

USE OF FABRICS FOR  
REFLECTIVE CRACK CONTROL IN  
ASPHALT CONCRETE OVERLAYS  
OVER PCC JOINTED PAVEMENTS

Experimental Features  
Final Report  
OR 75-05,75-06,75-07

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16. Abstract  <p>This report summarizes the installation and performance of three geotextile fabrics used to retard reflective cracking in an asphalt overlay test project. The project consisted of fifteen test sections, including twelve fabric sections; two control sections, and a nonfabric test section. Test sections included fabrics placed mid-level and full depth. In addition, half of the test sections included bond breakers while the other half were without bond breakers.</p> <p>Fabrics placed at mid-level with and without bond breakers were effective at retarding reflective cracks. Fabric placed at full depth with bond breakers performed best. Fabric placed at full depth without bond breakers did not provide any more protection than control sections. Results from this study may not apply to AC Overlays on AC Cracked Pavements.</p>					
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## TABLE OF CONTENTS

PURPOSE.....	1
BACKGROUND -	
General.....	1
Background and Design.....	2
Installation.....	2
EVALUATION -	
Field Surveys.....	7
Discussion.....	8
Cost & Availability.....	9
CONCLUSIONS -	
Conclusions.....	10
Summary.....	10
TABLES -	
Table 1: Linear Feet of Transverse Cracking.....	12
Table 2: Number of Transverse Cracks & Rutting Performance.....	13
Table 3: Number of Cracks as of 9/88.....	14
Table 4: Percentage of Reflected Joints.....	15
Table 5: Cost Estimate.....	16
APPENDICES -	
Appendix A: Work Plan.....	17
Appendix B: Materials & Mix Design.....	19

## LIST OF FIGURES

Figure 1: Test Section Details.....	3
Figure 2: Bond Breaker Details.....	5

## PURPOSE

In the 1970's many Oregon highways were in need of asphalt overlays to maintain deteriorated Portland cement concrete jointed pavements. These asphalt concrete overlays tended to experience reflective cracking in a short time, particularly due to the thermal movements of the transverse PCC joints. It was proposed to use a full width geotextile fabric to retard reflective cracking.

The purpose of this study is to evaluate the effectiveness of three materials specifically developed to retard reflective cracking. In addition, bonding, bond breakers\*, and variations in the location of the reinforcement fabrics were studied. The products chosen were Petromat, marketed by the Phillips Petroleum Company; Fabric I-1980, marketed by the Burlington Glass Fabrics Company; and Typar Style 3401, marketed by the DuPont Company. These materials were evaluated on a paving project through a series of inspections over a period of 13 years.

## BACKGROUND

### General -

This project, constructed in 1975, is located on a four lane section of interstate freeway (I-5) between the Linn County line and the McKenzie River in Lane County, 5 miles north of Eugene, Oregon. The existing facility was composed of two roadways, each having two 12-foot Portland cement concrete traffic lanes separated by an open 76-foot median. The shoulders were paved with asphaltic concrete. The PCC pavement on this project was reinforced with welded wire fabric and had doweled contraction joints at 61.5 foot spacing. With this spacing, the joints have significant thermal activity.

The deteriorated PCC traffic lanes received a 5-inch asphaltic concrete overlay with a 1-inch open graded plant mix seal. The project consisted of 15 test sections. Originally the project included only two fabrics. A third fabric, Typar 3401, was added after construction began. An additional test section of bond breaker only (no fabric) was added when the Typar fabric ran out.

\* See page 5 for a complete description of bond breaker construction

## Background & Design -

It was learned prior to the construction of this project that Washington, California, and Idaho Highway Divisions had used the Petromat product and believed the benefits were well worth the cost. Their experience indicated that reinforcing fabrics should be placed at or slightly below the midpoint of the overlay, and the joints and cracks should be sealed prior to overlay. It was also recommended that the pavement be subsealed or jacked along with subbase drainage to prevent vertical movement of the slabs.

It was also noted that two experimental installations in an area of climatic extremes, North Dakota and Saskatchewan, failed within the first year. Temperatures in the northern and mid-continental plains have a 140-150 degree annual range with frequent and abrupt changes. Also, in both cases, the overlays placed were thin and it is presumed the fabric was placed beneath the overlay in direct contact with the existing pavement.

Substantial evidence was available that effectiveness could be increased by separating the reinforcing fabric from the old surfacing with a cushion course. This was successfully demonstrated in an Idaho project using an aggregate cushion course. Because of this a similar approach was tried on this project, except that in this case the aggregate cushion (bond breaker) was applied only at the joints.

## Installation -

Test sections utilizing several fabrics for the control of reflective cracking in an asphalt concrete overlay were constructed during September, 1975. The construction consisted of a 3-inch base course, a 2-inch top course, and a 1-inch open graded wearing course applied over existing PCC pavement. The base and top courses were constructed during September, 1975 and the 1-inch wearing course was added during the summer of 1976.

The fabrics were installed in conjunction with an overlay project, the Linn County Line-McKenzie River Bridge Section. The total overlay project was approximately 10 miles in length. The various fabrics and control sections were installed along 7,000 feet of the right lane of each of the north and southbound roadways. The test sections were varied in length (most were 1000 feet) and they were arranged as follows (see figure 1):

Northbound starting at south end: Petromat placed between base and top courses; Burlington fiberglass fabric placed between base and top courses; Typar placed between base and top courses; Control section (no fabric or bond breakers);

