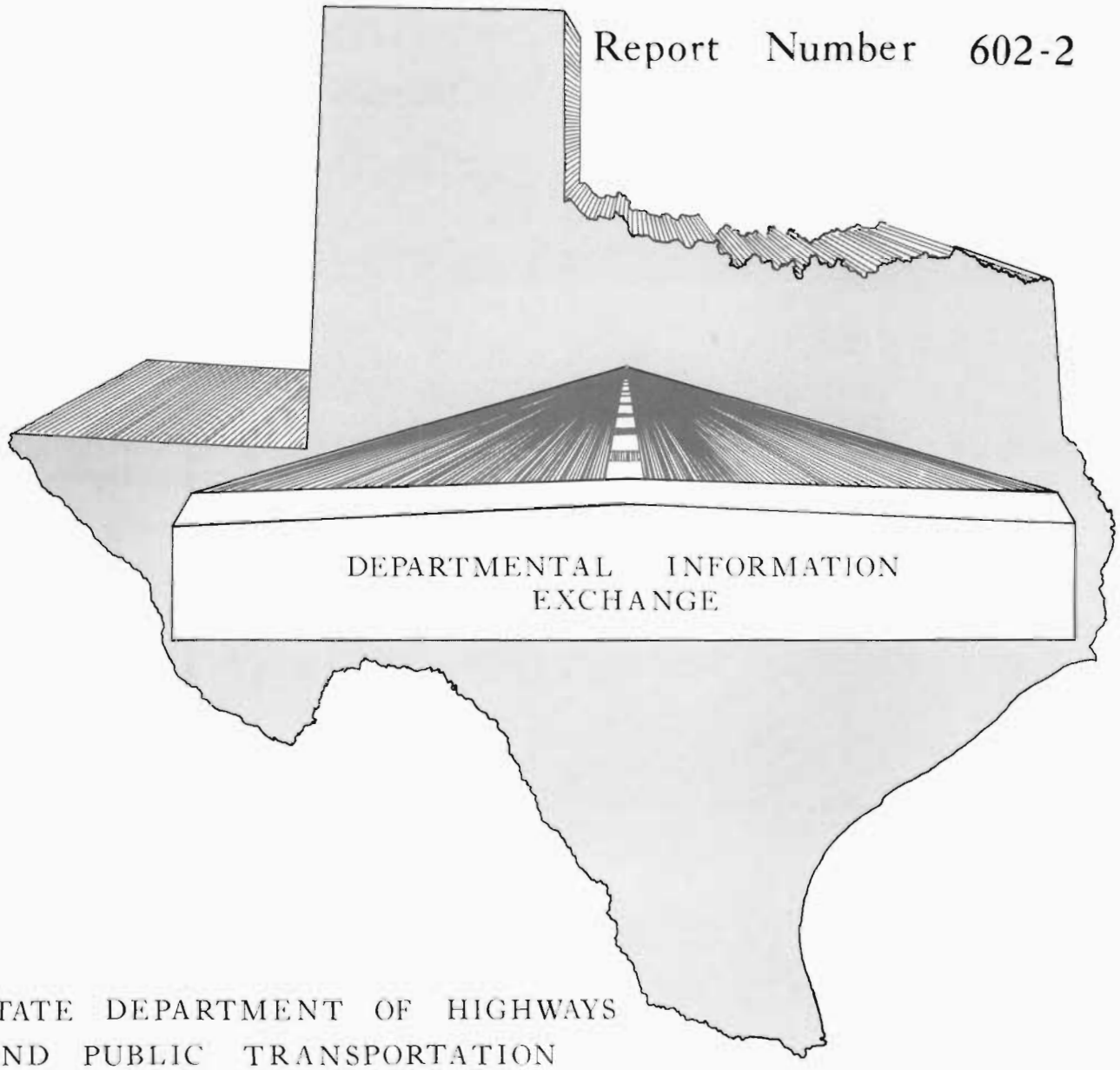
EXPERIMENTAL PROJECTS

PLANT MIX SEAL IN DISTRICT 7

Report Number 602-2



STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

PLANT MIX SEAL IN DISTRICT 7

Report Number 602-2

Project No. HHS-000S(25)
U.S. Highway 87
Coke and Tom Green Counties

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DISCLAIMER STATEMENT

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

BACKGROUND

Although plant mix seal has been placed on a number of highways in various parts of Texas by the Department, the placement of this type surface in District 7 in any quantity had not been previously attempted. Only a small test section of approximately 500 ft. in length had been placed on FM 2105 north of San Angelo in April, 1975, for the purpose of checking a proposed batch design and placement procedures.

In September, 1975, bids were received for placement of Plant Mix Seal wearing surface on two sections of US Highway 87 northwest of San Angelo. US Highway 87 in this area is a rural, four-lane divided facility. One section in Coke County began at the Sterling/Coke County Line on the southbound lanes only, and extended from that point 2.9 miles. The other section in Tom Green County began at a point 10.7 miles southeast of the Coke/Tom Green County Line, extending southeast a distance of 5.3 miles in the northbound lanes only. The Average Daily Traffic count on these two sections ranged from 2960 to 3220. This was a Federal-Aid project under a Highway Safety Improvement Program.

