MDOT Research Spotlight
Michigan Department of Transportation
Office of Research & Best Practices

In-house Research Improves Concrete Bridge Barriers

When Michigan's transportation system has immediate needs, in-house Michigan DOT research engineers are up to the task. They can quickly collect and assess information and then make recommendations on new practices as well as identifying larger-scale research needs. This is what happened when Michigan DOT needed to address premature deterioration of concrete bridge barriers around the state.

Problem

Ideally, concrete barriers on bridges should be designed and built for a service life equal to the other parts of the structure. However, premature weathering and wear of some barriers in Michigan has required rehabilitation and reconstruction over the course of normal bridge life. These instances of premature barrier deterioration raised concerns related to cost and safety alike and led to questions about current design and construction methods. This prompted Michigan DOT to investigate the causes of early barrier deterioration and to propose possible solutions.

Approach

This research project was a highly targeted assessment of the condition of concrete bridge barriers in Michigan. In-house investigators documented the evolution of Michigan DOT's design configurations for portland cement concrete bridge railings and barriers since the 1960s. Changing standards and requirements over half a century suggested the possible trade-offs between design and performance that must be considered for each change in practice.

For example, solid-faced wall barriers (such as the GM and Jersey barriers) came into use for their safety features, but unlike open railings, their tendency to trap snow—often laden with corrosive deicing chemicals—makes them susceptible to early deterioration. Clearly, Michigan DOT needed to look comprehensively at barrier design, concrete mix design, manufacturing standards and maintenance practices, and then find possible solutions to early deterioration.

This barrier shows crumbling common in concrete barriers made with blast-furnace slag coarse aggregates—a discontinued practice in Michigan, thanks in part to this study.

Research

An important step in improving bridge barriers was taking a "snapshot in time" of bridge projects that used different barrier configurations and construction methods, and which were in varying states of deterioration. The investigation included field inspection of barrier projects across the state as well as laboratory evaluation of samples, comparing these at a microscopic level to concretes known to be highly durable. The project's summary of 26 bridge barrier projects includes their

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Project Information

Report Name: *Performance of Michigan's Concrete Barriers*
Start Date: April 1997
Report Date: August 2007
Research Report Number: RC-1498
Total Cost: The costs of this research were incidental to the daily activities of the Michigan DOT investigators.
Cost Sharing: None

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ages, the casting method used, the aggregate type, and their overall condition. This inventory served as a critical tool for identifying possible causes of deterioration.

Results

Looking at performance together with current design and construction practices, investigators made these important observations:

- The winter freeze-thaw cycles and increased use of chemical deicers proved to be the top external contributors to barrier deterioration. Barrier design, concrete mix design and construction methods need to be optimized to withstand these seasonal factors.
- Early deterioration was commonly seen in concrete walls constructed by slipforming, or continuous casting with a moving form. Compared to casting in-place with a stationary form, slipforming appears to introduce excessive internal stresses in the concrete structure that lead to premature deterioration.
- Concrete mixes containing blast-furnace slag coarse aggregate, a steel industry byproduct, displayed early deterioration and appear to be inappropriate for barrier walls.

These and other observations prompted recommendations to improve the long-term performance of concrete barriers exposed to harsh winters. Michigan DOT has already implemented some of the study's recommended changes, having discontinued traditional slipform construction as well as the use of blast-furnace slag coarse aggregates and other low-durability coarse aggregates in concrete mixes for bridge barriers. Other recommendations are gradually appearing in new projects, such as using optimized, well-graded aggregates and reducing cement content by using ground granulated slag (a cement substitute). New barriers in Michigan combine these improved mix design and construction techniques to promise high performance in the years ahead.

"This research project responded to a real need in the field and helped drive major new research efforts in Michigan."

John Staton, P.E.
Project Manager

Value

This project raised awareness of an issue of high interest to Michigan DOT. What began as an informal, in-house study not only helped change practice, but also became the basis of the major in-depth research investigation "Causes & Cures for Cracking of Concrete Barriers." This spinoff research was conducted at two research institutions: Michigan Technological University performed a laboratory investigation (report RC-1445) and Wayne State University conducted a complementary field study (report RC-1448). Both studies drew from and expanded upon the key findings of this initial in-house Michigan DOT research project, exemplifying how low-cost, quick-response research can provide high-value results and advance the priorities identified by the department. ■

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Wayne State University's follow-up research report is available online at https://mdotjboss.state.mi.us/SpecProv/getDocumentById.htm?docGuid=a9ead88e-1e51-45c3-81ca-92c064ebfbe2 or contact 517-636-0305 for these reports or for Michigan Technological University's follow-up research report.

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