Demonstration Projects Program
Technology Transfer
FHWA-DP-39-2
August 1978

DEMONSTRATION PROJECT NO. 39

RECYCLING ASPHALT PAVEMENTS

McAllen, Texas

Prepared for
and
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U.S.DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 15
DEMONSTRATION PROJECTS DIVISION
1000 NORTH GLEBE ROAD
ARLINGTON, VIRGINIA 22201

NOTICE

SURFACE RECYCLING ASPHALTIC CONCRETE PAVEMENT

by

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Research Study 1-21D-77-530
Recycling Asphaltic Concrete Pavement

in cooperation with

U.S. Department of Transportation

Federal Highway Administration

Region 15

Demonstration Projects Division

September 1977

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SUMMARY

In many areas of the State and nation quality aggregate as well as asphalt materials have become increasingly scarce. The shortage of available fossil fuels in the U.S. has resulted in importation of these materials from OPEC countries, thus continually increasing their costs. These fuels are necessary to operate the usual asphaltic concrete pavement plants. These shortages have emphasized the need for recycling and repaving with existing materials to restore oxidized, cracked and rutted pavement surfaces. This project demonstrated that recycling with a heater-scarifier-repaver, adding additional asphaltic material and new asphaltic concrete pavement material to the mixture can satisfactorily restore these surfaces.

The proper design of new asphaltic concrete pavement material to be added was considered. This laboratory investigative work and needed construction controls are discussed.

Careful records of fuel consumption by the heater-scarifier-repaver machine were kept as were all costs attributed to the project for comparison with conventional resurfacing methods. This method of surface restoration compares very favorably economically with conventional methods.

IMPLEMENTATION STATEMENT

The results of this investigation indicate that oxidized, cracked and rutted pavements can be restored satisfactorily with a heater-scarifier-repaver machine. This method is particularily adaptable in urban curb and gutter sections where additional thicknesses from conventional overlays would hamper or complicate operation of gutters, drainage handling, or safety and "rideability" near the gutter.

Construction experiences indicate that some positive method of controlling the depth of scarification preventing override by the operator is needed. This would insure a more uniform mixture or blend of the amounts of old and new material. Similarly an automatic control of the paver screed would provide better riding qualities.

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Within the City of Edinburg the pavement surfaces of U.S. Highway 281 were badly deformed with attendant alligator cracking. The pavement surface on State Highway 336 was badly cracked and characterized by excessive crown in the City of McAllen. Both highways were curb and gutter sections on which several thin overlays had been placed resulting in a condition which precluded the placement of very much more new material.

FIGURE 1

BADLY DEFORMED AND ALLIGATOR-CRACKED PAVEMENT

The existing pavement on U.S. 281 was made up of three different asphaltic concrete layers and three seal coats placed between 1953 and 1972. The pavement thickness varied from six inches in the driving lanes to three inches next to the gutter. The top inch was hot-mix asphaltic concrete pavement placed in 1972.

On SH 336 the pavement was made up of three different asphaltic concrete layers and one seal coat placed between 1955 and 1972. The pavement thickness varied from three-and-one-half inches near the centerline to one-and-one-half inches next to the gutter. The top inch was limestone rock asphalt placed in 1972.

The pavement condition on both locations was oxidized, cracked and rutted. The skid resistance was low and the ride as determined by the Mays Ride Meter was rough in most lanes. A survey of cracks in the pavement surface showed that areas of U.S. 281 had as much as thirty-seven percent of the surface cracked. On SH 336 the survey showed the cracked area to be as high as forty-four percent.

With the pavement surfaces being in these conditions it was obvious that corrective construction must be provided. It was acknowledged that at sometime in the future it will be necessary to reconstruct these sections removing in the process enough subgrade material to lower the centerline thus reducing the excessive crown. However, with funds not being available for a project of that magnitude and aggregates and asphalt in short supply it was decided to correct the pavement surface by surface recycling with a heater-scarifier-repaver adding asphalt and about one-half inch of asphaltic concrete pavement.

CHAPTER II

INVESTIGATION AND DESIGN OF ASPHALTIC CONCRETE PAVEMENT

The recycling work was to consist of heating and scarifying the existing pavement, the addition of emulsion where needed, the addition and mixing of new asphaltic concrete material with the old, laying and compacting the material. To seal the cracked pavement below that which would be recycled a variety of materials were used. Records of those treatments and areas were recorded for later evaluation. On both locations some surface cracks were left unsealed, some sealed using reclamite, some sealed using emulsion with latex and some sealed using a combination of reclamite, emulsion and a "scat seal."

To develop an asphaltic concrete mixture design to use with the recycled asphaltic concrete pavement the existing pavement was sampled by coring as follows:

US 281 - Two samples from three different points were taken along the pavement to be recycled. Each sample consisted of three 4" diameter cores.

SH 336 - Two samples from two different points were taken along the pavement. Samples were three 4" diameter cores.

In the laboratory, extractions were performed on the core samples to determine the percent asphalt and the gradation of the aggregate. The recovered asphalt was tested for penetration, ductility and viscosity. Following this, various percentages of the asphalt additive were blended with the recovered asphalt. Penetration, ductility, viscosity and thin film oven tests were performed on the blend.

The test results of the above may be found in APPENDIX A.

Following the initial testing of the existing asphaltic concrete pavement materials, various designs and amounts of new hot-mix ACP were mixed with the sampled existing material and molded as HVEEM specimens and tested for stability, density and cohesiometer. From this laboratory investigation it was recommended that a material be added as the pavement was being recycled meeting the State Department of Highways and Public Transportation Type "F" Hot Mix ACP Design except for a slight modification in gradation. This modification was made so that material available at the hot-mix plant site could be used (5.3% asphalt was used in this mix design). The rate at which the asphaltic concrete material was added varied with the condition of the pavement, lane position and scarification depth. On US 281 the average rate added was 44.6 pounds per square yard and on SH 336 it was 79.4 pounds per square yard. The test report sheets and design data may be found in APPENDIX A.

In order to provide comparative data for long term evaluation of this recycling work, preconstruction and post construction tests were performed as follows:

1. Dynaflect before and after recycling.
2. Skid on pavement surface
   a. Before recycling
   b. After recycling.
3. Pavement rating on section to be recycled.
4. Reflective crack survey.

The results of these tests are in APPENDIX B.

