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Materials & Research Section
Research Report

WESTFALL FIBERGLASS BRIDGE DRAIN SYSTEM

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Westfall Fiberglass Bridge Drain System

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Follow Up to Initial Report 2007 – 07

Reporting on Work Plan 2000-R-02

STATE OF VERMONT
AGENCY OF TRANSPORTATION

MATERIALS & RESEARCH SECTION

BRIAN R. SEARLES, SECRETARY OF TRANSPORTATION
RICHARD M. TETREAULT, P.E., DIRECTOR OF PROGRAM DEVELOPMENT
WILLIAM E. AHEARN, P.E., MATERIALS & RESEARCH

Prepared By:

Devon Sanborn, Technical Apprentice
Jason Tremblay, M.S., E.I., Research Engineer

Reviewed By:

William E. Ahearn, P.E.,
Materials & Research Engineer

Date: March 12, 2013

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VTrans Transportation District Administrators have asked the Agency’s Structures Section to consider using nonmetallic materials in bridge drainage systems. Fiberglass is inert to oil, gas, road salt, ice melting solutions and many other corrosive chemicals. The effort behind this project was to learn about the product, the installation details, to compare its costs to other commonly installed drainage systems and to make observations regarding its durability.

The drain system used was the Westfall Company Fiberglass Bridge Drain System. This system had not been used in Vermont. The material that is to be used is for bridge and highway piping and is a filament wound composite pipe consisting of a thermosetting resin and continuous glass filament structural reinforcement. The individual components are nonmetallic.

The results of this work showed that the initial installation cost of using Fiberglass Bridge Drain System is about same as current practice. The work showed that the system is less susceptible to corrosion and defects, and subsequently the product will sustain its functionality longer, thus reducing the costs of repairs and/or replacement. The Agency should update the Special Provisions and Supplemental Specifications to include specifications that allow and direct the use of the Fiberglass Drain System.

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ABSTRACT

VTrans Transportation District Administrators have asked the Agency's Structures Section to consider using nonmetallic materials in bridge drainage systems. Fiberglass is inert to oil, gas, road salt, ice melting solutions and many other corrosive chemicals. The effort behind this project was to learn about the product, the installation details, to compare its costs to other commonly installed drainage systems and to make observations regarding its durability.

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INTRODUCTION

Bridge drainage systems preserve concrete decks and reinforcing steel while reducing the potential for vehicular incidents caused by hydroplaning or icing. Specifically, drainage systems remove runoff from the surface of the bridge deck produced by precipitation or other sources. When properly constructed and maintained, a drainage system will provide efficient water removal resulting in enhanced public safety. Through the conveyance of runoff, these systems also impede the onset and rate of concrete delamination and deterioration of structural members caused by corrosive contaminates, such as deicing road salts.

Historically, the Vermont Agency of Transportation (VTrans) has installed bridge drainage materials comprised of metallic members. Over time, these materials are subjected to corrosive atmospheric conditions including precipitation containing varying degrees of acidity or alkalinity, dissolved gases and salts resulting in the deterioration of the metal. Other viable alternatives include PVC (polyvinyl chloride) and fiberglass. While lightweight, rust resistant and cost effective, PVC is sensitive to UV and oxidative degradation. In addition, it displays low impact strength. Conversely, fiberglass is inert to oil, gas, deicing salts and other corrosive chemicals. According to a representative from the New York Department of Transportation (NY DOT), fiberglass is resistant to impact and permits compatible steel support bracing allowing the Agency to reuse existing hangers and supports when replacing the system.

In an effort to assess a corrosive resistant drainage system, VTrans installed six ~ 8″ diameter fiberglass bridge drain systems on Bridge # 68 on I-89 in the town of South Burlington in conjunction with Workplan No. 2000-R-2. The following final report provides an overview of the product, installation details, a cost comparison to other commonly installed drainage systems and observations regarding durability. (1)

PROJECT LOCATION AND SUMMARY

Westfall Fiberglass Bridge Drain Systems were installed on South Burlington I-89 Bridge #68, Williston Road (US Route 2) over I-89 at Exit 14.(2) This was part of the South Burlington IM DECK(36) project, in conjunction with South Burlington STP BIKE (28) S project. Bridge #68 has four spans, for a total overall length of 261 feet crossing four lanes of traffic over I-89. The Average Daily Traffic for US Route 2 Bridge #68 is estimated to be 43,500.

