



IDEA

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**Innovations Deserving  
Exploratory Analysis Programs**

## ***NCHRP IDEA Program***

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*Products with an Impact or Potential Impact  
on Current Highway Practice*

*Notable Examples*

***December 2010***

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TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES

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## Introduction

This report presents a summary of some of the successful projects from the ongoing IDEA Project of the National Cooperative Highway Research Program from 1993 – 2010.

IDEA (Innovations Deserving Exploratory Analysis) is a unique concept to traditional transportation research programs. Unlike most transportation research solicitations where competitive proposals are requested on a specific objective with specific tasks, IDEA seeks out proposals from entrepreneurs, inventors, forward thinkers, and problem solvers – anyone who has a possible solution to a vexing transportation problem.

The NCHRP IDEA program provides seed money to explore the technical feasibility of innovative, untried concepts for transportation applications. Recognizing that product development and implementation is an involved and intensive process, an IDEA project is intended to help initiate this process. Before a product can be implemented, it usually must go through further development, evaluation, commercialization, and marketing. Considering what it takes to do all this, an IDEA project is a very modest investment (\$100,000-150,000). There is a high risk associated with untried and unproven approaches; not every IDEA concept is expected to materialize. Still, despite the modest investment of resources and the high risk involved, a number of NCHRP IDEA projects not only have proved the technical feasibility of their innovative concepts but also have led to the development of implementable products.

As of now, 133 NCHRP IDEA projects have been completed. Of these projects, 19 have led to products that are now in the marketplace (Please see the accompanying tables). This translates into a success rate of about 1 in 7 projects. Another 20 or so projects have resulted in products that show a high implementation potential in the near term. Some of these products are expected to be on the market as early as 2011.

The following pages present examples of some of the successful NCHRP-IDEA products in the following categories:

- Mature NCHRP IDEA products with a significant impact on current practice
- NCHRP IDEA products supported by FHWA's Highways for Life Program for further development and commercialization
- NCHRP IDEA products being supported by state DOTs through pooled funds for further evaluation and implementation
- Recently developed NCHRP IDEA products with high near-term implementation potential

**Examples of Mature NCHRP IDEA Products with an Impact  
on Current Practice**

## **Sprayed Zinc Galvanic Anode for Corrosion Protection of Reinforcing Steel in Marine Substructures (Project #3)**

### **Inventor/Investigator**

Alberto Sagues and Rodney Powers

### **IDEA Funding**

\$65,000

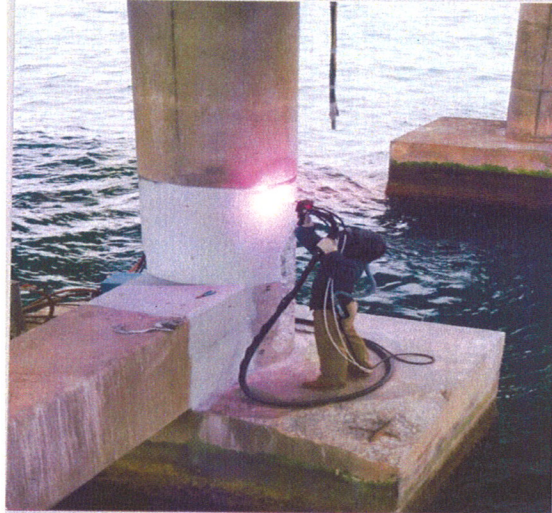
### **IDEA Project Completion**

1995

### **Description**

Product: A cathodic protection sacrificial anode system using sprayed zinc for protecting reinforcing steel (acting as the cathode) from corrosion in marine bridge substructures

Splash and seawater evaporation above the waterline cause high chloride ion concentrations in concrete that can lead to the corrosion of the reinforcing steel in the bridge substructure. Cathodic protection is the only technology that can directly stop corrosion in reinforced concrete structures. Sacrificial cathodic protection, by means of sprayed zinc galvanic anodes, offers a low cost alternative (several times less expensive than the impressed current method) for protecting these substructures. Furthermore, the method is applicable to a variety of structural components and can be easily applied with commonly available metalizing equipment. Sprayed zinc corrosion protection works best in a humid (not wet) environment.



### **Sprayed Zinc as sacrificial anode for the cathodic protection of steel in bridge substructures**

#### **Benefits**

Thermally-sprayed zinc anode costs about \$15-\$30 per square foot whereas impressed current system would cost about \$400 per square foot, not even including the cost of its long term maintenance, according to Ivan Lasa, a corrosion engineer at Florida DOT. The zinc application lasts for about 5-8 years in tropical climate (as in Florida Keys and south Florida) and about 10-12 years in subtropical

climate. Respraying the structure with zinc is neither expensive nor labor or equipment intensive

## **Applications**

The technique was successfully field tested at Florida Keys sites on U.S. Highway 1 at the Bahia Honda, Niles Channel, and Seven Miles bridges. A number of state DOTs have now standardized the use of these systems for the repair and rehabilitation of bridges and other substructures. Florida and Oregon DOTs lead the way with the largest portfolio of metalized zinc cathodic protection systems installed on their bridges along the coast.

Bridges in Florida with sprayed zinc anode system include Verle Allen Pope Bridge (SR 206, Crescent Beach, 1988), Niles Channel Bridge (US 1, Florida Keys, 1988), Julia Tuttle Relief Bridge (I-195, Miami, 1990), Indian Key Bridge (US 1, Florida Keys, 1991), Long Key Bridge (US 1, Florida Keys, 1991), Seven Mile Bridge (US 1, Florida Keys, 1991), Bahia Honda Bridge (US 1, Florida Keys, 1991), Howard Frankland Bridge (I-275, Tampa Bay, 1992), Bryant Patton Bridge (St. George Island, 1995), Sunset Island Bridge (29th Street, Miami, 1999), Channel Five Bridge (US 1, Florida Keys, 2002), Indian River High Rise Bridge (SR 404, Melbourne, 2004), Melbourne Causeway Relief Bridge (SR 192, Melbourne, 2004), Skyway Fishing Pier Bridge (US 275, Tampa Bay Entrance, 2004), Clapboard Creek Bridge (SR 105, Jacksonville, 2006), Julia Tuttle Causeway High Rise Bridge (SR 112, Dade, 2006), Anna Maria Bridge (SR 64, Anna Maria, 2008), Gandy Bridge (US 92, Tampa Bay, 2009), and Boca Ciega Bridge (SR 679, Pinellas, 2009).

Oregon bridges protected by sprayed zinc include Cape Creek Bridge (North of Florence, 1991), Depoe Bay Bridge (Depoe, 1993), Yaquina Bay (Newport, 1994), Big Creek Bridge (South of Yachats, 1997), Cape Perpetua Bridge (South of Yachats, 1997), Rocky Creek Bridge (South of Depoe Bay, 2000), Cumins Creek Bridge (South of Yachats, 2001), Rouge River Bridge (Gold Beach, 2001), Tenmile Creek Bridge (South of Yachats, 2007), and Coos Bay Bridge (North Bend, expected completion 2011-12).

