A STUDY OF POURED JOINT SEAL MATERIALS

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FOREWORD

The present standard specifications covering poured joint sealing material for portland cement concrete pavement and bridge decks (Item 360(8), 1972 Standard Specifications) have been in use for at least 15 years essentially in their present form. None of the material obtained under this specification has been completely satisfactory. The effective life of these sealers has been quite short - 3 to 5 years.

The majority of poured joint material used has been the single component hot poured rubber asphalt or the two-component polymer (polysulfide) sealer. Over the past several years, manufacturers have offered a number of newer poured materials, including upgraded hot poured rubber asphalts and two-component polyurethane materials. It was believed that some of these materials might perform better.

On many pavements and structures already under traffic, use of a poured material is the only practical way to reseal a joint. If better, longer lasting poured materials could be obtained, they would probably be more widely used in new construction.

A number of suppliers of poured joint sealers were contacted and asked to submit for evaluation what they considered to be their best hot poured sealer and also their best two-component sealer. This report presents the results of laboratory evaluation of these materials and also some additional two-component polyurethane sealers that were received for test under Special Specification Item 4028, Polyurethane Joint Seal. Problems encountered in the field with two-component polyurethane materials are also discussed.

The majority of the laboratory work was done by Clifton Coward, Engineering Technician V.

I. PURPOSE

The purpose of this project was to make a laboratory evaluation of the various poured joint sealers on the market and determine if there were materials which would give better performance than those presently in use. If such materials were found, suitable specifications would be prepared.

II. CONCLUSIONS AND RECOMMENDATIONS

The tests performed on the hot poured rubber asphalt sealers did not show any significant difference between those obtained under the present specification and the "upgraded" materials.

The two-component polysulfide sealers complying with present specification requirements have exhibited only fair performance under field conditions. This evaluation revealed that one of the main problems with these materials is shrinkage on aging.

A two-component neoprene sealer was evaluated. Based on the high shrinkage and age-hardening of this material, it is not recommended for use.

Of the six two-component polyurethane sealers evaluated, one of them evidenced high shrinkage which would make it undesirable for use. The other five materials performed well in the laboratory. District 14 has used several two-component polyurethanes obtained under Special Specification Item 4028 to seal armor joints on bridge decks. Their experience with these materials has been varied.

Two polyvinyl chloride - coal tar single-component hot poured sealers were evaluated. The overall performance of these sealers was generally good, but there is some drop in performance on aging. These materials are recommended by their manufacturers as alternates to hot poured rubber asphalt for sealing joints in concrete pavement. They are not recommended for bridge joints. One of the main advantages of this material compared to hot poured rubber asphalt is its ability to reject incompressibles.

We believe the properties of the PVC-coal tar sealers are sufficiently good to warrant their use in concrete pavement joints on a trial basis. A recommended specification, which is based on pertinent ASTM specifications, is included in the Appendix.

We do not recommend any change in the present specifications for poured joint material in Item 360. The PVC-coal tar sealers can be obtained by use of a special specification until some field experience is obtained with the material. We believe it is possible to obtain good performance with two-component polyurethane sealers complying with Special Specification Item 4028, but care must be exercised to protect the resin component from moisture and to insure that the material is properly proportioned and extremely well mixed.

A seal will not perform satisfactorily unless the joint is properly designed. Proper cleaning of the joint faces and the use of good technique in placing the sealer is very important. One of the most common mistakes in placement is overfilling the joint. The surface of the joint material should be at least 1/4 inch below the surface of the roadway so that vehicle tires will not come in contact with the seal.

Sealers Evaluated

Type	Code	Description
Hot Poured Rubber Asphalt	A-1	Designed to meet present Texas Specification.
	A-2	Upgraded material.
	A-3	Designed for low temperature areas.
	B-1	Upgraded material.
	C-1	Designed to meet present Texas Specification.
	C-2	Upgraded material.
	E-1	Upgraded material.
Hot Poured PVC-Coal Tar	E-2	Solid material prior to melting.
	H-1	Single component liquid prior to heating.
Two-Component Polysulfide	A-4	Designed for hand mixing and application.
	A-5	Designed for hand mixing and application - non-sag version for vertical joints.
	C-3	Designed for hand mixing and application - liquid base and powdered catalyst.
Two-Component Polysulfide	C-4	Designed for hand mixing and application. Manufacturer indicated material was a higher quality than C-3 which they are presently furnishing under Texas Specification.
Two-Component Neoprene	E-3	Liquid - liquid material for hand mixing and application.
Two-Component Polyurethane	B-2	Designed for hand mixing and application.
	C-5	Designed for hand mixing and application.
	D-1	Designed for hand mixing and application.
	D-2	Designed for machine mixing and application.
	F-1	Designed for hand mixing and application.
	G-1	Designed for hand mixing and application.

