SPARKING INNOVATIVE TRANSPORTATION SOLUTIONS

Issue 9
Spring/Summer
2005

HIGH-SPEED RAIL
HIGHWAY SYSTEMS
TRANSIT &
TRANSPORTATION SAFETY

Ignition

News from TRB's IDEA Programs

INSIDE:

- Wheelchair Securement System Could Advance Bus Rapid Transit
- Museum Exhibit Highlights IDEA Project

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THE IDEA PROGRAMS

Innovations Deserving Exploratory Analysis

IDEA programs provide start-up funding for promising but unproven innovations in surface transportation systems. The programs' goal is to foster ingenious solutions that are unlikely to be funded through traditional programs.

Managed by the Transportation Research Board, IDEA programs are supported by the member state departments of transportation of the American Association of State Highway and Transportation Officials (AASHTO), the Federal Transit Administration (FTA), the Federal Railroad Administration (FRA), and the Federal Motor Carrier Safety Administration (FMCSA).

The Transit IDEA program, which receives funding from FTA as part of the Transit Cooperative Research Program, is guided by a panel chaired by Fred Gilliam, President/CEO, Capital Metropolitan Transportation Authority in Austin, Texas. Harvey Berlin is the TRB program officer.

High-Speed Rail IDEA is funded by the FRA as part of its next-generation high-speed rail research. A committee chaired by Mike Franke, National Railroad Passenger Corporation, has oversight. Charles Taylor is the TRB program officer.

The NCHRP Highway IDEA program is supported by the member state departments of transportation of AASHTO through the National Cooperative Highway Research Program (NCHRP). It is guided by a panel chaired by Carol Murray, New Hampshire DOT; Inam Jawed is TRB program officer.

Safety IDEA is jointly funded by FMCSA and FRA. The committee is chaired by Ray Pethtel, Virginia Tech Transportation Institute. Harvey Berlin is TRB program officer.

Visit the IDEA web site:
www.trb.org/idea

On the cover: Foster-Miller photo of carbon fiber I-beam by Robert Bossart.

TRANSPORTATION RESEARCH BOARD
500 Fifth Street, NW
Washington, DC 20001

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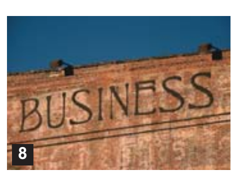
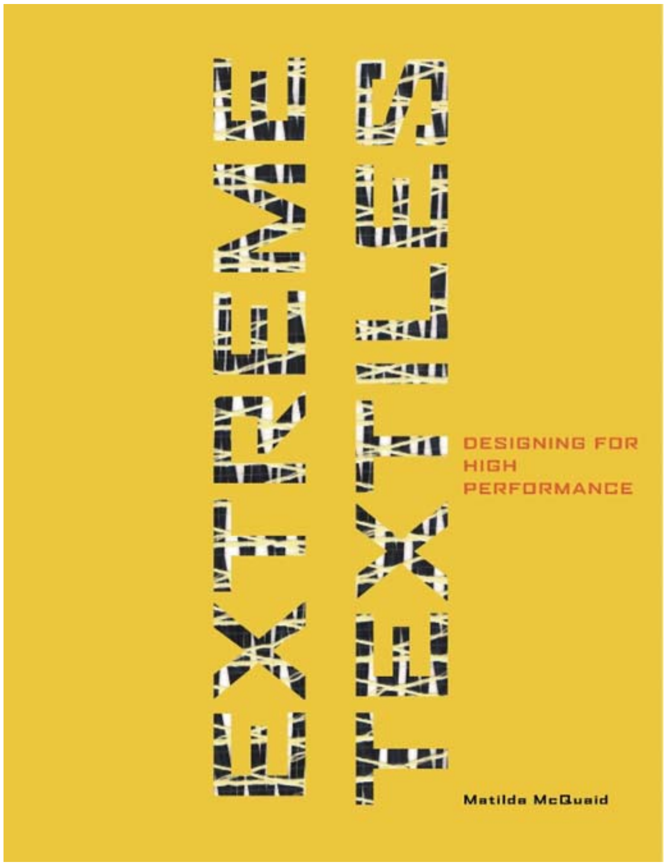
Contents



