NORTH DAKOTA

DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION

Experimental Study ND 92-02

Evaluation of Stratagrid's A-100 Ability to Strengthen an Asphalt Overlay

Final Report

Projects
ST-6-032(017)191 & NH-4-002(046)130

October 1997

Prepared by

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
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RCS HHO-30-19

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO. [1]	STATE: ND, YEAR: 92 – NUMBER: 02, SUF.:
CONSTRUCTION PROJ. NO. [8]	NH-4-002(046)130 ST-6-032(017)191
LOCATION [28]	Ward and Walsh Counties
EVALUATION FUNDING [48]	1 [X] HP&R; 2 [ ] CONSTRUCTION; 3 [ ] DEMONSTRATION; 4 [ ] IMPLEMENTATION
NEEP NO. [49]	
PROPRIETARY FEATURE? [51]	[X] YES; [ ] NO

SHORT TITLE

TITLE [52] Evaluation of Stratagrid's A-100 Ability to Strengthen an Asphalt Overlay

THIS FORM

DATE [140]	MO. 10 – YR. 97
REPORTING [144]	1 [ ] INITIAL; 2 [ ] ANNUAL; 3 [X] FINAL

KEY WORDS

KEY WORD 1 [145]	PAVEMENTASPHALT
KEY WORD 2 [167]	OVERLAYS
KEY WORD 3 [189]	REINFORCEMENT
KEY WORD 4 [211]	ASPHALT
UNIQUE WORD [233]	
PROPRIETARY FEATURE NAME [255]	STRATAGRID

CHRONOLOGY

Date Work Plan Approved: [277]	Date Feature Constructed: [281]	Evaluation Scheduled Until: [285]	Evaluation Extended Until: [289]	Date Evaluation Terminated: [293]
06-92	08-92	05-97	–	06-97

QUANTITY AND COST

QUANTITY OF UNITS (Rounded to whole numbers) [297]	3400
UNITS [305]	1 [ ] LIN. FT.; 2 [X] S.Y.; 3 [ ] S.Y.-IN.; 4 [ ] C.Y.; 5 [ ] TON; 6 [ ] LBS.; 7 [ ] EACH; 8 [ ] LUMP SUM
UNIT COST (Dollars, Cents) [306]	3.15

AVAILABLE EVALUATION REPORTS

[315] [X] CONSTRUCTION; [X] PERFORMANCE; [X] FINAL

EVALUATION

CONSTRUCTION PROBLEMS [318]	1 [ ] NONE; 2 [X] SLIGHT; 3 [ ] MODERATE; 4 [ ] SIGNIFICANT; 5 [ ] SEVERE
PERFORMANCE [319]	1 [ ] EXCELLENT; 2 [ ] GOOD; 3 [ ] SATISFACTORY; 4 [ ] MARGINAL; 5 [X] UNSATISFACTORY

APPLICATION

[320] 1 [ ] ADOPTED AS PRIMARY STD.; 2 [ ] PERMITTED ALTERNATIVE; 3 [ ] ADOPTED CONDITIONALLY; 4 [ ] PENDING; 5 [ ] REJECTED; 6 [ ] NOT CONSTRUCTED

(Explain in Remarks if 3, 4, 5, or 6 is checked)

REMARKS

[321] Project ST-6-032(017)191, Stratagrid test section has approximately 65% less cracking than the control section. Project NH-4-002(046)130, Stratagrid test section has less cracking than the average of the two corresponding control sections, however, the difference is not significant. In general the performance of Stratagrid's A-100 ability to strengthen an asphalt overlay is questionable. It is not recommended that Stratagrid A-100 be used on North Dakota Projects.

[700]

Experimental Study ND 92-02

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Projects ST-6-032(017)191 &
NH-4-002(046)130

October, 1997

Written by
Curt Dunn

Disclaimer

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Evaluation of Stratagrid's Ability to Strengthen an Asphalt Overlay

Objective

The objective of this study is to determine if a geogrid reinforcement, when installed in an asphalt-concrete overlay, will reduce pavement failures caused by excessive reflective cracking.

