Research Report Documentation Page

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ND 96-04	September 2001	N/A	H-5-085(004)041

5. Title and Subtitle

Evaluation of CRAFCO Crack Sealant On Asphalt Pavement

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- Construction ☐
- Evaluation ☐
- Final ☒

7. Project No.

8. Project No.

9. Project No.

10. Project No.

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Mike Marquart

12. Performing Organization Name and Address

- NDDOT M+R ☒
- NDDOT OTHER* ☐
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- OTHER* ☐

*see supplementary notes

North Dakota DOT
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13. Sponsoring Agency Name and Address

North Dakota DOT
Materials and Research Division
300 Airport Road
Bismarck ND 58504-6005

14. Supplementary Notes

15. Abstract

Purpose and Need

The sealing of cracks in asphalt pavements is vital to the life of the roadway and the pavement. Many products and methods have been used to try and seal these cracks. Most cracks need to be resealed in a few years if not annually depending on the sealing method and sealant used. New methods or sealants need to be evaluated in order to reduce the cost of maintaining these cracks.

Objective

The objective of this study is to evaluate the effective sealant capabilities of different Crafco sealants. This study is being conducted on an asphalt pavement project.

Scope

The project is located on US 85 from Amidon east and north to the county line. Four Crafco products will be installed on project H-5-085(004)041. The Crafco products ROADSAVER 34522, 34231, 34230, and 34221 will be installed by routing the joint on a one-to-one ratio of width to depth. The products will be evaluated for (1) Elastic characteristics (2) Durability (3) Adhesive strength (4) Cohesion strength and (5) Resilience. The project will be evaluated annually and reports written. A final will follow at the end of five years.

Summary

It is vital to the success of the project to provide a routed vessel with vertical walls and a flat bottom. This means that the cutting wheels on a router must be kept in good condition. This would help to construct a properly routed crack that can provide optimum performance.

Joints were measured during a cold winter day and a warm spring day for 1997, 1998, and 1999. Crack spacing ranged from 65 feet to 90 feet in the Crafco 230 and 231 sections. The routed joints expanded from $^{7}/_{16}$ inch to$^{7}/_{8}$ inch during the cold winter of 1996/1997 and from a ¼ inch to ½ inch during the winter of 1998/1999. The section with the greater crack spacing shows the most crack expansion. A warm weather evaluation will produce up to a 30% better joint rating than a cold weather evaluation.

This report fails a joint if combined failures total 20% or more. The sealant cannot be blamed for all of the failures on this project. The Crafco 221 and 522 were judged a failure. The majority of the joint failures in each section were attributed to missing or near missing the crack during the routing process. This represents about 85% of the failures. The rest of the failures are primarily adhesion.

Severe rutting problems were overlaid with asphalt to correct the problem. Rutting was measured at 1¼ inches to 1½ inches at several locations. Cracks were becoming depressed in some areas within the test sections in 1997 and 1998. These depressed cracks are becoming multiple cracked and more depressed in 1999. All of the sections would have received a much better rating if the routing had not missed so much of the crack. Routed cracks that were constructed properly are performing satisfactorily. The Crafco material seems to be able to expand with the crack at these locations.

The August 2000 evaluation shows that the Crafco 230 and 231 sealants are performing about equally.

Recommendations

Any time cracks are routed and sealed, it cannot be stressed enough the importance of obtaining a good vessel with vertical sidewalls and a flat bottom. Most importantly is the need to take the time to follow the crack as closely as possible with the router. Crafco 230 and 231 sealants provided good performance in this study and are recommended for use. Although some of the problems were construction related and not necessarily product related, the Crafco sealants 522 and 521 in this study did not perform very well and are not recommended.

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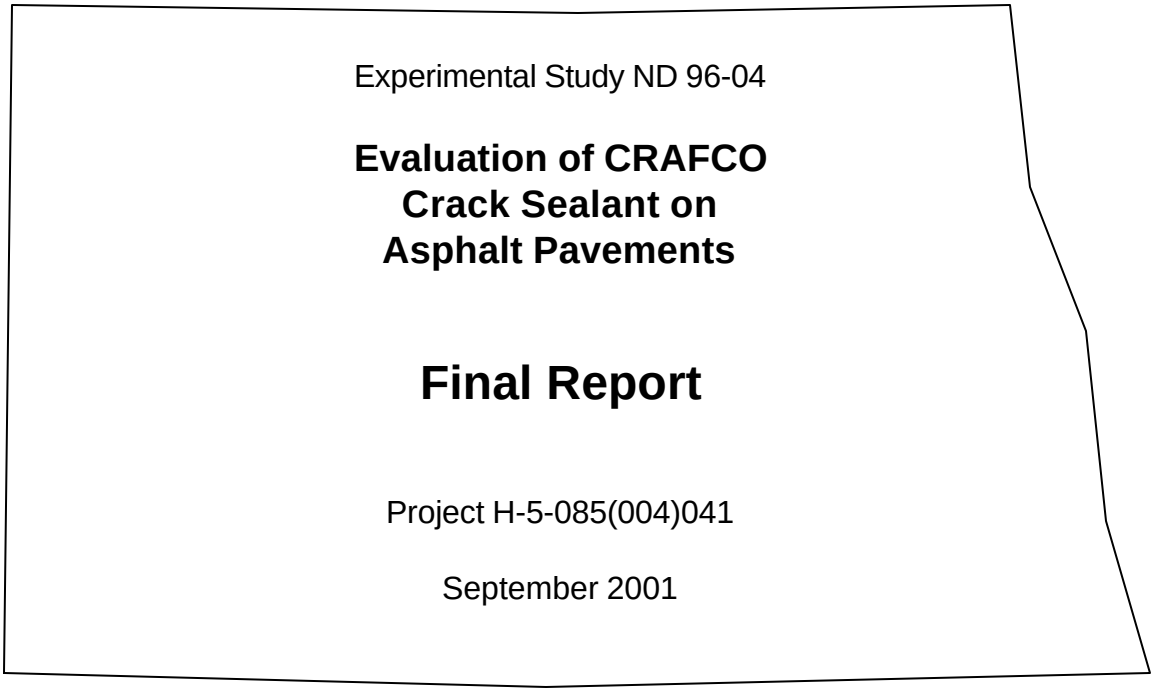
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION



Experimental Study ND 96-04

Evaluation of CRAFCO Crack Sealant on Asphalt Pavements

Final Report

Project H-5-085(004)041

September 2001

Prepared by

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO. — STATE: ND | YEAR: 96 | NUMBER: 04 | SURF:
1

CONSTRUCTION PROJ NO: H-5-085(004)041
8

LOCATION: Slope County
28

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 Crafco Crack Sealant on Asphalt Pavements

THIS FORM

DATE — MO. 0 9 - YR. 0 1
140

REPORTING
144 1 INITIAL 2 ANNUAL 3 X FINAL

KEY WORDS

KEY WORD 1
145 Maintenance

KEY WORD 2
167 Pavement

KEY WORD 3
189

KEY WORD 4
211

UNIQUE WORD
233

PROPRIETARY FEATURE NAME
255 Crafco

CHRONOLOGY

Date Work Plan Approved	Date Feature Constructed:	Evaluation Scheduled Until:	Evaluation Extended Until:	Date Evaluation Terminated:
0 8 - 96	0 8 - 9 6			09-2000
277	281	285	289	293

QUANTITY AND COST

QUANTITY OF UNITS: 5 7 5
297

UNITS
305
1 X LIN. FT
2 SY
3 SY-IN
4 CY
5 TON
6 LBS
7 EACH
8 LUMP SUM

UNIT COST (*Dollars, Cents*): 0 . 3 7
306

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 X MARGINAL
5 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 Crafco experimental sealant 221 and 522 are considered a failure on this project. Original 3/4 inch joints opened to 1 5/8 inch with adhesion failures. Many failures are due to missing the crack with the router. Crafco 231 and 230 materials are performing satisfactorily after four years.

700

Form FHWA 1461

Experimental Feature ND 96-04

EVALUATION OF CRAFCO CRACK SEALANT ON ASPHALT PAVEMENTS

Final Report

H-5-085(004)041

September 2001

By

Mike Marquart

Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

TABLE OF CONTENTS

EVALUATION OF CRAFCO CRACK SEALANT ON ASPHALT PAVEMENTS

H-5-085(004)041

ND 96-04

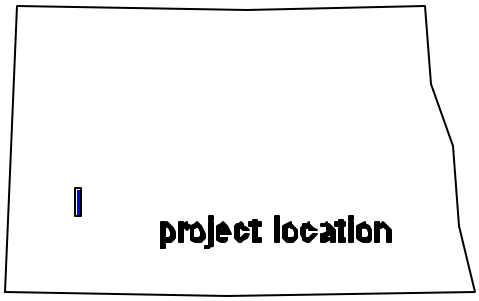
Objective

The objective of this study is to evaluate the effective sealant capabilities of various types of crack sealing products. This study is being conducted on an asphalt pavement project.

