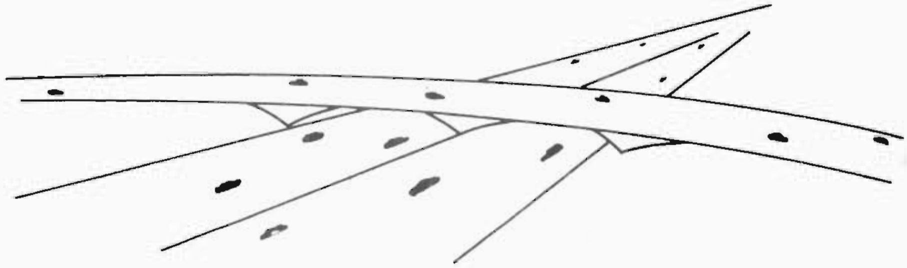

DEPARTMENTAL RESEARCH

Report Number SS — 4.0

SALVAGING OLD PAVEMENTS BY RESURFACING

TEXAS HIGHWAY DEPARTMENT

SALVAGING OLD PAVEMENTS BY RESURFACING

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District Eight

Special Study No. SS-4.0

TEXAS HIGHWAY DEPARTMENT

July 1966

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DISTRICT EIGHT

The purpose of this paper is to report on two methods of salvaging old concrete pavement by resurfacing and comparing the performance behavior of these two methods to new construction on a project built in 1957. This data is compiled on a section of US Highway 83 in Taylor County from its junction with US Highway 84, then west, for a distance of approximately two miles.

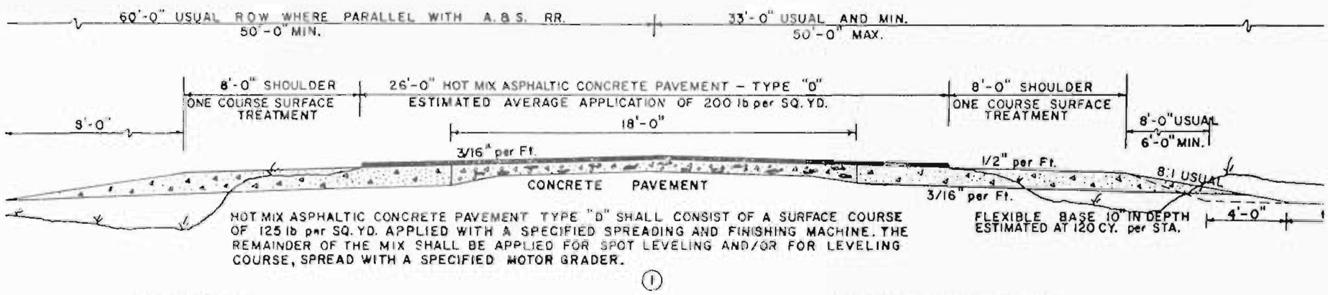
The highway was originally built with PC Concrete Pavement in 1928 and was widened with flexible base in 1944.

A contract was awarded on January 25, 1957, calling for reconstruction of a section of US Highway 83 from its junction with US Highway 84 in Taylor County west and south to the Runnels County Line. The total distance of this project F-90 (11) was 14.689 miles.

The project consisted of grading, structures, flexible base, and HMAC surfacing. Mr. E. L. Harris was the project engineer and Cooper & Woodruff, Inc. of Amarillo, Texas, was the prime contractor. Work was started on February 4, 1957, and the job was accepted by the State in August, 1957.

This project called for three principal designs, two of which used the old concrete pavement by salvaging and resurfacing. A study project was initiated for accumulating certain data just before, during, and after the above project was completed. The study portion of the project consisted of 11,100 feet beginning at station 1237+00 and ending at station 1348+00 and included the following types of construction.

(1) Design number (1) consisted of 3200 feet of concrete pavement originally 18 feet wide. It was widened 8 feet on each side with ten inches of flexible base and overlaid with two inches of Type "D" Hot Mix Asphaltic Concrete. See Typical section (1).



