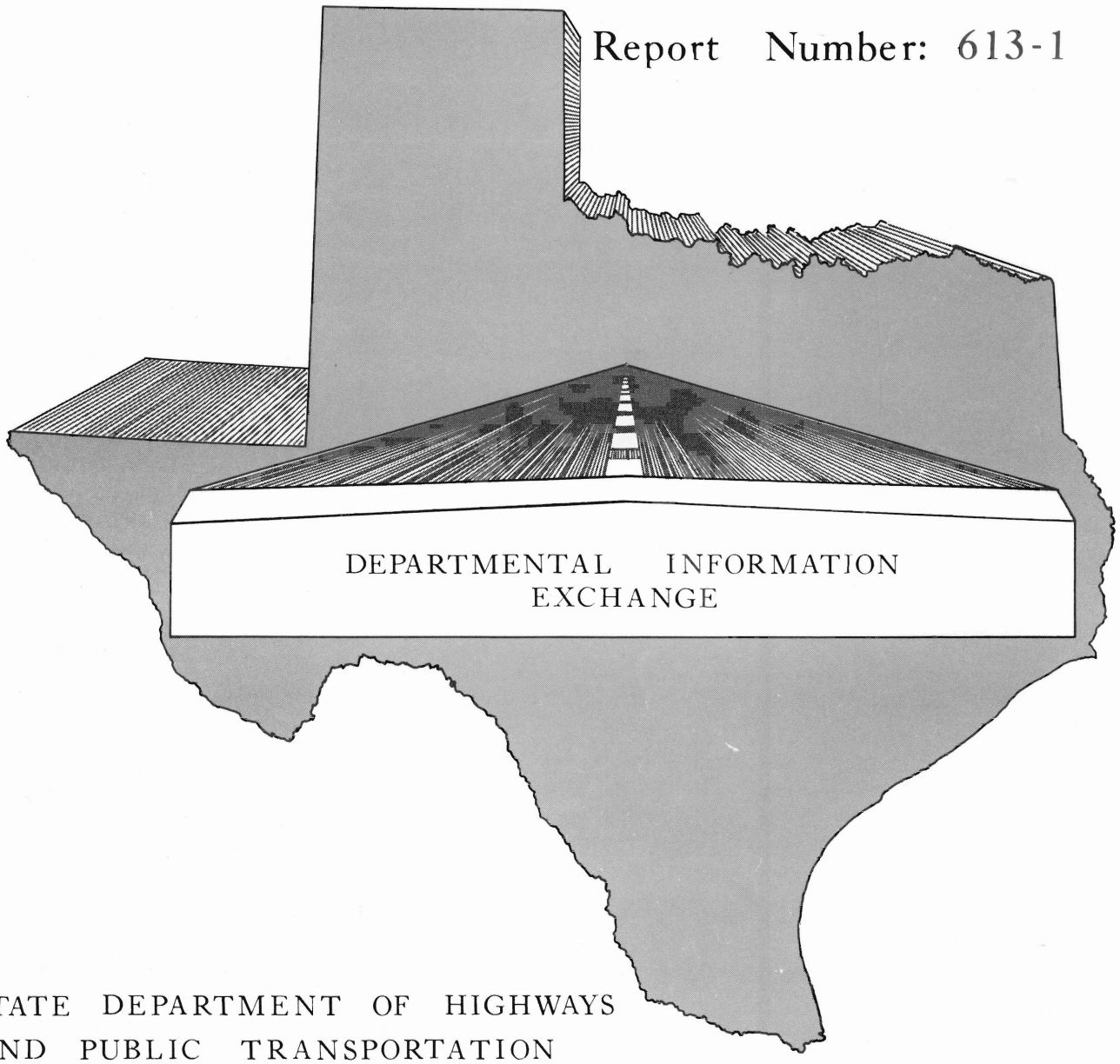
EXPERIMENTAL PROJECTS

COLD RECYCLING OF ASPHALT CONCRETE PAVEMENT

Report Number: 613-1



STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

STATE DEPARTMENT OF HIGHWAYS

AND

PUBLIC TRANSPORTATION

COLD RECYCLING OF ASPHALT CONCRETE PAVEMENT

by

B. R. Lindley
Asst. District Engineer
District 8

Report No. 613-1

U. S. Highway 277
Taylor County, Texas

October, 1975

Cold Recycling of Asphalt Concrete Pavement

TABLE OF CONTENTS

INTRODUCTION

An experimental project was initiated to determine the feasibility for recycling old asphaltic-concrete pavement by breaking down, pulverizing in place, adding additional asphalt and replacing without the use of heating equipment.

The site for this project was selected on a 0.4 mile section of U. S. Highway 277 approximately four miles southwest of Abilene, Texas. The highway at this location consists of two thirteen-foot lanes with nine-foot paved shoulders. The travel lanes had approximately four inches of asphaltic-concrete pavement.

We had previously tried this experiment on another project by the use of heat through both a standard and a dryer-drum type plant.[1] Both plants produced a workable material, but problems were encountered with pollution of the surrounding atmosphere. However, we believe that the problem of pollution can be corrected. One such process, which is apparently successful, is the heat transfer system that has been developed by Las Vegas Paving Company. Other similar systems of recycling are being developed nationally.

There is a demand for rehabilitation of old asphaltic-concrete pavement using methods other than heat. In many instances it would be more economical to recycle without the use of heat and provide the contractor an alternate method of operation.