Among other states, Virginia has used sprayed zinc anode on several of its bridges that include bridges on I-64 over Willoughby Bay and East 13th View Street in Norfolk (1986 and 1997), Route 58 over Leatherwood Creek in Henry (1996), Interstate-95 over James River in Richmond (1998), and Route 15 over Willis River in Albemarle (2004). Missouri has also applied sprayed zinc on some of its structures that include a flyover bridge on I-70/I-270 Interchange and a 9th Street ramp in St. Louis. Alaska DOT is currently installing zinc anode system on a bridge on Tongass Avenue in Ketchikan, Alaska.

In addition to bridge substructures, piles, and columns, sacrificial sprayed zinc cathodic protection systems are also being applied to structures such as high-rise buildings, parking garages, concrete cooling towers, concrete intake and outfall structures in power plants, and dock facilities.

## **Admixture for Improved Corrosion Resistance of Concrete (Hycrete) (Project #13)**

### **Inventor/Investigator**

Jack Stephens and James Mahoney

### **IDEA Funding**

\$60,000

### **IDEA Project Completion**

1995

### **Description**

Product: An additive based on highly hydrophobic dipolar alkenyl dicarboxylic acid diammonium salts that inhibits corrosion of reinforcing steel in concrete

Corrosion of reinforcing steel remains a major problem for the durability of concrete structures exposed to deicing chemicals or marine environment. The corrosion-inhibiting hydrophobic IDEA product, developed at the University of Connecticut in collaboration with the Connecticut DOT, was further evaluated by the New England Transportation Consortium, a group of New England state DOTs, to establish its corrosion protective performance and its effect on concrete properties. The product is now being marketed as a corrosion inhibitor under the name Hycrete by a company with the same name (Hycrete Technologies, Inc.) located in Carlstadt, New Jersey. In fact, the IDEA product forms the basis of what now has become a suite of trademarked 'Hycrete' corrosion inhibiting and waterproofing products.



**Waterproofing concrete with Hycrete**

### **Benefits**

The admixture greatly reduces the water and chloride ion permeability of concrete and the corrosion of reinforcing steel bars in cracked concrete specimens. It also exhibited air entraining properties that improved the resistance of concrete to frost damage but decreased the compressive strength by about 10-20%, although still adequate for most construction applications. Since the hydrophobic nature of the admixture makes concrete waterproof, it eliminates the need for waterproofing membrane around the concrete and the associated cost of the membrane and the time for installing it.

Hycrete sells for between \$50 and \$75 per gallon which is enough for a cubic yard of concrete. This would amount to about 25-30% increase in cost per cubic yard of concrete. However, the advantages (superior corrosion resistance, less maintenance, and longer service life) outweigh the upfront material cost increase. A

life cycle cost analysis by Stephen Sharp and Celik Ozyildirim of Virginia DOT for the 2007 construction season (with an allocation of about \$15 million for new bridge decks) estimated a cost saving of \$1.5 million each year with a service life increase of 10% through the use of Hycrete<sup>1</sup>.

### **Applications**

Many states and agencies have been experimenting with Hycrete for the past several years. These include the states of New Jersey, New York, Ohio, Virginia, and Kansas, the six New England states, and the U.S. Army Corps of Engineers. The Hycrete projects evaluated by the New England Transportation Consortium included major structural components of a ferry terminal in Rockland, Maine, a bridge curb in Hartland, Vermont, I-91 overpass bridge bent columns in Massachusetts, and large precast culverts in New York. Connecticut DOT implemented Hycrete in precast Jersey Barriers positioned along the I-84 corridor. Kansas DOT evaluated Hycrete on a Highway 99 bridge, south of Howard in Elk County. However, all these projects are essentially evaluation studies and are being monitored for the long term performance of Hycrete. So far, Virginia and Ohio DOTs have approved the use of Hycrete in their construction projects.

While states DOTs have been slow in their acceptance of Hycrete, it is being used increasingly in the private sector in non-transportation projects that include parking garages (Seattle and SeaTac, Washington), medical school laboratories and office buildings (Seattle, Washington), a high school (Arlington, Virginia), a housing and retail complex (Salt Lake City, Utah), and residential buildings (Los Angeles, California). The Thomas Jefferson Law School in San Diego reports to have saved about \$187,000 on construction costs by using Hycrete in its new building.

### **Awards/Recognition**

Since Hycrete helps keep environment clean by eliminating the need for using petroleum-based waterproofing membranes, the CEO of Hycrete, Inc., was among the eight CEOs of clean technology-focused companies invited to the White House in 2009 by President Barak Obama for a roundtable on the economic impact of environmentally-friendly technologies.

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<sup>1</sup> Virginia Transportation Research Council Final Report 07-R30 [http://www.virginia.dot.org/vtrc/main/online\\_reports/pdf/07-r30.pdf](http://www.virginia.dot.org/vtrc/main/online_reports/pdf/07-r30.pdf)

## **Automated Bridge Deck Anti- and De-Icing System (Project #27)**

### **Inventor/Investigator**

Rand Decker

### **IDEA Funding**

\$70,000

### **IDEA Project Completion**

1998

### **Description**

Product: A bridge-mounted automated anti-icing spray system to prevent snow and ice on bridge decks

Icy conditions on the bridge during winter are a major safety hazard for motoring public. Although in use in Europe since late 1970s, this IDEA project represented the first attempt to introduce the automated anti-icing spray technology in the U.S. by funding an experimental system on a Utah bridge on I-215 near Salt Lake City in 1997. The IDEA project used accepted de-icing liquids and conventional spraying techniques coupled with modern roadway weather information systems (RWIS) and data communication and process controls to prevent icing on bridge decks. A comparison of accident data for a test section and control before and after the installation of the system showed a 64% reduction in accidents for the test section.



**Automated anti-icing spray system for bridge decks**

### **Benefits**

While the automated anti-icing system is expensive compared to conventional deicing or anti-icing methods and requires maintenance, there are strong safety benefits. For example, the system on the now-collapsed I-35 Bridge over the Mississippi River in Minnesota DOT's St. Paul district cost about \$1.2 million to install and used potassium acetate at a cost of about \$3 per gallon as opposed to less than 50 cents for salt. However, the deicer was only sprayed when needed and, according to maintenance engineer Chris Beckwith, crashes were reduced by 60% in one year. Data reported in 2000 by Paul Keranen of Minnesota DOT for three bridge sites showed a drop of snow-related accidents from 22 to 4 in the 24 month period before and after installation of the system. Use of the system on a 165 meter stretch of Highways 401/416 interchange in Ontario, Canada resulted in a 100% reduction in weather-related collisions in its first year of operation in 2001, according to

maintenance superintendent Rick Hofstteter. So, while the system may not save money to states, it saves human life and avoids or minimizes injuries and property damage.

### **Applications**

Since 1997, a number of states and provinces in the U.S. and Canada have used or evaluated the system in bridge anti-icing projects. These include Colorado, Kansas, Kentucky, Maryland, Minnesota, New York, North Carolina, Pennsylvania, Wisconsin, Virginia, Washington State, New Jersey, Montana, and Ontario, Canada, among others.