Reece Albert, Inc., of San Angelo, was the low bidder with a total bid price of $116,058.00. The unit price under this contract for AC-10 asphalt was bid at $100 per ton, and for Special Specification Item 3022 aggregate (Grade 2) the unit bid price per c.y. was $29.30. Tack coat was a subsidiary item, with rate estimated at .05 gal/s.y.

Since it was desired to place this material during warm weather months, it was specified that placement would be limited between the months of May 15 to October 1; therefore, since the bids were received during the month of September, little time remained for the contractor to accomplish the work under this contract. Time was therefore suspended after October until May 15, 1976.

The two sections chosen for placement of the plant mix seal were over areas of U.S. Highway 87 which had suffered loss of aggregate and flushing in varying amounts, resulting in slick pavement needing correction. In the Tom Green County section northbound lane (refer to Figure 1) the average skid values in the outside lanes were 12--on the Coke County section southbound lane, average skid values on the outside lane were 21. Both of these sections of road contained very little cracked pavement, and therefore, were not susceptible to water entry into the base. Under these two conditions, slick pavement and reasonably well sealed from water entrance, it was our opinion that the plant mix seal wearing surface with its open graded characteristics would be a desirable solution to the problem of slick pavement.

Prior to attempting a project using this type of wearing surface, members from the District 7 Laboratory and members from one of the Tom Green County Residencies visited in some of the other areas of the State--District 2 and District 11--who had previously designed and placed plant mix seal. Helpful suggestions based on their experiences were of great assistance to us in this endeavor.

PLACEMENT OPERATIONS

The aggregate used on this project was a crushed limestone produced from the Willeke Pit located approximately 3.7 miles west of San Angelo and north of U.S. 67. The Los Angeles Abrasion Test value for this material was 27, and the polish value was 35. For this project, a polish value of 33 was required.

Under Special Specification Item 3022, Grade 2 Aggregate was required for this plant mix seal. The specification gradation is as follows:

	Percent Retained			
5/8	1/2	3/8	#4	#10
0	0-2	20-35	95-100	98-100

The asphalt range under the specification allows 5.0 to 7.5 percent by weight.

By note on the plans, it was required that the trucks transporting the mix use canvas covers, and that the truck beds be insulated for the purpose of reducing heat loss of the mix while in transit. The contractor, in compliance with this requirement, used 6" bat type insulation around the truck bed, which was covered with a light gauge sheet metal fastened to the bed with pop rivets. Canvas tarps covering the complete truck bed were securely tied down after each truck was loaded at the plant.

For the section placed on U.S. 87 in the northbound lane in Tom Green County, beginning of the placement was at a distance of 14 miles from the batch plant. An average time for the haul trucks from the plant to the job was 39 minutes. Temperature average at the plant was 201° F, and the average temperature upon arrival was 190° F. Approximately 12 trucks were used by the contractor on this section.

On the Coke County portion, which was placed on the southbound lanes, the distance from the plant to the job site was 30.8 miles. Average haul time in this case from plant to job site was 61 minutes where again the average

plant temperature was 201°F, with the temperature upon arrival at job site at 187°F. The contractor furnished approximately 16 trucks during this operation, one half of those hauling eight tons and the other half hauling 16 tons.

Operation of the laydown machine from time to time would be interrupted for several minutes; however, during these periods, enough mix was allowed to remain in the laydown machine in order that a few feet advancement could be made every 5 to 10 minutes to avoid constructing a cold joint. The diligent efforts on the contractor's part in maintaining a continuous plant operation, as well as almost continuous delivery of the mix to the job site, resulted in a much better completed job. As on any other construction project, good equipment and well trained personnel furnished by the contractor resulted in a much superior completed project.

During this period of longer haul, the plant production was reduced from about 95 tons per hour to around 85 tons per hour to allow the trucks more time for the round trip.

The plant mix seal was dumped into a Barber Green laydown machine, and the mat placed on the roadway over a tack coat averaging .03 to .04 gal./s.y. which was spread using a light pneumatic roller. Rolling on the mat was accomplished with a tandem steel wheel roller operated immediately behind the laydown machine. Further rolling was obtained with a medium pneumatic roller. Two complete passes over the plant mix seal with each roller resulted in a satisfactory compaction and finish of the completed mat. A minor amount of aggregate crushing resulted from the steel wheel tandem roller, but was not considered sufficient to be a serious problem. Water was used on the rollers to avoid pickup of the mix. Rolling of the edges to achieve a "rounding" effect was accomplished with the pneumatic roller. Edge rolling by the steel wheel roller was unsatisfactory since it resulted in excessive breakage of the aggregate.

Adjoining mats of the plant mix seal were butt jointed, and where minor irregularities were encountered, corrections were achieved by hand using a shovel to place the material with initial levelling off with the back of the shovel. Raking of the material was not satisfactory. Rolling over the butt joints and over those areas correcting the minor irregularities resulted in a good quality of completed mat.

Under the Special Specification Item 3022, the measurement of the aggregate in cubic yards required the establishment of a "K Factor" which is the unit weight of aggregate in pounds per cubic feet. Establishment of this factor was achieved by weighing two trucks filled with aggregate and struck off level to obtain two tests to reach an average unit weight. The material used for these tests came through the plant hot bins and then was dumped directly into the trucks. This "K Factor" was again checked later during the project using this same procedure.