The purpose of this experiment was to develop a procedure to utilize existing asphalt pavement by crushing and adding additional asphalt and a softening agent to the crushed mixture. There were six main points to

[1] See Experimental Project Report Number 604-1

be proven on the development of this system:

1. Determine the possibility of crushing old hot-mix in place,
2. Provide an asphalt softening agent capable of re-establishing specified qualities of the old asphalt,
3. Determine the best type of asphalt to be used as an additive,
4. Establish a sequence of work and the type equipment needed for this type project,
5. Compare cost with other standard reconstruction operations,
6. And, study strength comparisons with other hot-mix and base courses.

The first four main points of interest were proven during the course of this project. We had no way of truthfully comparing cost of a completely new process with that of a process that has been used for years. An analysis of the complete project reveals that using certain techniques which were developed and improved upon during the course of the experiment could shave the cost by approximately fifteen percent. The strength and durability of the mix will be determined by time and performance under traffic.

PROJECT HISTORY

The project location is approximately 4 miles southwest of Abilene, Texas on U.S. Highway 277 in Taylor County, Texas. The highway consists of two thirteen-foot travel lanes, with nine-foot paved shoulders. The length of the project is 0.4 mile. The original section was ten inches of crushed limestone base with a penetration course placed in 1941. In 1955, 200 pounds per square yard of Type D Hot-Mix was placed over the original section. In 1964, flexible base was placed on the shoulders and the entire surface was sealed, then another two inches of Type D Hot-Mix was placed on the main lanes. State maintenance forces has also placed numerous patches and spot seals at various locations.

This section of highway has a traffic volume of approximately 1900 ADT with approximately 15% truck traffic. The 20 year ADT is predicted at approximately 3150. This portion of U.S. Highway 277 is used by trucks hauling base material from the hills west of the View community into Abilene and surrounding territory. Most of the base material and crushed limestone rock used in the Abilene area is being hauled along this route. Severe cracking of the pavement structure and heaving caused by the subsoils in the area is an increasingly persistent problem.

PROJECT PROPOSAL

The intent of this project was to remove all existing asphalt surface, reshape the existing base, prime the base with emulsified asphalt, crush the old hot-mix, mix with proper additives, and relay in its original position. After this was accomplished, a penetration seal coat was to be placed for a wearing surface.

The materials used on this project were:

1. Reclamite - Asphalt Rejuvenating Agent,
2. CMS-2 - Cationic Emulsion,
3. Grade 4 Lightweight Aggregate,
4. Hot-Mix Cold Laid Type D,
5. And, EA 11-M Anionic Emulsion.

The equipment used for this project consisted of:

1. 12-A Motor Grader,
2. Light Pneumatic Roller,
3. Medium Pneumatic Roller,
4. Asphalt Distributor and Booster,
5. Front End Loader,
6. P-500 Pettibone Pulverizer,
7. C-200 Pettibone Vibratory Roller,
8. SM-700 Pettibone Speed Mixer,
9. Blaw-Knox Laydown Machine,
10. And, D-6 Dozer with Blade Ripper Tooth.

EQUIPMENT SELECTION

All equipment for this project was available from our regular maintenance operations with the exception of the traveling crusher, speed mixer, and the vibratory roller. This equipment was leased from Pettibone Equipment Corporation of Irving, Texas. Pettibone Corporation was very cooperative in using their equipment on this project in order to demonstrate the capabilities of the equipment.

The traveling crusher was needed to crush the old hot-mix in a windrow in lieu of hauling the material to a crusher and back to the roadway. The crusher has capabilities of crushing the old hot-mix back down to original aggregate size dependent upon the number of passes of the crusher. This machine will crush approximately 250 tons per hour, depending on the type of material and the size of the windrow.

The speed mixer is very important to this operation because it is extremely hard to mix cold asphalt emulsion and aggregates. This was especially difficult on this project because the traveling crusher had crushed the existing pavement to a fairly small size, and the amount of liquid material added was quite small.

The vibratory roller was used in order to receive proper compaction on varied depths. Our opinion was that the use of this type roller eliminated the requirement for at least two other rollers.

MATERIAL SELECTIONS

Reclamite was chosen as a rejuvenating agent after much laboratory analysis here in District 8 and also in the Materials and Test Division in Austin. Experiments demonstrated a standard AC-5 asphalt could be hardened in the laboratory to pitch and by adding a low percentage of Reclamite would bring the AC-5 asphalt back into specification limits. Other rejuvenating agents were tested but Reclamite produced a more satisfactory end result and was readily available on the open market.

By laboratory manipulations it was determined that one percent (by weight) of Reclamite would be required with an additional two percent asphalt. Cationic Emulsion (CMS-2) was chosen due to its slow setting qualities and also because both CMS-2 and Reclamite are cationic, thus creating a compatible mixture.

Tests on the above mixture determined that two parts water would have to be added as a carrying agent to properly disperse the additional asphalt.

Test reports and other determining factors are enclosed as attachments to this report.

CRUSHING OPERATIONS

The largest problem encountered in this experiment was the processing of the pavement prior to the actual crushing of the old hot-mix. We began by placing all traffic in the northbound lane and shoulder, ripping out all of the southbound lane and shoulder for the full length of the project. This proved to be awkward because the operation provided an excessive quantity of old materials for windrowing, crushing and manipulating. We soon learned that a strip of old pavement from 30 to 40 inches wide was much easier to handle and would process much better. These narrow strips were ripped, bladed to one side, and crushed by a chopping type roller. This operation produced chunks 14-inch or less in size. We found that if the chunks were smaller the traveling crusher would perform with more efficiency. These windrows were then crushed with the Pettibone machine. Originally water was sprayed on the windrow in front of the crusher, but it was soon learned that a mixture of water and Reclamite could be sprayed at the same time. This combination eliminated one operation and provided a means to reduce dust pollution as well as placing the Reclamite into the crushed mixture. The crushing operation was very successful. This operation crushed the hot-mix to a maximum two-inch size with very few oversized particles. It was also observed that there was very little evidence of the crushing operation breaking down the original aggregate.

