Greetings,

Welcome to the newest edition of Hydrolink, the AASHTO Technical Committee on Hydrology and Hydraulics’ newsletter.

One of the goals of the TCHH is to support research. I am fortunate to serve as a panel member for an NCHRP study looking at improved contraction scour equations. At our last meeting I was again impressed by the facilities and staff that work on research projects. There is no better way to a Hydraulic Engineer’s heart than to show them a large-scale flume!

After returning to my office I was reminded of the reality of large project lists and tight budgets. Training and research are some of the first items to go under the microscope because they are often seen as non-essential. I wholeheartedly disagree. Whether you are talking about stormwater BMPs, scour or climate change, research in these areas is paramount in building cost effective and resilient infrastructure. One successful research project can pay dividends on 100’s of construction projects. I encourage everyone to develop a research plan, advocate for funding and participate in any way possible.

If you have any exciting research happening in your state you would like to share, or any unmet research needs please contact me.

I wish everyone a healthy and prosperous 2018.

-Nick

AASHTO NTPEP Background

The AASHTO National Transportation Product Evaluation Program (NTPEP) was established within AASHTO in 1994 as a technical service program with the purpose of evaluating material, products and devices of common interest for use in highway and bridge construction. NTPEP’s primary goal is to provide cost-effective product evaluations for the State Department of Transportation (DOTs). Work plans are developed by collaborative efforts of DOTs, and Manufacturers in the form of Technical Committees that meet regularly. Work plans simplify product evaluation, standardize product testing, and reduce duplication of efforts across State DOTs. They are “living” documents that are routinely updated, balloted, and voted on by AASHTO DOT member states. NTPEP contracts with third-party labs to perform product evaluations outlined in the work plan. Manufacturers submit products to the third-party lab and provide funding to complete the product evaluation in accordance to the work plan. Product testing results are published and shared to the public through NTPEP’s website application called DATAMINE. Users that have a State DOT email address may
Spray Applied Pipe Liners Technical Committee

A Technical Committee (TC) was created for Spray Applied Pipe Liners (SAPL) that consists of DOTs, manufacturers of resin based material, and manufacturers of cementitious based material. An early request from the DOT members was to ensure that the spray applied liner functioned as a structural liner. However, it was quickly realized that no standardized structural design methodology existed for this technology. Manufacturers utilize different design methodologies with some using the Cured-In-Place- Pipe (CIPP) ASTM 1216 methodology and others using various classical analytical structural design equations developed for other purposes. A gap in knowledge was identified and preliminary discussions for research among the SAPL TC members was formed. In the meantime, a collaborative work plan for SAPL was developed, balloted, and finally published in January 2017. A third-party lab was selected and contracted with NTPEP, which became active in October 2017.

The work plan includes ASTM and AASHTO tests to determine physical properties of each resin and cementitious materials as well as two optional structural tests developed by the SAPL TC. Manufacturers may choose between a “D-Load” type test for spray applied liners that behave like a rigid pipe and a “Parallel Plate” type test for spray applied liners that behave like a flexible pipe. Manufacturers may also choose to not perform a structural test or to perform both tests.

The “D-Load” type test requires three-edge bearing testing according to AASHTO T 280 to be performed on 6 – 48 inch reinforced concrete pipes to determine the design load that produces the 0.01-inch crack. Once cracked, the Manufacturer or their approved contractor will perform repair under the supervision of the lab per the following: 2 pipes with 0.5-inch thickness, 2 pipes with 1-inch thickness, and 2 pipes with 1.5-inch thickness. Once the repaired pipes are cured they will be subject to the three-edge bearing test and the interior spray applied liner will be monitored until the 0.01-inch crack is developed in the SAPL. Further loading will be applied to determine the ultimate load of the repaired pipe as well. Throughout the test, a constant load rate will be applied and a loading versus deflection curve will be developed.

The “Parallel Plate” type test will require the ASTM D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate testing to be performed on 6 round 48-inch removable forms or forms that lack stiffness. The Manufacturer or their approved contractor will apply the spray applied liner under the supervision of the lab per the following: 2 specimens at 0.25 inches, 2 specimens at 0.5 inches, and 2 specimens at 0.75 inches. Testing will be performed once the spray applied liner is fully cured and the specimen will be loaded and deflected per the ASTM D 2412 test.