PLANT CONTROL

The contractor produced the plant mix seal in a Standard batch plant of a 5,000 pound capacity, which was a permanent type plant installation within the City of San Angelo. Batches of 4,000 pounds each were produced. The asphalt was held at an approximate temperature of 300°F, and the aggregate at 200°F with the resulting batch temperatures at the plant averaging 201° when dumped into the trucks. At the beginning of batching operations, a temperature of 225° for the aggregate was tried for one truck load; however, it was soon determined that this temperature was too hot since the asphalt had considerable tendency to drain to the bottom of the truck.

The batch design used throughout this project for the aggregate and asphalt is as follows:

		Percent Retained		
5/8	1/2	3/8	#4	#10
0	1.0	28.3	95.3	98.9

AC-10 Asphalt was used at 6.7% by weight. Penetration range for this asphalt was 85-100.

During plant operations, samples of the hot bins were taken three to four times daily during a full day's operation, and satisfactory gradation results within the specifications were achieved. Samples for extractions were also obtained, but test values resulted in a wide range which in our opinion, indicated that sampling of the mix to obtain a representative sample was difficult. Therefore, efforts to continue extraction tests were abandoned.

To insure proper temperature control of mix, which we considered of utmost importance, Dial Thermometers were checked in the District Laboratory using a beaker of boiling water. A thermometer that would not read 210-212° when placed in boiling water was not used. In addition, thermometers were checked after

each days run and discarded when they did not check within this tolerance. This was considered very important as a few degrees error in a thermometer could result in mix too hot causing the asphalt and aggregate to separate.

Another phase of temperature control that was suggested by State Forces and carried out by contractor's Plant Foreman was closer control on heating the aggregate using the Plants Automatic Control System. The average operation range normally was from 15° to 20° above or below the "set point" of desired temperature. By experimenting with changes in the gas pressure and burner openings prior to beginning the job, he was able to control the range within about 5° plus or minus of the "set point" or desired temperature.

Correct thermometers and close control in heating the aggregate resulted in excellent control of the temperature for the mix.

METHOD OF DESIGN

The method used to design the plant mix seal is one that has been used to some extent in other areas of the State, and basically, is a ratio by volume of 1 to 10; i.e. 1 part by volume of asphalt to 10 parts by volume of the loose aggregate. Our unit weight of the aggregate based on an average value from three tests was 89.21 pounds per cubic foot. The specific gravity of asphalt was 1.025. Using these figures, the following typical calculations are listed below converting to weight:

$$89.21 \times 10 = 892.1$$

$$62.5 \times 1.025 = \underline{64.06}$$

$$956.16$$

$$64.06 \div 956.16 = 6.5\% \text{ asphalt by weight}$$

In addition to other preliminary laboratory work conducted on the material in preparation for this work, several samples of the proposed mix were prepared in the District Laboratory. These samples were placed in clear, round pyrex dishes approximately 8" in diameter, and heated to different temperatures. After cooling, the bottom of these dishes were observed to determine the amount of asphalt which had drained to the bottom. From these visual observations, a temperature of approximately 200° was chosen to be desirable for this mix.

In an attempt to measure the percent of voids, a six inch mold was used to compact a sample of 6.7% mix between two metal plates. The height was measured and using volume per inch of mold the volume of mix was calculated in cc. The sample was weighed in air and then in water to establish the absolute volume of sample in cc. The percent voids obtained using this method were from 25% to 30%. The amount of compaction effort for the sample was chosen to

approximate compaction received by the mat on the road after rolling.

Within approximately six weeks after completion of the project, skid values were obtained on both sections. These values ranged from 39 to 41 on the two sections. Periodical tests are planned for later skid values.

Figures 2, 3, and 4 show photographs of the plant mix seal during laying operations as well as the completed mat after rolling.

Special Specification 3022 is attached as Appendix A.

