National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Design & Construction of 70^{th} Street Recycled Sections at MnRoad

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SEVENTH RESEARCH CYCLE

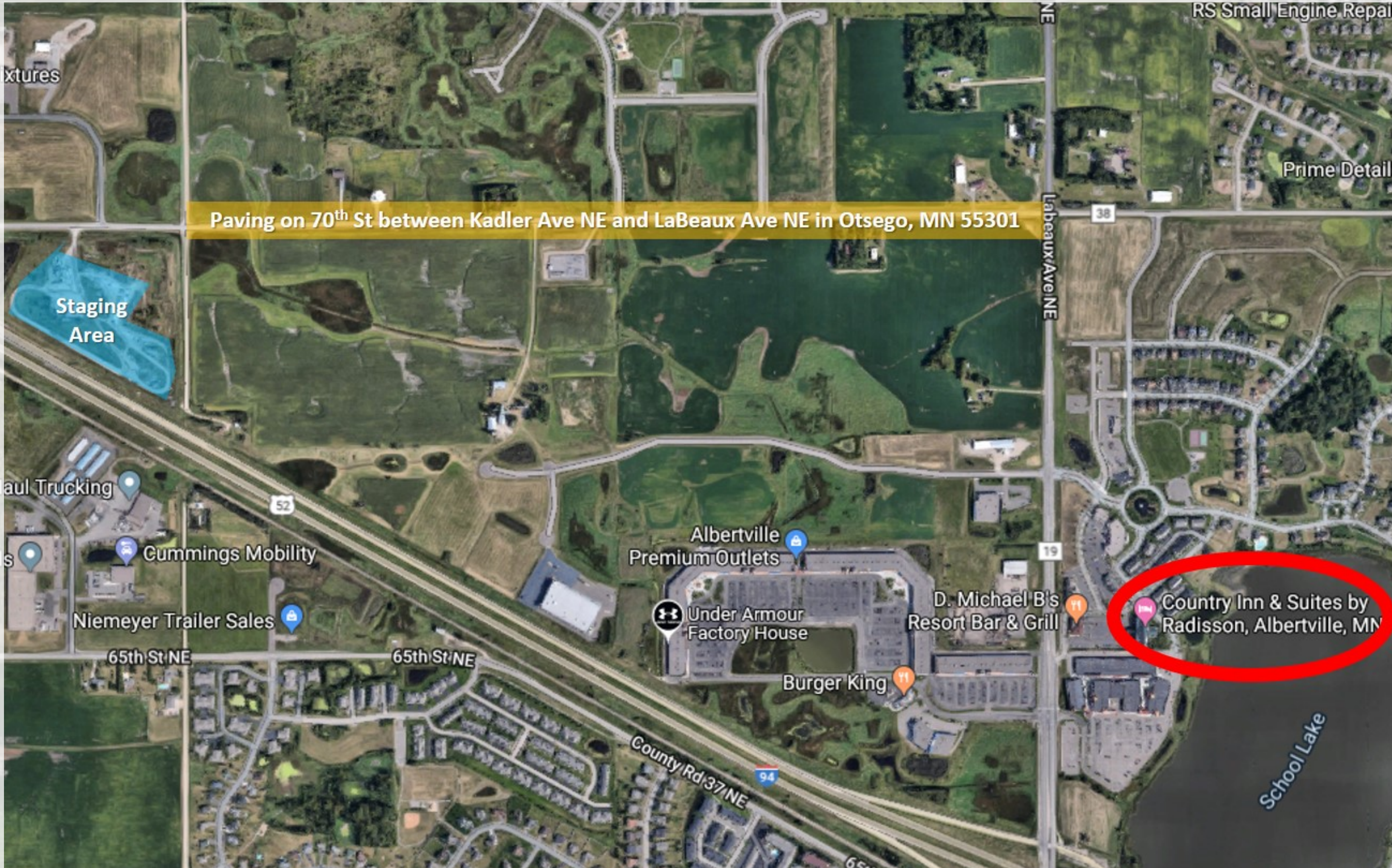
NCAT TEST TRACK CONFERENCE

Outline

- Project overview
- Construction
- Laboratory Testing Program
- Conclusions

Project Overview

- MnRoad Partnership with NCAT, part of Pavement Preservation evaluation project
- Existing:
  - 4 inches of asphalt pavement
  - 6 inches granular base
  - Clay subgrade
- Heavily distressed



