

# SOLUTIONS



## RESEARCH PROGRAMS WINTER 2005

## IN THIS ISSUE

### PROJECT HIGHLIGHTS

[\*\*Development of High-Performance Concrete Mixtures for Durable Bridge Decks In Montana Using Locally Available Materials\*\*](#)

[\*\*Billings District to Try New Automatic Anti-icing System on Area Bridge\*\*](#)

### [DID YOU KNOW?](#)

### [MDT'S RESEARCH REVIEW COMMITTEE](#)

### [RESEARCH SOLICITATION](#)

### [LIBRARY CORNER](#)

### [NEW RESEARCH PROJECTS](#)

### [NEW RESEARCH REPORTS](#)

### [CONTACT US](#)

## PROJECT HIGHLIGHTS

### DEVELOPMENT OF HIGH-PERFORMANCE CONCRETE MIXTURES FOR DURABLE BRIDGE DECKS IN MONTANA USING LOCALLY AVAILABLE MATERIALS

Concrete bridge decks in Montana are subjected to severe service conditions. Potential deterioration mechanisms include corrosion of the reinforcing steel and scaling of the concrete surface resulting from deicing salt applications, freezing and thawing distress, cracking due to thermal and humidity extremes during and after construction, and materials-related problems. To maximize the useful life of the structure, the concrete used in bridge decks constructed in Montana must be durable and impart durability to the bridge deck structure. The Montana Department of Transportation contracted with Wiss, Janney, Elstner Associates Inc. to determine how best to achieve this objective through the development of a high-performance concrete (HPC) based on locally available materials.

The following essential tasks in the HPC development process were conducted: 1) definition of performance objectives, 2) selection of the locally-available raw materials determined to be most likely consistent with the objectives, and 3) evaluation of possible combinations of raw materials.

The performance objectives for durable concrete were used to design an experimental program based on standardized tests. The intent of this program was to estimate performance of the concrete relative to these mechanisms. Testing included determining plastic and hardened properties. Plastic properties included slump, air content,



CONTINUED ON PAGE 2



setting characteristics, and others. Hardened properties included air-void system parameters, electrical conductivity, strength, chloride diffusion, freezing and thawing resistance, scaling resistance, and drying shrinkage.

The raw materials included aggregates and a Type I/II portland cement from Montana and the following supplementary cementitious materials (SCMs): Class C and Class F fly ashes, ground granulated blast furnace slag, high-reactivity metakaolin, and silica fume. Also examined were blended cements that pre-combined portland cement and SCMs. These blends included a slag blend, a Class C fly ash blend, and a calcined-clay blend. To ensure that the aggregates do not pose a potential limit on the concrete durability, aggregates from four sources throughout the State were evaluated for the potential for developing alkali-silica reaction. The aggregate test program was conducted in parallel to the HPC mixture design investigation.

Three rounds of HPC testing were conducted. The first examined combinations that have historically demonstrated good performance as reported through the literature review and based on the experience of the investigators. Since the mixes in the first round that performed best were complex (containing three SCMs), the second round quantified the performance of pre-combined blended cements that enabled similar combinations. The third round examined easy-to-produce mixtures. The first two rounds were conducted using an aggregate from the south central part of the state, while the third tested an aggregate source from western Montana.

In evaluating which mixture is the best performer, judgments must be made about the relative importance of desired properties in the actual concrete and about how well the laboratory results from the testing procedures represent the expected in-place concrete behavior. The greatest cause of deterioration in Montana bridge decks is expected to be corrosion of embedded steel initiated by the intrusion of chloride ions from deicers. Therefore, given reasonable or better performance in the other tested properties, the highest emphasis was placed on chloride ponding testing results since improvements in penetration resistance can be directly measured and will almost certainly translate into more durable structures.

More durable mixtures are often produced when one or more SCMs are substituted for some percentage of the normal cement. The cement SCM combinations that worked well in this testing are listed below.

- Cement + 5% silica fume
- Cement + 7% silica fume and 20% slag
- Slag-blended cement + 10% Class F fly ash and 5.5% silica fume
- Calcined clay-blended cement + 4% silica fume

The next step will be to implement the mix designs into trial batches or bridge deck construction for future evaluations.