The state DOTs, however, appear to be rather cautious in embracing the automated spray technology presumably because of unfamiliarity with the technology or cost. Some states such as Virginia evaluated the anti-icing technology (along a ramp from Route 7 to Route 66 in Fairfax County in 1998) but did not maintain it after two years. Plans to install a system on Buffalo Creek Bridge on I-81 also were not followed through. Minnesota DOT, on the other hand, appears to be most receptive of the technology with systems installed on several bridges in the Twin Cities, Duluth, Rochester, and Winona and on segments of I-90 at Worthington and Beaver Creek. In recent years, Minnesota DOT installed an anti-icing spray system on I-35 E Lexington Bridge over Mississippi River in St. Paul in 2005. The new \$234 million I-35 W Saint Anthony Falls Bridge in Minneapolis that opened in September 2008 to replace the collapsed I-35W Bridge is also equipped with the automated anti-icing spray technology. The new bridge over Mississippi River on Highway 61 near the City of Hasting that is due to open in the summer of 2012 will also install a similar anti-icing spray system. The Galena Creek Bridge currently under construction near Reno, Nevada will also feature a \$2 million automated anti-icing spray system.

## Corrosion Resistant Steel for Concrete Reinforcement (DMF/MMFX Steel) (Project #28)

### Inventor/Investigator

Gareth Thomas

### IDEA Funding

\$70,000

### IDEA Project Completion

1997

### Description

Product: An improved dual phase ferritic martensitic (DFM) reinforcing steel with superior mechanical properties and corrosion resistance

The high strength corrosion-resistant DMF steel is a low-alloy low-carbon steel produced by quenching the alloy from the two-phase ferrite/austenite field, thus producing a mixture of ferrite and martensite. Further work on DMF steel by the IDEA researcher led to the development of MMFX steel that was found to be about five times as corrosion resistant and twice as strong as the conventional steel. To commercialize and market the new steel, the MMFX Steel Corporation of America (San Diego, California) was founded in 1998. The IDEA researcher and Mr. Howard Yerusalim, a past President of AASHTO and a former Secretary of Pennsylvania Department of Transportation, served on the corporation's management team.



**MMFX steel deck reinforcement for US 20 Bridge over South Beaver Creek in Gundy County, Iowa**

### Benefits

MMFX steel is a highly corrosion resistant material with superior mechanical properties. It currently costs about \$1600 a ton as compared to regular steel (about \$900 a ton). However, according to the manufacturers, by using higher yield strength MMFX steel of 100 or 120 ksi over conventional Grade 60 steel, construction projects can be completed with 20-50% less steel and up to 60% lower labor costs (placement and fabrication). In addition, superior corrosion resistance adds years to the service life of the structure. A 2007 Michigan DOT study estimated a higher service life for a bridge with MMFX steel than that with epoxy coated steel and concluded that MMFX steel reinforcement was worth the investment despite an increase of about \$12 per square yard over

epoxy coated steel reinforcement<sup>1</sup>.

## **Applications**

A number of state DOTs have evaluated MMFX steel for its mechanical performance and corrosion resistance. These include Iowa, Florida, West Virginia, Virginia, Delaware, New Jersey, Louisiana, South Dakota, and Michigan, along with FHWA. In addition, California, Texas, Pennsylvania, and Virginia participated in a round robin study to evaluate its corrosion resistance. All evaluation studies have validated the superior corrosion resistance of MMFX steel. MMFX rebar qualifies as ASTM A615 Grade 75, ASTM A1035-04 low-carbon, chromium steel bars for concrete reinforcement at 100,000 psi, and AASHTO M31 Grade 75.

MMFX steel is now being used across North America in construction projects on bridges, highways, parking structures, and residential and commercial buildings. For bridge structures, the applications include bridge decks in New Haven, Connecticut (Church St. Extension), New Castle County, Delaware (State Route 82 over Red Clay Creek), Grundy County, Cedar Hill, Iowa (US 20 over South Beaver Creek), Lexington, Kentucky (Scott County Road 1218), Jensen Beach, Florida (Causeway Bridge over Intercoastal Waterway), East of Pittsburgh, Pennsylvania (Exit 9 – Interstate Highway I-70-76), Derby Township, Vermont (SR105 over the Clyde River), and Swan River, Manitoba, Canada (Province Highway over East Favel River), new bridge structures in Amarillo, Texas (Washington Street Overpass located over I-40) and Cabo Rojo, Puerto Rico (PR-102 over Laguna Channel). The entire bridge structure of US 64 over the Gobernador Arroyo River in New Mexico featured MMFX steel including the deck. The Sacramento Regional Transit chose MMFX steel for Folsom’s Light Rail Bridge over Alde Creek for girders, abutments, and columns. The US Army Corps of Engineers used MMFX steel in the entire structure of Lake Tenkiller Spillway Channel Bridge in Sequoyia County, Oklahoma, and the US Navy used it in hybrid modular piers in San Diego, California. Washington State DOT used MMFX steel dowel bars in several of its pavement projects (Richland’s I-182/SR 240 to Colombia Center Interchange, US 395/US 2 to Wandermere Vicinity, and US 395/North Spokane Corridor Railroad Tunnel).

## **Awards/Recognition**

2002 Winner of the American Society of Civil Engineers’ ‘Charles Pankow Award’ for innovation in design and construction

2004 Winner of the ‘NOVA Award’ for innovations by the Construction Innovation Forum, an international non-profit organization that recognizes innovations that help improve construction quality and reduce costs

2004 ‘Experts’ Choice Award’ Winner at the 2004 World of Concrete Exposition

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<sup>1</sup>Michigan Department of Transportation Research Report R-1499 [http://www.michigan.gov/.../MDOT\\_Research\\_Report\\_R1499\\_209781\\_7.pdf](http://www.michigan.gov/.../MDOT_Research_Report_R1499_209781_7.pdf)

## Fiber-Reinforced Polymer Composite Bridge Deck (Projects #30 and 46)

### Inventor/Investigator

Jerry Plunkett

### IDEA Funding

\$144,000

### IDEA Project Completion

2000

### Description

Product: Lightweight composite bridge made of fiberglass-reinforced polymer (FRP) honeycomb structural panels

The composite decks cost slightly more than the current concrete and steel decks on an initial cost basis. However, they save time and labor in installation, are corrosion free, require less maintenance over time, and are expected to have a longer service life than a concrete bridge.



**No-Name Creek Bridge with FRP composite decks under test in Russell, Kansas**

### Benefits

The composite bridge technology allows rapid construction or reconstruction of bridges saving time and reducing traffic delays. The composite bridge decks are strong enough for vehicular traffic but light enough to allow major sections to be factory-built and shipped to the site on a flatbed trailer. Installation is similar to that of prestressed concrete panel but, being lightweight, it is quicker and easier to install using smaller cranes. The decks can be installed in hours or days instead of weeks or months it takes for a traditional bridge on site. Furthermore, the reduced deck weight (dead weight) allows the bridge to carry an increased traffic load. The composite decks are also free from corrosion by winter salt, thereby significantly increasing their service life. The technology also permits the removal and replacement of damaged bridge decks and the removal and replacement of decks from bridges that are no longer in service or need to be upgraded.

## **Applications**

The IDEA-funded No-Name Creek Bridge in Russell, Kansas, was the first all-composite highway bridge built in the U.S. The bridge, designed in accordance with the U.S. Highway Bridge Code HS-25, used three fiberglass honeycomb panels (23 feet long and 9 feet wide) with interlocking edges, and was opened to traffic in December 1996. The installation took only 6 hours. The honeycomb design resulted in about 20% less weight of the bridge and almost 50% less cost than other composite bridges meeting the same AASHTO requirements. The No-Name Creek Bridge is still performing well and, according to David Meggers of Kansas DOT, routine inspections have revealed no problems after 14 years of use. The IDEA support was also used to build two additional bridges, each 32 feet wide and 45 feet long, in Crawford County, Kansas, that are still performing well.