From the **Editor's** Desk

As the Shakers have shown us with hay rakes and hat racks of elegant simplicity, there can be beauty in the most utilitarian of items. The tools of daily living—when artfully crafted, designed perfectly for their purpose—can be appreciated as art. Our cover photo, taken by Robert Bossart for Foster-Miller, shows an example of everyday art that was once an NCHRP IDEA project. The carbon fiber I-beam is part of an exhibit at the Smithsonian Cooper-Hewitt National Design Museum in New York and the photograph is included in the exhibit's catalog, *Extreme Textiles*. The exhibit features fantastic fabrics that can help you fly or that can inflate to form an arch from which a car can be suspended. The story is in the Business section on page 8.



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The other side of design's relationship to function is reflected in our Insight section. Serious problems can result from accumulated dirt on hard-to-clean third rail insulators in rail rapid transit systems. Now a Transit IDEA project tests the design of an articulated cleaning station to address a problem that is frequently the cause of system shut down.

The New IDEAS section brings us up to date on four promising projects. Two NCHRP IDEA projects by the same principal investigator test materials that improve structural performance of bridges under seismic stress. A Safety IDEA project takes a timely look at detecting cracks in rail car axles to prevent axle failure and possible derailments. And results of a Transit IDEA project suggest that a system for securing wheelchairs on transit buses could be the basis for a change in ADA requirements.

Art, innovation, safety, security—it's all just a matter of having IDEAs.

Linda Mason
Communications Officer
Transportation Research Board
of the National Academies

Your comments are welcome and may be sent to the editor at: **lmason@nas.edu**

Automated Cleaner Keeps the Current Flowing for Rail Rapid Transit Systems

The third rail—in political metaphors as well as subway systems—it's what you don't touch. The third rail carries electricity, some 600 to 1,000 volts, that powers rail rapid transit systems. It sits on insulators typically spaced about 10 feet apart, which means there are more than 500 insulators in just one mile of track. Dirt and grime can short-circuit an insulator, which can cause arcing of electrical current and potential fire, smoke damage, explosive breaking, and other consequences that result in the need to shut down train operations. In fact, rail rapid transit systems around the country report that damaged insulators are most frequently the cause of system shut down.

Keeping insulators clean is more complicated than one might think. First, of course, there's all that high-voltage power, and, because of it, third rails are usually covered by housing that limits access to insulators, as do tunnel walls. Even in manual cleaning processes, it is virtually impossible to clean the side of insulators that is

Prototype insulator cleaner in action.

Insulators come in different shapes, sizes, and materials. Courtesy of Bay Area Rapid Transit.

only a few inches from tunnel walls. Tunnels present other problems as well. While they are often damp from water leaks, causing corrosion and rust, there is no rain to wash away soot and other particulates. These conditions accelerate insulator failure.

Another complication is that the thousands of insulators on a given transit system may vary in size, shape, and material. The dirt itself varies in kind, from carbon dust, metal filings, and rust particles to greasy grime, corrosion, and soot. Chemical cleaning agents are generally disallowed because of environmental and worker health considerations.

Insulator maintenance is also expensive, but if not cleaned regularly, insulators must be replaced at even greater expense. This of course does not address the costs of system down time when smoke or fire result from damaged insulators. In addition to lost revenue, there are costs to riders in lost time and possibly lost confidence in the system's reliability.

Plenty of reason, then, to look for an efficient and cost-effective way to clean the insulators that keep electricity flowing through the third rail, where it belongs. Current methods typically involve cleaning with hand brushes, cleaning pads, or pressure washing with a hand-held wand, which requires blow-drying with compressed air to prevent wet surfaces from conducting electricity. While the problem is complex and current methods inelegant, few advances toward its resolution have been made until now.

A promising project of the Transit IDEA program would automate the process, thereby reducing labor costs, and improve effectiveness by cleaning where other methods can't reach. Investigator Arun Vohra, an engineer with experience in research and development, has developed a prototype device that cleans all sides of an insulator with four spray jets configured in an adjustable U-shaped cleaning station at the end of an articulated arm. The device attaches to a service vehicle that travels on the rails. The cleaning station engages, rotates around, and disengages from an insulator on the adjacent third rail as the cart passes by.

