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ASSESSMENT OF SUPER-SLAB, A PRECAST CONCRETE BRIDGE APPROACH SLAB

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16. Abstract

With a growing amount of highway infrastructure in need of reconstruction or rehabilitation and ever-increasing construction costs, State Agencies are seeking cost effective methods of increasing the service life of infrastructure and reducing construction times. Prefabricated elements and systems, such as deck panels and stay in place forms, have many advantages including less disruption to the traveling public and environment, rapid deployment, and are manufactured under a controlled environment. However, there are other considerations such as planning, handling and transport, modular integration, and proper placement.

In an effort to decrease construction times and improve overall quality, Fort Miller Co., Inc. has developed a product known as "Super-Slab," a pre-cast pavement system. Once cast and cured at a concrete plant, the slabs are placed upon an engineered subgrade and then grouted into place with a bedding grout distribution system. Fort Miller Co. provides both engineering design and installation guidance in conjunction with the process. Slab dimensions are reportedly accurate to within ± 1/8 in. This system is designed for use as bridge approaches, ramps, intersections, and continuous mainline pavements.

Super-Slabs were used in Vermont in 2011 as the approaches to two bridges in Chester. This report describes the construction and performance experience with these two installations.

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With a growing amount of highway infrastructure in need of reconstruction or rehabilitation and ever-increasing construction costs, State Agencies are seeking cost effective methods of increasing the service life of infrastructure and reducing construction times. Prefabricated elements and systems, such as deck panels and stay in place forms, have many advantages including less disruption to the traveling public and environment, rapid deployment, and are manufactured under a controlled environment. However, there are other considerations such as planning, handling and transport, modular integration, and proper placement.

In an effort to decrease construction times and improve overall quality, Fort Miller Co., Inc. has developed a product known as “Super-Slab,” a pre-cast pavement system. Once cast and cured at a concrete plant, the slabs are placed upon an engineered subgrade and then grouted into place with a bedding grout distribution system. Fort Miller Co. provides both engineering design and installation guidance in conjunction with the process. Slab dimensions are reportedly accurate to within ± 1/8 in. This system is designed for use as bridge approaches, ramps, intersections, and continuous mainline pavements.

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1. Introduction

The Super-Slab System by Fort Miller Co. was installed on the approaches of two bridges, Chester BRF 025-1(28) and BRF 025- 1(37), roughly 0.25 miles apart along VT 103 in the town of Chester, as shown in Figure 1. Both bridges were combined into a single contract and were complete bridge replacement projects, which included minor roadway approach and channel work. Both bridges along this National Highway System (NHS) route were replaced and the Super-Slab System installed in 2011.

The purpose of this study was to examine and evaluate the impacts to construction sequencing, constructability, overall performance, and life cycle cost of the Super-Slab system. Research personnel assessed the product's durability in a bridge approach application. By using the Super-Slab system on bridge approaches, VTrans expects comparable or better performance, cost and ease of installation compared to the standard approach: cast-in-place approach construction.

Figure 1: Location of Bridges 8 and 9, VT 103, Chester

2. Project Location and Summary

2.1. Project Location Description

Chester Bridge 8

The Super-Slab System was used on the project Chester BRF 025-1(28). Bridge 8, which spans 61.25 feet is located on VT 103 near mile marker 2.2. This structure consists of precast concrete "NEXT-D'' beams and also incorporates concrete precast abutments. One of the abutments sits on bedrock and the other abutment on steel H piles. The total area utilizing the approach slabs was rectangular, 32.0 feet wide by 20.0 feet long and covered with about 2.5 inches of pavement. Average annual daily traffic (AADT) at the location of this bridge was approximately 7100 vehicles in 2008.

Chester Bridge 9

The Super-Slab System was also used on the project Chester BRF 025-1(37). Bridge 9, which spans 122.97 feet is located on VT 103 near mile marker 2.5. This structure consists of precast concrete abutments and deck panels on curved steel girders. Both abutments sit on steel H piles. The area utilizing approach slabs is irregularly shaped due to the road curvature and skewed abutments. The approaches are approximately 36.0 feet wide by 20.0 feet long and covered with about 2.5 inches of pavement. Average annual daily traffic (AADT) at the location of this bridge was approximately 7100 vehicles in 2008.

2.2. System Summary

Super-Slab is a system of precast concrete slabs that are placed on precisely graded subgrade material. The slabs are joined in place by a dowel system. A highly pumpable (low viscosity) grout is placed in the channels to connect the slabs together and connect to the bridge. A foam gasket is installed around the bottom of the slabs, designed to create a good seal with the subbase. Grout is subsequently pumped into channels on the bottom of the slabs to cement them in place and provide uniform contact with the subgrade.

Reported advantages of the Super-Slab system include:

- Zero (field) cure time and can be opened to traffic immediately upon placement
- Installed in a very short work window, proven reliable down to five-hour windows
- A projected long life of 40 years or more
- The manufacturer, Fort Miller, Inc. provides complete technical support, including design and engineering guidance, along with on-site training and assistance

The concrete used in the Super-Slabs for these construction projects met the requirements for precast concrete specified in Section 540 of the 2006 Vermont Standard Specifications for Construction. All other material properties were as specified by Fort Miller, Inc., as part of their proprietary product.

3. Construction

3.1. Pre-Construction

Approaches to Bridge 8 at pre-construction showed significant signs of pavement distress, including fatigue, thermal, and alligator cracking, accompanied by formation of potholes (see Figure 2). Approaches to Bridge 9 showed less signs of distress than Bridge 8, revealing thermal cracking and some fatigue cracking (see Figure 3).

