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SD Department of Transportation
Office of Research

Evaluation of Geosynthetics in Asphalt Overlays of Jointed Concrete Pavements

Study SD95-23
Executive Summary

Prepared by

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16. Abstract

This report presents the findings and recommendations based on the Evaluation of Geosynthetics in Asphalt Overlays of Jointed Concrete Pavements. This project evaluated Linq Tac-711N and Strata Grid-200's ability to ease distress and reflective cracking in the asphalt overlay at the Portland Cement Concrete (PCC) joints.

The Department researchers established a test section south of MRM 14 on Interstate 29 near Elk Point, South Dakota. The test section was 2.2 kilometers (1.4 miles) long and contained 120 joints in both the passing lane and driving lane. The section was split into twelve segments with different materials, rehabilitations, and joint treatments. Each segment consisted of ten joints. Every joint was monitored to determine the amount of movement and the amount of joint and shoulder cracks, which reflected through the asphalt overlay adjacent to each joint. The monitoring occurred during warm and cold weather over a three-year period.

A literature search was performed to see whether any other states had conducted similar research. Following the literature search, the field data that was collected was analyzed to determine the performance of each fabric, concrete rehabilitation technique, and treatment for joints in the asphalt concrete overlay.

At the conclusion of the project, recommendations were made based on the results of the study of geosynthetics in asphalt overlays on Interstate 29 and other state Department of Transportation's reports.

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Executive Summary

This report presents the findings and recommendations on the Evaluation of Geosynthetics in Asphalt Overlays of Jointed Concrete Pavements. Many long jointed concrete pavements in South Dakota are approaching the end of their design life. The service life of these pavements needs to be extended due to limited funds. With various options available, including asphalt concrete overlay, concrete rehabilitation, and complete reconstruction, the South Dakota Department of Transportation (SDDOT) must determine the best method of handling these pavements.

Asphalt concrete overlays are less expensive than some alternatives for improving the roadway's performance. However, a problem of asphalt deteriorating at the transverse concrete joint has been documented. The South Dakota Department of Transportation (SDDOT) requested a study to determine whether geosynthetics lessen the deterioration experienced from reflective cracks at the existing concrete joints. Two geosynthetic fabrics, Linq Tac-711N and Strata Grid-200, were placed on the Portland Cement Concrete (PCC) prior to the asphalt overlay and evaluated against control segments containing no geosynthetic fabric.

Research Objectives

The technical panel overseeing Research Project SD 95-23 "Evaluation of Geosynthetics in Asphalt Overlays of Jointed Concrete Pavements", defined the following objective for the study:

1) **To evaluate Linq Tac-711N and Strata Grid-200's ability to alleviate distress in the asphalt over Portland Cement Concrete (PCC) joints.**

Research

The project started with a literature search of the Transportation Research Information System (TRIS), the internet, and other sources to find information concerning geosynthetics. Articles were found that indicated geotextiles and geogrids both worked and failed depending on the specific application. The main functions of geosynthetics are to increase initial stiffness, decrease creep, increase tensile strength, reduce cracking, improve cyclic fatigue behavior, hold cracked pieces together, and provide low life-cycle cost.

West Virginia Project

While looking on the West Virginia Department of Transportation website, the article "Performance of Flexible Pavements Reinforced with Geogrids" was found. It stated, "This research project has been completed and successfully met the goals set forth by investigators. Studies proved that the addition of the geogrid improved the performance of new asphalt pavements. This can be translated into a longer-lasting pavement that uses less raw material (asphalt) because pavement thickness can be reduced. When using the geogrid, the same pavement thickness as conventional designs results in a longer service life. Moreover, the same service life as conventional pavements can be extended to geogrid-altered pavements by using reduced pavement thickness. This is a very important finding from an economic standpoint. Researchers also learned that the use of the geogrid tends to impede reflective cracking. The data achieved by this study can play a beneficial role in the construction of new roads and rehabilitation of existing pavements in West Virginia."

