NCHRP Project 1-61
Evaluation of Bonded Concrete Overlays on Asphalt (BCOA)

National Concrete Consortium

Savannah, GA
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Acknowledgements

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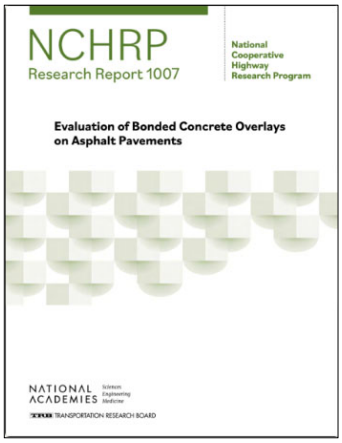
- Kelly Smith and Kurt Smith from APTech

Background

- National Cooperative Highway Research Program
  - Project 1-61 completed 2020
- Bonded concrete overlays of asphalt (BCOA) in use since the 1990s
  - Most in the Midwest
  - Design and performance not well documented
- Project was to assess BCOA performance
  - Site investigations
  - Factors impacting performance

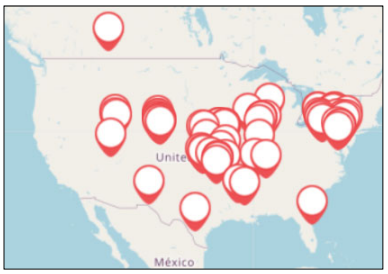


Why BCOA?

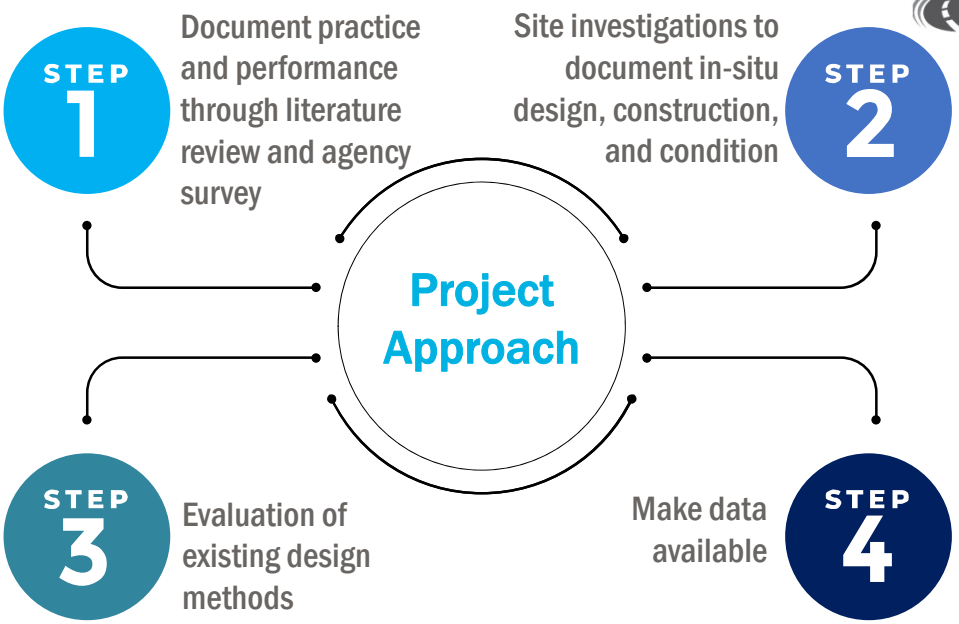
- Excellent treatment for structurally sound asphalt pavement with mixture instability issues
  - Rutting and shoving
  - Intersections and mainline truck routes
- Effective use of in-place materials
  - Rapid and straightforward construction
- Strategy to improve resilience of asphalt pavements at risk of inundation
  - Stiffens pavement structure and raises elevation (slightly)

Why This Study?