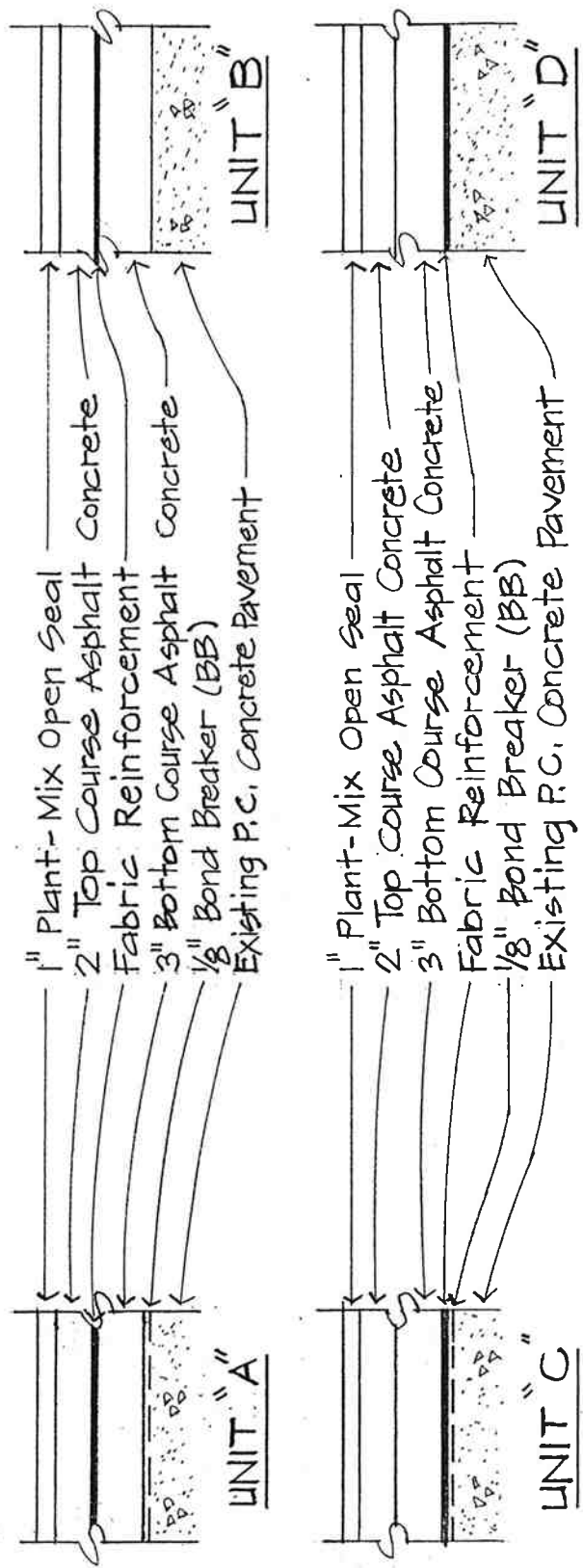
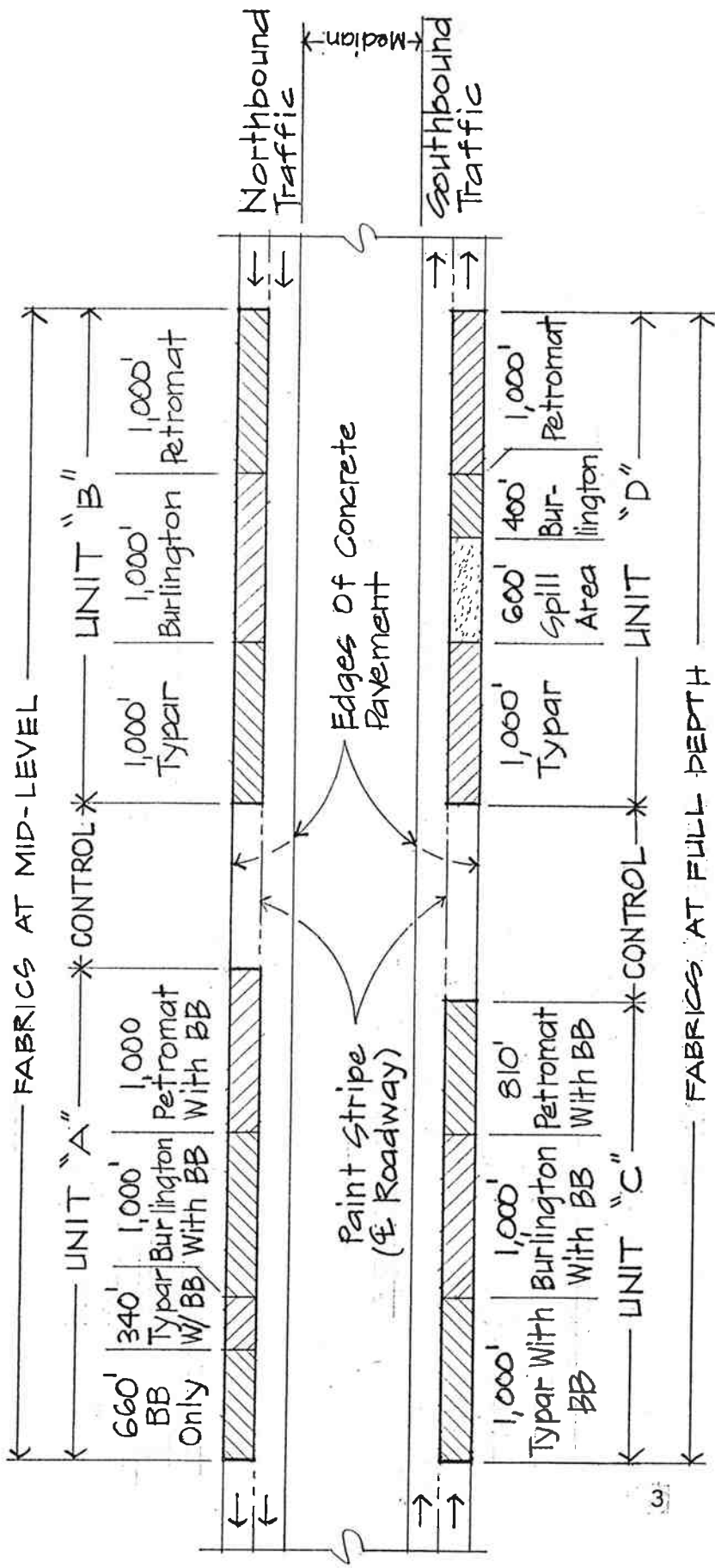


FIGURE 1: TEST SECTION DETAILS

Petromat placed between base and top course with bond breaker placed over old PCC contraction joints; Burlington fiberglass fabric placed between base and top courses with bond breaker placed over old PCC joints; Typar placed between base and top courses with bond breaker placed over old PCC joints; Bond breakers without fabrics.

Southbound starting at south end: Petromat placed between old PCC and base course; Burlington fiberglass placed between old PCC and base course; Typar placed between old PCC and base course; Control section (no fabric or bond breakers); Petromat placed between old PCC and base course with bond breaker over old PCC joints; Burlington fiberglass placed between old PCC and base course with bond breaker placed over old PCC joints; and Typar placed between old PCC and base course with bond breaker placed over old PCC joints.

The bond breaker was applied over existing contraction joints and major cracks in the old PCC pavement (see figure 2). It consisted of a nonplastic, nonangular sand which was broomed over the area covering a section three feet on each side of the crack extending the length of the joint. This material was then covered with a reinforced Kraft paper coated with polyethylene. (See appendix B for more details about materials.)

The asphalt binder used was CRS-2, and was applied at the following rates: Petromat, 0.4 gal./yd.<sup>2</sup>; Typar, 0.3 gal./yd.<sup>2</sup>; and Burlington, 0.2 gal./yd.<sup>2</sup>. Placement temperature of the drier-drum-mixed asphalt concrete was about 250° F.

The majority of construction problems had to do with pickup and displacement of the fabric and bond breaker cover. Belly-dump trucks were used to windrow the A.C. This resulted in trucks traversing the fabric several times.

Trucks would pick up tack on their wheels and then pick up and/or tear the bond breaker cover paper. This situation was partially remedied by broadcasting A.C. on the paper ahead of the trucks. A similar situation occurred with the fabrics, usually resulting in torn or wrinkled material. This was particularly critical at fabric splices. The Burlington fabric, being narrow, required two joints its entire length, which increased the pickup problem. The fabric was sometimes wrinkled by the wheels of the paver as it traversed. In addition, where the fabric was placed directly on the old PCC, extreme care had to be exercised in controlling the height of the cow catcher to prevent it from picking up and tearing the fabric.

