FIELD PERFORMANCE EVALUATION OF NOVOPHALT MODIFIED ASPHALT CONCRETE

Gary Williams, P.E.
Research Project Manager

CONSTRUCTION REPORT

Under the Supervision of
C. Dwight Hixon, P.E.
Research and Development
Division Engineer
Research and Development Division
Oklahoma Department of Transportation
200 N.E. 21st Street
Oklahoma City, Oklahoma 73105

June, 1993

Oklahoma Department of Transportation
Materials and Research Division

Date **March 3, 1998**

To David Cline, Division Engineer,

From Lawrence J. Senkowski, Assistant Division Engineer

Subject Project IM-35-3(223)130 Project Area
(I-35, between 23rd and 63rd Streets, Oklahoma City).

The attached report summarizes the present condition of the above project area.

A brief comparison regarding the field performance of the sections with experimental Novophalt Modified binder, "Polymer Modified" AC binder, and unmodified AC-20 binder is included.

If you have any questions or require further information, please call Gary Williams in our office (405-521-2671).

Attachment

cc: Pete Byers
Jack Telford
Gary Williams

IM-35-3(223)130 Project Area

(I-35, Between 23rd and 63rd Streets, Oklahoma City)

Gary Williams

ODOT MATERIALS AND RESEARCH

January 23, 1998

INTRODUCTION

In 1992, a research project was set up to evaluate the field performance of Novophalt Modified Asphalt Cement (NMAC). The IM-35-3(223)130 project area (I-35 between Northeast 23rd and 63rd, in Oklahoma City) made up the location where the evaluation was to be done.

Asphalt concrete laydown operations for the project were completed in October, 1992. Project IM-35-3(223)130 consisted of removing 4 ½ inches of existing pavement by cold milling, then replacing it with 3 inches of Type "A" AC and a 1 ½ in thick surface course.The surface course contained sections of Type "B" AC with "Polymer modified" (PMAC 1-B) binder, Novophalt Modified binder (NMAC), and unmodified AC-20 binder. Section with the various binders are located as shown in Figure 1. The project was 3.229 miles long. The contract amount was $1,688,040.
The Construction Report is attached. The report describes the laydown operation and gives general information on NMAC.

After five years have passed, the are clear differences in the performances of the three surfaces on the project, as described below.

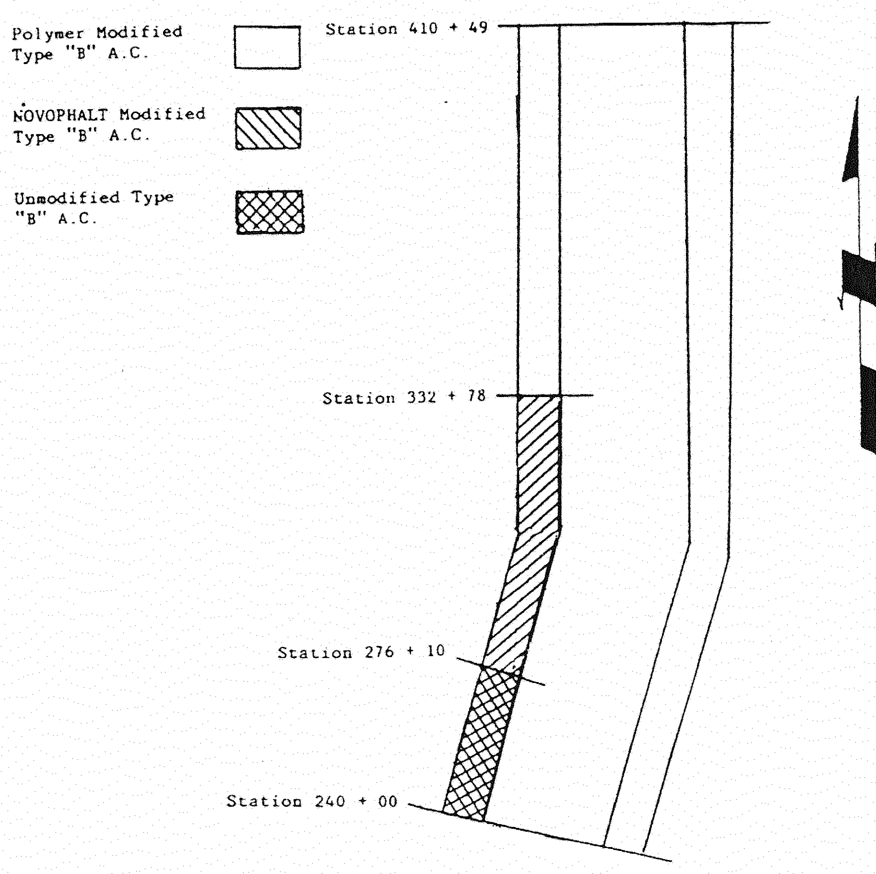


Figure 1. Location of Experimental Surface Sections on Project IM-35-3(223)130

SOUTHBOUND EXPRESSWAY

The three sections in this expressway are described in location order beginning at the north end of the project and moving south (in the direction of traffic).

"POLYMER MODIFIED" AC

The surface of this section consists of Type "B"AC with a modified asphalt binder where the modifier is an SBS block co-polymer, this product was originally distributed by ELF Corporation, under the name , "Styrelf". By the time this project was done, Koch Materials had purchased the rights to it. This is a "Type I" modified binder under the present classification system. At the time work on this project was in progress it was known as "Polymer Modified binder" on all contract documents. The "Polymer Modified" Section of the Southbound Expressway begins at the north end of the project (Station 410 + 49) and extends to Station 332 + 78.

Of the three sections in the Southbound Expressway, this one is in the best condition. Longitudinal fatigue cracks are located in the wheel paths (in one wheel path or the other) over approximately one-half of this section. In some of the worst cracked spots, (less than 10 percent of total area) transverse cracks have formed also. Where cracks intersect, pieces of the surface have come out, leaving holes approximately 1 foot in diameter. So far, maintenance forces have been able to keep these spots patched. Rut depths in this section ranged from 0.1 to 0.5 inches. Figure 1 shows typical conditions in this section.

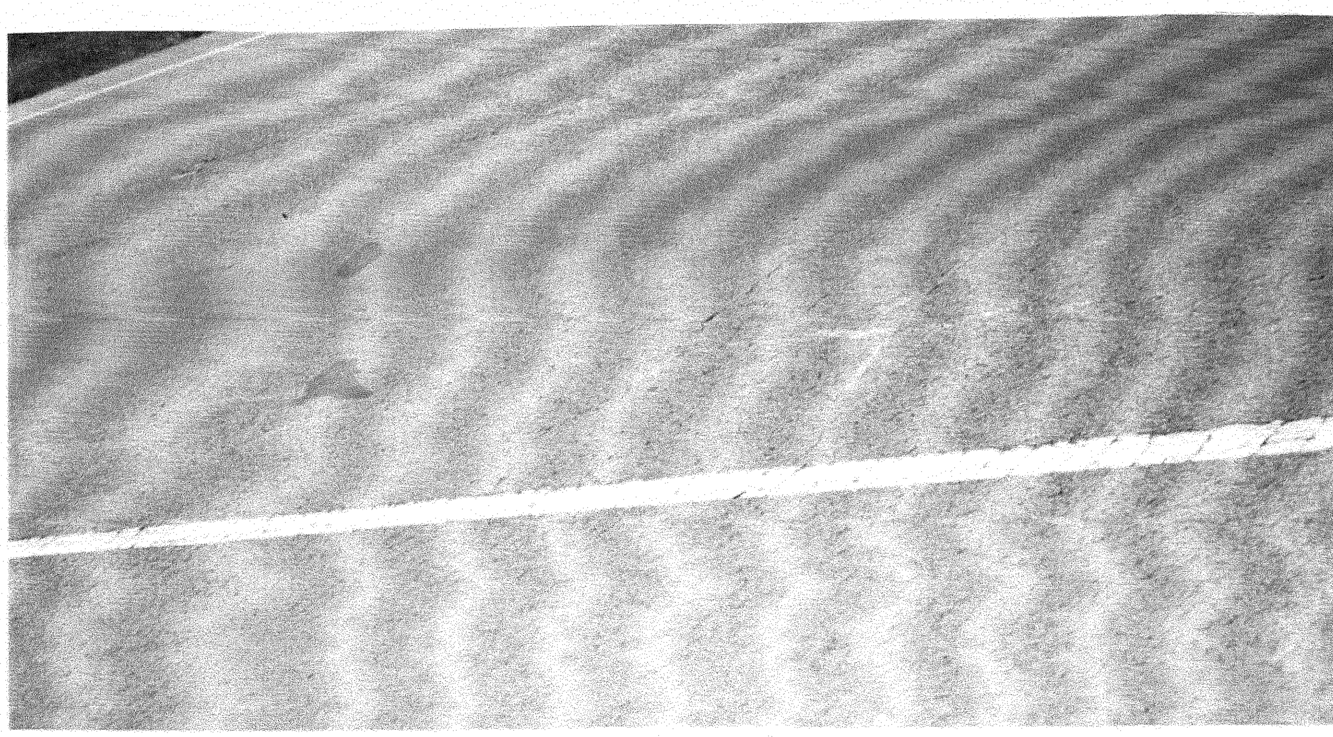


Figure 2. Typical conditions, "Polymer Modified" AC Section.

NOVOPHALT MODIFIED AC

In this section, located from Station 332 + 78 to 276 + 10, cracking was more widespread and severe than the previous section. In over half of the outside lane fatigue cracking has progressed to the point where there are several longitudinal cracks in each wheel path of the outside lane. There is also transverse cracking in much of this section. A network of cracks has developed in a three to four foot wide strip along one or both wheel paths of the outside lane (Figure 3). There are numerous spots where cracks intersect and pieces of asphalt have spalled out of the surface. Maintenance forces have attempted to keep up with patching these spots, but their number is increasing. This section will soon require either an overlay or a large scale patching operation. Patching would have to cover at least half of the outside lane. The inside lane is in slightly better condition, but it also shows considerable cracking. Rut depths in this section are 0.1 - 0.5 inch.

Figure 3. Cracking in outside lane, Novophalt Modified Asphalt Cement Binder section.

UNMODIFIED AC (CONTROL) SECTION

Conditions in this section are better than the "Novophalt" Section, but slightly worse than the "Polymer Modified" AC Section. Approximately 20 percent of the outside lane has longitudinal cracking in one or both wheel paths. In approximately 10 percent of the outside lane a network of cracks similar to that described in the "Novophalt" Section has developed. Rut depths ranged from 0.1 - 0.5 inch.

Figure 4. Typical Cracking in Unmodified AC Binder Section.

DISCUSSION

SOUTHBOUND EXPRESSWAY

The areas where the worst cracking has occurred will need corrective action soon. This applies mainly to the "Novophalt" Section where a large percentage (approximately 50 percent) of the outside lane will soon have to be patched or overlaid. There are areas in all three sections where corrective action (patching) will be required, but the areas are smaller, and the locations are generally isolated.

NORTHBOUND EXPRESSWAY

Performance of the entire Northbound Expressway, which was surfaced with "Polymer Modified" AC, has been better than that of the Southbound. The Northbound expressway did not contain any experimental or control sections. There are a few (approximately 5) isolated areas which will need patching, due to the occurrence of longitudinal and transverse cracks, but they make up a small percentage of the total expressway area (one or two percent).

Before Project IM-35-3(223)130, rutting and shoving were the major problems here. At that time, there was essentially no cracking in the project area. While IM-35-3(223)130 greatly improved the situation with regard to rutting, the cracking that has appeared since completion creates a situation that is as serious as the rutting and shoving that occurred here before IM-35-3(223)130. The major difference is that the worst cracking (now) is in the Novophalt section, (station 276 +10 - 332 + 78, Southbound Expressway), where the worst of the severe rutting (before IM-35-3(223)130) was located at the north end of the project (stations 355 + to 410 + 49). Five years after completion, all sections of this project require at least some patching. 1996 ADT for this area is 58,200, with 6.8 percent trucks. Another type of pavement may give better long-term performance.

Based on the performance of the Novophalt section, I recommend that ODOT not accept this product for use on Department projects.

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. FHWA/OK 93(04)	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE Field Performance Evaluation of NOVOPHALT Modified Asphalt Concrete		5. REPORT DATE May, 1993
		6. PERFORMING ORGANIZATION CODE ODOT Item Number 2727.
7. AUTHOR(S) Gary G. Williams		8. PERFORMING ORGANIZATION REPORT
		10. WORK UNIT NO.
9. PERFORMING ORGANIZATION ADDRESS Oklahoma Department of Transportation Research and Development Division 200 NE 21st Street, Room 2A2 Oklahoma City, Oklahoma 73105		11. CONTRACT OR GRANT NO.
		13. TYPE OF REPORT AND PERIOD COVERED Construction Report October, 1992.
12. SPONSORING AGENCY NAME AND ADDRESS Federal Highway Administration 200 NW 5th Street, Room 454 Oklahoma City, Oklahoma 73102		14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

The Oklahoma Department of Transportation (ODOT) has completed an experimental section of NOVOPHALT modified asphalt concrete on I-35 in northeast Oklahoma City. The experimental section was done as part of Project IM-35-3(223)130.