CHAPTER III

CONSTRUCTION OPERATIONS

Pavement recycling work began April 13, 1977 on US Highway 281 in the City of Edinburg, Texas, at the intersection of US 281 and Freddy Gonzalez Drive and proceeded north to Stubbs Street. This section of roadway consists of two parking lanes, four driving lanes and a continuous left turn lane. The surface of the four driving lanes and two parking lanes, covering an area of 26,030 square yards was recycled in a four day period, ending April 18, 1977. On April 21, 1977 pavement recycling began on State Highway 336, a four lane roadway, in the City of McAllen, Texas. Work began at the intersection of SH 336 and Hackberry Avenue and proceeded south to Ash Street, covering an area of 11,079 square yards. The work was completed on April 22, 1977. This work was accomplished by the use of a repaver owned and operated by the Cutler Repaving, Inc., Lawrence, Kansas. This repaver is referred to by the owners as the Cutler Metro Repaver.

FIGURE 2

THE CUTLER METRO REPAVER

Prior to the recycling work, the areas along and adjacent to the gutters were milled using a milling machine owned and operated by Cutler Repaving, Inc. This machine was called an "Eager Beaver." The area milled was approximately thirty inches wide and was cut from one-quarter to one-half inch. On SH 336, a utility line, running the length of the project, had been back filled with lean concrete and finished flush with the pavement surface. This back fill, approximately four inches wide, was milled to one-inch below the pavement surface. On US 281, the break in crown between the outside driving lanes and the parking lanes was quite severe. Using the Cutler Metro Repaver to heat and scarify, approximately sixty cubic yards of material was removed from this area on the northbound lane. The material was loaded, hauled and used by the State maintenance forces as patch material. The crown on the southbound lanes was not cut down so that a comparison could be made after the recycling work was done. The Cutler Metro Repaver was also used on SH 336 to remove some of the crown. The full width of the pavement was heated and scarified. Approximately 250 cubic yards of material was removed and used as patching material.

FIGURE 3

THE RADIANT HEATERS

FIGURE 4

SCARIFYING OF EXISTING PAVEMENT SURFACE
(Note air bag located above scarifying teeth.
The air pressure in the bag controls the depth of the scarification.)

The work started by heating the surface to a temperature in excess of 300° F using radiant heat. Scarifying followed the heating with the scarifying teeth penetrating the heated surface up to one inch. Temperatures taken at this point were found to be around 300° F. The scarified material was then moved laterally towards the center of the repaver by augers which tended to level the surface and windrow some

FIGURE 5

AUGERS LEVELING THE SURFACE AND MOVING
SCARIFIED MATERIAL TOWARDS CENTER OF MACHINE

material under the machine. A liquid asphalt or other additive could be added to the old material at this point by spinning slingers. Visual

FIGURE 6

LAYING THE RECYCLED ASPHALTIC CONCRETE MAT

control was the only method available to determine the rate of application. Emulsion, Grade EA-HVMS, was added at selected locations where the old pavement was badly cracked and oxidized. No other additives were used on this project. As the scarifying started, new hot-mix material was being placed in a receiving hopper located at the front of the repaver. The new material was moved to the rear of the machine by a conveyor and emptied into a feeder, where spreading screws partially mixed the new material with the old that had been windrowed under the machine. The material was then fed through a manually controlled screed. The laying widths on US 281 varied from nine feet to ten feet. On SH 336 they varied from nine feet to twelve feet. It was noted that at times the windrowed material under the repaver would build up to a point where it would slow down the operation. To relieve this situation, the operator reduced the flow of new material and let more of the old material pass under or through the screed. This tended to bring more of the old material to the surface of the mat and resulted in some undesirable ride conditions. Compaction of the reworked surface was done using an eight ton tandem flat wheel roller also owned and operated by Cutler Repaving, Inc. On SH 336 it was felt that additional rolling was necessary before opening the reworked surface to traffic, so a light pneumatic tire roller owned and operated by the State Department of Highways and Public Transportation was used.

FIGURE 7

COMPLETED RECYCLED ASPHALTIC CONCRETE PAVEMENT SURFACE

CHAPTER IV

COSTS AND ECONOMICS

Careful records were kept of fuel consumption, materials, labor and equipment costs required to perform this work.

The repaver and rollers used diesel as fuel. An average of 0.014 gallons of diesel was used for each square yard of surface worked, costing $.0058 per square yard. The heaters were fueled by propane. An average of 0.071 gallons of propane was used for each square yard of surface work, costing $.0229 per square yard. Total fuel cost was $.029 per square yard of surface worked.

The total cost per square yard for recycling 26,030 square yards of US 281 was $1.00 per square yard. On SH 336 in McAllen the 11,079 square yards were recycled at a cost of $1.29 per square yard. The resulting average recycled pavement depths were approximately 0.96 inches on US 281 and 1.20 inches on SH 336. These costs were approximately $1.04 per square yard inch depth for US 281 and $1.08 per square yard inch for SH 336. For comparison purposes with conventional overlay methods for asphaltic concrete pavements recent letting bid prices for this quantity projects have been about $1.02 per square yard inch.

A breakdown of costs for fuel, material, labor, equipment, etc., as a basis for the $1.00 and $1.29 per square yard respectively may be found in APPENDIX C. Also in Appendix C is an energy analysis for this project and a hypothetical typical hot-mix asphaltic concrete overlay project.

CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This method of surface recycling worked satisfactorily though there are several features that warrant consideration for improvement. Generally it can be said that:

a. The surface cracks were sealed.

b. The ride was improved.

c. The skid resistance was improved.

d. Ravelling began in areas where the limestone rock asphalt was predominate on the surface.

e. Tree leaves directly overhead of the repaver and shrubs that were within a foot or so adjacent to the repaver were scorched.

f. No method for accurately metering the addition of liquid additives was available.

g. Controls to prevent the repaver operator from raising the scarifier blades were not available. This raising occurred periodically to increase speed of the machine and the engineer had no control measure.

h. There was no positive method for mixing the recycled pavement and the new asphaltic concrete pavement. Therefore, there was no method for obtaining a uniform mixture throughout the project.

i. Apparently due to some characteristic of the limestone rock asphalt pavement it was difficult to impossible to achieve the temperature of that recycled material with the equipment as could be obtained with the other aggregates. This made for a colder pavement which did not mix, lay nor compact as well and some ravelling occurred.

5.2 Recommendations

Even though a satisfactory surface recycling project was obtained the authors feel that with further experimentation with the equipment under the direct control of the State Department of Highways and Public

Transportation that improved construction and construction methods could be developed. Following are recommendations worthy of consideration for future projects and possible modifications of the equipment.

a. For a more lasting improvement in skid qualities use a better polish resistant aggregate as the coarse aggregate fraction of the new hot-mix ACP.

b. Develop an accurate metering device for adding liquid asphalt or rejuvenating agents to the recycled material.

c. Develop a control measure for the depth of scarification that can be locked in preventing "override" by the operator. This would provide the desired depth and uniformity for the project. It would no doubt slow production but would provide a uniform amount of recycled material for mixing with the new ACP.

d. Provide an automatic screed control which would reference to an established gradeline which could be locked in preventing operator override. This would result in uniform or established thickness and better ride qualities. The operator now raises or lowers the screed depending upon the amount of material in the windrow under the repaver.

e. Develop a system for positively mixing the recycled material with the new material. This would provide uniformity and adherence to the laboratory design giving some predictability to what the resulting material will be and how it will perform.