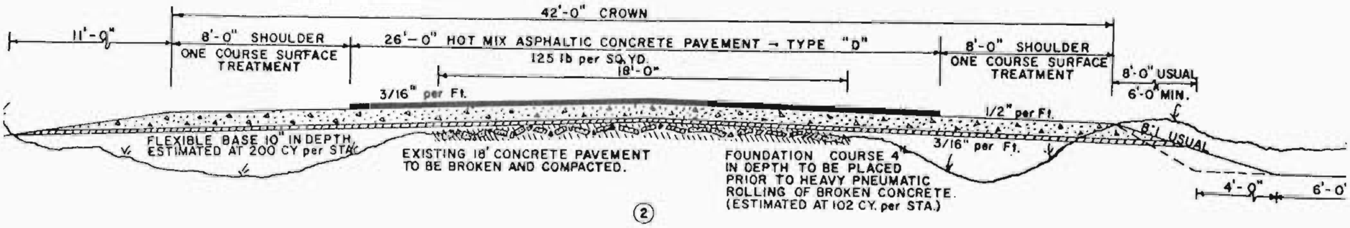
TYPICAL SECTION CONCRETE PAVEMENT WIDENED WITH FLEXIBLE BASE

Photographs number (1) and (2) indicate the original pavement condition before overlay of HMAC surface.

PHOTOGRAPH (1)

PHOTOGRAPH (2)

(2) Design number (2) consisted of 4500 feet of concrete pavement broken up and overlaid with four inches of foundation course, ten inches of flexible base. It was surfaced with one and one quarter inches of Type "D" Hot Mix Asphaltic Concrete. See typical section number (2).



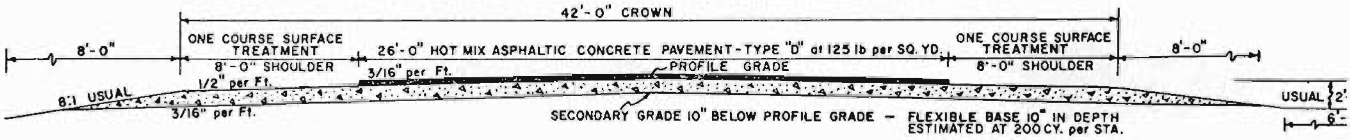
TYPICAL SECTION CONCRETE PAVEMENT BROKEN AND COMPACTED

Photographs number (3) and (4) indicate the condition of the concrete pavement prior to construction.

PHOTOGRAPH (3)

PHOTOGRAPH (4)

(3) Design number (3) consisted of 3400 feet of new construction. This required the removing the old concrete pavement from the job and preparing the old subgrade for cover with ten inches of flexible base and one and one quarter inches of Hot Mix Asphaltic Concrete. See typical section number (3).



③

TYPICAL SECTION NEW LOCATION TO IMPROVE ALIGNMENT OR GRADE CHANGE

The foundation course and flexible base materials were constructed by ordinary compaction methods.

The old concrete pavement of typical section (2) was broken up in accordance with the special specification listed below.

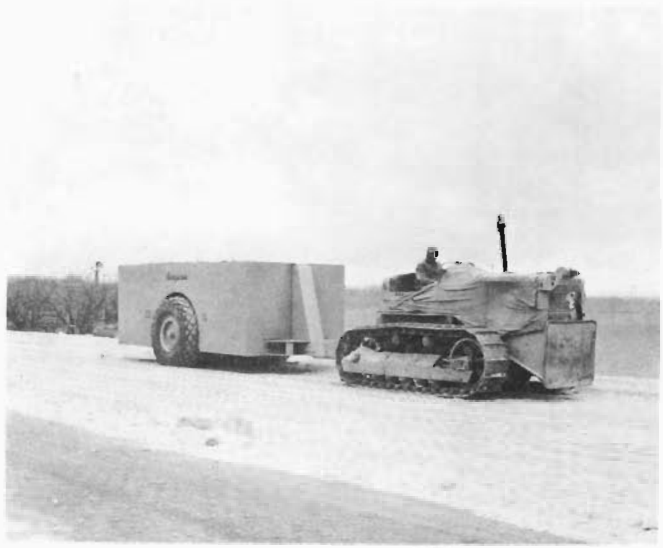
"BREAKING OLD PAVEMENT"

CONSTRUCTION METHODS: Existing pavement (concrete, with or without bituminous top) shall be broken up into pieces not greater than twelve (12) inches in any dimension by air-driven machinery or other suitable means. It is the intention of this Item of work to shatter the existing pavement in such manner that all pieces may be seated firmly on the subgrade as a foundation for the proposed new base course. The use of explosives for breaking up old pavement will not be permitted.