3.2. Construction

The prime contractor for these projects was Cold River Bridges, LLC. Bridge 9 was closed for construction on May 16, 2011 and Bridge 8 on June 20. Representatives from Fort Miller were onsite on June 29 to provide the contractor and VTrans training on the installation of the Super Slab approach slabs. Slab installation began on June 29, with bridge 9 completed on June 30th, and bridge 8 installation on July 6 and 7. Cold River Bridges used a pressure grouting system and mixed bags of grout for grouting the approach slabs. Approaches and bridges were subsequently paved over with asphalt. The bridges were opened to traffic on July 10, with finishing work taking place through the fall. The resident engineer who oversaw the projects found no deficiencies with the product as far as design or installation, and noted total construction time and support from the fabricator were excellent.

4. Performance and Observations

A site visit to Bridge 8 and 9 in Chester, August 30 of 2017, was conducted to close the project. Observations and photos on the performance and appearance of the Super-Slab System after installation were collected. Figure 4 shows the bridge joints of Bridge 8. Figures 5 and 6 shows cracking in the Bridge 8 approach slabs. The eastern approach of Bridge 8 showed a transverse crack approximately 19ft from the east end bridge joint, a second transverse crack approximately 39ft from the east end bridge joint, and a third transverse crack approximately 59ft from the east end bridge joint (figure 5). Two longitudinal wheelpath cracks (one for each wheelpath) were observed emanating from the 1st transverse crack on the westbound lane (figure 5). A longitudinal crack was also noted emanating from the first transverse crack on the left wheelpath within the eastbound lane. No wheelpath cracking was noted on the eastbound lane near the second and third transverse cracks, but a small 2-foot wheelpath crack was found on the westbound side near the third transverse crack.

Figure 2: Approaches to Bridge 8, preconstruction

Figure 3: Approaches to Bridge 9, preconstruction

The western end approach to Bridge 8 showed a transverse crack approximately 20ft from the west end bridge joint, a second transverse crack (Eastbound side) and third transverse crack (Westbound side) both approximately 55-feet from the west end bridge joint (figure 6). On the eastbound side a 20-foot longitudinal crack between the wheelpaths was noted connecting the west bridge joint with the first transverse crack along with small wheelpath cracking (figure 6). Two wheelpath cracks that extended 8ft on the eastbound side (one on each wheelpath) near the second transverse crack were also observed and can slightly be seen in the middle photo (figure 6). An extensive wheelpath crack was also noted on the westbound lane near the second transverse crack (figure 6).

Figure 4: Bridge 8 joints, east and west ends respectively, appearing to be in good condition

Figure 5: Cracking at eastern approach of Bridge 8

Figure 6: Cracking at western approach of Bridge 8

Bridge 9 bridge joints can be seen in Figure 7, and the cracking can be seen in Figures 8 and 9. The eastern approach of Bridge 9 shows both longitudinal and transverse cracking (figure 8) within the westbound wheelpath. There is a 26-foot centerline longitudinal crack emanating from the east end bridge joint, and a transverse crack across the width of the bridge approximately 19 feet west of the east end bridge joint (figure 8). A few wheelpath cracks were also observed on the westbound lane. Two of them were four to five feet in length and one was 18 feet in length. A 14-foot eastbound wheelpath crack emanating from the east end bridge joint was also noted. No other cracking was observed or noted on the bridge deck.

Figure 7: Joints at Bridge 9, appearing to be in good condition

Figure 8: Cracking at eastern approach of Bridge 9

Transverse cracking across the width of Bridge 9 western approach was seen 18 feet east of the west end bridge joint. Wheelpath cracking, approximately 18 to 24 feet in length was observed extending from the western bridge joint on the westbound lane (figure 9). Smaller right wheelpath cracking was also noted on the westbound lane turning onto Pleasant Street (figure 9). No wheelpath cracks were found on the eastbound lane.

Figure 9: Cracking at the western approach of Bridge 9

4.1. Bridge Management and Inspection Unit Observations:

The Bridge Management and Inspection Unit conducted their last inspection on 6-1-2017. The inspection personnel concluded that Bridges 8 and 9 were in good condition. The longitudinal or transverse cracking on the bridge approaches were not mentioned in their recent maintenance report. The structure inspection, inventory and appraisal sheet for bridge 8 and 9 can be found (Bridge 8) and (Bridge 9) and the June 1st 2017 photos can be found (Bridge 8) and (Bridge 9). Summary

The performance of the Super-Slab 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. The field visit documentation shows longitudinal and transverse overlay cracking on the approaches of both Bridge 8 and 9 on VT 103 in the town of Chester. It is difficult to determine from just the visual inspections if the observed approach cracking was only and directly caused by the Super-Slab System, but the location of the transverse cracks at approximately 20ft intervals (slabs were 20ft in length) suggests that they are most likely reflective or thermal cracks caused by the movement of the Super-Slab beneath the surface overlay.

The Super-Slab system generally preformed as expected, showing only minor cracking and rutting after 6 years. Construction was quicker than a typical approach construction, and resident engineers working on the project were pleased with the installation, design support, and contractor performance. Overall, the Super-Slab system was a success, and is a worthy tool to use in conjunction with accelerated bridge construction.

5. References

VTrans Structures Inspection Appraisal Sheet:
http://crashweb.vtransweb.aot.state.vt.us/VTransparency/ViewReport.aspx?rpt=RecordID&RecordID=2093&Type=structuresL

VTrans Structures Inspection Photos:
http://vtransmap01.aot.state.vt.us/rp/dpr/diphotowebstore/State_Long_Structures_/brinsp.asp?AID=State_Long_Structures_&brid=200025000814072