Location

The project is located on US 85 from Amidon east and north to the county line. The project number is H-5-085(004)041.

A map to the right shows the project location in the state. Experimental sections are located within the project and are shown below.



Crafco Experimental Sections

Crafco 34221	Mile 49.000 to 50.093
Crafco 34522	Mile 50.107 to 51.154
Crafco 34230	Mile 51.154 to 52.242
Crafco 34231	Mile 52.242 to 53.000 (Control)

Project plans are located in appendix A. They show the project location and notes governing work activities.

Project History

Traffic

Year	Pass>Car	Trucks	Total	Flexible ESALs - Two way
1996	660	120	780	85
1997	1130	220	1350	160
1998	1190	210	1400	150
The 1997 ESAL increase is due to increased crude oil activity in the area.				

Construction

"EXPRO" splits the highway status of the project into two parts. The first part begins at Amidon and proceeds east and north 9.7 miles.

Year	Thickness	Type		Width
1963		Grade		46'
1964	4.0"	Aggregate Base		43'
1964	2.0"	Hot Bit Pavement	120-150	43'
1964	1.5"	Hot Bit Wrng. Crse	120-150	24'
1975	1.5"	Hot Bit Pavement	120-150	24'
1991	2.8"	Milling		27'
1991	2.5"	Large Stone Mix	120-150	27'
1991	1.5"	Hot Bit Pavement	120-150	27'
1991	3.0	Finished Roadway Width		37'
1993		Contract Chip Seal	MC-3000	27'

The second part is from 9.7 miles north of Amidon to 0.25 miles south of the county line.

Year	Thickness	Type	Width
1963		Grade	46 '
1991	5.0"	Aggregate Base	40'
1991	3.0"	Stabilized Base	43'
1991	6.0"	Recycled Bituminous Base	36'
1991	3.0"	Large Stone Mix - 120-150	30'
1991	1.5"	Hot Bit Pavement 120-150	27'
1991		Finished Roadway Width	34'
1993		Contract Chip Seal- MC-3000	27'

Construction

The contractor for this project was Roadway Services, Inc. of Fargo, North Dakota. The work consisted of routing and sealing transverse and longitudinal cracks in an asphalt concrete roadway surface. A sealant conforming to the requirements of ASTM D-3405 with the following modifications was specified.

Penetration at 77° F - 90-150

Bond at -20° F, Std Specimen

3 cycles, 200% Extension - Pass

The sealant material shall weigh not less than 9.00 nor more than 9.35 lbs/gal.

A product called Crafco Roadsaver 34231 was to be used on the entire project. An agreement was reached between Spec Materials, Inc. and the North Dakota Department of Transportation to install three other Crafco materials on this project for experimental purposes. Roadway Services agreed to construct the test sites at the bid price for crack sealing. A change order was written to include the various types of material for the test sites.

A copy of the change order is located in Appendix A. The basic procedure to rout and seal cracks using any of the sealants on the project is as follows. Provide traffic control, route cracks, clean routed cracks, fill crack with material, squeegee material, and if needed apply toilet

paper to prevent tracking.

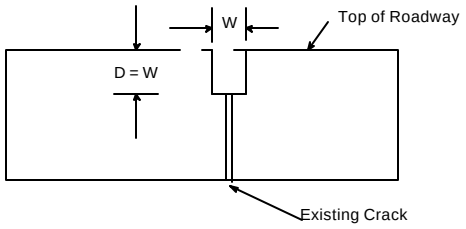
All of the sealants used on this project have a pour temperature of 380° F. The typical reservoir of a routed crack is found in the project plans. The plans are located in Appendix A.

Problems can occur during the routing process. The cutting edges on the routers will wear down and become rounded. This is not acceptable as it will produce a reservoir that does not comply to construction requirements. A poor reservoir is shown in photo 1. Notice in photo 1 that the reservoir bottom is rounded. Also notice the surface edge is very irregular. Worn cutting wheels actually hammer their way through and can cause hairline cracks next to the

Photo 1
Poor reservoir---worn cutting wheels on router.

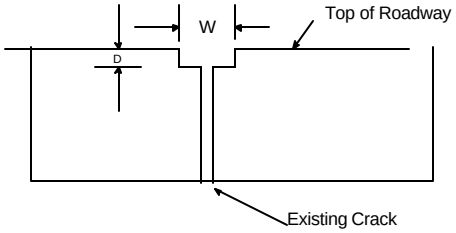
vessel edge. These hairline cracks later show up as spalls.

Ten low profile reservoirs were cut and filled in each type of sealant section. A typical reservoir and a low profile reservoir are shown below.



W = 3/4" MINIMUM

TYPICAL RESERVOIR SECTION FOR CRACKS



W = 1 1/4" D = 3/8" MINIMUM

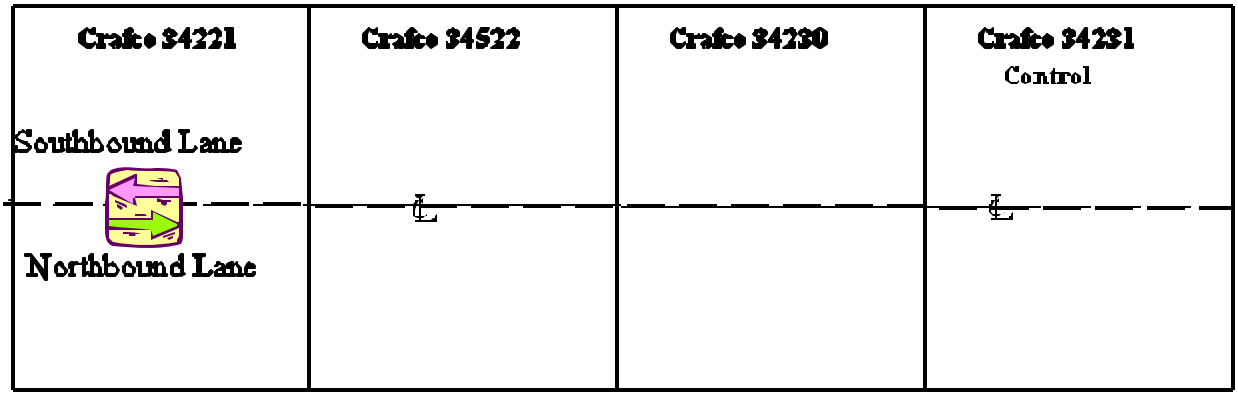
LOW PROFILE RESERVOIR SECTION FOR CRACKS

The experimental sections on this project are listed below.

Material	Test Area	Footage(LF)	Remarks
34221	MP 49.000 to 49.907	3,147.0	¾" × ¾" reservoir
34221	MP 49.907 to 50.093	401.0	1¼" ×⅜" reservoir
34522	MP 50.107 to 50.189	329.0	1¼" ×⅜" reservoir
34522	MP 50.189 to 51.154	2,026.0	¾" × ¾" reservoir
34230	MP 51.154 to 51.909	1,405.0	¾" × ¾" reservoir
34230	MP 51.909 to 52.000	227.0	1¼" ×⅜" reservoir
34230	MP 52.095 to 52.242	375.0	¾" × ¾" reservoir
34231	MP 52.012 to 52.095	201.0	1¼" ×⅜" reservoir
34231	MP 52.242 to 53.000	control	¾" × ¾" reservoir

The map below gives a visual observation of the various Crafco Sealant sections. Each

sealant covers both lanes.



A total of 5750 linear feet of crack repair was installed in the three experimental sections. Materials and Research personnel returned to the project several weeks after the project was completed. A method was developed to measure how much a crack expands during the winter months. A nail was driven into the asphalt approximately 3" on each side of the crack. Square headed concrete nails were driven flush with the roadway surface. A ruler was used to measure the distance from the outer edge of one nail to the outer edge of the other nail. Measurements were taken in millimeters. Photo 2 shows the method used. Three crack locations were selected in each of the four sealant sections.