The IM-35-3(223)130 area had an ADT of 46,800. Before construction, the project area was heavily rutted. Shoving had occurred adjacent to some of the ruts, which added to the effect of the ruts on motorists.

Other Agencies have reported that NOVOPHALT modified asphalt concrete has been successful in resisting rutting and shoving. NOVOPHALT is produced by blending polyolefins, mainly polyethylene, into paving grade asphalt cement.

Briefly, IM-35-3(223)130 consisted of the following: Cold milling was done to remove two existing pavement layers which were considered to be unstable. After cold milling, the project area was overlayed with 3 inches of Type "A" asphalt concrete, then surfaced with 1 1/2 inches of Type "B". The experimental section of NOVOPHALT modified asphalt concrete was in the Type "B" surface layer.

Novophalt America, the NOVOPHALT distributor, provided a mobile blending unit to supply NOVOPHALT to the contractor's hot mix plant. The blending unit supplies NOVOPHALT to the plant in ready to use condition.

Rut measurements, Mays Ridemeter tests, and Falling weight Deflectometer tests were done before construction and after completion. All areas showed improvement. Similar data will be collected during the remainder of the evaluation period.

17. KEY WORDS Asphalt additives, Bituminous pavements, NOVOPHALT.	18. DISTRIBUTION STATEMENT No restrictions.

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	32	

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

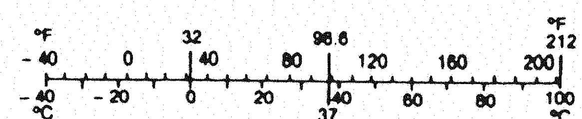
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
		AREA		
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
		AREA		
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2
		VOLUME		
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F



* SI is the symbol for the International System of Measurement

(Revised April 1989)

Table of Contents

List of Illustrations

List of Tables

INTRODUCTION

Rutting and shoving often occur on asphalt concrete roadways located in areas of high traffic. Other State Highway Agencies have reported that NOVOPHALT Modified Asphalt Concrete, hereafter called NMAC, shows increased resistance to both rutting and shoving (1). NMAC has also been reported to increase durability and resilience, resulting in reduced maintenance and longer pavement life (2). These improvements lower pavement costs, on a life cycle basis.

A separate problem is the accumulation of large quantities of used plastic as more cities begin recycling programs (3). A large proportion of the accumulated plastic is polyethylene.

NMAC is produced by blending polyolefins, primarily polyethylene, into paving grade asphalt cement. The polyethylene may be either virgin or recycled material. NOVOPHALT is produced by Novophalt America Incorporated, Sterling, Virginia.

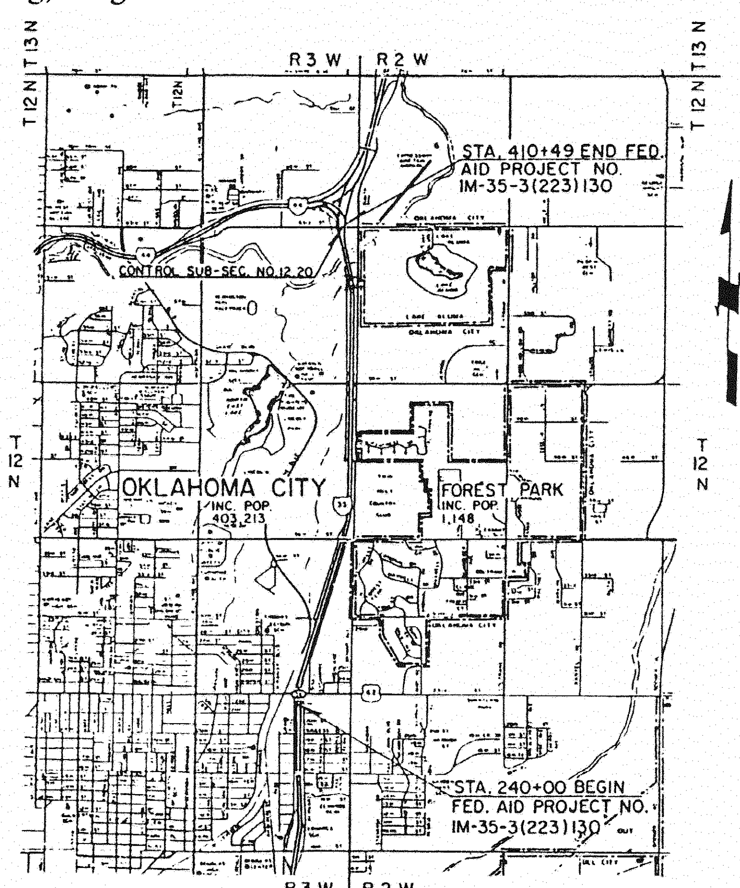


Figure 1. Location, Project IM-35-3(223)130.

Project Data

Original Construction and Overlays

I-35, in the Project Area, was originally constructed in 1958. The original pavement was made up of 2 inches of Type "B", and 3 inches of Type "A" Asphalt Concrete on a 7 inch stabilized aggregate base course.

In 1974, the IM-35-3(223)130 area was overlaid with a 3/4 inch thick plant mix seal coat and 1 1/2 inches of Type "C" asphalt concrete.

The next overlay was done in 1984, when this area was overlaid with 1 1/2 inches of Type "C" AC with a 3/4 inch Open Graded Friction Course surface. The Type "C" AC contained 38 percent reclaimed asphalt pavement. Prior to the 1984 overlay, the existing roadway was cold-milled, and Petromat was placed on the milled surface.

The existing pavement layers prior to IM-35-3(223)130 are shown in Figure 2.

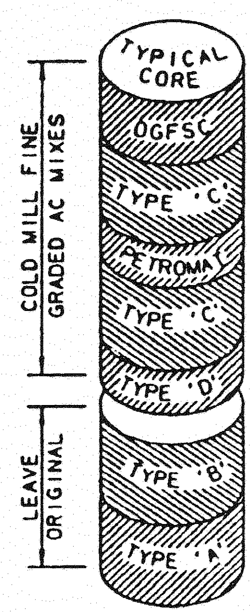


Figure 2. Existing Pavement Layers, Prior to IM-35-3(223)130

Roadway Condition

Prior to IM-35-3(223)130, this area had deep ruts. The entire project a area was rutted, with the Southbound Expressway more deeply rutted than the Northbound. Rut depths were greatest (all greater than 1.0 inch) toward the north end of the project, in the Southbound Expressway. Rut depths decreased from north to south. At the south end of the project, rut depths averaged (approximately) 1/2 inch. Shoving had occurred beside many of the ruts, making their overall effect worse than that due to rutting only. Some of the deepest ruts had developed corrugations in the bottom of the rut. Conditions described above are illustrated in Figure 3.

Figure 3. Ruts before construction, IM-35-3(223)130 Project Area.

Construction

Hot Mix Plant Operations

Novophalt modified asphalt cement is a binder system containing 4 to 6 percent, by weight, polyolefin additives, and paving grade asphalt cement. The polyolefins are typically polyethylene, which may be either virgin or recycled material. The modified asphalt cement is prepared by manufacturer's representatives, using a customized, high shear mill. NOVOPHALT Modified Binder is typically 3 to 4 times more viscous than the unmodified base asphalt cement.

NOVOPHALT modified asphalt cement must be stored with agitation to prevent stratification. It was not necessary to store the modified binder on this project. NOVOPHALT can be piped and transferred through plant piping lines in the same manner as unmodified AC. NOVOPHALT will not damage or clog lines or pumps that come in contact with the product, provided that the temperature is kept at least 50 degrees F above the melting point of the additive, which is (typically) 250 degrees F (121 degrees C).

On this project, the manufacturer provided a mobile blending unit (with operator) to supply NOVOPHALT to the contractor's hot mix plant. The blending unit (Figure 4) is self contained, and carries its own generator, heating system, and power train.

The blending unit was set up and connected to the hot mix plant in slightly less than four hours. The manufacturer's employees did the set up and connection. The blending unit is equipped with agitated mixing and storage tanks to insure uniformity of the product until it goes into the binder feeding line of the plant.

NOVOPHALT modified asphalt cement was added to the aggregate in the pug mill of the plant at a temperature of 330 degrees F (166 degrees C).

On this project, the manufacturer's blending unit was connected to the plant as shown in Figure 5. One hose from the blending unit connected to the plant asphalt intake line. The other connected to a return line. Both lines had shutoff valves at the connector.

The blending unit combines the polyolefin additive and asphalt cement (AC-20 on this project). Briefly, the combination process consists of adding polyethylene pellets (Figure 6) to asphalt cement in a high-shear, customized mill. The pellets may be produced from recycled or virgin polyethylene. Pellets used on this project consisted of recycled material. Where recycled polyethylene is used, its chemical makeup is verified prior to converting it to pellet form.

Figure 4. Mobile Blending Unit.

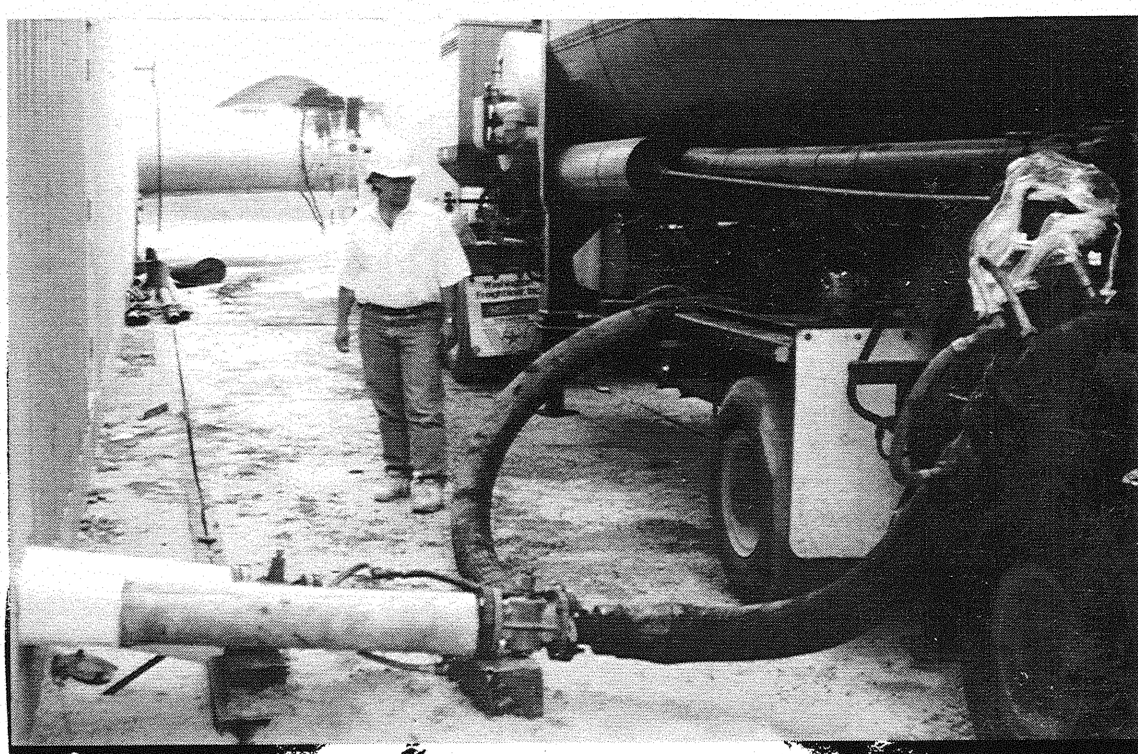


Figure 5. Connection of Mobile Blending Unit to Hot Mix Plant.

