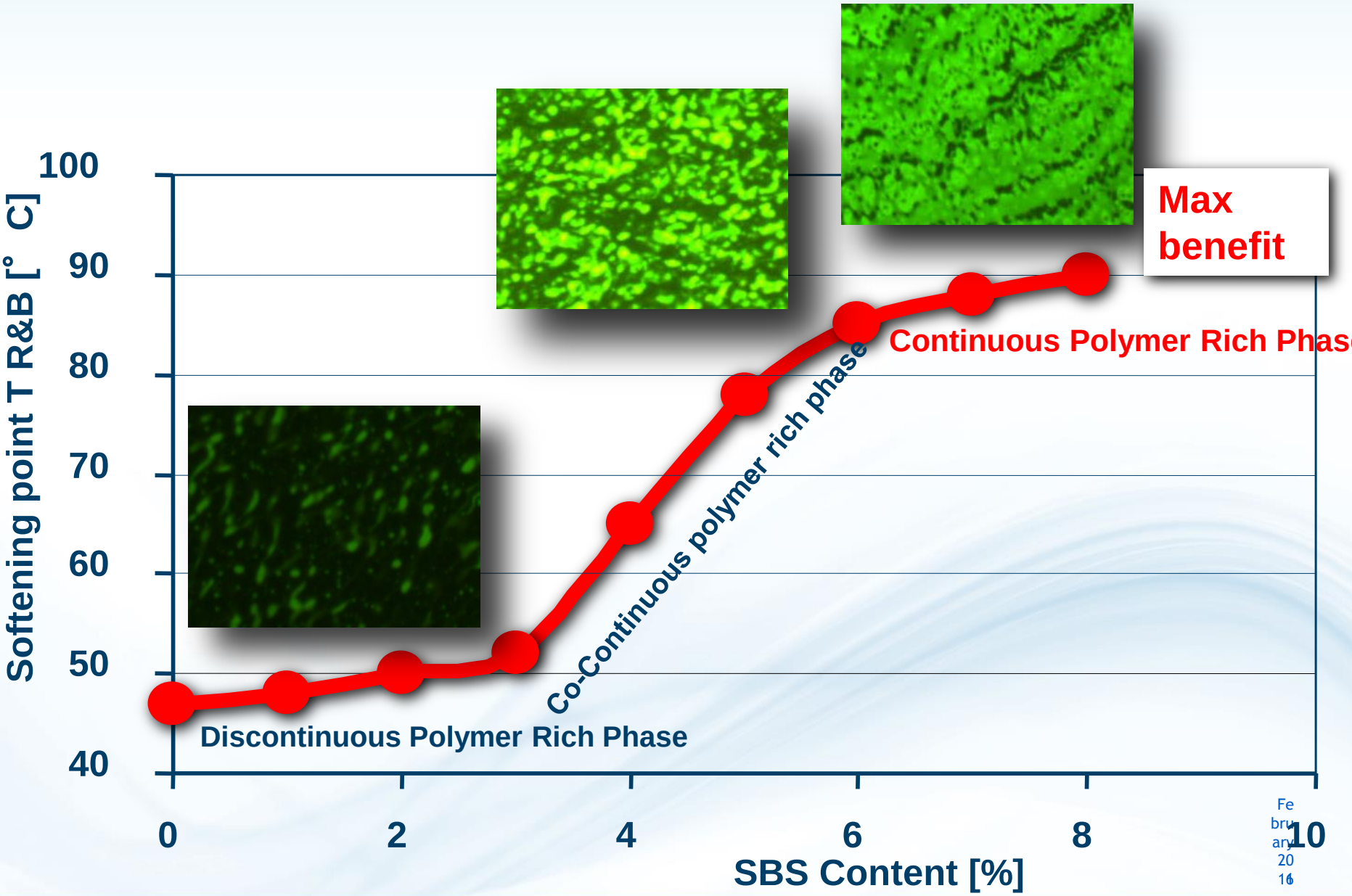


Crack Propagation in Toughened Composite



S. López-Esteban, J.F. Bartolemé, C. Percharromán, S.R.H. Mello Castanho, J.S. Moya, *Wet Processing and Characterization of ZrO_2/Stainless Steel Composites: Electrical and Mechanical Performance*, Materials Research, Vol. 4, São Carlos, July 2001. Used with permission.

