NCAT INNOVATIONS AND TECHNOLOGY

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at AUBURN UNIVERSITY

63rd Annual Asphalt Paving Conference

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MnROAD
Safer, Smarter, Sustainable Pavements Through Innovative Research

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Past Implementable Findings

- Materials – aggregates, polymers, additives
- Mixes – gradations, gyrations, balanced designs
- Structures – E, M-E, CR mix, rehabilitation
- Construction – WMA, increased density, tack
- Preservation – objective life cycle selection

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2018 Track Research Focus

- Interlayers to reduce reflective cracking
- Performance optimized mixes (construction focus)
- Single pass full depth rapid reconstruction
- Thinlays and "ultra thinlays" for preservation
- Validation of laboratory cracking tests$_{\text{Design,QC}}$

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REFLECTIVE CRACKING PREVENTION

GDOT Traditional Approach

- Traditional approach
  - Single surface treatment (#7 stone)
  - Not satisfactory

Treatments in 2012 Cycle

- N12: Double surface treatment with sand seal
- N13: Open-graded interlayer (OGI)

Treatments in 2018 Cycle

- N12 Section
  - GlasGrid
  - PETROMAT paving fabrics
  - Chip seal with 7# stone
- N13 Section
  - Chip seal with RAP
  - Rubber modified asphalt mix (3/4”)
  - Open-graded interlayer (OGI) (3/4”)

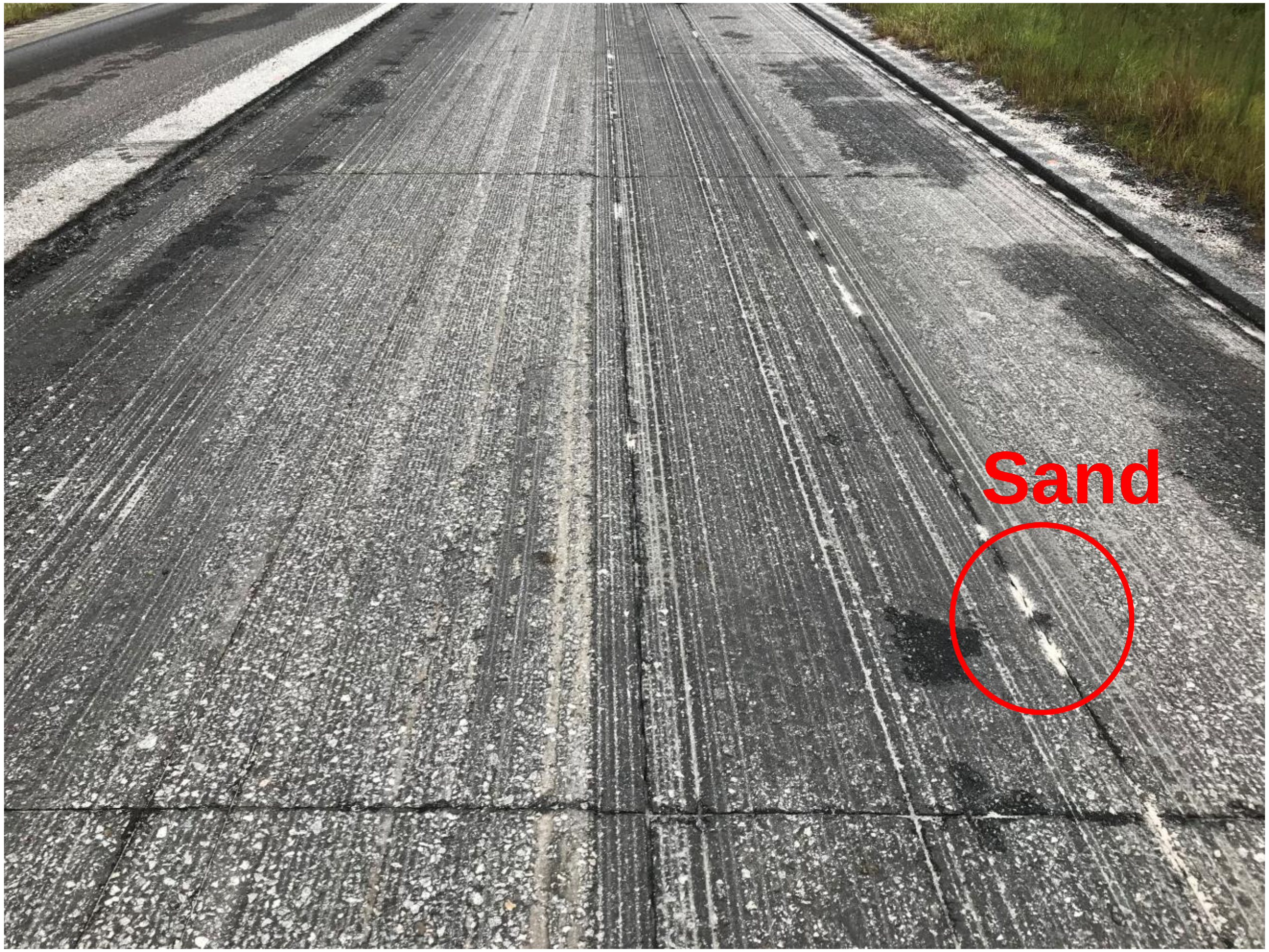
Research Objective

- Evaluate the long-term performance of different reflective cracking treatments
- Determine the most cost-effective approach to mitigate reflective cracking

Saw Cuts to Simulate Cracks

- Mill to 2.2 inch depth
- Deep cuts 1/8 inch wide
- Longitudinal cuts at 3 foot spacing
- Transverse cuts at 15 foot spacing
- Filled with sand to prevent healing

Saw Cut Pattern



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Geosynthetic Interlayers

Chip Seals

Leveling Mix

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OGI and Rubber Mix Interlayer

