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Evaluation Of Polysulfide Rubber Joint Sealant In Concrete Joints

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- Evaluation ☐
- **Final** ☒

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11. Author(s)/Principle Investigator(s)

Mike J. Marquart

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- NDDOT OTHER* ☐
- NDSU ☐
- UND ☐
- UGPTI ☐
- OTHER* ☐

*see supplementary notes

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Materials and Research Division
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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

Preformed neoprene compression joint sealers have been widely used in North Dakota for many years. The first compression seals were used on I-94 near Sweet Briar Dam in 1964. There has been an increase in the usage of silicone sealants in concrete joints in the past few years. Preformed neoprene compression joint sealers have been effective at keeping out incompressible but tend to leak water. Preformed neoprene also are known to take a compression set, which is when the neoprene no longer presses tightly against the joint wall. Preformed sealers can often pop out of the joints at many locations causing an open joint and are unsightly. Silicone sealants seem to be performing satisfactorily. Research is needed to identify products that will provide long-term performance.

Objective

The objective of this study is to evaluate a polysulfide rubber joint sealant to determine if it provides effective long-term performance, hopefully ten years or more.

Location

The project is located in the city of Cavalier, North Dakota. The test section is partly in project NH-6-005(013)312 and project SS-6-018(033)224.

Scope

The contractor was using silicone to seal the joints on these projects and agreed to substitute the polysulfide sealant in the test section at no added cost. The installation procedure should be the same.

Summary

Both silicone and polysulfide joints had many leaks when tested with the I-Vac system. Thiokol 1P polysulfide sealants have been used in the private sector but never in a government project. The Cavalier project is one of the first to use this product.

No leaks were found in any of the sections right after construction in 1996. Approximately 155 lineal feet of joints were tested of each sealant. The polysulfide sealant performed better than silicone sealant for the first 2 to 3 years, then rapidly deteriorated to a point where it is equal to silicone after 5 years of performance. In 1997 there were 45% more leaks in the polysulfide than in the silicone section. In 1998 there was a 46% increase in leaks in the silicone section compared to the polysulfide section. It should be mentioned that many of the leaks counted in the polysulfide section were concentrated in a few joints. These joints with the most leaks are located near a stop bar or at turning points.

The largest or longest spalls were found in the polysulfide joints. The polysulfide sealant is stiffer than the silicone and could increase spalling.

As of the August 2000 evaluation, both the silicone and polysulfide sealants have a 45% failure rating. It is questionable that the polysulfide sealant will meet our objective of providing long-term performance.

The cost of polysulfide at the time of construction was $32.00/gal. Compared to $26.00/ gal. For silicone. However, the contractor agreed to install polysulfide at the silicone bid price.

Recommendation

Based on physical properties and the results of the study, the polysulfide sealant did not perform any better than the silicone; The use of polysulfide rubber joint sealants is not recommended.

Present research has revealed that the PolySpec Corporation had acquired Morton's line of formulated polysulfide products in 1998. According to a PolySpec representative they have stopped production of two unprofitable products in 1999, which are the 1P and 2P sealant types. Thus, the Thiokol 1P polysulfide product used on this project is no longer available.

16. Key Words

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NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION

Experimental Study MR 96-02

Evaluation of Polysulfide Rubber Joint Sealant in Concrete Joints

Final Report

Projects NH 6-005(013)312 & SS-6-018(033)224

December 2001

Prepared by

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Experimental Study MR 96-02

EVALUATION OF POLYSULFIDE RUBBER JOINT SEALANT IN CONCRETE JOINTS

Final Report

NH-6-005(013)312 and SS-6-018(033)224

December 2001

by
Mike J. Marquart

Disclaimer

TABLE OF CONTENTS

EPOXY-COATED REINFORCING STEEL

Objective

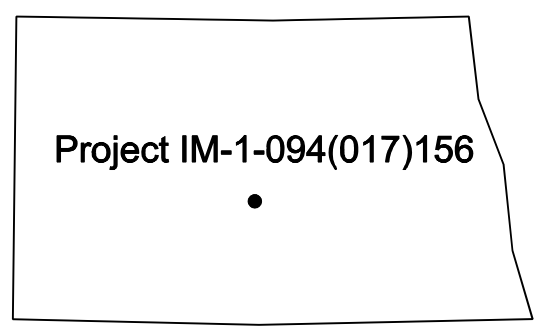
Reinforced concrete structures can experience premature deterioration due to the effects of corrosion of the reinforcing steel. When the reinforcing steel is exposed to moisture and oxygen, corrosion is formed. The addition of salt related admixtures can accelerate the corrosion process. The objective of this report is to determine if epoxy-coated reinforcing steel will serve as a corrosion-protection system for concrete structures and ultimately extend the service life of the structure.

Scope

The North Dakota Department of Transportation (NDDOT) has substituted epoxy-coated reinforcing steel for regular reinforcing steel in a portion of the continuous reinforced concrete pavement project IM-1-094(017)156 (WB). This portion of roadway will serve as a test section and will be compared to a section of roadway containing regular reinforcing steel.

Location

Project IM-1-094(017)156 (WB) is located on I-94 from the West Midway Interchange east to the East Bismarck Interchange. The epoxy-coated reinforcing steel test section is located between the Washington and 4th Street Bridges from Station 363+03.0 to Station 380+97.8. The control section will lie adjacent and to the east of the test section between Station 382+42.8 and Station 400+37.6.



Project History

Year	Depth	Type of Improvement	Width
1996		Grade	
1996		Geotextile Separation Fabric Type S2	43 feet
1996	11.7"	Dense Graded Base	43 feet
1996	7.8"	PCC Pavement	43 feet

Table 1

Traffic Data

Highway 5 from Jct. ND 18 in Cavalier, N to Corp limits.

Year	Cars	Trucks	Total ADT	Rigid Pavement ESAL's
1996	5705	125	5830	100
1997	4850	200	5050	250
1998	4995	205	5200	255
1999-2000	No traffic data collected			
2001	No traffic data collected (Rescheduled)			

Table 2

The difference in ESAL's from 1996 to 1997 is a result of calculations. The ESAL's for 1996 were estimates based on a 1992 count and those for 1997 are based on an actual count from 1996.

Highway 18 from south city limits to Jct. 5

Year	Cars	Trucks	Total ADT	Rigid Pavement ESAL's
1996	5520	180	5700	160
1997	5500	200	5700	230
1998	5595	205	5800	255
1999-2000	No traffic data collected			
2001	No traffic data collected (Rescheduled)			

Table 3

Design

Typical sections showing roadway construction are found in Appendix A. This project was constructed using metric units, but the DOT switched back again the following year. The project plan quantities show that 3848 m (12,625 FT) of preformed elastomeric compression joint seal was planned for the project. The longitudinal joint silicone seal quantity was 1375 m (4,511 FT).

Construction

Construction on the project began on May 6, 1996. The work progressed through the various stages of development. As portions of the project were paved, the joints were sawed to relieve the concrete. Joint details are found on D-550-3 in Appendix A.

Preformed elastomeric compression joint seal was bid for the project. Plan notes allowed the use of either a preformed joint seal or silicone seal. The contractor elected to use silicone. The silicone used was Dow Corning (R) 888. A copy of the certification is shown in Appendix B.

Ron Hamm of Morton International contacted the project engineer, Morris Evens, about trying a polysulfide on this project. An agreement was reached between all parties to use one barrel of polysulfide. There would be no additional costs involved. This polysulfide sealant is called Thiokol 1P. It is manufactured by Morton International, Inc. of Chicago, Illinois. Thiokol 1P one part, is a non-sag, medium-modulus, moisture-curing polysulfide rubber joint sealant. Previous studies have shown that Thiokol 1P resists the effects of sunlight, rain, snow, ozone, aging, shrinkage, and the daily and seasonal cyclic changes in temperature. A copy of the manufacturers Spec Data is included in Appendix B. A copy of the specifications covering sawing, widening, and filling of the joints is found in Appendix B.

The contractor started using the polysulfide sealer on the preselected locations on the afternoon of October 3, 1996. Problems were encountered with installing the polysulfide sealant that were not experienced with the silicone sealant. The polysulfide is sticky when compared to silicone. It also needed twice as much pressure as silicone to make the product flow out of the filling tube. The contractor claims there is more waste than when using silicone. He said the polysulfide skins over faster than silicone and does not provide enough time to use up material left over from tooling. This slows down his operation.

The material recovered from tooling is usually used in curb joints and such. Many of these problems can be attributed to lack of knowledge or experience with a new product. Even though the contractor did not like working with the polysulfide sealant, he provided good workmanship.

Evaluation

Various joint locations were selected for leakage testing in both silicone and polysulfide sections. Silicone was tested from station 361+409.8 to station 361+804.48. on the Highway 18 portion of the project in the northbound lane. Testing began at station Polysulfide testing occurred on Highway 18 from station 361+804.48 to station 361+959.17 in the northbound lane and on Highway 5 from station 504+508.7 to station 504+812.14.

Test locations are shown on plan sheet pages 62, 63, 96, 97, and 98. These plan sheets are found in Appendix C. The polysulfide joints on the plans have been darkened to make them easier to see. The joint leakage tests were conducted using the Iowa Vacuum (I-Vac) chamber. Testing was done across the lane and included the parking lane. Photo 1 shows a view of the I-Vac testing chamber and bubbles reveling areas that leak.