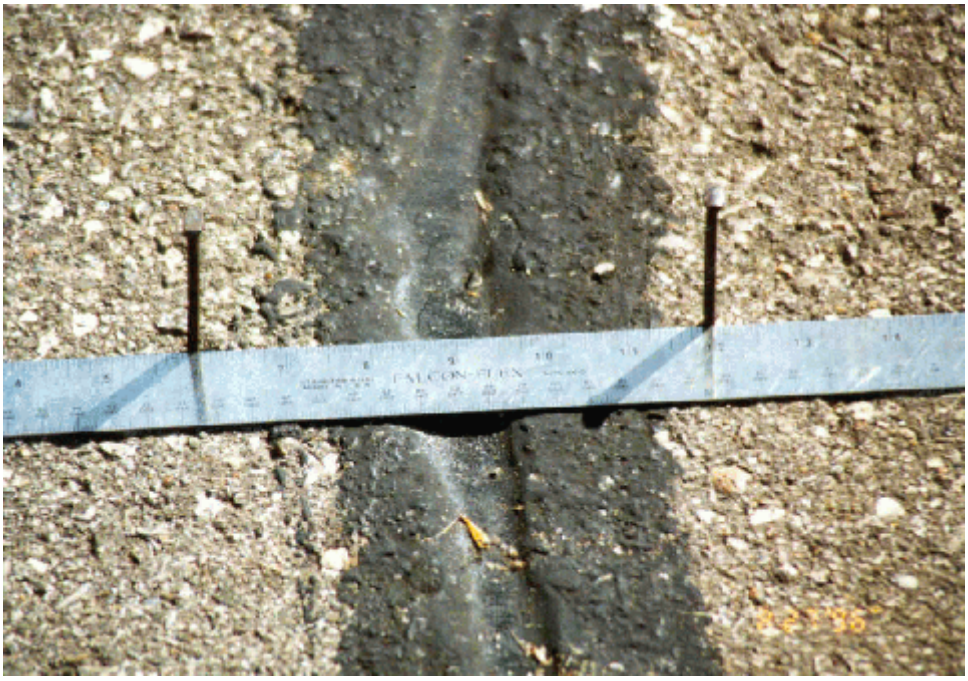


Photo 2
Method for nail installation.

Measurements between the nails are taken each winter. The ruler in photo 2 was used for demonstration only. Actual measurements are taken in millimeters. These measurements are to determine how much the transverse crack opens up under cold conditions. A comparison can be made to the bond extension percent for each tested material. Cracks are routed to obtain a ¾" × ¾" reservoir. A crack like this would have to expand ¾" to receive a 100% extension.

Each sealant was tested according to their own respective specifications. The laboratory report sheets and the Crafco product data sheets are found in Appendix B. Specifications and test results of the sealants are shown in the following two tables.

Table 1 shows that sealant 221 has a different specification than the other three sealants. Crafco 221 is a standard crack sealant whereas the 522, 230 and 231 sealants have polymers added and are low modulus fillers. They are then tested by different methods.

Table 1

Specifications				
Product #	**221**	**522**	**230**	**231**
Pen	90 max.	120-150 Max.	120-150 Max.	120-150 Max.
Bond	3 cycles 50% extension	3 cycles 200% extension	3 cycles 200% extension	3 cycles 200% extension
Flow	3.0 mm Max.	3.0 mm Max.	3.0 mm Max.	3.0 mm Max.
Resilience	60% Min.	60% Min.	60% Min.	60% Min.

Table 2

Test Results of Sealants				
Product #	**221**	**522**	**230**	**231**
Pen	86	122	126	132
Bond	passed	passed	passed	passed
Flow	2.0 mm	2.0 mm	3.0 mm	2.0 mm
Resilience	81%	67%	63%	66%

Evaluation

The project was evaluated each year at two different times. The first evaluation was during a winter month and the second was during a summer month. Data will be shown from both evaluations, with emphasis on the winter evaluation. This is when the most stress is placed on the joint materials.

1997 Evaluation

Two representatives from Crafco and two representatives from Materials and Research formed the evaluation team for the first winter 1996/1997 evaluation. Table 3 shows how much the cracks expanded in the winter and remarks on sealant failures. Table 4 refers to the low profile or wide width joints.

H-5-085(004)041
Expansion of Routed & Sealed Joints
January 28 and August 12, 1997

Table 3

Crafco	Milepoint	Joint Width -- mm			Remarks based on 1-28-97 Evaluation
		original	1-28-97	8-12-97	
231	52.307	158	176	lane patched over	¾" Wide joint. 22% of the joint failed --most is attributed to missing the crack during routing. The plow took out the nail---resulting in spall. Measurement was by nail impression. Sealant was very stiff ----thumb pressure
231	52.554	158	175	patched over	¾" Wide joint. 20% pulled away beyond the routed joint. Very stiff but good bond with the routed joint.
231	52.765	155	179	155	¾" Wide joint. About 6%failed due to spalling. Sealant looks good.
230	51.236	158	185	158	¾" Wide joint. 14% failed due to spalling. Sealant looks good. About the same stiffness as the Crafco 231
230	51.340	159	179	159	¾" Wide joint. 40% pulled away beyond the routed joint.
230	51.752	158	176	158	¾" Wide joint. 6% pulled away beyond the routed joint. Including 6 small spalls. Same stiffness as crafco 231 Sealant is performing very well. Good bonding
522	50.240	158.5	186	159	¾" Wide joint. 29%-- pulled away beyond the routed joint. Softer than Crafco 231 or 230
522	50.431	160	184	161	¾" Wide joint. 20%-- pulled away beyond the routed joint. Sealant in good condition. Softer than Crafco 231 or 230
522	50.776	160	177	159	¾" Wide joint. 30%-- pulled away beyond the routed joint. Sealant in good condition. Softer than Crafco 231 or 230
221	49.076	160	173	160	¾" Wide joint. 35%-- pulled away beyond the routed joint. Sealant very stiff, similar to Crafco 231 & 230
221	49.277	159	170	159	¾" Wide joint. 40%-- pulled away beyond the routed joint --includes 4 spalls. very stiff material
221	49.530	158	169	158	¾" Wide joint. 50%-- pulled away beyond the routed joint. some spalls, some adhesion. May not bond as well as others

H-5-085(004)041
Expansion of Wide Width Routed & Sealed Joints
January 28, 1997

Table 4

Crafco	Location	Remarks
231	Between MP 52.0 & 52.1	1¼" wide joint. Sealant looks good. About 10--15 % joint failure. Some spalling and adhesion failures. No width measurements were taken on any wide width joints.
230	Between MP 51.9 & 52.0	1¼" wide joint. Adhesion or spall failure. Sealant looks good. 10% joint failure
522	Between MP 50.1 & 50.2	1¼" wide joint. 30 - 35% joint failure. A few adhesion, but most pulled away beyond the routed joint. (Routing missed crack)
221	Between MP 49.9 & 50.1	1¼" wide joint. 70% of the joint failed, of which 60% is adhesion and 40% is that which has pulled away beyond the routed joint. More of a bonding problem than the others.

When referring to the open space in a crack that pulled away beyond the routed joint, I am referring to a crack that was missed during the routing process. The routed area is along side this crack and provides no benefit. These areas are counted as joint failures. Most failures occur due to poor crack routing.

According to the measurements, the routed joints in the sections containing the Crafco 231,230 and 522 material all expanded an average of⅞" during this winter season. The Crafco 221 did not expand as wide. This section average was $^{7}/_{16}$". This is only half as much joint expansion compared to the other sections. Joint failure is the highest in the Crafco 221 with more adhesion failures than the other sections. Crafco representatives consider the 221 and 522 sections to have failed. Judging the amount of failure per joint on a scale of 1 to 10, with 10 showing very little failure and 1 as a total failure, Crafco rated the sections a 2.

The next four photos show a crack condition from each section from the 1996/1997 winter evaluation. Notice the routing to the right in photo 3. When this happens the sealant cannot protect the crack from moisture or incompressibles. Photo 4 shows the same kind of failure. Notice the failure to follow the crack.

Photo 5 is a close-up of a routed crack in the Crafco 522 section. In the top part of the picture, the crack is wide open. In the bottom part of the picture where the

Photo 3
Crafco 231–failure–routing missed crack (winter 96/97)

Photo 4
Crafco 230–failure–routing missed crack (winter 96/97)

Photo 5
Crafco–failure–routing missed crack (winter 96/97)

routing is on the edge of the crack, the sealant has elongated enough to provide crack protection. Crafco 221 sealant is the material that has the highest failure rating. The major cause for failure of this sealant is adhesion. A typical adhesion failure is seen in photo 6.

