State DOT Bridge Monitoring Studies

Prepared by John Duke

The term structural health monitoring with regard to bridge structures encompasses a broad range of monitoring approaches ranging from focused technology-based data gathering to comprehensive systems for globally assessing the behavior of a bridge structure. Below is information that is readily available from an internet search of studies funded by various State DOTs. If a report was available and discovered, at the time this study was conducted (early 2014), the citation for the report is provided otherwise only basic information about the nature of the monitoring is provided gleaned from press releases, or news articles. It is not meant to suggest that this is comprehensive since undoubtedly other work has been done, but if it is not readily accessible it has not been included. Also the work listed here is limited to those studies where it is clear a State DOT was involved.

The purpose is to offer State DOT personnel with an interest in using such technology-based monitoring an idea about which other States may have some previous experience with such monitoring.

**Alabama DOT (Auburn University Report 2008)**

Alabama DOT maintains within it Maintenance Bureau a Bridge Rating and Load Testing section, which it feels is state-of-the-art. Identified need for

1. Barge Impact- Instrumentation needed for detecting occurrence, location, direction of impact.
2. Hurricane Aftermath assessment (other) – rapid assessment of bridge geometry mentions desire for vehicle based system...
3. Streambed Scour- Detect and assess during peak flow
4. Overweight vehicle assessment- need for a portable system to determine number of axles, weight etc.
5. Bridge Health Monitoring- system which can identify potential problems where more targeted bridge monitoring is appropriate.
6. Has list of questions for potential vendors.

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**Alaska DOT** *Bridges Structural Health Monitoring and Deterioration Detection Synthesis of Knowledge and Technology, Alaska University Transportation Center, Sept. 2010.* The authors conclude “In summary, the report explains the basic knowledge of structural health monitoring, and summarizes the commercially available SHM products and systems. Many companies claim to offer ‘turn-key’ systems that can be easily used to the bridge SHM. Quite a number of bridges have been instrumented with SHM systems and are under monitoring, but literature of the system performance, monitoring results, and how they helped the bridge owners are often not available.”
Arizona DOT no items identified

Arkansas State Highway and Transportation Division (AHTD) uses continuous automated traffic monitoring of vehicle volume, vehicle classification and WIM. Also work during FY 2012 and 2013 was direct at developing an automated image processing system for crack detection. In FY 2012 high definition cameras were used in conjunction with helium filled balloons for imaging bridges. AHTD has funded various research programs at universities within the state.

California Department of Transportation CALTRANS- Long-term Structural Performance Monitoring of Bridges done by University of California –Irvine (Vibration Monitoring to determine element stiffness)

Colorado DOT installed equipment in early September under the Williams Canyon Bridge on U.S. 24 at the west end of Manitou Springs. With the technology in place, CDOT will be able to monitor the structure’s movements from its Denver headquarters. It is the first bridge in the state to have this technology.

“We’re in the testing phase at this point but it’s important to find out how well it works in order to better manage our bridge infrastructure,” said CDOT Staff Bridge Manager Josh Laipply. “If it proves successful, we’ll install these sensors on other structures throughout the state, allowing us to monitor a variety of characteristics, such as load capacity and bridge movement, which will enhance everything that we’re already doing as part of our inspection program.” Parsons is the engineering firm that assisted CDOT with installation of the system under a $150,000 contract. Other entities currently utilizing this technology include the transportation departments in Pennsylvania, Massachusetts, South Carolina and New York, and the Canadian Pacific Railroad.


District of Columbia DOT no items identified

Delaware DOT (Delaware Transportation Center http://www.ce.udel.edu/dct/Publications.html)

In-service Monitoring for Improved Maintenance and Management of DELDOT’s Bridges, University of Delaware, Jan. 2012 describes short-term strain monitoring over an extended period of time, including repeated measurements on the same structures. The strains are used for determining load ratings. This report mentions that long-term monitoring for some bridge structures (signature bridges) is occurring.

