CP Tech Center Update

National Concrete Consortium Spring Meeting
Lakewood, Colorado
April 3, 2019

National Concrete Pavement Technology Center

Tech Center

IOWA STATE UNIVERSITY
Institute for Transportation

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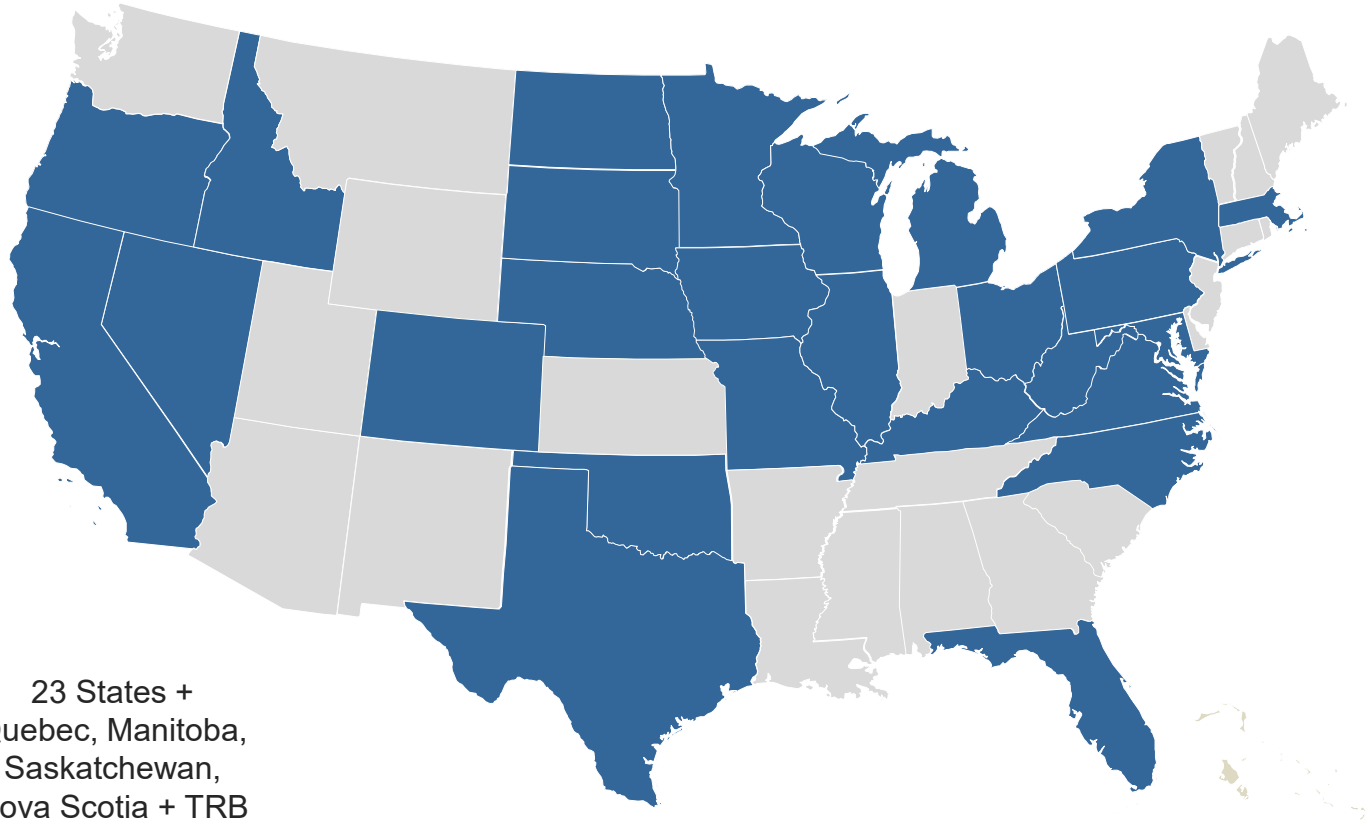
Travels/Presentations October – March 2019

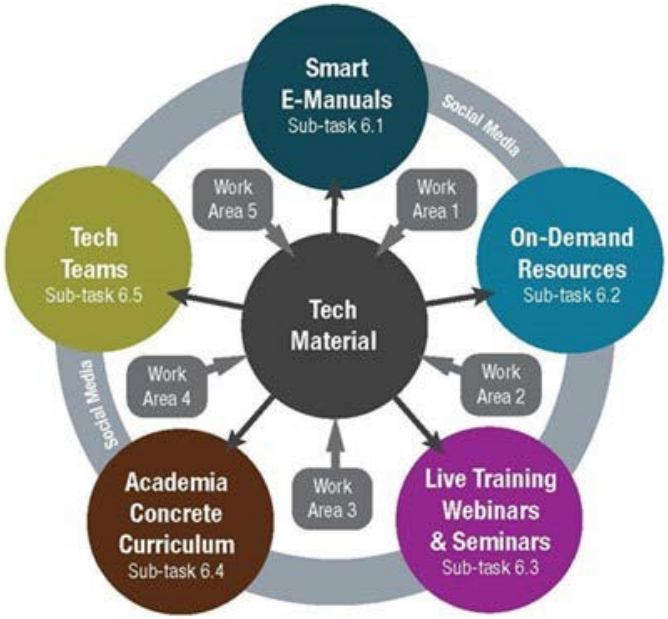


23 States +
Quebec, Manitoba,
Saskatchewan,
Nova Scotia + TRB
& NRMCA/PCA

Advancing Concrete Pavement Technology Solutions *(the new FHWA Cooperative Agreement)*

