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16. Abstract

NOVACHIP™ was successfully constructed on two highways in the San Antonio District of the Texas Department of Transportation: US 281 and SH 46. The French process, NOVACHIP™, is a new technology for Texas and the United States created to provide evaluation and documentation of the process and resulting performance.

After one year of service, the NOVACHIP™ pavement surfaces are in excellent condition. The pavements appear to be in essentially the same condition as immediately after construction and will be monitored for a period of three years and performance will be documented.

In general, NOVACHIP™ appears to have promise as a preventive maintenenance treatment or surface rehabilitation technique for asphalt concrete pavements. It should provide the maintenance engineer with an alternative for chip seals, micro-surfacing, plant-mix seals, or thin asphalt concrete overlays.

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EVALUATION OF NOVACHIP™ -

CONSTRUCTION REPORT

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Sponsored by the
Texas Department of Transportation
In Cooperation with
U.S. Department of Transportation
Federal Highway Administration

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TEXAS TRANSPORTATION INSTITUTE

IMPLEMENTATION STATEMENT

The goal of this study was to conduct a thorough investigation of the NOVACHIP™ construction process and evaluate performance at regular intervals for a period of three years. This report documents partial completion of this goal, in that the construction process has been thoroughly evaluated and performance documented for one year. Two additional years of performance documentation will be required prior to implementation of research results.

Early findings in the study indicate that the NOVACHIP™ pavement surface is a viable alternative to conventional pavement surfacings and offers some distinct advantages over conventional surfacings as described in the report. Limitations involving implementation at this time may be related to the availability of the NOVACHIP™ paving process in this country. However, if there is a demand here in the U.S., it is likely that the process will be readily available.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes.

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SUMMARY

NOVACHIP™, sometimes known as ultrathin friction course, was successfully constructed on two highways in the San Antonio District of Texas. The French process, NOVACHIP™, is a new technology for Texas and the United States and this research study was initiated by the Federal Highway Administration in cooperation with the Texas Department of Transportation to provide a means for evaluation and documentation of the process and resulting performance.

After one year of service, the NOVACHIP™ pavement surfaces are in excellent condition. The pavements appear to be in essentially the same condition as immediately after construction. The pavements will be monitored for a period of three years and performance documented.

In general, NOVACHIP™ appears to have promise as a preventive maintenance treatment or surface rehabilitation technique for asphalt concrete pavements. It should provide the engineer with an alternative for chip seals, micro-surfacing, open-graded friction courses, or thin asphalt concrete overlays.

For a more detailed summary, see page 37.

1

Introduction

The San Antonio District of the Texas Department of Transportation (TxDOT) included the NOVACHIP™ process on a surface rehabilitation project in Comal County (SH 46) and Bexar County (US 281) during October of 1992. These locations are shown in Figure 1. This experimental installation was one of three in the United States. Others were constructed by Mississippi DOT and Alabama DOT. Because this is a new technology for Texas and the United States, this research study was created to provide evaluation and documentation of the process and resulting performance.

1.1 Background

The NOVACHIP™ process was developed in France in 1986 by a company known as SCREG ROUTES and TRAVAUX PUBLICS and is marketed by that company. NOVACHIP™ has been utilized successfully in Europe. (1) The process has promise in pavement surface rehabilitation and provides the engineer with alternatives for chip seals, micro-surfacings, plant-mix seals, or thin overlays. NOVACHIP, sometimes called ultrathin friction course, was developed to be used for preventive maintenance or surface rehabilitation. (2) Its primary function is to restore skid resistance and surface impermeability.

Some of the advantages of NOVACHIP™ touted by the manufacturer are:

- excellent adhesion (no chip loss)
- reduced rolling noise (particularly for urban use)
- rapid application

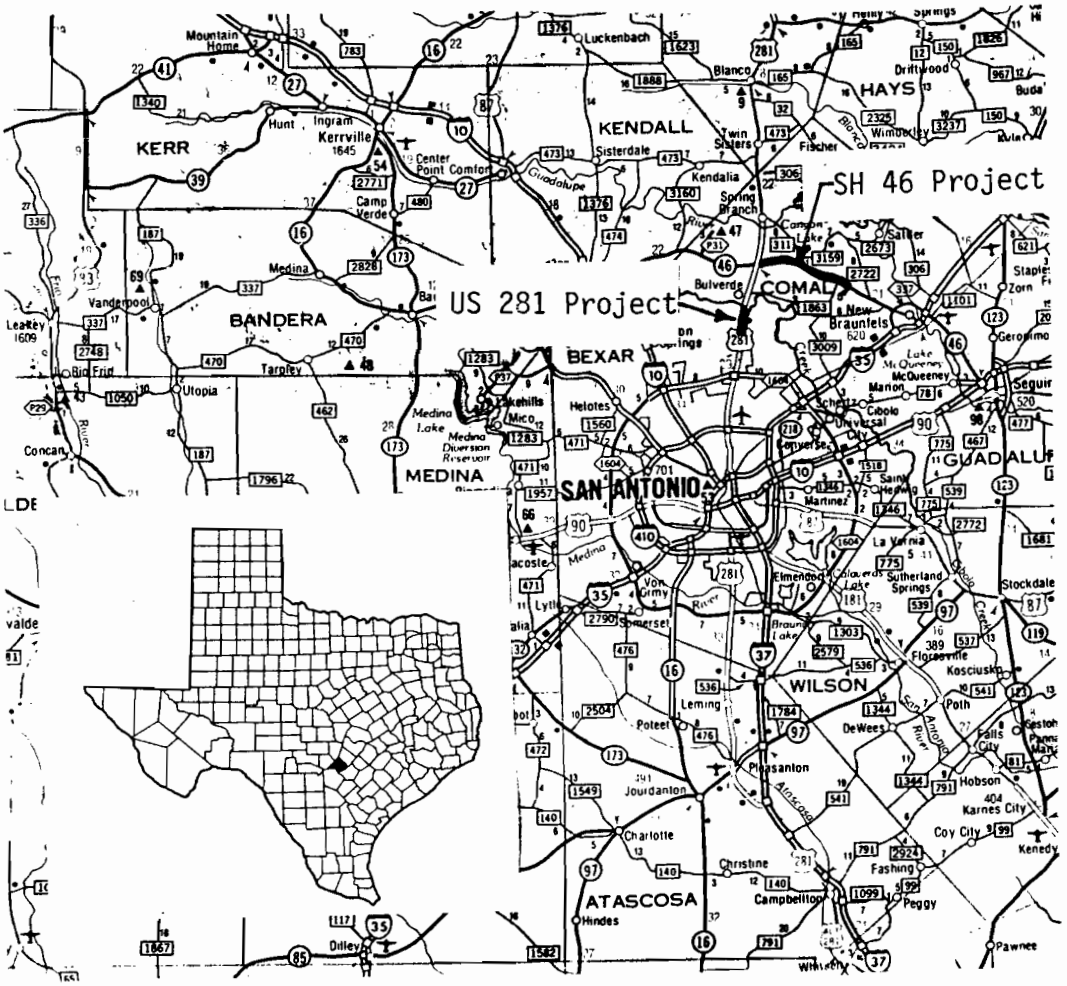


Figure 1. NOVACHIP™ Paving Project Locations.

- quick opening to traffic
- reshaping of existing pavement (drainage, ride quality).

NOVACHIP™ can be used as a surface seal for bituminous pavements to reduce deterioration caused by weathering, ravelling, traffic, and oxidation. It can seal small, "non-working" cracks and provides a wearing surface with excellent skid resistance. NOVACHIP™ can also be used to restore pavement surface smoothness to a limited extent, e.g., minor rut-filling and smoothing corrugations and other surface irregularities. NOVACHIP™ does not, however, substantially increase the structural capacity of the pavement.

1.2 Description of NOVACHIP™

A NOVACHIP™ friction course consists of a layer of hot-mix material placed over a heavy tack coat. The course thickness ranges from 3/8 to 3/4-inch (10 to 20 mm), depending on the maximum size of the stone. Layer thickness is generally about 1 1/2 times the diameter of the largest stone. (2)

The hot-mix material is a gap-graded mixture which includes a large portion (70 to 80 percent) of single-sized crushed aggregate which is bound with a mastic composed of sand, filler (if needed) and binder. (2) This mixture is sometimes described as "hot, coated chippings".

The binder content ranges from 5.3 to 6.0 percent, depending on the traffic, climate and peculiarities of the existing pavement as determined by SCREG ROUTES engineers.

The heavy tack coat is generally a polymer-modified emulsified asphalt and the application rate commonly varies between 0.15 and 0.22 gallons per square yard (0.7 and 1.0 liters per square meter).

NOVACHIP™ is placed with a specially designed paving machine which combines the functions of an asphalt distributor and a laydown machine. The paver applies the tack coat and the hot asphalt mixture in a single pass. This heavy application of tack helps to ensure adhesion of the friction course to the underlying pavement and reduce the possibility of the intrusion of surface water into the pavement structure.

1.3 Description of Paving Equipment

Application equipment for the NOVACHIP™ process was designed to accommodate the following operations: (1)

- collection of the mixture from the transport trucks,
- storage of the mixture,
- storage of sufficient tack emulsion for at least 3 hours of operation,
- distribution of the tack coat with servo-controlled application rate,
- immediate covering of the tack with the mixture,
- smoothing of the applied mixture into a virtual monogranular layer with respect to the 2 or 3 highest points of the existing pavement surface.

The NOVACHIP™ paving machine, as it was developed, includes the following components (listed here from the front to the rear of machine): (1)

- A hopper for the collection of the mix with a coupling for attachment to the hook of the truck supplying the mixture. The design of this hopper was changed several times to prevent the mixture of hot, coated chippings from sticking together. Because of the tendency of the "chippings" to stick together, their manipulation, storage and collection is not easy. The hopper is now fitted with two transfer screws.
- A screw or rake conveyor which lifts and feeds the mix into a hopper.
- A heated compartment where the mixture is stored having a total capacity of about 4 to 6.5 cubic yards (3 to 5 cubic meters).
- A heated tank for the tack binder (16 cubic yards or 12 cubic meters).
- A conveyor serving to transfer the mixture to the forward part of the smoothing assembly where the mixture is deposited onto the road.
- A spray bar for the distribution of the tack coat. The nozzles on the spray bar are at a large distribution angle and are very closely spaced. The transverse displacement of the spray bar is servo-controlled so as to ensure that it lines up with the boundary of the hot mix.

- A continuously, or nearly continuously, heated assembly for screeding the hot mix layer. The width of the screed can be varied from 8 to 15 feet (2.5 to 4.6 meters).

2

Preconstruction Information

2.1 Existing Pavement Cross Sections

The existing pavement surface of US 281 prior to construction consisted of a seven-year old double chip seal: Grade 5 (No. 4 or 4.75 mm) over Grade 3 (1/2-inch or 12.5 mm). Underneath the double chip seal, most of US 281 is a three-inch (75 mm) layer of hot-mix asphalt concrete preceded by a Grade 3 (1/2-inch or 12.5 mm) surface treatment on eight inches (200 mm) of flexible base which was constructed in 1972.

SH 46 was surfaced with a one-inch (25 mm) thick layer of asphalt concrete pavement (ACP) which was about eight years old at the time of this construction project. The cracks in the pavement surface were sealed with asphalt-rubber crack sealant the previous spring. Beneath this ACP surface is a series of chip seals preceded by a one-inch (25 mm) thick layer of ACP. This lower layer of ACP was built in about 1958. Underneath this layer is the original pavement which was built in about the mid 1930's and is thought to be a double surface treatment on a limestone base.

Limestone bedrock is at or very near the surface in this portion of Texas; therefore, on much of the pavement, the subgrade is a limestone bedrock providing excellent support.

2.2 Traffic Data

Traffic data on US 281 and SH 46 near the time of construction as provided by the Office of Research and Technology Transfer of TxDOT is as follows:

US 281

Weighted Average Daily Traffic (ADT) = 20,300 vehicles per day (vpd) with 6.0 percent trucks,

SH 46

Weighted ADT = 4,200 vpd with 6.4 percent trucks.

2.3 Precondition Surveys

Prior to construction, precondition surveys were performed on US 281 and SH 46. An index of pavement condition has been described which quantifies all forms and levels of pavement distress. (3) Based on maintenance costs, this index, or Pavement Rating Score (PRS), allows numerical comparison of pavement condition. A PRS value of 100 describes a pavement with no distress. Progressively lower PRS values describe pavement condition with more severe forms of distress. The form shown in Figure 2 is used to catalog distress observed on the pavement. Deduct values are assigned to each type and level of distress according to Table 1. The sum of deduct values is subtracted from 100 resulting in the pavement rating score (PRS).

US 281 was in good condition at the time prior to construction. Pavement Rating Scores were obtained at several stations along the pavement and are shown in Table 2. US 281 had an overall PRS of 93 prior to construction. The surface was a double chip seal which was in relatively good condition. The primary types of distress observed were some slight to moderate bleeding in places and slight ravelling.

