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Use of Double-Layer Chip Seals Over Paving Fabrics

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16. Abstract

Seal coating is well established as one of the most commonly used techniques for pavement preservation. For weather-aged pavements, it serves to maintain the existing pavement in its present condition by delaying or eliminating further aging due to radiation and oxidation. For slippery pavements, it helps to change the texture of the road to be skid resistant while being smooth and uniform in appearance. It can be used to waterproof porous surfaces, seal cracks, and enrich under-asphalted pavements. It is believed that a combination of double chip sealing over fabrics, referred to as geosynthetic-reinforced double chip seal, can help better with prevention of reflective cracks in the pavement. This research was conducted with the objective of investigating the performance of geosynthetic-reinforced double chip seal through monitoring one low-volume road project built in York County, Pennsylvania using this system. The project was placed in August 2018 and was monitored roughly every six months through July 2020. Overall, a satisfactory performance was observed, and reflection of surface cracks was reduced to a considerable extent. The results of the study were used to propose recommendations for developing pertinent specifications for inclusion in PennDOT Publication 447 (Pub 447).

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CHAPTER 1

Introduction

Seal coating is well established as one of the most commonly used techniques for pavement preservation. For weather-aged pavements, it serves to maintain the existing pavement in its present condition by delaying or eliminating further aging due to water or sun. For slippery pavements, it helps to change the texture of the road to be skid resistant while being smooth and uniform in appearance. It can be used to waterproof porous surfaces, seal cracks, and enrich under-asphalted pavements. Sometimes it is combined with microsurfacing to create a special treatment known as cape seal. Finally, it can be placed over pavements with newly placed cold recycled mix. Seal coating is considered a very economical approach in pavement preservation.

There are different types of seal coats including fog sealing, slurry sealing, and chip sealing. A chip seal consists of a sprayed application of asphalt immediately covered by a single layer of graded aggregate. Chip seals are applied as either a single layer or a double layer. It is believed that in some cases a double chip seal benefits from application over a suitable paving fabric. Such a combination of chip sealing over fabrics is sometimes referred to as geosynthetic-reinforced double chip seal.

OBJECTIVE OF THIS RESEARCH

This research was conducted with the objective of investigating the performance of geosynthetic-reinforced double chip seal through monitoring low-volume road projects built in Pennsylvania using this system. The results of the study will be used to develop pertinent specifications for inclusion in PennDOT Publication 447 (Pub 447).

SCOPE OF WORK

The work included the following:

- Monitoring and documenting placement of a double chip seal with geofabric in York County, PA;
- Four follow-up visits to the site at approximately 6-month intervals to evaluate the pavement condition;
- Provision of a report documenting the placement and pavement evaluation results; and
- Provision of recommendations toward the development of relevant specifications.

CHAPTER 2

Monitoring of Field Projects

REVIEW OF EXISTING PAVEMENT BEFORE PLACEMENT (AUGUST 6, 2018)

The pilot project was placed in Dover Township, York County, PA. The geosynthetic-reinforced double chip seal at the site was placed on August 6, 2018. Review of the existing pavement took place on the same day that the surface treatment was installed and prior to installation. Visit of the site took place by the principal investigator and the project technical liaison, who coordinated all research-related activities with the township and the contractor. The existing pavement appeared to be highly aged but structurally sound. Alligator and longitudinal cracking were prevalent through the entire length of the project, both on the northbound and the southbound. The surface cracks were noticeable on the surface, mostly in the longitudinal direction in the form of alligator cracks in the wheel path. The cracks were shallow, and the width varied in the range of 1/8 inch to 3/16 inch. No bleeding of the surface was observed. Raveling was minimal. Rut depth was not measured but did not appear to be noticeable. Pictures were taken from the surface but mapping of the crack pattern was not conducted. The pavement distress evaluation was conducted visually. No quantitative measurements were conducted. For example, length of cracks was not measured. Examples of the cracked surface are presented in Figures 1 through 5.

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Figure 1. Longitudinal crack at the center of the mat on the southbound.

Figure 2. Alligator fatigue cracks on the northbound.

Figure 3. Longitudinal fatigue cracks on the southbound.

Figure 4. Cracks were mostly 1/8- to 1/4-inch wide.

Figure 5. Another closeup view of surface cracks.