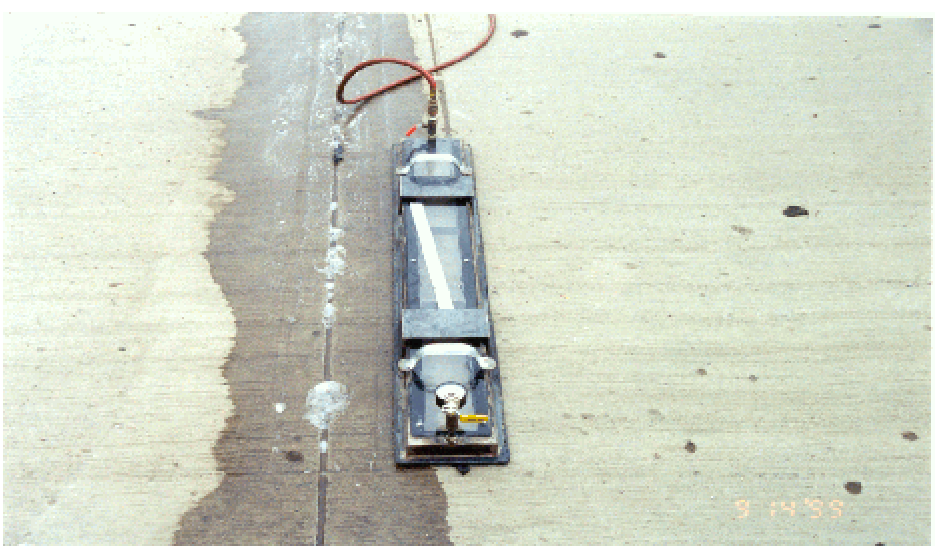
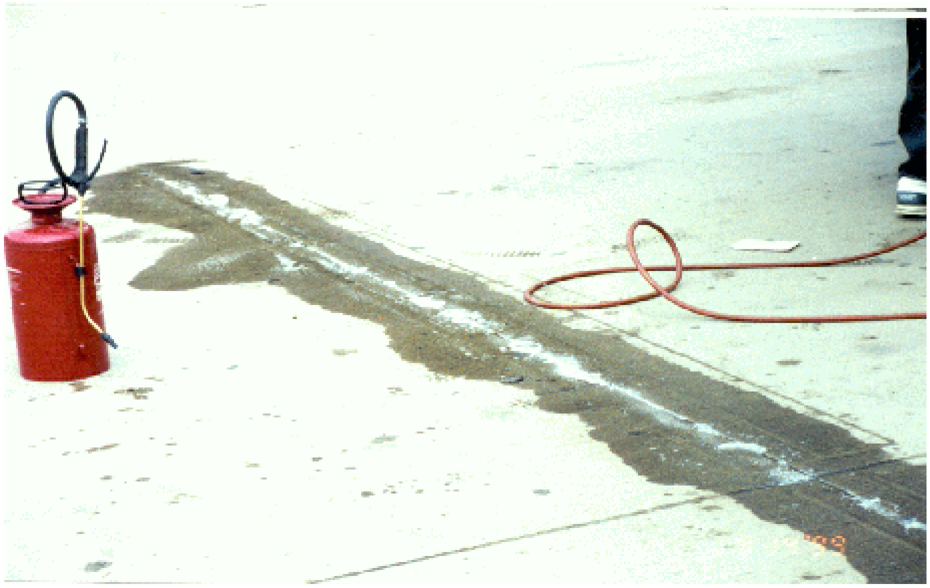


Photo 1: I-Vac testing chamber and leaking areas.


Photo 2: I - Vac test.

The I-Vac testing chamber is 4 feet long. To test across the driving lane and parking lane requires five separate tests. The type and number of leaks were not recorded this year. Instead, the lineal footage of leaks was measured at each joint. It is often difficult to determine the exact cause of each failure. To run a test, the pavement surface is first sprayed with soapy water. The I-Vac is placed over the joint and vacuum is applied. If the joint leaks at any point within the chamber, bubbles will appear as air is drawn up through the joint. The I-Vac has a soft rubber seal that contacts the pavement surface. Small or large leaks can be determined. Photo 2 shows a test in progress. Photo 3 shows the leaks from testing. Just by looking at the joint condition, you can tell which areas or spalls might leak.



According to the DOT's annual average bid prices, a comparison of contraction joint sealant usage was made and is shown below.

Year	Preformed		Average Bid Price	Silicone		Average Bid Price
	Lineal Feet Used	%Used		Lineal Feet Used	%Used	
1995	124,928	71%	$1.05	51,384	29%	$1.77
1996	171,793	89%	$1.22	21,991	11%	$1.85
1997	348,374	69%	$1.12	156,676	31%	$1.86
1998	77,746	14%	$1.99	482,260	86%	$1.31
1999	263,968	61%	$1.71	122,254	39%	$0.94
2000	330,517	58%	$1.36	240,824	42%	$1.16

Table 4

The project plans usually left the type of joint sealant up to the contractor. Preformed compression seals fluctuated from year to year. Preformed average bid prices have been slightly higher than silicone during the last three years. The use of each type of sealant is about even for 2000. Project test results from the past years are shown in tables 5 and 6 on the following pages.

Iowa Vacuum Test of Joints

SS-6-018(033)224 & NH-6-005(013)312

Cavalier City Section

North Bound Lane and Parking Lane

Silicone Test Locations	Joint Condition -----Leaks								
	October 1996			August 1997			August 1998		
	spalls	adhesion	total leaks	spalls	adhesion	total leaks	spalls	adhesion	total leaks
361+409.80	----	----	**0**	5	1	**6**	10	18	**28**
361+497.20	----	----	**0**	8	2	**10**	12	19	**31**
361+533.20	----	----	**0**	3	2	**5**	6	5	**11**
361+660.95	----	----	**0**	2	----	**2**	5	6	**11**
361+704.95	----	----	**0**	4	----	**4**	7	2	**9**
361+756.48	----	----	**0**	6	2	**8**	14	10	**24**
361+772.48	----	----	**0**	14	----	**14**	15	12	**27**
Column Totals			**0**			**49**			**141**

Table 5

Tables 5 and 6 show the number of leaks detected and does not take into account the size or length of the leak.

Iowa Vacuum Test of Joints

SS-6-018(033)224 & NH-6-005(013)312

Cavalier City Section

North Bound Lane and Parking Lane

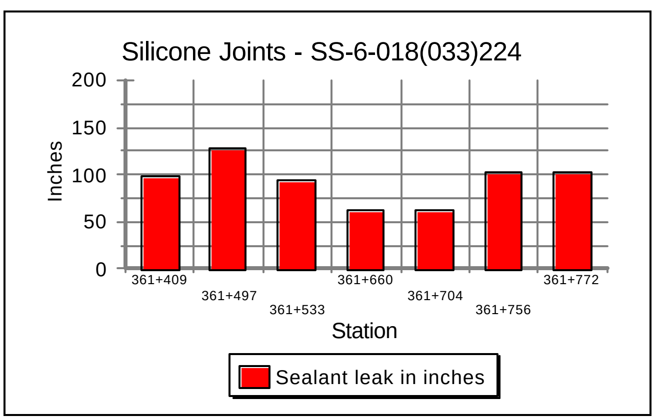
Polysulfide Test Locations	**Joint Condition -----Leaks**								
	October 1996			**August 1997**			**August 1998**		
	spalls	adhesion	**total leaks**	spalls	adhesion	**total leaks**	spalls	adhesion	**total leaks**
361+820.48	----	----	**0**	9	----	**9**	10	11	**21**
361+861.98	----	----	**0**	5	----	**5**	10	1	**11**
361+893.98	----	----	**0**	3	2	**5**	5	2	**7**
361+935.22	----	----	**0**	8	----	**8**	10	2	**12**
504+524.13	----	----	**0**	11	----	**11**	21	1	**22**
504+574.16	----	----	**0**	27	----	**27**	43	----	**43**
1st Panel N of **6**–WB	----	----	**0**	6	----	**6**	13	4	**17**
Column Totals			**0**			**71**			**133**

Table 6

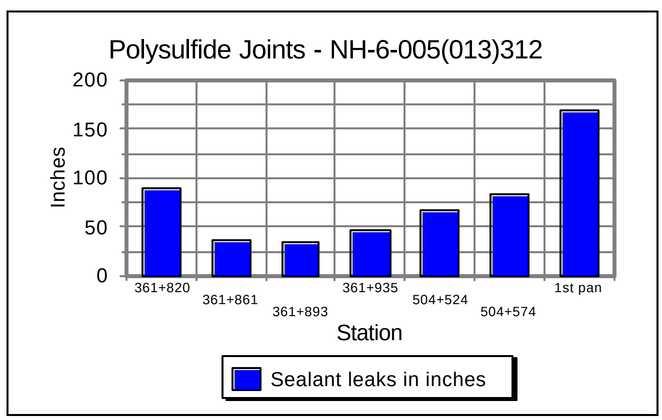
Tables 5 and 6 show that every joint tested had some leaks after one year of service. Approximately 155 lineal feet each of the silicone and polysulfide was tested. In 1997 the polysulfide joints had 45% more leaks than the joints with silicone. A big change took place in 1998 where the silicone joints now have about ¾ of 1% more leaks than the polysulfide joints. This is about a 46%

change. The leakage for 2001 is less than for 2000. This may be the result of individual measurements or differences in pavement temperature which affects the joint pressure. It can be said that the leaks in the silicone joints versus the polysulfide joints are near equal. Most of the leaks were due to spalls of various sizes. It is not known what caused the spalls, some may be from the sawing operation, but most spalls are attributed to traffic. Small stones or pebbles from sanding operations during the winter are believed to cause spalling. These pebbles located on the edges of a joint are driven over by vehicles and the high pressure under the pebble breaks off a small piece of concrete.

In the 1999 evaluation with the I-Vac system, the number of leaks was changed to leak lengths. This results in a better comparison between the two materials. A total of 1680 lineal inches of silicone joints were tested. The detected leaks totaled 650 linear inches and represent a failure rating of 38.7 percent. A total of 1620 lineal inches were tested in the Polysulfide joints and 528 inches of leaks were detected. This represents a failure rate of 32.6 percent. The polysulfide sealant is performing a little better than the silicone. A comparison of the total length of sealant leaks on the two projects is shown in graphs 1 and 2.

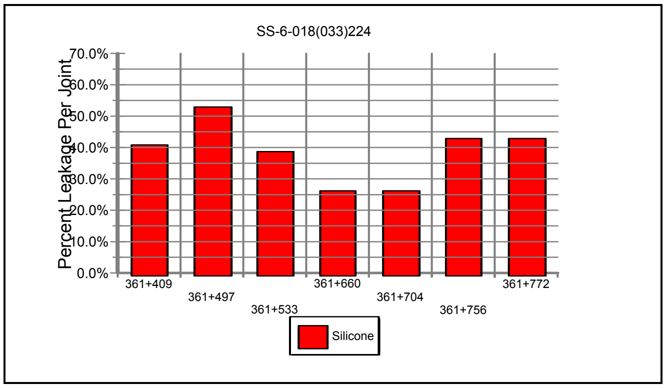


Graph 1

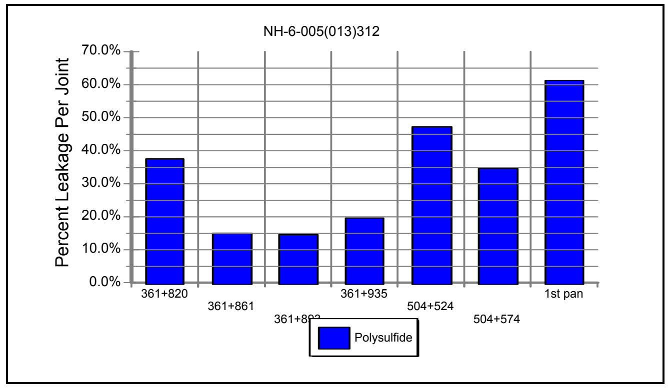


Graph 2

A comparison of the percent leakage per joint of the two sealants is shown in graphs 3 and 4.



