



Stage 2 - Research Topic Statement

Print Form

RESEARCH PROGRAMS USE ONLY

RESEARCH IDEA NO:	21-014
DATE OF RECEIPT:	Apr 30, 2020
TOTAL MDT COST W/ICAP:	

RESEARCH PROGRAMS

Please submit completed forms via e-mail to [MDTResearch@mt.gov](mailto:MDTResearch@mt.gov). All fields are required, except the last field: XVIII, Sponsor(s). Incomplete forms will not be accepted.

TITLE (required): Exploration of UHPC Applications for Montana Bridges

TOPIC STATEMENT:

Ultra-high performance concrete (UHPC) has mechanical and durability properties that far exceed those of conventional concrete. However, using UHPC in conventional concrete applications has been cost prohibitive, with commercially available/proprietary mixes costing approximately 30 times more than conventional concrete. Previous research conducted at Montana State University (MSU) has focused on the development and evaluation of non-proprietary UHPC mixes made with materials readily available in Montana. These mixes are significantly less expensive than commercially available UHPC mixes, thus opening the door for their use in construction projects in the state. Building on the success of this previous research, the focus of the project proposed herein is to investigate further uses of this novel material in MDT bridge projects.

RELATED RESEARCH SUMMARY FROM STAGE 1:

Previous research conducted at MSU has included 1) the development of nonproprietary UHPC mixes that are significantly less expensive than commercially available mixes and are made with materials readily available in Montana, 2) an investigation into several items related to the field batching of these mixes, 3) an exploration into the potential variability in performance related to differences in constituent materials, and 4) the investigation of rebar bond strength and the subsequent effect this has on development length. The MDT Bridge Bureau is interested in using UHPC in field-cast joints between precast concrete deck panels to reduce congestion and the requisite spacing between the decks, and ultimately improve the overall performance of the bridge. Currently, another research project is being proposed that will focus on the successful implementation of UHPC in this application. There is significant potential for the use of UHPC in other applications that will improve the performance of Montana bridges; however, before the mixes can be used in other field applications, further research must be conducted to ensure performance in the desired application(s).

RESEARCH PROPOSED:

Bridge deterioration (including decks and other members) is a problem across Montana, and UHPC overlays/patching may be a viable solution to rehabilitate these bridges instead of replacing. Specifically, the research proposed herein will focus on exploring the following applications: 1) thin-bonded overlays for bridge decks, 2) patching, and 3) reinforcing/replacing deteriorating members. Confidence in the use of UHPC as a strengthening material will require the exploration of surface preparation/treatments and bonding between UHPC and standard concrete. Experiments will be performed including stiffness and strength testing of both small slab sections with UHPC overlays, and damaged beams with UHPC patches. Fatigue testing of smaller-scale specimens may also be warranted. This project is a required step to fully understand and capitalize on the benefits of using UHPC to increase the lifespan of Montana's existing concrete infrastructure.

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RESEARCH PERIOD (Time to complete research project.):

2 Years

IT COMPONENT: Identify if the project includes an IT component (purchasing of IT hardware, development of databases, acquisition of existing applications, etc.). If so, describe IT component in as much detail as possible.

The work proposed herein does not require IT hardware, software or support.

FEASIBILITY, PROBABILITY OF SUCCESS, AND RISK:

Now that UHPC has been thoroughly investigated at the material level, an implementation project is being explored, and the required expertise has been developed at MSU, a logical next step is to conduct a preliminary screening of new applications of UHPC that can benefit future MDT Bridge Bureau projects. The proposed research has a high likelihood for success and is low risk.

URGENCY, IMPORTANCE, AND EXPECTED BENEFITS/PAY-OFF: Address urgency, timeliness, and importance of the research. Identify if the research is required for any federal or state initiative or compliance. This section must include a description of how this research will help to meet MDT’s mission (i.e., serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and/or sensitivity to the environment).

Aging infrastructure and limited budgets require robust and proven bridge construction, rehabilitation and replacement strategies that are cost-effective and efficient. The non-proprietary fiber-reinforced UHPC mixes developed in the Phase I/II research are significantly less expensive than proprietary mixes, costing \$1000 per cubic yard, compared to \$2500-3500 per cubic yard from commercial suppliers. If these mixes are found to be viable for other applications, Montana can take advantage of the cost savings of the non-proprietary mixes and ultimately improve the performance and durability of our bridges. If successful, using UHPC for field cast joints and other applications could potentially turn a \$50M bridge replacement into a \$10M rehabilitation.

IMPLEMENTABILITY, IMPLEMENTATION PLAN, AND RESPONSIBILITY: Address the implementability of the expected results from the proposed project. Identify products that will enhance implementation. Identify any known implementation barriers and how these barriers might be eliminated or reduced. Identify MDT office or entity outside of MDT responsible for implementation. Describe initial implementation plan, include timeframe for implementation.

Another proposed project aims to demonstrate the viability of these non-proprietary UHPC mixes in field cast joints for a bridge project within the state. Upon completion of a successful pilot project, MDT will have a new concrete available for use in bridge construction. The mixture proportions, batching procedures, and material properties will be documented in the final report for the project. This information can be used as appropriate to develop standard specifications for the material, and/or to identify additional work that must be done to move this material forward for standard use. Future implementation projects will be pursued dependent on the findings of the research proposed here of exploring other potential UHPC applications.

MDT PRIORITY FOCUS AREAS: MDT may, as often as annually, identify priority research focus areas. These focus areas will be listed on <http://www.mdt.mt.gov/research/unique/solicit.shtml>.

None

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**TOTAL COST ESTIMATE** (If the project proposal comes in at a higher cost, it may require further approval and may be delayed.):

The preliminary cost estimate is \$160,000.

**MDT FUNDING SOURCE** (If MDT Research, enter SPR): SPR

**FUNDING MATCH SOURCE AND AMOUNT:** None

**FUNDING PARTNER(S):** None

**POTENTIAL TECHNICAL PANEL MEMBERS** (At this time, individuals do not necessarily need to be identified; rather, MDT offices and outside entities can be named. However, if known, individuals may be named):

Stephanie Brandenburger, Nathan Haddick, Lenci Kappes

<b>SUBMITTED BY: (required)</b>	
<b>NAME:</b>	Kirsten Matteson; Michael Berry
<b>TITLE:</b>	Assistant Professor; Associate Professor
<b>AFFILIATION:</b>	Montana State University
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**CHAMPION:** Must be internal to MDT, feel strongly that the research will benefit the Department, and is willing to chair the technical panel. Note: If a champion is not identified by you or Research staff, this topic statement will not move forward.

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**SPONSOR(S) (optional):** Must be internal to MDT (Division Administrator or higher) and willing to ensure implementation occurs, as appropriate. If a sponsor is not identified by you or Research staff, this topic statement will not move forward.

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## Stage 2 - Research Topic Statement

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