III. TEST METHODS

A. The majority of the tests used in evaluating the joint sealers were those set forth in Test Method Tex-525-C or a variation of these tests. These include the following properties:

1. Cone Penetration on original and oven aged material.

2. Resilience on original and oven aged material.

3. Flow at 140 or 200 F.

4. Bond and Extension. The procedure set forth in ASTM D 1191 was modified as follows:

   The configuration of sealer formed between the mortar blocks was 1" x 1" x 2". Unless otherwise stated in the report, this configuration was used in the bond and extension test because a one-inch square cross-section more nearly represents the joint configuration considered as good design. For the two component polyurethane sealers tested for compliance with Special Specification Item 4028, the sealer configuration was 1/2" x 1/2" x 2".

5. Rex (Shore A Durometer) Hardness on original and heat aged material at 77 F.

6. Viscosity of components at 77 F.

7. Compression set.

8. Adhesive strength. This property was determined on the various materials following initial cure. The specimens used were the same as those used for the bond and extension test. In the case of materials submitted for compliance with Special Specification Item 4028, the test was performed on material following water immersion, heat aging and after subjection to the bond and extension test.

9. Application life.

Tests other than those covered by Test Method Tex-525-C were as follows:

1. Artificial weathering.

   This test was performed using a light and water exposure apparatus conforming with Type EH described in ASTM Recommended Practice G 23. The specimens were formed on asbestos-cement panels 3 by 9 by 1/8-inch conforming to ASTM Specification C 220, Type U. The specimen dimensions were 1-1/2 by 4 by 1/4-inch, prepared in the same manner as flow specimens. The material was allowed to cure 24 to 48 hours at room temperature prior to initiating the test.

   The cycle of the equipment was 18 minutes light with water spray, followed by 102 minutes of light only. Approximately eighteen hours exposure was received during a 24-hour period. The black panel temperature was 130 $\pm$ 5 F. The specimens were not inverted at the end of each day's test cycle.

2. Atmospheric Weathering.

   The panels and specimens were prepared in the same manner as those used for the artificial weathering test. The specimens were exposed to direct weathering in accordance with ASTM Designation G 7. The panels were placed at an angle of 45 degrees and faced south.

3. Weight and volume change on heat aging.

The specimen for this test is 2.00 $\pm$ 0.05 inches by 1.00 $\pm$ 0.05 inch diameter. The specimens were formed by pouring the sealer into a cylindrical mold set on a metal plate. The inside of the mold and surface of the plate were coated with a silicone release agent. After the specimen had cured for 24 hours, it was removed from the mold and the surface blotted with a paper towel to remove the release agent. The specimen was then weighed to the nearest 0.001 gm.

The volume was determined using a gallon weight cup having a volume of 83.2 ml as described in Federal Test Method Standard No. 141a, Method 4184.1. The tared cup was filled with distilled water at 77 F and the weight of cup and water recorded. The dry cup and specimen were weighed, then water was added to fill the cup and the total weight of specimen, cup and water was recorded.

The specimen was removed from the cup, dried with a paper towel and placed in a forced draft oven maintained at 158 $\pm$ 2 F for 168 hours. After aging, the specimen was conditioned in air at 77 ± 5 F for at least one hour, weighed to the nearest 0.001 g and the volume determined as described above. The original and aged volumes are calculated as follows:

$$\text{Weight of Displaced Water Equivalent to Volume of Specimen} = A-(C-B)$$
$$(1\ g = 1\ ml\ volume)$$

Where A = wt. of water in filled gallon wt. cup

B = wt. of cup and specimen

C = wt. of cup, specimen and water

The percent weight and volume changes are then calculated as follows:

$$\%\ change = \frac{(\text{original value} - \text{aged value})(100)}{\text{original value}}$$

B. The significance of the various tests is as follows:

1. Viscosity of components

   Determine if consistency is satisfactory for application.

2. Application life

   Length of time available for placing mixed two component sealers in joints.

3. Cone penetration and Rex Hardness

   A measure of the hardness of the material. This correlates with the amount of stress at joint face that will result from movement and to some extent with ability to reject incompressibles.