Pavement Rating Scores for SH 46 are shown in Table 3. This pavement had an overall PRS of 85. The primary surface distress was longitudinal cracking and some slight ravelling. The cracks had been sealed the previous spring; however, at the time of the survey, they were observed to be partially sealed.

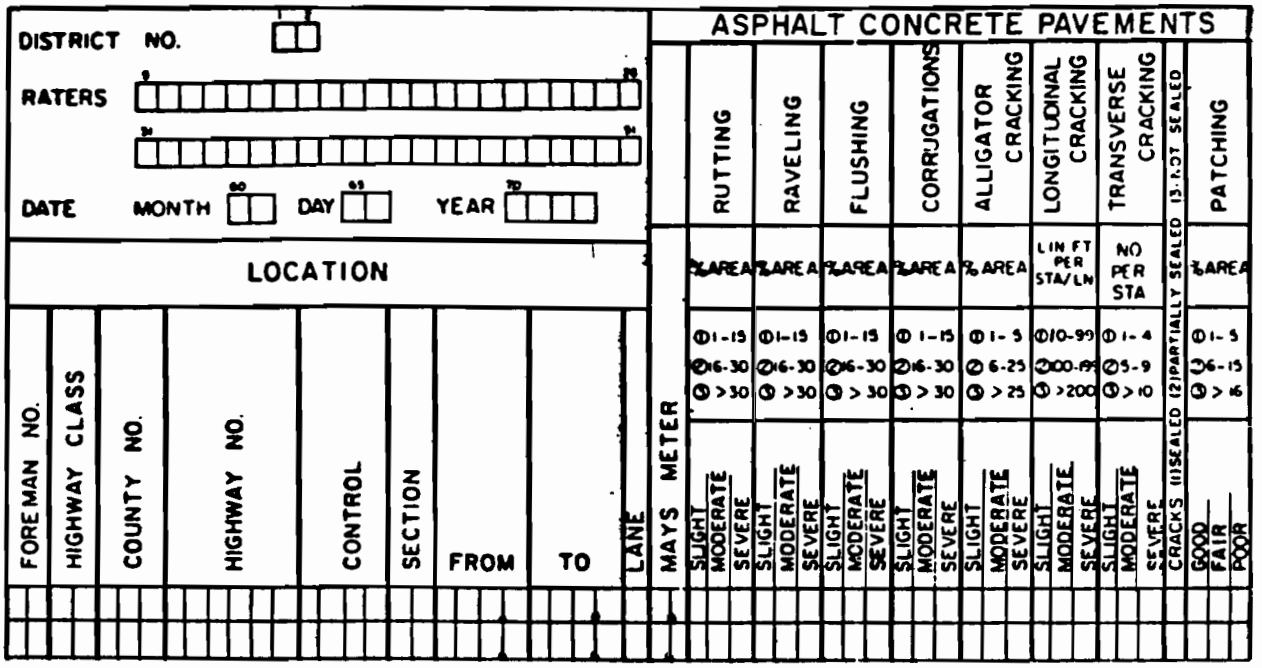


Figure 2. Pavement Rating Form.

Table 1. Pavement Rating Deduct Values.

Type of Distress	Degress of Distress	Extent or Amount of Distress (1)	(2)	(3) *
Rutting	Slight	0	2	5
	Moderate	5	7	10
	Severe	10	12	15
Raveling	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Flushing	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Corrugations	Slight	5	8	10
	Moderate	10	12	15
	Severe	15	18	20
Alligator Cracking	Slight	5	10	15
	Moderate	10	15	20
	Severe	15	20	25
Patching	Good	0	2	5
	Fair	5	7	10
	Poor	7	15	20

Deduct Points for Cracking

Longitudinal Cracking

	Sealed			Partially Sealed			Not Sealed *		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Slight	2	5	8	3	7	12	5	10	15
Moderate	5	8	10	7	12	15	10	15	20
Severe	8	10	15	12	15	20	15	20	25

Transverse Cracking

Slight	2	5	8	3	7	10	3	7	12
Moderate	5	8	10	7	10	15	7	12	15
Severe	8	10	15	10	15	20	12	15	20

* Numbers in parentheses refer to quantity of distress observed as indicated on Figure 1.

Table 2. US 281 Preconstruction Pavement Rating Scores.

Station	Northbound Lanes		Southbound Lanes	
	Inside	Outside	Inside	Outside
730 + 00	95	85	93	90
710 + 00	95	95	95	90
690 + 00	100	92	100	92
670 + 00	95	95	95	85
640 + 00	100	95	95	85
620 + 00	100	88	100	85
600 + 00	100	85	100	92
580 + 00	100	85	100	85
560 + 00	100	88	100	85
540 + 00	100	88	100	88
526 + 85	100	88	100	88
AVG.	**99**	**89**	**98**	**88**

Grand Average 93

Table 3. SH 46 Preconstruction Pavement Rating Scores.

Station	Eastbound Lane	Westbound Lane
1060 + 00	88	88
1030 + 00	88	88
1000 + 00	83	83
970 + 00	83	73
940 + 00	83	88
910 + 00	88	88
880 + 00	88	92
850 + 00	88	78
820 + 00	88	85
790 + 00	89	81
760 + 00	90	83
730 + 00	90	83
700 + 00	90	90
670 + 00	90	93
640 + 00	90	90
610 + 00	88	88
580 + 00	88	90
AVG.	**88**	**86**

Grand Average 87

2.4 US 281 Pavement Test Sections

Eight test sections were designated on US 281 as shown in Figure 3. These were 120-foot sections of the pavement which were chosen for more detailed pavement evaluation. Data collected on these test sections prior to construction of the NOVACHIP™ surface consisted of visual evaluations, photographs, rutting measurements, and surface texture measurements.

The pavement surface and cross-section at the south end of the US 281 job is essentially the same as the pavement underlying the NOVACHIP™ surface. Test sections within a two-mile portion US 281 beginning at the south end of the NOVACHIP™ pavement will serve as a control (no treatment) throughout the monitoring process.

2.5 SH 46 Pavement Test Sections

Seven 120-foot test sections were designated on SH 46 as shown in Figure 4. In addition to the type of data collected on US 281, crack maps of these test sections were also developed. Crack maps were not developed for US 281 as there was no cracking observed. There is no control section on SH 46.

2.6 Ride Quality Data

One of the claims to be investigated in this study is that NOVACHIP™ can be used to restore pavement surface smoothness to a limited extent, e.g., rut-filling and smoothing corrugations and other surface irregularities. TxDOT's SIometer was used to measure ride quality of the pavement surface before and after application of NOVACHIP™. A SIometer has an accelerometer, a processing computer, and a data storage computer, all mounted in a vehicle. SIometer data is converted into a Ride Score based on a user panel rating, that ranges from 0.1 (very rough) to 5.0 (very smooth). Ride Score Classes are shown below. A Ride Score below 3.0 indicates a rough road to the average person.

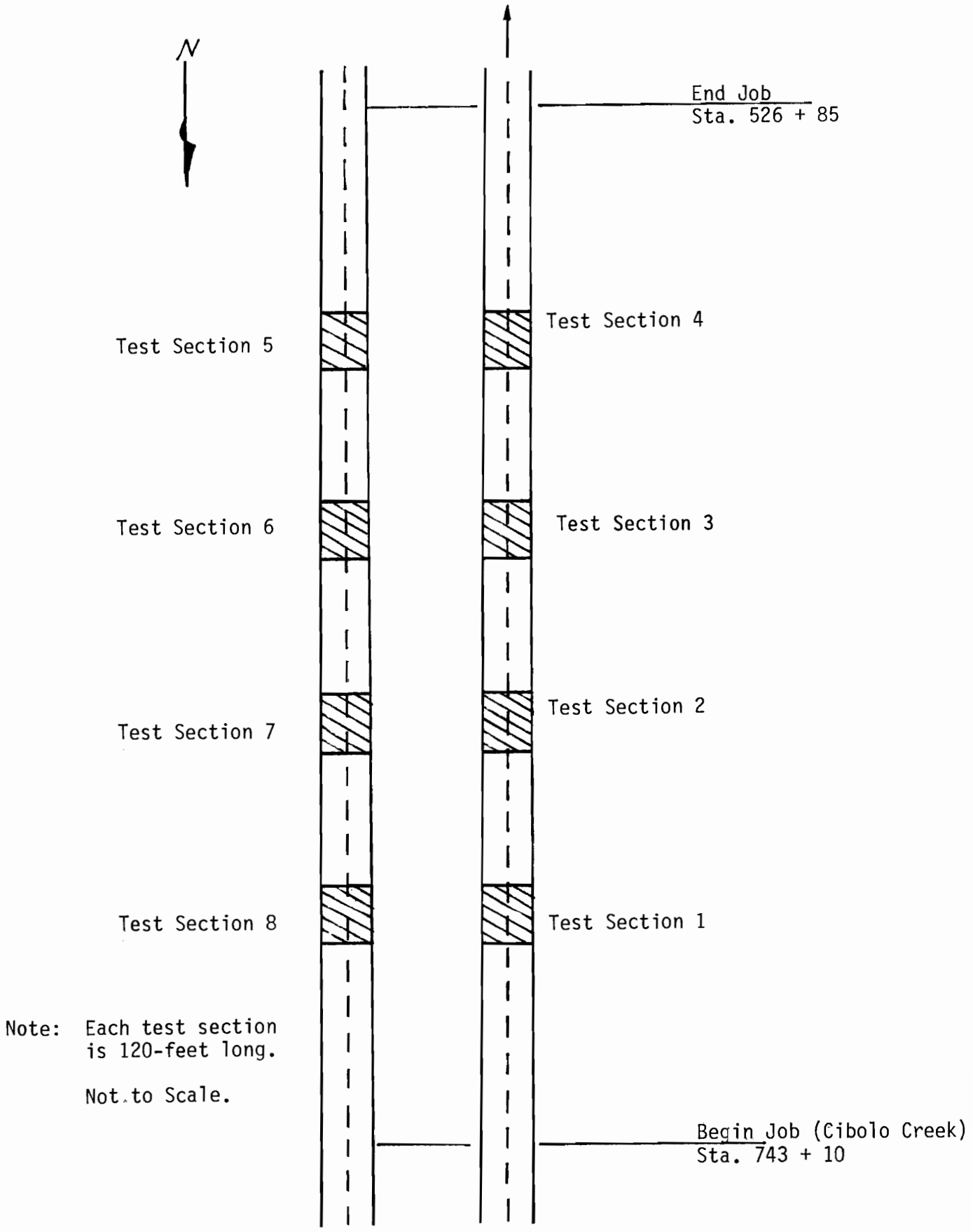
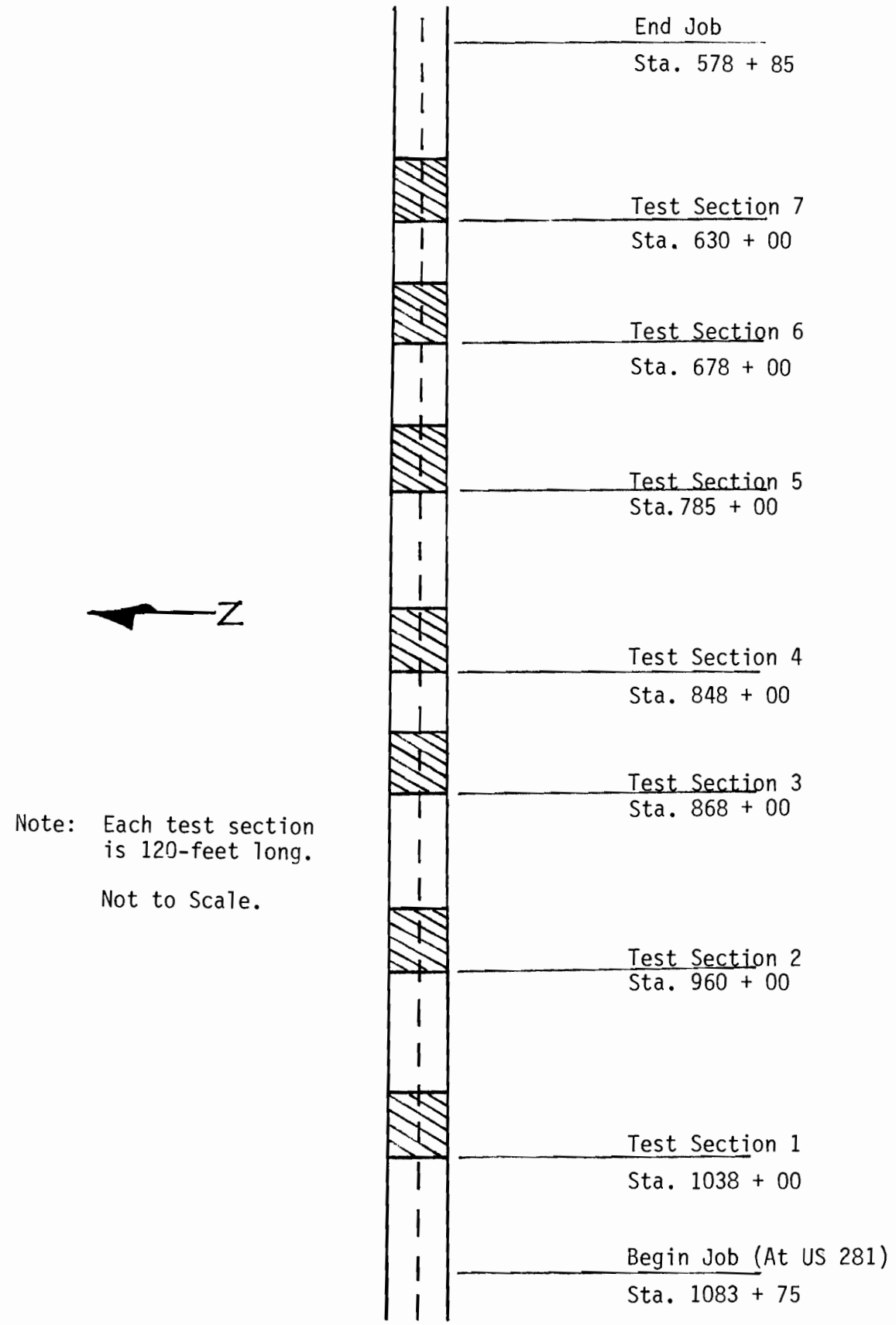


Figure 3. US 281 Test Section Layout.