The installation of the bridge drains began on Saturday, July 13, 2003 by the contractor, J.A. McDonald Inc, and continued on different dates throughout the summer. For further installation details, please reference VTrans Materials and Research Section Report No. 2007-07. (2)

MATERIAL DESCRIPTION

Westfall Company manufactured the Fiberglass Drainage System used in this project. Westfall states, "All drainage pipes and fittings are to be a reinforced thermosetting resin pipe system which shall meet the requirements of ASTM D 2996, 'Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.'" They continue "... with at least 30,000psi short time rupture strength hoops tensile stress, and accelerated ultra-violet weathering performance requirements of ASTM G154, 'Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.' All pipes and related fittings shall be a color of standard concrete-gray or a designated color which blends with the aesthetics of the bridge."

Drainpipes, with a wall thickness of ⅛″, are available in variety of outside diameters ranging from four to eighteen inches. The manufacturer specifies that straight pipe sections should be supported by a standard sling, clamp, and clevis hangers typically used with the traditional steel pipes which shall maintain no less than 120 degrees of contact between the pipe and support at all times. Minimum strap width varies from 1¼″ to 2½″ for pipe diameters ranging from three to sixteen inches, respectively. The thickness of the hanger supports are $^{3}/_{16}$″. All cleanouts are manufactured with a threaded PVC plug for removal.

Adhesive material used for bonding the elbow and other joints is composed of a vinyl ester resin based product with silica filler, polyester pigment, and a methyl ethyl ketone peroxide catalyst. Formulation of the adhesive must be certified and proven to be suitable for the intended application. The resin material must not retain any additives that may leach out, catalysts which remain active, or other corrosive ingredients which could lead to deterioration. (1)

PERFORMANCE AND OBSERVATIONS

Periodic site visits were conducted throughout the evaluation period. In 2006, a more thorough site visit was conducted on Tuesday, December 19, 2006 to monitor the performance of the fiberglass downspouts. Personnel from the Research and Development Unit met with Peter Bergeron from the Structures Section's Bridge Inspection Unit at the project site. The site visit included a visual inspection of the fiberglass system, which entailed an examination of the downspouts, catch basin, and connections. In addition, the outlet of the drainage systems and troughs were also assessed.

Upon inspection, leakage along most of the pier caps was noted. According to Peter Bergeron, this was most likely attributed to a tear or puncture within the troughs. Peter also stated that the leakage could be caused by something plugging the drains, which frequently occurs at the intersection of the troughs and downspouts, known as a hopper or catch basin.

Adjacent to the drainage system, all of the weeping tubes, a mechanism that discharges water between the bridge deck and curbing, were frozen and not functioning properly.

The group also examined the pipefittings. While found to be in good condition, external flaking of the resin adhesive, used to bond and seal the elbow pieces to the straight pipe section, was observed as shown in Figure 1. This raised concerns regarding the potential for water infiltration between the connections potentially resulting in freeze thaw damage during winter months. Immediately following the site inspection, the Westfall Company was contacted to discuss this phenomenon. The company explained that the resin adhesive would not adhere to the glazed finish on the exterior of the pipe. The company further stated, the bond between fittings is the only place requiring the resin and that it is not required beyond the joint.

Figure 1 – Flaking of Adhesive

The group examined all lower supports during the site visit and found that they displayed signs of distress. As shown in Figure 2, the bolts that secure the drainage system to the pier were slightly deformed. This is most likely caused by shear forces generated from wind currents and bridge vibration. Section loss resulting from rust was also observed. Both will likely contribute to some form of stem or shear failure. When assessed by Peter Bergeron, he stated that the bolts were too small in diameter to withstand shear and vibratory forces.