4. Flow at 140 and 200

   Indicates tendency of material to flow out of joint in hot weather.

5. Resilience and Compression set

   Indicates ability of sealer to reject incompressibles and amount of elasticity or ability to return to original joint shape after being compressed.

6. Bond and Extension

   Determines quality of initial bond to joint faces and ability to function at low temperature without tearing or pulling away from joint face. During the test, the development of a crack, separation, or other openings that at any point is over 1/4 inch deep, in the sealer or between the sealer and mortar block, constitutes failure.

7. Adhesive strength

Determines quality of bond to joint face and amount of stress at interface during opening of joint. Effect of water and heat aging on these properties are included.

8. Oven aging and weathering tests, including weight and volume change

The various oven aging and weathering tests are intended to indicate the performance life of the sealers. Factors detrimental to performance indicated by these tests include flow at elevated road temperature, hardening, loss of elasticity or bond and excessive shrinkage.

Table 1

Properties of Hot Poured Rubber Asphalt Sealers

Property	Sealer						
	A-1	A-2	A-3	B-1	C-1	C-2	E-1
Cone Penetration, mm	71	56	57	67	70	70	82
Cone Penetration, mm after 15 days @ 158 F	47	59	56	71	53	60	65
Resilience, Percent	35	41	51	61	38	47	60
Resilience, Percent after 15 days @ 158 F		48	64	52		48	64
Flow at 140 F, cm	0.4	0.3	0.3	0.1	0.1	0.1	0
Bond and Extension, 5 cycles @ 0 F, 50% Extension	PASS --						
Bond and Extension, 5 cycles @ 0 F, 50% Extension, after 96 Hours water immersion.	PASS----------------------------------					FAIL	PASS
Bond and Extension, 5 cycles @ 0 F, 50% Extension, after 15 days @ 158 F.	PASS	FAIL	PASS---------------			FAIL	PASS
Adhesive Strength, 150% Elongation, psi.	1.4	2.7	4.25	4.25	1.25	2.0	4.5
Artificial Weathering	Blistered and flowed off panel during first cycle---------						

Table 2

Atmospheric Weathering of Hot Poured Rubber Asphalt Sealers

Sealer	Condition After Exposure Time Shown		
A-1	60 days - surface weathered and blistered. Resilience Poor.	6 months - further surface weathering, material had sagged on panel. Soft and sticky under surface. Shore A Durometer-24	
A-2	30 days - surface weathered and map cracked. Resilience Fair.	12 months - sealant had blistered - soft and sticky to touch - resilience Poor.	27 months - additional weathering and blistering - material had sagged on panel. Shore A Durometer - 25.
A-3	30 days - same as A-2.	12 months - same as A-2.	27 months - same as A-2. Shore A Durometer - 17.
B-1	45 days - surface weathered and map cracked. Resilience Poor.	75 days - material sliding down panel. Max. temperature reached was 78 F.	4 months - material slid off exposure panel. Max. temperature during period was 80 F.
C-1	60 days - same as A-1.	6 months - same as A-1. Shore A Durometer - 21.	
C-2	60 days - voids appearing. Some blistering - surface weathered - resilience Poor.	12 months - some additional surface weathering.	28 months - additional blistering and weathering. Shore A Durometer - 20.
E-1	60 days - same as C-2.	12 months - same as C-2.	28 months - same as C-2. Shore A Durometer - 20.

Table 3
Properties of Two Component Polysulfide Sealers

Property	Sealer A-4	Sealer A 5	Sealer C-3	Sealer C-4
Cone Penetration, mm	59	48	54	55
Cone Penetration, mm After 15 days @ 158 F	48	20	23	Not determined.
Resilience, Percent	91	89	93	Too hard to test.
Resilience, Percent After 15 days @ 158 F	85	76	93	Too hard to test.
Flow @ 200 F	None	None	None	None
Bond and Extension, 5 cycles @ 0 F, 50% Extension	Pass	Pass	Pass	Pass
Bond and Extension After 96 hours immersion in water.	Pass	Pass	Pass	Pass
Bond and Extension After Heat Aging 15 days @ 158 F.	Pass Material shrunk 1/4" on top, bulging on sides.	Pass Shrinkage on top.	Fail Material contains large voids.	Pass Material bulging on sides.
Adhesive Strength @ 150% Elongation, psi.	19	19	25	16
Weight Loss after Heat Aging, percent.	9.8	13.2	12.4	11.7
Volume Change after Heat Aging, percent shrinkage.	5.7	8.5	4.8	6.3
Artificial Weathering, (1000 hours)	Surface cracked and chalking, resilience poor, evidenced considerable shrinkage.	Same as A-4.	Surface chalking, poor resilience, large amount of shrinkage.	Surface good, but large amount of shrinkage evident.
Durometer, Shore A Original	8	20	19	16
After 1000 hours artificial weathering.	18	44	67	45