Photo 6
Crafco 221–adhesion failure

The same rating system was used for the August 1997 summer evaluation. The ratings were up as expected. This is not an accurate account of the joint condition. Due to heat expansion the crack narrows and many failures are hidden. All sections received about a 30% better rating when evaluated during summer months instead of during the winter months. Because the cracks are tighter in the warmer months, the material performance may be better than the winter rating suggests. But, the failures are still there and the sealant can not fully protect the crack from moisture intrusion.

A sealed routed crack is considered failed if the combined failures total 20% or more of the joint length. See Table 5 for sealant ratings from data collected in January of 1997.

Table 5

Crafco Sealants Per Section---January 1997					
Crafco Type	Crack Spacing in Feet	Failure Rating		Failure Type	
		1 to 10	%	M*	A*
221	50	failed	90 ?	-------	majority
522	64	failed	39	82%	18%
230	90	8.1	19	84%	16%
231	65	8.5	15	95%	5%

* M= crack area missed during routing

* A= Adhesion Failure

Both Crafco 221 and 522 sealants have failed the first cold weather season. It can be said that all sealants would have received a better rating if the routing had not missed so much of the crack.

1998 Evaluation

The winter of 1998 was an exceptionally warm winter with no snow cover. The evaluation was conducted in February. We knew that the evaluation would be tainted by the warm weather and would reflect in improved ratings. See Table 6.

Table 6

Crafco Sealants Per Section---January 1997 & 1998					
Crafco Type	Crack Spacing in Feet	Failure Rating January 1997		Failure Rating February 1998	
		1 to 10	%	1 to 10	%
221	50	failed first year	90 ?	4.9	51
522	64	failed first year	39	6.3	37
230	90	8.1	19	8.3	17
231	65	8.5	15	8.0	20

The Crafco 221 and 522 received failure ratings even in the 1998 warm winter evaluation. Crafco 230 is performing a little better than the Crafco 231. The ratings in Table 6 for the winter of 1998 show an improved rating over 1997. This is due to the warm winter weather which affects the crack expansion. The sealed cracks would be tighter. This results in a better rating because less failures shows up.

Severe rutting is taking place on many parts of the project. Some areas have been completely overlaid with asphalt mix to correct the rutting. A good stretch in the Crafco 231 control section was overlaid due to rutting. This section was extended to include about the same number of cracks as in the other sections. In some areas the entire roadway was overlaid. Photo 7 shows a lane overlay at milepoint 52.308 in the Crafco 231 section.

Photo 7
Asphalt overlay to correct rutting---Crafco 231 section

The asphalt overlay has been in place for about a year and shows that the routed crack is reflected through the overlay.

Rutting varies in depth, with measurements up to 1¼ inches. This may be directly related to the increased crude oil activity in the area. Rutting is not reserved to any Crafco section, but is mostly found in the Crafco 231 and 230 sections.

Depressed transverse cracks started showing up in 1997 and continued to increase in

Photo 8
Depressed and multiple cracking--Crafco 221 section

1998. Many of these are starting to become multiple cracked. See photo 8. The ride is being affected by these depressed cracks.

1999 Evaluation

The 1999 evaluation was conducted February 4 th and 5 th. There was very little snow on the ground and the temperature was not very cold. Some of the cracks were expanded from ¼ inch to ½ inch. For the most part, the test sections are very similar to the 1998 evaluation. The Crafco 221 and 522 sections have been rated a failure and are not included in the 1999 evaluation. Most of the 522 section has been covered by a maintenance overlay.

All of the cracks in each of the Crafco 230 and 231 sections were rated and the average results are shown in Table 7. The crack spacing was not checked in the 1999 evaluation.

Table 7

Crafco Sealants Per Section---January 1997,1998, and 1999							
Crafco Type	Crack Spacing in Feet	Failure Rating January 1997		Failure Rating February 1998		Failure Rating February 1999	
		1 to 10	%	1 to 10	%	1 to 10	%
230	90	8.1	19	8.3	17	8.8	12
231	65	8.5	15	8.0	20	8.3	17

The 1999 rating has improved from 1998. This is attributed to changes in each section. About half of the 230 section has been overlaid with asphalt or chip sealed. This leaves less cracks for the evaluation. The 231 section has been patched and overlaid in some areas to repair severe rutting. To compensate for less cracks for the evaluation, this test section was extended in length. Thus, new cracks are included in the evaluation and may influence the outcome.

Two photos taken at the same crack location are shown on the next page. Photo 9 shows a typical bad crack during the early part of February 1999. This crack is located in the Crafco 231 section. Photo 10 shows the same crack on May 5, 1999. This is not during the warmest part of the year, but already shows how the crack is closing up. This is why there can be such a difference between evaluators and also what time of year the evaluation occurs.

Photo 9
Crafco 231 section – February 1999 crack severity level

Photo 10
Crafco 231 section–Same crack as Photo 9 except taken on May 5, 1999
You do not see as much failure–even though it is there

It would seem logical that maintenance forces will patch the areas that are the most rutted. This has been done in past years. Many cracks continue to become more depressed each year.

The Crafco 231 and 230 material placed in the wide width routed joints seem to perform better. They look better and do not have as many failures.

2000 Evaluation

Materials and Research did not conduct a winter evaluation for 1999/2000. The winter

Photo 11
Bleeding in wheel paths

was rather mild and may have produced results that would not accurately represent the sealants performance. A summer evaluation took place on August 9, 2000. The Crafco 221 and 522 sealants are still in the routed cracks but, are considered failed and have been dropped from the evaluation.

The Crafco 230 section has been patched in some areas leaving only 23 cracks to evaluate. The cracks look like they are in rather good shape in this section but, some places are rutted over an inch. Photo 11 shows a sand seal where the asphalt is bleeding through. Photo 12 shows the depth of rutting at places in the Crafco 230 section.

Photo 12
Rutting in inside wheel path – SB

The Crafco 231 section also has been overlaid in areas due to rutting. This section was extended in 1999 and has 52 cracks to evaluate. Photo 13 shows a typical crack in either the Crafco 230 or 231 section.

Photo 13
Typical crack found in Crafco 230 or 231 section

As in other years, the percent of failure was determined for each crack by visual analysis. The evaluation was expected to be good based on the time of the year that the evaluation was taken. A copy of the field evaluation data sheets are included in Appendix B. The Crafco sealants 230 and 231 were rated as in the past where failure per crack was based on a scale of 1 to 10. A rating of 10 is the best and 1 is the worst.

Table 8

Crafco Sealants Per Section---January 1997,1998, and 1999								
	Failure Rating							
Crafco Type	January 1997		February 1998		February 1999		August 2000	
	1 to 10	%	1 to 10	%	1 to 10	%	1 to 10	%
230	8.1	19	8.3	17	8.8	12	9.5	5
231	8.5	15	8.0	20	8.3	17	9.4	5

The section ratings are up over last year as expected by a summer time evaluation. Photos 9 and 10 from the 1999 evaluation show this very well. These photos show the visual difference of a cracks sealant failure between a winter and spring environment. Both materials were given the thumb test for flexibility and were judged equal. After four years of service both Crafco Sealants 230 and 231 are performing satisfactorily.

Summary

It is vital to the success of the project to provide a routed vessel with vertical walls and a flat bottom. This means that the cutting wheels on a router must be kept in good condition. The requirements for routing are found in the project plan notes. Strict adherence to these requirements must be mandated. This would help to construct a properly routed crack that can provide optimum performance.

Joints were measured during a cold winter day and a warm spring day for 1997,1998, and 1999. Crack spacing ranged from 65 feet to 90 feet in the Crafco 230 and 231 sections. The routed joints expanded from $^{7}/_{16}$ inch to $^{7}/_{8}$ inch during the cold winter of 1996/1997 and from a ¼ inch to ½ inch during the winter of 1998/1999. The section with the greater crack spacing shows the most crack expansion. A warm weather evaluation will produce up to a 30% better joint rating than a cold weather evaluation.

This report fails a joint if combined failures total 20% or more. The sealant cannot be blamed for all of the failures on this project. The Crafco 221 and 522 were judged a failure. Crafco 231 and 230 have received a slightly better failure rating for 1999. The majority of the joint failures in each section were attributed to missing or near missing the crack during the routing process. This represents about 85% of the failures. The rest of the failures are primarily adhesion.

Severe rutting problems were overlaid with asphalt to correct the problem. Rutting was measured at 1¼ inches to 1½ inches at several locations. Cracks were becoming depressed in some areas within the test sections in 1997 and 1998. These depressed cracks are becoming multiple cracked and more depressed in 1999. All of the sections would have received a much better rating if the routing had not missed so much of the crack. Routed cracks that were constructed properly are performing satisfactorily. The Crafco material seems to be able to expand with the crack at these locations.

