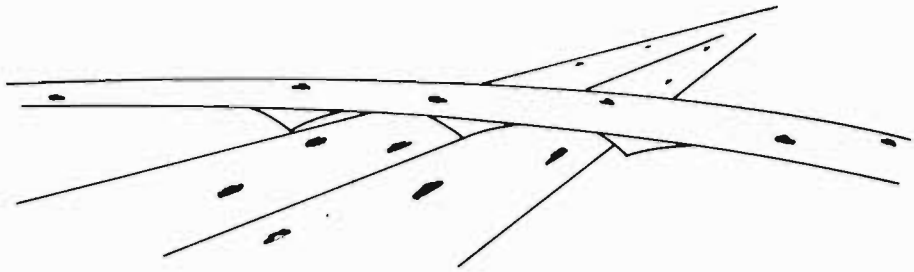

DEPARTMENTAL RESEARCH

Report Number SS 15.10

TRAVELING PLANT OPEN GRADED SURFACE COURSE

TEXAS HIGHWAY DEPARTMENT

TRAVELING PLANT

OPEN GRADED SURFACE COURSE

by

Warren N. Dudley
Supervising Resident Engineer

District 20
Texas Highway Department

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Planning & Research Division
Texas Highway Department

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ABSTRACT

This paper is a presentation of the experiences of District 20 of the Texas Highway Department in the development of an open graded surface course via use of a travel plant mixer paver. Included is a cost analysis of the final project and a cost comparison with conventional surface courses. We also present skid data and mix design data along with pictures of typical road construction operation.

TRAVELING PLANT OPEN GRADED SURFACE COURSE

The purpose of this report is to relate the experience of District 20 of the Texas Highway Department in the development of an open graded surface course (plant mix seal) via the use of a traveling mixer-paver. The term open graded surface course as used herein refers to a wearing course consisting of an open graded aggregate with a maximum size of 1/2" mixed with a high asphalt content. Thickness of the finished pavement layer is approximately 3/4".

Advantages of this type surface course have been listed below as:

1. High skid resistance with a reduction in the possibility of hydroplaning.
2. Smooth riding surface.
3. Low highway noise levels.
4. Less splash and spray during wet weather.
5. Improved visibility of road markings.

Since the issuance of Special Specification Item 3014 "Plant Mix Seal" District 20 has contracted for and placed approximately 36 miles of central plant mixed open graded surface course with good results. We have learned to place the material only on structurally sound roadway and at low placement temperatures. We learned the average cost of stationary plant mix placed with a conventional paver was $36.65 per cubic yard or $1.03 per square yard when placed at 0.028 cubic yard per square yard. We were attempting to place the material 3/4" thick. We have also learned contrary to the name "Plant Mix Seal" that the existing surface does not receive an asphaltic seal.

Our interest in open graded surface courses extends back to the fall of 1971 when FHWA Area Engineer John Nichols furnished us literature on the events occurring in Colorado and New Mexico concerning the product. Then approximately one year later we were introduced to the Midland Mix Paver. The Midland Paver is a traveling mixer paver advertised to be designed "expressly for cold mix paving". The machine would mix cold aggregate with ambient temperature emulsified asphalt as it traveled down the roadway spreading the mixture. The paver is manufactured by the Midland Machinery Company of Tonawanda, New York and the machine we saw is the property of the Lewis Hagan Company, Inc. based in Lafayette, Louisiana. Our assignment was to find the combination of aggregate, aggregate gradation and type of asphalt emulsion that could be mixed and placed as an open graded surface course under traffic with the traveling mixer-paver.

Our first attempt to accomplish our assignment ended in disaster in May of 1973. The aggregate we attempted to use was 1972 Specification Grade 4 trap rock. The asphalt emulsion we used was a combination of EA-CRS-2 and EA-CMS-2 (modified). We also used EA-CSS-1h. Our analysis of the failure indicated that the aggregate was too one-sized and the viscosity of the asphalt emulsion was too low and slow to set. Viscosity of the EA was approximately 100 at 122°F.