NOTE: Specimens having 2 in. by 2 in. cross-section of sealer were used for the bond and extension and adhesive strength tests on Samples A-4, A-5 and C-3.

Table 4

Atmospheric Weathering of Two Component Polysulfide Sealers

Sealer	Condition After Exposure Time Shown		
A-4	60 Days - no significant change	One year - surface weathered but smooth - very little shrinkage - resilience fair.	23 months - surface still smooth - some additional hardening and slight shrinkage - resilience fair - Shore A Durometer - 18.
C-3	60 Days - some surface hardening and shrinkage - resilience good.	One year - additional hardening and shrinkage, resilience fair.	19 months - surface has begun to crack - resilience still fair Shore A Durometer - 55
C-4	60 Days - no change except slight hardening.	One year - some shrinkage and surface hardening evident - resilience good.	27 months - additional hardening and shrinkage, but surface looks good, Resilience fair Shore A Durometer - 45

Table 5

Properties Of Two Component Neoprene Sealant

Cone Penetration, mm	23
Cone Penetration, mm After 15 days @ 158 F	18
Resilience, Percent	Too Hard to Test
Resilience, Percent After 15 days @ 158 F	Too Hard to Test
Flow at 158 F	None
Bond and Extension, 5 cycles @ 0 F, 50% Extension	Pass
Bond and Extension, after 96 hours immersion in water	Pass
Bond and Extension after Heat Aging 15 days @ 158 F	Pass
Adhesive Strength @ 150% Elongation, psi	50
Weight Loss after Heat Aging, percent	16.30
Volume Change after Heat Aging, percent shrinkage	18.7
Artificial Weathering (1000 hours)	Rough surface - blistering and pinholing, resilience fair - evidence of considerable shrinkage.
Durometer, Shore A	
Original	20
After 1000 hours weathering	48
Atmospheric Weathering	
30 Days Exposure	Some surface weathering - resilience fair.
1 Year	Surface hardened and chalking - resilience fair.
26 Months	Surface cracked and very hard. Resilience still fair, but surface breaks and cracks fairly deep when pressed.

Table 6
Properties Of Two Component Polyurethane Sealants

Property	Sealer B-2	Sealer C-5	Sealer F-1	Sealer G-1
Cone Penetration, mm	59	26	49	39
Cone Penetration, mm After 15 days @ 158 F	54	26	34	9
Resilience, Percent	96	Too Hard to Test	82	Too Hard to Test
Resilience, Percent After 15 days @ 158 F	89	Too Hard to Test	88	Too Hard to Test
Flow @ 158 F	None	None	None	None
Bond and Extension, 5 cycles @ 0F, 50% Extension	Pass	Pass	Pass (-20 F)	Pass
Bond and Extension after 96 Hours immersion in water	Pass	Pass	Pass	Pass
Bond and Extension after Heat Aging 15 days @ 158 F	Pass	Pass	Pass	Pass
Adhesive Strength @ 150% Elongation, psi	18	93	16.5	Not Determined
Weight Loss after Heat Aging, Percent	0.69	0.67 Gain	4.92	8.31
Volume change after Heat Aging, Percent shrinkage	1.5	0.0	5.9	13.0
Artificial Weathering (1000 hours)	Good appearance, Good resilience, very little shrinkage	Same as B-2	Good appearance some hardening, resilience good, very little shrinkage.	Surface good, some hardening, resilience fair, evidence of shrinkage.
Durometer, Shore A				
Original	4	23	6	30
After 1000 hours Artificial Weathering	6	24	50	70