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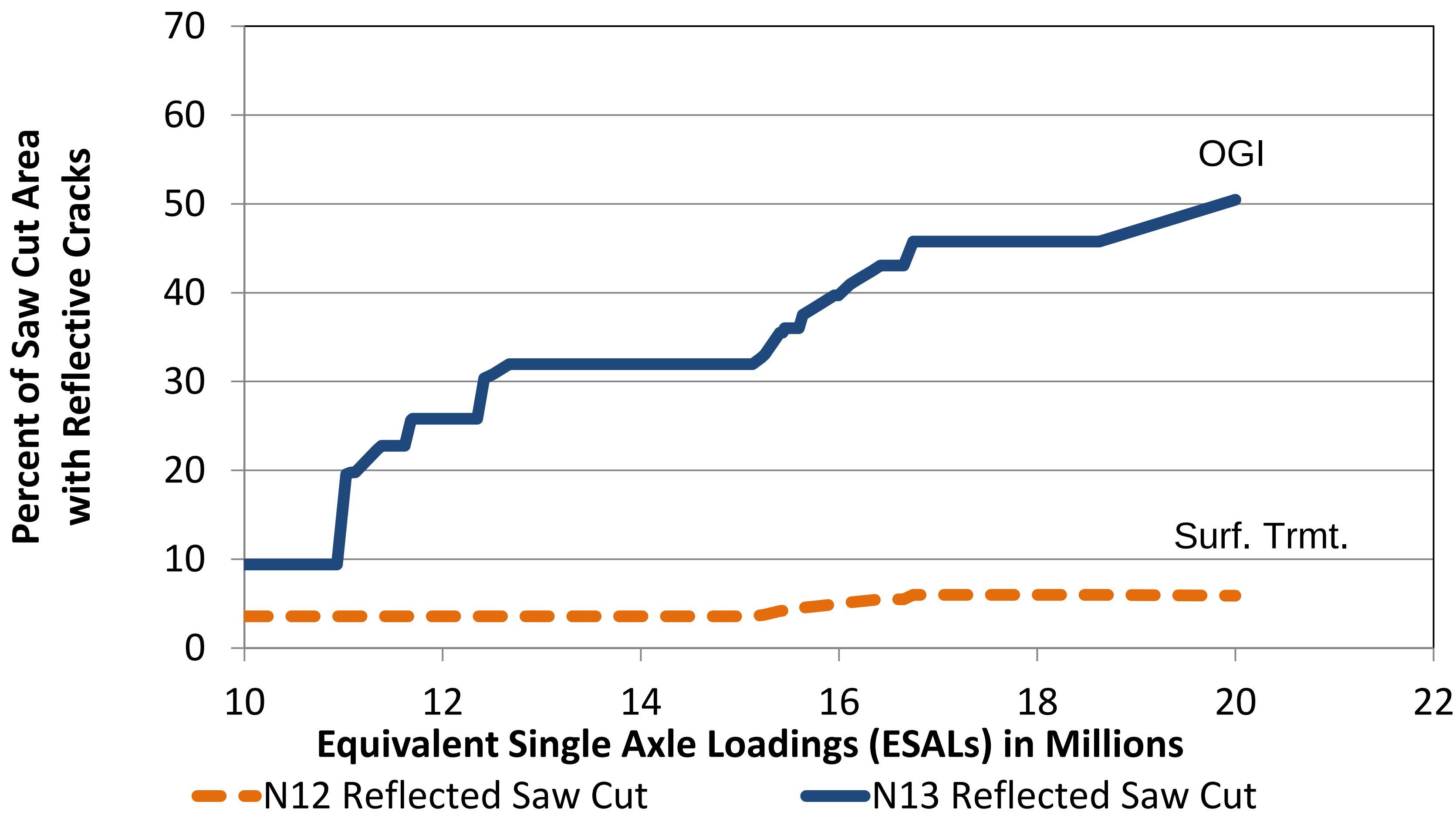
Overlay

Research Plan

- Determine percent of saw cut area with reflective cracks
- Measure rut depth on a routine basis
- Conduct cost-benefit analysis

Cracking



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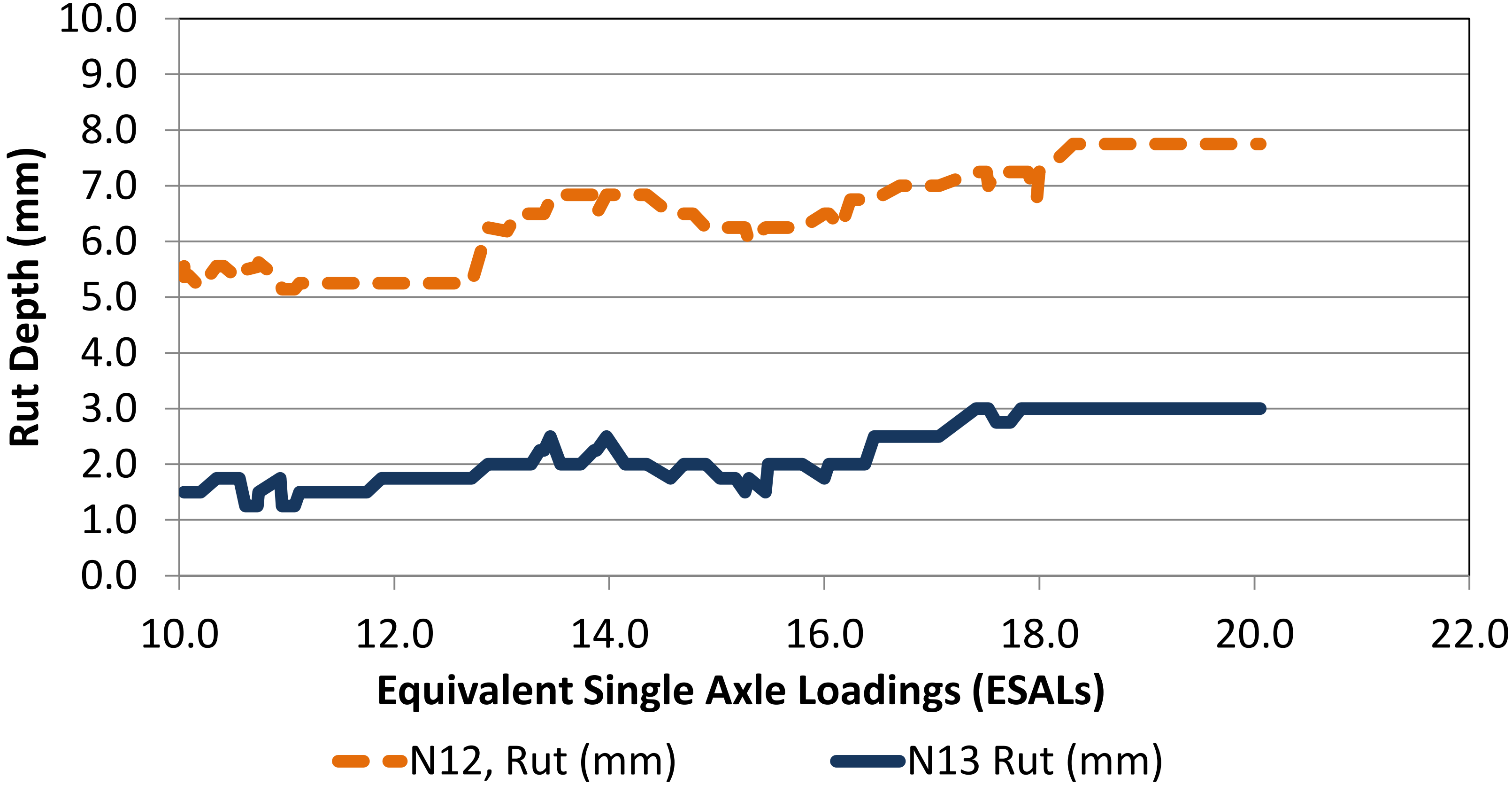
N12
Surface Treatment


N13
Open-Graded Interlayer

Rutting



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After 20 Million ESALs

- 50.5% of saw cuts have reflected through the OGI (N13) compared to only 6% in the Double Surface Treatment with a Sand Seal (N12)
- Cracking in both sections is low severity
- Additional dense-graded layer thickness in N12 may have affected performance
- N13 has less rutting than N12 (3 mm vs 7.8 mm)