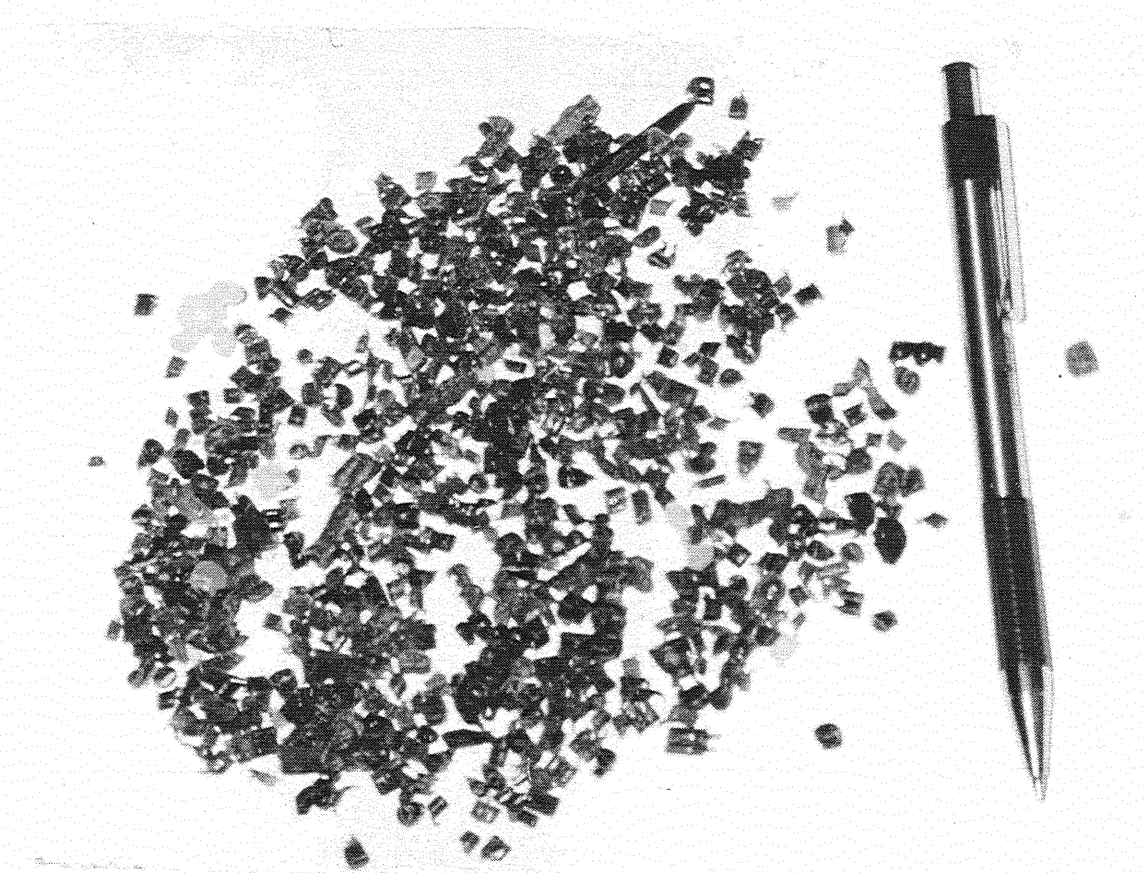


Figure 6. Polyethylene Pellets.

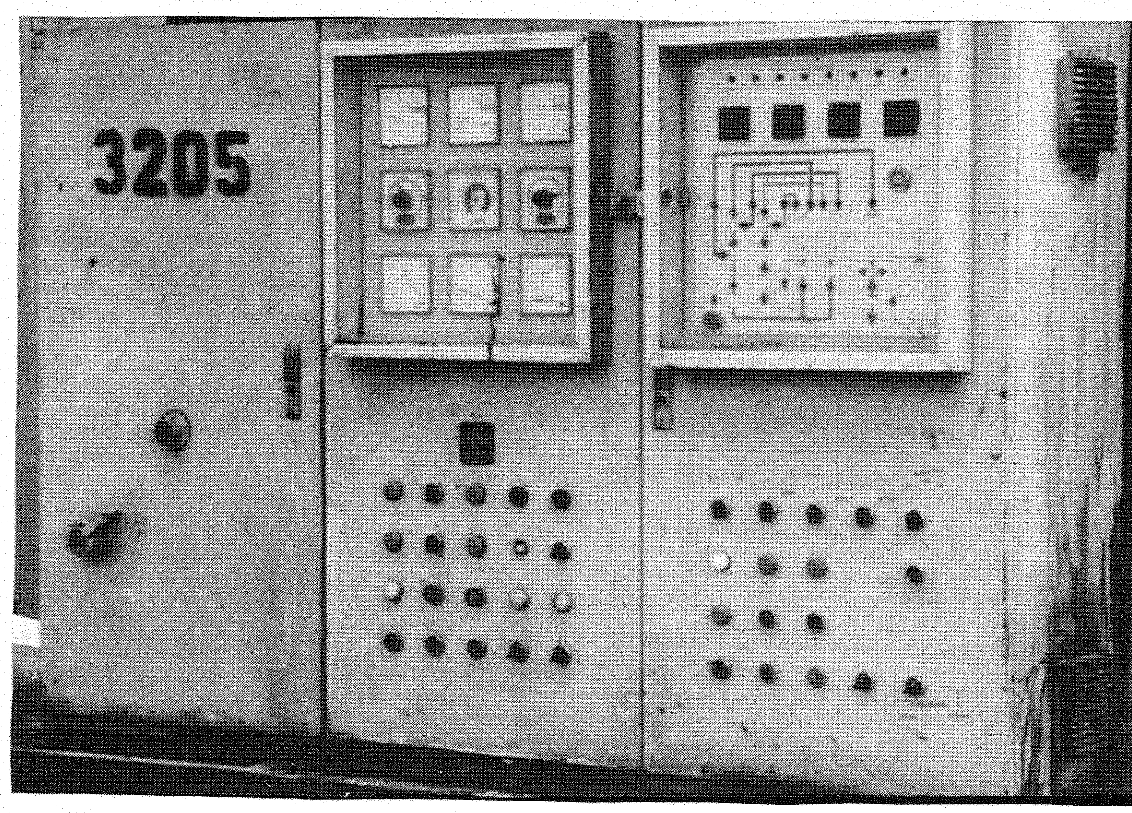


Figure 7. Central Processing Unit.

NMAC Laydown Operations

Before laydown operations began, the project area was cold milled to remove the layers shown in figure 2. Average depth of the milling was 5 inches. Depths at specific locations varied widely, between 3 and 6 1/2 inches, due to the extreme amount of rutting and shoving. The Type "A" and "B" layers below the cold milling were considered to be stable, and were left intact. The milling subcontractor was able to adjust milling depth so that material removed was that above these layers.

Following cold milling, a 3 inch lift of unmodified Type "A" AC was laid over the entire project. A 1 1/2 inch thick, Type "B" AC surface course was laid over the Type "A" mat.

From station 276 + 10 to 332 + 78, the surface course was NMAC, Type "B" mix. NMAC is laid, more or less, in the same manner as unmodified AC. Specific operations, and slight differences, whether required for NMAC handling, or due to the contractor's preference, are described below.

NOVOPHALT modified AC requires temperatures of over 280 degrees F. (138 degrees C.) during laydown and compaction. The contractor's employees constantly monitored mix temperature using a non-contact thermometer. This instrument reads surface temperature only. The minimum temperature monitored was 290 degrees F. (143 degrees C.)

The contractor's initial breakdown roller had a Troxler Continuous Density Gauge mounted on it (Figure 8). The screen of the density gauge (Figure 10) was mounted where the operator could monitor compaction, and adjust his pattern if necessary. The Gauge was set up so that it gave one reading for approximately every ten feet the roller travelled. Also, the Density Gauge had a light which came on automatically, if compaction varied more than one percent from the contractor's 95 percent target.

The contractor began laying NOVOPHALT on October 7, 1992. On that date, the ambient temperature dropped to 51 degrees F. (11 degrees C.). There were thunderstorms in the area (not on the project area), with wind gusts up to 55 mph (89 kmph). These conditions caused a more rapid cooling of the AC surface than had been the case up to then. Small surface cracks began showing up in one area of the NMAC. The contractor corrected this by moving up the breakdown roller, closer to the laydown machine. This left less time for the surface to cool. No surface cracking was observed once this change was made.

The contractor's Project Manager, and most of the laydown crew personnel working on this project had laid NOVOPHALT modified AC on a previous project for The Oklahoma Turnpike Authority. Because of this, all personnel were aware of the temperature requirements and the need to complete compaction before the mat could cool below 280 degrees F. (138 degrees C.)

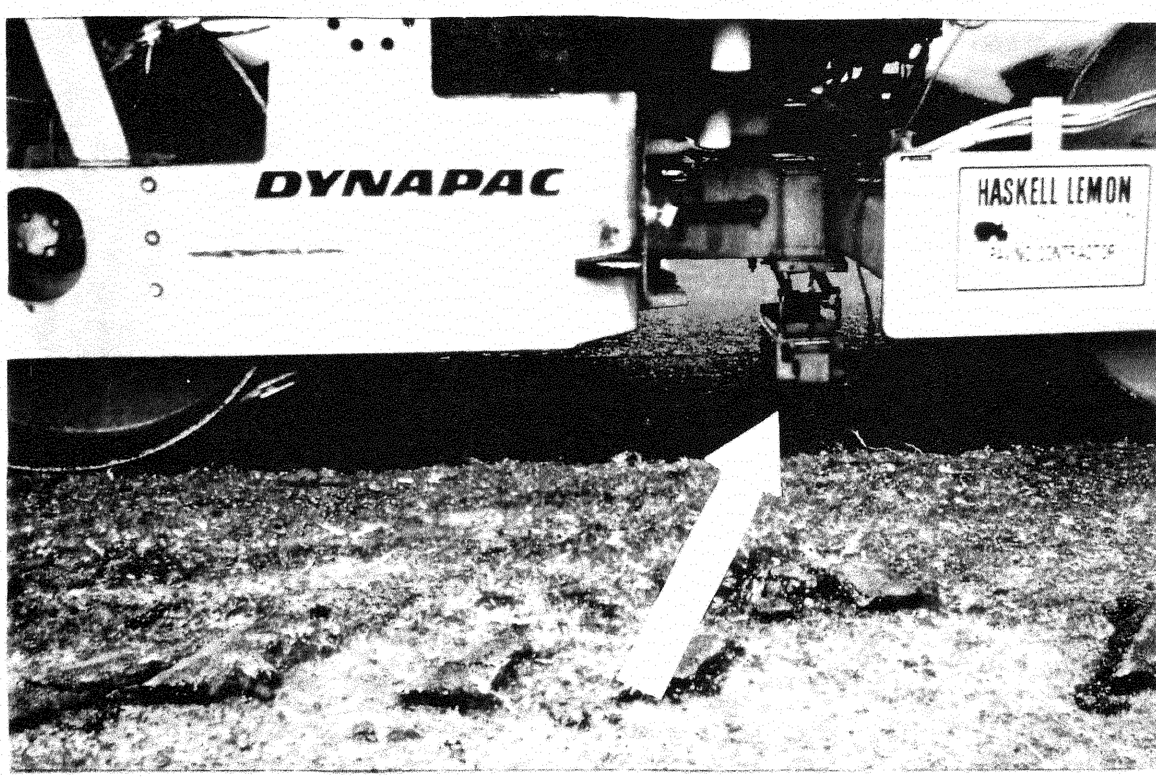


Figure 8. Continuous Density Gauge Mounted on Roller.

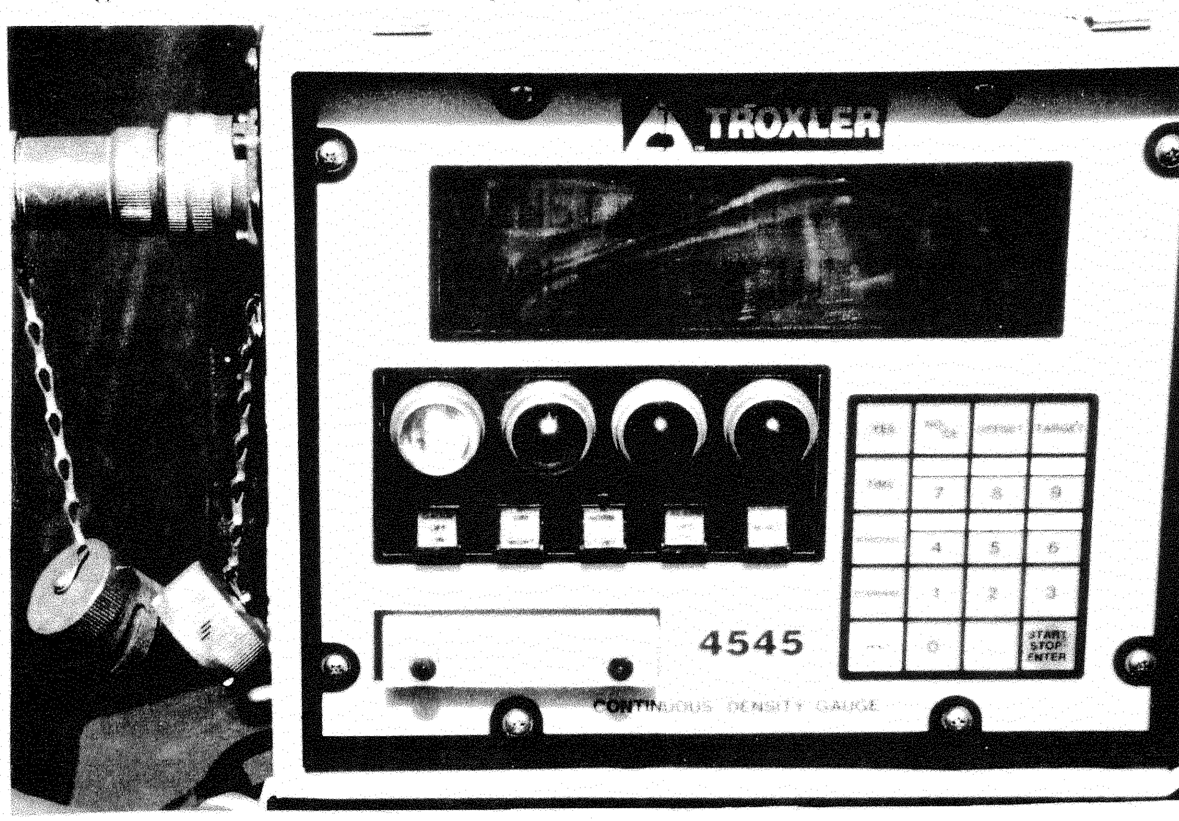


Figure 9. Screen for Continuous Density Gauge.

