ULTRAPAVE

CONSTRUCTION REPORT
January 1996

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ABSTRACT

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proximately one year after construction, a visual survey revealed some minor reflection cracking and raveling in the rmoplastic section. The ULTRAPAVE section showed early signs of reflection cracking. A thorough condition survey l be conducted at the end of the second year and a performance evaluation will be documented in the final report.

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contents of this report reflect the views of the author(s) who is responsible for the facts and the accuracy of the presented herein. The contents do not necessarily reflect the views of the Oklahoma Department of nsportation or the Federal Highway Administration. This report does not constitute a standard, specification, or ulation. While trade names may be used in this report, it is not intended as an endorsement of any machine, tractor, process, or product.

SI (METRIC) CONVERSION FACTORS

Approximate Conversions to SI Units

Symbol	When you know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	25.40	millimeters	mm
ft	feet	0.3048	meters	m
yd	yards	0.9144	meters	m
mi	miles	1.609	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.0929	square meters	m^2
yd^2	square yards	0.8361	square meters	m^2
ac	acres	0.4047	hectares	ha
mi^2	square miles	2.590	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0283	cubic meters	m^3
yd^3	cubic yards	0.7645	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.4536	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	(°F-32)/1.8	degrees Celsius	°C
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.448	Newtons	N
lbf/in^2	poundforce	6.895	kilopascals	kPa

Approximate Conversions from SI Units

Symbol	When you know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.0394	inches	in
m	meters	3.281	feet	ft
m	meters	1.094	yards	yd
km	kilometers	0.6214	miles	mi
		AREA		
mm^2	square millimeters	0.00155	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.196	square yards	yd^2
ha	hectares	2.471	acres	ac
km^2	square kilometers	0.3861	square miles	mi^2
		VOLUME		
mL	milliliters	0.0338	fluid ounces	fl oz
L	liters	0.2642	gallons	gal
m^3	cubic meters	35.315	cubic feet	ft^3
m^3	cubic meters	1.308	cubic yards	yd^3
		MASS		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.1023	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	degrees Celsius	9/5+32	degrees Fahrenheit	°F
		FORCE and PRESSURE or STRESS		
N	Newtons	0.2248	poundforce	lbf
kPa	kilopascals	0.1450	poundforce	lbf/in^2

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EXECUTIVE SUMMARY

In the summer of 1994, a 38 mm (1½ in) overlay was constructed on Interstate 40 near Elk City in order to combat a rutting problem. An 8.85 km (5.50 mi) section of the outside eastbound lane was divided into two longitudinal sections. A 4.15 km (2.58 mi) section was overlaid with a standard (thermoplastic) polymerized liquid asphalt mix. The remaining 4.70 km (2.92 mi) was overlaid using a mix modified with a styrene butadiene rubber latex thermoset polymer from Goodyear, ULTRAPAVE 70.

ULTRAPAVE 70 is blended with the asphalt and aggregate in the pugmill, unlike the thermoplastic polymer which is blended with the liquid asphalt at the refinery. The most significant difference in the two types of additive results from their molecular structures. Thermoplastics can be reshaped when heated while thermosets produce longer chain molecules and will not soften appreciably once the polymerization is complete. The intent is to produce a modifier that will provide the same high temperature characteristics as thermoplastics do, resistance to rutting, along with an improved resistance to the primary low temperature distress, cracking.

Research, Development, & Technology Transfer was asked to evaluate the performance of ULTRAPAVE 70 as compared to the styrene-butadiene (vulcanized) binder currently used by the Oklahoma Department of Transportation (ODOT). At that time, the contract had already been let and construction was under way. The mix design was Type BH for both overlays and each used AC 20. Similar construction methods were used for the application of both mixes.

Polymerized mixes require more breakdown roller activity than standard AC binders. The tires on the pneumatic roller were kept well lubricated in order to avoid sticking to the tacky mat produced by the binders.

A comparative analysis of the performance of the two mixes will be documented in the final report. Cost effectiveness will be determined at the end of a two year evaluation period.

INTRODUCTION

Premature rutting is a common problem with asphalt concrete (AC) pavements, particularly when they are subjected to frequent heavy-axle loading. In October 1991, the Planning Division did an Infrastructure Management Systems (IMS) survey on I-40 in Beckham county. Rut information provided by the survey (Table 1) indicated maximum rutting of 42 mm (1.66 in) and a rut depth average of 8.5 mm (0.36 in).

Table 1. IMS SURVEY RUT DATA

IDENTITY (COUNTY # - CONTROL SECTION # - MILE #)	DATE	DEPTH OF RUT (INCHES)	
		AVERAGE	MAXIMUM
05 - 01 - 10.8	10/91	0.53	1.30
05 - 04 - 12.9	10/91	0.41	0.71
05 - 04 - 18.8	10/91	0.42	1.39
05 - 04 - 14.8	10/91	0.20	0.62
05 - 04 - 16.2	10/91	0.27	1.66

Producers of asphalt modifiers claim that polymers reduce rutting by providing stability and durability to the pavement (1). This project evaluates and compares two modifiers of a dense graded hot-mix asphalt overlay for performance, cost, and ease of construction.

A styrene-butadiene (vulcanized) binder from Koch Materials has been the standard additive used by the Oklahoma Department of Transportation (ODOT) as an AC modifier. It is a thermoplastic polymer blended with liquid asphalt at the refinery before shipping.

ODOT is now testing ULTRAPAVE 70, a new product from Goodyear. This liquid styrene butadiene rubber latex thermoset polymer is shipped directly to the asphalt plant in a tanker and fed into the pugmill or in-line to the drum mixer.

A maintenance overlay contract was awarded for I-40 in Division V, Beckham County and an 8.85 km (5.50 mi) section of the outside eastbound lane was selected as the test site. A 4.15 km (2.58 mi) section was overlaid with the standard thermoplastic polymer mix and a 4.70 km (2.92 mi) section with the ULTRAPAVE 70 mix. See Figure 1 for site layout.