Scope

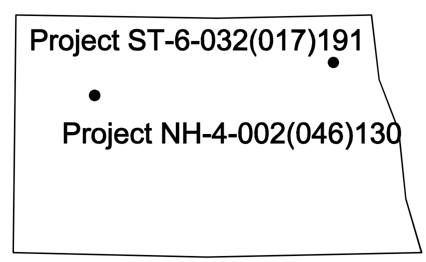
The North Dakota Department of Transportation (NDDOT) incorporated experimental test sections into two North Dakota projects in 1992.

One of the test sections is a city section and the other test section is located in a rural setting where more rapid speeds are encountered. The test sections are comprised of an asphalt overlay with a geogrid reinforcement called Stratagrid A-100 installed between the binder layer and the wearing course.

The NDDOT is evaluating these test sections to determine if Stratagrid A-100 will aid in strengthening an asphalt overlay, reduce reflective cracking, and increase the life of the roadway. The test sections will be compared to control sections having no Stratagrid.

Location

PROJECT ST-6-032(017)191



The 600-foot test section is in the Grand Forks District, on Highway 32, in the town of Edinburg. The test section is near mile point 198.04 from station 386+77.2 to 392+77.2 Lt. and Rt. This section of roadway is a two-lane highway and classified as a minor arterial.

PROJECT NH-4-002(046)130

The 600-foot test section is in the Minot District, on Highway 2, westbound lanes, west of Minot, North Dakota. The test section is near mile point 143 from station 150+00 to 156+00 left. This is a four lane divided highway. The two westbound lanes and portions of the adjoining shoulders were reinforced with Stratagrid.

Project History

Construction

Table 1 shows the history of the pavement section from 1/2 mile north of Junction 17 to Edinburg, North Dakota.

Year Constructed	Type of Construction	Depth (in.)	Rdwy Width (ft.)
1976	Grade		48
1976	Traffic Service Gravel	2	46
1977	Aggregate Base	6	43
1977	Hot Bit. Pavement (200-300)	2	24
1992	Hot Bit. Pavement (120-150)	3.5	24
1992	Finished Roadway Width		36
1992	Safety Project		
1992	Hot Bit. Pavement Shoulders (120-150)	4.7	12

Table 1

Table 2 on the following page shows the history of the pavement section on Highway 2 from two miles west of Junction 83 to one mile west of Junction 83 (WB).

Year Constructed	Type of Construction	Depth (in.)	Rdwy Width (ft.)
1957	Grade		48
1957	Aggregate Base	9	44
1957	Hot Bit. Pavement (150-200)	2	42
1957	Hot Bit. Wearing Course (120-150)	3.0	24
1992	Slope Flattening		
1992	Milling	1.0	24
1992	Hot Bit. Pavement (120-150)	5	28
1992	Finished Roadway Width		37

Table 2

Traffic

Table 3 depicts the two-way traffic estimates within the Edinburg city limits. The years mentioned correspond to when the traffic was counted.

YEAR	PASS>CAR	TRUCKS	TOTAL	30TH MAX HOUR	FLEX ESALS
1992	705	170	875	90	120
1993	625	150	775	80	105
1997	705	170	875	90	120

Table 3

Table 4 depicts the one-way traffic estimates between reference point 143 and reference point 144 (WB). The years mentioned correspond to when the traffic was counted.

YEAR	PASS>CAR	TRUCKS	TOTAL	30TH MAX HOUR	FLEX ESALS
1992	3,470	390	3,860	400	280
1995	3,920	390	4,310	430	280

Table 4

Design

Stratagrid A-100 is manufactured from polyester yarn, coated with polymer modified bitumen resin for good adhesion to asphalt. The aperture size is 2" x 2". The rolls are 300 feet in length by 12 feet wide. The tensile strength has been measured at 2,000 pounds per foot width. The concept is to use the Stratagrid A-100 geogrid material as an interlayer between an asphalt leveling course and the wearing course. It is hoped that the geogrid will absorb a portion of the tensile force created by the traffic and extend the fatigue life of the pavement.

