GlasGrid Pavement Reinforcement System
Charleston and Barnet, Vermont
Final Report

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Reporting on Work Plan 95-R-11

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16. Abstract

The appearance of cracking in pavement roadways leads to increased maintenance needs and a shorter pavement life. As a result, many products have been developed to help prevent distresses in new asphalt pavement overlays by minimizing the appearance of cracking, in particular reflective cracking. One way to combat the appearance of reflective cracking is through the use of geotextiles that are designed to reinforce the pavement overlay and distribute the stresses in the underlying layers. These geotextile materials are placed on the underlying pavement layer prior to placement of the overlay and help to prevent or delay cracks from propagating through into the new asphalt overlay.

In the fall of 1998, the Vermont Agency of Transportation (VTrans) engaged in an assessment of a type of geotextile designed to prevent reflective cracking, known as the GlasGrid® Pavement Reinforcement System. Several problems were encountered during installation. The projects were evaluated annually to observe the location and type of cracking and when it began in both the experimental test sites and in the adjacent areas. Cracking was observed to have begun at roughly the same time in both areas. No conclusions can be made regarding the performance of GlasGrid, as the experimental installations were flawed in both design and application in such a way that the performance of the product was likely compromised.

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INTRODUCTION:

With a growing number of pavement miles in need of reconstruction or rehabilitation and ever increasing construction costs, State Agencies are seeking out cost effective methods of increasing the service life of pavements. One such preventative method is to retard the appearance of cracking in asphalt overlays. Pavement cracking is a serious concern as it decreases the structural strength of the overlay and allows water to penetrate through to sublayers, resulting in reduced ride quality and significant, and often premature, roadway deterioration. The main types of pavement cracking include fatigue and reflective cracking. Crack orientation can be longitudinal, transverse or alligator (with rectangular block cracking). Longitudinal cracks run parallel to the laydown direction and are usually a type of fatigue or load associated failure. Transverse cracks run perpendicular to the pavement's centerline and are usually a type of critical-temperature failure or thermal fatigue that may be induced by multiple freeze-thaw cycles. Reflective cracks occur when cracks that exist within the base course, subbase or subgrade material propagate through the new wearing course.

The appearance of cracking leads to increased maintenance needs and shorter service life. As a result, many products have been developed to help prevent distresses in new asphalt pavement overlays by minimizing the appearance of cracking, in particular reflective cracking. Reflective cracks are generally caused by vertical movements in underlying pavement layers due to traffic loading and temperature changes. One way to combat the appearance of reflective cracking is through the use of geotextiles that are designed to reinforce the pavement overlay and distribute stresses in the underlying layers. These geotextile materials are placed on the existing pavement layer prior to placement of the overlay and help to prevent or delay cracks from propagating through into the new asphalt overlay. Many geotextiles materials are available, ranging from woven fiberglass grids to polypropylene mats. Some of these products also serve as a water-resistant barrier, preventing moisture penetration into lower pavement layers.

In an effort to assess the performance and cost effectiveness of a type of geotextile designed to mitigate reflective cracking, the Vermont Agency of Transportation (VTrans) utilized GlasGrid® Pavement Reinforcement System on two concurrent construction projects in the fall of 1998. The following final report contains product specifications, installation details, long term performance and associated cost effectiveness. Recommendations regarding future applications have also been provided.

PROJECT DETAILS:

In an effort to assess the performance and cost effectiveness of the GlasGrid® Pavement Reinforcement System, the product was applied on two separate projects in the fall of 1998, Charleston-Brighton STP 9716(1)S and Barnet-St Johnsbury STP 9624(1)S. Locations are provided in Figure 1. The Charleston-Brighton project began at mile marker (MM) 0.800 in West Charleston and extended easterly along VT Route 105 for a distance of 12.435 miles to MM 3.205 in Brighton. The Barnet-St Johnsbury project began in Barnet on US Route 5 at MM 3.525 and extended northerly to MM 1.321 in St. Johnsbury for a total distance of 8.816 miles.