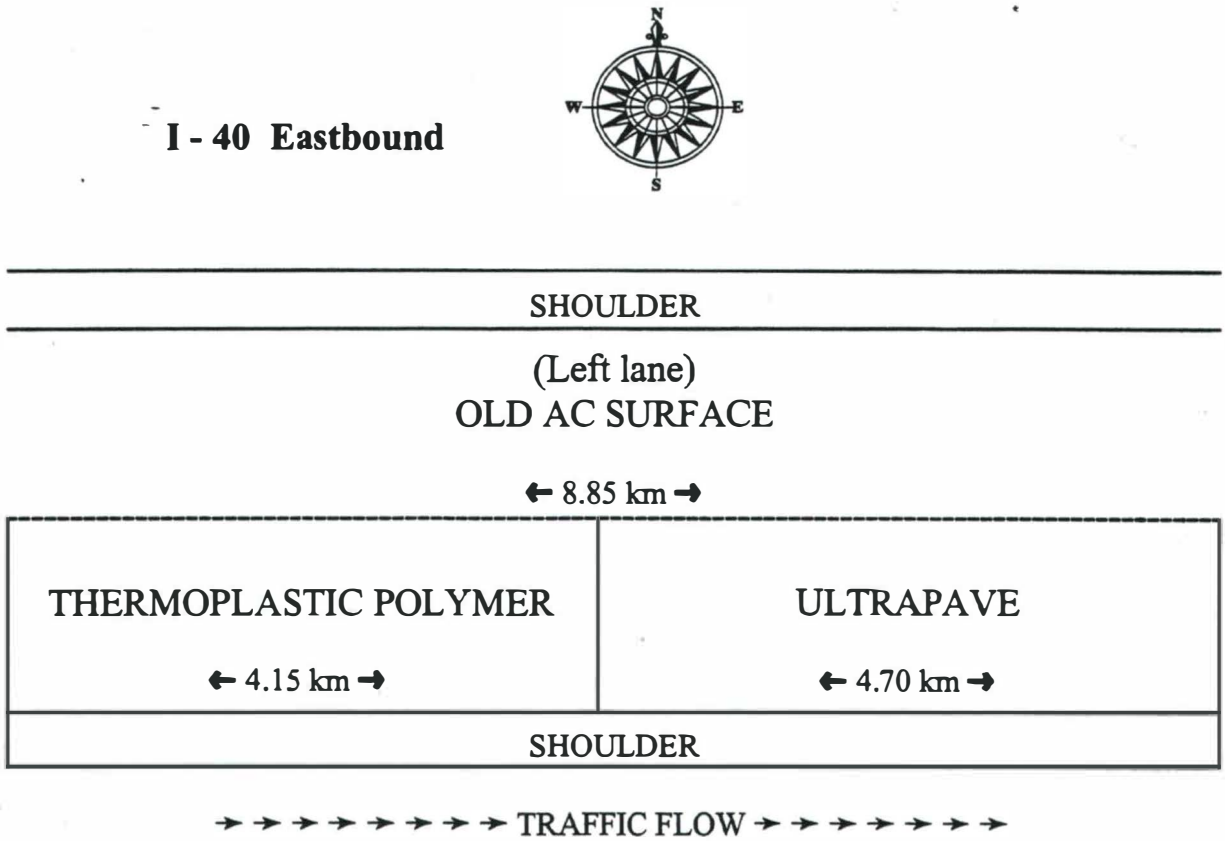


Figure 1. LAYOUT OF TEST SECTIONS.

BACKGROUND

The 8.85 km (5.5 mi) section of I-40 was constructed in 1970 as a four lane divided highway. The pavement was composed of a fine aggregate bituminous base, a Type B dense graded mix binder, and an open graded friction surface course. Rutting was the primary distress addressed by the new overlay although the pavement also exhibited depressed transverse cracks and raveling.

The average daily traffic count was 11,000 vehicles.

The regional geology consists of weakly cemented, fine grained sandstone beneath very gently sloping, well drained loamy soils on uplands (2). The majority of the project lies over fine sandy loam with relatively good engineering properties. Annual rainfall averages 560 mm to 610 mm (22 in to 24 in).

LOCATION

The test site is located on I-40 in Beckham county, near Elk City. (See Figure 1 for Location Map.)

The project begins at mile post 34.09 and extends 8.85 km (5.5 mi) east to mile post 39.96.

