NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Performance of Concrete Overlays on Asphalt Pavement

April 4, 2023

3:00 – 4:30 PM

NOVEMBER 2022 UPDATE

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

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Purpose Statement

This webinar will provide agencies with a national perspective on the design, construction, maintenance, and performance of bonded concrete overlays on asphalt pavements. Presenters will provide viewpoints on how recent research may be implemented by roadway authorities, enhance ongoing technology transfer related to concrete overlays, and the potential impacts on acceptance of concrete overlays.

Learning Objectives

At the end of this webinar, you will be able to:

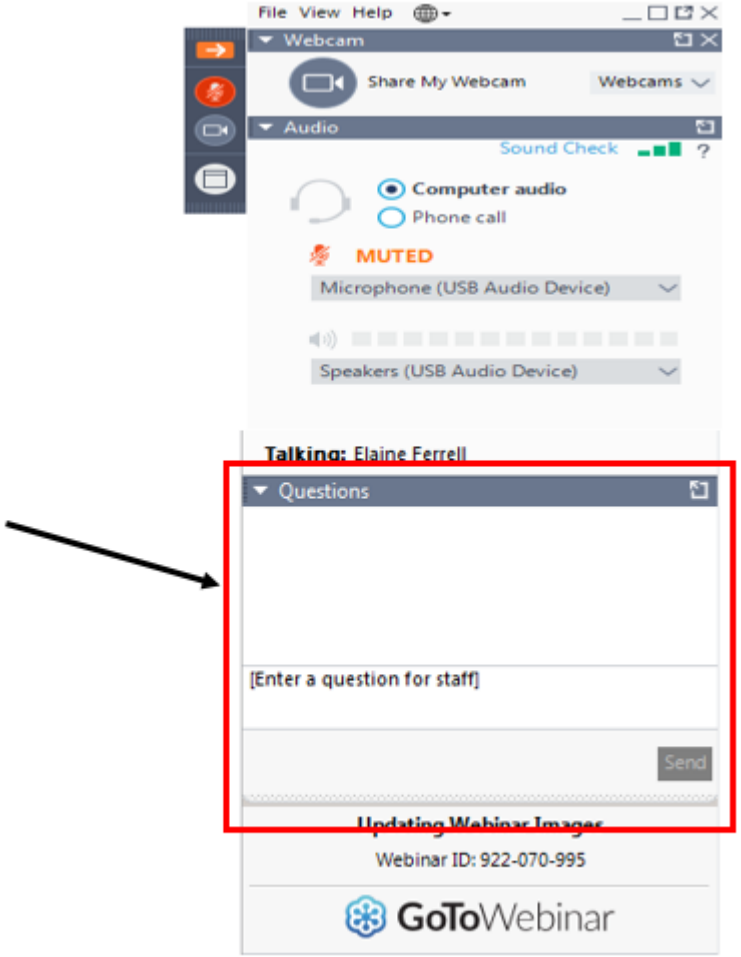
(1) Identify the design procedures, construction methods, maintenance, and historical performance of bonded concrete overlays on asphalt pavements throughout the U.S.

(2) Apply research in NCHRP Research Report 1007 to enhance technology transfer related to concrete overlays

(3) Explain the potential impacts the report might have on acceptance of concrete overlays [illegible] as implementation

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

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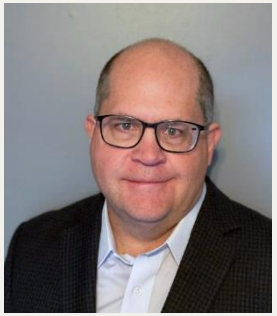

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Transportation Research Board Webinar

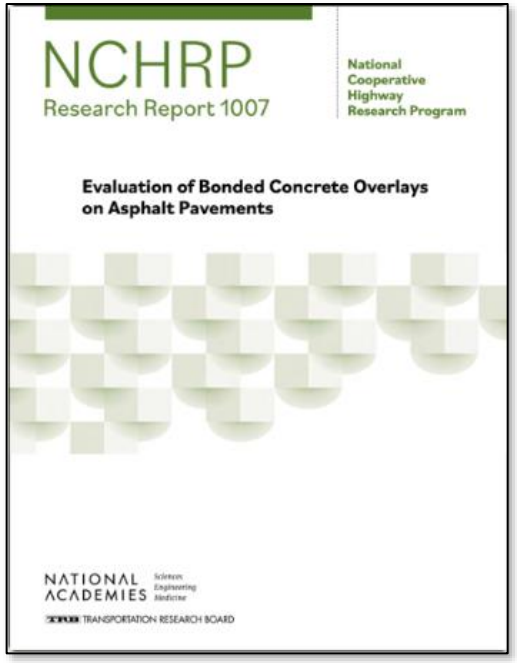
Performance of Concrete Overlays on Asphalt Pavement: Overview of the National Performance

Linda Pierce, PhD, PE
NCE

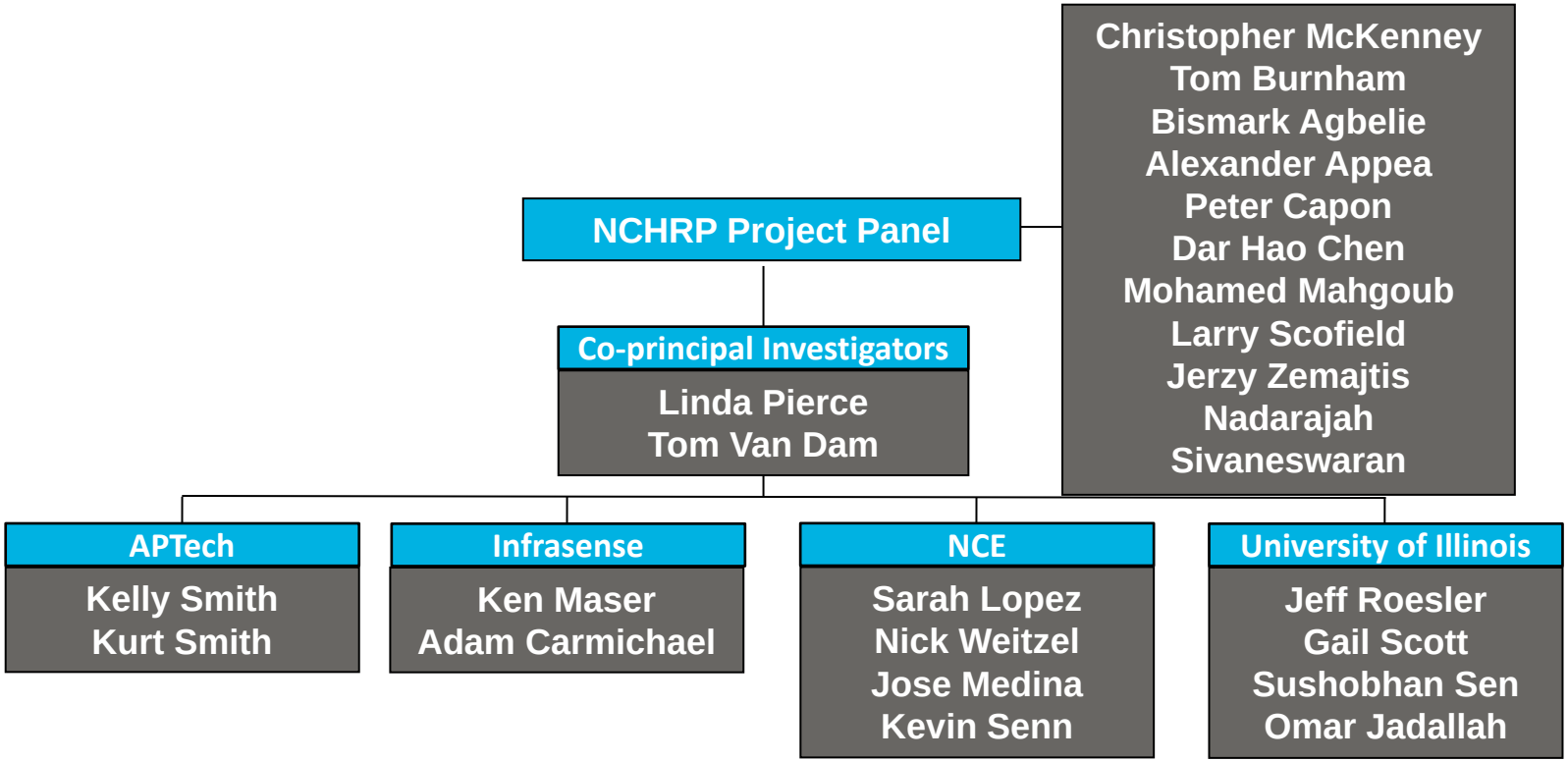
April 4, 2023

Background

- BCOAs successfully used since the 1990s
  - Mostly in the Midwest
  - Design and performance not well documented
- National Cooperative Highway Research Program
  - Project 1-61 completed 2020
  - Objective: Assess in-service performance
    - Site investigations
    - Factors impacting performance
    - Further facilitate implementation



Acknowledgements

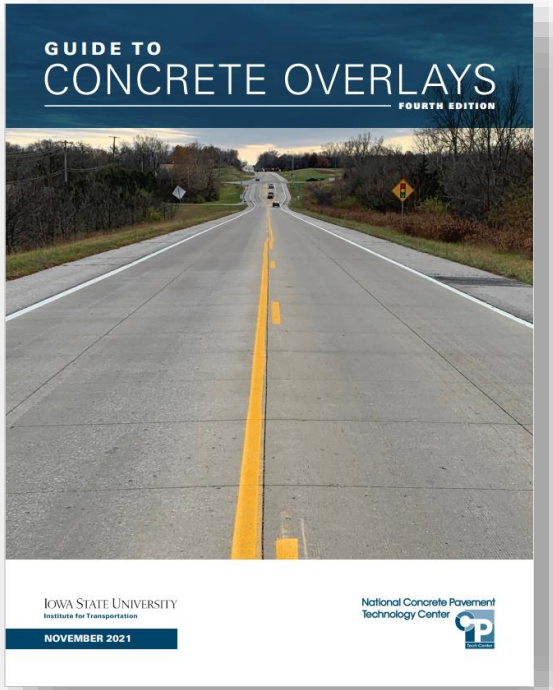


Why BCOA?