Graph 3



Graph 4

Table 7contains the 1999 data of both types of sealants and a comparison of each joints percent leakage or sealant failure.

Iowa Vacuum Test of Joints

SS-6-018(033)224 & NH-6-005(013)312

9 - 4 - 1999

Location	Sealant Type	Joint Length - Inches	Leak in Inches	% Leaking	Location	Sealant Type	Joint Length - Inches	Leak in Inches	% Leaking
361+409.80	Silicone	240	98	40.8	361+820.48	Polysulfide	240	90	37.5
361+497.20	Silicone	240	127	52.9	361+861.98	Polysulfide	240	36	15.0
361+533.20	Silicone	240	93	38.8	361+893.98	Polysulfide	240	35	14.6
361+660.95	Silicone	240	63	26.3	361+935.22	Polysulfide	240	47	19.6
361+704.95	Silicone	240	63	26.3	504+524.13	Polysulfide	144	68	47.2
361+756.48	Silicone	240	103	42.9	504+574.16	Polysulfide	240	83	34.6
361+772.48	Silicone	240	103	42.9	1st Panel N of 6–WB	Polysulfide	276	169	61.2
Totals		**1680**	**650**	**38.7**	**Totals**		**1620**	**528**	**32.6**

Table 7

2000 Evaluation

The test sections were checked for leaks on 8-23-00. The following table shows the data collected which indicates the condition of the sealants.

Iowa Vacuum Test of Joints

SS-6-018(033)224 & NH-6-005(013)312

8-23-2000

Location	Sealant Type	Joint Length - Inches	Leak in Inches	% Leaking	Location	Sealant Type	Joint Length - Inches	Leak in Inches	%Leaking
361+409.80	Silicone	240	116	48	361+820.48	Polysulfide	240	148	62
361+497.20	Silicone	240	141	59	361+861.98	Polysulfide	240	82	34
361+533.20	Silicone	240	115	48	361+893.98	Polysulfide	240	52	22
361+660.95	Silicone	240	56	23	361+935.22	Polysulfide	240	83	35
361+704.95	Silicone	240	95	40	504+524.13	Polysulfide	144	109	76
361+756.48	Silicone	240	179	75	504+574.16	Polysulfide	240	151	63
361+772.48	Silicone	240	139	58	1st Panel N of **6**–WB	Polysulfide	276	224	81
Totals		**1680**	**841**	**50**	**Totals**		**1620**	**849**	**52**

Table 8

The total per cent of leaks has increased by 10% from 1999 to 2000. Both sealants are performing much the same at this time. Photos 4 and 5 show some typical joint conditions in 2000.

Photo 4 Typical Joint.

Photo 5 Typical Joint Close-up.

The failures in the silicone section are about equal with 50% adhesion and 50% spalls. The silicone is very dirty, but is still soft. More spall failures were noticed in the Polysulfide section than adhesion and they were larger in size. The Polysulfide sealant is whiter looking than the silicone, but is harder or less flexible. Both sealants are staying in the joint and do keep most of the incompressible material out. The joints in the intersection exhibit the most lineal leakage.

2001 Evaluation

The fifth and final evaluation was conducted on 8-29-01. Table 9 contains the I-Vac data collected and comparisons between the two sealants.

Iowa Vacuum Test of Joints

SS-6-018(033)224 & NH-6-005(013)312

8-29-2001

Location	Sealant Type	Joint Length - Inches	Leak in Inches	% Leaking	Location	Sealant Type	Joint Length - Inches	Leak in Inches	% Leaking
361+409.80	Silicone	240	120	50	361+820.48	Polysulfide	240	120	50
361+497.20	Silicone	240	129	54	361+861.98	Polysulfide	240	81	34
361+533.20	Silicone	240	107	45	361+893.98	Polysulfide	240	59	25
361+660.95	Silicone	240	50	21	361+935.22	Polysulfide	240	69	29
361+704.95	Silicone	240	81	34	504+524.13	Polysulfide	144	90	63
361+756.48	Silicone	240	131	55	504+574.16	Polysulfide	240	127	53
361+772.48	Silicone	240	138	58	1st Panel N of **6**–WB	Polysulfide	276	179	65
Totals		**1680**	**756**	**45**	**Totals**		**1620**	**725**	**45**

Table 9

Spalling and adhesion loss are the two main reasons for failure of these sealants to keep moisture from entering the roadway. Of the 45% silicone joint failure, 21% is from spalls and 24% is due to adhesion loss. And of the 45% polysulfide joint failure, 28% is from spalls and 17% is due to adhesion loss.

The polysulfide has less adhesion failures and more spalling than silicone. This supports what was stated earlier in this report, that polysulfide is very sticky when applied and stiff yet pliable when cured.

Summary

Both silicone and polysulfide joints had many leaks when tested with the I-Vac system. Thiokol 1P polysulfide sealants have been used in the private sector but never in a government project. The Cavalier project is one of the first to use this product.

No leaks were found in any of the sections right after construction in 1996. Approximately 155 lineal feet of joints were tested of each sealant. The same joints were tested in 1997 and 1998. The polysulfide sealant performed better than silicone sealant for the first 2 to 3 years , then rapidly deteriorated to a point where it is equal to silicone after 5 years of performance. In 1997 there were 45% more leaks in the polysulfide than in the silicone section. In 1998 there was a 46% increase in leaks in the silicone section compared to the polysulfide section. Thus, both sealants are performing about the same in 1998. In most cases, the spalled material is still adhering to the sealant whether it be silicone or polysulfide. It should be mentioned that many of the leaks counted in the polysulfide section were concentrated in a few joints. These joints with the most leaks are located near a stop bar or at turning points.

The number of leaks counted in 1998 increased from 1997 by 188% in the silicone joints and 87% in the polysulfide joints. The same joints tested in 1998 were again tested in 1999 for leakage using the I-Vac system. The largest or longest spalls were found in the polysulfide joints. The polysulfide sealant is stiffer than the silicone and could increase spalling.

As of the August 2000 evaluation, both the silicone and polysulfide sealants have a 45% failure rating. See table 10 for the last 3 years data. The silicone sealant had a 21% failure due to spalling and 24% due to adhesion loss. The polysulfide sealant had a 28% failure due to spalling and 17% due to adhesion loss. Each type of failure was measured with a ruler and recorded. These sealants are performing very similar at this point. It is questionable that the polysulfide sealant will meet our objective of providing long-term performance.

The cost of polysulfide at the time of construction was $32.00/gal. Compared to $26.00/ gal. for silicone. However, the contractor agreed to install polysulfide at the silicone bid price.

Iowa Vacuum Test of Joints

SS-6-018(033)224 & NH-6-005(013)312

8-29-2001

Year	Sealant Type	Total Length - Inches	Total Leak in Inches	% Leaking	Sealant Type	Total Length - Inches	Total Leak in Inches	% Leaking
1999	Silicone	1680	650	39	Polysulfide	1620	528	33
2000	Silicone	1680	841	50	Polysulfide	1620	849	52
2001	Silicone	1680	756	45	Polysulfide	1620	725	45

Table 10

Recommendation

Based on physical properties and the results of the study, the polysulfide sealant did not perform any better than the silicone; The use of polysulfide rubber joint sealants is not recommended.

Present research has revealed that the PolySpec Corporation had acquired Morton's line of formulated polysulfide products in 1998. According to a PolySpec representative they have stopped production of two unprofitable products in 1999 which are the 1P and 2P sealant types. Thus, the Thiokol 1P polysulfide product used on this project is no longer available.

APPENDIX A

HWY 5 DESIGN DATA				
Traffic	Average Daily			Est. Max-Hr.
Current	Pass. 5705	Trucks 125	Total 5830	590
Forecast	Pass. 5995	Trucks 130	Total 6125	620
Minimum Sight Dist. for:		Design Speed 60 Km/hr		
Stopping 74.3 m				

HWY 18 DESIGN DATA				
Traffic	Average Daily			Est. Max-Hr.
Current	Pass. 5520	Trucks 180	Total 5700	685
Forecast	Pass. 5810	Trucks 190	Total 6000	720
Minimum Sight Dist. for:		Design Speed 60 Km/hr		
Stopping 74.3 m				

JOB# 19

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

PEMBINA COUNTY

PROJECT NOS.

NH-6-005(013)312
SS-6-018(033)224

Grading, Surfacing, Storm Drains, Structural, Signals, Lighting, Signing, Marking & Incidentals

FHWA REGION	STATE	PROJECT NO.	SHEET NO.
8	ND	NH-6-005(013)312 SS-6-018(033)224	1

METRIC

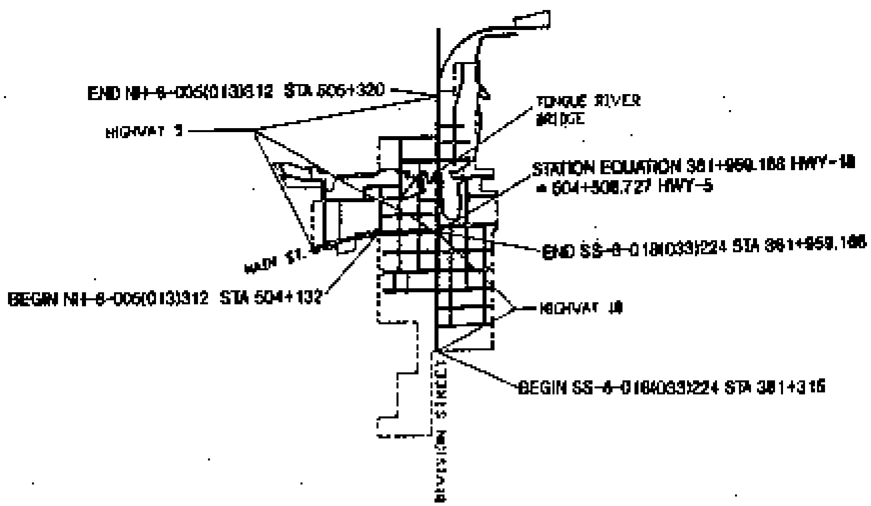
GOVERNING SPECIFICATIONS

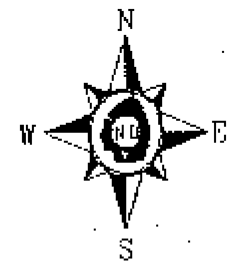
Standard Specifications adopted by the North Dakota Department of Transportation September 1992; Standard Drawings currently in effect; and other Contract Provisions submitted herein.