Extending pavement life and performance
Reducing initial and lifecycle costs
Accelerating construction techniques
Design criteria and specifications
Non-destructive testing

Technology transfer



The FHWA Cooperative Agreement Team

Tara Cavalline
Tom Van Dam
Norb Delatte
Gary Fick
Al Innis
Tyler Ley
Jeff Roesler
Kurt Smith
Mark Snyder
Larry Sutter
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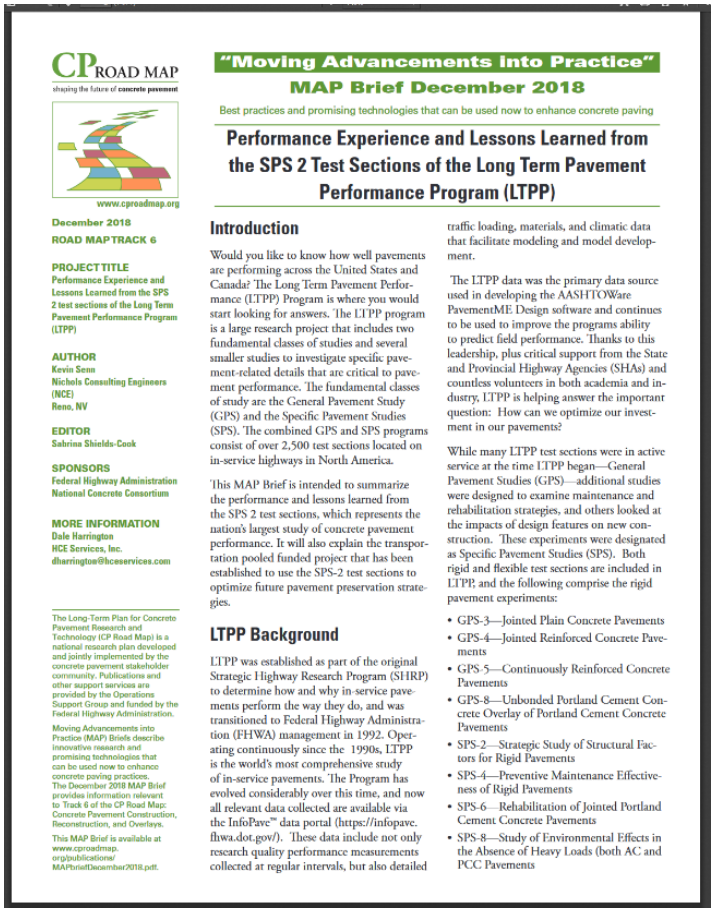
Tom Cackler
Jerod Gross
Dale Harrington
Gordon Smith
Peter Taylor
Steve Tritsch

Gina Ahlstrom
Mike Praul
Sam Tyson

http://www.cproadmap.org/publications/MAPbriefMarch2019.pdf

http://www.cproadmap.org/publications/MAPbriefDecember2018.pdf



CP ROAD MAP
shaping the future of concrete pavement

www.cproadmap.org

December 2018
ROAD MAP TRACK 6

PROJECT TITLE
Performance Experience and Lessons Learned from the SPS 2 test sections of the Long Term Pavement Performance Program (LTPP)

AUTHOR
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EDITOR
Sabrina Shields-Cook

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The Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map) is a national research plan developed and jointly implemented by the concrete pavement stakeholder community. Publications and other support services are provided by the Operations Support Group and funded by the Federal Highway Administration.

Moving Advancements into Practice (MAP) Briefs describe innovative research and promising technologies that can be used now to enhance concrete paving practices. The December 2018 MAP Brief provides information relevant to Track 6 of the CP Road Map: Concrete Pavement Construction, Reconstruction, and Overlays.

This MAP Brief is available at www.cproadmap.org/publications/MAPbriefDecember2018.pdf.

"Moving Advancements into Practice"

MAP Brief December 2018

Best practices and promising technologies that can be used now to enhance concrete paving

Performance Experience and Lessons Learned from the SPS 2 Test Sections of the Long Term Pavement Performance Program (LTPP)

Introduction

Would you like to know how well pavements are performing across the United States and Canada? The Long Term Pavement Performance (LTPP) Program is where you would start looking for answers. The LTPP program is a large research project that includes two fundamental classes of studies and several smaller studies to investigate specific pavement-related details that are critical to pavement performance. The fundamental classes of study are the General Pavement Study (GPS) and the Specific Pavement Studies (SPS). The combined GPS and SPS programs consist of over 2,500 test sections located on in-service highways in North America.

