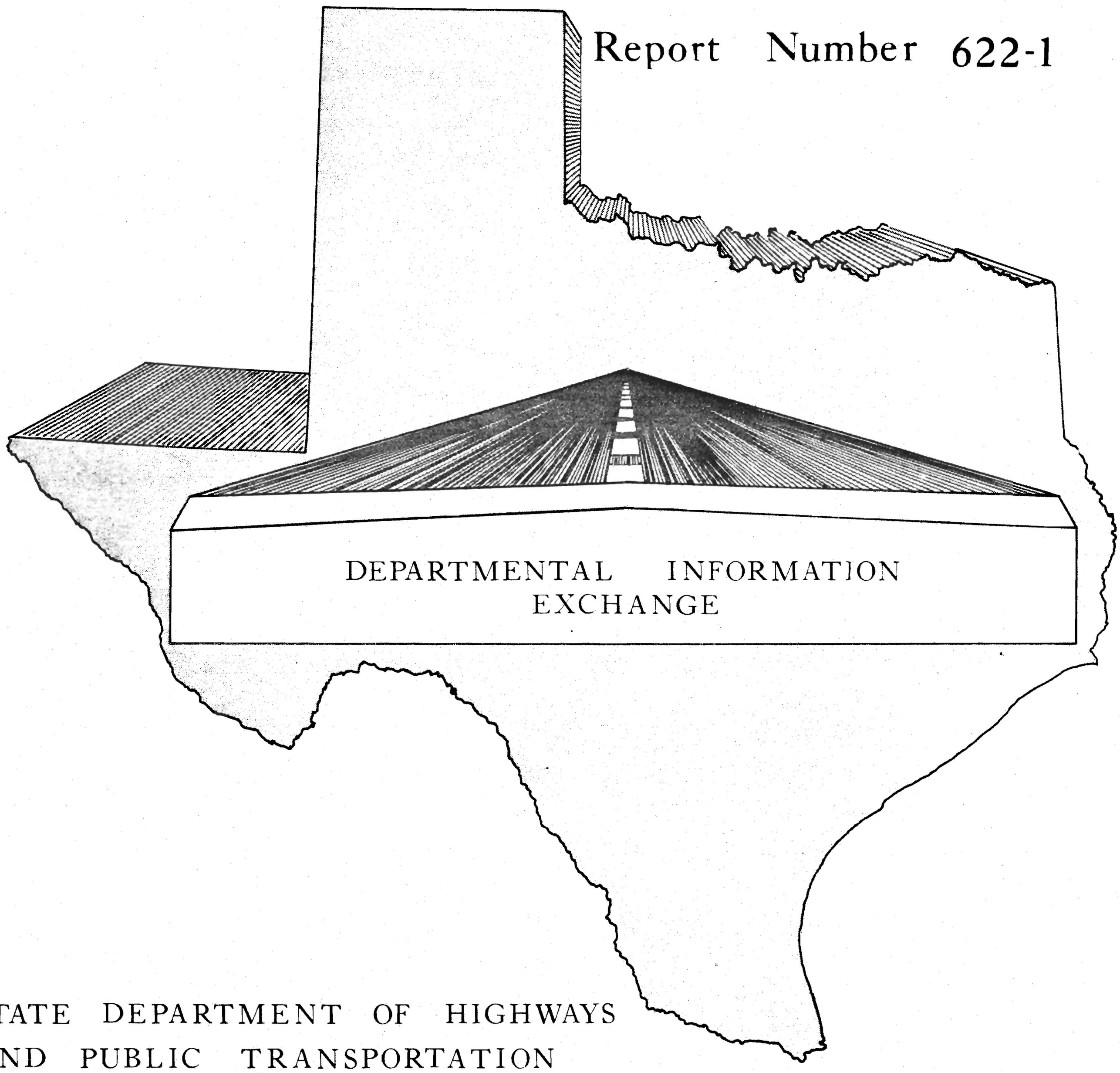
EXPERIMENTAL PROJECTS

AMORPHOUS POLYPROPYLENE AS AN ASPHALT ADDITIVE

Report Number 622-1



STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

STATE DEPARTMENT OF HIGHWAYS

AND

PUBLIC TRANSPORTATION

A NARRATIVE REPORT

REPORT NO. 622-1

AMORPHOUS POLYPROPYLENE AS AN ASPHALT ADDITIVE

by

B. R. Lindley
Assistant District Engineer
District 8

DISCLAIMER STATEMENT

AMORPHOUS POLYPROPYLENE

AS AN ASPHALT ADDITIVE

TABLE OF CONTENTS

BACKGROUND

Back in the late fifties and early sixties one of the greatest problems in placing asphalt was the prevention of asphalt strings getting on surrounding private property. These long strings of fine asphalt would float through the air and stick to the first thing they touched.