Following the success of the IDEA project, the IDEA contractor, Kansas Structural Composite, Inc. (KSCI) has installed composite bridge decks on a number of bridges in the states of Kansas (Kansas Detour Bridge #1 and 2), Missouri (St. John Street Bridge, Jay Street Bridge, and St. Francis Street Bridge), West Virginia (West Buckeye Bridge, Hanover Bridge, Goat Farm Bridge), Ohio (Salem Avenue Bridge near Dayton, Ridge Road Bridge near Fairfield), New York (RI 36 over Tributary to Troups Creek), Pennsylvania (T 565 over Dunning Creek), Colorado (O'Fallen Park, West of Denver), and Nebraska. KSCI's success led other composite technology companies (Martin Marietta Composites, NC, Hardcore Composite, DE, Creative Pultrusions, PA, Fiber-Reinforced Systems, Bedford Reinforced Plastics, Diversified Composites, etc.) also to enter the composite bridge business, and these companies have installed a number of composite bridges in California, Idaho, Ohio, New York, Oregon, Pennsylvania, Illinois, Maryland, Delaware, Iowa, North Carolina, South Carolina, Virginia, Washington State, Wisconsin, and West Virginia.

## **Awards/Recognition**

Winner of the 'Best of Market' and the 'Counterpoise Grand Design Award' from the International Composite Expo of 1997. The IDEA contractor is the smallest ever company to receive this prestigious design award that has generally gone to major auto and aircraft companies such as General Motors, Chrysler, Boeing and Lockheed Martin

Winner of the 1997 'R&D 100 Award,' sponsored by the Research & Development magazine, for being selected as one of the most important innovative developments of the year

The composite bridge built by KSCI in Fairfield, Ohio in 2008 was featured on the National Public Radio

## Pavement Quality Indicator (Projects #32 and 47)

### Inventor/Investigator

Harry Apkarian

### IDEA Funding

\$158,000

### IDEA Project Completion

1998

### Description

Product: A non-nuclear asphalt pavement density measuring device based on capacitance energy dissipation

The Pavement Quality Indicator (PQI) estimates density by measuring change in electromagnetic field when an electrical current is transmitted through an asphalt pavement. The impedance or resistance to electrical flow is related to the dielectric constant while the overall dielectric constant of an asphalt pavement is directly proportional to its density. Changes in the dielectric constant, therefore, can be correlated to changes in the density of asphalt pavement during compaction. Developed with funding from the NCHRP IDEA Program and the New York State Energy Research and Development Authority (NYSERDA), the device continues to be upgraded, and currently, a third generation Model 380 is available that includes features such as GPS status display, ability to download files to PQI via USB drive, and new data management system.

The device is being marketed both in the U.S. and overseas by Trans Tech, Inc. located in Schenectady, New York. TransTech and Engius, the vendors for PQI, report selling about 10-20 units a month, mostly to private contractors. A modified version of the PQI device is also available as the Soil Density Gauge for measuring soil density.



**Pavement Quality Indicator (Model 380)**

### Benefits

The pavement quality indicator (PQI) offers a rapid, convenient, and safe alternative to the nuclear gauge for measuring asphalt pavement density. The PQI, unlike the nuclear gauge, does not expose the operator to harmful radioactive isotopes with ionizing radiation that can penetrate human skin and concrete. It requires no extensive training, no radiation badges, no badge service and licensing fees, no constant radiation exposure monitoring of personnel, no testing for radiation leaks, no special storage or transportation needs, no disposal hassles, and no accident, security or terrorism concerns. It is much more rapid than the nuclear gauge, and

takes only three seconds to measure density allowing quality tester to get on the mat, do the test, and get out of the way of the roller for the next pass. The nuclear gauge takes about a minute for a reading.

The PQI costs about \$8900 which is about the same as the cost of a nuclear gauge. However, a 2005 Ohio DOT study estimated the operating cost for PQI to be about \$210 per year as compared to about \$3,075 for the nuclear gauge while a 2007 Iowa study estimated that a non-nuclear device such as the PQI could save as much as \$50,318 over a period of 5 years<sup>1</sup>.

### **Applications**

The PQI has been extensively evaluated by a number of state DOTs, including Maryland, Pennsylvania, New York, Minnesota, Connecticut, Oregon, Virginia, Delaware, Ohio, Florida, North Carolina, Nebraska, Iowa, Illinois, Kentucky, Texas, Wisconsin, and Arkansas, among others. Most of these evaluations have found that PQI, although a better performer than its competitor PaveTracker, was still not as accurate as the nuclear density gauge when compared with core density measurements. Moisture (whether surface or internal), mix types, aggregate size, and gauge position (parallel or perpendicular to paving direction) appeared to affect the density readings. The studies recommend it as a useful quality control tool but not for the purpose of quality assurance. Consequently, some states, such as Maryland and Pennsylvania, allow the use of PQI and PaveTracker for quality control purposes while some states such as West Virginia still do not. A recent Ohio DOT evaluation recommended PQI for both QC and QA purposes provided it is calibrated daily by applying a mix-specific offset. Many paving contractors now use PQI in their paving operations for quality control purpose in accordance with the AASHTO specifications for non-nuclear gauges for density measurements.

### **Awards/Recognition**

Winner of the 2003 'NOVA Award' for innovation by the Construction Innovation Forum, an international non-profit organization that recognizes innovations that help improve construction quality and reduce costs

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<sup>1</sup> Mack-Blackwell Transportation Center-University of Arkansas Final Report No. 2075 <http://ww2.mackblackwell.org/...williams/MBTC%202075%20-%20FINAL%20REPORT.pdf>

## Hybrid Composite Beam for Bridges (Project #60)

### Inventor

John Hillman

**IDEA Funding** (funded jointly by NCHRP and High-Speed Rail IDEA programs)  
\$150,000 (total NCHRP and HSR-IDEA funding)

### IDEA Project Completion

2007

### Description

Product: A high-strength, lightweight, corrosion-resistant hybrid composite beam for bridge construction

The hybrid-composite beam has three main subcomponents- a shell, compression reinforcement, and tension reinforcement. The compression reinforcement consists of self-consolidating concrete that is pumped into a profiled conduit within the beam shell. The tension reinforcement consists of Hardwire® steel reinforcing fabrics which run along the bottom flanges of the beams.

Whereas FRP materials are generally too expensive and too flexible when arranged in a homogeneous form, the strength and stiffness of the HCB are provided by a more efficient use of materials that are well suited to purely axial tension or compression. The classical arch shape of the compression reinforcing dramatically reduces the shear carried by the FRP webs. Due to the low density of the FRP materials and the ability to place the compression reinforcing in-situ, what results is an economical structural member that can be used in the framing system of a bridge structure in the same manner as a steel or prestressed concrete beam, but that is much lighter and well suited to accelerated bridge construction with potentially longer service life.



**Hybrid Composite Beam (HCB) being installed on High Road Bridge in Lockport Township, Illinois**

### Benefits

1. Improved speed of construction. Well suited to Accelerated Bridge Construction.

2. Improved service life, estimated to be > 100 years.
3. Costs- currently HCB first-cost construction basis is competitive with conventional methods such as pre-stressed concrete beam for many applications. This will improve as demand for HCB increases, due to scale economies. For life-cycle costs, HCB is superior, due to longer service life.