Based on the experience gained from our initial unsuccessful attempt to produce an open graded surface course it was determined to use more than one type of aggregate with a more uniform gradation on our second trial. We also wanted a faster setting asphalt emulsion with a relatively high viscosity. The aggregates selected for use on our second attempt were crushed limestone, crushed natural limestone rock asphalt and lightweight

aggregate meeting the requirements of Special Specification Item 3014 "Plant Mix Seal" Grade 1. Gradation requirements for Grade 1 aggregates are:

	% by wt.
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

With the help and cooperation of Texas Emulsions representative Woody Smith we were able to obtain the cationic emulsion grade EA-CMS-2 that exhibited the asphalt qualities that were desired. Austin Office D-9 tests indicated that the emulsion used had a viscosity at 122°F of 200, oil distillate 10% by volume and the penetration of the residue at 77°F to be 149 which satisfied Item 300 requirements for CMS-2 grade cationic emulsions. Complete test results of the EA-CMS-2 are in Appendix No. 1.

Bids were taken and orders for delivery were issued for the aggregate. Crushed limestone was furnished by Servtex Materials Company, New Braunfels, Texas; crushed limestone rock asphalt was furnished by Uvalde Rock Asphalt Company, San Antonio, Texas and the lightweight aggregate was supplied by Superock, Inc., Streetman, Texas. Aggregate samples were secured from stockpiles of the materials at the job site on FM 1293 at Honey Island and laboratory mixes were made to determine optimum asphalt content. Past experience with plant mixes using AC Grade asphalt indicated asphalt demand for natural aggregates to be

approximately 7% by weight. Also used to determine the required amount of asphalt for the various aggregates was Federal Highway Administration Report No. FHWA-RD-74-2 "Design of Open Graded Asphalt Friction Courses". Test results obtained from the FHWA procedure confirmed our experience record. Emulsified asphalt content required for the three aggregates are listed below:

Crushed Limestone	25 gal./cu. yd.	10.1% by wt.
Crushed LRA	25.6 gal./cu. yd.	11.1% by wt.
Lightweight	24.6 gal./cu. yd.	19.0% by wt.

During the laboratory phase of this project seven and a half pound samples of each aggregate were trial mixed with various grades of anionic and cationic emulsified asphalt. The trial mixes indicated the most desirable grade to be EA-CRS-2. We determined during this phase that it would be possible to overmix the asphalt aggregate mixture causing the asphalt to strip off the aggregate. Asphalt and aggregate were mixed in a mechanical mixer approximating the mixing action of the twin pug mix on the mixer-paver. After mixing, the laboratory samples were spread on our parking lot, rolled with a steel cylinder and observed for a time of set. It was during this step that we knew to anticipate set time problems with the lightweight aggregate mixtures.

On July 15, 1974 Lease Agreement No. 20-200 was executed by Lewis Hagan Company, Inc. for furnishing operated equipment to cold mix and apply an open graded surface course on FM 1293 Project 1947-1-6 in Hardin County. Actual work by the Lewis Hagan Company was commenced August 30 when 6 cubic yards each of the three aggregates were mixed and placed on a District Office service road. Actual road operation started September 23, 1974 with the placement of 3420 LF, 12 foot width of lightweight aggregate.

It was apparent that the lightweight mixture was too unstable to carry traffic so the section was coned off and traffic routed around the freshly placed mixture for a period of 18 hours.

Paving operations were continued the following day with the placement of 5300 LF of crushed limestone mix and 4450 LF, 12 foot width of crushed natural rock asphalt mix. The three sections were rolled with a 5-8 ton flatwheel roller sprinkled with approximately 60 cubic yards of uncoated lightweight Grade 4 aggregate, rolled again with a self propelled light pneumatic roller and opened to traffic.

The following day, September 25, we were rained out.

On September 26 operations commenced at 8:00 A. M. The adjacent 12 foot lane was paved in the reverse order, 4450 LF of limestone rock asphalt, 5300 LF of crushed limestone and 3420 LF of lightweight Aggregate. As paving operations continued the tandem roller kept up with the paver. Following the tandem roller the pavement was sprinkled with uncoated lightweight aggregate, rolled with the light pneumatic tired roller and opened to traffic. Paving operations ceased at 5:00 P. M.

Again, the section of lightweight aggregate mixture was too unstable and it was necessary to keep it closed to traffic. After curing for 24 hours it was opened to traffic and performed satisfactorily.