- BCOA has been successfully used since the 1990's
  - Experience centered in the Midwest
- Major advancements in BCOA design methods
  - BCOA-ME
- Needs still exist
  - Optimization of BCOA mix proportioning, construction practices, maintenance, repair, and rehabilitation
  - Performance data for model calibration
- Overall goal is to facilitate further implementation of BCOA



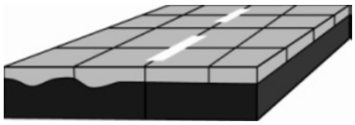
ACPA Concrete Overlay Explorer

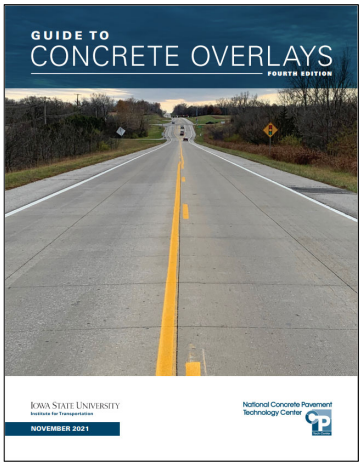


BCOA Construction

BCOA Details

- Conventional concrete with or without fibers
- Concrete overlay
  - Thickness: 4 to 7 inches
  - Closely-spaced joints
- Existing asphalt
  - Fair to good condition
  - At least 3 inches after milling
- Bond between concrete overlay and asphalt is an essential element of design





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

Common Joint Spacing

4’ x 4’

6’ x 6’

BCOA Project Selection

- Existing condition
  - Asphalt pavement structurally sound – only needs spot repairs
  - Limited 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)

