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Attendees:
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November 13, 2017 **FINAL FIELD REPORT** **U2017 - 06**

Assessment of the Stirling Lloyd Eliminator Waterproofing Membrane System

Overview:
Eliminator Waterproofing Membrane Systems were installed on two VTrans bridges rehabilitation projects in St. Johnsbury, Bridge 1 (BHF MEMB(28)) and Bridge 86 (IM MEMB(27)). As part of this Work Plan, a third bridge in St. Johnsbury, Bridge 89 (IM MEMB(27)), was retrofitted with a standard torch applied membrane and used as a control. Each bridges respected membrane was installed during 2012. This report summarizes the August 2017 field visits of these bridges.

The purpose of this study was to examine and evaluate the impacts of the constructability, overall performance, and life cycle cost of a spray applied methyl-methacrylate membrane waterproofing system produced by Stirling Lloyd called Eliminator. By using the Eliminator membrane waterproofing system on bridge decks, VTrans expects comparable or better pavement performance, cost and ease of installation compared to the standard approved torch applied sheet membranes.

Bridge 1 Site Visit - VT 973, St. Johnsbury VT

EA: Experimental Features – SPR 352

Work Plan: WP 2011 R-6

Date: Wednesday, August 23rd, 2017

Time: 10:45 AM to 11:15 PM

Weather: 68ºF, Partly Cloudy

A site visit to Bridge 1 in St. Johnsbury was conducted as part of an investigative check. Observations and photos on the performance and appearance of the Stirling Lloyd Eliminator Membrane System after installation were collected and can be seen in Figures below.

Background on Site:
Bridge number 1 is located along VT Route 973 over the Connecticut River, a railroad, and TH 27 in the town of St. Johnsbury. Bridge 1 is approximately 0.1 miles west of the junction with US 5. The bridge is 391 feet long by 45 wide, with a reported average annual daily traffic (AADT) of 3,000. The deck was initially cast in 1986 and the Eliminator Membrane System was installed in 2012, when the deck was repaved.

Bridge 1 Eliminator Membrane Site Visit Photos & Notes:

Overall View of Bridge 1 on VT 973, St. Johnsbury VT. The photo was taken on the eastbound travel lane facing east. During the site visit it was evident that the pavement markings had recently been painted.

Overall View of Bridge 1 on VT 973, St. Johnsbury VT. The photo was taken on the eastbound travel lane facing west.

Close-up of paving joints on the Bridge 1 deck from the westbound travel lane, looking east towards US 5. Notice that the cracks have been sealed. Rutting on both the westbound and eastbound lanes were observed during the recent site visit. The slight discoloration/wearing within the wheelpaths shows the start of the rutting on the surface overlay.

The photo on the left shows the bridge joint on the east end of the bridge while the photo on the right shows the bridge joint on the west end of the bridge. The bridge joints were in good condition. There was evidence of patching around the west end bridge joint. A close-up of the mentioned patching can be seen in the following image.

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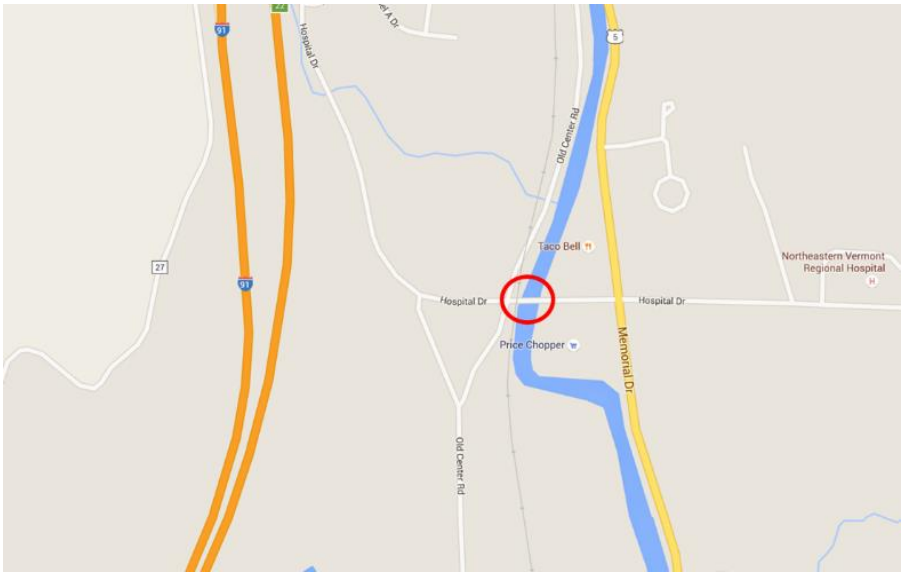
A close-up of the patching around the bridge joint on the west side of Bridge 1.