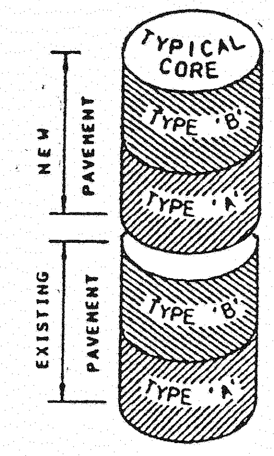


Figure 10. **Pavement Layers, After Completion of IM-35-3(223)130.**

Test Sections

It was originally intended that all of the surface course on this project would be (Styrelf) Polymer Modified Type "B" AC. Conditions before construction included severe rutting and shoving. It was decided to include an experimental section of NMAC to evaluate its ability to resist these conditions. A section of unmodified Type "B" was included for use as a control section. Both the experimental NMAC section and the control section were located in the southbound expressway The remainder of the project was surfaced with Polymer Modified Type "B" mix.

Surface of the Southbound Expressway was as follows:

Station 410 + 49 to 332 + 78	(Styrelf) Polymer Modified Type "B" AC
Station 332 + 78 to 276 + 10	NMAC, Type "B" AC
Station 276 + 10 to 240 + 00	Unmodified Type "B" AC

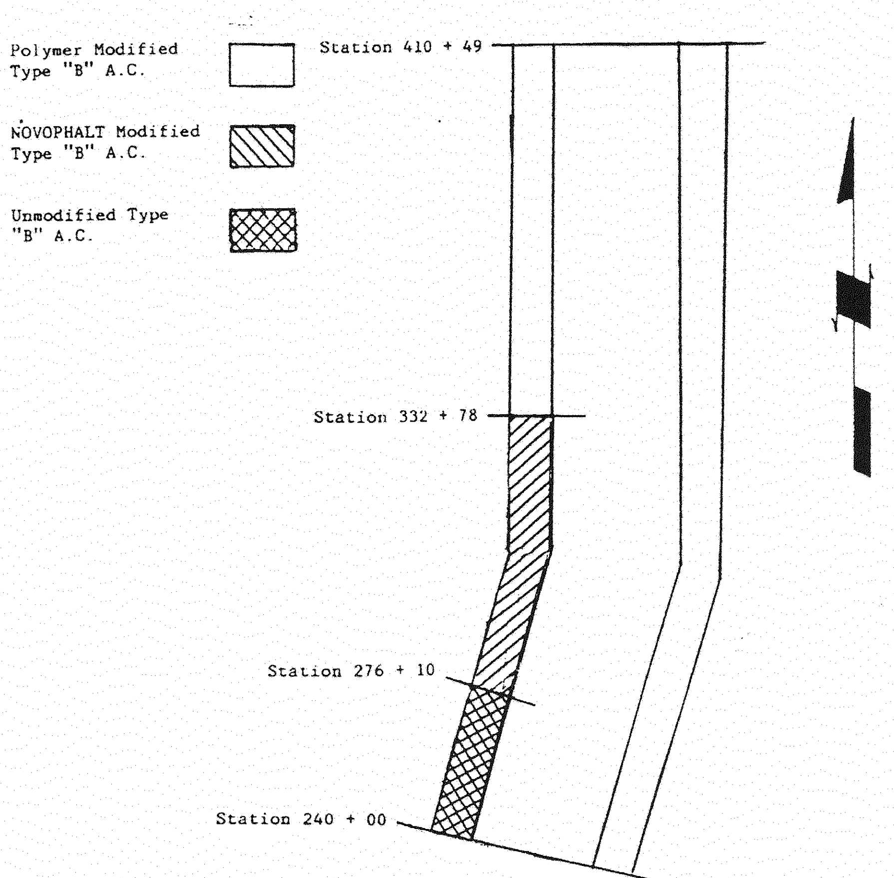


Figure 11. Polymer Modified, NOVOPHALT Modified, and Unmodified Surface Locations.

Data Collection

Before Construction

Rut depth measurements, FWD Tests, and Condition Ratings were done in the Southbound Expressway from Station 396 + 60 to 240 +00 (South end of Project). The area between 396 + 60 and 410 + 49 (North End of Project) contains the I-44/I-35 Interchange and it is very difficult to control traffic adequately to safely test this area.

The average rut depth was 0.8 inch in the outside wheel path, outside traffic lane. All ruts measured were deeper than 0.4 inch, with the deepest ruts located toward the north end of the project. Rut depths before construction are illustrated in Figure 12, with stations at the limits of the test sections marked.

The project area was tested with a Mays Ridemeter prior to construction. In the outside (west) lane, southbound expressway, the Mays Ridemeter rating was 3.7. The lowest rated section was a 2.6. In the inside (east) lane, the Mays Ridemeter rating was 4.2, with the lowest rated section receiving a 3.6.

Falling Weight Deflectometer (FWD) testing was done over the entire project length in the outside traffic lane, southbound expressway. Test data was analyzed separately for the sections surfaced with polymer modified, NOVOPHALT modified, and unmodified Type "B" AC. Results are summarized in Appendix "B", with the mean modulus of elasticity calculated for each section, corrected to 77 degrees F (25 degrees C). Moduli generally range from 325 to 550 ksi. Results of tests before construction were in that range, with the exception of one section surfaced with unmodified Type "B", where the mean was (roughly) 284 ksi. FWD testing was done when parts of the project area were closed, prior to cold milling. The section with unmodified Type "B" surface was done on two different days, so there are two different "before construction" moduli calculated for that section.

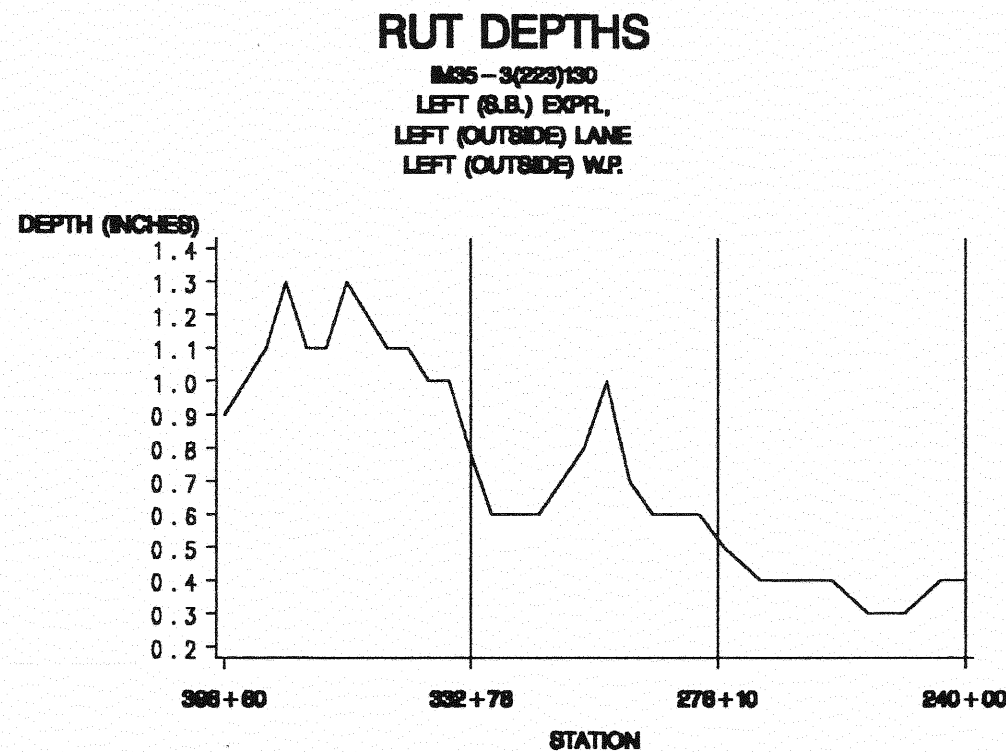


Figure 12. Ruts Before Construction, Project IM-35-3(223)130 Area.

After Construction.

After project completion, rut measurements were made, Mays Ridemeter and FWD Tests were done, and a condition rating was done.

Rut measurements were essentially zero. The Mays Ridemeter rating for the Project Area was 4.4, with the lowest rated section rated at 3.8. FWD Tests showed an increase in the average modulus for each of the three sections. However, there was a considerable amount of variation between individual tests. This was the case both before and after construction. The condition rating increased to 99.7 percent.

Results of all tests and measurements are tabulated in Appendix "B".

Analysis

Severe rutting has been a chronic problem in the project area for several years. In 1988, an investigation of the cause of the rutting was requested by ODOT Division IV. The investigation was done by the ODOT Materials Division, and included pavement and soil surveys. Visual inspection of cores taken during this survey indicated instability in the Type "C" pavement layer, laid in 1984. The pavement layers considered to unstable were removed by cold milling during this project. A report on the 1988 investigation is included in Appendix "D".

Results of tests by the Research and Development Division were summarized in the previous section. In the Southbound Expressway, where the test sections were located, rut depths were greatest in the area surfaced with Polymer Modified AC. The average rut depth in this area was 1.1 inches. The NMAC surfaced section had ruts with less depth (average depth was 0.7 inch). In the unmodified Type "B" section, depths averaged 0.4 inch.

Mays Ridemeter Test Results did not differ significantly for any of the three sections, either before or after construction.

Generally, greater amounts of rutting would be expected where FWD tests indicate a relatively low modulus of elasticity. There was no correlation of this type on this project. Average moduli after construction showed an increase, relative to those before determined before construction, for each of the three sections.

Cost

Contract costs of the three different surfaces are given in Table 1 and illustrated in Figure 11. The relatively high price of NOVOPHALT modified AC reflects the cost of moving their mobile blending unit to Oklahoma for a relatively small job. On a larger project, or a situation where NOVOPHALT was used on more than one project, the costs would be competitive with other modified AC mixes.

Table 1. Costs, Type "B" Mixes, IM-35-3(223)130

Asphalt Concrete	Contract Price, ($)
Unmodified	25.00
Polymer	29.00
NOVOPHALT	200.00

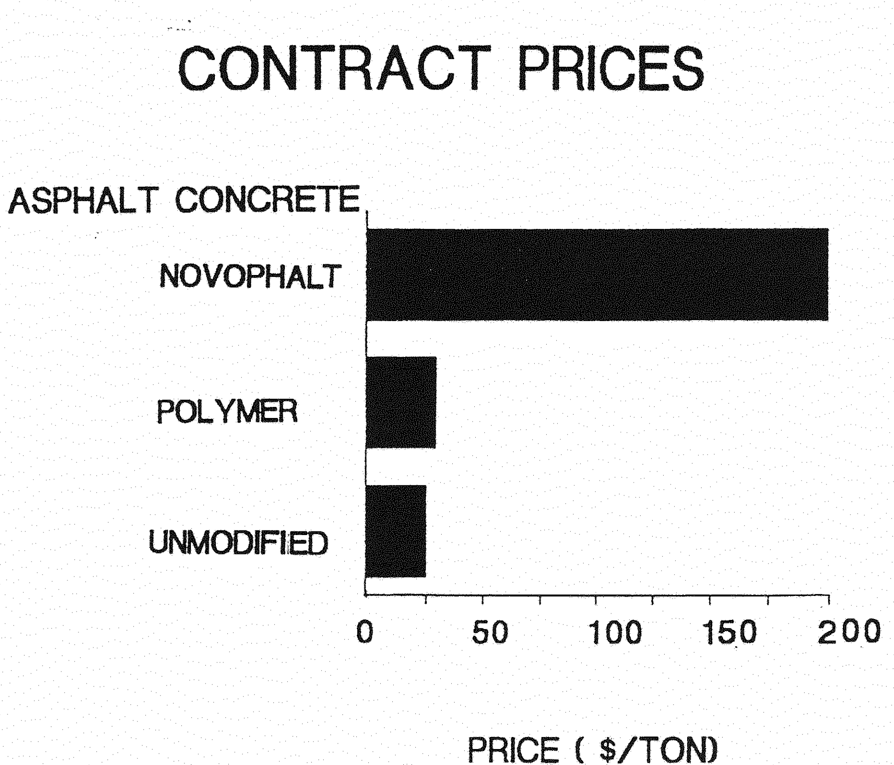


Figure 13. Costs of Type "B" Mixes.

Monitoring and Reporting

For the remainder of the three year evaluation period, FWD testing and condition ratings will be done annually. Rut depth measurements and Mays Ridemeter tests will be done twice a year. Any significant change in test results or measurements will be reported in an annual interim report.

At the end of the three year evaluation period, a Final Report will be written detailing performance of the NOVOPHALT section, relative to that of the unmodified Type "B" control section and the polymer modified comparison section. The Final Report will be written within six (6) months of the end of the evaluation period.

If substantial failure of the NOVOPHALT section should occur before the scheduled end of the evaluation, the ODOT Design Divisions will be notified at the time the failure is noted. In case of failure, the Final Report will be written within three (3) months of the date failure is observed.