HiMA Binders – Asphalt – Modified Polymer

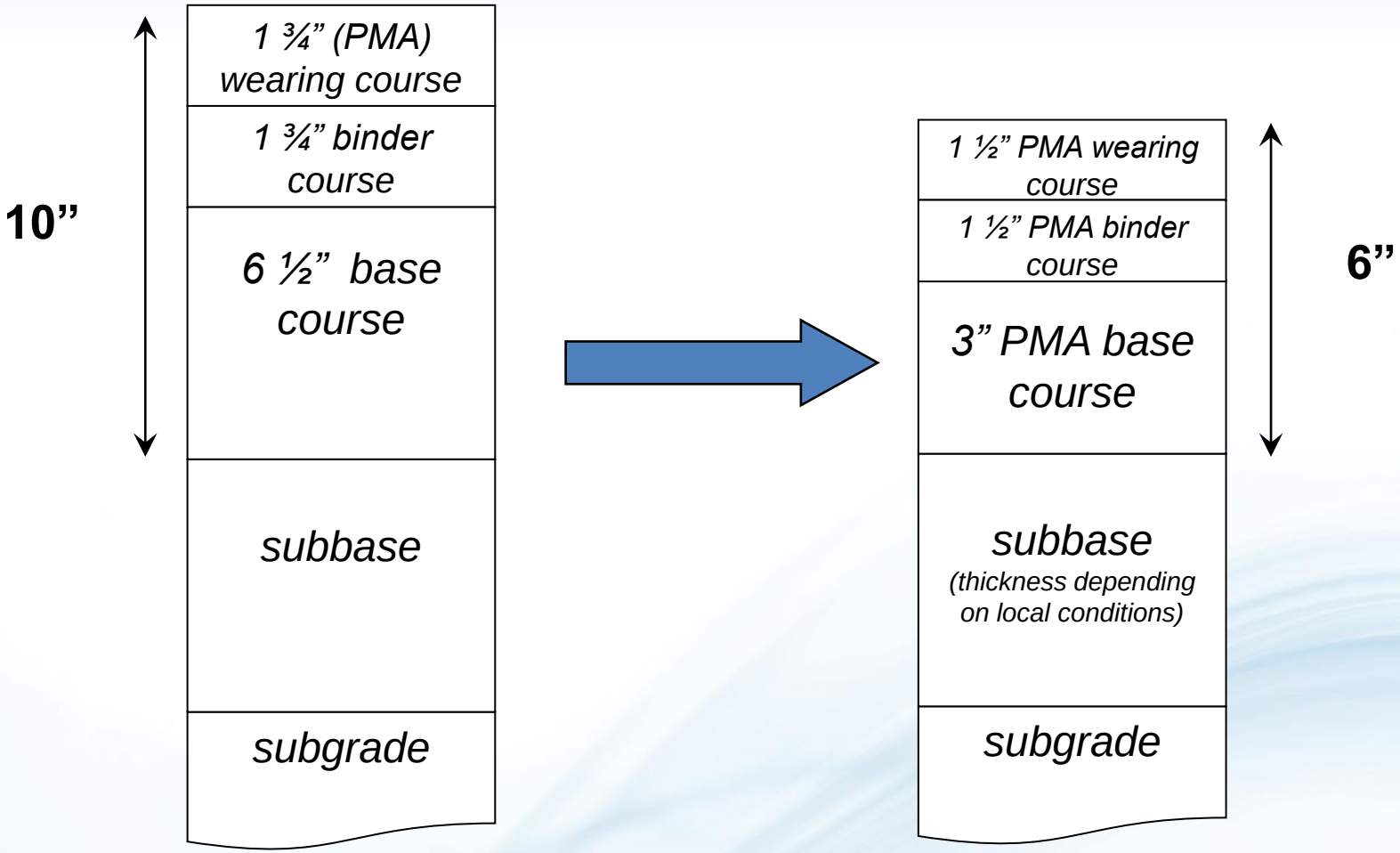


Background – HiMA Binder Concept

- Higher traffic intensities and pavement loadings require more durable pavements.
- Higher traffic intensities also command longer maintenance intervals to increase availability of the road.
- Environmental pressure is increasing; reduction of use of natural resources such as aggregate and less emissions are highly desired.
- SBS modification has proven benefits in wearing courses over the past decades in every relevant property.

→ Use the benefits of SBS to create a polymer modified base course, intermediate course, and/or wearing course at reduced thickness – individual layer or composite pavement design

Proposed System Redesign



This an example; depending on local conditions other types may apply

Applications

- Highly Modified Asphalt is a tool. It can be used to improve performance and cost effectiveness in a variety of asphalt paving applications:

- **New construction and structural rehabilitation – thinner structures, lower upfront cost.**
- **Preservation overlays – thinner structures, more resistant to thermal and reflective cracking. (AASHTO TSP2 program)**
- **Micro surfacing – more resistant to cracking and raveling**
- Open grade mixes – more resistant to raveling. Resistant to drain down (no need for fibers)
- Waterproof bridge decks – zero void mixes that are rut resistant and yet highly flexible
- Etc.