An unrelated problem occurred in rolling out the Typar. Being in a single roll, it was extremely heavy and hard to handle. Any deviations from the desired course in rolling it out could not be handled by simply lifting the roll and pulling the material tight



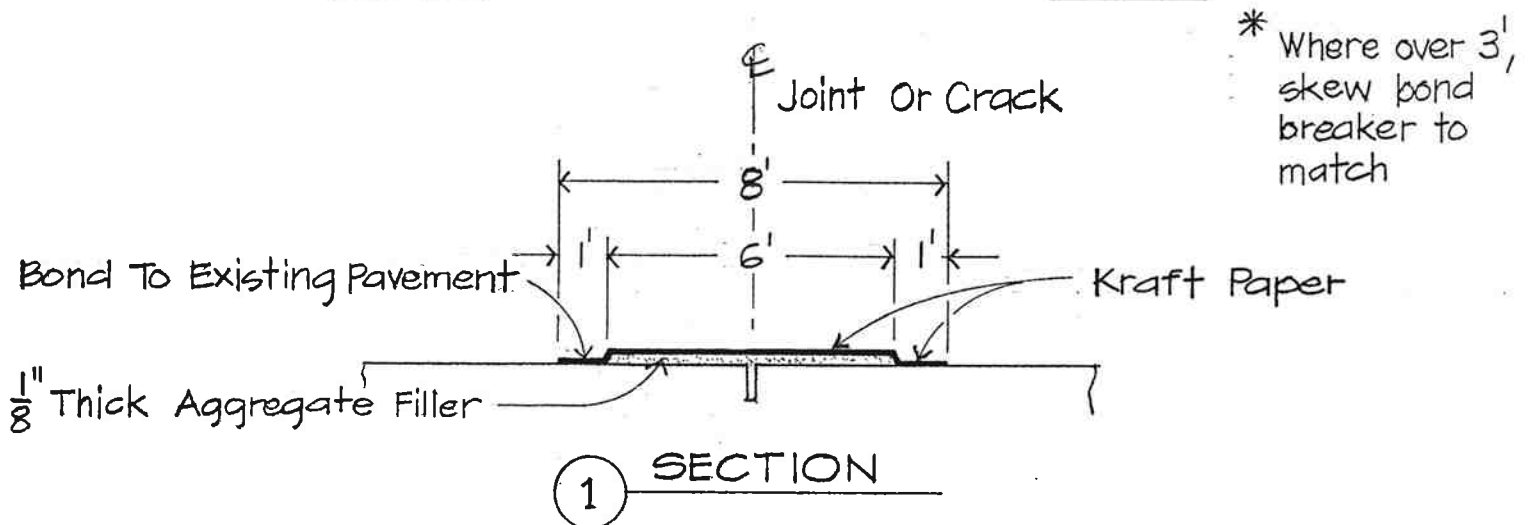
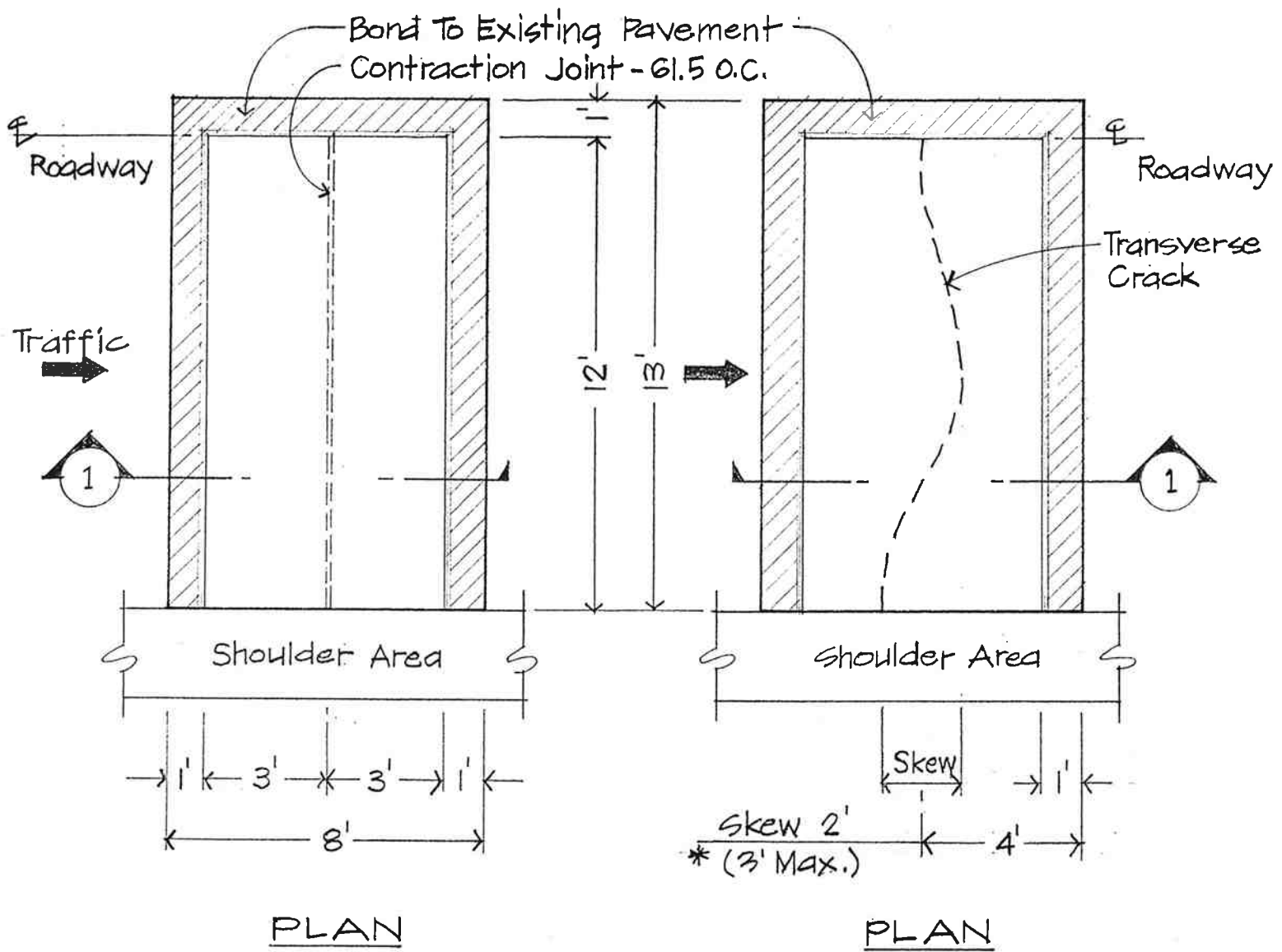


FIGURE 2 : BOND BREAKER DETAILS

and straight. It had to be cut and moved over to the correct position, before the rollout continued. Machine laydown would probably remedy this situation. Needless to say, experience in laying the bond breaker, fabric, etc., could greatly lessen the problems encountered. The contractor, although experienced with Petromat, had no experience with the other fabrics. This prevented some problems because these others behaved differently during laydown.