LENGTH OF PROJECTS

PROJECTS	KILOMETERS
NH-6-005(013)312	1.19
SS-6-018(033)224	0.84

A-1





CAVALIER

PAVING SECTION ____
URBAN SECTION ____
TRAFFIC SECTION ____
RURAL SECTION ____
RECOMMEND APPROVAL 12-14, 1995
DESIGN ENGINEER ____

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED

DIVISION ADMINISTRATOR DATE

APPROVED DATE 12-26-95

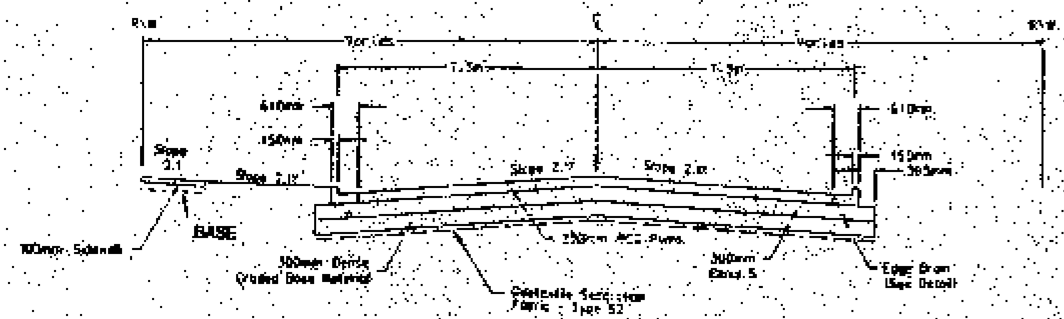
DIRECTOR OF HIGHWAYS
AND ENGINEERING
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

FHWA REGION	STATE	FED. AID PROJ. NO.	SHEET NO.
8	ND	SS-6-018(033)924	45

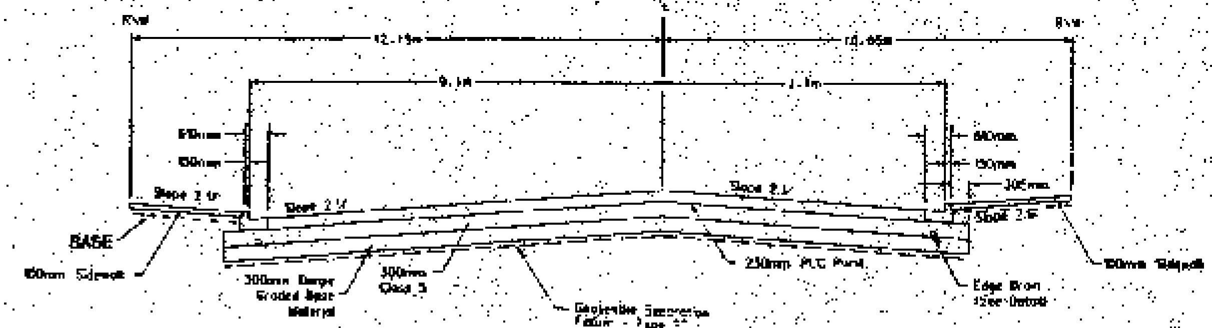
METRIC

TYPICAL SECTIONS

DIVISION AVE SOUTH OF MAIN ST



SOUTH END OF PROJECT TO MOUNTAIN ST.

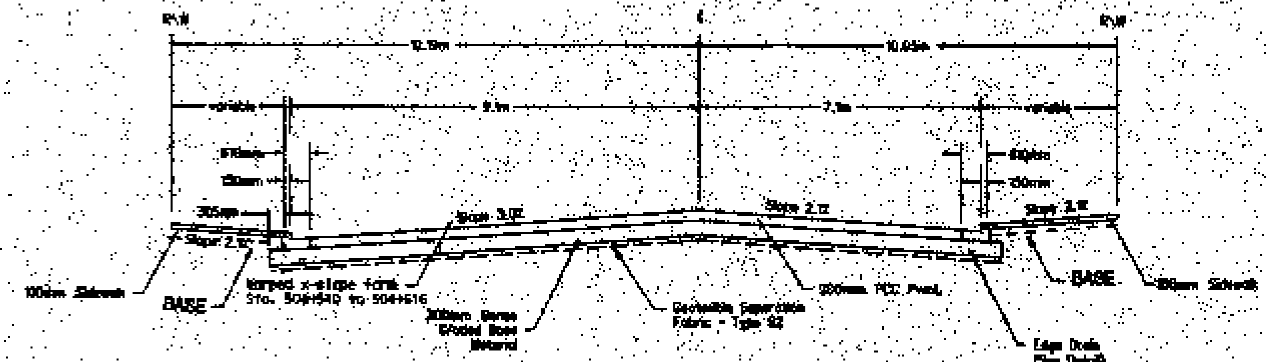


MOUNTAIN ST TO MAIN ST

FHWA REGION	STATE	FED. AID PROJ. NO.	SHEET NO.
8	ND	NH-6-005(013)312	42

METRIC

TYPICAL SECTIONS
DIVISION AVE NORTH OF MAIN ST.



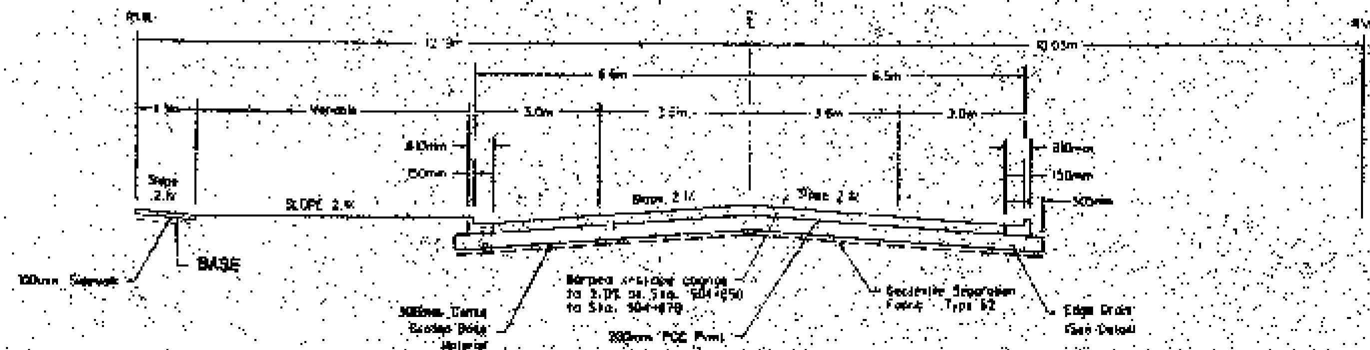
MAIN STREET TO ELIZABETH ST

A - 3

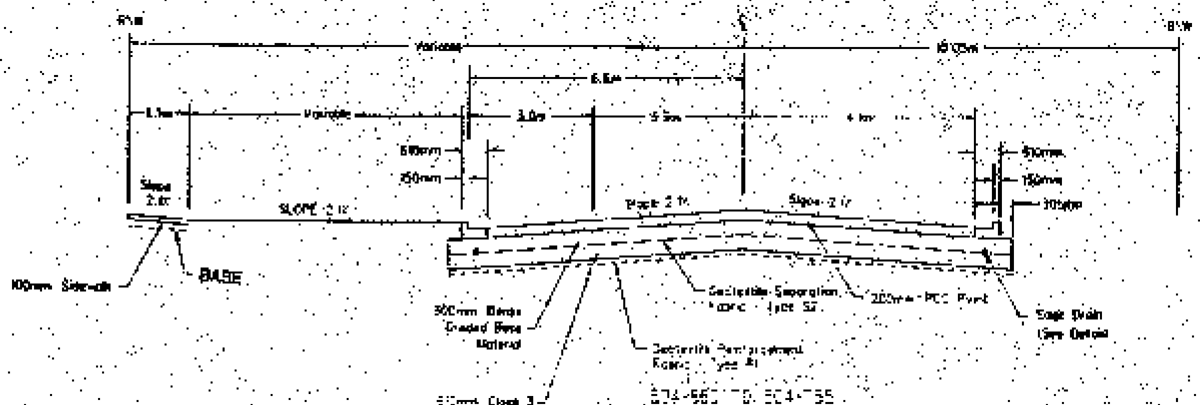
FHWA REGION	STATE	FED. AID PROJ. NO.	SHEET NO.
8	ND	NH-8-005(013)312	45

METRIC

TYPICAL SECTIONS
DIVISION 4.E. NORTH OF MAIN ST.