Note: Each test section is 120-feet long.

Not to Scale.

Figure 4. SH 46 Test Section Layout.

Ride Score	Description
4.0 - 5.0	Very Smooth
3.0 - 3.9	Smooth
2.0 - 2.9	Medium Rough
1.0 - 1.9	Rough
0.1 - 0.9	Very Rough

US 281 had an overall average ride score of 4.5 and SH 46 had an average ride score of 4.0 prior to construction.

3

Construction

Construction of the NOVACHIP™ pavement surfaces began October 15, 1992 on US 281 and the job was completed on SH 46, October 31, 1992. The weather was favorable throughout construction with morning temperatures usually at 65°F (18°C) and afternoon high temperatures at about 85°F (30°C). Skies were clear to partly cloudy and wind was calm to about 20 miles per hour (32 km per hour).

3.1 Specifications

Some of the specification requirements for the NOVACHIP™ mixture which are somewhat more stringent than what is normally required in Texas for hot-mix asphalt concrete are discussed below.

Materials

Special specifications prepared for the NOVACHIP™ pavement are shown in Appendix A. A general term chosen to describe the NOVACHIP™ surface was "paver-laid surface treatment".

The NOVACHIP™ process requires that the coarse aggregate in the mix be a high-quality, 100 percent crushed material. Coarse aggregate (plus No. 10 or 2.0 mm) must have a polish value of more than 35. This requirement eliminates many of the aggregate sources in Texas. The Los Angeles Abrasion Test loss shall be less than 35 percent, and the magnesium sulfate soundness test loss shall not exceed 25 percent.

The fine aggregate (minus No. 10 or 2.0 mm) must also be 100 percent crushed

material. It must be supplied from a source where coarse aggregate meets the Los Angeles abrasion and magnesium sulfate soundness loss requirements shown above. It must also have a sand equivalent value of not less than 60.

The asphalt material used for the paving mixture was required to meet TxDOT's standard specifications for AC-20. Specifications for the tack coat, CRS-2p, are shown in the Special Provision to Item 300 in Appendix A.

Paving Mixture

The NOVACHIP™ contractor was required to provide the mixture design for the project. The gradation requirement for the aggregate in the mix follows:

	Percent by Weight
Retained on the 1/2" (12.5 mm) sieve	0
Retained on the 3/8" (9.5 mm) sieve	0 - 15
Retained on the No. 4 (4.75 mm) sieve	65 - 75
Retained on the No. 10 (2.00 mm) sieve	73 - 81
Retained on the No. 40 (425 μm) sieve	87 - 92
Retained on the No. 80 (180 μm) sieve	91 - 94
Retained on the No. 200 (75 μm) sieve	93 - 96

Specification Changes Prior to Construction

At the preconstruction conference held on October 13, 1992, it was revealed that the aggregate which was to be used for the mixture did not meet the specifications. The aggregate was out of specification on the No. 4 (4.75 mm) and No. 40 (425 μm) sieve and was very close to the lower end of the specification limits on other screens as shown in the following gradation:

	Percent by Weight
Retained on the 1/2" (12.5 mm) sieve	0
Retained on the 3/8" (9.5 mm) sieve	9.4

Retained on the No. 4 (4.75 mm) sieve	62.0
Retained on the No. 10 (2.00 mm) sieve	74.6
Retained on the No. 40 (425 μm) sieve	86.7
Retained on the No. 80 (180 μm) sieve	91.2
Retained on the No. 200 (75 μm) sieve	94.2

The sand equivalent value was measured to be 54 instead of the required 60.

Engineers from SCREG ROUTES stated at the meeting that it was of primary concern that the percent retained on the No. 10 be below 75 and the percent passing the No. 200 be a minimum of 5.5. SCREG ROUTES engineers stated that the above gradation and the sand equivalent value of 54 was acceptable for the NOVACHIP™ process.

A fundamental objective in this construction was to provide the opportunity for SCREG ROUTES to showcase the NOVACHIP™ pavement; therefore, it was the decision of TxDOT engineers that if these material properties were acceptable to SCREG ROUTES, then the specifications would be changed to reflect this. The mixture gradation specifications were changed to the following:

	Percent by Weight
Retained on the 1/2" (12.5 mm) sieve	0
Retained on the 3/8" (9.5 mm) sieve	0 - 15
Retained on the No. 4 (4.74 mm) sieve	60 - 70
Retained on the No. 10 (2.00 mm) sieve	70 - 78
Retained on the No. 40 (425 μm) sieve	85 - 92
Retained on the No. 80 (180 μm) sieve	90 - 94
Retained on the No. 200 (75 μm) sieve	93 - 96

These gradation limits are plotted in Figure 5. The sand equivalent specification was changed from a minimum value of 60 to a minimum value of 50.

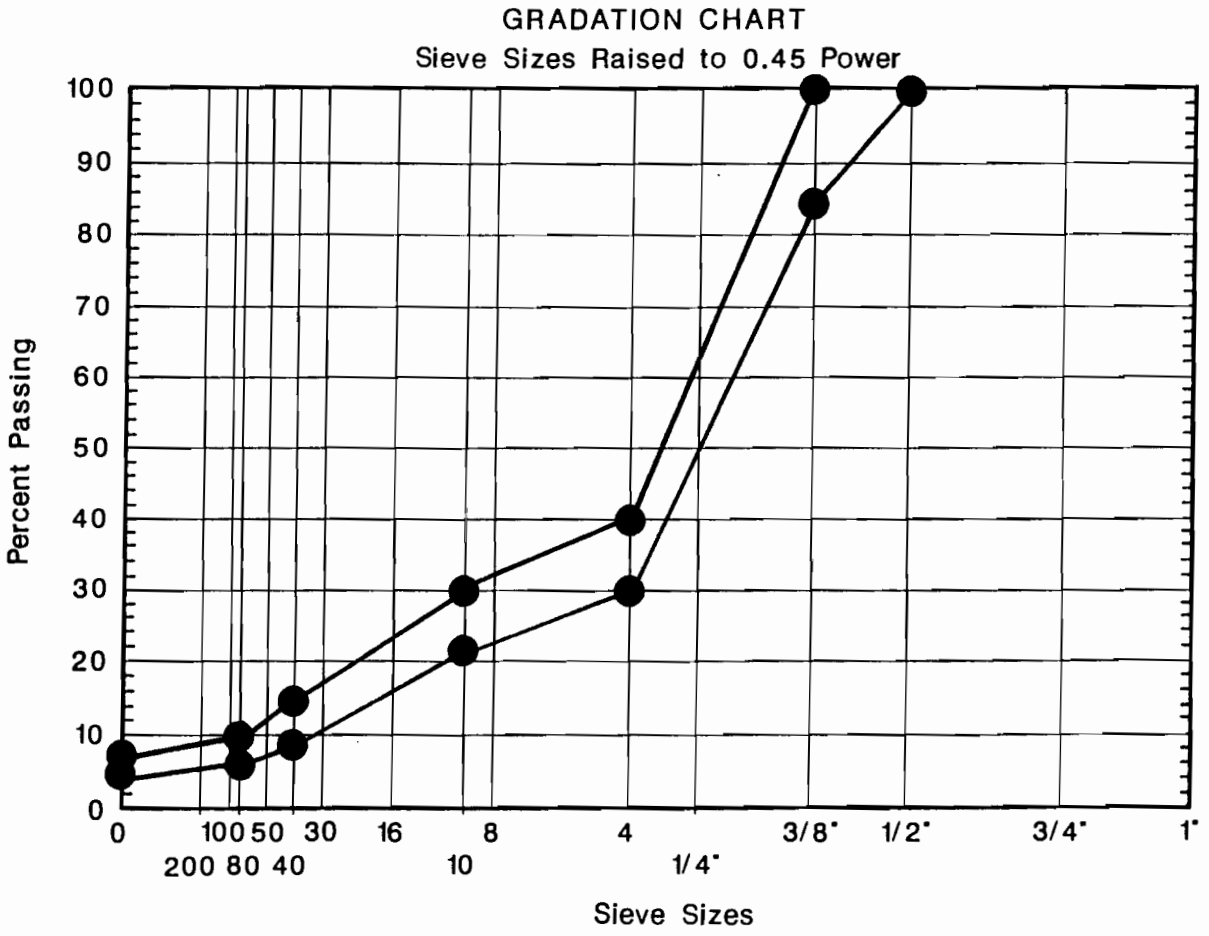


Figure 5. NOVACHIP Aggregate Gradation Job Specification Limits.

3.2 Job Materials

US 281

The coarse aggregate for US 281 was a traprock (basalt) provided by Vulcan Materials from the plant at Knippa, Texas. Typical properties of the traprock as provided by Vulcan are shown in Table 4. This traprock is a very hard, durable, and dark-colored aggregate with a polish value of 38. The fine aggregate used on the job consisted of dry, limestone screenings from Gifford Hill. The aggregate portion of the NOVACHIP™ mix was comprised of 68 percent of the coarse traprock aggregate and 32 percent of the dry, limestone screenings.

The design asphalt content was 5.0 percent of an AC-20 grade. A liquid antistripping agent (PERMATAC) was also used at a rate of 1/2 percent by weight of the binder.

SH 46

It was decided by TxDOT engineers, material suppliers, and contractors, that the existing supply and projected production rate of the traprock was insufficient to yield sufficient mix to keep up with the paving machine for SH 46. According to the rock supplier, the gradation was difficult to produce and cut production rates by 50 percent.

For SH 46, a new mixture design was developed by SCREG ROUTES engineers. The new design mixture contained 34 percent traprock, 34 percent limestone from Helotes, and 32 percent dry limestone screenings. The asphalt content was increased to 5.3 percent.

Tack Coat

As mentioned previously, the tack coat was a polymer-modified emulsion designated CRS-2p. It was to be applied at a design application rate of 0.20 gallons per square yard (0.90 liters per square meter).

Table 4. Physical and Chemical Properties of Knippa, Traprock.

Physical Properties	
Specific Gravity (g/cc)	3.0
Absorption (24 hr, Water), %	0.8
L.A. Abrasion, % loss	9.0
$MgSO_4$ Soundness, % loss	< 7
Mohs Hardness	6

Chemical Analysis	
Silicon dioxide	38%
Iron oxides	14%
Aluminum oxide	12%
Titanium dioxide	4%
Calcium oxide	13%
Magnesium oxide	14%
Potassium oxide	1%
Sodium oxide	3%
Phosphorous oxide	<1%

3.3 Construction Sequence (US 281 and SH 46)

Prior to placement of NOVACHIP™, the traffic buttons were removed from the existing pavement and the pavement surface was broomed. The NOVACHIP™ paving machine as described previously is capable of applying the tack coat and the paving mixture in one pass. A nurse truck was used to periodically fill the NOVACHIP™ emulsion tank with the CRS-2p. Trucks transported hot-mix material from the drum-mix plant which was approximately 10 miles (16 km) from the US 281 job and 20 miles (32 km) from SH 46. Trucks backed up to the paving machine and dumped the mix into the hopper located at the front of the NOVACHIP™ paver which augured the mixture to the back of the paver where it was placed onto the pavement. The tack coat was applied to the pavement about 2 seconds prior to placement of the mix.

Two 10-ton (9-metric ton), steel-wheel rollers (66-inches or 1.7 m wide and 54-inches or 1.4 m wide) were used for a total of 4 passes. The first roller was immediately behind the paver. Traffic was allowed onto US 281 about four hours after construction and on SH 46 about 2 hours.

Traffic control on US 281 was accomplished through lane closure and on SH 46 pilot vehicles were used.