This MAP Brief is intended to summarize the performance and lessons learned from the SPS 2 test sections, which represents the nation's largest study of concrete pavement performance. It will also explain the transportation pooled funded project that has been established to use the SPS-2 test sections to optimize future pavement preservation strategies.

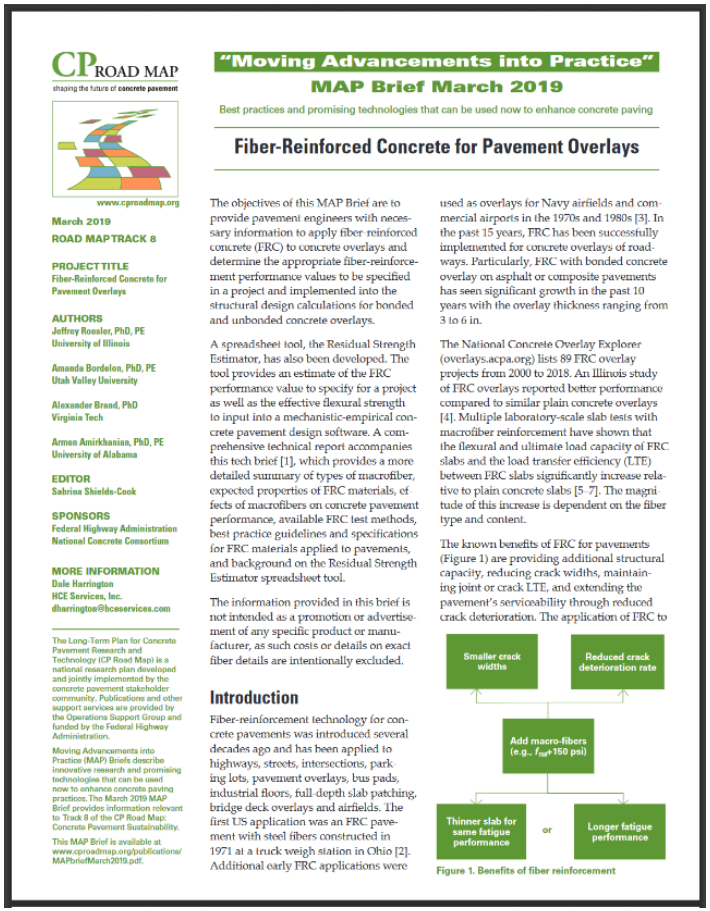
LTPP Background

LTPP was established as part of the original Strategic Highway Research Program (SHRP) to determine how and why in-service pavements perform the way they do, and was transitioned to Federal Highway Administration (FHWA) management in 1992. Operating continuously since the 1990s, LTPP is the world's most comprehensive study of in-service pavements. The Program has evolved considerably over this time, and now all relevant data collected are available via the InfoPave™ data portal (https://infopave.fhwa.dot.gov/). These data include not only research quality performance measurements collected at regular intervals, but also detailed traffic loading, materials, and climatic data that facilitate modeling and model development.

The LTPP data was the primary data source used in developing the AASHTOWare PavementME Design software and continues to be used to improve the programs ability to predict field performance. Thanks to this leadership, plus critical support from the State and Provincial Highway Agencies (SHAs) and countless volunteers in both academia and industry, LTPP is helping answer the important question: How can we optimize our investment in our pavements?

While many LTPP test sections were in active service at the time LTPP began—General Pavement Studies (GPS)—additional studies were designed to examine maintenance and rehabilitation strategies, and others looked at the impacts of design features on new construction. These experiments were designated as Specific Pavement Studies (SPS). Both rigid and flexible test sections are included in LTPP, and the following comprise the rigid pavement experiments:

- GPS-3—Jointed Plain Concrete Pavements
- GPS-4—Jointed Reinforced Concrete Pavements
- GPS-5—Continuously Reinforced Concrete Pavements
- GPS-8—Unbonded Portland Cement Concrete Overlay of Portland Cement Concrete Pavements
- SPS-2—Strategic Study of Structural Factors for Rigid Pavements
- SPS-4—Preventive Maintenance Effectiveness of Rigid Pavements
- SPS-6—Rehabilitation of Jointed Portland Cement Concrete Pavements
- SPS-8—Study of Environmental Effects in the Absence of Heavy Loads (both AC and PCC Pavements



CP ROAD MAP
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March 2019
ROAD MAP TRACK 8

PROJECT TITLE
Fiber-Reinforced Concrete for Pavement Overlays

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Moving Advancements into Practice (MAP) Briefs describe innovative research and promising technologies that can be used now to enhance concrete paving practices. The March 2019 MAP Brief provides information relevant to Track 8 of the CP Road Map: Concrete Pavement Sustainability.