Figure 2 - Deformed Bolt

The group inspected the interior of each catch basin and associated trough, revealing iron-oxide discoloration as seen in Figure 3 and in Figure 4. The discoloration is likely resulting from bridge deck runoff containing rust. The inspection also indicated that there was some plugging resulting with water pooling in the catch basin, thereby forming an orange colored ring around the top. Peter pointed out what he referred to as “fissure cracking” within some of the fiberglass structure, a term referring to the miniscule cracks in the fiberglass caused by fatigue, movement and expansion stressing.

Figure 3 - Iron-Oxide Discoloration 2006

Figure 4 - Iron Oxide Discoloration 2010

During the inspection, runoff from the downspout was pooling around the bottom of the pier columns rather than draining away. This indicates that the stone fill drainage has failed. According to the Portland Cement Association (PCA), concrete absorbs water, which expands when it undergoes a freeze-thaw cycle and builds pressure. This internal pressure can cause damage to the concrete such as scaling and spalling. The infiltration of water also provides a mechanism for the penetration of destructive materials such as chloride and sulfate ions increasing the likelihood for concrete delamination and corrosion of reinforcing steel. (3)

Subsequent site visits were conducted since the 2006 inspection with a final site visit being conducted on October 22, 2010. These visits were to assess any changes in the four-year time span. These visual inspections indicated that many of the same issues were found to remain in place; however, there did not appear to be an extensive progression of any imperfections identified during the 2006 inspection. From comparison of pictures from both visits, the amount of staining within the drains and the distresses on the connecting bolts seemed sufficient considering a four-year time span.

COST COMPARISON

The cost for 254 feet of 8″ diameter pipe was $2,200.00, or $8.66 per linear foot, in 2003. (1) A recent estimate supplied by the Westfall Company indicates that the current cost for 8″ diameter pipe is now $15.00 per foot resulting in a total estimated cost of $3,810.00 for the pipe alone. In comparison, according to an estimate from United States Plastic Corp., the cost of 254 feet of 8″ diameter Schedule 40 PVC pipe is $12.41 per foot, resulting in a total cost of

$3,152.14. Finally, according to an estimate from Federal Steel Supply, Inc., the cost of 8″ diameter steel pipe is $15.10 per foot, resulting in a total cost of $3,987.80 for 254 feet. (1)

SUMMARY AND RECOMMENDATIONS

The intent of this investigation was to assess the durability of a material that is reportedly inert to oil, gas and deicing salts known as fiberglass in a bridge drain application. Installed in 2003, the six fiberglass drainage systems were found to be performing well four years following installation. Minor fisher cracking typically caused by fatigue, movement and expansion stressing was observed inside a few catch basins located at the outlet of the trough. Iron-oxide staining was also visible inside the catch basin most likely resulting from runoff containing rust. Although there was concerns raised regarding flaking of the resin adhesive found at joint connections, the Westfall Company assured that this is common when adhered to the glaze finish of the fiberglass. The bolts connecting the supporting system for the drainage pipe to the pier column were deformed as a result of wind and vibratory forces. This along with apparent section loss will most likely result in some type of shear or stem failure in the future. As a final aside, inadequate drainage was noted below the fiberglass drainage system indicating that the stone fill basin has failed generating a ponding effect around the adjacent concrete piers. This will cause premature concrete spalling and corrosion of reinforcing steel if left unaddressed. This could be accomplished by cleaning the stone fill or by extending the discharge drainage pipe away from the column. (1)

This seven-year investigation (2003 to 2010) indicated that the Fiberglass Drain Systems installed on Bridge #68 in South Burlington are effective concerning failure due to corrosive materials and UV exposure. Through extensive research efforts, minimal defects have been noted. There are some other concerns with the material; however, the cost benefit analysis shows no true difference between costs of some other various traditional bridge drain materials. It should also be noted that this bridge drain system might not show a significant difference in cost initially, however this does not consider the cost benefit over time. The Fiberglass Bridge Drain System is less susceptible to corrosion and defects, and subsequently the product will sustain its' functionality for a longer period of time, thus reducing the costs of repairs and/or replacement.