The August 2000 evaluation shows that the Crafco 230 and 231 sealants are performing about equally. The ratings were much better than in past years but this is attributed to the summer evaluation.

Recommendations

Any time cracks are routed and sealed, it can not be stressed enough the importance of obtaining a good vessel with vertical side walls and a flat bottom. Most importantly is the need to take the time to follow the crack as closely as possible with the router. Crafco 230 and 231 sealants provided good performance in this study and are recommended for use. Although some of the problems were construction related and not necessarily product related, the Crafco sealants 522 and 521 in this study did not perform very well and are not recommended.

Appendix A

JOB# 25

8	ND	H-5-085(004)041

TRAFFIC - 1000 ADT

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

STATE HD PROJECT H-5-085(004)041
IN SLOPE COUNTY
CRACK CLEAN AND SEAL

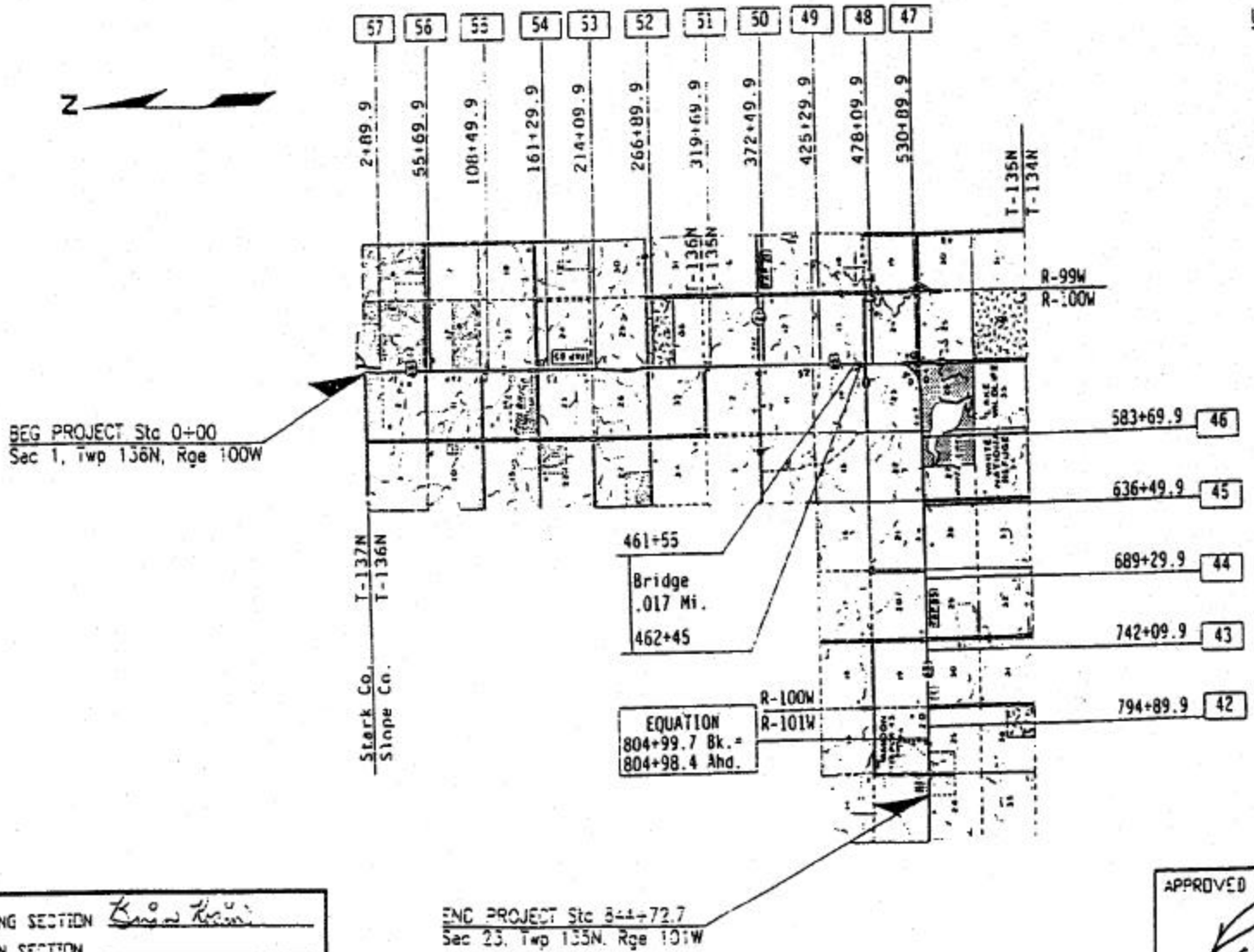
GOVERNING SPECIFICATIONS:

Standard Specifications adopted by the North Dakota Department of Transportation September 199 Standard Drawings currently in effect and other Contract Provisions submitted herein.

LENGTH OF PROJECT

Miles-Gross	Miles-Net
15.999	15.982

.017 Mi Deducted for Structure



CRAFCO EXPERIMENTAL SECTIONS	
CRAFCO PRODUCT #	LOCATION
34221	mile 49.000 to 50.093
34522	mile 50.107 to 51.154
34230	mile 51.154 to 52.242
34231	CONTROL mile 52.242 to 53.000

A-1

PAVING SECTION Kay Kirk
URBAN SECTION
TRAFFIC SECTION
RURAL SECTION
RECOMMEND APPROVAL 4-1 1996

APPROVED DATE April 1 1996
Kay Kirk
DIRECTOR OF HIGHWAYS
AND ENGINEERING
NORTH DAKOTA

ESTIMATE OF QUANTITIES

FHWA REGION	STATE	FED. AID PROJ. NO.	SHEET NO.
8	N.D.	H-5-085(004)041	3

SPEC	CODE	ITEM DESCRIPTION	UNIT	MAINLINE	TOTAL
103	0100	CONTRACT BOND	L SUM	1	1
702	0100	MOBILIZATION	L SUM	1	1
704	0100	FLAGGING	MHR	170	170
704	1100	TRAFFIC CONTROL	L SUM	1	1
704	1185	PILOT CAR	HR	85	85
950	9750	ASPH CONC CRACK CLEAN & SEALING	LF	41,440	41,440

A-2

I. Description

This work shall consist of routing and sealing transverse and longitudinal cracks in an Asphalt Concrete roadway surface with the specified sealant.

II. Materials

The sealant shall conform to the requirements of ASTM D-3405 with the following modifications:

Penetration at 77°F 90-150
Bond at -20°F, Std Specimen,
3 cycles, 200% Extension ..... Pass
The sealant material shall weigh not less than 9.00 nor more than 9.35 lbs/gal.

Only those products that meet the above requirements and have performed satisfactorily based on Department analysis, may be used. A listing of acceptable products may be obtained by contacting the NDDOT Maintenance Engineer.

The blocking media shall be an inert, compressible material which is compatible with the sealant.

III. CONSTRUCTION REQUIREMENTS

A. Routing

1. Routing equipment shall be mechanical, power driven and capable of cutting a reservoir to the required dimensions. Equipment designed to plow the cracks to dimensions will not be permitted. Each side wall of the finished reservoir shall be vertical within a tolerance of 1/16 inch. Riding routers will not be acceptable.

2. Cracks which are less than 3/4 inch in width or depth will require routing to a width and depth of 3/4 to 7/8 inch.

3. Cracks which are 3/4 inch or greater in width and depth will not require routing, but shall be thoroughly cleaned of foreign material to a depth equal to the width of the crack.

4. The walls of the finished reservoir shall be vertical and the reservoir bottom shall be flat.

5. Routing will not be allowed when the roadway is wet.

B. CLEANING

1. Cleaning shall be accomplished with an air compressor producing a minimum of 125 CFM output and equipped with a maximum 3/4" nozzle.

2. Reservoirs and cracks shall be thoroughly cleaned of dust, dirt, and loose materials so that it is clean and dry at the time the blocking medium or sealant is applied.

3. If a routed reservoir or crack is left overnight, it shall be recleaned immediately before the blocking medium or sealant is applied.

4. All routed asphalt concrete and foreign material resulting from the reservoir preparation shall be removed from the roadway surface before an area is opened to traffic.

C. SEALING

1. Cracks 1/8" or larger existing below the routed and cleaned reservoir shall be filled with an inert compressible material to ensure a nominal sealant depth equal to the width of the reservoir. The compressible material proposed for use shall be approved by the Engineer. All costs for furnishing and placing the blocking medium shall be absorbed in the contract unit price bid for "Asphalt Concrete Crack Cleaning and Sealing."