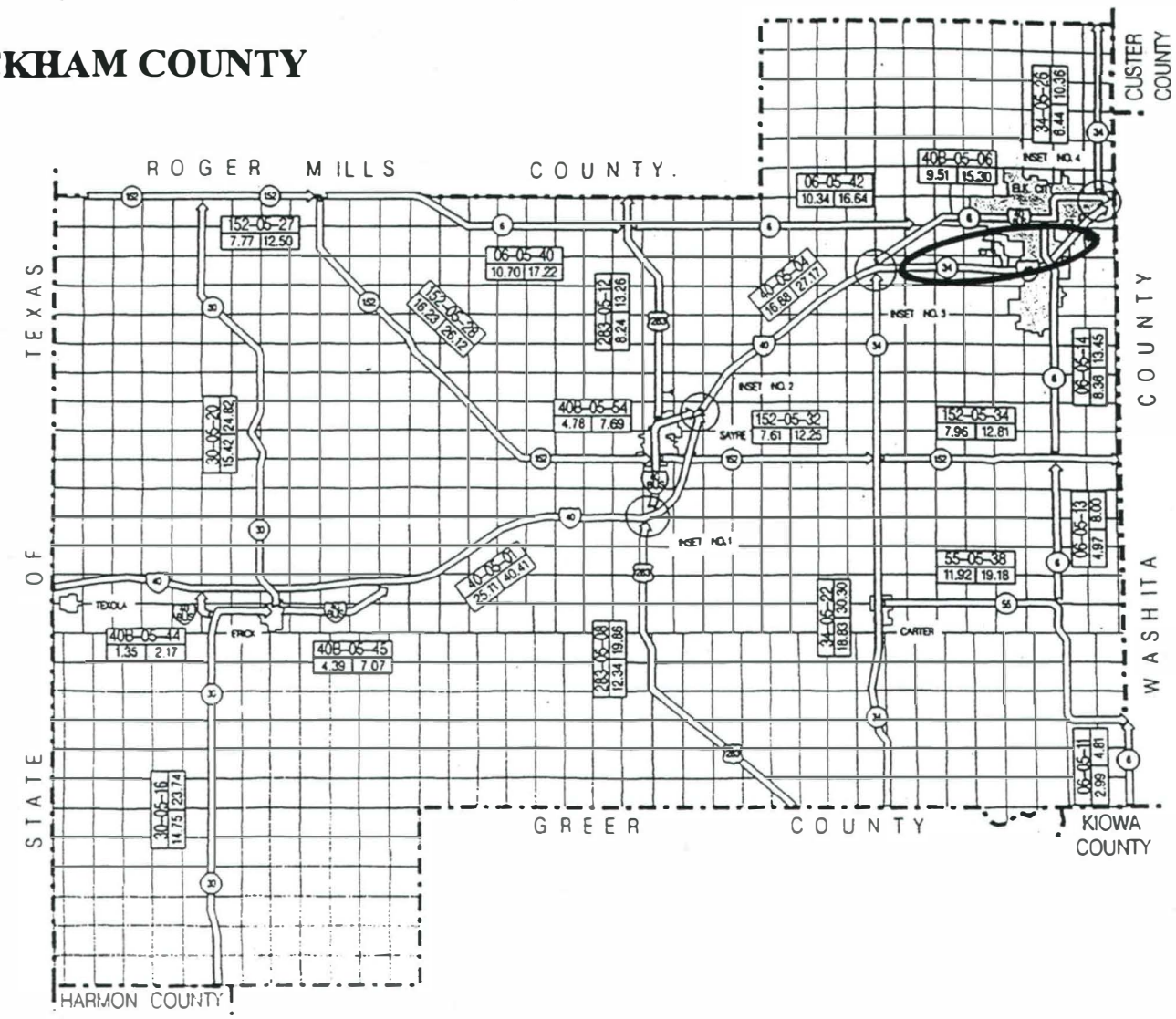


Fig. 2 Location map.

MATERIALS

Materials for this project were purchased from various Oklahoma based companies. Aggregates included 15.8 mm (5/8 in) chips, #4 sieve screenings and shot, and pit sand. See Table 2 for a listing of the materials used and their sources. The gradation for both mix designs was Type BH (Table 3), which conforms to ODOT Special Provision 411-5(a) 91S. The gradation has a broad range with a minimum asphalt content of 4.5%, 0.2% less than the minimum for Type B. Both polymers, vulcanized and latex, were blended with AC 20 grade asphalt.

Table 2. SOURCE OF MATERIALS

AGGREGATES	
15.8 mm (⅝ in) Chip	Meridian Aggregates, Snyder, OK
#4 Screenings and Shot	The Dolese Co., Cooperton, OK
Sand	McLemore Pit, Elk City, OK
ASPHALT CEMENTS	
PMAC-1C	Koch Materials, Muskogee, OK
PMAC-1C	Honegger Materials, Oklahoma City, OK

Thermoplastic and thermosetting polymers have differing properties as a result of their molecular structures. Polymerization refers to the process of combining relatively simple molecules to form a more complex molecule of higher molecular weight. In thermo*plastic* polymers this process has been carried out as far as it will go, resulting in a substance that may be softened by heat and reshaped again and again. In thermo*setting* polymers the reaction is not completed until the modifier is introduced to the mix in the pugmill and the polymerizing temperature is reached, resulting in a cross-linked three dimensional polymer which will not appreciably soften when reheated (3).

Table 3. TYPE BH MIX DESIGN

SIEVE	⅝"CHIPS %PASS	SCRNS %PASS	SHOT %PASS	SAND %PASS	COMBINED AGGREGATE %PASSING	JOB FORMULA %PASSING
¾ IN	100	-	-	-	100	100
½ IN	89	-	-	-	95	95
⅜ IN	29	100	100	-	70	70
NO. 4	1	90	90	100	58	58
NO. 10	1	50	5	99	25	25
NO. 40	1	21	2	70	14	14
NO. 80	1	14	2	17	6	6
NO. 200	0.2	11.2	1.5	6.1	4.1	4.1
% Asphalt Cement (PMAC-1C)						5.2
Mix temperature @ discharge from mixer.						305°F
Optimum roadway compaction temperature.						290°F

The ULTRAPAVE mix met the ODOT specifications for plant mix asphalt concrete pavement with latex modified asphalt cement [ODOT Special Provision 708-8(a-b) 91S] shown in Appendix A.

CONSTRUCTION

In the summer of 1994, the Caswell-Orth Construction company overlaid the east bound outside lane, while the inside lane was left untreated.

The thermoplastic polymer was blended with AC 20 asphalt at the refinery, pumped into a tanker, and shipped to the plant site. It was fed into the pugmill as the binder material for the asphalt concrete mix. The aggregate was heated to 163 °C (325 °F) in the dryer drum and discharged into the 1.8Mg (2 ton) pugmill with the modified asphalt. The mixing time was 35 seconds.

The ULTRAPAVE 70 was shipped to the batch plant in a tanker. The polymer, liquid asphalt, and heated aggregates were individually fed into the pugmill where they were blended simultaneously. The materials were mixed for 43 seconds, 8 seconds longer than the standard polymer asphalt concrete mix. Each mix conformed to the ODOT Type BH aggregate gradation.