Project Overview

- Two-lanes, 500 foot sections
- CIR, CCPR, FDR with foamed and emulsified recycling/stabilizing agents
- New sections
  - CIR and CCPR 4 inches
  - FDR 7 inches
  - All with 1 inch thinlay
- Monitored by MnRoad
- Materials collected for laboratory testing

West Limits – Kadler Ave

Westbound Lane

7001W	7002W	7003W	7004W	7005W	7006W	7007W	7008W
1" Thinlay 4" Existing	1" Thinlay 4" Existing	1" Thinlay 4" Existing	1" Thinlay 4" Existing	1" Thinlay 4" Existing	1" Thinlay 2" Mill & Inlay 2" Existing	1" Thinlay 3" CCPR Foam 1" Existing	1" Thinlay 4" Existing
1" Thinlay 7" SFDR Emulsion	1" Thinlay 7" SFDR Foam	1" Thinlay 3" CIR Foam 1" Existing	1" Thinlay 3" CIR Emulsion 1" Existing	1" Thinlay 3" CCPR Emulsion 1" Existing	1" Thinlay 3" Mill & Inlay 1" Existing	1" Thinlay 3" CCPR Foam 1" Existing	1" Thinlay 4" Existing
7001E	7002E	7003E	7004E	7005E	7006E	7007E	7008E

Eastbound Lane

East Limits – Labeaux Ave

Photo credit: Vargas

Mix Design Information

- Designers:
  - CIR/CCPR Foam – NCAT
  - CIR/CCPR Emulsion – Ingevity
  - FDR Foam and Emulsion – American Engineering Testing
- Foam = PG58-28; expansion ratio = 9, half life = 6.2
- Emulsion = PG58-28 base asphalt

Mixture	CIR-E		CIR-F	CCPR-E	CCPR-F	FDR-E	FDR-F
Method	Medium Mix Design	Coarse Mix Design	Mix Design	Mix Design	Mix Design	Mix Design	Mix Design
Agent Content, %	3.0	2.5	2.6	3.5	2.3	3.0	2.0
Active Filler Content, %	N/A	N/A	1.0	N/A	1.0	1.0	1.0
Moisture Content, %	3.0	2.8	4.5	3.7	4.5	6.0	7.2