THIN OVERLAYS FOR PAVEMENT PRESERVATION

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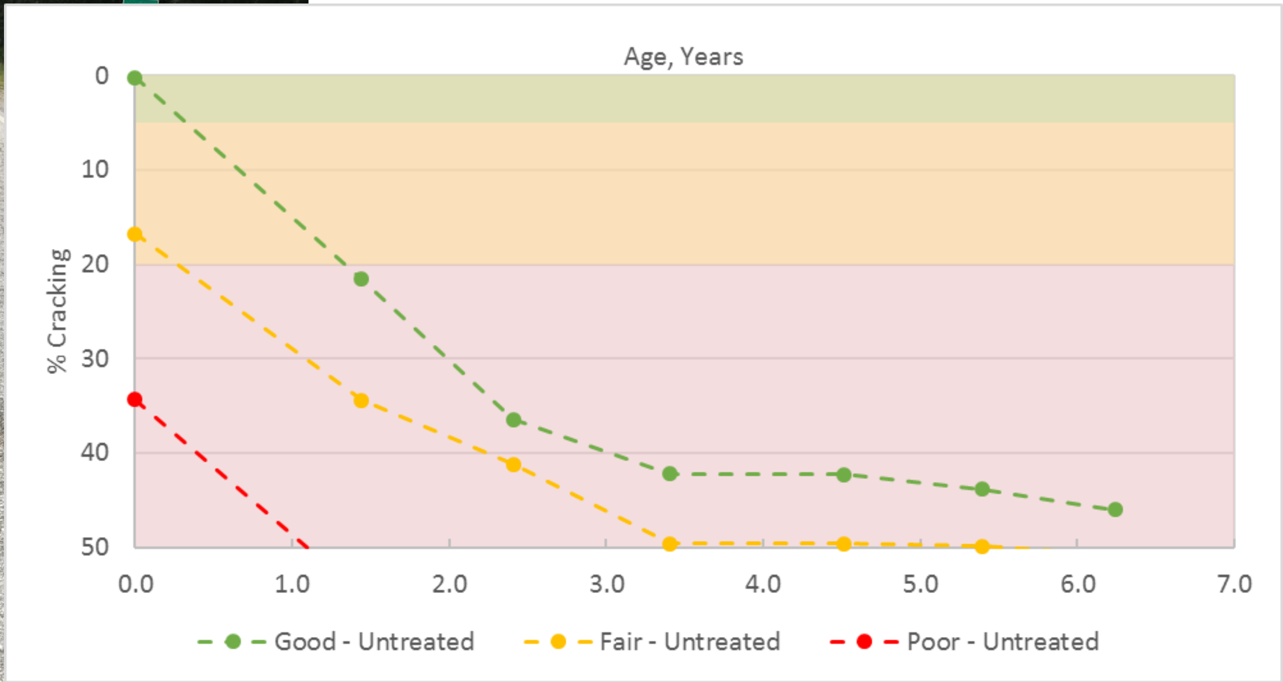
Pavement Preservation (PG) Group Study

- Study life-extending and condition improving benefits of treatments under different conditions
  - Traffic
  - Climate
  - Initial condition

Thin overlay test sections

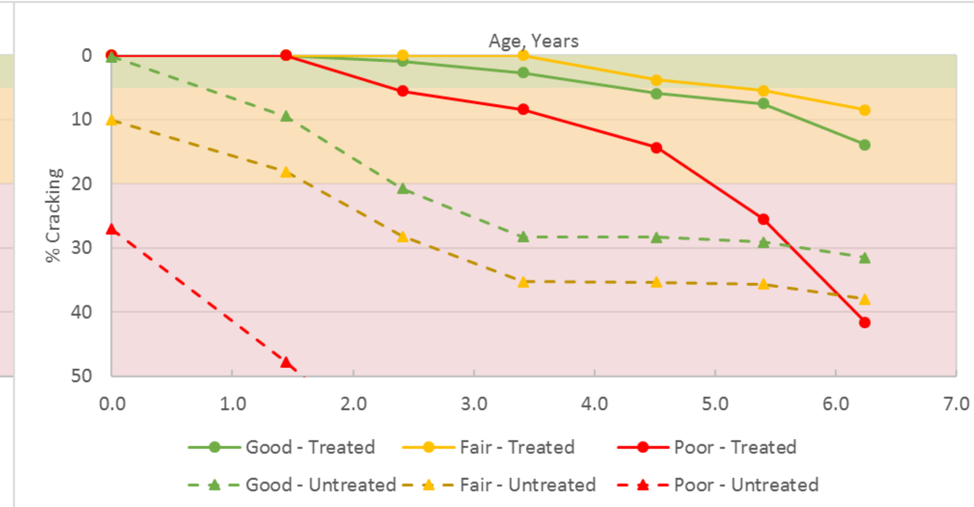
- ¾” thick overlay
  - Dense graded (virgin, RAP, RAS, ABR, HiMA)
  - UTBWC
  - OGFC (different tacks)
- Cold recycle (CIR, CCPR) + 1” thick overlay

Untreated sections



Age, Years
% Cracking
0
10
20
30
40
50
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Good - Treated
Fair - Treated
Poor - Treated
Good - Untreated
Fair - Untreated
Poor - Untreated

Age, Years
% Cracking
0
10
20
30
40
50
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Good - Treated
Fair - Treated
Poor - Treated
Good - Untreated
Fair - Untreated
Poor - Untreated



Age, Years
% Cracking
0
10
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0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Good - Treated
Fair - Treated
Poor - Treated
Good - Untreated
Fair - Untreated
Poor - Untreated

50% RAP

5% RAS


11% RAP + 3% RAS

OGFC Thin Overlays

Cold Recycling + Thin Overlays

Cold climate performance

Preliminary findings

- Thin overlays effective in extending pavement life
- Performance strongly dependent on initial condition

THICK LIFT ASPHALT PAVING

Background – Thick Lift Paving

- Asphalt pavements typically built in series of lifts
  - Usually <3” thick
  - Tack between layers
  - Different mixes in each layer
  - Long work zones with traffic riding on intermediate layers and potential uneven lanes
- Due to traffic demands and work zone scheduling, SCDOT has been moving toward single, thick lift paving (5+ inches)

Thick Lift Paving Advantages

- Shorter work zones
    - Both time and distance
- No lift interfaces
    - Prevents interface shear failure
- No uneven lanes
- Open new pavement to traffic almost immediately
- Can be accomplished on any schedule
    - Off peak
- SCDOT aiming for greater depths (7+ inches)

http://www.worldhighways.com/_resources/assets/inline/custom/73/100641.jpg

Key Questions

- Cooling
  - How long will it take thick mat to cool before opening it to traffic?
- Compaction
  - Can density be achieved throughout pavement depth?
- Structural Response
  - How does a thick lift pavement carry traffic relative to conventional multi-lift pavements?
- Performance
  - How does a thick lift pavement perform relative to conventional multi-lift pavements?