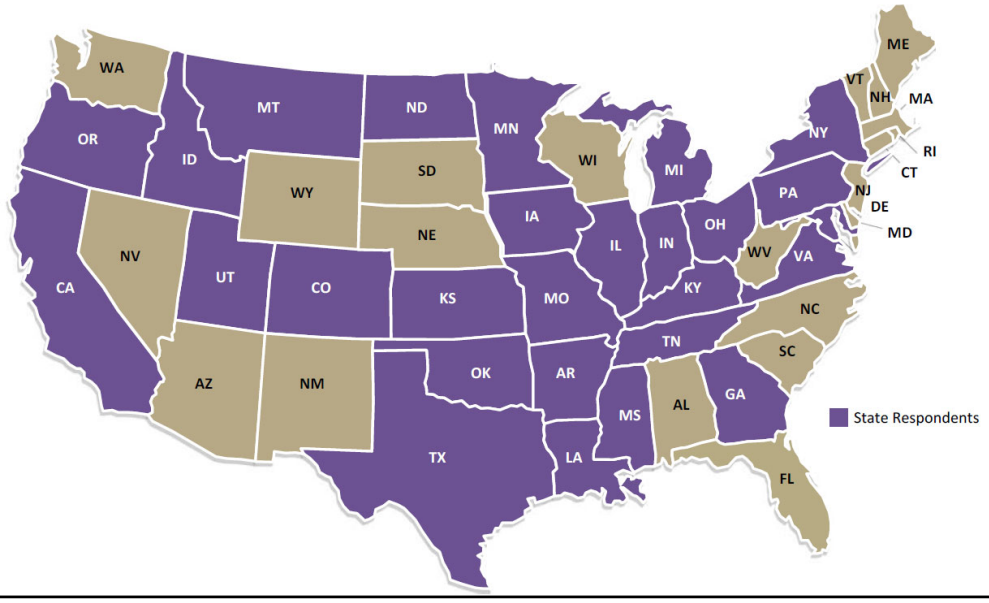
Pre-overlay Repairs

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

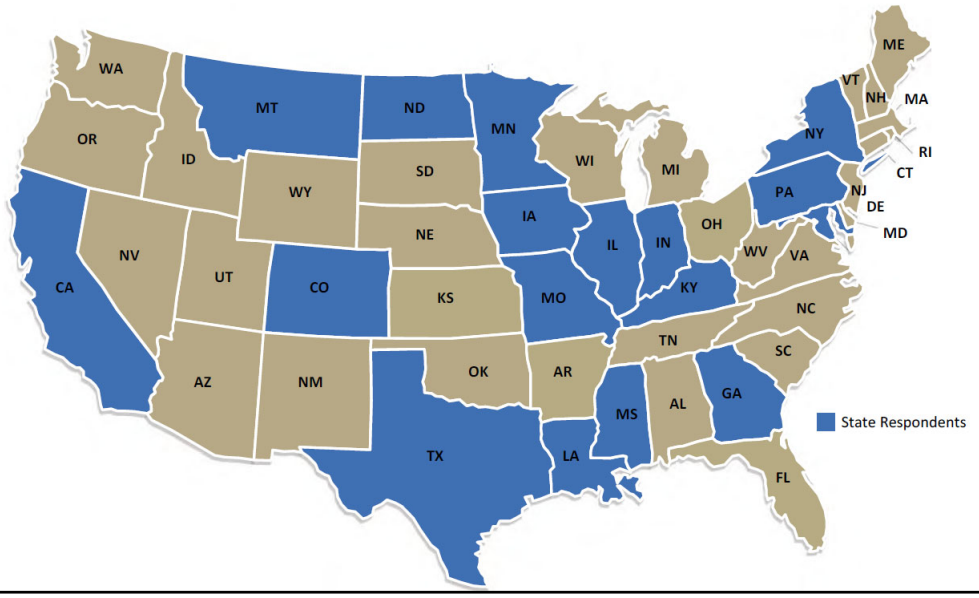
Construction

State of Practice

States Responding to Survey



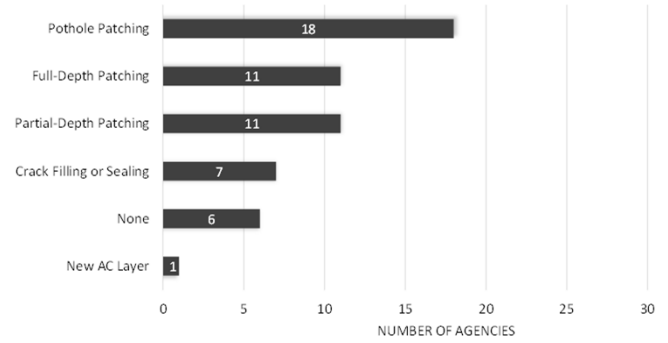
States Considering BCOA Construction 2018 -2020



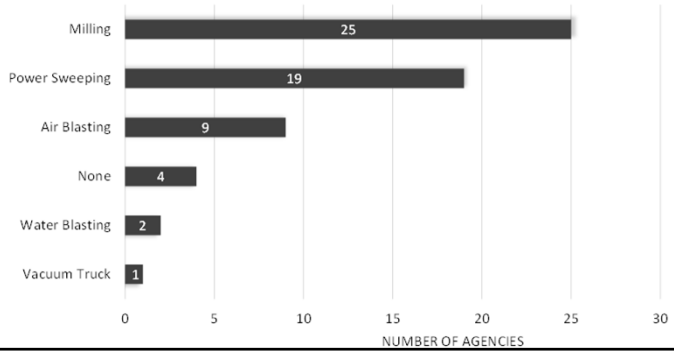
Survey Responses

Does your agency utilize a specialized paving mixture for BCOA applications?			
Specialized Paving Mixture	Yes	No	Total Responses
Specialized Paving Mixture Used for BCOA Applications?	14	14	28
Fibers Used in BCOA Concrete Mixtures? If yes, what type of fibers are used? Polypropylene/Synthetic macrofibers/Macro Polyolefin Structural/Microfibers (monofilament)/Unspecified	11 (5/1/1) (1/1/2)	3	14
Early-opening-to-traffic (EOT) BCOA Concrete Mixture Available?	8	6	14
Specific BCOA Concrete Mixture Requirement for Aggregate?	6	7	13
Specific BCOA Concrete Mixture Requirement for Cementitious Materials?	2	9	11
Specific BCOA Concrete Mixture Requirement for Chemical Admixtures?	1	10	11