Asphalt has been reported on houses one-forth mile from the highway, white clothes hanging on the line to dry, all vehicles that passed by, and numerous other similar complaints. This was the negative side of what we now realize was extremely good asphalt. The positive side was a penetration seal that would remain flexible in extreme temperatures and would stay in place after application. A certain amount of elasticity keeping the aggregate bonded to the surface existed in cold weather. A reasonable amount of bleeding insuring that the aggregate was well seated was expected and considered worthwhile.

For the past several years the above mentioned qualities of asphalt have not been evident. The asphalt no longer strings out in hot weather and is certainly easier to place because adjoining traffic is not impaired at all. The engineer only needs to keep traffic away far enough to prevent splattering of asphalt. There are, however, very definite negative points to this type asphalt. Extreme temperatures have a definite affect on the present asphalt cements. In cold weather we are witnessing a very brittle seal coat that will shatter like glass if you use a harder asphalt such as AC-10. This grade of asphalt has been banned from use in this district. AC-5 will not be as brittle and will not shatter as bad, but in very hot weather there is a constant fight with bleeding if you place enough asphalt to hold the aggregate. Maintenance expense for correcting bleeding asphalt has become a tremendous economic problem. All types and grades of asphalts and emulsions have been used with very little change in the results.

Early this fall the Materials and Tests Division informed this office that Eastman Chemical Products, Inc. produces Eastobond Amorphous Polypropylene in their plant in Longview, Texas and it has proven, by laboratory test, to greatly improve the properties of asphalt for penetration work and hot-mix[1]. The results of laboratory studies are included in this report for further study.

1. See Appendix 1

DEVELOPMENT

After studying this report we decided to purchase a small quantity of the polypropylene to be used in sealing a portion of U. S. 84 north of Roscoe, Texas.[2] The polypropylene was purchased in a solid state in blocks of approximately fifty pounds and had to be melted before a 10% solution could be added to regular asphalt. The melting operation was found to be the most difficult part of the experiment, however, it may be purchased in the liquid state if arrangements are made for storage.

U. S. 84 was selected as a logical trial location for this additive because it was badly map cracked and has foiled every attempt that has been made for successful correction. We have also placed three short test sections of "Petromat" manufactured and sold by Phillips Petroleum Company because we believe this is a good location to compare the two products under the same traffic conditions.

The following asphalts and mixtures were used in this test section[3] so that a good analysis can be made in the next few years to determine the best product available for a successful sealing operation.

a) Petromat sections remained unsealed
b) AC-3 with 10% polypropylene
c) AC-5 with 10% polypropylene
d) AC-3 standard grade
e) AC-5 standard grade
f) AC-10 standard grade

A sample of the AC-3 with 10% polypropylene was sent to D-9 for testing and a copy of the results are enclosed for comparison with regular AC-5 asphalt.[4] The results as shown by this test report are very close to those performed by D-9 in the laboratory.

2. See Appendix 2
3. See Appendix 3
4. See Appendix 4

PROCEDURE

On July 28, 1976 two small melting kettle heating pots, by Chausse Manufacturing Company, were used to melt the polypropylene blocks to be used the following day. Each pot would completely melt approximately 150 gallons in four to five hours. The melted polypropylene was immediately transferred to an asphalt distributor where the temperature was maintained until there was ample supply to mix with the asphalt needed for the project. It should be noted here that metal transfer lines should be used in order that they may be heated if the polypropylene cools in the line and stops pumping operations.

From this stage it was a simple matter to pump the required amount from the storage distributor to the shooting distributor and proceed with the regular sealing operations. There was no change in the rate of application because of the additive. Grade 3 precoat rock was used as a coverstone at a rate of 1 CY per 85 SY. The following is the shot record during the three days for this experiment.

Report No. 1
Date 7-29-76

Shot No.	Gal. Polymer	Gal. AC-3	Gal. Total Mix	Temp. Polymer	Temp Mix	Gal. SY	Sta. - Sta. SBL (lt Side)	End Gal.
1	180	1300	1480	350°	330°	.362	105-130	250
2	200	1455	1655	350°	330°	.359	130-155	430
3	200	1455	1655	400°	330°	.367	155-185	160
4	200	1455	1655	380°	330°	.357	185-215	200
5	200	1455	1655	360°	330°	.364	215-245	170
6	200	1455	1655	360°	330°	.370	245-275	110

Note: The air temp. was 92°

Time of application from 2:00 P.M. to 5:00 P.M.