Construction

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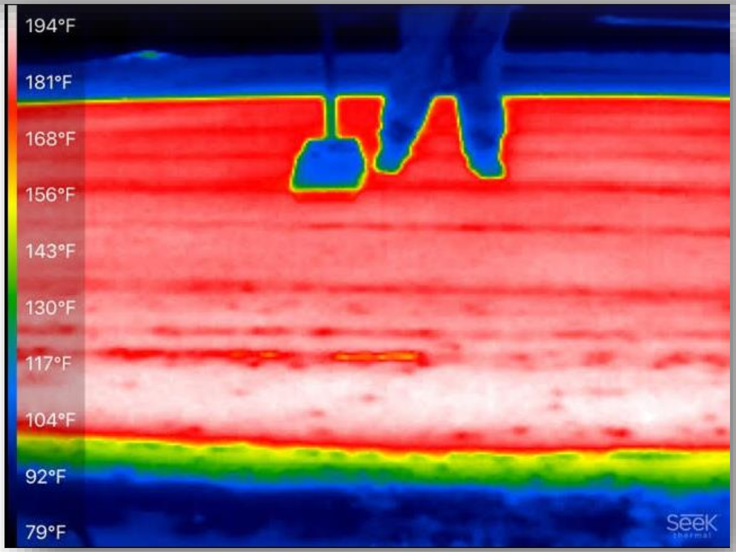
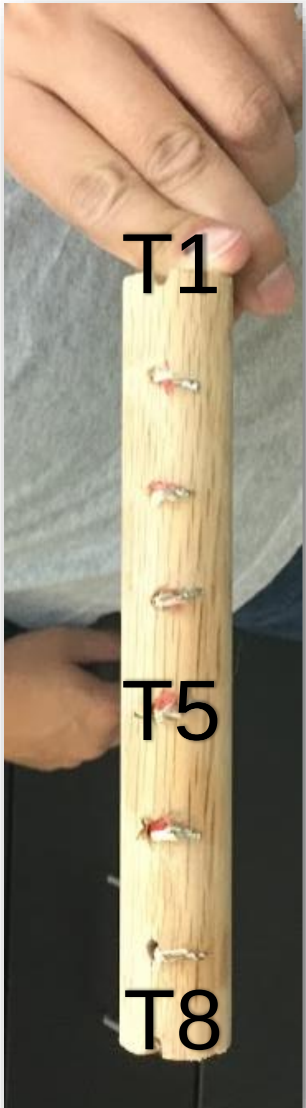
Construction

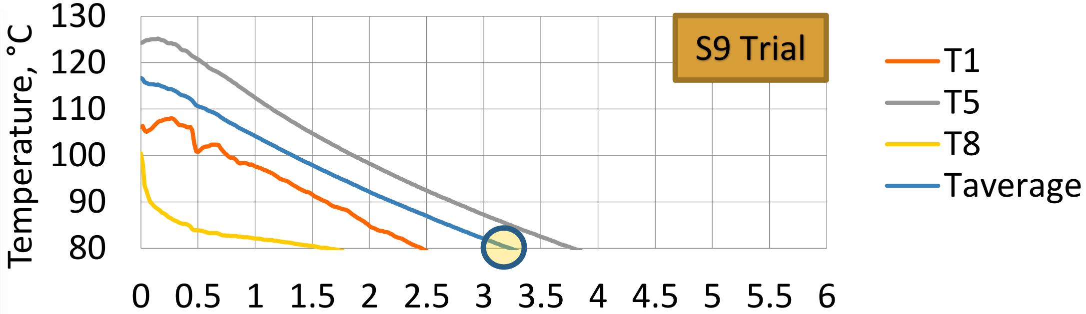
Embedded Temp Probe During Paving

Temperature Monitoring



In Situ Cooling Curves





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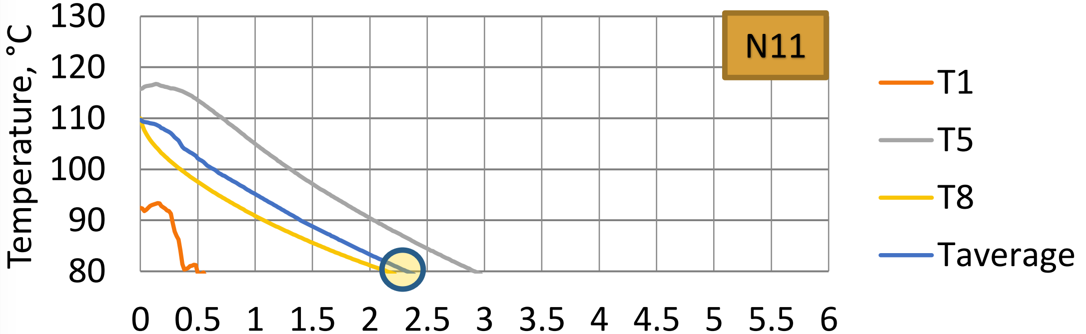

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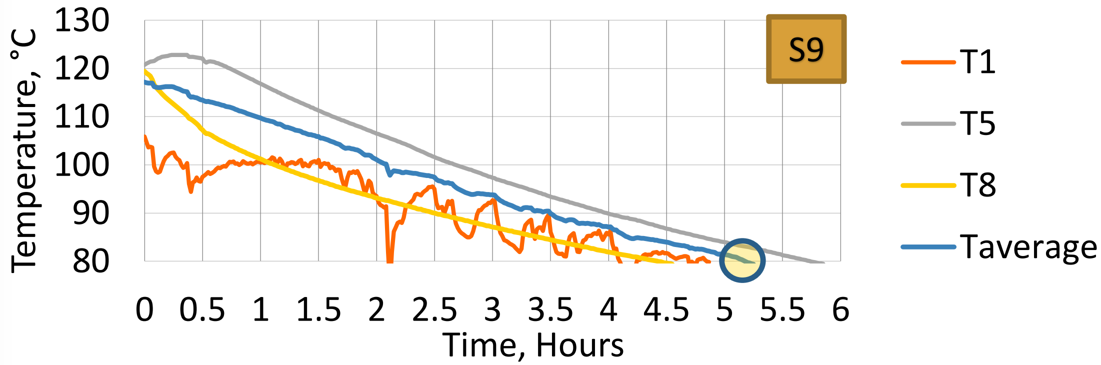

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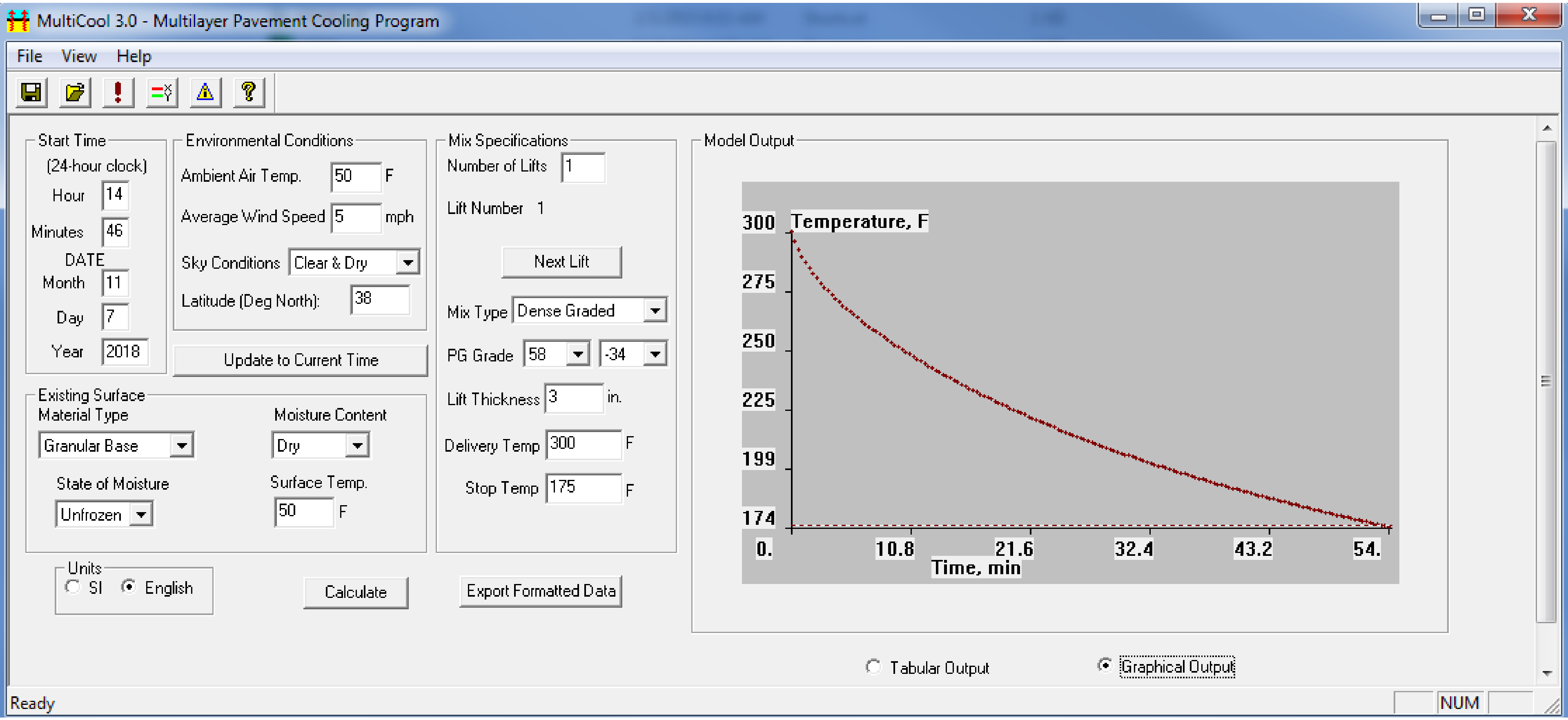
MultiCool Simulations