The hot-mix plant operated at a temperature of 315°F (157°C); however, SCREG ROUTES engineers would have preferred the plant to be operated at 330°F (165°C). The higher temperature improves workability of this "harsh" mixture but it was not possible to operate the plant at 330°F (165°C) and stay within the air quality limits.

3.4 Construction Notes - US 281

Construction of US 281 began on Thursday, October 15. US 281 is a four-lane, divided highway and the job was approximately four miles (6.5 km) long for a total of 16 lane miles (26 lane km). US 281 was completed in four working days. Production rates and job yields are shown in Table 5.

Table 5. US 281 Job Production Rates.

Date	CRS-2p Tack Rate, gsy	Mix Produced, tons	Area Paved, sq. yd.	Yield, lb/yd^2
10/15/92 Th.	0.20	829	25,835	64.2
10/16/92 Fr.	0.18	1246	40,466	61.4
10/19/92 Mn.	0.16	1081	32,852	65.8
10/20/92 Tu.	0.18	814	25,646	63.5

The construction of US 281 went very well with only some minor problems noted. The most notable problem for the US 281 job can be attributed to the equipment. Whenever the paving machine was stopped for any length of time on the pavement, the distributor nozzles continued to leak emulsion causing excessive puddling. Sometimes the excess emulsion was washed off the pavement but often it was paved over. TxDOT engineers were concerned that this excess emulsion would eventually lead to a flushed surface in these areas. Therefore, after the second day of production, the equipment was repaired.

Another problem noted with the NOVACHIP™ process also occurs when the paver is stopped for an extended time period. Generally, there were two reasons for the paver to be stopped during the construction operation: (1) to wait for trucks supplying hot-mix or (2) to refill the emulsion tank on the paver with the tack material. In the locations where the paver was stopped for an extended period, there is a very slight hump in the NOVACHIP™ surface which is noticeable when passing over the surface at normal driving speed. When the paver stopped, it appeared that the mix in front of the screed cooled excessively causing the screed to ride up over the mix leaving a slight hump in the mat.

3.5 Construction Notes - SH 46

Construction of SH 46 began in the eastbound lane on Wednesday, October 21, 1992. SH 46 is a two-lane highway, and the job was approximately 9.5 miles (15 km) long for a total of 19 lane miles (30 lane km) plus several climbing lanes dispersed throughout the length. The main travel lanes of SH 46 were constructed in six working days and another three days was devoted to construction of the climbing lanes. Production rates and job yields for the main travel lanes are shown below in Table 6.

Table 6. SH 46 Job Production Rates.

Date	CRS-2p Tack Rate, gsy	Mix Produced, tons	Area Paved, sq. yd.	Yield, lb/yd^2
10/21/92 W.	0.17	575	21,003	54.7
10/22/92 Th.	0.18	828	25,989	63.7
10/23/92 Fr.	0.18	847	30,215	56.1
10/26/92 Mn.	0.21	737	23,074	66.2
10/27/92 Tu.	0.21	487	15,069	64.6
10/28/92 W.	0.19	801	24,336	65.8

The eastbound lane of SH 46 was constructed without incident; however, problems began to develop with the mix during the construction of the westbound lane. Excessive tearing of the mat began to occur. Material appeared to be building up in front of the screed and then dragging along the pavement causing tears in the mat anywhere from 6-inches (150 mm) wide to 4-feet (1.2 m) wide. This required a significant amount of handwork to repair the mat. The NOVACHIP™ mixture is 100 percent crushed material and lacks workability; therefore, it does not lend itself to handwork. This tearing in the mat occurred frequently for two days until the problem

was resolved.

The problem was attributed to variability which was present in the dry screenings. There was only a half-day supply of screenings on hand throughout this period; therefore, the stockpile was changing constantly making quality control testing of the stockpile difficult.

Once this problem was discovered, SCREG ROUTES engineers redesigned the mixture replacing the dry screenings which comprised 32 percent of the aggregate portion to 22 percent dry screenings and 10 percent washed screenings. This resolved the problem and the remainder of the job was completed without difficulty.

In the numerous locations where the mat required handwork, an unattractive "blemish" remained visible on the pavement surface which was also noticeable by a slightly rougher ride in these areas. It was hoped that these "blemishes" would fade with time and traffic; however, at ten months after construction, they still remained quite evident.

3.6 Comments and Opinions of Engineers on Site

Some of the comments which were noted by engineers visiting the construction site are listed below.

TxDOT Area Engineer: "For a pavement where I am very concerned about sealing the surface from the intrusion of water, the NOVACHIP™ pavement appears to be a good choice."

FHWA Engineer: "I am pleased with the way the NOVACHIP™ pavement looks, but the real issue is life-cycle cost. It has its place, but I'm not yet sure where -- maybe in urban areas. I would like for NOVACHIP™ to be a success in this country so that we have more paving options available to us."

FHWA Engineer: "NOVACHIP™ pavement looks very good - it's a very tough-looking mix. The NOVACHIP™ paving operation appears to be a lot quicker than a laydown machine. NOVACHIP™ may be a good alternative to microsurfacing as there is no waiting time to allow traffic on surface. This pavement surface would be good to use anywhere ride quality and frictional characteristics need improvement."

4

Early Performance

The NOVACHIP™ pavement surfaces on US 281 and SH 46 were evaluated for performance in the spring and fall of 1993 and were observed to be in excellent condition. The pavements appeared to be in essentially the same condition as immediately after construction.

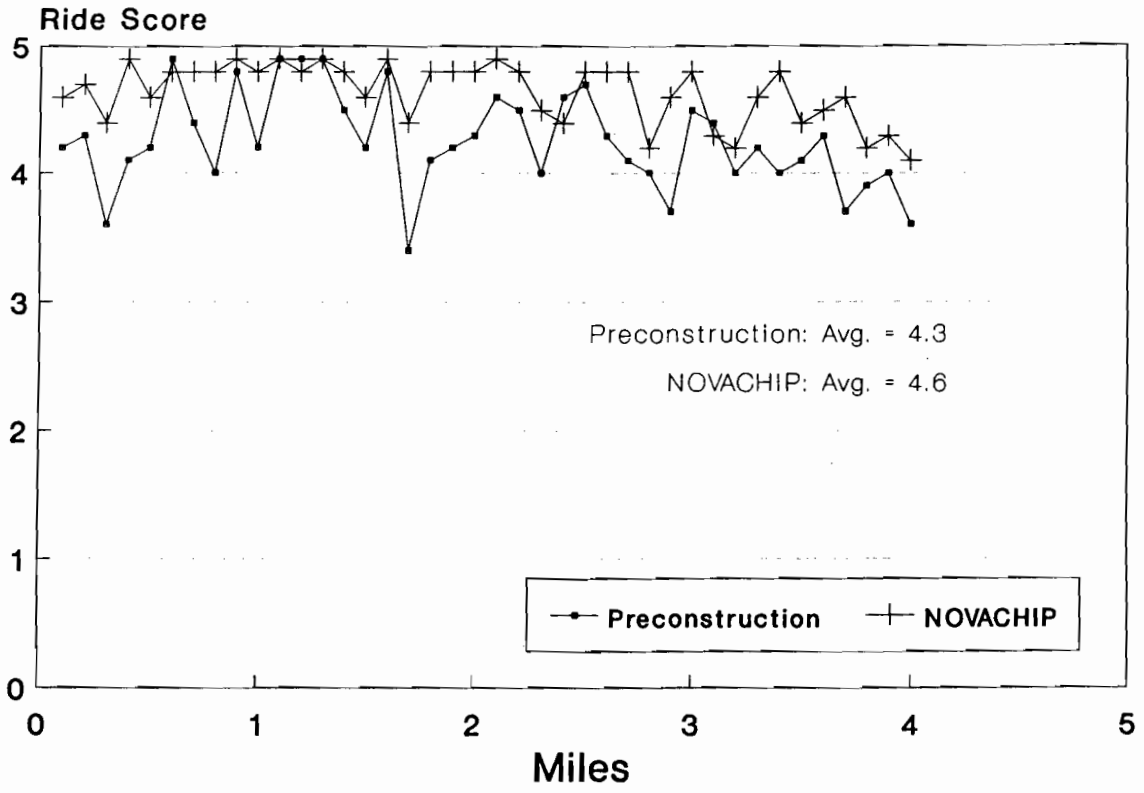
4.1 Ride Quality

Ride quality measurements were made on the projects prior to construction and again about three weeks after construction. These data are shown in Figures 6 and 7 for US 281. Prior to construction, US 281 had an excellent overall average ride score of 4.5. After construction of the NOVACHIP™ surface the overall average ride score was also measured to be 4.5; therefore, no additional improvement in ride quality was detected.

Ride quality data for SH 46 is shown in Figure 8. The average ride score for SH 46 prior to construction was 4.0. The NOVACHIP™ surface improved the ride score to 4.4.

4.2 Frictional Characteristics

Skid resistance data was collected on the project using TxDOTs locked-wheel skid trailer (ASTM E274). The skid unit travels at a constant speed with the left trailer wheel locking at periodic intervals on a wetted surface. Classes of Skid Numbers are shown below:



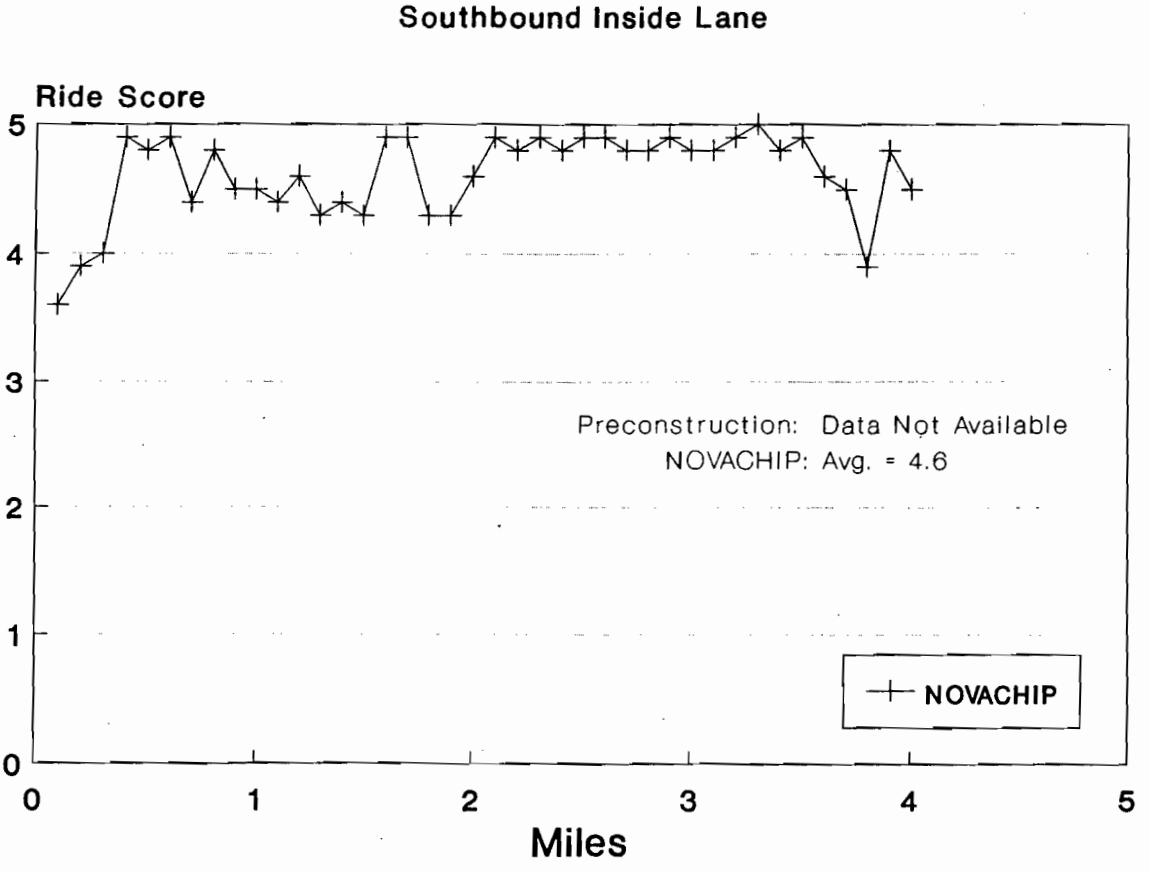
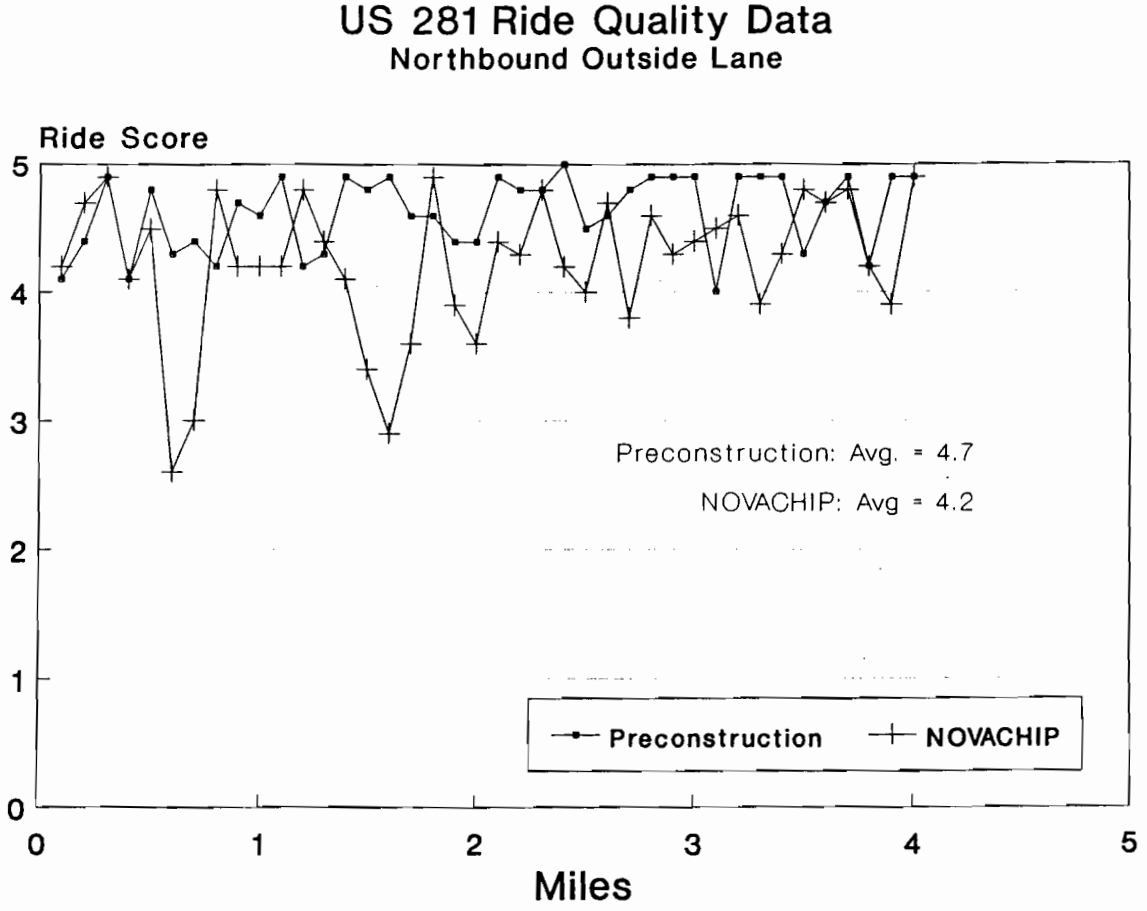