PROJECT ST-6-032(017)191

The plans specified a 3-1/2 inch overlay consisting of 6.8% 120-150 asphalt cement with a Class 30 aggregate. An SS-1h emulsified cationic tack coat asphalt was to be placed between the leveling course and wearing surface prior to installing the Stratagrid A-100. The Stratagrid A-100 was to then be placed between the leveling course and the wearing surface. A copy of the NDDOT standard specification for Class 30 asphalt is located in the appendix.

PROJECT NH-4-002(046)130

The plans specified a 4-1/2" Class 33 overlay with 5.5% 120-150 asphalt cement. The shoulders were to be overlaid with 30% recycled hot bituminous pavement and 70% virgin aggregate Class 33 material. The Stratagrid A-100 was to then be placed between the leveling course and the wearing surface. A copy of the NDDOT standard specification for Class 33 asphalt is located in the appendix.

Construction

Project ST-6-032(017)191

The prime contractor was Mayo Construction. Stratagrid A-100 was placed in the test section August 19, 1992. The northbound and southbound overlaid lanes were reinforced with Stratagrid A-100. The shoulders were not reinforced with geogrid. The installation process involved a sweeping operation to clean the surface of the leveling course that was laid several days earlier. Photo 1 shows the sweeping process. After the surface was cleaned the geogrid was rolled out. Photo 2 shows the Stratagrid A-100 rolled out in the southbound lane.

Photo 1. View of the sweeping process on Hwy 32.

Photo 2. View of the geogrid rolled out.

As each roll of Stratagrid A-100 was rolled out and a new roll started it became necessary to overlap the geogrid ends. In this case a minimum of 20" was used as shown in photo 3.

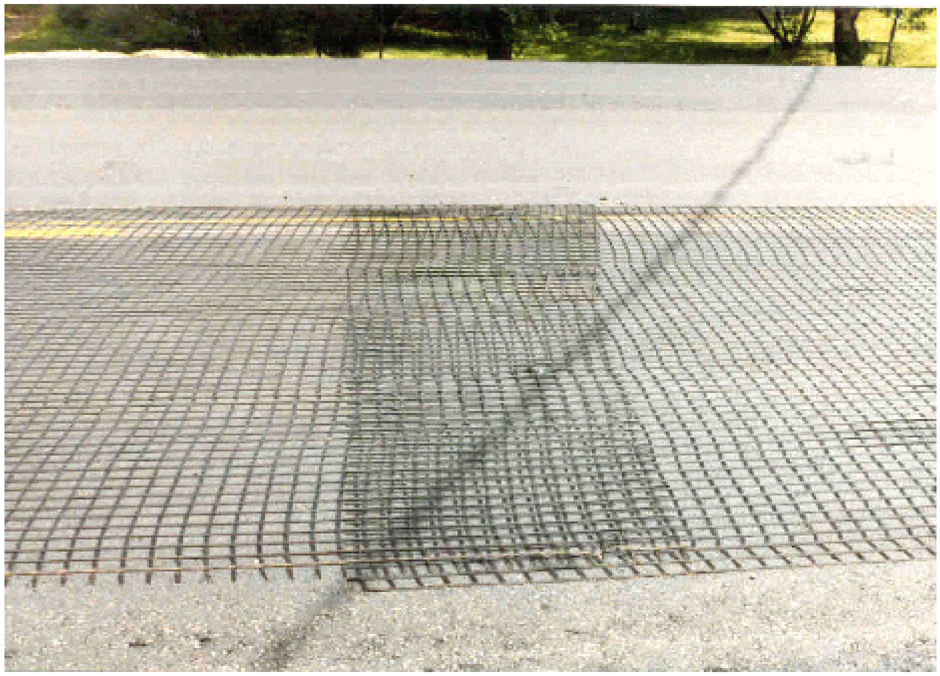


Photo 3. View of the geogrid overlap.

After rolling and fastening the geogrid, a tack coat emulsion was then applied to assist in holding the geogrid in position. Before applying the wearing course over the leveling course, the tack coat was permitted to break and set up. Once the tack coat had set up, hot mix was spread by hand on the leading edge of the geogrid as shown in photo 4. This was done to ensure that the geogrid would stay in place while the wearing course was applied.


Photo 4. View of workers spreading hot mix on the leading edge of the geogrid to ensure it would stay in place.