The contractor used two types of machinery for breaking up the old concrete as shown in Photograph (5).

These broken-up chunks of concrete were then seated into the underlying soils by use of heavy rollers in accordance with the following special item. See Photograph (6).

PHOTOGRAPH (5)



PHOTOGRAPH (6)

"HEAVY PNEUMATIC ROLLING"

EQUIPMENT: Heavy Pneumatic Tire Roller shall have four wheels in one transverse axle line equipped with pneumatic tires. Wheels shall be on not less than two oscillating axles, and shall be designed to give uniform coverage and mounted in a rigid frame and provided with a loading platform or body suitable for ballast loading. With no ballast, the roller shall weigh not more than ten tons (Gross), and when fully ballasted shall weigh not less than fifty tons (Gross). The rolling equipment shall be drawn at speeds from five to ten miles per hour. Rolling equipment shall be maintained in good repair and operating condition and shall be approved by the Engineer.

CONSTRUCTION METHODS: The work shall be done only when ordered by the engineer. The broken concrete pavement shall be rolled by driving the roller equipment over the entire area, at the speed and carrying the ballast designated by the Engineer. The Contractor shall furnish a sufficient number of rolling units, as needed, to insure seating of the concrete blocks in the underlying soil as required without undue delay after the pavement has been broken into blocks of the specified maximum diameter.

Foundation course material was placed on the broken concrete pavement prior to heavy pneumatic rolling. The foundation course material was pit run and contained large chunks of loosely cemented material. These were broken up by use of heavy grid roller. Only 35% was retained on a 40 mesh sieve as shown in Table I below. Thus, the chunks of broken concrete were easily surrounded. This operation is shown in Photograph (7).

SOILS AND BASE MATERIALS WORK SHEET

Control No.	Section No.	Job No.
34	2	14

Federal Project No.	IPE No.	Req. No.
F 90 (11)		

County: Taylor

Soil Constants	Screen Anal.	Hyd. Anal.

Lab. No.	LL	PI	SL	LS	SR	Class	Soil Binder	W B M % Loss	% Moisture	
31	21	7	12.3	5	1.62					

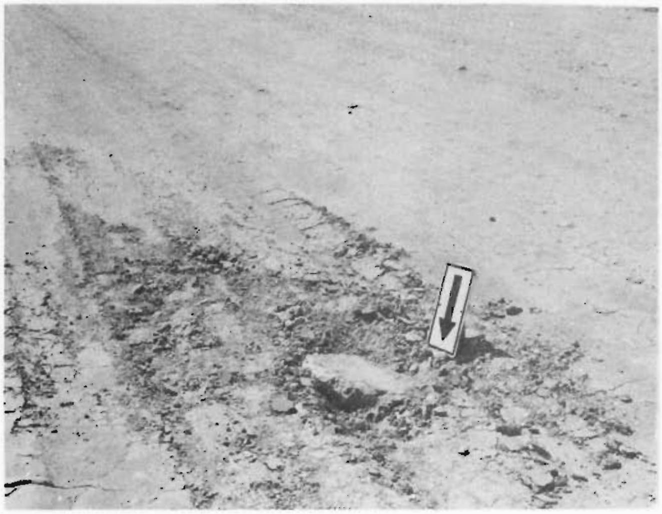
PERCENT RETAINED ON

Laboratory No.	Square Mesh Sieves: Opening in Inches								Square Mesh Sieves: Sieve Numbers							Grain Diam. In Millimeters			Spec. Grav.	Material
	3	2½	2	1¾	1¼	7/8	5/8	3/8	4	10	20	40	60	100	200	.05	.005	.001		
31				0		5			21		32	35								Foundation Course Material

TABLE I

Photograph (7)

The heavy pneumatic rolling proved useful because it showed flaws in the seating of the old concrete pavement. Photographs (8) and (9) indicate improper seating. These places were reworked to the satisfaction of the Engineer before subsequent construction was performed.



PHOTOGRAPH (8)

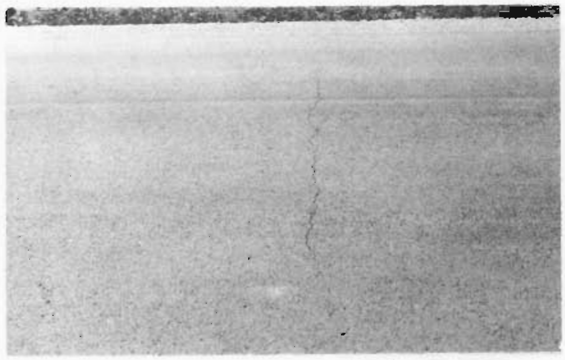
PHOTOGRAPH (9)

Photograph (10) shows a section of the completed highway.