APPENDIX A

Texas Highway Department
Construction Form No. 544 Rev. (2)

TEXAS HIGHWAY DEPARTMENT
ASPHALTIC CONCRETE SIEVE ANALYSIS WORK SHEET

County: Hidalgo   Highway: US-281 / SH-336   Project: Recycling   Control: ______
Date: 1/31/77   Time: ______   Station: ______   Sampled By: S. M. Giles
Spec. Item: ______   Type: F (Mod.)   Design No.: 1

Sieve Size	Bin No. 1 1/4 Aggr. (a) Weight (grams)	Total % x	60 %	Bin No. 2 Field Sand (b) Weight (grams)	Total % x	20 %	Bin No. 3 Screenings (c) Weight (grams)	Total % x	20 %	Bin No. 4 (d) Weight (grams)	Total % x	%	Combined Analysis % (a+b+c+d)
1¾" — ⅞"													
⅞" — ⅜"													
⅝" — ⅜"													
½" — ⅜"													
⅜" — 4		18.1	10.9		8.3	1.7		7.4	1.5				14.1
¼" — 10													
4 — 10		78.8	47.5		8.7	1.7		13.1	2.6				51.8
+ 10													
10 — 40		2.1	1.3		19.8	4.0		6.6	1.3				6.6
40 — 80		0.2	0.1		32.7	6.5		52.6	10.5				17.1
80 — 200		0.1	0.0		25.1	5.0		19.2	3.8				8.8
Pass 200		0.7	0.2		5.3	1.1		1.1	0.3				1.6
Total	gm	100.0%	%	gm	100.0%	%	gm	100.0%	%	gm	100.0%	%	100 %

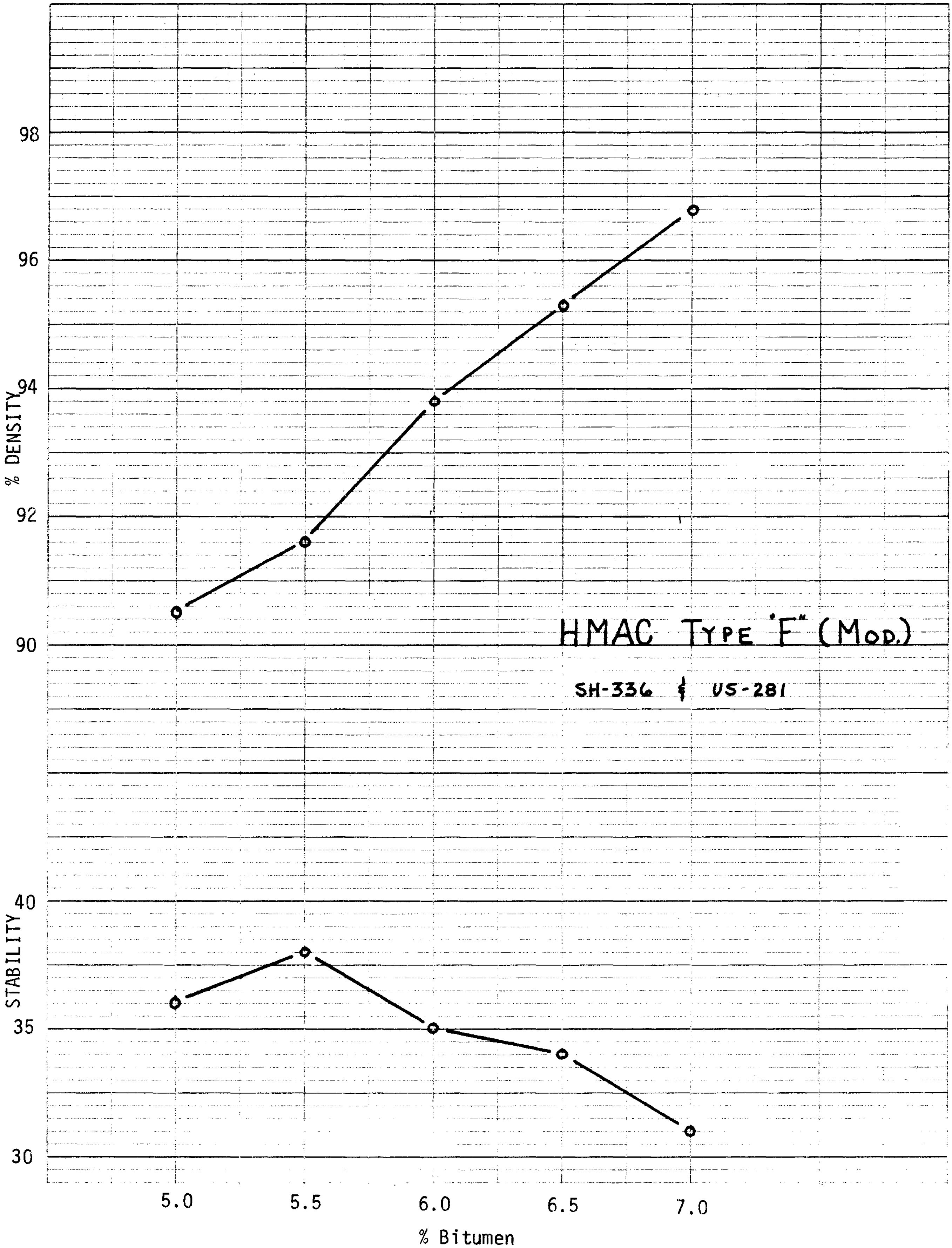
PER CENT MOISTURE IN AGGREGATES IN HOT BINS

Bin No.	(a) Tare Wt. (gms.)	(b) Gross Wet Wt. (gms.)	(c) Gross Dry Wt. (gms.)	(d) Wt. Moist (gms.) b-c	(e) Dry Wt. Aggr. (gms.) c-a	% Moist. $\frac{d}{e}$ x100%
1						
2						
3						
4						

Asphaltic Binder = ______%

Total = 100.0%

____
Inspector



98
96
94
92
90
% DENSITY
HMAC TYPE "F" (MOD.)
SH-336 & US-281
40
35
30
STABILITY
5.0
5.5
6.0
6.5
7.0
% Bitumen

Form 231

GENERAL TEST REPORT

Laboratory No. 77-330

Date Received 4/14/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway (pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (Old)