A small spalled area (about 1 sq. ft.) was found prior to placing the 1" wearing course. The spall resulted from a wrinkle in the fabric caused by a truck or the paver. The area was dug out and repaired prior to placing the wearing course.

Some difficulty was caused by the emulsified asphalt tack coat. Often it did not break quickly enough or thoroughly enough and penetrated through the fabrics. This caused it to get on the truck tires, which lifted and wrinkled the fabric. To solve the problem, Phillips Petroleum recommends a hot asphalt cement tack for Petromat. This would be preferable for all fabrics.

## EVALUATION

### Field Surveys -

Cracking surveys were performed bi-annually, with the first survey March, 1976 prior to application of the 1-inch wearing course. Following are discussions and tables showing the results of those surveys.

In March, 1976 in the northbound lane at station 69+90, a rough hole 4" long by 1" to 2" wide by 1" deep was found. A fold of Typar fabric was sticking up into the hole from the surface below. It was noted during the laydown procedure that the fabric in the first 50 feet of this section was torn by the paving machine. This area was dug out and repaired prior to placing the wearing course.

In November, 1976 the project was surveyed again after the 1-inch seal coat had been applied. It appeared as if several areas had been "burned off", assumably because they were high spots. As a result, the areas were somewhat smoother than the surrounding surface. No cracking was observed.

Surveys continued twice yearly, with no cracking observed in any sections. In June, 1979 a truck accidentally dumped a load of what was reported to have been emulsified asphalt. The spill occurred approximately from station 71+00 through station 75+50 in both lanes in the southbound direction. State maintenance forces could not remove all of the asphalt.

In November, 1980, the first cracking was observed, a 2.5 foot transverse crack in the southbound control section. Also, a darkened area was observed at the spill site. The pavement in this area was disturbed but did not show any reflective cracking. Reflective cracking appeared in fabric test sections in March, 1982, approximately eight areas in the southbound lanes and seven areas in the northbound lanes. Most of the cracking first appeared as hairline cracks perpendicular to the flow of traffic between the right wheel path and the fog line. Table 1 shows the linear feet of transverse reflective cracking in each section by date of inspection. Cracking appeared in the control sections and the southbound fabric section without bond breakers (fabrics placed between old PCC and base course). Two small cracks appeared in the northbound Petromat section with bond breakers (fabric placed between base and wearing course).

Between 1983 and 1988, cracking appeared in all sections. Table 1 shows the relative amounts of cracking for each section and when the cracking occurred. Table 1 does not show the actual lengths

of cracking, but an adjusted amount based on cracking per 1000 feet. Actual test sections varied from 800 feet to 1200 feet.

### Discussion -

Tables 1, 2, 3, and 4 summarize the amount of cracking by section, and all tables were adjusted to reflect a standard test section of 1000 feet. Table 1, discussed earlier, shows the linear feet of transverse cracking per 1000 feet (by date of inspection). Table 2 shows the number of transverse cracks per 1000 feet and the average rut depths of each section. Table 3 shows the number of cracks by type and the average length of transverse crack as of September, 1988. Table 4 shows the percentage of joints in each section which has reflected through as of September, 1988.

When the crack surveys were summarized, it became apparent that some discrepancies were appearing. From one evaluation to the next, cracks were appearing and then disappearing. This is particularly evident between the February, 1988 and September, 1988 evaluations. One possible explanation is that in the February evaluation the cracks were wide open and easy to see. In the September evaluation, the day was warm and many of the marginal cracks were not visible. In addition, the pavement is extremely coarse and in many instances it is difficult to see cracks forming.

It was observed that most transverse cracks appeared first between the fog line and the right wheel path. Once this crack formed, it progressed from the fog line through the right wheel path, across to the left wheel path, eventually all the way across. This could be due to stresses at the old longitudinal joint between the PCC and the asphalt shoulder. The crack appears to begin at the longitudinal joint and progress across the travel lane. Perhaps if the fabric overlapped and bond breakers had been used at the longitudinal joint, transverse cracking would have been further retarded.

All the transverse cracks except one can be attributed to a joint reflecting through the asphalt pavement. In Table 4, a large percentage of joints have reflected through the asphalt pavement. This may indicate that most sections were at or near end of life. Sometime before the last survey, some of the sections that were doing better were starting to severely crack. One fabric, Typar, did particularly well at retarding joint reflection, according to this table.

From Table 1 there does not appear to be a significant difference between fabrics placed at mid-depth, with or without bond breakers. But when the fabric is placed at the bottom of the overlay, the sections with bond breakers did much better than sections without bond breakers. In fact, the sections without bond breakers and

fabrics at the bottom did no better, and in some instances worse, than the controls.

The fabrics placed at the bottom with bond breakers did the best job at retarding reflective cracks. This tends to support the theory of stopping the crack as quickly as possible. The fabrics placed at mid-depth did well compared to the control sections, and were not dependent on the use of bond breakers.

The Burlington fiberglass southbound fabric section without bond breakers was disturbed by an accidental asphalt spill in 1979. Over the course of this project, the area was observed to have transverse cracking, longitudinal cracking, rutting and/or raveling. By 1988, almost 600 feet of the section had been disturbed. It seems unusual that an emulsified asphalt would cause this, but one possible explanation is that maintenance forces used something to clean the asphalt off the pavement. Because this cracking is from the asphalt spill, the disturbed portion of this section has been eliminated from the summary of cracking.

#### Cost & Availability -

The cost to install fabrics and bond breakers will vary widely depending on the quality of fabric and the joint spacing. Costs on this project were not so well documented, so an attempt at estimating current costs of fabrics and bond breakers has been made. Table 5 shows cost estimates based on 1988 materials costs. Labor costs will vary greatly depending on the size of project. Colorado\*\* reported costs varying from \$.53 to \$1.20 per square yard installed. Suppliers in Oregon report bid prices range from \$.75 to \$1.20 per square yard installed (these figures were used for estimating purposes). Also shown are Oregon's current asphalt paving costs based on an average \$28 per ton asphalt laid, no traffic control included.

From table 5 we see that fabric and bond breakers increase the cost of a 4" overlay about 14 to 21% depending on the size of the project. Assuming a 10 year life of overlay the fabric would have to extend the life of the pavement at least 1.4 years to be cost effective.

The Petromat fabric is available in a variety of weights from 4.0 to 6.0 oz. The Typar fabric is available under a new name T-3401, from Reemay, Inc. The Burlington fabric has been discontinued.

\*\*Harmelink, Donna S., "Reflective Cracking--Fabrics", CDOH-DTP-R-86-11, Colorado Department of Highways, June 1986.

## CONCLUSIONS

### Conclusions -

Examining the summary of evaluations (table 1), the fabrics placed at midlevel delayed reflective cracking about two years over the control sections. The fabrics placed at the bottom with bond breakers delayed reflective cracking at least six years, maybe seven. The fabrics placed at the bottom without bond breakers did not appear to do any better than the control sections without fabrics.