Width 12.25'

Report No. 2
Date 7-30-76

Shot No.	Gal. Polymer	Gal. AC-3	Gal. Total Mix	Temp. Polymer	Temp Mix	Gal. SY	Sta. - Sta. SBL (Rt Side)	End Gal.
1	190	1500	1690	365°	330°	.418	196-225	40
2	200	1600	1840	365°	330°	.389	165-196	200
3	175	1400	1780	360°	330°	.383	135-165	220
4	175	1400	1780	360°	330°	.369	135-110+30	540

Note: The air temp. was 90°

Time of application from 10:30 A.M. to 12:00 Noon

Width 12.25'

Report No. 3
Date 8-10-76

Shot No.	Gal. Polymer	Gal. AC-5	Gal. Total Mix	Temp Polymer	Temp Mix	Gal. SY	Sta. - Sta. SBL (Rt Side)	End Gal.
1	165	1200	1365	390°	320°	.384	285-260	
2	165	1200	1435	390°	320°	.359	260-235	70
3	205	1500	1925	390°	320°	.362	235-200	220
4	205	1500	1915	360°	320°	.355	200-165	210
5	205	1500	1935	380°	320°	.363	165-130	230
6	205	1500	1915	380°	320°	.347	130- 95	210

Note: The air temp. was 90°

Time of application from 10:45 A.M. to 2:25 P.M.

Width 12.25'

PROBLEMS

The heating of the solid polypropylene proved to be the most serious problem because of the time involved and the transferring of the melted material from one container to another. It absolutely will not pump unless the temperature is 300° F or above. If, however, the results of its use are as anticipated the time element will be well worthwhile. After polypropylene is mixed with regular asphalt the asphalt mixture becomes very sticky and has the general appearance of asphalt we used to purchase as described earlier. Otherwise no difference can be noted.

CONCLUSION

The cost of this additive is approximately sixty dollars a ton. We believe this may be a very economical additive for future asphalt applications.[5] The true test will be made as we observe the different materials through the winter months. This highway carries approximately 3700 VPD and traffic is increasing steadily.

The sections with regular applications of AC-3 and AC-5 are bleeding on hot days, as anticipated, and the maintenance department has been busy treating these sections. The section with a regular AC-10 application has not bled and has the appearance of the best seal coat but under close examination on a cool, damp morning it was found that the asphalt was brittle and the aggregate would turn loose with very little effort. We expect shelling of this aggregate during the first cold weather.

The AC-3 and AC-5 with 10% polypropylene is well embedded with aggregate and it is very difficult to pry loose. When the aggregate is removed it does come out of the asphalt very sticky and each aggregate has five or six strings of asphalt that will stretch for two or three inches. It is obvious that temperature differential has little effect on the asphalt, and it is not bleeding.

We suggest that the amorphous polypropylene be purchased hot in transport loads on large seal type projects. The contractor should make arrangments to store it hot or keep the temperature above 300° F until it is used.

We anticipate this product to be very beneficial for the contractor and for the Department of Highways and Public Transportation.

5. See Appendix 5

APPENDIX 1

Evaluation of Eastobond Amorphous Polymer as an Additive for Asphalt 5-30-75-024

Eastman Chemical Products, Inc. produces polypropylene in their plant located at Longview. A by-product of the polypropylene production is amorphous polypropylene which has been marketed primarily for use as a hotmelt adhesive. Eastman has built up a fairly large surplus of the material and has experimented with it as an additive for asphalt. They state the properties of asphalt can be improved by addition of approximately 10% by weight of amorphous polymer. Typical properties of the amorphous polymer are as follows:

Softening Point, R. & B., F	223
Penetration, 100 g, 5 sec.	20
Viscosity at 300 F, cps	8500
Density, 23 C, g/cm^3	0.86
Flash Point, C.O.C., F	525

Addition of the polymer to asphalt increases its viscosity at 140 F and higher temperatures. For this reason, the base asphalts selected for modification with the polymer were low viscosity materials.

Ten percent by weight of the polymer was added to an AC-3 and an AC-5 from both Cosden, Big Spring, and American Petrofina, Mt. Pleasant.

The procedure used to blend the asphalt and polymer was as follows:

Nine hundred grams of asphalt in a friction top can was heated to 275 F. The polymer was also heated in a can to 275 F and 100 grams added to the hot asphalt. The mixture was then placed on a hot plate set to maintain the temperature at 275 to 300 F. The mixture was then blended for 20 minutes with an electric stirrer operating at approximately 250 rpm. No problem was encountered in making the blends. The asphalt and polymer seem to mix quite readily.

