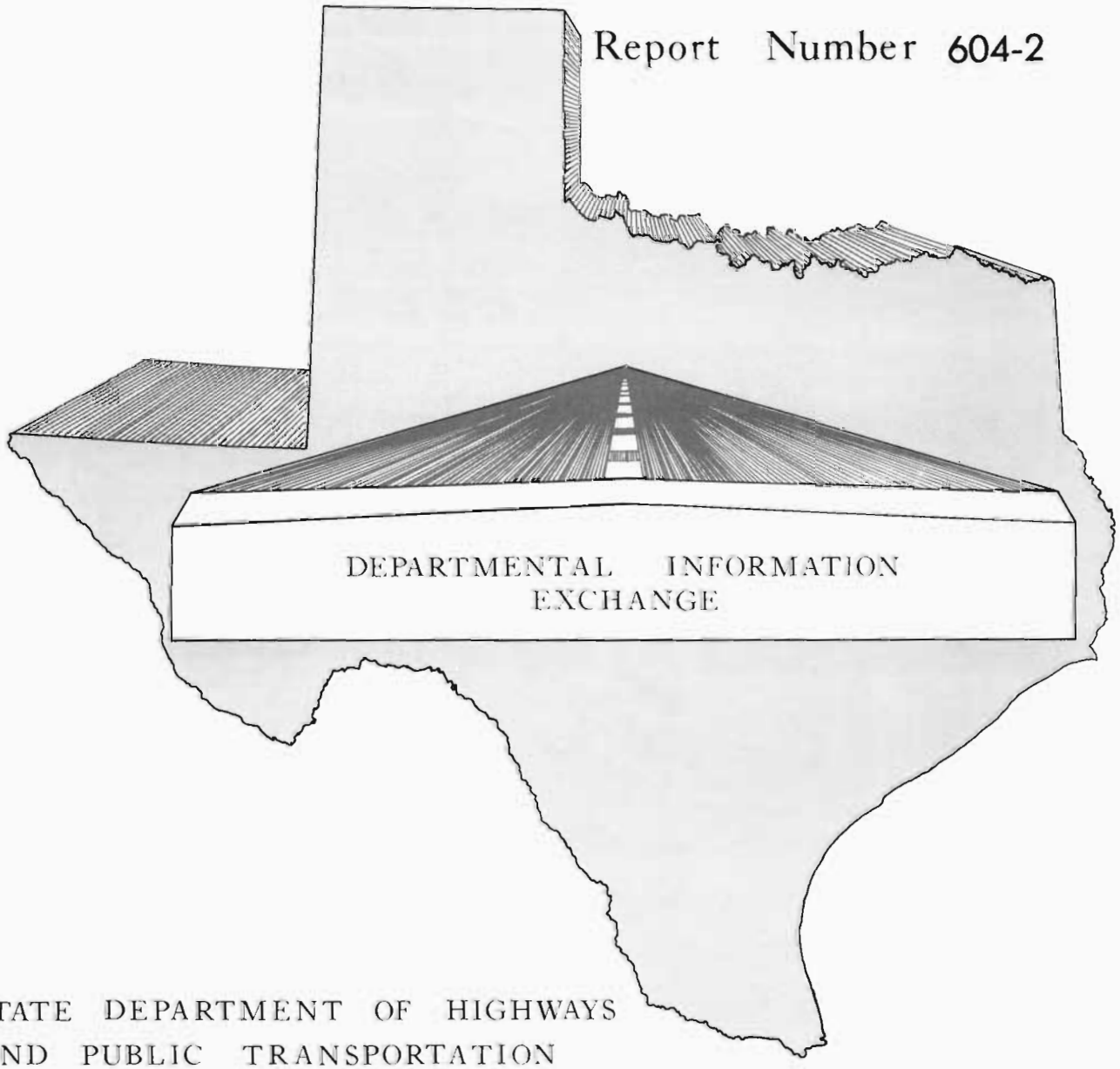
EXPERIMENTAL PROJECTS

THE USE OF WIRTGEN IN-PLACE RECYCLING EQUIPMENT IN LUFKIN

Report Number 604-2



STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
Exp. Proj. Report 604-2		

4. Title and Subtitle	5. Report Date
The Use of Wirtgen In-place Recycling Equipment in Lufkin	Oct. 1984
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
District 11	Exp. Proj. Report 604-2
9. Performing Organization Name and Address	10. Work Unit No.
State Department of Highways and Public Transportation District 11 Lufkin, Texas	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	
State Department of Highways and Public Transportation District 11 Lufkin, Texas	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

State Highway 59, south of Lufkin, is the site of this in-place recycling field trial. The West German built Wirtgen recycler used on the trial is the only one of its kind in the U.S.A., at the present time. It differs from conventional recyclers in that it has an in-line twin shaft pugmill. The Wirtgen conforms to Special Specification to Item 3199 (5-84). The portion of US 59 on which the Wirtgen was used had a severely rutted, year-old overlay that had a mix design which utilized a feldspar rock, rhyolite, and which was asphalt-content sensitive. The plan was to restore stability to the existing mix through in-place recycling via an admixture of 20% new, 4%-asphalt HMAC to the old mix. The Wirtgen equipment performed quite satisfactorily, especially on the section where cold precoated 2% asphalt limestone aggregate was sprinkled on the pavement ahead of the preheater. This finding is significant in that it has shown that this process can be used in locations where a hot mix plant is not available to furnish hot precoated new material.