2. Sealant material shall be placed within 72 hours of routing.

3. There shall be no visible signs of moisture on the roadway surface or in the reservoir at the time the sealant is applied.

4. The sealant manufacturer's recommended handling, mixing and application temperature restrictions shall be strictly adhered to.

5. Sealant shall be applied with a pressure type applicator.

6. When applying the sealant, the reservoir shall be overfilled and squeegeed to provide a film of sealant on the roadway surface 1 to 3 inches on both sides of the reservoir.

7. The squeegee shall be a "U" shaped device which will produce a full, uniform and neat appearing reservoir and adjoining surface area. Other type devices will require prair approval by the engineer.

8. A blotting material such as toilet tissue shall be placed over the sealant material immediately after placement at intersections, superelevated curves, grades steeper than 4 percent or as specified on the plans. Blotting material will be required when traffic is allowed to cross a sealed area before track free status has been achieved.

REGION	STATE	FED. AID PROJ. NO.	NO.
8	N.D.	H-5-085(004)041	5

9. The Contractor shall repair or refill, at his own expense, any part of a sealed reservoir damaged by traffic.

D. SEASONAL AND TEMPERATURE LIMITATIONS

1. Routing and sealing of asphalt concrete surfaces will be permitted only during daylight hours between May 1 and October 15.

2. Routing with a star bit type router will not be allowed when the air temperature is below 55°F.

3. Application of the sealant material will not be allowed when the air temperature is below 45°F.

E. GENERAL

1. Only one-half of the roadway shall be worked on at a time.

2. Routing and crack sealing shall be considered as one work zone. A work zone shall not exceed two miles in length at any one time.

3. During weekends, nighttime and other non-working hours all temporary traffic control devices, materials, and equipment shall be removed to a minimum distance of 30 feet from the driving lane.

4. The contractor shall provide one lane for traffic at all times. The contractor's traffic shall be in the same direction as public traffic. Routing and sealing of joints shall be considered moving operations and shall be daylight operations.

5. The contractor shall provide temporary "Road Construction Ahead" signs on county roads when they are included in the work zone. The cost of these signs shall be included in the unit price bid for "Traffic Control, Lump Sum."

6. Traffic approaching the project from intersecting roadways, streets, and approaches must be adequately accommodated. At major intersections or large commercial entrances this may require additional signing, flaggers and channelizing devices on a temporary basis until work activities pass these areas.

7. The rear vehicle of the contractor's operations which is exposed to oncoming traffic will be fitted with a truck mounted attenuator. Cost of furnishing and maintaining the truck mounted attenuator shall be included in the price bid for "Traffic Control, Lump Sum."

8. Traffic control shall comply with construction sign layout Type A on Department Standard 704.15 Standard Drawings D-704-9, 10, 11, 12, 13, and 14 are also applicable.

9. Indiscriminate driving and parking of vehicles on the slopes and in the ditches will not be permitted. Damage as a result of such use shall be restored by the Contractor at no additional cost to the State.

IV. METHOD OF MEASUREMENT

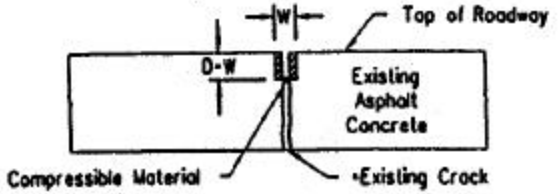
Sealed cracks shall be measured by the linear foot, complete, and accepted.

V. BASIS OF PAYMENT

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Asphalt Concrete Crack Cleaning and Sealing	Linear Foot

This Payment will be full compensation for all labor, equipment, and materials necessary to complete the work as specified.



TYPICAL RESERVOIR SECTION FOR CRACKS

W = ¼" minimum

*Insert compressible material required for cracks ⅜" or more in width.

CRACK SURVEY

MILE	FULL WIDTH CRACKS(FT)	OTHER CRACKS(FT)	TOTAL
56	0	0	0
55	4x34=136	0	136
54	84x34=2856	401	3257
53	1x34=34	0	34
52	5x34=170	6	176
51	13x37=481	17	498
50	62x37=2294	191	2485
49	110x37=4070	459	4529
48	99x37=3663	454	4117
47	41x37=1517		
	41x40=1640	374	35
46	19x40=760		
	60x37=2220	125	34
45	97x41=3977	196	41
44	79x41=3239	174	34
43	99x41=4059	505	45
42	85x41=3485	200	36
41	88x41=3608	129	37

-These are field measurements from December, 1995 survey.-

TOTALS: 987 FULL WIDTH CRACKS
197 PARTIAL WIDTH CRACKS
41,440 FEET OF CRACKS

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
CHANGE ORDER

SFN 11570

SHEET 1

C[illegible]: 1P
ORDER NO: 1C

PROJECT: H-5-085(004)041
COUNTY: SLOPE COUNTY
FOR: CRACK CLEAN AND SEAL

CONTRACTOR: ROADWAY SERVICES, INC.
PO BOX 654
FARGO, ND [illegible]

ORIGINAL CONTRACT AMOUNT
$ 19,225.60

DATE: 08/08/96

SPEC NO	CODE NO	ITEM OF WORK	UNIT	ORIG + OR - PREVIOUS CHG QUANTITY	+ OR - QUANTITY	UNIT PRICE	INCREASE AMOUNT	DECREASE AMOUNT
		ADDED CONTRACT ITEM						
		NON-PARTICIPATING(STATE FUNDS)						
950	9751	ASPH CNCRT CRCK CLN & SL W/CRAFCO 34221	L.F.	0.000	2,500.000	0.365	912.50	
950	9752	ASPH CNCRT CRCK CLN & SL W/CRAFCO 34230	L.F.	0.000	5,750.000	0.365	2,098.75	
950	9753	ASPH CRNCT CRCK CLN & SL W/CRAFCO 34522	L.F.	0.000	5,750.000	0.365	2,098.75	
		DECREASE TO BID ITEM						
950	9750	ASPH CONCRETE CRACK, CLEAN & SEALING	L.F.	41,440.000	-14,000.000	0.365		-5,110.00

NET INCREASE OR DECREASE TO DATE 0.00 PART 0.00 NON-PART

	INCREASE AMOUNT	DECREASE AMOUNT
TOTALS	5,110.00	-5,110.00
NON-PARTICIPATING	5,110.00	-5,110.00
PARTICIPATING	0.00	0.00

DUE TO THIS CHANGE, THE CONTRACT TIME:
IS NOT CHANGED.

EXPLANATION OF CHANGE IN PLAN RECOMMENDED

CRAFCO AND ROADWAY SERVICES HAVE AGREED TO INSTALL TEST SECTIONS FOR THREE DIFFERENT CRAFCO MATERIALS ON THIS PROJECT. THESE WOULD REPLACE AREAS SET UP ON THE PROJECT AND WOULD BE INSTALLED AT CONTRACT PRICES. SEE ATTACHED LETTER TO JERRY HORNER FROM KEVIN AGETON OF SPEC MATERIALS INC FOR THE DETAILS.

Theo Schaaf (signature)	8-15-96	Robert Chmorale (signature)	8/15/96
CONTRACTOR	DATE	PROJECT ENGINEER	DATE
N/A		N/A	
CITY/COUNTY/OTHER OFFICIAL	DATE	DISTRICT ENGINEER	DATE
		N/A	
		CONSTRUCTION ENGINEER	DATE
N/A		N/A	
F H W A		ASS'T CHIEF ENGINEER	DATE

Appendix B

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
REPORT OF TEST ON SAMPLE

MATERIAL	ROADSAVER 221	PROJECT	H-5-085(004)041
LAB NO	CS-14-96	SAMPLE FROM	LOT T8243
FIELD SAMPLE NO	3	DATE RECEIVED	08/12/96
COUNTY	SLOPE	SUBMITTED BY	DVORAK
DATE SAMPLED	08/09/96	MANUFACTURER	CRAFCO
SPECIFICATION	AASHTO M301, ASTM D3405, ASTM D5329		
REPORT NO	237	DATE TESTED	08/29/96

	TEST RESULTS ORIGINAL	CHECK	SPECIFICATION REQUIREMENTS
PENETRATION 25 C 150 G 5 SEC	86		90 MAXIMUM
FLOW @ 60 F	2.0 MM		3 MM MAXIMUM
BOND -29 C @ 3 CYCLES	PASS		RATE 3.2MM PER HR TO 6.4MM
RESILIENCE @ 25 C	81.0		60% MINIMUM

