

NCHRP 9-62

Rapid Tests and Specifications for Opening to Traffic and Surfacing Asphalt-Treated Cold Recycled Pavement

Brian Diefenderfer, PhD, PE
Virginia Transportation Research Council / VDOT

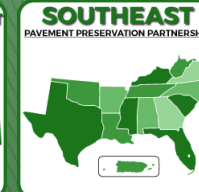
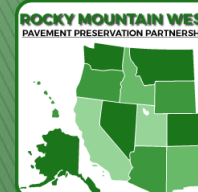
National Pavement Preservation Conference

npcc23

IMPACTS AND BENEFITS FROM PAVEMENT PRESERVATION
September 18-21 • J.W. Marriott Hotel • Indianapolis, Indiana



MICHIGAN STATE
UNIVERSITY



NCHRP 9-62 Tasks

- ▶ Develop a set of time-critical tests for asphalt-treated FDR, CIR, and CCPR materials
 - Tests to be simple and practical
- ▶ Develop guide specifications for using these tests for...
 - Process control and product acceptance, and
 - Allow agencies to determine when the pavement can be opened to traffic and/or surfaced

NCHRP 9-62 Team

▶ Project

- Brian Diefenderfer, PI; David Jones, Co-PI; Adam Hand, Benjamin Bowers, Gerardo Flintsch, Ilker Boz, Jhony Habbouche

▶ Technical Support

- Stephanie Drain, Tom Kazmierowski, Don Mathews, Jason Wielinski

▶ NCHRP Staff

- Ed Harrigan and Roberto Barcena



NCHRP 9-62 Work Completed (2017-2022)

▶ Phase I

- Literature review, stakeholder survey
- Review of existing agency specifications
- Identify existing tests

▶ Phase II

- Refine or develop tests through testing lab prepared mixtures

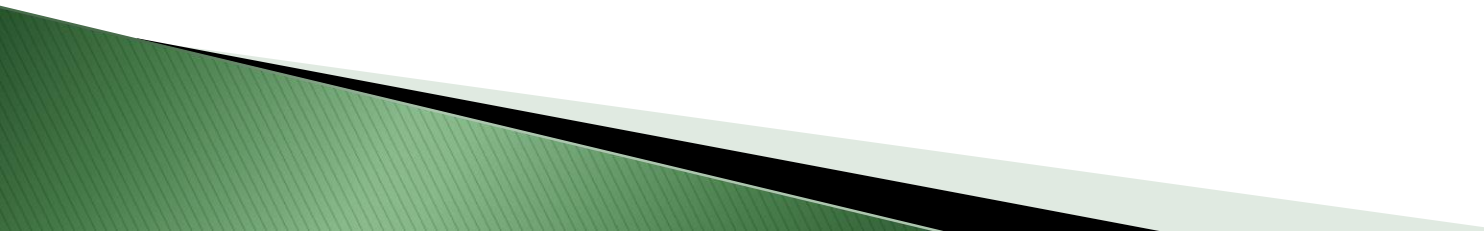
▶ Phase III

- Field testing, field inter-lab study, test methods, guide specifications

▶ Phase IV

- Field validation
- 

Phase I: Literature Review

- ▶ Documented economic and environmental benefits of recycling
 - ▶ Found that lack of rapid process control and acceptance tests limits widespread adoption
 - How does the contractor demonstrate the material meets agencies intent?
 - How does the agency rapidly accept material and make decisions on trafficking/surfacing
- 