Pre-overlay repairs



Surface preparation



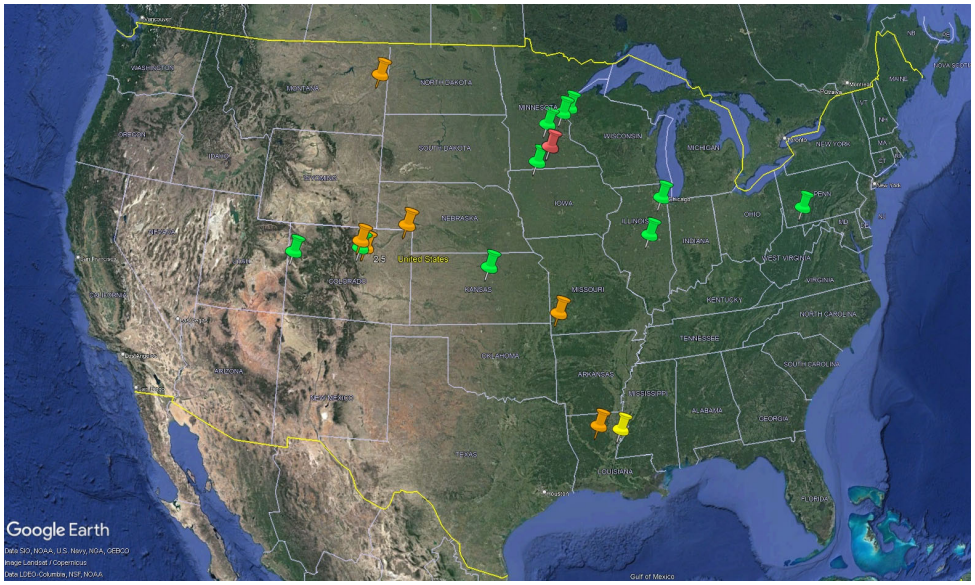
Site Investigations

Projects

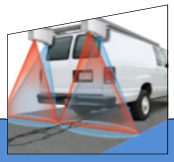
- Evaluated 19 projects
  - Farm-to-market roads to Interstate
- In-service age: 7 to 26 years
- Thickness: 4 to 6 inches
- Joint spacing: 4x4 to 12x12
- Traffic: 13 to 2,717 trucks/day

State	Route	Age (yrs)	Thickness (in.)		Slab Size	Trucks/day
			Design	Field		
CO	I-70	7	6.0	6.5	6x6	1,845
IA	US-71	7	6.0	6.6	6x6	940
IL	SR-53	7	4.0	3.7	4x4	2,277
CO	SH-121B	8	6.0	6.3	6x6	1,444
KS	I-70	8	6.0	6.3	6x6	1,782
MN	CSAH-22	8	6.0	6.2	6x6	594
PA	SR-119	9	6.0	6.6	6x6	698
MN	CSAH-7	10	5.0	5.2	6x6	213
MN	I-35	10	6.0	6.5	6x6	1,985
CO	SH-83B	14	6.0	6.1	6x6	2,461
IL	CH-27	16	5.3	5.4	6x6	50
LA	US-425	16	4.0	4.4	4x4	1,106
MT	SR-16	18	4.0	4.4	4x4	388
CO	SH-83A	19	5.0	7.6	6x6	2,717
CO	SH-121A	19	6.0	6.0	6x6	1,058
MO	US-60	20	4.0	5.0	4x4	2,145
CO	US-6	21	5.5	5.5	12x12	293
LA	US-167	21	4.0	5.4	4x4	1,315
MN	TH-30	26	6.0	6.2	12x12	13

NCHRP Project 1-61 COA Projects



NCHRP Study Site Evaluations



Automated Condition Survey

IRI, faulting, and cracking

GPR

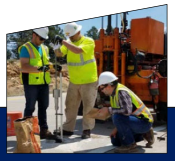
Number, type, and thickness of each layer