The crushing operation by the traveling hammer-mill was successful with little wearing of hammers witnessed. The hammers had to be hard surfaced after approximately ten hours of use. The total crushing time was approximately 20 hours and the hammers were in good shape but will have to be hard surfaced before further use.

Again it should be reiterated that using the above mentioned equipment, it was quite difficult to scarify the pavement and break it down to the small size required for the crusher. The machine will take larger chunks of old hot-mix but the speed of the hammer mill is reduced immediately, thus leaving oversized material and placing a strain on the crusher motor.

The precrushing operation would have been less difficult if we had operated a D-8 Caterpillar or equivalent and a heavy self-propelled sheep-foot roller to rip up the pavement. We also began using a knife edge ripper tooth attached to a motor grader to slice the pavement in lieu of tearing the surface apart. This operation proved to be very beneficial to the progress of the experiment. A regular ripper was altered in our shop to perform this operation. Our welders took the tip from a regular tooth and cut an edge similar to a knife. By hard surfacing this knife edge we were able to cut the pavement in one-foot strips instead of pulling it out in large unmanageable chunks.

Applying moisture to the windrow in front of the crushing operation reduced air pollution to a minimum.

MIXING OPERATIONS

As discussed previously, the Reclamite was added to the existing broken up hot-mix in front of the crushing operation. Water diluted with one percent (by weight) of Reclamite was used to reduce the dust caused by this traveling crusher. The amount of water was determined by trial and error. The Reclamite should be dispersed throughout the crushed material and should be allowed to set for a minimum of six hours before additional asphalt is added. This lag time will permit the Reclamite to soften the aged asphalt instead of softening the new asphalt. Immediately after applying the Reclamite a darkening of the mixture is observed. Upon close examination it could be determined that the chemical process was beginning and the Reclamite was performing its expected task.

The entire mixture was leveled over the exposed base as soon as the required time had lapsed after the Reclamite was introduced into the mixture. Two percent (by weight) of Cationic Emulsion (CMS-2) was placed on the material with an asphalt distributor. We found that if the recycled asphalt concrete had dried, water should be added to the CMS-2 in order to facilitate the mixing of the asphalt into the mixture. It should be pointed out here that all water will not mix with CMS-2, however there is a simple process that can be used to test the mixture. Fill a large bucket one-half full of water to be used and add a gallon of CMS-2 to the water. After thoroughly mixing the water and CMS-2 there should be no indications of lumps or heavy scum on the water surface. If the asphalt will not go into solution another water source should be found.

The high speed mixer is then used to mix the asphalt into the crushed

hot-mix. The best mixing results are produced when the mixer is driven at least three times through the mix. This will completely mix the asphalt with the crushed hot-mix and will produce a uniform mix. A final mixing operation should then be performed with the blade which will combine the entire mixture and provide a means for aeration.

The mixture should be studied carefully to insure that it contains a proper amount of moisture before laying operations begin. Moisture content is critical because trapped moisture in the mix will delay curing time and cause rutting under heavy traffic.

REPLACING MIXTURE

Two methods of laying operations were used on this project. A laydown machine can be used or the material can be bladed in using a motor grader. Either method can be used, however it is much easier and better density is produced by laying with a blade rather than using a laydown machine. The blading operation was performed by the method used by our maintenance forces when placing hot-mix cold-laid asphaltic concrete pavement. The material was placed in approximately one-inch layers with light pneumatic rollers being driven directly behind the blade at all times.

Small lifts may also be placed by the laydown machine, but the depth of mix is determined by size of the aggregate. The use of this machine requires loading equipment to fill the hopper. The added expense for the use of these two machines should be considered. Use of a laydown machine is feasible and would be recommended on larger projects where it would be more economical to accelerate the laying operation.

The compacting and rolling of the recycled mix is highly critical because tracks are difficult to roll out of the surface. Even footprints are difficult to remove. We recommend, because of this, that a flat wheel steel roller be used as a break down roller. The rolling can then be completed with a light pneumatic roller.

There was evidence of pulled places where some oversized particles marked the surface after the mixture had been placed and the rolling operation completed. A riding surface was placed on top of the recycled material using Type D Hot-Mix Cold-Laid Asphalt. This surface gave the overall roadway a neat uniform appearance and enhanced the riding quality.