17. Key Words	18. Distribution Statement
Wirtgen, in-place recycling, rutting, stability, hot recycling	This document is available from: State Department of Highways and Public Transportation Transportation Planning Division P.O. Box 5051; Austin, TX 78763

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	18	

Form DOT F 1700.7 (8-69)

The material contained in this report is experimental in nature and is published for informational purposes only. Any discrepancies with official views or policies of the DHT should be discussed with the appropriate Austin Division prior to implementation of the procedures or results.

TABLE OF CONTENTS

WORLD DISTRIBUTION

OF

WIRTGEN RECYCLER

COUNTRY	NO. OF UNITS
Germany	8
France	6
USSR	5
South Korea	3
Mexico	2
Denmark	2
Greece	1
Italy	1
Switzerland	1
England	1
Singapore	1
India	1
Kuwait	1
Venzuala	1
USA	1
	35

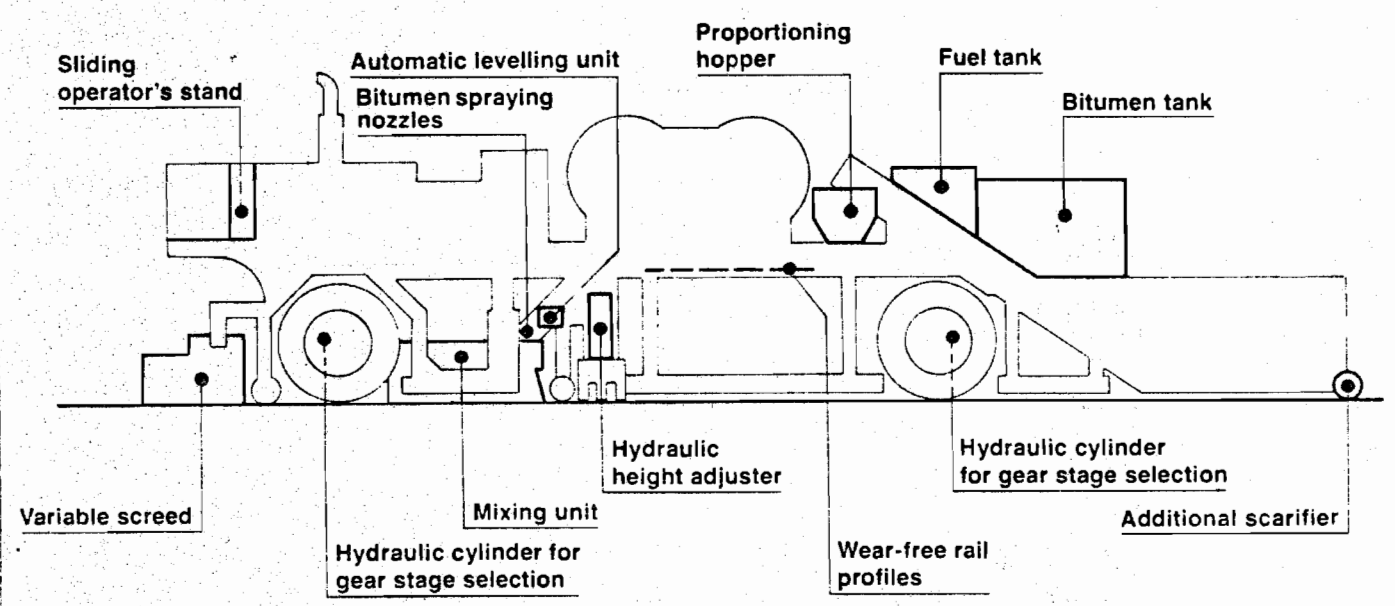
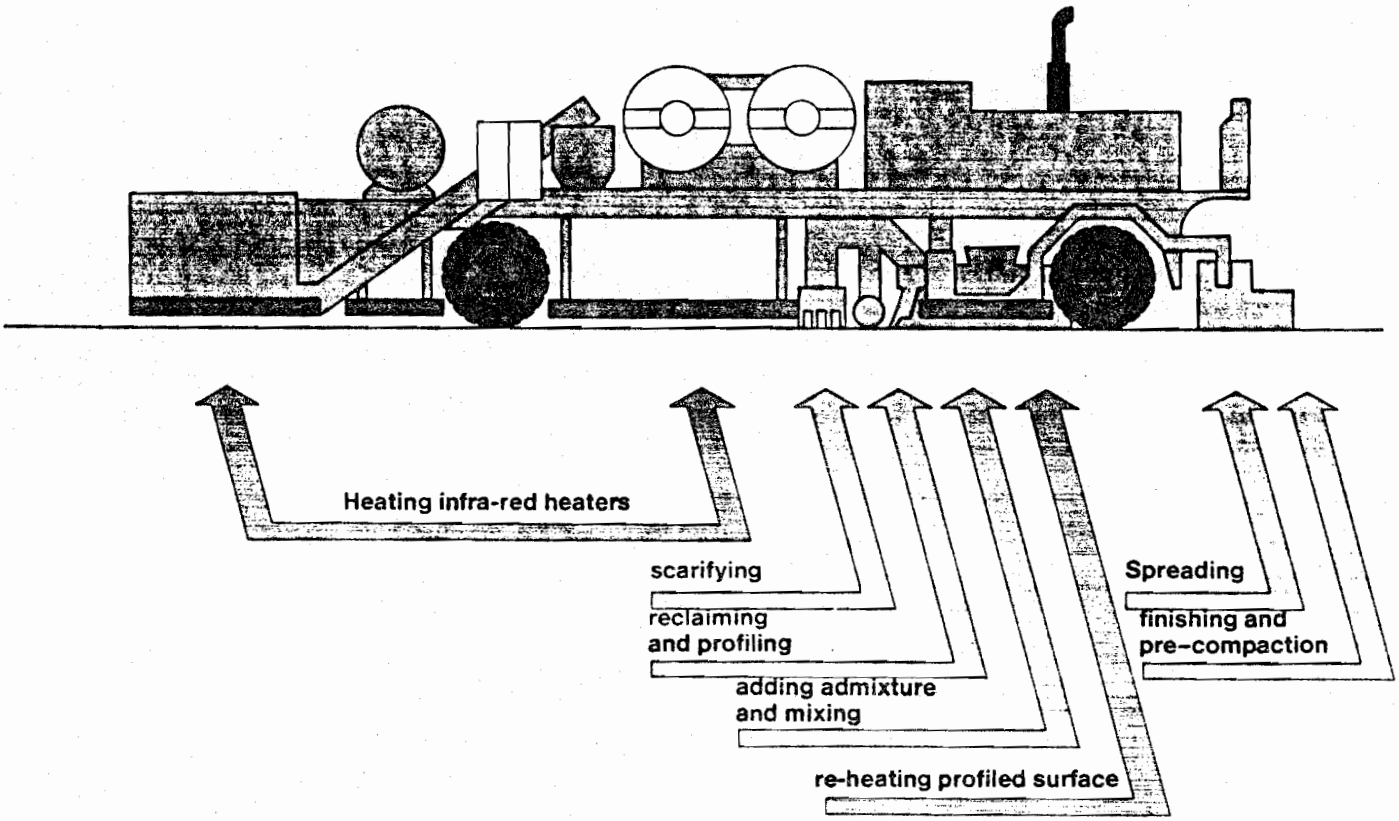
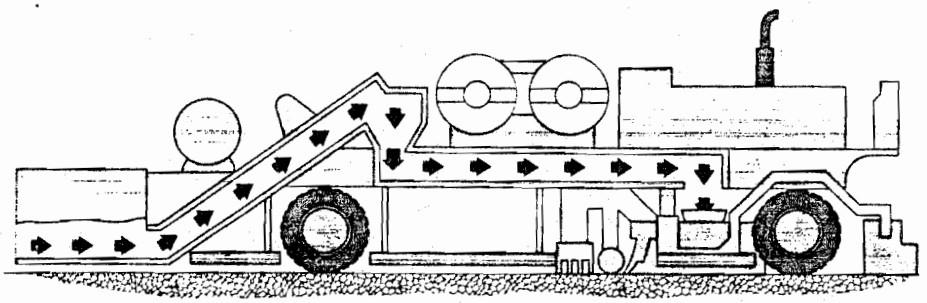
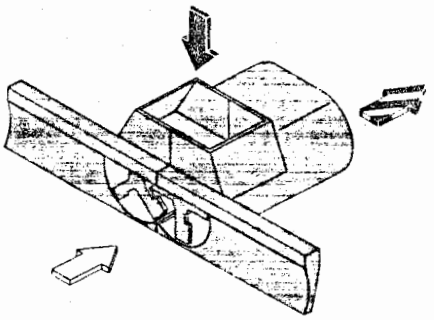