- Address structurally sound asphalt pavement:
  - Rutting and shoving
  - Intersections and mainline truck routes
- Rapid and straightforward treatment

BCOA Details

- Conventional concrete with or without fibers
- Concrete overlay
  - Thickness: 4 in. to 7 in.
  - Closely spaced joints
- Existing asphalt
  - Fair to good condition
  - At least 3 in. after milling



https://intrans.iastate.edu/app/uploads/2021/11/guide_to_concrete_overlays_4th_Ed.pdf

Project Selection

- Existing condition
  - Pavement structurally sound – only needs spot repairs
  - Moderate fatigue cracking – milling/spot repairs
  - Coring and material testing
    - Adequate base support
    - No asphalt layer stripping
- Vertical constraints (e.g., bridges, curb and gutter)

Pre-overlay Repairs

- Milling
  - Rutting ≥ 2 in.
  - Shoving
- Crack filling
  - Crack width ≥ concrete overlay maximum coarse aggregate size
- Pothole repair
  - Low to medium severity fill integrally with concrete overlay
  - High severity make full-depth repair, full lane width

Construction

Milling

Concrete Placement

Levelling

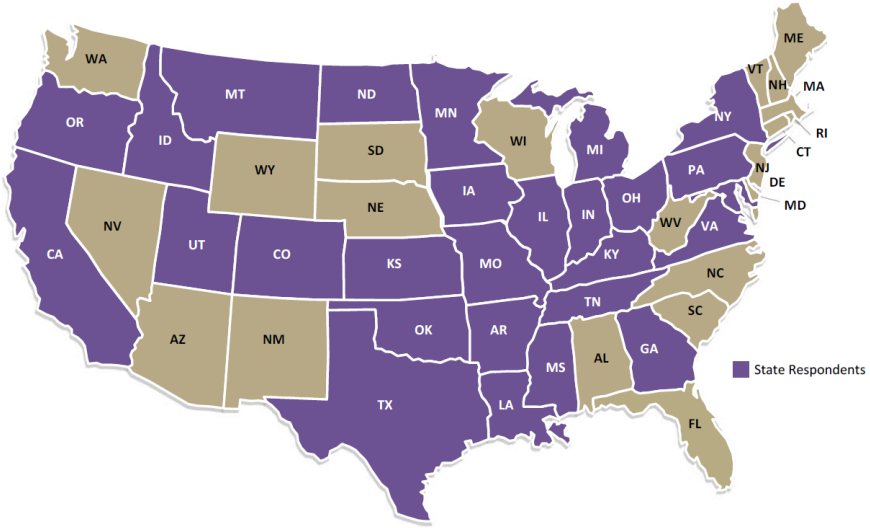
Texturing

Curing

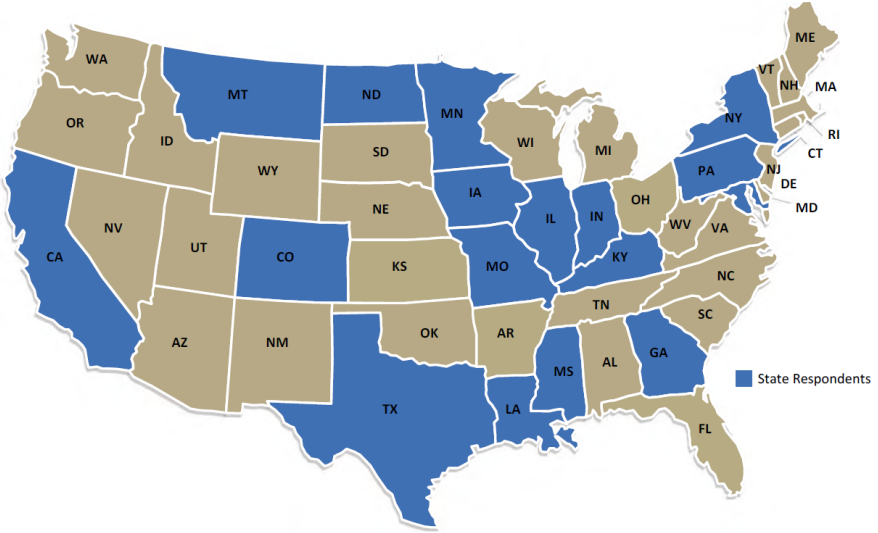
Saw cutting

State of the Practice

Agencies (28) with BCOA experience

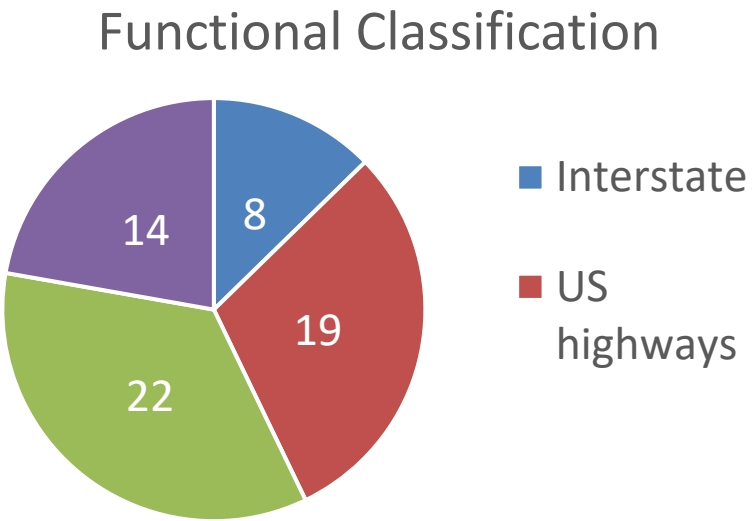


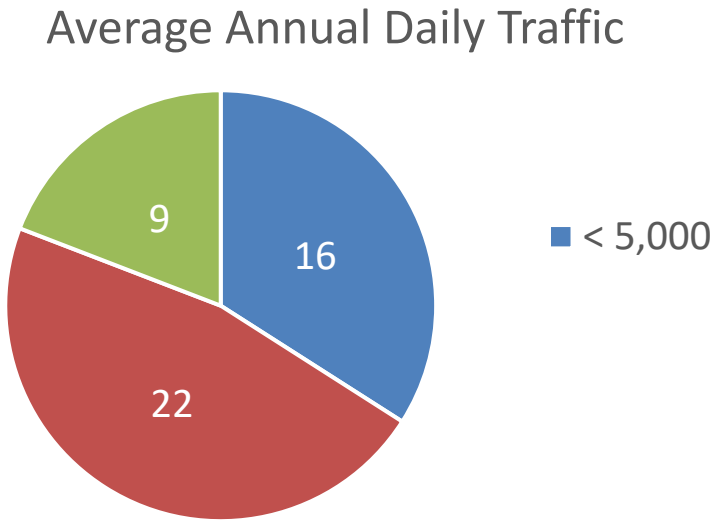
Agencies (18) considering BCOAs (2018-2020)



State of the Practices (continued…)

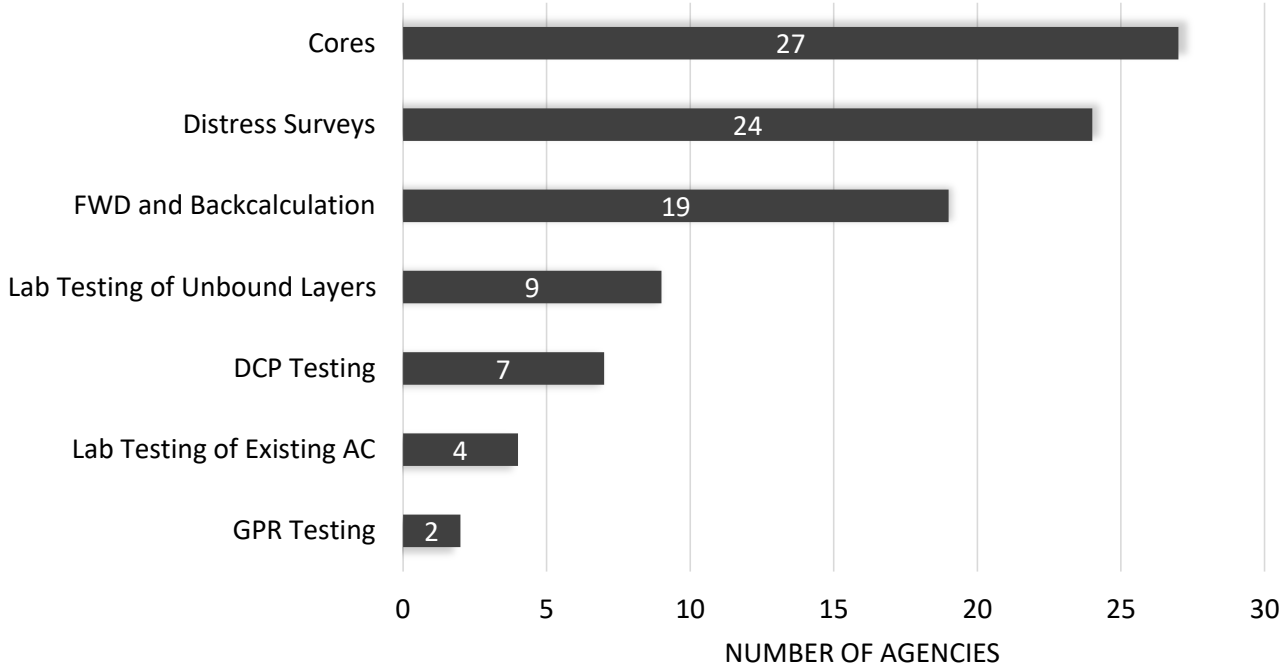
Application (27 agencies)





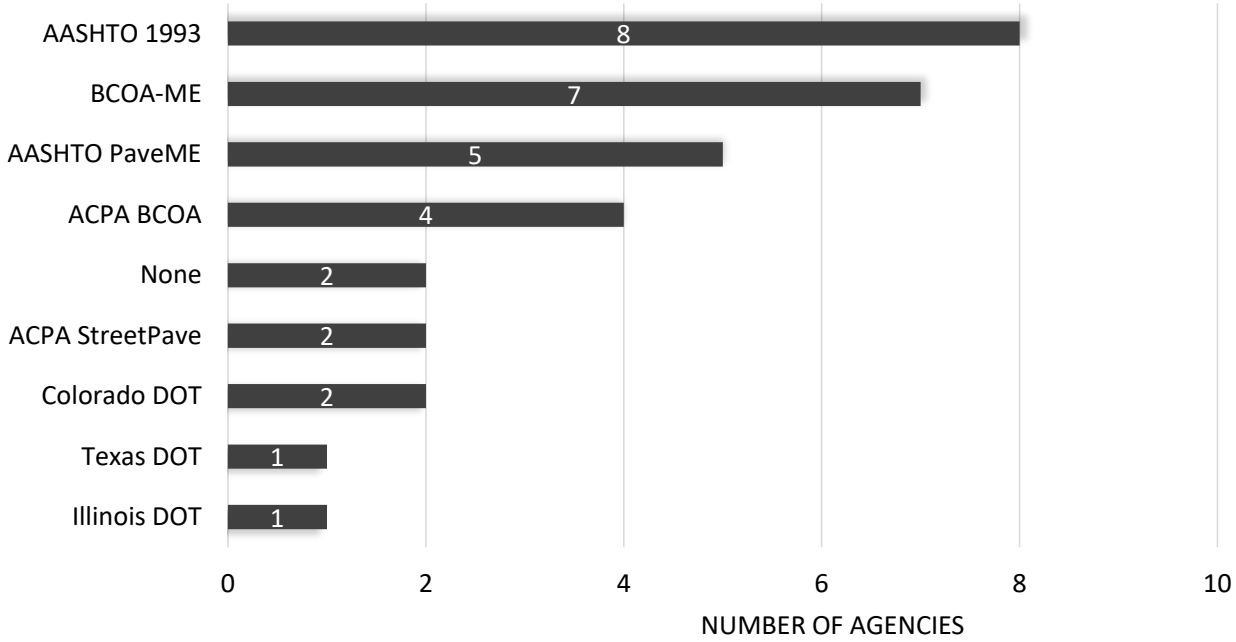
State of the Practices (continued...)

Site investigations (27 agencies)



State of the Practices (continued...)

Thickness design procedures (26 agencies)



State of the Practices (continued…)

Most common slab dimensions and thickness (24 agencies)

- 4-in. slab + 4 ft x 4 ft panel size (13 agencies)
- 5-in. slab + 6 ft x 6 ft panel size (10 agencies)
- 6-in. slab + 6 ft x 6 ft panel size (17 agencies)

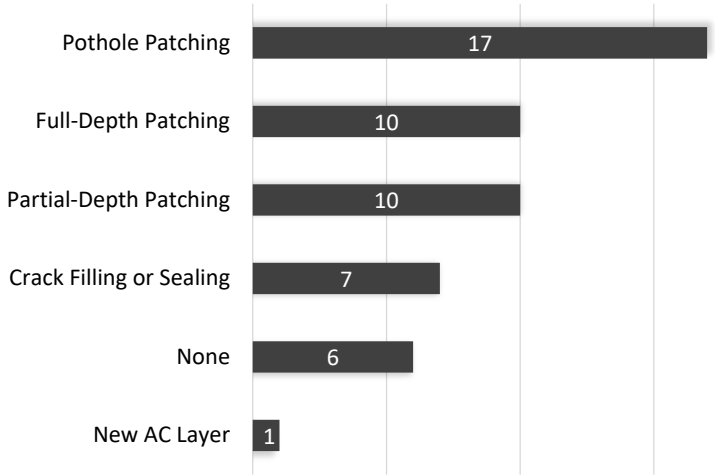
State of the Practices (continued...)