Cold milling to a depth of 38mm (1½ inches) removed all but the deepest surface distresses [some ruts measured as deep as 42mm (1.66 in)] and leveled the roadway. The milled surface was prepared with an AC tack coat applied at a rate of 0.79 liter/m² (0.25 gal/yd²) and overlaid with 38 mm (1½ inches) of modified AC.

In the breakdown phase, A 14 Mg (17 ton) double-drum vibratory roller followed closely behind the laydown machine. The intermediate rubber tired pneumatic roller stayed about 0.4 km (0.25 mi) behind the breakdown roller. The steel wheeled finish roller made several passes before compaction was achieved. Photographs of the construction procedure appear in Appendix B.

Construction was completed on August 30, 1994.

CONCLUSIONS

The constructability of the overlay modified with a thermoset polymer, ULTRAPAVE 70, was essentially equal to that of the one modified with a thermoplastic polymer. The same construction methods were employed with each mix and no problems were encountered.

The difference in the way each polymer is added to the mix creates some significant considerations concerning storage and batching procedures. Because a thermoset polymer, such as ULTRAPAVE 70, is stored in a separate container at the batch plant, the actual mixing procedure can be delayed for prolonged periods without the need for heating or other special treatments of the additive. And, since the polymer is injected directly into the pugmill, the operator can quickly alternate between modified and unmodified batches with the simple flip of a switch.

Modifying hot-mix asphalt with ULTRAPAVE 70 costs about $3.00/ton. ODOT's Office Services Division currently estimates the cost of modifying with a vulcanized polymer at $3.00 to $4.00/ton.

Approximately one year after construction, a visual survey by the project manager revealed minor reflection cracking and some minor raveling in the thermoplastic section. The ULTRAPAVE section showed only early signs of reflection cracking. A thorough condition survey will be conducted at the end of the second year and an evaluation of the performance of each mix will be documented in the final report.

REFERENCES

1. "Specifiers Guide to Asphalt Modifiers," Roads & Bridges, May 1988, page 69.

2. Soil Survey of Beckham County Oklahoma, National Cooperative Soil Survey, September 1980.

3. English and Cassidy, Principals of Organic Chemistry, McGraw-Hill, New York, 1956, Second Edition.

APPENDICES

APPENDIX A

ODOT SPECIAL PROVISION FOR LATEX ASPHALT MODIFICATION

OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
FOR
PLANT MIX ASPHALT CONCRETE PAVEMENT
WITH
LATEX MODIFIED ASPHALT CEMENT

These Special Provisions revise, amend, and where in conflict, supercede applicable sections of the Standard Specifications for Highway Construction, Edition of 1988 and the Supplemental thereto, Edition of 1991.

411.01 DESCRIPTION. (Add the following)

The plant mix asphalt concrete specified shall contain styrene butadiene rubber latex (latex) as an asphalt modifier.

411.04 CONSTRUCTION METHODS. (c) MIXING (Add the following)

The Latex shall be added to the paving mix at the mixing plant. The asphalt delivery pipe line shall contain an in-line blender. The in-line blender shall provide preblending of the liquid asphalt and the latex. The in-line blender shall provide for both the injection of the latex and a method for sampling the mixed material (sampling valve).

The Latex delivery system shall be integrated into the mixing plant control system. The plant mixing control system shall provide for delivery of latex and asphalt at prescribed rates shown in the job mix formula. The control system shall provide for separately accumulated totals of asphalt cement and latex delivered to the asphalt paving mixture.

708.03(a) ASPHALT MATERIALS. (Add the following)

The latex modified asphalt shall meet the requirements shown in the following table:

		TYPE LMA	TYPE LMB
Penetration 77 Deg.F 100g,5 Sec.	AASHTO T-49	70 min.	50 min.
Viscosity 140 Deg.F,Poises	AASHTO T-202	1600 min.	4000 min.
Viscosity 275 Deg.F,cst.	AASHTO T-201	2000 max.	3500 max.
Ductility 39.2 Deg.F,5 cpm,cm	AASHTO T-51	50 min.	30 min.
Flash Point Deg.F	AASHTO T-48	450 min.	450 min.
Solubility * %	AASHTO T-44	99 min.	99 min.
Toughness 77 Deg.F,20 ipm,in-lbs.		110 min.	110 min.
Tenacity 77 Deg.F,20 ipm,in-lbs.		75 min.	75 min.

* To be performed on asphalt cement prior to adding latex.

RTFOR or TFOT Residue:

Viscosity 140 Deg.F,Poises	AASHTO T-202	8000 max.	12000 max.
Ductility 39.2 Deg.F,5 cpm,cm	AASHTO T-51	25 min.	10 min.

708.04 COMPOSITION OF MIXTURES. (a) Asphalt Mix Design And Initial Job-Mix Formula (Add the following)

Prior to developing the job-mix formula, the amount of latex to be added shall be determined by the asphalt cement or latex supplier. Samples of the proposed latex and asphalt shall be mixed to a smooth and homogenous blend and be evaluated to meet the specified properties. This shall be repeated until the proper amount of latex is determined that will impart the properties specified above.