Sliding operator's stand
Automatic levelling unit
Bitumen spraying nozzles
Proportioning hopper
Fuel tank
Bitumen tank
Variable screed
Hydraulic cylinder for gear stage selection
Mixing unit
Hydraulic height adjuster
Wear-free rail profiles
Hydraulic cylinder for gear stage selection
Additional scarifier

Diagram of the Remixer illustrating the various components





Transport of the admixture inside the Remixer



Function of the pugmill mixer

The admixture brought to the site by truck is loaded into the receiving hopper at the front of the Remixer. It is then transported via an inclined belt conveyor into a surge bin which drops the correct amount of material on to the horizontal belt. The belt conveyor tunnel is heated by infra-red heaters. The admixture then falls from the belt conveyor into the pugmill.

The Remixer is equipped with a twin shaft compulsory pugmill mixer. Both materials, the reclaimed and the new design admixture are thoroughly mixed together. The length of time that the reclaimed material and the admixture are mixed in the pugmill is dependent on the advance speed of the machine and the length of the pugmill. The constant forward speed of the complete machine ensures that a homogeneous mixture with the required characteristics is consistently obtained.

The Remixer is also equipped for repaving work. The mixer unit is then closed off, and a new material is transported via the horizontal conveyor belt directly to the screed. This means that maintenance can also be carried out using this machine when the wearing course is deformed as a result of wear and the material is still suitable for further use.

TECHNICAL SUMMARY
IN-PLACE PAVEMENT RECYCLING
US 59 SOUTH OF LUFKIN

The Project Limits: Between Lufkin and the Neches River on US 59, northbound travel lanes.

Project History: During the winter of 1980-81, an HMAC overlay of 1½ inches of 292 Type "A" base with 1 inch of Item 340 Type "D" riding surface was placed. The mix design utilized a feldspar rock, rhyolite, in the coarse aggregate since a high polish value of 35+ was required due to the high traffic volume of 20,000 ADT. The mix design was "sensitive" in that small increases of asphalt content above the optimum resulted in a significant decrease in Hveem stability and reduced air voids. During the summer of 1981, the mix became unstable and began to rut severely.