The bridge curb shows overspray (white) that occurred during installation of the Eliminator membrane.

Full view of the underneath of the Bridge 1, near the west abutment looking towards the east bridge abutment.

No new cracking or deterioration was visible on the underside of Bridge 86. A white substance was found protruding from what seems to be a crack in a concrete deck slab. No moisture was present along the crack making it likely that the white substance is either evidence of the Eliminator membrane sealing a prior concrete deck crack during the application of the membrane or the leaching of calcium from the concrete structure, a sign that the concrete is degrading and deteriorating. A closer inspection of the crack would have to be conducted to determine whether it's one or the other.

Bridge abutment cracking and deterioration on the West side of Bridge 1.



The location of Bridge 1 is represented by the red circle on this map from Google Maps.

Most Recent Bridge Management and Inspection Unit Observations:
The Bridge Management and Inspection Unit conducted their last inspection on 7-26-2017. The inspection personnel concluded that Bridge 1 was in good condition, but noted that there was some scaling at the eastern abutment which would need patching in the near future. They also noticed some minor erosion to the northwest corner of the west abutment below the drain, which could also use some repair. This type of deterioration was also observed during the Research site visit and can be seen in the abutment image. The structure inspection, inventory and appraisal sheet can be found (here) and the July 26th 2017 photos can be found (here).

Bridge 86 Site Visit - VT 2B, St. Johnsbury VT

EA: Experimental Features – SPR 352

Work Plan: WP 2011 R-6

Date: Wednesday, August 23rd, 2017

Time: 12:05 PM to 12:35 PM

Weather: 69ºF, Mostly Sunny

A site visit to Bridge 86 in St. Johnsbury was conducted as part of an investigative check. Observations and photos on the performance and appearance of the Stirling Lloyd Eliminator Membrane System after installation were collected and can be seen in Figures below.

Background on Site:
Bridge number 86 is on VT Route 2B over I-91 in the town of St. Johnsbury and is located at mile marker 130.08 of I-91. The bridge is 588 feet long by 35 feet wide, with a reported average annual daily traffic (AADT) of 670. The deck was cast in 1975. The maximum grade of the bridge is approximately 6.5%. As of the 2010 bridge inspection summary, "the pavement overlay is in need of full replacement." According to the project description, this project (constructed in 2012) involved removing and replacing the bituminous concrete wearing surface on the bridge and its approaches, removing and replacing the membrane on the bridge deck, and minor associated approach work.

Bridge 86 Eliminator Membrane Site Visit Photos & Notes:

Overall view of Bridge 86 on VT 2B, St. Johnsbury VT. The photo was taken on the Southeastern approach of the bridge, looking Northwest over I-91. Longitudinal and transverse cracks were observed throughout the ramp or approach on the Southeast side of Bridge 86.

Minor localized longitudinal cracking occurring on the Northwest bound travel lane near the Northwest end of the bridge was observed during the recent site visit. It was also noticed during the prior year's site visit. Field observations showed that there were five longitudinal cracks that ranged between 1' to 10' in length. At this point it is inconclusive if the cracking is correlated in any way with the performance of the Eliminator Membrane. Water from the pavement surface through the bridge deck would be evidence of a membrane failure. No water dripping through the sealed cracks was found, when an inspection of the underside of the bridge was conducted during the site visit, shown in the following figures.

No new cracking or deterioration was visible on the underside of Bridge 86. A white substance was found protruding from what seems to be a crack in a concrete deck slab. No moisture was present along the crack making it likely that the white substance is either evidence of the Eliminator membrane sealing a prior concrete deck crack during the application of the membrane or the leaching of calcium from the concrete structure, a sign that the concrete is degrading and deteriorating. A closer inspection of the crack would have to be conducted to determine whether it's one or the other.

Full view of the underneath of Bridge 86, near the Northwest abutment looking towards the Southeast end of the bridge.