NCAT Trials

National Center for Asphalt Technology Auburn, Alabama

- 2.7 km dedicated test track
- Full pavement lifetime simulated in 2+ years

Thin structural test section N7 (2009)

- 18% thinner pavement, 145 mm versus
- 175 mm control sections
- 1/3 as much rutting
- No cracking

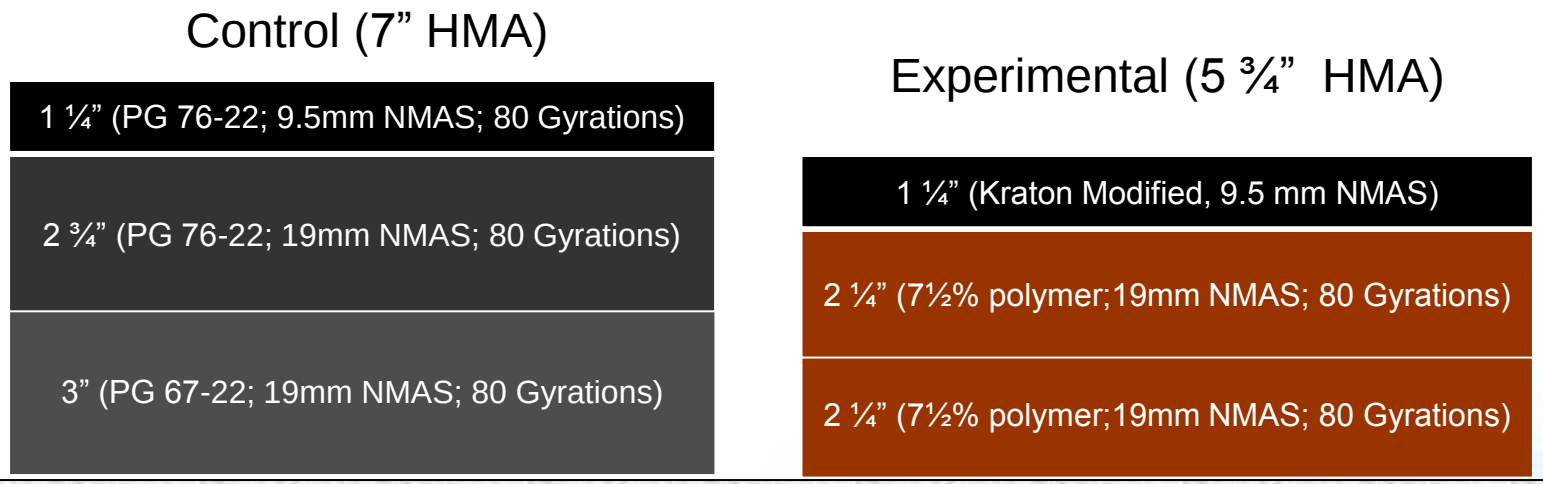
Structural rehabilitation N8 (2010)

- Oklahoma sponsored section
- Standard rehab (2009) failed in 10 months
- HiMA rehabilitation 4 mm rutting and no cracking at 24 months

Continuing N7 & N8 for 2012 cycle

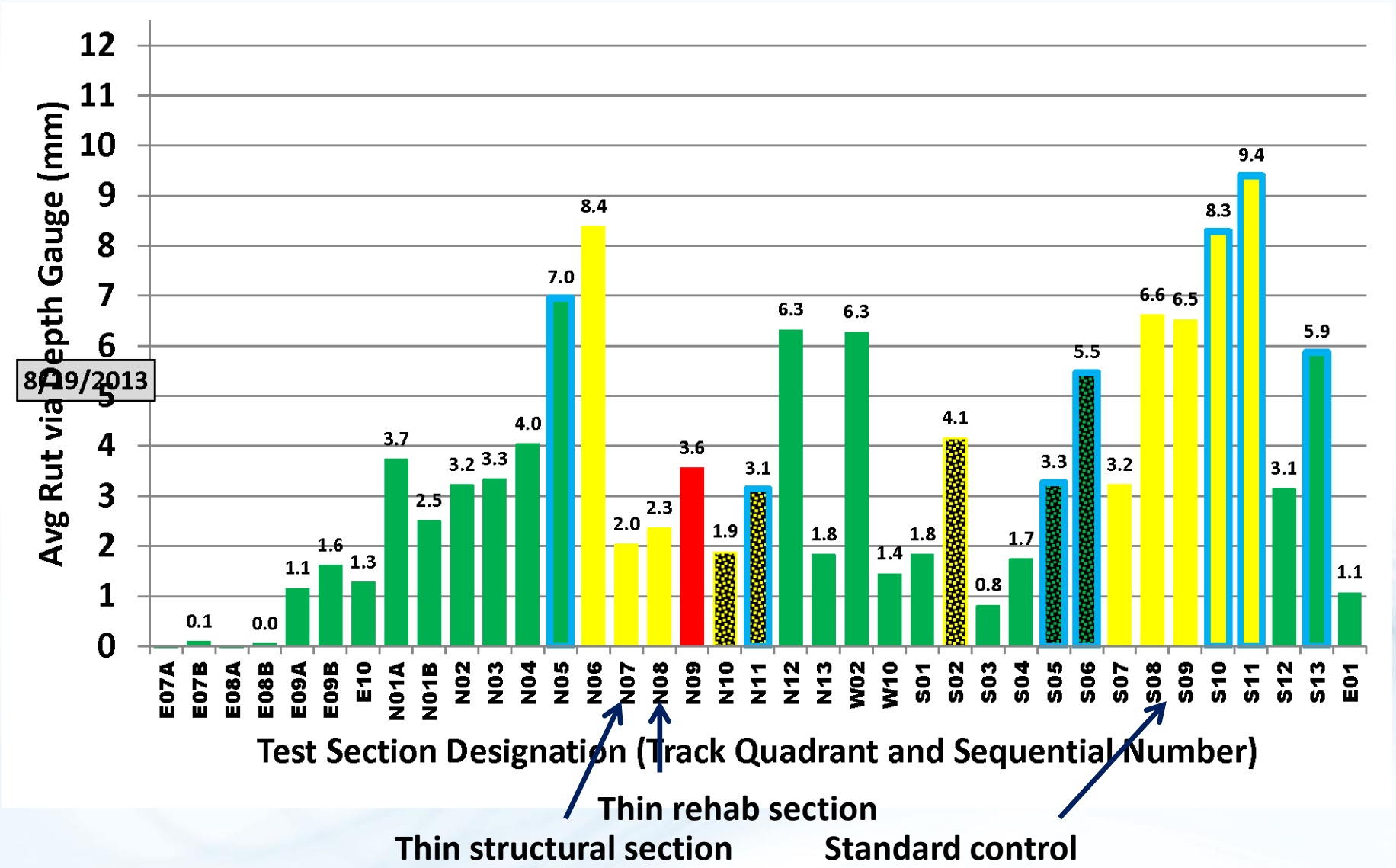
Invited to also participate in preservation sections, e.g. microsurfacing, for 2012 cycle