Table 7

Atmospheric Weathering of Two Component Polyurethane Sealants

Sealer	Condition After Exposure Time Shown		
B-2	60 Days - surface weathered, but sealer is soft - resilience good.	One year - very little change.	21 months - weather cracking of surface - small voids appearing. Still soft - resilience fair - no noticeable shrinkage Shore A Durometer - 6
C-5	60 Days - surface weathered, small voids appearing, but sealer is soft and resilience good.	One year - very little change.	21 months - weather cracking of surface, some hardening, but resilience still good - no shrinkage Shore A Durometer - 26
F-1	60 Days - some surface weathering and slight hardening. Resilience good.	One year - very little change.	19 months - surface weathered, some additional hardening - resilience fair Shore A Durometer - 41
G-1	60 Days - appearance good, some hardening and shrinkage - resilience fair.	One year - little change.	20 months - some additional hardening and shrinkage Shore A Durometer - 58

Table 8
Properties of Two Component Polyurethane Sealants
Tested for Compliance with Special Specification Item 4028

Property	Sealer D-1	Sealer D-2	Specification Requirements
Cone Penetration, mm	33	57	
Cone Penetration, mm After 15 days @ 158 F	-	106	
Resilience, Percent	87	92	80 minimum
Resilience, Percent After 15 days @ 158 F	Too Hard to Test	48	
Bond and Extension, 5 cycles @ -20 F, 150% Extension	Pass	Pass	Pass
Bond and Extension, 5 cycles @ -20 F, 150% Extension after 96 hour water immersion.	-	Pass	Pass
Bond and Extension, 5 cycles @ -20 F, 150% Extension after 15 days @ 158 F.	-	Pass	Pass
Adhesive Strength @ 77 F, 150% Elongation, psi, Initial	36.5	31.0	15 minimum, 75 maximum
Adhesive Strength @ 77 F, 150% Elongation, psi, after 96 hours water immersion.	40.5	30.0	15 minimum, 75 maximum
Adhesive strength @ 77 F, 150% Elongation, psi, after 96 hours at 158 F	74.5	30.0	15 minimum, 75 maximum
Adhesive Strength after bond and Extension @ -20 F.	36.0	34.0	15 minimum, 75 maximum
Shore A Durometer, Original	13	6	5 minimum, 20 maximum
Shore A Durometer after 120 hours @ 158 F.	24	6	5 minimum, 30 maximum
Weight Loss after Heat Aging, Percent	0.29	1.32	5 maximum
Volume Change after Heat Aging, Percent Shrinkage	0.7	1.7	

Table 8 - Continued

Property	Sealer D-1	Sealer D-2	Specification Requirements
Viscosity at 77 F Poises: Comp. A	850	840	100 minimum, 1000 maximum
Comp. B	600	900	
Compression Set, Percent	6	14	45 maximum
Application Life @ 77 F	20 Minutes	10 Minutes	D-1: 60 minutes minimum D-2: 2 minutes minimum
Cure Time Required at 77 F Before opening to traffic.	2-3 Hours	2-3 Hours	

NOTE: Bond and extension and adhesive strength specimens had a 1/2-inch by 1/2-inch cross section of sealer.

Table 9
Properties of Hot Poured PVC-Coal Tar Sealants

Property	Sealer E-2	Sealer H-1
Cone Penetration, mm	69	70
Cone Penetration, mm After 15 days @ 158 F	17	32
Resilience, Percent	82	62
Resilience, Percent After 15 days @ 158 F	45	46
Flow at 140 F	None	None
Bond and Extension, 5 cycles @ 0 F, 50% Extension	Pass	Pass
Bond and Extension after 96 hours immersion in water.	Failed during 5th cycle.	Pass
Bond and Extension after Heat Aging 15 days @ 158 F.	Failed during 1st cycle.	Failed during 3rd cycle.
Weight Loss after Heat Aging, Percent	4.07	1.58
Volume Change, after Heat Aging, Percent shrinkage	6.76	2.00
Adhesive Strength @ 150% Elongation, psi.	12	10
Artificial Weathering (1000 hours)	Surface alligatored, resilience fair - very little shrinkage.	Surface good, resilience good, some hardening on edges, very little shrinkage.
Durometer, Shore A		
Original	9	6
After 1000 hours artificial weathering.	45	35
Outdoor Weathering		
60 Days Exposure	Some surface weathering - otherwise, no change.	No change
1 Year	Some surface weathering - resilience fair.	Surface appearance good - resilience good.
27 Months	Hard film and cracking on surface, resilience low. No noticeable shrinkage. Shore A Durometer - 55	Hardening and some cracking of surface - resilience low - slight shrinkage. Shore A Durometer - 45

IV. DISCUSSION

This evaluation did not show any significant difference between hot poured rubber asphalt sealant obtained under Item 360.2(8)(c) and the "upgraded" materials. The primary problem with these sealers is the fact that in hot weather, they become quite soft and sticky and incompressibles will embed in the joint material rather than being rejected by it. This will eventually result in failure of the sealer or failure of the joint to function properly. Since the upgraded materials do not evidence any properties which indicate they will reject incompressibles better than the sealers presently being obtained, we do not believe a change in the specification would be of much benefit.