PHOTOGRAPH (10)

The first section to show signs of distress was that of section (1). Cracks began to show at joints of the old concrete pavement.

These cracks began to show, Photograph (11), within three months after job completion. Crack sealing operations were started, Photograph (12), on this section in January, 1958. Photographs (13), (14), and (15), show how one particular failure had progressed through March, 1959, and



PHOTOGRAPH (11)

PHOTOGRAPH (12)

PHOTOGRAPH (13)

PHOTOGRAPH (14)

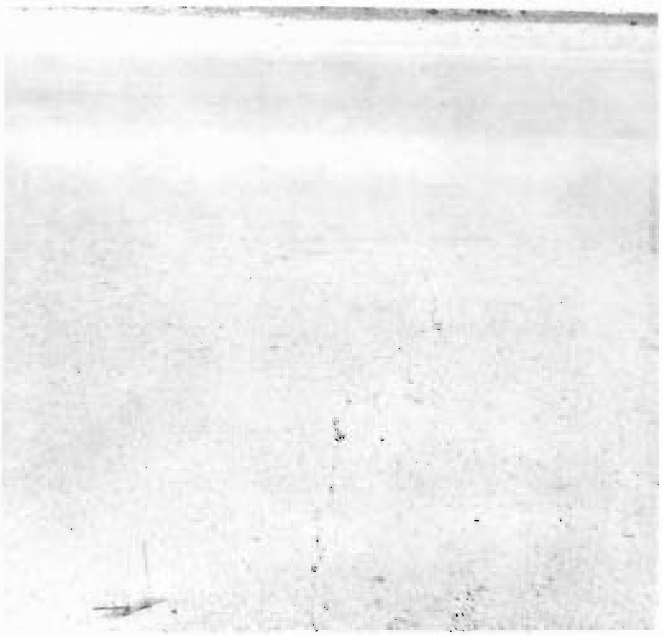
PHOTOGRAPH (15)

Photograph (16) shows the general condition of typical section (1) in April, 1961.

PHOTOGRAPH (16)

The second section to show signs of distress was that of section (3). Photograph (17) shows the type of distress first noticed in March, 1959. This condition progressed to that shown in Photograph (18) by April, 1961; and

PHOTOGRAPH (18)



PHOTOGRAPH (17)

PHOTOGRAPH (19)

Photograph (19) shows the general condition of this section in April, 1961.

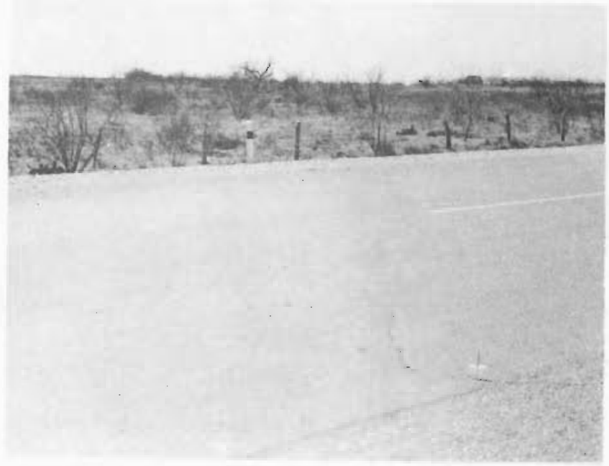
The section of highway represented by typical section (2) had begun showing signs of distress by March, 1959, as evidenced in Photograph (20). By April, 1961, the general condition of this section was good with the exception of one particular failure shown in Photograph (21).

It is believed that this failure resulted from faulty structure support. Comparison should be made between Photographs (4), (8), and (21).

Photograph (22) shows a typical failure prior to seal coat being applied in the summer of 1964.

After the seal coat was applied, the general appearance of the highway was good on all sections. The present serviceability rating is 3.7 to 4.1 on all sections. Cracking was pronounced but distortion and rutting were of minor proportions before the seal coat was applied.