Load Rating of Bridges without Plans (DCT 195) Nov.2007 describes loading tests and procedures for load rating. It cautions about measuring “strains” in concrete and suggests measuring displacements because of possible cracking in the vicinity of the strain gage.
Development of Delaware’s First Smart Bridge (DCT 194) Oct. 2007 describes the process for determining structural monitoring sensors and placement, consistent with LTBP program guidance. The installation of instrumentation on the I-495 Bridge over Edgemoor Road north of Wilmington as well as intentions to install an SHM system during construction on the Indian River Bridge. The Indian River Inlet Bridge has approximately 88 fiber optic sensors some of which measure strain, acceleration, tilt, and vibration. There are also sensors which monitor wind speed and direction, and chlorides in the deck. The fiber optic sensors are built by Micron Optics, integrated by Cleveland Electric Labs and Chandler Monitoring Systems.

Florida DOT Long Term Bridge Maintenance Monitoring Demonstration on a Moveable Bridge, June 2010 (Univ. of Central Florida) describes bridge health monitoring for maintenance purposes.

Remote monitoring of Bridges, July 2011(Univ. of South Florida) describes a 24 month project to monitor the cathodic protection systems on two bridges on I-75.

Florida DOT also has instrumented some bridges with ultrasonic wind sensor attached to a datalogger which computes wind speeds and communicates via a National Oceanographic and Atmospheric Administration (NOAA) Geostationary Operational Environmental satellite (GOES); the satellite transmitters are solar powered.

Georgia DOT uses a system called BridgeWatch (USEngineering Solutions http://www.usengineeringsolutions.com/solutions/bridgewatch/) to monitor scour critical bridges. The system collects and processes real-time data at regular intervals from weather and hydrologic sources, meters and gauges, and other sensing devices; it alerts when system alert levels are exceeded via cellphone or other modes.

Hawaii DOT- Professors from University of Hawaii use electrical-resistance and fiber optic strain gages and accelerometers to monitor shaking in the bridge and surrounding soil, they also use to sonar to chart scour.

Idaho Transportation Department uses BridgeWatch for monitoring possible scour issues


Illinois DOT also uses BridgeWatch for web-based bridge scour monitoring and has used instrumentation on the I-72 bridge over the Sagamon River for monitoring substructure settlement and rotation caused by mine subsidence Jan. 2011.

Indiana DOT Development and Verification of Web-based Bridge Monitoring Interface FHWA/IN/JTRP-2013/13 Purdue University April 2013 describes the use of an accelerometer for impact detection and triggering of a digital network camera to monitor bridge impacts for a low vertical clearance structure. Monitoring of Long-Term Performance of highway Bridge Columns Retrofitted by Advanced Composite Jackets in Indiana, FHWA/IN/JTRP-2000/3, July 2000, Purdue University describes monitoring strain gages and thermocouples to assess the performance of FRP wrapped columns. Also Purdue University (for Indiana DOT) used monitoring of thermocouples, thermistors, inclinometers, string potentiometer on during emergency repair work on I-64 Sherman Minton Bridge over the Ohio River.
Iowa DOT had Iowa State University monitor the HPS East 12th Street Bridge over I-235 using FBG sensors ~2004. Iowa DOT has Iowa State University conduct research for using monitoring for various applications including supporting load rating.

Kansas DOT Field Instrumentation and Monitoring of Kansas Department of Transportation Fiber Composite Bridge for Long-term Behavior Assessment K-TRAN:KU-00-11 University of Kansas April 2005 describes monitoring of FRP bridge decks.


Louisiana DOT and Development contracted with CTL Group to monitor the Huey P. Long Bridge using 827 static and dynamic strain gages to measure axial and bending load effects; tilt meters monitored the inclination of the piers. Louisiana DOTD initially funded Louisiana State University and more recently (2013) Straen to install the Osmos WIM and GEOCOMP to install more than 350 devices including strain gages, corrosion meters, tilt meters, extensometer, inclinometers, accelerometers and water pressure cells on the I-10 Twin Spans near New Orleans. Some sensors are embedded in the substructure and some in the superstructure.

Maine DOT allowed University of Maine (2013) to install fiber optic sensors to monitor the tension of carbon fiber strands in the continuous cable stay system of the Penobscot Narrows Bridge.

Maryland SHA Low Cost Structural Health Monitoring of Bridges Using Wireless SenSpot Sensors, MD-12-SP109B4M, University of Maryland, May 2012 describes monitoring of wireless low powered humidity, temperature, strain and crack sensors and tilt inclinometers on the I-495 Northwest Branch Bridge; sensors are made by RESENSYS a small business run by the project PI.