DOCUMENTATION OF MATERIAL PLACEMENT (AUGUST 6, 2018)

The following items were recorded during placement of the material:

- Review and use the design provided by the contractors as a guideline for possible future specification development.
- Photographs of the construction process at various stages.
- Weather conditions during placement (temperature, sunny, cloudy, humidity, wind speed).
- The contractor's name, crew supervisor/superintendent/foreman's name and contact information.
- List of the contractor's crew including number of persons and general assignments (if people had different responsibilities).
- The inspector's name and contact information.
- Documentation of any cleaning effort and repair before placement.
- Type and amount of binder placed on the existing pavement before placement of fabric.
- Type of fabric, placement technique, and length of fabric placed.
- Type of equipment, including aggregate spreader, binder distributor, rollers, sweepers, etc.
- The start and finish time of the operation and the duration of the placement of the materials.

Placement of geofabric chip seal was conducted on a calm day with air temperature in the range of 80 ºF to 94 ºF during the period of operation. Air humidity and wind speed were roughly 65% and 2 mph, respectively. The width covered during the placement was 24.7 ft, extending beyond the travel lanes.

Before placement, the surface was swept using a motor-driven broom. The construction sequence included placement of PG 70-22 binder followed by placement of the geofabric and two layers of emulsion/chips. The contractor reported placement of 358 gallons of asphalt (PG 70-22) on the northbound. The paving fabric was Mirafi MPV600 geotextile and from the approved product list in PennDOT Bulletin 15. The emulsion was CRS-2P and the aggregate came from two quarries (Roosevelt and Thomasville quarries), both satisfying requirements of AASHTO #8. For the northbound, chips from the Roosevelt quarry were placed first, followed by aggregate from the Thomasville quarry. For the southbound, the Thomasville aggregate was placed first, followed by Roosevelt chips. The chip spreader was fed with the dump truck attached to the chip spreader's hopper. The spreader had an automatic adjustment for the rate of application. From the large hopper, aggregate was led into the bin at the tail of the spreader. From there it was uniformly distributed.

The emulsion was reported to have an application rate of 0.45 gal/yd^2 and 0.40 gal/yd^2 for the first and second layers of seal coat, respectively. The chips for the first and second layers were reported at 22 lb/yd^2 and 21 lb/yd^2, respectively.

The PG 70-22 tack was applied at a width of roughly 14 ft. The fabric was placed 12.5 ft wide and the chips were placed at a width of about 12 ft. The whole operation lasted roughly 6 hours, which included the gaps in operation where the distributors/spreaders had to wait for reloading. This time also included the coverage of non-geofabric sections of the road. After completion of the work, the paved surface looked in very good shape. Figures 6 through 14 present photos in sequence of placement.

Figure 6. Placement of PG 70-22 asphalt binder on the existing pavement surface.

Figure 7. PG 70-22 asphalt placed on a section of the road on the northbound.

Figure 8. Placement of geofabric on the freshly placed tack coat asphalt.

Figure 9. Geofabric placed on the tack asphalt on the northbound.

Figure 10. Cutting through wrinkled section of the geofabric to smooth it out.

Figure 11. CRS-2P emulsion placed over geofabric before chip application.

Figure 12. Spreading the #8 chips on the emulsion.

Figure 13. Rolling the second chip seal layer.

Figure 14. Finished mat after placement of the second chip seal layer.

SITE VISITS AND EVALUATION AFTER PLACEMENT

Visit of August 15, 2018

This visit took place 8 days after placement and was conducted by the project technical liaison. The research team from Penn State was not involved with this evaluation. The report by the technical advisor of the project indicated a very good and tight finished product with no loose aggregate. Figures 15 and 16 manifest the overall appearance of the road. The surface looks very good with no loss of chips and no signs of bleeding. Figure 17 shows an example of the surface texture, well integrated and uniform.

Figure 15. General appearance of the mat after eight days in service looking northbound.