Proposed Action: Two alternatives were considered as remedial action. The first involved complete removal of the distressed HMAC via cold milling and replacing it with a new overlay. The cost for this operation was estimated at $2.25 to $ 2.50 per square yard per inch of depth. The second alternative involved in-place recycling to restore stability to the existing HMAC via a mixture of a small percentage of a lean HMAC. Lab tests indicated that an addition of 20% of a lean, 4% asphalt-content mix would indeed adjust the voids in the mineral aggregate (VMA), air voids and, ultimately, Hveem and Marshall stabilities to acceptable levels. This alternative was estimated at $1.25 to $1.75 per square yard per inch of depth. Due to funding constraints, consideration of the availability of the latter technique and its history of success, the decision to recycle in-place was made.

Recycling Process: Remixer Contracting Company, Inc. bid the project at $1.33/sq yd for 1 inch depth and $1.66/sq yd for 1½ inch depth recycling. The material to be added to the existing mixture was supplied by the State at rates specified by the Engineer. A 4% asphalt lean new HMAC mix was used initially, but this was soon replaced by a 3% asphalt mix. Subsequently, after a short trial section of a 2% asphalt precoated limestone coarse aggregate proved more successful than other additives, a switch to this formula was made. In all cases, 20% of the new material was metered into the recycled mix, resulting in a 20/80 ratio of new to old mix.

The equipment, which was manufactured by the Wirtgen Company of West Germany, is the only one of its kind in the United States. It did a very adequate job of:

1) heating the pavement to the full 1½ inch depth;
2) milling the heated pavement to the full 1½ inch depth;
3) blending the old and new mix;
4) relaying the composite mixture.

If there are any complaints with the finished product to date, they would be with ride quality. However, it should be noted that the "before" ride quality as measured by the Mays Ride Meter was 2.0 to 2.5 and the "after" ride quality was 3.0 to 3.5 or an overall improvement of 1.0 numerical value, which is significant.

Related Research: In an effort to fully evaluate the recycling process, a series of laboratory tests (see Laboratory Data) were conducted. It is noteworthy that the mixture after processing is significantly improved as indicated by:

1) improved values of VMA and VMAFA;
2) increased air voids to desired percentage;
3) improved stability (both Hveem and Marshall);
4) equal or improved indirect tensile and cohesive properties;
5) improved Marshall flow characteristics;
6) desirable roadway densities.

In noting the effect the processing has on the asphalt as compared to the original asphalt properties, it appears that with a few limited areas as exceptions, the asphalt has retained much of its penetration, ductility and viscosity values resulting in an asphalt very much like an AC-40 grade on the roadway.

One short section (less than 200 feet in length) was placed using a cold Grade 3 rock asphalt at a 20% induction rate through the hopper system of the machine. The results were not impressive, although not catastrophic.

Another short section (approximately 500 feet) was placed using a cold precoated (2% asphalt) limestone aggregate sprinkled on the pavement ahead of the preheater by a chip spreader at the rate of 1 cu yd/ 120 sq yd. This produced a very acceptable mat, possibly superior to all others placed. This finding is significant in that it has shown that this process can be used in locations where a hot mix plant is not available to furnish hot precoated new material.

A third test section involving the recycling of an existing open-graded friction course has resulted in limited success.

A fourth test section using non-precoated rock sprinkled ahead of the the preheater worked very well. The non-precoated aggregate became well coated with asphalt when it made its way up into the pugmill. This test section produced a mat that was nearly as good as the cold, 2% asphalt precoated, limestone aggregate section.

Although not bid as part of the original contract, a one thousand foot test section utilizing lightweight (synthetic) aggregate was placed in the southbound lane. There was concern that the lightweight aggregate, being very porous, would not transmit heat very effectively and consequently would not produce a consistent mat. Fortunately, the aggregate absorbed enough asphalt to enable sufficient heat to be transmitted and an acceptable mat resulted.

IPE 400

		STATE	
		MC 176-3-79	
11	ANGELINA	176-3-79	US 59

STATE OF TEXAS
STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PLANS OF PROPOSED STATE HIGHWAY IMPROVEMENT

State PROJECT MC 176-3-79

ANGELINA COUNTY US. 59

NET LENGTH OF PROJECT = 46,943.40 FT = 8.87 MI

BETWEEN LOOP 287 AND NECHES RIVER (SECTIONS)

ASPHALTIC CONCRETE SURFACE REHABILITATION

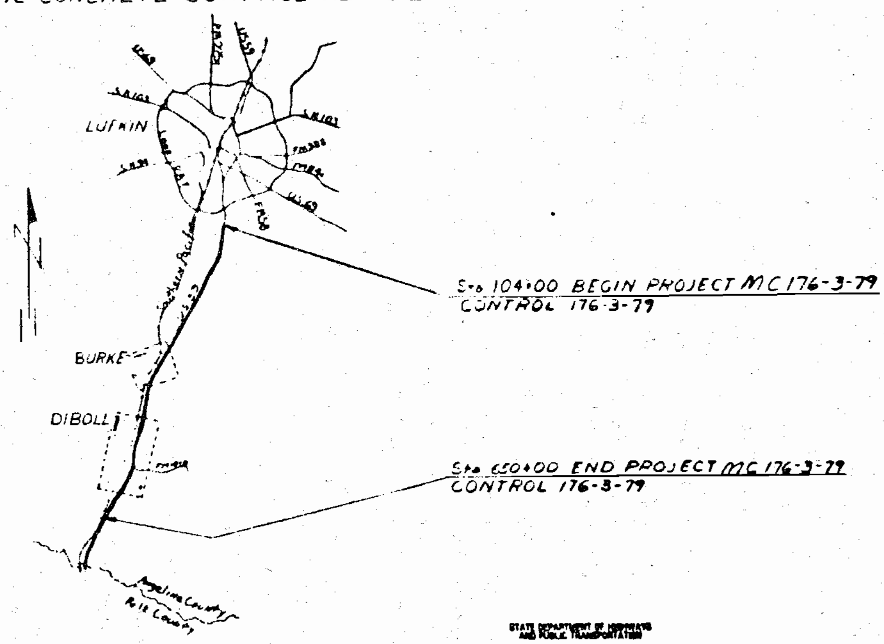
EQUATION:

Sta 581+209 Bk. = Sta 581+27.5 Fwd = -6.60 Ft

EXCEPTION:

Sta. 504+00 to Sta. 580+50 = 7,650.00 Ft.

INDEX OF SHEETS



Barricades and Signs

Type III C Barricades with signs R20-3, CW20-1A, CW20-1E, CW20-1C, G20-1, G20-2 & G20-6 shall be used at each end of the project

Type III Barricade Panels with signs CW20-1D & G20-2 shall be placed at all FM Highways, street and county road approaches except between Station 504+00 and Station 580+50 (thru Diboll).

Type III(c) Barricade with signs CW20-1D shall be placed at Station 504+00 (northbound lanes only) and Station 580+50 (southbound lanes only)

Specifications adopted by the Texas State Department of Highways and Public Transportation September 1982 and Specification Items listed and dated as follows shall govern on this project

Special Labor Provisions for State Projects (000---011)

LAYOUT SCALE 1 IN = 2 MI

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

Correct 1-9-84

Resident Engineer

Approved

Recommended For Approval 1-24-84

Bridge Engineer

Approved For Letting

District Engineer

For Chief Engineer Of Highway Design

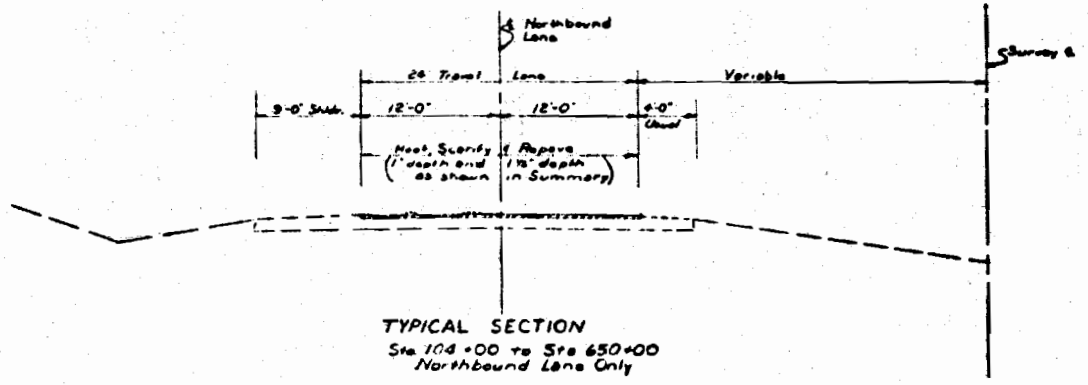
COUNTY Angelina PROJ NO.

HWY NO. US 59 LETTING DATE

DATE ACCEPTED

Angelina

6



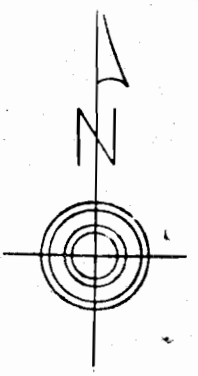
TYPICAL SECTION
Sta 104+00 to Sta 650+00
Northbound Lane Only

Summary of Heat, Scarify and Repave Operation

Sta. to Sta	L.F.	Width (ft)	Area S.Y. 1" Depth	Area S.Y. 1½ Depth	Remarks
104+00 to 399+00	29,500	12		39,333	Outside Lane
399+00 to 441+00	4,200	12	5,600		Outside Lane
441+00 to 504+00	6,300	12		8,400	Outside Lane
580+50 to 650+00	6943.4	12		9258	Outside Lane
104+00 to 504+00	40,000	12	53,333		Inside Lane
650+50 to 621+00	4043.4	12	5,391		Inside Lane
	Total		64,324	56,991	

TYPICAL SECTION
AND SUMMARY SHEET

	STATE NUMBER	
	SAC 176-J-79	
Los Angeles	176	8



LANE R	LANE S	MEDIAN	LANE M	LANE L	
					7 END 102 + 00
					7 104 + 00
					3 197 + 00
					6 202 + 00
					3 372 + 00
					5 374 + 00
					3 412 + 00
					2 504 + 00
					DIBOLL
					4 580 + 25
					3 589 + 00
					2 639 + 00
					1 START 650 + 00

TEST SECTION

CODE SHEET

TEST SECTION	PAVEMENT TYPE	RECYCLE ADDITIVE (at 20% Rate)
NO. 1	Ty D 'Rhyolite'	340 Ty D @ 4% asphalt
NO. 2	Ty D 'Rhyolite'	340 Ty D @ 3% asphalt
No. 3	Ty D 'Rhyolite'	Hot Precoated Aggr. @ 2% asphalt
No. 4	Ty C 'Limestone'	Hot Precoated Aggr. @ 2% asphalt
No. 5	Ty D 'Rhyolite'	Cold Grade 3 Rock Asphalt
No. 6	Ty D 'Rhyolite'	Cold Precoated Aggr. @ 2% asphalt (Spread w/Chip Spreader)
No. 7	PMS 'Rhyolite'	Hot Precoated Aggr @ 2% asphalt