Massachusetts DOT has funded Tufts University working with Geocomp Corp to install and monitor 100 strain gages, 15 tilt meters, 16 accelerometers, 30 concrete deck temperature sensors, 36 girder temperature sensors, 3 ambient temperature sensors, and two pressure plates on the Vernon Avenue Bridge over the Ware River, October 2009.

Michigan DOT A Sensor Network System for the Health Monitoring of the Parkview Bridge Deck RC 1536, Western Michigan University January 2010, describes monitoring the Parkview Bridge deck in Kalamazoo, during and after rapid-bridge-construction. The system monitors data from vibrating wire strain and temperature sensors. Monitoring the Health of Michigan Bridges, MDOT ORBP Newsletter, October 2011, briefly describes an installation of vibrating wire strain gages with wireless communication nodes on the Mackinac Bridge as well as a solar powered system on the Cut River Bridge to monitor 16 fiber-optics strain sensors, embedded bridge deck sensors to detect moisture content deck temperature, chloride content and icing conditions. Detectors installed in travel lanes before the bridge detect traffic speed, volume and occupancy of vehicles passing over the bridge. CCTV cameras verify surface conditions and vehicle type. An environmental weather station monitors weather.
data and logs the deck sensor data. A WIM a mile away collects data on vehicles crossing the bridge. A civil engineering consulting firm is managing and analyzing the collected data.

**Minnesota DOT** Bridge Health Monitoring and Inspections – A Survey of Methods MN/RC 2009-29, September 2009, University of Minnesota lead MinnDOT at that time to observe: “While many products are available, most systems would serve as components of a global monitoring strategy that needs to be developed independently. Specific monitoring needs like crack width and girder strain are addressed, but judgments regarding bridge health require further evaluation of the output from these monitoring systems. In particular, reliable, robust systems for warning of imminent collapse have yet to be developed and will likely be a system composed of the pieces that are currently available.” Development of an Advanced Structural Monitoring System MN/RC 2010-39, University of Minnesota, Nov. 2010 describes the development of specifications as the basis for seeking a commercial vendor for acoustic emission monitoring of the Cedar Avenue Bridge (MN 77) in Burnsville, MN, a fracture critical tied arch bridge. Structural Health Monitoring System for the new I-35 W St Anthony Falls Bridge, 4th Int’l conference on SHM on Intelligent Infrastructure (SHMII-4) July 2009, describes the monitoring sensors which include fiber optic sensors, vibrating wire sensors, embedded chloride detection sensors and humidity sensors.

University of Minnesota also performed a study 2001 to monitored cyclic stress effects on Bridge 9340 of I-35W. The results are reported in Fatigue Evaluation of the Deck Truss of Bridge 9340, MN/RC—2001-10, March 2001 (available 6/30/2014 at [http://www.lrrb.org/media/reports/200110.pdf](http://www.lrrb.org/media/reports/200110.pdf)).

**Mississippi DOT** no items identified

**Missouri DOT** Remote Health Monitoring for Asset Management OR09-019, University of Missouri-Columbia, March 2009 describes an instrumented pile for use in scour monitoring. An undated report described work done by University of Missouri-Rolla using a laser measuring system for remote metrology of bridge structures.

**Montana DOT** no items identified

**Nebraska DOT** Long Term Monitoring of a Steel Bridge During construction Using Phase Construction SPR-PL-1 (038) P530, July 2005, University of Nebraska describes monitoring of the Dodge Street Bridge over I-480; sensors included vibrating wire strain gages, ambient temperature sensors. Monitoring was conducted over a 5 year period which continued for a timer after construction was completed.

**Nevada DOT** uses pavement sensors to trigger de-icing spraying from recessed pavement disks.

**New Hampshire DOT** In-service Performance Monitoring of a CFRP Reinforced HPC Bridge Deck, FHWA-NH-RD-142821, August 2010, University of New Hampshire describes a study where 80 (during construction 2000) fiber optic strain and temperature sensors were installed on the Rollins Road Bridge and at the time of the report 50 remained operational.