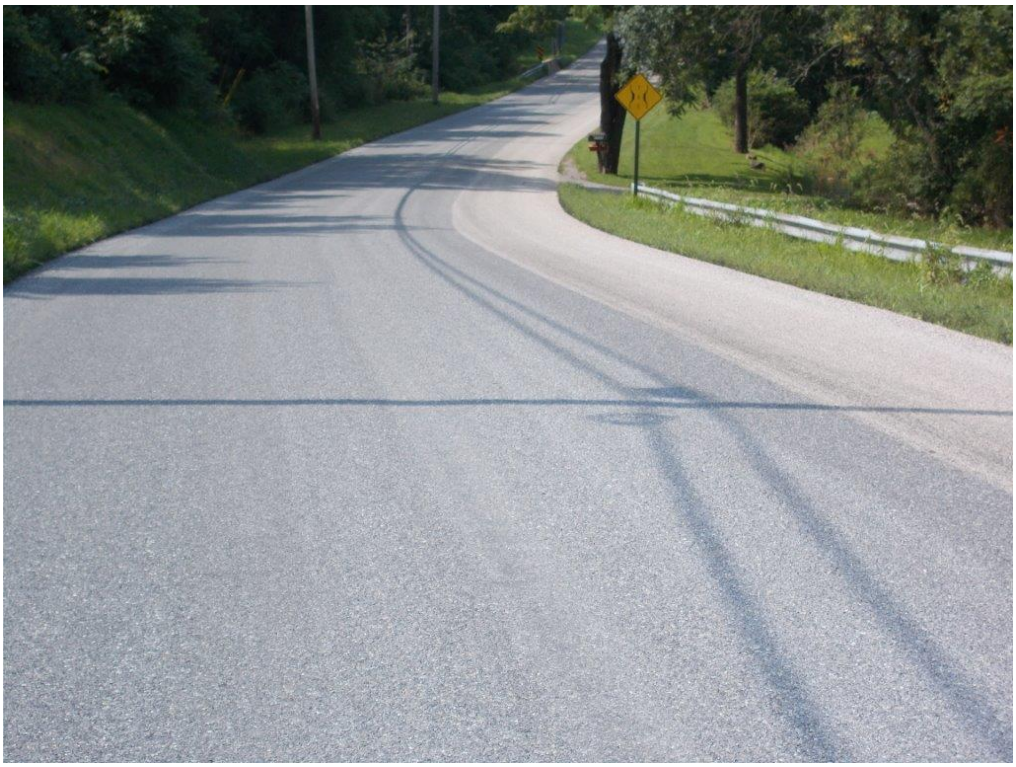

Figure 15. General appearance of the mat after 8 days in service, looking southbound.

Figure 16. Tight texture of the mat after 8 days in service.

Visit of October 18, 2018

One member of the research team visited and evaluated the site on October 18, 2018, approximately 10 weeks after placement. The purpose of this visit and subsequent visits was to evaluate the chip seal performance after months of service and to document any signs of aggregate loss or bleeding. Photographs of the site were taken as part of this monitoring.

Upon arriving at the site, sections were numbered on the northbound lane starting at the bridge where the placement of the geofabric chip seal had started. The pavement edge was marked every 100 ft, starting at 0. It was not exactly known where the original fabric section had ended, but it appeared that the fabric ended around the 1,500-ft mark due to a slight transverse lip across the entire road surface from shoulder to shoulder. However, marking the pavement and site evaluation was carried out for 1,700 ft of the road. Similarly, 1,700 ft were marked on the southbound. The northbound lane looked very good overall (Figure 18) except for some minor bleeding in the left wheel pass in some areas (Figure 19). There were also a few small holes through the fabric (Figure 19) and some transverse bleeding across the road surface. The southbound also looked very good overall, except for a few areas where large pieces of aggregate on the surface appeared embedded into the small chips of the seal aggregate (Figure 20).

Figure 17. The surface generally looked good and well performing.

Figure 18. Several spots indicated the beginning of surface chip loss or minor bleeding.

Figure 19. A few spots showed large pieces of aggregate stuck into the chip seal (southbound).

Visit of April 25, 2019

The principal investigator and the project technical liaison visited the site in April 2019, approximately 8 months after initial placement of the geofabric-reinforced chip seal. The mat appeared to be in an excellent shape, with no visible signs of distress.

Figure 20. Surface looked good after almost 8 months in service.

Visit of October 8, 2019

The site visit started with the northbound lane. As with previous visits, it was started by labeling every 100 ft on the shoulder to assist with locating any problem areas faster from previous visits and for future visits.