Virginia Project

In the Transportation Research Record 1687, an abstract from the article "Evaluation of Geosynthetics Used as Separators," (1999) states "Geosynthetics have been used in pavement systems for several purposes, including reinforcement, layer separation, drainage, and moisture barriers. For the layer-separation application, the geosynthetic material is used to prevent soil fines from migrating into the base-course layer as well as stones from this layer from penetrating into the subgrade. This material migration would affect the drainage capability as well as the structural capacity of the pavement. However, such an effect is very hard to detect since soil pumping will occur under the pavement surface, and therefore a comparison of the performance of different types of geosynthetic separators is almost impossible. A three-year project to study the in situ behavior of geosynthetically stabilized flexible pavements in Bedford County, Virginia, ended recently. Results from ground-penetrating radar surveys, falling-weight deflectometer results, rutting measurements, and ground-truth excavation indicated that the separation provided by geotextiles was important in reducing base-course contamination by subgrade soil. Such a reduction will significantly reduce the resilient modulus of the base-course layer. In addition, service-life predictions of evaluated sections were conducted based on the traffic applied and rutting distress. Geosynthetics improved secondary-road pavement performance; geotextiles increased service life more than geogrids, due to their separation function."

Texas Project

According to the abstract of Transportation Research Record 1248, "Overlay Construction and Performance Using Geotextiles," (1989) "Geotextiles (engineering fabrics) were installed at four locations in Texas to evaluate their potential as cost-effective measures to reduce or delay reflection cracking in asphalt concrete overlays. Test pavements were 0.25 miles long with the fabric installed edge to edge. Nine different types of commercially available geotextiles made of nonwoven polypropylene or polyester were tested. One woven experimental product composed of polypropylene and polyester was also tested. Resistance to reflective cracking has been evaluated for up to nine years. Results, based solely on these test pavements, indicate that geotextiles are not cost-effective methods in addressing reflective cracking. However, limited evidence indicates that geotextiles will reduce pumping after cracking occurs. Additional data are presented showing that a fabric can be effective in reducing reflective cracking. Recommendations are made to maximize the probability of success when geotextiles are installed to reduce or delay reflective cracking."

Washington Project

As stated by Robert D. Holtz in the article “WA-RD 321.2 Performance of Geotextile Separators,” (1996) “This research involved field investigations and laboratory testing to evaluate the properties and overall performance of geotextile separators exhumed from the roadway at eight sites in eastern and central Washington (Phase I), and fourteen sites in western Washington (Phase II). Both nonwoven and woven geotextile separators of different in-service ages were examined in detail, and specimens were tested in the laboratory for strength and hydraulic characteristics. The subgrade condition and geotechnical properties of the base course aggregate and subgrade soils were also evaluated.

Although all of the geotextile separators performed their intended separation function adequately, the geotextiles experienced very different levels of damage during construction. Base aggregate type, rather than initial aggregate lift thickness, appeared to have the most influence on the level of damage. All of the recovered geotextiles installed under an angular base aggregate sustained some damage, while geotextiles installed under sub-rounded to rounded aggregate experienced minor damage, if any. The woven slit-films and needle-punched nonwoven geotextiles experienced similar reductions in strength, and both survived the installation conditions reasonably well (except for one lightweight, needle-punched nonwoven, which was over stressed during installation and which may have been installed under an excessively thin pavement section). Although the heat-bonded nonwovens were heavily damaged during installation, they were installed under some of the more severe site survivability conditions.

Test results indicated that the permittivity of the woven slits-films and needle-punched nonwovens both increased by similar percentages after being washed. The heat-bonded nonwovens had the highest percentage increases in permittivity after washing; this finding suggests that they clog more than other geotextiles. There was evidence that the woven slit-films experienced much more binding than did the other geotextiles, and that iron staining and caking may also have affected their drainage performance adversely. Most woven slit-film geotextiles did not meet the filtration requirements set forth by Task

Force 25 (1) and Christopher and Holtz (2) when they were placed on fine-grained subgrade soils.

The unwashed (i.e. “undisturbed”) permittivity results also indicated that most woven slit-film geotextile permeabilities fell well below the Washington State Department of Transportation (WSDOT) required value. The presence of caked fines on the upper surface of the three woven slit-films could indicate that their port openings were too large for the intended filtration function, and that they might be subject to fines migration. However, the evidence on this point was inconclusive. There was no other evidence of fines migration at any of the sites.

All of the pavements examined were in good condition, and damage to the geotextile separators did not appear to have had any negative impact on the pavements’ long-term performance. Although one pavement surface showed signs of premature failure, this could not be attributed to the performance of the geotextile separator.