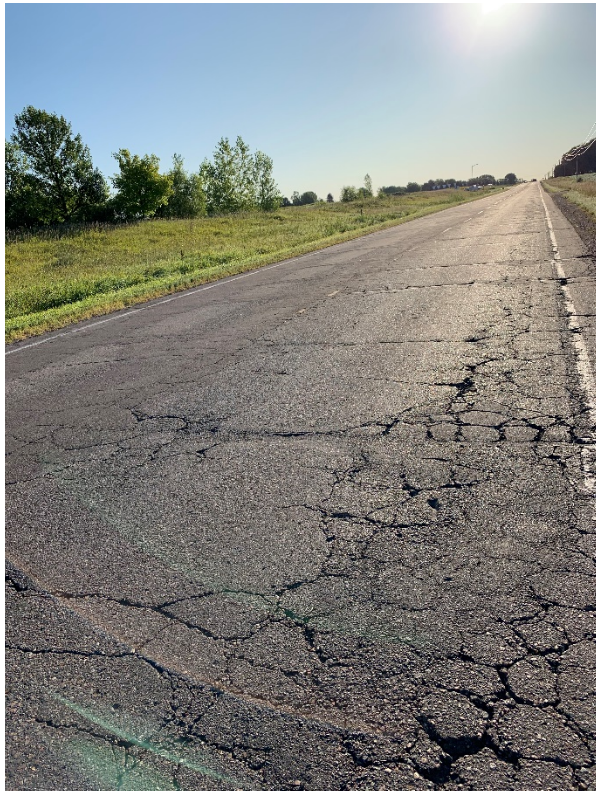
Mix Design Information

- Foam designs required to meet dry ITS = 45 psi and TSR = 0.70
  - FDR-F design did not meet the required TSR
- Emulsion designs required to meet 4” diameter stability = 1250 lb and retained stability of 0.70
  - FDR-E design did not meet the required retained stability (~0.60)

Photo credit: Allain

Construction

Before



During

After

Photo credit: Vargas

NCHRP 09-62

- *Rapid Tests and Specifications for Construction of Asphalt-Treated Cold Recycled Pavements*
  - VTRC, UCPRC, UNR, VT, Auburn
- Developed a test that evaluates whether CIR, CCPR, and FDR (bituminously stabilized) are ready for opening to traffic
  - Based on vane shear test
  - Uses DCP to sink pins into pavement
  - Torque wrench to shear
  - Non-destructive
  - Long pin (shear) and short pin (raveling)
- Used MnRoad project for ILS

Photo credit: NCHRP 9-62 Webinar

NCHRP 09-62

- Preliminary recommendations below
- More info in NCHRP Report 490
  - https://www.nap.edu/login.php?record_id=25971

Recommended Tests	Properties	Mean	Pooled σ	Threshold Value (Average of 3 Tests)
Short-Pin Raveling Test (SPRT)	Number of Blows	8.4	0.8	7.1
	Torque, ft-lb	24.3	2.5	20.2
Long-Pin Shear Test (LPRT)	Number of Blows	22.8	2.1	19.3
	Torque, ft-lb	76.4	8.2	62.9

Credit: NCHRP 9-62 Webinar

Post-Construction

- Road condition prior to paving = "poor"
  - IRI > 300 in/mi
- Road condition *after* paving = "good"
  - avg IRI = 75 in/mi
- Periodic testing:
  - Cracking
  - Rutting
  - Roughness
  - Structural condition

Photo credit: Vargas

Laboratory Program

- Indirect Tensile Test (foam) and Marshall Stability (emulsion)
  - Lab mixed from field collected materials
- IDEAL-CT
  - Lab mixed from field collected materials
- Hamburg rutting
  - Lab mixed from field collected materials
- Dynamic modulus
  - Lab mixed from field collected materials
  - Lab *compacted* from *field mixed* materials
  - Field cores