The resulting asphalt-polymer blends were subjected to the tests normally performed on an asphalt cement submitted for compliance with Item 300. In addition, the ductility at 39.2 F and the low temperature brittleness were determined. The low temperature brittleness test consists of dropping a 1-1/4 inch diameter steel ball (130.5 grams) onto the center of an asphalt disk 3/8 inch in thickness and 3 inches in diameter to determine the height at which a single drop will cause the disk to crack. The test is normally performed with the disk chilled to 50 F. However, for those asphalts which have good low temperature properties, the test may be performed at 40 F or even 30 F.

The properties of the asphalts before and after addition of the polymer are presented in Tables 1 through 3. Three separate blends of Cosden AC-3 and 10 percent polymer were prepared. One of these blends was maintained in a covered quart can at 325±5 F for 72 hours to simulate holding in storage, after which the tests shown were performed. The other two blends were tested following preparation. Addition of 10 percent by weight polymer to the Cosden AC-3 resulted in a material that would comply with the requirements for an AC-10. Properties of a typical Cosden AC-10 are included in Table 1 for comparison purposes. The polymer results in a less temperature susceptable material. The penetration at 77 F is considerably softer than a typical Cosden AC-10. The most significant improvement is in the low temperature brittleness of the asphalt. The AC-3+ polymer required a drop of 53 to 54 inches at 50 F to cause failure compared with only 16 inches for the AC-10. The low temperature brittleness is of particular interest if the material is to be used for sealcoat work. A less brittle material would have more resistance to "shelling out" or losing aggregate at low temperatures. The ductility of the asphalt polymer blends was less than that of the base asphalt. Since the polymer is a considerably different material than asphalt, this may not be significant.

There was a fairly large difference in properties between Blends 1 and 2 although they were prepared in exactly the same way. This inconsistency in performance of the asphalt-polymer blend is undesirable, but additional experience with the material would be necessary to determine if this will be a problem. The hot storage test showed some degredation in properties, primarily the low temperature brittleness. This indicates it would be best to use the material soon after blending rather than hold it in storage.

Cosden AC-5+ 10% polymer results in a material complying with all the requirements for AC-20. The main advantage obtained was a less temperature susceptable material - a softer penetration material meeting the AC-20 viscosity requirement. The low temperature brittleness was exactly the same as the AC-5, which is slightly better than is obtained with an AC-20.

In the case of the American Petrofina asphalts, addition of 10% polymer to the AC-3 resulted in a material with a 140 F viscosity slightly above the AC-10 range. The AC-5 + polymer fell in the AC-20 range with regard to viscosity at 140 F. As in the case of the Cosden material, the AC-3 showed marked improvement in low temperature brittleness, whereas the AC-5 blend had essentially the same low temperature properties as the AC-5. This is, however, considerably better than a conventional American Petrofina AC-20. The temperature susceptability of both grades was improved.

In order to determine if the polymer would improve the resistance of asphalt to stripping, Test Method Tex-218-F was used to compare American Petrofina AC-20 (75-3364-C) and American Petrofina AC-5 (73-3046-C) + 10 percent polymer. The aggregate used for the test was a grade 3 rhyolite-type coverstone from Gifford-Hill's Allamore Pit in District 24. The aggregate was coated with two percent by weight of asphalt and then subjected to the stripping test. The test was performed twice, using the aggregate coated with AC-20 in one bottle and the aggregate coated with AC-5 + 10% polymer in the other bottle. On the initial run, the AC-20 began to strip sooner than the AC-5 + 10% polymer. Upon completion of the test, both samples evidenced stripping, but the AC-5 + 10% polymer did not evidence quite as much stripping as the AC-20. In the second determination both asphalts began to strip at essentially the same time and there was no noticeable difference in the total amount of stripping upon completion of the test. Based on the tests performed, it appears that addition of polymer to American Petrofina asphalt will not result in any significant change in its resistance to stripping.

We believe addition of the polymer to asphalt shows enough improvement in properties to warrant use of it in the field on a trial basis, particularly since Texas Eastman has indicated that they are willing to furnish it at a price competitive with asphalt. For sealcoat or surface treatment work, we recommend addition of 10 percent by weight to an AC-3. It would probably be best if the AC-3 had a viscosity at 140 F of 300 stokes or less.

It appears that an AC-5 with 10 percent by weight polymer added would be a good blend to experiment with in hot mix. The asphalt and polymer can be blended in a transport or distributor, but it should be agitated sufficiently to insure complete mixing.