Figure 6. US 281 Ride Quality Data for the Southbound Lanes.



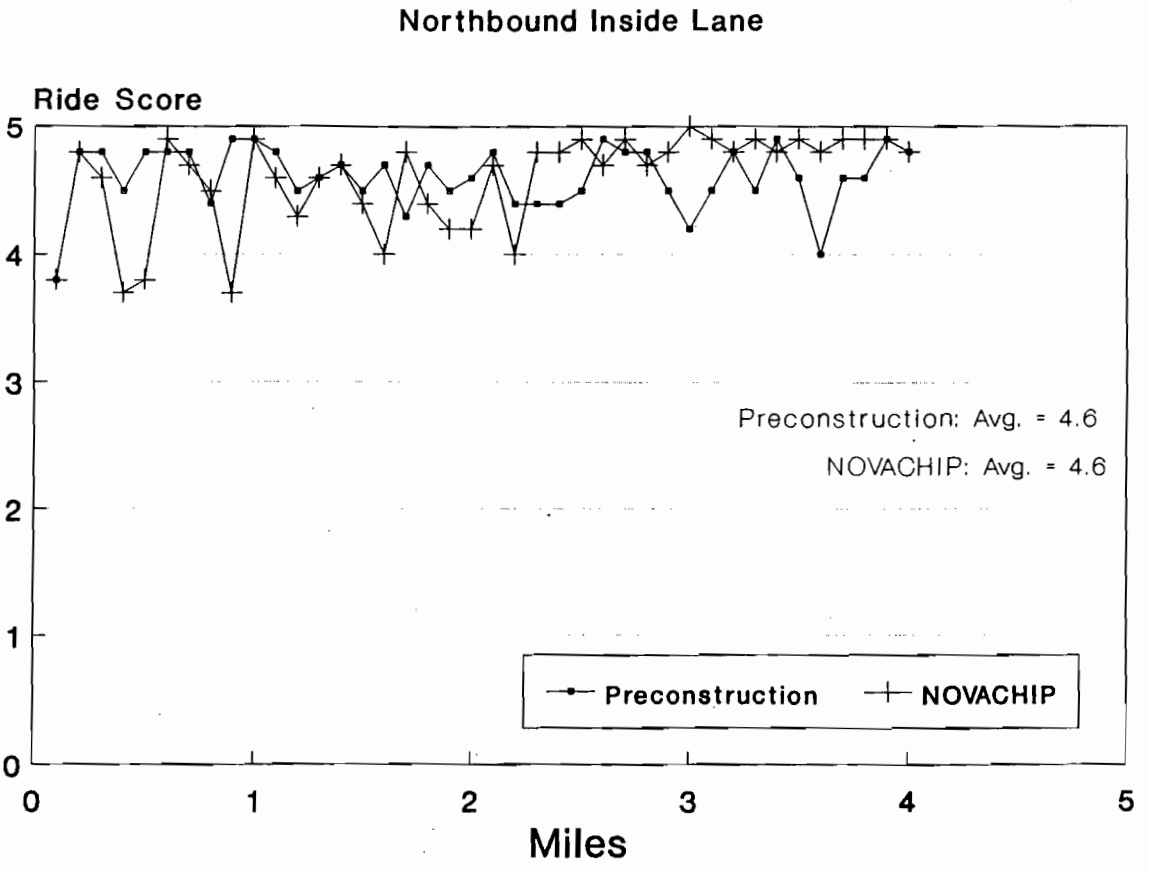
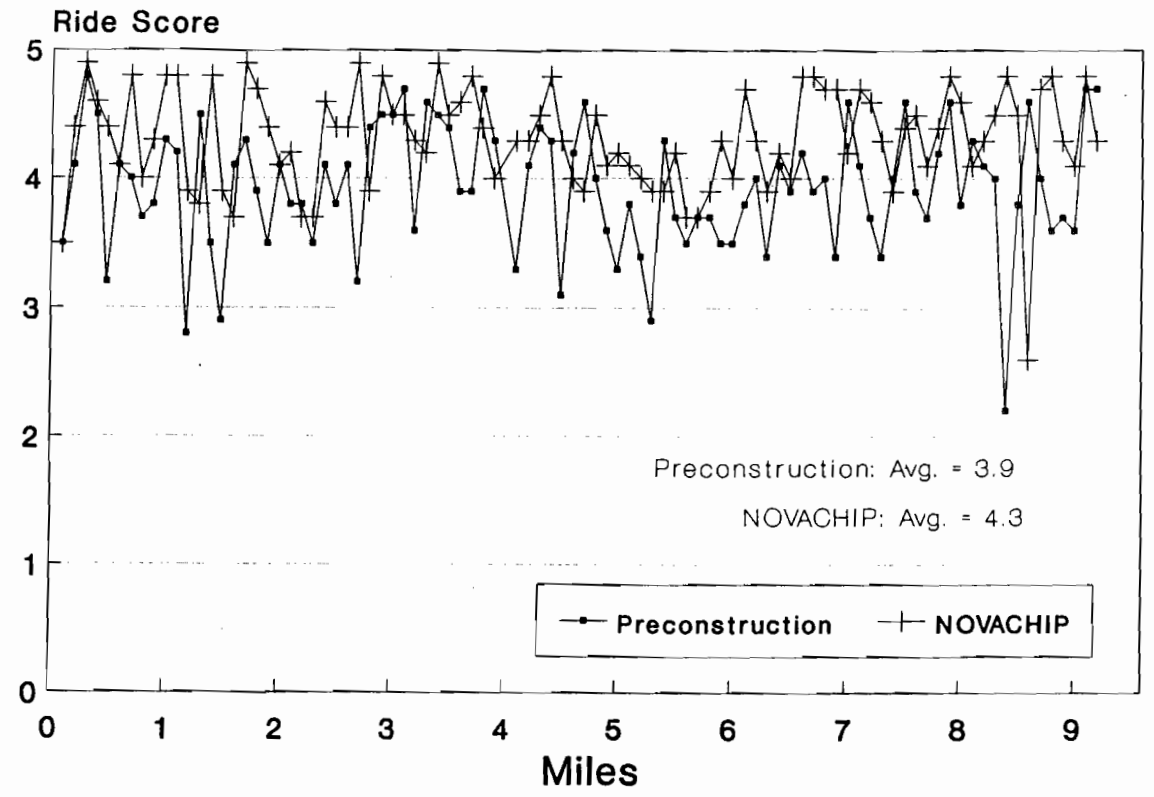


Figure 7. US 281 Ride Quality Data for the Northbound Lanes.



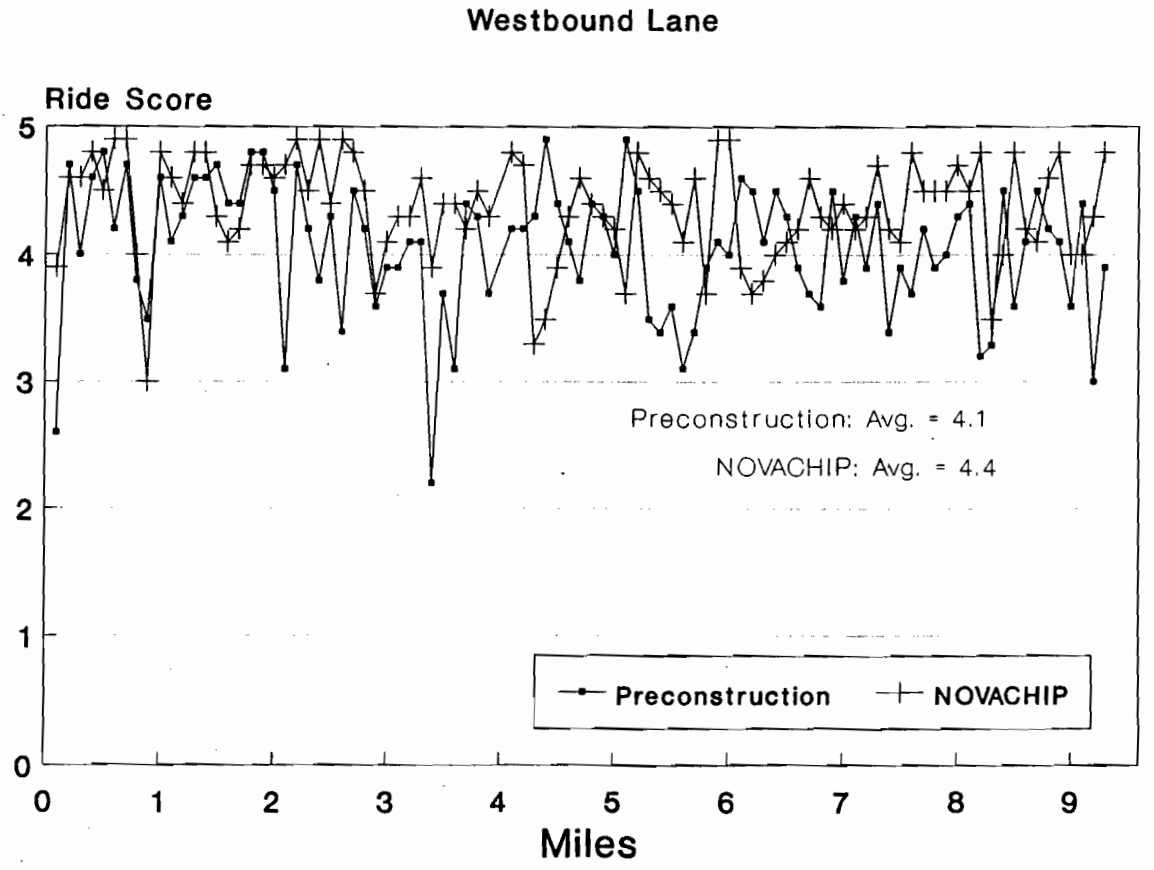


Figure 8. SH 46 Ride Quality Data.

Skid Number	Description
50 - 100	Very good
40 - 49	Good
30 - 39	Fair
20 - 29	Poor
1 - 19	Very poor

Skid resistance data were obtained from the district prior to construction of the NOVACHIP™ surfaces. These data were obtained in May of 1992. The average skid number for both US 281 and SH 46 was 31. (See Figures 9 and 10.)