COMMENTS:

CONFORMITY TO SPECIFICATIONS: MEETS SPECIFICATIONS

DICKINSON DISTRICT
LABORATORY
BITUMINOUS LAB
DVORAK
ROADWAY SERVICES

DENNIS J. BLASL
LABORATORY SUPERVISOR

09/10/96

SFN 10080

#3

Proj #5-085(004)041

CRAFCO INC
6975 W. Crafco Way • Chandler AZ 85226
1-800-528-8242 • (602) 276-0406 • FAX (602) 961-0513

PRODUCT DATA SHEET

ROADSAVER 221 SEALANT

PART NO. 34221

JANUAR

READ BEFORE USING THIS PRODUCT

GENERAL

CRAFCO RoadSaver 221 sealant is a single component, hot-applied petroleum based pavement crack and joint sealant which meets all requirements of ASTM D3405 and AASHTO M301. The sealant exceeds requirements of ASTM D1190, AASHTO M173 and Federal Specification SS-S-164. RoadSaver 221 is supplied in solid block form which is easily melted. When properly applied, RoadSaver 221 will form a long lasting resilient seal which is flexible and extensible at sub-zero temperatures and which resists tracking at hot summer temperatures. RoadSaver 221, can be applied to pavement cracks and joints using either pressure feed melter applicator units or pour pots.

SPECIFICATION CONFORMANCE

Specification limits for RoadSaver 221 when tested for conformance with ASTM D3405 are:

Test	ASTM D3405 Spec. Limits
Cone Penetration	90 max.
Flow	3mm max.
Resilience	60% min.
Bond, -20F (-29C), 50% ext.	Pass 3 cycles
Asphalt Compatibility	Compatible
Recommend Pour Temperature	380F (193C)
Safe Heating Temperature	410F (210C)

APPLICATION

The unit weight of Crafco RoadSaver 221 is 10.0 lbs. (4.5 kg) per gallon at 60F (15.5C). For detailed application procedures refer to the CRAFCO Application Instructions for 34221 (December 1995).

PACKAGING

Packaging consists of individual boxes of sealant which are palletized into shipping units. Boxes contain a non-adherent film which permits easy removal of the sealant. Each pallet contains 72 boxes which are stacked in six layers of 12 boxes per layer. The weight of sealant in each box does not exceed 40 lbs. (18kg) and pallet weights do not exceed 2,880 lbs. (1310kg). Pallets of sealant are weighed and product is sold by the net weight of product. Sealant boxes are manufactured from double wall kraft board producing a minimum bursting test certification of 350 psi (241 N/cm^2) and using water resistant adhesives. Boxes use tape closure and do not contain any staples. Boxes are labeled with the product name, part number, lot number, specification conformance, application temperatures and safety instructions. Palletized units are protected from the weather using a two mil thick plastic bag, a weather and moisture resistant cap sheet and a minimum of two layers of six month u.v. protected stretch wrap. Pallets are labeled with the product part number, lot number and net weight. Application instructions are provided with each pallet in a weather resistant enclosure.

WARRANTY

CRAFCO, Inc. warrants that CRAFCO sealants meet applicable ASTM, AASHTO, Federal or State specifications at time of shipment. Techniques used for the preparation of the cracks and joints prior to sealing are beyond our control as are the use and application of the sealants; therefore, Crafco shall not be responsible for improperly applied or misused sealants. Remedies against Crafco, Inc., as agreed to by Crafco, are limited to replacing nonconforming product or refund (full or partial) of purchase price from Crafco, Inc. All claims for breach of this warranty must be made within three (3) months of the date of use or twelve (12) months from the date of delivery by Crafco, Inc. whichever is earlier. There shall be no other warranties expressed or implied. **For optimum performance, follow Crafco recommendations for sealant installation.**

Item # 6
approved
DeBrock
8/17/96

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
REPORT OF TEST ON SAMPLE

MATERIAL	ROADSAVER 522 SEALANT	PROJECT	H-5-085(004)041
LAB NO	CS-13-96	SAMPLE FROM	LOT T8257
FIELD SAMPLE NO	2	DATE RECEIVED	08/12/96
COUNTY	SLOPE	SUBMITTED BY	DVORAK
DATE SAMPLED	08/09/96	MANUFACTURER	CRAFCO
SPECIFICATION	AASHTO M301,ASTM D3405,ASTM D5329		
REPORT NO	236	DATE TESTED	08/23/96

	TEST RESULTS ORIGINAL	CHECK	SPECIFICATION REQUIREMENTS
PENETRATION 25 C 150 G 5 SEC	122		120-150 MAXIMUM
FLOW @ 60 F	2.0 MM		3 MM MAXIMUM
BOND -29 C @ 3 CYCLES	PASS		RATE 3.2 MM PER HR TO 25.4 MM
RESILIENCE @ 25 C	67%		60% MINIMUM

COMMENTS:

CONFORMITY TO SPECIFICATIONS: MEETS SPECIFICATIONS

DICKINSON DISTRICT
LABORATORY
BITUMINOUS LAB
DVORAK
ROADWAY SERVICES

DENNIS J. BLASL
LABORATORY SUPERVISOR

09/10/96

SFN 10080

Proj. H 5.085(004) 041

CRAFCO INC
6975 W. Crafco Way • Chandler AZ 85226
1-800-528-8242 • (602) 276-0406 • FAX (602) 961-0513

PRODUCT DATA SHEET

CRAFCO 34522 SEALANT

PART NO. 34522

JANUARY

READ BEFORE USING THIS PRODUCT

GENERAL

Crafco 34522 sealant is a single component petroleum based pavement crack and joint sealant which is formulated specifically for use in cold areas where extreme movements occur. The sealant is supplied in solid form which, when melted and properly applied, forms a resilient and adhesive compound that will effectively seal cracks in both asphalt and concrete pavements and joints in concrete pavements. When properly applied, 34522 sealant will form a long lasting seal which resists tracking during the summer and cracking during the winter. When melted, 34522 sealant can be applied to pavement cracks and joints using either pressure feed melter applicator units or pour pots. Due to the softness of the sealant, RoadSaver 34522 is not recommended for use as a crack sealant in parking lot or other areas with high levels of foot traffic.

SPECIFICATION CONFORMANCE

The recommended specification limits for 34522 when heated to the safe heating temperature in accordance with ASTM D5167 are as follows:

Test	Spec. Limits
Cone Penetration, 77F (25C), dmm (ASTM D5329)	100-150
Cone Penetration, 0F (-18C), dmm (ASTM D5329 modified)	25 min.
Flow, 140F (60C), 5h (ASTM D5329)	10 mm max.
Resilience, (ASTM D5329)	30-60%
Bond, -20F (-29C), 200% ext. (ASTM D5329)	Pass 3 cycles
Recommended Pour Temperature	380F (193C)
Safe Heating Temperature	410F (210C)
Asphalt Compatibility (ASTM D5329)	Pass

APPLICATION

The unit weight of Crafco 34522 is 9.6 lbs. (4.3 kg)/gallon at 60F (15.5C). For proper application procedures, refer to the Crafco Application Instructions for 34522 (December 1995).

PACKAGING

Packaging consists of individual boxes of sealant which are palletized into shipping units. Boxes contain a non-adherent film which permits easy removal of the sealant. Each pallet contains 72 boxes which are stacked in six layers of 12 boxes per layer. The weight of sealant in each box does not exceed 40 lbs. (18kg) and pallet weights do not exceed 2,880 lbs. (1310kg). Pallets of sealant are weighed and product is sold by the net weight of product. Sealant boxes are manufactured from double wall kraft board producing a minimum bursting test certification of 350 psi (241 N/cm^2) and using water resistant adhesives. Boxes use tape closure and do not contain any staples. Boxes are labeled with the product name, part number, lot number, specification conformance, application temperatures and safety instructions. Palletized units are protected from the weather using a two mil thick plastic bag, a weather and moisture resistant cap sheet and a minimum of two layers of six month u.v. protected stretch wrap. Pallets are labeled with the product part number, lot number and net weight. Application instructions are provided with each pallet in a weather resistant enclosure.