Visual Distress Survey

LTPP distress protocols, identify other common BCOA-specific distress

FWD

Load transfer efficiency, layer stiffness



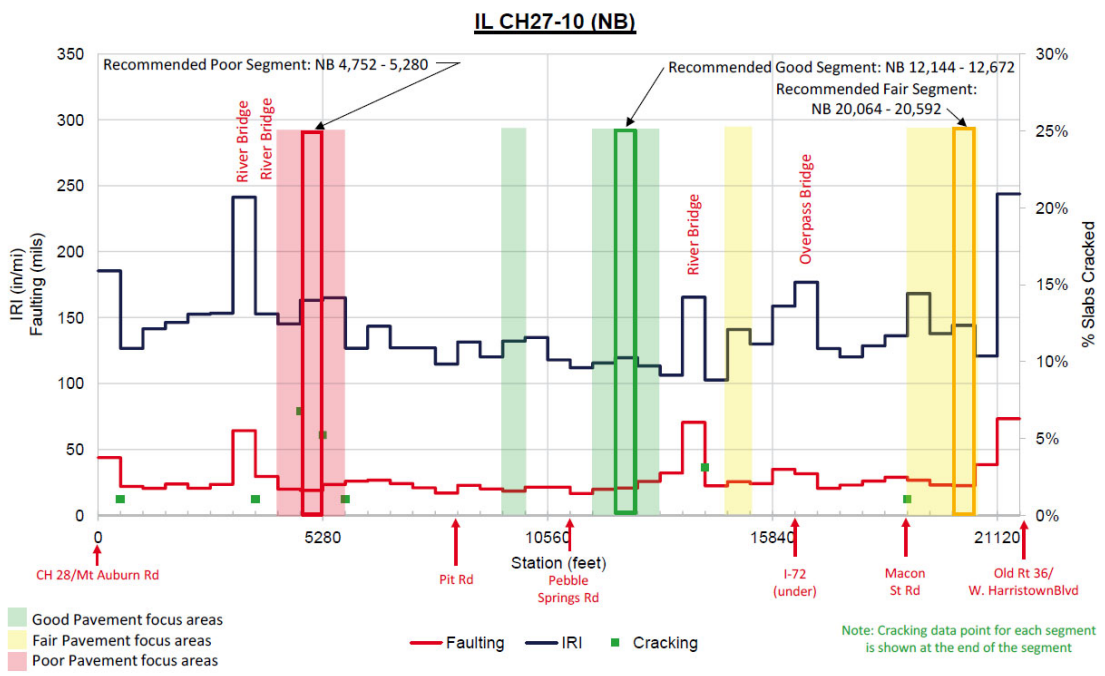
Coring, DCP, & Unbound Material Sampling

Asphalt layer stripping & debonding

Test	No. of Projects	No. of 0.10-mi Segments	Quantity
Automated pavement condition survey	20	60	175.7 miles
GPR survey	20	60	175.7 miles
Visual (manual) distress survey	19	56	23.8 miles
Faultmeter	14	40	921 tests
MIRA	15	43	1,433 tests
FWD	18	53	3,905 stations
BCOA cores	13	38	146
Asphalt cores	12	36	113
DCP	11	31	56 tests
Soil classification	12	34	37 tests
Atterberg Limit	12	34	37 tests
Aggregate gradation – base	3	7	7 tests
Aggregate gradation – subgrade	10	29	30 tests
Concrete compressive strength	7	21	24 tests
Concrete split tensile strength	10	28	58 tests
CTE	10	28	29 tests
Complex modulus	4	12	14 tests
Hamburg wheel	5	14	26 tests
Bulk specific gravity	5	14	56 tests
Concrete-asphalt shear	4	11	20 tests