ELIZABETH ST. TO 504+555
504+770 TO TONGUE RIVER BRIDGE

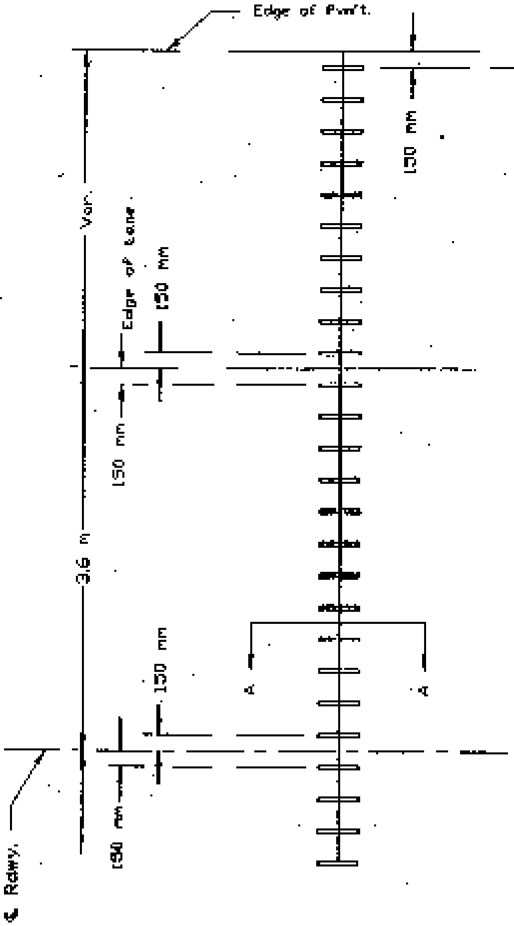


504+560 TO 504+755

A-4

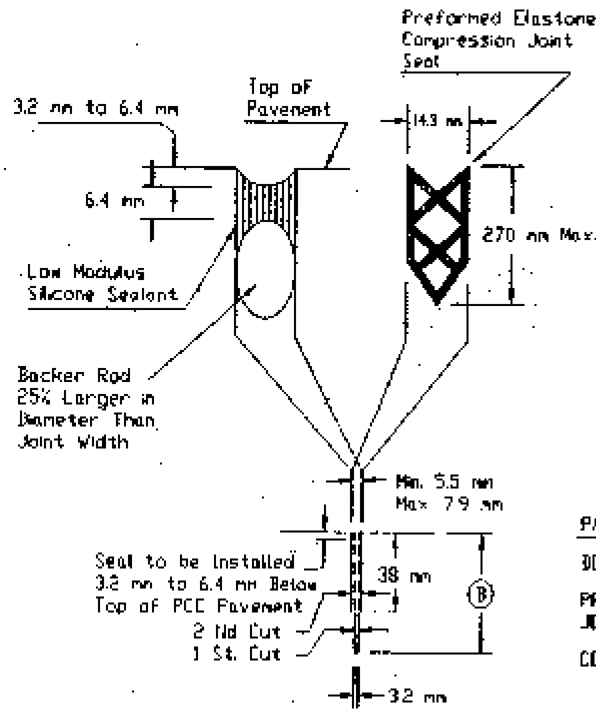
D-550-3

TRANSVERSE CONTRACTION JOINT DETAILS



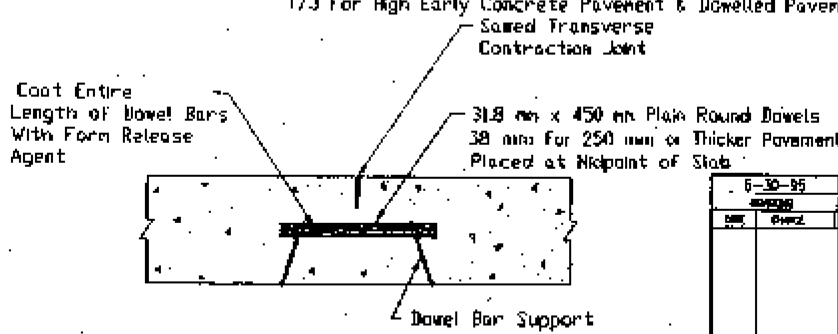
CONTRACTION JOINT DOWEL BAR ASSEMBLY

(1/2 Roadway Shown)



SAWED TRANSVERSE JOINT

(B) T/4 +1/4 For AE or YE Non Dowelled Concrete Pavement or
T/3 For High Early Concrete Pavement & Dowelled Pavement



SECTION A-A

Notes: Preformed Compression joint seals of other shapes may be used. The shape and dimensions must be approved by the Engineer.
Preformed inserts used to form grooves for transverse joints will not be allowed.

The joint Seal details apply to both doweled and plain (non-doweled) transverse joints.

All Dowels shall be epoxy coated in accordance with AASHTO M-254 TYPE B.

T = Thickness of Pavement

PAY ITEMS

DOWELED CONTRACTION JOINT ASSEMBLY-L.m.

PREFORMED ELASTOMERIC COMPRESSION JOINT SEAL 14.3 mm - L.m.

CONTRACTION JOINT SILICONE SEAL- L.m.

6-30-95

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

APPROVED: DESIGN ENGINEER

APPENDIX B

NDDOT Standard Specifications for Road and Bridge Construction

153.12 CONCRETE SAWS.

Saws shall be adequately powered and furnished with suitable blades to effectively cut pavement joints to required dimensions. Each blade of multiple-blade saws shall be maintained in accurate alignment to the other blades. A device shall be provided to guide the saw along the required joint alignment. Manual guidance of the saw will be permitted if specified results are obtained. A sufficient number of sawing units shall be available to maintain required progress and provide prompt replacement in case of breakdown. Adequate artificial lighting shall be provided for night sawing.

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550.04 I. Joints.

1. General. Joints in concrete pavement shall be of the design specified and shall be constructed at the spacings and locations shown. The ramp joints beyond the ramp taper shall have the same spacing sequence as the mainline. The Contractor shall establish joint locations.

2. Transverse Contraction Joints. The contraction joints shall consist of weakened planes created by sawing on mainline paving and by either sawing, inserting preformed inserts, or forming grooves in the pavement surface on shoulders, small areas or tapers. The location of grooves to be formed or sawed shall be clearly and accurately marked on the plastic concrete surface by the Contractor. When specified, the contraction joints shall include a load transfer device.

   Sawed contraction joints shall be cut to the required dimensions with equipment meeting Section 153.12. The time and sequence of sawing shall be adjusted so all joints are cut before uncontrolled cracking occurs, and to permit sawing without excessive raveling. Joints shall be sawed within 24 hours to prevent uncontrolled cracking. Uncontrolled cracking that occurs shall be routed, cleaned and sealed according to Section 550.04 M.3 at the Contractor's expense. Immediately after sawing, the joint shall be flushed with water under sufficient pressure to remove residue left

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by the sawing operation. If an uncontrolled crack occurs within 5 feet of any proposed joint location before or during sawing, the joint shall be omitted and sawing of the joint discontinued. Any joint sawed within 5 feet of an uncontrolled crack shall be repaired at the Contractor's expense. When sawing is performed before removing side forms, the initial saw cut will extend to within 1/2 inch or less of the side forms. If the forms have been removed, the saw cut will be extended to the edges of the slab. Any curing media removed during sawing shall be immediately replaced.

Before installing silicone sealant or preformed elastomeric compression joint seal, all joint grooves shall be inspected and spalls which are greater than 1/4 inch in depth shall be repaired by patching with an approved epoxy mortar meeting Section 806. Loose concrete shall be removed from the spalled area and the area shall be thoroughly cleaned. Heavy sheets of polyethylene, polyvinyl chloride, or other suitable material which do not bond to the epoxy shall be inserted in the joint groove to form the faces of the spalled patch. After cleaning, the spalled surface shall be primed with a brush application of epoxy binder, and an epoxy mortar of troweling consistency shall be placed in the spalled area and finished as the original pavement surface. The epoxy binder components shall be mixed in proportions and by methods recommended by the manufacturer. After the epoxy binder is thoroughly mixed, dry concrete sand shall be blended into the mixture to give an epoxy mortar of trowelable consistency. Patching of spalls shall be done only when the air and pavement temperature is above 40°F. Dry concrete sand shall be sprinkled onto the fresh epoxy mortar surface to eliminate any gloss. After the epoxy mortar has cured, the inserts shall be removed.

Formed contraction joints shall be constructed by installing an approved preformed insert into the plastic concrete before final surface finishing. The inserts shall be vibrated into place or installed in a groove formed by a vibrating cutter bar. The inserts top edges shall be flush with the concrete surface. Any voids, depressions, or ridges of concrete caused by installing inserts shall be filled or removed by hand-finishing methods, and the surface across the joints shall be straight-edged according to Section 550.04 J.5. The groove formed by the inserts shall be perpendicular to the pavement surface, true to the required alignment, and continuous along the full length of the joint. Inserts, except those designed to remain, shall be removed without damage to adjacent concrete.

3. Silicone Joint Sealant Installation.

a. Cleaning Joints. Joints shall be sawed and blown out with compressed air.

Before installing silicone sealant, the vertical joint faces shall be cleaned by sandblasting with a nozzle capable of fitting inside the joint slot. Oil, asphalt, curing compound, paint, rust, and other foreign materials shall be completely removed. The joint shall be blown out with compressed air immediately before installing silicone sealant. All incompressible materials shall be removed from the joint slot.

b. Backer Rod Installation. Backer Rod shall be installed in transverse joints in a manner and at a location that produces the shape factor (width and depth) for the sealant specified.

c. Joint Sealer Application. The joint sealer shall be applied by an approved mechanical device.

Sealant shall be applied from inside the joint and squeezed against the sides of the joint to provide good adhesion. Sealant surface shall be tooled to produce a slightly concaved surface approximately 1/4 inch below the pavement surface. Sealants that are not self leveling shall be tooled before a skin forms on the surface. Soap or oil shall not be used as a tooling aid.

Failure of the joint material in either adhesion or cohesion in the first year, will be cause for rejection. Repair shall be at the Contractor's expense.

SPEC-DATA®

This Spec-Data sheet conforms to editorial style prescribed by The Construction Specifications Institute. The manufacturer is responsible for technical accuracy.

Morton International, Inc
August 1993

Morton
Morton Polymer Systems

1. PRODUCT NAME

Thiokol® 1P One-Part, Non-Sag, Medium-Modulus, Moisture-Curing Polysulfide Rubber Joint Sealant

2. MANUFACTURER

Morton International, Inc.
100 North Riverside Plaza
Chicago, IL 60606-1598
Phone: (312) 807-3127

3. PRODUCT DESCRIPTION

Basic Uses: Thiokol 1P is a general purpose sealant which provides a durable, flexible, weather-tight seal for caulking joints in masonry and metal curtainwalls; expansion and control joints; precast panels; window and door perimeters; tilt walls, coping joints, steps and risers; and certain low-traffic areas and horizontal joints on plaza decks and ramps. Thiokol 1P sealant maintains an effective bond between materials of similar or dissimilar porosities, surface textures or expansion coefficients.

Limitations: Not recommended for:

- Structural or butt glazing
- Joints less than ¼" in width or depth
- Exposure to harsh chemicals without prior testing
- Contaminated joints
- Certain architectural paints and finishes without prior testing
- Pedestrian traffic areas

Colors: White, Black, Redwood Tan, Bronze, Stone, Limestone Gray, and Tan

Packaging: 10.3 oz. cartridges, 20 oz. sausage paks and 3 gal. or 5 gal. pails

Applicable Standards: Thiokol 1P sealant meets all aspects of ASTM C 920 Specification for Non-Sag, Class 25 Sealants, without primer.

4. TECHNICAL DATA

Thiokol 1P, single-component joint sealant products, based on Morton's LP® liquid polysulfide polymers, resist the effects of sunlight, rain, snow, ozone, aging, shrinkage, and the daily and seasonal cyclic changes in temperature, even after years of exposure.

Life Expectancy: Normal conditions, 20 years; severe conditions, 10 years or less.

See technical data table for additional properties and test standards.

5. INSTALLATION

Joint Design: The minimum width of the joint should be 4 times the anticipated movement, but not less than ¼". Maximum recommended width is 1". The depth of the joint should be no more than one-half the width without exceeding the minimum/maximum limits. Maximum depth should be ½". For additional information, consult Morton's Joint Design Digest.

Surface Preparation: Joint interface must be clean, dry, and free from oils, loose mortar, laitance, waterproofings, and other contaminants. A thorough grinding, sandblasting, or solvent cleaning may be required to expose clean, sound surfaces. Priming is not normally required with common building materials. However, an instance may occur where priming is necessary for certain substrates or for water immersion, and Morton FEC-2410 primer should be used. The sealant must be applied within 8 hours after priming. Re-prime if time limit has expired.