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.”

South Dakota Project

In this project, a test section was located at MRM 14 in the southbound lane of Interstate 29. The section was 2.2 km (1.4 miles) long and consisted of twelve segments, each containing ten joints. Each set of joints either contained Strata Grid-200, Linq Tac-711N or no fabric, maximum or minimum rehabilitation, and a sawed or unsawed joint. The start of each segment was marked with a railroad spike in the shoulder and each joint was marked with a nail at the edge of the joint. Following the asphalt concrete overlay, measuring pins were anchored through the asphalt into the concrete to determine any movement of the concrete slabs and its impact on the joints and overlay.

Table 1 Order of the test sections.

Joints	Material	Rehabilitation	Asphalt Joint Treatment
615-624	Strata-Grid 200	Maximum	Sawed
625-634	Linq Tac - 711N	Maximum	Sawed
635-644	None	Maximum	Sawed
645-654	Strata-Grid 200	Maximum	Unsawed
655-664	Linq Tac - 711N	Maximum	Unsawed
665-674	None	Maximum	Unsawed
675-684	Strata-Grid 200	Minimum	Unsawed
685-694	Linq Tac - 711N	Minimum	Unsawed
695-704	None	Minimum	Unsawed
705-714	Strata-Grid 200	Minimum	Sawed
715-724	Linq Tac - 711N	Minimum	Sawed
725-734	None	Minimum	Sawed

Installation

Personnel from the Office of Research and Yankton Area Office photographed the procedures during installation. Following are the steps for preparation and installation of the geosynthetic fabrics:

Step 1 The joints that received maximum rehabilitation had four-foot sections that were cut down to the base aggregate and removed. Nine steel bars were then tied into the remaining bars and concrete was laid over them.

Figure 1 Joint 618 following the removing of the four-foot section and prior to the insertion of the steel bars and concrete.

Figure 2 Joint 618 after maximum rehabilitation and prior to the asphalt overlay.

Step 2 The joints that received minimum rehabilitation were brushed off and small holes were repaired. Prior to this, a partial depth repair was performed in 1979 and no additional repair was done since.

Figure 3 Joint 685 before minimum rehabilitation.

Figure 4 Joint 685 after minimum rehabilitation and prior to the asphalt overlay.

Step 3 Following the rehabilitations, the geosynthetic fabrics were placed over the joint before receiving the asphalt overlay.

Figure 5 Supplier-Personnel and Gill Hedman (Office of Materials and Surfacing) installing Linq Tac-711N.

Figure 6   Linq Tac-711N installed and ready for the asphalt overlay.

Figure 7   Strata Grid-200 installed and ready for the asphalt overlay.

Step 4 Once the fabrics were laid, the asphalt overlay began. Trucks were run over the fabrics and in some cases caused bubbling in the Strata Grid-200 so a thin layer of spread was placed on the fabric to avoid pulling and stretching from tack on the tires. No problems occurred when the Linq Tac-711N was being installed.

Figure 8   Strata Grid-200 bubbling under the tires of a truck.

Figure 9   A thin layer of spread used to avoid pulling and stretching from the tires.

Figure 10 Linq Tac-711N under construction with no pulling or shoving.

Figure 11 The pickup machines were kept raised to prevent damage to the fabric.

Figure 12 Linq Tac-711N with passing lane overlaid with asphalt.

Figure 13 Strata Grid-200 with passing lane overlaid with asphalt.

Step 5 After the asphalt overlay, joints were either sawed and sealed or left unsawed.

Figure 14 Joint sawed after asphalt overlay.

Following the installation, the joints were monitored. A researcher measured the joint movement, joint cracking, shoulder cracking, and additional cracks five times during a three-year period. Maps of the joints were also made showing the location of additional cracks and the condition of the joint. From the data that was collected, it was observed that the joint seals opened in the colder months and closed in the warmer months. Knowledge Seeker 2.1® and Systat 8.0® were also used to see whether statistically any type of material, rehabilitation, or asphalt joint treatment had a higher chance of cracking.

Findings and Conclusions

This project focused on alternatives to aid against asphalt overlay deterioration at the Portland Cement Concrete (PCC) joints. There were a total of 120 joints and twelve segments containing ten joints each for both the driving lane and passing lane. The twelve segments consisted of different fabric materials, rehabilitation, and asphalt joint treatments.

