

Lab and Field Evaluation of Extended Life HMA Sections and Implications on Pavement Design

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Acknowledgement



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Background on IDOT Pavement Design



Bureau of Design and
Environment Manual



Full-depth (perpetual) asphalt pavement mechanistic-empirical (M-E) design was **last modified in 2011**.

Development of New Technologies

Outdated Guidelines & Potential Losses



Bottom-up fatigue cracking has not been a recurrent problem in IL for Perpetual Sections.

Increasing interest in **higher amounts of Recycled Asphalt** within HMA Mixtures, especially lower binder.

Current IDOT/ICT Research in Progress



Typical HMA Dynamic Modulus ($|E^*|$) values



Alternative $|E^*|$ Measurement and Modeling



Fatigue Endurance Limit (FEL) criteria

Potential reduction of \$30,000/lane-mile per 10 $\mu\epsilon$ increase in FEL



Why Use Extended Life Pavement Design?



- Warranty demonstration project mandated by Illinois FIRST legislation in 1999
- "The Department shall implement a demonstration project, under which 20 of the contracts ... for fiscal years 2000 through 2004 shall have a performance-based warranty of at least 5 years..."
- **Also required extended life designs**
- "10 of those contracts shall be designed for a 30-year life cycle."
- Asphalt industry wished to compete on "30-year life cycle" warranty projects

What Is An Extended Life HMA Design?

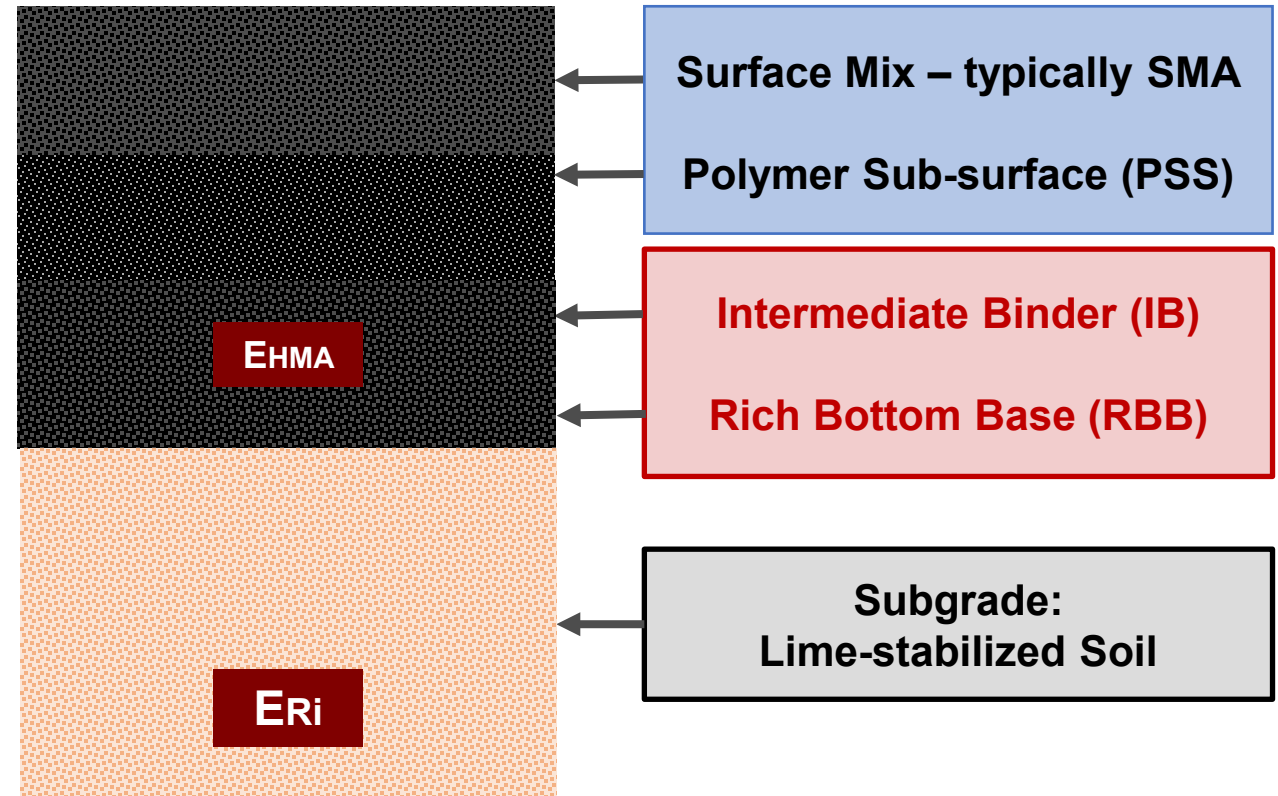


- Built to last longer than the standard 20-year design
- Will not require major rehabilitation or patching
- Considered “Perpetual” - Surface is sacrificial and is replaced at some frequency

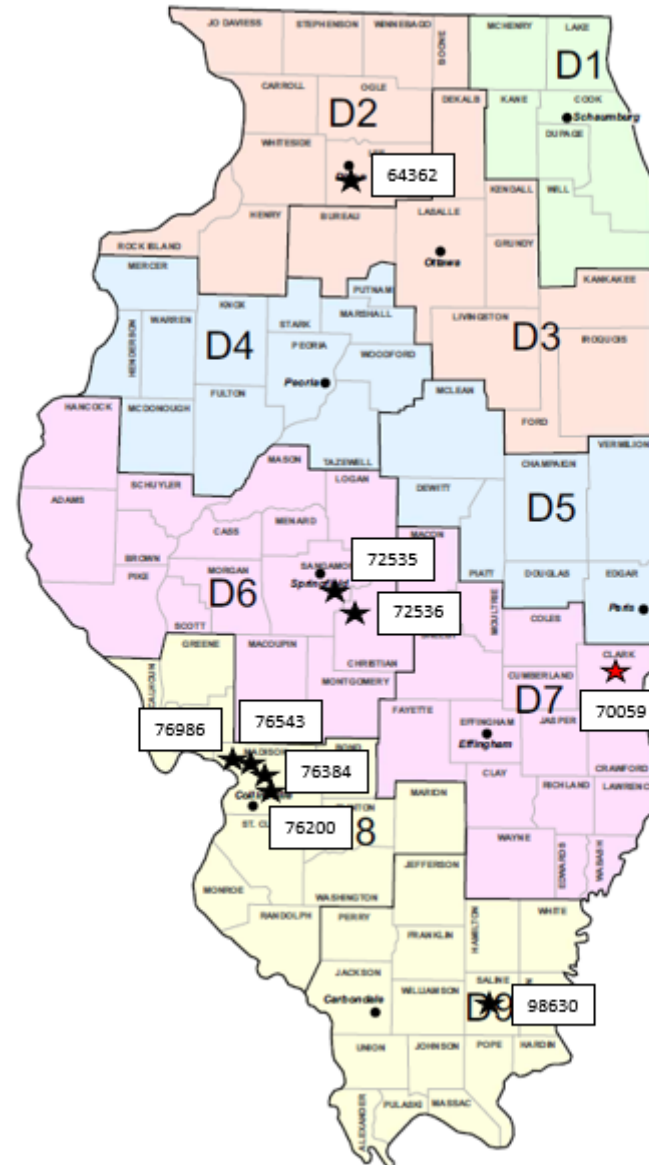
Extended Life HMA Elements



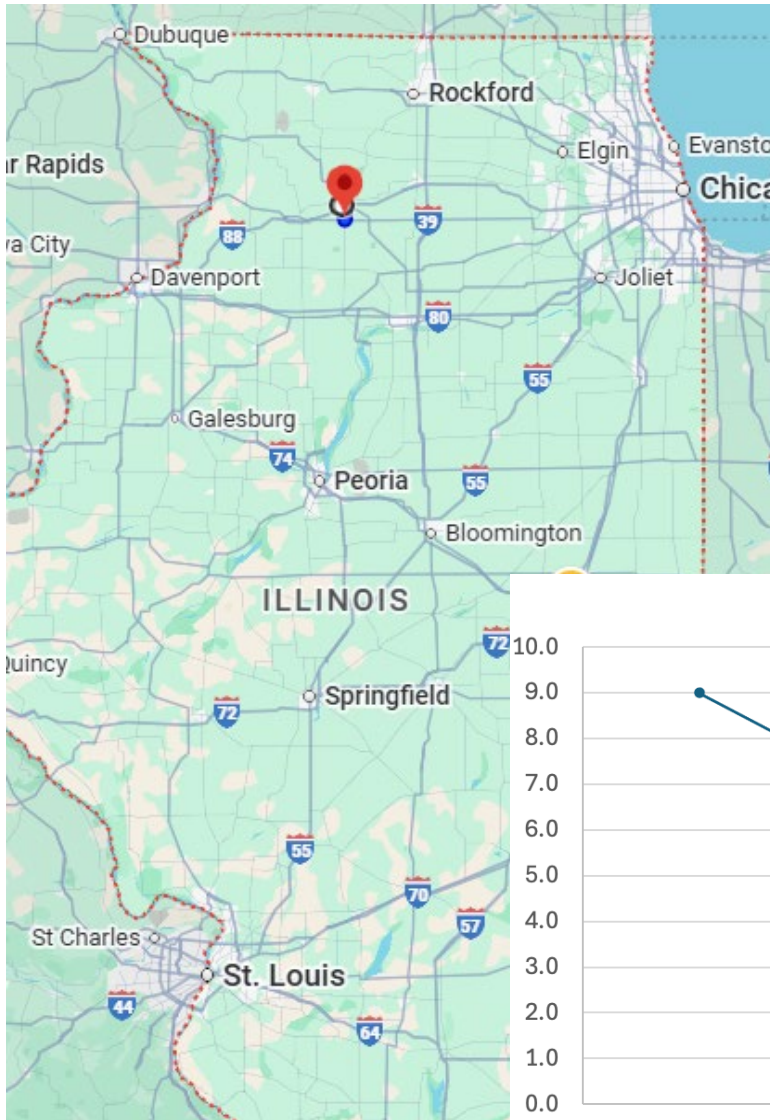
- Polymer required in upper lifts
- SMA surface preferred
- 1.0% hydrated lime (dry) anti-strip used on 2 projects
- Polymer tack coat between lifts
- Extra tack coat on longitudinal joints (early form of LJS)
- Material transfer device required on all lifts
- Rich bottom base used on most projects
- Minimal RAP or RAS allowed, but more RAP would likely be used today



Extended Life HMA Project Locations



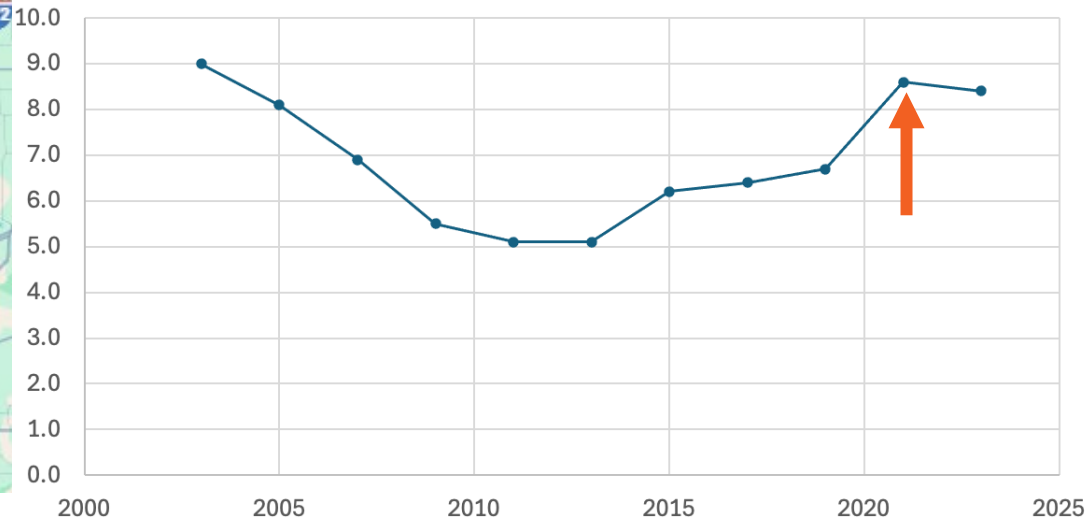
Field Sections



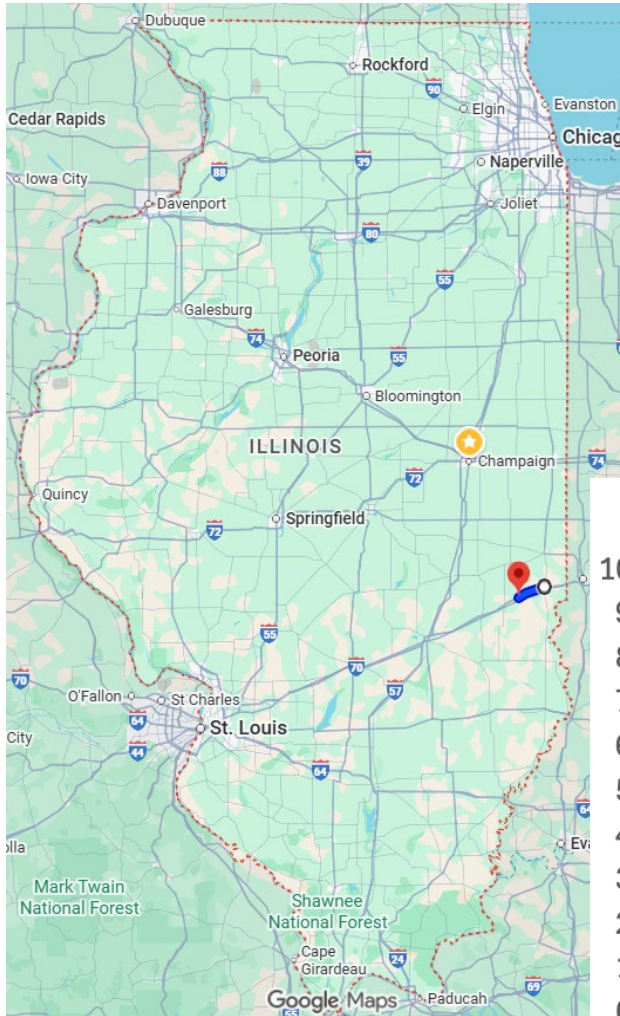
IL 26 (Contract 64362)
Lee County, 2003 (D2)
Resurfaced in 2020