NCAT – Cross Sections Evaluated



Courtesy Prof. David Timm, Auburn U.

NCAT Rutting & Cracking as of 8/13



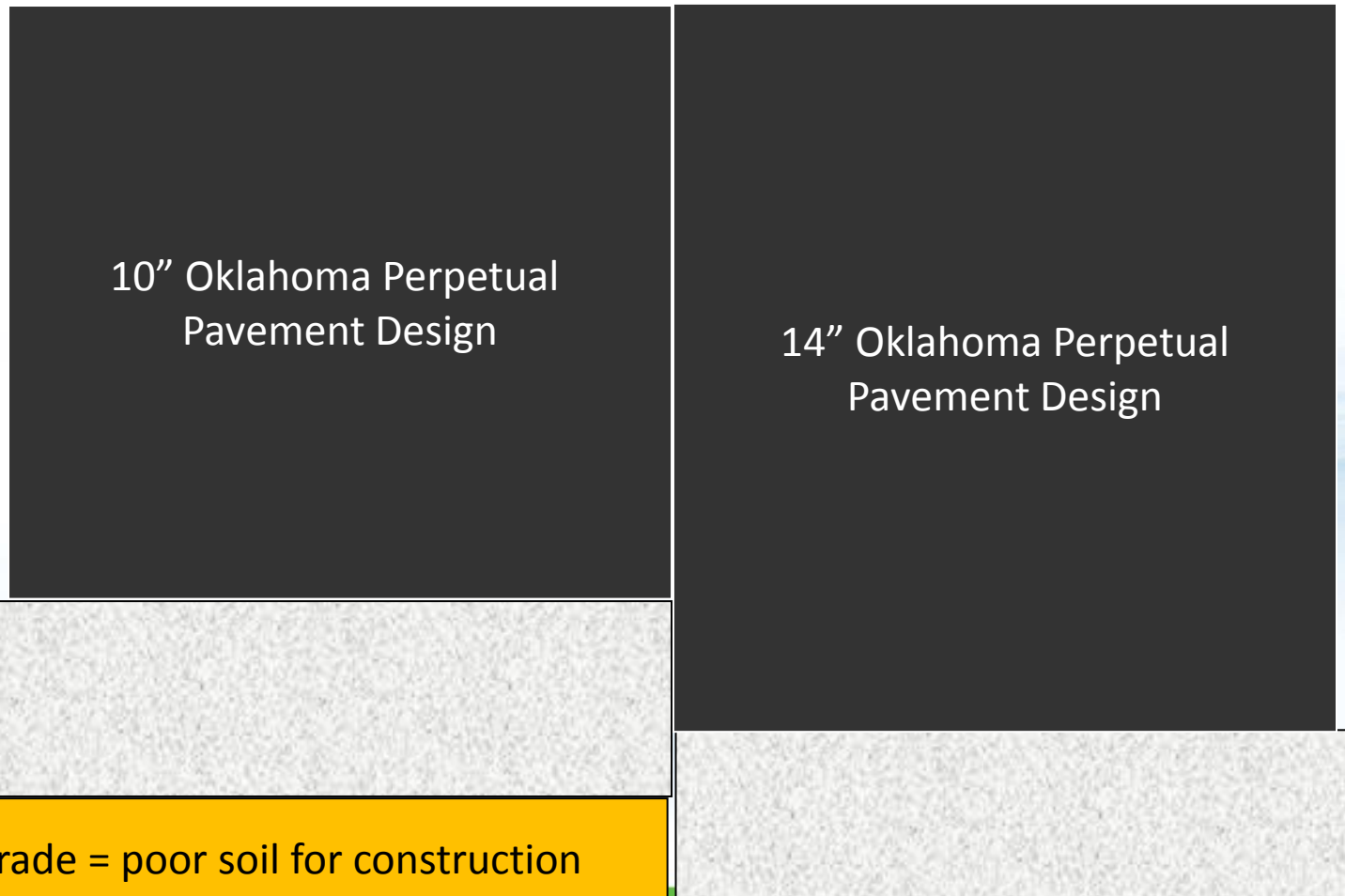
Group Experiment – all but one showing early cracking. No cracking on either N7 or N8.