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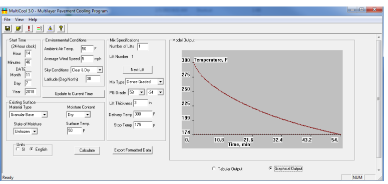
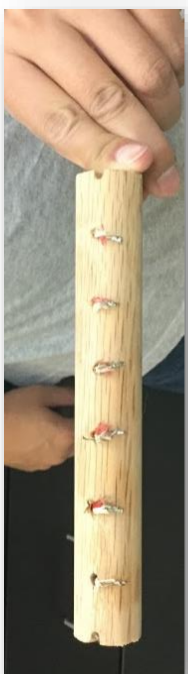
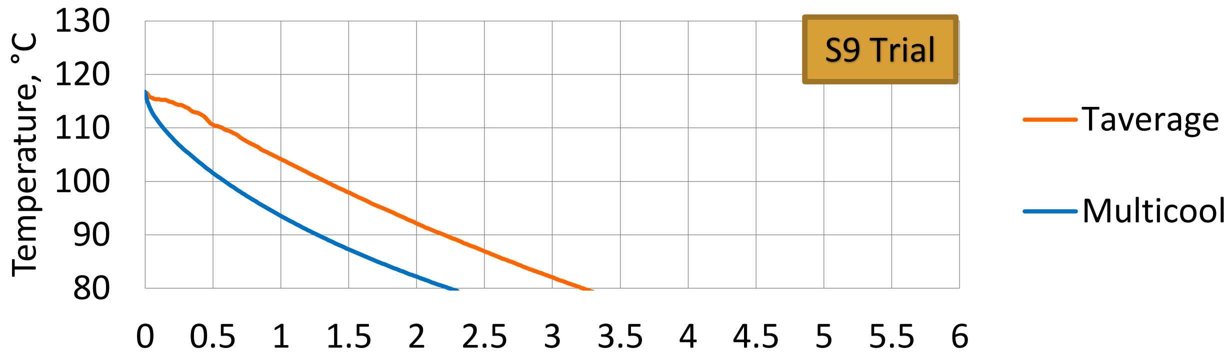
Measured vs Predicted Cooling Curves







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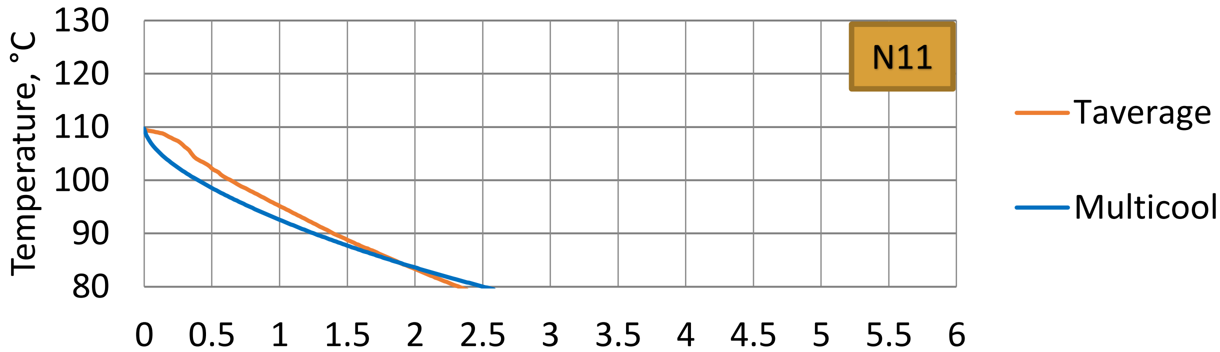

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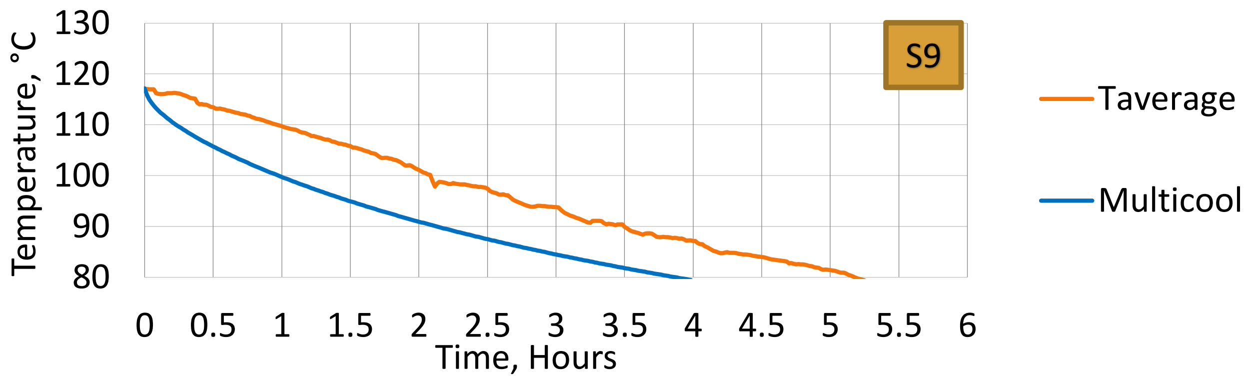