Phase I: Literature Review

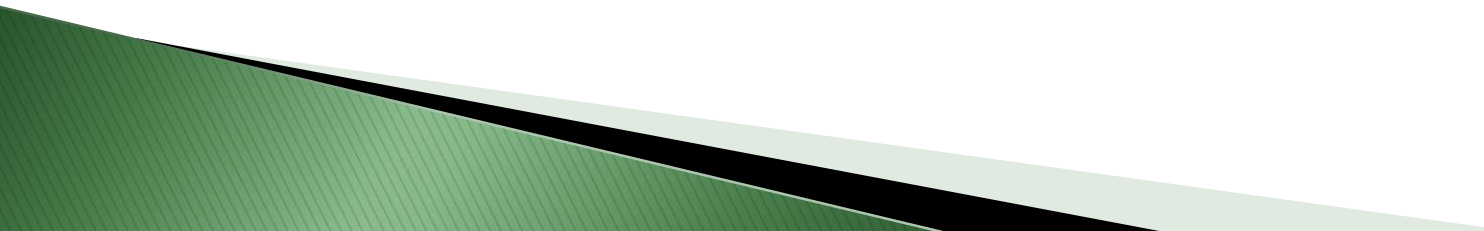
- ▶ Existing tests focus on
 - Stiffness (FWD, etc.)
 - Moisture (direct sampling)
 - Density (nuclear density gauge)
- ▶ Other parameters include
 - Deflection / penetration resistance (DCP, MH)
 - Deformation resistance (proof roll)
 - Raveling resistance (lab test)

Phase I: Stakeholder Survey

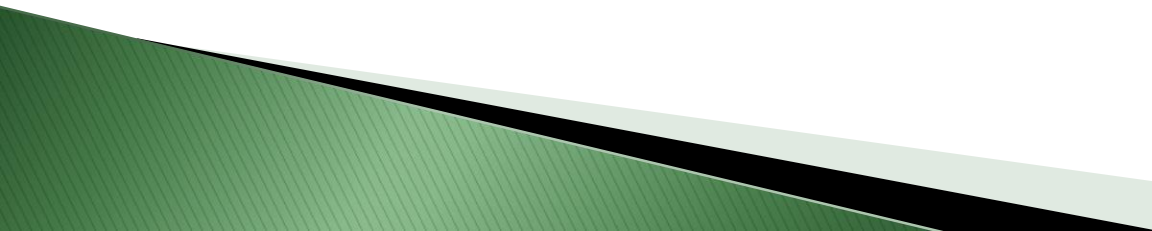
▶ Objectives

- Identify existing non-standard or unpublished tests, improvements to existing tests, hurdles for implementation, background info

▶ Results

- Opening to traffic tests <4 hours, surfacing tests <1 day
 - 75% prefer field-based test
 - Ranked factors to evaluate proposed tests
- 

Phase I: Specification Survey

- ▶ Reviewed 62 specifications for CIR, CCPR, and FDR
 - ▶ Acceptance parameters most cited
 - Density, moisture content, curing time
 - ▶ For summary, see Bowers et al., TRR 2674 (2020)
 - Test strip and acceptance reference density
 - Required curing times and moisture contents
 - Gradation
- 

Phase II: Laboratory Testing

- ▶ Loose materials sampled locally and shipped to VTRC
- ▶ 12 source projects / 18 mixture combinations
 - CIR, CCPR, FDR
 - Emulsified and foamed asphalt
 - Active filler = cement, none
- ▶ Prepared test slabs and conducted tests identified in Phase I



Phase II: Laboratory Testing



Phase II: Laboratory Testing

► Objectives

- Identify promising tests
 - Widest range of responses and lowest variability between replicates
- Identify correlations between tests
- Ruggedness assessment