A summary of material used is shown in Appendix II.

Overall cost of the paving operation was $29,500.00. We covered 35,120 square yards at a unit cost of 84 cents per square yard. This included limited production due to equipment adjustments and personnel training. On September 26, 17,560 square yards of pavement was placed at a total

cost of $9,708.00 for the day or 0.55 cents per square yard. In our District, contract cost of a single course surface treatment is 0.60 cents per square yard, hotmix asphaltic concrete is $1.50 per square yard and hot plant mix seal coat is 0.91 cents per square yard.

Skid coefficients on the three materials as recorded by skid trailer No. 42 on October 7, 1974 are shown below:

	High	Low	Average
Crushed Limestone	75	50	63
Limestone Rock Asphalt	67	50	61
Lightweight	72	68	70

Advantages of the travel mix open graded surface course over conventional central plant mix are:

1. High initial coefficient of friction.
2. Lower in cost.
3. No pollution problems.
4. No limitation of haul distance from plant to job site.
5. Fast. The travel mixer was running at 75 feet per minute.

It is recommended that the travel mix method of placing open graded surface course be adopted for use by the Texas Highway Department.

ACKNOWLEDGEMENTS

The author is grateful for the support of District Engineer, Franklin C. Young who initiated the movement to develop work for the travel mixer paver and for the assistance of Construction Engineer, Ken Nagai in developing the correct mix design and construction sequence. Special recognition is extended to Woody Smith, Texas Emulsion, Inc., for his work in the development and production of the needed grade of asphalt emulsion and his suggested modifications to mixer paver operations. We also wish to thank Lewis Hagan, Lewis Hagan Company, Inc., for his cooperation and assistance.

APPENDIX I

Lab No. 74-2956-C
(For Lab Use Only)

ASPHALTIC SAMPLE IDENTIFICATION

Dist. or Res. Engr. _____ MATERIAL EA-CMS-2

Address _____

Control No. Sec. No. Job No.

Contractor _____

County Fed. Proj. No. Hwy. No.

Sampler's Name JOHN CASTO 9/27/74

Dist. No. Req. No. Date Sampled

Producer TEXAS EMULSION Spec. Item No. _____

Location PT. NECHES, TEXAS Tank Number 610
(Refinery, Mill or Plant)

Destination UNASSIGNED Seal Numbers 05454

Car Initial & Number _____ Batch Numbers _____

Seal Numbers _____ Quantity, Gals. 30,000

Quantity, Gals. _____ Number of Samples 2

Remarks:

EA-CMS-2 74-2956-C

REPORT ON EMULSIFIED ASPHALT

Saybolt Viscosity (Furol) at 122 °F. 60 cc.	200	Sec.
Residue by distillation by Weight	69.0	%
Oil portion of distillate by volume	10.0	%
Sieve Test	0.02	%
Miscibility with water, 2 hours	-	
Coating Test	Good	
Cement Mixing	-	%
Penetration of residue at 77°F., 100 g., 5 sec.	149	
Solubility of Residue in Carbon Tetrachloride (CCl_4)	99.7+	%
Ductility of Residue at 77°F., 5 cms. per minute	100+	cms.
Settlement, 5 Days	1.3	%
Demulsibility, - cc. - N $CaCl_2$	-	%
Specific Gravity	1.057	
Ash	-	%
Water	-	%
Particle Charge	Positive	

APPENDIX II

MATERIAL SUMMARY

I. Lightweight Aggregate

a. 232 cu. yds. placed

b. 6,840 gallons EA-CMS-2 used

c. 8,864.4 sq. yds. covered

d. Yield = 29.0 lbs. per sq. yd.

e. Gallons EA per cu. yd. = 29.5

II. Crushed Limestone

a. 278 cu. yds. placed

b. 10,970 gallons EA-CMS-2 used

c. 13,530 sq. yds. covered

d. Yield = 60.3 lbs. per sq. yd.

e. Gallons EA per cu. yd. = 29.0

III. Crushed Limestone Rock Asphalt

a. 336 cu. yds. placed

b. 8,970 gallons EA-CMS-2 used

c. 12,583.6 sq. yds. covered

d. Yield = 53.4 lb.s per sq. yd.

e. Gallons EA per cu. yd. = 26.7

Total length of project = 13,170 LF - 24' wide

Total aggregate placed = 946 cu. yds.