This MAP Brief is available at www.cproadmap.org/publications/MAPbriefMarch2019.pdf.

"Moving Advancements into Practice"

MAP Brief March 2019

Best practices and promising technologies that can be used now to enhance concrete paving

Fiber-Reinforced Concrete for Pavement Overlays

The objectives of this MAP Brief are to provide pavement engineers with necessary information to apply fiber-reinforced concrete (FRC) to concrete overlays and determine the appropriate fiber-reinforcement performance values to be specified in a project and implemented into the structural design calculations for bonded and unbonded concrete overlays.

A spreadsheet tool, the Residual Strength Estimator, has also been developed. The tool provides an estimate of the FRC performance value to specify for a project as well as the effective flexural strength to input into a mechanistic-empirical concrete pavement design software. A comprehensive technical report accompanies this tech brief [1], which provides a more detailed summary of types of macrofiber, expected properties of FRC materials, effects of macrofibers on concrete pavement performance, available FRC test methods, best practice guidelines and specifications for FRC materials applied to pavements, and background on the Residual Strength Estimator spreadsheet tool.

The information provided in this brief is not intended as a promotion or advertisement of any specific product or manufacturer, as such costs or details on exact fiber details are intentionally excluded.

Introduction

Fiber-reinforcement technology for concrete pavements was introduced several decades ago and has been applied to highways, streets, intersections, parking lots, pavement overlays, bus pads, industrial floors, full-depth slab patching, bridge deck overlays and airfields. The first US application was an FRC pavement with steel fibers constructed in 1971 at a truck weigh station in Ohio [2]. Additional early FRC applications were used as overlays for Navy airfields and commercial airports in the 1970s and 1980s [3]. In the past 15 years, FRC has been successfully implemented for concrete overlays of roadways. Particularly, FRC with bonded concrete overlay on asphalt or composite pavements has seen significant growth in the past 10 years with the overlay thickness ranging from 3 to 6 in.

The National Concrete Overlay Explorer (overlays.acpa.org) lists 89 FRC overlay projects from 2000 to 2018. An Illinois study of FRC overlays reported better performance compared to similar plain concrete overlays [4]. Multiple laboratory-scale slab tests with macrofiber reinforcement have shown that the flexural and ultimate load capacity of FRC slabs and the load transfer efficiency (LTE) between FRC slabs significantly increase relative to plain concrete slabs [5–7]. The magnitude of this increase is dependent on the fiber type and content.

The known benefits of FRC for pavements (Figure 1) are providing additional structural capacity, reducing crack widths, maintaining joint or crack LTE, and extending the pavement's serviceability through reduced crack deterioration. The application of FRC to

Smaller crack widths
Reduced crack deterioration rate
Add macro-fibers (e.g., f_{flat}=150 psi)
Thinner slab for same fatigue performance
or
Longer fatigue performance

Figure 1. Benefits of fiber reinforcement

https://intrans.iastate.edu/app/uploads/2018/12/accomplishments_summ_for_t2_of_concrete_pvmt_technologies.pdf

http://www.cproadmap.org/publications/MAPbriefOctober2018.pdf

FHWA Cooperative Agreement DTFH61-12-H-00010 (2013-2018)
Technology Transfer of Concrete Pavement Technologies

Summary of Accomplishments
IN SUPPORT OF
Accelerated Implementation and Deployment of Pavement Technologies (2013-2018)

Sustainability 1
Preservation and Overlays 2
Long-Life Pavements 3
Innovative Concrete Materials 4
Advancements in Placement 5

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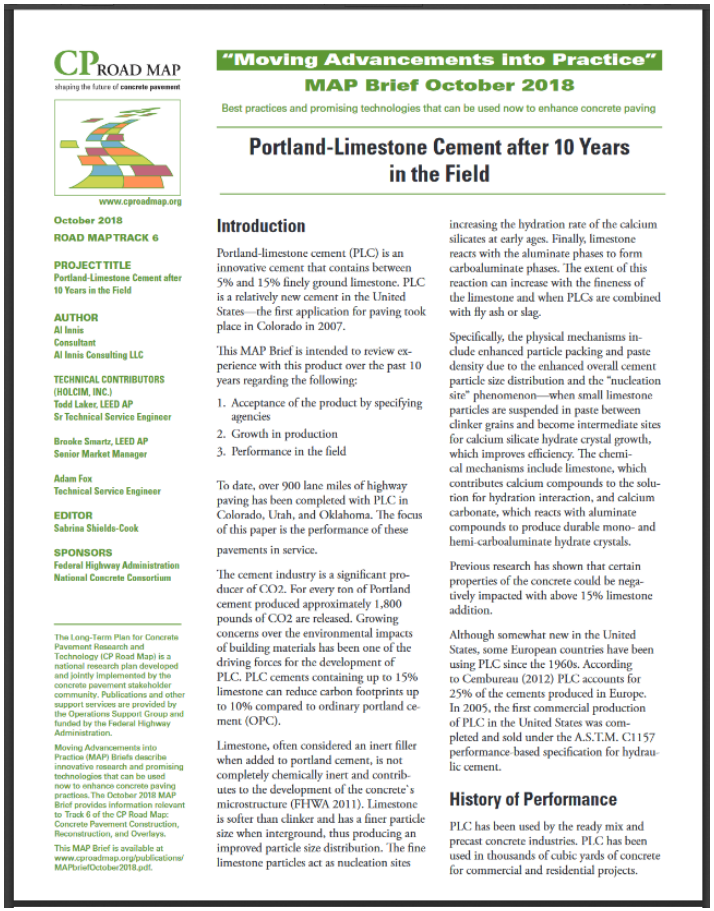
National Concrete Pavement Technology Center