For more information, contact Craig Abernathy, [cabernathy@mt.gov](mailto:cabernathy@mt.gov), 406-444-6269.

---

## BILLINGS DISTRICT TO TRY NEW AUTOMATIC ANTI-ICING SYSTEM ON AREA BRIDGE

The Montana Department of Transportation Billings District will install a new automatic pavement deicing system on an area bridge near Billings this spring. Research staff will evaluate system effectiveness as an experimental feature.

The device selected is the Boschung Fixed Automatic Spray Technology or FAST. This technology anticipates the surface freezing point with sensors artificially cooling themselves to determine the exact temperature at which the surface will freeze, so anti-icing applications occur just before the roadway freezes. In addition, the system is powerful enough to cover large areas and self-test to assure continuous working order. Finally, the spray units are fully integrated into the road surface, traffic-proof, and distribute anti-icing agents evenly.

For more information, contact Craig Abernathy, [cabernathy@mt.gov](mailto:cabernathy@mt.gov), 406-444-6269.





## DID YOU KNOW?

Have you ever had the need to find out what research has been conducted, what research is currently ongoing, or the current state of the practice on a particular topic? Research staff can help you. These projects that include a literature review and a state of the practice are called synthesis projects, just like the NCHRP synthesis projects. They are low-cost and short duration projects and can be conducted under MDT's MPART (Montana Partnership for the

Advancement of Research in Transportation) Small Projects contracts with either Montana State University or The University of Montana. The contracts are in place. All we need to do is obtain a proposal and request funding from MDT's Research Review Committee (RRC). For more information, contact Sue Sillick (406-444-7693 or [ssillick@mt.gov](mailto:ssillick@mt.gov)) or Craig Abernathy (406-444-6269 or [cabernathy@mt.gov](mailto:cabernathy@mt.gov)).

## MDT'S RESEARCH REVIEW COMMITTEE

MDT's Research Review Committee (RRC) is composed of the FHWA-MT Division Research Representative and the following MDT staff: Director, Deputy Director, Research Manager, and Division Administrators from Administration, Aeronautics, Highway and Engineering, Information Services, Maintenance, Motor Carrier Services, and Rail, Transit and Planning (see [www.mdt.state.mt.us/general/mdtorg.shtml](http://www.mdt.state.mt.us/general/mdtorg.shtml) for an organizational chart). This committee meets at most once a month (see [www.mdt.state.mt.us/research/](http://www.mdt.state.mt.us/research/)

[projects/rcommittee\\_mtgs.shtml](http://www.mdt.state.mt.us/projects/rcommittee_mtgs.shtml) for meeting details) and determines the Department's high priority research needs, approves research projects, and reviews implementation recommendations and progress.

Research staff would like to welcome our new Director, Jim Lynch, to the Research Review Committee.

---

## RESEARCH SOLICITATION

Every year, Research staff solicits for new research topics. For the current solicitation cycle, topics were due December 31, 2004. Sixteen topics were submitted during this cycle. In order for topics to have the opportunity to move forward to a research project, each topic must be championed within MDT. The champion chairs the project technical panel and shepherds the project from inception through implementation. Technical panels determine if a research need exists and, if so, the most effective and efficient manner in which to conduct the research. In addition, each topic requires a sponsor, a division administrator or higher, who agrees that the topic is important and takes the responsibility for implementation of research results.

Six of the sixteen original topics did not have either a champion or a sponsor. These topics will not move forward. Two topics were synthesis projects. These projects go through a different process; proposals will be considered for funding

at a later date. One topic was not considered research and was sent to the Director's office for implementation consideration. The remaining seven topics (see below) were moved forward to the technical panel stage.

- Evaluation of fence modifications to exclude deer and elk from highways
- Design of a vertical shape portable concrete barrier
- Business market analysis
- Compost application for optimized vegetation response
- Integrating public/specialized transportation information into the 2-1-1 system
- Field evaluation of passing lane operational benefits on two-lane rural roads in Montana
- Logistics and marketing research in support of container on flatcar shuttle train on BNSF mainline to Port of either Seattle or Tacoma



## LIBRARY CORNER

There are numerous resources for transportation information. In the Fall 2004 quarterly Research Newsletter, the MDT library was highlighted (see [www.mdt.mt.gov/research/docs/library/news\\_nov04.pdf](http://www.mdt.mt.gov/research/docs/library/news_nov04.pdf)). A database called TRIS Online will be highlighted in this article.