References

1. "Performance Assessment of Binder-Rich Polyethylene-Modified Asphalt Concrete Mixtures (NOVOPHALT)", Dallas N. Little, The Texas Transportation Institute, Texas A. and M. University, 1991

2. "Comparative Life-Cycle Cost Analysis of NOVOPHALT and Conventional Asphalt Concrete Overlays in the Dallas, Texas Area". Dallas N. Little, The Texas Transportation Instsitute, Texas A. and M. University, May, 1990

3. "Brainpower to Make Recycling Work".Plastics News, September 17, 1990

Appendix "A", ODOT Special Provisions for NOVOPHALT.

OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
FOR
EXPERIMENTAL MODIFIED ASPHALT CONCRETE (NOVOPHALT)*
PROJECT NO. IR-35-3(223)130, OKLAHOMA COUNTY

These Special Provisions revise, amend, and where in conflict, supersede applicable Sections of Standards for Highway Construction, Edition of 1988, and the Supplement thereto, Edition of 1991.

411.01. DESCRIPTION. (Add the following.) The work shall consist of the addition of the polymer modifier, recycled polyethylene, to paving grade asphalt using the NOVOPHALT* process. The NOVOPHALT* modified asphalt shall be used in a bituminous paving mixture according to these Special Provisions. This Special Provision provides for the experimental use of NOVOPHALT*.

A technical representative of NOVOPHALT AMERICA, INC., shall be present at the pre-bid conference and during construction. The representative shall also provide information and technical advice to the Contractor and Engineer.

*NOVOPHALT, a trade name for NOVOPHALT Modified Asphalt Product, produced by NOVOPHALT AMERICA, INC., 107 Carpenter Drive, Suite 200, Sterling, VA, 22170.

Amend Section 708 to the following:

708.03.(a). ASPHALT MATERIALS. (Add the following.) NOVOPHALT MATERIAL. The NOVOPHALT Modified Asphalt shall meet the following requirements:

Test	AASHTO Test Method	Requirement
Penetration (77 F,100g, 5s)	T-49	30 Min 130 Max
Penetration (39.2, 200g,60s)	T-49	20 Min
Viscosity, 275F, cSt	T-201	150 Min 2000 Max
Softening Point, R & B, F	----	135 Min
Flash Point, F	T-48	425 Min
RTFOT Residue	T-240	
Loss, %		1.0 Max
Penetration (39.2, 200g, 60s)	T-49	10 Min

Solubility in Trichloroethylene, %	----	**

** Solubility in trichloroethylene (TCE) will be 99% minus the percentage additive. Most polyolefins are not soluble in TCE.

(b) Binder. The NOVOPHALT* modified asphalt cement shall contain 5 - 6% recycled polyethylene additive and 94 - 95% asphalt cement.

The uniform mixing of NOVOPHALT with the specified asphalt shall be performed at the asphalt plant or approved mixing and storage facilities provided for on the job site in strict accordance with the manufacturer's recommendations and instructions. The Contractor is to be responsible for assuring that the NOVOPHALT modified asphalt is properly mixed, delivered, stored and utilized according to these specifications.

708.04. COMPOSITION OF MIXTURES. (Amend as follows.) The paving mixtures shall consist of a uniform mixture of the combined aggregate and NOVOPHALT bituminous material and shall conform to the requirements shown in Table III for the type of mixture designated on the Plans or in the Proposal.

708.05. TOLERANCES. (Add the following.) The content of the NOVOPHALT additive shall be tested by the Engineer or Manufacturer with a test kit supplied by the NOVOPHALT AMERICA Corporation.

411.04. CONSTRUCTION METHODS. (Add the following.) (g). Spreading and Finishing. The NOVOPHALT asphalt mixture shall be laid with a paver meeting the requirements of Subsection 411.03(g) at a minimum temperature of 290 degrees F and only upon an approved surface, which shall be dry.

(i). Compaction. (Amend the third paragraph by adding the following.) Initial breakdown compaction shall be done at a minimum temperature of 290 degrees F. Rolling shall be continuous until the paving mixture reaches a temperature approved by the Resident Engineer for proper compaction. Pneumatic rollers shall not be used for compaction of the asphalt mixture unless it has sufficiently cooled to prevent tire pickup of the surface.

411.06. BASIS OF PAYMENT. (Add the following.) Accepted quantities of NOVOPHALT Modified Asphalt Concrete, measured as provided above, will be paid for at the contract unit price for:

TYPE B AGGREGATE	TON
NOVOPHALT ASPHALT	TON

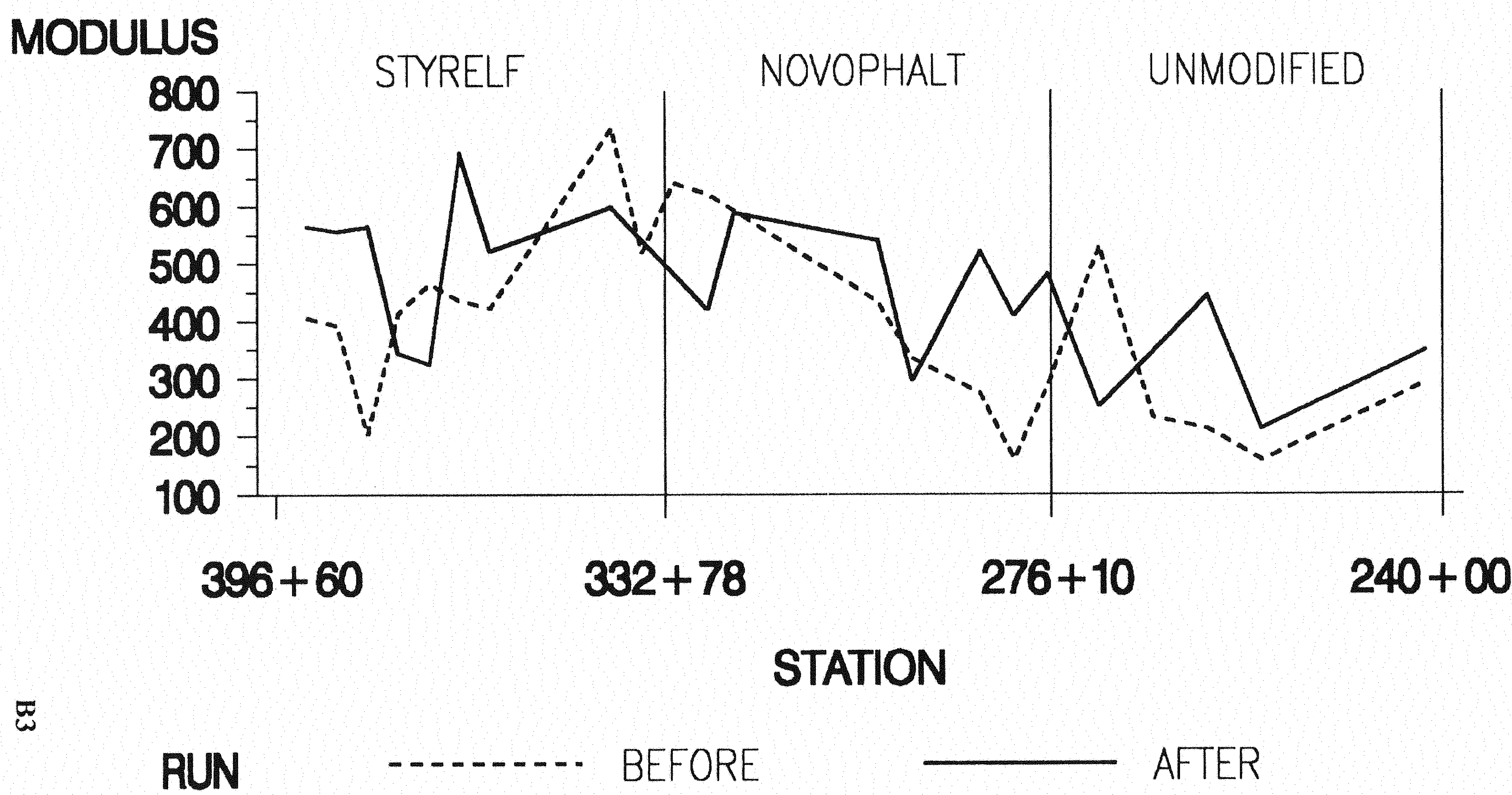
which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Appendix "B", Measurements and Test Results.

RUT MEASUREMENTS, PROJECT IM-35-3(223)130. Measured 8-21-92 and 9-16-92.		
Southbound Expressway, Outside (West) Traffic Lane		
Station	Outside Wheel Path	Inside Wheel Path
	Depth (In.)	Depth (In.)
396 + 60	0.9	0.8
391 + 32	1.0	0.9
386 + 04	1.1	1.3
380 + 76	1.3	1.5
375 + 48	1.1	0.9
370 + 20	1.1	0.9
364 + 92	1.3	1.0
359 + 64	1.2	1.1
354 + 36	1.1	1.0
349 + 08	1.1	1.0
343 + 80	1.0	1.0
338 + 52	1.0	0.9
333 + 24	0.8	0.8
327 + 96	0.6	0.5
322 + 68	0.6	0.5
317 + 40	0.6	0.5
312 + 12	0.7	0.5
306 + 84	0.8	0.6
301 + 56	1.0	0.6
296 + 28	0.7	0.9
291 + 00	0.6	0.5
285 + 72	0.6	0.5
280 + 44	0.6	0.4
275 + 16	0.5	0.2
269 + 88	0.4	0.3
264 + 60	0.4	0.3
259 + 32	0.4	0.3
254 + 04	0.3	0.3
248 + 76	0.3	0.3
243 + 48	0.4	0.2
240 + 20	0.4	0.5

RUT MEASUREMENTS, PROJECT IM-35-3(223)130. Measured 2-09-93		
Southbound Expressway, Outside (West) Traffic Lane		
Station	Outside Wheel Path	Inside Wheel Path
	Depth (In.)	Depth (In.)
396 + 60	0.0	0.0
391 + 32	0.0	0.0
386 + 04	0.0	0.0
380 + 76	0.0	0.0
375 + 48	0.0	0.0
370 + 20	0.0	0.0
364 + 92	0.1	0.0
359 + 64	0.0	0.0
354 + 36	0.0	0.0
349 + 08	0.1	0.0
343 + 80	0.0	0.0
338 + 52	0.1	0.0
333 + 24	0.0	0.0
327 + 96	0.0	0.0
322 + 68	0.0	0.0
317 + 40	0.0	0.0
312 + 12	0.0	0.0
306 + 84	0.1	0.0
301 + 56	0.0	0.0
296 + 28	0.0	0.0
291 + 00	0.0	0.0
285 + 72	0.0	0.0
280 + 44	0.0	0.0
275 + 16	0.0	0.0
269 + 88	0.0	0.0
264 + 60	0.0	0.0
259 + 32	0.0	0.0
254 + 04	0.0	0.0
248 + 76	0.0	0.0
243 + 48	0.0	0.0
240 + 20	0.0	0.0

FWD DATA
NOVOPHALT I-35



Analysis Variable : EAC77

---------------------- RUN=after SURFACE=NOVOPHALT ----------------------

N	Mean	Std Dev	Minimum	Maximum
7	465.5551561	98.0281619	296.5166746	588.6375494

---------------------- RUN=after SURFACE=STYRELF ----------------------

N	Mean	Std Dev	Minimum	Maximum
8	520.6525099	125.7297402	324.4899457	692.1386527

---------------------- RUN=after SURFACE=UNMOD ----------------------

N	Mean	Std Dev	Minimum	Maximum
4	313.5004464	103.6557948	212.1972428	443.5761574

---------------------- RUN=befor SURFACE=NOVOPHALT ----------------------

N	Mean	Std Dev	Minimum	Maximum
7	392.4260762	181.3483505	160.1808788	639.5281356

---------------------- RUN=befor SURFACE=STYRELF ----------------------

N	Mean	Std Dev	Minimum	Maximum
9	443.2202260	138.9327159	203.2145477	735.1585110

---------------------- RUN=befor SURFACE=UNMOD ----------------------

N	Mean	Std Dev	Minimum	Maximum
5	284.0222150	145.2167403	157.7901194	529.5532038

Date: 8-10-92

Location: S.B. Expressway Sta. 396+60-240+100

Length: 2.8 Ml.

CONDITION RATING FOR FLEXIBLE PAVEMENTS

Project Number: IM-35-3(223)130

Control Section: 35-55-15

Surveyed By: G. Williams

BEFORE CONSTRUCTION.