Once final preparations were complete, the hot mix was brought in as shown in photo 5 on the following page. Trucks were required to back up from the end of the test section to the start of the test section. The trucks drivers were instructed to minimize sharp turns and sudden braking or acceleration movements while backing on the geogrid. It was important the geogrid was left lying flat and undisturbed. This was not the case when the overlay operation began. In photo 6 the geogrid is being lifted by the adhesive tack on the laydown machine wheels.

Photo 5. View of the second lift of HBP being applied over the geogrid.

Photo 6. View of the geogrid being lifted by the laydown machine wheels.

The requirements for optimum interaction and effectiveness with geogrid was that the thickness of the asphalt layer, above the reinforcement, should not exceed 3-1/2", nor be less than 2 inches. Upon further observation it was determined that the thickness of the asphalt layer above the geogrid was approximately 1" to 1-1/2".

After the southbound lane was complete the operation began overlaying the northbound lane. There were no problems encountered while doing the northbound lane.

Project NH-4-002(046)130

Photo 7. View of the lathe-nail system.

The prime contractor for project NH-4-002(046)130 was Border States Paving out of Fargo, North Dakota. The test section is west of Minot, North Dakota on the westbound lanes of Highway 2 from station 150+00 to 156+00. Many of the construction practices that were applied to project ST-6-032(017)191 were applied on this project also. One exception to the Edinburg project was in the fastening of the geogrid to the leveling course prior to the laying of the final lift. A lathe-nail system was used for this purpose as opposed to u-shaped nails. The lathe-nail system is shown in photo 7. There were also similar problems encountered with the geogrid sticking to the wheel of the paver. The tack coat material when applied, formed a sticky surface on the fabric which in turn adhered to the paver wheels. As a result the fabric would lift up allowing the asphalt to work its way under the fabric. There was one incident where the fabric actually lifted high enough that the fabric climbed up onto the wheel of the paver.

Evaluation

Project ST-6-032(017)191

Materials and Research evaluated project ST-6-032(017)191 on 6/12/97. The control section lies adjacent and to the south of the test section. Both the test section and the control section are 600 feet in length.

A visual inspection was conducted on the test section and the control section. The evaluation included documenting the number of transverse cracks, both full and half, and longitudinal cracks that have reflected through since the asphalt overlay in 1992.

In general the distresses do not appear to be getting worse in the test section. Materials and Research registered approximately 9 full length transverse cracks, 3 half-length transverse cracks, and 1 longitudinal crack in the test section. Photo 8 is an overview of the test

Photo 8. Overview of the test section looking north.

section looking south.

Photo 9 is a view of a typical transverse crack located in the test section.

Photo 9. View of a transverse crack in the stratagrid test section

Photo 10 is an overview of an area located in the test section taken in 1997. Photo 11 is a view of the same area taken before the asphalt overlay and Stratagrid were applied. It would appear from these photos that the cracks shown in photo 11 have not all reflected through at this time. Also the test section appeared to

Photo 10. Overview of an isolated area located in the test section

Photo 11. Similar view of the area shown in photo 10 taken before the asphalt overlay and stratagrid were laid down.

have more distresses existing in it, prior to construction of the overlay, than the corresponding control section. In general the existing cracks in the test section do not appear to be widening to any significant amount as compared to last year.

The control section registered approximately 32 transverse cracks, 16 of which were characterized as full length. There were also 7 longitudinal cracks of various lengths.

Photo 12. View of the control section looking north.

Photo 13. View of a typical transverse crack in the control section.

Photo 12 shows an overview of the control section looking north. Photo 13 is a view of a typical transverse crack located in the control section.

Photo 14 is an overview of an area suffering from a combination of longitudinal and transverse cracking located in the control section. Photo 15 is a view of typical longitudinal cracking. Upon viewing the preconstruction video, it would appear that most or all of the distresses in the control section had already reflected through.

Photo 14. View of an area displaying both transverse and longitudinal cracking in the control section.

Photo 15. A view of typical longitudinal cracking occurring in the control section.