The two different kinds of rehabilitation were maximum and minimum. Maximum rehabilitation was when a four-foot section was cut down to the base aggregate and removed. Nine steel bars were then tied into the remaining bars and concrete was laid over them. Minimum rehabilitation consisted of brushing off and repairing small holes. In 1979, a partial depth repair was performed but no additional repairs have been done since.

Most of the unsawed joints reflected through the asphalt overlay regardless of whether or not a fabric was used. These reflections were not counted on Table 2 in the column "Number of Cracks which Reflected through the Asphalt Overlay Adjacent to the Joint". The number of cracks reflecting through the asphalt overlay are only the cracks adjacent to the joint, not the joint itself.

The "Observed Movement" in Table 2 was the difference between the widest joint width and the narrowest joint width. The average, minimum, and maximum amount of observed movement is noted in the table for each segment. Below is a diagram of four joints that show how the observed movement was found.

Figure 15 Observed Movement

Observed Movement= Widest Joint Width - Narrowest Joint Width

OM = Observed Movement

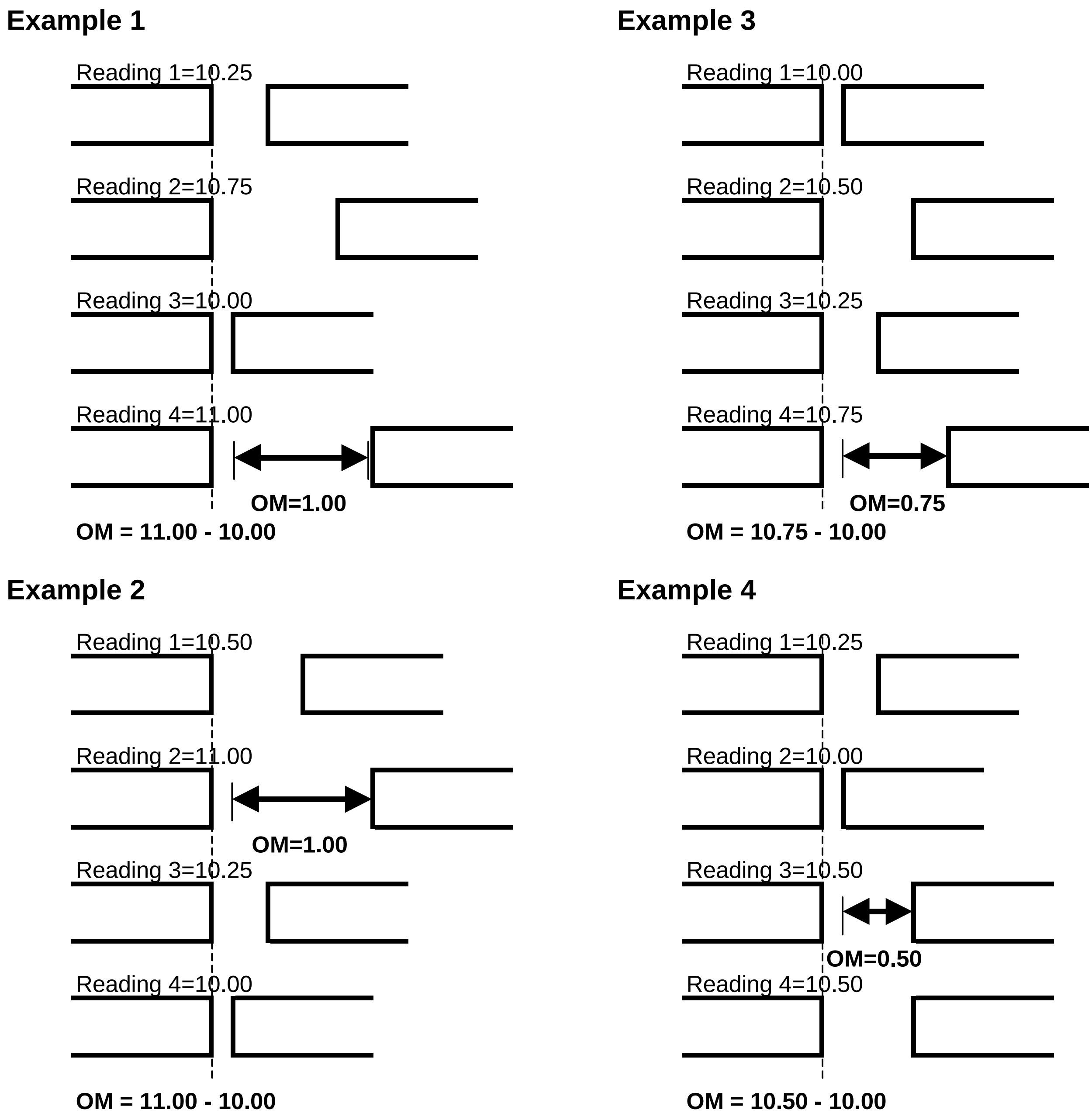

Table 2   Amount of Cracks Reflecting through Asphalt Overlay

Joints	Material	Rehab-ilitation	Asphalt Joint Treat-ment	Number of Cracks which reflected through the Asphalt Overlay Adjacent to the Joint		Observed Movement (inches)					
						Driving			Passing		
				Driving	Passing	Ave	Min	Max	Ave	Min	Max
615-624	Strata Grid-200	Max	Sawed	2	0	0.17	0.09	0.25	0.23	0.06	0.38
625-634	Linq Tac – 711N	Max	Sawed	0	0	0.20	0.13	0.31	0.17	0.13	0.25
635-644	None	Max	Sawed	0	1	0.17	0.09	0.28	0.23	0.13	0.41
645-654	Strata Grid-200	Max	Unsawed	5	0	0.14	0.09	0.31	0.18	0.06	0.38
655-664	Linq Tac – 711N	Max	Unsawed	2	2	0.14	0.06	0.22	0.23	0.06	0.34
665-674	None	Max	Unsawed	3	0	0.14	0.06	0.28	0.24	0.13	0.44
675-684	Strata Grid-200	Min	Unsawed	1	1	0.21	0.06	1.06	0.17	0.06	0.22
685-694	Linq Tac – 711N	Min	Unsawed	2	0	0.21	0.06	0.56	0.22	0.09	0.69
695-704	None	Min	Unsawed	2	0	0.19	0.09	0.41	0.27	0.13	0.94
705-714	Strata Grid-200	Min	Sawed	2	0	0.24	0.06	0.63	0.20	0.06	0.50