LEGEND FOR RATING CLASSES

CONDITION RATING	CRACKING	DISTORTION	RAVELING	SURFACE ROUGHNESS	BASE FAILURE	TOTAL SURFACE AREA OF RATING INTERVAL
	1-2-3-4	1-2-3-4	1-2-3-4	1-2-3-4	1-2-3-4	64.3%
1. 100-98% = EXCEL. 2. 97-90% = SUPER. 3. 89-80% = GOOD 4. 79-65% = AVER. 5. 64-50% = POOR 6. 50%-LESS= FAIL						1 = LESS THAN 5% 2 = 5% TO 15% 3 = 15% TO 30% 4 = 30% OR MORE

RATING INTERVAL (MI.)	CONDITION RATING (%)	CRACKING: LONGITUDINAL	TRANSVERSE	RANDOM	BLOCK	ALLIGATOR	CRACKING	DISTORTION: MINOR BLEEDING	INTER. BLEEDING	MAJOR BLEEDING	SHOVING	CORRUGATING	DISTORTION	RAVELING: MINOR	INTERMEDIATE	MAJOR	RAVELING	SURFACE ROUGHNESS: SMOOTH	MOD. ROUGH	ROUGH	SURFACE ROUGH	BASE FAILURE: MODERATE	SEVERE	BASE FAILURE	RUT DEPTH: 0.1 or 0.2 INCH	0.3 or 0.4 INCH	0.5 or GREATER	PATCH FT^2	COMMENTS
0.2	60							x				3									3						4	No Patches	Ruts 1"
0.4	60							x				3									3						4	No Patches	Ruts 1"
0.6	60											3									3						4	No Patches	Ruts 1"
0.8	60							x				3									3						4	No Patches	Ruts 1"
1.0	60							x				3									3						4	No Patches	Ruts 1"
1.2	60							x				3									3						4	No Patches	Ruts 1"
1.4	60							x				3									2						4	No Patches	Ruts 1"
1.6	60																				2						4	No Patches	Ruts 1"
1.8	70							x				1									2						4	No Patches	Ruts 1"
2.0	70	1										2									2						4	No Patches	Ruts 1"
2.2	70											3									2						4	No Patches	Ruts 1"
2.4	70							x				1									2						4	No Patches	Ruts = ½"
2.6	70							x													2						4	No Patches	Ruts = ½"
2.8	70							x													2						4	No Patches	Ruts = ½"
																													B5
	64.3																												

Date: 10-12-92

Location: S.B. EXPRESSWAY STA. 396+60-240+00

Length: 1.8 Miles

CONDITION RATING FOR FLEXIBLE PAVEMENTS

Project Number: IM-35-3(223)130

Control Section: 35-55-15

Surveyed By: G. Williams

AFTER COMPLETION.

LEGEND FOR RATING CLASSES

CONDITION RATING	CRACKING	DISTORTION	RAVELING	SURFACE ROUGHNESS	BASE FAILURE	TOTAL SURFACE AREA OF RATING INTERVAL
	1-2-3-4	1-2-3-4	1-2-3-4	1-2-3-4	1-2-3-4	99.7%

1. 100-98% = EXCEL.
2. 97-90% = SUPER.
3. 89-80% = GOOD
4. 79-65% = AVER.
5. 64-50% = POOR
6. 50%-LESS= FAIL

1 = LESS THAN 5%
2 = 5% TO 15%
3 = 15% TO 30%
4 = 30% OR MORE

RATING INTERVAL (MI.)	CONDITION RATING (%)	CRACKING: LONGITUDINAL	TRANSVERSE	RANDOM	BLOCK	ALLIGATOR	CRACKING	DISTORTION: MINOR BLEEDING	INTER. BLEEDING	MAJOR BLEEDING	SHOVING	CORRUGATING	DISTORTION	RAVELING: MINOR	INTERMEDIATE	MAJOR	RAVELING	SURFACE ROUGHNESS: SMOOTH	MOD. ROUGH	ROUGH	SURFACE ROUGH	BASE FAILURE: MODERATE	SEVERE	BASE FAILURE	RUT DEPTH: 0.1 or 0.2 INCH	0.3 or 0.4 INCH	0.5 or GREATER	PATCH FT^2	COMMENTS
0.2	100																												
0.4	100																												
0.6	98																								1				
0.8	100																												
1.0	98																								1				
1.2	100																								1				
1.4	100																												
1.6	100																												
1.8	100																												
2.0	100																												
2.2	100																												
2.4	100																												
2.6	100																												
2.8	100																												
	99.7																												

Appendix "C", Mix Design Sheets.

A.D. No. 009-022-092 ASPH. CONC. TYPE B INS. *Design No.* 3012-OAPA-92217

Project No. IM-35-3(223)130 12670(04) *Hwy.* I-35 *Avg. Daily Traffic* 5000+

Contractor: Haskell Lemon Const. Co. *Producer:* Haskell Lemon Const. Co. @ OKC

MATERIAL	*SOURCE*	*% USED*
5/8" Chips	Western Rock @ Davis, Okla.	40
Screenings	Dolese Co. @ Richards Spur, Okla.	23
Stone Sand	Dolese @ Davis, Okla.	24
Sand	G.M.I. Meridian Pit	13
Asphalt Cement (PMAC-1B)	Elf @ Muskogee, Okla.	

Laboratory No. *Percent Passing*	92217 Chips	92218 Scrns	92219 S. Sand	92220 Sand	*Combined Aggregate*	*Job Formula*	JMF Tolerance
3/4"	100				100	100	-0-
1/2"	96				98	98	± 7
3/8"	71	100			88	88	± 7
No. 4	18	87	100		64	64	± 7
No. 10	12	49	81	100	49	49	± 4
No. 40	10	19	21	88	25	25	± 4
No. 80	7	13	8	33	12	12	± 4
No. 200	5.4	9.7	4.2	2.4	5.7	5.7	± 2
% Asphalt Cement (PMAC-1B)						4.9	±0.4
Mix temperature @ discharge from mixer, °F						305	±20

Tests on Asphalt Cement:

	Found	Required
Penetration @ 25° C	88	75-100
Viscosity @ 60° C	5898	2500+
Viscosity @ 135° C	1131	-2000
Residue from RTFO		
Viscosity @ 60° C		8000 Max.
Ductility @ 25° C		50 Min.
Specific Gravity @ 25° C	1.0154	

Tests on Aggregates:

	Found	Required
Sand Equivalent	68	40 Min.
L.A. Abrasion % Wear	16.6	40 Max.
Durability (DC)	82	40 Min.
Insoluble Residue (Cal)	61.5	30 Min.
Fractured Faces	100	75 w/2
BISG	2.692	
Hveem Weight	1235	

Tests on Compressed Mixtures:

Percent Asphalt	*Spec. Grav. Specimen*	*Max. Theo. Spec.Grav.*	*Dens. % of Max. Theo.*	*Dens. % Req'd. of Max. Theo.*	*V.M.A. (%)*	*V.M.A. (Min.%)*	*Hveem Stab.*	*Hveem Stab.(*
4.5	2.346	2.506	93.6		16.8	15	60	40
5.0	2.364	2.487	95.1	94-96	16.6		59	
5.5	2.384	2.468	96.6		16.3		59	

Retained Strength 81.1 % 75% Minimum Required

Recommended 4.9 % Asphalt Cement (PMAC-1B)
Compacted Wt. 109.6 lbs./sq.yd./1" thickness
Max. Theo. Spec. Grav. @ 4.9 % Asphalt Cement is 2.491 (155.4 Pcf).

C1

MEETS SPECIFICATION REQUIREMENTS

OK 1-25-9 EF

A.D. No. 009-025-092 ASPH. CONC. TYPE B INS. *Design No.* 3012-OAPA-92218

Project No. IM-35-3(223)130 12679(04) *Hwy.* I-35 *Avg. Daily Traffic* 5000+

Contractor: Haskell Lemon Const. *Producer:* Haskell Lemon @ Okla. City, Okla.

MATERIAL	*SOURCE*	*% USED*
5/8" Chips	Western Rock @ Davis, Okla.	40
Screenings	Dolese Co. @ Richards Spur, Okla.	23
Stone Sand	Dolese @ Davis, Okla.	24
Sand	G.M.I. @ Meridian Pit	13
Asphalt Cement (AC-20)	Kerr McGee @ Wynnewood, Okla.	

Laboratory No. *Percent Passing*	92217 Chips	92218 Scrns	92219 S. Sand	92220 Sand	*Combined Aggregate*	*Job Formula*	JMF Tolerance
3/4"	100				100	100	-0-
1/2"	96				98	98	± 7
3/8"	71	100			88	88	± 7
No. 4	18	87	100		64	64	± 7
No. 10	12	49	81	100	49	49	± 4
No. 40	10	19	21	88	25	25	± 4
No. 80	7	13	8	33	12	12	± 4
No. 200	5.4	9.7	4.2	2.4	5.7	5.7	± 2
% Asphalt Cement (AC-20)						4.8	±0.4
Mix temperature @ discharge from mixer, °F						305	±20

Tests on Asphalt Cement:

	Found	Required
Penetration @ 25° C	74	60-100
Viscosity @ 60° C	1942	2000±400
Viscosity @ 135° C	429	300 Min.
Residue from RTFO		
Viscosity @ 60° C	4462	8000 Max.
Ductility @ 25° C	110+	50 Min.
Specific Gravity @ 25° C	1.0129	

Tests on Aggregates:

	Found	Required
Sand Equivalent	68	40 Min.
L.A. Abrasion % Wear	16.6	40 Max.
Durability (DC)	82	40 Min.
Insoluble Residue (Cal)	61.5	30 Min.
Fractured Faces	100	75 w/2
BISG	2.692	
Hveem Weight	1235	

Tests on Compressed Mixtures:

Percent Asphalt	*Spec. Grav. Specimen*	*Max. Theo. Spec.Grav.*	*Dens. % of Max. Theo.*	*Dens. % Req'd. of Max. Theo.*	*V.M.A. (%)*	*V.M.A. (Min.%)*	*Hveem Stab.*	*Hveem Stab. (M*
4.5	2.354	2.505	94.0		16.5	15	52	40
5.0	2.373	2.486	95.5	94-96	16.3		53	
5.5	2.390	2.467	96.9		16.1		51	

Retained Strength 81.8 % 75% Minimum Required

Recommended 4.8 % Asphalt Cement (AC-20)
Compacted Wt. 109.7 lbs./sq.yds./1" thickness
Max. Theo. Spec. Grav. @ 4.8 % Asphalt Cement is 2.494 (155.6 pcf).

C2

MEETS SPECIFICATION REQUIREMENTS

OK 10-1-9
E

A.D. No. 009-022-092 ASPH. CONC. TYPE B INS. Design No. 3012-0APA-92219

Project No. IM-35-3(223)130 12670(04) Hwy. I-35 Avg. Daily Traffic 5000+

Contractor: Haskell Lemon Const. Producer: Haskell Lemon Const. Co. @ OKC, Okla.

MATERIAL	SOURCE	% USED
5/8" Chips	Western Rock @ Davis, Okla.	40
Screenings	Dolese Co. @ Richard Spur, Okla.	23
Stone Sand	Dolese @ Davis, Okla.	24
Sand	G.M.I. Meridian Pit	13
Asphalt Cement (Novophalt)	Novophalt and Kerr McGee	

Laboratory No. / Percent Passing	92217 Chips	92218 Scrns	92219 S. Sand	92220 Sand	Combined Aggregate	Job Formula	JMF Tolerances
3/4"	100				100	100	-0-
1/2"	96				98	98	± 7
3/8"	71	100			88	88	± 7
No. 4	18	87	100		64	64	± 7
No. 10	12	49	81	100	49	49	± 4
No. 40	10	19	21	88	25	25	± 4
No. 80	7	13	8	33	12	12	± 4
No. 200	5.4	9.7	4.2	2.4	5.7	5.7	± 2
% Asphalt Cement (Novophalt)						4.8	±0.4
Mix temperature @ discharge from mixer, °F						305	±20

Tests on Asphalt Cement:

	Found	Required
Specific Gravity @ 25° C	1.023	

Tests on Aggregates:

	Found	Required
Sand Equivalent	68	40 Min.
L.A. Abrasion % Wear	16.6	40 Max.
Durability (DC)	82	40 Min.
Insoluble Residue (cal)	61.5	30 Min.
Fractured Faces	100	75 w/2
BISG	2.692	
Hveem Weight	1235	

Tests on Compressed Mixtures:

Percent Asphalt	Spec. Grav. Specimen	Max. Theo. Spec.Grav.	Dens. % of Max. Theo.	Dens. % Req'd. of Max. Theo.	V.M.A. (%)	V.M.A. (Min.%)	Hveem Stab.	Hveem Stab.(M.
4.5	2.351	2.508	93.7		16.6	15	63	40
5.0	2.378	2.489	95.5	94-96	16.1		61	
5.5	2.390	2.470	96.7		16.1		60	

Retained Strength 83.8 % 75% Minimum Required

Recommended 4.8 % Asphalt Cement (Novophalt)
Compacted Wt. 109.8 lbs./sq.yd./1" thickness
Max. Theo. Spec. Grav. @ 4.8 % Asphalt Cement is 2.496 (155.8 pcf).

C3

MEETS SPECIFICATION REQUIREMENTS

OK
9-25-

Appendix "D", Soil and Pavement Survey.

Report No.
64-5280-93651

OKLAHOMA DEPARTMENT OF TRANSPORTATION

DATE: October 8, 1991

RECEIVED
OCT 9 1991
URBAN DESIGN

TO: Bruce Taylor, Urban Design Engineer

FROM: Materials Division

SUBJECT: BENKELMAN BEAM TEST DATA
PROJECT NO. I-35, 06343(05)
OKLAHOMA COUNTY, I 35 from N.E. 10th Street
north to N.E. 63rd Street

Attached are Benkelman Beam deflection ratings, design values and rut depth measurements. Deflections in excess of a beam rating of 22 are critical for a 15,000 lb. wheel load design.