The Charleston-Brighton project included resurfacing of the existing highway with a leveling course and wearing course, associated pavement markings, guardrail and other incidental items. Specifically, the preexisting roadway received 0.6” of a Type IV Marshall leveling course containing a nominal aggregate size of 0.375” and 1.375” of a Type III Marshall wearing course containing a nominal aggregate size of 0.50”. The binder utilized for this project was a performance grade (PG) 58-34 which indicates that it should perform satisfactorily at an average 7 day high temperature of 58^{o}C, or 136^{o}F, and an average one day low temperature of -34^{o}C, or -29^{o}F. The project included the installation of 130 longitudinal feet of GlasGrid 8501 on the westbound lane and an L-shaped installation with a total of 100 longitudinal feet of GlasGrid 8501 on the eastbound lane of VT Route 105 between the leveling and wearing course in the town of Charleston near MM 9.87. This site is located on a flat, tangent section of roadway. Please refer to Figure 4 for a detailed layout of the reflective crack control treatment. The reported AADT for 2006 for this section of VT Route 105 in Charleston was 1300, which is an increase from the 1998 AADT of 1200 and is considered a relatively low AADT for Vermont.

The Barnet-St. Johnsbury project included resurfacing of the existing highway with a leveling course, wearing course, new pavement markings, guardrail, signs and other incidental items. The existing roadway received 0.6” of a Type IV Marshall leveling course and 1.5” of a Type III Marshall wearing course. The binder utilized for this project was a PG 58-34. The project included the placement of a 100’ by 5’ layer of GlasGrid 8502 installed over the outside wheel path of the southbound lane on US Route 5 in the town of Barnet at approximately MM 8.935 between the leveling and wearing course. The reported AADT for 2006 for this section of US Route 5 in Barnet is 1200, which is a decrease from the 1998 AADT of 1500 and is a relatively low AADT for Vermont.

Figure 1 – GlasGrid Project Locations

HISTORICAL INFORMATION:

As with any surface treatment, the overall success of a pavement is often dictated by the underlying structure. Insufficient lateral support may cause fatigue cracking or rutting. An impervious media coupled with surface cracks, allows for further water infiltration causing moisture damage in the subbase further leading to thermal cracking. Figures 2 and 3, provided below, contains the profile of the original construction in the 1920s and1930s. UNK indicates an unknown thickness.

1.4" Bituminous Concrete (1998)
0.75" Bituminous Concrete (1982)
UNK Bituminous Mix (1938)
12" Gravel Subbase (1938)

Figure 2 – MM 9.87 in Charleston

1.4" Bituminous Concrete (1998)
0.75" Plant Mix (1985)
0.5" Plant Mix (1973)
2.5" Bituminous Concrete (1955)
UNK Concrete (1928)

Figure 3 – MM 8.94 in Barnet

According to the Natural Resources Conservation Service (NRSC), the primary soil type in Charleston and Barnet is a Buckland fine sandy loam and a Salmon very fine sandy loam, respectively. The Buckland series is moderately well drained and the Salmon series is well drained. These soils exhibit moderate frost expansion qualities.

PRODUCT DETAILS:

According to the manufacturer, Saint-Gobain Technical Fabrics Inc. from Albion, NY, the GlasGrid® Pavement Reinforcement System is a self-adhesive, fiberglass reinforcement mesh that provides support to the overlay by rotating "crack stresses horizontally and effectively dissipating them." GlasGrid® "is composed of a series of fiberglass strands coated with an elastomeric polymer and formed into a grid structure." The strands have a high tensile strength and modulus of elasticity and a low elongation which provide them with superior strength when placed between the leveling and surface course bituminous concrete layers.

There are two systems of GlasGrid, the Complete Road System (8501) and the Detail Repair System (8502). Both are designed with a ½ inch x ½ inch grid and have identical material composition. The 8501 product is constructed as a single strand mesh and is designed to be used to cover the entire roadway width. It has a tensile strength of 560 lb/in by 560 lb/in and an elongation at break of less than 5%. The 8502 product is constructed with a single strand longitudinally and a double strand transversely, doubling the tensile strength along its width, making it ideal for installation over specific cracks. It has a reported tensile strength of 1120 lb/in by 560 lb/in and an elongation at break of less than 5%. The systems are self-adhesive with a pressure-activated adhesive allowing for easy installation with only the use of a rubber coated or pneumatic roller. Both GlasGrid products are fully millable and recyclable, as they are made of fiberglass, which is mainly composed of silica and can easily be broken up by milling equipment.