Technical Data Chart

Application Properties	Result	Test Method
Tack-Free Time, hours	<6	ASTM C 679
Cure Rate, .25" Bead, days	4–5	
Slump	Pass	ASTM C 639
Tensile Strength, psi	140–180	ASTM D 412
Ultimate Elongation, %	300–400	ASTM D 412
Joint Movement, %	±25	ASTM C 719
Peel Strength, lbs./in.		ASTM C 794
On concrete	16	
On glass	15	
On anodized aluminum	13	
Hardness, Shore A	Durometer 25–30	ASTM C 661
100% Modulus, psi	50	ASTM D 412
Service Temperature, cured bead	−40°–180°F (−40°–82°C)	
Accelerated Weathering	Pass	ASTM C 793
All values are typical at 73°F (23°C), 50% RH unless otherwise noted.		

Caution: Different and unusual building materials, special coatings, and/or surface treatments may effect optimum adhesion. In these instances, a field trial is recommended to determine actual adhesion with or without primer. Morton will conduct laboratory testing, under simulated conditions, on substrate specimens provided.

The cure rate of 1P sealant depends upon the relative humidity during the curing process. A relative humidity below 40% will significantly retard the cure rate and Thiokol 2P sealant should be considered as a substitute.

Joint Backing: Backer rod is necessary to control depth of sealant and provide a base for tooling pressure. The most widely used types of backer rod are closed-cell polyurethane or polyethylene foam. Open-cell backer rod performs well with one-part moisture cure sealants. Use a size that will compress at least 25% when inserted into the joint. In joints too shallow for backer rod, a bondbreaker tape should be used to prevent adhesion to the bottom of the joint. Typical bond breakers are polyethylene tape or coated papers. Refer to Morton's Joints Design Digest for additional information.

Application: Fill joint completely, using standard caulking equipment and tool immediately. Proper width to depth ratios must be maintained.

Tooling: Immediately after application, tooling is recommended to ensure full contact with the joint interfaces. Dry tooling is preferred. Care should be taken to avoid contamination of open joints below.

Estimated Coverage Rates*

Joint Depth	Joint Width				
	1/4"	3/8"	1/2"	3/4"	1"
1/4"	308	205	154	102	
3/8"		136	102	68	
1/2"			77	51	38

*Coverage shown is estimated lineal feet/gallon. Waste should be calculated when estimating usage levels.

Cleaning: Use xylene or toluene to remove smears and excess sealant before it cures or to clean equipment. Taping joints can ensure neatness and keep cleaning requirements to a minimum.

Shelf Life: Six (6) months in original, unopened containers stored at temperatures lower than 80°F (26°C).

Precautions: Personal cleanliness is essential when using sealants. Do not smoke or eat with sealant on your hands. A barrier cream should be used on forearms and hands to remove sealant material from skin. This will also protect your hands from the drying effect of solvents used to clean equipment. The use of gloves is preferred for improved hygiene.

Wash skin with an industrial hand cleaner (not the solvent or cleaning fluid used to clean equipment). Any material contacting the skin should be removed at once with a clean, dry cloth before using cleaner. Avoid contact with skin. If contact occurs, remove material on skin with an industrial-type hand cleaner. Prolonged or repeated exposure to 1P elastomeric sealant may cause skin irritation or allergic reactions. Refer to Material Safety Data Sheet (MSDS) for additional information.

6. AVAILABILITY AND COST

Morton sealants are available from the manufacturing plant in Moss Point, MS, or warehouse locations in Fairfield, NJ, Chicago, IL and Irvine, CA. Morton sealants are also available through select stocking distributors in major cities. For the name and number of the nearest Morton representative, contact the Customer Service Center, phone (800) 257-9596. A representative can provide prices or put you in touch with the nearest stocking distributor.

7. WARRANTY

Products manufactured by Morton International, Inc. are produced to meet our manufacturing and sales specifications and will be free of defects. User shall rely on their own information and tests to determine suitability of the product for the intended use, and because that use is beyond our control, we accept no responsibility or liability for damages resulting from failure in performance. In cases where our products are found not to conform to our specifications, our liability is limited to replacement, up to original purchase amount, of the product proved to be defective. Morton International, Inc. makes no warranty that the product is merchantable or fit for any particular purpose, nor is there any other warranty, express or implied, except as provided herein.

Recommendations made by us for use of a product are based upon tests believed to be reliable, but the purchaser assumes all risks and liability for results obtained in the handling or in the use of the product, whether alone or in combination with other products. In no case will Morton be liable for incidental or consequential damages.

8. MAINTENANCE

Thiokol 1P sealant, when installed properly, requires no maintenance; however, if the sealant is damaged and the bond is intact, cut out the damaged area and recaulk. No primer is required. If the bond has been affected, remove the sealant, clean and prepare the joint in accordance with the instructions under "Surface Preparation."

9. TECHNICAL SERVICES

Local Morton representatives are available to provide on-site field service, specification assistance and use evaluation. For further technical or testing assistance, call the Sealant R&D Technical Services Department, phone (815) 338-1800.

10. FILING SYSTEMS

SPEC-DATA® II

Sweet's General Building and Renovation

DOW CORNING CORPORATION MIDLAND MICHIGAN 48686-0994 TELEPHONE 800-248-2481

CERTIFICATE OF ANALYSIS

PRODUCT: DOW CORNING(R) 888 SILICONE JOINT SEALANT
LOT NUMBER: ET066822 QUANTITY: 62 X 50GAL

DATE OF SHIPMENT: 10JUN96

CONSTRUCTION MATERIALS, INC.
6725 OXFORD ST
MINNEAPOLIS, MN 55426

ATTN: WYNN BINGER

CUSTOMER PURCHASE ORDER NUMBER
10178
CUSTOMER SPECIFICATION NUMBER

DOW CORNING INVOICE NUMBER
678129 01
REVISION DATE

TEST	DESCRIPTION	ANALYSIS	UNITS	SPECIFICATION LIMITS	
0040	COLOR	PASS		PASS	MINIMUM
0062	FLOW MIL 88802 JIG	NIL	IN	MAXIMUM	0.20
0095	TACK FREE TIME	35	MIN	35.	75.
0097	DENSITY	1.467		1.450	1.515
0176	APPEARANCE	PASS		PASS	MINIMUM
	SMOOTH, FREE FROM GELS.				
0364	EXTRUSION RATE	172	G/MIN	90.	250.
0099	DUROMETER-SHORE A	19		15	25
0137A	ELONGATION AT BREAK	1500	%	1200	MINIMUM
137A	MODULUS	22	PSI	MAXIMUM	45
950A	ELONGATION AT BREAK	712	%	500	MINIMUM

THIS IS TO CERTIFY THAT THE ABOVE DESIGNATED MATERIAL HAS BEEN TESTED AND DID COMPLY WITH LISTED SPECIFICATIONS (WITH LISTED EXCEPTIONS) WHEN SUPPLIED IN ORIGINAL CONTAINER. THE MATERIAL IS SUBJECT TO THE CONDITIONS LISTED ON THE DOW CORNING INVOICE. THE ABOVE IS A COPY OF INFORMATION ON FILE. THE LOT ACCEPTANCE DATA ARE AVAILABLE FOR EXAMINATION.

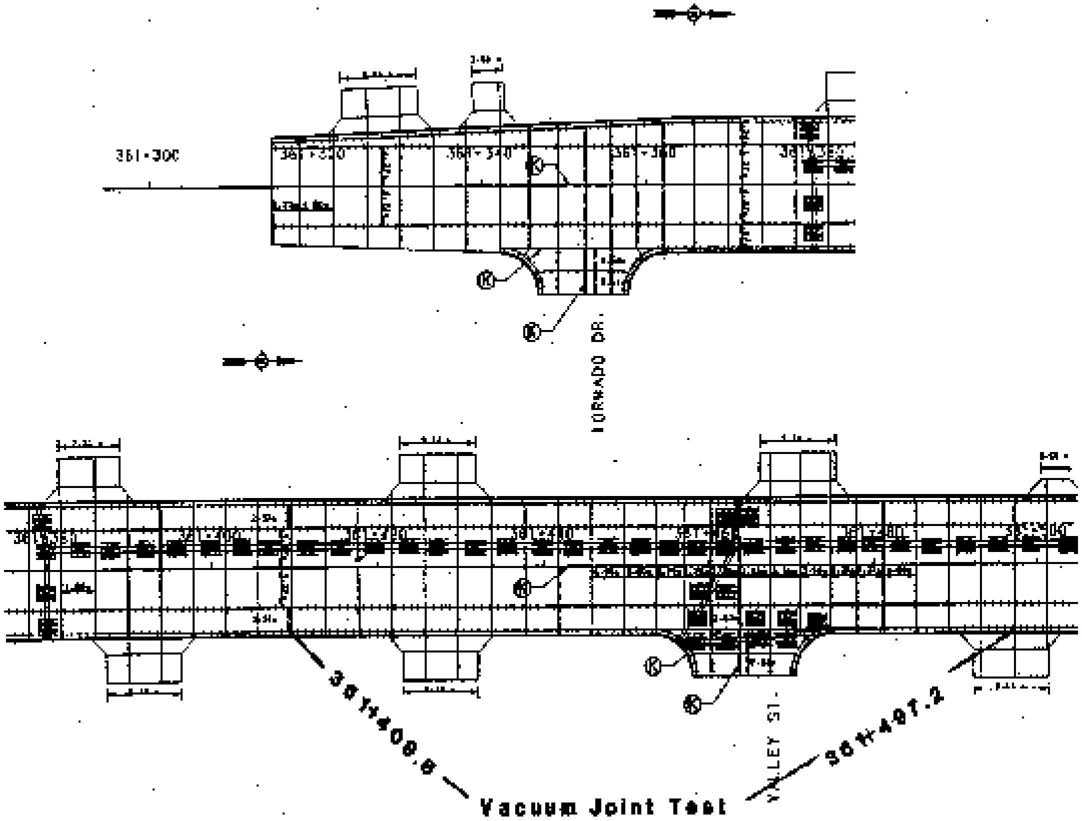
REVIEWED BY: J J MABRY DATE: 10JUN96 LAST PAGE: 1

APPENDIX C

FHWA REGION	STATE	FED. AID PROJ. NO.	SHEET NO.
8	ND	SS-6-058(033)224	[illegible]

METRIC

PAVING DETAILS



230 mm NON-REINFORCED CONC. PVMT. CL. AE

361+320 TO 361+500 2625.3 m^2

PREFORMED COMP. JOINT SEAL 14 mm

361+320 TO 361+500 701.3 m

LONGITUDINAL JOINT SILICONE SEAL

361+320 TO 361+500 214.0 m

GEOTEXTILE SEPARATION FABRIC

361+320 TO 361+500 2966.3 m^2

CURB AND GUTTER TYPE I

LT. SIDE [illegible] m

RT. SIDE [illegible] m

DRIVEWAY CONCRETE HIGH EARLY STRENGTH

LT- SIDE [illegible] m^2

RT- SIDE [illegible] m^2

DENSE GRADED BASE MATERIAL 300 mm

361+320 TO 361+500 [illegible] M TON

AGGREGATE BASE COURSE - CL 5 (300 mm)