Materials (27 agencies)

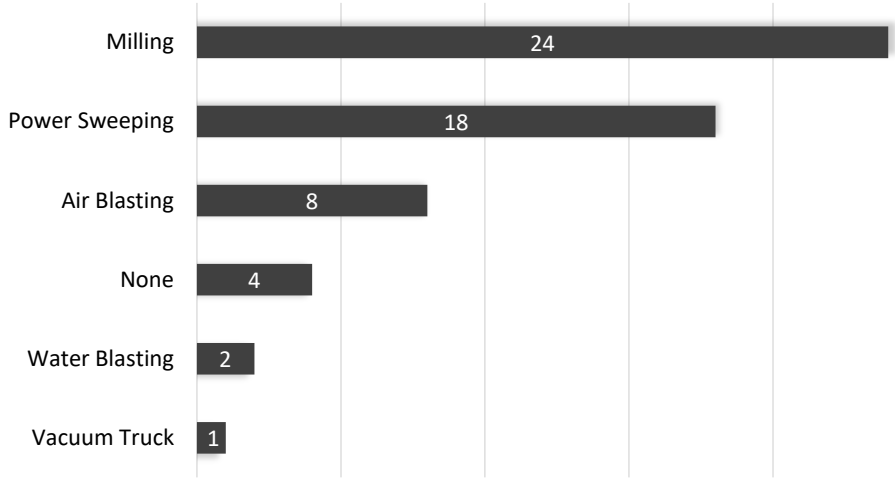
Mixture	Yes	No
Specialized paving mixture	13	14
Use of fibers	11	2
Early-opening-to-traffic concrete mixture	8	5
BCOA-specific aggregate requirement	5	7
BCOA-specific cementitious materials requirement	2	9
BCOA-specific chemical admixtures	1	10

State of the Practices (continued...)

Pre-overlay repairs (27 agencies)



Surface preparation (26 agencies)



State of the Practices (continued...)

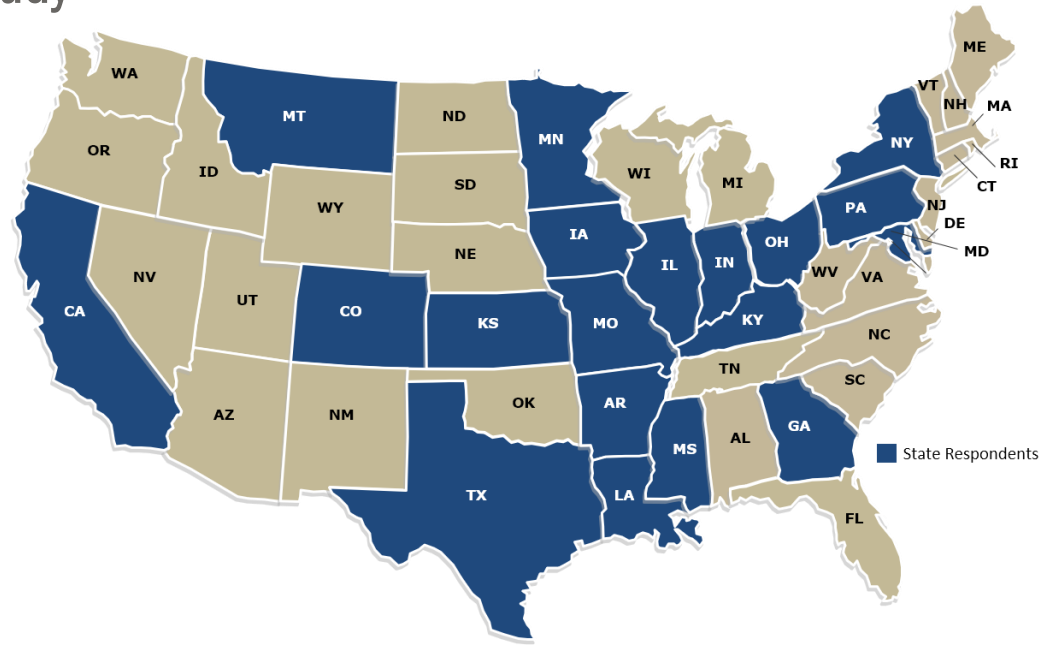
Maintenance activities (19 agencies)

Distress Type	Crack Seal	Joint Reseal	Spall Repair	Partial Slab Replacement	Full Slab Replacement	Diamond Grind
Corner breaks	5	1	1	**9**	**7**	1
Transverse cracks	**9**	1	1	3	**7**	0
Longitudinal cracks	**9**	0	1	2	**9**	0
Transverse spalling	2	5	**12**	2	3	0
Longitudinal spalling	2	4	**10**	1	4	0
Faulting	1	2	0	3	4	**11**
Debonding	0	0	0	2	**12**	0
Seal damage	2	**6**	0	0	0	0

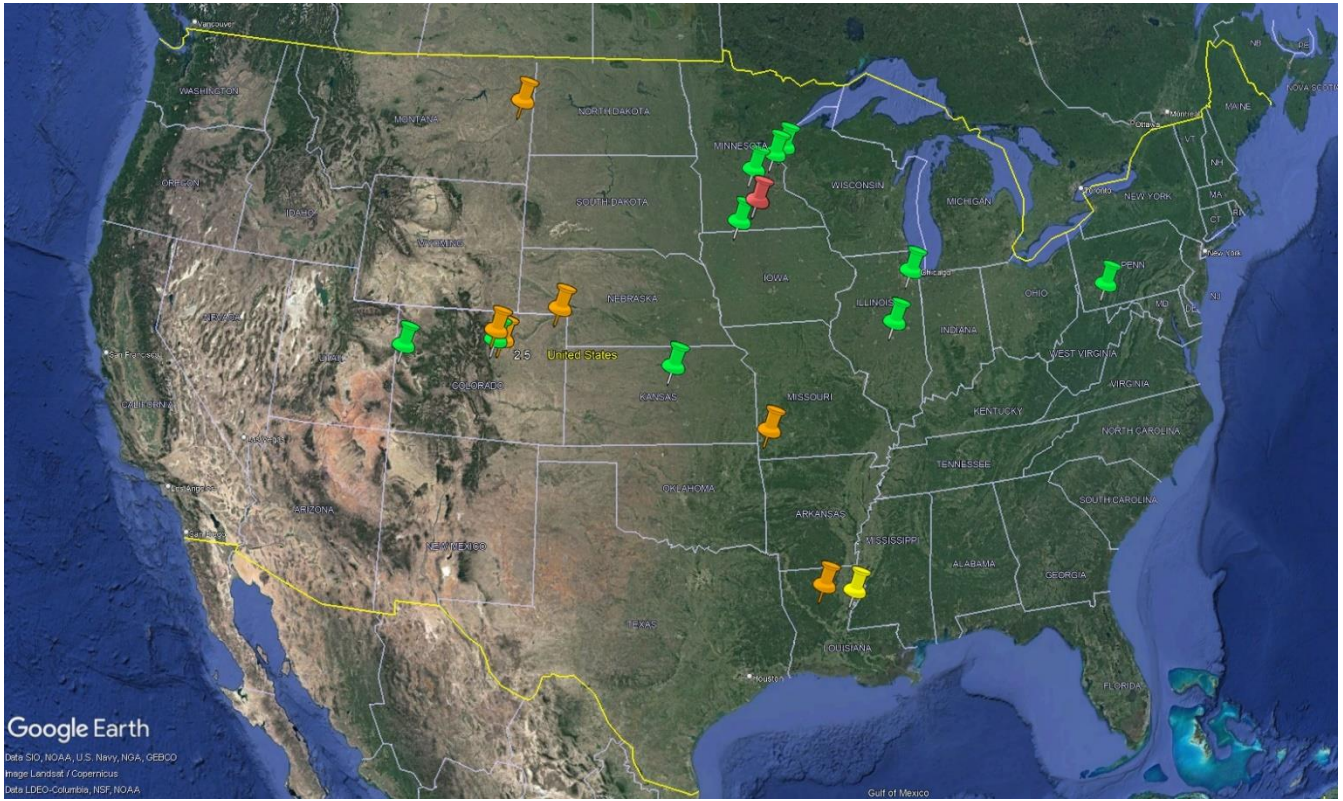
State of the Practices (continued...)

Site selection

- Willingness to participate in study
- "Typical" performance
- Mainline: length ≥ 0.5 mi
  - Tangent sections
- In-service age ≥ 5 years
- Received info on:
  - 52 BCOA projects
  - 14 agencies



Selected Projects



Age as of 2019 (years)

- 5-10
- 11-15
- 16-20
- 21-25

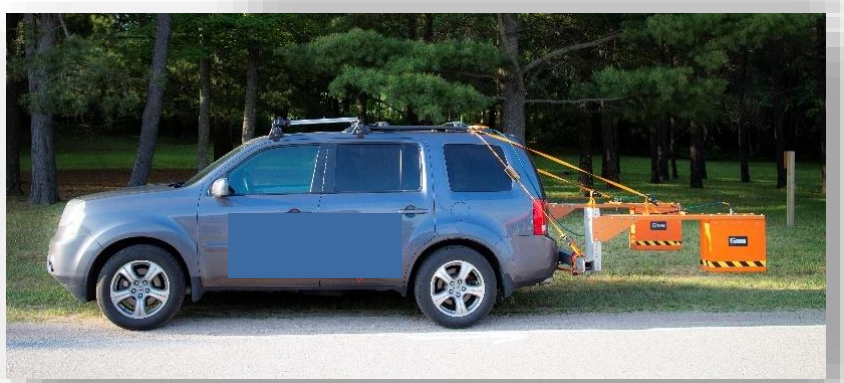
Project Summary Details

- 4 ft x 4 ft slab sizes
  - Age: 7-21 years
  - Design slab thickness: 4.0 in.
  - Trucks/day: 388-2,277
- 6 ft x 6 ft slab sizes
  - Age: 7-19 years
  - Design slab thickness: 5.0-6.0 in.
  - Trucks/day: 50-2,717
- 12 ft x 12 ft slab sizes
  - Age: 21-26 years
  - Design slab thickness: 5.5-6.0 in.
  - Trucks/day: 13-293

State	Route	Age (yrs)	Design (in.)	Slab Size (ft x ft)	Trucks/day
MT	SR-16	18	4	4x4	388
LA	US-425	16	4	4x4	1,106
LA	US-167	21	4	4x4	1,315
MO	US-60	20	4	4x4	2,145
IL	SR-53	7	4	4x4	2,277
IL	CH-27	16	5.3	6x6	50
MN	CSAH-7	10	5	6x6	213
MN	CSAH-22	8	6	6x6	594
PA	SR-119	9	6	6x6	698
IA	US-71	7	6	6x6	940
CO	SH-121A	19	6	6x6	1,058
CO	SH-121B	8	6	6x6	1,444
KS	I-70	8	6	6x6	1,782
CO	I-70	7	6	6x6	1,845
MN	I-35	10	6	6x6	1,985
CO	SH-83B	14	6	6x6	2,461
CO	SH-83A	19	5	6x6	2,717
MN	TH-30	26	6	12x12	13
CO	US-6	21	5.5	12x12	293