The placement of this material requires the road surface to be smooth, clean and dry with previously sealed pavement cracks. Cracks between 1/8" and ¼" should be filled with crack filler. Wider cracks and holes should be treated to provide a level surface. A leveling course of at least ¾" thick should be applied prior to the placement of GlasGrid to provide an even surface and better bonding between the roadway and the mesh. A tack coat is not required but can be recommended by the manufacturer if necessary based on local conditions. The grid can be laid out by hand or using mechanical means as long as there is sufficient tension to eliminate ripples. Transverse joints need to be overlapped between 3 and 6 inches in the direction of the pave, and longitudinal joints need to be overlapped between 1 and 2 inches. The grid then needs to be rolled to activate the adhesive. A wearing course with a compacted thickness of at least 1.5 inches should be placed over the GlasGrid.

INSTALLATION:

CHARLESTON – BRIGHTON (VT ROUTE 105):

On October 6-7, 1998, GlasGrid® pavement reinforcement was placed on a portion of VT Route 105 in the town of Charleston near MM 9.87. The GlasGrid Complete Road System (8501) was installed on both travel lanes. On October 6, the product was applied to a 130 ft section of the westbound lane over the leveling course. Prior to the installation, the lane was swept clean of any dirt or debris. Following installation, the lane was then paved with a 1.375” wearing course, with no asphalt emulsion used between courses. A product representative, Alan Ward, of Nead Products, Lewiston, N.Y., was present for the installation. On October 7, the product was applied to the eastbound lane in an L-shaped section with a total length of 100 ft. The shorter length on the eastbound lane was done to allow for a side-by-side comparison with the product applied on the westbound lane. The layout of the GlasGrid installation is shown in Figure 4 below. The eastbound lane was also paved with a 1.375” wearing course, with no asphalt emulsion used between courses. The site was not swept prior to the installation of the product, as a considerable quantity of small aggregate was observed under the grid. It was also noted that the overlap of the GlasGrid at the centerline was less than the minimum required.

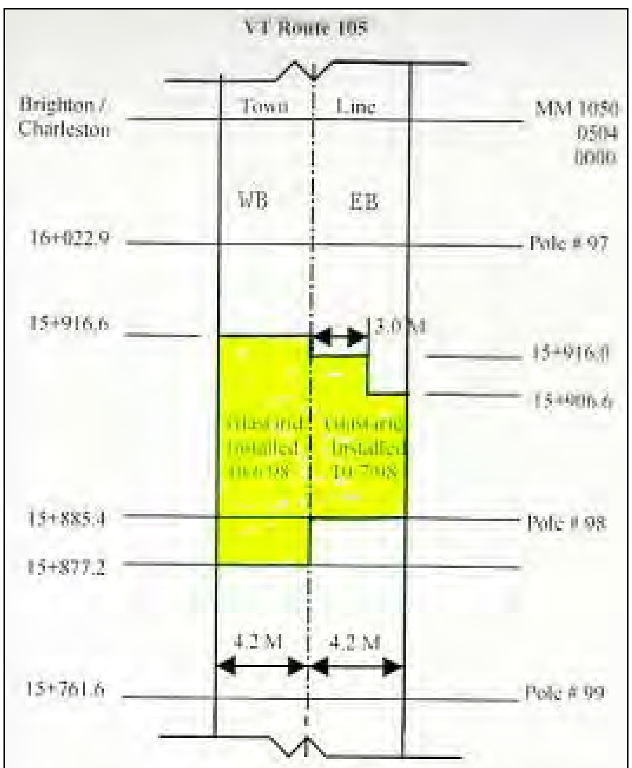

Figure 4 - GlasGrid® layout in Brighton

BARNET (US ROUTE 5):

On September 25, 1998, GlasGrid® pavement reinforcement was placed on a portion of US Route 5 in the town of Barnet. The GlasGrid Detail Repair System (8502) was installed on the outside wheel path of the southbound lane. A preliminary crack survey of the test site clearly defined the location of the underlying concrete road base, with longitudinal and full-length transverse cracking. Severe fatigue cracking in the outside wheel paths was also evident, a distress possibly associated with the gravel subbase structure beneath the asphalt overlay, adjacent to the concrete slabs. This was probably created by the widening of the original concrete roadway. The test product was applied to a 100 ft x 5 ft section of the southbound lane as depicted in Figure 5. The material was installed by hand from a roll attached to the back of a pickup truck shown in Figure 6. The product was placed with the tacky side down on the leveling course and the material was coated with asphalt emulsion. The lane was then paved with a 1.5” wearing course. There was no manufacturer’s representative present during the installation.