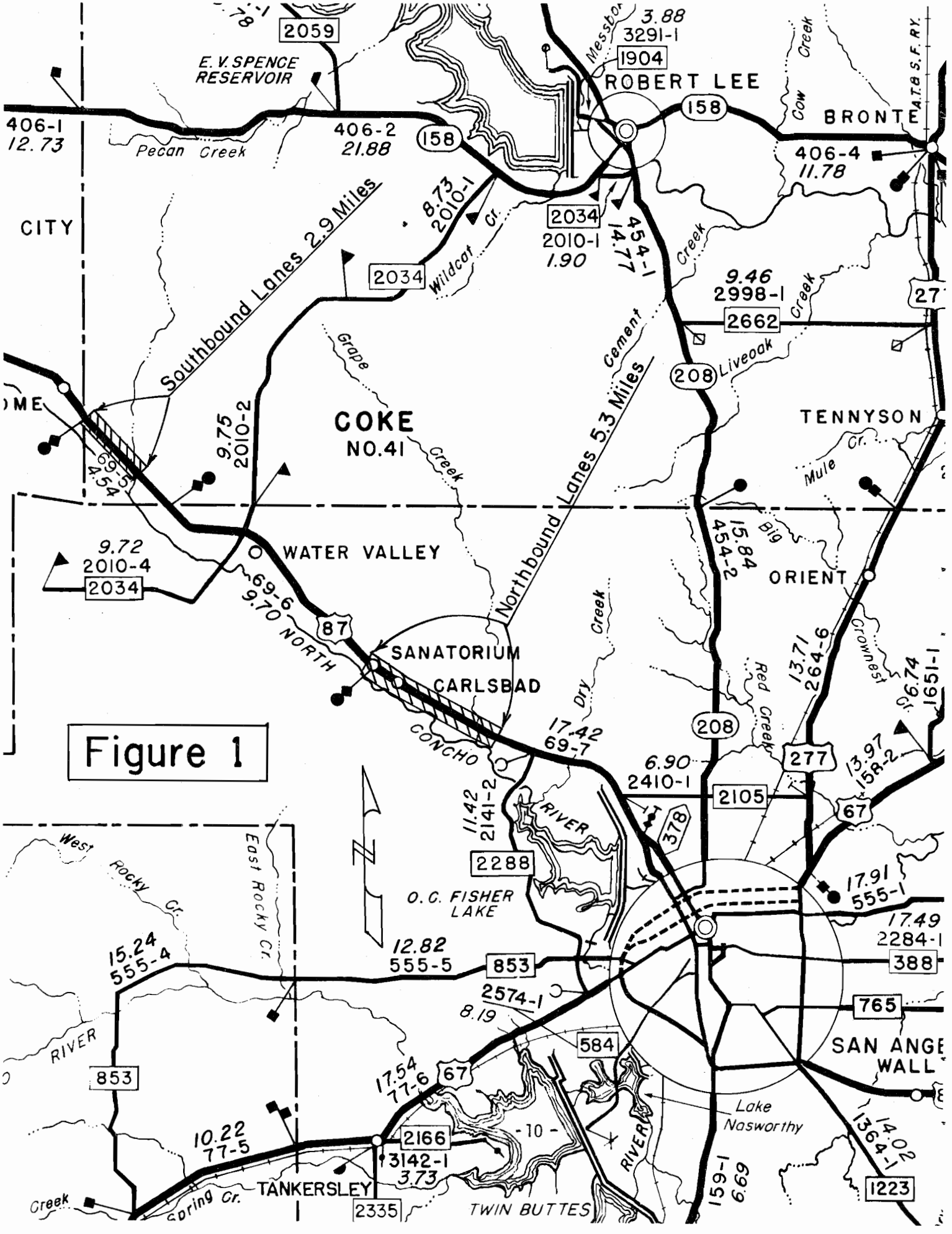
2059
E. V. SPENCE RESERVOIR
406-1
12.73
Pecan Creek
406-2
21.88
158
3.88
3291-1
1904
ROBERT LEE
158
Cow Creek
BRONTE
406-4
11.78
CITY
Southbound Lanes 2.9 Miles
8.73
2010-1
2034
Wildcat Cr.
2034
2010-1
1.90
454-1
14.77
Creek
9.46
2998-1
2662
Creek
27
Grape
Cement
208
Liveoak
TENNYSON
Mule Cr.
COKE
NO. 41
Creek
9.75
2010-2
69-5
4.54
Northbound Lanes 5.3 Miles
15.84
454-2
Big
9.72
2010-4
2034
WATER VALLEY
ORIENT
69-6
9.70 NORTH
87
SANATORIUM
CARLSBAD
Dry Creek
Red Creek
13.71
264-6
Crownest
16.74
1651-1
208
17.42
69-7
CONCHO
6.90
2410-1
2105
277
13.97
15R-2
67
11.42
2141-2
RIVER
378
2288
O. C. FISHER LAKE
17.91
555-1
17.49
2284-1
388
West Rocky Cr.
East Rocky Cr.
15.24
555-4
12.82
555-5
853
2574-1
8.19
765
584
SAN ANGE
WALL
RIVER
853
17.54
77-6
67
Lake Nasworthy
10.22
77-5
2166
3142-1
3.73
-10-
RIVER
14.02
1364-1
159-1
699
Creek
Spring Cr.
TANKERSLEY
2335
TWIN BUTTES
1223