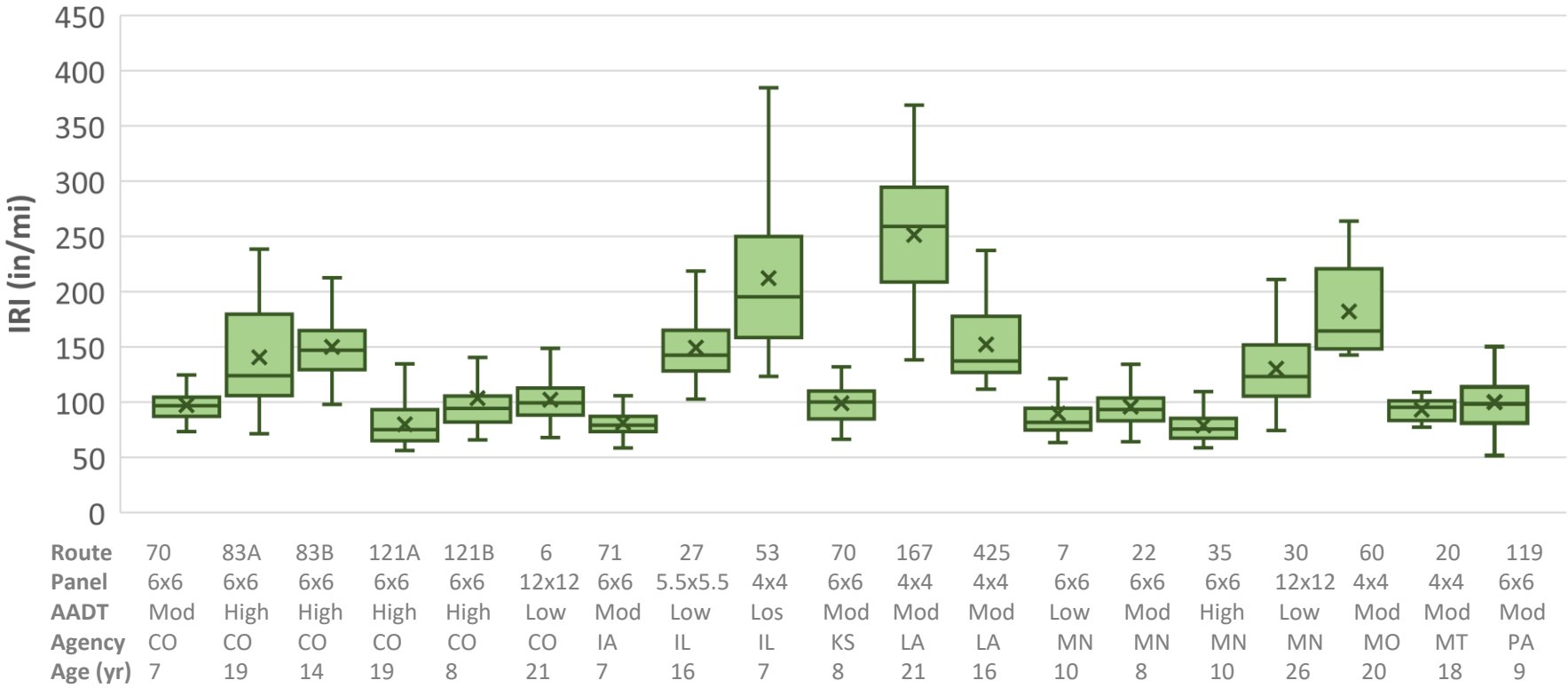
Site Evaluations

- Conducted on 20 projects
  - 1 project removed from study due to traffic control restrictions
- Automated condition survey
  - IRI
  - Faulting
  - Cracking (corner breaks, transverse, and longitudinal)
- Ground penetrating radar
  - Layer thickness

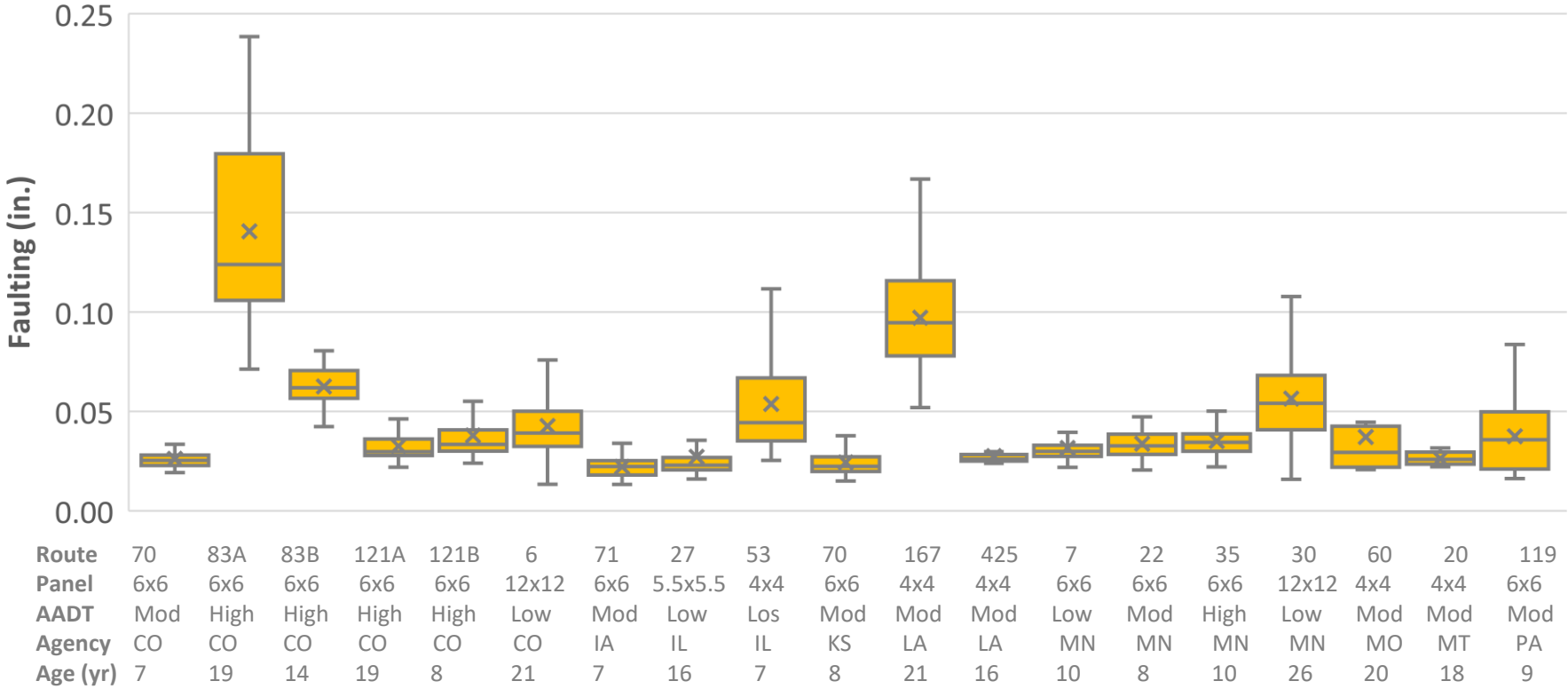


Low = ≤ 5,000 AADT
Mod = 5,000 – 20,000 AADT
High = ≥ 20,000 AADT

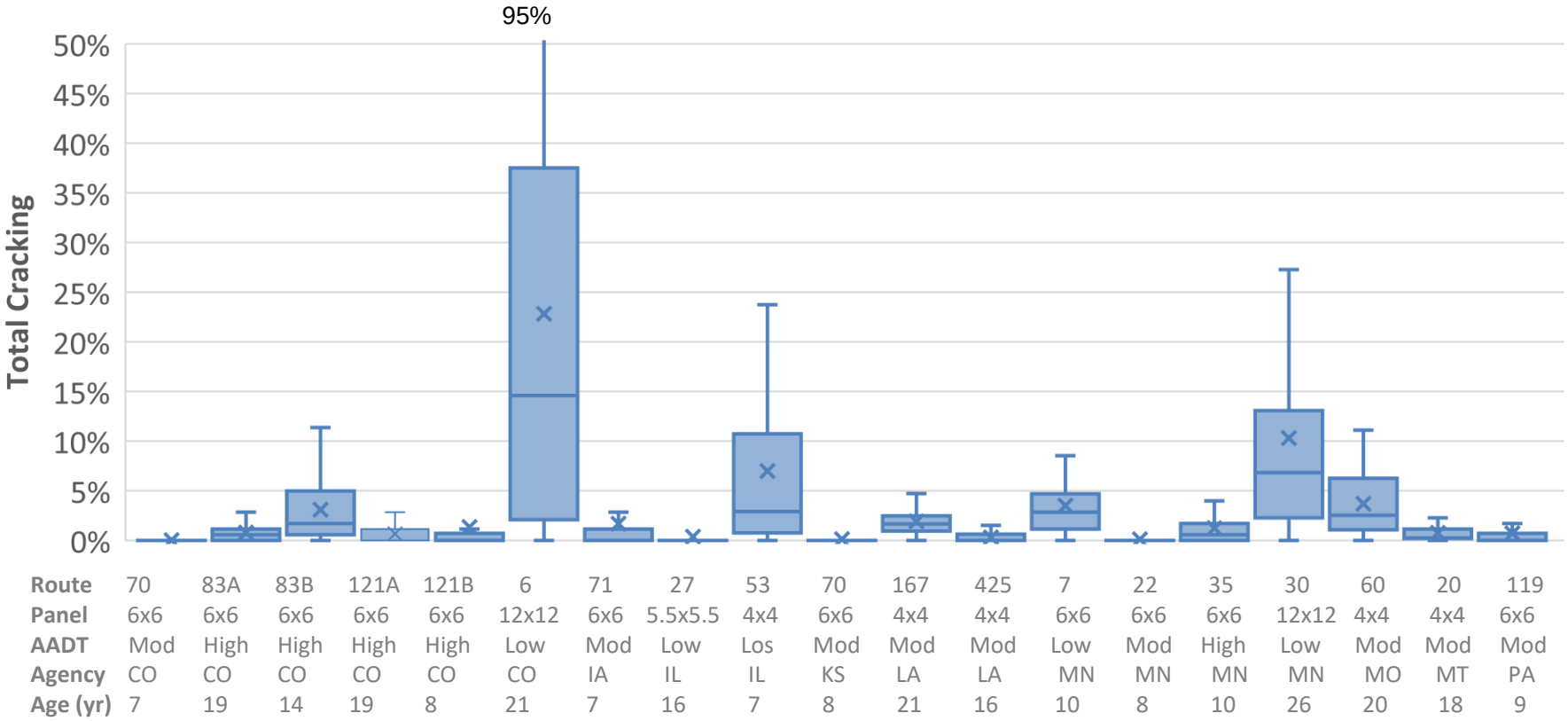
Overall Performance – IRI



Overall Performance – Faulting (automated)



Overall Performance – Total Cracking (automated)