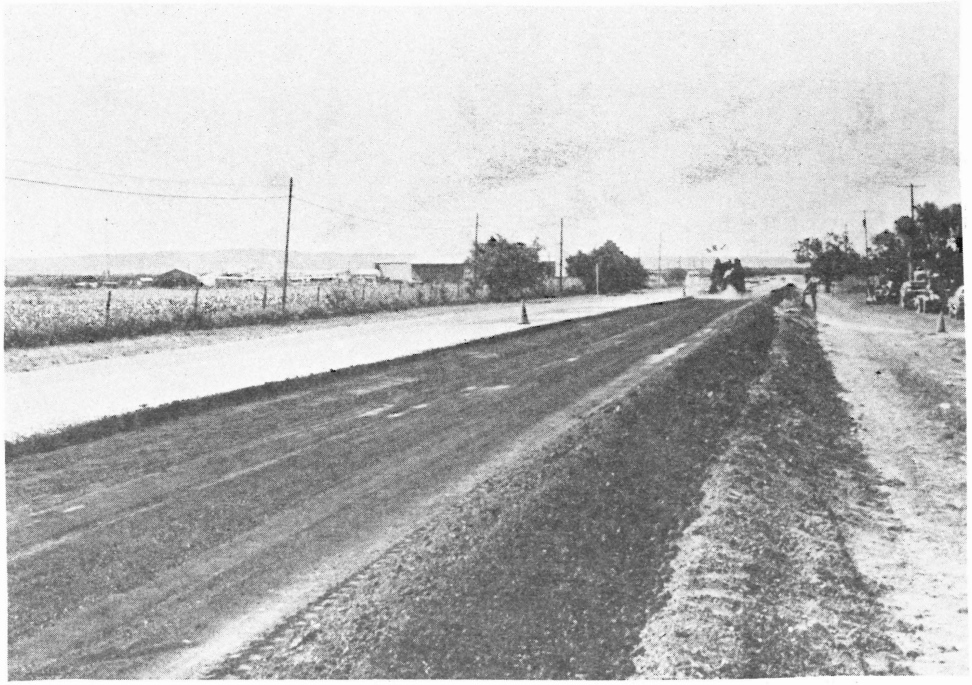
CONCLUSION

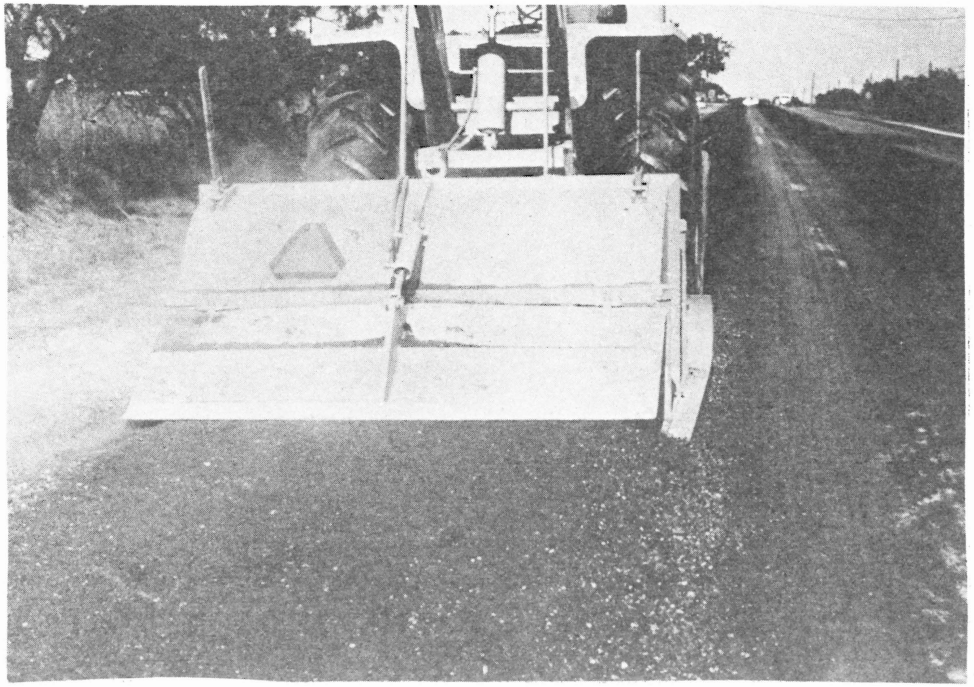
After completing this experimental project, we believe that cold recycling of asphaltic-concrete pavement is feasible and in many cases highly practical. The capability of the contractor in handling traffic and the depth of existing pavement are two factors which should be considered when figuring costs for this process. Difficulty in ripping operations are dependent on the thickness of the existing pavement. Pavement greater than four or five inches in depth will be extremely costly to rip and crush into small chunks. In deep pavements it may be more economical to rip the pavement into large particles and haul it to a crusher. The P-500 crusher performed exceptionally well on this project. It is our opinion that this is a useful tool in this type operation.

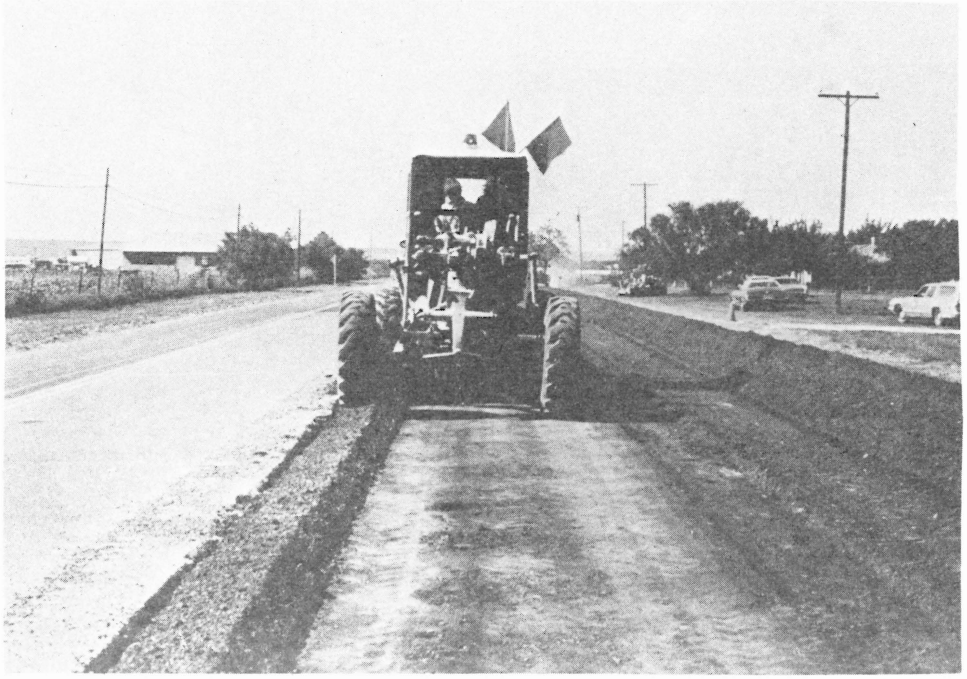
The use of Reclamite, or a comparable product, as a softening agent is considered desirable. As mentioned earlier in this report, tests were made in our central laboratory on samples from the existing pavement to determine the amount of softening agent required to bring the existing asphalt back into the specifications. It was determined by laboratory process that .6% Reclamite was required, however 1% was used on this project in order to replace losses due to manipulation and absorption into the underlying base. There are other softening agents available, but this product was recommended by our central laboratory. There are products that are commonly called Gas-Oils which, in some areas, are on the market and may provide comparable results.