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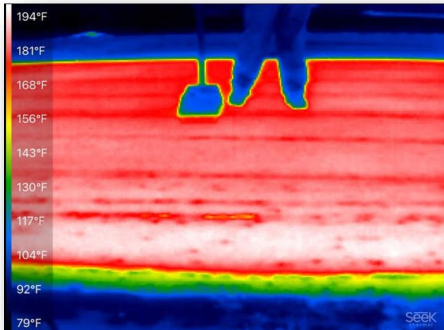
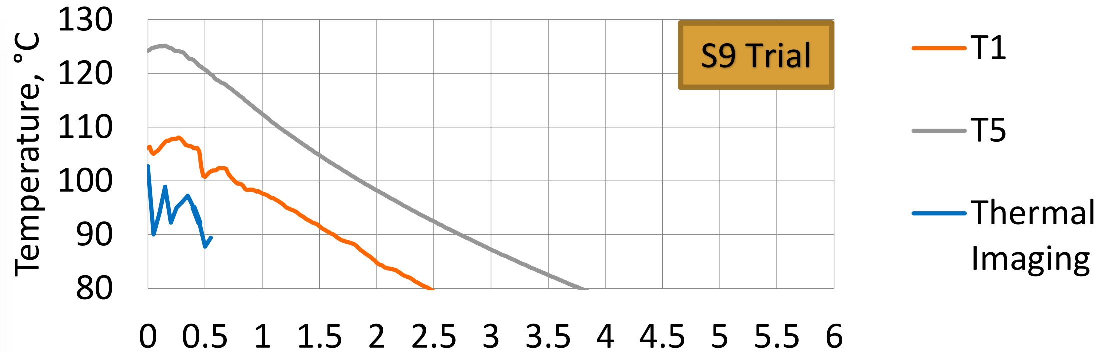
Surface vs In Situ Monitoring





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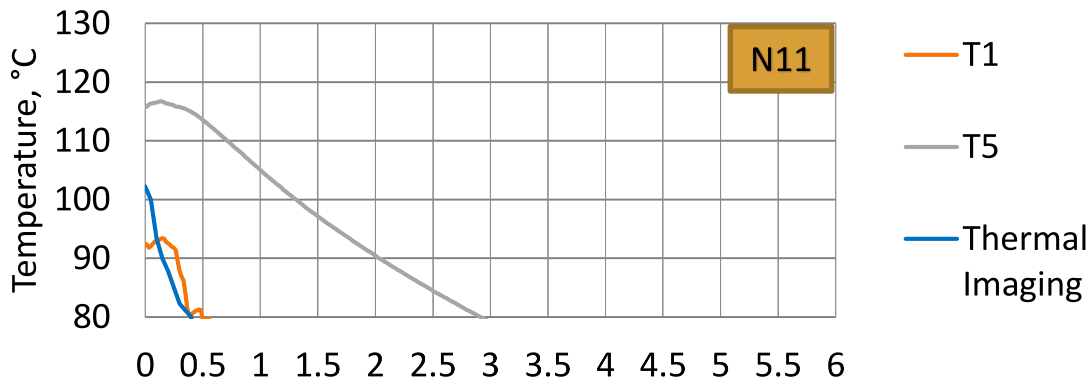

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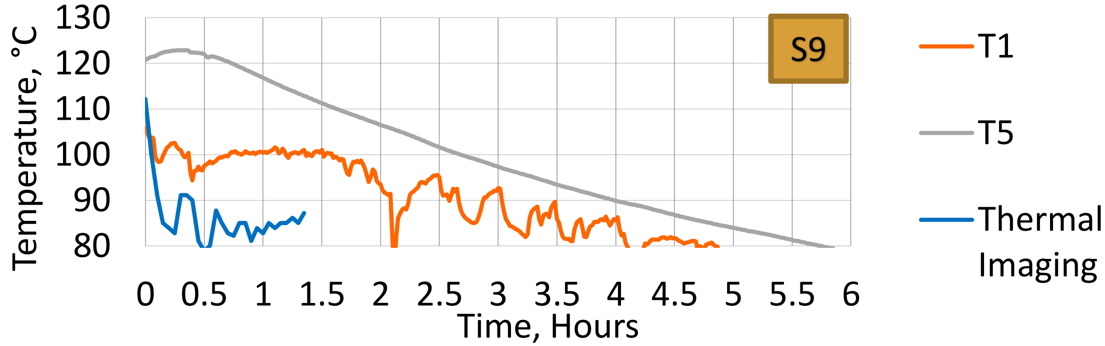

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Findings from Construction

- Time of day has strong influence on cooling rate
- MultiCool is most accurate over short durations & when ambient conditions are less variable
  - MultiCool needs some improvements
- Cooling may be significantly longer than measured at surface
  - Recommend simple thermocouple probe inserted at mid-depth to monitor in real-time
- Adequate in-place density was achieved
  - 95% G_{mm}
- Precision grinding needed to achieve acceptable IRI

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Future Testing

- Falling Weight Deflectometer
- Strain and Pressure Measurements
- Performance
  - Ride, Rutting, Cracking

CRACKING RESEARCH

Cracking Group (CG) Experiment

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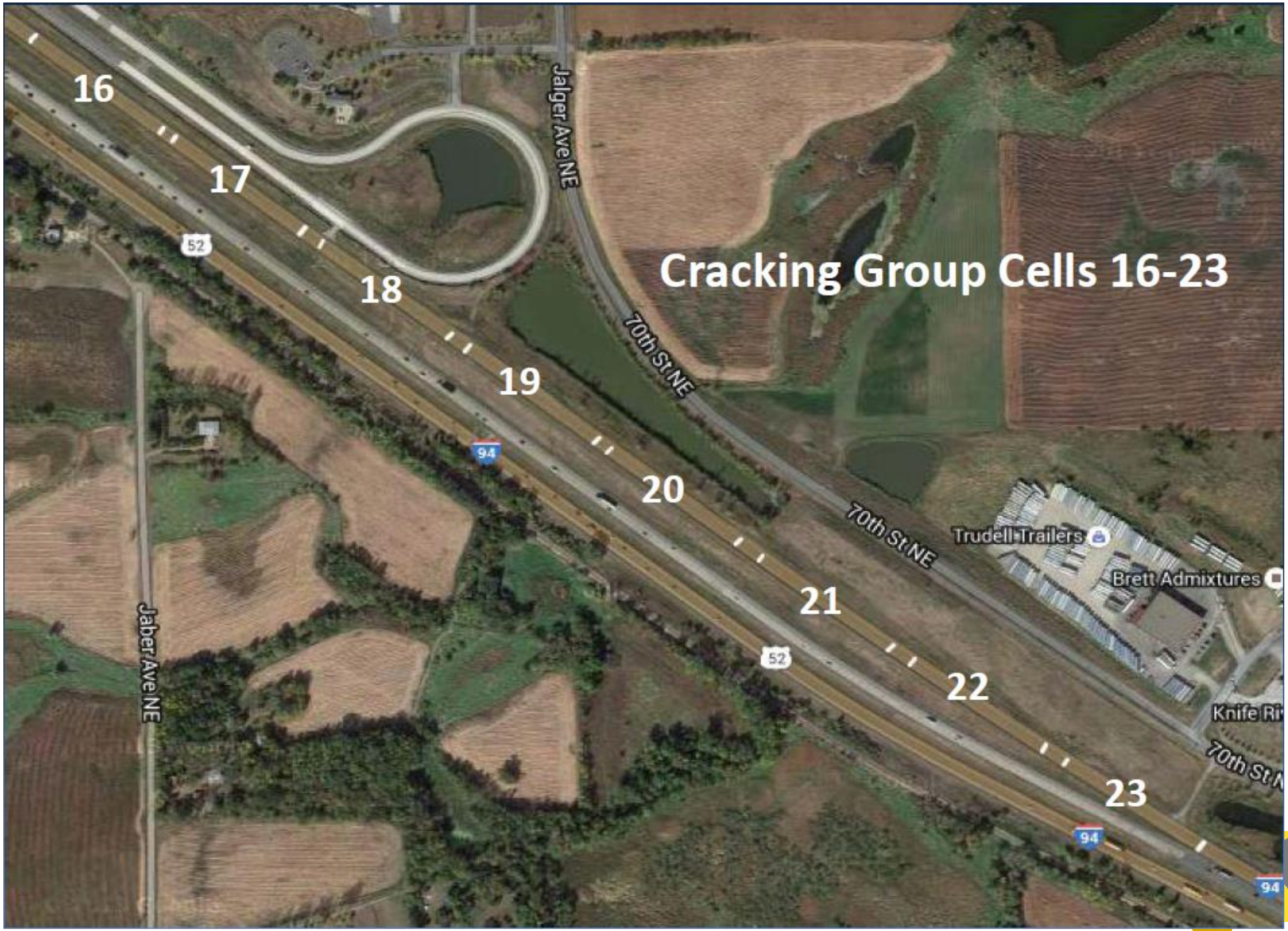
MnROAD Test Sections