After construction of NOVACHIP™, skid data were collected again on November 17, 1992. On US 281, the skid number increased to 40 and on SH 46 the number increased to 46.

Skid data were collected again on March 17, 1993 at which time the NOVACHIP™ surface of US 281 had a skid number of 48 and SH 46 had a skid number of 53. This increase in skid resistance from soon after construction is likely due to the action of traffic and weather wearing or eroding away the asphalt binder on the aggregate surface.

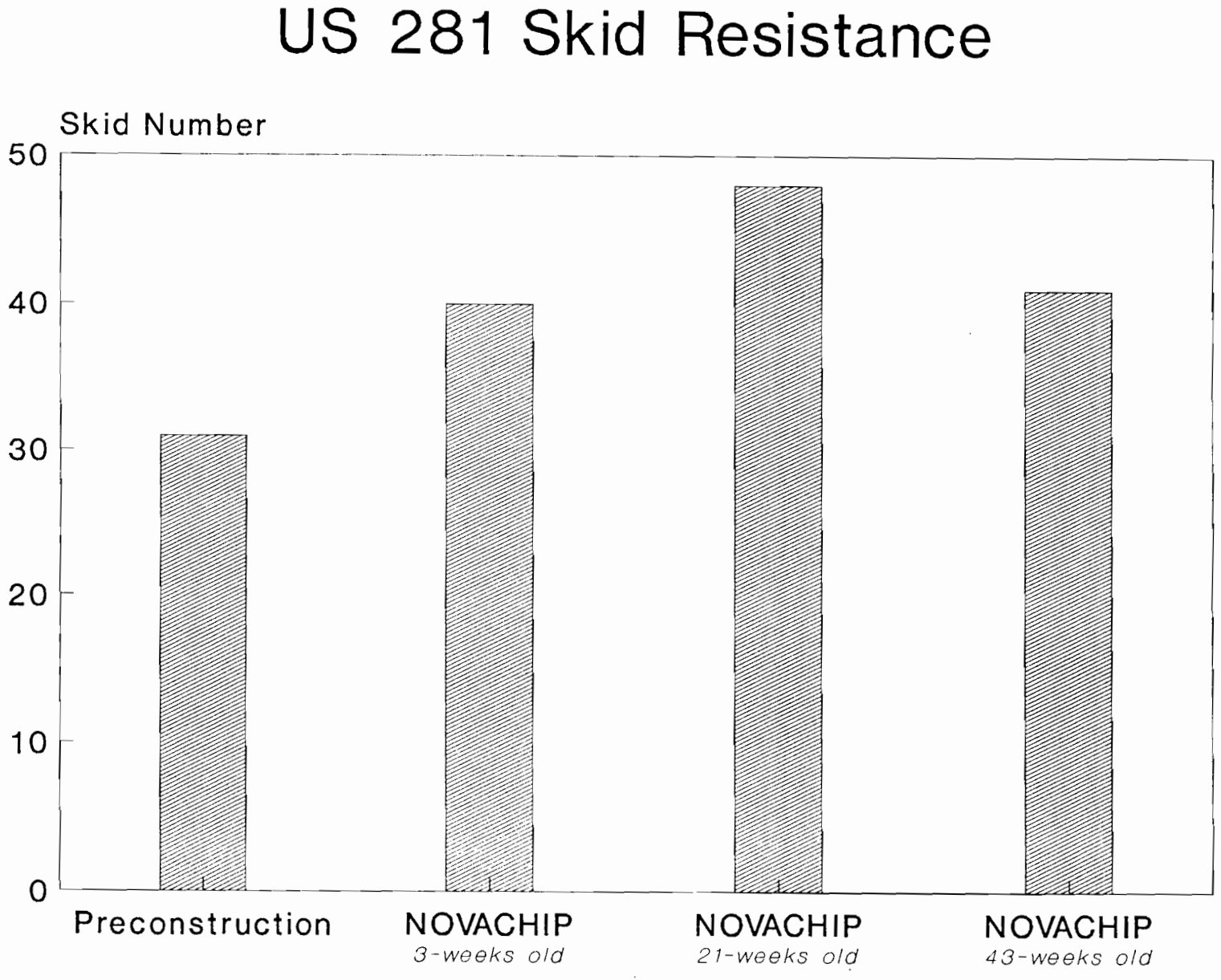


Figure 9. US 281 Skid Resistance Data.

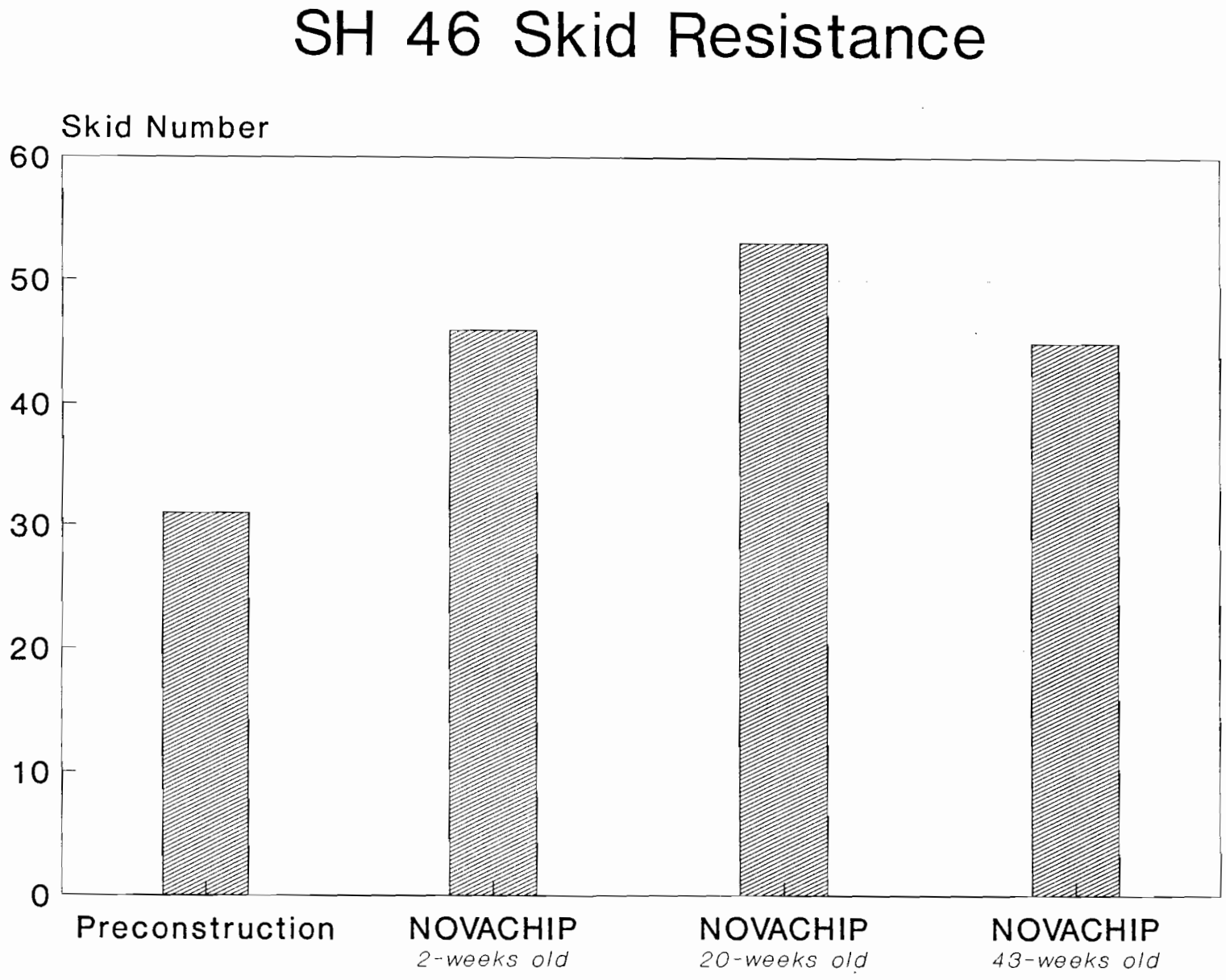


Figure 10. SH 46 Skid Resistance Data.

5

Summary and General Comments

NOVACHIP™ was successfully constructed on two highways in the San Antonio District of the Texas Department of Transportation: US 281 and SH 46 in Bexar County. The French process, NOVACHIP™, is a new technology for Texas and the United States and this research study was created to provide evaluation and documentation of the process and the resulting performance.

After one year of service, the NOVACHIP™ pavement surfaces are in excellent condition. The pavements appear to be in essentially the same condition as immediately after construction. The pavements will be monitored for a period of three years and performance will be documented.

Total cost of the NOVACHIP™ pavements in this project were excessive due to the small number of jobs constructed here in the U.S. The equipment was transported to the U.S. from France to perform these jobs on a demonstration basis. The cost of the NOVACHIP™ surface for this job was about $2.54 per square yard ($3.02 per square meter). Current prices for microsurfacing in Texas range from $.60 to $.80 per square yard ($.70 to $.95 per square meter). Depending on the type of binder used, chip seals range from $.50 to $.70 per square yard ($.60 to $.85 per square meter) in cost, and thin overlays (1 inch or 25 mm) are about $1.50 per square yard ($1.80 per square meter). The selling price of NOVACHIP™ in France is reported to be the same as micro-surfacing and just a little more than a polymer modified asphalt chip seal.

In general, NOVACHIP™ appears to have promise as a preventive maintenance treatment or surface rehabilitation technique for asphalt concrete pavements. It should provide the maintenance engineer with an alternative for chip seals, micro-surfacing, plant-mix seals, or thin asphalt concrete overlays. This research study cannot provide a direct comparison of NOVACHIP™ to other maintenance treatments since no comparable test sections were constructed involving other maintenance treatments. Some of the advantages NOVACHIP™ may have over these maintenance treatments are listed below (not quantified in this study):

Advantages NOVACHIP™ May Have Over Chip Seal

1. Excellent chip retention.
2. Reshaping of existing pavement to a limited degree, e.g. minor rut-filling and smoothing corrugations and other minor surface irregularities.
3. Less rolling noise.
4. Suitable for use on high traffic volume roads.
5. More resistant to damage caused by turning and stopping maneuvers.
6. Higher probability of success in cool, wet weather.

Advantages NOVACHIP™ May Have Over Micro-Surfacing

1. Quick reopening to traffic.
2. May have better adhesion to underlying surface due to heavy tack coat.
3. Greater surface macrotexture.
4. Better drainage -- Reduced splash and spray due to open surface texture.

Advantages NOVACHIP™ May Have Over Open-Graded Friction Courses

1. May have better adhesion to underlying surface due to heavy tack coat.
2. Better protection of underlying pavement from surface water which is often a problem with OGFCs.

Advantages NOVACHIP™ May Have Over Dense-Graded Thin Overlay

1. May have better adhesion to underlying surface due to heavy tack coat.
2. High-quality crushed materials should be more rut-resistant.
3. Greater surface macrotexture.
4. Improved surface drainage.
5. Better protection of underlying pavement from surface water.

Some preliminary conclusions regarding NOVACHIP™ as a result of construction observations and early performance data are listed below.

1. NOVACHIP™ is a high quality mixture, consisting of 100 percent crushed materials. This type of mixture, however, does not lend itself to a significant amount of handwork and raking.
2. It is very important that the mixture be placed at 280°F (138°C) or above. Due to the openness of the aggregate gradation and thinness of the layer, the mixture loses heat quickly. If the mixture gets too cool, the paver must operate at a slower-than-optimum speed. Excess mixture may also back up in front of the screed causing tears in the mat which are not as easy to repair as dense-graded hot mix. The plant temperature should be 315°F (157°C) or more. Trucks which are transporting the mix should be covered with tarps, if possible.
3. NOVACHIP™ significantly increased the skid resistance of the pavement.
4. No improvement in ride quality was measured on US 281 resulting from NOVACHIP™; however, the existing pavement had a very good ride score. An improvement in ride quality on SH 46 was measured (ride score increased from 4.0 to 4.4).
5. Quality control procedures used for conventional hot-mix asphalt concrete jobs may not be acceptable for NOVACHIP™. The mixture is noticeably sensitive to changes in mixture proportions. A performance-based specification regarding workmanship quality may be appropriate for this type of surfacing. Recommendations will be made in a subsequent report.

6. NOVACHIP™ provides a uniform, attractive appearance; however, the mixture lacks workability, therefore, excessive handwork and raking of the mix is very noticeable and detracts from the appearance and sometimes ride quality. No raking is required when a paving project is proceeding as it should.

References

1. "NOVACHIP™, A New Type of Pavement Surfacing", SCREG ROUTES.

2. Serfass, J. P., Bense, P., and Samanos, J., "Performance Assessment of Ultrathin Friction Courses," Preprint of paper presented at the Transportation Research Board Meeting, Washington, D.C., January, 1993.

3. Epps, J. A., Meyer, A. H., Larrimore, I.E., Jr. and Jones, H. L., "Roadway Maintenance Evaluation User's Manual," Texas Transportation Institute Research Report 151-2, September, 1974.