- 4.3 miles
- Full-depth, 13.25 in (total)
- Structure: 4 in RBB + 3.25 in IB + 4 in PSS + 2 in SMA
- Binders: PG 64-22 (RBB, IB), PG 64-28 (PSS), PG 76-22 (SMA)
- Max RAP = 15% (IB)

CRS History



Field Sections



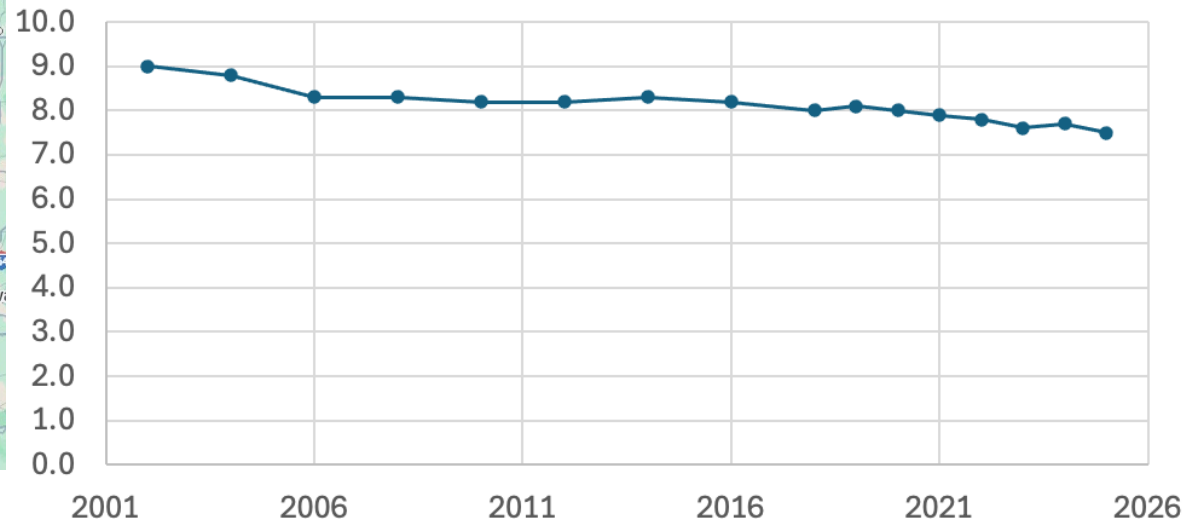
I-70 (Contract 70059)

Clark County, 2003

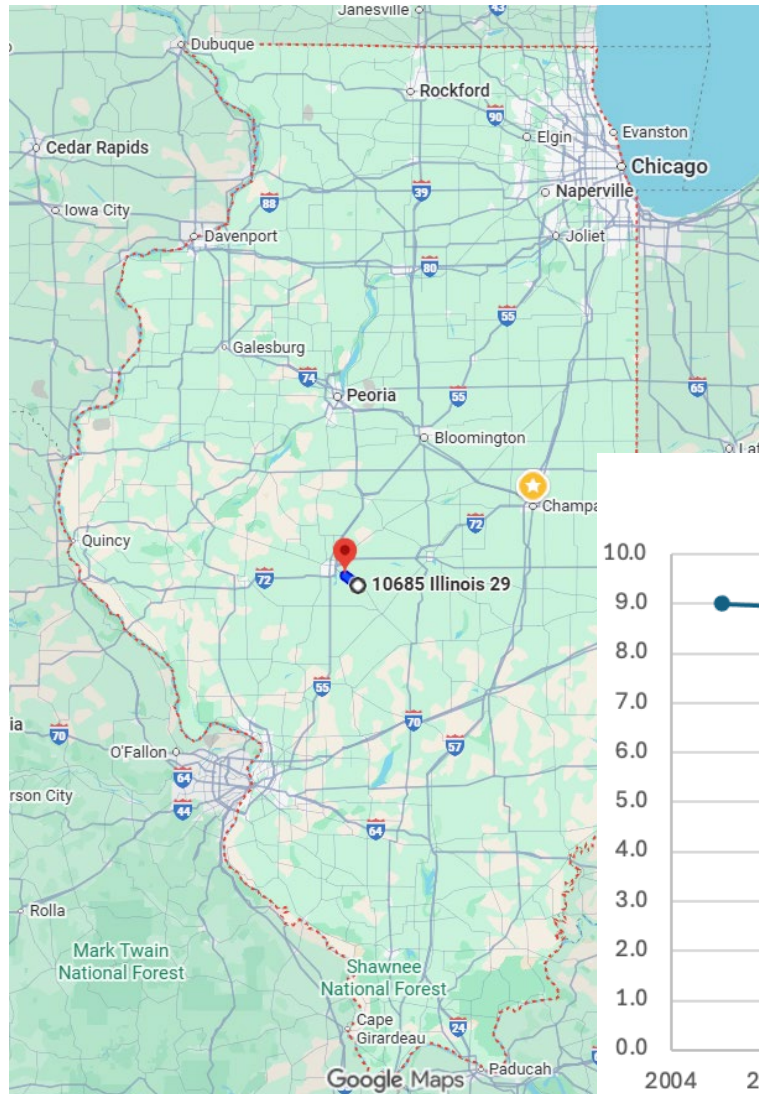
Microsurfacing at centerline and lane-shoulder joints only in 2024

- 9.76 mi
- HMA over 8-in Rubblized PCC, 17.5 in (total)
- 10 in IB + 5.5 in PSS + 2 in SMA
- PG 70-22 (IB), PG 76-28 (PSS), PG 76-28 (SMA + Steel Slag)
- Max RAP = 0% (IB)

CRS History



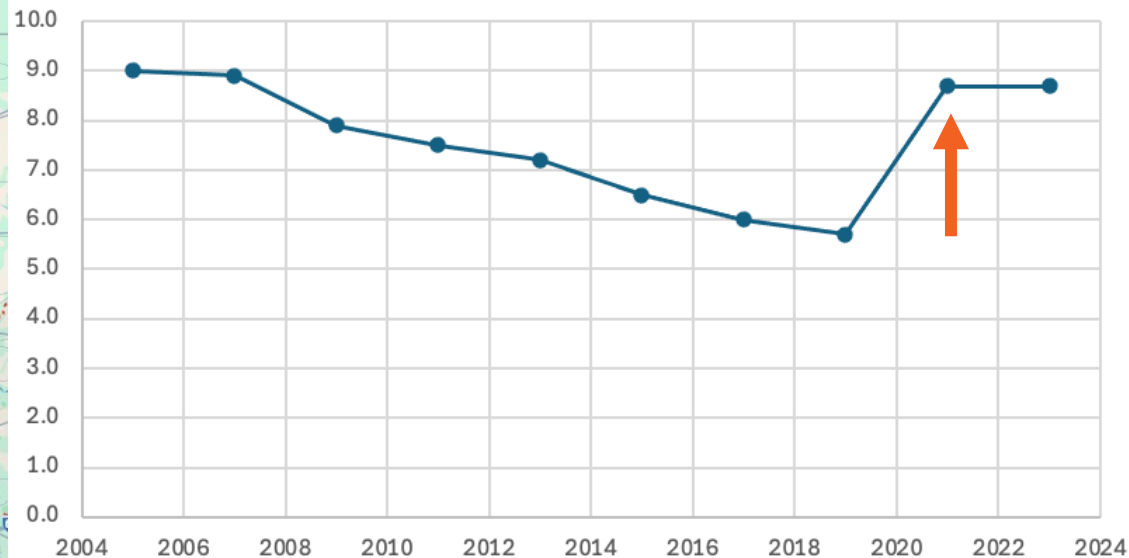
Field Sections



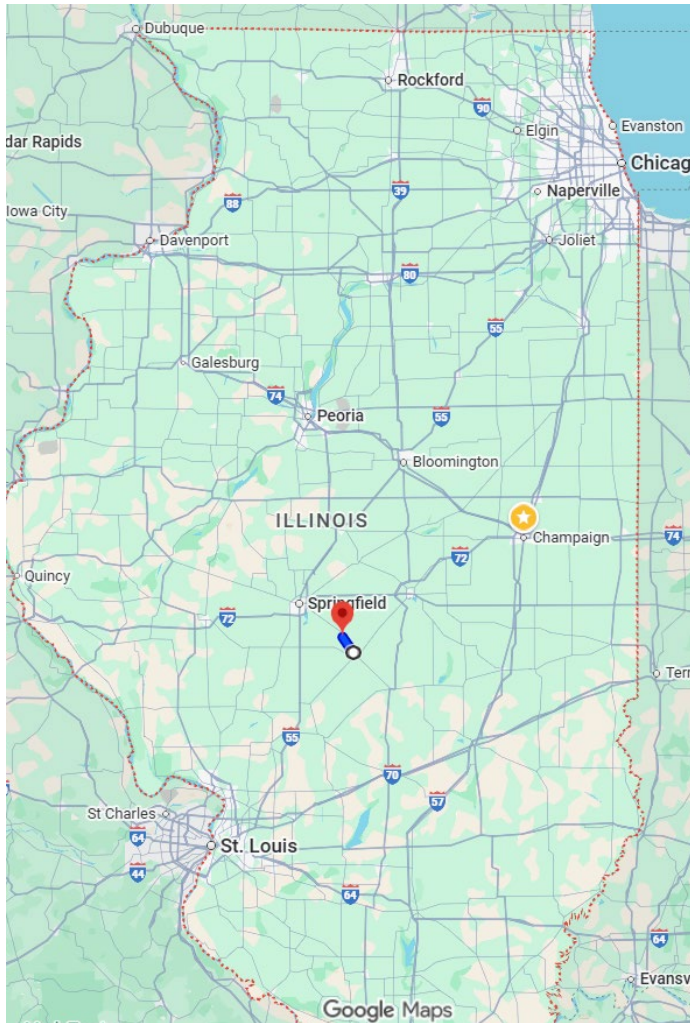
IL 29 (Contract 72535) Sangamon County (2004) 2020 Thinlay (3/4-inch mill and fill)

- 5.47 mi
- Full-depth, 13.75 in (total)
- 4 in RBB + 3.75 in IB + 4 in PSS + 2 in Dense-Graded AC
- PG 64-22 (RBB, IB), PG 64-28 (PSS), PG 70-28 (DG AC)
- Max RAP = 15% (IB)

CRS History



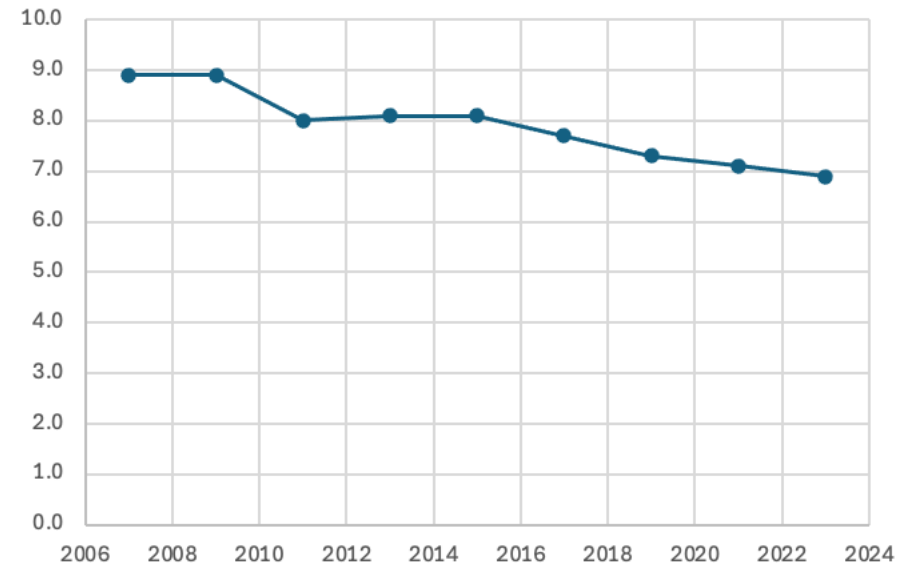
Field Sections



IL 29 (72536)
Christian County
2006 (19 years) (Original Surface)

