CRACK SEALING: EFFECTIVENESS

WA-RD 256.1
Experimental Feature WA 87-05

Final Report
January 1992

Washington State Department of Transportation

Washington State Transportation Commission
Transit, Research, and Intermodal Planning (TRIP) Division
in cooperation with the U.S. Department of Transportation
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. WA-RD 256.1	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE CRACK SEALING: EFFECTIVENESS		5. REPORT DATE January 1992
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) David E. Erickson		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington State Department of Transportation 5720 Capitol Boulevard, Mailstop 7440 Olympia, Washington 98504-7440		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Washington State Department of Transportation PO Box 47370 Olympia, Washington 98504-7370		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14. SPONSORING AGENCY CODE Experimental Feature WA 87-05

15. SUPPLEMENTARY NOTES

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

16. ABSTRACT

A short, one year performance evaluation was made of four crack sealing products. The products: (1) CRF manufactured by the Golden Bear Division of Witco Chemical Corporation; (2) Flex-A-Fill manufactured by Deery Oil; (3) RoadSaver 221 manufactured by Crafco Incorporated; and (4) a sand slurry mixture designed by the Washington State Department of Transportation.

The two rubber-asphalt products, Flex-A-Fill and RoadSaver 221, performed better than the other two products, which used an emulsified asphalt cement as a base.

17. KEY WORDS crack sealing, rubber-asphalt, emulsified asphalt	18. DISTRIBUTION STATEMENT No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None	15	

CRACK SEALING EFFECTIVENESS

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January 1992

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INTRODUCTION

An evaluation was conducted by District 6 (see Figure 1.) of the Washington State Department of Transportation (WSDOT) to determine the effectiveness of crack sealants to extend pavement life in asphalt concrete pavement (ACP). Sealing cracks in ACP to extend pavement life is a routine practice in District 6. The general construction practice is to seal the cracks immediately prior to an ACP overlay as part of the construction contract.

Cracks in ACP are a defect which effects the performance of not only the surface layer of the pavement but may contribute to the deterioration of the entire pavement structure. As the cracking develops, incompressible materials fill the cracks which leads to a widening of the crack and further deterioration of the pavement. Cracks which extend through the entire pavement structure allow water to penetrate into the subgrade resulting in a weakening of the foundation soils. The weakened subgrade in turn allows larger magnitudes of pavement deformation under loads, causing even more cracking to develop and eventually the complete failure of the pavement.

STUDY OBJECTIVES

This research effort attempted to determine if pavement life could be extended by sealing cracks and what combination of sealant type and placement method was best for the climatic conditions in District 6. The study further attempted to determine whether the sealant should be placed prior to an ACP overlay as a part of the overlay contract or as part of a maintenance effort prior to the contract.

STUDY SITES

The study involved 11 test sections located on two state routes in eastern Washington. One of the locations, Study Site 1, was on State Route 2 (SR-2) west of Spokane between MP 263.44 and MP 272.34. SR-2 is a principle arterial with an average daily traffic (ADT) of 4,150 vehicles with 8% being trucks. The roadway has two 12 foot lanes with 8 foot shoulders. Study Site 1 was divided into 4 sections, each 2,000 feet in length.

The other location, Study Site 2, was on SR-270 east of Pullman from MP 3.44 to MP 9.89. SR-270 is a principle arterial with an ADT of 7,400 and 7% trucks. The roadway has two 11 and 1/2 foot lanes with 7 foot shoulders. This site was divided into seven test sections. The first section was 0.56 mile long and extended from MP 3.44 to MP 4.00. Following that there were five even one mile sections which divided the mileage from MP 4.00 to MP 9.00. The last section was 0.89 miles in length and extended from MP 9.00 to MP 9.89.

Study Site 1 was overlaid with 0.15 feet of ACP after sealing. Study Site 2 was not overlaid after sealing the cracks.

MATERIALS

Four crack sealants were evaluated at the two study sites. The sealants were as follows; (1) CRF crack filler manufactured by the Golden Bear Division of the Witco Chemical Corporation, (2) Flex-A-Fill manufactured by Deery Oil, (3) RoadSaver 221 manufactured by Crafco Incorporated, and (4) a sand slurry prepared in accordance with WSDOT specifications.