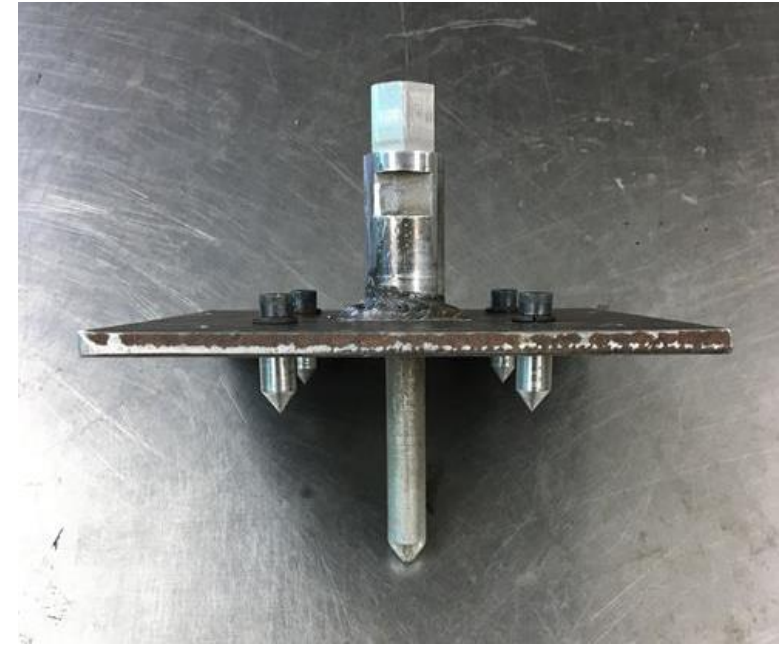
► Tests

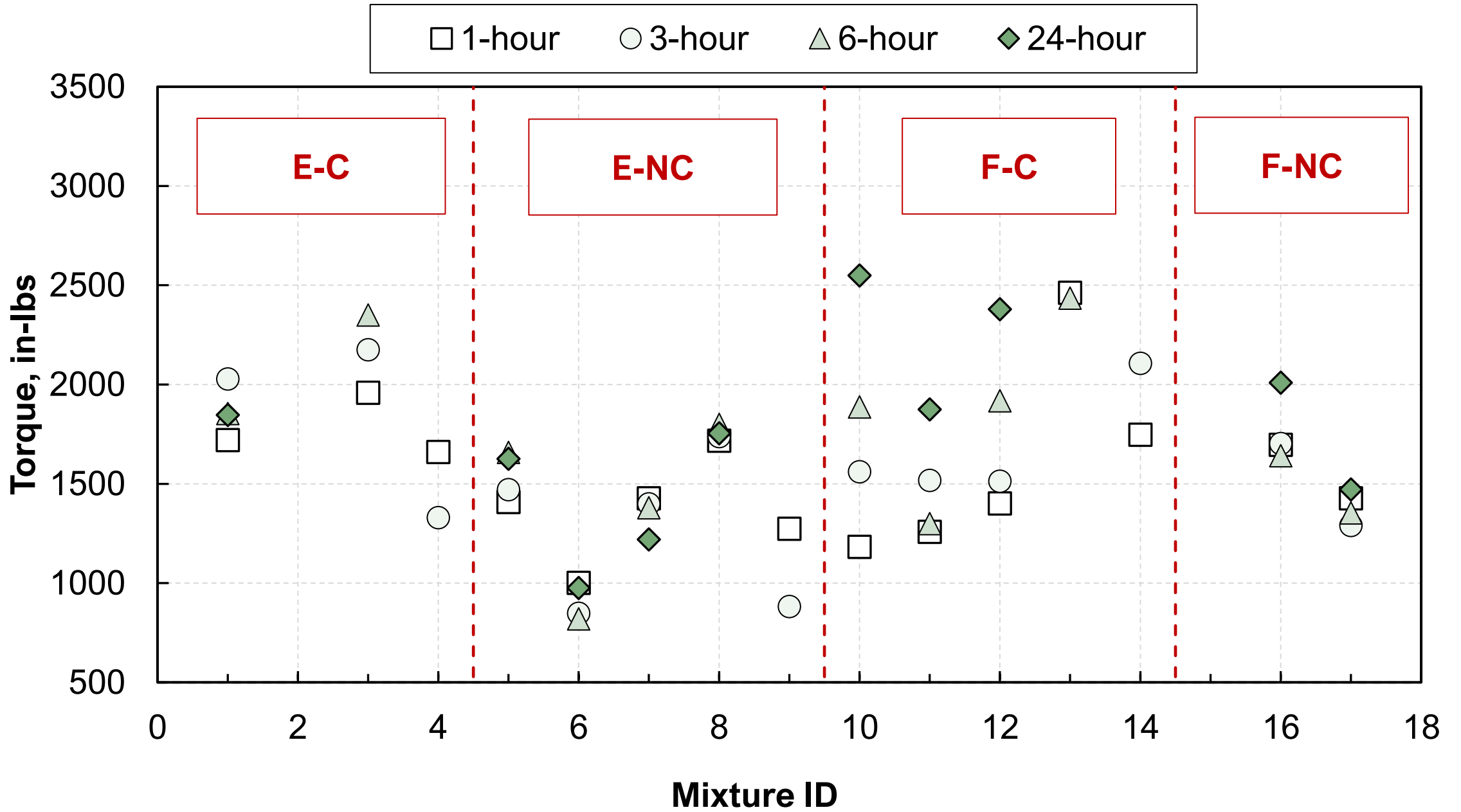
- LWD, DCP, MH, SSG, SPRT, LPST



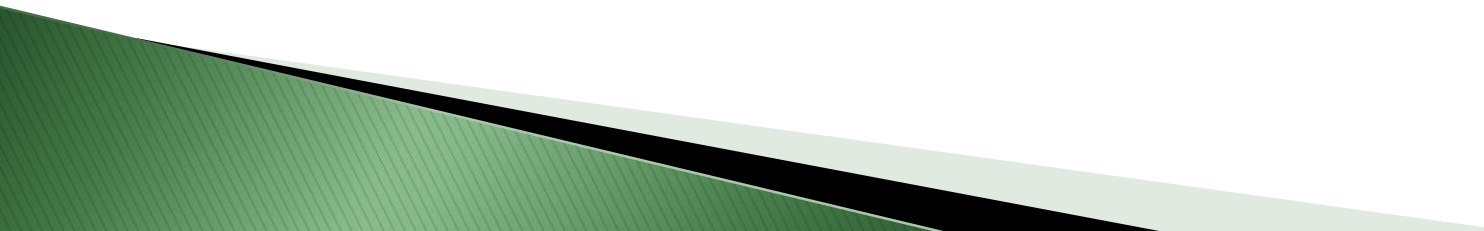
Phase II: Laboratory Testing

- ▶ Developed tests
 - Short-Pin Raveling Test (SPRT) – trafficking
 - Long-Pin Shear Test (LPST) – surfacing
- ▶ Two measures
 - Penetration resistance (# of blows)
 - Torque value
- ▶ Benefits
 - Responsive to property changes
 - Lower COV (generally < 20%)