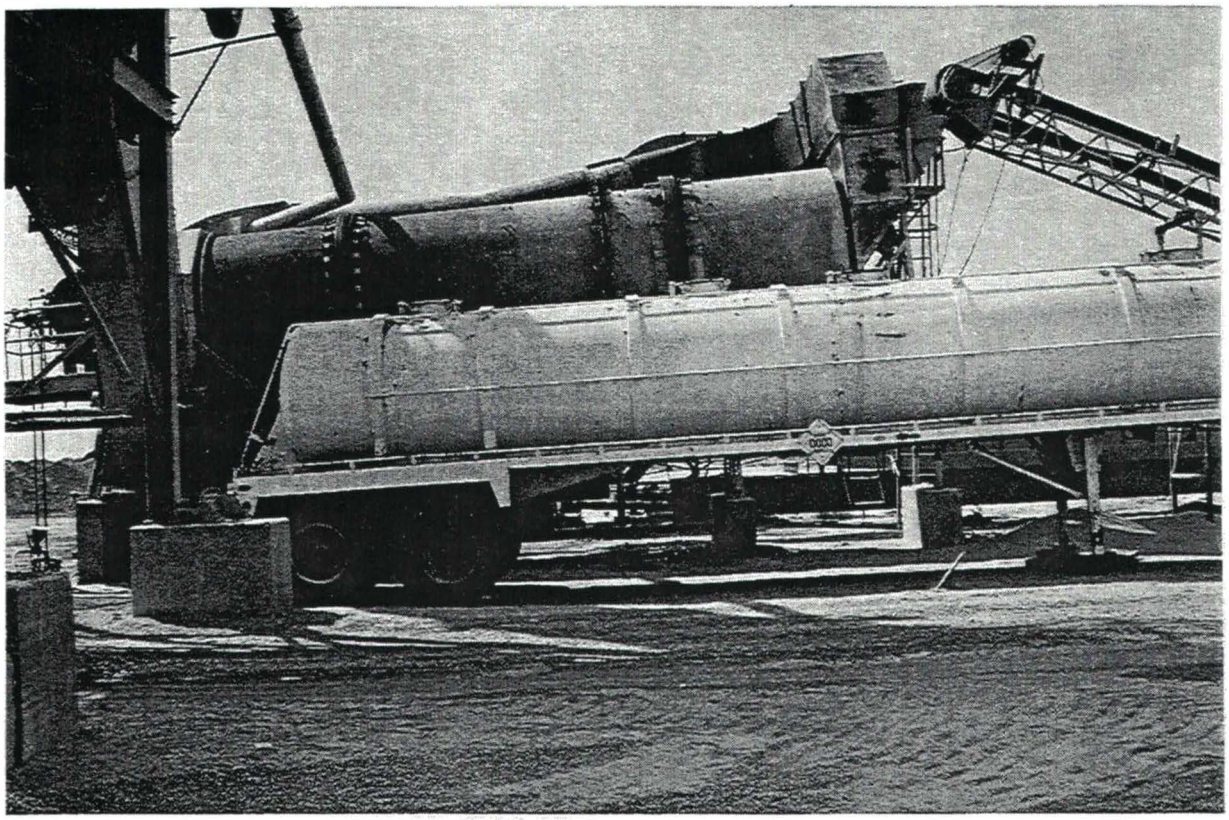
Samples of the required blended latex and asphalt cement, shall be furnished to the laboratory for completion of the job-mix formula. Additional samples of the latex, asphalt and aggregates shall be furnished the Materials Engineer along with the proposed job-mix formula for approval.

(b) Plant Produced Mixtures (Add the following)

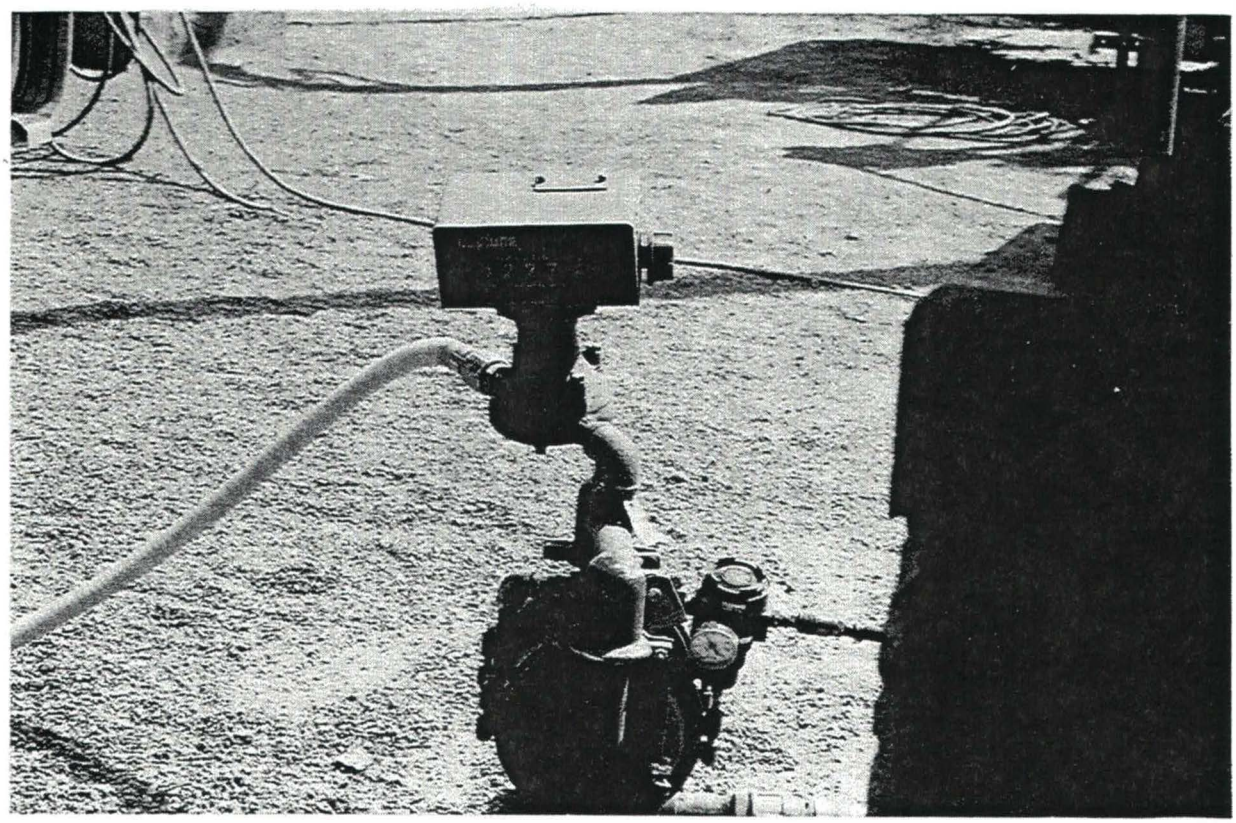
The amount of latex in the mix shall be determined from the readings of the metering devices in the delivery system and shall be within plus or minus 5% of the amount of latex shown in the job-mix formula.