- 4.5 RBB + 3.5 + 2.5 IB + 2.5 PSS + 2 DG

CRS History

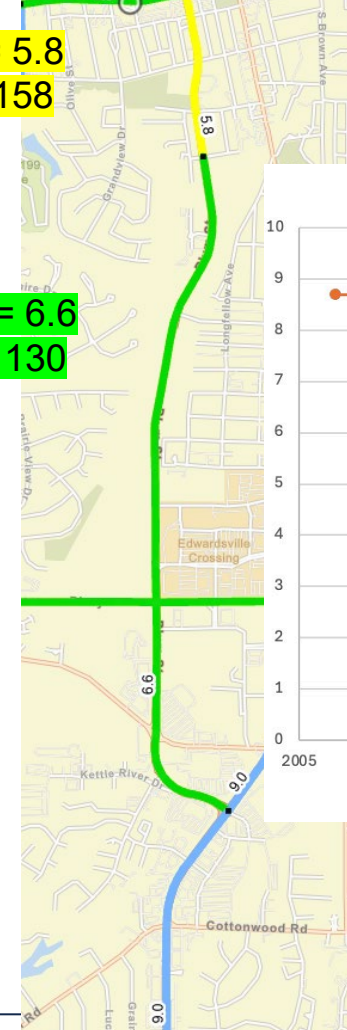
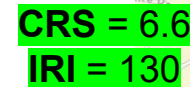


CRS = 6.9
IRI = 66.0

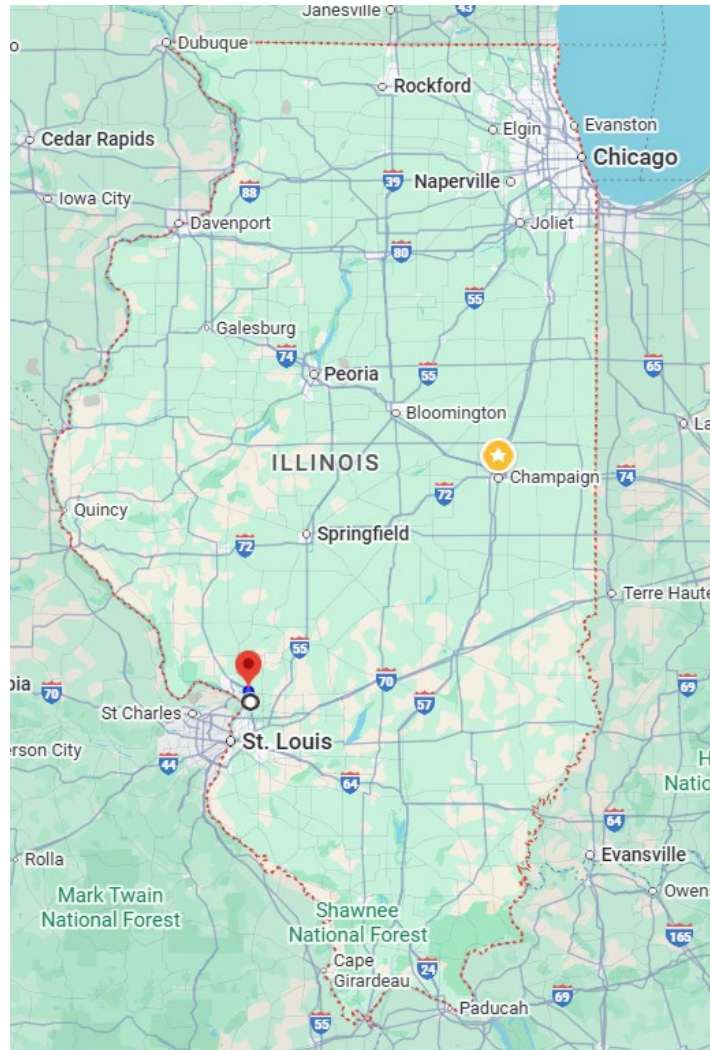




- CRS = 5.8**
IRI = 158



Field Sections

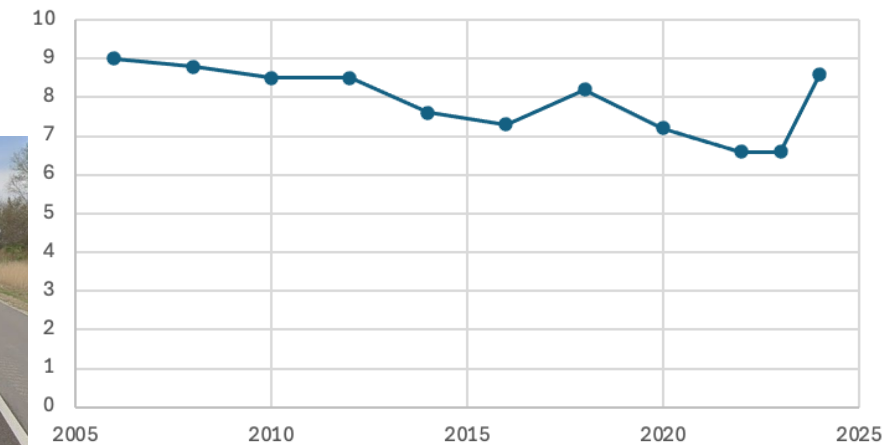


IL 255 (Contract 76384) IL 143 to IL 140 (Madison County) 2006 (Resurfaced in 2023)

- 4.38 mi
- 15.1 in (total)
- 4 in RBB + 5.1 in IB + 4 in PSS + 2 in SMA
- PG 64-22 (RBB, IB), PG 70-28 (PSS), PG 76-28 (SMA)
- Max RAP = 10% (IB)



CRS History



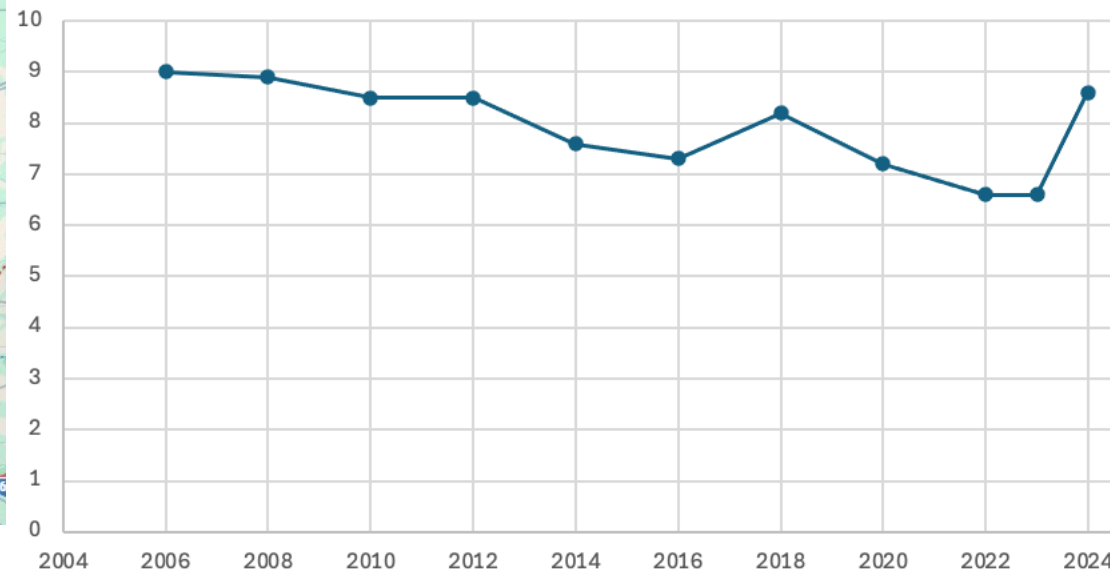
Field Sections



IL 255 (Contract 76543) IL 140 to Fosterburg (Madison County) 2005 (2" mill & 2" overlay in 2023)

- 3.06 mi
- 15.1 in (total)
- 4 in RBB + 5.1 in IB + 4 in PSS + 2 in SMA
- PG 64-22 (RBB, IB), PG 70-28 (PSS), PG 76-28 (SMA)
- Max RAP = 15% (IB)

CRS History



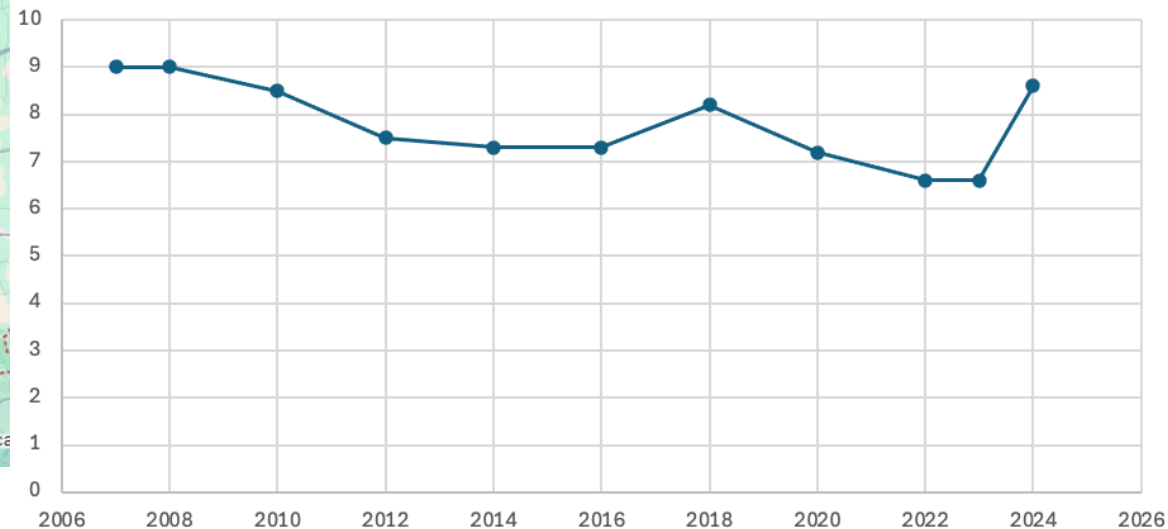
Field Sections



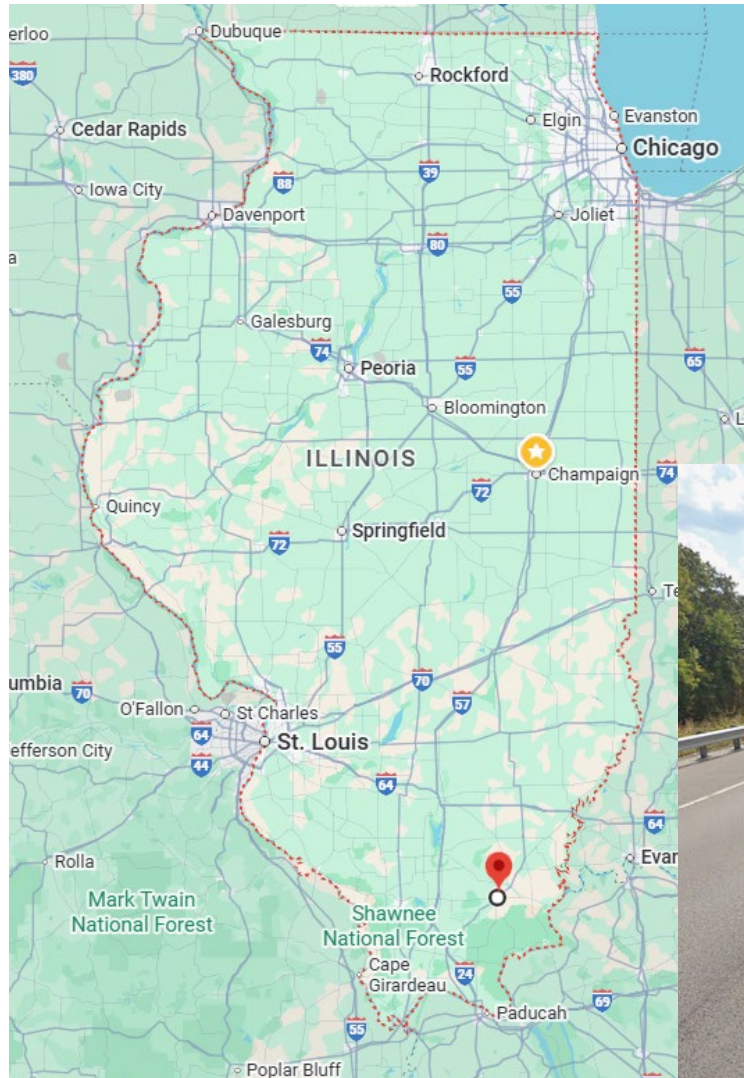
IL 255 (Contract 76986) Fosterburg to Seminary (Madison County) 2008 (2" mill & 2" overlay in 2023)

- 2.6 mi
- 15.0 in (total)
- 10.75 in IB + 2.25 in PSS + 2 in SMA
- PG 64-22 (IB), PG 76-22 (PSS), PG 76-22 (SMA)
- No RAP

