

Engineered Cementitious Composite May Replace Bridge Deck Joints

Michigan DOT's Office of Research and Best Practices (ORBP) makes sure that promising new practices will actually work, putting them through their paces in the lab and in the field—and making improvements as needed. This research effort involved a multiphase process of testing engineered cementitious composite (ECC) as a replacement for traditional joints on bridge decks.

Problem

For bridges constructed of a series of deck spans, the finishing of the interior gaps between the decks requires special attention. The traditional method of accommodating fixed-end deck terminations is to install mechanical joints between the decks. However, after several years of punishment from traffic and the elements, these joints can deteriorate and allow water, dirt and debris into the substructure of the bridge. The resulting corrosive damage to the steel and concrete structural components can mean expensive repairs that interrupt traffic and can also lead to premature replacement.

Approach

ORBP saw potential in using engineered cementitious composite to replace joints. While ECC contains many of the same components as traditional portland cement concrete (including cement, aggregate, water and fly ash), it also contains a polymer microfiber that gives it unique properties. Unlike traditional concrete, which is resistant to compressive (squeezing) forces but prone to failure under tensile (stretching) forces, ECC is highly ductile and strong in both tension and compression.

When poured as a slab to link bridge deck sections, ECC becomes part of a continuous, concrete-like surface that remains flexible enough to accommodate bridge deck deformations. The result is a jointless multispans bridge with a substructure completely sealed off from weather and surface abuse.

Just how well can this technology perform over the long haul for real-world applications? ORBP undertook research to determine the feasibility of using this intriguing alternative to deck joints.

Research

The investigation of ECC was carried out in three phases, starting in the lab, moving to the field, and then working to make improvements.

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Michigan DOT field testing of engineered cementitious composite showed that the ECC link slab was even more resistant to deterioration than the concrete of the adjacent bridge decks while accommodating mechanical and environmental loads.

Project Information

Report Name: *Field Demonstration of Durable Link Slabs for Jointless Bridge Decks Based on Strain-Hardening Cementitious Composites—Phase 3: Shrinkage Control*

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MDOT Project Manager

Roger Till
Construction and Technology Division
Michigan Department of Transportation
8885 Ricks Road
Lansing, Michigan 48917
TillR@michigan.gov
517-322-5682



- In the first phase, completed in 2003, researchers investigated physical and chemical properties of the composite materials using laboratory testing and modeling methods. The study assessed the ECC and optimized it for superior durability and resistance to the freeze-thaw cycles it would see in the field. The project also produced ECC link slab design and construction guidelines.
- In the second phase, completed in 2005, researchers implemented the Phase 1 results by constructing an ECC link slab for the new deck of the Grove Street Bridge over Interstate 94 in Ypsilanti. Design and construction considerations included scaling up operations, resolving contracting issues, and conducting load tests after construction to ensure safety. Data collection and analysis revealed early-age cracking on the ECC link slab and necessitated fine-tuning of the composite for maximum performance.
- In the third phase of the research, completed in 2007, investigators addressed mix design and construction issues to enhance long-term performance.

Results

The Phase 3 research yielded specific guidelines on ways to reduce early-age cracking of ECC through mix design, particularly by adjusting fly ash content, and through construction techniques. It also provided an opportunity to assess the performance of the ECC link slab on the Grove Street Bridge. Observations revealed that after two years in service, the ECC showed better wear and scaling resistance than the concrete bridge deck itself.

The study concluded that this ECC link slab technology is proving to be a success—one with demonstrable potential today and with room to become even better. As a result of this research, Michigan DOT is investigating additional candidate sites to further demonstrate, evaluate and refine ECC link slabs.

“This research took several important steps toward realizing a technology to replace bridge joints.”

*Roger Till, P.E.
Project Manager*

Value

A major goal in Michigan’s long-term (2005 to 2030) transportation plan is to secure the “greatest possible performance from Michigan’s existing transportation assets and future system improvements.” This research into ECC link slabs could represent a leap forward in bridge design that helps achieve this goal. It is anticipated that a bridge that incorporates this technology will require less maintenance and will have a longer service life. These benefits mean long-term savings on repairs and new construction alike. ■

Michigan Department of Transportation



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OFFICE OF RESEARCH &
BEST PRACTICES

Principal Investigator

Victor Li
Department of Civil and Environmental Engineering
University of Michigan
2326 GG Brown Building
Ann Arbor, Michigan 48109
vcli@engin.umich.edu
734-764-3368

For More on MDOT Research

Calvin Roberts
Office of Research & Best Practices
Michigan Department of Transportation
425 W. Ottawa Street
Lansing, Michigan 48933
robertsc@michigan.gov
517-241-2780
www.michigan.gov/mdotresearch

Final reports are available online:

Phase 1: http://www.michigan.gov/documents/mdot_rc-1438_83611_7.pdf

Phase 2: http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC1471_200102_7.pdf

Phase 3: http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC-1506_232611_7.pdf or contact 517-636-0305.