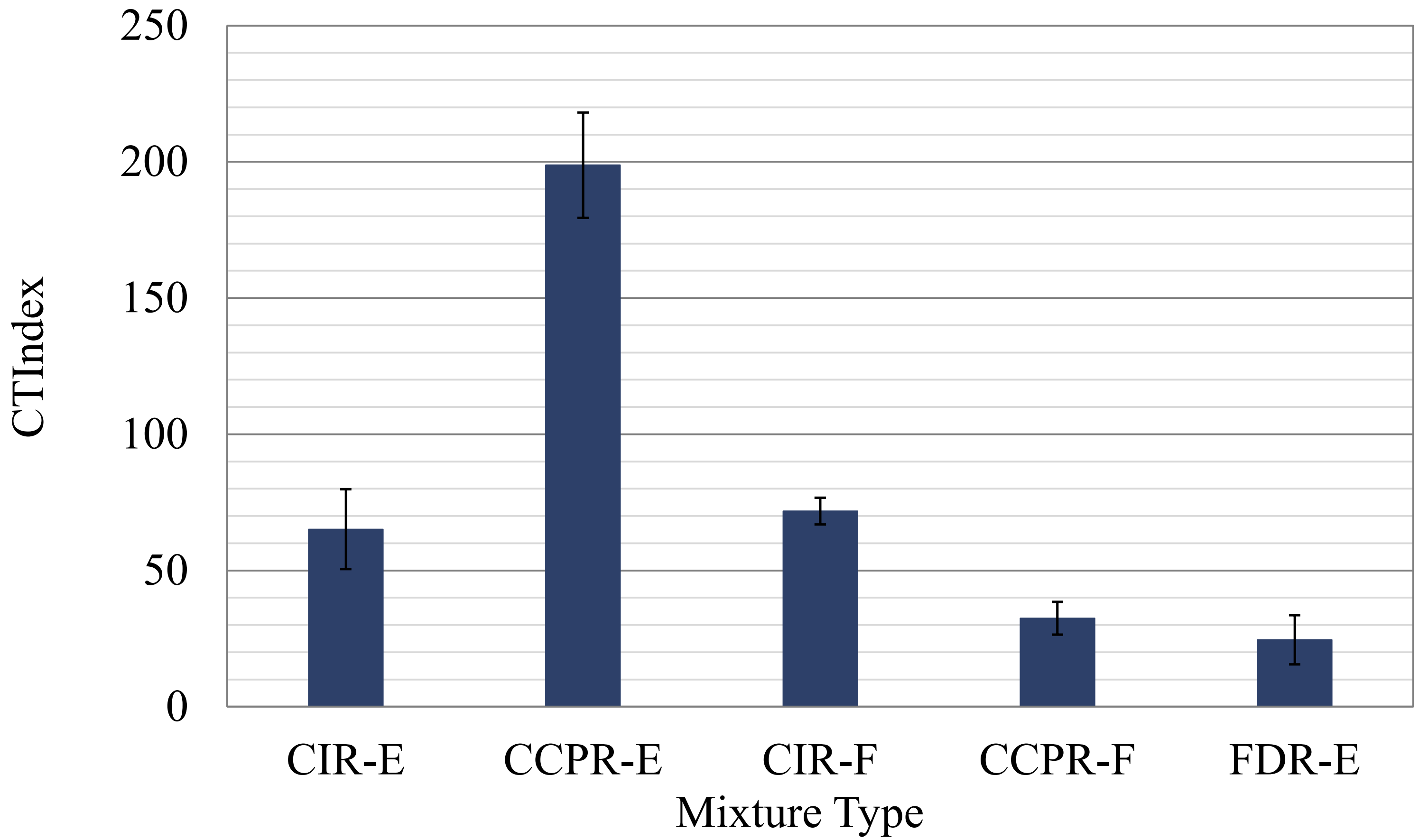
IDT and Marshall stability

- As-Built Mixture Acceptance Criteria
  - Note: Construction phase recorded mixture properties informed laboratory as-built mixture production

Mixture	CIR-E			CCPR-E		CIR-F		CCPR-F		FDR-E		
Method	Medium Mix Design	Coarse Mix Design	As-Built	Mix Design	As-Built	Mix Design	As-Built	Mix Design	As-Built	Mix Design	As-Built	Minimum, Req.
Dry ITS, psi	N/A	N/A	N/A	N/A	N/A	51.9	46.8	50.2	43.0	N/A	N/A	45
Conditioned ITS, psi	N/A	N/A	N/A	N/A	N/A	44.0	42.5	44.7	39.5	N/A	N/A	
TSR	N/A	N/A	N/A	N/A	N/A	0.85	0.91	0.89	0.92	N/A	N/A	0.70
Dry MS, lbf	2335	2190	1354	2113	1397	N/A	N/A	N/A	N/A	2382	2460	1250
Conditioned MS, lbf	2030	1870	2166	1765	1561	N/A	N/A	N/A	N/A	3825	2131	
MSR	0.87	0.85	1.60	0.84	1.12	N/A	N/A	N/A	N/A	0.62	0.87	0.70

IDEAL-CT

- CCPR-E had the highest IDEAL-CT
- FDR-E was the lowest
- CIR ranged between 65.1-71.8 on average