Part of the increase in transverse cracking in the control section is due to the type of cracking shown in photo 16. These cracks appear tighter and more closely spaced. They also rarely extend across the entire roadway. Upon viewing the preconstruction video, it was difficult to locate any of these distresses prior to the overlay.

Photo 16. View of the transverse cracking emerging in the control section.

Table 5 tabulates the number of transverse and longitudinal cracks found in both the test section and the control section during the 1996 evaluation. The results are also shown for the years 1993 through 1996.

YEAR OF EVALUATION	TEST SECTION		CONTROL SECTION	
	Transverse cracks (full & half length)	Longitudinal cracks	Transverse cracks (full & half length)	Longitudinal cracks
1993	9	1	5	0
1994	10	1	13	0
1995	11	1	20	1
1996	11	1	29	3
1997	12	1	32	7

Table 5

Table 6 tabulates the 1997 rut and ride results obtained from PavTech. In comparing the rut and ride scores there does not appear to be any significant difference between the two sections.

Section	Direction	From station	To station	Avg. Rut	Ride
				1996	1996
Test	Southbound	386+77	392+77	0.07	4.44
Control	Southbound	392+77	398+77	0.11	4.62

Table 6

The Pave Tech distress rut and ride scores are rated according to the following scale.

	Rut Rating (inch)	Ride Rating
Excellent	0.004 - 0.10	> 4.00
Good	0.10 - 0.25	3.50 - 4.00
Fair	0.25 - 0.50	3.00 - 3.49
Poor	0.50 >	< 3.00

Project NH-4-002(046)130

June 10, 1997, Materials and Research evaluated project NH-4-002(046)130. The control sections lie adjacent and to the east and west of the test section. The test section and both of the control sections are 600-feet in length.

A visual inspection was conducted on the test section and both of the control sections. The evaluation included documenting the number of transverse cracks, both full and half, and longitudinal cracks that have reflected through since the asphalt overlay in 1992.

Photo 17. An overview of the stratagrid test section

Photo 18. A view of a typical transverse crack located in the stratagrid test section.

The test section registered nine full length transverse cracks and one longitudinal crack approximately 30' in length located along one of the shoulders. Photo 17 shows a view of the Stratagrid test section. Photo 18 shows a view of a typical crack in the test section.

Photo 19 shows a longitudinal crack present in the shoulder (driving lane). Photo 20 shows one of several shoulder cracks present in the test section. These cracks have increased in length over the last two years but not to any significant amount. As was previously mentioned the

Photo 19. A veiw of a longitudinal crack located in the shoulder of the test section

Photo 20. A view of a typical shoulder crack that is extending into the mainline.

test section has Stratagrid present in the shoulders also.

Compared to last year's evaluation, all of the cracks, in general, do not appear to be widening to any appreciable amount.

Photo 21 shows an overview of the east control section. The east control section registered 12 full transverse cracks and a 30' longitudinal crack in the shoulder. Photo 22 shows a typical crack located in the east control section.

Photo 21. An overview of the east control section.

Photo 22. A view of a typical crack in the east control section.

Photo 23 shows an overview of the west control section. The west control section registered eight full transverse cracks and a 30' longitudinal crack in the passing lane. Photo 24 shows a typical crack located in the west control section.

Photo 23. An overview of the west control section.

Compared to last year's evaluation, all of the cracks, in general, do not appear to be widening to any appreciable amount.

Photo 24. A view of a typical crack in the west control section.

In general all of the roadway looks good. There were slight depressions where the wheel tracks meet the cracks in all sections. One particular crack in the test section has some spalling as a result.

Table 7 tabulates the amount of full and half length transverse cracks registered in the test section and the corresponding control sections during the 1997 evaluation. This table does not take into account the small shoulder cracking. The results are also shown for the years 1994 through 1997.

YEAR OF EVALU-ATION	TEST SECTION		EAST CONTROL SECTION		WEST CONTROL SECTION	
	Transverse cracks (full length)	Longitudinal cracks	Transverse cracks (full length)	Longitudinal cracks	Transverse cracks (full length)	Longitudinal cracks
1994	10	0	9	0	8	0
1995	10	0	11	0	10	0
1996	9	0	12	0	8	0
1997	9	1	12	1	8	1

Table 7

Table 8 tabulates the 1997 rut and ride results obtained from PaveTech. In comparing the rut and ride scores there does not appear to be any significant difference between the two sections.