WARRANTY

CRAFCO, Inc. warrants that CRAFCO sealants meet applicable ASTM, AASHTO, Federal or State specifications at time of shipment. Techniques used for the preparation of the cracks and joints prior to sealing are beyond our control as are the use and application of the sealants; therefore, Crafco shall not be responsible for improperly applied or misused sealants. Remedies against Crafco, Inc., as agreed to by Crafco, Inc. are limited to replacing nonconforming product or refund (full or partial) of purchase price from Crafco, Inc. All claims for breach of this warranty must be made within three (3) months of the date of use or twelve (12) months from the date of delivery by Crafco, Inc. whichever is earlier. There shall be no other warranties expressed or implied. **For optimum performance, follow Crafco recommendations for sealant installation.**

Item #6
approved
8/7/96

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
REPORT OF TEST ON SAMPLE

MATERIAL	ROADSAVER 230	PROJECT	H-5-085(004)041
LAB NO	CS-16-96	SAMPLE FROM	LOT T8227
FIELD SAMPLE NO	5	DATE RECEIVED	08/12/96
COUNTY	SLOPE	SUBMITTED BY	DVORAK
DATE SAMPLED	08/12/96	MANUFACTURER	CRAFCO
SPECIFICATION	ASTM D3405, ASTM D3407		
REPORT NO	239	DATE TESTED	/ /

	TEST RESULTS ORIGINAL	CHECK	SPECIFICATION REQUIREMENTS
FLOW @ 60 F	4.0 MM *		3 MM MAXIMUM
BOND -29 C @ 3 CYCLES	PASS		RATE 3.2 MM PER HR TO 12.7 MM
RESILIENCE @ 25 C	63		60% MINIMUM
PEN 25 C, 150 G, 5 SEC	126		110-150 3405 SPEC 90 MAX

COMMENTS:

CONFORMITY TO SPECIFICATIONS: DOES NOT MEET SPECIFICATIONS

DICKINSON DISTRICT
LABORATORY
BITUMINOUS LAB
DVORAK
ROADWAY SERVICES

DENNIS J. BLASL
LABORATORY SUPERVISOR

09/10/96

SFN 10080

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
REPORT OF TEST ON SAMPLE

MATERIAL	ROADSAVER 230	PROJECT	H-5-085(004)041
LAB NO	CS-16-96CK	SAMPLE FROM	LOT T8227
FIELD SAMPLE NO		DATE RECEIVED	08/12/96
COUNTY		SUBMITTED BY	RON TESSIER
DATE SAMPLED	/ /	MANUFACTURER	CRAFCO
SPECIFICATION	ASTM D3405, ASTM D3407		
REPORT NO	281	DATE TESTED	10/21/96

	TEST RESULTS ORIGINAL	CHECK	SPECIFICATION REQUIREMENTS
FLOW @ 60 F	3 MM		3 MM MAXIMUM

COMMENTS:

CONFORMITY TO SPECIFICATIONS: MEETS SPECIFICATIONS

DICKINSON DISTRICT
LABORATORY
BITUMINOUS LAB
MIKE MARQUART

DENNIS J. BLASL
LABORATORY SUPERVISOR

10/22/96

SFN 10080

CRAFCO INC.
6975 W. CRAFCO WAY · CHANDLER, AZ 85226 · 602/276-0406
WATS (800) 528-8242 · FAX (602) 961-0513

PRODUCT DATA SHEET

ROADSAVER 230 SEALANT

PART NO. 34230

January 1991

READ BEFORE USING THIS PRODUCT

GENERAL

Crafco RoadSaver 230 sealant is a premium quality single component, hot-applied, low modulus sealant that remains pliable at temperatures to -40F. RoadSaver 230 is composed of selected asphalts, oils, polymers and reinforcing fillers. The sealant is self-leveling and has a high degree of resiliency which gives the sealant the capability of rejecting incompressibles. Its low modulus properties permit the material to elongate with low stresses when at extremely low temperatures. In addition, RoadSaver 230 has sufficient elastic characteristics at high pavement temperatures to resist flow or tracking. Its low stiffness greatly reduces temperature susceptibility and low stress development (when extended) gives the sealant an exceptional capability of remaining adhered to joint faces under repeated freeze-thaw cycles. RoadSaver 230 is suited for use as either crack sealant in asphalt concrete or a joint sealant in portland cement concrete pavements in moderate to cold climates.

SPECIFICATION CONFORMANCE

RoadSaver 230 is specifically formulated and produced to meet requirements of Minnesota 3720 and Michigan 8.16.04(a)(L.M). Specification limits are as follows:

Test	Minnesota 3720	Michigan 8.16.04(a)(L.M.)
Cone Penetration, 77F	110-150	130+/-20
Flow, 140F	3.0 mm max.	3.0 mm max.
Resilience, 77F	60% min	60% min.
Bond, -20F, 100% ext.	Pass 3 cycles	Pass 3 cycles
Asphalt Compatibility	Pass	Pass
Cone Penetration, 0F	40 min	40 min.
Ductility, 77F	55 cm min.	
Elongation, 77F	600% min.	
Elongation, -20F	300% min.	

APPLICATION

The unit weight of Crafco RoadSaver 230 is 8.5 lbs. per gallon at 60F, 11.1 lbs. of material is required to fill 100 feet of a 1/2" x 1/2" joint. For detailed application procedures refer to the CRAFCO Application Instructions for RoadSaver 230 sealant.

PACKAGING

Packaging of Crafco sealants consists of individual boxes of sealants which are palletized into shipping units each weighing approximately 2400 pounds. Sealants are sold by the net pallet weight. Standard packaging consists of boxes containing approximately 50 pounds of sealant. Sealant may be ordered in boxes weighing approximately 50 pounds with two compartments each containing approximately 25 pounds of sealant. All boxes contain a non-adherent film for easy sealant removal. Several alternate packaging types are available on a special order basis.

AVAILABILITY AND COST

For prices and to order RoadSaver 230, contact your local CRAFCO Distributor or Crafco, Inc.

WARRANTY

CRAFCO, Inc. warrants that CRAFCO sealants meet applicable ASTM, AASHTO, Federal or State specifications at time of shipment. Techniques used for the preparation of the cracks and joints prior to sealing are beyond our control as are the use and application of the sealants; therefore, Crafco shall not be responsible for improperly applied or misused sealants.

Remedies against Crafco, Inc., as agreed to by Crafco, are limited to replacing nonconforming product or refund (full or partial) of purchase price from Crafco, Inc. All claims for breach of this

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
REPORT OF TEST ON SAMPLE

MATERIAL	ROADSAVER 231	PROJECT	H-5-085(004)041
LAB NO	CS-12-96	SAMPLE FROM	LOT T8222
FIELD SAMPLE NO		DATE RECEIVED	08/12/96
COUNTY	SLOPE	SUBMITTED BY	DVORAK
DATE SAMPLED	08/09/96	MANUFACTURER	CRAFCO
SPECIFICATION	ASTM D3405, ASTM D5329		
REPORT NO	235	DATE TESTED	08/20/96

	TEST RESULTS ORIGINAL	CHECK	SPECIFICATION REQUIREMENTS
PENETRATION 25 C 150 G 5 SEC	132		120-150 MAXIMUM
FLOW @ 60 F	2.0 MM		3 MM MAXIMUM
BOND -29 C @ 3 CYCLES	FAIL		RATE 3.2 MM PER HR TO 25.4 MM
RESILIENCE @ 25 C	66		60% MINIMUM

COMMENTS: BOND-200% EXTENSION FAILED FIRST CYCLE

CONFORMITY TO SPECIFICATIONS: DOES NOT MEET SPECIFICATIONS

DICKINSON DISTRICT
LABORATORY
BITUMINOUS LAB
DVORAK
ROADWAY SERVICES

DENNIS J. BLASL
LABORATORY SUPERVISOR

09/10/96

SFN 10080

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
REPORT OF TEST ON SAMPLE

MATERIAL	ROADSAVER 231	PROJECT	H-5-085(004)041
LAB NO	CS-12-96CK	SAMPLE FROM	BATCH T8222
FIELD SAMPLE NO		DATE RECEIVED	08/12/96
COUNTY		SUBMITTED BY	
DATE SAMPLED	/ /	MANUFACTURER	
SPECIFICATION	ASTM D3405, ASTM D5329		
REPORT NO	280	DATE TESTED	10/17/96

	TEST RESULTS ORIGINAL	CHECK	SPECIFICATION REQUIREMENTS
BOND -29 C @ 3 CYCLES	PASS		RATE 3.2 MM PER HR TO 25.4 MM

COMMENTS:

CONFORMITY TO SPECIFICATIONS: MEETS SPECIFICATIONS

DICKINSON DISTRICT
LABORATORY
BITUMINOUS LAB
MIKE MARQUART

DENNIS J. BLASL
LABORATORY SUPERVISOR

10/22/96

SFN 10080