CRS History



Field Sections

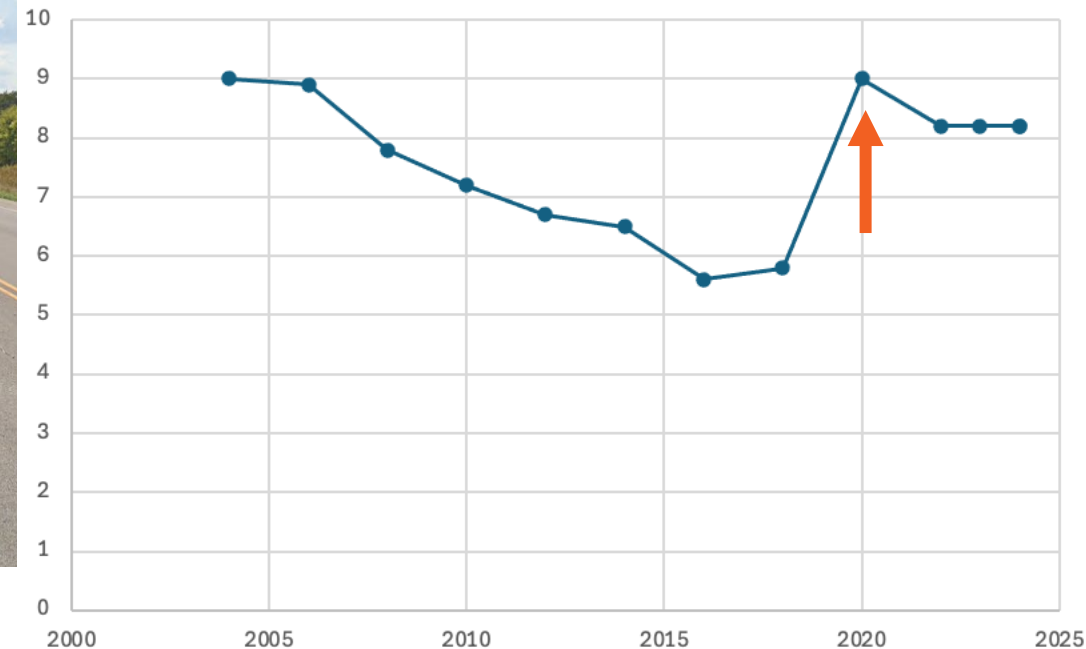


US 45 (Contract 98630)
Saline County
2005 (1.5" mill & 1.5" overlay in 2016)

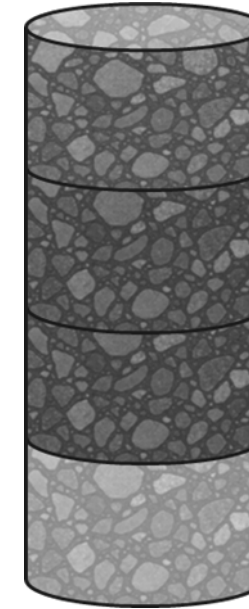
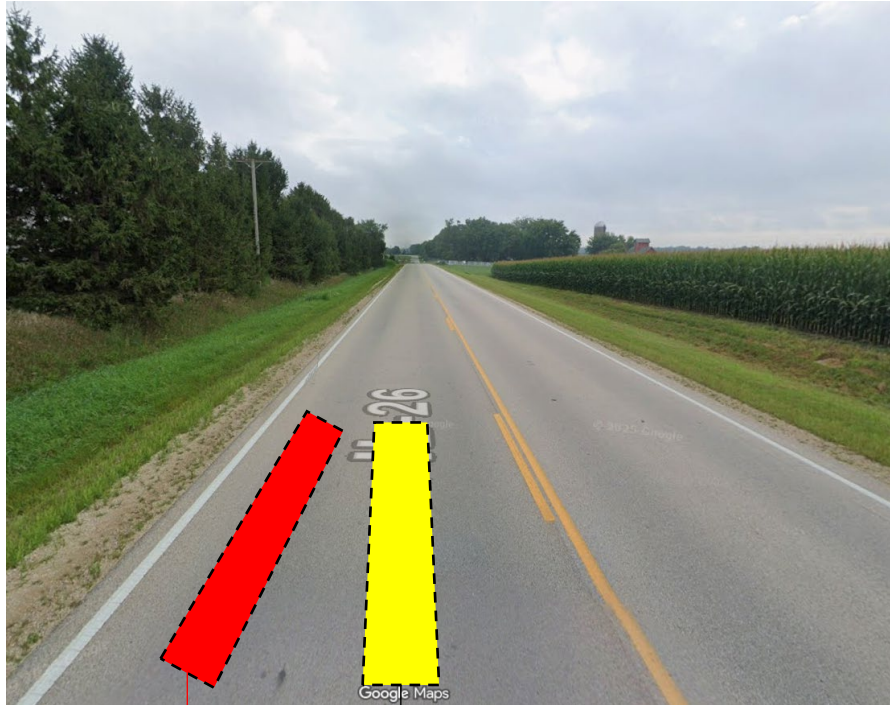
- 1.43 mi
- 14.5 in (total)
- 3.5 in RBB + 4.5 in IB + 4.5 in PSS + 2 in SMA
- PG 64-22 (RBB, IB), PG 70-22 (PSS), PG 70-28 (SMA)
- Max RAP = 0% (IB)



CRS History



Overview of Testing Plan



Surface (2 in SMA)

Sub-surface (IL-19.0 + Modified binder)

Intermediate Binder (IB)
(IL-19.0, PG 64-22 + 0-15% RAP)

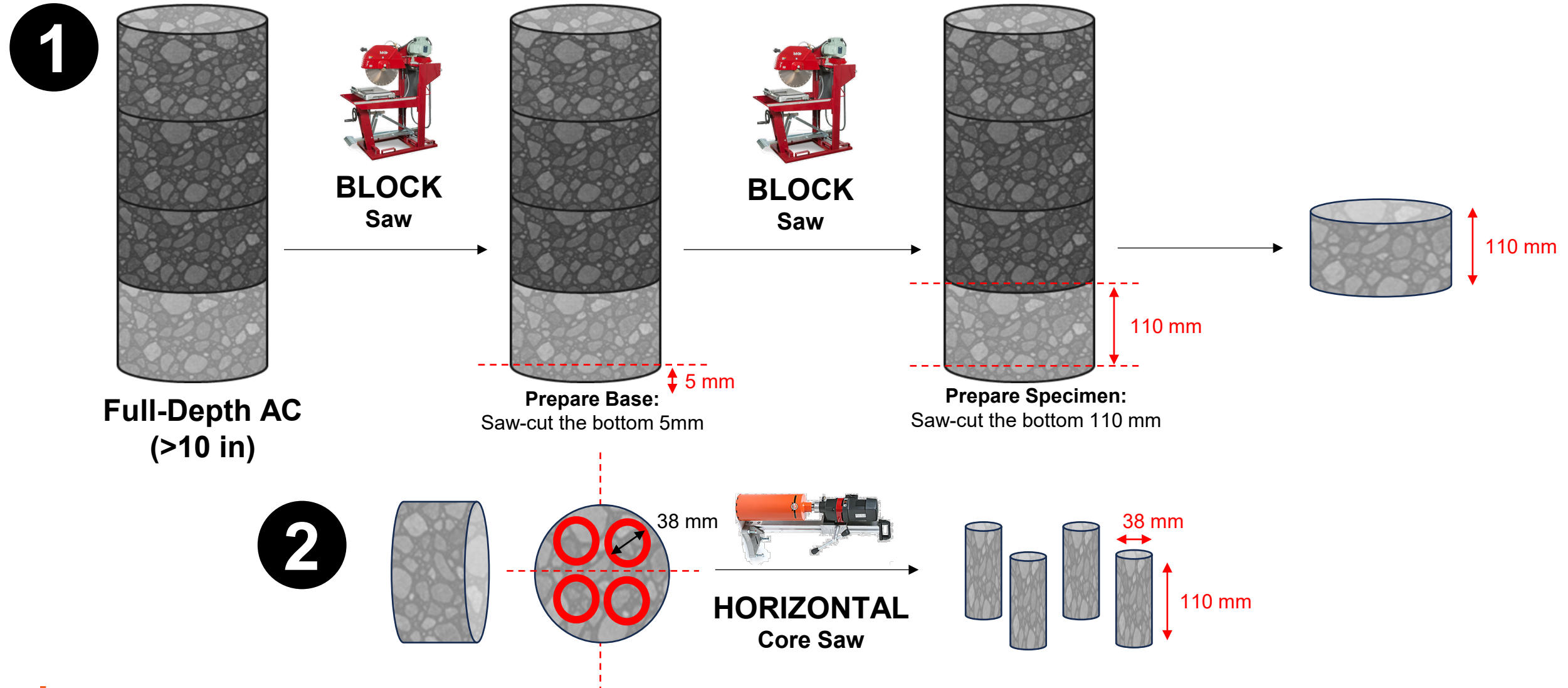
Rich Bottom Base (Low AV)

Wheel-path: direct tire-pavement interaction volume → more damage.

Center of lane: expected lower load effect → less damage.

HWTT, TSR, I-FIT

Modulus & Fatigue



ICT - Methodological Framework – E* (AASHTO TP132-25)

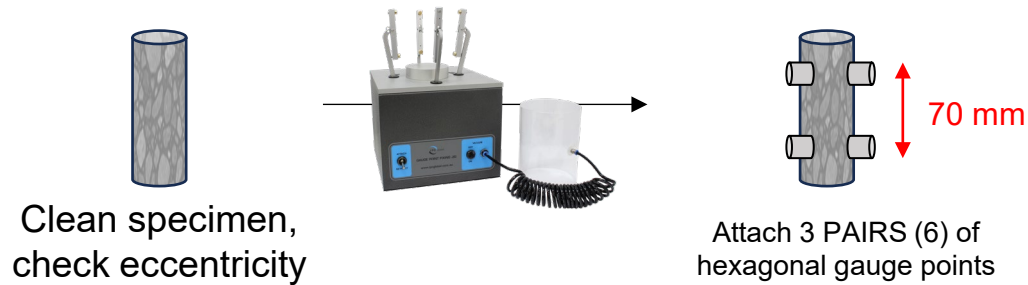


Table 1—Recommended Testing Temperatures and Loading Frequencies

PG 58-XX and Softer		PG 64-XX and PG 70-XX		PG 76-XX and Stiffer	
Temperature, °C	Loading Frequencies, Hz	Temperature, °C	Loading Frequencies, Hz	Temperature, °C	Loading Frequencies, Hz
4	10, 1, 0.1	4	10, 1, 0.1	4	10, 1, 0.1
20	10, 1, 0.1	20	10, 1, 0.1	20	10, 1, 0.1
35	10, 1, 0.1, and 0.01	40	10, 1, 0.1, and 0.01	45	10, 1, 0.1, and 0.01

Phase 1 (110 mm, Bottom)

Section	Layer Type	Binder	AV (%)	RAP
64362	RBB	64-22	2.5	0
70059	IB	70-22	4.0	0
72535	RBB	64-22	2.5	0
72536	RBB	64-22	2.5	0
76200	RBB	64-22	2.5	0
76384	RBB	64-22	2.5	0
76543	RBB	64-22	4.0	0
76986	IB	64-22	4.0	0
98630	RBB	64-22	2.5	0

Run **FIRST TEMPERATURE** (4C, 10, 1, 0.1 Hz)
Pre-condition at 4C overnight.

Run **SECOND TEMPERATURE** (20C, 10, 1, 0.1 Hz)
Pre-condition at 20C (servo room) overnight.