361+320 TO 361+500 [illegible] M TON

TIE BAR SPACING - LONGITUDINAL JOINTS

CURB AND GUTTER (ALL)
- [illegible] mm TIE BARS, [illegible] mm × 1219 mm C TO C (CONTINUOUS)

200 mm PCC PAVEMENT [illegible]
- 12-[illegible] mm TIE BARS, [illegible] mm × 914 mm C TO C (CONTINUOUS)

230 mm PCC PAVEMENT [illegible]
- [illegible] mm TIE BARS, [illegible] mm × 1219 mm C TO C (CONTINUOUS)

NOTE:

[illegible] = KEYED LONG. JOINT - SILICONE SEAL [illegible]

[illegible] = [illegible] C TO C SPACING

[illegible] = PAVEMENT REINFORCING (SEE DETAILS)

JOINT SPACING - [illegible]

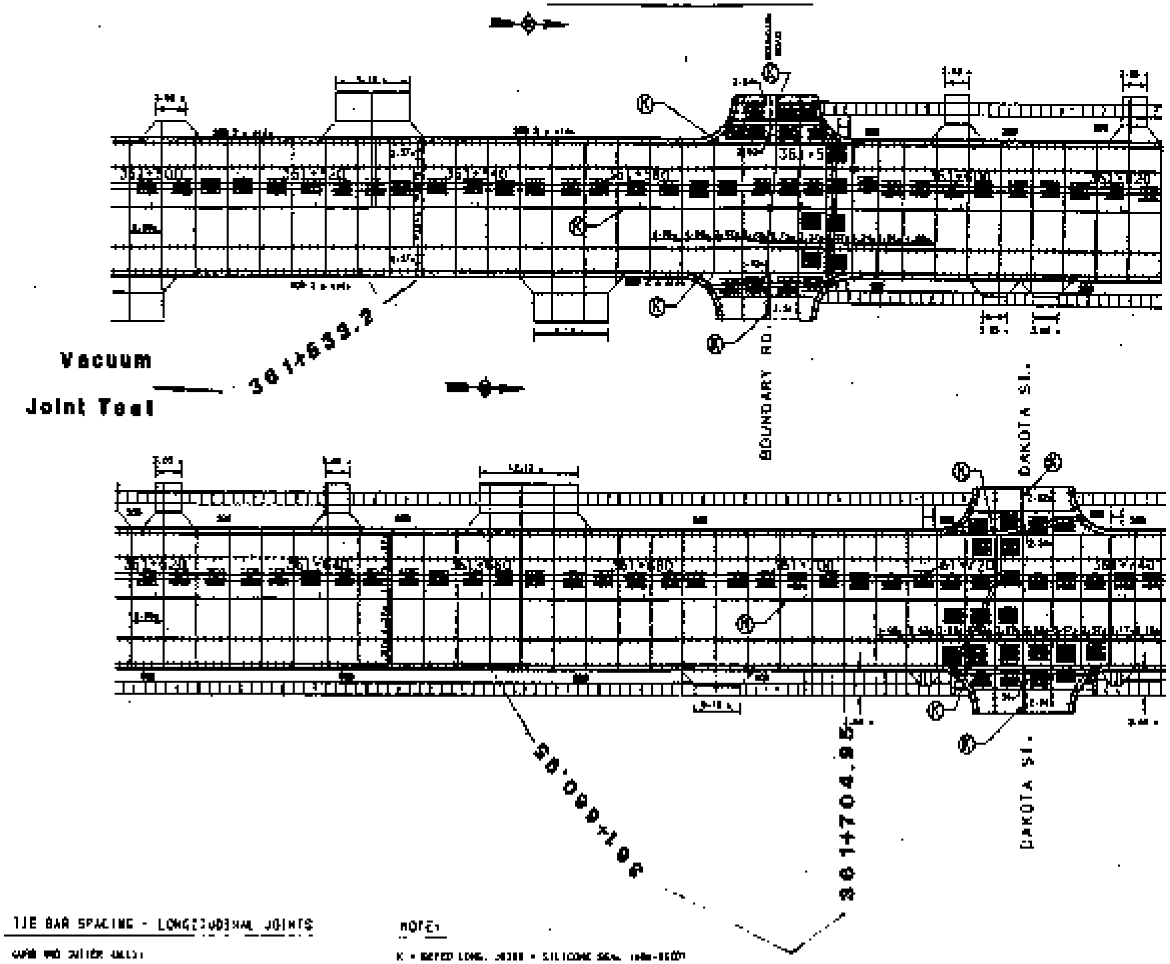
SIDEWALK JOINT SPACING - [illegible] BLOCKS [illegible] AS SHOWN

HWY 18 CAVALIER

STA 361+315 TO 361+500

SHT1-HWY18.CRF

PAVING DETAILS



230 mm NON-REINFORCED CONC. PVMT. CL. AE
361+500 TO 361+740 — 3604.2 m^2

PREFORMED COMP JOINT SEAL - 14 mm
361+500 TO 361+740 — [illegible] m

LONGITUDINAL JOINT SILICONE SEAL
361+500 TO 361+740 — 340.0 m

GEOTEXTILE SEPARATION FABRIC
361+500 TO 361+740 — [illegible] m^2

CURB AND GUTTER TYPE 1
LT. SIDE — [illegible] m
RT. SIDE — 223.4 m

DRIVEWAY CONCRETE HIGH EARLY STRENGTH
LT. SIDE — [illegible] m^2
RT. SIDE — 120.9 m^2

SIDEWALK CONCRETE
LT. SIDE — [illegible] m^2
RT. SIDE — [illegible] m^2

DENSE GRADED BASE MATERIAL 300 mm
361+500 TO 361+740 — 2660.9 M TON

AGGREGATE BASE COURSE - CL 5 (300 mm)
361+500 TO 361+740 — 2660.9 M TON

SODDING
LT. SIDE — 387.5 m^2
RT. SIDE — 174.9 m^2

TIE BAR SPACING - LONGITUDINAL JOINTS

CURB AND GUTTER [illegible]
- [illegible] TIE BARS, [illegible] C TO C (CONTINUOUS)
[illegible] PAVEMENT [illegible]
- [illegible] TIE BARS, 610 mm [illegible] C TO C (CONTINUOUS)
230 mm PCC PAVEMENT [illegible]
- [illegible] TIE BARS, [illegible] C TO C (CONTINUOUS)

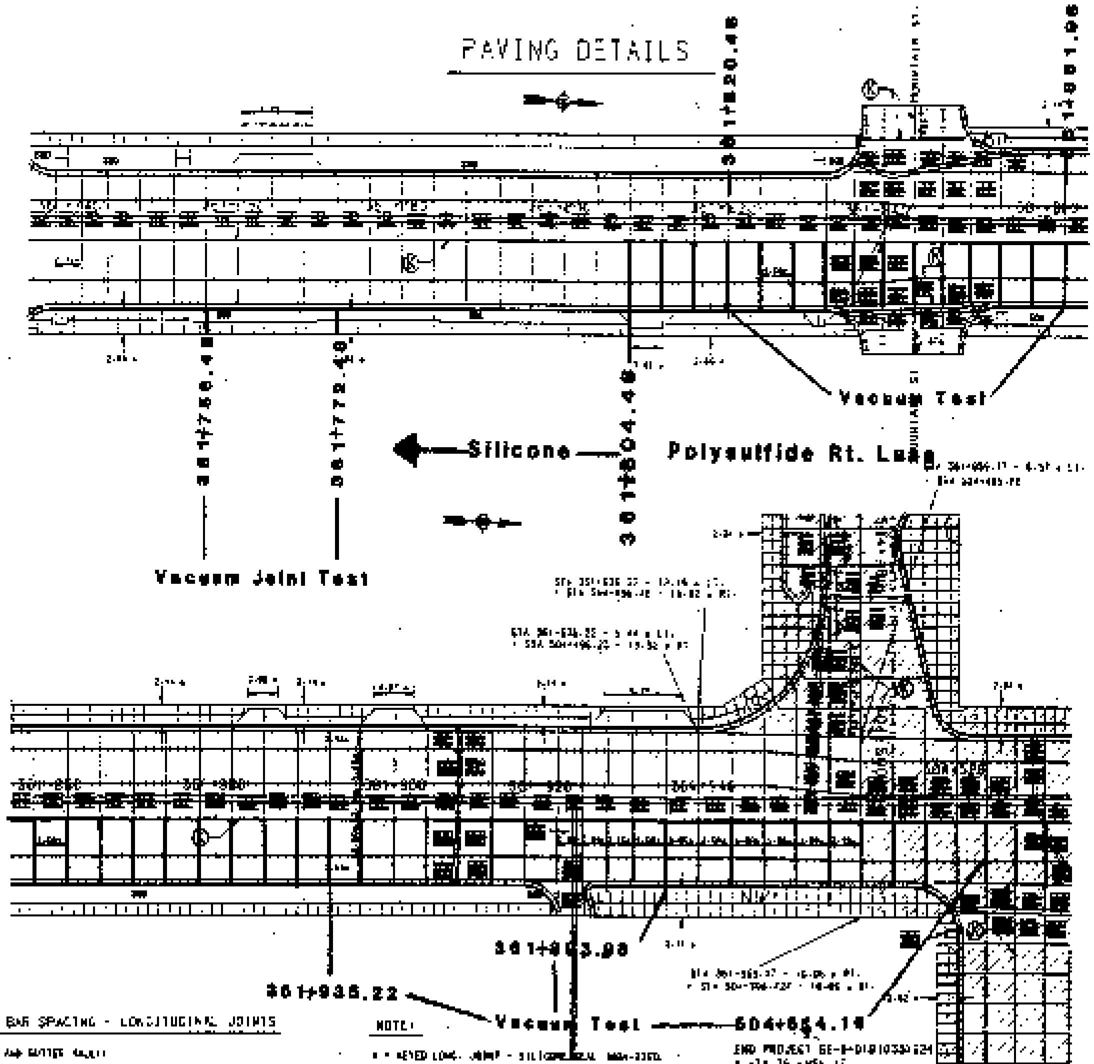
NOTE:

K = KEYED LONG. JOINT + SILICONE SEAL [illegible]
[illegible] J-BOLT [illegible] 610 mm C TO C SPACING
[illegible] = PAVEMENT [illegible] (SEE DETAIL)

JOINT SPACING - [illegible] OR AS SHOWN
SIDEWALK JOINT SPACING - [illegible] OR AS SHOWN