2006 NCAT Construction Cycle

Oklahoma Perpetual
Pavement Experiment

N8 – 10” HMA
over weak base

N9 – 14” HMA
over weak base



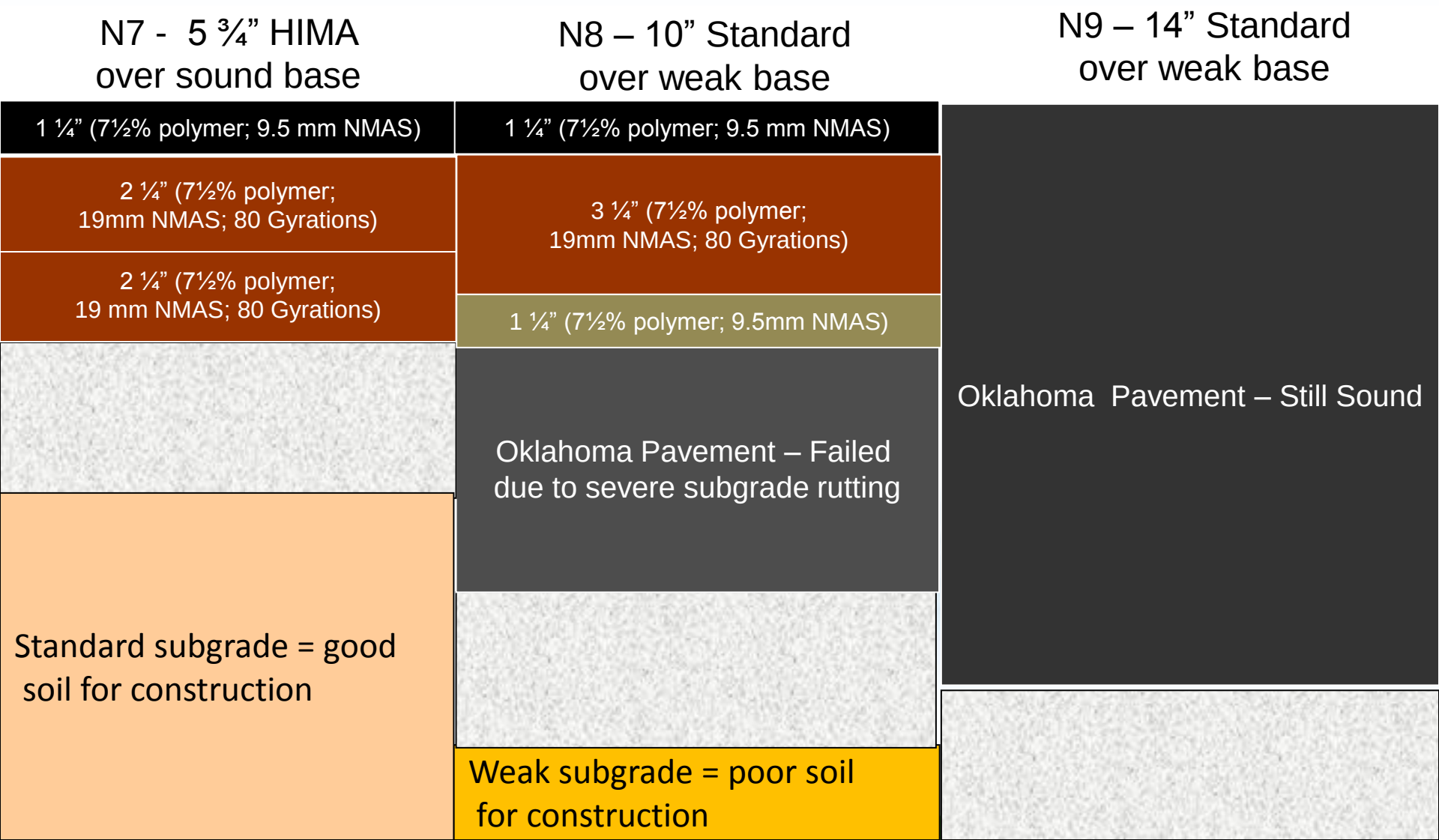
Section N8 – June 29, 2010 – 4.0 MM ESALs