At the time of writing of this article several SAPL vendors have submitted products for evaluation at the third-party lab and testing is underway. Results of the testing will be available through DATAMINE once testing is complete. DOT’s will be able to leverage the testing results to develop material specifications for SAPL products. The structural testing will yield relative results and give an indication of whether the liner provides a structural repair. However, further research is required to fully understand the design methodology and mechanics of SAPL products as a structural repair.
SAPL Research Need Statement

Discussions within the SAPL TC led to the development of a research need statement (RNS) to determine the structural design methodology for spray applied liners. After several iterations and funding considerations, the RNS became a pooled funded solicitation with Ohio DOT as the lead state.

A proposed design methodology for cementitious and resin SAPL that uses loading as detailed in the AASHTO LRFD Bridge Design Specifications is the primary deliverable of this research. The design methodology will incorporate various shapes: round, elliptical, pipe arch, arc, and box. Additional objectives will be to recommend laboratory testing methods to verify structural design, recommend laboratory methods to determine material durability, recommend laboratory physical material testing, and to recommend a performance based construction installation specification for SAPL products.

The funding commitment was achieved and a contingent of 6 DOTs (North Carolina, Florida, Pennsylvania, New York, Minnesota, and Ohio) are participating members. The RNS was posted through Ohio DOT’s Research Program and the University of Texas at Arlington was selected. Final contracting details are currently being vetted and the research is expected to commence in late 2017. The research will be active for approximately 2 years. Data collected via the SAPL NTPEP program will be incorporated into the pooled funded research project in addition to field and laboratory testing via the research project.

The research team will evaluate previously installed SAPL within the participating States in addition to locations identified by Industry. Site visits will be performed at select locations deemed significant by the research team with collaboration with the DOT participants. Design details such as plan sheets and submitted structural calculations will be collected and evaluated as part of the process.

Results and findings from the pooled funded research project will be incorporated into the AASHTO NTPEP SAPL TC work plan and will be shared with the AASHTO Subcommittee on Bridges and Structures T-13 Technical Committee.
Experts predict significant growth in the demand for qualified employees in science, technology, engineering and math fields. Aware of this, the Minnesota Department of Transportation (MnDOT) initiated their STEM education and outreach program for children, grades K-12 - Minnesota's future generations of civil engineers and technicians.

Our goal is to provide high quality activities and initiatives to help promote science, technology, engineering, and mathematics from kindergarten through post-secondary education. This includes presentations, activities, mentorships, or a host of other programs to encourage interest in STEM fields.

The primary tool to deliver this message is the Bridge UP! curriculum. The Bridge Up! curriculum, designed by teachers, MnDOT, and other external partners, is an interactive learning program that brings students closer to the everyday work of engineers and construction workers.

The curriculum provides teachers with resources that require little-to-no training in order to educate students. It includes three main components for different grade levels: an iBook (K-3), web modules (4-8), and lesson plans (K-12).

“Bridge UP! is really a gateway to STEM. We are reaching out to younger generations for a sort of early recruitment and retention,” said Nicole Bartelt, hydraulic design engineer and STEM education and outreach coordinator. “We also want to reach students from different communities. By working on the diversity aspect of our outreach efforts, we can reflect what the state of Minnesota looks like within MnDOT to better serve our community’s needs.”

A big part of the STEM outreach program is to promote our work to schools, before and after school programs, and other education groups. MnDOT encourages staff to do outreach activities, like bringing one of our Bridge-in-a-Bag kits to classrooms. The Bridge-in-a-Bag kit is a 6-ft long aluminum truss bridge that students can put together, test, crawl through, and then deconstruct. It is a great learning tool that shows young people how interests in science and math can be fun and rewarding.

Lastly, Minnesota is one of the AASHTO TRAC & RIDES participating states. This program provides high quality resources to teachers and professionals to promote transportation as a profession.

This effort has been well received by teachers and kids, and is a good outreach opportunity to the people and communities we serve. For other DOT’s interested in developing their own program contact Nicole Bartelt at stemoutreach.dot@state.mn.us for more information, or check out our website at www.mndot.gov/stem.
Construction Report – UV Cured CIPP Culvert Rehabilitation

The East of Glendive East project is located on Interstate 94 in Eastern Montana. Due to severely corrosive soils, piping, erosion, and several drainage structures needed to be rehabilitated or replaced. The following is a construction report documenting one of the culverts being rehabilitated with a Cured in Place Pipe (CIPP) pipe liner utilizing the Ultraviolet Light (UV) curing process. The UV curing process is in place of steam or hot water curing.