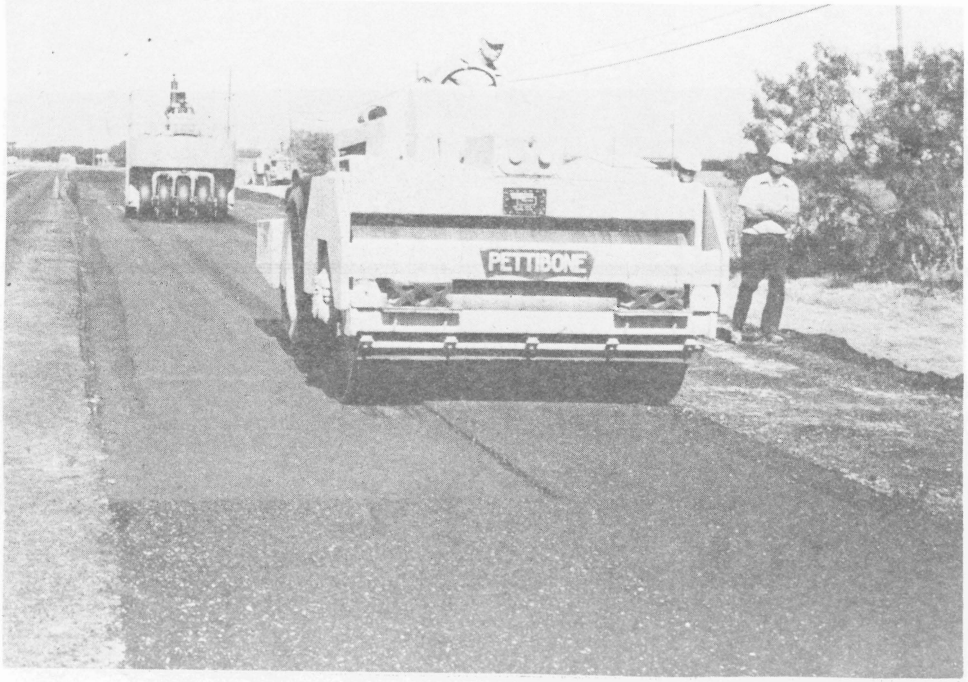
It is our opinion that a riding surface should be placed on the recycled material. This riding course would seal out moisture and give the required serviceability index.

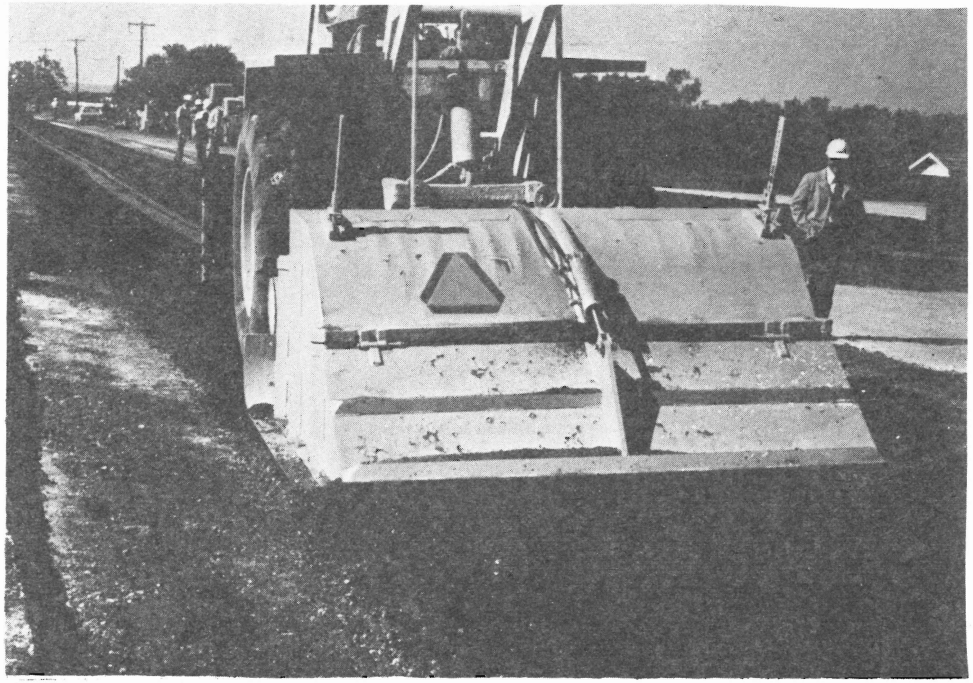
We believe this experiment proved that a material can be produced that is workable, homogeneous and can be extremely valuable as an asphalt stabilized base. It is a feasible alternate to overlaying and trying to bridge over a distressed pavement structure.