Control No.	Sect. No.	Job No.
255	8	56

County	Federal Project No.	Hwy. No.
Hidalgo		US 281

District No.	Req. No.	Date Sampled
21		4/14/77

Identification marks Sta. 37+00 - Outside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	4.2
Ret. 3/8" - No. 4	34.9
Ret. No. 4 - No. 10	25.0
Ret. No. 10	64.1
Ret. No. 10 - No. 40	6.6
Ret. No. 40 - No. 80	8.6
Ret. No. 80 - No. 200	10.4
Pass No. 200	5.0
Residual Bitumen	5.3

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes	2388
Ductility @ 77°F., Cm	21
Penetration @ 77°F.	28

HVEEM STABILITY TEST 31

Form 231

GENERAL TEST REPORT

Laboratory No. 77-252

Date Received 4/14/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway (pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (New)

Control No.	Sect. No.	Job No.
255	8	56

County	Federal Project No.	Hwy. No.
Hidalgo		US 281

District No.	Req. No.	Date Sampled
21		4/14/77

Identification marks Sta. 37+00 - Outside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	0.0
Ret. 3/8" - No. 4	20.2
Ret. No. 4 - No. 10	49.1
Ret. No. 10	69.3
Ret. No. 10 - No. 40	3.1
Ret. No. 40 - No. 80	11.0
Ret. No. 80 - No. 200	9.8
Pass No. 200	1.6
Residual Bitumen	5.2

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ------------------ 2119

Ductility @ 77°F., Cm ---------------------- 141

Penetration @ 77°F. ----------------------- 52

HVEEM STABILITY TEST 31

Form 231

GENERAL TEST REPORT

Laboratory No. 77-333

Date Received 4/14/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway (pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (Old & New)

Control No.	Sect. No.	Job No.
255	8	56

County	Federal Project No.	Hwy. No.
Hidalgo		US 281

District No.	Req. No.	Date Sampled
21		4/14/77

Identification marks Sta. 37+00 - Outside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	0.5
Ret. 3/8" - No. 4	20.8
Ret. No. 4 - No. 10	44.7
Ret. No. 10	66.0
Ret. No. 10 - No. 40	3.7
Ret. No. 40 - No. 80	11.2
Ret. No. 80 - No. 200	10.9
Pass No. 200	2.7
Residual Bitumen	5.5

TEST RESULT ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ------------- 3739

Ductility @ 77°F., Cm ----------------- 141

Penetration @ 77°F. ------------------- 39

HVEEM STABILITY TEST 33

Form 231

GENERAL TEST REPORT

Laboratory No. 77-351

Date Received 4/13/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway
(pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC MIX (Old)

Control No.	Sect. No.	Job No.
255	8	56

County	Federal Project No.	Hwy. No.
Hidalgo		US 281

District No.	Req. No.	Date Sampled
21		4/13/77

Identification marks Ebony Int.-Parking Lane(NB)

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	3.8
Ret. 3/8" - No. 4	28.4
Ret. No. 4 - No. 10	24.3
Ret. No. 10	56.5
Ret. No. 10 - No. 40	8.9
Ret. No. 40 - No. 80	11.2
Ret. No. 80 - No. 200	11.5
Pass No. 200	6.9
Residual Bitumen	5.0

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ---------------- 45,692

Ductility @ 77°F., Cm ---------------------- 5

Penetration @ 77°F. ----------------------- 27

HVEEM STABILITY TEST 47

Form 231

GENERAL TEST REPORT

Laboratory No. 77-345

Date Received 4/13/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway (pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (New)

Control No.	Sect. No.	Job No.
255	8	56

County	Federal Project No.	Hwy. No.
Hidalgo		US 281

District No.	Req. No.	Date Sampled
21		4/13/77

Identification marks Ebony Int.-Parking Lane(NB)

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	0.0
Ret. 3/8" - No. 4	20.0
Ret. No. 4 - No. 10	46.6
Ret. No. 10	66.6
Ret. No. 10 - No. 40	2.0
Ret. No. 40 - No. 80	11.1
Ret. No. 80 - No. 200	13.4
Pass No. 200	1.6
Residual Bitumen	5.3

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ---------------- 5332

Ductility @ 77°F., Cm --------------------- 141

Penetration @ 77°F. ----------------------- 28

HVEEM STABILITY TEST 34

Form 231

GENERAL TEST REPORT

Laboratory No.	77-350
Date Received	4/13/77
Date Reported	
Dist. or Res. Engr.	G. G. Garcia
Address	Pharr, Texas
Contractor	Cutler Repaving Inc.
Sampler	R. E. Cuellar
Sampler's Title	Engr. Tech. I
Sampled from (pit, quarry, car or stockpile)	Roadway
Producer	
Quantity represented by sample	
Has been used on	
Proposed for use as	

Material AC Mix (Old & New)

Control No.	Sect. No.	Job No.
255	8	56

County	Federal Project No.	Hwy. No.
Hidalgo		US 281

District No.	Req. No.	Date Sampled
21		4/13/77

Identification marks Ebony Int.-Outside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	3.9
Ret. 3/8" - No. 4	29.7
Ret. No. 4 - No. 10	28.7
Ret. No. 10	62.3
Ret. No. 10 - No. 40	7.2
Ret. No. 40 - No. 80	8.9
Ret. No. 80 - No. 200	10.5
Pass No. 200	5.4
Residual Bitumen	5.7

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ----------- 37,965

Ductility @ 77°F., Cm --------------- 6

Penetration @ 77°F. ----------------- 23

HVEEM STABILITY TEST 27

Form 231

GENERAL TEST REPORT

Laboratory No. 77-461

Date Received 4/21/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway
(pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (Old)

621	1	47
Control No.	Sect. No.	Job No.
Hidalgo		SH 336
County	Federal Project No.	Hwy. No.
21		4/21/77
District No.	Req. No.	Date Sampled

Identification marks Sta. 17+50 - Inside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	1.1
Ret. 3/8" - No. 4	21.5
Ret. No. 4 - No. 10	33.0
Ret. No. 10	55.6
Ret. No. 10 - No. 40	4.6
Ret. No. 40 - No. 80	18.6
Ret. No. 80 - No. 200	11.0
Pass No. 200	4.5
Residual Bitumen	5.7

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ------------ 5284

Ductility @ 77°F., Cm ----------------- 141+

Penetration @ 77°F. ------------------ 33

HVEEM STABILITY TEST 40

Form 231

GENERAL TEST REPORT

Laboratory No. 77-449

Date Received 4/21/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway (pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (New)