Work in Progress:

The contractor was installing a CIPP at station 453+89. The contractor elected to use an Ultra Violet light curing system to install this pipe. This is a newer technology than the standard steam cure method. This report will concentrate on the steps required for installation during construction. For detailed discussion of the material or CIPP design, please contact the Hydraulics section.

1. The first step in the process involves cleaning the existing pipe. The pipe must be clean so that when the liner is installed it will bond to the inside surface of the pipe. The pipe is cleaned with high pressure water and a vacuum truck. Deposits that are not removed by the water must be cleaned off by hand. The adjacent picture shows the pipe after cleaning. The soils in this area are very alkaline and corrode steel more quickly than normal. This pipe was asphalt coated when it was installed to help prevent corrosion. The asphalt coating is peeling off from the abrasion of the water and soil over the years.

2. A thin sheet of slick plastic is then pulled through the pipe. This plastic is coated in vegetable oil to reduce friction and protect the liner when it is pulled through the pipe.
3. The liner chosen by this contractor comes on large rolls. It is made of several layers of material. The outer layer is a plastic material that protects the inner layers. It has tiny pores in it that allow the resin used in the fiberglass to be injected into the roll. An inner liner helps hold the material in place. This is followed by three sheets of woven fiberglass material. Each sheet is oriented in a different direction to give the liner strength to resist loads in all directions.

4. A Caterpillar TL1255 was used to lift the roll of liner into place. The boom extends on this piece of equipment allowing it to maneuver the roll as close to the end of pipe as possible. The blue reel shown here was designed and patented by the contractor to speed up installation.

5. The liner is pulled from one side of the pipe to the other with a winch mounted on a skid steer. An aluminum fitting is placed in the end of the liner and secured with a ratchet strap to seal the liner.
6. A “light train” is inserted into the pipe. The train consists of four sets of wheels that extend out and make contact with the inside of the liner. There are 8 1000-watt UV lights on the device.

7. After the light train is inside the pipe both ends of the pipe are sealed with an aluminum fitting. A ratchet strap seals the liner to the fitting. The end of the liner must be shaded from sunlight during this stage of the work to avoid an early cure. Several feet of excess are left on each end of the pipe in case of accidental exposure to UV.

8. A four-inch hole in the fitting connects to a compressor mounted in on a truck. The liner is inflated inside the pipe using compressed air. The light train is pulled from one end of the pipe to the other. Two cameras on the train give the operator a view ahead of, and behind the lights. The inside of the liner is checked to ensure there are no holes, wrinkles, or imperfections in the liner. If everything looks good, the light train is pulled back through the pipe with the UV lights on. The resin hardens under UV light. The computer measures temperature and the rate the light train is pulled back through the liner. Using all 8 bulbs they can retrieve the light train at around 1 m/sec. The temperature of the inside reaches approximately 150 degrees Celsius.

9. The liner is very smooth when finished. The supplier stated that the new liner will have a 10-15% increase in flow over a standard CSP.
10. The hardened liner is shown above after being cut off and trimmed to the end of the pipe (the existing CSP is slightly bent outward in this photo). The cured liner is considered a structural member and can support the same loading as a CSP of similar size.

This UV curing system has several advantages over traditional CIPP that is cured with steam. It should be noted that this information was supplied by a tech rep for this material. After watching the installation, I tend to agree with their assessment, but a more in-depth review of their technical data should be completed to verify these claims.

- The glass fibers produce 4-5 times more strength than a standard polyester felt liner used in traditional CIPP.
- Standard CIPP liners that are cured at high temperatures must be refrigerated before use. The UV liners are not cured by temperature, so a refrigerated truck is not needed.
- Loss of refrigeration can ruin a standard CIPP liner.
- A traditional CIPP uses a boiler and larger compressor to cure the pipe using steam. This requires a significant amount of water and fuel to maintain temperature and pressure.
- The UV system uses 90% less fuel during installation.
- Traditional CIPP uses styrene in the epoxy. Styrene contamination while curing can result in a permit violation. This makes the traditional CIPP less desirable for installation in wetlands.