CRF is an emulsified crack filler with a recommended application temperature from 32°F to 120°F. Cure time is one to three weeks depending on ambient temperature and atmospheric conditions. Flex-A-Fill is a hot poured sealant with a recommended pouring temperature of 380°F. Curing time of Flex-A-Fill is listed as 30 minutes. RoadSaver 221 is similar to Flex-A-Fill in that it is a hot poured sealant. Both Flex-A-Fill and RoadSaver 221 contain recycled tire rubber. The WSDOT sand slurry is a mixture of approximately 20% CSS-1 emulsified asphalt cement, approximately 2% Portland cement, water (if required), and the remainder clean 1/4 inch-0 paving sand.

CONSTRUCTION

The crack sealants were placed during the summer of 1989. The construction process for sealing the cracks generally involved some type of crack cleaning operation followed by the application of the sealant material. At Study Site 1 on SR-2, the only method of crack cleaning used was compressed air. Three methods of preparing the cracks for the sealant were used at Study Site 2. Compressed air was used for one section of each of the four sealant products. Hot, compressed air was used on one of the other section and the remaining two section were not cleaned. Table 1 shows which type of crack preparation technique was used on each test section

Section 1 in Study Site 2 on SR-270 did not have any crack preparation prior to filling the cracks with CRF. While this is not in accordance with the manufacturer's directions, it is how many miles of cracks have been filled in District 6. A hot air lance was used to clean the cracks in Section 6 on Study Site 2 prior to sealing with Flex-A-Fill. The hot air lance heats the air to temperatures of from 600° to 2200°F. The hot air, in addition to blowing the incompressible materials out of the cracks, should burn away any organic materials growing in the crack and should dry the pavement in preparation for the sealant. It also softens the asphalt when used properly which may improve the bond between the ACP and sealant.

Application of the four sealants was done by two methods. The CRF and sand slurry, both being emulsified asphalts, could be poured into the crack at ambient temperature. The other two sealants, Flex-A-Fill and RoadSaver 221, required that the material be heated in a kettle to melt the sealant. A control sections where no crack sealant was used was included at each study site. Table 1 shows which sealant product was used at each test section.

Both types of sealant, the emulsions and the hot poured, had advantages and disadvantages over the other during the initial placement of the sealant. Application of sealants at ambient temperatures provides for a safer working environment and required less equipment with elimination of a kettle to heat the material. After placement, however, the emulsions required topping with sand to prevent tracking of the material. Some tracking of the sealant was still observed even with the sand topping.

A disadvantage of the hot poured sealants is that if delays occur in filling cracks during cool, windy conditions the sealant thickens and clogs the application wand. An advantage of the hot poured sealants was their ability to set up quickly. Traffic could be placed over the hot poured sealants shortly after installation without any detrimental results to the sealant or the vehicles passing over the cracks.

DATA COLLECTION

In preparation for the evaluation of the performance of the sealants, the location and size of the existing cracks were mapped for each section. This was completed on the overlay section so that any cracks in the new ACP mat could be reviewed to determine if they were reflective cracks or new cracks. The cracks were coded into three size classifications based on their width as follows; (1) 1/4 inch an smaller, (2) 1/4 to 3/4 inch, and (3) 3/4 inch and greater. This provided a base map for the monitoring of how well the sealant bonded to the sides of the crack and how much sealant was lost from the crack. In the CRF and sand slurry sections all of the cracks were filled. In the Flex-A-Fill and RoadSaver 221 sections, only the cracks 1/4 inch and larger were filled.

Following completion of the installation of the sealants and the overlay of Study Site 1, the sections were evaluated over a one year period. The following results were obtain on each of the study sites.

<u>Smoothness</u>

The smoothness of the ACP was measured by a roughness meter three times after placement of the sealants. A summary of the road roughness testing is shown in Table 2. The general trend indicated an overall increase in roughness for all of the sections except the control section in Study Site 1. At Study Site 1, the overlaid section, it appears that the underlying crack sealing is being reflected through the overlay and manifesting itself in an increase in roughness at the surface. The relatively small increases for the three sealed sections is not conclusive proof, however, that this is actually the cause of the observed increase in roughness.