CP ROAD MAP
shaping the future of concrete pavement

www.cproadmap.org

October 2018
ROAD MAP TRACK 6

PROJECT TITLE
Portland-Limestone Cement after 10 Years in the Field

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The Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map) is a national research plan developed and jointly implemented by the concrete pavement stakeholder community. Publications and other support services are provided by the Operations Support Group and funded by the Federal Highway Administration.

Moving Advancements into Practice (MAP) Briefs describe innovative research and promising technologies that can be used now to enhance concrete paving practices. The October 2018 MAP Brief provides information relevant to Track 6 of the CP Road Map: Concrete Pavement Construction, Reconstruction, and Overlays.

This MAP Brief is available at www.cproadmap.org/publications/MAPbriefOctober2018.pdf.

"Moving Advancements into Practice"
MAP Brief October 2018
Best practices and promising technologies that can be used now to enhance concrete paving

Portland-Limestone Cement after 10 Years in the Field

Introduction

Portland-limestone cement (PLC) is an innovative cement that contains between 5% and 15% finely ground limestone. PLC is a relatively new cement in the United States—the first application for paving took place in Colorado in 2007.

This MAP Brief is intended to review experience with this product over the past 10 years regarding the following:

1. Acceptance of the product by specifying agencies
2. Growth in production
3. Performance in the field

To date, over 900 lane miles of highway paving has been completed with PLC in Colorado, Utah, and Oklahoma. The focus of this paper is the performance of these pavements in service.

The cement industry is a significant producer of CO2. For every ton of Portland cement produced approximately 1,800 pounds of CO2 are released. Growing concerns over the environmental impacts of building materials has been one of the driving forces for the development of PLC. PLC cements containing up to 15% limestone can reduce carbon footprints up to 10% compared to ordinary portland cement (OPC).

Limestone, often considered an inert filler when added to portland cement, is not completely chemically inert and contributes to the development of the concrete's microstructure (FHWA 2011). Limestone is softer than clinker and has a finer particle size when interground, thus producing an improved particle size distribution. The fine limestone particles act as nucleation sites increasing the hydration rate of the calcium silicates at early ages. Finally, limestone reacts with the aluminate phases to form carboaluminate phases. The extent of this reaction can increase with the fineness of the limestone and when PLCs are combined with fly ash or slag.

Specifically, the physical mechanisms include enhanced particle packing and paste density due to the enhanced overall cement particle size distribution and the "nucleation site" phenomenon—when small limestone particles are suspended in paste between clinker grains and become intermediate sites for calcium silicate hydrate crystal growth, which improves efficiency. The chemical mechanisms include limestone, which contributes calcium compounds to the solution for hydration interaction, and calcium carbonate, which reacts with aluminate compounds to produce durable mono- and hemi-carboaluminate hydrate crystals.

Previous research has shown that certain properties of the concrete could be negatively impacted with above 15% limestone addition.

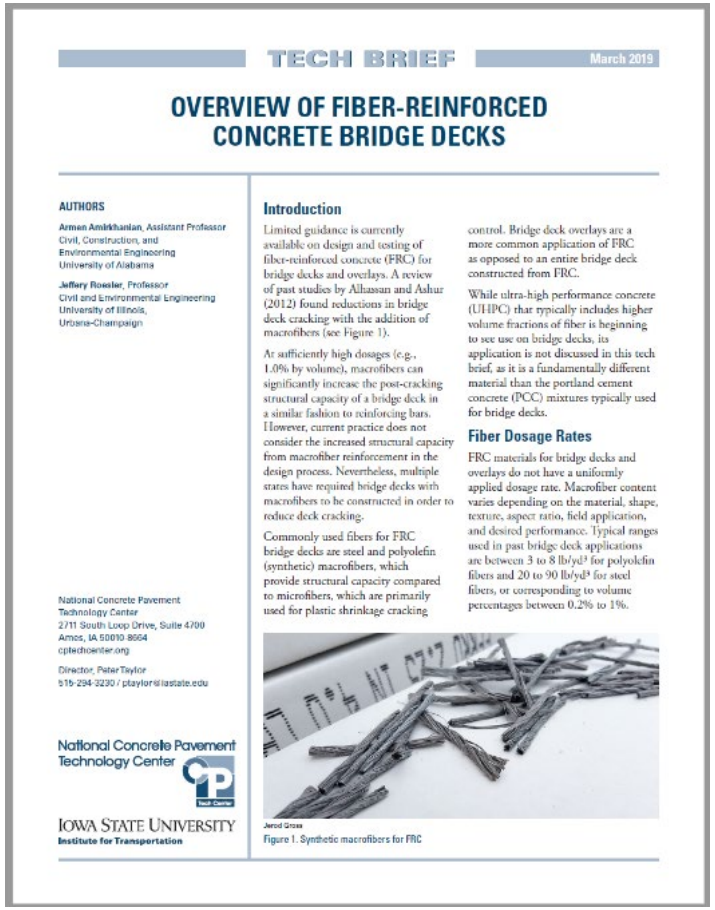
Although somewhat new in the United States, some European countries have been using PLC since the 1960s. According to Cembureau (2012) PLC accounts for 25% of the cements produced in Europe. In 2005, the first commercial production of PLC in the United States was completed and sold under the A.S.T.M. C1157 performance-based specification for hydraulic cement.