HWY-18 CAVALIER
STA 361+500 to 361+740
SHT2-HWY18.GRF

PAVING DETAILS



230 mm NON-REINFORCED CONC. PVMT. CL. AE
361+947 TO 361+955.17 — 302.5 m²

230 mm NON-REINFORCED CONC. PVMT. CL. AE
361+740 TO 361+940 — 3145.8 m²

PREFORMED COMP JOINT SEAL – 14 mm
361+740 TO 361+955.17 — 451.1 m

LONGITUDINAL JOINT SILICONE SEAL
361+740 TO 361+955.17 — 246.17 m

GEOTEXTILE SEPARATION FABRIC
361+740 TO 361+955.17 — 3894 m²

CURB AND GUTTER TYPE I
LT. SIDE — 190.8 m
RT. SIDE — 212.0 m

DRIVEWAY CONCRETE HIGH EARLY STRENGTH
LT. SIDE — 81.71 m²
RT. SIDE — 10.72 m²

SIDEWALK CONCRETE
LT. SIDE — 246.45 m²
RT. SIDE — 276.50 m²

SODDING
LT. SIDE — 206.80 m²
RT. SIDE — 143.80 m²

DENSE GRADED BASE MATERIAL 300 mm
361+740 TO 361+940 — 2517.6 M TON

AGGREGATE BASE COURSE – CL 5 (300 mm)
361+740 TO 361+940 — 2338.4 M TON

TIE BAR SPACING – LONGITUDINAL JOINTS

NOTE:

HWY-16 CAVALIER

STA 361+740 TO 361+955.17

FILE: SHT3-HWY16.GRF

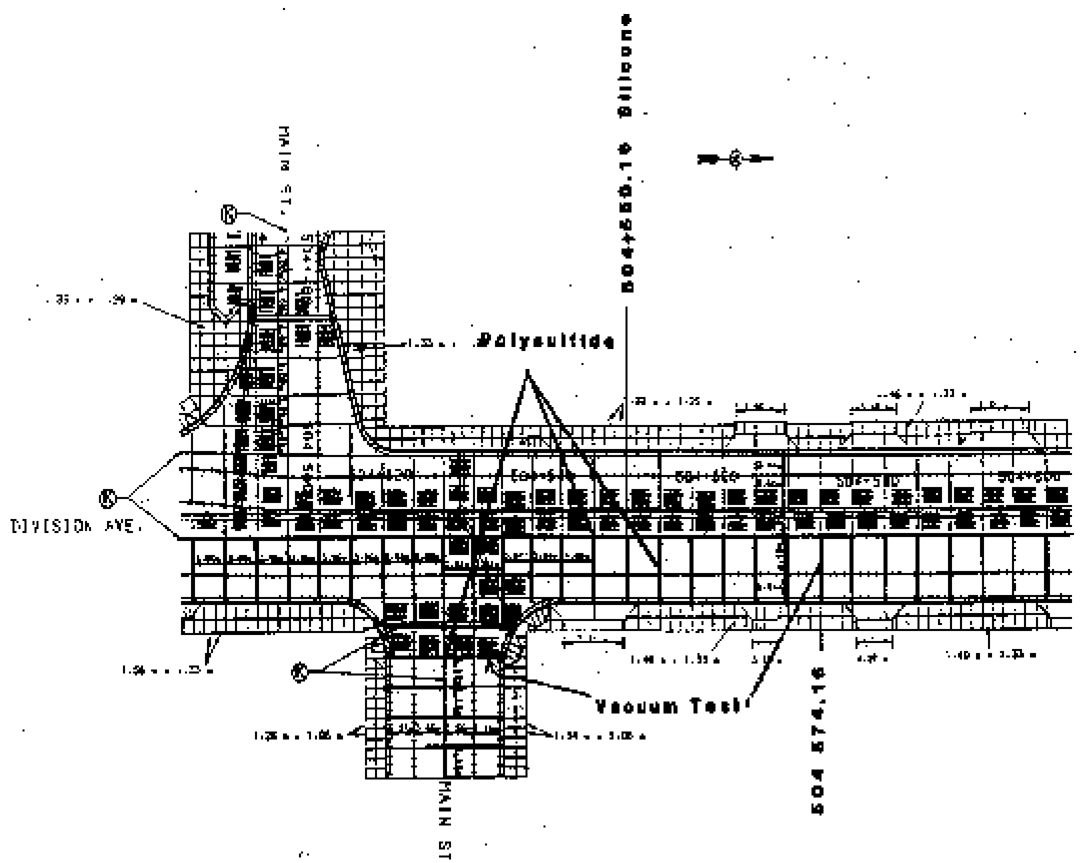
C-3

STATE	PROJ.	FED. AID PROJ. NO.	SHEET NO.
8	ND	NH-8-005(040)212	92

METRIC

C-4

PAVING DETAILS



200 mm NON REINFORCED CONC. PVMT. CL. AE
504+540 TO 504+600 516.6 m^2

PREFORMED COMP JOINT SEAL - 14 mm
504+540 TO 504+600 296.2 m

LONGITUDINAL JOINT SILICONE SEAL
504+540 504+600 60.5 m

GEOTEXTILE SEPARATION FABRIC
504+540 TO 504+600 1625.6 m^2

CURB AND GUTTER TYPE I
LT. SIDE 60.0 m
RT. SIDE 60.6 m

DRIVEWAY CONCRETE HIGH EARLY STRENGTH
LT. SIDE 57.99 m^2
RT. SIDE 44.14 m^2

SIDEWALK CONCRETE
LT. SIDE 92.5 m^2
RT. SIDE 110.8 m^2

DENSE GRADED BASE MATERIAL 300 mm
504+540 TO 504+600 884.9 m TON

TIE BAR SPACING - LONGITUDINAL JOINTS

CURB AND GUTTER (TYP.)
- 9.525 mm TIE BARS, 457 mm x 1219 mm C TO C (CONTINUOUS)

200 mm PCC PAVEMENT (HWY 5)
- 12.700 mm TIE BARS, 610 mm x 914 mm C TO C (CONTINUOUS)

230 mm PCC PAVEMENT (HWY 18)
- 15.875 mm TIE BARS, 762 mm x 1219 mm C TO C (CONTINUOUS)

NOTE:

C - KEYED LONG. JOINT - SILICONE SEAL (NON-TIED)

J - JOINT 16 mm 4.816 m C TO C SPACING

▦ - PAVEMENT REINFORCING (SEE DETAILS)

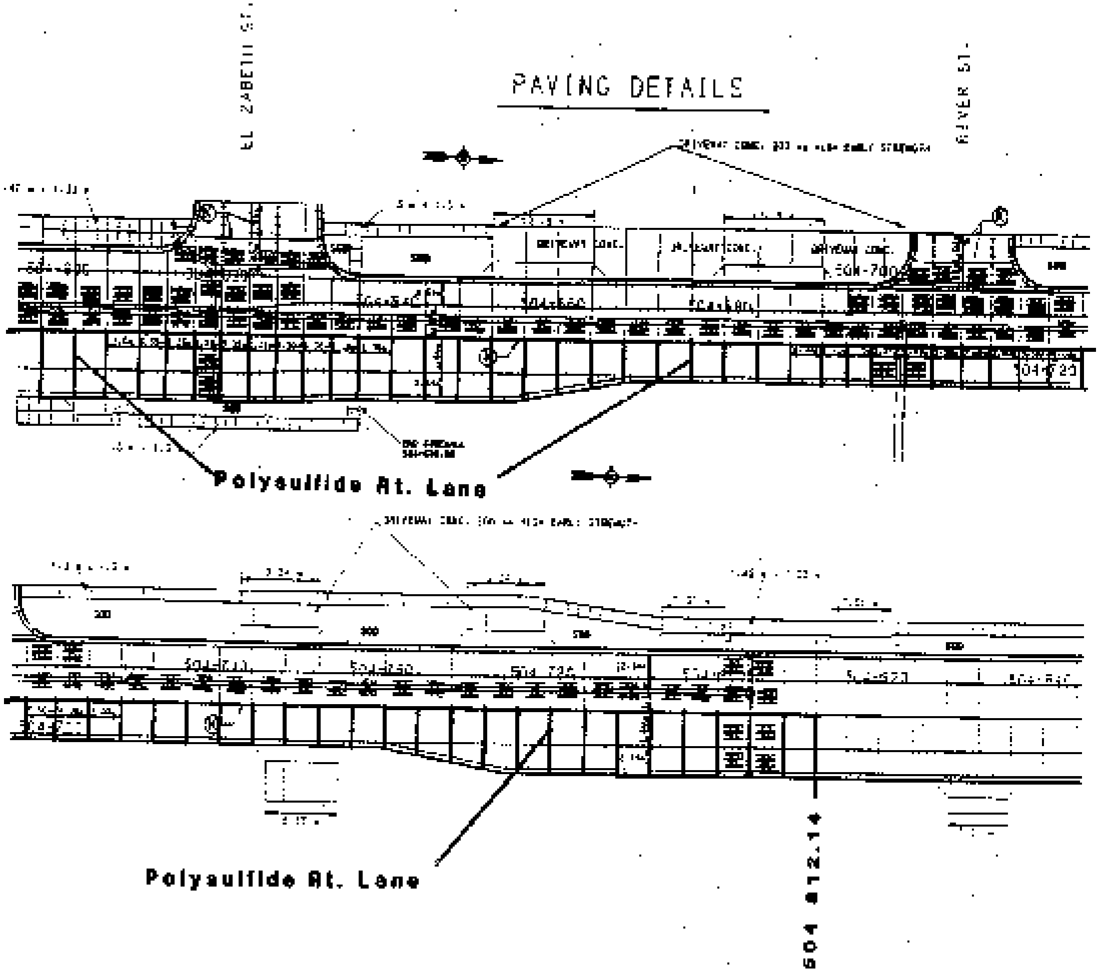
JOINT SPACING 4.8 m OR AS SHOWN
SIDEWALK JOINT SPACING 1.5 m x 1.5 m SQUARES OR AS SHOWN
PAPER EXPANSION SIDEWALK JOINTS ADJACENT TO DRIVEWAYS

HWY 5 CAVALIER
STA 504+508.727 TO 504+600
FILE: SHT5-HW15.GRP

6	MD	MA-5-005(03)JA.SIZ	13

METRIC

PAVING DETAILS



200 mm NON-REINFORCED CONC. PVMT. CL. HE
504+600 TO 504+840

PREFORMED COMP JOINT SEAL - 13 mm
504+600 TO 504+840 — 775.0 m

GEOTEXTILE SEPARATION FABRIC

CURB AND GUTTER TYPE

LT. SIDE
RT. SIDE — 241.0 m

DRIVEWAY CONCRETE HIGH EARLY STRENGTH
LT. SIDE — 50 m²

SIDEWALK CONCRETE

DENSE GRADED BASE MATERIAL 200 mm
504+600 TO 504+840

SODDING

C-5