TRIS stands for Transportation Research Information Services. It is a database maintained by the Transportation Research Board (TRB). TRIS Online is a subset of the TRIS database and is a joint project between TRB and the Bureau of Transportation and Statistics (BTS). TRIS Online is the largest and most comprehensive source of information on published transportation research on the Web (<http://trisonline.bts.gov/search.cfm>), covering all modes and disciplines of transportation. It provides access to over a half million records of published transportation research through a user-friendly searchable database. Over 470 serial publications are regularly indexed and abstracted for the database. TRIS Online includes material indexed and abstracted by TRB as well as the material entered by the Transportation Libraries at the University of California at Berkeley and Northwestern University. TRIS Online not only includes access to the bibliographic

records and abstracts found in TRIS, but it also provides links to the full text of public-domain documents or document suppliers. Currently there are over 19,000 TRIS records with links to electronic copies of the full-text of the reports or papers. Search TRIS Online at the link provided above or request a search of the full TRIS database through any of MDT's Research staff.

Training is provided on searching for transportation information. This hands-on training includes discussion of searching various library catalogs and databases, with the next training session being offered on March 3, 2005. To sign up for a training session, contact Sue Sillick at 406-444-7693 or [ssillick@mt.gov](mailto:ssillick@mt.gov).

Watch future newsletter issues for Library Corner articles on searching:

- TRB's Research in Progress (RIP) database
- Transportation Libraries Catalog (TLCat)
- Montana Library Network Group Catalog
- Literature Searches

---

## NEW RESEARCH PROJECTS

Montana Air Service: Opportunities and Challenges  
[www.mdt.mt.gov/research/projects/aer/air\\_challenges.shtml](http://www.mdt.mt.gov/research/projects/aer/air_challenges.shtml)

Transportation Library Connectivity  
[www.pooledfund.org/projectdetails.asp?id=910&status=1](http://www.pooledfund.org/projectdetails.asp?id=910&status=1)

Midwest States Pooled Fund Pavement Preservation Partnership  
[www.pooledfund.org/projectdetails.asp?id=880&status=1](http://www.pooledfund.org/projectdetails.asp?id=880&status=1)

Evaluation of Low Cost Safety Improvements  
[www.pooledfund.org/projectdetails.asp?id=332&status=4](http://www.pooledfund.org/projectdetails.asp?id=332&status=4)

A listing of all past and current projects can be found at:  
[www.mdt.mt.gov/research/projects/sub\\_listing.shtml](http://www.mdt.mt.gov/research/projects/sub_listing.shtml)



## NEW RESEARCH REPORTS

### Evaluation of Biodiesel Fuel: Field Test

[www.mdt.mt.gov/research/docs/research\\_proj/biodiesel/phaseII/final\\_report.pdf](http://www.mdt.mt.gov/research/docs/research_proj/biodiesel/phaseII/final_report.pdf)

### Recommendations for Winter Traction Materials Management on Roadways adjacent to Bodies of Water

[www.mdt.mt.gov/research/docs/research\\_proj/traction/final\\_report.pdf](http://www.mdt.mt.gov/research/docs/research_proj/traction/final_report.pdf)

A listing of all past and current projects can be found at: [www.mdt.mt.gov/research/projects/sub\\_listing.shtml](http://www.mdt.mt.gov/research/projects/sub_listing.shtml)

---

## REMINDER

Information on research services and products, such as research and experimental project processes and reports, and technology transfer services, including our library catalog can be found on the Research web site at [www.mdt.mt.gov/research](http://www.mdt.mt.gov/research).

---

## CONTACT US

Sue Sillick – Research Manager  
406-444-7693  
[ssillick@mt.gov](mailto:ssillick@mt.gov)

Craig Abernathy – Project Manager  
406-444-6269  
[cabernathy@mt.gov](mailto:cabernathy@mt.gov)

Jeanne Nydegger – Library Services  
406-444-6125  
[jnydegger@mt.gov](mailto:jnydegger@mt.gov)