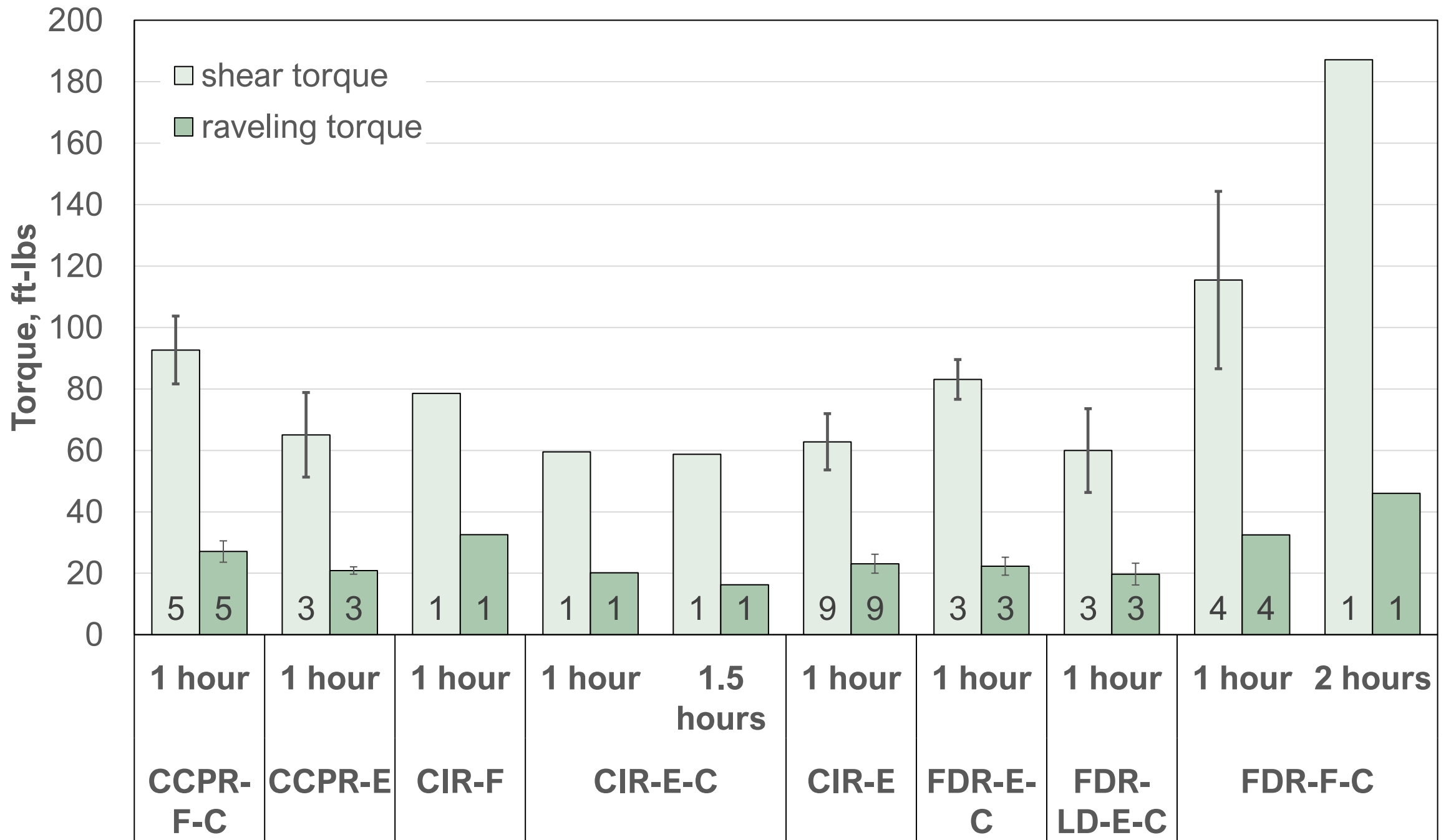


Phase III: Field Testing

- ▶ Field validation
 - Test criteria at early curing ages
 - ▶ Field interlab study (ILS)
 - Field precision using replicate pieces of equipment and multiple operators
 - ▶ Tests considered
 - LWD, SSG, DCP, short-pin raveling and long-pin shear tests
 - ▶ Testing at 9 locations
 - NY (3), MN, IN, SC, CA (2), NM
- 

Phase III: Field Testing





Phase III: Field ILS

- ▶ Original idea was a lab study
 - How do we ship slabs and test at early curing times?
- ▶ Actual desired outcome is field precision
 - August 2019, MnRoad
 - 6 recycling process/agent combinations
 - 3 replicate pieces of equipment
 - 3 operators



Phase III: Recommended Tests

Recommended

- ▶ Short-pin raveling test
- ▶ Long-pin shear test
- ▶ Number of blows and torque value for each

Not Recommended

- ▶ LWD and SSG
 - Influenced by stiffness of lower layers
- ▶ DCP
 - Good repeatability but not thought to address shear properties

Final Report: Recommended Tests

- ▶ NCHRP Report 960
 - Recommended SPRT and LPST for time to opening/trafficking
- ▶ Threshold values
 - Statistical approach (PWL) using Phase III results
 - 95% of observations determined to be adequate
- ▶ Compared these values in field and lab to 0% binder material
 - 100% RAP with no added binder
 - 0% binder material did not pass threshold values