Figure 1

Figure 2

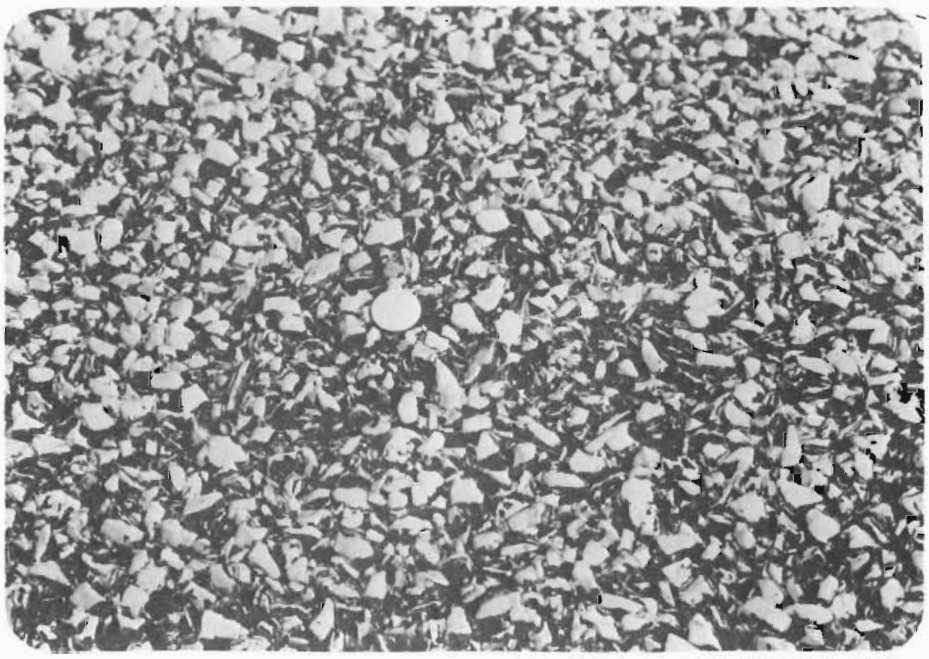

Figure 3

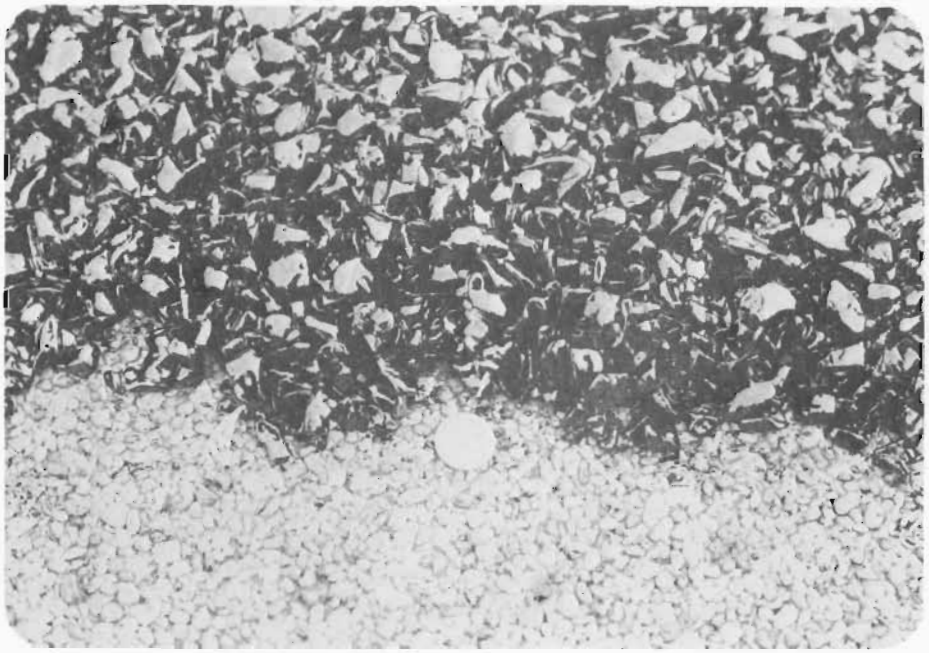

Figure 4

APPENDIX A

TEXAS HIGHWAY DEPARTMENT

SPECIAL SPECIFICATIONS

ITEM 3022

PLANT MIX SEAL

1. DESCRIPTION:

This item shall consist of a wearing surface composed of a compacted mixture of mineral aggregate and asphaltic material, constructed on prepared bases or surface in accordance with these specifications and to the dimensions as shown on the plans.

2. MATERIALS:

(1) Asphaltic Materials.

(a) Plant Mix Seal Asphaltic Material shall be of the types and grades of asphalt cement as indicated on the plans and shall meet the requirements of the Item, "Asphalts, Oils and Emulsions". The Contractor shall notify the Engineer of the source of asphaltic material prior to production of the surfacing mixture and this source shall not be changed during the course of the project except on written permission of the Engineer.

(b) Tack Coat. The asphaltic material for tack coat shall meet the requirements for emulsified asphalt EA-11M, cut-back asphalt RC-2, or shall be a cut-back asphalt made by combining 50 to 70 percent by volume of the asphaltic material as specified for the asphalt-aggregate mixture with 30 to 50 percent by volume of gasoline and/or kerosene. If RC-2 cut-back asphalt is used, it may, upon instructions from the Engineer, be diluted by the addition of an approved grade of gasoline and/or kerosene, not to exceed 15 percent by volume. Asphaltic materials shall meet the requirements of the Item, "Asphalts, Oils and Emulsions".

(2) Mineral Aggregate.

(a) Description. Except for gradation, the mineral aggregate used shall be either crushed stone conforming to the requirements of Item 302, "Aggregate for Surface Treatments", lightweight aggregate conforming to the requirements of Item 303, "Aggregate for Surface Treatments (Lightweight)" or that material as shown on the plans.

In addition to the above requirements, the mineral aggregate shall have a "Polish Value" of not less than 35, unless otherwise shown on the plans, when tested in accordance with Test Method Tex-438-A.