History of Performance

PLC has been used by the ready mix and precast concrete industries. PLC has been used in thousands of cubic yards of concrete for commercial and residential projects.

https://intrans.iastate.edu/app/uploads/2019/03/FRC_bridge_decks_ovw_TB.pdf

https://intrans.iastate.edu/app/uploads/2019/03/FRC_for_overlays_TB.pdf



TECH BRIEF March 2019

OVERVIEW OF FIBER-REINFORCED CONCRETE BRIDGE DECKS

AUTHORS

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National Concrete Pavement Technology Center

IOWA STATE UNIVERSITY
Institute for Transportation

Introduction

Limited guidance is currently available on design and testing of fiber-reinforced concrete (FRC) for bridge decks and overlays. A review of past studies by Alhassan and Ashur (2012) found reductions in bridge deck cracking with the addition of macrofibers (see Figure 1).

At sufficiently high dosages (e.g., 1.0% by volume), macrofibers can significantly increase the post-cracking structural capacity of a bridge deck in a similar fashion to reinforcing bars. However, current practice does not consider the increased structural capacity from macrofiber reinforcement in the design process. Nevertheless, multiple states have required bridge decks with macrofibers to be constructed in order to reduce deck cracking.

Commonly used fibers for FRC bridge decks are steel and polyolefin (synthetic) macrofibers, which provide structural capacity compared to microfibers, which are primarily used for plastic shrinkage cracking control. Bridge deck overlays are a more common application of FRC as opposed to an entire bridge deck constructed from FRC.

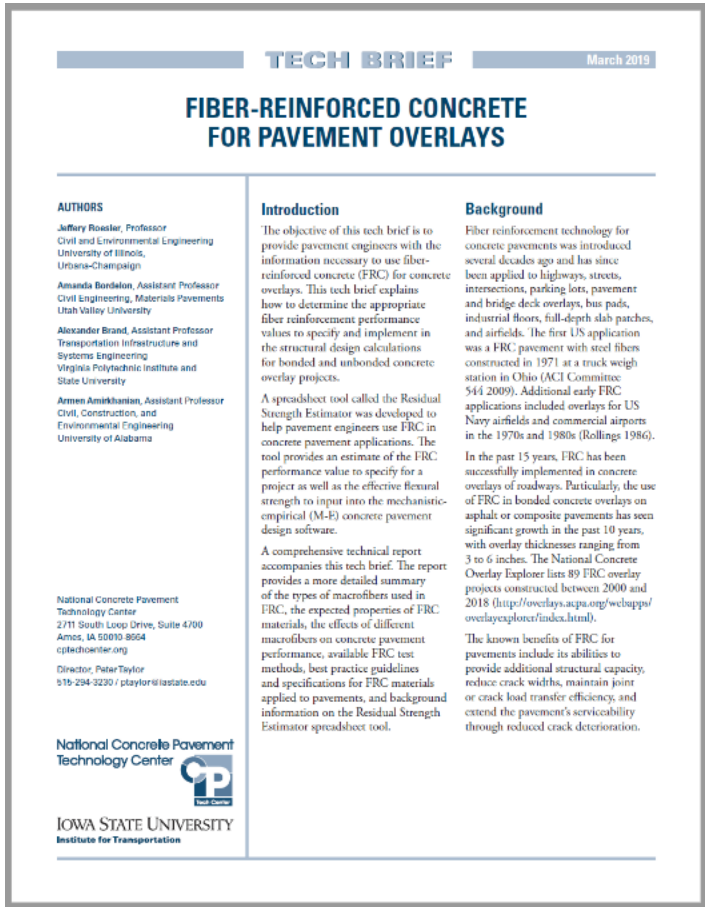
While ultra-high performance concrete (UHPC) that typically includes higher volume fractions of fiber is beginning to see use on bridge decks, its application is not discussed in this tech brief, as it is a fundamentally different material than the portland cement concrete (PCC) mixtures typically used for bridge decks.