APPENDIX B

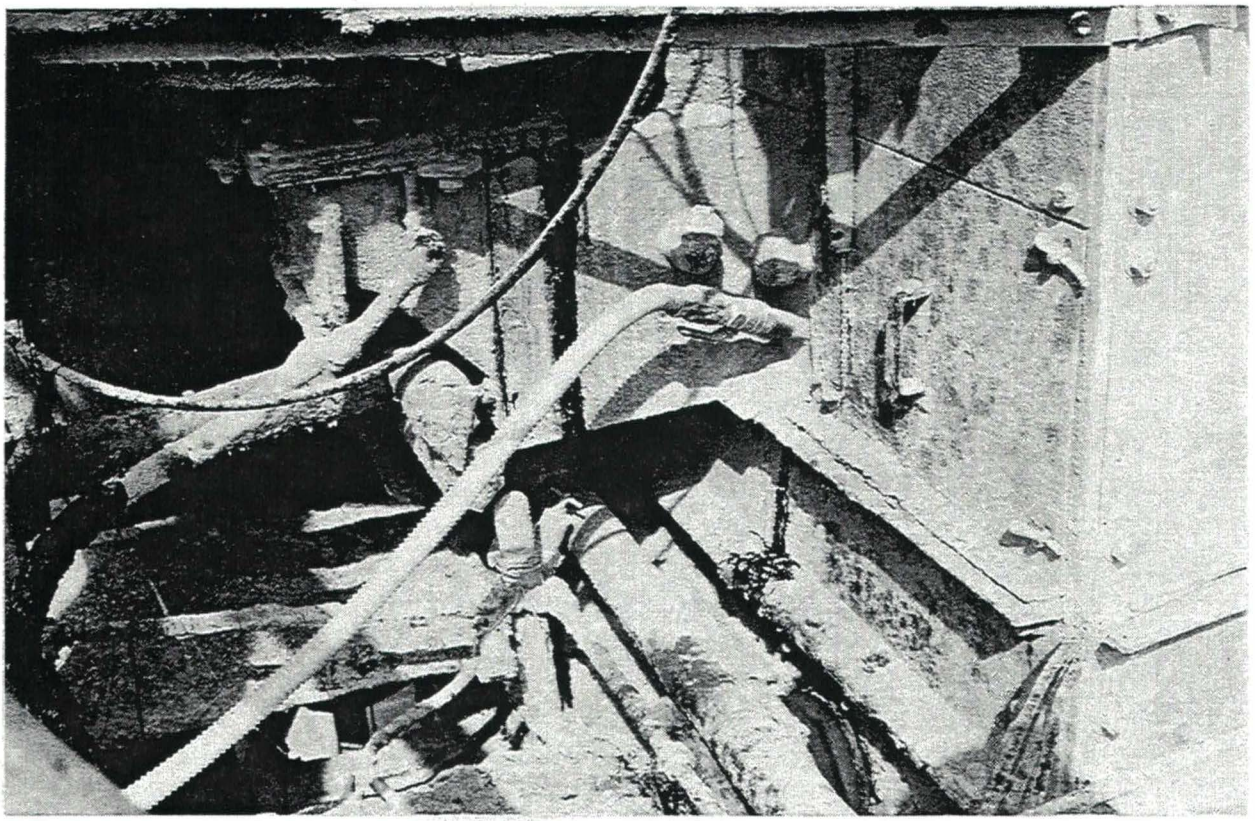
CONSTRUCTION PHOTOGRAPHS



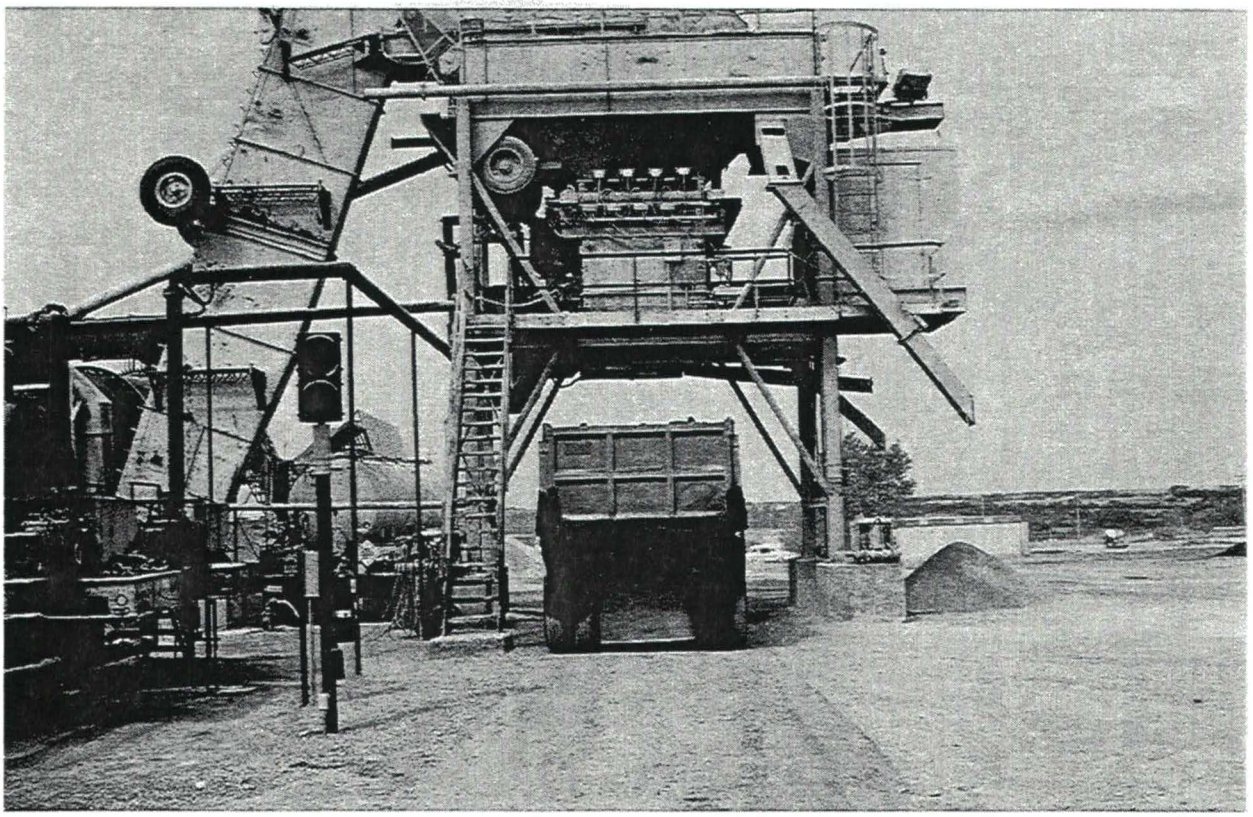
ULTRAPAVE 70 is delivered to the batch plant in the white tanker. (Foreground)