It should be noted that the enclosed data is for the outside lanes only. Adjustments will have to be made for the additional lanes.

This concludes our investigation, unless otherwise notified.

J. D. Telford, P. E.
Materials Engineer

By:

James B. Nevels, Jr.

James B. Nevels, Jr., P. E.
Soils and Foundations Engineer

JBN/rk

Attachment

c: Materials File
T. Borg, Pavement Design Engineer
Chris Senkowski, Project Engineer
Soils and Foundations Branch
Bookkeeping

AC OVERLAY PROGRAM

DATE 10-07-91

DIVISION 4 COUNTY Oklahoma TEST DATE 10-7-91

PROJECT NUMBER I-35, NE 10 to NE 63

DESCRIPTION
Northbound Lane, Outside Wheelpath

RUT DEPTH	MILAGE EXTENTS	BEAM DEFLECTION	LOAD SUPPORTING ABILITY	INCHES OF A.C. EQUIVALENT REQUIRED — WHEEL LOAD DESIGN 11000.	12000.	13000.	14000.	15000.
1	0.04	0.017	19915.	0.0	0.0	0.0	0.0	0.0
1	0.13	0.003	******	0.0	0.0	0.0	0.0	0.0
1	0.23	0.013	******	0.0	0.0	0.0	0.0	0.0
1	0.51	0.015	******	0.0	0.0	0.0	0.0	0.0
1	0.61	0.013	******	0.0	0.0	0.0	0.0	0.0
1	0.70	0.005	******	0.0	0.0	0.0	0.0	0.0
2	0.89	0.011	******	0.0	0.0	0.0	0.0	0.0
1	0.99	0.015	******	0.0	0.0	0.0	0.0	0.0
2	1.08	0.007	******	0.0	0.0	0.0	0.0	0.0
2	1.36	0.009	******	0.0	0.0	0.0	0.0	0.0
6	1.55	0.007	******	0.0	0.0	0.0	0.0	0.0
1	1.84	0.003	******	0.0	0.0	0.0	0.0	0.0
1	1.93	0.003	******	0.0	0.0	0.0	0.0	0.0
4	2.03	0.015	******	0.0	0.0	0.0	0.0	0.0
1	2.12	0.003	******	0.0	0.0	0.0	0.0	0.0
1	2.22	0.005	******	0.0	0.0	0.0	0.0	0.0
2	2.31	0.007	******	0.0	0.0	0.0	0.0	0.0
1	2.69	0.009	******	0.0	0.0	0.0	0.0	0.0
1	2.78	0.005	******	0.0	0.0	0.0	0.0	0.0
3	2.92	0.005	******	0.0	0.0	0.0	0.0	0.0
1	2.97	0.013	******	0.0	0.0	0.0	0.0	0.0
1	3.10	0.005	******	0.0	0.0	0.0	0.0	0.0
2	3.16	0.011	******	0.0	0.0	0.0	0.0	0.0
3	3.45	0.005	******	0.0	0.0	0.0	0.0	0.0
2	3.54	0.007	******	0.0	0.0	0.0	0.0	0.0
2	3.66	0.005	******	0.0	0.0	0.0	0.0	0.0
2	3.73	0.005	******	0.0	0.0	0.0	0.0	0.0

****** - WHEEL LOAD GREATER THAN 20000 LB.

AC OVERLAY PROGRAM

DATE 10-07-91

DIVISION 4 COUNTY Oklahoma TEST DATE 10-7-91

PROJECT NUMBER I-35, NE 10 to NE 63

DESCRIPTION
Southbound Lane, Outside Wheelpath

RUT DEPTH	MILAGE EXTENTS	BEAM DEFLECTION	LOAD SUPPORTING ABILITY	INCHES OF A.C. EQUIVALENT REQUIRED — WHEEL LOAD DESIGN				
				11000.	12000.	13000.	14000.	15000.
11	3.68	0.029	10576.	0.5	1.6	2.7	3.8	4.9
9	3.59	0.019	17456.	0.0	0.0	0.0	0.0	0.0
15	3.50	0.011	******	0.0	0.0	0.0	0.0	0.0
17	3.40	0.015	******	0.0	0.0	0.0	0.0	0.0
20	3.24	0.011	******	0.0	0.0	0.0	0.0	0.0
22	3.21	0.005	******	0.0	0.0	0.0	0.0	0.0
12	3.03	0.011	******	0.0	0.0	0.0	0.0	0.0
12	2.93	0.019	17456.	0.0	0.0	0.0	0.0	0.0
9	2.84	0.007	******	0.0	0.0	0.0	0.0	0.0
7	2.74	0.011	******	0.0	0.0	0.0	0.0	0.0
9	2.65	0.013	******	0.0	0.0	0.0	0.0	0.0
11	2.55	0.029	10576.	0.5	1.6	2.7	3.8	4.9
8	2.46	0.019	17456.	0.0	0.0	0.0	0.0	0.0
7	2.37	0.009	******	0.0	0.0	0.0	0.0	0.0
8	2.72	0.017	19915.	0.0	0.0	0.0	0.0	0.0
7	2.18	0.017	19915.	0.0	0.0	0.0	0.0	0.0
17	2.08	0.019	17456.	0.0	0.0	0.0	0.0	0.0
13	1.99	0.021	15504.	0.0	0.0	0.0	0.0	0.0
11	1.90	0.021	15504.	0.0	0.0	0.0	0.0	0.0
9	1.80	0.021	15504.	0.0	0.0	0.0	0.0	0.0
12	1.71	0.023	13919.	0.0	0.0	0.0	0.1	1.2
11	1.61	0.015	******	0.0	0.0	0.0	0.0	0.0
5	1.43	0.021	15504.	0.0	0.0	0.0	0.0	0.0
2	1.33	0.005	******	0.0	0.0	0.0	0.0	0.0
3	1.24	0.019	17456.	0.0	0.0	0.0	0.0	0.0
4	1.14	0.021	15504.	0.0	0.0	0.0	0.0	0.0
3	1.05	0.023	13919.	0.0	0.0	0.0	0.1	1.2
8	0.96	0.017	19915.	0.0	0.0	0.0	0.0	0.0
1	0.86	0.007	******	0.0	0.0	0.0	0.0	0.0

****** - WHEEL LOAD GREATER THAN 20000 LB.

RUT DEPTH	MILAGE EXTENTS	BEAM DEFLECTION	LOAD SUPPORTING ABILITY	INCHES OF A.C. EQUIVALENT REQUIRED — WHEEL LOAD DESIGN 11000.	12000.	13000.	14000.	15000.
2	0.77	0.003	******	0.0	0.0	0.0	0.0	0.0
4	0.67	0.009	******	0.0	0.0	0.0	0.0	0.0
5	0.58	0.005	******	0.0	0.0	0.0	0.0	0.0
4	0.49	0.007	******	0.0	0.0	0.0	0.0	0.0
2	0.39	0.005	******	0.0	0.0	0.0	0.0	0.0
4	0.30	0.005	******	0.0	0.0	0.0	0.0	0.0
5	0.20	0.019	17456.	0.0	0.0	0.0	0.0	0.0
5	0.11	0.025	12610.	0.0	0.0	0.4	1.5	2.7

****** - WHEEL LOAD GREATER THAN 20000 LB.

Oklahoma Dept. of Transportation

Date November 2, 1988

To David Golden, Division Engineer

From J. D. Telford, Materials Engineer

Subject I-35 From N.E. 40th to N.E. 63rd

This section of I-35 was constructed in 1958, overlaid in 1974, and overlaid again in 1984. The original pavement section consisted of 2 inches of asphalt concrete type B and 3 inches of asphalt concrete type A on 7 inches of stabilized aggregate base course. The 1972 overlay consisted of 3/4 inches of plant mix seal coat and 1-1/2 inches of asphalt concrete type C. The 1984 overlay consisted of 3/4 inches of open-grade friction surface course and 1-1/2 inches of asphalt concrete type C. The existing roadway was milled and petromat was placed on the milled surface as part of the 1984 project.

Asphalt cores and soils samples were obtained from this section of I-35. Attached find a soils survey and a pavement survey. The soils survey lists the various subgrade soils encountered. The pavement survey lists the various asphalt mixtures encountered.

Rutting of the asphalt pavement was noted throughout the section. The rutting measured varied from 1/4 inch to 1-3/4 inches in the outside lane and from 1/8 inch to 5/8 inch in the inside lane. A visual inspection of the asphalt cores revealed that the rutting is occurring primarily in the asphalt mixture above the petromat(see pavement survey summary for asphalt cores 2A, 2B, and 2C; 3A, 3B, and 3C; and 11A, 11B, and 11C). A review of the project records for the 1984 overlay revealed that the asphalt concrete type C contained 38% reclaimed asphalt pavement and used AC-3.5 for the asphalt cement. Problems with rutting have occurred on other roadways using high percentages of reclaimed materials and soft grades of asphalt cement.

It is recommended that any rehabilitation of roadway include removal of the asphalt mixture above the petromat.

If you have any questions regarding this matter, please do not hesitate to contact me.

J. D. Telford, P. E.
Materials Engineer

By:

Reynolds H. Toney

Reynolds H. Toney, P. E.
Bituminous Branch Manager Engineer

cc: Director
Monty Murphy
Jack Blaess
Pete Byers
Richard Hankins
Bob Stringer
W. T. Merrill

DH Form 301-82

CALCULATIONS
CHECKED BY ____________

PROOF READ BY ____________

10 ... (illegible top line)
63-5010-10787
63-5190-10787

STATE OF OKLAHOMA

DEPARTMENT OF TRANSPORTATION

Materials Division

SOILS SURVEY

urveyed By: Davis - Seiter and Party

Date Aug. 23-26, 1988

Date Reported 9-8-88

C.S. No.

Project No. I-35-3(1)129 Inactive

Location Oklahoma County - I-35 from NE 40th north to NE 63rd.

IDENTIFICATION			Pavement and Subgrade Soil Survey			PHYSICAL & MECHANICAL ANALYSIS						
Laboratory ...O. Number	Field Number	Soil Group	Station Cl-Rt-Lt	Station, Location and Description of Sample	Depth, Inches	Liquid Limit	Plasticity Index	Percent Passing No. 10	Percent Passing No. 40	Percent Passing No. 200	OSI	Nat. Mois... %
				North Bound								
			333+00 (1) Rt	ASPHALT	0-9 3/8							
	A	A-1-b(0)	Underlay (2)	SILTY CLAYEY SAND with GRAVEL	9 3/8-15	19	4	*60	41	17.7	0	5.2
	B	A-6(3)	"	SANDY LEAN CLAY	15-17	26	12	*95	88	56.9	8	10.
	C	A-2-6(0)	"	CLAYEY SAND	17-24	25	14	*9[illegible]	89	29.7	4	12.
	D	A-4(1)	"	SANDY SILTY CLAY	24-28	25	7	*97	96	51.4	5	12.
	E	A-6(9)	"	SANDY LEAN CLAY	28-30	34	18	*99	98	65.8	11	14.
	F	A-6(8)	"	LEAN CLAY with SAND	30-36	31	13	100	98	73.9	12	14.
			343+00 (1) Lt.	ASPHALT	0-11							
	A	A-2-4(0)	Underlay (2)	CLAYEY SAND with GRAVEL	11-31	24	10	*51	41	19.5	1	8.
	B	A-6(9)	"	SANDY LEAN CLAY	31-37	33	18	*96	92	66.4	12	14.
	C	A-6(12)	"	LEAN CLAY with SAND	37-47	37	17	*97	95	78.4	14	11.
			353+00 (1) Rt.	ASPHALT	0-9 1/2							
	A	A-1-b(0)	Underlay	SILTY SAND with GRAVEL	9 1/2-17 1/2	17	3	*78	49	20.2	0	4.
	B	A-6(7)	" (2)	SANDY LEAN CLAY	17 1/2-21 1/2	29	15	*96	91	68.0	11	10.
	C	A-6(9)	"	LEAN CLAY with SAND	21 1/2-33 1/2	29	14	*95	90	82.5	11	12.
			363+00 (1) Lt.	ASPHALT	0-11							
	A	A-1-a(0)	Underlay (2)	GRAVEL with SILT and SAND	11-31	NP	NP	*36	25	10.4	0	3.
	B	A-2-4(0)	"	SILTY SAND	31-36	NP	NP	*80	78	31.5	0	7.
			373+00 (1) Rt.	ASPHALT	0-9 7/8							
	A	A-1-b(0)	Underlay (2)	SILTY SAND with GRAVEL	9 7/8-16	NP	NP	*58	45	17.2	0	4.
	B	A-4(0)	"	SANDY SILT	16-44	NP	NP	*99	98	51.2	0	9.
			383+00 (1) Lt.	ASPHALT	0-11 3/4							

DH Form [illegible]-87

CALCULATIONS CHECKED BY ____________

PROOF READ BY ____________

STATE OF OKLAHOMA

DEPARTMENT OF TRANSPORTATION

Materials Division

SOILS SURVEY

C.S. No.

Project No.