Table 1

PROPOERTIES OF COSDEN AC-3
ASPHALT MODIFIED WITH 10% AMORPHOUS POLYPROPYLENE

Property	AC-3 (73-3415-C)	AC-3 (73-3415-C + Polymer Blend #1	AC-3 (73-3415-C) + Polymer Blend #2	AC-3 (73-3415-C) + Polymer After Hot Storage	AC-10 (76370053)
Vis. @ 140, Stks.	254	1090	956	981	995
Vis. @ 275, Stks.	1.39	3.31	2.49	-	2.45
Pen. @ 77 F	211	122	142	142	86
Flash Point, C.O.C., F	505	520	515	565	595
Duct. @ 77 F	141+	65	123	76	141+
Duct. @ 39.2 F	116	141+	140	53	
T.F. Vis. @ 140 F	639	2160	2372	2103	1914
T.F. Pen. @ 77 F	106	74	70	80	53
T.F. Duct. @ 77 F	141+	96	93	115	141+
T.F. Duct. @ 39.2 F	31	7	4	6	-
Brittleness @ 50 F, inches to failure (130.5 gm ball)	39	53	54	35	16
T.F. Brittleness @ 50 F, inches to failure (130.5 gm ball)	21	29	35	34	12

Table 2

PROPERTIES OF COSDEN AC-5
ASPHALT MODIFIED WITH 10% AMORPHOUS POLYPROPYLENE

Property	AC-5 (73-3157-C)	AC-5 (73-3157-C) + Polymer	AC-20 (75-3506-C)
Vis. @ 140, Stks.	460	2162	1677
Vis. @ 275, Stks.	1.75	3.39	3.05
Pen. @ 77 F	139	73	57
Flash Point, C.O.C., F	535	515	600
Duct. @ 77 F	-	118	141+
Duct. @ 39.2 F	9	7	-
T.F. Vis. @ 140 F	1096	3668	4013
T.F. Pen. @ 77 F	75	67	36
T.F. Duct. @ 77 F	141+	141+	141+
T.F. Duct. @ 39.2 F	-	1.5	-
Brittleness @ 50 F, inches to failure (130.5 gm ball)	20	20	14
T.F. Brittleness at 50 F, inches to failure, (130.5 gm ball)	20	20	-