Lab Data 176-3-79 US 59 Remix Project

STATION	641+80	635+75	618+00	586+00	586+00	604+00	498+50	464+00	428+00	428+00
LANE	L	L	L	L	L	M	L	L	L	L
DATE	10/3/84	10/3/84	10/4/84	10/4/84	10/4/84	10/5/84	10/8/84	10/9/84	10/10/84	10/10/84
ADDITIVE	'4%'Mix	'3%'Mix	'3%'Mix	None	Precoat	'3%'Mix	'3%'Mix	'3%'Mix	None	'3%'Mix
% +10	50.6	50.4	49.3	50.4	57.5	50.8	51.7	49.3	46.8	48.0
% -200	6.7	6.7	7.4	4.3	5.9	5.7	5.6	6.3	8.7	5.3
% ASPH.	6.4	5.2	6.3	6.5	5.0	5.4	5.9	5.8	6.4	5.1
% VMA	16.3	17.9	16.7	15.7	16.1	14.0	15.5	15.9	17.7	15.7
% VFA	90.2	66.5	86.8	94.9	74.1	88.6	87.8	83.7	82.0	74
G_A (LAB)	2.347	2.285	2.356	2.356	2.356	2.354	2.363	2.357	2.326	2.339
G_T (RICE)	2.387	2.439	2.404	2.375	2.463	2.392	2.410	2.421	2.398	2.439
LAB. DENS.	98.4	93.7	97.8	99.2	95.6	98.4	98.1	97.4	97.0	95.6
MARSH.STAB.	2000	1613	2198	1414	2484	1895	1530	1814	1187	1657
MARSH. FLOW	15	10	13	23	14	17	14	13	9	9
IND. TENS.	101	100	152	123	186	138	116	132	126	158
HVEEM STAB.	43	51	37	12	53	24	40	42	43	37
HVEEM COHES.	372	156	258	238	319	285	314	326	248	224
ROADWAY										
AIR VOIDS	10.2	8.1	5.0	--	7.9	7.2	3.2	5.6	--	5.3
MARSH.STAB.	323	569	776	--	1393	616	1367	939	--	468
MARSH. FLOW	9	9	13	--	11	13	11	10	--	9
ASPH. PEN.	47	55	55	39	33	29			55	22
ASPH. VIS.	11,807	4994	4916	8518	12,862	14,878			5,363	31,292
ASPH. DUCT.	141	141	141	141	141	141			141	30
ASPH.SP.GR.	1.044	1.042	1.044	1.094	1.076	1.046			1.053	1.073

Lab Data 176-3-79 US 59 Remix Project

STATION	393+75	393+75	373+00	373+00	358+00	358+00	338+00	338+00	320+00	320+00
LANE	L	L	L	L	L	L	L	L	L	L
DATE	10/11/84	10/11/84	10/11/84	10/16/84	10/16/84	10/16/84	10/16/84	10/16/84	10/17/84	10/17/84
ADDITIVE	None	Precoat	None	Gr.3 Rk. Asph.	None	Precoat	None	Precoat	None	Precoat
% +10	50.9	54.7	50.1	56.3	54.2	50.7	55.1	55.9	53.8	64.1
% -200	6.8	4.8	7.8	5.0	4.9	6.2	5.0	5.8	6.1	5.0
% ASPH.	5.9	5.7	6.0	5.6	6.0	6.2	6.0	5.5	5.9	4.4
% VMA	14.1	15.0	17.2	15.5	16.0	15.7	16.5	14.9	16.0	14.8
% VFA	97.2	86.7	79.6	82.5	85.6	91.3	83.0	85.2	84.3	68.2
G_A (LAB)	2.376	2.354	2.335	2.334	2.338	2.370	2.342	2.363	2.338	2.347
G_T (RICE)	2.386	2.392	2.421	2.398	2.392	2.404	2.410	2.415	2.398	2.463
LAB. DENS.	99.6	98.0	96.5	97.3	97.7	98.6	97.2	97.8	97.5	95.3
MARSH. STAB.	1477	1634	1807	1786	1426	2066	1239	1758	1391	2112
MARSH. FLOW	15	16	13	14	16	17	16	15	12	13
IND. TENS.	59	158	153	150	144	81	130	133	143	103
HVEEM STAB.		35	44	46	34	21	29	34	39	51
HVEEM COHES.		338	276	333	277	241	255	343	248	284
ROADWAY										
AIR VOIDS	--	5.8	--	5.3	--	6.6	--	7.1	--	11.4
MARSH. STAB.	--	727	--	1304	--	1112	--	749	--	515
MARSH. FLOW	--	12	--	11	--	11	--	11	--	10
ASPH. PEN.	55	47		24	42	34	47	35		37
ASPH. VIS.	6417	14,419		65,054	7,092	14,509	5,780	34,913		9,646
ASPH. DUCT.	141	141		15	141	141	130	50		141
ASPH.SP.GR.	1.073	1.066		1.057	1.057	1.053	1.073	1.062		1.057