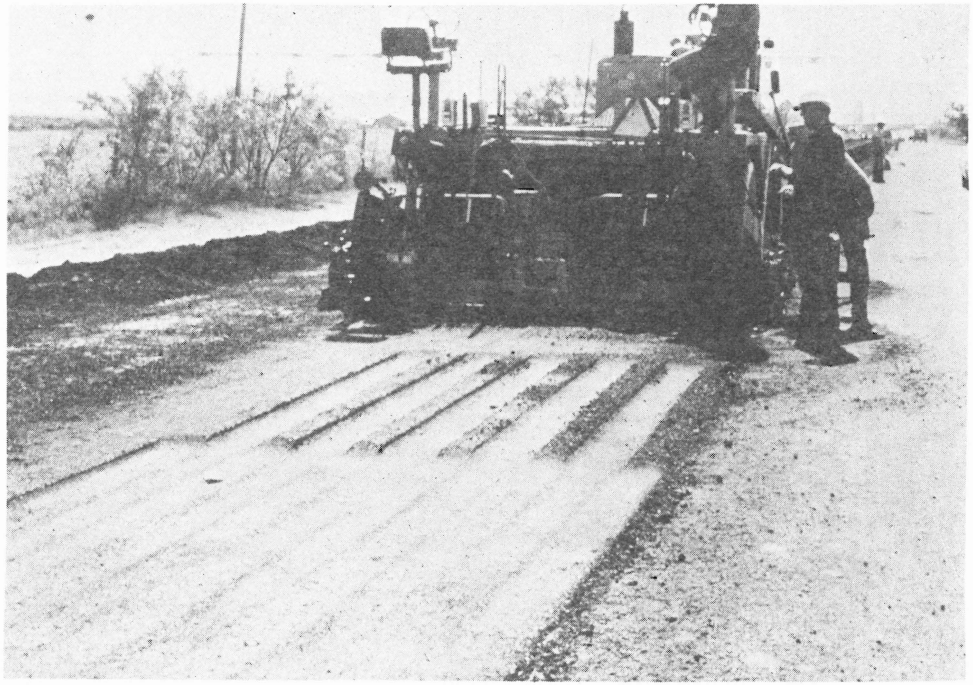




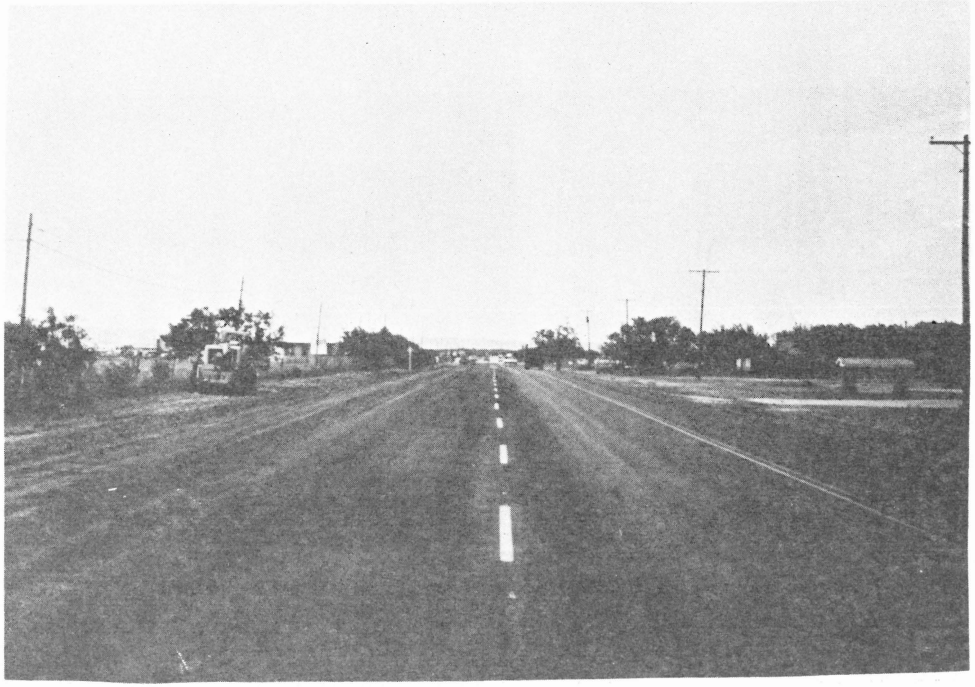



PETTIBONE






PETTIBONE



Form 433-A THD-6-45-1M

TEXAS HIGHWAY DEPARTMENT

INTEROFFICE MEMORANDUM

Austin, Texas

Date 9-3-75

To: MR. CHARLES HUGHES

From: ROBERT F. KRIEGEL

Remarks:

F. I. PROJECT 5-20-75-240

MOLDED SPECIMEN DATA

	SP. GR.	HVEEM COMP. STAB.	VALUE
0.6% RECLAMITE			
1.4% WATER	AVG. 2.257	27	177
	(140.8 lbs./cu.ft.)		
0.8% RECLAMITE			
1.2% WATER	AVG. 2.249	27	175
	(140.3 lbs./cu.ft.)		