Based on the evaluations, the following conclusions appear warranted :

- 1) Separation of the reinforcing fabric from the old surfacing with a bond breaker was extremely effective when the fabric was placed directly over the old surfacing.
- 2) When the fabrics were placed at midlevel, the bond breakers did not have a substantial effect on crack retardation.
- 3) Fabrics placed at midlevel with or without bond breakers were effective at retarding reflective cracking.
- 4) Fabrics placed directly on the old wearing surface without the bond breakers did not provide any more reflective crack protection than nonfabric sections.
- 5) Bond breakers alone, without fabrics, did not provide a significant amount of protection against reflective cracking.

The Typar product appeared to outperform the Burlington and Petromat products. All three reduced reflective cracking over the control sections. The fabrics did not appear to have any effect on the rutting performance of the pavement (table 2).

### Summary -

The installation of fabrics and bond breakers delay the formation of reflective cracks and delay maintenance of the pavement. Although the fabrics with bond breakers delayed cracking as much as seven years, the overall condition of all pavement sections is still good. The cracking in the control sections has not resulted in any other distress and the pavement has not failed, as it still provides a good ride.

Possibly a good application of these fabrics and bond breakers would be over pavements with closer joint spacing, where reflective cracking may produce an undesirable ride and a maintenance problem. Because closer spacing means less expansion/contraction movement, the fabrics may inhibit the formation of reflective cracking or at least delay the cracking.

TABLE 1 - USE OF FABRICS FOR REFLECTIVE CRACK CONTROL IN ASPHALT CONCRETE OVERLAYS

TOTAL LINEAR FEET OF TRANSVERSE CRACKING PER 1000 FEET (BY DATE OF INSPECTION **)												
DATE OF INSPECTION, MONTH/YEAR	9/88	2/88	3/86	5/85	11/84	6/84	12/83	3/83	9/82	3/82	7/81	11/80
SOUTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN PCC AND BASE COURSE)												
FABRIC W/BB:												
TYPAR	10	11	0	0	2	2	0	0	0	0	0	0
BURLINGTON	57	34	0	0	0	0	0	0	0	0	0	0
PETROMAT	76	86	0	0	0	0	0	0	0	0	0	0
NO FABRIC:												
CONTROL	80	86	37	33	14	12	22*	20*	9*	8	4	2 1/2
FABRIC W/O BB:												
TYPAR	109	112	32	24	17	11	11	11	5	3	0	0
BURLINGTON	120	132	32	24	12	12	6	5	10	5	0	0
PETROMAT	137	140	50	42	14	14	7	5	5	3	0	0
NORTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN BASE AND WEARING COURSE)												
FABRIC W/BB:												
TYPAR	50	76	6	2	0	0	0	0	0	0	0	0
BURLINGTON	44	65	15	9	6	4	3	6	0	0	0	0
PETROMAT	53	90	22	22	8	6	6	8	4	3	0	0
NO FABRIC:												
CONTROL	141	179	62	59	33	39	22*	20*	9*	6	0	0
FABRIC W/O BB:												
TYPAR	23	54	2	8	3	3	6	3	0	0	0	0
BURLINGTON	28	57	12	6	1	0	0	0	0	0	0	0
PETROMAT	69	76	21	12	9	9	3	6	6	0	0	0
NO FABRIC:												
BOND BREAKERS ONLY	100	110	29	15	5	5	4	4	3	1 1/2	0	0

W/BB = WITH BOND BREAKERS  
W/O BB = WITHOUT BOND BREAKERS  
\* CONTROL SECTIONS WERE AVERAGED TOGETHER  
\*\* NO CRACKS PRIOR TO 11/80



TABLE 2 - USE OF FABRICS FOR REFLECTIVE CRACK CONTROL IN ASPHALT CONCRETE OVERLAYS

DATE OF INSPECTION, MONTH/YEAR	ACCUMULATED NUMBER OF CRACKS PER 1000 FEET (BY DATE OF INSPECTION)						AVERAGE RUT DEPTHS (IN 1000TH'S FOOT)		
	9/88	2/88	3/86	5/85	11/84	6/84	9/88	2/88	5/85
<b>SOUTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN PCC AND BASE COURSE)</b>									
FABRIC W/BB:	4	4	0	0	1	1	45/35	30/25	25/25
TYPAR	9	10	0	0	0	0	50/35	30/30	20/20
BURLINGTON	10	11	0	0	0	0	50/30	30/25	25/20
PETROMAT									
NO FABRIC:									
CONTROL	11	12	8	6	3	3	50/25	45/30	25/20
FABRIC W/O BB:									
TYPAR	14	16	9	9	4	4	50/30	35/30	25/20
BURLINGTON	16	16	13	8	5	5	55/30	50/30	25/20
PETROMAT	14	14	12	12	6	6	45/30	45/30	25/20
<b>NORTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN BASE AND WEARING COURSE)</b>									
FABRIC W/BB:									
TYPAR	8	10	3	0	0	0	60/40	45/35	30/25
BURLINGTON	11	11	5	5	3	2	55/40	55/35	30/25
PETROMAT	10	11	3	3	3	3	50/40	50/35	30/25
NO FABRIC:									
CONTROL	17	17	13	15	11	11	45/35	40/35	20/20
FABRIC W/O BB:									
TYPAR	6	7	1	2	2	2	50/40	50/35	30/25
BURLINGTON	8	10	3	1	1	0	45/35	45/30	30/20
PETROMAT	13	12	6	3	3	3	45/30	45/30	30/20
NO FABRIC:									
BOND BREAKERS ONLY	11	10	7	5	2	2	50/35	40/30	30/20

W/BB = WITH BOND BREAKERS

W/O BB = WITHOUT BOND BREAKERS

LMP/RMP = LEFT WHEEL PATH / RIGHT WHEEL PATH

\* PRIOR TO 6/84 ONLY FEET OF TRANSVERSE CRACKING RECORDED

TABLE 3 - USE OF FABRICS FOR REFLECTIVE CRACK CONTROL IN ASPHALT CONCRETE OVERLAYS

NUMBER OF CRACKS PER 1000 FEET (BASED ON 9/88 INSPECTION)

	NUMBER OF CRACKS PER 1000 FEET (BASED ON 9/88 INSPECTION)			ALLIGATOR	AVERAGE LENGTH OF TRANSVERSE CRACK (FEET)
	TRANSVERSE	LONGITUDINAL			
<b>SOUTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN PCC AND BASE COURSE)</b>					
FABRIC W/BB: *					
TYPAR	4	1	0		2.5
BURLINGTON	9	2	2 (MINOR)		6.3
PETROMAT	10	5	2 (MINOR)		7.6
NO FABRIC:					
CONTROL	11	3	4 (MAJOR)		7.3
FABRIC W/O BB:					
TYPAR	14	4	2 (MAJOR)		7.8
BURLINGTON	16	5	5 (MAJOR)		7.5
PETROMAT	14	0	0		9.8
<b>NORTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN BASE AND WEARING COURSE)</b>					
FABRIC W/BB:					
TYPAR	8	0	2 (MINOR)		6.2
BURLINGTON	11	0	0		4.0
PETROMAT	10	3	6 (MINOR)		5.3
NO FABRIC:					
CONTROL	17	0	4 (MAJOR & SPALLING)		8.3
FABRIC W/O BB:					
TYPAR	6	0	0		3.8
BURLINGTON	8	0	0		3.5
PETROMAT	13	0	0		5.3
NO FABRIC:					
BOND BREAKERS ONLY	11	0	0		9.1