## Applications

1. Illinois- Lockport Township High Road Bridge over Long Run Creek (2009). The superstructure for this 57-foot, single-span bridge comprises six 42-inch deep Hybrid Composite Beams supporting a conventional 8-inch thick reinforced concrete deck. The HCBs weigh approximately one-tenth of what a typical precast concrete beam weighs for the same span length. This lighter weight reduced shipping and erection costs. All of the beams for the bridge were shipped on one truck instead of what would have taken six trucks using competing methods, and they were erected using a 30-ton crane instead of a large 150-200-ton crane that would have been required for precast concrete beams. The bridge was finished under budget and ahead of schedule. Ralph Anderson, Illinois State Bridge Engineer, said "I expect this technology will provide an economical option that will greatly benefit the citizens of Illinois."<sup>1</sup>
2. New Jersey- Rte. 23 Bridge over Peckman's Brook in Cedar Grove, (2009) a single-span bridge with a span of 31-feet and a total deck width of 60-feet.
3. Maine- Knickerbocker Bridge over Back River in Boothbay (completion expected 2011). This 540-foot long, 8-span bridge has a framing system that is one-tenth the weight of precast concrete, requires no deck forming, and provides a corrosion resistant FRP outer shell to provide protection from the salt water in the bay. Recent tests validated that the load carrying capacity of the HCB girders is more than 170 percent of the code specified ultimate capacity.
4. Missouri- "Safe and Sound Project" Three HCB bridges will be built in 2012 using a Highways for Life grant.
5. Burlington Northern and Santa Fe. The first live load test of a full scale HCB rail bridge was begun at the Transportation Technology Center, Inc. (TTCI) near Pueblo, Colo., in November 2007. A 30' span has been subjected to 237 million gross tons. Endurance testing at TTCI will be conducted for a 42' span for one year starting in 2010. If this is successful, BNSF will install the span for a structure in revenue service.
6. In general- for highways, HCB is suitable for 50' to 110' spans; for rail, HCB is suitable for 30' to 45' spans. Utah has submitted for an HFL grant to construct one or more. There is a shipping facility application underway in Vancouver, British Columbia, Canada. EU, Russia, Kuwait, and Brazil have licensing agreements.

## Awards/Recognition

1. American Council of Engineering Companies 2009 Grand Award for the Lockport Township High Road Bridge
2. *Engineering News Record* 2010 Award of Excellence to John Hillman.
3. The AASHTO's Technology Implementation Group has selected HCB as a focus technology for implementation in 2011 and is looking for a lead state.

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<sup>1</sup> Concrete Construction <http://www.concreteconstruction.net/industry-news.asp?sectionID=718&articleID=800467&artnum=2>

## DriveCam (Project ITS #84)

### Inventor/Investigator

Gary Rayner

**IDEA Funding** (this project was funded through the ITS-IDEA program)

\$95,000

### IDEA Project Completion

2001

### Description

Product: A palm-sized video event data recorder that mounts behind a vehicle's rearview mirror and monitors driving activity by continuously recording video of the roadway, audio, and acceleration/deceleration forces into a digital looping memory.

DriveCam is triggered as a result of crash or erratic driving but can also be activated manually to capture road rage events, hit-and-run accidents, or other road hazards. The information is saved from 10 seconds before the trigger event to 10 seconds after.

DriveCam device continues to be upgraded and is being sold worldwide by DriveCam, Inc., founded in 1998 and based in San Diego, California. The IDEA product has now evolved into a major business enterprise that claimed a spot on the Inc. magazine's list of 500 fastest growing companies for three consecutive years and was ranked 67th in 2005. Most recently, it ranked #30 in the Wall Street Journal's listing of Top 50 Venture-Backed Companies as 'The Next Big Thing.' Currently, a DriveCam unit costs about \$900. However, transit agencies and fleet owners should be able to negotiate a significantly lower price for their large orders.



DriveCam

### Benefits

The device has enhanced safety on the road by improving driver behavior through greater driver accountability and saved time and money by helping determine liability in collisions. Fleets that regularly review the DriveCam's event recording as part of a driving feedback system with their drivers typically report a 40-70% reduction in incidents<sup>1</sup>. An FMCSA-sponsored study at Virginia Tech involving 100 trucks found that risky driving incidents fell by 52% in the first fleet and by 37% in the second fleet for vehicles over a 17-

week period as a result of using DriveCam<sup>2</sup>.

The information captured by DriveCam is also invaluable for legal defense and insurance purposes. According to DriveCam, Inc., the use of the device has reduced vehicle damages, workers' compensation and personal injury costs by more than 50% in over 130,000 commercial, government, and consumer vehicles<sup>3</sup>.

## **Applications**

The use of DriveCam by industries and government agencies in their fleets continues to increase. According to a recent Microsoft case study, more than 1500 commercial enterprises and government agencies worldwide have deployed DriveCam in their vehicles. These include all types of businesses such as waste management and sanitation, construction, transit, paratransit, motor coach, utilities, telecom, goods distribution and logistics, and government and municipality vehicles. For example, in March 2010, Masco Contractor Services, a provider of home improvement products and a subsidiary of Fortune 500 Masco Corporation, contracted to deploy DriveCam in its 23 locations nationwide, and in May 2010, Sysco Corporation, a major supplier of food products, decided to install DriveCam on its entire fleet of 9000 vehicles. For government agencies, DriveCam is already in use in transit agencies in San Francisco, Austin, and New Jersey. In August 2010, Washington Metropolitan Area Transit Authority decided to install DriveCam on all of its 1500 buses at a cost of \$3 million to help reduce vehicle damage, workers' compensation claims, and personal injury through accident prevention.

Insurance companies have also taken notice of the DriveCam's impact. In 2008, the American Family Insurance teamed up with DriveCam in 'Teen Safe Driver Program' to help reduce risks presented by teen drivers by providing its policyholders with DriveCam service and plans to extend service to the commercial auto market. Also in 2008, the Maryland State Highway Administration's Highway Safety Office initiated a 'DriveCam for Families' program to help newly-licensed teens become safe and competent drivers. The University of Iowa and Iowa DOT also used DriveCam in a similar study of teen drivers' behavior.

Other companies with similar products have come into being. SmartDrive Systems was recently selected by the Los Angeles County Metropolitan Authority to equip all their buses with SmartDrive event recorders.

## **Recognition/Awards**

Featured on the ABC's World News Tonight and Good Morning America, CBS's Early Show, NBC's Dateline, and the CNN in recent years. Major newspapers such as Wall Street Journal and Dallas Morning News have also carried stories on DriveCam.

Featured on the Discovery Channel's show, 'The Truth about Traffic' that focused on improving traffic flow and improving driving habits.

DriveCam along with the American Family Insurance was the 2008 recipient of A.M. Best Co's 'E-Fusion Award' that recognizes best applications of cutting-edge technology in the insurance industry.