Interagency Coordination for Early Permitting

For State Transportation Agencies across the country, the time required to prepare, submit and acquire approval of environmental permit applications can have a significant impact on project schedules and ultimately project delivery. In the summer of 2012, the Connecticut Department of Transportation (CTDOT) and the Connecticut Department of Energy and Environmental Protection (CTDEEP), the agency that administers regulatory programs for State projects, held a joint “LEAN” (Kaizen) process in an effort to streamline the acquisition of environmental permits. The most significant interagency realization during this process was that the CTDOT often did not involve CTDEEP until just prior to permit submission, at the semi-final design stage or later. Typically, many decisions relating to the scope of improvements, roadway and/or bridge alignment, project footprint and associated resource impacts had already been made at that time; subsequent changes to the design for environmental permitting reasons or otherwise were highly undesirable, possibly delaying project delivery. In addition to early project level coordination on environmental issues, the following items were determined key to the process:
• A broader interagency discussion on other project issues, such as schedule, traffic operations, scope of work, cost limitations and municipal and public concerns.

• Larger permitting envelope that allows more flexibility for a contractor and fewer permit revisions in construction.

As a result, CTDOT and CTDEEP agreed to begin holding monthly screening meetings together on individual projects earlier in the design process. These meetings offered the opportunity to daylight environmental resource concerns early, have a recurring forum for engineers and regulators to resolve environmentally-related issues as they arise, promote better and more continuous communication between the agencies and to document the discussions and decisions made. Additionally, the LEAN team continued to meet on a regular basis to address broader permitting process and policy issues. Initial successes of these meetings included:

• Elimination of insufficient permit application submissions.

• Reductions in the average permit processing time.

• Significant reduction in the number of permit technical revisions.

Building upon these successes and the ensuing interagency cooperation, the following coordination measures have further evolved; Interagency Coordination Meetings and the CTDOT/CTDEEP Working Group.

Interagency Coordination Meeting (ICM)

The current ICM enables a more robust discussion of project level environmental issues and a consolidated and more efficient approach to the subsequent guidance provided. These monthly meetings provide a project-oriented face-to-face dialogue between Department engineers (including consultants) and representatives from all the regulatory agencies (CTDEEP, US Army Corps of Engineers, US Environmental Protection Agency, US Fish & Wildlife).

The ICM has developed into an open forum which gives engineers the opportunity to discuss projects early in the design phase, specifically those projects with permitting/environmental issues, alternative-impact tradeoffs, or those with unique challenges and gives the regulatory agencies an early introduction to the projects that will ultimately require permits. Discussions at these meetings often balance environmental constraints, engineering design and project delivery issues covering a wide variety of topics that may affect projects (mitigation, safety, schedule, best management practices, constructability, maintenance and protection of traffic, water handling and stage construction, construction cost, “permitability”, local concerns, etc.).

Generally, every project requiring environmental permits is presented at an ICM. CTDOT has developed written guidance that explains the purpose, procedure and consistent information required by staff and consultant engineer’s necessary for meaningful technical discussions and successful outcomes at the monthly ICM meetings. This guidance includes a standardized presentation format and outline. Each project on the ICM agenda will be given a time slot, based on complexity of the project for presentation and discussion that will typically be 20-30 minutes. Projects may need to be presented more than once through
their design development depending on the complexity of the environmental impacts and/or direction given at a prior meeting.

The intent of the ICM is to have a full and complete vetting of all issues, based on available information, in an attempt to deliver the transportation capital improvement while making the best environmental recommendations and documenting the decisions. The information presented by engineers at the ICM enables more informed decisions to be made that endure through the environmental permitting process and subsequent construction phase of any given project.

The information presented, and decisions made at the meeting are preserved (memorialized) for future reference. The agenda, approved reports of meetings, attendance sheets, presentations, plans, and other supporting information, are stored on the Department's server and accessible for future reference by both CTDOT and regulatory agency staff. The ICM documentation will also be included in the final permit application.

**CTDOT/CTDEEP Working Group**

The original LEAN team from CTDOT and CTDEEP has transitioned to the CTDOT/CTDEEP Working Group that also meets each month to address broad permitting and policy issues and develop improvements between the agencies. In between these meetings the staff from CTDOT meets to discuss internal issues related to permitting processes. Over time the working group meetings have developed into a regular forum that allows a problem solving discussion on a wide variety of issues that often leads to better communication and trust between the agencies. Some of the more recent accomplishments of the group have been as follows:

- Established monthly CTDEEP project review meetings (following the ICM) to provide a forum for towns to receive guidance from CTDEEP on locally sponsored projects.
- Developing a variety of sample permit plan sets for staff engineers to use as guidance in producing clear and concise plans for ease in permit application review.
- Negotiating and then issuing guidance generally allowing the installation of in-stream confinement at any time of the year that has reduced unnecessary restrictions on construction and shortened construction timeframes.
- Developing a revised project specification on Rounded Stone/Natural Stream Bed Material for streambed restoration and fisheries enhancements.