W/BB = WITH BOND BREAKERS  
W/O BB = WITHOUT BOND BREAKERS  
MAJOR = MAJOR ALLIGATORING  
MINOR = MINOR ALLIGATORING

TABLE 4 - USE OF FABRICS FOR REFLECTIVE CRACK CONTROL IN  
ASPHALT CONCRETE OVERLAYS

PERCENTAGE OF PCC EXPANSION JOINTS REFLECTED THROUGH ASPHALT CONCRETE AS OF 9/88

-----  
SOUTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN PCC AND BASE COURSE)  
-----

FABRIC W/BB:  
TYPAR 24%  
BURLINGTON 56%  
PETROMAT 62%

NO FABRIC:  
CONTROL 68%

FABRIC W/O BB:  
TYPAR 88%  
BURLINGTON 100%  
PETROMAT 82%

-----  
NORTHBOUND TEST SECTIONS (FABRICS PLACED BETWEEN BASE AND WEARING COURSE)  
-----

FABRIC W/BB:  
TYPAR 50%  
BURLINGTON 68%  
PETROMAT 62%

NO FABRIC:  
CONTROL 100%

FABRIC W/O BB:  
TYPAR 37%  
BURLINGTON 50%  
PETROMAT 76%

NO FABRIC:  
BOND BREAKERS ONLY 70%

W/BB = WITH BOND BREAKERS  
W/O BB = WITHOUT BOND BREAKERS

TABLE 5 - COST ESTIMATE FOR AC PAVING  
WITH FABRICS AND BOND BREAKERS

Fabrics & Bond Breakers	Small Quantity	Large Quantity
Bond Breakers (1 mile, 87 joints @ 61.5'):		
Materials (Kraft paper, adhesive, aggregate)	\$300.00	\$300.00
Labor	\$600.00	\$450.00
Subtotal	\$900.00	\$750.00
Fabric:		
Materials & Labor	\$8,800.00 (\$1.20/sq yd)	\$5,500.00 (\$0.75/sq yd)
Total	\$9,700.00 per mile	\$6,250.00 per mile

Asphalt Paving	4" overlay	6" overlay
(assuming 1 mile, 12' wide, \$28/ton laid)		
Paving (no fabric) per mile	\$45,600.00	\$68,400.00
Paving (fabric only) per mile	\$51,100 to 54,400 (12 to 19% increase)	\$73,900 to 77,200 (8 to 13% increase)
Paving (fabric and bond breakers) per mile	\$51,850 to 55,300 (14 to 21% increase)	\$74,650 to 78,100 (9 to 14% increase)

\* All figures based on 1988 prices

## APPENDIX A

October 21, 1974

Linn County Line-McKenzie River Section

Oregon Project I-5-4(-)198

Experimental Use of Fabric Reinforcement in Flexible Pavement

Overlay of Deteriorated Rigid Pavement

### WORK PLAN

PROJECT DESCRIPTION - The project is a section of four lane interstate freeway (I-5) between the Linn County line and the McKenzie River in Lane County. The existing facility is composed of four 12-foot Portland cement concrete traffic lanes with asphaltic cement concrete paved median and outer shoulders and a 76-foot open median separation of the roadways. The deteriorated PCC traffic lanes are to receive a 5-inch asphaltic concrete overlay with a 1-inch open graded plant mix seal. The experimental features to be included in the normal overlay operation are eight 1,000' sections of the overlay in which fabric reinforcements will be placed under varying conditions and two 1,000' designated control sections for comparative monitoring purposes. Both experimental and control sections shall be located in the outside or truck lane.

OBJECTIVES - The purpose of the experiment is to definitively evaluate under regional field conditions the effectiveness of selected fabric reinforcements in retarding the reflective cracking of flexible pavement overlays of deteriorated rigid pavements. In addition, joint sealants, bonding and bond breakers and variations in the structural location of the reinforcement fabrics will be studied.

EXPERIMENTAL FEATURES - The fabrics proposed for use in the experiment are proprietary materials specifically developed for this purpose. They are:

1. Petromat, a nonwoven polypropylene fabric marketed by the Phillips Petroleum Company of Bartlesville, Oklahoma, and
2. Glass fabric, designation I-9180/52, a woven open mesh fabric marketed by Burlington Glass Fabrics Company of Greensboro, North Carolina.

It is planned that two 1,000' sections of each fabric, 4,000' in all, shall be placed immediately over the old pavement, i.e., under the full depth of the overlay. The other two 1,000' sections of each fabric, also 4,000', in all, shall be placed mid-depth in the overlay, between the top and base courses (see attached Sketch "A"). Of the eight 1,000' sections of differing materials and placements, one half each shall be provided bond breakers (see

attached Sketch "B") at all contraction joints and full lane width transverse random cracks. The other four 1,000' sections shall be fully bonded to the underlying old pavement.

#### INSPECTION AND REPORTING -

PRECONSTRUCTION - Preparatory work to be performed prior to construction shall include selection of the various sections for experimental future identification, fully photographed and graphically described through field measurements. Deflection tests and drill cores will be taken where merited. Detailed sketches accurately showing the location and nature of the failures and evidenced distress of each of the eight 1,000' experimental and two control sections will be prepared (see attached sample, Sketch C).

CONSTRUCTION - Excepting variations in placement and bonding as previously outlined, the manufacturer's recommendations on materials and application procedures for their respective products will be followed wherever practical (see attachment D).

POST-CONSTRUCTION - Field inspections of the experimental and control sections shall be made annually each spring for the first four years and biennially for the next six years as a minimum. Inspection shall primarily be visual with deflection measurements and drill cores being taken if warranted. It is anticipated that some coring will be necessary for the final report to evaluate bonding, bond breakers, joint sealants, fabrics, et cetera.

Fixing a specific time period for finalizing the study appears inappropriate inasmuch as substantive evidence of the reinforcement's effectiveness may not develop in less than ten or more years. Therefore, it may be found that a later supplemental review and report is warranted after the scheduled ten year time frame.

Inspection and reporting of all phases of the experimental work shall be done by or under the supervision of the Research Section of the Division Planning Branch, Gordon Beecroft, Research Engineer.

## APPENDIX B

### MATERIALS

FABRICS - Three types of fabric reinforcements were evaluated on this project: Petromat by Phillips Petroleum Company; Fabric I-1980 by Burlington Glass Fabrics Company; and Typar Style 3401 by DuPont Company.

