



PUTTING RESEARCH TO WORK

BRIEF

New Materials for Stay-in-Place Bridge Deck Forms

Building a concrete bridge deck typically requires crews to construct temporary wooden shoring, or formwork, to provide a foundation for the concrete slab as it hardens. WisDOT is making increased use of wide-flanged concrete girders because of their durability and long life. The close spacing of these girders makes this wooden formwork more difficult to install. Moreover, wooden formwork is expensive to construct, and it must be removed from underneath the bridge deck a few days after the concrete has cured. Apart from the expense involved, contractors report this removal is one of the most dangerous tasks associated with bridge deck construction.

What's the Problem?

With WisDOT approval, some contractors had begun investigating and making limited use of alternative stay-in-place formwork to support wet concrete on wide-flanged girders. SIP formwork uses inexpensive, off-the-shelf materials that become a permanent part of the bridge, though they are not meant to contribute to its structural support. There was particular interest in nonmetallic options to avoid the rust problems associated with conventional steel. However, the use of formwork alternatives was limited by the lack of a standard specification that would give both WisDOT and contractors confidence in the materials and methods used for SIP formwork.

Research Objectives

This study was initiated to develop performance specifications for testing nonmetallic SIP formwork that could be used to evaluate current and future formwork options and yield design guidelines for use in Wisconsin highway bridge deck construction.

Methodology

Investigators reviewed the state-of-the-art in nonstructural SIP formwork via a literature review, interviews with experts and local bridge site visits. They used this information to select candidate systems for testing, including several types of materials such as concrete slabs reinforced with various fibers, grids and bars, as well as fiber-reinforced plastic planks. They tested both panels obtained commercially and panels constructed in the lab from off-the-shelf materials.

Testing involved multiple impact tests: Investigators repeatedly dropped weights on the panels to gauge how well they would hold up both to the weight of the wet concrete that would be poured on them to form the bridge deck and, more importantly, to the weight of workers walking on the materials during construction. The tests simulated common accidental impact loads, such as workers tripping and dropping heavy tools on the panels.

Finally, the team developed a model specification that addresses design procedures and constructability concerns for different types of SIP forms.

Results

The results of these tests provided information on the strength, serviceability and behavior under accidental impact loads of these SIP forms. The study found that several types of panels can be used as nonstructural, nonmetallic, SIP formwork panels for bridge deck construction:

- fiber-reinforced concrete panels
- fiber-reinforced polymer panels
- concrete panels reinforced with fiber-reinforced polymer grids or rebar

However, not all systems can be used to span all width gaps; specific procedures, including design calculations and performance tests, must be followed to ensure safe and efficient use of these panels.

Investigator



"The key benefit of this study is that we can decrease the cost of construction formwork while increasing worker safety."

—Lawrence Bank

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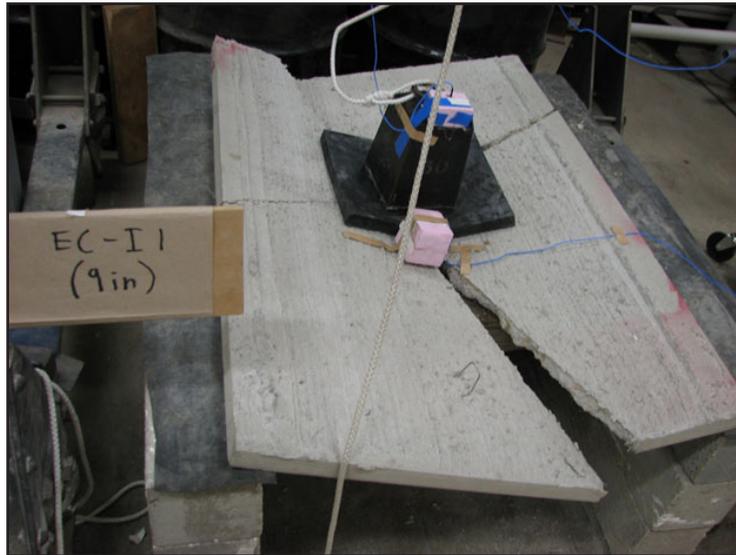


“With this study we identified criteria for evaluating different types of materials to be used as formwork between wide-flanged, pre-stressed concrete beams.”

—Scot Becker

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Poor performance on impact tests by these precast fiber-reinforced forms, which had already been used for a small number of bridge projects, led WisDOT to immediately stop using this type of formwork.

The study produced the desired specification, including a design procedure, an impact performance test protocol and a panel classification procedure for different width gaps based on the type of material in the panel and its behavior under design loads.

Implementation and Benefits

This study established a standard for SIP bridge formwork that will allow bridges to be built more quickly, will decrease construction costs and will increase the safety of construction workers.

The approved types of SIP formwork will be included in the Wisconsin Bridge Manual, and some types that performed poorly were immediately excluded from WisDOT bridge projects. The performance criteria developed will be used to evaluate additional proposed formwork materials to help enable rapid adoption of the most effective, least costly materials.

Because no other specification of this type was found to exist, the specification developed for this project could be used as a national model.

Further Research

The next step in this research is more extensive evaluation of these materials in the field. In coming years, several bridges will incorporate the successful formwork types from this research, and WisDOT will compare the labor issues, constructability and costs involved with each type.

This brief summarizes Project 0092-06-07, “Specification and Design of Fiber Reinforced Bridge Deck Forms for Use on Wide Flange T-Girders,” produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.

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