Overlay Thickness	Direction	From station	To station	Avg. Rut	Ride
				1997	1997
Test section	Westbound	150+00Lt	156+00Lt	0.15	4.12
Control sections (ave)	Westbound	Approximately 1200' on each side of the test section.		0.19	4.35

Table 8

The PavTech distress rut and ride scores are rated according to the following scale.

	Rut Rating (inch)	Ride Rating
Excellent	0.004 - 0.10	> 4.00
Good	0.10 - 0.25	3.50 - 4.00
Fair	0.25 - 0.50	3.00 - 3.49
Poor	0.50 >	< 3.00

Summary

PROJECT ST-6-032(017)191

At this point in the evaluation the Stratagrid test section has less distresses reflecting through the overlay than the corresponding control section.

The experimental section has approximately 66% less cracking than the control section.

PROJECT NH-4-002(046)130

At this point in the evaluation the Stratagrid test section has approximately the same amount of cracks reflecting through the HBP overlay as the west control section. The east control section has approximately three more transverse cracks reflecting through the HBP overlay than the test section. If the two 600-foot control sections are combined, an average of ten transverse cracks are present. The presence of an average of ten transverse cracks over the eight transverse cracks found in the test section is not significant.

Recommendation

The performance of Stratagrid A-100 geogrid material as an aid in strengthening an asphalt overlay is questionable. In project ST-6-032(017)191 the test section is experiencing less cracking than the corresponding control section, however, it is not known for sure whether the use of Stratagrid A-100 was the reason for this. In project NH-4-002(046)130 there was no significant improvement in the Stratagrid test section. With the inconsistency of the results it is my opinion that Stratagrid A-100 not be recommended for use on North Dakota projects.

Appendix A

Table II: Aggregates for Asphalt Mixes, Blotter, and Seal Coats

Sieve Size Percent Passing	Asphalt Hot Mix Low to High Quality					Chip Seal	Chip Seal	Blotter Sand	Sand Seal
	25	27	29	31	33	42	43	44	45
3"									
1-1/2"									
1-1/4"									
1"									
3/4"									
5/8"	100	100	100	100	100			100	
1/2"	70–100	70–100	70–100	70–100	70–100				
3/8"						100	100		100
No. 4	40–70	40–70	40–70	40–70	40–70	20–70	20–70	90–100	85–100
No. 8	33–55	33–55	33–55	33–55	33–55	2–20	0–17		
No. 16	25–45	25–45	25–45	25–45	25–45				45–80
No. 30	15–35	15–35	15–35	15–35	15–35				
No. 50	10–30	10–30	10–30	10–30	10–30				10–30
No. 200	2.0–9.0	2.0–9.0	2.0–9.0	2.0–9.0	2.0–9.0	0–5	0–2	0–20	0–3
Shale[1]	8%	5%	5%	5%	5%	8%	8%		3%
L. A. Abrasion[1]	40%	40%	40%	40%	40%	40%	40%		
Plasticity Index[2]	0–3	0–3	0–3	N.P.	N.P.				
Fractured Faces[3]	35%	50%	50%	95%	95%				
Crushed Fines[4]			50%	65%	80%				

Footnotes for Tables I and II:

[1] Maximum Allowable Percentages.

[2] Maximum allowable unless range shown. N.P. = Non Plastic as per AASHTO T-90. Use material passing the No. 40 sieve (standard method). For Class 5 aggregate the maximum allowable Plasticity Index shall be determined from the following formula: Max. allowable PI for Class 5 = 10 - (% Passing No. 40 Sieve / 10)

[3] Minimum weight percentage allowable for the portion of the aggregate retained on a No. 4 sieve having at least 1 fractured face for Classes 4, 5, 13, 31, and 33, and at least 2 fractured faces for Classes 7, 25, 27 and 29.

[4] Minimum percentage of material passing a No. 4 sieve that is composed of fractured material produced by a crushing process. The Contractor shall demonstrate that the crushing operation produces this result.