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<sup>1</sup> Ignition, Interview with DriveCam inventor Gary Raynor [http://www.trb.org/publications/ignition/ignition\\_2.pdf](http://www.trb.org/publications/ignition/ignition_2.pdf)

<sup>2</sup> DriveCam Newsletter [http://www.drivecam.com/News\\_and\\_Events/DriveCam\\_in\\_the\\_News.aspx](http://www.drivecam.com/News_and_Events/DriveCam_in_the_News.aspx)

<sup>3</sup> DriveCam Fleet Risk Management <http://www.drivecam.com/Fleet-Risk-Management-Solutions.aspx>

**Examples of NCHRP IDEA Products supported by FHWA's  
Highways for Life Program for further Development and  
Commercialization**

## **A Computer-Controlled Image Analysis System for Measuring Aggregate Shape Properties (Projects #77 and 114)**

### **Inventor/Investigator**

Eyad Masad

### **IDEA Funding**

\$110,000

### **IDEA Project Completion**

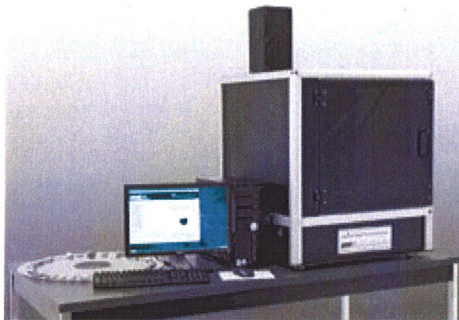
2007

### **Description**

Product: An automated computer controlled image analysis system (AIMS) for measuring aggregate shape characteristics such as angularity, form, and texture

The shape characteristics of aggregates used in asphalt mix, Portland cement concrete, and unbound aggregate pavement layers are known to affect the structural integrity and durability of pavement as well as its skid resistance. The AIMS determines aggregate shape characteristics by capturing digital images of aggregate samples and comparing them to a reference database to classify the aggregates with a graphical output of aggregate characteristics. The system's software uses a series of analysis algorithms that objectively quantify aggregate properties on both the macro scale (such as shape and angularity) and the micro scale (such as surface texture). The software allows characterization of the distribution of shape and angularity for correlation with performance in pavement layers.

The IDEA product, further developed and evaluated with support from FHWA's Highways for Life Program, is commercially available from Pine Instruments Company (Grove City, Pennsylvania), and units have been sold both in the U.S. and overseas. The latest version of the instrument with all the accessories costs about \$29,000.



**Automated image analysis system (AIMS) for aggregate characterization**

### **Benefits**

The AIMS method is rapid, accurate and more convenient than the current manual method that is tedious and time consuming and often results in inconsistencies in measurement, quality assurance, and mix design. The automated image-based analysis is free from operator's influence and bias. The system is able to characterize aggregates for Superpave sieve sizes ranging from 0.075 mm to 25 mm retained.

## **Applications**

The IDEA product was selected by the FHWA's Highways for Life Program for further evaluation and commercialization. A number of state DOTs participated in evaluating the system for accuracy and reproducibility along with FHWA and several universities and private laboratories. The participating state DOTs and Canadian provinces included Maine, Vermont, New York, Florida, Mississippi, South Carolina, Alabama, Michigan, Ohio, Indiana, Illinois, New Mexico, Texas, Nebraska, Kansas, Oklahoma, Iowa, Minnesota, North Dakota, South Dakota, Oregon, Washington, Alaska, and Saskatchewan, Canada. As a result of this evaluation, two test methods for aggregate testing based on AIMS technology are being considered for adoption by the AASHTO subcommittee on materials. The AIMS is currently being used by FHWA for demonstration and training in its mobile testing laboratory.

## Asphalt Binder Thermal Cracking Test (Project #99)

### Inventor/Investigator

Sang-soo Kim

### IDEA Funding

\$76,000

### IDEA Project Completion

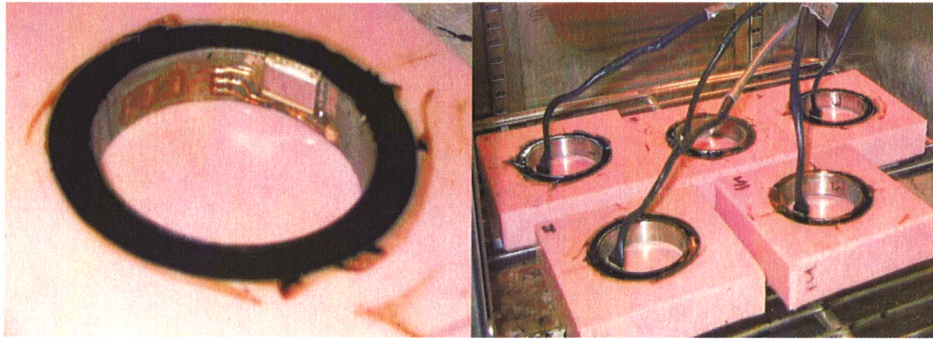
2007

### Description

Product: A simple, reliable test for determining thermal cracking temperature of asphalt

The Asphalt Binder Cracking Device (ABCD) is a simple equipment that accurately measures the low temperature thermal cracking potential of modified asphalt binders that current AASHTO binder specifications are not able to do. For ABCD test, a circular asphalt binder specimen is prepared on the outside of a 2 in. diameter Invar ring. Invar is a steel alloy with near zero CTE. As the temperature is lowered, the thermal stress within the asphalt specimen increases until it fractures. The device also allows accurate measurement of asphalt strength at low temperatures that until now had been problematic.

The IDEA product, further developed and evaluated with support from FHWA's Highways for Life Program, is commercially available from EZ Asphalt, Inc. based in Athens, Ohio. Due to limited commercial production, it currently costs about \$50,000, but the cost is likely to come down significantly when increased usage would require large volume production.



Asphalt binder cracking device (ABCD)

### Benefits

Low temperature thermal cracking is a major type of asphalt pavement failure requiring state DOTs to allocate significant financial resources to repair cracked pavements. To minimize premature failure due to thermal cracking, it is essential to properly grade asphalt binders for the expected climatic environment. The ABCD simulates cracking in the field as it monitors thermal stress induced by a lowering of temperature in an asphalt specimen molded onto an Invar ring. The device directly reads cracking temperature and allows simultaneous testing of multiple specimens (up to 16 specimens) saving time and money. It can be used by itself or in conjunction with other test methods to accurately grade asphalt binders for low temperature performance. In field tests, ABCD cracking temperatures correlated consistently better with crack severities of test pavement than AASHTO M320 critical temperatures. The ABCD can also measure polymer modification effects on the low

temperature thermal cracking as well as the fracture strength of asphalt binders at the cracking temperature. The ABCD test has been found to be more accurate than the current Bending Beam Rheometer (BBR) test and with further validation may eventually replace the BBR test.

### **Applications**

The IDEA product was selected by the FHWA's Highways for Life Program to facilitate its further refinement, evaluation and commercialization. The state DOTs and Canadian provinces that participated in evaluating ABCD for accuracy, reproducibility, and ease of use included Alaska, Florida, Iowa, Kansas, Massachusetts, Minnesota, Montana, New Hampshire, New York, Ohio, Oregon, Texas, Vermont, Virginia, Washington, Wyoming, and Ontario, Canada, along with FHWA. A number of private industries such as Exxon Mobil, Mathy Technology and Engineering, and the Hudson Company also participated. The test was also used in Minnesota's MnRoad project. Based on performance results to-date, a draft AASHTO test procedure has been submitted to the AASHTO subcommittee on materials for review.