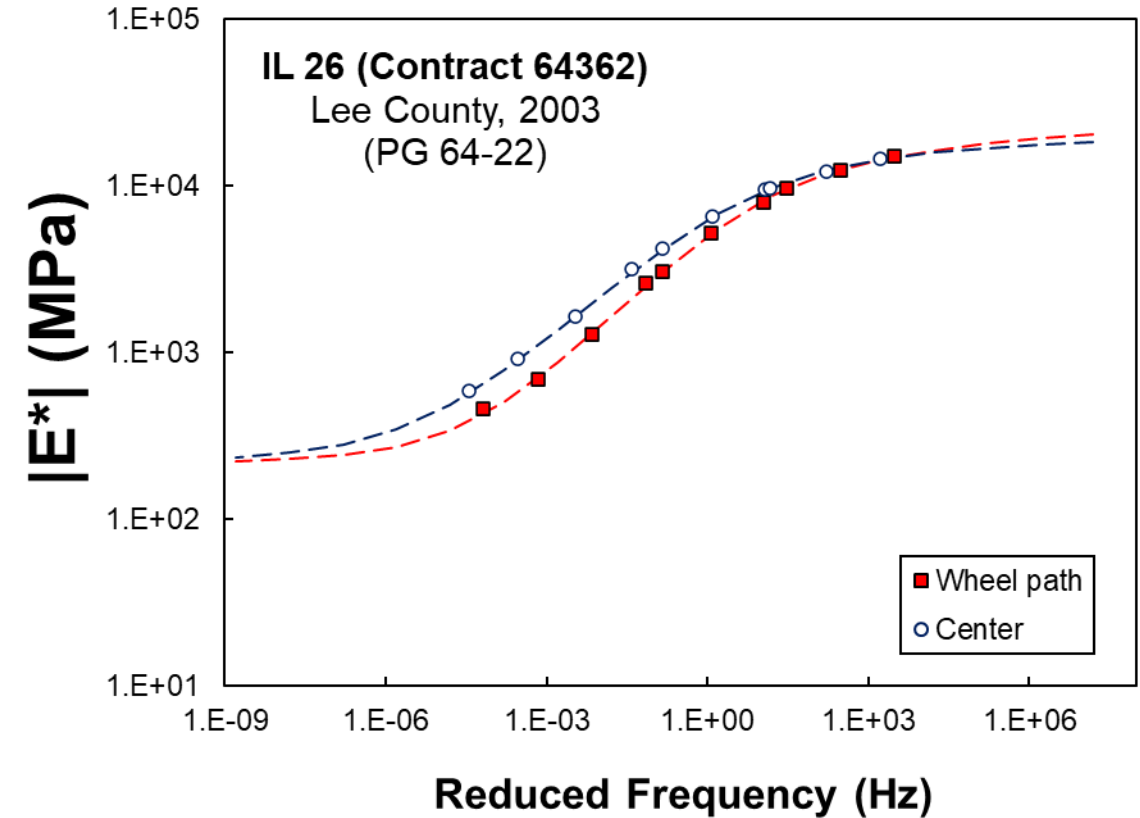
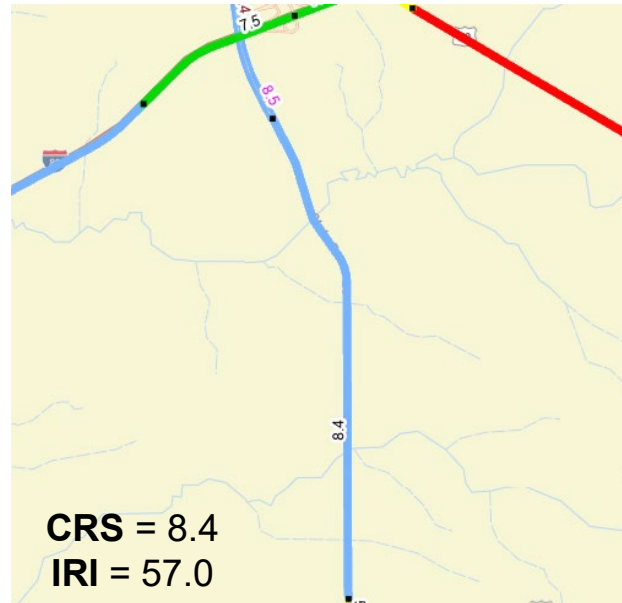
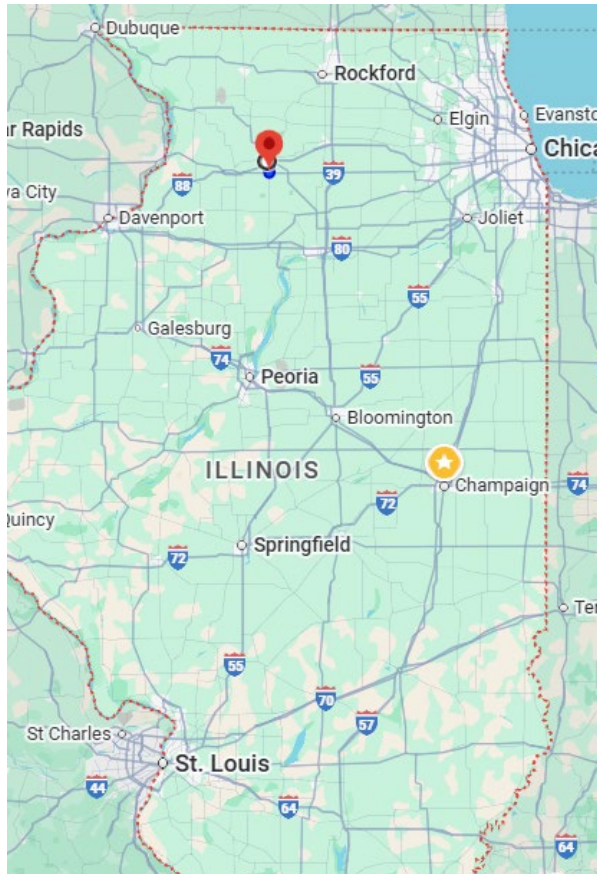
Run **THIRD TEMPERATURE** (35, 40 or 45C, 10, 1, 0.1, 0.01 Hz)
Pre-condition at 35-40-45 (env. chamber) 4h.

Export FlexMAT file and upload to the FlexMAT software. Get master curves.

Field Cores – Dynamic Modulus



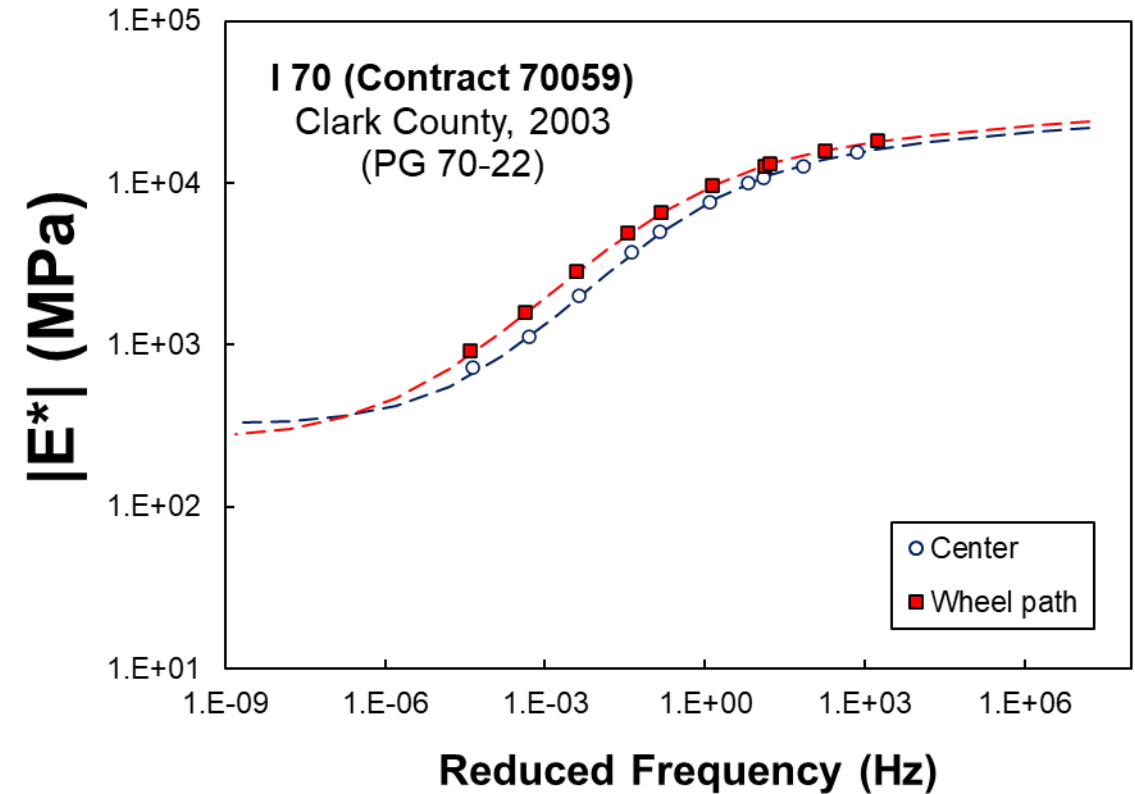
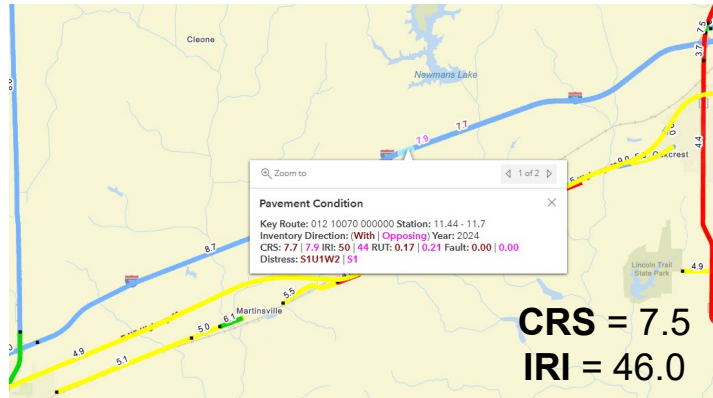
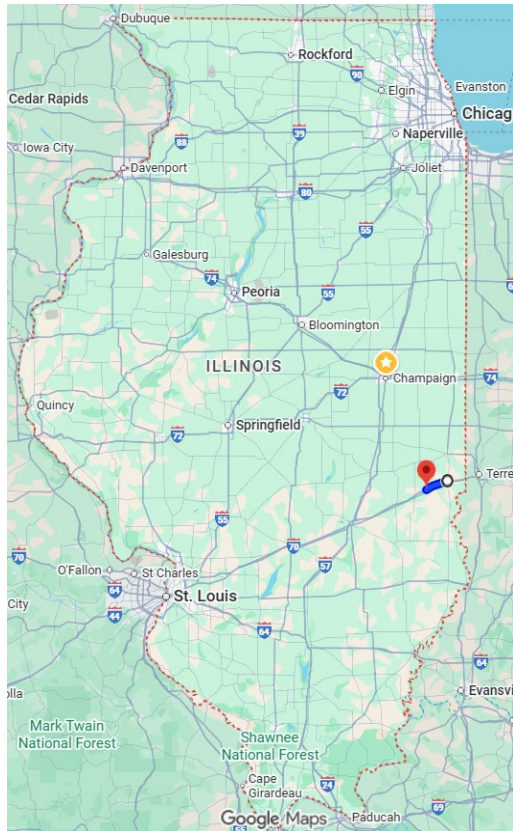
IL 26 (Contract 64362)
Lee County, 2003
(22 years – Resurfaced 2020)



Field Cores – Dynamic Modulus



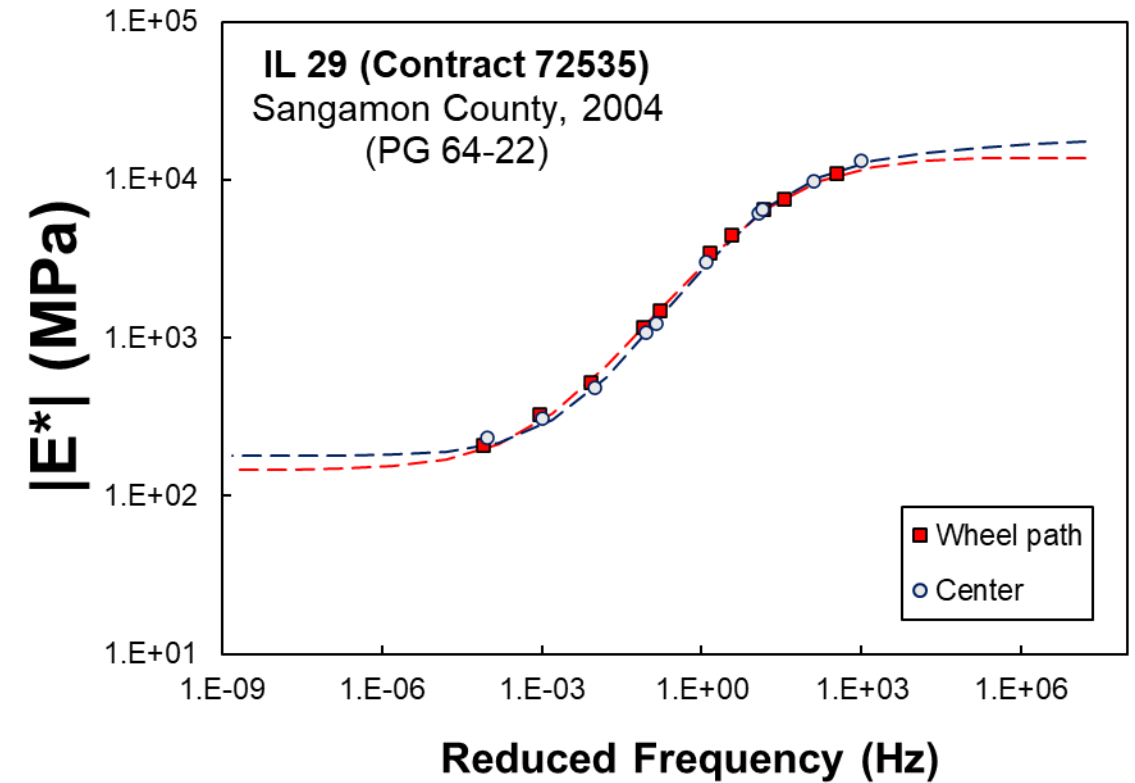
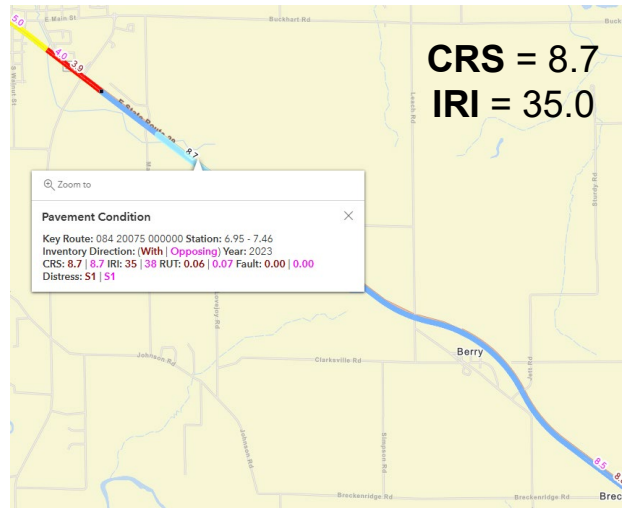
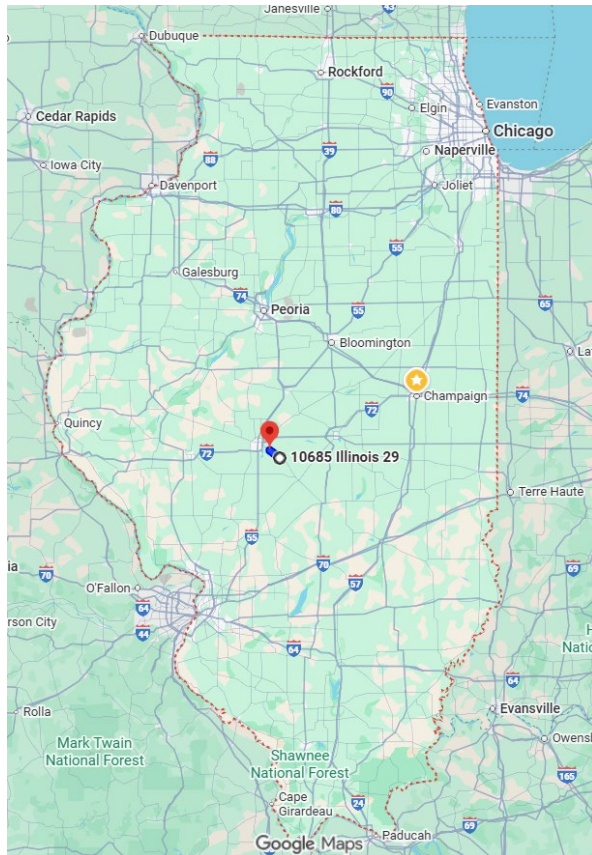
I-70 (Contract 70059)
Clark County, 2003
(22 years)