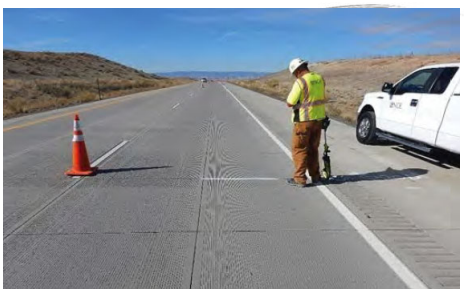
Qualitative Performance Assessment

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

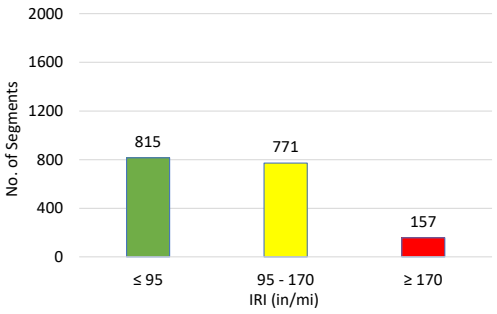


Detailed Surveys

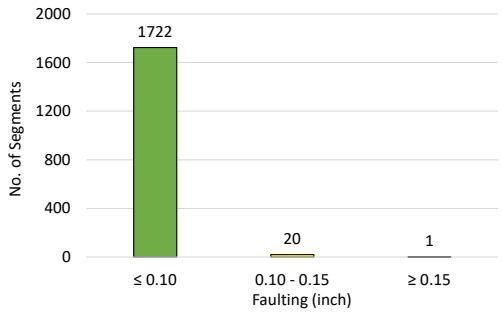
- Wanted to conduct on a good, fair, and poor 0.1-mile segment for each project
- LTPP distress survey
- Faultmeter
- Ultrasonic tomography
- Falling weight deflectometer
- Coring and dynamic cone petrography,
- Laboratory testing: soil characterization, concrete strength and CTE, and asphalt complex modulus and Hamburg wheel, and bond shear