It should be noted that the manufacturer generally does not recommend using asphalt emulsion between courses. Also, in a 2000 telephone conversation with a GlasGrid sales representative while researching the possibility of another GlasGrid project, the Agency was advised against the use of GlasGrid as an interlayer between an old concrete road base and an asphalt surface because the properties of the material are not designed to handle the movement of concrete slabs. GlasGrid is designed to handle thermal expansion problems, not movement of the subbase like that caused by concrete slabs.

Figure 5 - GlasGrid Placement in Barnet

Figure 6 – Installation in Barnet

Table 1 below summarizes the installation of both projects, including the manufacturer's recommendations and the actual methods used during installation.

Project	GlasGrid System Used	Surface Preparation Required	Overlay Thickness Required	Actual Surface Preparation	Actual Overlay Thickness	Asphalt Emulsion Used
Charleston	8501 Complete Road System	¾" leveling course, crack fill, sweep surface	1.5 inch wearing course	0.6" Type IV leveling course, WB lane swept, EB lane not swept, EB lane centerline overlap less than required	1.375 inch Type III wearing course	No
Barnet	8502 Detail Repair System	¾" leveling course, crack fill, sweep surface	1.5 inch wearing course	0.6" Type IV leveling course, lane not swept	1.5 inch Type III wearing course	Yes

Table 1 – Installation Overview

OBSERVATIONS:

Pavement surveys to characterize the conditions of the roadways were conducted prior to installing the treatments and nearly every year following construction. Site visits were conducted annually beginning in October 1999 and continuing through August 2003, and a final site visit was conducted in June 2007. The inspections consisted of observing and recording the location and type of cracking, both in the GlasGrid test section and adjacent area.

CHARLESTON-BRIGHTON:

A preliminary survey of the test site revealed 5528 ft/328 ft of cracking, with severe alligator cracking in the eastbound lane. At the initial site visit in October 1999, one year following application, there were no signs of reflective or stress related cracking. In general the pavement seemed to be performing well in the test section and adjacent areas. A center line joint crack was noted that existed both in the GlasGrid test area and the areas on the immediate ends of the test section. This crack was attributed to construction practices as it is located on the paving joint, which indicates that the sealing of pavement was inadequate at the junction of the separate paver passes. Other forms of cracking appeared in the test area in May 2000, 18 months following installation. Faint transverse cracking was noticed in two areas of the westbound lane, one near Station 15+916.6 and the other slightly west of it. The cracks were hairline and about three feet long located in the center of the travel lane. Similar cracking patterns were found to the east of the test area. The transverse cracking in the westbound lane appeared to be more defined in the next inspection conducted in June 2001. Three cracks around 5 mm in width with lengths of 75 cm, 35 cm, and 75 cm were noted at 0.9 m, 3.4 m, and 5.2 m west of Sta 15+916.6. Similar and slightly more severe cracking was noticed east of the test section, but no other cracking was noted in the area.

The cracking in the westbound lane continued to expand over the next two years, but not as severe as in the area outside of the test section. In July 2002, minor cracking was noticed in the inner wheel path of the eastbound travel lane. Again, this cracking appeared worse in the area outside of the test section, indicating that the GlasGrid may be aiding in retarding reflective thermal cracking. In August 2003, the cracking appeared to have increased in both travel lanes, although it appeared worse in the westbound lane. The pavement was observed to be in generally good condition at that time. A site visit in June 2007 revealed that fatigue cracking in the eastbound lane had increased significantly since the previous site visit and appeared to have more cracking than the westbound lane. Figures 7 and 8 display the cracking observed in the 2007 site visit. The westbound lane had developed minor fatigue cracking in the outer wheelpath as well as a few short transverse cracks in the middle of the lane. In general, less longitudinal cracking was observed in the test section than in the adjacent areas.

Figure 7 – Eastbound view, 2007

Figure 8 – Eastbound Lane cracking, 2007

BARNET:

At the initial site visit in November 1999, only one year following installation, minor transverse cracking was observed. Two transverse cracks began in the northbound lane and spread slightly into the GlasGrid section of the southbound lane, as displayed in Figure 9. No evidence of longitudinal cracking, the primary type prior to the installation, was found. In July 2000, one of the previously noted transverse cracks had extended across the full width of the roadway and the other had extended all but one foot of the full width. Similar cracks, predominantly full width, were found both north and south of the test site. The first signs of longitudinal cracking were observed in June 2001 near the edge of the material in the southbound lane. The amount and length of transverse cracks also continued to increase, with some cracks up to 3 cm wide. No major new cracking was noted in July 2002, although the previously observed longitudinal cracks continued to increase in length. In August 2003, the site was found to be in relatively good condition with little deterioration in the GlasGrid test area.