Field Cores – Dynamic Modulus



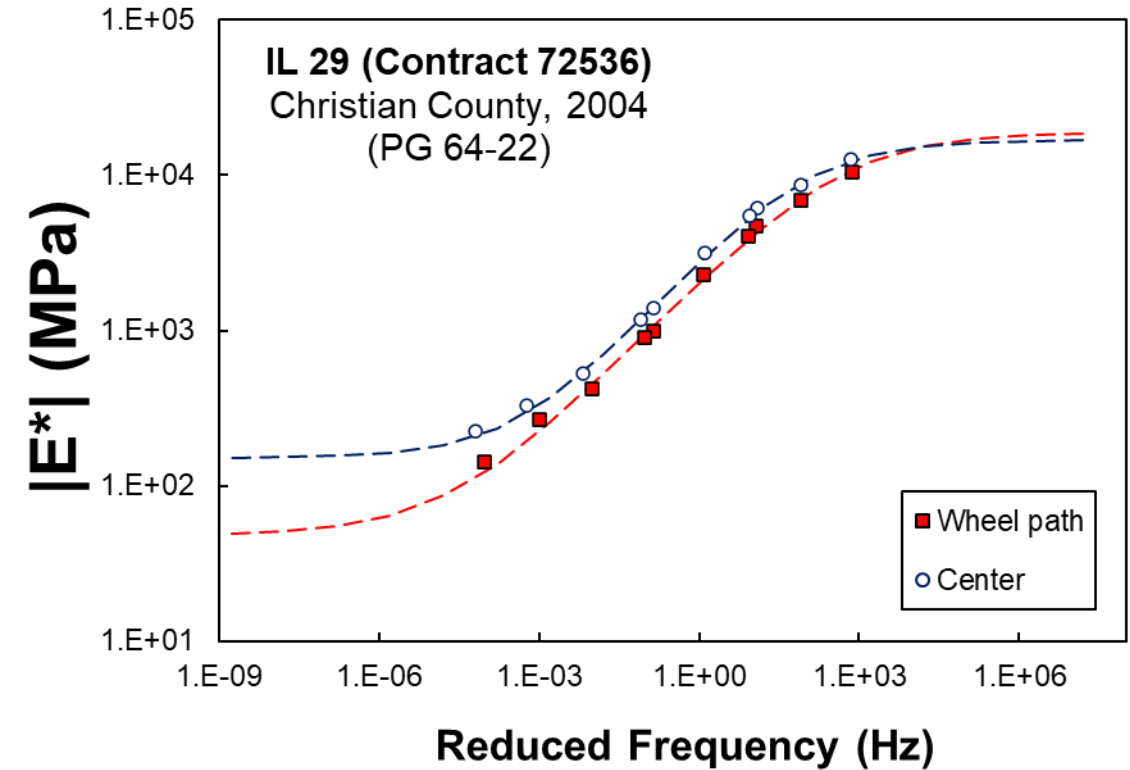
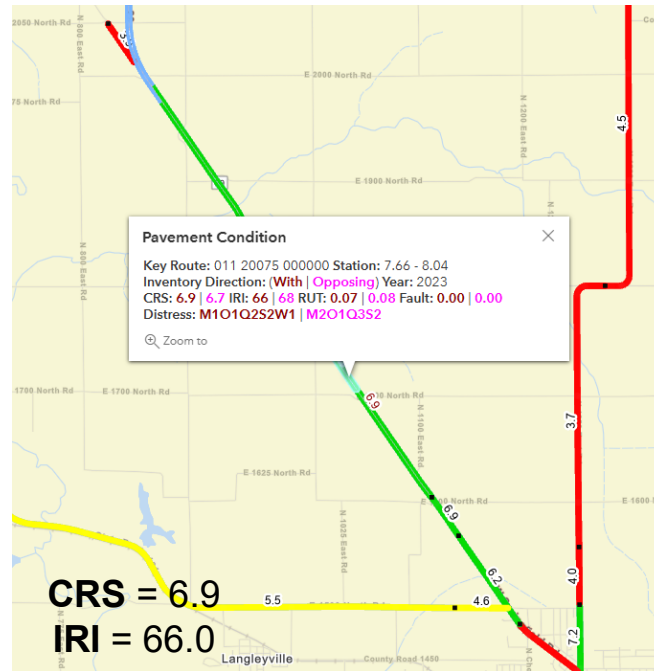
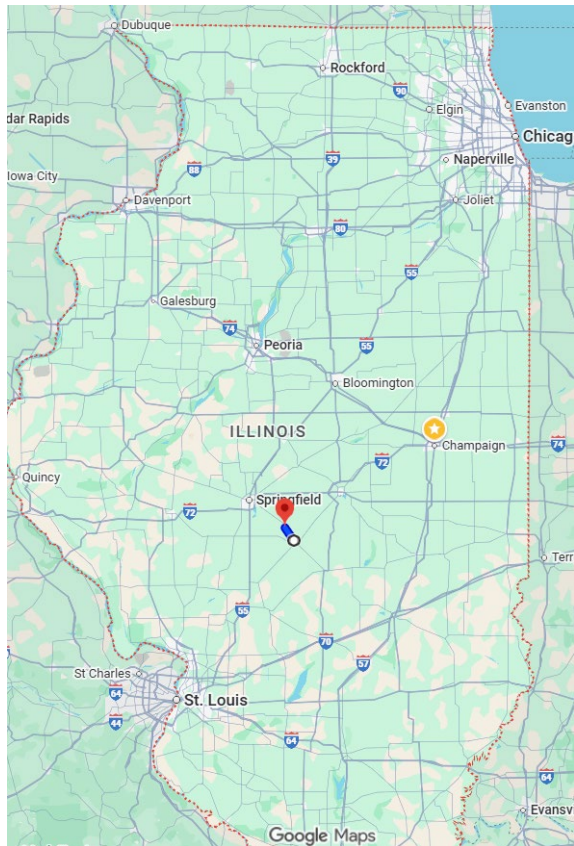
IL 29 (Contract 72535)
Sangamon County
2004 (21 years; 2020 thinlay)



Field Cores – Dynamic Modulus



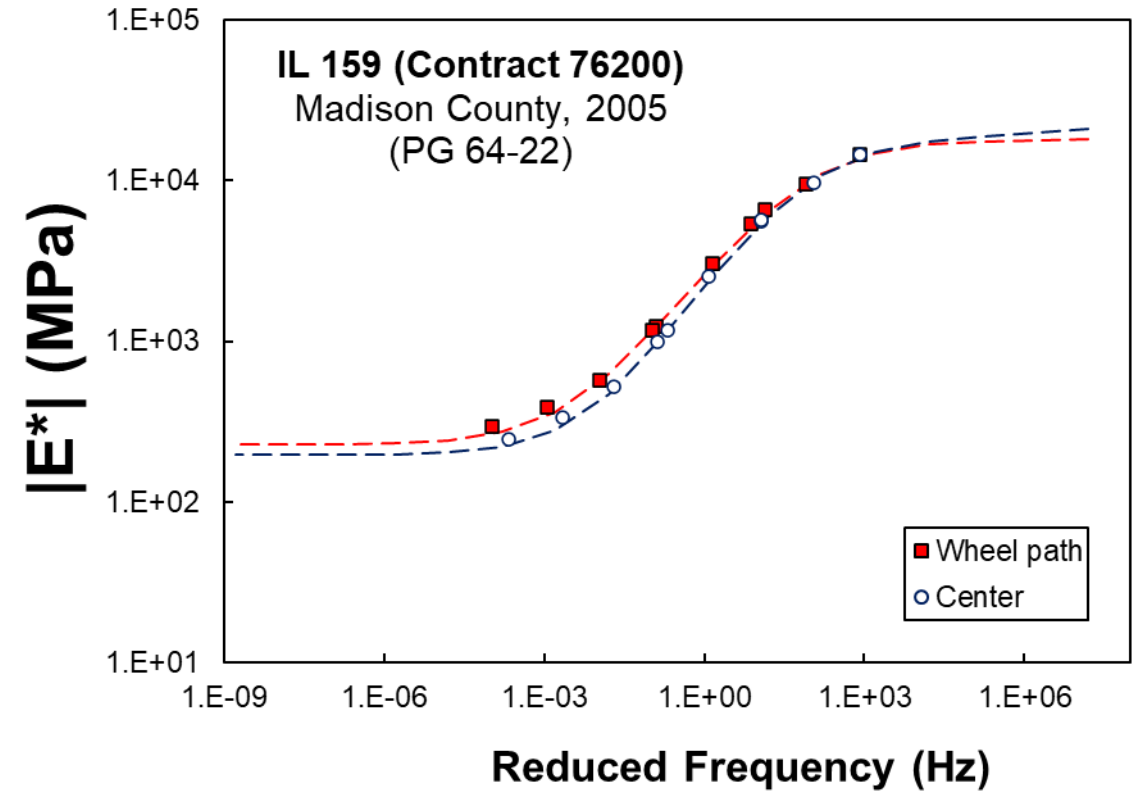
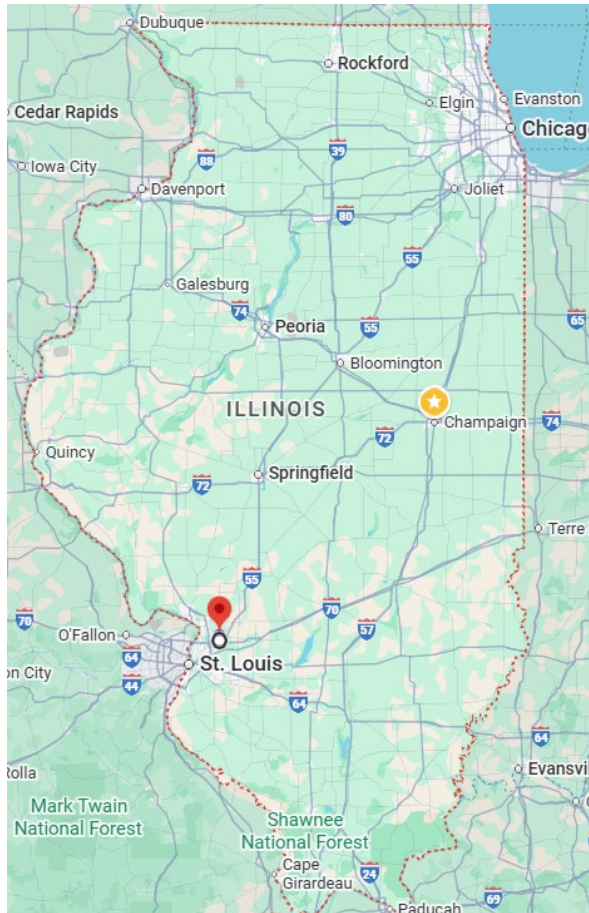
IL 29 (Contract 72536)
Christian County
2006 (19 years)