Early stages of this project evaluated insulator cleaning methods by testing rotating brushes, both hydronic and pneumatic polishing with rice hulls, light abrasives, and pressure washing with both tap water and deionized water. The investigator's recommended method is pressure washing with hot tap water, which provides a good result with lower costs than deionized water. Although deionized water is an effective cleaner, it is more expensive than tap water and requires more expensive steel-tipped equipment.

Vorha worked in cooperation with a number of rail rapid transit agencies in developing and testing the prototype device for cleaning insulators, and is now developing a device that operates more quickly. A U.S. patent has been applied for. ❖

Contact:

Arun Vohra
E-mail: trakleaner@masstransitmail.com

Service vehicle equipped with spray nozzle device in tests at WMATA. Testing was also conducted at the Maryland Transit Administration.

Seismic Stress Reduction

In two NCHRP IDEA projects, researchers at the University of Nevada, Reno, are testing materials that could improve the chances that a bridge will withstand an earthquake. In NCHRP IDEA Project 97, investigators Saiidi and Maragakis tested bridge restrainers made from polymers reinforced with glass fibers, carbon fibers, and with a combination of the two. Restrainers are placed where bridge spans are hinged to prevent collapse of the spans due to unseating. Fiber-reinforced restrainers are found to have the advantages of being durable, lightweight, and easy to install, inspect, and replace if necessary. Preliminary design guidelines are developed from data compiled during tests of a full-scale model on a shake table. (More information on this project is available at http://gulliver.trb.org/publications/sp/nchrp-idea_report_Jan2005.pdf.)

In NCHRP IDEA Project 116, investigators Zadeh and Saiidi are testing a combination of flexible concrete and an alloy that remembers to return to its original shape to improve the seismic survivability of bridge columns with minimal damage. An engineered cementitious composite could reduce the amount of steel reinforcement needed to resist shear while contributing properties that substantially improve structural performance. Combined with bars of a shape-memory alloy that has super-elastic behavior, the new concrete placed in the section of bridge columns most susceptible to earthquake damage, is expected to improve safety, serviceability, and cost savings. ❖

Contact:

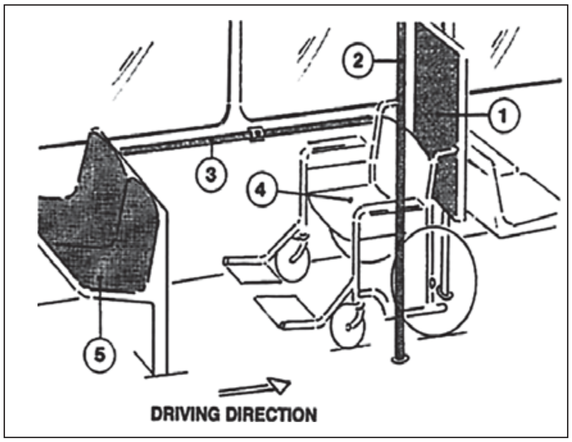
M. Saiidi, PhD
saiidi@unr.edu

GFRP restrainer during shake table tests.

Positioning Wheelchairs for a Safe and Speedy Ride

Bus rapid transit (BRT) combines passenger-friendly features—easy access from a bus-level platform, prepaid fare collection, less time at stops, and shorter travel times along dedicated guideways—with the relatively low investment costs of bus systems.

The Federal Transit Administration has encouraged research and development that will make BRT practical and now a Transit IDEA project has demonstrated that one hurdle to implementing BRT can be addressed. Securing wheelchairs on large urban transit buses has been limited to forward-facing belt-type systems since before the advent of the American with Disabilities Ace (ADA) in 1990. To meet current ADA regulations, a bus operator typically attaches straps to the wheelchair, a procedure that is sometimes difficult, always time-consuming, and incompatible with short dwell times.