Appendix: Special Specifications

SPECIAL SPECIFICATION

ITEM 3820

PAVER-LAID SURFACE TREATMENT

1. DESCRIPTION. This Item shall govern for the construction of a surface treatment composed of a polymer-modified asphalt emulsion application followed immediately with a thin placement of hot, plant-mixed paving mixture, in accordance with the details shown on the plans and the requirements herein.

2. MATERIALS. The Contractor shall furnish materials to the project meeting the following requirements prior to mixing. Additional test requirements affecting the quality of individual materials or the paving mixture shall be required when shown on the plans.

   (1) Aggregate. The aggregate shall be composed of a coarse aggregate, a fine aggregate and, if required, a mineral filler, meeting the requirements below, and of such gradation that the master gradation requirements for the paving mixture will be met. Samples of each material shall be submitted for approval in accordance with Item 6, "Control of Materials".

   (A) Coarse Aggregate. Coarse aggregate is defined as that part of the aggregate retained on the No. 10 sieve. The aggregate shall be of natural origin, of uniform quality throughout, and shall be 100 percent crushed material.

   The polish value of the coarse aggregate shall be not less than the value shown on the plans, when tested in accordance with Test Method Tex-438-A. Unless otherwise shown on the plans, the polish value requirement shall apply only to aggregate used on the travel lanes. For rated sources, the Materials and Tests Division's Rated Source Polish Value (RSPV) catalog will be used to determine polish value compliance. Blending of coarse aggregate to meet polish value requirements will not be allowed.

   The coarse aggregate shall have a Los Angeles Abrasion Test loss of less than 35 percent when tested in accordance with Test Method Tex-410-A.

   The aggregate shall be subjected to five (5) cycles of magnesium sulfate soundness testing in accordance with Test Method Tex-411-A. The loss shall not exceed 25 percent, unless otherwise shown on the plans.

   The aggregate shall not contain more than 1.0 percent loss from fine dust, clay-like particles and/or silt when tested in accordance with Test Method Tex-217-F, Part II.

The flakiness index for the aggregate, as determined by Test Method Tex-224-F, shall not exceed 17 unless otherwise shown on the plans.

The aggregate shall not contain more than 2.0 percent by weight of soft particles and other deleterious material as determined by Test Method Tex-217-F, Part I.

The coarse aggregate gradation shall comply with the following requirements.

	Percent by Weight
Retained on the 1/2" sieve	0
Retained on the 3/8" sieve	0 - 15
Retained on the No. 4 sieve	95 - 100
Retained on the No. 10 sieve	99 - 100

(B) Fine Aggregate. Fine aggregate is defined as that part of the aggregate passing the No. 10 sieve. The aggregate shall be of natural origin, of uniform quality throughout, and shall be 100 percent crushed material.

The fine aggregate shall be supplied from a source whose coarse aggregate meets the Los Angeles abrasion and magnesium sulfate soundness loss requirements shown above for coarse aggregate.

The fine aggregate, when tested alone, shall have a sand equivalent value of not less than 60 when tested in accordance with Test Method Tex-203-F.

The gradation of the fine aggregate shall be such that it will all pass the No. 4 sieve and will have no more the 10 percent retained on the No. 10 sieve.

(C) Mineral Filler. Mineral filler shall consist of thoroughly dried limestone dust, portland cement, or other mineral dust approved by the Engineer. The mineral filler shall be free from foreign matter.

The mineral filler shall be proportioned into the mix by a vane meter or an equivalent measuring device acceptable to the Engineer. A hopper or other acceptable storage system shall be required to maintain a constant supply of mineral filler to the measuring device.

(2) Asphaltic Material.

(A) Paving Mixture. Asphalt cement for the paving mixture shall be of the grade shown on the plans or as designated by the Engineer and shall meet the requirements of Item 300, "Asphalts, Oils and Emulsions". The Contractor shall notify the Engineer of the source of supply of the asphaltic material prior to beginning production, and the source of supply shall not be changed during the course of the project without the authorization of the Engineer.

(B) Tack Coat. The tack coat shall be polymer-modified asphalt emulsion meeting the requirements for CRS-2P (low viscosity) of Item 300, "Asphalts, Oils and Emulsions", unless otherwise shown on the plans.

(3) Additives. Additives to facilitate mixing and/or improve the quality of the paving mixture shall be used when shown on the plans or may be used with the authorization of the Engineer.

Unless otherwise shown on the plans, the Contractor may choose to use either lime or liquid antistripping agent to reduce the moisture susceptibility of the aggregate. The addition of antistripping agents will be in accordance with Special Specification Items, "Asphalt Antistripping Agent (Lime)" or "Asphalt Antistripping Agent (Liquid)".

3. PAVING MIXTURE. The paving mixture shall consist of a uniform mixture of aggregate, hot asphalt cement and additives if allowed or required.

(1) Mixture Design. The Contractor shall furnish the Engineer with representative samples of the materials to be used in production. The Engineer will select the proportions of the aggregates and asphalt cement to compose the job-mix formula. The proportioning of the aggregate will be such that the job-mix formula percentages fall within the master gradation limits shown below. Unless otherwise shown on the plans, the gradation of the aggregate will be determined in accordance with Test Method Tex-200-F, Part I (Dry Sieve Analysis). The asphalt cement shall compose from 4.7 to 6.2 percent by weight of the mixture, as selected by the Engineer.

	Percent by Weight
Retained on the 1/2" sieve	0
Retained on the 3/8" sieve	0 - 15
Retained on the No. 4 sieve	65 - 75
Retained on the No. 10 sieve	73 - 81
Retained on the No. 40 sieve	87 - 92
Retained on the No. 80 sieve	91 - 94
Retained on the No. 200 sieve	93 - 96

Unless otherwise shown on the plans, the mixture of aggregate, asphalt and additives proposed for use will be evaluated in the design stage for moisture susceptibility in accordance with Special Specification Items, "Asphalt Antistripping Agent (Lime)" or "Asphalt Antistripping Agent (Liquid)", except that the method of test will be Test Method Tex-530-C and the mixture must evidence a coating loss of 10 percent or less.

(2) Tolerances. The gradation of the aggregate and the asphalt cement content of the produced paving mixture shall not vary from the job-mix formula percentages by more than the following tolerances when tested in accordance with Test Method Tex-210-F or Test Method Tex-228-F.

	Tolerance, Percent by Weight
Retained on the 3/8" to No. 10 sieve	Plus or minus 5
Retained on the No. 40 to No. 200 sieve	Plus or minus 3
Asphalt	Plus or minus 0.5

If three consecutive tests indicate that the material produced exceeds the above tolerances on any individual sieve, or if two consecutive tests indicate that the asphalt content tolerance is exceeded, production shall stop and not resume until test results or other information indicate, to the satisfaction of the Engineer, that the next mixture to be produced will be within the above tolerances.

4. EQUIPMENT.

(1) General. All equipment for the handling of all materials, mixing, placing and compacting of the paving mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture will not be allowed.

(2) Mixing Plants. Mixing plants may be the weigh-batch type, the modified weigh-batch type, or the drum-mix type. All plants shall be equipped with satisfactory conveyors, power units, mixing equipment, aggregate handling equipment, bins and dust collectors.

Automatic proportioning devices are required for all plants and shall be in accordance with Item 520, "Weighing and Measuring Equipment".

It shall be the Contractor's responsibility to provide safe and accurate means to enable inspection forces to take all required samples, to provide permanent means for checking the output of any specified metering device, and to perform calibration and weight checks as required by the Engineer.

When using fuel oil heavier than Grade No. 2, or waste oil, the Contractor shall insure that the fuel delivered to the burner is at a viscosity of 100 SSU or less, when tested in accordance with Test Method Tex-534-C, to insure complete burning of the fuel. Higher viscosities will be allowed if recommended by the burner manufacturer. If necessary, the Contractor shall preheat the oil to maintain the required viscosity.

The Contractor shall provide means for obtaining a sample of the fuel, just prior to entry into the burner, in order to perform the viscosity test. The Contractor shall perform this test or provide a laboratory test report that will establish the temperature of the fuel necessary to meet the viscosity requirements. There shall be an in-line thermometer to check the temperature of the fuel delivered to the burner.

Regardless of the burner fuel used, the burner or combination of burners and types of fuel used shall provide a complete burn of the fuel and not leave any fuel residue that will adhere to the heated aggregate.

(A) Weigh-Batch Type.

Cold Aggregate Bin Unit and Proportioning Device. The cold aggregate bin unit shall have a separate bin for each aggregate which is of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back, and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The proportioning device shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned from a separate bin.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the hot aggregate bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. The hot bins shall be constructed so that oversize and overloaded material will be discarded through overflow chutes. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by weight of asphaltic material in the paving mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 3,000 pounds (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The paving mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The paving mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of paving mixture in each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch weights shall be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(B) Modified Weigh-Batch Type.

General. This plant is similar to the weigh-batch type plant. The hot bin screens shall be removed and the aggregate control is placed at the cold feeds. The cold feed bins will be the same as those required for the drum-mix type plant.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with Construction Bulletin C-14, or other methods of cold bin calibration acceptable to the Engineer.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the hot aggregate surge bins.

Dryer. The dryer shall continually agitate the aggregate during heating. The temperature shall be controlled so that the aggregate will not be damaged in the drying and heating operations. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The hot aggregate shall not be separated into sizes after being dried. There shall be one or more surge bins provided between the dryer and the weigh hopper. Surge bins shall be of sufficient size to hold enough combined aggregate for one complete batch of paving mixture.

Aggregate Weigh Box and Batching Scale. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

Asphaltic Material Measuring System. If an asphaltic material bucket and scales are used, they shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. The bucket and scales shall conform to the requirements of Item 520, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of Item 520, "Weighing and Measuring Equipment", shall apply. This system shall include an automatic temperature compensation device to insure a constant percent by weight of asphaltic material in the mixture.

Provisions of a permanent nature shall be made for checking the accuracy of the asphaltic material measuring device. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material.

Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 3,000 pounds (of natural-aggregate mixture) in a single batch, unless otherwise shown on the plans. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixture with the asphaltic material shall not be used. All mixers shall be provided with an automatic timer that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pugmill.

Surge-Storage System and Scales. A surge-storage system may be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The paving mixture shall be weighed upon discharge from the surge-storage system.

When a surge-storage system is used, scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. The paving mixture shall be weighed for payment. If a surge-storage system is used, an automatic recording device and a digital record printer shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of paving mixture in each load and the number of loads for the day, unless otherwise indicated on the plans. When surge-storage is not used, batch weights shall be used as the basis for payment and automatic recording devices and automatic digital record printers in accordance with Item 520, "Weighing and Measuring Equipment", shall be required.

(C) Drum-Mix Type.

General. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt. The plant shall be equipped with satisfactory conveyors, power units, aggregate-handling equipment and feed controls.

Cold-Aggregate Bin Unit and Feed System. The number of bins in the cold-aggregate bin unit shall be equal to or greater than the number of stockpiles of individual materials to be used.

The bins shall be of sufficient size to store the amount of aggregate required to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another. There shall be vertical partitions between each bin and on each end of the bins of sufficient height so that any overflow

will be to the front and back and not allow overflow to the sides or between bins. Overflow that might occur shall not fall onto any feeder belt. The feed system shall provide a uniform and continuous flow of aggregate in the desired proportion to the mixer. The Contractor shall furnish a chart indicating the calibration of each cold bin in accordance with Construction Bulletin C-14, or other methods of cold bin calibration acceptable to the Engineer.

The system shall provide positive weight measurement of the combined cold-aggregate feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 520, "Weighing and Measuring Equipment". When a belt scale is used, paving mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the Engineer if accuracy checks show the scale to meet the requirements of Item 520, "Weighing and Measuring Equipment", at the selected rate. It shall be satisfactorily demonstrated to the Engineer that paving mixture uniformity and quality have not been adversely affected.

Scalping Screen. A scalping screen shall be required after the cold feeds and ahead of the combined aggregate belt scales.

Asphaltic Material Measuring System. An asphaltic material measuring device meeting the requirements of Item 520, "Weighing and Measuring Equipment", shall be placed in the asphalt line leading to the mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device output. The asphalt line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line near the temperature specified for the asphaltic material. The measuring system shall include an automatic temperature compensation device to maintain a constant percent by weight of asphaltic material in the paving mixture.

Synchronization Equipment for Feed-Control Systems. The asphaltic material feed-control shall be coupled with the total aggregate weight measuring device to automatically vary the asphalt-feed rate in order to maintain the required proportion.

Mixing System. The mixing system shall control the temperature so that the aggregate and asphalt will not be damaged in the drying, heating and mixing operations. A continuously recording thermometer shall be provided which will indicate the temperature of the paving mixture as it leaves the mixer.

Surge-Storage System and Scales. A surge-storage system shall be used to minimize the production interruptions during the normal day's operations. A device such as a gob hopper or other device

approved by the Engineer to prevent segregation in the surge-storage bin shall be used. The paving mixture shall be weighed upon discharge from the surge-storage system.