Mixture	CIR-E	CCPR-E	CIR-F	CCPR-F	FDR-E	HMA (PG 58-28) w/ 40% RAP Binder Content	HMA (PG 64-22) w/ 20% RAS Binder Content
CTIndex	65.1	198.8	71.8	32.4	24.6	160[1]	45.2[1]
Std. Dev.	14.6	19.3	4.9	6	9		

[1]Zhou 2019

Hamburg Rutting

CIR-E

CIR-F

FDR-E

CCPR-E

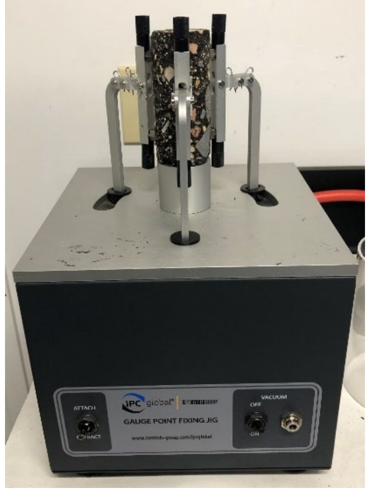
CCPR-F

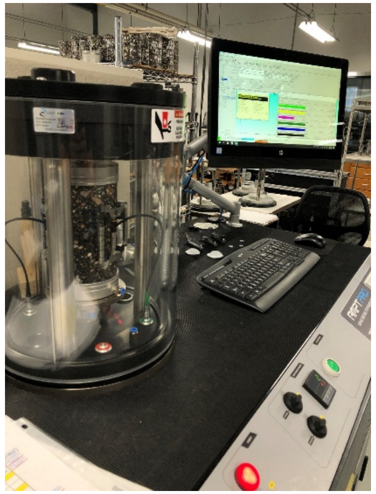
HMA

Photo credit: Allain

Dynamic Modulus

- Conducted on Full-size:
  - Lab Produced, Lab Compacted
  - Field Produced, Lab Compacted
- Conducted on Small-size
  - Lab Produced, Lab Compacted
  - Field Produced, Field Compacted (Cores)