715-724	Linq Tac - 711N	Min	Sawed	2	0	0.21	0.06	0.53	0.25	0.13	0.91
725-734	None	Min	Sawed	1	0	0.11	0.03	0.19	0.22	0.16	0.34

The first ten joints 615-624, Segment 1, had Strata Grid-200 with maximum rehabilitation and a sawed joint. In the driving lane there were two additional cracks, which reflected through the asphalt overlay, while in the passing lane there were no additional cracks. The average observed movement as determined by the pin measurements for the driving lane was 0.17 inches and 0.23 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.09 inches and 0.25 inches. The minimum and maximum readings for the passing lane were 0.06 inches and 0.38 inches.

Segment 2, joints 625-634, had Linq Tac-711N with maximum rehabilitation and sawed joints. Both the driving lane and passing lane had no additional cracks reflecting through the asphalt overlay. The average observed movement as determined by the pin measurements for the driving lane was 0.20 inches and 0.17 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.13 inches and 0.31 inches. The minimum and maximum readings for the passing lane were 0.13 inches and 0.25 inches.

Segment 3, joints 635-644, consisted of no geotextile material and had maximum rehabilitation and sawed joints. In this section, there was no cracking in the driving lane, but one crack occurred in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.17 inches and 0.23 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.09 inches and 0.28 inches. The minimum and maximum readings for the passing lane were 0.13 inches and 0.41 inches.

Segment 4, joints 645-654, had Strata Grid-200 for a geosynthetic fabric, maximum rehabilitation, and unsawed joints. Five additional cracks surfaced in the driving lane although no cracks appeared in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.14 inches and 0.18 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.09 inches and 0.31 inches. The minimum and maximum readings for the passing lane were 0.06 inches and 0.38 inches.

Figure 16   Joint 645 contains Strata Grid-200, with maximum rehabilitation and an unsawed joint prior to the asphalt overlay.

Figure 17   Joint 645 with crack reflecting through the asphalt overlay where the joint is.