The two component polysulfide sealers tested are being supplied under Item 360.2(8), Class 1-a or 1-b materials, with the exception of Sealer C-4. The polysulfide materials all evidence considerable weight loss and shrinkage on aging. The shrinkage on oven aged bond extension specimens and artificial weathering panels is sufficiently great that it is readily visible to the eye. This shrinkage is probably one of the major factors in the rather limited performance life of polysulfide materials under field conditions.

The two component neoprene sealant had the highest shrinkage of any two component material evaluated. Based on this high shrinkage and hardening of the material on aging, we believe this sealer will not perform satisfactorily under field conditions.

The two component polyurethane sealants tested performed well with the exception of Sealer G-1, which had high shrinkage on aging. In addition to the four polyurethane sealers in Table 6, results of tests on two sealers submitted for compliance with Special Specification Item 4028, Polyurethane Joint Seal are presented in Table 8. Laboratory tests indicate that the two component polyurethanes should give good performance. District 14 has several structures the joints of which have been sealed with polyurethane material complying with Special Specification Item 4028. All of these were armor joints. The steel was sandblasted and coated with a primer prior to pouring the joint material. Some of these installations have performed well, but problems have been encountered with others. The resin component of these sealers is quite sensitive to moisture. Exposure to moisture will cause the resin to increase in viscosity and the pot life of the material will be shortened considerably. In the case of materials designed for machine use, moisture can shorten the pot life to the extent that the material cannot be properly mixed and placed before it begins to gel. These sealers are also quite critical with regard to mixing. They must be proportioned properly and the two components well mixed together. If the components are not intimately mixed there is a tendency for separation to take place prior to completion of the reaction, resulting in a non-uniform cured material. Discussion with a representative of the California DOT indicates that they have experienced some of these problems with the two component polyurethanes in the field. Although laboratory tests indicate good properties their performance has been quite good in some cases and rather poor in others. Extreme care in application is necessary to obtain a good job.

The PVC-Coal Tar sealers are relatively new materials which are placed hot in a manner similar to hot poured rubber asphalts. The overall performance of these sealers was generally good, although there is some degradation on aging, as evidenced by the failure on the bond extension test after heat aging. These materials are recommended by their manufacturers as alternates to hot poured rubber asphalt. They are recommended only for sealing joints in concrete pavement. They do not possess sufficient extensibility to be used in bridge joints and they will not bond to metal, so they cannot be used in armor joints. One of the main advantages of the PVC-Coal Tars compared to hot poured rubber asphalt is their ability to reject incompressibles. Based on field evaluations by the Highway Departments of Louisiana and Minnesota (see Bibliography page 24), Sealer H-1 has performed well in concrete pavement joints. The cost of the PVC-Coal Tars is greater than hot poured rubber asphalt, but less than most of the two component sealers available. The manufacturer of Sealer E-2 indicates that their product has been improved since this evaluation was performed, and tests are in progress on a sample of the "improved" material. Initial results indicate better performance, particularly with regard to shrinkage and hardening on aging. An ASTM specification and test procedures have been prepared covering PVC-Coal Tar sealants. These are D 3406, "Tentative Specification for Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements," and D 3408, "Tentative Methods of Testing Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements."

We believe the PVC-Coal Tar materials evidence sufficiently good properties and performance to warrant their use in concrete pavement joints on a trial basis by the Department. A recommended specification which is based on the ASTM specification is included in the Appendix. A shrinkage requirement and application requirements have been included.

Based on the work done in this project, we do not recommend any change in the present specifications for poured joint material in Item 360. The hot poured PVC-Coal Tar sealers can be obtained by use of a special specification until some field experience is obtained with the material. We believe it is possible to obtain good performance with two component polyurethane sealers complying with Special Specification Item 4028, but care must be exercised to protect the resin component from moisture and to insure that the material is properly proportioned and extremely well mixed. Development of polyurethane sealers is still in progress, so newer materials of this type may offer better performance under field conditions.