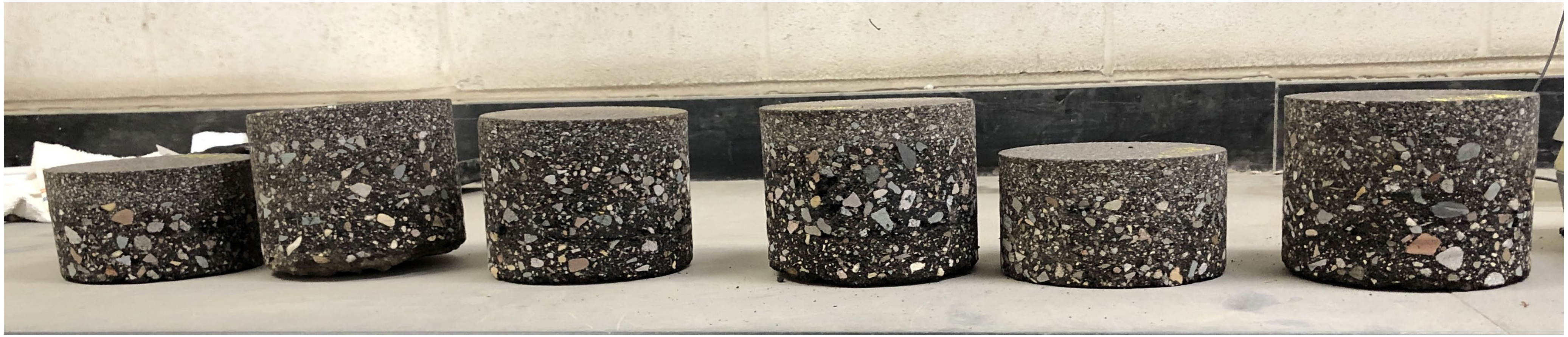
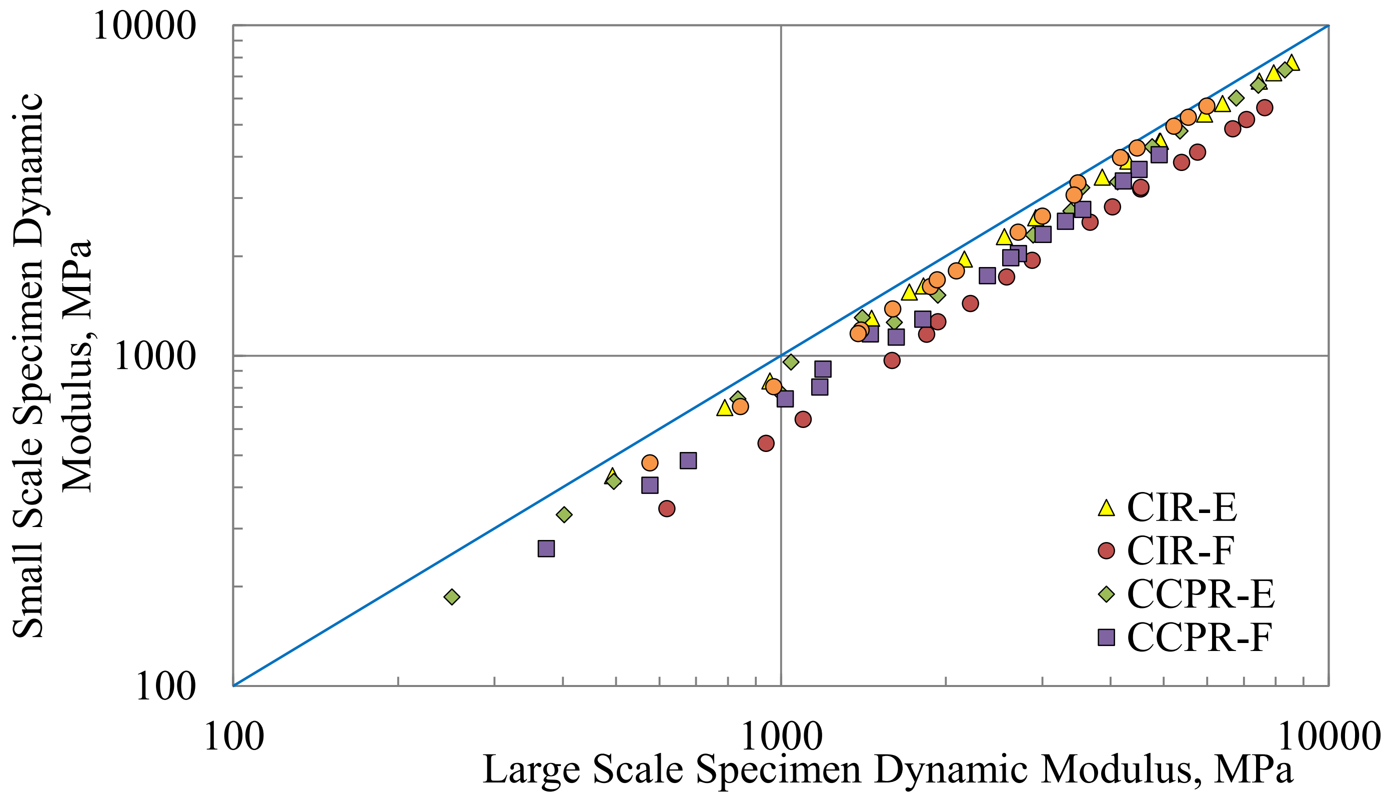