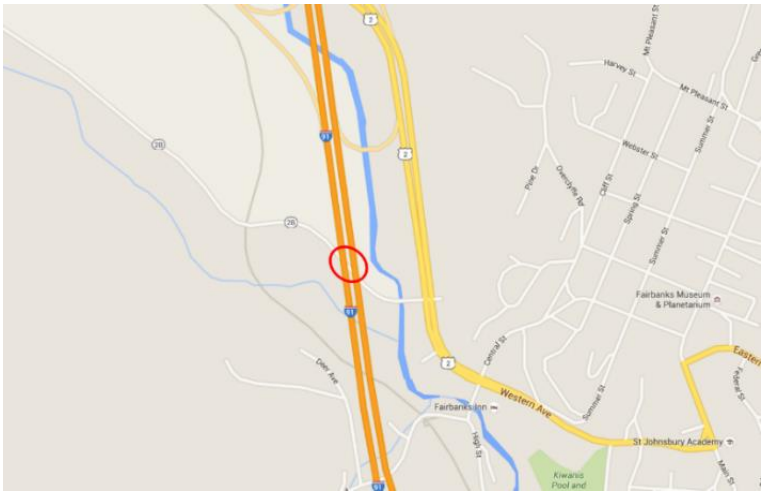
The bridge curb shows overspray (white) that occurred during installation of the Eliminator membrane.

Close-up of the paving joint on Bridge 86.

The photo on left shows the bridge joint on the Southeast end of the bridge, while the photo on the right shows the bridge joint on the Northwest end of the bridge. Both the Northwest and Southeast bridge joints were in excellent condition, where little to no deterioration is evident.

Close-up of Bridge 86 fascia near the Northwest end. As mentioned in the above abutment image, storm water run-off is most likely attributing to the observed fascia deterioration.

Bridge abutment cracking and deterioration on Northwest side of Bridge 86 was observed and noted. Strom water run-off is most likely attributing to the abutment deterioration. This type of concrete surface delaminations could be decreased by using gutters that extend beyond the abutments and fascia.



The location of Bridge 86 is represented by the red circle on this map from Google Maps.

Most Recent Bridge Management and Inspection Unit Observations:
The Bridge Management and Inspection Unit conducted their last inspection on 5-12-2016. The inspection personnel did note that there was some recent joint drainage and pier repair work done. The structure inspection, inventory and appraisal sheet can be found (here) and the May 12th 2016 photos can be found (here).

Bridge 89 Site Visit - Pleasant St. (TH 4), St. Johnsbury VT

EA: Experimental Features – SPR 352

Work Plan: WP 2011 R-6

Date: Wednesday, August 23rd, 2017

Time: 11:30 AM to 11:55 AM

Weather: 68ºF, Partly Cloudy

A site visit to Bridge 89 in St. Johnsbury was conducted as part of an investigative check. Observations and photos on the performance and appearance of a Standard Torch Applied Membrane System after installation were collected and can be seen in Figures below.

Background on Site:
Bridge number 89 along TH 4 (Pleasant St.) in the town of St. Johnsbury received a standard Vermont approved torch applied sheet membrane and was monitored as part of this research project identically to the other experimental bridges (Bridge 1 & Bridge 86) and acted as the control. Bridge 89 is located at mile marker 131.42 ofl-91. The bridge is 228 feet long by 29.5 wide, with a reported AADT of 120. The deck was cast in 1975. The maximum grade of the bridge is approximately 4%. As of the most recent bridge inspection summaries, "Both approaches are in need of full shim pavement (2010). Pavement is heaving along the east side (2008)." According to the project description, this project (constructed in 2012) involved removing and replacing the bituminous concrete wearing surface on the bridge and its approaches, removing and replacing the standard torch applied membrane on the bridge deck, and minor associated approach work.

Bridge 89 Standard Torch Applied Membrane Site Visit Photos & Notes:

Overall view of Bridge 89 on Pleasant St. (TH 4) over I-91, St. Johnsbury VT. The photo was taken on the westbound travel lane facing west. The section of Pleasant St. is a gravel road and loose aggregate gets pushed onto Bridge 89. The aggregate seems to pile on the westbound lane and minor potholing and washboarding was observed on the east end approach.

Overall view of Bridge 89 on Pleasant St. (TH 4) over I-91, St. Johnsbury VT. The photo was taken on the westbound travel lane facing east on the west end of Bridge 89. Loose aggregate was observed on the end of the westbound lane.

Some potholing and washboarding was noticed on the west end approach of Bridge 89.

The photo on the left shows the bridge joint on the east end of the bridge while the photo on the right shows the bridge joint on the west end of the bridge. The bridge joints were in good condition.