**New Jersey DOT** in April 2007 NJDOT contracted MATECH to utilize its electrochemical fatigue sensors (EFS) to monitor crack growth of known cracks as well as other regions where cracks were repaired, still other regions where details suggested fatigue cracks might form. The US 202/NJ 23 Bridge at Wayne, NJ has been instrumented with fiber optics sensors for
monitoring strains. NJDOT uses over-height vehicles detection systems (OVDS) to warn truck drivers that their vehicles are too high for upcoming bridge clearance.

**New Mexico DOT** has experience with the use of optical fiber sensors with the I-10 bridge in Las Cruces and the I-24 bridge in Dona Ana.

**New York DOT** *Development of a Smart Bridge Bearings System – A Feasibility Study Project C-02-02, December 2005, The City College of New York* describes different instrumentation approaches for monitoring bearings. It is likely that more work has been done, but only items where explicit NYDOT sponsorship was involved, and for which a timeframe and report were accessed have been included.

**North Carolina DOT** *Infrastructure Investment Protection with LiDAR FHWA/NC/2012-15, Oct. 2012 North Carolina State University* describes a study to identify possible applications for this technology.

**North Dakota DOT** no items identified

**Ohio DOT** *Instrumentation of the US Grant Bridge for monitoring of fabrication, erection, In-service Behavior, and to support Management, Maintenance, and Inspection, FHWA/OH-2013/23, Dec. 2013 University of Cincinnati* describes monitoring of the US Grant Bridge over the Ohio River. Data was collected during and after construction to enable comprehensive analysis of the structure and to compare with finite element models.

**Oregon DOT** has instrumented the lift span of the southbound portion of I-5 Bridge over the Columbia River near Portland using tiltmeters and laser position sensors to monitor the lift system performance. They have also instrumented the steel-tied arch Fremont Bridge in Portland with 64 for sensors measuring strain and surface temperature in an effort to measure the thermally induced stress cycles. They have also instrumented the steel box girder Kamal’s Bridge in Tualatin over I-5to measure the strains in the box girder and cross-beam diaphragms, as well as any rotation between them; the surface and ambient temperatures were measure as well all to understand the effectiveness of retrofits of fatigue cracks. *Applications of Structural Health Monitoring to Highway Bridges (ftp://ftp.odot.state.or.us/Bridge/SHM/SHM_SCL_submission.pdf)* describes 6 different types of monitoring efforts bridge foundations, concrete superstructures, moveable bridges, structural dynamics, steel fatigue, and corrosion protection. Details of the various instrumentations for these different applications are provided along with cost information.

**Pennsylvania DOT (Penn DOT)** no items identified

**Puerto Rico DOT** no items identified

**Rhode Island DOT** extensive use is made of sensing for traffic congestion messaging on I-95.

**South Carolina DOT** used strain and temperature monitoring instrumentation on the old Great Pee Dee River Bridge during construction of the new bridge. *Load Testing for Assessment and Rating of Highway Bridges, Research Report 655, Clemson University, January 2006* describes using Bridge Diagnostics strain transducers as part of a testing and analysis procedure to load rate bridges.

**South Dakota DOT** uses unmanned aerial vehicles for various surveys, although no specific bridge related study was found. Also in early 2000s SDDOT monitored two bridges on I-29
near Sioux Falls; in particular high-strength prestressed concrete girders and low permeability bridge decks were monitored using strain gages, temperature sensors, and electrical measurements for correlation with the concrete permeability. No report regarding this study was found.

**Tennessee DOT** uses BridgeWatch for scour monitoring.

**Texas DOT** *Evaluation of Two Monitoring Systems for Significant Bridges in Texas, FHWA/TX-04/0-4096-1, January 2004, University of Texas at Austin* describes a study to evaluate two monitoring systems. One is a battery-powered single channel strain gage unit with rainflow counting algorithm for use in evaluating fracture critical bridges. The second system used global positioning sensors (GPS) with time averaging for use in assessing bridge displacements.

**Utah DOT** *Health Monitoring of Precast Bridge Deck Panels Reinforced with Glass Fiber Reinforced Polymer (GFRP) Bars Report no. UT-12.03, March 2012, University of Utah* describes collection of concrete strains, bridge deflections, vertical girder accelerations, as well as load testing. *Structural Health Monitoring: Long-term, real-time ambient vibration monitoring system, UMI Publication no. 1445053, November 2007 Utah State University* describes the system placed on UDOT Bridge C846 along I-15 consisting of 18 strong motion accelerometers to monitoring ambient vibration data induced by traffic and wind.