Current topics being pursued by the group:

- Identifying potential efficiencies in the project design process and refining (reducing) the level of detail of design information required for permitting purposes.
- Identifying procedures to acquire environmental permits earlier in the design process, under alternative contracting and exploring the feasibility of "conditional" permits.
- Developing a fisheries design guide and mitigation program.
- Inland Wetland Mitigation/In Lieu Fee program-developing.
- Planning and participating in a Peer Exchange with Massachusetts DOT regarding Design-Build, Permitting Processes and NEPA.
- Potential expansion of internal (CTDOT) approval process for Flood Management Certification (FMC). Currently CTDOT can approve the FMC for Federal and State funded municipal projects per a Memorandum of Understanding with CTDEEP.

The recurring interagency coordination developed in 2012 and continuously refined, provides project and policy level opportunities for both CTDOT and CTDEEP to improve their respective business practices, work relationships and communication. This has resulted in enhanced project delivery and earlier, more efficient and streamlined environmental permitting.
Introduction

The Turner-Fairbank Highway Research Center (TFHRC) hydraulics’ team formally demonstrated the capabilities of its In-Situ Scour Testing Device (ISTD) to a group of 22 engineers in Fairfax County, Virginia, on November 7, 2017. The successful demonstration marked the end of the development phase and the beginning of the deployment phase for the ISTD. Engineers from FHWA hydraulics, geotechnical, and structural disciplines attended, along with representatives of Virginia DOT, District of Columbia DOT, and the USGS. Before describing the first step of the deployment phase, a quick reminder of the ISTD purpose, operational concept, and the key system components is in order.

Purpose

The purpose of the ISTD is to measure the erosion resistance of fine-grained, cohesive soils in-place. The erosion resistance is measured in terms of a critical shear stress for the specific soil layer being tested. Knowing this information will allow the erosion resistance of all subsurface soils within the scour zone (cohesive and non-cohesive) to be defined. Coupling this information with the decay of hydraulic shear with scour depth is the basis of FHWA’s new scour vision for greatly improving the accuracy of future bridge scour estimates.

Operation

The basic operational concept, which is patented, is shown in Figure 1 and described as follows:

1. Place erosion head down a standard drill casing that is inside a standard hollow-stem auger used for geotechnical investigations (erosion head is gray cylinder with hole through center).
2. Pump water down the casing and around the outside of the erosion head (blue arrows pointed downward).
3. Water flows horizontally at the erosion head-soil interface (red arrows) imparting hydraulic shear to the soil surface (imparted shear stress increases with increasing flow rate or decreasing erosion gap).
4. Eroded soil particles are carried out of the casing by the exiting flow (blue arrows pointed upward through middle of cylinder).

Figure 1. ISTD Operational Concept
The inside diameter of the standard pipe casing is 3.5 inches, while the diameter of the prototype erosion head is 3.25 inches. Consequently, the width of the annular space between the inside of the pipe casing and the outside of the erosion head is 0.125 inches.

**Key Components**

The prototype erosion head for the ISTD is shown in Figure 2 below. The left side of the figure shows the zoom-in of erosion head top. The inflow ports (red) are cast within the erosion head (transparent cylinder) to avoid having to pressurize the entire drill casing for a test. This requires that two O-ring seals be placed near the top of the head to prevent inflow from escaping upward into the drill casing. Once the test pump is turned on, the water moves through the inflow ports, is forced downward, then horizontal through the gap at the erosion head-soil interface. The flowing water imparts a hydraulic shear stress, eroding the test soil surface. The eroded soil is carried away by the flow through the outflow port (blue), located at the center of the erosion head bottom. The outflow then wells up the pipe casing and discharges into a collection tank, where a separate submersible pump is used to recycle the water back to the test supply tank.

*Figure 2. Prototype Erosion Head*
The erosion head is attached to lengths of 1.25” inside diameter PVC piping, which in turn, is clamped to a linear drive that is above and attached to the drill pipe casing. This subsystem serves three purposes:

1. it delivers flow to the erosion head,
2. it advances the erosion head down the pipe casing as the soil erodes (via computer control), hence measuring the erosion rate, and
3. it prevents the erosion head from being ejected from the pipe casing by the reaction force produced by the flowing water.