Segment 5, joints 655-664, was composed of Linq Tac-711N, maximum rehabilitation, and unsawed joints. Both lanes had a total of two additional cracks. The average observed movement as determined by the pin measurements for the driving lane was 0.14 inches and 0.23 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.06 inches and 0.22 inches. The minimum and maximum readings for the passing lane were 0.06 inches and 0.34 inches.

Segment 6, joints 665-674, had no fabric, maximum rehabilitation, and unsawed joints and had three cracks in the driving and none in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.14 inches and 0.24 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.06 inches and 0.28 inches. The minimum and maximum readings for the passing lane were 0.13 inches and 0.44 inches.

Segment 7, joints 675-684, had Strata Grid-200, minimum rehabilitation, and unsawed joints. There was one additional crack in both lanes. The average observed movement as determined by the pin measurements for the driving lane was 0.21 inches and 0.17 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.06 inches and 1.06 inches. The minimum and maximum readings for the passing lane were 0.06 inches and 0.22 inches.

Segment 8, joints 685-694, had Linq Tac-711N, minimum rehabilitation, and unsawed joints. There were two cracks in the driving lane and none in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.21 inches and 0.22 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.06 inches and 0.56 inches. The minimum and maximum readings for the passing lane were 0.09 inches and 0.69 inches.

Segment 9, joints 695-704, had no fabric, minimum rehabilitation, and unsawed joints. There were two cracks in the driving lane and none in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.19 inches and 0.27 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.09 inches and 0.41 inches. The minimum and maximum readings for the passing lane were 0.13 inches and 0.94 inches.

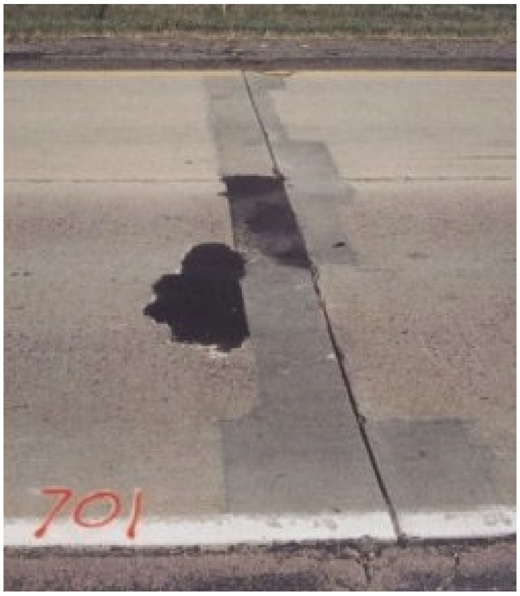

Figure 18 Joint 701 with no fabric, an unsawed joint, and minimum rehabilitation prior to the asphalt overlay.

Figure 19 Joint 701 with buckling of the concrete causing cracks to reflect through the asphalt overlay. (Only minimum rehabilitation joint that showed buckling problems in the entire test section.)

Segment 10, joints 705-714, had Strata Grid-200, minimum rehabilitation, and sawed joints. There were two additional cracks in the driving lane and the passing lane had none. The average observed movement as determined by the pin measurements for the driving lane was 0.24 inches and 0.20 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.06 inches and 0.63 inches. The minimum and maximum readings for the passing lane were 0.06 inches and 0.50 inches.

Segment 11, joints 715-724, had Linq Tac-711N, minimum rehabilitation, and sawed joints. There were two cracks in the driving and none in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.21 inches and 0.25 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.06 inches and 0.53 inches. The minimum and maximum readings for the passing lane were 0.13 inches and 0.91 inches.

Segment 12, joints 725-734, had no fabric material, minimum rehabilitation, and sawed joints. There was one crack in the driving lane and none in the passing lane. The average observed movement as determined by the pin measurements for the driving lane was 0.11 inches and 0.22 inches for the passing lane. The minimum and maximum observed movement for the driving lane was 0.03 inches and 0.19 inches. The minimum and maximum readings for the passing lane were 0.16 inches and 0.34 inches.

Figure 20 Joint 730 with no fabric, minimum rehabilitation, and a sawed joint prior to the asphalt overlay. (note the partial depth repair that was completed in 1979)

Figure 21 Joint 730 showing no problems with the joint. (More typical performance of minimum rehabilitation)

Cost

The cost for the different types of segments and joints depended mainly on what type of fabric material and what type of rehabilitation was used. The price of fabric material depended on the size of the roll and brand used.