**Vermont Agency of Transportation** has installed 28 strain sensors and 10 accelerometers on Bridge 58 N&S along I-89 to monitor the dynamic response due to concerns regarding the grade of steel used during construction, 2012. *Performance Monitoring of Jointless Bridges – Phase III Interim Report, 2011-6 University of Massachusetts Amherst, April 2011* describes instrumentation of three jointless bridges. The focus is on determining passive and active pressures at the abutment and wing walls, abutment movements (lateral, longitudinal and rotational, pile strains to monitor yielding and locations of positive and negative moments, strains in girders at critical locations and pile deformations.

**Virginia DOT** has experience with acoustic emission monitoring for various applications.

**Washington DOT** no items identified

**West Virginia DOT** no items identified


**Wyoming DOT** *Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, April 2013, University of Wyoming* describes development of fiber optic strain sensors and associated instrumentation.

The following item is reprinted in its entirety and is hopefully self-explanatory:
AASHTO's Member State DOTs Are Using Smart Technology to Keep Infrastructure Operating Safely

Autonomous Vehicles Are Tomorrow: Here's What Transportation Technology Is Doing Today

The Galena Creek Bridge in Washoe County, located between Carson City and Reno, Nevada. “State DOTs are dramatically improving the way transportation systems, services and information are being delivered, shared and utilized all across the country.” Washington (PRWEB) August 30, 2013

Just as patients communicate their symptoms to doctors – smart technology is allowing infrastructure to tell civil engineers when something is wrong. Sensors installed on bridges, in roadways, and on maintenance vehicles, are communicating real-time performance and weather data, allowing engineers to solve problems before they occur.

“Most people look at a road or a bridge and never realize the technology that today’s modern transportation agencies are using to help our transportation system function at its best,” said Bud Wright, executive director of the American Association of State Highway and Transportation Association. “State DOTs are dramatically improving the way transportation systems, services and information are being delivered, shared and utilized all across the country.”

Smarter Decisions

The North Carolina Department of Transportation is using 3-D imaging to dramatically improve the process of conducting annual pavement condition surveys on the state’s 16,000 miles of interstate and primary roadways. The surveys, which relied on visual assessments taken from slow moving vehicles on highway shoulders, previously took hundreds of man-hours. Today a contractor, using a specially equipped vehicle takes two sets of images as it passes over a roadway at normal highway speeds. A forward looking camera captures images of the highway while a 3-D camera photographs the pavement.

The pavement images are analyzed using a special software program which identifies every pavement defect. The data is used to calculate pavement quality and identify problems such as rutting caused by heavy loads.

Engineers can access all of the images and data via computer to help them make more accurate assessments and decisions. NCDOT’s Pavement Preservation and the Contract Resurfacing programs rely on this data to determine which roadways will be treated in the coming year.

“Not only is this improving the quality of the data being collected, it’s taking our pavement survey teams out of what can sometimes be a risky situation,” said Judith Corley-Lay, NCDOT pavement engineer. “This is a huge technological leap forward and I think as more states deploy it, we’ll be able to get an even better assessment of what’s occurring on our roadways, nationwide.”

Smart Maps

State departments of transportation are using a remarkable user-friendly computer mapping platform dubbed “UPlan.” This leading-edge technology combines and displays real-time information from data banks, both inside and outside transportation agencies in the form of maps. These multilayered displays make it easy to see the many ways proposed transportation projects will interface with the surrounding environment. Transportation projects can be created virtually to determine how they will match up with historical landmarks, population centers and environmentally sensitive spaces such as wetlands.

To date, 14 States (WA, OR, CA, AZ, NM, NV, CO, WY, ID, UT, MT, MN, NC and PA) have developed their own version of the platform through the Technology Implementation Group
(TIG), a peer-review program sponsored by the American Association of State Highway and Transportation Officials.

Smart Bridges

Modern bridges have built-in smart-technology. Hundreds of sensors are scattered throughout Minnesota Department of Transportation's I-35 West Bridge in Minneapolis and the I-10 Twin Span Bridge near New Orleans. The sensors provide data on vibration and corrosion and they can activate anti-icing systems, alert authorities when secure areas have been breached, and detect bridge strikes by anything ranging from a barge to a natural disaster.