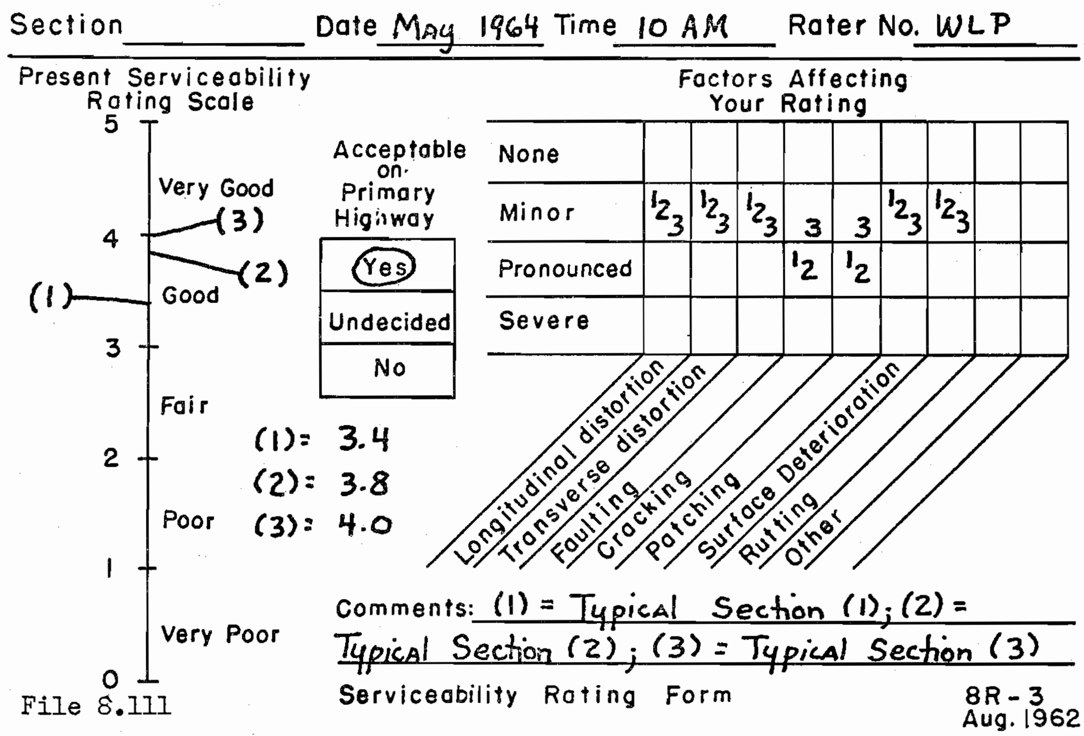
Refer to Serviceability Rating form on following page for the rating on each section in 1964 before the seal coat was applied.



PHOTOGRAPH (20)

PHOTOGRAPH (21)

PHOTOGRAPH (22)



The following table lists the history of cracking for the most severe failures of each section:

TABLE II

TABLE OF FAILURE HISTORY

(See Attachment "A" Pages 1 and 2)

Year	Section (1) T	Section (1) L	Section (1) M	Section (2) T	Section (2) L	Section (2) M	Section (3) T	Section (3) L	Section (3) M
1957	T1								
1958	T2	L1					T1	L1	
1959	T2	L2	M1A	T1	L1	M1A	T2	L2	
1960	T2	L2	M2A	T2	L1	M2A	T2	L2	M1A
1961	T2	L2	M2A	T2	L1	M2A	T2	L2	M2A
1962	T2	L2	M2A	T2	L1	M2A	T2	L2	M2A
1963	T2	L2	M2A	T2	L1	M2A	T2	L2	M2A
1964	T2	L2	M2B	T2	L1	M2B	T2	L2	M2B

T = Transverse Cracking Pattern
L = Longitudinal Cracking Pattern
M = Map Cracking Pattern

Table III shows the base and surfacing construction cost of this facility.

TABLE III
CONSTRUCTION COST INDEX

Typical Section	Description	Cost Per Mile
(1)	HMAC Overlay	$ 20,500
(2)	Broken Concrete	$ 30,880
(3)	New Structure	$ 37,880

Table IV shows the average maintenance cost index per mile per year for maintaining this facility during the past seven years since construction.