Table 3 Cost of Materials

	Size or Amount Used	Cost		Cost Per 12 foot Lane
Linq Tac-711N	*36 inch by 60 feet*	$ 95.00	per roll	$ 19.00
	12 inch by 100 feet	$ 55.00	per roll	$ 6.60
Strata Grid-200	6 feet by 300 feet	$ 600.00	per roll	$ 24.00
Saw and Seal	12 feet	$ 0.69	per foot	$ 8.28
PCC Pavement	5 1/3 yd^2	$ 57.78	per sq yd	$ 308.16
Steel Bars	9 bars	$ 4.00	per bar	$ 36.00

*Type of Linq Tac-711N we used.

Table 4 Cost of Joints Per Lane

Joints	Material	Rehab	Asphalt Joint Treatment	Cost Fabric	Cost Saw and Seal	Cost PCC Pave-ment	Cost Steel Bars	Cost per Joint
615-624	Strata	Max	Sawed	$ 24.00	$ 8.28	$ 308.16	$ 36.00	$ 376.44
625-634	Linq	Max	Sawed	$ 19.00	$ 8.28	$ 308.16	$ 36.00	$ 371.44
635-644	None	Max	Sawed	$ 0.00	$ 8.28	$ 308.16	$ 36.00	$ 352.44
645-654	Strata	Max	Unsawed	$ 24.00	$ 0.00	$ 308.16	$ 36.00	$ 368.16
655-664	Linq	Max	Unsawed	$ 19.00	$ 0.00	$ 308.16	$ 36.00	$ 363.16
665-674	None	Max	Unsawed	$ 0.00	$ 0.00	$ 308.16	$ 36.00	$ 344.16
675-684	Strata	Min*	Unsawed	$ 24.00	$ 0.00	$ 0.00	$ 0.00	$ 24.00
685-694	Linq	Min*	Unsawed	$ 19.00	$ 0.00	$ 0.00	$ 0.00	$ 19.00
695-704	None	Min*	Unsawed	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
705-714	Strata	Min*	Sawed	$ 24.00	$ 8.28	$ 0.00	$ 0.00	$ 32.28
715-724	Linq	Min*	Sawed	$ 19.00	$ 8.28	$ 0.00	$ 0.00	$ 27.28
725-734	None	Min*	Sawed	$ 0.00	$ 8.28	$ 0.00	$ 0.00	$ 8.28

* the minimum rehabilitation costs were for the 1995 asphalt overlay project only, and did not include the cost of the 1979 partial depth repair completed on each of these joints.

The Linq Tac-711N came in two sizes of rolls. The twelve-inch by one hundred-foot roll cost $55.00 per roll, while the thirty-six inch by sixty foot roll, which we used, cost $95.00 per roll.

The Strata Grid-200 cost $3.00 per square yard or $600.00 for a six foot by three hundred-foot roll.

Other costs include the maximum and minimum rehabilitation and whether the joint was sawed or not. The cost for maximum rehabilitation alone was $344.16. The cost for sawing and sealing a joint was $8.28. The total cost for maximum rehabilitation and sawing the joint was $352.44. Minimum rehabilitation cost little to nothing due to the fact that in 1979 a partial depth repair was performed on the joints. No additional work has been done since so most of the minimum rehabilitation joints looked as though they were just swept off. A few had small holes that were filled prior to the asphalt overlay.

From the information that was gathered, a conclusion can be made as to what the most economical choice is. When analyzing the data with Knowledge Seeker 2.1® and Systat 8.0®, the researcher determined what type of joints reflected additional cracks and what type of joints performed best. The results from Knowledge Seeker 2.1® showed that Strata Grid-200, unsawed, maximum rehabilitation joints had more cracks reflect through the asphalt overlay.

Systat 8.0® calculated that on the average twenty-five percent of Strata Grid-200 joints in the driving lane had cracks reflect through the asphalt overlay.

The segments containing no fabric or Linq Tac-711N fabric had only fifteen percent of the joints in the driving lane containing cracks.

Systat 8.0® also showed that an average of twenty percent of maximum rehabilitation joints in the driving lane received cracks, with only about seventeen percent of minimum rehabilitation joints cracking.