The Nevada Department of Transportation (NDOT) Structures Division teamed up with the University of Nevada, Reno, to make the Galena Creek Bridge in Pleasant Valley a smart bridge. One of the largest "Cathedral Arch" bridges in the world, the 1,700 foot long structure has twin arches spanning 690 feet, supporting a bridge deck 295 feet above Galena Creek. The instrumentation system on the arches allows NDOT to perform "structural health monitoring" to evaluate the day-to-day performance of the bridge over its lifetime. The real-time data, communicated via the Internet, is being supplied by strain gauges, accelerometers and communication equipment installed while the bridge was constructed.

“This investment will allow NDOT engineers to monitor the bridge performance over their service life to help insure structural performance and effective, low-cost, long-term maintenance of these unique structures,” NDOT Director Rudy Malfabon said.

Sensors are also being added to existing bridges to extend their lifespans and detect anomalies that can be the first sign of trouble.

Engineers with the Kentucky Transportation Cabinet and other emergency responders are notified automatically when sensors measure the large magnitude barge impacts on two piers of the U.S. 41 North Bridge over the Ohio River. The bridge connects Henderson, Ky., and Evansville, Ind.

In Florida, GPS sensors have been installed on a flyover bridge in Miami and the Sunshine Skyway Bridge in Tampa. Data is collected continually throughout the day on how the bridges are behaving --measuring the movement, shrinkage and cracking of concrete.

By studying variations in the data, the Florida Department of Transportation (FDOT) can detect potential problems in the concrete or the cables that hold segments of the bridge together.

“We expect the data from these sensors to tell us what the bridge is actually experiencing and, if there are any problems, the data will likely assist us in providing a more appropriate and timely solution,” said FDOT District Structures Design Engineer Jorge A Rodriguez, P.E. “It’s too soon to assess the value of the data collected, however based on the results; we may want to add this to other bridges in the future.”

Improving Safety and Controlling Quality

The Oklahoma Department of Transportation and Oklahoma Department of Public Safety have teamed up to more efficiently process permit requests and create safe routes for commercial trucks carrying oversized or overweight loads. The Oklahoma Permitting and Routing Optimization System dubbed (OKiePROS) uses advanced GPS technology and real-time geographic and bridge information to quickly process requests on-line. Permits for oversized or overweight truck loads which use to take several days to issue, can now be processed in about 10 minutes.

Design and implementation of OKiePROS cost about $2.4 million and was funded through an appropriation by the state legislature. Last year, in its first year of operation, Oklahoma issued more than 250,000 permits; generating nearly $47 million in revenue and shattering previous state
records. Most importantly, there have been no bridge strikes or accidents involving properly permitted trucks.

“With OKiePROS, we can protect the traveling public and the state’s infrastructure while making the movement of goods more efficient,” ODOT Director Mike Patterson said. “Public safety, transportation and commerce all benefit from this technology.”

The Louisiana Department of Transportation and Development has turned to smart technology to help it more easily locate compaction problems in new road construction projects. Improper compaction of construction materials can lead to costly problems such as erosion, potholes or worse.

Louisiana DOTD is using Roller Integrated Compaction Monitoring (RICM) or intelligent compaction (IC) to measure the density of a road in real time. The system which uses GPS technology has the capability to measure continuous stretches of roadway, allowing contractors to find and fix problems fast.

“Our agency is constantly researching innovative technology,” said Louisiana DOTD Secretary Sherri H. LeBas. “The use of intelligent compaction on construction projects will not only contribute to cost savings, but also to the safety of the traveling public by enhancing the quality of roads.”

In an effort to minimize traffic congestion and improve safety the Virginia Department of Transportation is in the process of deploying an Active Traffic Management (ATM) system on Interstate 66 in Northern Virginia. ATM integrates information from a wide range of sources including cameras, pavement sensors, and driver input to enhance incident management, maximize roadway capacity, and promote environmental sustainability.

Weather Data and DOTs

In Alaska, extreme winter weather can occur quickly, which is why the Alaska Department of Transportation and Public Facilities (ADOT&PF) is equipping its fleet of maintenance vehicles with instruments to gather location-specific temperature and humidity data along roadways. The data are fed to a weather modeling system, or Maintenance Decision Support System (MDSS), which can forecast when and where roadway icing is likely to occur. Deicing equipment can be mobilized more quickly and efficiently.