Both northbound and southbound lanes appeared in good shape (Figure 22), with the southbound being in a better condition. While the northbound appeared in good shape for the most part, there were almost 20 spots of small areas where aggregate was completely lost and the fabric was visible. These chip loss areas were not in the wheel path and were almost oval shaped with the long diameter approximately 4 to 6 inches and the small diameter roughly 3 to 4 inches in most cases (Figures 23 and 24). In most places where the chips were lost, the fabric was soft to the touch, it was wet, and under a push the water would come through to the surface. Considering the zero mark at the bridge on the northbound where the placement of chip seal started, the first chip seal loss appeared at approximately the 160-ft mark. The last one appeared roughly at the 950-ft mark. An interesting observation relates to the size and frequency of appearance of these spots. They were generally larger and more frequent in the early part of the road (further down the slope where water accumulated) compared to the areas closer to the top of the road. Several of these lost chip spots typically appeared together, about 10 to 20 ft apart from each other, appearing in a straight line. This straight line was mostly about 2.5 ft from the right-side white stripe of the lane (Figures 25 and 26). In one case, the straight line of lost chips appeared about 2 to 3 ft away from the center yellow stripe (Figures 27 and 28), and in one case it was close to the lane center (Figure 29). In almost all cases, it appeared the loss was in areas where water could accumulate and retain under the pavement for a longer time compared to some other areas of the pavement. This observation probably is an indication that the chip loss is connected to the presence of water below the fabric, contributing to separation of the chip seal from the fabric. Intrusion

and contribution of water to this effect is most probably true because the fabric of the spots with lost chip seal appeared to have bubbled up, an indication of a pressure pushing the fabric upward. Another evidence is that in most cases these spots were found in the wet areas of the pavement, as this visit took place after rain had occurred prior to the visit. It should be noted that most of the emulsion had come off the fabric along with the chips. Since these lost chip spots formed a line in the longitudinal direction, it is also possible that underlying PG 70-22 tack binder had not been adequately applied (maybe due to nozzle problems) and the material was subsequently susceptible to loss under water due to a weak bond.

Figure 21. Overall the texture looks very good after more than a year in service.

Figure 22. Spots of chip loss and the bubbled up exposed geofabric.

Figure 23. Additional spots of chip loss and the bubbled up exposed geofabric.

Figure 24. Spots of chip loss to the right of the mat center.

Figure 25. Spots of chip loss to the right of the mat center on the northbound.

Figure 26. Spots of chip loss to the left of the mat center on the northbound.

Figure 27. Spots of chip loss to the left of the mat center on the northbound.

Figure 28. Spots of chip loss to the right but close to the mat center on the northbound.

These chip loss spots were reported, and the contractor conducted the repair of all. The project technical liaison visited the job site after the repair and reported the problem areas were fixed satisfactorily.

It was noticed that more areas of minor bleeding have occurred since the visit of October 2019. Across from the 1501 Butter Road mailbox was an entrance to a farm; that section of the road had areas of aggregate loss and bleeding. This could easily be attributed to vehicles entering the road from the farm road, causing dislocation of the chips. There were areas of bleeding along the right wheel path and white paint line near the 730-ft mark, and it appears the bleeding and chip dislocation actually shoved the white paint line toward the shoulder by a few inches. From the 818-ft to 832-ft marks, there were more small areas of aggregate loss along the right wheel path. At the 949-ft mark, bleeding was noticeable across the entire road surface. Bleeding was also observed along most of the northbound lane at the left wheel path (Figure 30).

Figure 29. Surface bleeding in the left wheel path.

After finishing the survey of the northbound lane, the survey of the southbound lane was started from the far end and walked toward the bridge end. The southbound lane looked better than the northbound lane overall. There were some areas of wheel path bleeding. Near the start of the southbound survey, one can see what looks like the application from the northbound lane overlapping the southbound lane and starting to lose aggregate (Figure 31). There was a small area of bleeding near the right wheel path at the 619-ft mark. A few small areas along the shoulder showed aggregate loss and the fabric could be seen. The fabric was no longer attached to the road surface, as a ruler could be pushed under the fabric at the edge. At the 1,336-ft mark, there was some transverse bleeding across the road surface, especially near the yellow and

white paint lines. Near the 1,439-ft mark there was severe bleeding near the center yellow paint line. At the 1,482-ft mark, there was a small area of aggregate loss, but no underlying fabric was visible. Overall, the southbound lane looked better than the northbound lane.

Figure 30. Minor chip loss at the chip seal joint.

Visit of December 3, 2019

This visit was made by the project technical liaison. The research team from Penn State was not involved with this evaluation. The purpose of the visit was to evaluate the condition of the repairs that were applied to the spots of aggregate loss observed during the visit of October 2019 (Figure 32). The technical liaison reported that the spots in question were sealed and the completed work was neat and satisfactory.