Petromat by Phillips Petroleum is a non-woven polypropylene material. When installed it had the following properties:

Tensile Strength, minimum per inch width (either direction)	50 lbs
Elongation, warp direction, 20 lbs	0.5 in
Elongation, fill direction, 50 lbs	1.1 in
Weight, per sq yd	3.8 to 4.5 oz
Width	150 in

Fabric I-1980 by Burlington Glass Fabrics is a fiberglass reinforced fabric. When installed it had the following properties:

Weight, per sq yd	5.51 oz
Minimum Tensile Strength, inch width	260 X 190 lbs
Width	52 in
Roll Length	250 ft

(Fabric I-1980 has since been discontinued)

Typar Style 3401 by DuPont is a spunbonded polypropylene material. When installed it had the following properties:

Weight, per sq yd	4.0 oz
Thickness	15 mils
Grab Tensile	120 lbs
Elongation at break	60%
Trapezoidal Tear	57 lbs
Mullen Burst	190 psi
Coefficient of H <sub>2</sub> O Permeability, cm/sec	3 X 10 <sup>4</sup>
Melting Point	340°F

(Available through Reemay, Inc., product name T-3401)

Petromat and Fabric I-1980 were supplied to the contractor at a cost of 50 cents a square yard. The Typar fabric was supplied at no cost after the contract was let. All three fabrics were assumed to be competitively priced. The State of California informed us that 50 cents per square yard was an average price for these fabrics.

#### BOND BREAKERS -

Aggregates used in constructing the bond breaker were nonplastic, nonangular material, all of which pass a 10 mesh screen and were retained on a 200 mesh screen. Cover paper used to cover the aggregates was Kraft paper reinforced with glass fibers, with black polyethylene extruded to both sides.

Aggregates were carefully spread to widths and depths as shown in figure 2, and then covered with Kraft paper. Edges were bonded to the existing pavement with an adhesive recommended by the paper supplier.

#### ASPHALT MIX DESIGN -

The wearing course was a 1" open graded mix using Douglas AR8000 at 7.1% asphalt. The base course was 2 lifts, 3" and 2", a dense graded mix using Douglas AR4000 at 6.1% asphalt. See the following pages for the original laboratory mix designs.



OREGON STATE HIGHWAY DIVISION  
Materials Section

PRELIMINARY BITUMINOUS MIXTURE DESIGN

Laboratory No. 17675  
Data Sheet No. AB-1226-7  
Prefix 620-1963  
Amount Charge 160.00  
Date Received 8/5/75  
Date Reported 8/29/75  
Mix Type-Class "E" / c

Project Lionel King - McKenzie River  
Contractor: Prime Morse Bros. Inc. Contract No. 8116 Fed. Aid No. I-RF-5-4(80) 198  
Paving " " "  
Engineer: Region A Shirley Resident D. Greene  
Aggregate: Source Cuitanovich Pit - Coburg #20-199-3 Type Gravel  
Asphalt: Brand Douglas Grade ARB000

MIX DESIGN PROPORTIONS:

Agg. Size	Grading Design	3/8-10	10-0	Comb. Agg.		RECOMMENDED MIX PROPORTIONS			
				Dry Sieve <sup>1</sup>	Washed by Vacuum	Wearing Surface <sup>2</sup>	Base Course <sup>2</sup>	Shoulder Course <sup>2</sup>	P.M.B.B. Course
1	7/29/75								
3/4									
1/2	100	100		100	100	100			
3/8	91.6	90		91.6	91.6	91.6			
1/4	59.7	52	100	59.7	59.7	59.7			
4				37.0	37.0	37.0			
10	15.2	5	68.6	15.2	15.2	15.2			
40				7.5	8.4	7.5			
200	* 4.0		11.5	* 4.0	* 4.3	* 4.0			
P200			T-30 (P200)	5.0					
No. Ave.									
Asphalt Content Including				0.0	% Retention	7.4			

COMPACTION CONTROL AND VOID CONTENT DATA:

Mix Type - Course	Wearing	Base	Shoulder	P.M.B.B.
Bulk Sp. Gravity @ 100% Compaction	2.32			
Mix Design % Voids @ 100% Compaction	4.8			

MIX DESIGN TEST DATA: Temperature of Mixture ~~modified~~ @ compaction 261°F.  
Resistance to Deformation and Cohesion: (ASTM-D1560 and 1561) Recommend 230°F.

Asphalt Content (%)	Douglas 8000	6.5	7.0	7.5	8.0	8.5
Asphalt Film Thickness		Suff-thick	thick	thick	thick	very thick
Stability Value @ 1st Compaction		27	27	26	32	27
Cohesion Value @ 1st Compaction		152	169	203	210	213
Bulk Sp. Gravity @ 1st Compaction		2.21	2.23	2.25	2.27	2.29
Percent Voids @ 1st Compaction		10.5	9.0	7.4	5.8	4.2
Stability Value @ 2nd Compaction		41	40	40	40	36
Bulk Sp. Gravity @ 2nd Compaction		2.28	2.30	2.32	2.34	2.36
Percent Voids @ 2nd Compaction		7.7	6.1	4.5	2.9	1.3
Real Gravity @ 0% Voids	Rice Method	2.47	2.45	2.43	2.41	2.39

Effect of Water on Cohesion: (AASHTO-T-165)

Asphalt Content (%)	Douglas ARB000	6.5	7.5	8.5
Index of Ret. Str. (%)		61	72	82

<sup>1</sup> Test Gradation calculated from aggregate production averages.  
<sup>2</sup> Design Gradation provides full job mix tolerance within broad band grading limits (section 403.11).

- X FWHA
- X Construction: Maintenance
- Regional Engineer
- Regional Maint. Eng.
- Resident Engineer Greene
- Soils & Geology
- Regional Geologist Parker
- Files
- X Morse Bros.

\* includes 1% Portland Cement.

*John C. Jenkins*  
Engineer of Materials and Research

BITUMINOUS MIX DATA

Prefix 620-1063  
 Traffic Co. \_\_\_\_\_

Project Linn Co. Line - McKenzie River Mix Type-Class "E.a/c"  
 Contractor: Prime Morse Bros Inc. Contract No. 8116 Fed. Aid No. I-RF-5-4(80)198  
 Paving \_\_\_\_\_  
 Engineer: Region A Shirley Resident D Greene Inspector \_\_\_\_\_  
 Date: Specs 2-20-75 Started 2-26-75 Tons Contracted 15,650  
 Completed 11-10-76 Tons Laid 14,301.13  
 Width: Travel Lanes 12<sup>(4)</sup> Out. Sh. 10<sup>(2)</sup> Inside Sh. 4<sup>(2)</sup> Median \_\_\_\_\_  
 Thickness: Travel Lanes T- 1" Out. Sh. 1" Inside Sh. 1" Median \_\_\_\_\_  
 Borca/c Travel Lanes B- \_\_\_\_\_ Out. Sh. \_\_\_\_\_ Inside Sh. \_\_\_\_\_ Median \_\_\_\_\_  
 Asphalt: Brand Douglas Grade AR 8000 Quantity Supplied 1010.68 % of Mix 7.1

AGGREGATE DATA:  
 Source #20-199-3 Type Gravel  
 Deg. p20 21.6/9.4 %, Ht. 1.0/1.2 Lab. No. \_\_\_\_\_ L.A.R. 19.30  
 Lab. No. 75-4962-65

AVERAGE AGGREGATE GRADATION:

Agg. Size							
1 1/2							
1							
3/4							
1/2							
3/8							
1/4							
4							
10							
40							
200							
P200							
Wet							
No. Ave.							
Sp. Gr.							
Lbs/c.f.							