Location

Date

Date Reported

IDENTIFICATION			Station, Location and Description of Sample				PHYSICAL & MECHANICAL ANALYSIS						
Laboratory O. Number	Field Number	Soil Group	Station	Cl-Rt-Lt	Description	Depth, Inches	Liquid Limit	Plasticity Index	Percent Passing No. 10	Percent Passing No. 40	Percent Passing No. 200	OSI	Nat. Moi. %
	A	A-1-b(0)	Underlay	(2)	SILTY SAND with GRAVEL	11 3/4-20	NP	NP	*50	35	13.7	0	3.
	B	A-2-4(0)	"		SILTY SAND	20-32	NP	NP	*85	83	29.6	0	6.
	C	A-4(0)	"		SANDY SILTY CLAY	32-36	17	4	100	96	58.1	4	10.
			393+00	(1) Rt.	ASPHALT	0-14							
	A	A-1-b(0)	Underlay	(2)	SILTY CLAYEY SAND with GRAVEL	14-15	20	5	*62	40	18.6	0	13.
	B	A-6(5)	"		SANDY LEAN CLAY	15-21	29	15	*89	83	53.5	8	16.
	C	A-7-6(27)	"		FAT CLAY	21-25	50	30	*99	96	86.8	22	18.
	D	A-4(2)	"		SANDY LEAN CLAY	25-33	23	9	*98	94	59.4	7	10.
	E	A-4(2)	"		SILTY CLAY with SAND	33-38	21	5	*97	94	77.5	6	16.
	F	A-2-4(0)	"		SILTY SAND	38-43	17	2	*99	97	38.9	0	9.
			404+10	(1) Lt.	ASPHALT	0-7 1/2							
	A	A-1-b(0)	Underlay	(2)	SILTY SAND with GRAVEL	7 1/2-16	NP	NP	*47	33	13.4	0	4.
	B	A-2-4(0)	"		SILTY SAND	16-32	21	1	100	99	28.9	0	9.
					South Bound								
			404+10	(1) Rt.	ASPHALT	0-15							
	A	A-2-4(0)	Underlay	(2)	SILTY SAND	15-27	NP	NP	*97	96	26.8	0	11.
	B	A-2-4(0)	"		" "	27-33	NP	NP	100	99	31.4	0	8.
	C	A-4(0)	"		" "	33-38	NP	NP	100	100	38.4	0	8.
	D	A-4(0)	"		SANDY SILTY CLAY	38-43	19	4	*99	98	67.5	5	11.
			393+00	(1) Rt.	ASPHALT	0-9 3/4							
	A	A-1-b(0)	Underlay	(2)	SILTY SAND with GRAVEL	9 3/4-18	NP	NP	*57	45	14.5	0	3.
	B	A-2-4(0)	"		SILTY SAND	18-24	NP	NP	*96	94	29.0	0	9.
	C	A-4(0)	"		" "	24-30	NP	NP	*99	96	39.0	0	9.
	D	A-2-4(0)	"		" "	30-34	NP	NP	*95	93	25.2	0	5.

DH Form 104-87

CALCULATIONS CHECKED BY ______________

PROOF READ BY ______________

STATE OF OKLAHOMA

DEPARTMENT OF TRANSPORTATION

Materials Division

SOILS SURVEY

C.S. No.

Project No.

Location

Date

Date Reported

IDENTIFICATION						PHYSICAL & MECHANICAL ANALYSIS						
Laboratory I.O. Number	Field Number	Soil Group	Station Cl-Rt-Lt	Station, Location and Description of Sample	Depth, Inches	Liquid Limit	Plasticity Index	Percent Passing No. 10	Percent Passing No. 40	Percent Passing No. 200	OSI	Nat. Mois %
	E	A-4(0)	"	SILTY SAND	34-37	20	1	*95	92	46.5	2	9.
	F	A-6(12)	"	SANDY LEAN CLAY	37-42	37	21	*93	89	68.5	14	15.
			383+00 (1) Lt.	ASPHALT	0-10 3/4							
	A	A-2-4(0)	Underlay (2)	SILTY SAND with GRAVEL	10 3/4-20	NP	NP	*68	56	17.4	0	5.
	B	A-2-4(0)	"	" " " "	20-25	NP	NP	*77	75	22.6	0	7.
	C	A-2-4(0)	"	SILTY SAND	25-31	NP	NP	*84	80	31.3	0	5.
	D	A-4(0)	"	" "	31-35	NP	NP	*91	90	40.0	0	10.
	E	A-2-4(0)	"	" "	35-40	NP	NP	*90	89	25.2	0	8.
	F	A-4(3)	"	SANDY LEAN CLAY	40-46	25	9	*99	98	58.8	6	15.
			373+00 (1) Rt.	ASPHALT	0-11							
	A	A-1-b(0)	Underlay (2)	SILTY SAND with GRAVEL	11-19	NP	NP	*51	41	13.0	0	3.
	B	A-4(0)	"	SANDY SILT	19-30	19	2	*97	95	50.3	2	8.
	C	A-2-4(0)	"	SILTY SAND	30-36	NP	NP	*96	93	30.4	0	9.
	D	A-4(0)	"	" "	36-43	NP	Np	*99	98	40.0	0	6.
			363+00 (1) Lt.	ASPHALT	0-11							
	A	A-1-b(0)	Underlay (2)	SILTY SAND with GRAVEL	11-20	17	3	*56	42	16.9	0	3.
	B	A-4(1)	"	SANDY LEAN CLAY	20-26	21	8	*97	95	54.0	5	12.
	C	A-6(14)	"	LEAN CLAY with SAND	26-39	34	20	*97	91	79.5	15	12.
			353+00 (1) Rt.	ASPHALT	0-10							
	A	A-2-4(0)	Underlay (2)	SILTY CLAYEY SAND with GRAVEL	10-17	18	4	*56	38	15.6	0	4.
	B	A-6(4)	"	SANDY LEAN CLAY	17-25	25	12	*85	81	59.1	8	10.
	C	A-4(0)	"	SANDY SILTY CLAY	25-31	20	5	*98	95	57.5	4	9.
	D	A-4(0)	"	SILTY SAND	31-41	NP	NP	*99	95	39.7	0	8.

CALCULATIONS
CHECKED BY

PROOF READ BY

STATE OF OKLAHOMA

DEPARTMENT OF TRANSPORTATION

Materials Division

SOILS SURVEY

C.S. No.
Project No.
Location

Date
Date Reported

IDENTIFICATION						PHYSICAL & MECHANICAL ANALYSIS						
Laboratory S.O. Number	Field Number	Soil Group	Station C1-Rt-Lt — Station, Location and Description of Sample		Depth, Inches	Liquid Limit	Plasticity Index	Percent Passing No. 10	Percent Passing No. 40	Percent Passing No. 200	OSI	Nat. Mois %
			343+00 (1)Lt.	ASPHALT	0-11							
	A	A-2-4(0)	Underlay	(2) CLAYEY SAND with GRAVEL	11-19	22	8	*61	37	16.3	0	6.
	B	A-7-6(16)	"	LEAN CLAY with SAND	19-26	41	24	*96	91	74.8	18	19.
	C	A-7-6(20)	"	" " " "	26-36	44	23	*92	88	84.8	18	17.
	D	A-7-6(20)	"	LEAN CLAY	36-42	42	20	*97	94	91.3	16	16.
			333+00 (1)Rt.	ASPHALT	0-10 1/2							
	A	A-2-4(0)	Underlay	(2) CLAYEY SAND with GRAVEL	10 1/2-18	23	9	*60	46	21.3	0	4.
	B	A-6(16)	"	LEAN CLAY with SAND	18-21	37	23	*99	97	81.2	16	14.
	C	A-6(10)	"	SANDY LEAN CLAY	21-26	32	16	100	98	56.5	10	13.
	D	A-4(3)	"	" " "	26-31	24	9	*99	98	69.3	7	13.
	E	A-4(0)	"	SILTY SAND	31-45	22	2	*98	97	41.3	1	13.

NOTES: *Maximum size passing the two inch sieve
(1) Rt. indicates outside lane
Lt. indicates inside lane
(2) Does not meet current specifications for aggregate base (703.01).

Transmitted 9-8-88

J. D. Telford, P.E.
Materials Engineer

D10

PAVEMENT SURVEY SUMMARY

Identification	1A	2A	2B	2C	3A
Station	333+00	353+00	353+00	353+00	373+00
Expressway	N.B.	N.B.	N.B.	N.B.	N.B.
Lane	O.L.	O.L.	O.L.	O.L.	O.L.
Core Location	B.W.P.	B.W.P.	I.W.P.	O.W.P.	B.W.P.
Rut Depth (in.)	---	3/8	---	---	1/2
Core Thickness (in.)	9-1/4	9	8-1/4	8-1/2	9-1/2

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	1	3/4	1/2	1/2	3/4
A.C. Type C	2-1/4	2	1-1/2	2	2-1/2
Petromat	-----	-----	-----	-----	-----
A.C. Type C	1	1	1-1/4	1	1
A.C. Type D	1/2	1	1	1	3/4
A.C. Type B	1-1/2	1-3/4	1-1/2	1-3/4	1-1/2
A.C. Type A	3	2-1/2	2-1/2	2-1/4	3

Identification	3B	3C	5A	6A	7A
Station	373+00	373+00	343+00	363+00	383+00
Expressway	N.B.	N.B.	N.B.	N.B.	N.B.
Lane	O.L.	O.L.	I.L.	I.L.	I.L.
Core Location	I.W.P.	O.W.P.	B.W.P.	B.W.P.	B.W.P.
Rut Depth (in.)	---	---	5/8	1/2	5/8
Core Thickness (in.)	8-3/4	8-1/2	11-1/4	10-3/4	10-1/2

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	3/4	1/2	1/2	1/2	3/4
A.C. Type C	1-3/4	1-1/2	2-1/2	2	2-3/4
Petromat	-----	-----	-----	-----	-----
A.C. Type C	1	1-1/4	2	2-1/4	2-1/2
A.C. Type D	3/4	3/4	1	1	1/2
A.C. Type B	1-1/2	1-1/2	2-1/4	2	2
A.C. Type A	3	3	3	3	3

Identification	11A	11B	11C	12A	13A
Station	373+00	373+00	373+00	353+00	333+00
Expressway	S.B.	S.B.	S.B.	S.B.	S.B.
Lane	O.L.	O.L.	O.L.	O.L.	O.L.
Core Location	B.W.P.	I.W.P.	O.W.P.	B.W.P.	B.W.P.
Rut Depth (in.)	1-1/8	---	---	1-3/4	1-1/8
Core Thickness (in.)	10-1/2	10-1/2	10-1/8	9-3/4	10-3/4

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	3/4	1/2	1/2	1/2	3/4
A.C. Type C	3-1/4	2	2-1/2	3-1/4	3-1/2
Petromat	-----	-----	-----	-----	-----
A.C. Type C	1	1-3/4	2	1/2	1
A.C. Type D	1/2	3/4	5/8	1/2	1
A.C. Type B	1-3/4	1-1/2	1-1/2	2	1-1/2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PAVEMENT SURVEY SUMMARY

Identification	14A	15A	16A
Station	383+00	363+00	343+00
Expressway	S.B.	S.B.	S.B
Lane	I.L.	I.L.	I.L
Core Location	B.W.P.	B.W.P.	B.W.P
Rut Depth (in.)	1/2	1/8	1/8
Core Thickness (in.)	9-1/4	9	8-1/4

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	7 3/4 5/8	8 3/4	7 3/4 1/2
A.C. Type C	2-1/2	2-1/2	2-1/2
Petromat	-----	-----	-----
A.C. Type C	2-1/2	2	2-1/4
A.C. Type D	1/2	3/4	1/2
A.C. Type B	1-3/4	2	2
A.C. Type A	3	3	3

Identification	8A	10A
Station	404+00	393+00
Expressway	N.B.	S.B.
Lane	I.L.	O.L.
Core Location	B.W.P.	B.W.P.
Rut Depth (in.)	1/4	1/2
Core Thickness (in.)	8	9-3/4

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	5 1/2 1	6 3/4
A.C. Type C	2-1/2	3-3/4
Petromat	-----	-----
A.C. Type B	2	1-1/2
A.C. Type A	2-1/2	4

Identification	9A
Station	404+00
Expressway	S.B.
Lane	O.L.
Core Location	B.W.P.
Rut Depth (in.)	1/4
Core Thickness (in.)	14-3/4

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	3" 1/2
A.C. Type C	2-1/2
Petromat	-----
A.C. Type A	3-1/2
B.B.F.A.T.	8-1/4

PAVEMENT SURVEY SUMMARY

Identification	4A
Station	393+00
Expressway	N.B.
Lane	O.L.
Core Location	B.W.P.
Rut Depth (in.)	3/8
Core Thickness (in.)	13-3/4

Layer Analysis, Top Lift to Bottom Lift, Mix Type and Thickness (in.)

O.G.F.S.C.	3/4 1/2
A.C. Type C	1-3/4
Petromat	-----
A.C. Type C	1
Petromat	-----
A.C. Type A	2
B.B.F.A.T.	8-1/2

Legend:

N.B. = Northbound
S.B. = Southbound
O.L. = Outside Lane
I.L. = Inside Lane
B.W.P. = Between Wheel Paths
I.W.P. = In Right Wheel Path
O.W.P. = Outside Right Wheel Path