TABLE IV
MAINTENANCE COST INDEX

Typical Section	Description	Cost Per Mile
(1)	HMAC Overlay	$ 840
(2)	Broken Concrete	$ 420
(3)	New Structure	$ 280

Chart I describes the relationship indicating total cost of construction and maintenance for the three sections projected to a 15-year life. Please note that after 10 years it would be advisable to spend an estimated $8,000 per mile on the HMAC pavement overlay section (1) for level up and surface course of asphaltic concrete. The same would be true for the other two sections after fifteen or twenty years.

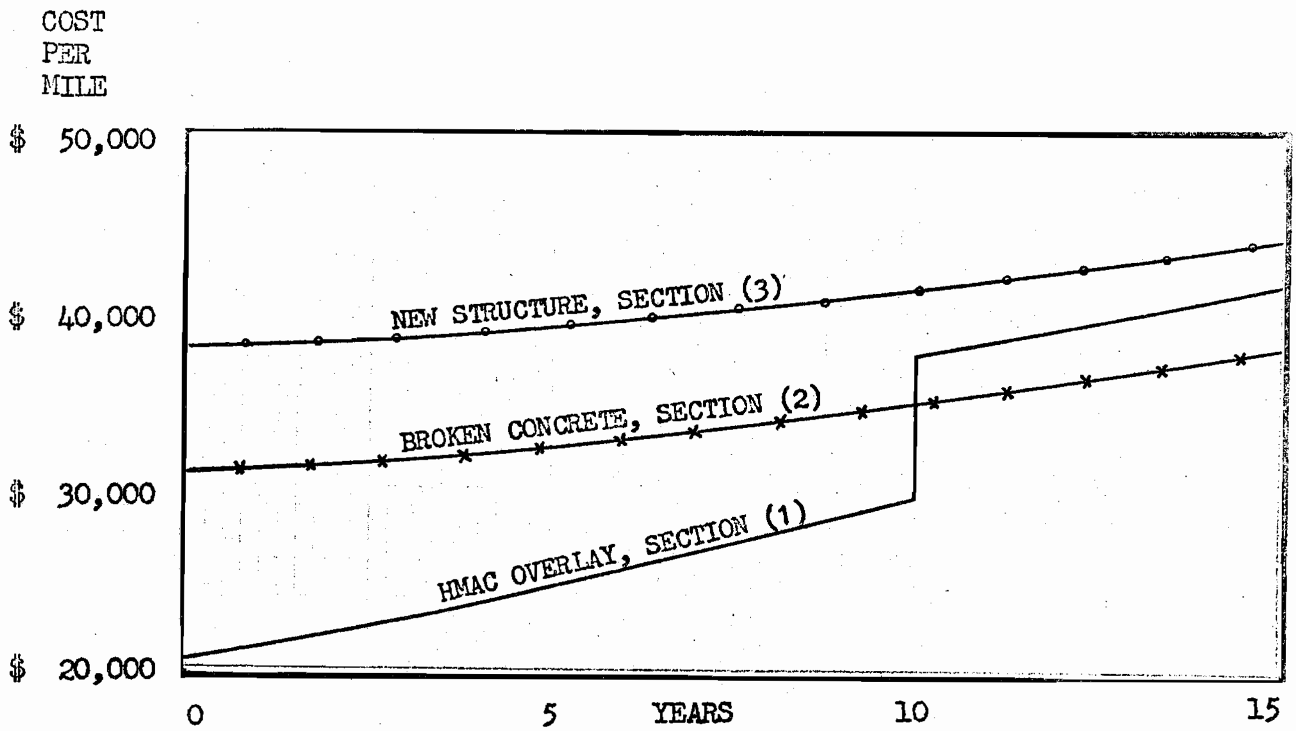


CHART I

SUMMARY

In making an evaluation on the three types of construction, there are three major factors which should be considered.

First, all three sections have a good riding quality at this time, and it is predicted that they will continue to produce a good serviceability record for several years. However, the section that has been overlaid with HMAC pavement does not produce as smooth a ride as the other two sections.

Second, the cost of construction did vary considerably. The section which was overlaid with HMAC pavement, section (1), cost about two-thirds of what the section where concrete was broken up and resurfaced did. The HMAC pavement overlay cost just over one-half as much as the new structure.

Third, the base and surface maintenance operations required to keep the highway serviceable should also be considered. After approximately seven years of use, the maintenance requirements seem to fit into the following pattern. The new structure, section (3), has required least maintenance. The broken concrete, section (2), has required about 160% more maintenance than the new structure. That which was overlaid with HMAC pavement has required approximately 300% more maintenance than the new structure.