(b) Grades. When tested by Test Method Tex-200-F, Part I, the mineral aggregate shall conform to the following gradation limits or that shown on the plans:

		Percent by Weight
GRADE 1:	Retained on 5/8" sieve	0
	Retained on 1/2" sieve	0-2
	Retained on 3/8" sieve	5-25
	Retained on No. 4 sieve	80-100
	Retained on No. 10 sieve	95-100
GRADE 2:	Retained on 5/8" sieve	0
	Retained on 1/2" sieve	0-2
	Retained on 3/8" sieve	20-35
	Retained on No. 4 sieve	95-100
	Retained on No. 10 sieve	98-100

GRADE 3: As shown on plans.

3. SURFACING MIXTURE:

(1) General. The mixture shall be uniform and consist of mineral aggregate and asphaltic material. For mixtures composed of crushed stone, the asphaltic material shall form from 5.0 to 7.5 percent of the mixture by weight unless otherwise shown on the plans. For mixtures composed of lightweight aggregate, the asphaltic material shall form from 10.5 to 14.0 percent of the mixture by weight unless otherwise shown on the plans.

(2) Tolerances. The Engineer will designate the asphalt content to be used in the mixture after tests have been made with the aggregate to be used in the project. When tested, as determined by the Engineer, samples of the mixture shall not vary from the asphalt content designated by the Engineer by more than 0.5 percent dry weight (based on total mixture).

4. EQUIPMENT:

(1) Mixing Plants. Mixing plants that will not continuously produce a mixture meeting all of the requirements of this specification will be condemned.

Mixing plants may be either the weight-batching type, the continuous mixing type, or the dryer-drum mixing type. Either type of plant shall be equipped with satisfactory conveyors, power units, aggregate handling equipment and dust collectors and shall consist of the following essential pieces of equipment. In addition, plants of the weight-batching type and the continuous mixing type shall be equipped with satisfactory hot aggregate screens and bins.

(a) Weight-batching Type.

Cold Aggregate Bin and Proportioning Device. The cold aggregate bins or aggregate stockpiles shall be of sufficient number and size to supply the amount of aggregate required to keep the plant in continuous operation. The proportioning device shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the plant.

Dryer. The dryer shall be of the type that continually agitates the aggregate during heating and in which the temperature can be so controlled that aggregate will not be injured in the necessary drying and heating operations required to obtain a mixture of the specified temperature.

The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregate to the desired or specified temperatures, no residue from the fuel shall adhere to the heated aggregate. A recording thermometer shall be provided which will record the temperature of the aggregate when it leaves the dryer. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screening and Proportioning. The screening capacity and size of the 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. Proper provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where accurate representative samples of aggregate may be taken from the bins for testing. Separation of hot bin into compartments will not be required providing uniform grading and asphalt content are consistently produced in the completed mix.

Aggregate Weigh Box and Batching Scales. 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 the Item, "Weighing and Measuring Equipment".

Asphaltic Material Bucket and Scales. The asphaltic material bucket and scales shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. If the material is measured by weight, the bucket and scales shall conform to the requirements of the Item, "Weighing and Measuring Equipment".

If a pressure type flow meter is used to measure the asphaltic material, the requirements of the Item, "Weighing and Measuring Equipment" shall apply.

Mixer. The mixer shall be of the pug mill type and shall have a capacity of not less than 20 cubic feet unless otherwise shown on the plans. The number of blades and the position of same shall be such as to give a uniform and complete circulation of the batch in the mixer. The mixer shall be equipped with an approved spray bar that will distribute the asphaltic material quickly and uniformly throughout the mixer. Any mixer that has a tendency to segregate the mineral aggregate or fails to secure a thorough and uniform mixing with the asphaltic material shall not be used. This shall be determined by mixing the standard batch for the required time, then dumping the mixture and taking samples from its different parts. This will be tested by the extraction test and must show that the batch is uniform throughout. All mixers shall be provided with an automatic time lock 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 pug mill.

(b) Continuous Mixing Type.

Cold Aggregate Bin and Proportioning Device. Same as for weight-batching type of plant.

Dryer. Same as for weight-batching type of plant.

Screening and Proportioning. Same as for weight-batching type of plant.

Aggregate Proportioning Device. The hot aggregate proportioning device shall be so designed that when properly operated a uniform and continuous flow of aggregate into the mixer will be maintained.

Asphaltic Material Spray Bar. The asphaltic material spray bar shall be so designed that the asphalt will spray uniformly and continuously into the mixer.

Asphaltic Material Meter. An accurate asphaltic material recording meter shall be placed in the asphalt line leading to the spray bar 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 meter output. The asphalt meter and line to the meter shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and meter near the temperature specified for the asphaltic material.

If a pressure type flow meter is used to measure the asphaltic material, the requirements of the Item "Weighing and Measuring Equipment" shall apply.

Mixer. The mixer shall be of the pug mill continuous type and shall have a capacity of not less than 40 tons of mixture per hour. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing of the aggregate with the asphaltic material shall not be used. The dam gate at the discharge end of the pug mixer and/or pitch of the mixing paddles shall be so adjusted to maintain a level of mixture in the pug mixer between the paddle shaft and the paddle tips (except at the discharge end).