10” pavement
paved Aug. 2006
5” rehabilitation
Aug. 2009
10 months old

2009 NCAT Construction Cycle - August 2010

Kraton

Oklahoma proposed design modification



Section N8 – Sept. 12, 2011 – 5.27 MM ESALs as of 5/31/13 – 9.1 MM ESALs

10” pavement
paved Aug. 2006
5” rehabilitation
Aug. 2009
5 ½” HiMA rehab
Aug. 2010
13 months old

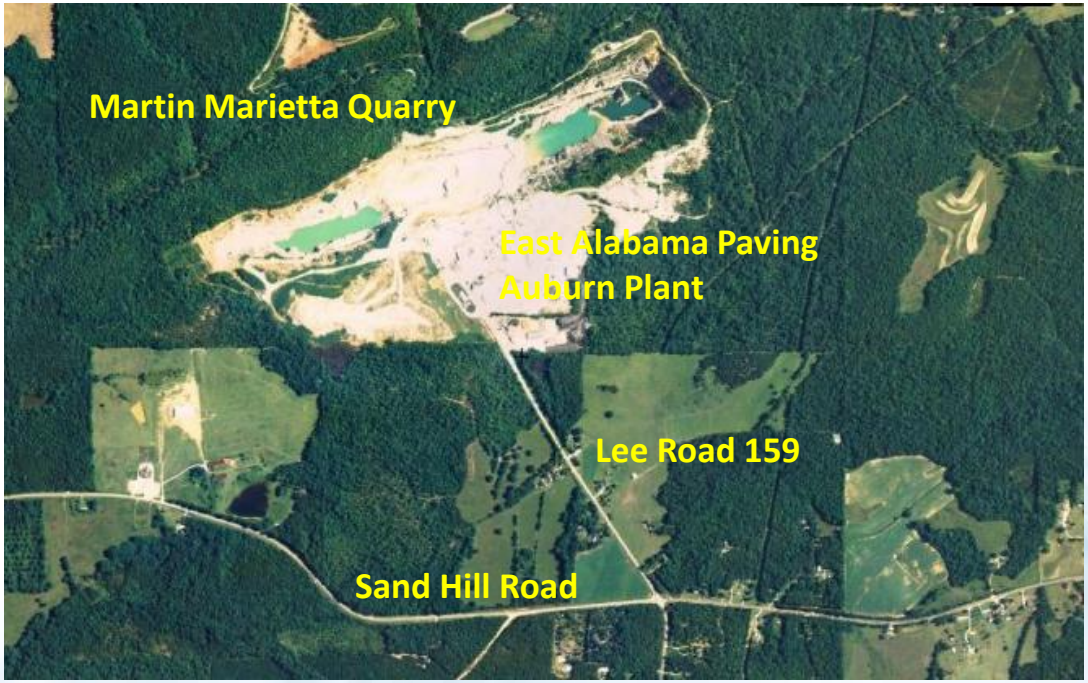
Similar crack appeared in first overlay at 2.7 MM ESALs
Oklahoma is sponsoring this section through the 2012 cycle to monitor further deterioration and evaluate preservation strategies.

Conclusions – HiMA Structural Sections

- **Highly modified binders can give dramatic improvement in pavement resistance to rutting and fatigue damage.**
- Thickness reduction can more than offset increased material costs.
- In severe distress situations, highly modified binders can possibly double pavement life.
- *Current modeling and design software may be used to predict material performance characteristics and rationally design pavements.*
- **Current field trials will help determine if there is benefit for thin lift and micro surfacing preservation strategies.**

HiMA Thin Overlay Trials – Lee Road 159, NCAT

- **Lee Road 159 Quarry Access Road – predominantly unloaded and heavily loaded truck traffic.**
  - 4.75 mm mix, limestone/sand, 6.4% binder content, 0.8” thickness
  - Final section of 25 at the Lee Road 159/Sand Hill Road intersection, heaviest distress with stopping/starting/turning trucks.
  - **Paved August 13, 2012.**



Thin Overlay Trials – New Hampshire
AASHTO TSP2 Mix Design

- **NH DOT U.S. 202 (4,600 ADT)**
  - AASHTO TSP2 thin lift HiMA paving program constructed September 2011
  - Two lanes for two miles; dense graded mix design with 25% RAP content at 1 inch thickness for a 1 inch asphalt overlay contract
  - Comparison was 1 inch PG 64-28 dense mix
  - No rutting or raveling evident on either section
  - Control section – ~10% transverse cracking
  - HiMA section – One 3 foot reflective crack and one 12 foot longitudinal crack noted over the two miles in west lane

- HiMA technology being specified on a *FHWA Highways for Life* grant to be contracted by the NHDOT in 2012 – Job completed in August, 2013