For your file | Action | Approval | Attention

For your suggestions and please return

For your information and file please return

For an answer by memo / letter / teletype / telegram to be signed by you / me

Texas Highway Department
Form 433-B

47407—1259—50m

INTEROFFICE MEMORANDUM

TO: Mr. C. H. Hughes, Sr. ✓ Date October 16, 1975

FROM: Avery W. Smith Responsible

SUBJECT: F. S. 5-20-75-240 Desk D-9-E
Recycling District 8 HMAC

Three samples of the District 8 HMAC were received and designated 75-107-R, 75-108-R and 75-109-R. 75-107-R was the untreated pulverized material containing no additives. 75-108-R was also pulverized, but contained 1% Reclamite to reclaim the old asphalt. 75-109-R was also pulverized, and in addition to the 1% Reclamite contained 1.76% CMS-2 emulsified asphalt.

These three samples were prepared in accordance with Test Method Tex-101-E. The + 7/8" material was crushed in the lab crusher to pass the 7/8" sieve, and the following gradations were obtained:

	+5/8	+3/8	+No. 4	+ No.10	-No. 10
75-107-R	4.05	14.33	43.30	67.60	32.40
75-108-R	3.44	17.18	48.80	74.57	25.43
75-109-R	7.82	29.25	63.95	86.73	13.27

Specimens of all three samples were weighed out on the above basis, dried to constant weight in the 130°F oven, placed in the mold, and molded in the large gyratory press to approximately 6" diameter by 8" in height. These were then placed in the 140°F oven overnight, measured, and tested in unconfined compression on the Tinius-Olsen press. Results of the compression tests are as follows:

	% H_2O in mold	Temp. in Mold	Pushed out Density,Pcf	Unconfined Comp.Str.Psi	Test Temp °F
75-107-R_1	1.00	102°F	129.06	19.1	135
75-107-R_2	0.97	105	129.60	16.0	134
75-108-R_1	0.77	106	134.11	16.5	134
75-108-R_2	0.83	111	134.56	19.9	135
75-109-R_1	0.78	109	138.48	25.8	136
75-109-R_2	0.81	113	136.14	23.3	136

75-107-R specimens were visible dry looking, and contained horizontal cracks about 1/2" above the bottom surface.

Texas Highway Department
Form 433-B

47407—1259—50m

INTEROFFICE MEMORANDUM

TO: Mr. Charles H. Hughes, Sr. Date October 16, 1975

FROM: Avery W. Smith Responsible

SUBJECT: F. S. 5-20-75-240 Desk D-9-E
Recycling District 8 HMAC

75-108-R specimens were somewhat darker in appearance, and had no visible cracks.

75-109-R specimens were again somewhat darker in appearance, had no cracks, and also had the best densities and unconfined compressive strengths of the three samples tested.

Avery Smith

KAD/sr

cc: Mr. Elmore
Mr. Hill
Mr. Chaffin

Texas Highway Department
Form 433-B

47407—1259—50m

INTEROFFICE MEMORANDUM

TO: Mr. Larry G. Walker

Date October 20, 1975

FROM: Arthur J. Hill

Responsible

SUBJECT: Recycling Old Bituminous Pavement
Field Service Project No. 5-20-75-240

Desk D-9-F

The following information is reported with regard to the testing of roadway sampled materials from US 277 in District 8. The materials are from a project which involves the recycling of old bituminous pavement.

Sample given Laboratory No. R3-75-252 is a sample of the old broken up, crushed pavement taken from a windrow on the roadway. This sample of the original old pavement was dried to constant weight in seven hours and forty five minutes at 140°F.

Sample given Laboratory No. R3-75-253 was accompanied by an identification slip that stated that this material had been treated with reclamite, sampled from a windrow on the roadway. It was cured to a constant weight in ten hours at 140°F.

Sample given Laboratory No. R3-75-254 had an identification slip that stated that this material had been treated with "1.0% Reclamite and 1.76% EA-CMS-2", sampled from a windrow on the roadway just prior to compaction. The material was cured to a constant weight in ten hours at 140°F.

After curing to a constant weight, each of the above samples was extracted, the Abson recovery test performed, and the residual bitumen submitted to the Asphalt Section for testing. Hveem stability test specimens were molded at 100 F. and 250 F. from material sampled from each of the above submitted samples. The specimen specific gravity, the Hveem stability value, and the cohesiometer value were then determined. Since some values were questioned, check test were made with the remaining materials. The test results are reported in the accompanying table. It should be noted that the materials used in molding the check test specimens were badly segregated, the segregation possibly influencing the test results.

RFK/sr

cc: Weldon Chaffin
Avery Smith
W. E. Elmore

RECYCLING OLD BITUMINOUS PAVEMENT - DISTRICT 8 - US 277
F.S. PROJECT NO. 5-20-75-240

IDENTIFICATION	RESID. BIT. CONT. (% by wt.)	ORIG. SAMPLE MOIST. CONT. (% by wt.)	TEST RESULTS ON MOLDED SPECIMENS						TESTS ON RESIDUAL BIT.		
			MOLDING TEMP. = 100°F.			MOLDING TEMP. = 250°F.					
			SPEC. GRAVITY lbs./cf	HVEEM STAB. (Avg.%)	COHES. VALUE (Avg. %)	SPEC. GRAVITY lbs./cf	HVEEM STAB. (Avg. %)	COHES. VALUE (Avg. %)	VISCOS. @ 140°F. (Stokes)	DUCTILITY @ 77°F. (CM)	PEN. @ 77°F.
R3-75-252	5.1	2.7	2.215	45	217	2.308	65	692	13,744	29	27
			138.2			144.0					
					Check Test -	2.295	67	517			
						143.2					
R3-75-253	5.9	2.4	2.275	42	209	2.360	39	356	1,025	141+	86
			142.0			147.3					
					Check Test -	2.338	35	317			
						145.9					
R3-75-254	5.8	2.2	2.265	28	216	2.331	30	357	1,648	141+	62
			141.3			145.5					
					Check Test - (one spec. only)	2.342	26	374			
						146.1					