Two other projects in this area, US Highway 380 in Stonewall County and State Highway 351 in Taylor County, have been constructed using the same design as that of section (2) where the old concrete pavement was broken up and strengthened with new base material. The construction and maintenance costs on these projects parallel those of this report. Finally, salvaging an old concrete pavement by breaking it up and resurfacing it as in design (2) is justifiable for four principal reasons:

(1) The finished facility produces a safe and satisfying ride to the traveling public.

(2) The initial cost is reasonable.

(3) The maintenance requirements are not excessive.

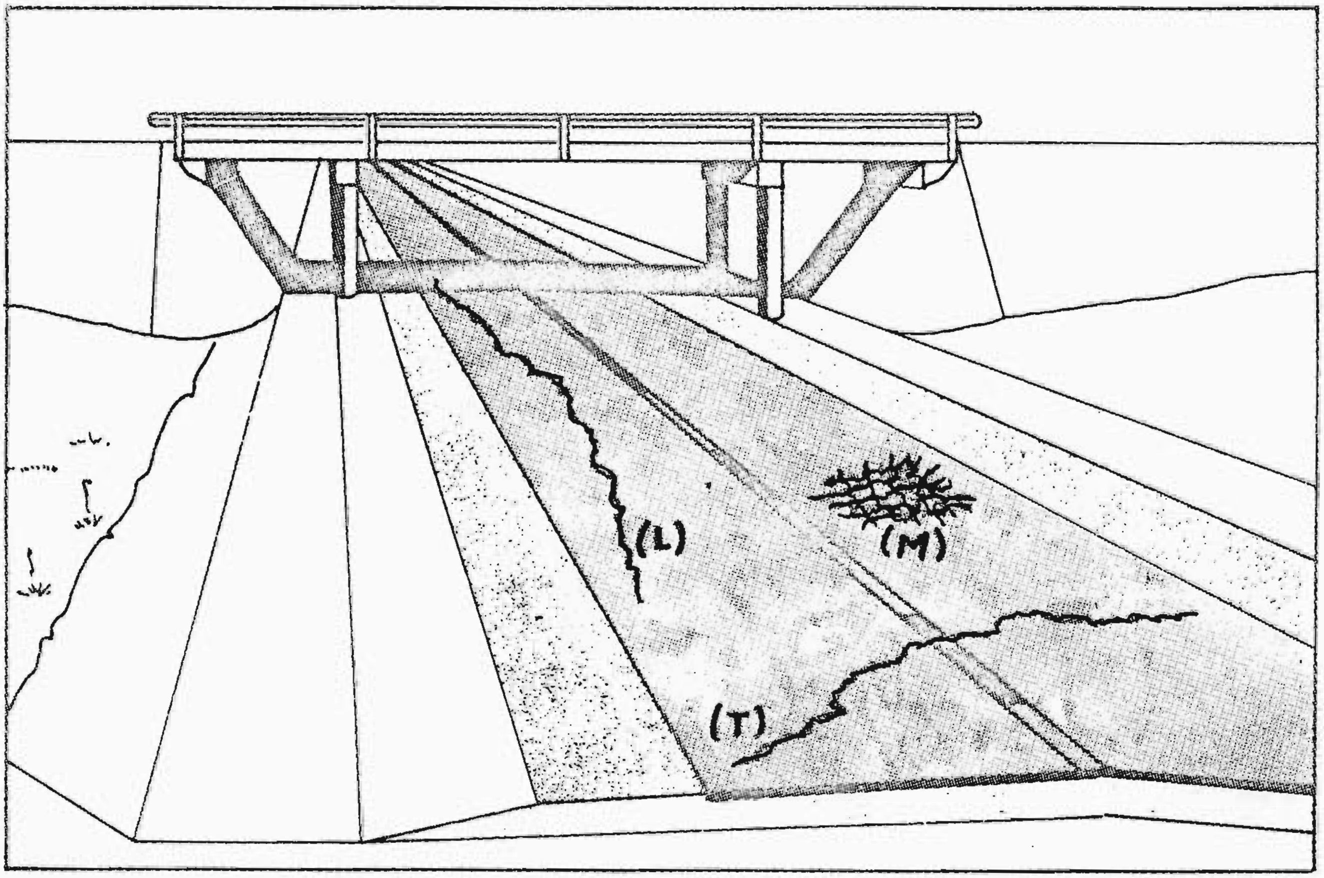
(4) The lift expectancy of the facility is good and compares favorably with other designs usually costing much more.