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Asphalt Mixtures

CELL NO	BINDER GRADE	ABR %	RAS
16	64S-22	30-40	Yes
17	64S-22	20-30	Yes
18	64S-22	15-25	No
19	64S-22	15-25	No
20	52S-34	25-35	No
21	58H-34	15-25	No
22[1]	58H-34	15-25	No
23	64E-34[2]	10-20	No

All mixes are 12.5 mm NMAS

All mixes are N_{des} = 80 and target air voids = 4.0% except cell 19 which has N_{des} = 100 and target air voids = 3.0%

[1] Cell 22 limestone aggregate in mix

[2] Highly modified asphalt binder

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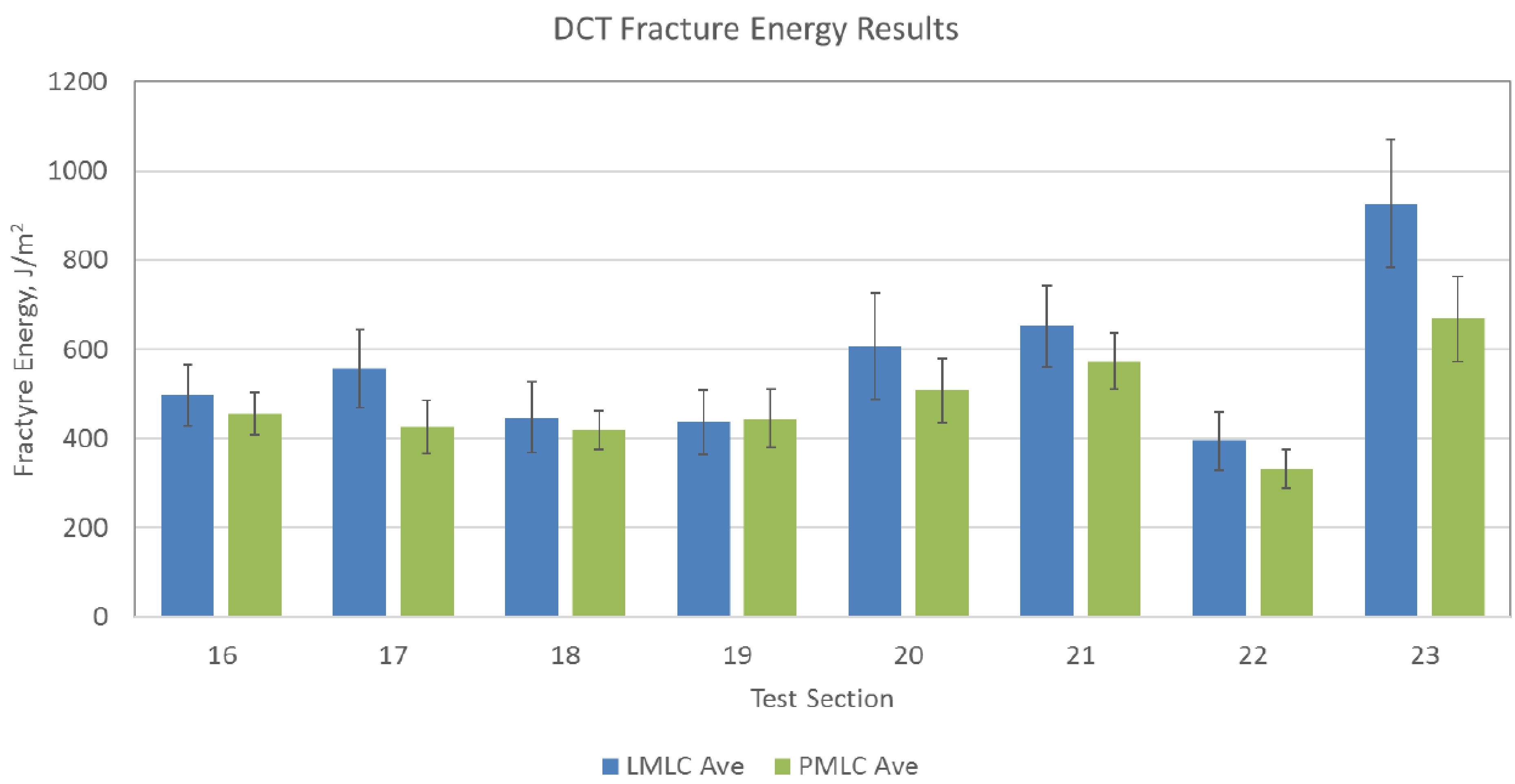
Cracking Modes and Testing

- Types of cracking investigated
  - Low temperature
  - Top-down likely
  - Fatigue also possible
- PMLC testing
  - Low temp: DCT-MN and IDT Creep or SCB-MN
  - Intermediate temp: IFIT, OT, BBF
  - E*, TSR, Hamburg, loose mix, cores
- Sampling for other research studies