Phase IV: Verification

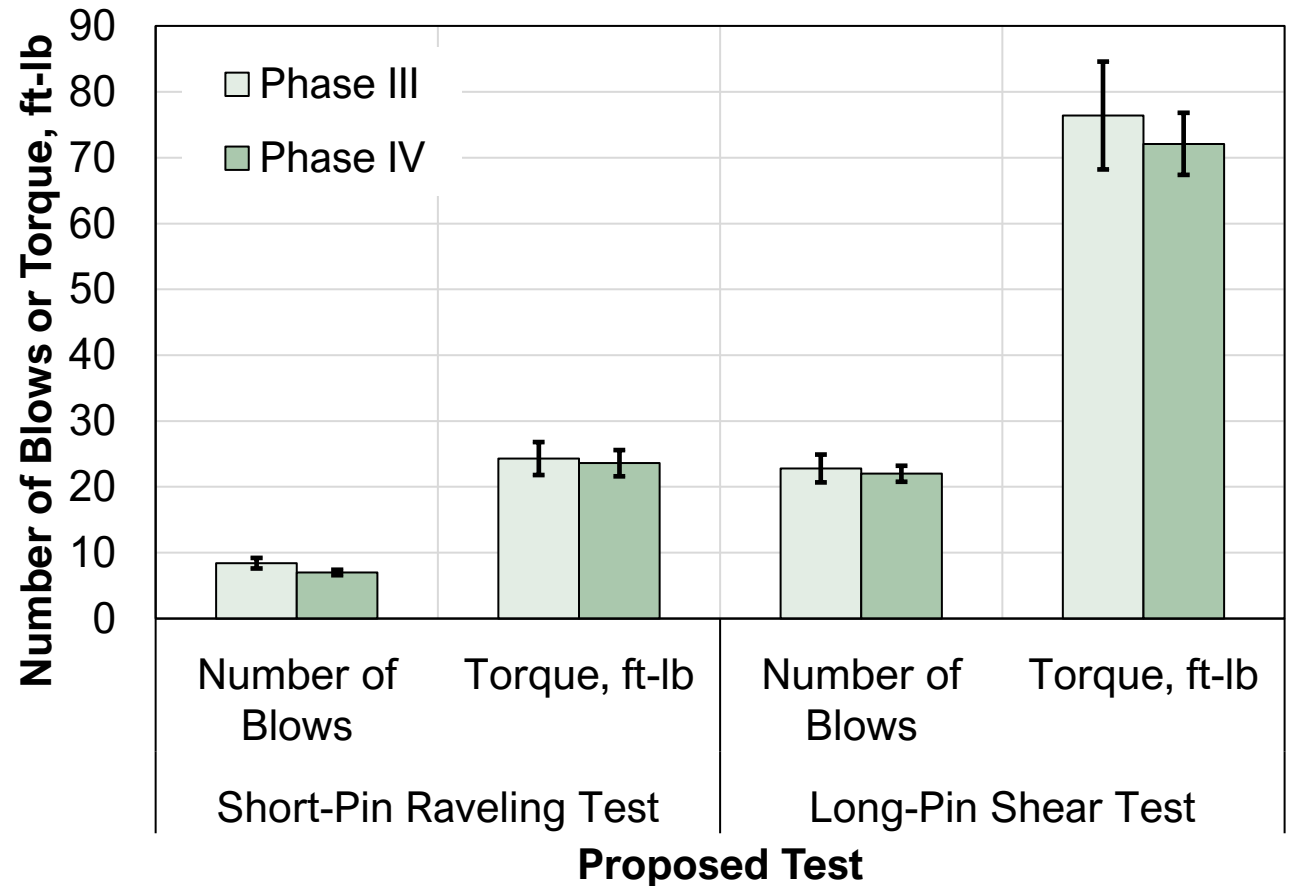
- ▶ 17 additional projects
 - Beyond original study scope
 - All testing by agency or contractor volunteers
- ▶ Revised test fixtures
- ▶ Training videos



Phase IV: Verification

- ▶ Similar results to Phase III
- ▶ Less variability
 - Attributed to more experienced operators and training efforts