Figure 3 identifies the major components of this subsystem, as well as the external pumps, flow meter, water tanks, piping, and control computer.
Test Procedure

The general ISTD test procedure is as follows:

1. Drive auger and pipe casing down to soil layer to be tested. Disconnect and move drill table aside.

2. Setup and connect all ISTD system components.

3. Attach linear drive to top of pipe casing.

4. Lower erosion head into pipe casing via PVC piping to the prescribed gap between the bottom of the head and the soil surface to be tested. Record reference elevations.

5. Start variable-speed pump at low discharge to begin test. Hold discharge until a uniform erosion rate is attained and recorded. (Note: The more erosion resistant the soil, the longer the time required to acquire a reasonably uniform erosion rate.)

6. Increase the pump discharge by 20% and repeat Step 5.

7. Repeat Step 6 until erosion rates are collected for a minimum of 4 different discharges.

Figure 4 illustrates the surface of a lean clay soil eroded by different flow rates. (The samples were recovered from within the drill casing after the test was completed.) Note that the erosion pattern can vary with the homogeneity and erosion resistance of the soil across the diameter of the drill casing. The two samples on the left side of the figure reflect good homogeneity, while the sample on the far right reflects less homogeneity. The 'gap sensors' on the bottom of the erosion head, which allow the applied shear stress to be controlled, are also capable of detecting irregular erosion patterns so the test can be stopped, any obstruction to erosion can be removed, and the test continued.

Figure 4. Erosion Patterns on Test Soils
Test Results

Figure 5 is an example data plot from an ISTD test. Note that the plot is eroded soil depth (mm) vs. time (sec). Two curves are plotted directly and automatically from the data collected during the ISTD test. The blue curve shows the flow rates (liters/sec) used during the test. (The applied shear stress for a given gap between the bottom of the erosion head and the soil being tested is directly related to the flow rate through a previously completed calibration process performed in the laboratory.) The gap was maintained constant as 20 mm. The black curve represents the eroded soil depth with time. The average erosion rate in mm/min is obtained from the black curve by simply computing the slope of a best-fit straight line fitted to the data.

The Figure 5 plot shows 4 erosion rates that were computed from the raw data for each of 4 flow rates tested within the soil layer. The flow rates are delineated by the vertical dashed lines. Using the left-hand erosion rate as a reference, the flow rate was increased three times. An increased flow rate will increase the applied shear stress, which should increase the erosion rate. Note this is confirmed by the erosion rate increasing from 0.25 mm/min to 0.57 mm/min while the flow rate increased from 3.1 L/s to 4 L/s. As the flow rate increased two more times, the erosion rate also increased accordingly.

Analysis

The ultimate objective of ISTD testing is to obtain the critical shear stress for fine-grained, cohesive soils in-situ. If 4 erosion rates can be obtained for 4 different applied shear stresses (which vary with the discharge rate used in the test), these data points can be plotted and a curve can be fitted to the data. The curve can then be extrapolated to an erosion rate of ‘zero’, which will identify the critical shear stress for the in-situ soil. Figure 6 below illustrates such a curve and the extrapolation to a zero erosion rate.
Next Step

As mentioned previously, the successful demonstration marks the beginning of the deployment phase of the ISTD. The first step of the deployment phase is to transfer the ISTD technology to the state DOTs and the highway industry. The strategy to accomplish this is to solicit interest within the DOTs through a short series of webinars introducing the technology (webinars expected to be offered in early 2018). The technology will then be taken to interested states for a demonstration at a site of their choice. A technical presentation describing the use of the ISTD and the application of the measured test data will be given, followed by a field demonstration.

The goal of the technology transfer effort is to see implementation of the ISTD as a bridge foundation design tool in 2 years. If the technology transfer effort is successful, a formal, but independent, marketing effort will begin after the first year of demonstrations.

For more information on the ISTD status and deployment, contact Bart Bergendahl (Bart.bergendahl@dot.gov) or Kornel Kerenyi (Kornel.Kerenyi@dot.gov).
Background

The locals in Ohio manage a large number of roadway culverts. Inverts of many of these culverts deteriorate over time due to environmental factors such as water chemistry, soil resistivity, and drainage flow abrasiveness. One common field method to rehabilitate deteriorated metal culvert inverts is concrete paving. Although this method has been commonly applied, a question still remains concerning how much this rehabilitation method restores the metal culvert structurally.