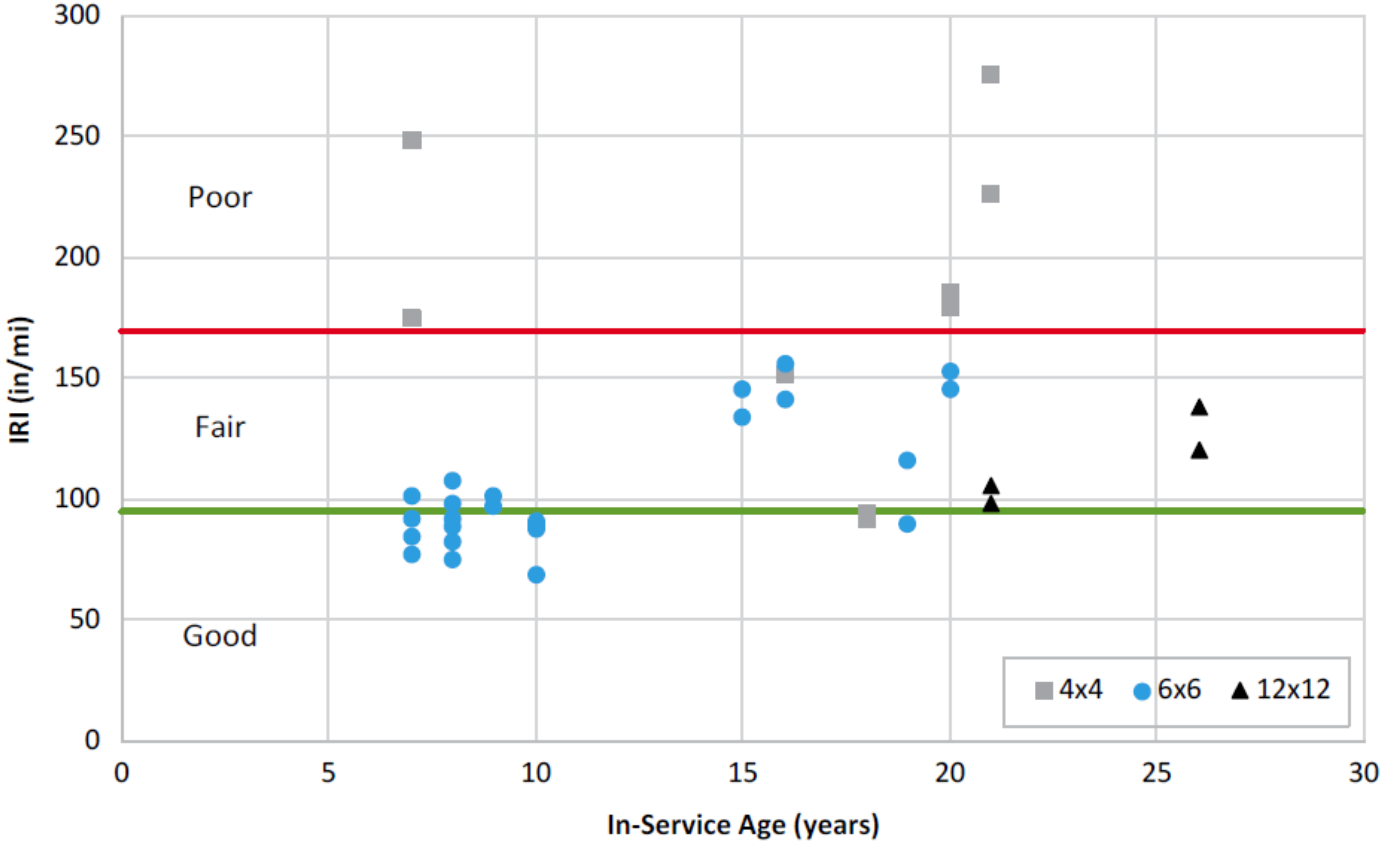


Performance Assessment

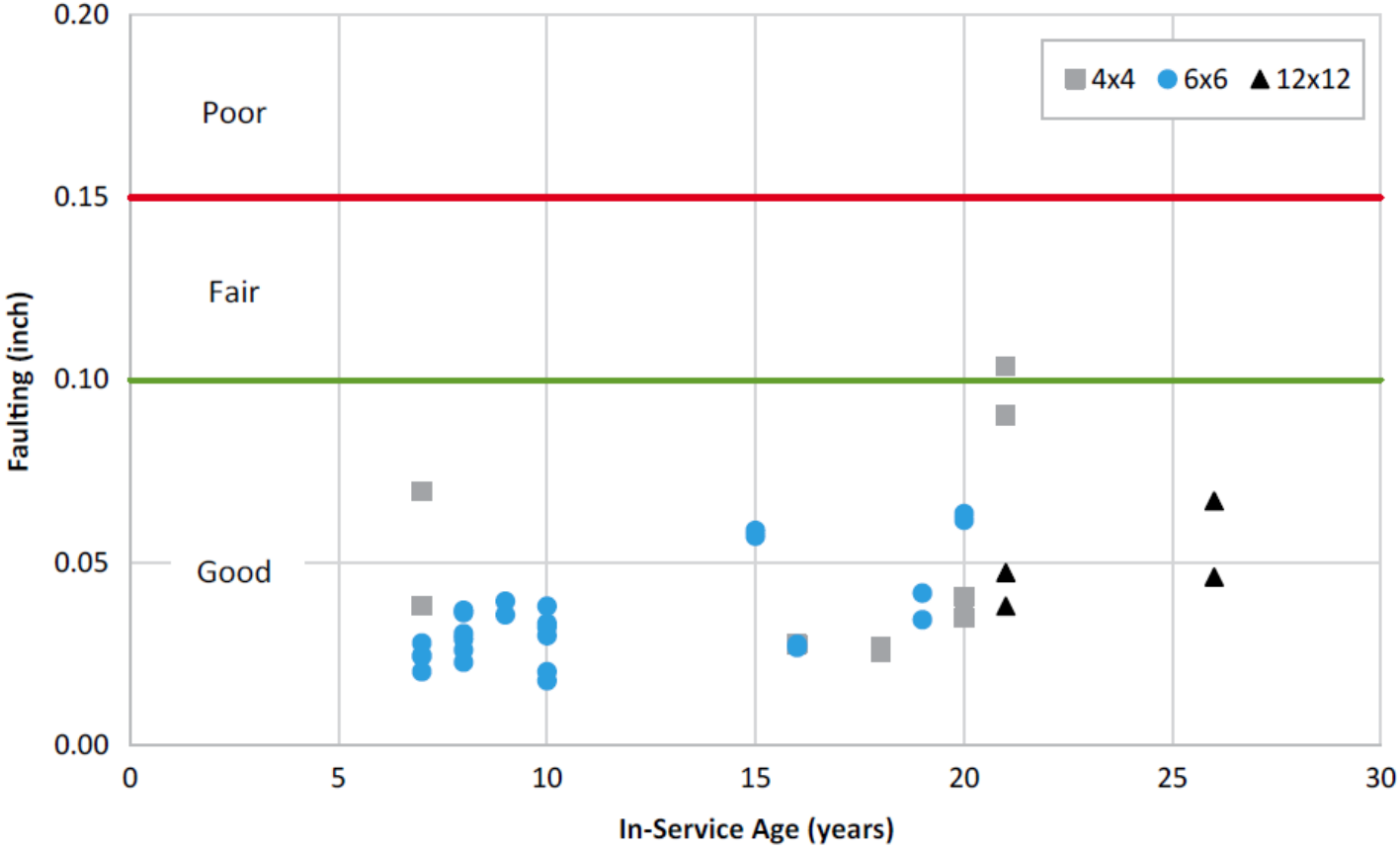
- Based on the National Highway Performance Program
- 0.10-mi segments

Overall Condition	Good	Fair	Poor
IRI (in/mi)	≤ 95	95 – 170	≥ 170
Cracking (% area)	≤ 5	5 – 15	≥ 15
Faulting (inch)	≤ 0.10	0.10 – 0.15	≥ 0.15