COST BREAKDOWN

Salary and Labor	$ 4,687.48
*Equipment Rental	10,014.75
Stock Issues	8,187.40
**Traffic Controls	4,760.90
Engineering	917.00
TOTAL	$28,567.53

*Special Equipment Rental is included in the Total Cost as follows:

D-500	$3,600 per month
C-200	1,500 per month
SM-700	2,000 per month

**This item includes all barricades, warning signs, temporary and final traffic control markings for the project.

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

County: Taylor Highway: US 277 Project: PD 08-5-5259

Application Rates - Actual Quantities

South Bound Lane:

Salvaged material	1,375 tons
Reclamite used	1.0%
CMS-2 used in 1st course, North 1000'	1.68%
CMS-2 used in 1st course, South 900'	1.58%
CMS-2 used in 2nd course, North 1000'	1.87%
CMS-2 used in 2nd course, South 900'	1.94%

North Bound Lane:

Salvaged Material	1,783 tons
Reclamite, mixed in with pulverizer	0.99%
CMS-2, 1st land, North 760'	1.97%
CMS-2, 2nd land, Middle 520'	1.95%
EA-11M, 3rd land, South 620'	2.15%

VISITORS REGISTER

	TITLE	
E. W. Honegger	Honnegger Construction Co.	Okla. City, Oklahoma
Tony Boswell	Honnegger Construction Co.	Okla. City, Oklahoma
Tom Wilson	Pettibone Corporation	Dallas, Texas
George A. Williams	Pettibone Corporation	Ft. Worth, Texas
E. R. Galvin	Pettibone Corporation	Jackson, Mississippi
William Stanis	Pettibone Corporation	Milwaukee, Wis.
Ray Price	Pettibone Corporation	Dallas, Texas
Robert G. Keyser	D-6 - SDHPT	Austin, Texas
B. C. Hortrowfy	Okla. Highway Dept.	Oklahoma
Leroy Sanders	White's Mines	Abilene, Texas
Johnson Mayfield	White's Mines	Abilene, Texas
Silbestre B.	White's Mines	Abilene, Texas
W. M. Allen	Dealer Truck	Sheveport, La.
Ronald Carlson	Parish Engineer	Bousher Parish, La.
Carlisle S. Richard	D.E. Dept. of Highways	Baton Rouge, La.
Ed Breckwoldt	Mat'l & Research Engr.	La. Dept. of Highways
Bob Boothby	Bus. Mgr. - Kortz Bros.	
Dan Traux	Mid-State Paving Co.	Jeffersonville, Ind.
C. W. Chaffin	D-9, SDHPT	Austin, Texas
Arthur Hill	D-9, SDHPT	Austin, Texas
Avery W. Smith	D-9, SDHPT	Austin, Texas
Roy L. Willis	Abilene Paving Co.	Abilene, Texas
Charles Preslar	Abilene Paving Co.	Abilene, Texas
Joe H. Smoot	R.E., SDHPT	Big Spring, Texas
C. W. Wesbrooks	R.E., SDHPT	Hamlin, Texas
J. H. Strain	J. H. Strain & Sons	Tye, Texas
James Strain	J. H. Strain & Sons	Tye, Texas
Don Neill	Asst. Sales Manager White's Mines	Abilene, Texas
John E. Nichols	Area Engr. - FHWA	Austin, Texas
Steven R. Criste	Engr.-Trainee-FHWA	Austin, Texas
Buff Silveria	Witco Chemical-Golden Bear Div.	Bakersfield, Calif.
Frank Munn	Riffe Petroleum	Tulsa, Oklahoma
W. A. Henley	Abilene Paving Co.	Abilene, Texas
T. R. Kennedy	D-10, SDHPT	Austin, Texas
John R. Nixon	D-10R	Austin, Texas
Bobby Moore	Texas Emulsion	Austin, Texas
Andy Winters	Branch Manager-Pettibone	
Chuck Huffman	DynaMat	Carrollton, Texas
Cecil Holloway	White's Mines	Abilene, Texas
Don Huddleston	Equ. Sales	Talihima, Oklahoma
Jim Freshwaters	Black Top Const. Co.	Mpls. Minn.
Bill Eppler	Black Top Const. Co.	Minn. (Spokapoll)
Ernest Strain	J. H. Strain & Sons	Tye, Texas

VISITORS REGISTER

	TITLE	
Bob Hagberg	Jim Jackson, Contractor	
Gene Thomas	Pettibone Texas Corp.	
Mac Shelby	Jim Jackson Southwest	Bryan, Texas
Jon Epps	Texas A&M University	Bryan, Texas
Bill Scott	Texas A&M University	Bryan, Texas
Victor Koontz	Pettibone Texas Corporation	
Bill Bridges	Pettibone Texas Corporation	
John Capling	Pettibone Texas Corporation	
Pete Peterson	Pettibone Texas Corporation	
Tom Ohlendorf	D-18 M	Austin, Texas
Irl Larrimore	D-18 M	Austin, Texas
Bob Guinn	D-18 M	Austin, Texas
Ralph Banks	D-18 M	Austin, Texas
Don Nunnally	District 6	Odessa, Texas
James String	District 6	Odessa, Texas
Jack Alexander	American Petrofina	Big Spring, Texas
Ray Brown	D-18 M	Austin, Texas
Raymond Stotzer	District 15	San Antonio, Texas