Sketch of rear facing securement. Numbered features are (1) rear-facing load bearing back rest, (2) aisle side vertical stanchion, (3) horizontal handrail, (4) rear-facing wheelchair (5) rear-facing general seats. (Courtesy of Uwe Rutenberg)

A rear-facing system for securing wheelchairs on the bus, requiring no straps and no operator assistance, was investigated in Transit IDEA Project 38. An alternative that has been used in Europe and Canada, this system allows wheelchair users to position themselves in a securement station facing the rear of the bus with the rear of the wheelchair against a padded backrest. A handrail on one side and a stanchion on the aisle side provide lateral restraint. Researchers tested vehicle dynamics of six different bus types under normal and extreme driving conditions, three types of wheelchairs, and conducted a survey of rider perceptions.

Researchers determined that rear-facing securement of wheelchairs has important advantages for BRT and has high acceptance among users surveyed. ❖

Contact:

Katharine Hunter-Zaworski
National Center for Accessible Transportation
Oregon State University
hunterz@engr.orst.edu

Laser Focus on a Serious Rail Car Problem Proves Promising

The fifth leading cause of train accidents in North America between 1999 and 2001 was the failure of rail car axles. According to the Federal Railroad Administration, the resulting economic impact of accidents caused by axle failure during those three years was $4.5 million annually. It's a problem that needs solving.

Preliminary studies show that axles are designed to withstand the strain typical of their environment, but can fail if surface defects resulting from routine handling develop into fatigue cracks, and propagate throughout the axle. Detecting cracks before they reach a critical length has the potential to prevent service failures as well as reduce safety hazards and maintenance costs. Through a project of the Safety IDEA program, which is sponsored by the Federal Motor Carrier Safety Administration and the Federal Railroad Administration, researchers investigated a way to couple laser ultrasound with air-coupled detection to provide a wayside system capable of inspecting axles on a moving train.

Tests conducted at the Transportation Technology Center, Inc., in Pueblo, Colorado, support application of the technology in the axle body, and indicate that the technique has the potential to detect flaws in other axle segments as well. Further laboratory work is being conducted to develop a prototype design for a wayside cracked axle detector. ❖

Contact:

Kari Gonzales
Transportation Technology Center, Inc.
KariGonzales@aar.com

Business

Museum Quality IDEA

The first major museum exhibition to present technical textiles and their applications includes the product of an NCHRP IDEA project. *Extreme Textiles: Designing for High Performance* at the Smithsonian Cooper-Hewitt National Design Museum in New York (through October 2005) showcases some of the most inventive uses of engineered fabrics in a broad range of areas, including aeronautics, medicine, apparel, sports, agriculture, civil engineering, and transportation. Programs and exhibitions at the Cooper-Hewitt demonstrate how design shapes culture and history. Extreme Textiles features what the catalog describes as "highly engineered materials designed for ultimate performance in extreme conditions." A carbon-fiber I-beam developed by researchers at Foster-Miller, Inc., in Waltham, Massachusetts, and E.T. Techtronics, Inc., Philadelphia through NCHRP IDEA Project 67 is featured both in the exhibition and in the catalog. (http://www.cooperhewitt.org)

The project developed and tested a lightweight sidewalk for roadway bridges. I-beams molded from carbon fabric and epoxy resin support the cantilevered structure. The superstructure is fabricated from standard fiberglass pultruded sections that are assembled in the factory and can be delivered in units up to 40 feet long. The sidewalk superstructure is a version of E.T. Techtronics' proven composite pedestrian bridge, shown below. The system was successfully tested for load capacity and deflection limits at the University of New Hampshire and investigators are working with some transportation agencies to arrange an installation.

E.T. Techtronics, Inc.

The design could resolve some issues that complicate bridge maintenance for DOTs. For example, during a bridge retrofit, composite sidewalks can be installed where standard steel and concrete construction is too heavy for the existing bridge. Roads can be widened within an existing bridge envelope by moving sidewalks outboard and, because the composite materials are non-corroding, maintenance costs are reduced.

Contact:

Doug Thomson
Business Development Manager
Foster-Miller, Waltham, MA
dthomson@foster-miller.com

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Washington, DC 20001

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