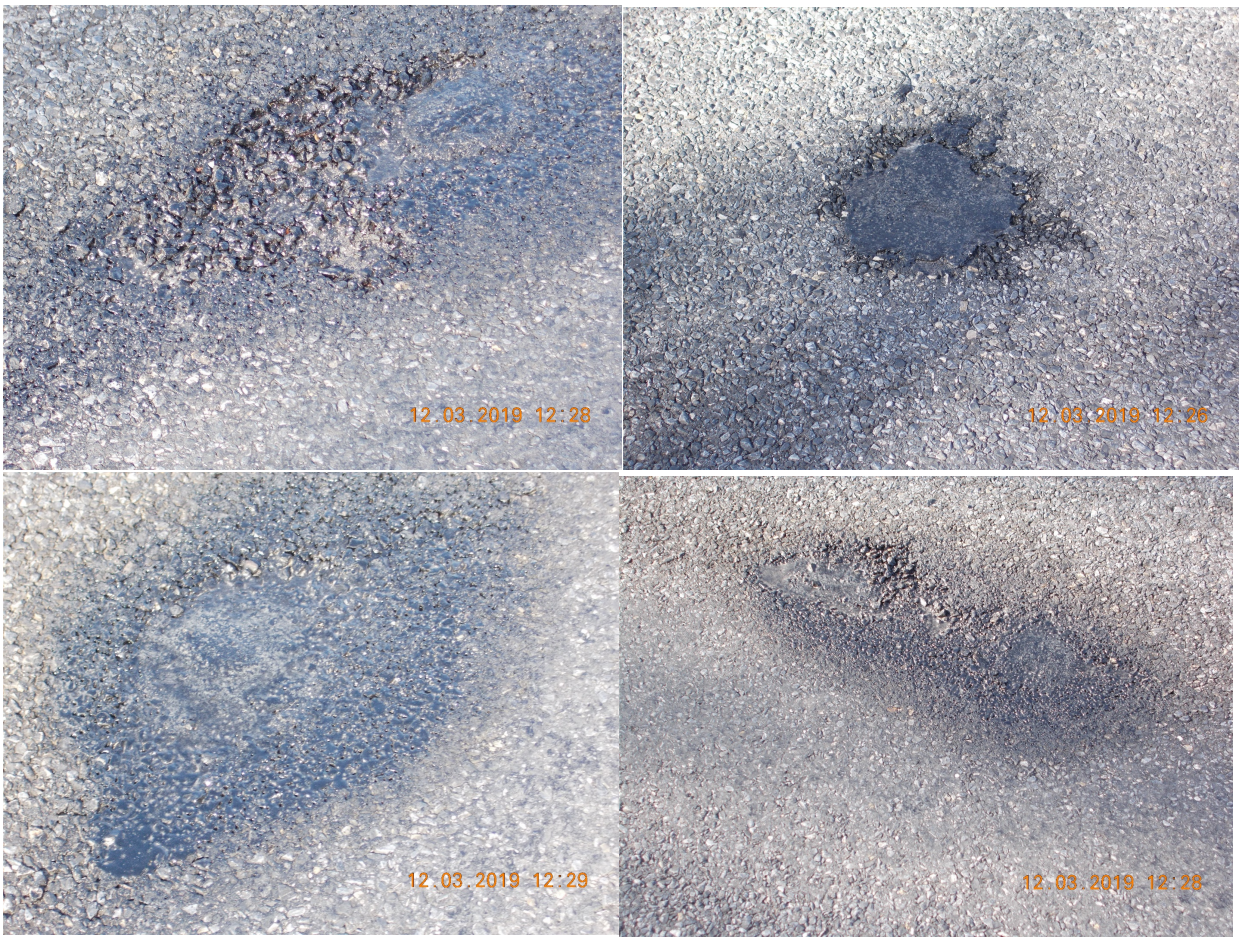

Figure 31. Repaired spots of chip loss.

Visit of July 6, 2020

This was the last visit for this project. At the time of this visit the project was almost two years old. The principal investigator of the project was accompanied by the project technical liaison. The mat appeared in good shape after two years of service (Figures 33 and 34). Only one small section of the road could be identified as the location of reflective cracking, implying that the placed material has been very successful in preventing cracks. The visit of July 2018, before placement of the chip seal, indicated many cracked areas on the pavement surface. The texture of the mat looked very good with no sign of material loss. This performance is satisfactory considering the fact that the pavement had been exposed to two winters at the time of this visit.