On Study Site 2, the section not overlaid, the trend is also toward greater pavement roughness. The magnitudes of these readings are 3-5 times greater than the increases noted in Study Site 1. This definitely indicates that the sections were increasing in roughness over time. This is not really surprizing considering the deterioration noted in the sealants over the time period (see following section on sealant performance). If portions of the sealant are missing from the cracks this will be manifested in an increase in the roughness measurements due to the open crack present in the pavement.

Sealant Performance

The performance of the sealants could only be measured in Study Site 2, the site which was not overlaid. The cracks that had been mapped prior to sealing were rated on the basis of what percentage of the cracks had crack sealant that was; (1) split, (2) missing, or (3) not bonded to one side of the crack. Table 3 shows these percentages in separate columns and then combines them into one column showing the total number of cracks that showed some type of defect.

The CRF and sand slurry had the highest percentage of defective cracks. Loss of bond with the pavement was the major problem with the CRF and sand slurry sealants as evidenced by the percentage of cracks noted where the sealant was missing or where it was bonded to only one side of the crack. The RoadSaver 221 and Flex-A-Fill showed better performance with a slight edge to the RoadSaver product. The Flex-A-Fill was more prone to splitting than the RoadSaver sealant which showed a greater tendency to debond.

Meeting Specifications

The Flex-A-Fill and RoadSaver 221 crack sealants were tested in accordance with ASTM D 1190 for penetration and flow. Both of the sealants passed the flow specification but only the Flex-A-Fill passed the penetration specification. The penetration of the RoadSaver 221 averaged 110 which is above the value allowed of 90. The CSS-1 used in the sand slurry was also tested for viscosity at 77°F and passed.

DISCUSSION OF RESULTS

The RoadSaver 221 and Flex-A-Fill appeared to provide a better seal than the CRF or sand slurry, with RoadSaver 221 providing the best overall performance. All of the sealants had sections where either the sealant was missing, not bonded to both sides of the crack, or split down the middle.

The failure of RoadSaver 221 in the penetration requirement of ASTM D 1190 did not appear to be a detrimental factor in the performance of the sealant. Revision of the penetration requirement for sealants placed in District 6 should be considered. With the temperature extremes from summer to winter in eastern Washington, a sealant with a higher penetration may prove to be better.

The cost to place the CRF and sand slurry sealants was approximately 20-30% less than the placement costs of Flex-A-Fill or RoadSaver 221. With the better seal provided by the Flex-A-Fill and RoadSaver 221 this cost may be offset by longer life of the ACP. As a result of the short time period to evaluate the benefits of crack sealing, it could not be determined if the higher costs were offset by an ability to prolong the life of the ACP.

CONCLUSIONS

Due to the short analysis period to evaluate the crack sealants, it is inconclusive if crack sealing does provide the benefits such as longer ACP life and smoother pavement that justify the cost. The good performance of the hot applied rubber-asphalt products seems to indicate that these are the best choices for crack sealing, especially if the pavement is not scheduled for an overlay in the very near future. The overall poor performance of the emulsified products would seem to indicate that these should only be used where an overlay is scheduled.