Table 3

PROPERTIES OF AM. PET.
ASPHALTS MODIFIED WITH 10% AMORPHOUS POLYPROPYLENE

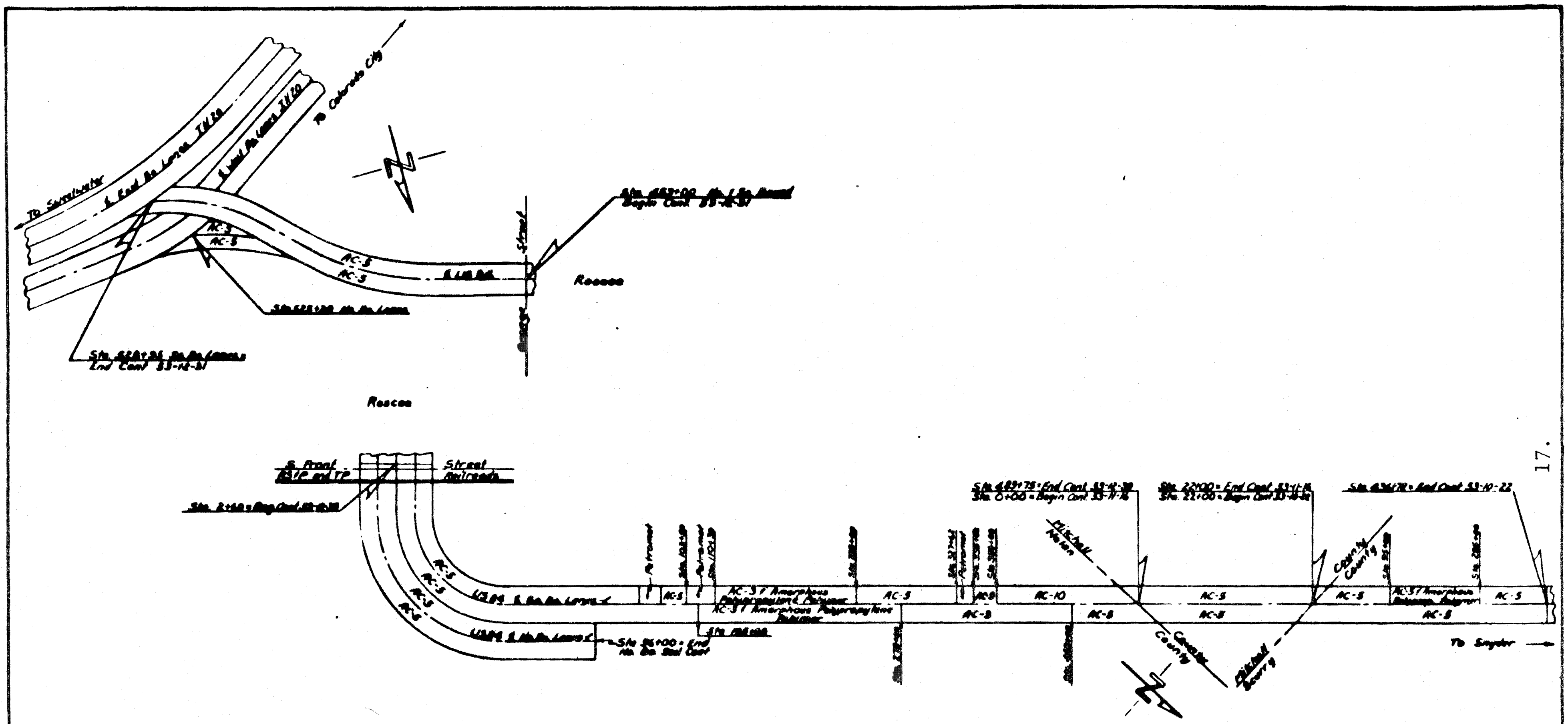
Property	AC-3 (74-240-C)	AC-3 + Polymer	AC-10 (75-3144-C)	AC-5 (73-3046-C)	AC-5 + Polymer	AC-20 (75-3533-C)
Vis. @ 140, Stks.	330	1386	1000	457	1753	1676
Vis. @ 275, Stks.	2.33	4.26	3.46	2.53	5.17	3.90
Pen @ 77 F	259	164	114	208	139	73
Flash Point, C.O.C., F	600	590	580	580	575	600
Duct. @ 77 F	141+	111	141+	141+	46	141+
Duct. @ 39.2 F	57	129	-	104	18	0
T.F. Vis. @ 140 F	642	2912	2470	991	4861	3987
T.F. Pen. @ 77 F	147	78	71	124	61	46
T.F. Duct. @ 77 F	141+	117	141+	141+	85	141+
T.F. Duct. @ 39.2 F	22	26	-	-	5	-
Brittleness (130.5 gm ball)	44 inches at 40 F	68+ inches at 40 F, 31 inches at 30 F	33 inches at 50 F	38 inches at 40 F	39 inches at 40 F	17 inches at 50 F

Table 1

PROPOERTIES OF COSDEN AC-3
ASPHALT MODIFIED WITH 10% AMORPHOUS POLYPROPYLENE

Property	AC-3 (73-3415-C)	AC-3 (73-3415-C + Polymer Blend #1	AC-3 (73-3415-C) + Polymer Blend #2	AC-3 (73-3415-C) + Polymer After Hot Storage	AC-10 (76370053)
Vis. @ 140, Stks.	254	1090	956	981	995
Vis. @ 275, Stks.	1.39	3.31	2.49	-	2.45
Pen. @ 77 F	211	122	142	142	86
Flash Point, C.O.C., F	505	520	515	565	595
Duct. @ 77 F	141+	65	123	76	141+
Duct. @ 39.2 F	116	141+	140	53	
T.F. Vis. @ 140 F	639	2160	2372	2103	1914
T.F. Pen. @ 77 F	106	74	70	80	53
T.F. Duct. @ 77 F	141+	96	93	115	141+
T.F. Duct. @ 39.2 F	31	7	4	6	-
Brittleness @ 50 F, inches to failure (130.5 gm ball)	39	53	54	35	16
T.F. Brittleness @ 50 F, inches to failure (130.5 gm ball)	21	29	35	34	12