Truck Scales. A set of standard platform truck scales, conforming to the Item, "Weighing and Measuring Equipment", shall be placed at a location approved by the Engineer.

(c) Dryer-Drum Mixing Plant. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt in the dryer-drum without preheating the aggregates. The plant shall be equipped with satisfactory conveyors, power units, aggregate handling equipment and feed controls, and shall consist of the following essential pieces of equipment.

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

The bin 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 of one bin to that of another bin. The feed system shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the dryer. Each aggregate shall be proportioned in a separate compartment with total and proportional control.

The system shall provide positive weight measurement of the combined cold aggregate feed by use of belt scales or other devices.

Asphaltic Material Metering System. An accurate asphaltic material meter shall be placed in the asphalt line leading to the dryer-drum 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 meter output. The asphalt meter and line to the meter shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and meter near that temperature specified for the asphaltic material. Unless otherwise shown on the plans the temperature of the asphaltic material entering the meter shall be maintained at $\pm$ 10 F of the temperature at which the asphalt metering pump was calibrated and set.

If a pressure type flow meter is used to measure the asphaltic material, the requirements of the Item "Weighing and Measuring Equipment" shall apply.

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

Dry-Drum Mixing System. The dryer-drum mixing system shall be of the type that continually agitates the aggregate and asphalt mixture during heating and in which the temperature can be so controlled that aggregate and asphalt will not be injured in the necessary drying and heating operations required to obtain a mixture of the specified temperature. A continuous recording thermometer shall be provided which will indicate the temperature of the mixture as it leaves the dryer-drum mixer. The dryer-drum mixing system shall be of sufficient size to keep the plant in continuous operation.

Surge-Storage System. The system shall be adequate to minimize production interruptions during the normal day's operation.

Truck Scales. A set of standard platform truck scales, conforming to the Item, "Weighing and Measuring Equipment", shall be placed at a location approved by the Engineer.

(2) Asphaltic Material Heating Equipment. Asphaltic material heating equipment shall be adequate to heat the amount of asphaltic material required to the desired temperature. Asphaltic material may be heated by steam coils which shall be absolutely tight. Direct fire heating of asphaltic material will be permitted, provided the heater used is manufactured by a reputable concern and there is positive circulation of the asphalt throughout the heater. Agitation with steam or air will not be permitted. The heating apparatus shall be equipped with a recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the highest temperature.

(3) Spreading and Finishing Machine. The spreading and finishing machine shall be of a type approved by the Engineer, shall be capable of producing a surface that will meet the requirements of the typical cross section and a surface test, when required, and when the mixture is dumped directly into the finishing machine shall have adequate power to propel the delivery vehicles in a satisfactory manner. The finishing machine shall be equipped with a flexible spring and/or hydraulic type 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 mixture is being unloaded.

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

Automatic screed controls, if required, shall meet the requirements of the Item, "Automatic Screed Controls for Asphaltic Concrete Spreading and Finishing Machines".

(4) Pneumatic Tire Rollers. The rollers shall be acceptable medium pneumatic tire rollers conforming to the requirements of the Item "Rolling (Pneumatic Tire)", Type B unless otherwise specified on plans.

The tire pressure of each tire shall be adjusted as directed by the Engineer and this pressure shall not vary by more than 5 pounds per square inch.

(5) Two Axle Tandem Roller. This roller shall be an acceptable power driven tandem roller weighing not less than 8 tons.

(6) Three Wheel Roller. This roller shall be an acceptable power driven three wheel roller weighing not less than 10 tons.

(7) All equipment shall be maintained in good repair and operating condition and shall be approved by the Engineer.

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

5. STOCKPILING, STORAGE, PROPORTIONING AND MIXING:

(1) Aggregate Storage. If the mineral aggregates are stored or stockpiled, they shall be handled in such a manner as to prevent segregation, mixing of the various materials or sizes, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. Suitable equipment of acceptable size shall be furnished by the Contractor to work the stockpiles and prevent segregation of the aggregates.

(2) Storage and Heating of Asphaltic Materials. The asphaltic material storage shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in the Item "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 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 or dryer-drum mixer shall be done through the cold aggregate bin and proportioning device or feed system in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. When specified on the plans, the cold aggregate bins shall be charged by use of a Clamshell, dragline, shovel or front end loader. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature.

(4) Proportioning. The proportioning of the various materials entering the asphaltic mixture shall be as directed by the Engineer and in accordance with these specifications. Aggregate shall be proportioned by weight using the weigh box and batching scales herein specified when the weight-batch type of plant is used and by volume using the hot aggregate proportioning device when the continuous mixer type of plant is used. The asphaltic material shall be proportioned by weight or by volume based on weight using the specified equipment. The asphaltic material shall be introduced into the dryer-drum mixer through the asphaltic material meter.

(5) Mixing and Storage.

(a) Batch Type Mixer. In the charging of the weigh box and in the charging of the mixer from the weigh box, such methods or devices shall be used as are necessary to secure a uniform asphaltic mixture. In introducing the batch into the mixer, all mineral aggregate shall be introduced first; shall be mixed thoroughly for a period of 5 to 20 seconds, as directed, 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 total mixing period of not less than 30 seconds. This mixing period may be increased, if, in the opinion of the Engineer, the mixture is not uniform.