Dry aggregate used for choke = 100 cu. yds.

Total EA-CMS-2 used = 26,780 gallons

Total gallons EA per cu. yd. = 28.3

APPENDIX III

COST ANALYSIS

1. Total Project Cost

a.	Laydown Equipment Rental - - - - - - - -	$ 9,750.00
b.	Aggregate* - - - - - - - - - - - - - - -	9,786.25
c.	Asphalt Emulsion (incl. freight)- - - -	7,870.37
d.	THD Salary and Equipment Rental - - - -	2,139.86
	Total - - - - - - - - - - - - - - - - - - -	$ 29,546.48

Total area paved = 35,120 square yards.
Cost per square yard = $0.84
*Included approximately 500 cubic yards to be salvaged in stockpile area.

2. On the last day of operation, October 26, 1974 the unit cost was developed as follows:

a.	Laydown Equipment - - - - - - - - - - - -	$ 2,700.00
b.	Aggregate (408 cubic yards) - - - - - -	3,059.22
c.	Asphalt Emulsion (incl. freight) - - -	3,508.39
d.	THD Haul - - - - - - - - - - - - - - - -	242.79
e.	THD Traffic Control - - - - - - - - - -	197.60
	9/26/74 Total - - - - - - - - - - - - - - -	$ 9,708.00

Area paved 9/26/74 = 17,560 square yards.
9/26/74 cost per square yard = $ 0.55

Figure 1

Midland Mix-Paver

Figure 2

Hopper of Midland Mix-Paver showing
adjustable entrance gate for uncoated aggregate

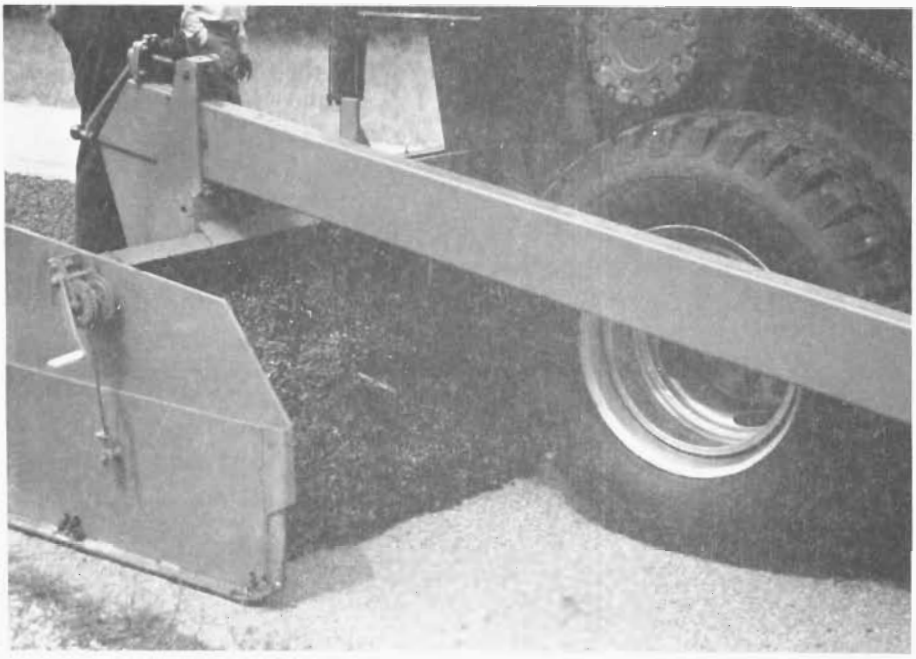

Figure 3

Mixed aggregate roll in
front of vibrating screed

Figure 4

Uncoated aggregate being dumped into hopper,
mixed and spread. Rate of travel is 75 ft. per minute

Figure 5

Asphalt tank on midland Mix-Paver
being filled from transport

Figure 6

Stockpile area adjacent
to roadway being resurfaced

Figure 7

Paving Train
Note distance from paver to roller

Figure 8

Spreading dry choke aggregate on fresh
open graded surface course prior to opening to traffic