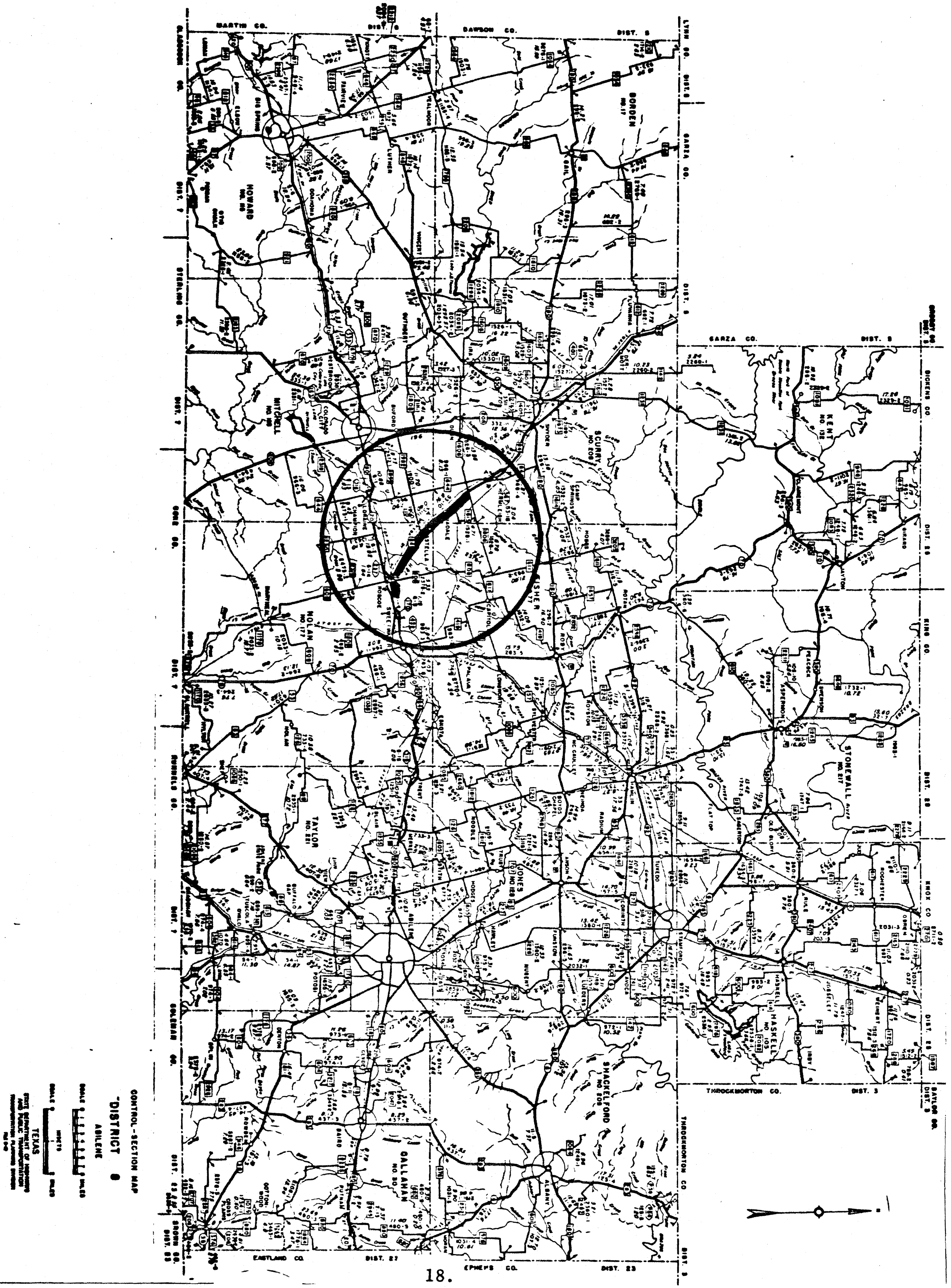
APPENDIX 2



LAYOUT SHOWING LOCATION AND TYPE ASPHALT USED ON SEAL COAT PROGRAM FOR US 84 IN NOLAN, MITCHELL & SCURRY COUNTIES

(No Scale)

APPENDIX 3


CONTROL-SECTION MAP
"DISTRICT 8
ABILENE
TEXAS
HOWARD
BORDEN
MITCHELL
SCURRY
KENT
NOLAN
FISHER
STONEWALL
TAYLOR
JONES
HASKELL
SHACKELFORD
CALLAHAN
MARTIN CO.
DAWSON CO.
GARZA CO.
THROCKMORTON CO.
EASTLAND CO.