Regardless of what joint sealer is used, proper preparation of the joint faces is extremely important. One of the most common problems in installation is overfilling the joint. The surface of the joint material should be at least 1/4 inch below the surface of the roadway.

BIBLIOGRAPHY

1. "Field Evaluation of Joint Seal Materials," Investigation No. 166 - Final Report 1974, Office of Research and Standards Division, Minnesota Department of Highways.

2. "Evaluation of Joint Sealant Materials," March 1972, Research Report No. 62, Louisiana Department of Highways.

APPENDIX

Suggested Specification for Hot-Poured
Single Component PVC-Coal Tar Joint Sealer

1. Description: This item shall govern for the furnishing and placing of single component hot-poured sealant in joints of portland cement concrete pavement.

2. Material: The joint sealer shall comply with all the requirements of ASTM D 3406, Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements, and also the following requirement:

   Volume Change on Heat Aging, Percent Maximum - 5.0

   The tests shall be performed in accordance with ASTM D 3408 with the following modifications and additions:

   Bond and Tensile Adhesion Tests

   The blocks used in these tests shall be prepared as specified in ASTM D 1191. The bonding surface of the mortar blocks shall be ground to remove any laitance.

   Storage of the blocks shall be as specified in ASTM D 3408.

   Artificial Weathering

   The light and water-exposure apparatus (carbon-arc type) used for the artificial weathering test shall conform to Type EH described in ASTM Recommended Practice G 23. The equipment shall be operated at a black panel temperature of 130 ± 5 F. The specimens shall be formed on asbestos-cement panels 3 by 9 by 1/8-inch conforming to ASTM Specification C 220, Type U.

   Volume Change on Heat Aging

   The specimens for this test shall be 2.00 ± 0.05 by 1.00 ± 0.05 inch diameter. The specimen may be formed by pouring the sealer into a cylindrical mold set on a metal plate. The interior of the mold and the surface of the plate should be given a light coat of silicone release agent. After the specimen has cured for 24 hours, it is removed from the mold and the surface blotted with a paper towel to remove release agent. The specimen then is weighed to the nearest 0.001 g and the volume determined using a gallon weight cup having a volume of 83.2 ml as described in Federal Test Method

Standard No. 141a, Method 4184.1. The tared cup is filled with distilled water at 77 F and the weight of cup and water recorded. The specimen is then placed in the dried cup and the weight of cup and specimen is determined. Water then is added to fill the cup and the total weight of specimen, cup and water is recorded.

The specimen is removed from the cup, dried with a paper towel and placed in a forced draft oven maintained at 158 $\pm$ 2 F for 168 hours. After aging, the specimen is conditioned in air at 77 $\pm$ 5 for at least one hour, weighed to the nearest 0.01 g and the volume determined as described above. The original and aged volumes are calculated as follows:

Weight of Displaced Water Equivalent to Volume of Specimen = A-(C-B)
(1g = 1 ml volume)

Where A = Weight in gms of water in filled gallon weight cup

B = Weight of cup and specimen

C = Weight of cup, specimen and water

$$\text{Percent Volume Change} = \frac{(\text{Original Volume} - \text{Aged Volume})(100)}{\text{Original Volume}}$$

3. Application:

Joint Preparation:

Joints must be clean and dry. The surfaces shall be cleaned thoroughly by sandblasting or jet waterblasting. Joints should be blown out with compressed air just prior to sealing. Backing material to be placed in the joint shall be as specified on the plans.

Application Equipment:

The joint sealer shall be heated in an oil-jacketed, double boiler type melter equipped with a mechanical agitator, pump, gas pressure gauges and separate temperature indicators for both the oil bath and melting vat. The kettle, lines and pump must be completely clean and free of any residual joint sealing compound prior to use with this sealer.

Heating of Material:

The manufacturer's instructions regarding addition of material to the kettle and heating temperature shall be strictly adhered to. IN NO CASE SHALL THE MANUFACTURER'S SAFE HEATING TEMPERATURE BE EXCEEDED. Any material damaged by overheating shall be rejected. All material must be placed within six hours of application of heat or discarded. Any material remaining in the kettle at the end of a work day must be pumped out and discarded and the lines, kettle and pump cleaned with a flushing oil recommended by the manufacturer.

Sealant Application:

The pavement temperature at time of application must be above 40 F. The joints shall be filled in a neat workmanlike manner to 1/4 inch $\pm$ 1/16 inch below the surface of the pavement.