A greater difference between unsawed and sawed joints was seen. There were twenty-five percent of unsawed joints that obtained cracks and approximately twelve percent in sawed joints.

The passing lane had an insufficient number of cracks to do an analysis with Systat 8.0®.

Table 5 Mean amount of Cracks with the Following Variables

Material	Variable	Mean amount of Cracks
Strata Grid-200	Unsawed	0.30
Linq Tac-711N	Unsawed	0.20
None	Unsawed	0.25
Strata Grid-200	Sawed	0.20
Linq Tac-711N	Sawed	0.10
None	Sawed	0.05
Strata Grid-200	Maximum	0.35
Linq Tac-711N	Maximum	0.10
None	Maximum	0.15
Strata Grid-200	Minimum	0.15
Linq Tac-711N	Minimum	0.20
None	Minimum	0.15

The passing lane had too few cracks to determine the best type of joint.

Table 6 Average Daily Traffic

I-29 MRM 14.00 SBL

	1999	1998	1997	1996	1995
Total Vehicles	4285	4260	4030	3900	4035
Trucks	908	1142	1080	1045	1080
Driving Lane Total Vehicles	3857	3834	3627	3510	3632
Driving Lane Trucks	818	1028	972	941	973
Passing Lane Total Vehicles	428	426	403	390	403
Passing Lane Trucks	90	114	108	104	107

Note: Passing/Driving lanes splits are estimates

Traffic counts for the passing lane show only ten percent of trucks and vehicles driving in the passing lane. Therefore, ninety percent of trucks and vehicles drive in the driving lane.

From these results and from the economical advantages it appears that the most dependable asphalt concrete overlay joint would be one that has no geosynthetic fabric, that is sawed, and that has minimum rehabilitation, which would include restoring load transfer where necessary and repairing spalled areas. The findings also determined that the asphalt concrete overlays performed better when the joints were sawed. When the joints were not sawed the Portland Cement Concrete Pavement (PCCP) joint reflected through by creating a jagged crack in the asphalt concrete overlay above the Portland Cement Concrete Pavement (PCCP) joint. This made sealing the crack more difficult.

As for the materials that were used, Linq Tac-711N faired better than Strata Grid-200, but Linq Tac-711N and no fabric were typically the same. There seemed to be no fabric better than the other so neither geosynthetic material is recommended to be used to cover the Portland Cement Concrete (PCC) joints prior to completing an asphalt overlay.

Implementation Recommendations

Based on the findings of this study, the following recommendations are presented to the Research Review Board for their consideration:

1) **The South Dakota Department of Transportation (SDDOT) should use minimum rehabilitation including restoring load transfer where necessary and repairing spalled areas on Portland Cement Concrete Pavement (PCCP) joints prior to completing asphalt concrete overlays.**

From the study it was discovered that fewer additional cracks occurred adjacent to joints that had partial depth repair in 1979 and minimum rehabilitation in 1995 versus those that had maximum rehabilitation (full depth repair) prior to the asphalt overlays. In addition, the cost of maximum rehabilitation far outweighs that of minimum rehabilitation. The cost for maximum rehabilitation for each joint in this study was $344.16, while minimum rehabilitation (not including the partial depth repairs completed in 1979) was little to none.

2) **The South Dakota Department of Transportation (SDDOT) should saw and seal joints in asphalt concrete overlays over long jointed Portland Cement Concrete Pavement (PCCP).**

In this study, joints that were sawed tended to have less additional cracks than those that were unsawed. The unsawed joints also ended up having a jagged crack reflect through the asphalt overlays at the joint regardless of whether or not fabric was used.

3) **The South Dakota Department of Transportation (SDDOT) should not use Strata Grid-200 or Linq Tac-711N geosynthetic fabrics in asphalt overlays over Portland Cement Concrete Pavement to prevent reflective cracking at the joints.**

When completing this project, the information was analyzed to determine if the fabrics helped to prevent cracks reflecting through at the joints. It was determined that the Linq Tac-711N joints performed about the same as the joints where no fabric was used. The Strata Grid-200 joints reflected more cracks than the Linq Tac-711N and the joints where no fabric was used. Therefore, neither material is recommended to be used to cover the Portland Cement Concrete Pavement (PCCP) joints prior to completing an asphalt overlay.