Control No.	Sect. No.	Job No.
621	1	47

County	Federal Project No.	Hwy. No.
Hidalgo		SH 336

District No.	Req. No.	Date Sampled
21		4/21/77

Identification marks Sta. 17+50- Inside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 1/2"	0.0
Ret. 1/2" - 3/8"	0.2
Ret. 3/8" - No. 4	19.4
Ret. No. 4 - No. 10	42.2
Ret. No. 10	61.8
Ret. No. 10 - No. 40	1.9
Ret. No. 40 - No. 80	15.8
Ret. No. 80 - No. 200	13.1
Pass No. 200	2.0
Residual Bitumen	5.4

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes ------------ 5512

Ductility @ 77°F., Cm ---------------- 141+

Penetration @ 77°F. ------------------ 27

HVEEM STABILITY TEST 33

Form 231

GENERAL TEST REPORT

Laboratory No. 77-460

Date Received 4/21/77 Date Reported

Dist. or Res. Engr. G. G. Garcia

Address Pharr, Texas

Contractor Cutler Repaving Inc.

Sampler R. E. Cuellar

Sampler's Title Engr. Tech. I

Sampled from Roadway (pit, quarry, car or stockpile)

Producer

Quantity represented by sample

Has been used on

Proposed for use as

Material AC Mix (Old & New)

Control No.	Sect. No.	Job No.
621	1	47

County	Federal Project No.	Hwy. No.
Hidalgo		SH 336

District No.	Req. No.	Date Sampled
21		4/21/77

Identification marks Sta. 17+50 - Inside NBL

Specification Item No.

Material from property of

DETERMINATIONS

EXTRACTION TEST RESULTS

Sieve Size	% By Wt.
Ret. 7/8"	0.0
Ret. 7/8" - 5/8"	5.7
Ret. 5/8" - 1/2"	4.4
Ret. 1/2" - 3/8"	4.1
Ret. 3/8" - No. 4	28.6
Ret. No. 4 - No. 10	13.5
Ret. No. 10	56.3
Ret. No. 10 - No. 40	8.0
Ret. No. 40 - No. 80	9.9
Ret. No. 80 - No. 200	15.6
Pass No. 200	5.0
Residual Bitumen	5.2

TEST RESULTS ON RESIDUAL BITUMEN

Viscosity @ 140°F., Stokes -------- 1716

Ductility @ 77°F., Cm ------------ 141+

Penetration @ 77°F. -------------- 75

HVEEM STABILITY TEST 32

RATE AT WHICH NEW ASPHALTIC CONCRETE MATERIAL WAS ADDED

Date	Location	Area Worked (Square Yards)	Tons Of New AC Mix Added	Avg. Rate (Lbs/Sq. Yd.)
4/13/77	US 281	5250	135	51.4
4/14/77	US 281	7686	174	45.3
4/15/77	US 281	8408	193	45.9
4/18/77	US 281	4686	78	33.3
TOTAL	US 281	26,030	580	44.6
4/21/77	SH 336	4631	180	77.7
4/22/77	SH 336	6448	260	80.6
TOTAL	SH 336	11,079	440	79.4

APPENDIX B

DYNAFLECT

Location	Average Surface Curvature Index	
	Before Recycling (2/3/77)	After Recycling (7/19/77)
US-281 Outside NBL	0.547	0.456
Inside SBL	0.510	0.438
SH-336 Outside NBL	0.713	0.530
Inside SBL	0.698	0.530

SKID TEST

Location		Average Skid Number	
		Before Recycling (4/5/77)	After Recycling (5/5/77)
US-281	Outside NBL	15	23
	Inside NBL	14	33
	Outside SBL	17	20
	Inside SBL	16	13
SH-336	Outside NBL	9	18
	Inside NBL	10	22
	Outside SBL	9	20
	Inside SBL	15	24

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

(Before Recycled)

THIS PROGRAM WAS RUN - 04-19-77

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		L	04-15-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.483	584.		21- 142-F

****

LOCATION INFORMATION

FROM - LP 374
TO - HACKBERRY (OUTSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	286.0	1.3	40	
0.4	208.0	2.0	50	
0.483	84.0	2.0	30	

LOW SI = 1.3 AVERAGE SI = 1.6 HIGH SI = 2.0
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 04-19-77 (Before Recycled

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		M	04-15-77

CALIBRATION CONSTANTS ALPHA	BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.485	661.		21- 142-F

****

LOCATION INFORMATION

FROM - LP 374
TO - HACKBERRY (INSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	305.0	1.1	30	
0.4	261.0	1.5	40	
0.485	95.0	1.8	30	

LOW SI = 1.1 AVERAGE SI = 1.3 HIGH SI = 1.5
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 04-19-77 (Before Recycled)

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		R	04-15-77

CALIBRATION CONSTANTS ALPHA	BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.490	791.		21- 142-F

****

LOCATION INFORMATION

FROM - HACKBERRY
TO - LP 374 (OUTSIDE SBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	338.0	0.9	40	
0.4	263.0	1.5	40	
0.490	193.0	0.5	40	

LOW SI = 0.9 AVERAGE SI = 1.2 HIGH SI = 1.5
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

(After Recycled)

THIS PROGRAM WAS RUN - 04-19-77

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		S	04-15-77

CALIBRATION CONSTANTS ALPHA	BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.491	492.		21- 142-F

****

LOCATION INFORMATION

FROM - HACKBERRY
TO - LP 374 (INSIDE SBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	189.0	2.2	40	
0.4	187.0	2.2	40	
0.491	107.0	1.7	20	RED LITE LP 374

LOW SI = 2.2 AVERAGE SI = 2.2 HIGH SI = 2.2

THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 04-26-77

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		L	04-25-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.0	0.		21- 142-F

****

LOCATION INFORMATION (After Recycled)

FROM - LP 374
TO - HACKBERRY(OUTSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	150.0	2.7	40	
0.4	139.0	2.9	40	
0.600	64.0	4.1	40	

*****THE TOTAL LENGTH FOR THE TEST SECTION IS LESS THAN THE SUM OF THE LOCATIONS*****

LOW SI = 2.7 AVERAGE SI = 2.8 HIGH SI = 2.9

THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 04-26-77

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		M	04-25-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.478	391.		21- 142-F

****

LOCATION INFORMATION (After Recycled)

FROM - LP 374
TO - HACKBERRY (INSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	172.0	2.4	40	
0.4	154.0	2.7	40	
0.478	117.0	1.2	40	

LOW SI = 2.4 AVERAGE SI = 2.5 HIGH SI = 2.7
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 04-26-77

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		R	04-25-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.0	0.		21- 142-F