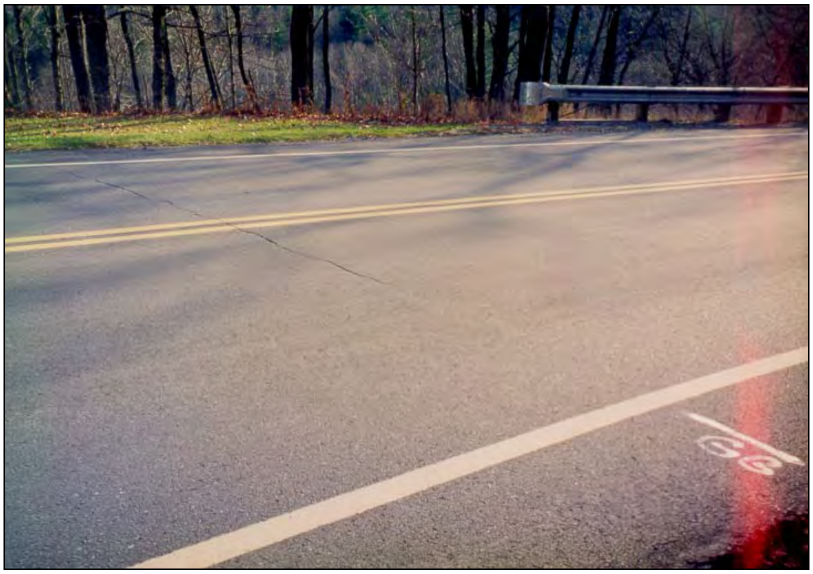

Figure 9 – Barnet in 1999, 1 year after placement

A site visit in June, 2007, shown in Figure 10, found that although there were only two transverse cracks in the GlasGrid area, both were rather severe and had developed into alligator cracking in the GlasGrid area, as shown in Figures 11 and 12. The northernmost transverse crack, shown in Figure 13, had expanded to about 4” wide exposing the underlying GlasGrid. A piece of the material was removed for inspection and appeared rotten looking and weak, as it could easily be pulled apart by hand. This transverse cracking pattern was typical outside of the test area as well, although generally not as severe in terms of crack width. It is believed that this cracking is caused by movement of the concrete subbase, which is reflecting through into the overlay. In addition to the transverse cracking, severe fatigue cracking had developed in the outer southbound wheel path of the GlasGrid test area. Outside of the test area, a single fatigue crack was found that spanned the test site in the inner northbound wheel path.

Figure 10 – Southbound view of Barnet test site in 2007

Figure 11–Crack 24m south of edge, 2007

Figure 12–Crack 9m south of edge, 2007

Figure 13 - Exposed GlasGrid material, 2007

LITERATURE SEARCH:

A literature search was conducted upon completion of this project, with a focus on similar projects completed in other states. The Pennsylvania Department of Transportation conducted a project from 1995 to 2000 involving GlasGrid 8501 and two other reflective crack control products. Based upon the results, none of the products were recommended for further use. In regards to the GlasGrid 8501, initially it appeared to be outperforming the control sections, but "by the end of the second year it became evident that the cracks in the test section were deteriorating the road surface more severely than the control section. The GlasGrid caused the reflective crack to spread out over a larger area." Due to the poor performance, the GlasGrid test section was terminated from the project in 1997, as the cracks were widening and would have started to ravel without immediate maintenance. The GlasGrid product was not recommended for approval or further research in Pennsylvania.

The Oregon Department of Transportation (ODOT) conducted a study from September 1998 to May 2007 evaluating the performance of five different geosynthetic materials designed to prevent reflective cracking, one of which was GlasGrid 8502. During installation the GlasGrid was the most labor intensive and most expensive in terms of labor by nearly $6 per meter as compared to the other materials. At the end of the study in 2007, all of the cracks had reflected in all of the experimental sections. The GlasGrid was found to be "the best product in reducing reflective crack severity," although all of the cracks had reflected. It was found that the "crack fill only sections outperformed geosynthetic material." Overall the study determined that if reflective transverse cracking is the only deterioration factor, then it appeared that it would be cost effective to apply certain geosynthetic materials. However, the roadway in the study required resurfacing after nine years due to fatigue cracks, rutting and longitudinal cracking.