(b) Continuous Type Mixer. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced. Checks on asphalt used shall be made at least twice daily by comparing the asphalt used in ten loads of completed mix as shown on the asphalt recording meter and the design amount for these ten loads. The acceptable percent of variation between the asphalt used and the design amount will be as shown on the plans or as determined by the Engineer.

(c) Dryer-Drum Type Mixer. The amount of aggregate and asphaltic material entering the dryer-drum 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. The mixture when discharged from the mixer shall have a moisture content not greater than 3% by weight unless otherwise permitted by the Engineer. The moisture content shall be determined in accordance with Test Method Tex-103-E.

(d) The mixture produced from each type of mixer shall not vary from the specified mixture by more than the tolerances herein specified.

(e) The asphaltic mixture from either type of mixer shall not exceed a temperature of 260°F. The temperature of the mixture shall not be lower than 180° F when placed on the road. The Engineer will determine the temperature, within the above limitations, and the mixture when discharged from the mixer shall not vary from this selected temperature more than 25° F.

(f) A Surge-Storage System may be used during the normal day's operation. Overnight storage will not be permitted unless authorized in the plans or in writing by the Engineer. The mixture coming out of the surge-storage bin must be of equal quality to that coming out of the mixer.

6. CONSTRUCTION METHODS:

The tack coat or surfacing mixture shall not be placed when the air temperature is below 50° F and is falling, but it may be placed when the air temperature is above 40° F and is rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the tack coat or surfacing mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the pavement surface, in the opinion of the Engineer, are suitable.

(1) Tack Coat. Before the surfacing mixture is laid, 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. This tack coat shall be applied, as directed by the Engineer, with an approved sprayer at a rate not to exceed 0.07 gallon per square yard of surface. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. The tack coat shall be rolled with a pneumatic tire roller when directed by the Engineer.

(2) Transporting the Surfacing Mixture. The mixture, prepared as specified above, shall be hauled to the work 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. In cool weather or for long hauls, canvas covers and insulating of the truck bodies may be required. The inside of the truck body may be given a light coating of oil, lime slurry or other material satisfactory to the Engineer, if necessary, to prevent the mixture from adhering to the body.

(3) Placing. The asphaltic mixture shall be dumped directly into the specified spreading and finishing machine and spread on the approved prepared surface in such a manner that,when properly compacted, the finished surface will be smooth and of uniform texture and density. The spreading and finishing machine shall be operated at a speed satisfactory to the Engineer. During application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures.

(4) Compacting.

(a) As directed by the Engineer, the surface mixture shall be compressed thoroughly and uniformly with the specified rollers and/or other approved rollers.

(b) Immediately, following placement of the asphaltic mixture, the surface shall be given complete rolling with a tandem or three wheel roller of such weight as to accomplish good density without excessive breakage of the mineral aggregate. Immediately following initial rolling, the entire surface will be rolled with the pneumatic roller as directed by the Engineer. The motion of the rollers shall be slow enough at all times to avoid displacement of the mixture. If any displacement occurs, it shall be corrected at once by the use of rakes and of fresh mixture where required. To prevent adhesion of the surfacing 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.

7. MEASUREMENT:

The surfacing mixture will be measured separately by the ton of 2,000 pounds of "Asphalt" and by the cubic yard of dry, loose "Aggregate" of the type and/or grades actually used in the completed and accepted work in accordance with the plans and specifications for the project. The volume of aggregate shall be calculated from the measured weights of the surfacing mixture by use of the following formula:

$$V = \frac{(W - A)}{(27)K}$$

V = Cubic Yards of aggregate, dry, loose

W = Total weight of surfacing mixture in pounds

A = Weight of Asphalt in pounds

K = Unit Weight of Aggregate in pounds per cubic foot

The value "K" shall be the average of two or more tests determined by the Engineer in the following manner:

At the beginning of plant operations, a weight, specified by the Engineer, of dried mineral aggregate shall be placed in an acceptable container that will contain a minimum volume of three cubic yards. The aggregate shall be leveled or "struck-off" and measured, to determine the volume of the mineral aggregate, in cubic feet. The unit weight of the mineral aggregate shall be obtained by dividing the specified weight of dried aggregate in pounds by the measured volume in cubic feet. The value "K" is an average of two or more of the above described tests.

The value "K" shall be checked a minimum of one time for each 3,000 cubic yards of mineral aggregate. If in the opinion of the Engineer or the Contractor's

representative, the value of "K" has changed, a check test shall be made. A new value for "K" shall be determined if the checked value of "K" varies more than two percent (plus or minus) from the value being used.

The weight, "W", if mixing is done by a continuous mixer, will be determined by truck scales. The weight, if batched, will be determined on batch scales and records of the number of batches, batch designs and weight of "Asphalt" and "Aggregate" shall be kept.

8. PAYMENT.

(1) The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement", will be paid for at the unit price bid for "Asphalt" and "Aggregate", of the types and/or grades specified, which prices shall each be full compensation for quarrying, furnishing all materials and freight involved; for all heating, mixing, hauling, cleaning the existing pavement, tack coat, placing asphalt-aggregate surfacing mixture, rolling and finishing; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

(2) 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.