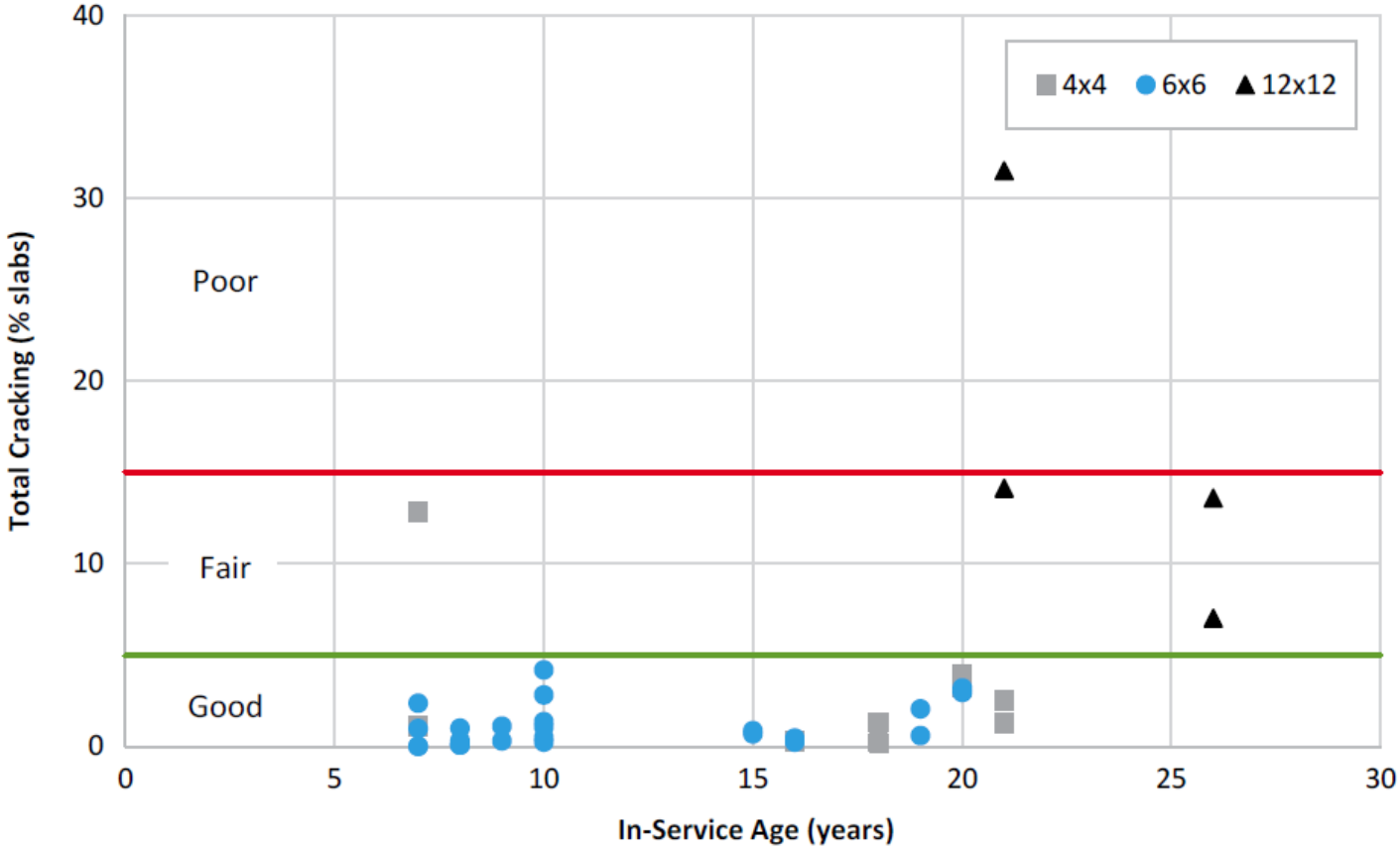
IRI – Slab Size



Faulting – Slab Size

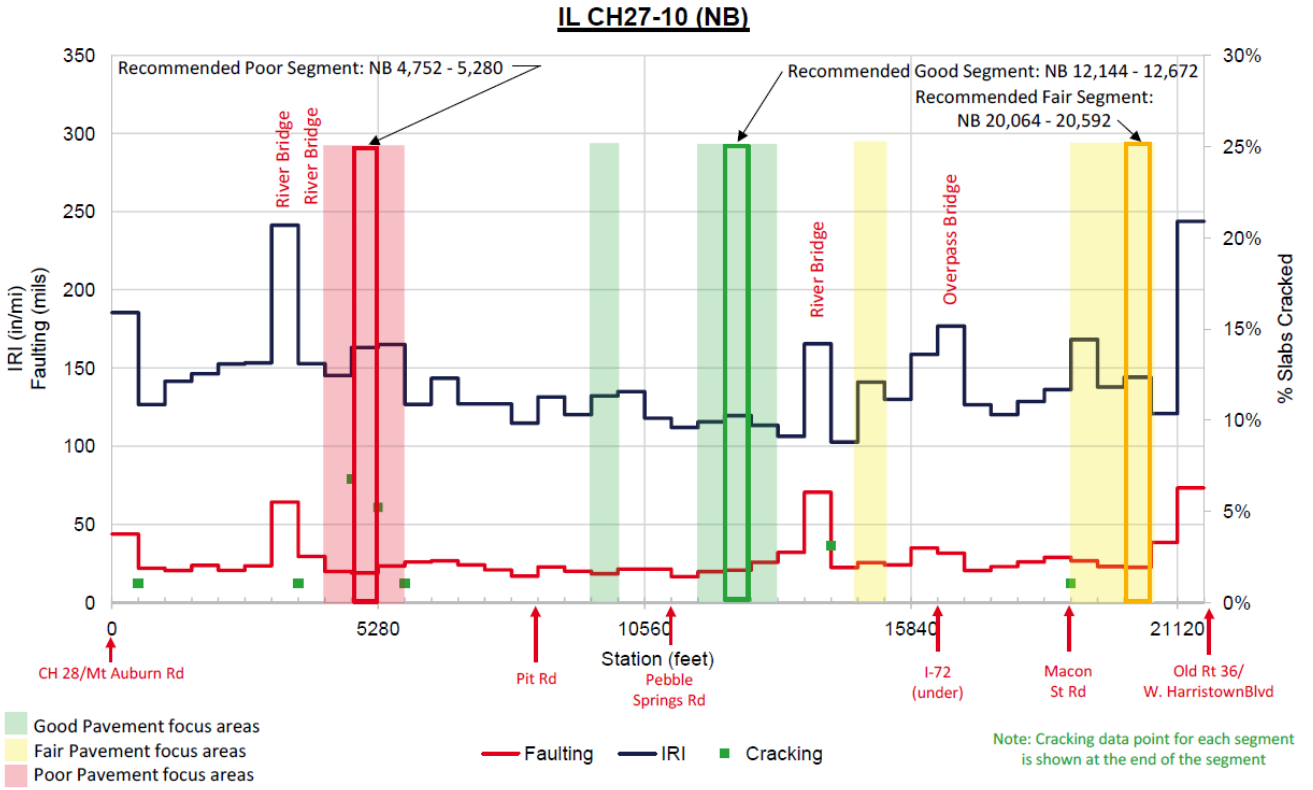


Total Cracking – Slab Size



Detailed Assessment

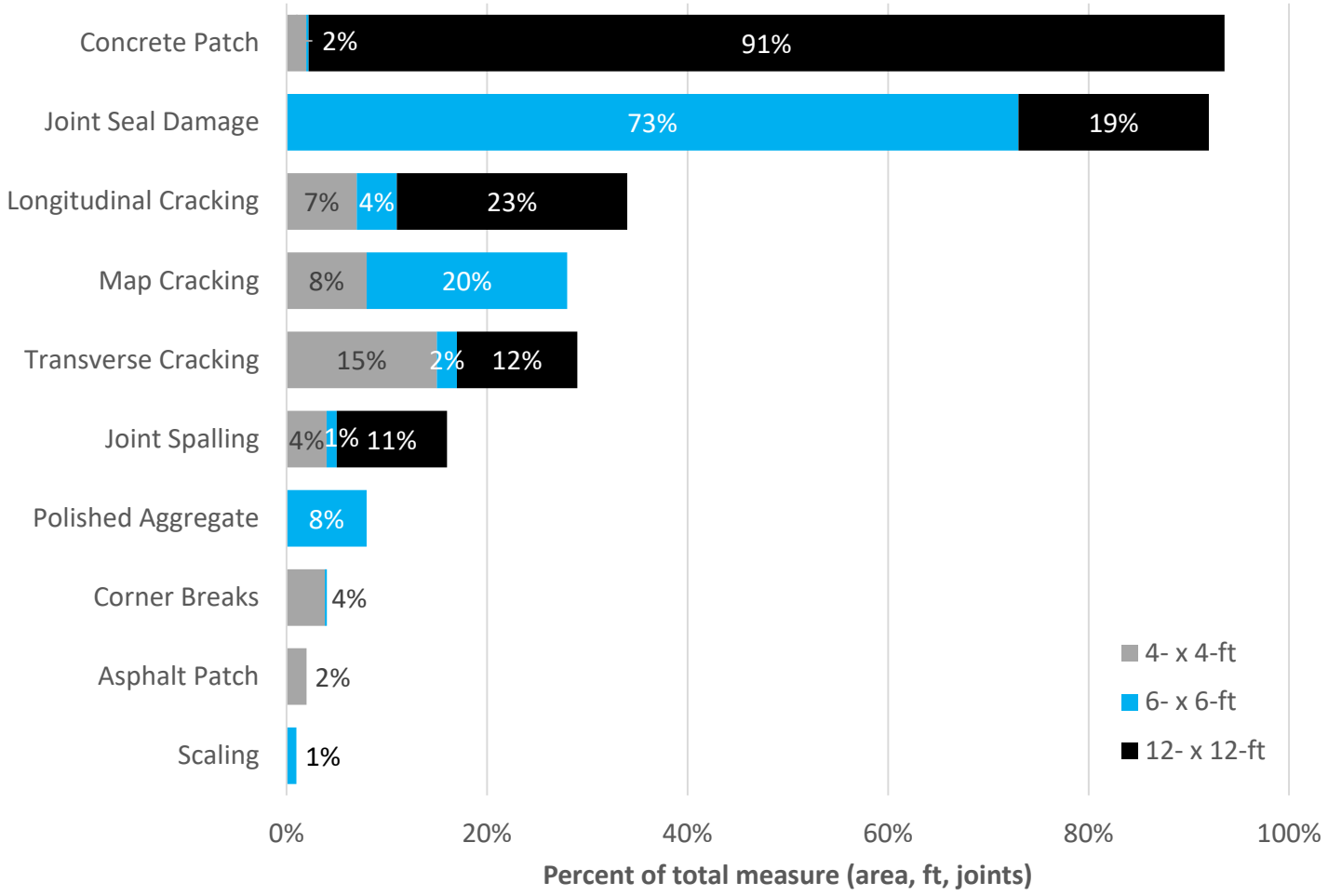
- Using automated results:
  - Identify 0.10-mi segments of “good, fair, and poor” condition for detailed assessment



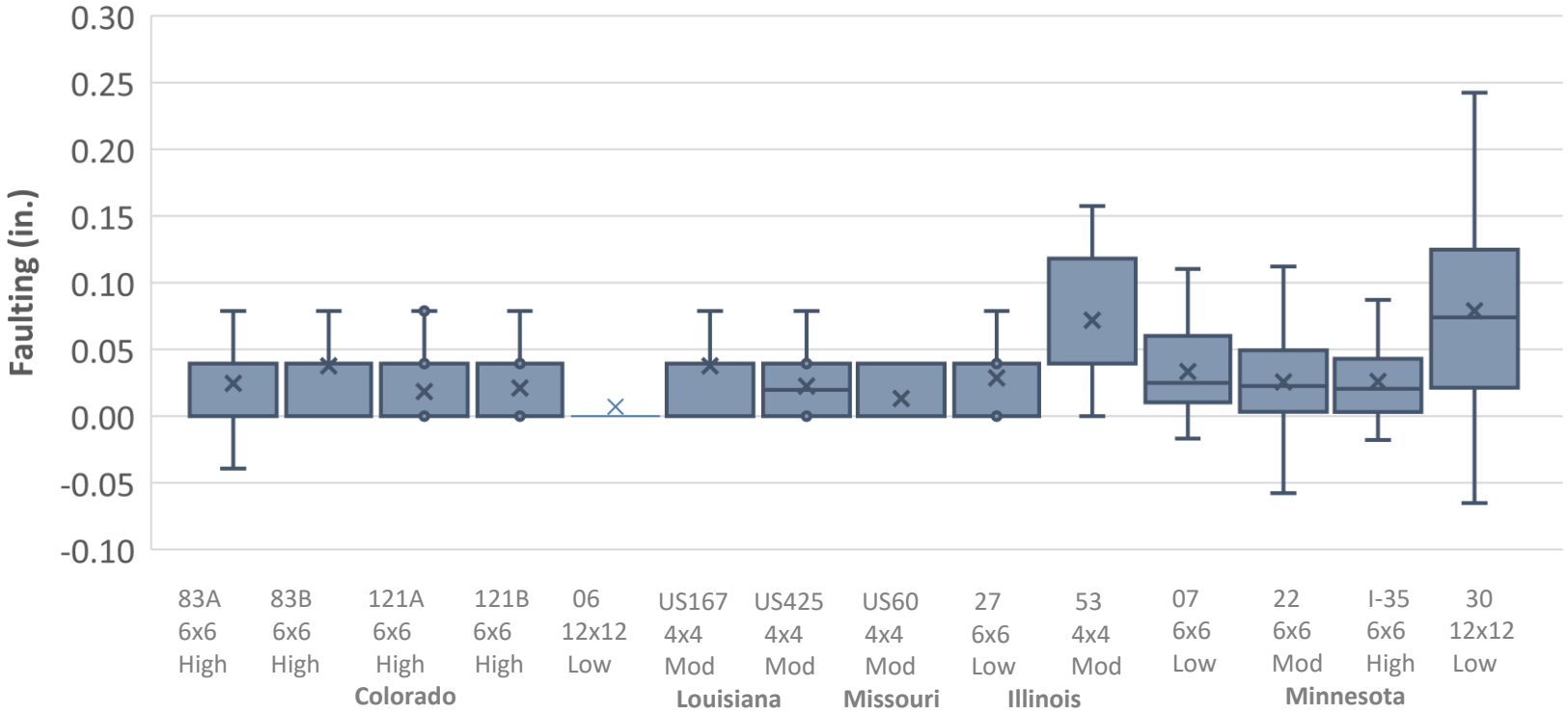
Detailed Assessment (continued)

- LTPP distress survey
- Faultmeter
- Ultrasonic tomography
- Falling weight deflectometer
- Coring and dynamic cone penetrometer
- Laboratory testing
  - Soil characterization
  - Concrete strength and CTE
  - Asphalt complex modulus and Hamburg wheel
  - Concrete-asphalt bond shear

Visual Distress Survey



Faultmeter


Faulting (in.)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
83A 6x6 High
83B 6x6 High
121A 6x6 High
121B 6x6 High
06 12x12 Low
US167 4x4 Mod
US425 4x4 Mod
US60 4x4 Mod
27 6x6 Low
53 4x4 Mod
07 6x6 Low
22 6x6 Mod
I-35 6x6 High
30 12x12 Low
Colorado
Louisiana
Missouri
Illinois
Minnesota

Study Findings

- Successful and cost-competitive rehabilitation option
- Simple pre-overlay preparation
- Relatively easy to construct
- Expediate construction due to placement of thinner concrete layer

Study Findings (continued…)

- Nearly 90% of the tested segments had IRI < 170 in/mi
- Faulting (detailed survey)
  - Range: 0 to 0.30 in. (all but 3 projects < 0.16 in.)
  - Average: 0.04 in.
  - Std: 0.05 in.
- Less than 5% of slabs had any type of cracking
- 6 ft x 6 ft slabs performed better than 4 ft x 4 ft and 12 ft x 12 ft slabs

Many of the evaluated projects evaluated are in fair or better condition after more than 15 years of service

Questions?