**Examples of NCHRP IDEA Products Supported by State  
DOTs through Pooled Funds for further Evaluation and  
Implementation**

## **Three-Dimensional Digital Imaging for Management of Unstable Highway Slopes (Project #119)**

### **Inventor/Investigator**

John Kemeny

### **IDEA Funding**

\$99,500

### **IDEA Project Completion**

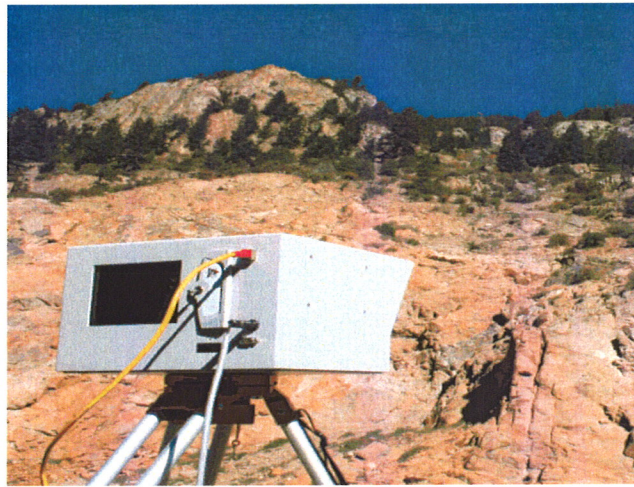
2008

### **Description**

Product: A software system for the identification, evaluation and management of unstable highway slopes

The software system (Split-FX) includes tools for rock mass characterization (finding discontinuities and their orientation, stereonet plotting), determining rockfall hazard ratings (slope and highway geometries, geotechnical factors, human exposure factors), and detecting ground movement between successive scans.

The Split-FX software is available from Split Engineering, Inc. (Tucson, Arizona) at a cost of about \$8,000 including all the accessories. It has been purchased by the pooled fund participant states and several other agencies including the U.S. Bureau of Reclamation and the British Geological Survey.



**Ground-based three-dimensional laser (LIDAR) scanning for analysis by Split-FX software**

### **Benefits**

There are thousands of miles of potentially unstable highway slopes in the U.S., far too many to analyze using traditional geotechnical techniques. Characterization and categorization of comparatively high risk slopes remains a labor-intensive task that is further complicated by the broad range of geologic conditions that influence rockfall hazards. The software (Split-FX) developed in the IDEA project allows highway slopes to be analyzed quickly, accurately, and without many of the safety hazards associated with traditional geotechnical surveying, by processing point clouds from ground-based LIDAR scanning (it can be carried out from distances as far as 2 kilometers).

## **Applications**

The developed software system was field tested and validated at a number of field sites in Arizona, Colorado and Utah with assistance from the respective DOTs. These sites included Mount Lemmon Highway (Mileposts 2 and 5) and Highway 60 near Globe in Arizona, Interstate 70 near Georgetown, Interstate 70 through Glenwood Canyon, and State Route 74 near Morrison in Colorado, State Route 190 at Big Cottonwood Canyon in Utah. Alaska DOT is also doing its own evaluation of the IDEA product for its use.

Further evaluation with a goal to implement the technology has continued through a pooled fund study involving eight states (Arizona, California, Colorado, New York, New Hampshire, Pennsylvania, Tennessee, and Texas) – [TP-5(166)]. The focus is on the geotechnical evaluation of potentially unstable slopes, including change detection that may affect the construction and maintenance activities of highways. Arizona is the lead state on this study (Christ Dimitritroplos of Arizona DOT is study administrator). Currently, scanning of sites in each of the eight states is underway. For instance, a slope along Interstate 40 near Flagstaff in Arizona and several slopes along Highway 375 near El Paso in Texas are being investigated. A major deliverable of this study will be a draft ‘Recommended Practice’ for AASHTO’s review.

The IDEA product is also able to analyze scans taken of the same location but at different times to look for changes due to rock movement and rockfall. This has led to funding by the National Science Foundation’s SBIR program to further extend the IDEA work to develop a low-cost LIDAR scanner that can be set up in the field to continuously scan a site and monitor for changes, particularly for highways and other geo-infrastructure sites such as bridge foundations, tunnels and dams.

## Instrumentation to Aid in Steel Bridge Fabrication (Project #127)

### Inventor/Investigator

Paul Fuchs

### IDEA Funding

\$140,000

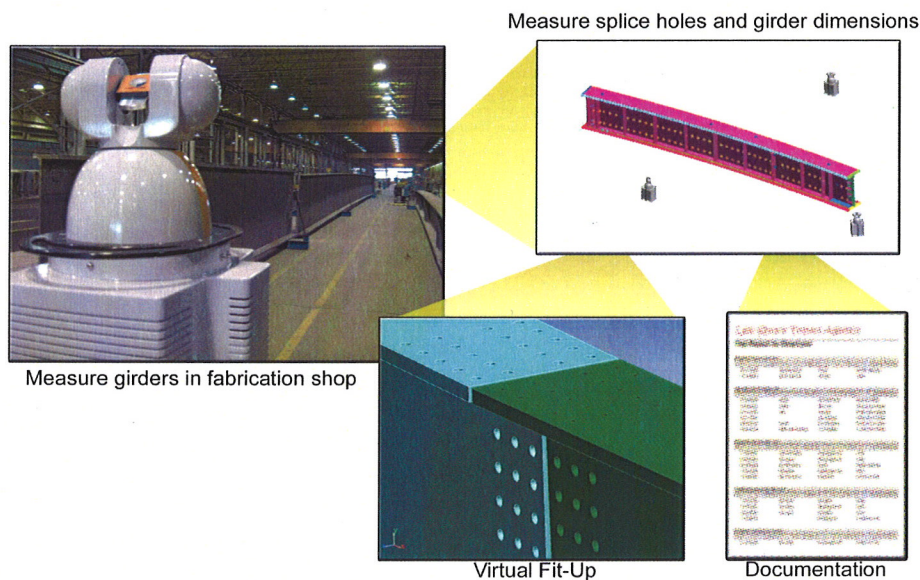
### IDEA Project Completion

2009

### Description

Product: A laser-based bridge measurement system to improve the quality and reduce the cost of complex steel bridge fabrication by precisely measuring fabricated components, and a virtual assembly software to take data from measured components and fit them together virtually without physical shop assembly

The system, designed specifically for steel bridge fabrication, measures accurately and precisely all aspects of bridge components, including splice hole locations, camber, sweep, and end-kick in a nearly fully-automated manner.



### System concept for laser measurement of steel bridge girders

#### Benefits

The measurement system would not only reduce or eliminate the need for shop fit-up and assembly (potentially saving millions of dollars in expenses) by providing a virtual assembly capability using specialized modeling and analysis software but could also allow for the use of complex steel bridge designs in circumstances previously considered impractical. It can identify errors at the shop allowing repairs to be made prior to painting and shipment to a job site and can provide a permanent record for a bridge fabricator of what was produced. The system can be used as a quality control tool to document as-built conditions of girders and as a virtual fit-up tool to eliminate shop assembly. Currently, there is no laser-based measurement system in

existence that can measure very large and very complex girders as accurately and rapidly and with as little operator intervention as the IDEA product.