Thin Overlay Trials – Vermont
AASHTO TSP2 Mix Design

- **VT AOT U.S. 7 (4,700 ADT)**
  - AASHTO TSP2 thin lift HiMA paving program constructed September 2011
  - Two lanes and shoulders for two miles; dense graded mix design with 25% RAP content at 1 inch thickness for one mile and virgin aggregate at 1 inch thickness for one mile for a 1 inch asphalt overlay contract
  - Comparison was ¾" Novachip type C mix with PG 58-28 with latex modified tack coat
  - No rutting or raveling evident on either section
  - HiMA section vs control – 75% reduction in cracking – October 2013

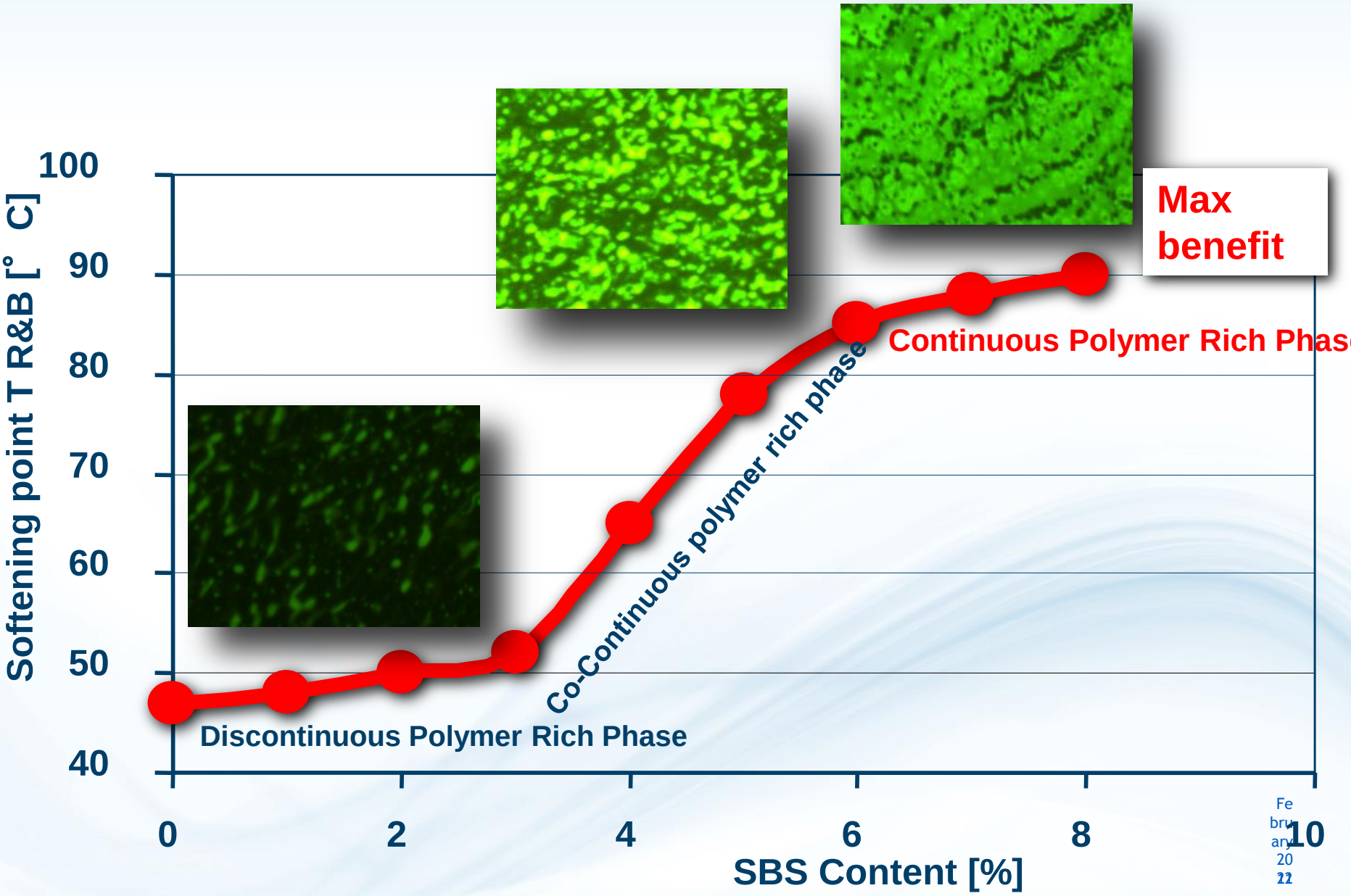
Thin Overlay Trials – Minnesota
Standard SP Mix Design

- **MN DOT TH 100 (64,000 ADT)**
  - AASHTO TSP2 thin lift HiMA paving program constructed August 2011
  - One lane for two miles; dense graded mix design with 25% RAP content at 2 inch thickness with a 1,500 feet section within the two miles at 1.5 inch thickness
  - No rutting or raveling evident
  - Control section – Reflective cracking at 10% in the control lane
  - HiMA section - 50% of those cracks carrying over into the HiMA lane and 50% stopping at the HiMA lane
  - No visual differences noted between the 2 inch and 1.5 inch HiMA pavements
  - 25% thickness reduction with, to date, similar/ improved cracking resistance