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NCHRP Research Report 1007 & Concrete Overlay Technology Transfer Initiatives

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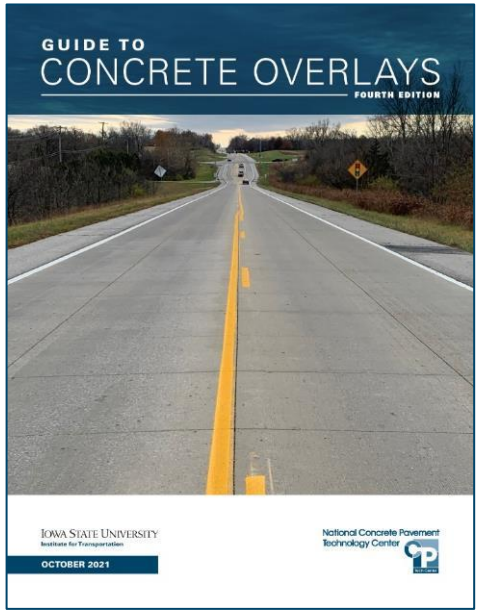
IOWA STATE UNIVERSITY
Institute for Transportation

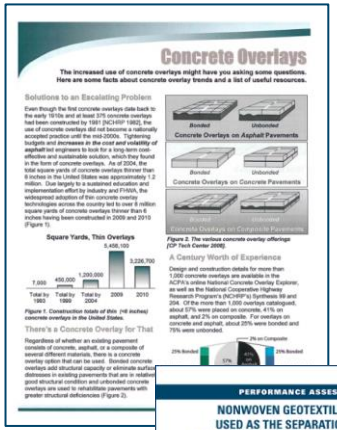
National Concrete Pavement Technology Center
Tech Center

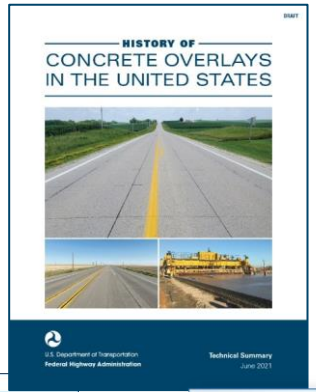
Concrete Overlay Technology Transfer

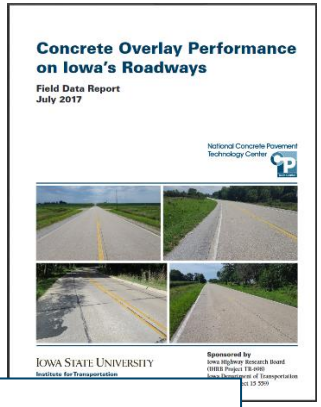
- A wide variety of guidance is available to assist and educate agencies, engineers and contractors
  - CP Tech Center
  - FHWA
    - EDC-6: TOPS
  - ACPA
  - NRRA

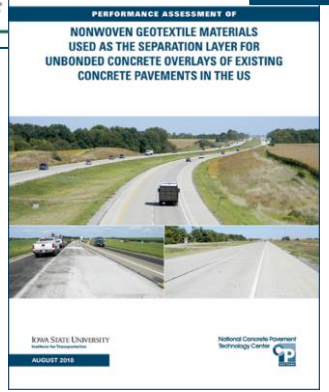


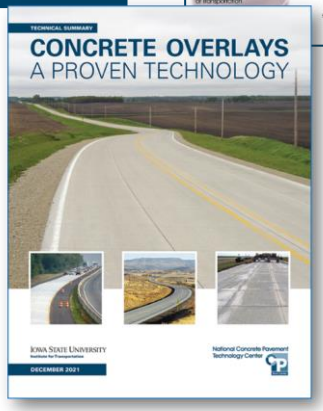
Concrete Overlay Technology Transfer

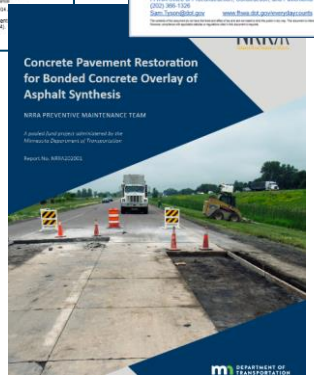






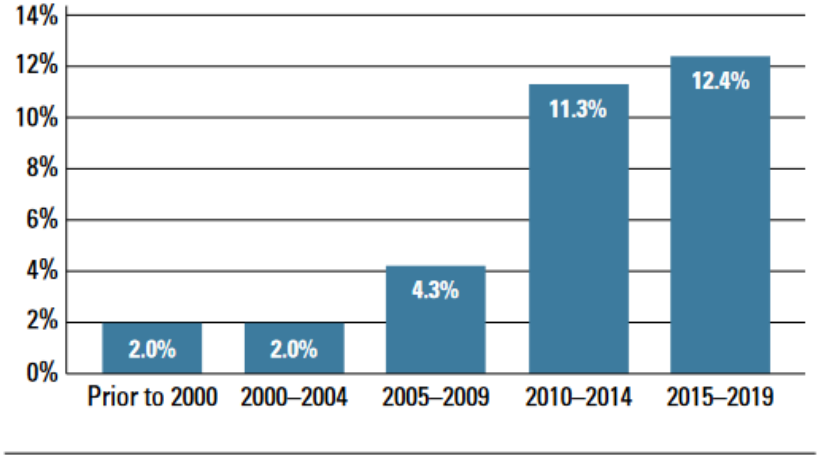






Concrete Overlay Technology Transfer

- Efforts to date have helped make a significant impact in recent years:

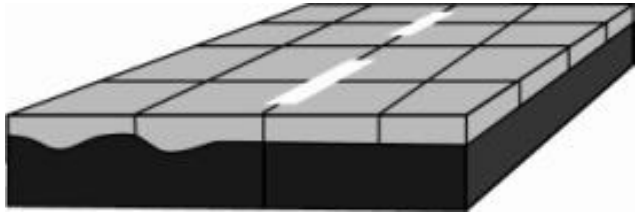


Based on data from ACPA

Figure 3. Concrete overlays as a percentage of total concrete paving in the United States

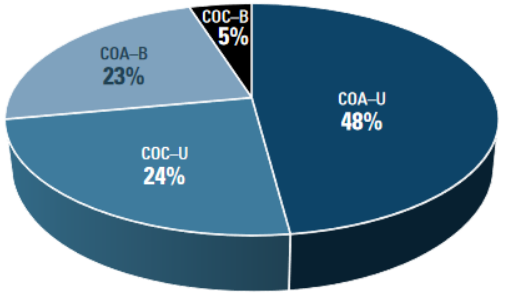
Concrete Overlay Technology Transfer

- Today's tech transfer guides offer a wealth of information on planning, design, and construction of BCOAs
- Several design tools are in use around the country:
  - University of Pittsburgh's BCOA-ME
  - ACPA BCOA Thickness Designer
  - Pavement ME
  - Colorado DOT
  - Illinois DOT



Tech Transfer Needs

- BCOAs are still a relatively new type of pavement and a relatively new type of concrete overlay
  - Many state agencies have yet to build a BCOA
- Several BCOA design concepts have only been in use for a limited amount of time
  - Shorter joint spacing designs
  - Fiber-reinforced concrete
- As projects age, agencies are just starting to recognize typical preservation and repair needs and evaluate best practices



Based on data from ACPA

Figure 2. Types of concrete overlays built in the US between 2000 and 2017

Tech Transfer Needs

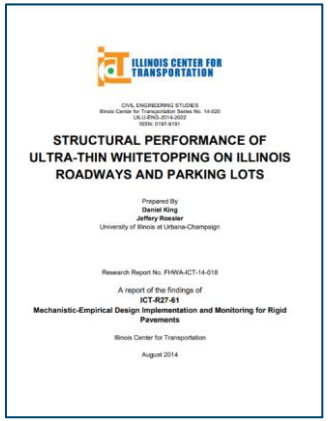
- We need performance data!
  - Helps agencies who use BCOA evaluate their typical design, construction, and maintenance practices
  - Provides guidance to agencies who are new to BCOA

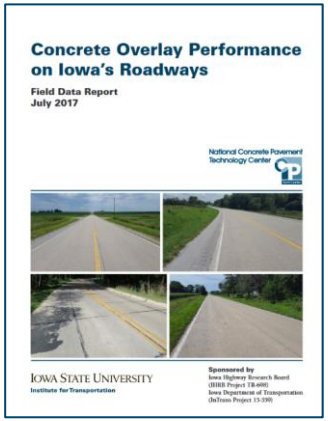
Boone County, Iowa
Constructed 1977
Pictured 2016

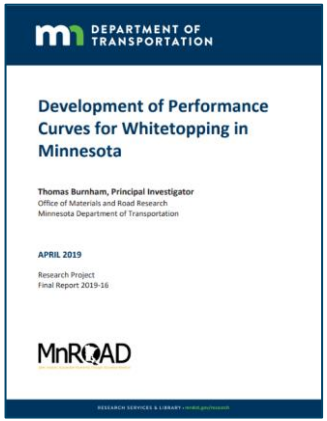
Tuscola, Illinois
Constructed 1999
Pictured 2012

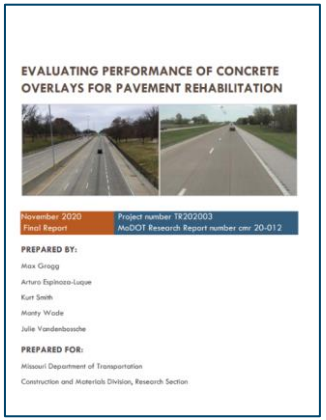
BCOA Performance

- Several states have conducted performance studies to document BCOA performance:
  - Illinois
  - Iowa
  - Minnesota
  - Missouri









BCOA Performance

- Limitations of state studies:
  - Materials, design practices, traffic levels, distress types, etc., can depend on state practices or the regional environment
  - Varying methodologies for surveys, data collection
  - Sometimes difficult to compare performance of newer BCOA design concepts to other types of concrete overlays

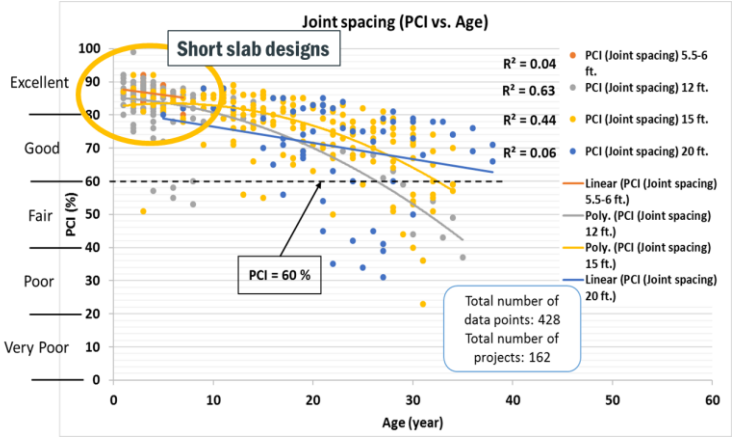
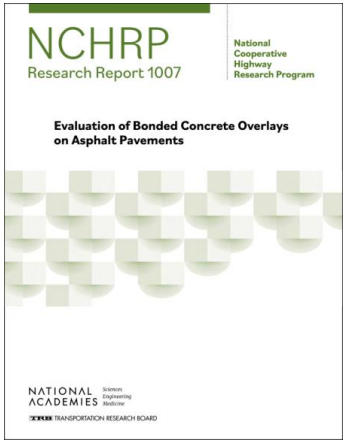


Image: Gross et al. (2017)

NCHRP Research Report 1007

- Collects state of the practice & performance data from BCOA projects across the US, covering multiple states and regions
- Contains detailed field evaluations for selected projects with comprehensive & uniform data collection
  - Testing provides additional insight into structural behavior and performance
  - Large project set for comparing performance of different design parameters, like joint spacing
- Performance is connected back to predictions from the most-used design procedures



NCHRP Research Report 1007

- The findings of this report will provide support for future tech transfer efforts:
  - Further BCOA-specific commentary on design and construction best practices
  - New information on use of innovative materials/methods
    - Fiber-reinforced concrete
    - GPR, ultrasonic tomography for evaluation
  - Insight into medium-to-long term BCOA behavior and appropriate preservation, rehab, and end-of-life strategies

NCHRP Research Report 1007

- Setting the stage for further research and areas of emphasis in BCOA tech transfer:
  - Incorporating BCOA into pavement management and planning
  - Improving design methods and commentary
  - Identifying of areas requiring further investigation, such as joint sealing, joint behavior, and bond interface
  - Evaluating how BCOAs can meet emerging needs for sustainable and resilient pavement solutions

NCHRP Research Report 1007 - Implementation Challenges

Tom Burnham, P.E. | Senior Road Research Engineer, Minnesota Department of Transportation

TRB Webinar: Performance of Concrete Overlays on Asphalt Pavement

4/4/2023

Implementation Into Practice

Definition according to pavement professionals:

- **Determined to be better than existing practice**
- **New specification**
- **Construction industry can build successful projects**
- **Economically justifiable**

Challenges to Implementation

Pavement industry in general very conservative toward changes

- **Restrained budgets – first cost often controls**
- **Empirical knowledge – has worked well over the years**
- **Liability – don’t want to deal with failures early or long term**
- **Investment in high cost specialized equipment**
- **Training needed for new materials/equipment**

Implementation Poll

Survey of state agency members of National Concrete Consortium

- **Experience with concrete overlays on asphalt**
- **Real or perceived barriers to their implementation**
- **Primary sources of information about the design, construction, and performance of COAs**
- **Awareness of the NCHRP Project 01-61**
- **Use of NCHRP Report 1007**
- **Will report lead to changes in implementation of COAs**
- **Use of NCHRP final reports to influence practices**

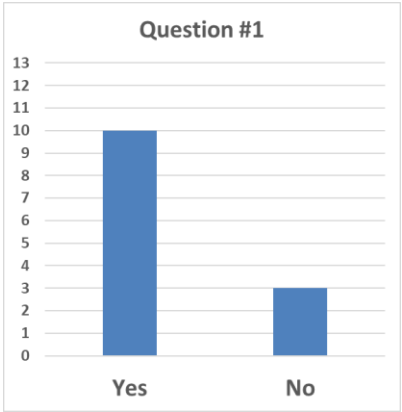
Implementation Poll

Survey Caveats:

- **Respondents may not make project selection decisions**
- **Some states have very small concrete pavement industry**
- **Conservative personalities**
- **Restrained budgets control decisions**
- **View of NCHRP products**

Survey Results

Question #1: Have concrete overlays on asphalt been built and/or are there agencies in your state planning to build COAs in the future?