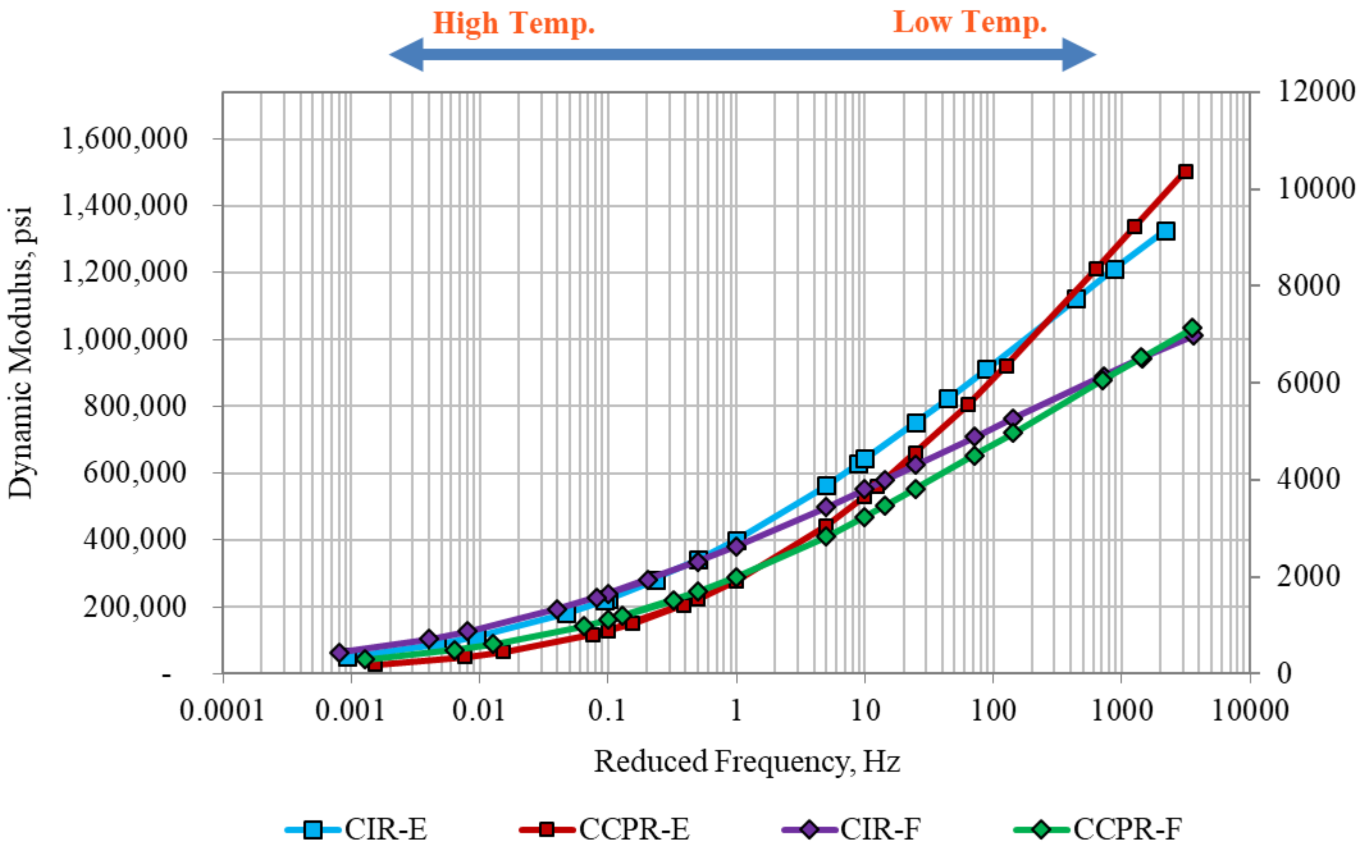
Photo credit: Allain

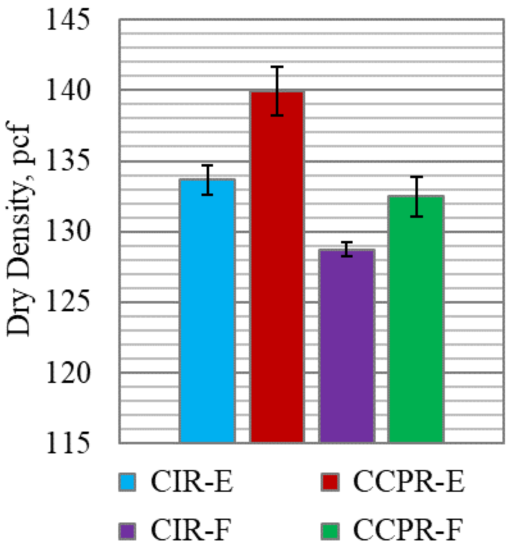
Small vs Large Samples

- Can we use small-scale specimens in lieu of full-size for cold recycled mixtures?
  - Generally, yes
  - Some offset may need to be applied
  - Overall trends are the same