Test results (all material types)
at <3 hours curing for Phases
III and IV



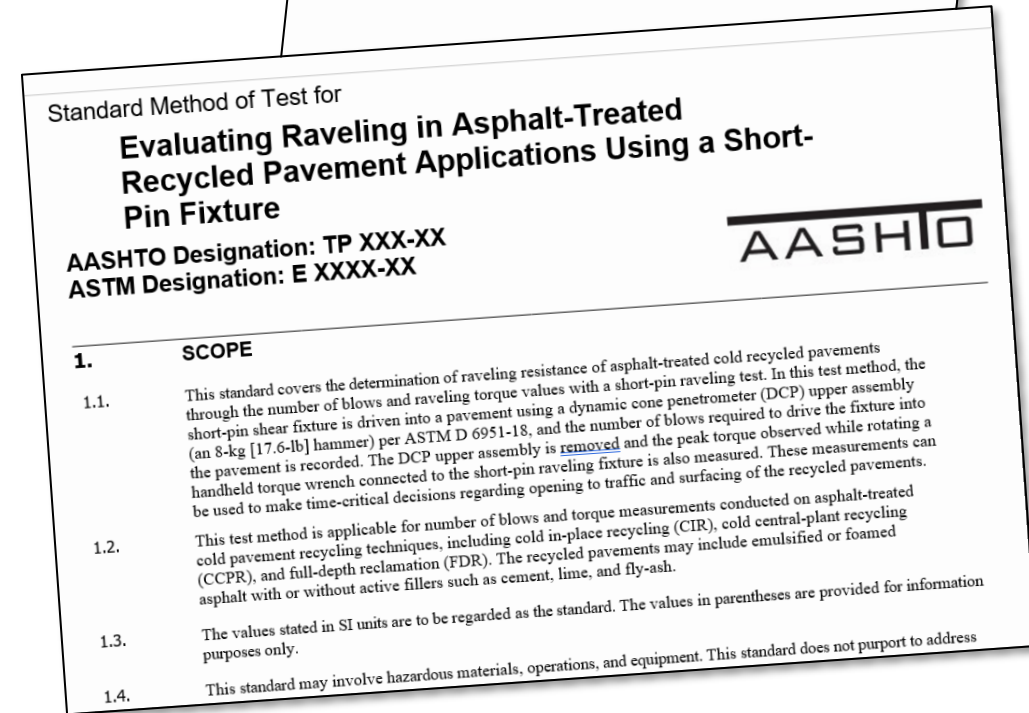
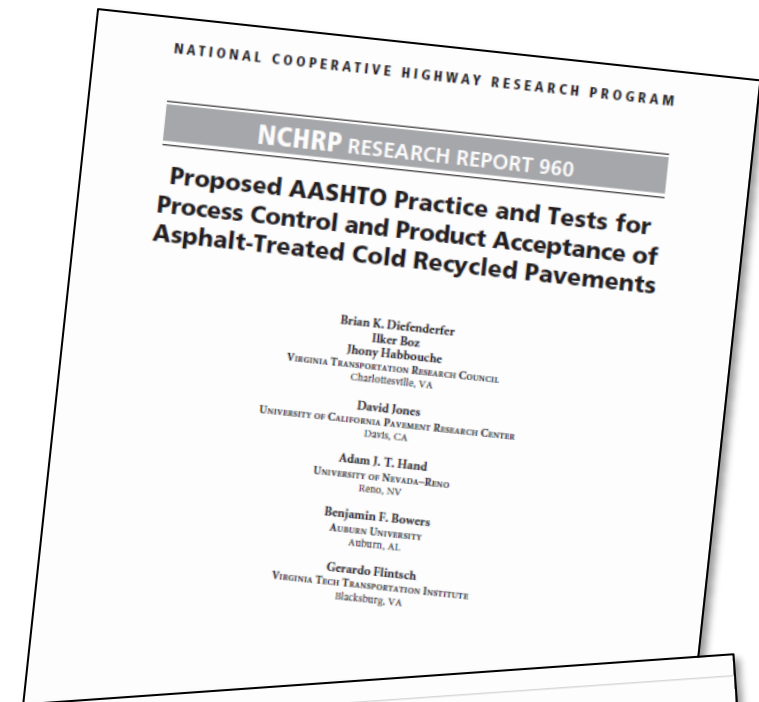
Phase IV: Verification

- ▶ Recommended threshold values

Test		Threshold Value (Avg of 3 tests)
Short-Pin Raveling Test	Number of Blows	7
	Torque, ft-lb	20
Long-Pin Shear Test	Number of Blows	20
	Torque, ft-lb	65

Current Status

- ▶ Phases I–III = NCHRP Report 960
 - Initial threshold values for SPRT and LPST
 - Proposed test methods
- ▶ Phase IV = in review by NCHRP
 - Revised threshold values for SPRT and LPST
- ▶ Revised proposed test methods submitted for balloting



Further Reading

- ▶ Phase I Spec Review
 - Bowers et al. (2020) TRR 2674
- ▶ Phase II Lab Testing
 - Diefenderfer et al. (2020) TRR 2674
 - Habbouche et al. (2021) TRR online
- ▶ Phase III Field ILS
 - Hand et al. (2021) TRR 2675

Questions?

Brian Diefenderfer, PhD, PE
Principal Research Scientist, VTRC
brian.diefenderfer@vdot.virginia.gov