There are many documented cases of steel bridge erection problems, particularly for complex structures, such as curved girders and box structures. In 2001, the Virginia DOT was faced with a problem at the Magruder Boulevard over I-64 Bridge in Hampton where an incorrectly fabricated girder was not identified until most of the structure was erected and some components did not fit together. This single incident resulted in millions of dollars in legal expenses, re-fabrication expenses, and delays in construction of the bridge. Because of these types of problems, most states require a steel bridge fabricator to shop assemble some or all parts of a steel bridge to make sure that the structure, primarily the splice plates and cross frames, will fit together at the job site as designed. However, this shop assembly procedure is labor and time-intensive and adds significantly to the cost. In addition, quality control data is typically taken by hand with string lines and rulers and recorded manually on paper reports. This process can sometimes contain errors (such as, wrong number written down or errors in measurements) and does not provide a complete permanent record of a fabricated component. The IDEA-developed laser based bridge measurement system will eliminate or minimize these problems, improve the quality, and reduce the cost of complex bridge fabrication.

### **Applications**

FHWA and two private manufacturers (High Steel Structure, Inc. of Lancaster, Pennsylvania and Eggers Steel Company of Sioux Falls, South Dakota) collaborated in the testing of the IDEA product. The IDEA product is being further developed and evaluated for its application to complex bridge structures in a pooled fund study involving four states (Virginia, New York, Iowa, and Texas) along with FHWA – [TP-5(226)]. Virginia is the lead state for this study (Jose Gomez of Virginia DOT is the project administrator). A leading private bridge fabricator, Hirschfeld Industries, based in San Angelo, Texas, is also collaborating in this evaluation and will help commercialize the product. As stated in the pooled-fund study announcement, the use of this laser system on just one complex bridge job could result in benefits that would exceed the cost of this entire pooled fund project.

**Examples of Some Recent NCHRP IDEA Products with  
High Near-Term Implementation Potential**

## **Non Destructive Evaluation of Internal Grout Condition inside Bridge Post-Tensioning Ducts using Rolling Stress Waves (Project # 102)**

### **Inventor/Investigator**

Larry Olson and Yajai Tinkey

### **IDEA Funding**

\$85,000

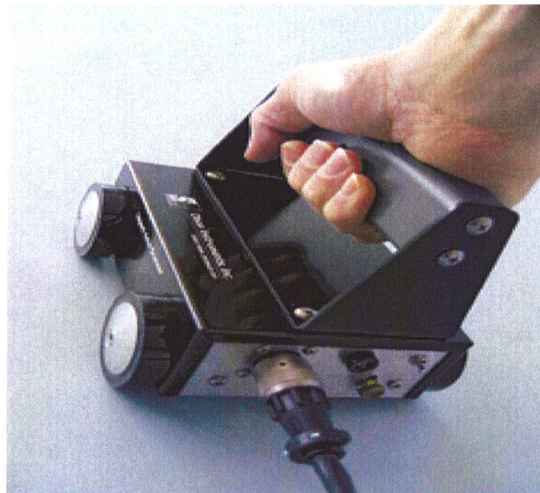
### **IDEA Project Completion**

2008

### **Description**

Product: A hand-held impact echo scanner for nondestructive evaluation of grout/void in post-tensioned bridge ducts for tendon corrosion mitigation and to image void, honeycomb, thickness and cracking damage in structural concrete

Using a combination of stress wave techniques to measure surface, shear, and compression waves, the scanning technology produces 3-D impact echo data that helps visualize ungrouted spaces within the duct. The upgraded IDEA product is commercially available from Olson Instruments, Inc. (Wheat Ridge, Colorado) and is being marketed both in the U.S. and overseas. The scanner along with its data acquisition and analysis system and technical support currently costs about \$23,000.



**Impact echo scanner**

### **Benefits**

Highway agencies can mitigate the risk of corrosion of post-tensioning strands by using impact echo scanning to locate areas of void in need of grouting repairs for both new and old bridges. Scan rates are rapid, on the order of 14 feet per minute, detecting voids both in steel and plastic post-tensioning ducts.

### **Applications**

At least, eight state DOTs have evaluated the scanner technology in their bridge projects. Virginia DOT has

purchased an impact echo scanner and is evaluating it for various applications. According to Dr. Stephen Sharp of Virginia Transportation Research Council, the device works well although they have yet to use it on grouted tendons. They have used it to locate distress/delaminations in box beams and to locate poorly consolidated concrete in a parapet and other applications. It has performed quite well in all the applications they have used it for.

Other agencies and institutions that have purchased the scanner system in addition to Virginia DOT include Metropolitan Water District of Southern California, Pennsylvania State University, BAM Federal Institute for Materials Research and Testing in Berlin, Germany, and King Abdul Aziz Center for Science and Technology in Riyadh, Saudi Arabia. China has been the biggest overseas customer of the IDEA product where over 20 units have been sold to various agencies and institutions.

## **BCD: A Soil Compaction Control Measurement Instrument (Project #118)**

### **Inventor/Investigator**

Jean-Louis Briaud

### **IDEA Funding**

\$95,000

### **IDEA Project Completion**

2009

### **Description**

Product: A portable equipment using a bending plate for rapid measurement of soil modulus both in the laboratory and the field to verify attainment of proper soil compaction

The Briaud Compaction Device (BCD) is a simple, small-strain non-destructive testing apparatus that works by applying a small repeatable load to a thin plate in contact with the compacted soil. The resulting deflections of thin plates are measured with radial and axial strain gages mounted on the thin plate. The software within the device uses correlations determined from field and laboratory tests in order to calculate strain modulus, referred to as the BCD modulus. The device is commercially available from Roctest, Inc., based in Montreal, Canada, with sales offices in Charleston, South Carolina and Seaside, California. The latest version of the device costs about \$10,000.



**Briaud compaction device (BCD)**

### **Benefits**

Controlling soil compaction for projects such as building roadway bases and backfilling retaining walls is essential to limit the extent to which soil will deform under stress. Highway agencies need modulus measurement because the trend is towards controlling compaction on the basis of modulus rather than dry density. The Briaud Compaction Device (BCD) allows the engineer to determine the target modulus value in the laboratory, write it in the specifications, and verify that proper compaction has been achieved by using the device in the field. Since modulus is very sensitive to how it is measured, it is critical to measure it the same way both in the laboratory and the field. BCD is the only tool in the market that allows one to do this and takes only a few seconds for the measurement.

## **Applications**

Florida DOT has purchased a BCD unit and is currently evaluating it in its projects. According to Dr. David Horhota of Florida DOT, although they have not tested BCD extensively, the evaluation so far indicates that the device gives consistent and reproducible results even when used by different operators. However, when compared with results obtained by standard methods, the BCD shows weak to moderate correlations that need to be improved. The IDEA researcher is working to improve the correlations.

Other agencies and institution that have acquired the BCD include Geotechnics, Inc., a geotechnical firm in New Zealand, the Missouri University of Science and Technology, and the University of New Mexico. The University of New Mexico plans to use it on a project for the New Mexico DOT. Following a demonstration project in New York about a year ago, FHWA had also expressed interest in acquiring a few units for evaluation but has not done so yet. The instrument is expected to have a widespread use once specifications requiring modulus-based compaction are developed and relevant AASHTO standards become available.