****

LOCATION INFORMATION

(After Recycled)

FROM - HACKBERRY
TO - LP 374 (OUTSIDE SBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	263.0	1.5	40	
0.4	175.0	2.4	40	
0.600	65.0	4.1	40	

*****THE TOTAL LENGTH FOR THE TEST SECTION IS LESS THAN THE SUM OF THE LOCATIONS*****

LOW SI = 1.5 AVERAGE SI = 1.9 HIGH SI = 2.4

THE LOW.AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 04-26-77

****

PROJECT IDENTIFICATION

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	SH-336	-	.	.		S	04-25-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.457	285.		21- 142-F

****

LOCATION INFORMATION -

(AFTER RECYCLED

FROM - HACKBERRY
TO - LP 374 (INSIDE SBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	114.0	3.3	40	
0.4	114.0	3.3	40	
0.457	55.0	2.2	40	

LOW SI = 3.3 AVERAGE SI = 3.3 HIGH SI = 3.3
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (BEFORE RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	255-08	.	.		R	03-03-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN.	MRM NUMBER
11.10597	8.86599	0.781	550.		21- 142-F

****

LOCATION INFORMATION

FROM - STUBBS ST (OUTSIDE SB)
TO - FREDDY GONZALEZ DR

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	210.0	2.0	30	STUBBS ST
0.4	308.0	1.1	30	
0.781	225.0	3.2	30	FREDDY GONZALEZ DR

LOW SI = 1.1 AVERAGE SI = 1.5 HIGH SI = 2.0
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

PROJECT IDENTIFICATION (BEFORE RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	225 -08	.	.		S	03-03-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11,10597	8,86599	0,781	550,		21- 142-F

LOCATION INFORMATION

FROM - STUBBS ST (INSIDE SB)
TO - FREDDY GONZALEZ DR

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0,2 MI)	SI	SPEED	REMARKS
BEG, TO 0,2	133,0	3,0	30	STUBBS ST
0,4	122,0	3,2	30	
0,781	195,0	3,5	30	FREDDY GONZALEZ DR

LOW SI = 3,0 AVERAGE SI = 3,1 HIGH SI = 3,2
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION,

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (BEFORE RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	225 -08	.	.		M	03-03-77

CALIBRATION CONSTANTS ALPHA	BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.781	550.		21- 142-F

****

LOCATION INFORMATION

FROM - FREDDY GONZALEZ DR
TO - STUBBS ST (INSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
0.2	0.0		20	FREDDY GONZALEZ DR
0.4	130.0	3.0	30	
0.6	99.0	3.5	30	
0.8	0.0		20	SPRAGUE ST
1.000	124.0	3.1	30	STUBBS ST

*****THE TOTAL LENGTH FOR THE TEST SECTION IS LESS THAN THE SUM OF THE LOCATIONS*****

LOW SI = 3.0 AVERAGE SI = 3.3 HIGH SI = 3.5
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (BEFORE RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	225 -08	.	.		L	03-03-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.781	550.		21- 142-F

****

LOCATION INFORMATION

FROM - FREDDY GONZALEZ DR
TO - STUBBS ST (OUTSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	263.0	1.5	30	FREDDY GONZALEZ DR
0.4	258.0	1.5	30	
0.6	0.0		20	SPRAGUE ST
0.781	282.0	1.1	30	STUBBS ST

LOW SI = 1.5 AVERAGE SI = 1.5 HIGH SI = 1.5

THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (AFTER RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	225 -08	.	.		M	04-15-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11,10597	8,86599	0,781	550.		21- 142-F

****

LOCATION INFORMATION

FROM - FREDDY GONZALEZ DR
TO - STUBBS ST (INSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0,2 MI)	SI	SPEED	REMARKS
BEG, TO 0,2	164,0	2,5	40	FREDDY GONZALEZ DR
0,4	126,0	3,1	40	
0,781	127,0	4,1	30	STUBBS ST

LOW SI = 2,5 AVERAGE SI = 2,8 HIGH SI = 3,1
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION,

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (AFTER RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	255 -08	.	.		L	04-15-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.781	550.		21- 142-F

****

LOCATION INFORMATION

FROM - FREDDY GONZALEZ DR
TO - STUBBS ST (OUTSIDE NBL)

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	157.0	2.6	40	FREDDY GONZALEZ DR
0.4	132.0	3.0	30	
0.781	138.0	4.0	30	STUBBS ST

LOW SI = 2.6 AVERAGE SI = 2.8 HIGH SI = 3.0
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (AFTER RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	255-08	.	.		R	04-20-77

CALIBRATION CONSTANTS ALPHA	BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11.10597	8.86599	0.781	550.		21- 142-F

****

LOCATION INFORMATION

FROM - STUBBS ST (OUTSIDE SB)
TO - FREDDY GONZALEZ DR

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0.2 MI)	SI	SPEED	REMARKS
BEG. TO 0.2	148.0	2.8	30	STUBBS ST
0.4	117.0	3.2	30	
0.6	99.0	3.5	30	
0.781	103.0	3.3	30	FREDDY GONZALEZ DR

LOW SI = 2.8 AVERAGE SI = 3.2 HIGH SI = 3.5
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION.

SERVICEABILITY INDEX (SI) COMPUTED FROM THE MAYS RIDE METER

THIS PROGRAM WAS RUN - 08-09-77

****

PROJECT IDENTIFICATION (AFTER RECYCLED)

DIST	COUNTY	HIGHWAY	CONT-SEC	BMP	EMP	PPSN	LANE	DATE
21	HIDALGO	US-281	225-08	.	.		S	04-20-77

CALIBRATION CONSTANTS ALPHA	CALIBRATION CONSTANTS BETA	TOTAL LENGTH FOR SECTION	TOTAL COUNTER FOR SECTION	ADT FOR PPSN	MRM NUMBER
11,10597	8,86599	0,781	550,		21- 142-F

****

LOCATION INFORMATION

FROM - STUBBS ST (INSIDE SB)
TO - FREDDY GONZALEZ DR

****

MAYS RIDE METER DATA

LOCATION	MAYS METER (READING/0,2 MI)	SI	SPEED	REMARKS
BEG. TO 0,2	159,0	2,6	30	STUBBS ST
0,4	160,0	2,6	40	
0,781	106,0	4,3	40	FREDDY GONZALEZ DR

LOW SI = 2,6 AVERAGE SI = 2,6 HIGH SI = 2,6
THE LOW,AVERAGE AND HIGH SI VALUES DO NOT INCLUDE THE SI AT THE END OF THE SECTION,

APPENDIX C

REPAVER: FUEL USE AND COST

US Highway 281

Gallons of Fuel used:

Diesel	Propane
358	1836

Gallons of Fuel used per square yard repaved:

Diesel	Propane	Total
0.014	0.071	0.085

Cost of Fuel used:

Diesel	Propane
$150.36	$596.70

Cost of Fuel used per square yard repaved:

Diesel	Propane	Total
$0.006	$0.023	$0.029

State Highway 336

Gallons of Fuel used:

Diesel	Propane
105	630

Gallons of Fuel used per square yard repaved:

Diesel	Propane	Total
0.009	0.057	0.066

Cost of Fuel used:

Diesel	Propane
$44.10	$204.75

Cost of Fuel used per square yard repaved:

Diesel	Propane	Total
$0.004	$0.018	$0.022

REPAVER: LABOR COST PER SQUARE YARD

US Highway 281

40 Man Hours @ $44.50* per hour = $1780.00

$$\frac{\$1780.00}{26030 \text{ S.Y.}} = \$0.068 \text{ per square yard}$$

State Highway 336

20 Man Hours @ $44.50* per hour = $890.00

$$\frac{\$890.00}{11079 \text{ S.Y.}} = \$0.080 \text{ per square yard}$$

*Cost per hour does not include indirect cost to Company.

COST OF HOT MIX ASPHALTIC CONCRETE MATERIAL AND HAUL

HMAC Mix at Plant: $10.86 per ton Haul from plant to project: $20.00 per hour

US Highway 281

580 Tons HMAC x $10.86 per ton = $6298.80

$$\frac{\$6298.80}{26030 \text{ S.Y.}} = \$0.24 \text{ per square yard}$$

Haul (9 Miles) at $20.00 per hour x 114.5 hrs. = $2290.00

$$\frac{\$2290.00}{26030 \text{ S.Y.}} = \$0.088 \text{ per square yard}$$

State Highway 336

440 Tons HMAC X $10.86 per ton =

$$\frac{\quad}{11079 \text{ S. Y.}} = \$0.43 \text{ per square yard}$$

Haul (6 Miles) at $20.00 per hour x 75.0 hrs. = $1500.00

$$\frac{\$1500.00}{11079 \text{ S.Y.}} = \$0.135 \text{ per square yard}$$

SUMMARY OF COST

SURFACE RECYCLING

US Highway 281

REPAVER:	Fuel	$0.029	per square yard
	Labor	0.068	" " "
	Equipment	0.503	" " "
	Sub Total:	$0.600	per square yard
	HMAC (Avg. 44.6 #/s.y.)	0.240	" " "
	Haul	0.088	" " "
	Traffic Control	0.072	" " "
	Total:	$1.00	per square yard

State Highway 336

REPAVER:	Fuel	$0.022	per square yard
	Labor	0.080	" " "
	Equipment	0.498	" " "
	Sub Total:	$0.600	per square yard
	HMAC (Avg. 79 #/S.Y.)	0.430	" " "
	Haul	0.135	" " "
	Traffic Control	0.125	" " "
	Total:	$1.290	per square yard

CONVENTIONAL HMAC OVERLAY

$0.90 per square yard for 100 #/ square yards
$1.13 per square yard for 125 #/square yards
$1.35 per square yard for 150 #/square yards
Cost based on $18.00 per ton of HMAC in place

ENERGY ANALYSIS

The comparison between the energy requirements for this surface recycling process and a conventional hot mix asphaltic concrete overlay is based upon the field data obtained during the project and energy data from the Asphalt Institue publication "Energy Requirements For Roadway Pavements" MISC-75-3, dated April 1975.

The following information and calculations apply to both the recycling process and a conventional hot mix asphaltic concrete overlay.

General

The asphalt cement was hauled 245 miles in a 4-axle diesel powered truck to the hot mix plant.

The coarse aggregate consisted of gravel which was run through a crusher to reduce oversized particles and to achieve a desired gradation. Screenings are a by-product of this operation, therefore no additional energy requirements are considered for their production. The coarse aggregate and screenings were hauled 33 miles to the hot mix plant. Aggregate hauling was done using 4-axle diesel powered trucks. The coarse aggregate contained an average moisture content of 1½% by weight, the screenings averaged 4% moisture by weight and the field sand averaged 6% by weight. The aggregates were combined at the hot mix plant using 60% coarse aggregate, 20% screenings and 20% field sand. The combined aggregates contained an average moisture content of 3% by weight and were dried and heated from 80°F to 300°F.

The asphaltic concrete mix composition was 5.3% asphalt and 94.7% aggregate and was hauled from the plant to the road in 3-axle gasoline powered trucks.

Energy Requirement-Materials

Manufacture of asphaltic cement	=	587,500 Btu/t*
Haul of asphaltic cement from Manufacture to hot mix plant 245 mi. x 2 x 3270 Btu/tm*	=	1,602,300 Btu/t
Total for asphaltic cement per ton	=	2,189,800 Btu/t
Aggregates:		
Crush coarse aggregate 60% x 40,000 Btu/t*	=	24,000 Btu/t
Process field sand 20% x 15,000 Btu/t*	=	3,000 Btu/t
Haul-coarse aggregate 33 mi. x 2 x 3270 Btu/tm* x 60% x 1.015	=	131,400 Btu/t
Haul-screenings 33 mi. x 2 x 3270 Btu/tm* x 20% x 1.04	=	44,900 Btu/t
Haul-field sand 12 mi. x 2 x 3270 Btu/tm* x 20% x 1.06	=	16,600 Btu/t
Total for aggregates	=	219,900 Btu/t

The following calculations apply only to the surface recycling projects.

Hot Mix Asphaltic Concrete

Mix composition, US-281 & SH-336		
Asphalt, 5.3% @ 2,189,800 Btu/t	=	116,100 Btu/t
Aggregate, 94.7% @ 219,900 Btu/t	=	208,200 Btu/t
Total for mix	=	324,300 Btu/t
Plant operations, US-281 & SH-336		
Dry aggregate, 3% @ 28,000 Btu/%*, 0.947t	=	79,500 Btu/t
Heat aggregate, 220°F @ 470 Btu/°F/t*, 0.947t	=	97,900 Btu/t
Other plant operations	=	19,800 Btu/t*
Total plant operations	=	197,200 Btu/t
Haul of mix		
US-281, 9 mi. x 2 x 4270 Btu/tm*	=	76,900 Btu/t
SH-336, 6 mi. x 2 x 4270 Btu/tm*	=	51,200 Btu/t

Spread, Heat, Scarify and Compact Material

US-281 - Diesel (Roller & Repaver) 358 gal. x 139,000 Btu/gal.*	=	49,762,000 Btu
US-281 - Propane (Repaver) 1836 gal. x 91,000 Btu/gal.*	=	167,076,000 Btu
Total Btu used to spread, heat and scarify material on US-281	=	216,838,000 Btu
SH-336 - Diesel (Roller & Repaver) 105 gal. x 139,000 Btu/gal.*	=	14,595,000 Btu
SH-336 - Propane (Repaver) 630 gal. x 91,000 Btu/gal.*	=	57,330,000 Btu
SH-336 - Diesel (Light Pneumatic Roller) 13 gal. x 139,000 Btu/gal.*	=	1,807,000 Btu
Total Btu used to spread, heat and scarify material on SH-336	=	73,732,000 Btu

Summary of Energy used for Surface Recycling

US-281, 26,030 sy of surface worked with the addition of 580 tons hot mix added for an average compacted depth of 0.96 inches.