Asphalt  
 Paving completed  
 10-12-76  
 Remarks

Rotarex Ext. Ave.	Lab. Top	Lab. 8-Sh.	Lab. PMBB	Field Top	Field 8-sh.	Field PMBB
No. Ave.						
1"						
3/4						
1/2						
3/8						
1/4						
4						
10						
40						
200						
P200						
A.C.						

T-165	Douglas	AR	8000
A/C	65	75	85
Dry	210	204	202
Wet	129	146	165
Index	61	72	82
BSG	2.22	2.24	2.27

Fd. Cores				
Gr. in Pl.				
Gr. Recomp.				
% Rel. Comp.				
Real Gr.				
% Voids				
No. Cores				

OREGON STATE HIGHWAY DIVISION  
Materials Section

PRELIMINARY BITUMINOUS MIXTURE DESIGN

Laboratory No. 1517494  
Data Sheet No. AB-122889  
Prefix 620-1063  
Amount Charge \$1 160-  
Date Received 8/5/75  
Date Reported 8/27/75  
Mix Type-Class "Cajc  
Fed. Aid No. FF-5-4(20)198

Project Linn Co Line - McKenzie River  
Contractor: Prime Morse Bros Inc. Contract No. 8116  
Paving " " "  
Engineer: Region A Shirley Resident D. Greene  
Aggregate: Source Cuitanovich Pitt-Coburn #20-199-3 Type Gravel  
Asphalt: Brand Douglas Grade AR4000

MIX DESIGN PROPORTIONS:

Agg. Size	Grading Designation	Field 1/2-1/4	Field 1/4-0	Comb. Agg.		RECOMMENDED MIX PROPORTIONS			
				Dry Sieve <sup>1</sup>	Washed by Vacuum <sup>2</sup>	Wearing Surface <sup>2</sup>	Base Course <sup>2</sup>	Shoulder Course <sup>2</sup>	P.M.B.B. Course
1	7/29/75	18	82						
3/4	100			100	100	Class	100	100	
1/2	96.9			96.9	96.9	"F" Mix	96.9	96.9	
3/8				85.6	85.6	specified	85.6	85.6	
1/4	70.0			70.0	70.0		70.0	70.0	
4				58.1	58.1		58.1	58.1	
10	34.0			34.0	34.0		34.0	34.0	
40	14.8			14.8	15.5		14.8	14.8	
200	5.0			5.0	5.6		5.0	5.0	
P200			T-30	(P200)	7.1				
No. Ave.									
Asphalt Content Including				0.2	% Retention		6.3	6.3	

COMPACTION CONTROL AND VOID CONTENT DATA:

Mix Type - Course	Wearing	Base	Shoulder	P.M.B.B.
Bulk Sp. Gravity @ 100% Compaction		2.42	2.42	
Mix Design % Voids @ 100% Compaction		1.2	1.2	

MIX DESIGN TEST DATA: Temperature of Mixture ~~XXXXXX~~ @ Compaction

Resistance to Deformation and Cohesion: (ASTM-D1560 and 1561)

Asphalt Content (%)	5.0	5.5	6.0	6.5	7.0
Asphalt Film Thickness	Dry	Dry-Suff	Suff.	Suff	Suff-74
Stability Value @ 1st Compaction	36	38	36	33	28
Cohesion Value @ 1st Compaction	217	295	450	461	425
Bulk Sp. Gravity @ 1st Compaction	2.30	2.32	2.34	2.36	2.38
Percent Voids @ 1st Compaction	8.0	6.5	4.9	3.3	1.7
Stability Value @ 2nd Compaction	59	53	47	36	18
Bulk Sp. Gravity @ 2nd Compaction	2.38	2.40	2.42	2.43	2.42
Percent Voids @ 2nd Compaction	4.8	3.2	1.6	0.4	0.0
Real Gravity @ 0% Voids	2.50	2.48	2.46	2.44	2.42

Effect of Water on Cohesion: (AASHTO-T-165)

Asphalt Content (%)	5.0	6.0	7.0
Index of Ret. Str. (%)	56	79	92

<sup>1</sup> Test Gradation calculated from aggregate production averages.

<sup>2</sup> Design Gradation provides full job mix tolerance within broad bond grading limits (section 403.11).

- X FWHA
- X Construction Maintenance
- X Regional Engineer
- X Regional Maint. Eng.
- X Resident Engineer Greene
- X Soils & Geology
- X Regional Geologist Parker
- X Files
- X Morse Bros., Inc.

*John C. Jenkins*  
Engineer of Materials and Research

BITUMINOUS MIX DATA

Prefix 620 - 1063  
 Traffic Co. \_\_\_\_\_

Project Linn Co. Line - McKenzie River Mix Type-Class Cajc  
 Contractor: Prime Morse Bros Inc Contract No. 8116 Fed. Aid No. I-RF-5-4(80)198  
 Paving \_\_\_\_\_  
 Engineer: Region A Shirley Resident D. Greene Inspector \_\_\_\_\_  
 Date: Specs 2-20-75 Started 2-26-75 Tons Contracted 81,000  
 Completed 11-10-76 Tons Laid 77,184.77  
 Width: Travel Lanes 12' (4) Out. Sh. 10' (3) Inside Sh. 4' (2) Median \_\_\_\_\_  
 Thickness: Travel Lanes T- \_\_\_\_\_ Out. Sh. \_\_\_\_\_ Inside Sh. \_\_\_\_\_ Median \_\_\_\_\_  
 Travel Lanes B- 2" + 3" Out. Sh. 2" + 3" Inside Sh. 2" + 3" Median \_\_\_\_\_  
 Asphalt: Brand Douglas Grade AR4000 Quantity Supplied 4709.85 % of Mix 6.1

AGGREGATE DATA: # 20 - 199 - 3 Type Gravel  
 Source \_\_\_\_\_ Type \_\_\_\_\_  
 Deg. p20 21.6/94 % Ht. 1.0/1.2 Lab. No. \_\_\_\_\_ L.A.R. 19.30  
 Lab. No. 75 4962 - 65

AVERAGE AGGREGATE GRADATION:

Agg. Size							
1 1/2							
1							
3/4							
1/2							
3/8							
1/4							
4							
10							
40							
200							
P200							
Wet							
No. Ave.							
Sp. Gr.							
Lbs/c.f.							

Asphalt  
 Paving completed  
10-12-76  
 Remarks

Rotarex Ext. Ave.	Lab. Top	Lab. 8-Sh.	Lab. PMBB	Field Top	Field 8-sh.	Field PMBB
No. Ave.						
1"						
3/4						
1/2						
3/8						
1/4						
4						
10						
40						
200						
P200						
A.C.						

T-165				
A/C				
Dry				
Wet				
Index				
BS6				

Fd. Cores	<u>Base</u>			
Gr. in Pl.	<u>2.22</u>			
Gr. Recomp.	<u>2.40</u>			
% Rel. Comp.	<u>92.4</u>			
Real Gr.	<u>2.46</u>			
% Voids	<u>2.5</u>			
No. Cores	<u>21</u>			