“This kind of technology gives ADOT&PF the ability to be in two places at once,” said Mike Coffey, Maintenance & Operations Director for Alaska DOT. “Employees can keep an eye on infrastructure during extreme cold temperatures, and we can learn how the cold impacts structures. This technology is giving us real-time information to make smart decisions, fast.”

ADOT&PF is also using smart technology on the 414 mile, Dalton Highway; one of the most isolated roads in the United States. The sensors are monitoring and analyzing an enormous, moving, formation of frozen soil, rock, and ice that, if left unchecked, could block and/or damage the highway.

In 2014, ADOT&PF will deploy an avalanche monitoring system that will automatically report the location and severity of a slide enabling ADOT&PF to select the most appropriate times to temporarily delay traffic to conduct avalanche hazard reduction work.

For more information AASHTO’s Technology Implementation Group and its technology projects, visit: http://tig.transportation.org.
### TABLE F18

**BRIDGE MONITORING**

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<td>Visual monitor</td>
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<td></td>
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<td>Delaware</td>
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<tr>
<td>Idaho</td>
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<td>Crack length, crack progress</td>
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<tr>
<td>Iowa</td>
<td>Visual monitor</td>
<td>By district personnel; might not be team leader</td>
</tr>
<tr>
<td></td>
<td>Measurement</td>
<td>Crack opening, movement</td>
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<td>Kentucky</td>
<td>Visual monitor</td>
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<td>Maine</td>
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<td>Crack opening, deflection, movement</td>
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<tr>
<td></td>
<td>Instrumentation</td>
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<td>Missouri</td>
<td>Visual monitor</td>
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<td></td>
<td>Measurement</td>
<td>Crack opening, deflection, movement</td>
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<td>Montana</td>
<td>Visual monitor</td>
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<td>Nevada</td>
<td>Instrumentation</td>
<td>As appropriate until repaired</td>
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<td>New Jersey</td>
<td>Visual monitor</td>
<td>Tracking defect without interim inspection</td>
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<tr>
<td></td>
<td>Instrumentation</td>
<td>For scour displacement probes, sonar probes</td>
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<td>New Mexico</td>
<td>Measurement</td>
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<td>New York</td>
<td>Measurement</td>
<td>Crack growth</td>
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<td>North Carolina</td>
<td>Visual monitor</td>
<td>For progress of defect</td>
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<tr>
<td>North Dakota</td>
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<td>Ohio</td>
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<tr>
<td></td>
<td>Instrumentation</td>
<td>Acoustic emission, strain gages</td>
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<tr>
<td>Pennsylvania</td>
<td>Visual monitor</td>
<td>For scour, after high water by maintenance crew or county manager</td>
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<tr>
<td></td>
<td>Measurement</td>
<td>Movement</td>
</tr>
<tr>
<td></td>
<td>Instrumentation</td>
<td>Inclinometers, strain gages, other detectors</td>
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<tr>
<td>South Dakota</td>
<td>Visual monitor</td>
<td>For known defect</td>
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<tr>
<td>Tennessee</td>
<td>Visual monitor</td>
<td>For known defect</td>
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<tr>
<td>Texas</td>
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<td>Utah</td>
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<td>Instrumentation</td>
<td>Ultrasound, electrochemical crack detection</td>
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<td>Vermont</td>
<td>Visual monitor</td>
<td>For scour after high water, for crack growth, for movement</td>
</tr>
<tr>
<td>Virginia</td>
<td>Visual monitor</td>
<td>For known defect</td>
</tr>
<tr>
<td>Washington</td>
<td>Visual monitor</td>
<td>For known defect</td>
</tr>
<tr>
<td></td>
<td>Measurement</td>
<td>Movement, settlement, streambed profile</td>
</tr>
<tr>
<td>West Virginia</td>
<td>Visual monitor</td>
<td>For known defect</td>
</tr>
<tr>
<td></td>
<td>Measurement</td>
<td>Crack opening, deflection, movement</td>
</tr>
<tr>
<td></td>
<td>Instrumentation</td>
<td>Acoustic emission, strain gages, other detectors</td>
</tr>
</tbody>
</table>

EDM = electronic distance meter