Lab Data 176-3-79 US 59 Remix Project

STATION	301+90	301+90	274+00	234+25	224+00	202+30	201+80	140+90	140+90
LANE	L	L	L	L	L	L	L	L	L
DATE	10/17/84	10/17/84	10/18/84	10/29/84	10/30/84	10/31/84	10/31/84	11/1/84	11/1/84
ADDITIVE	None	Precoat	Precoat	Precoat	Precoat	None	Cold Precoat 'Chip Spreader'	None	Precoat
% +10	56.7	58.4	55.8	66.1	61.3	51.7	50.0	55.3	57.3
% -200	5.6	5.5	6.5	4.2	5.0	5.3	6.2	5.3	5.2
% ASPH.	5.4	5.2	5.5	4.4	4.8	6.2	6.4	5.4	5.0
% VMA	15.6	13.5	14.7	12.5	13.8	16.2	16.5	13.7	14.0
% VFA	78.8	88.9	85.7	80.8	79.7	88.2	89.2	90.5	82.1
G_A (LAB)	2.330	2.361	2.360	2.357	2.348	2.357	2.362	2.368	2.366
G_T (RICE)	2.410	2.398	2.410	2.415	2.415	2.404	2.404	2.398	2.427
LAB. DENS.	96.7	98.5	97.9	97.6	97.2	98.1	98.2	98.8	97.5
MARSH. STAB.	1408	1751	1744	2208	1728	1597	1559	1510	1466
MARSH. FLOW	13	13	13	15	12	11	11	13	11
IND. TENS.	144	138	90	178	145	141	140	124	137
HVEEM STAB.	39	45	45	54	48	44	38		
HVEEM COHES.	237	296	266	295	303	257	264		
ROADWAY									
AIR VOIDS	--	4.4	5.9				1.9		10.9
MARSH. STAB.	--	1245	1225				1248		254
MARSH. FLOW	--	8	8				11		8
ASPH. PEN.	45	27	57						
ASPH. VIS.	6173	28,320	7973						
ASPH. DUCT.	141	27.5	141						
ASPH.SP.GR.	1.050	1.062	1.055						

COST COMPARISONS

USING AVERAGE BID PRICES

		REPAIR DEPTH	
		1 INCH	1½ INCH
I.	IN-PLACE RECYCLING		
	ITEM 3199 HEAT, SCAR, MIX & RELAY	$ 1.33/sy	$ 1.67/sy
	ITEM 340 ADD'L. MAT'L.	.33/sy	.50/sy
		$ 1.66/sy	$ 2.17/sy
	COST PER LANE MILE	($11,686)	($15,277)
II.	ROTO-MILL AND OVERLAY		
	ITEM 3006 ROTO-MILL	$ 0.65	$ 0.95
	ITEM 340 OVERLAY	1.67	2.50
		$ 2.32	$ 3.45
	COST PER LANE MILE	($16,333)	($24,288)
*II.	LEVEL-UP AND OVERLAY		
	ITEM 340 LEVEL-UP	$ 0.83	$ 1.25
	ITEM 340 SURFACE (1½")	2.50	2.50
		$ 3.33	$ 3.75
	COST PER LANE MILE	($23,443)	($26,400)

* This was not considered a suitable alternate due to the excess rutting and instability of the mix. Shown for comparison purposes only.

CONTRACT NO. 0784302
PROJECT MC 176-3-79
CONTROL 176-03-079
HIGHWAY US 59
COUNTY ANGELINA
DISTRICT 11

PROJECT AGREEMENT ESTIMATE
STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

CONTRACTOR REMIXER CONTRACTING CO., INC. ADDRESS AUSTIN, TEX.

LINE NO.	ITEM NO.	DESC CODE	S.P. NO. ALT	DESCRIPTION	UNIT	ESTIMATED QUANTITY	PRICE PER UNIT	AMOUNT
DISTRICT 11 . COUNTY ANGELINA CONTROL 176-03-079 LENGTH 8.890 MC 176-3-79								
ASPH. CONC. SURFACE REHAB.								
LIMITS: BETWEEN LP 287 AND NECHES RIVER (SECTIONS)								
PREPARED BY: J. L. BEAIRD, DIST ENGINEER, 4/25/84								
ROADWAY				NET LENGTH 8.890 MILES				
0060	0500	001		MOBILIZATION	LS	1.000	$ 23,000.00000	$ 23,000.00
0070	0502	001		BARCD,SIGN AND TRAF HANDLING	MO	3.000	1,000.00000	3,000.00
0080	0664	002		ABBREVIATED PAV MARK (WHITE)	LF	1,174.000	1.50000	1,761.00
0090	3199	001		ASPH CONC SURF REHAB (1 IN)	SY	64,324.000	1.33000	85,550.92
0100	3199	002		ASPH CONC SURF REHAB (1-1/2 IN)	SY	56,991.000	1.65000	94,035.15
							SUBTOTAL	$ 207,347.07
							ENGINEERING AND CONTINGENCIES	20,732.93
						TOTAL ROADWAY		$ 228,080.00
MATL FURN BY THE STATE								
				61 ASPHT AGGR MIXTURE	LS	1.000		$ 39,000.00
							TOTAL	$ 39,000.00

SUMMARY: CONTROL 176-03-079 PROJECT MC 176-3-79

	ESTIMATED COST	FEDERAL FUNDS REQUESTED	LENGTH
ROADWAY	$ 228,080.00		8.890
MATL FURN BY THE STATE	39,000.00		
TOTAL PROJECT	$ 267,080.00		8.890
TOTAL BID ITEMS	$ 207,347.07		