Field Cores – Dynamic Modulus



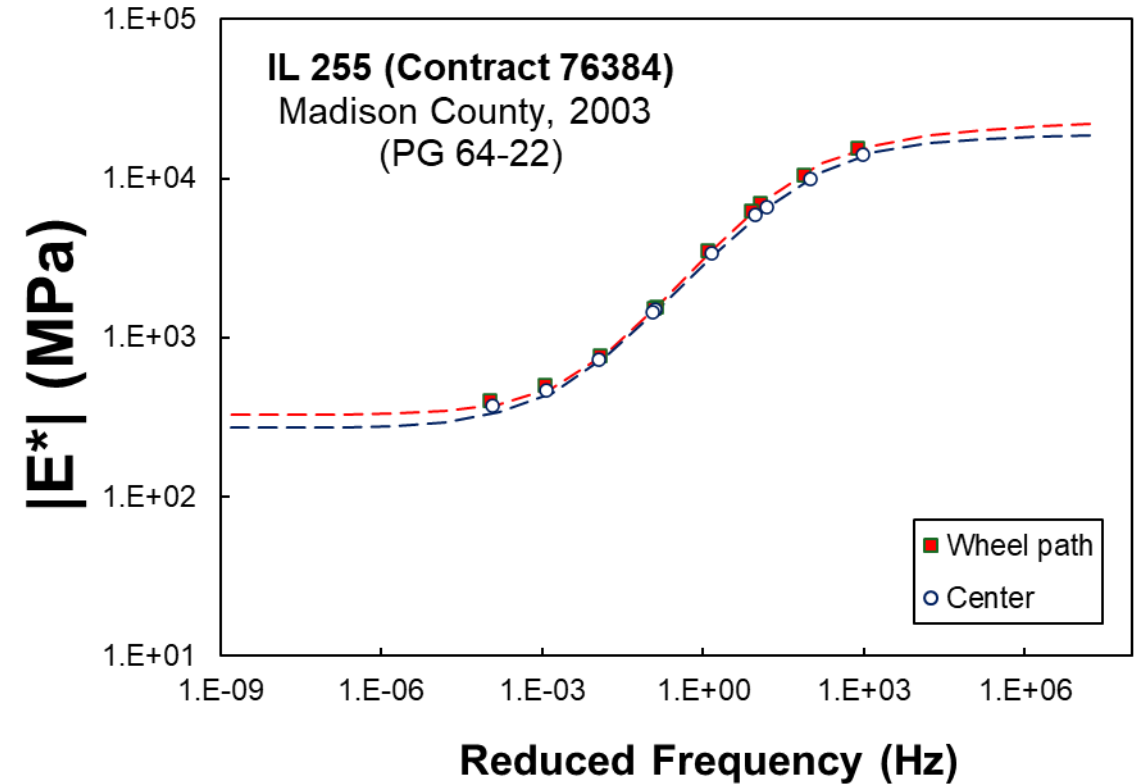
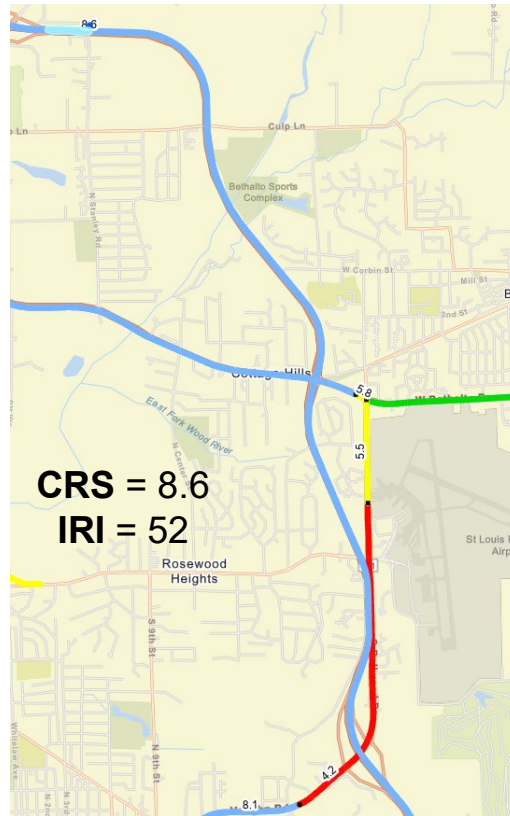
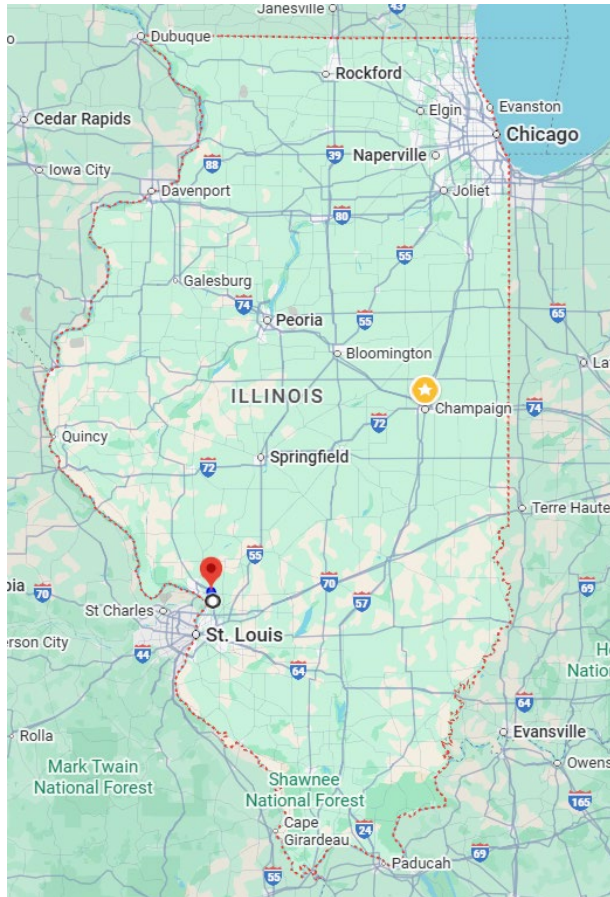
IL 159 (Contract 76200)
Madison County
2004 (21 years)



Field Cores – Dynamic Modulus



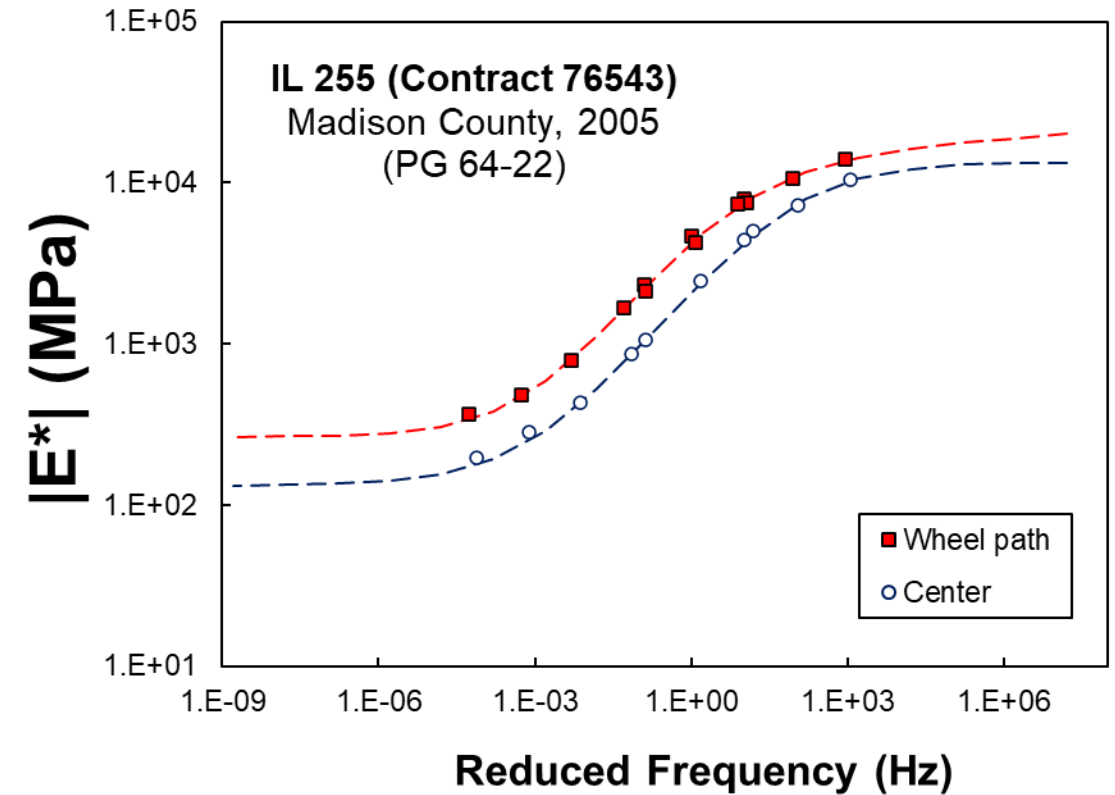
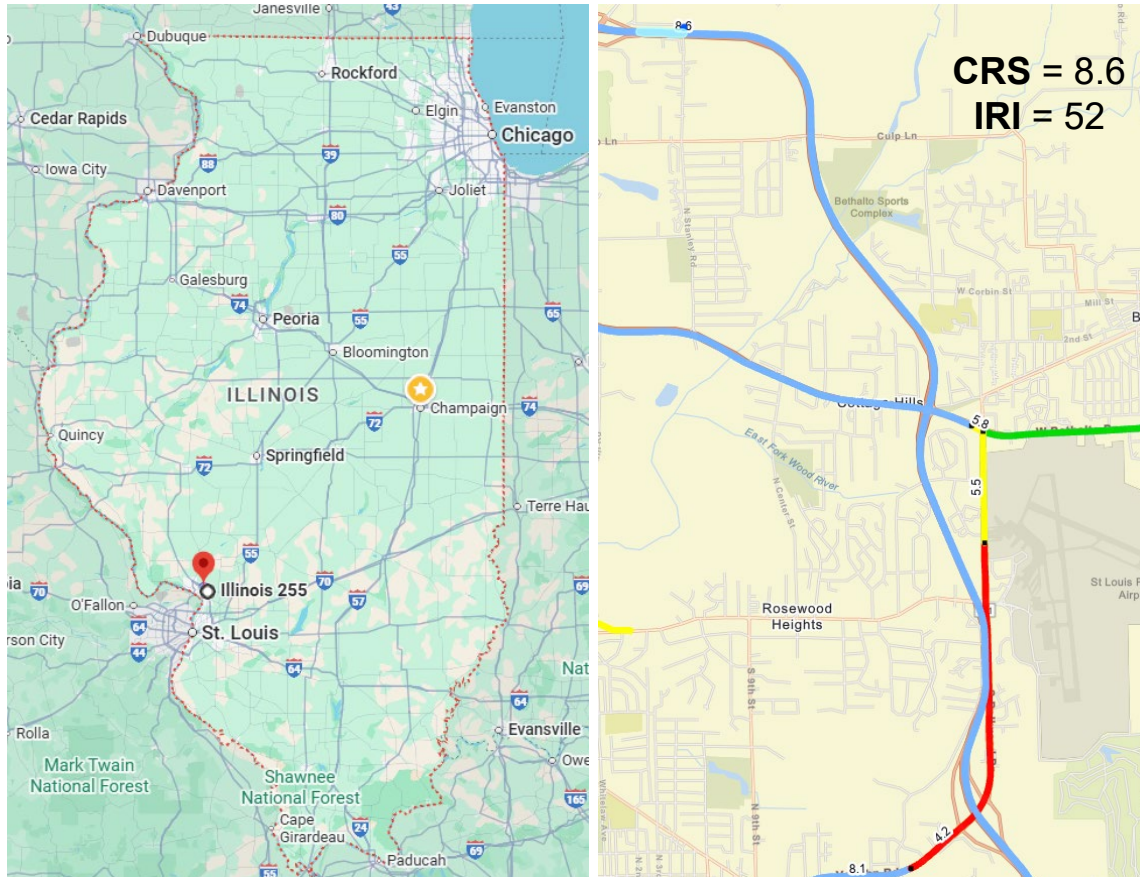
IL 255 (Contract 76384)
Madison County
2006 (19 years; 2023 resurfacing)