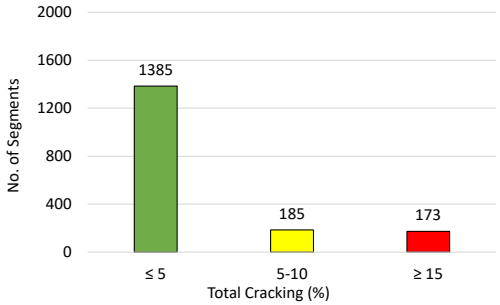


Overall Performance – All Projects

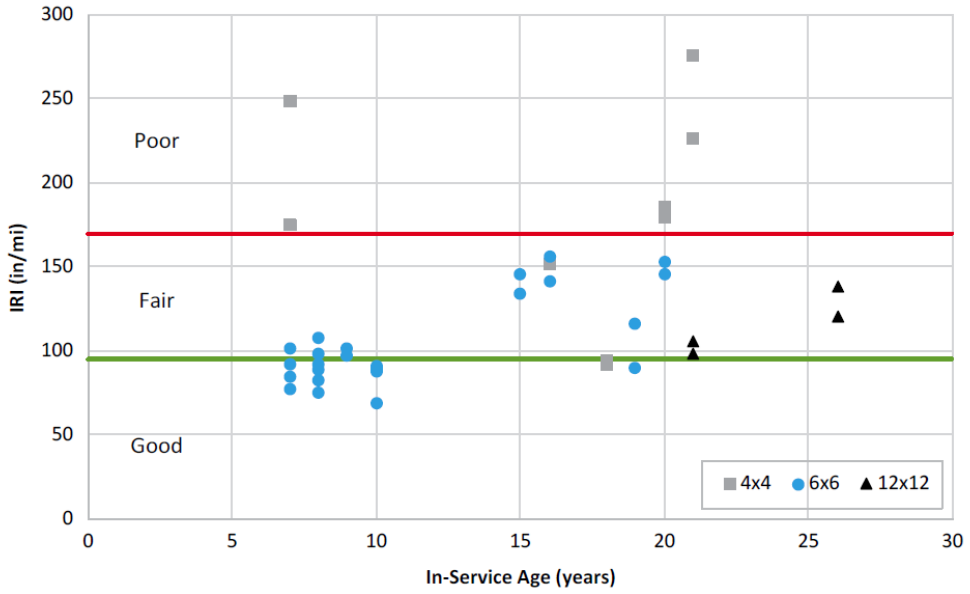


1,743 0.10-mile segments

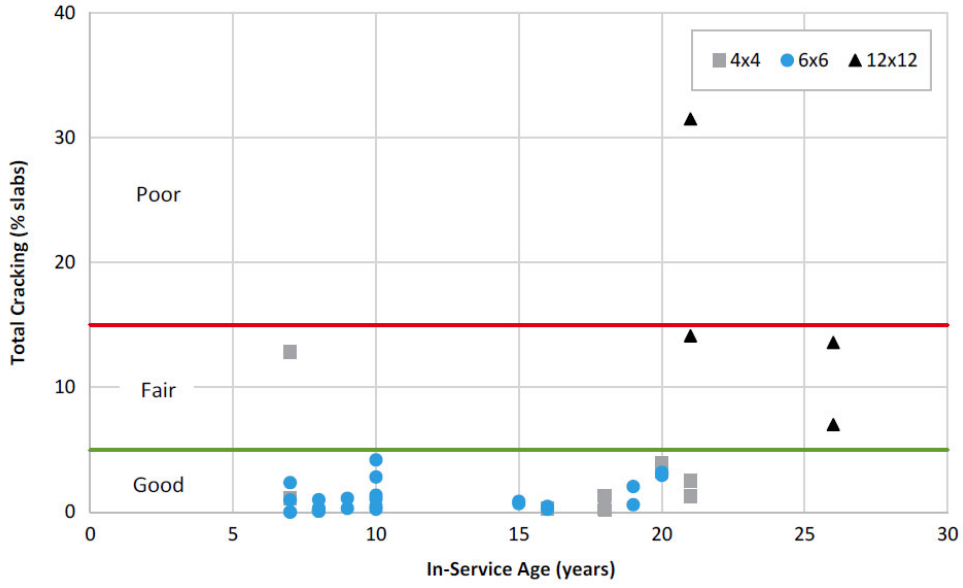




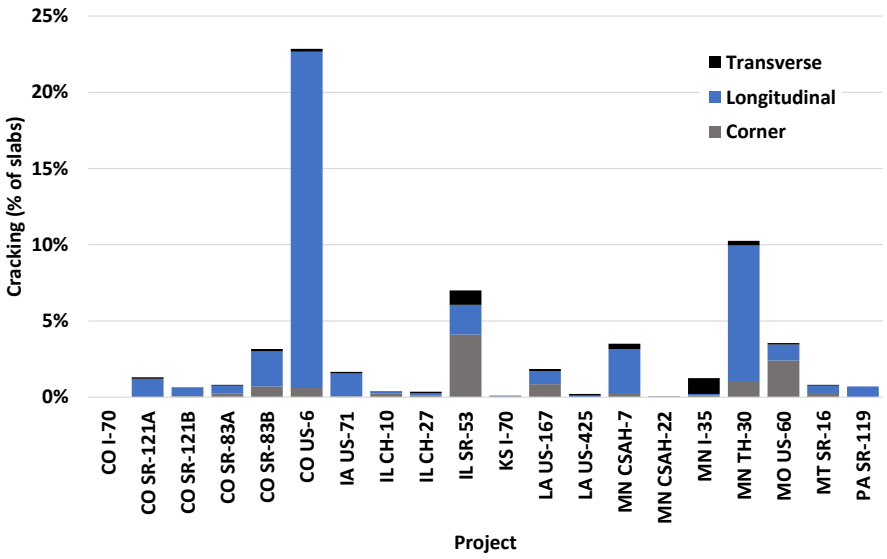
Performance by Slab Size – IRI



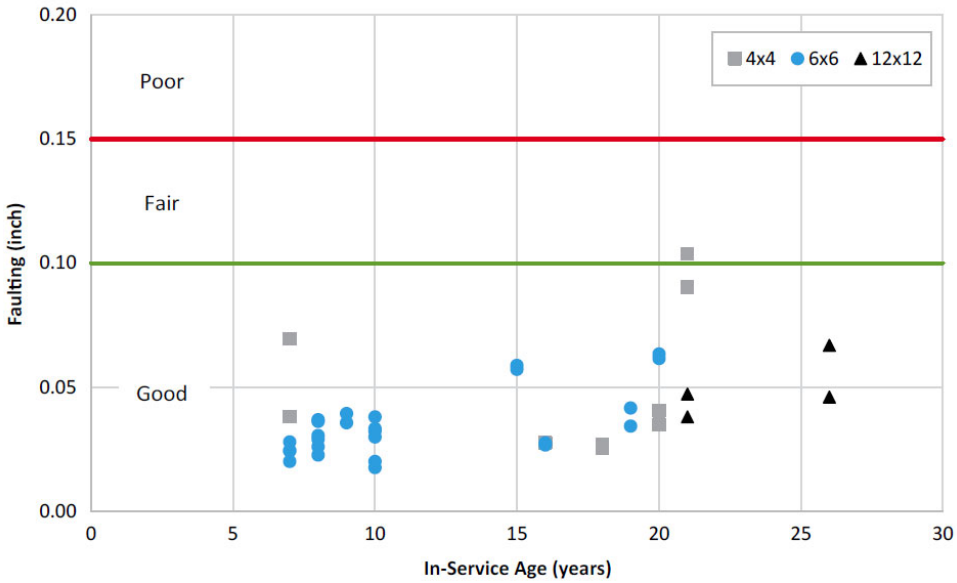
Performance by Slab Size – Automated Cracking



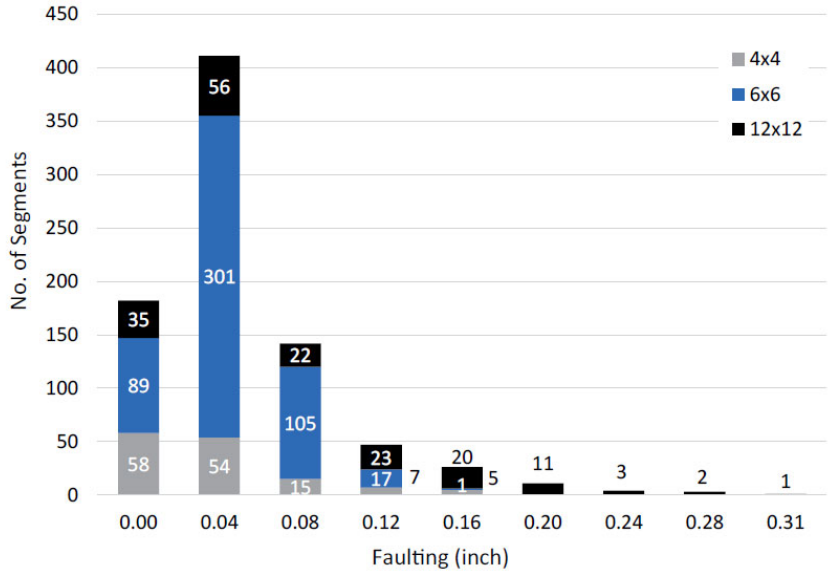
Cracking Type



Performance by Slab Size – Automated Faulting



Faultmeter Results



Performance by Slab Size – All Projects

Condition	Slab (ftxft)	Age (years)	No. Projects	Average	Std Dev
IRI (in/mi)	4x4	7 to 21	5	181	63
	6x6	7 to 21	13	104	26
	12x12	21 to 26	2	116	18
Faulting (inch)	4x4	7 to 21	5	0.05	0.03
	6x6	7 to 21	13	0.03	0.01
	12x12	21 to 26	2	0.05	0.01
Total cracking (% slabs)	4x4	7 to 21	5	3.0	3.9
	6x6	7 to 21	13	1.1	1.2
	12x12	21 to 26	2	16.6	10.5

Study Findings

- BCOA is a successful and cost-competitive rehabilitation option
  - Excellent choice to deal with asphalt mixture instability and improve resiliency
- Simple pre-overlay preparation
- Expediated construction due to working on stable platform and placement of relatively thin concrete layer

Study Findings

- Nearly 90% of the tested segments had IRI less than 170 in/mi
- Maximum faulting less than 0.10-inch (average 0.04 inches)
- Less than 5% of slabs had any type of cracking
- 6 ft x 6 ft slabs had superior performance compared to 4 ft x 4 ft and 12 ft x 12 ft slabs
- There is a boatload of data begging for further analysis

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

Questions?

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