CONTRACT 07840023
PROJECT MC 176-3-79
COUNTY ANGELINA

CONTRACT SUMMARY

		ESTIMATED COST	FEDERAL AID	LENGTH
176-03-079 MC 176-3-79				
ROADWAY		$ 228,080.00		8.890
MATL FURN BY THE STATE		$ 39,000.00		
TOTAL 176-03-079		$ 267,080.00		8.890
TOTAL BID ITEMS		$ 207,347.07		
ENGINEERING AND CONTINGENCIES		20,732.93		
TOTAL MISCELLANEOUS COST		39,000.00		
TOTAL COST		$ 267,080.00		8.890

SPECIAL SPECIFICATION

ITEM 3199

ASPHALTIC CONCRETE SURFACE REHABILITATION

1. Description. This item shall govern for asphaltic concrete surface rehabilitation, a process that consists of softening the existing asphaltic concrete surface with heat, scarifying to the depth shown in the plans, and thoroughly remixing and leveling scarified material. Blending of scarified material with additional aggregate or fresh hot mix asphaltic concrete will be required.

   All work under this item shall be in conformity with the typical sections shown on the plans and to the lines and grades as established by the Engineer.

2. Materials. Additional aggregate or fresh hot mix asphaltic concrete will be furnished to the Contractor free of charge at a location shown on the plans.

3. Equipment.

   a. Processing Equipment. The equipment for heating, scarifying, remixing, and repaving shall be as approved by the Engineer. The equipment shall consist of the following, either as a complete unit or in approved segments:

      (1) A heating mechanism capable of heating the asphaltic concrete pavement surface to a temperature high enough to allow scarification of the material without breaking aggregate particles, without charring the pavement, and without producing undesirable pollutants. The heating mechanism shall be so equipped that heat application shall be under an enclosed or shielded hood.

      (2) Scarifier sections capable of uniformly loosening the asphaltic pavement.

      (3) A leveling unit capable of gathering the heated and scarified material into a windrow or otherwise collecting for remixing, and of distributing over the width being processed and finishing so as to produce a uniform cross-section and surface.

      (4) A system for adding and uniformly blending addi tional aggregate or fresh hot mix asphaltic concrete. The application rate for the additional material shall be sychronized with the machine speed to provide uniform application.

b. Rollers. Rollers shall be in accordance with the Item "Hot Mix Asphaltic Concrete Pavement".

4. Construction Methods. The pavement surface to be rehabilitated shall be cleaned of all dirt and other objectional material by blading, brooming or other approved methods, prior to beginning heater-scarification operations.

The pavement surface shall be evenly heated, scarified and remixed to the widths and depths shown in the plans. Heating shall be controlled to assure uniform heat penetration without causing differential softening of the surfaces. Charring of the asphalt will not be permitted. The scarified material shall be gathered by the leveling device, uniformly mixed with the added material, and relaid. The rate of application of added material shall be as determined by the Engineer.

The heated and scarified material shall have a temperature in a range between 200 F and 265 F as measured immediately behind the scarifier. The Engineer will select the temperature within these limitations, and the mixture shall not vary from this selected temperature by more than 25 F and shall remain within the above limits.

There shall be no burning of trees, shrubs, or other landscaping adjacent to the pavement. It shall be the responsibility of the Contractor to protect the adjacent landscape from heat damage. This protection may consist of individual shielding and/or water spray or other methods approved by the Engineer.

When a pass is made adjacent to a previously placed mat, the longitudinal joint shall extend at least 2 inches horizontally into the previously placed mat, unless otherwise directed by the Engineer. Other methods approved by the Engineer may be used that insure a tight joint between the mats.

Compaction will begin before the reclaimed or blended paving material temperature drops below 190 F. All rolling shall be completed before the mixture temperature drops below 175 F unless determined by the Engineer that a higher temperature is required for proper compaction.

When rolling with the three-wheel, tandem or vibratory rollers, rolling shall start longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least half the width of the rear wheel unless otherwise directed by the Engineer. Alternate trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side unless otherwise directed by the Engineer. When rolling with vibratory steel-wheel rollers, the manufacturer's recommendation shall be followed unless directed otherwise by the Engineer. Rolling with

pneumatic-tire roller shall be done as directed by the Engineer. Rolling shall be continued until no further compaction can be obtained and all roller marks are elimi nated. One tandem roller, one pneumatic-tire roller and at least one three-wheel roller, as specified above shall be provided for each job unless otherwise directed by the Engineer. If the Contractor elects, he may substitute the three-axle tandem roller for the two-axle tandem roller and/or the three-wheel roller. Additional rollers shall be provided if needed. With approval of the Engineer, the Contractor may substitute a vibratory roller meeting the requirements of this specification and operated in the manner prescribed herein. The motion of the roller shall be slow enough at all times to avoid displacement of the mixture. If any displacement occurs, it shall be corrected at once by the use of rakes. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion of the surface mixture to the roller, the wheels may be kept moistened with water, but an excess of water will not be permitted. All rollers must be in good mechanical condition. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the Engineer, operate other compacting equipment that will produce equivalent relative compaction as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction as would be expected of the specified equipment, as determined by the Engineer, its use shall be discontinued.

The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such locations as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly-oiled tamps.

5. Measurement. Asphaltic Concrete Surface Rehabilitation will be measured by the square yard of surface area of completed and accepted work of the depth shown on the plans.

6. Payment. The work performed and material furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Asphaltic Concrete Surface Rehabilitation", of the depth shown, which price shall be full compensation for cleaning existing pavement, all heating and scarifying, blending additional material and relaying of scarified materials; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.