- Additional HiMA thin lift trials with up to 25% RAP with both OR DOT (1" - June, 2012) and NJ DOT (2" - September, 2013) – Standard SP mix designs

- **Best performance – TSP2 fine mix with higher net asphalt/virgin content**

HiMA Micro Surfacing – 6 wt% Loading Level



MN HiMA Micro Surfacing Job Story

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ACP western builder Edition

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MNDOT FURTHERS PAVEMENT MICRO SURFACING RESEARCH

Agency's District 3 tries new highly polymer modified asphalt emulsion in demonstration on section of Trunk Highway 23 near St. Cloud

By Paul Fournier

ASTECH Corporation applies micro surfacing containing emulsified highly polymer modified asphalt to a section of Trunk Highway 23 for Minnesota DOT.

Minnesota's Department of Transportation continues its practical research of pavement preservation techniques with the recent demonstration of micro surfacing containing emulsified highly polymer modified asphalt (HiMA) on a section of Trunk Highway 23.

ASTECH Corporation of St. Joseph, Minn., applied the micro surfacing on a one-mile section of the two-lane highway near the city of St. Cloud, the county seat of Stearns County and the largest population center in the state's central region. Bisected by the Mississippi River, St. Cloud is a regional transportation hub in Minnesota, with major roadways including Interstate Highway 94, U.S. Highway 10, and Minnesota State Highways (Trunk Highways) 15 and 23 passing through the municipality.

Located about 65 miles northwest of Minneapolis-St. Paul, the city of St. Cloud lies within MnDOT's District 3, which has the largest population base outside of the Twin Cities metropolitan area. District 3 encompasses all or part of 14 counties, and its personnel plan, design, construct and maintain roughly 1,650 centerline miles (nearly 4000 lane miles) of Interstate, U.S. and trunk highways.

Sophisticated Pavement Research

The June 2012 TH23 application was the first time MnDOT used HiMA emulsion in the micro surfacing process, although the agency did approve the installation of hot mix asphalt modified with HiMA on a section of TH100 west of Minneapolis last year, as part of its continuing search for advanced products capable of retarding pavement reflection cracks.

Minnesota's trunk highway system of 11,000 miles ranks it the fifth largest in the nation, and its DOT is considered to be in the forefront of highway maintenance, research and construction practices. In connection with this, the agency owns and operates MnROAD, a sophisticated pavement test track built to study various research materials and pavements. MnROAD works in conjunction with MnDOT's Materials Lab located in Maplewood, Minn. (See sidebar on last page.)

Jerry Geib, MnDOT research operations engineer, suggested the use of HiMA in the 2011 TH100 mill-and-fill hot mix asphalt operation. That application went without incident, with the paving crew noting there was no difference between handling HiMA mix and MnDOT's usual 12.5mm Superpave mix. The asphalt binder used in this mix was dosed at 7.5-percent SBS polymer.

INSIDE

MN HiMA Micro Surfacing Project – 6/2012

- **Emulsion producer – Flint Hills Resources – Wichita, KS**
  - 6 wt% D0243 in PG xx-34 base AC – >200 dmm PEN
    - **SP – 156°F**
    - **PEN – 122 dmm at 25C**
  - Control – 3.5 dry wt% cationic SBR latex in PG 64-22 base AC
  - Two trial sections
    - MN Road Cell #1 – Interstate 94 – **16 wt% emulsion** with no control
    - ADT – 28,000 vehicles/day including heavy truck traffic
    - TH 23 – **13 wt% emulsion** with control
    - ADT – >5000 vehicles/day
    - PCC slab (original) + 6 in. of bit. concrete ('98) + chip seal ('04)
- **Contractor – ASTECH Corporation – St. Joseph, MN**
  - Leveling course and surface course applied to trial sections
  - Type II gradation
  - Application rate – net 30 lbs/yd^2

HiMA Micro Emulsion Application
Mn Road Cell #1 – Before/After – 6/2012

Before

Passing Lane – PG 58-28 Asphalt Concrete – 12 yrs old over PCC slab

Slow Lane – PG xx-34 Asphalt Concrete – 6 yrs old over PCC slab

Additional HiMA Micro Surfacing Projects

- Vance Brothers – Lee's Summit, KC – 7/2012 (PG 58-28)
- Ergon/Viking – Dallas, TX – 9/2012 (PG 58-28)
- Ergon/Sealcoating – Hingham, MA – 10/12 (PG 58-28)
- Ergon/Sealcoating – Dartmouth, MA – 8/13 (PG 58-28)
- Ergon/Sealcoating – Northbridge, MA – 9/13 (PG 58-28)
- Ergon/APS – PENN DOT – Lancaster, PA – 9/13 (PG 58-28)
- Ergon/APS – Lakeland, FL – 9/13 (PG 58-28)

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