It was noticed that the delaminated spots discussed previously during the site visit of October 2019 were repaired. However, there was one localized area on the northbound, close to the mat center, where severe loss of aggregate and exposed fabric was observed (Figures 34 and 35). The phenomenon appeared similar to that observed during the visit of October 2019, but at a limited occasion and closer vicinity of chip loss

spots. Similarity of the problem to that of the October 2019 visit makes one believe that again water played a role in causing this problem.

Figure 32. The surface generally looked good after two years (looking southbound).

Figure 33. Except several distressed areas, the mat texture looked in very good shape.

Figure 34. The chip loss spots forming an almost straight line can be seen to the right of the center on the northbound.

Figure 35. A closeup of the area with material loss and exposure of fabric.

CHAPTER 3

Survey of Municipalities

Several counties in Maryland had prior experience with the use of geofabric with chip seals. Therefore, attempts were made to contact the pertinent municipalities and solicit their comments regarding performance of this system. Connection could be established with three of the counties that were pursued for survey. The overall response indicated satisfaction with the use of this system.

CARROL COUNTY, MD (DECEMBER 18, 2018)

The county did only one tenth of a mile of double chip seal over fabric 5 years ago. It looks good today. They did this in a reasonably straight part of the road, as the fabric wrinkles on curves. The part of the road where they did this did not have much cracking. They typically patch and crack seal before chip sealing or microsurfacing. They chip seal every 5 years. Mostly they do single chip seal with #8 aggregate. They have also done double chips with #6 and #8 stones. They do almost 10 miles of chip seal ever year, about 3 miles or so of that being double seal, if they see sections with block cracking. Sometimes they fog seal the top of chip seal. One concern about fabric is milling. It may slow down the milling process and the fabric may separate into pieces.

ST MARY'S COUNTY, MD (DECMBER 18, 2018)

The county has done a few chip seal geofabric projects within the last 4 years. Overall, the county is satisfied with their performance, but it is just more costly. In general, they resurface every 4 years. Most of what they do is cost driven.

CECIL COUNTY, MD (DECEMBER 20, 2018)

The county did two jobs, one on Basil Road in 2012 and one on Walnut Road in 2015. Both were asphalt over concrete before placement of fabric and chips. Both projects are still there. The former was about 0.7 miles (8,200 sq yd of coverage), and the latter about 0.25 miles. Prep-up work was done before placement. The alligator cracks were sealed, and parching was done before placement. They are satisfied with both projects, even though they noticed slight signs of bleeding on the Walnut Road section. Their most recent visit of the Basil Road job was in December 2018 and they reported good performance. They had an extended section on the Basil Road with single tar and chip (about 0.2 or 0.3 miles). It looked like this section with no geofabric had more cracks than the geofabric section.

CHAPTER 4

Summary and Recommendations for Specifications

Based on the results of this study and literature review, recommendations for development of specifications were developed. Those recommendations are submitted in a separate document, with the final goal of including the specifications on materials and construction of geofabric reinforced double chip seal in PennDOT Publication 447.

This research project was undertaken to evaluate performance of geofabric-reinforced double chip seal. The project pursued three objectives: (1) document placement and performance of a geofabric-reinforced double chip seal project in Pennsylvania, (2) survey experience of other municipalities with this pavement preservation system, and (3) make recommendations for inclusion of this system in PennDOT Publication 447 for low-volume roads.

Placement of the project took place on Butter Road, Dover Township of York County, PA in August 2018. The project was conducted smoothly, resulting in a tight, well-placed surface. The research team made four visits to the job site spaced almost 6 months apart. Two additional visits to the job site were conducted by the project technical liaison during the 2-year evaluation period. In addition, during December 2018, several counties in Maryland with experience using geofabric-reinforced double chip seal were contacted to assess their feedback regarding performance of this system.

The preconstruction site visit had indicated considerable surface cracking of the aged pavement on Butter Road. The placed chip seal project was successful in preventing reflection of these cracks to the surface as observed after 2 years of service. In general, the surface had maintained its tight structure and the chips were well integrated, as observed in the last visit. However, several spots of aggregate loss and bubbled-up fabric were observed, most possibly due to water intrusion and pressure. There was also a moderate level of bleeding of the pavement in the left wheel path on both the northbound and southbound lanes of the project.

The survey feedback received from three Maryland counties indicated satisfaction of those counties with the geofabric-reinforced double chip seal application. One concern raised was with milling of the material in case milling is needed and how it would affect the milling operation.