Fiber Dosage Rates

FRC materials for bridge decks and overlays do not have a uniformly applied dosage rate. Macrofiber content varies depending on the material, shape, texture, aspect ratio, field application, and desired performance. Typical ranges used in past bridge deck applications are between 3 to 8 lb/yd³ for polyolefin fibers and 20 to 90 lb/yd³ for steel fibers, or corresponding to volume percentages between 0.2% to 1%.

Jerod Gross

Figure 1. Synthetic macrofibers for FRC



TECH BRIEF March 2019

FIBER-REINFORCED CONCRETE FOR PAVEMENT OVERLAYS

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National Concrete Pavement Technology Center

IOWA STATE UNIVERSITY
Institute for Transportation

Introduction

The objective of this tech brief is to provide pavement engineers with the information necessary to use fiber-reinforced concrete (FRC) for concrete overlays. This tech brief explains how to determine the appropriate fiber reinforcement performance values to specify and implement in the structural design calculations for bonded and unbonded concrete overlay projects.

A spreadsheet tool called the Residual Strength Estimator was developed to help pavement engineers use FRC in concrete pavement applications. The tool provides an estimate of the FRC performance value to specify for a project as well as the effective flexural strength to input into the mechanistic-empirical (M-E) concrete pavement design software.

A comprehensive technical report accompanies this tech brief. The report provides a more detailed summary of the types of macrofibers used in FRC, the expected properties of FRC materials, the effects of different macrofibers on concrete pavement performance, available FRC test methods, best practice guidelines and specifications for FRC materials applied to pavements, and background information on the Residual Strength Estimator spreadsheet tool.

Background

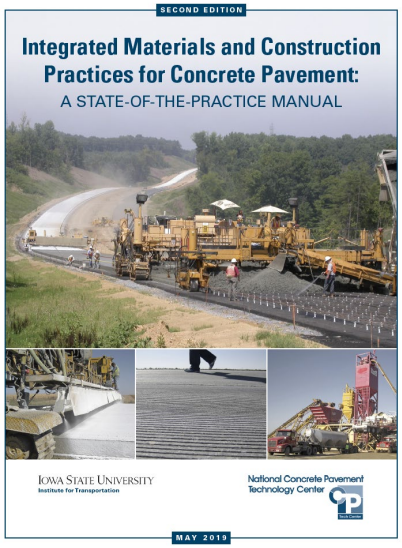
Fiber reinforcement technology for concrete pavements was introduced several decades ago and has since been applied to highways, streets, intersections, parking lots, pavement and bridge deck overlays, bus pads, industrial floors, full-depth slab patches, and airfields. The first US application was a FRC pavement with steel fibers constructed in 1971 at a truck weigh station in Ohio (ACI Committee 544 2009). Additional early FRC applications included overlays for US Navy airfields and commercial airports in the 1970s and 1980s (Rollings 1986).

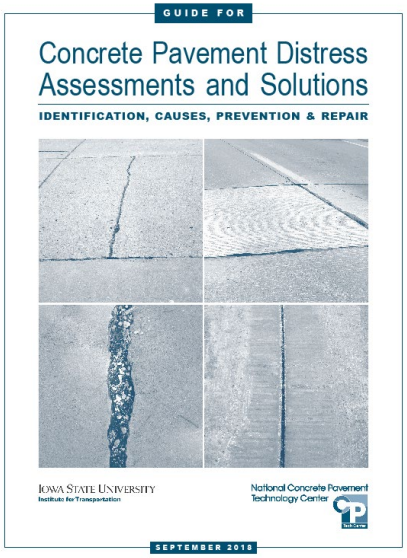
In the past 15 years, FRC has been successfully implemented in concrete overlays of roadways. Particularly, the use of FRC in bonded concrete overlays on asphalt or composite pavements has seen significant growth in the past 10 years, with overlay thicknesses ranging from 3 to 6 inches. The National Concrete Overlay Explorer lists 89 FRC overlay projects constructed between 2000 and 2018 (http://overlays.acpa.org/webapps/overlayexplorer/index.html).

The known benefits of FRC for pavements include its abilities to provide additional structural capacity, reduce crack widths, maintain joint or crack load transfer efficiency, and extend the pavement's serviceability through reduced crack deterioration.