The manufacturer of GlasGrid, Saint-Gobain Technical Fabrics, performed a study in conjunction with the Maine Department of Transportation from 1995 to 2000 comparing the performance of GlasGrid 8501 to another geosynthetic material and a standard treatment. After only six months, 80% of the high severity cracks had reflected into the overlay in all sections. It appeared that GlasGrid helped prevent the reflection of longitudinal pavement joints, as it performed nearly 3.5 times better than the other sections in this area. Overall, the study determined that "it does not appear that using reinforcement on this site had a big impact on retarding crack reflection especially on the high severity cracks."

The Wisconsin Department of Transportation (WisDOT) conducted an evaluation of GlasGrid 8501 and GlasGrid 8502 from 1990 to 2002. In the first three years, the control sections had the highest percentage of reflective cracking, although only by a slight margin. After three years, the GlasGrid 8502 sections appeared to have the highest percentage of reflective cracking. Additionally, the cracks that appeared in the GlasGrid sections were much more severe and had developed within the first year of the study. At the end of the study, it was determined that "coupled with the increased project cost, it is concluded that GlasGrid is not a cost-effective product for reducing or eliminating reflective cracking in asphaltic overlays placed on PCC pavements." The product was not recommended for further use by WisDOT for preventing reflective cracking or for extending the life of asphaltic pavement overlays on PCC pavement.

COST:

The only costs associated with this project were for the installation of the GlasGrid, as the material was supplied free of charge by the distributor. In 2008, a representative of the manufacturer gave an estimated cost for installation of the GlasGrid Complete Road System 8501 to be between $5.00/sq. yd. and $6.00/sq. yd. and an estimated cost for installation of the GlasGrid Detail Repair System 8502 to be between $8.00/sq. yd. and $9.00/sq. yd.

SUMMARY:

The GlasGrid Pavement Reinforcement System is a self-adhesive, fiberglass reinforcement mesh that is designed to prevent or delay the appearance of reflective cracking when it is installed on an existing roadway prior to placing an overlay. GlasGrid's polymer coated fiberglass strands provide support to the overlay by turning the stresses in the pavement and spreading them out over a larger area, preventing the formation of cracking. In an effort to explore new methods of extending pavement life, VTrans installed experimental applications of two different types of GlasGrid in the fall of 1998. The GlasGrid Complete Road System 8501 was installed on the Charleston-Brighton SPT 9716(1)S project and the GlasGrid Detail System 8502 was installed on the Barnet-St. Johnsbury STP 9624(1)S project. Annual inspections were conducted for five years following placement and a final visit was made in 2007 to observe the performance in regards to transverse, longitudinal, and reflective cracking.

There were several problems encountered with the installation of the GlasGrid at both locations. The installation in the westbound lane of the Charleston-Brighton site was overseen by a GlasGrid representative and had no problems. The representative was not present during the eastbound installation so the application didn't have the same quality control and the surface preparation was not completed as recommended. Additionally, the wearing course was thinner than recommended. The combination of these problems could have lead to early failure of the GlasGrid in preventing reflective cracking. The installation at the Barnet-St. Johnsbury site also had some problems, possibly due to the fact that there was not a manufacturer's representative present. The material was coated with asphalt emulsion prior to application of the overlay, a practice that is not recommended. The material was between a concrete roadway and an asphalt wearing course, something that the Agency was advised against for a later project.

The GlasGrid appeared to be less than fully effective on these projects. Cracking began to appear at roughly the same time in the GlasGrid test areas and the adjacent areas for both projects. At the time of the last site visit, the transverse cracking in the Barnet test site was much more severe in the GlasGrid area than in the adjacent roadway, though not at the preconstruction levels. Similar results were found in Charleston in terms of fatigue cracking, although the GlasGrid did appear to have minimized the amount of longitudinal cracking. In a literature search conducted upon the completion of this project, several states were found to have had results similar to those found by VTrans. Based on the findings of other states as well as the results of this study, it appears that the GlasGrid product does not effectively prevent reflective cracking from occurring in new pavement overlays. However, in regards to these installations, no conclusions can be made regarding the performance of GlasGrid, as the experimental installations were seriously flawed in both design and application in such a way that the performance of the product was most likely compromised. Future applications may be warranted to assess performance in the state of Vermont.

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