Delivery of the polymer to the mix is metered.

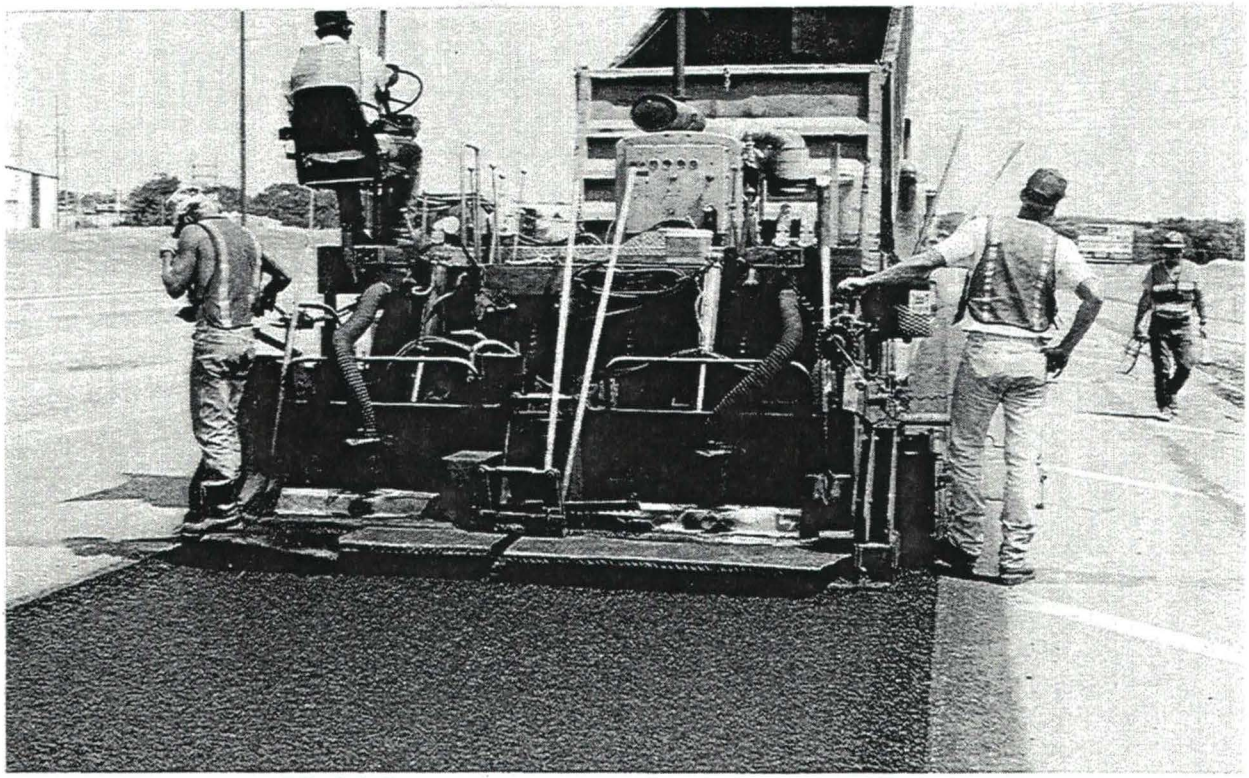


ULTRAPAVE 70 is delvered directly to the pugmill.