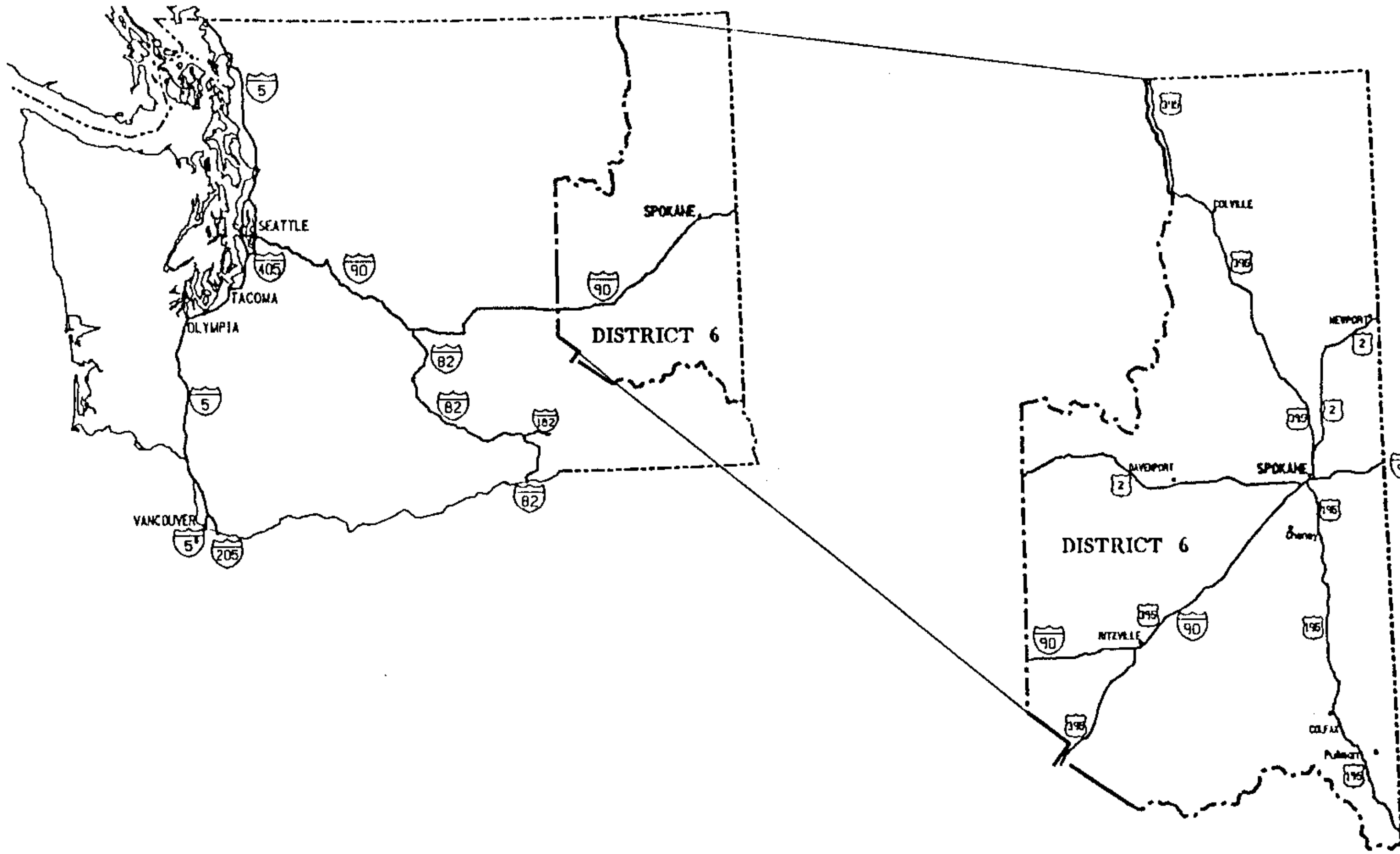

Figure 1. Washington State, District Six

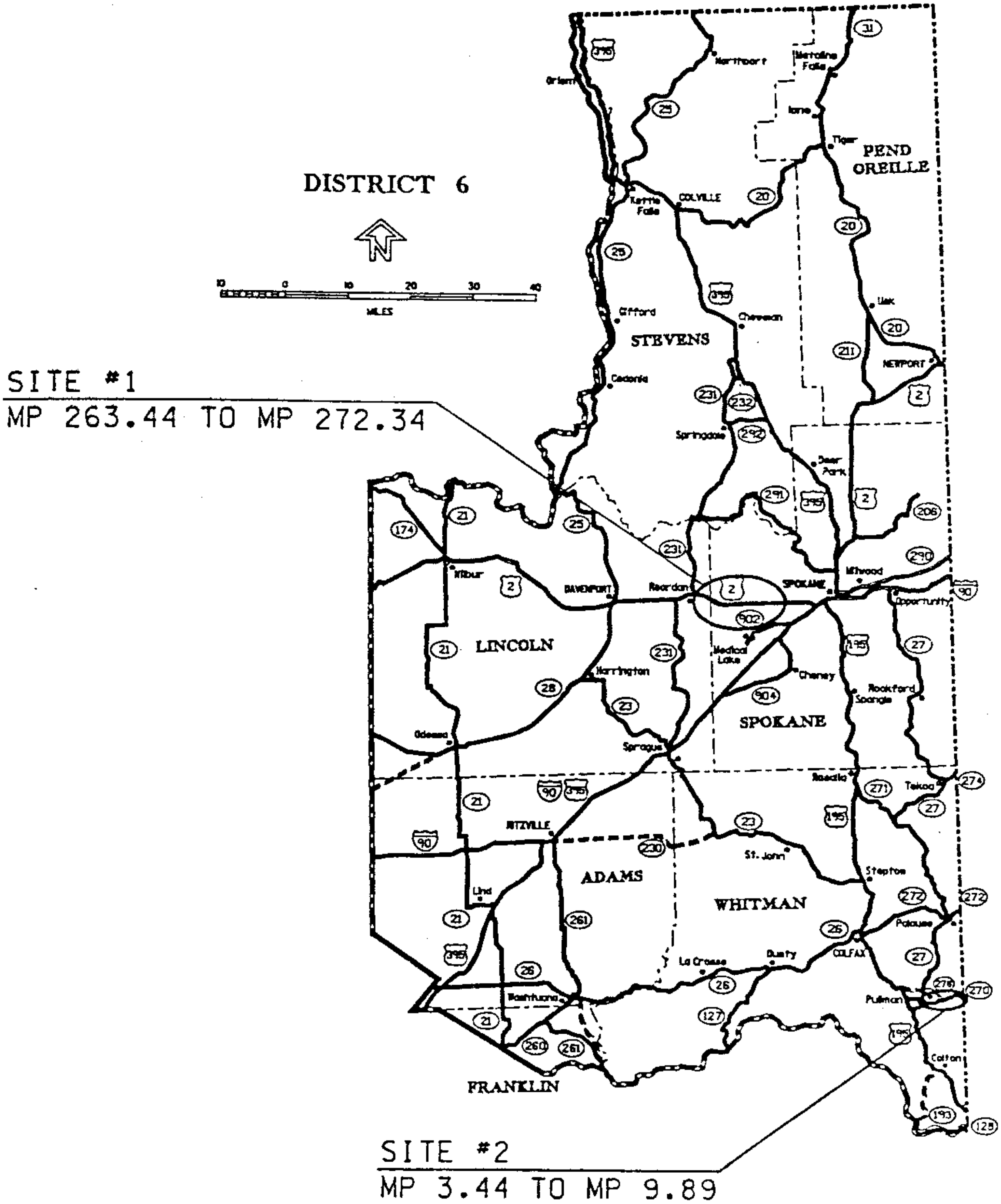

Figure 2. Location of study sites

STUDY SITE 1

SR-2

SECTION	MP to MP	SEALANT	CRACK PREPARATION
1	264.74 to 265.31	CRF	Compressed Air
2	265.31 to 265.88	Flex-A-Fill	Compressed Air
3	265.88 to 266.45	Control	N/A
4	267.02 to 267.58	Sand Slurry	Compressed Air

STUDY SITE 2

SR-270

SECTION	MP to MP	SEALANT	CRACK PREPARATION
1	3.44 to 4.00	CRF	None
2	4.00 to 5.00	RoadSaver 221	Compressed Air
3	5.00 to 6.00	Flex-A-Fill	Compressed Air
4	6.00 to 7.00	CRF	Compressed Air
5	7.00 to 8.00	Control	N/A
6	8.00 to 9.00	Flex-A-Fill	Hot Compressed Air
7	9.00 to 9.89	Sand Slurry	Compressed Air

Table 1. Test section locations and crack preparation methods.

ROAD ROUGHNESS TESTING

SR	SECTION	SEALANT	05-04-89	11-02-89	06-25-90	CHANGE
2	1	CRF	531	412	534	+3
	2	Flex-A-Fill	515	398	550	+35
	3	Control	623	536	527	-96
	4	Sand Slurry	643	556	668	+25
270	1	CRF	800	491	920	+120
	2	RoadSaver 221	860	940	1036	+176
	3	Flex-A-Fill	993	1024	1261	+268
	4	CRF	833	885	952	+119
	5	Control	770	778	886	+116
	6	Flex-A-Fill	761	751	905	+144
	7	Sand Slurry	704	703	812	+108

Table 2 Road roughness measurements.

SEALANT PERFORMANCE
SR-270

Sealant	Section	Total % Defective	% Split	% Lost	%Bonded 1 Side
CRF	1	89	0	89	0
RoadSaver 221	2	28	0	28	0
Flex-A-Fill	3	40	14	10	16
CRF	4	91	0	71	20
Flex-A-Fill	5	58	16	6	35
Control Section	6	-	-	-	-
Sand Slurry	7	92	1	60	31

Table 3. Measured performance of sealants.