2 New Manuals

- Integrated Materials and Construction Practices for Concrete Pavement (IMCP)
  - May – will be an Interactive pdf
  - Update 2007 document
  - Estimate 20% more pages w/changes
  - 10 Chapters
  - 5 Authors
  - 25 TAC members
- Concrete Pavement Distress Assessment and Solutions
  - Download as EPUB or pdf format
  - 19 chapters
  - 15 TAC members





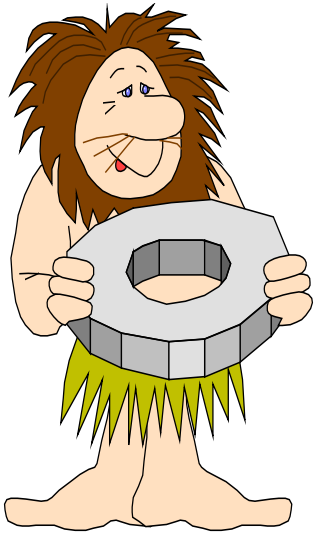
Attendance to date:

	TPF 5-(159)													
TPF 5-(159)	S 2008	F 2008	S 2009	F 2009	S 2010	F 2010	S 2011	F 2011	S 2012	F 2012	S 2013	F 2013	S 2014	F 2014
	Baton Rouge LA	Minneapolis MN	San Antonio TX	St Louis MO	Savannah GA	Sacramento CA	Indianapolis IN	Rapid City SD	Oklahoma City OK	Seattle WA	Philadelphia PA	Asheville NC	Jacksonville FL	Omaha NE
State Members	18	18	19	19	19	19	21	21	22	22	25	25	28	28
Reps/DOT attend	31	29	28	22	30	21	30	32	36	32	50	54	55	65
NCC total	75	77	80	84	82	67	94	86	90	94	125	116	137	160

TPF-5(313							
S 2015	F 2015	S 2016	F 2016	S 2017	F 2017	S 2018	F 2018
Reno NV	Milwaukee WI	Columbus OH	San Antonio TX	City UT	Minneapolis MN	Coeur d'Alene ID	New York NY
30	30	30	30	31	31	32	32
49	54	45	46	49	51	59	60
150	144	152		175	172	155	180

States that have not hosted: Alabama, Illinois, Kansas, Kentucky, Michigan North Dakota, Oregon, and Tennessee

Thanks for your time



Fall Meeting
September 10-12, 2019
Red Lion Hotel Kalispell
20 N. Main Street
Kalispell, Montana

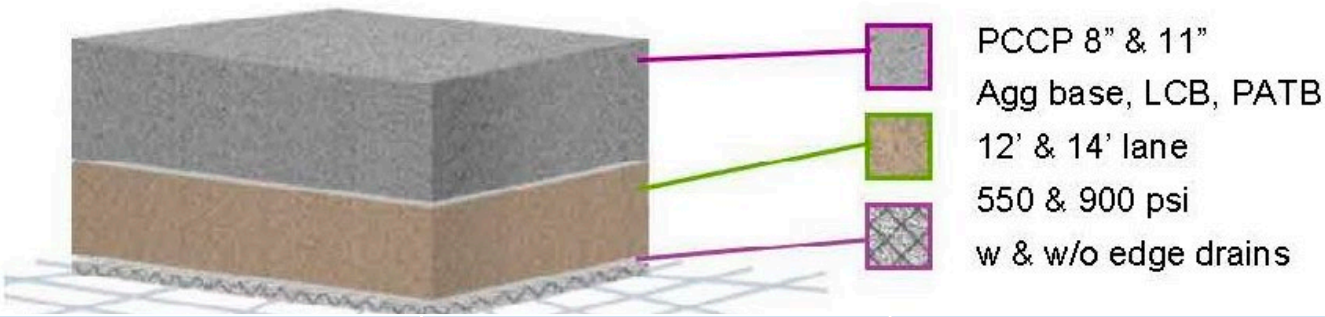
Spring 2020 Meeting in Alabama

www.cptechcenter.org

2018 Financial Report

January 1, 2018 NCC Workshop Acct Balance		$ 1,737.04
Spring 2018 - Idaho (Registration Fee: $300)		
Income	$ 42,685.00	
Expenses		
CDA Hotel Food/Space/AV	$ 25,475.24	
Group Dinner	$ 5,295.20	
Charter buses	$ 2,980.00	
Credit card processing fee	$ 1,409.23	
Handouts/shipping	$ 1,630.25	
Total Expenses	$ 36,789.92	
Fall 2018 - New York (Registration Fee: $250)		
Income	$ 42,150.00	
Expenses		
Holiday Inn Food/Space/AV	$ 20,987.43	
Charter buses	$ 1,050.00	
Handouts	$ 1,423.87	
Credit card processing fee	$ 1,511.11	
Total Expenses	$ 24,972.41	
January 1, 2019 NCC Workshop Acct Balance		$24,809.71

SPS-2 Pavement Preservation Experiment Pooled Fund TPF-5(291)



State	Tech Day Date	Year Constructed
Arizona	Feb 21, 2018	1993
Colorado	Mar 23, 2018	1993
Washington	May 2, 2018	1995
Iowa	May 30, 2018	1994
Kansas	Oct 2-3, 2018	1992
North Dakota	Oct 16-17, 2018	1994
California	Mar 12, 2019	2000
Arkansas	Mar 19, 2019	1995