ACKNOWLEDGMENTS

The investigations described herein were conducted under the general direction of Mr. J. C. Roberts, District Eight Engineer, Texas Highway Department. The writer wishes to acknowledge the help and cooperation of the many engineers as these investigations were carried out. Special acknowledgment is due Walter Plumlee who was active in the field.

Asphaltic - Concrete

Pavement Failure Patterns



L1, L2, L3 Longitudinal Cracking Pattern

T1, T2, T3 Transverse cracking Pattern

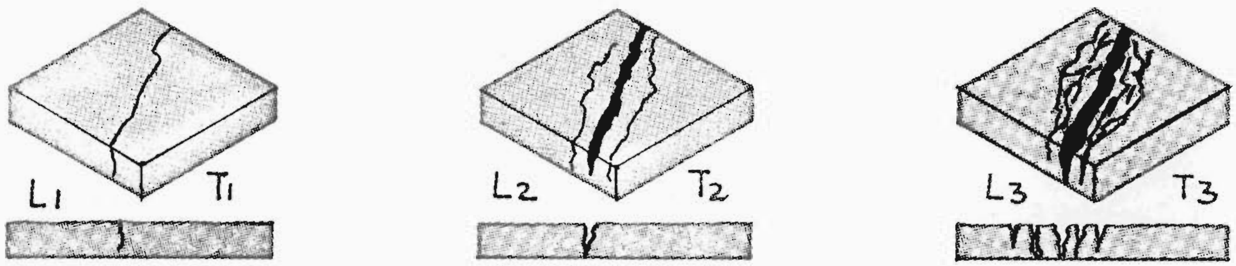
M1, M2, M3 Map Cracking Pattern

(NOTE: 1, 2, or 3 DENOTES VARYING DEGREE OF DISTRESS)

FIGURE 27

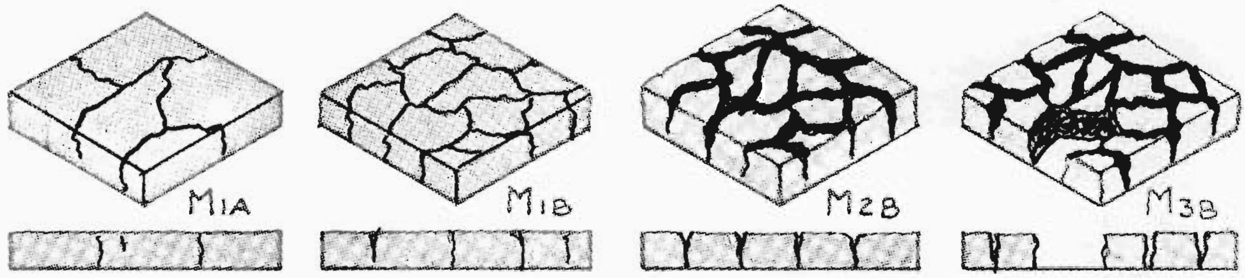
Asphaltic - Concrete
Pavement Failure Nomenclature

Longitudinal & Transverse Cracking Pattern

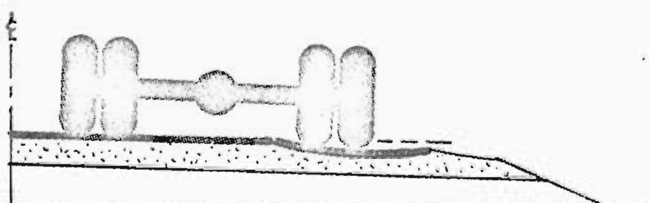


L1 , T1	Slight	Hairline Cracks
L2 , T2	Moderate	Cracks beginning to Spall
L3, T3	Severe	Disintegration of Material

Map Cracking Pattern



M1A	Very Slight	Hairline cracks not visibly connected
M1B	Slight	Hairline cracks visibly connected
M2A	Slight to Moderate	Cracks beginning to spall at intersections
M2B	Moderate	Cracks with considerable spalling
M3A	Severe	Chunks of A-C Loose but held in place
M3B	Very Severe	Chunks of A-C disintegrating & Crumbling away.



Pavement Deflection Marked on Plan by Symbol (A)

FIGURE 28