Dynamic Modulus and Density





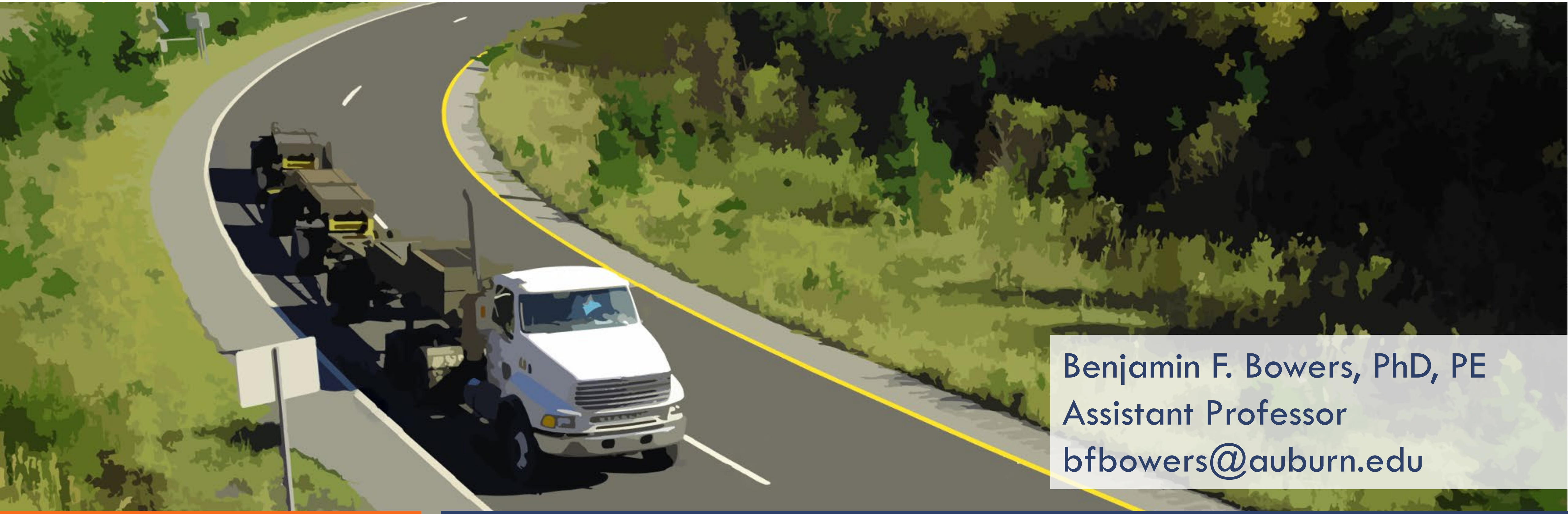
In Conclusion

- Some variability between field and mix design
- We have a lot of interesting laboratory data
  - CR mixes can get decent IDEAL-CT numbers
  - Hamburg rutting probably isn't ideal
  - Dynamic modulus may need some shift factors
- Connecting that information with *long-term* field performance will be important
  - Jerry will cover field performance to-date!

Special thanks…

- Adriana Vargas and Buzz Powell
- David Allain – thesis *"Evaluation of Laboratory and Field Produced Cold Recycled and Full Depth Reclaimed Asphalt Pavement Materials"*
- Jenna Bowers
- The NCAT lab team
- The MnRoad team
- NCHRP 09-62 team
- Many others…

Questions and Answers



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