

About This Research

Objectives

- Identify applications and locations where UHPC material could be used on bridges.
- Test the potential applications to eliminate barriers to uncertainties and ensure successful deployment.

Benefits

- More thorough understanding of UHPC's potential
- Preparation for using UHPC as a tool for bridge construction and repair

IDENTIFYING OPPORTUNITIES FOR ULTRA-HIGH PERFORMANCE CONCRETE ON MONTANA BRIDGES



UHPC samples undergo testing to evaluate the material's potential in different applications.

About This Project

Project title: Exploration of UHPC Applications for Montana Bridges

Project number: 10000-844

Technical Panel

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Research Need

Ultra-high performance concrete (UHPC) is superior to conventional concrete in many ways. However, the proprietary mixes can also be significantly more expensive, and the Montana Department of Transportation (MDT) must be selective about where to use it for maximum effect.

A previous MDT research project developed a more affordable, nonproprietary UHPC mix using local materials and formulating the mixture specifically for the state's environmental conditions. Montana's UHPC formula was initially intended for use as a joint filler between precast concrete elements. But as the budget-friendly material could feasibly be used more broadly, MDT initiated a new research study to identify additional potential applications. This effort also sought to explore any avenues of uncertainty and conduct any testing needed before MDT could successfully put the material to use in the newly identified applications.

Research Process

This project began with a review of the literature on bridge repairs using UHPC. Researchers also investigated other states' completed projects and experiences with using UHPC as an overlay for bridge decks and for repairing other bridge elements. Because other states reported significant success using UHPC for bridge overlays, this research project focused on evaluating Montana's UHPC formula for that application on bridges in the state.

“With new evidence showing where Montana’s ultra-high performance concrete can be used most effectively, MDT is even better positioned to help preserve and repair the state’s bridges.”

—Lenci Kappes, Project Champion

MDT Project Champion



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Learn More About This Project

Final report is available in [ROSA P](#).

Three UHPC mixes were assessed for their workability and potential strength in an overlay application: Montana’s UHPC mixture, the same mixture with an admixture added to increase viscosity, and a proprietary UHPC mixture. Each mix was tested to determine how well it bonded with normal concrete samples that had been prepared using various methods. During the material level testing stage of the project, two hurdles for being able to use Montana’s UHPC as a bridge deck overlay were identified. These involved the need to refine the thixotropy of the mix and the need for higher batch volumes. Finally, the proprietary mix was applied as overlays to sample concrete slabs. Structural tests were conducted on the slabs to help researchers understand how adding a UHPC overlay affects the performance of concrete.

Research Results

All three UHPC mixes generally performed well. Both the Montana UHPC with added thickener and the proprietary UHPC achieved the desired flow necessary for overlay applications, and all three mixes obtained similar results when subjected to strength tests. The three mixes also performed well during material level bond testing and met the industry standard bond required for concrete repair.

Overall, the research showed that adding a UHPC overlay can make concrete stronger, stiffer, and more durable than concrete without a UHPC overlay.

Below are additional findings from the research:

- A UHPC overlay significantly improves concrete’s stiffness as well as its strength, and a thicker overlay can produce proportionally greater effects.
- A thin layer of UHPC can help a bridge deck made with weaker-strength concrete perform as well as a bridge deck made completely with stronger concrete.
- To achieve a sufficient bond, a concrete slab must be wetted before the UHPC overlay can be applied.

The data suggests that a thin layer of UHPC material can be applied to the surface of an existing bridge deck to provide a viable alternative to costly bridge replacement projects.

Research Implementation

The evidence from this research demonstrated that the UHPC mixture could work well as a bridge overlay material in addition to the applications that have been previously identified. Though a number of factors must be considered as part of any project, this study showed that UHPC could offer a cost-effective solution for extending the life of Montana’s existing concrete infrastructure.

To demonstrate the abilities of UHPC material under real-world conditions, MDT initiated a follow-up project to replace two state bridges with precast concrete elements connected with Montana’s UHPC between the joints. Now that UHPC has shown promise as a bridge deck overlay material, a future research project could include a similar demonstration of UHPC as a bridge overlay.