- Select responses:
  - "several of them from 7 years ago"
  - "two projects I am aware of"
  - "No, any concrete overlay we have done has been on our bridges"
  - "both thin (6") and thick (11")"
  - "Yes, but I'm don't think they were designed as a bonded system"
  - "in the future I would expect to see more on the county system vs. the state system"

Survey Results

Question #2: If COAs have not been built in your state, what are the real or perceived barriers to their implementation?

- **Select responses:**
  - **Most were "N/A"**
  - **"Even though we build some, I still think the perceived barrier is maintenance (how to fix)"**
  - **"Accommodating the grade change has been a big challenge"**
  - **"Concerns exist regarding use on base pavements that are not in great condition"**
  - **"No plans that we are aware of at this time"**
  - **"cost/construction difficulty"**
  - **"We don't do many as they're somewhat cost prohibitive for us"**

Survey Results

Question #3: Prior to the complete of NCHRP Report 1007, what have been your primary sources of information about the design, construction, and performance of COAs?

Select responses:

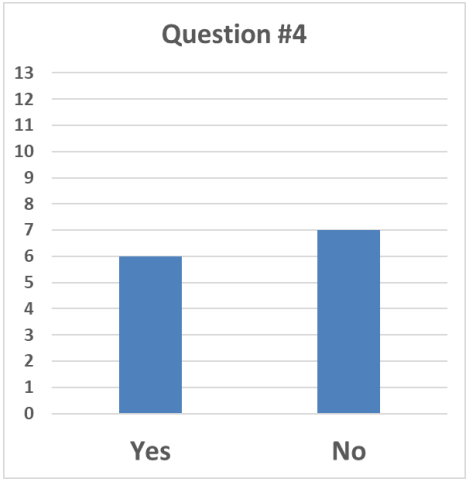
- **“Publications from research facilities in the U.S., including FHWA, NCHRP, and National Concrete Pavement Technology Center, TRB, FHWA sponsored webinars and/or workshops”**
- **“ACPA”, State Chapter ACPA guidance**
- **“CPTech Center, University of Pittsburgh (BCOA-ME, surrounding SHA’s(MnDOT, IowaDOT, WiscDOT and CoDOT)”**
- **“NCHRP Synthesis 338”**

Survey Results

Question #4: Were you aware of the NCHRP Project 01-61 that produced Report 1007?

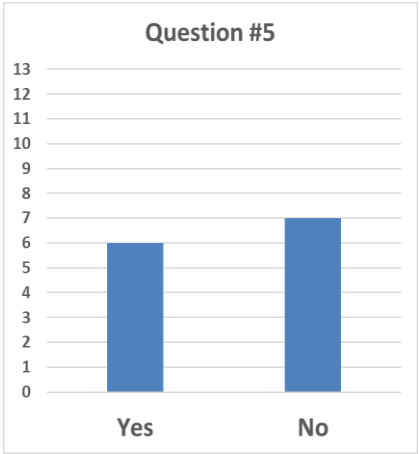
Select responses:

- **"We participated in the study"**



Survey Results

Question #5: Have you read/reviewed NCHRP Report 1007, and do you think it will lead to changes in your implementation of COAs?



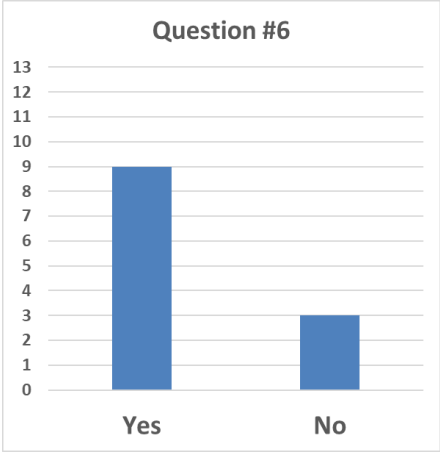
Select responses:

- **“We do not have a lot of concrete pavements, but this NCHRP report may lead to changes of COAs implementation in the future”**
- **“The conclusions did not provide anything to cause us to rethink our current BCOA design”**
- **“Will continue to implement COA’s as tool in tool box”**
- **“No, since very few concrete pavements are currently being placed in our state”**
- **“Probably not many, we may be able to bring it up as a rehabilitation option for more projects”**

Survey Results

Question #6: Do you regularly read NCHRP final reports and/or have they influenced practices in your state in the past?

Select responses:



- **"I do not unless someone draws my attention to information that may be relevant to a concrete concern we have"**
- **"Only occasionally, when very pertinent to work activities. Time constraints limit reading opportunities"**
- **"Yes, as smaller agency we rely on NCHRP and other collaborative research efforts for guidance on adopting new practices frequently"**
- **"occasionally read relevant NCHRP reports, some have influenced"**

Overview

- **This study was valuable in that it has been nearly 20 years since last NCHRP synthesis on concrete overlays on asphalt performance**
- **Studies involving a “snapshot” of pavement performance are limited in assessment of current or future performance**
- **Concrete overlays on asphalt remain a “tool in the toolbox”, and a significant increase in adoption will not likely occur due to findings from this study**
- **Implementation of findings in NCHRP Reports often controlled by factors outside of technical advancements**

Questions?

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Dan King

Concrete Pavement Technology Center at Iowa State University

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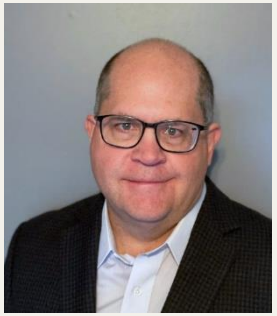
NATIONAL ACADEMIES Sciences Engineering Medicine



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DEPARTMENT OF TRANSPORTATION

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July 8, 2023

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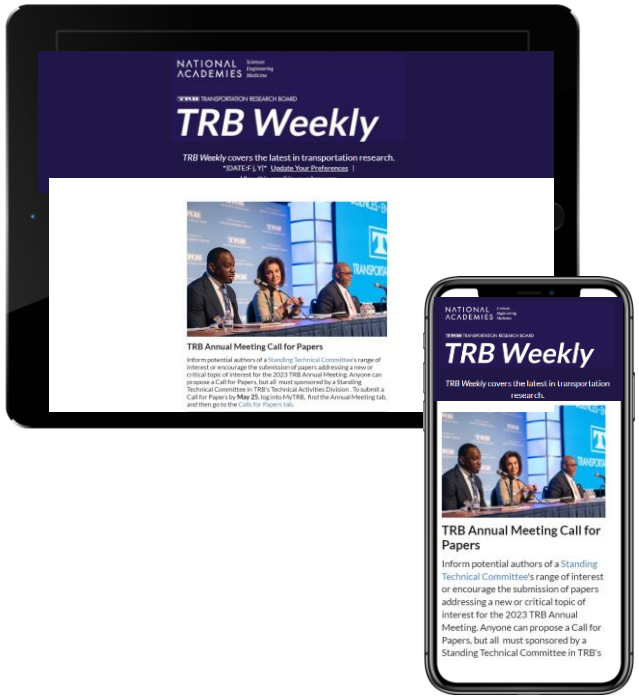

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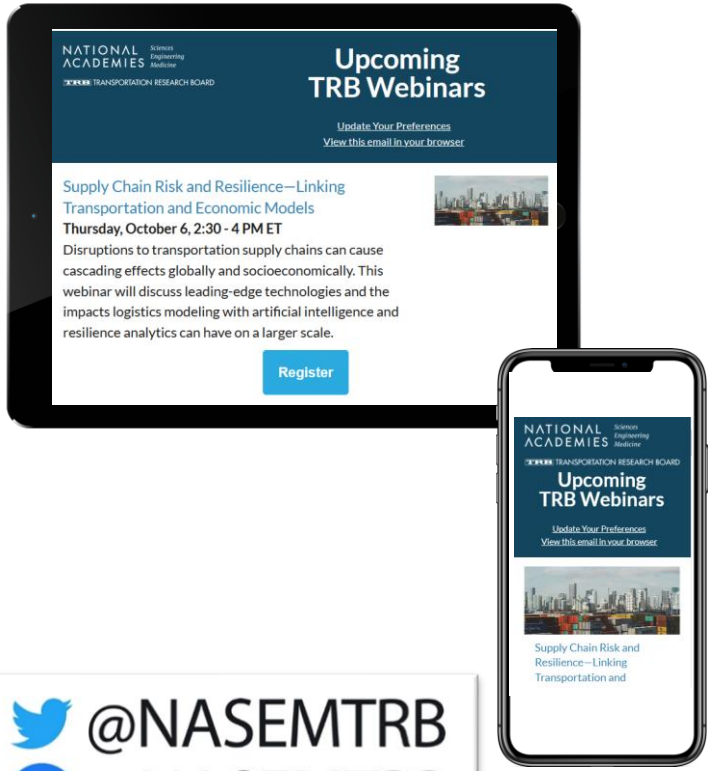

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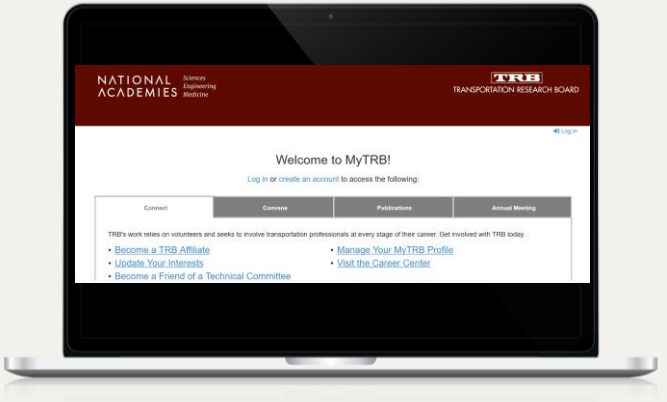

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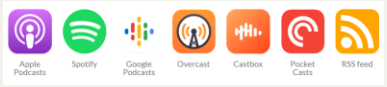

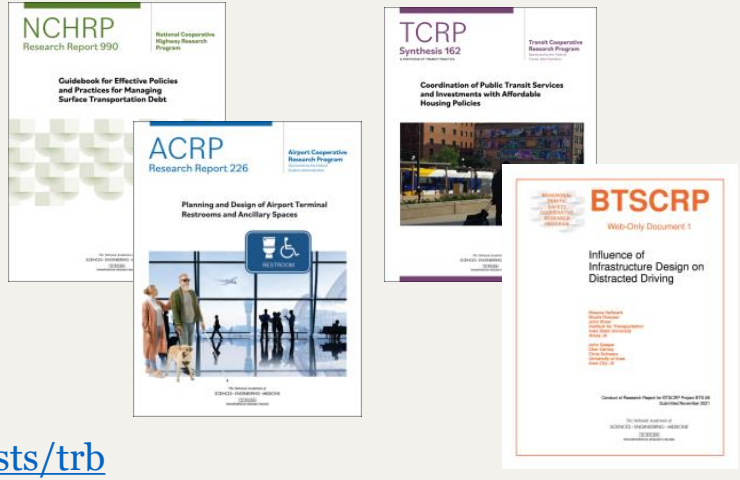

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