Field Cores – Dynamic Modulus



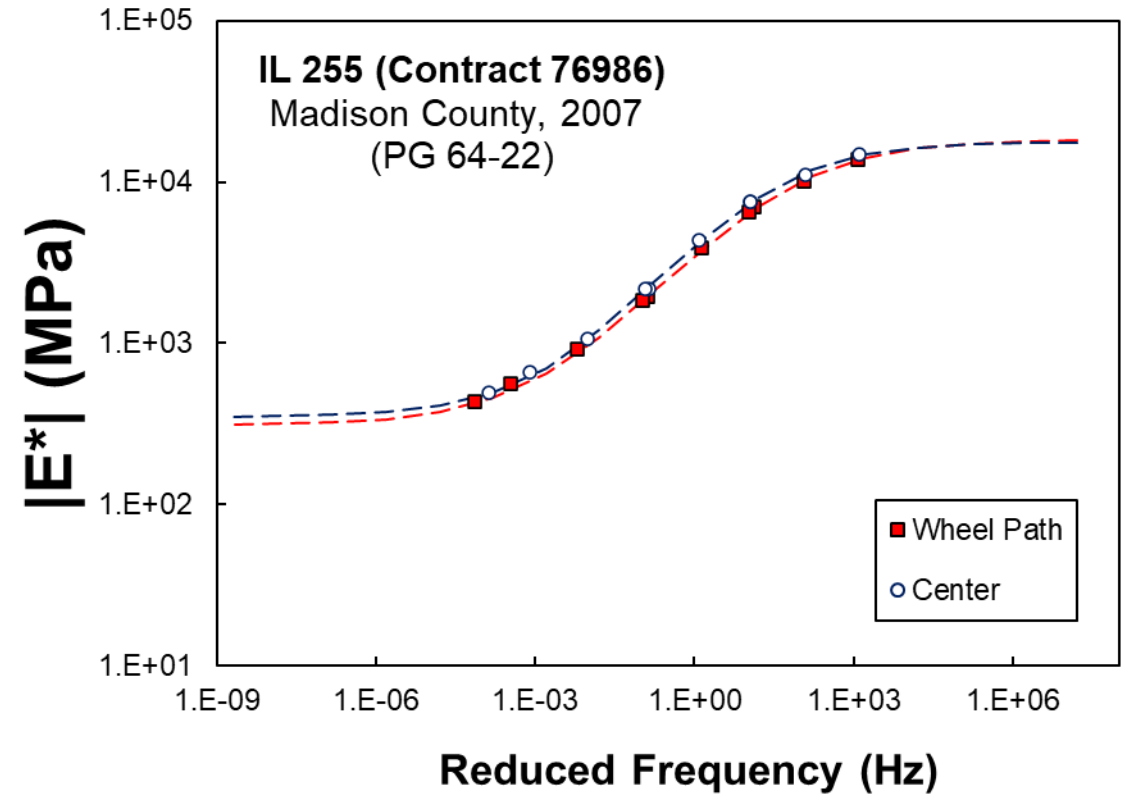
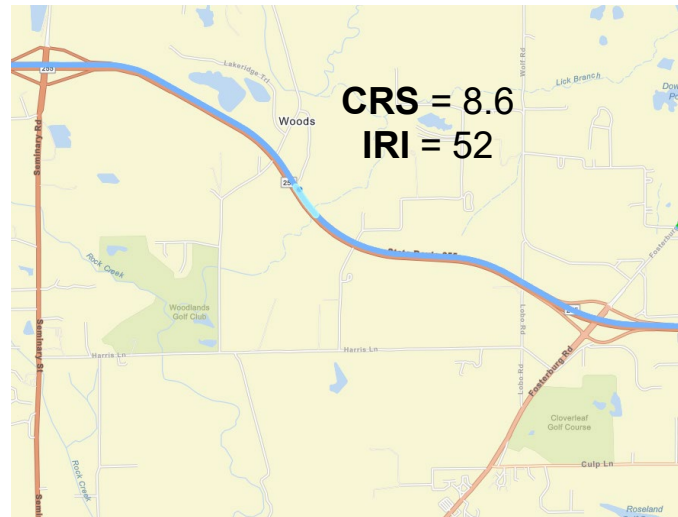
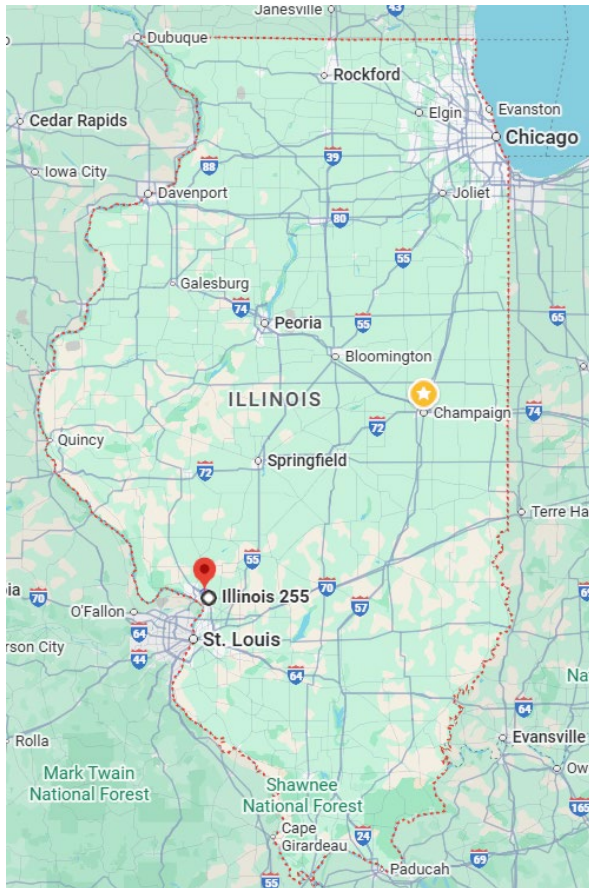
IL 255 (Contract 76543)
Madison County
2005 (20 years; 2023 resurfacing)



Field Cores – Dynamic Modulus



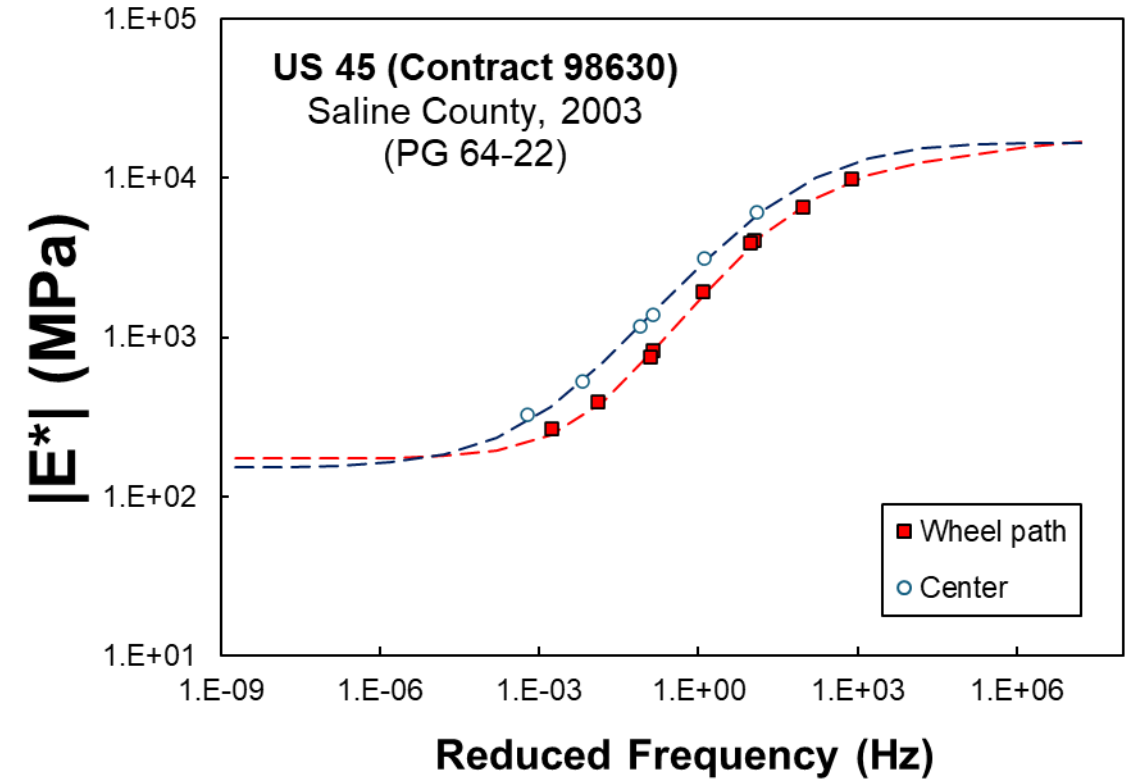
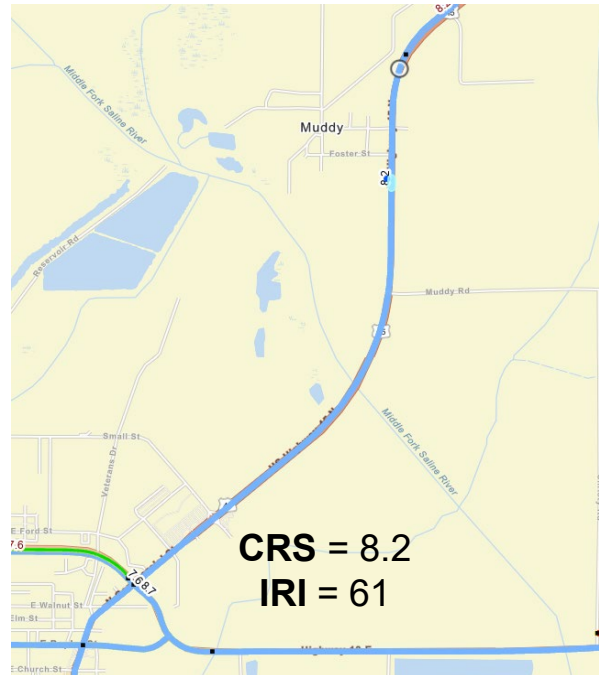
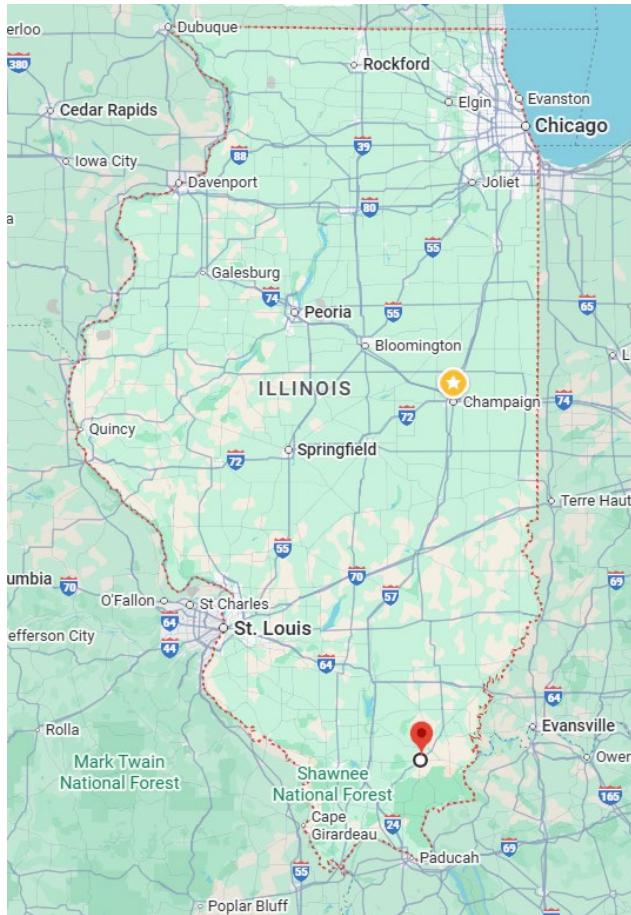
IL 255 (Contract 76986)
Madison County
2008 (17 years; 2023 resurfacing)



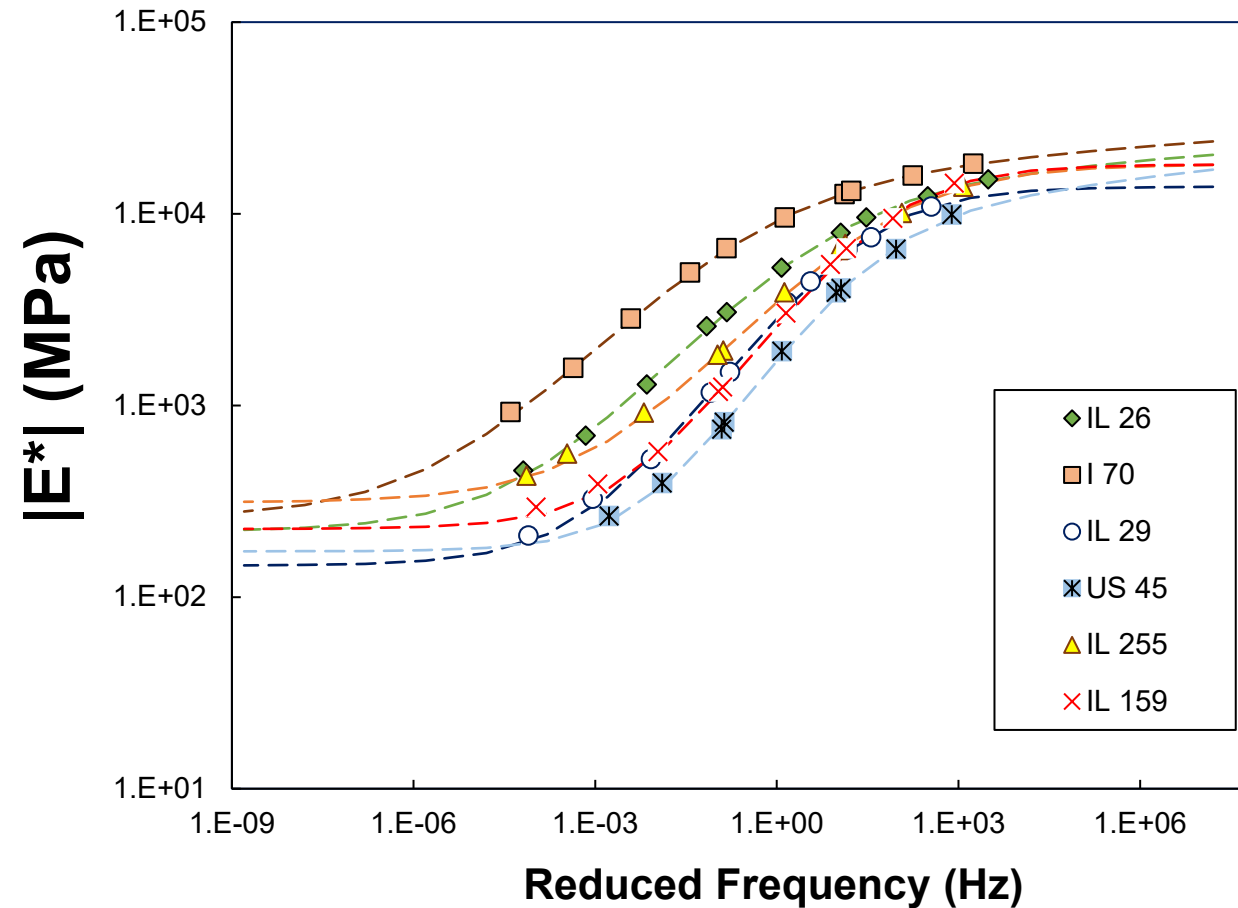
Field Cores – Dynamic Modulus



US 45 (Contract 98630)
Saline County
2005 (20 years)



Field Cores – Dynamic Modulus (Wheel Path)



Summary and Conclusions



- "Extended life" HMA pavements have worked very effectively in Illinois
- Timely maintenance, light rehabilitation, and now preservation have resulted in excellent surface, roughness, and overall structural performance
- E^* results show *some* structural change in modulus in wheel path in a few sections, but most sections performing as well as outside of wheel path
- Current sections likely overdesigned; potential for reducing to save costs while still constructing extended life pavements
- Future presentations will focus on lab testing of I-FIT, HWTD, and TSR for these sections as well as FWD/TSD structural testing

Thank You Questions?

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