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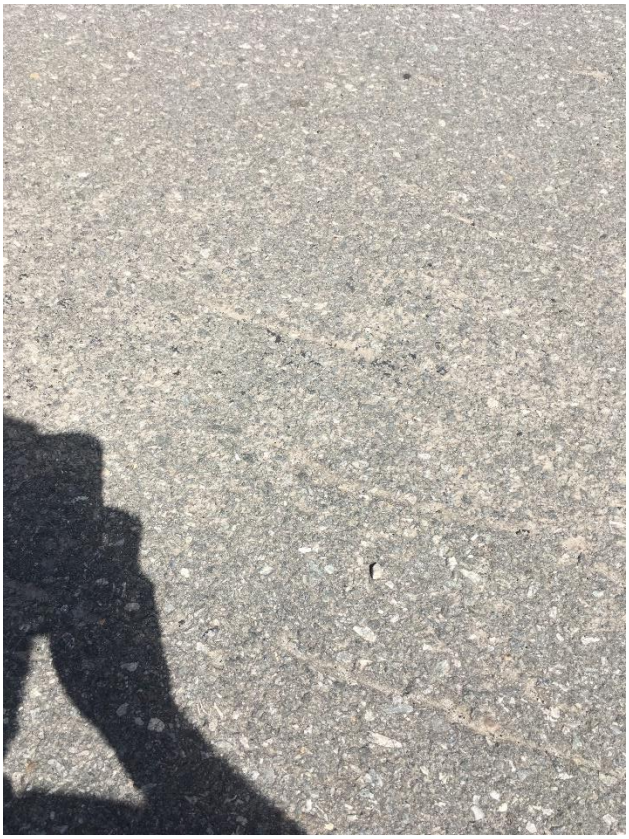
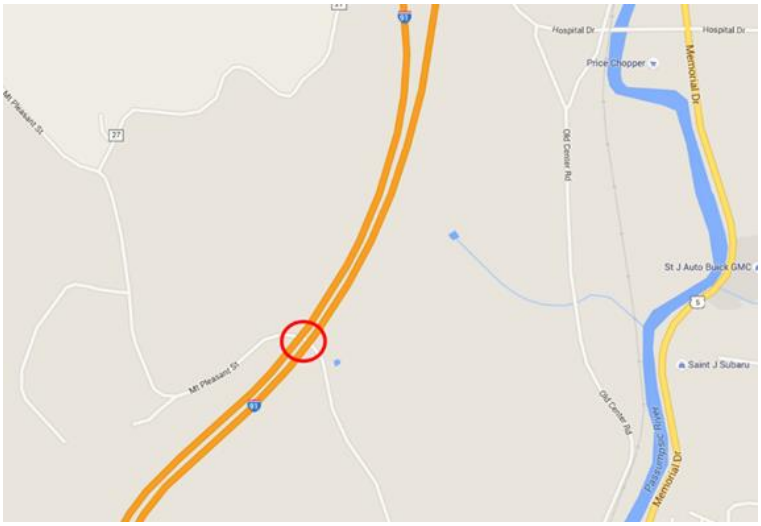


A close-up observation of the Bridge 89 pavement overlay shows some surface deterioration. The observed scratches were seen throughout the bridge deck and are most likely attributed to the loose aggregate being pushed around by the snow plows during the winter months.

Since a standard torch applied membrane was installed on Bridge 89, the close-up photo of the curb reveals no signs of overspray from the installation of the membrane. This is due to the different application method used when installing the standard torch applied membrane.

Full view of the underneath of the Bridge 89, near the east abutment looking towards the west end of the bridge. No new cracking or deterioration was visible on the underside of Bridge 89.

Bridge abutment cracking and deterioration on the east end abutment corner of Bridge 89. The white substance was found protruding from the abutments cracks are most likely leaching of calcium from the concrete structure, a sign that the concrete is degrading and deteriorating.



The location of Bridge 89 is represented by the red circle on this map from Google Maps.

Most Recent Bridge Management and Inspection Unit Observations:
The Bridge Management and Inspection Unit conducted their last inspection on 5-24-2016. The inspection personnel concluded that Bridge 89 was in good condition with no further notes. The inspection photos along with the Research Section photos show that the potholing and washboarding of the bridge approaches and also the loose aggregate on the westbound lane are a common occurrence on Bridge 89. Those same issues were observed during this current site visit. The structure inspection, inventory and appraisal sheet can be found (here) and the May 24th 2016 photos can be found (here).

Summary:
The performance of the Stirling Lloyd Eliminator Membrane System is supported by the visual inspection and photographic evidence gathered during the recent site visits. This study has surpassed its initial (no less than 3 years) study duration detailed in the approved FHWA Work Plan. While monitoring the Eliminator, no major overlay deterioration or stormwater leaking was reported or observed suggesting that the Eliminator Membrane System performs as expected and is comparable to the standard torch applied membrane that was applied to Bridge 89. No further monitoring is needed. A cost benefit analysis, which would be included in the Project Final Report would determine if the Eliminator Membrane System is a viable alternative to the standard torch applied membrane. Results from this study will be given to the VTrans Structures Section for consideration on future bridge designs.