Scales shall be standard platform truck scales or other equipment such as weigh hopper (suspended) scales and shall conform to Item 520, "Weighing and Measuring Equipment". If truck scales are used, they shall be placed at a location approved by the Engineer. If other weighing equipment is used, the Engineer may require weight checks by truck scales for the basis of approval of the equipment.

Recording Device and Record Printer. Automatic recording and automatic digital record printers shall be provided to indicate the date, project identification number, vehicle identification, total weight of the load, tare weight of the vehicle, the weight of paving mixture in each load and the number of loads for the day in accordance with Item 520, "Weighing and Measuring Equipment", unless otherwise shown on the plans.

(3) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the required amount of asphaltic material to the desired temperature. The heating apparatus shall be equipped with a continuously recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the location of highest temperature.

(4) Surface Treatment Paver. The surface treatment paver shall be approved by the Engineer and shall meet the following requirements.

(A) Screed Unit. The surface treatment paver shall be equipped with a heated screed. It shall produce a finished surface meeting the requirements of the typical cross sections.

Extensions added to the screed shall be provided with the same heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer. The screed, with extensions if necessary, shall be of such width as to pave an entire lane in a single pass.

(B) Asphalt Distribution System. A metered mechanical pressure sprayer shall be provided on the surface treatment paver to accurately apply and monitor the rate of application of the tack coat. The rate shall be uniform across the entire paving width. Application shall be immediately in front of the screed unit.

(C) Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the paving mixture is being unloaded.

No portion of the weight of hauling equipment, other than the

connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

(5) Rollers. Rollers provided shall meet the requirements for their type as follows:

(A) Two-Axle Tandem Roller. This roller shall be an acceptable self-propelled tandem roller.

(B) Three-Wheel Roller. This roller shall be an acceptable self-propelled three wheel roller.

(C) Three-Axle Tandem Roller. This roller shall be an acceptable self-propelled three axle roller.

(6) Straightedges and Templates. When directed by the Engineer, the Contractor shall provide acceptable 10 foot straightedges for surface testing. Satisfactory templates shall be provided as required by the Engineer.

(7) Alternate Equipment. When permitted by the Engineer, equipment other than that specified herein which will consistently produce satisfactory results may be used.

5. STOCKPILING, STORAGE AND MIXING.

(1) Stockpiling of Aggregates. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds, grass and shall be relatively smooth and well drained. The stockpiling shall be done in a manner that will minimize aggregate degradation, segregation, mixing of one stockpile with another, and will not allow contamination with foreign material.

The plant shall have at least a two-day supply of aggregates on hand before production can begin and at least a two-day supply shall be maintained through the course of the project, unless otherwise directed by the Engineer.

No stockpile shall contain aggregate from more than one source.

When required by the Engineer, additional material shall not be added to stockpiles that have previously been sampled for approval.

Equipment of an acceptable size and type shall be furnished to work the stockpiles and prevent segregation and degradation of the aggregates.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material storage capacity shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in Item 300, "Asphalts, Oils and Emulsions". All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregate. The feeding of various sizes of aggregate to the dryer shall be done through the cold aggregate bins and the proportioning device in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a paving mixture seal having the specified temperature.

(4) Mixing and Storage.

(A) Weigh-Batch Plant. In introducing the batch into the mixer, all aggregate shall be introduced first and shall be mixed thoroughly for a minimum period of 5 seconds to uniformly distribute the various sizes throughout the batch before the asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15 seconds. The mixing period shall be increased if, in the opinion of the Engineer, the paving mixture is not uniform or the aggregates are not properly coated.

Temporary storing or holding of the paving mixture by the surge-storage system will be permitted during the normal day's operation. The paving mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(B) Modified Weigh-Batch Plant. The mixing and storage requirements shall be the same as is required for a standard weigh-batch plant.

(C) Drum-Mix Plant. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced.

Temporary storing or holding of the paving mixture by the surge-storage system will be required during the normal day's operation. The paving mixture coming out of the surge-storage bin shall be of equal quality to that coming out of the mixer.

(D) Discharge Temperature. Unless otherwise directed by the Engineer, the paving mixture shall be at a temperature between 290 F and 335 F when discharged from the mixer. The Engineer will designate the temperature within the above limitations, and the mixture when discharged from the mixer shall not vary from this selected temperature more than 10 F.

(E) Moisture Content. The paving mixture shall have a moisture content not greater than 1 percent by weight when discharged from the mixer, unless otherwise shown on the plans and/or approved by the Engineer. The moisture content shall be determined in accordance with Test Method Tex-212-F.

6. CONSTRUCTION METHODS. Tack coat and paving mixture may be placed only when the temperature of the surface to be overlaid is 50 F or more, and the air temperature is above 50 F and rising, but shall not be placed when the air temperature is below 60 F and falling. The air temperature will be taken in the shade away from artificial heat. It is further provided that the tack coat or paving mixture shall be placed only when the humidity, general weather conditions and moisture condition of the pavement surface, in the opinion of the Engineer, are suitable.

(1) Tack Coat. Before the tack coat and paving mixture are applied, the surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Engineer. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification approximately 2 seconds prior to the placement of paving mixture. This tack coat shall be applied by the paving machine asphalt distributor at a rate of 0.22 $\pm$ 0.05 gallon per square yard of surface area, unless otherwise directed by the Engineer to counteract porosity of the existing pavement.

(2) Transporting Paving Mixture. The paving mixture, prepared as specified above, shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of vehicles shall be arranged so that all material delivered may be placed and all rolling shall be completed during daylight hours. Covers and insulated truck beds shall be required, unless otherwise shown on the plans. If necessary to prevent the paving mixture from adhering to the bed, the inside of the truck bed shall be given a light coating of release agent satisfactory to the Engineer.

(3) Placing. The temperature of the paving mixture shall not be less than 280 F when placed on the road, unless otherwise directed by the Engineer. The paving mixture shall be dumped directly into the specified surface treatment paver and spread on the tack coated surface in such a manner that, when properly compacted, the finished surface will be smooth and of uniform texture and density. The surface treatment paver shall be operated at a speed satisfactory to the Engineer. If, in the opinion of the Engineer, sporadic delivery of paving mixture adversely affects the quality of the work or unduly lengthens the time the traffic is restricted from full use of the through lanes, laying operations shall cease and traffic shall be fully restored to the through lanes until consistent delivery of the paving mixture is provided by the Contractor. Care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures during paving operations.

(4) Compacting. Immediately following placement of the paving mixture, the surface shall be rolled with a tandem or three wheel roller of such weight as to accomplish a good seating without excessive breakage of the aggregate. A minimum of three (3) passes shall be required unless otherwise directed by the Engineer. These passes shall be accomplished prior to the paving mixture cooling to below 180F. The speed and motion of the rollers shall be such as to avoid displacement of the paving mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Engineer. To prevent adhesion of the paving mixture to the roller, the wheels shall be kept thoroughly moistened with a soap-water solution. 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. Sprinkling of the fresh mat shall be required, when directed by the Engineer, to expedite opening the roadway to traffic. Sprinkling shall be with water or lime-water solution, as directed by the Engineer.

7. MEASUREMENT.

(1) The paving mixture will be measured separately by the ton of 2000 pounds of "Asphalt" and by the ton of dry "Aggregate" of the types used in the completed and accepted work in accordance with the plans and specifications for the project.

Asphalt. The weight of asphalt cement will be calculated from the measured weights of paving mixture using the selected percentage of asphalt.

Aggregate. Aggregate will be measured by the ton of 2000 pounds of the type used in the completed and accepted work. The aggregate weight will be determined from the total weight of paving mixture, in pounds, less the selected percentage of asphalt.

(2) Tack coat will be measured at the point of application on the road in gallons at the applied temperature.

8. PAYMENT.

(1) The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit prices bid for "Asphalt" and "Aggregate", of the types specified, which prices shall be full compensation for quarrying, furnishing all materials and freight involved; for all heating, mixing, hauling, cleaning the existing pavement, placing paving mixture, rolling, finishing, and sprinkling the finished surface; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work .

(2) The tack coat, measured as provided under "Measurement", will be paid for at the unit price bid for "Tack Coat", which price shall

be full compensation for furnishing, preparing, hauling and placing the asphaltic material of the type and grade used; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(3) All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

SPECIAL PROVISION

TO

ITEM 300

ASPHALTS, OILS AND EMULSIONS

For this project, Item 300, "Asphalts, Oils and Emulsions", of the Standard Specifications, is hereby amended with respect to clauses cited below and no other clauses or requirements of this Item are waived or changed hereby.

Article 300.2. Materials, Subarticle (6) Emulsions. The table of Cationic Emulsions is supplemented by the following:

Type - - - - - Rapid Setting Polymer Modified
Grade - - - - - CRS-2P (low viscosity)

Description
CRS-2P shall be a rapid setting cationic emulsion containing a minimum of three percent polymer by weight of the distillation residue, as determined by an analytical method approved by the Department. The emulsion supplier shall furnish the Department samples of the base asphalt and polymer used in the finished emulsion.

Properties	Min	Max
Viscosity, Saybolt furol at 77 F, seconds	20	100
Storage Stability Test, one day, percent	-	1
Demulsibility, 35 ml 0.8 percent sodium dioctyl sulfosuccinate	40	-
Particle Charge Test	positive	
Sieve Test, percent	-	0.10
*Distillation:		
Oil distillate, by volume of emulsion, percent	-	1/2
Residue, percent	60	-
Tests on Residue from Distillation:		
Penetration, 77 F, 100 g, 5 seconds	110	150
Viscosity at 140 F, Poises	1300	-
Ductility, 39.2 F, 5 cm/min, cm	50	-
Solubility in trichloroethylene, percent	97	-

*The standard distillation procedure shall be modified as follows:

The temperature on the lower thermometer shall be brought slowly to 350 plus or minus 10 F and maintained at this point for 20 minutes. Complete the total distillation in 60 plus or minus 5 minutes from the first application of heat.

SUPPLEMENTAL AGREEMENT NO. 1

PROJECT: CPM 215-1-27, Etc.
CONTROL: 0215-01-027, Etc.
HIGHWAY: S.H. 46, Etc.
COUNTY: Comal, Etc.

WHEREAS, a contract was entered into on the 14th day of September, 1992, by and between the State of Texas represented by the Executive Director, Texas Department of Transportation, and F.N. Ploch Construction Company, Inc., the Contractor for the highway construction and improvement as shown and described in the plans, specifications and special provisions for the above referenced project, and

WHEREAS, Special Specification Item 3820, Paver-Laid Surface Treatment, Article 3, Paving Mixture, Subarticle (1), Mixture Design, established job-mix master gradation limits for the project and Special Specification Item 3820, Article 2, Materials, Subarticle (1)(B), Fine Aggregate, establishes a minimum sand equivalent value for the fine Aggregate, and

WHEREAS, it has been determined that to design a paving mixture utilizing available materials that will be a good representation of this experimental paver-laid surface treatment certain changes to the specification values are deemed desirable, and

THEREFORE, it is agreed between the parties hereto that the Fine Aggregate, when tested alone, shall have a sand equivalent value of not less than 50 when tested in accordance with test method TEX-203-F.

IT IS FURTHER AGREED, that the proportioning of the aggregate will be such that the job-mix formula percentages fall within the master gradation limits shown below.

	Percent by Weight
Retained on the 1/2" Sieve	0
" 3/8" "	0-15
" No. 4 "	60-70
" No. 10	70-78
" No. 40 "	85-92
" No. 80 "	90-94
" No. 200 "	93-96

IT IS FURTHER AGREED, that no other provisions of the contract, plans, specifications or special provisions be changed by this agreement.

Project: CPM 215-1-27, Etc.
CSJ: 0215-01-027, Etc.
Highway: S.H. 46, Etc.
County: Comal, Etc.
District: 15
S.A. No.: 1

CORPORATE SEAL

In WITNESS WHEREOF the parties hereto have set their hands on the dates shown herein.

RECOMMENDED FOR APPROVAL BY:

TEXAS DEPARTMENT OF TRANSPORTATION

Bobbie L. Zaser, P.E. 10/16/92
Area Engineer Date

Director of Construction Date

"Executed for the Executive Director and approved for the Texas Transportation Commission under Minute Order 82513 and Administrative Order 15-88, for the purpose and effect of activating and/or carrying out the orders, established policies or work programs heretofore approved and authorized by the Texas Transportation Commission."

District Engineer Date

CONTRACTOR

F.N. Ploch Construction Co, Inc.
(Firm)

By: F N Ploch 10-16-92
Date

SURETY APPROVAL

FIDELITY AND DEPOSIT COMPANY OF MARYLAND
(Firm)

By: Deborah L Steele
Date OCT 16 1992

Deborah L Steele
Attorney-In-fact
(Typed Name)

POWER OF ATTORNEY ATTACHED

CORPORATE SEAL

Rev.(09-91)