IMPLEMENTATION STRATEGY

The performance of the drains included in this experimental evaluation would indicate designers might start using them on future projects where the bridge can fully utilize the material's advantages. The Agency should update the Special Provisions and Supplemental

Specifications to include specifications that allow and direct the use of the Fiberglass Drain System (refer to South Burlington IM DECK(36) for specifics.)

REFERENCES

1. Graham, Craig. *Category II Workplan for Fiberglass Bridge Drain System. State of Vermont Agency of Transportation Materials and Research Section. Work Plan No. WP 2000-R-2.* February-3,-2000

2. Fitch, Jennifer. *Westfall Fiberglass Bridge Drain System South Burlington, Vermont.* Vermont Agency of Transportation. Initial Report 2007-7, June 29, 2007.

3. *Durability Freeze-Thaw Resistance.* Portland Concrete Association. http://www.cement.org/tech/cct_dur_freeze-thaw.asp. June 5, 2012.

Prepared By: Craig Graham
& Sherward Farnsworth

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH SECTION

CATEGORY II WORK PLAN FOR FIBERGLASS BRIDGE DRAIN SYSTEM

Work Plan No. WP 2000-R-2

OBJECTIVE OF STUDY:

To evaluate the installation and durability of a Westfall Fiberglass Bridge Drain System.

LOCATION:

South Burlington I-89, Bridge #68, Williston Road (US Route 2) over I-89 at Exit 14. This is part of the South Burlington IM DECK(36) project.

BACKGROUND:

Vermont Agency of Transportation District Administrators have asked Structures Section to consider using nonmetallic materials in our bridge drainage systems. Presently the Fiberglass Bridge Drain System is being used on the Boston Mass Tunnel Projects. Fiberglass is inert to oil, gas, road salt, ice melting solutions and many other corrosive chemicals.

MATERIAL:

The drain system to be used will be the Westfall Company Fiberglass Bridge Drain System. This system has not been used in Vermont at this time. The material that is to be used is for bridge and highway piping and is a filament wound composite pipe consisting of a thermosetting resin and continuous glass filament structural reinforcement. It is available in standard sizes of 4 to 18 inches in 2-inch increments. The 4 and 6 inch pipe comes with the adhesive bonded, matched taper T.A.B. (threaded and bonded) joint. An adhesive bonded socket joint is the primary joining method for 8 inch and larger pipes. The elbows, elbows with cleanouts, inlet custom hopper, and other related components are nonmetallic.

For the So. Burlington IM DECK(36) project, six - 8 inch diameter Fiberglass Bridge Drain Systems including elbows, elbows with cleanouts, and inlet custom hoppers are called for. The piping system will be a concrete color.

1. Drainage pipes and related fittings shall be a reinforced thermosetting resin pipe system meeting the requirements of ASTM D 2996, with at least 30,000 psi short time rupture strength hoops tensile stress.

2. A minimum liner of 40-mil resin-rich 1-1/2 ounce glass mat shall be standard for all elbows.

3. The minimum total wall thickness shall be 0.115 inches for 8-inch nominal size pipe.

4. Strap width shall be 1-1/2 inch for nominal fiberglass pipe size 8 inch.

COST:

The estimated cost for 254 feet of 8-inch diameter Fiberglass Bridge Drain Systems is $ 2,200.

CONDUCT OF THE EVALUATION:

The work shall follow the specifications as laid out in the Special Provisions and contract plans for the South Burlington IM DECK(36) project.

Care will be taken to ensure that proper surface preparations are followed.

Once the bridge project has been completed, photos will be taken and a report done based on construction installation. Subsequent reports will document the performance during the annual inspection of the structure.

Additional photographs to document material performance will also taken annually.

At the end of the study, a comprehensive report will be written and distributed to all interested parties inside and outside the Agency.

DURATION OF THE STUDY:

The study will continue until valid conclusions can be drawn regarding the performance of the Fiberglass Downspouts.

REPORTS:

An initial and final report will be published. When required, interim reports may also be published.

Agency of Transportation
Materials and Research Division

Reviewed By:

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Robert F. Cauley, P.E.
Materials & Research Engineer
Date:

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Approved by Federal Highway Administration on February 14, 2000 (CPJ)