DCT Results



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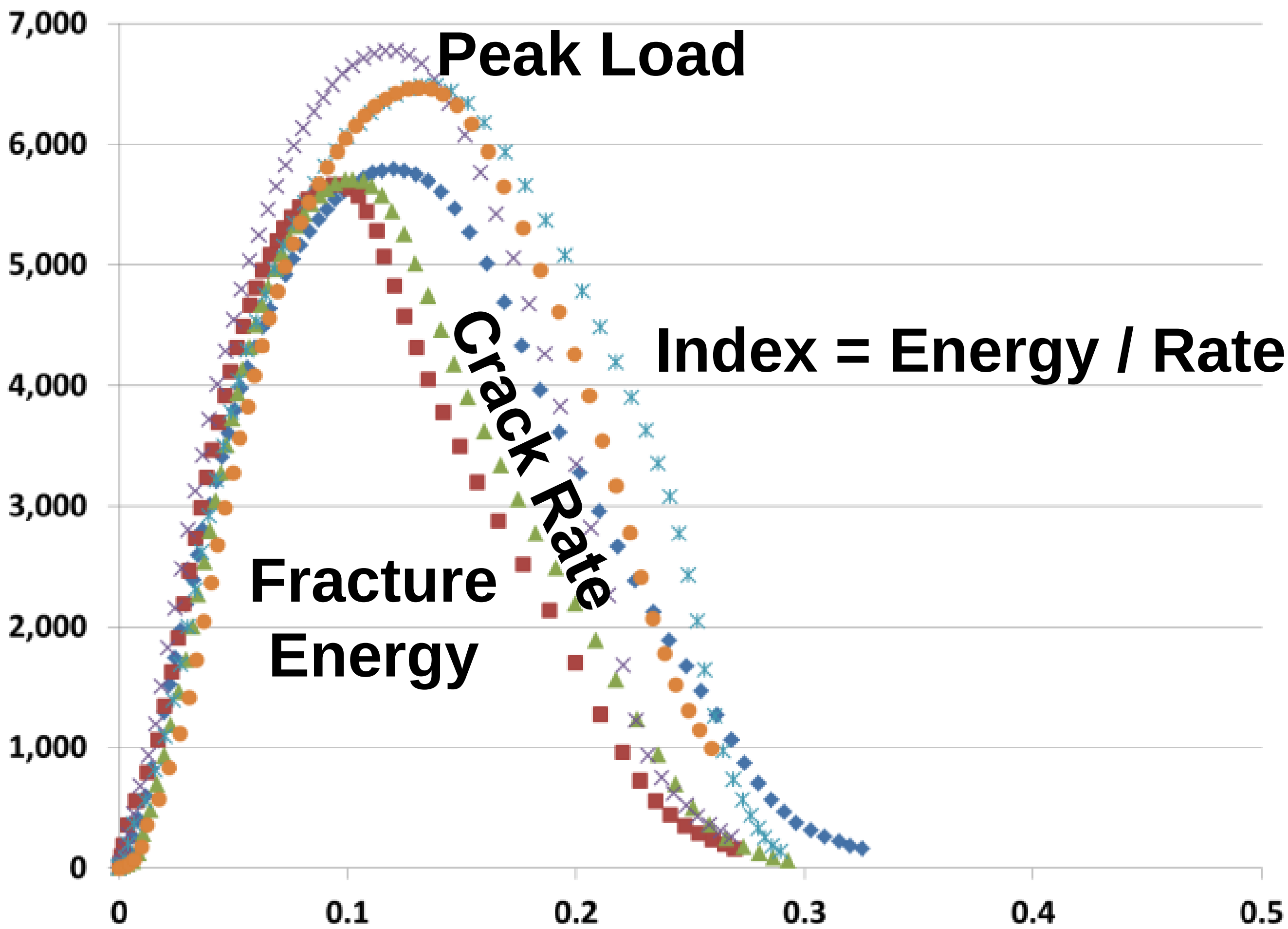
Field Measurements

Field Measurements

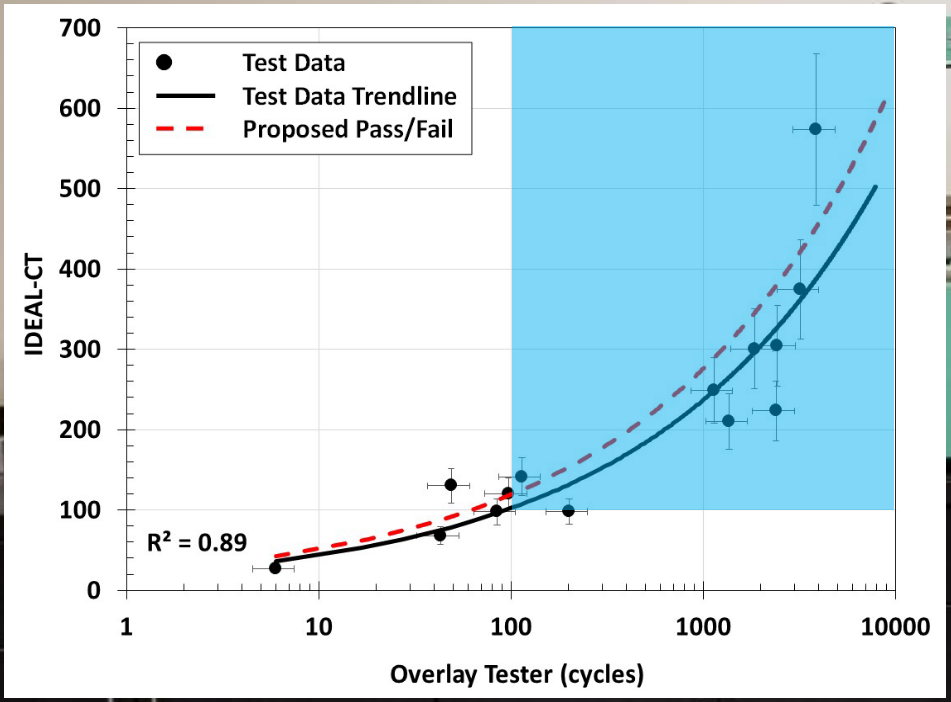
Test for QC/QA

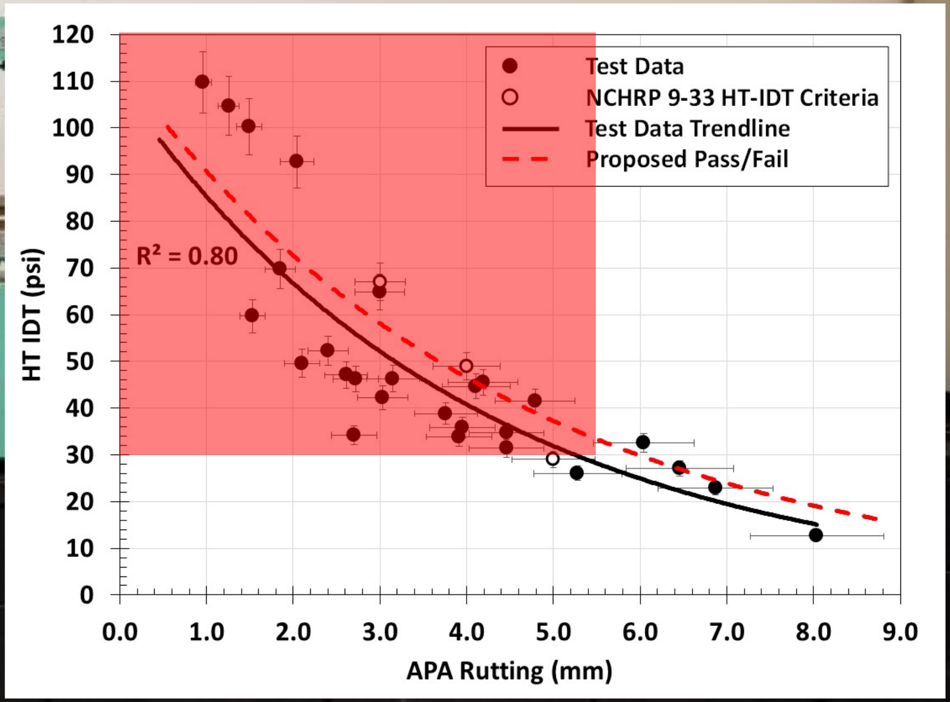
- IDEAL-CT
  - Conducted on gyratory specimens compacted to a target height and air void level
  - Temperature conditioning for 2 hrs @ 25°C
  - Test with IDT load frame using monotonic load 50 mm/min

Indirect Tension Testing (TSR)



Construction Quality Testing$_{\text{Bennert 2018}}$





Performance Optimized Construction Quality Testing & Mix Design Approval

SUMMARY

Implementation takeaways

- Interlayers effective in preventing reflective cracking
- Thin overlays extend pavement life
- Thick lift paving is possible
- Quest for practical cracking test
- Simple unaged tests for construction quality (3 hrs)

THANKS!

Any questions?
Reach me at
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