APPENDIX 4

Texas Highway Department
Form No. 326-A

ASPHALT CEMENTS TEST REPORT

MATERIAL AC-3, 10% POLYMER

Laboratory No. C76371757
Date Received 8-9-76 Date Reported 8-19-76
Dist. or Res. Engr. B. E. Vernon
Address Snyder
Sampler Billy E. Vernon
Sampler's Title Res. Engr.
Contractor Pioneer Const.Co.
Sampled from Truck (pit, quarry, car or stockpile)
Producer American Petrofina-Eastman Chem.Co.
Quantity represented by sample
Has been used on
Proposed for use as Seal Coat

Control No. C-53-10-22, Sect. No. PD 0563, etc. Job No.
County Scurry,etc. Federal Project No. Hwy. No. US 84, etc.
District No. 8 Req. No. Date sampled 7-30-76
Identification marks J 760259 Q
Specification Item No. 300
Material from property of Scurry Co., South 8 miles of Snyder on US 84

Water, %	0
Viscosity at 275°F., Stokes	2.1
Viscosity at 140°F., Stokes	787
~~Solubility in CCl_4, %~~ Duct. of original @ 39.2°	141
Flash Point C.O.C., °F.	570
Ductility, 77°F., 5 cm/min., cm.	86
Relative Viscosity (after oxidation, 15 u films for 2 hours at 225°F., viscosities determined at 77°F.)	
Penetration at 77°F., 100 g., 5 Sec.	143
Specific Gravity at 77°F.	
Tests on Residues from Thin Film oven test:	
Viscosity @ 140°F stokes	1536
Ductility @ 77°F 5 cm. per min., cms.	126
Ductility @ 39.2 F 5 cm. per min., cms.	6
Brittleness @ 50 F	49" (12.2 inch pounds)

D-9 Remarks:

bj

Division of Materials and Tests
FOR INFORMATION ONLY

APPENDIX 5

Form 133 Rev. 1/76/3M

PURCHASE ORDER

SHIP F. O. B. TO:

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

Dist. Whse.
US 83 By-Pass
Abilene, TX

THESE NOS. MUST APPEAR ON ALL PACKAGES RELATING TO THIS ORDER

ORDER NO: 14235

REQ'N NO. HW: 08-6-47330-Y

DATE July 1, 1976

SHIPPER

Eastman Chemical Products, Inc.
P.O. Box 431
Kingsport, TENN 37662

MAIL INVOICE TO: State Dept. of Hwys. & Public Transportation, P.O. Box 150
Abilene, TX 79604

SHOW REQUISITION and ORDER NUMBER AND INVOICE in 5 COPIES, sending all copies to the indicated agency.

All terms and conditions set forth in our bid invitation become a part of this order.
Vendor GUARANTEES Merchandise Delivered On This Order Will MEET OR EXCEED Specifications In The Bid Invitation.

Budget ________ Prefix ________ Auth. ________

Item No.	(Description)	Quantity	Unit	Unit Price	Extension
1	Amorphous Polypropylene Polymer, to be delivered on pallets in 50 lb. multi-walled paper bags. Polymer shall be a slightly tacky solid material at ambient temperatures and become gradually softer at higher temperatures. Polymer shall liquify so that it can be readily pumped, transported and stored with equipment used for asphalt cements. Polymer shall meet the following specs.: Eastobond AP-Polymer	16,000 8	Pounds Tons	$.03/ pound	$ 480.00

Viscosity at 375°F, CPS	1500-5000
Specific Gravity at 77°F	0.84-0.88
King and Ball Softening Point, F	203° - 230°
Flash Point, C.O.C. F	400° minimum

F.O.B. LONGVIEW, TEXAS

CONSIGNEE: Mr. Merrill Benz, Admin. Tech. IV
Box 150
Abilene, Texas 79604

PLEASE PREPAY TRANSPORTATION CHARGES AND ADD TO INVOICE

L/mm

EXPERIMENTAL PROJECT ON U.S. 84

In accordance with your bid proposal, supplies MUST be placed in the department receiving room in 14 days from receipt of order.

F.O.B. DESTINATION Cash Discount ________ % Days

"**Cash discounts** will not be considered in determining the low bid. All cash discounts offered will be taken if earned."

STATE SALES TAX EXEMPTION CERTIFICATE — The undersigned claims an exemption from taxes under Chapter 20, Title 122A, Revised Civil Statutes of Texas, for purchase of tangible personal property described in this numbered order, purchased from contractor and/or shipper listed above, as this property is being secured for the exclusive use of the State of Texas.

FAILURE TO DELIVER — If the contractor fails to deliver these supplies by the promised delivery date or a reasonable time thereafter, giving acceptable reasons for delay, or if supplies are rejected for failure to meet specifications, the State reserves the right to purchase specified supplies elsewhere, and charge the increase in price and cost of handling, if any, to the contractor. No substitutions nor cancellations permitted without prior approval of the Board of Control.
The State of Texas is exempt from all Federal Excise Taxes

20

STATE BOARD OF CONTROL

By ________________ Purchasing Division

1

P. O. BOX 13047 CAPITOL STATION
AUSTIN, TEXAS 78711