Mix Composition	=	324,300 Btu/t
Plant Operation	=	197,200 Btu/t
Haul	=	76,900 Btu/t
		598,400 Btu/t

$$598{,}400 \text{ Btu/t} \times \frac{580\text{t}}{26{,}030 \text{ sy}} = 13{,}300 \text{ Btu/sy}$$

$$\text{Spread, Heat, Scarify \& Compact} \quad \frac{216{,}838{,}000 \text{ Btu}}{26{,}030 \text{ sy}} = 8{,}300 \text{ Btu/sy}$$

Total: 21,600 Btu/sy

$$\frac{21{,}600 \text{ Btu/sy}}{0.96 \text{ inches}} = 22{,}500 \text{ Btu/sy-in.}$$

SH-336, 11,079 sy of surface worked with the addition of 440 tons hot mix added for an average compacted depth of 1.08 inches.

Mix Composition	=	324,300 Btu/t
Plant Operation	=	197,200 Btu/t
Haul	=	51,200 Btu/t
		572,700 Btu/t

$$572{,}700 \text{ Btu/t} \times \frac{440\text{t}}{11{,}079 \text{ sy}} = 22{,}700 \text{ Btu/sy}$$

$$\text{Spread, Heat, Scarify \& Compact} \quad \frac{73{,}732{,}000}{11{,}079 \text{ sy}} = 6{,}700 \text{ Btu/sy}$$

Total: 29,400 Btu sy

$$\frac{29{,}400 \text{ Btu/sy}}{1.08 \text{ inches}} = 27{,}200 \text{ Btu/sy-in.}$$

The following calculations apply only to conventional hot mix asphaltic concrete overlay.

Hot Mix Asphaltic Concrete

Mix Composition:		
Asphalt, 5.6% @ 2,189,800 Btu/t	=	122,600 Btu/t
Aggregate, 94.4% @ 219,900 Btu/t	=	207,600 Btu/t
Total for mix	=	330,200 Btu/t
Plant Operations:		
Dry aggregate, 3% @ 28,000 Btu/%*, 0.944t	=	79,300 Btu/t
Heat aggregate, 220°F @ 470 Btu/°F/t*, 0.944t	=	97,600 Btu/t
Other plant operations	=	19,800 Btu/t*
Total plant operations	=	196,700 Btu/t
Haul of Mix:		
7.5 mi. (avg.) x 2 @ 4270 Btu/tm*	=	64,100 Btu/t
Spread & Compact Material:		
3 @ 4.5 gal/hr @ 139,000 Btu/gal per 150t/hr*	=	12,500 Btu/t

Summary of Energy used for Conventional Hot Mix

Mix Composition	=	330,200 Btu/t
Plant Operation	=	196,700 Btu/t
Haul of Mix	=	64,100 Btu/t
Spread & Compaction	=	12,500 Btu/t
Total	=	603,500 Btu/t

Compacted density of the mix will be 145 pcf.

$$603{,}500 \quad \left(\frac{145}{2000}\right) \quad 0.75 = 32{,}800 \text{ Btu/sy-in.}$$

Comparison of Energy Requirements

Surface Recycling	24,900 Btu/sy-in. (avg. both projects)
Conventional Hot Mix	32,800 Btu/sy-in.

Comparison of Energy Requirements Considering Savings in Asphalt

Surface Recycling	24,900 + 56,700 = 81,600 Btu/sy-in.
Conventional Hot Mix	32,800 + 115,900 = 148,700 Btu/sy-in.

* Information taken from Asphalt Institute publication "Energy Requirements For Roadway Pavements" MISC-75-3, dated April 1975.

Comparison of Energy Considerations of Asphalt

Asphalt in itself is considered to be energy or an energy source. It generally will provide a Btu equivalent between fuel oil numbers 5 and 6. For comparative purposes, asphalt will be considered to have a Btu equivalent of 152,000 Btu/gal.

New Hot Mix

Hot mix weight of 145#/cu.ft. @ 5.6% asphalt
145#/cu.ft. x 0.75 cu.ft/sy-in. = 109#/sy-in. of ACP
109#/sy-in. x .056 asph = 6.1# asphalt/sy-in.
Asphalt @ 8# gallon = 6.1 ÷ 8.0 = 0.7625 gallons asphalt/sy/in.
Btu/sy-in. = 152,000 x 0.7625 = 115,900 Btu/sy-in.

Recycled Hot Mix

US Hwy. 281

New hot mix added: 44.6#/sy @ 5.3% asphalt
Amount Asphalt/sy = 44.6#/sy x .053 asphalt = 2.3638# asphalt/sy
Asphalt @ 8#/gallon = 2.3638 ÷ 8.0 = 0.2954 gallon asphalt/sy
Btu/sy = 152,000 x .2954 = 44,900 Btu/sy
44,900 Btu/sy ÷ 0.96 in. = 46,771 Btu/sy-in.

State Highway 336

New hot mix added: 79.4#/sy @ 5.3% asphalt
Amount asphalt/sy = 79.4#/sy x .053 asphalt = 4.2082# asphalt/sy
Asphalt @ 8#/gallon = 4.2082 ÷ 8.0 = 0.526 gallon asphalt/sy
Btu/sy = 152,000 x 0.526 = 79,952 Btu/sy
79,952 Btu/sy ÷ 1.20 in. = 66,627 Btu/sy-in.

Average Btu of Recycled Hot Mix

46,771 + 66,627 ÷ 2 = 56,699 Btu/sy-in.

Summary

USING NEW HOT MIX ENERGY CONTAINED IN ASPHALT ≈ 115,900 Btu/sy-in

USING RECYCLED HOT MIX ENERGY CONTAINED IN ASPHALT = 56,699 Btu/sy-in. (Avg.)

Savings in energy consideration of asphalt = 115,900 Btu - 56,699 Btu = 59,201 Btu/sy-in.