Research Context

Ohio University was contracted to conduct this study. The research team assembled was led by Dr. Masada (Civil Engineering Dept.). He was assisted by his Ph.D. student (Abdul Fekrat), John Hurd (E. L. Robinson), Shaw & Halter Inc., ORIL technical advisory committee members and County Engineer’s Association of Ohio.

Research Approach

Research approach consisted of a review of literature, statewide/nationwide surveys on the state-of-the-practice of culvert invert paving, engineering analysis (including AASHTO LRFD calculations), computer simulations, and field load tests of instrumented culvert structures. Information gathered from these different phases of the study were disseminated at the end not only to answer the question (addressed above) but also to develop an overall engineering procedure on how to inspect metal culvert inverts, when to pave the metal culvert inverts, and how much steel reinforcement is needed to restore the culvert structural capacity in the process.

Research Findings and Recommendations

The review of literature found no previous studies that examined structural aspects of concrete paving of metal culvert inverts. The statewide and nationwide surveys provided much helpful information but shed little light on the structural contributions associated with culvert invert paving. Engineering analysis provided some insights, and the computer simulations showed repeatedly that concreting of deteriorated invert can restore the culvert structure. This was confirmed during the field load tests performed at two highway culvert sites and at the Ohio University’s outdoor load frame facility. ODOT’s current specifications appear to be sound, but some details may need to be added to both CMS Item 611.11 (field paving of new or existing conduit) and L&D Manuals, concerning the amount of steel reinforcement that goes into concrete prior to paving. Lastly, the study produced a series of quick reference tables, flow charts, an engineering calculation procedure, and a few recommendations concerning field inspection and load rating of metal culverts.

This research will improve the longevity of drainage structures under roadways in Ohio.

This research was sponsored by Ohio’s Research Initiative for Locals, the Ohio Department of Transportation, and the Federal Highway Administration. To access copies of the final report, visit: http://oril.transportation.ohio.gov
Welcome New Members!

Matthew S. Lauffer

Matthew (Matt) has over 26 years of Hydraulics, Hydrology and Water Quality experience, consisting of 7 years in consulting and 19 years with the North Carolina Department of Transportation. He has been an Assistant State Hydraulics Engineer for three (3) years where he oversees the statewide project delivery for hydraulics and stormwater management design. Prior to his current position, he served as a Hydraulics Project Manager for the Central Region, two (2) years, and Program Manager for the Stormwater Program, fourteen (14) years. Matt enjoys collaborative efforts with multi-disciplines and interagencies that yield innovation in design and policy. He led an NCDOT 2-year stormwater project that included consultants, federal and state agencies, universities, and environmental non-profits that assessed the impacts of stormwater runoff from bridges on receiving waters. The project lead to further investigation through Project 25-42 that resulted in NCHRP Report 778, "Bridge Stormwater Runoff Analysis and Treatment Options", which he chaired. In addition, Matt is interested in extreme event response, infrastructure resiliency, transportation floodplain management, pipe rehabilitation, 3D design and 2D hydraulic modeling.

Matt chairs the NCDOT Research Board Committee on Environment and Hydraulics and looks for opportunities in applied research to develop the next generation of engineers, and scientists while providing solutions to NCDOT challenges. He is also a member of the Transportation Research Board Committee on Hydrology, Hydraulics, and Water Quality (AFB60).

Matt graduated from The Ohio State University in June 1991 with a BSCE. He is a registered Professional Engineer in North Carolina.

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Calendar of Events

**SAVE THE DATE**
August 28-31, 2018
2018 National Hydraulic Engineering Conference
Hyatt Regency – 350 N High St, Columbus, Ohio

“Advancing Hydraulic Engineering through Innovation and Resilient Design”

More information will be posted the following website when it becomes available.
https://www.fhwa.dot.gov/engineering/hydraulics/conference_listing.cfm

This newsletter is published biannually by the AASHTO Technical Committee on Hydrology and Hydraulics. To be added or removed from the mailing list, to suggest articles, or to provide comments contact: Andrea.Hendrickson@dot.state.mn.us, or call 651-366-4466.

For more information on the Technical Committee on Hydrology and Hydraulics, see https://design.transportation.org/technical-committees/hydrology-and-hydraulics/.

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