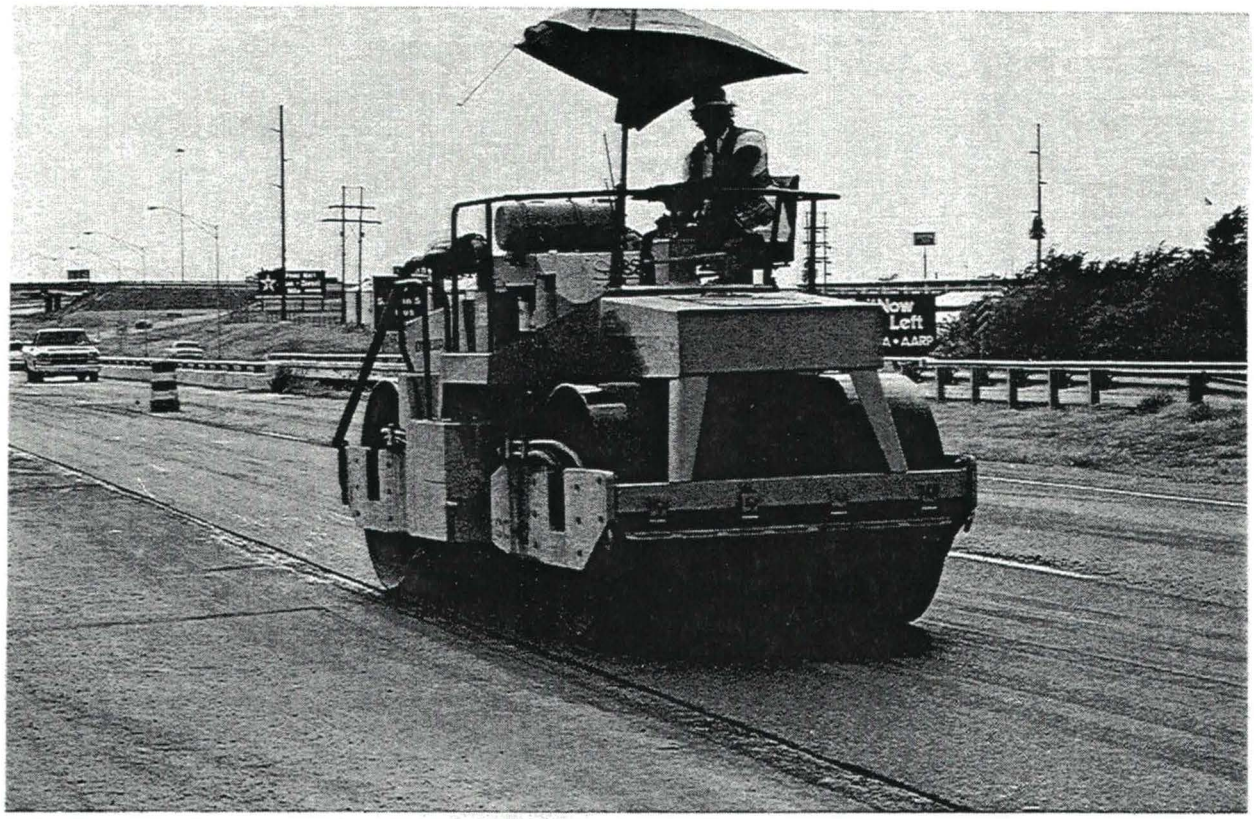


A truck waits for a fresh load.

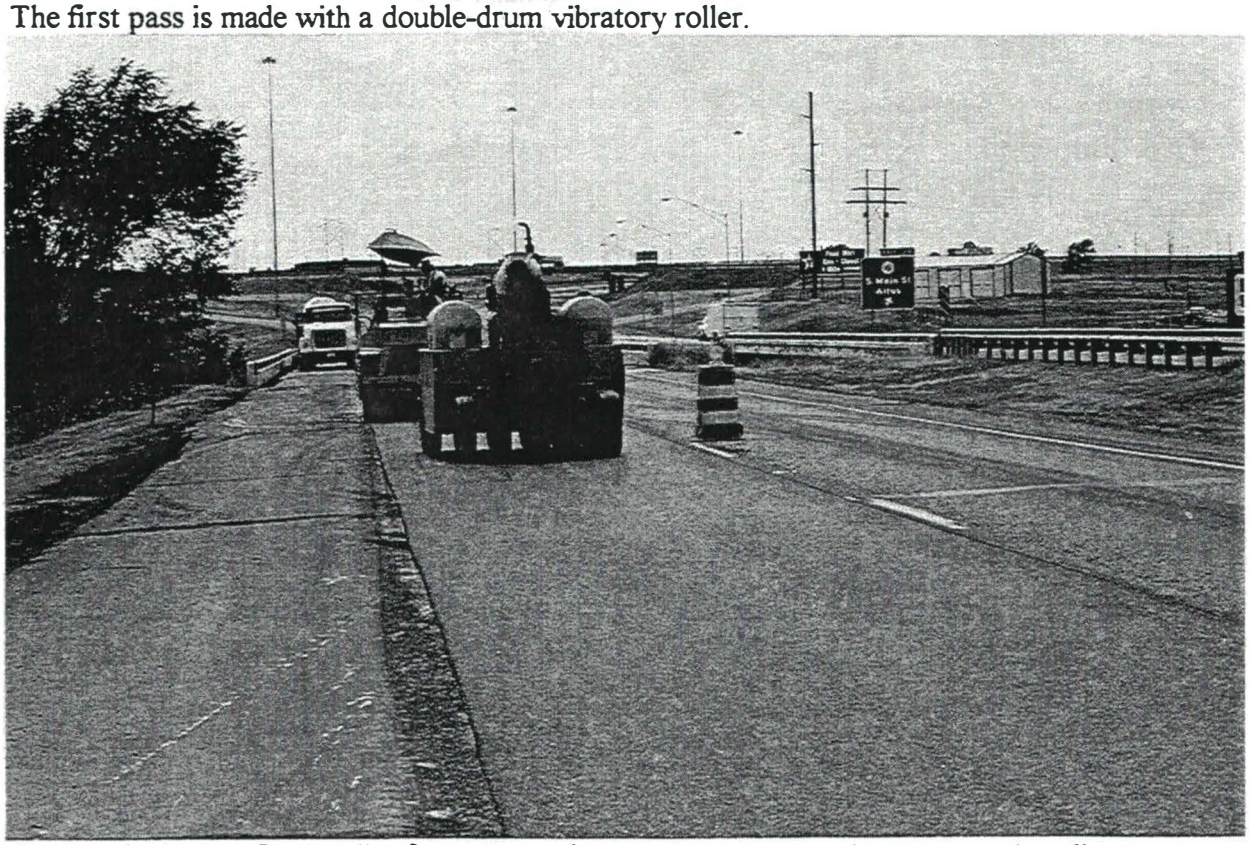
Milled surface.



Laying 38mm of modified AC.



The first pass is made with a double-drum vibratory roller.



The steel wheeled finish roller follows closely behind the intermediate pneumatic roller.