SALVAGING OLD PAVEMENTS BY RESURFACING

By

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Two methods of salvaging old concrete pavement by resurfacing were compared to new construction on a section of highway built by District Eight of the Texas Highway Department. The purpose of this project was to determine the best method of rehabilitating an old section of highway containing concrete pavement.

Photographic documentation and certain data were accumulated on such items as construction costs, maintenance costs, and pavement serviceability.

It is believed that salvaging an old concrete pavement by breaking it up and resurfacing it is justifiable. This is true because a safe and satisfying ride results, the initial costs are reasonable, and the life expectancy compares favorably with other designs usually costing much more.

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. These data are compiled on a section of US 83 in Taylor County from its junction with US 84, then west for a distance of approximately two miles.

The highway was originally built with portland cement 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 83 from its junction with US 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. E. L. Harris was the project engineer and Cooper and Woodruff, Inc. of Amarillo 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 project was completed. The study portion consisted of 11,100 ft beginning at Station 1237+00 and ending at Station 1348+00 and included the following types of construction.

1. Design No. 1 consisted of 3,200 ft of concrete pavement originally 18 ft wide. It was widened 8 ft on each side with 10 in. of flexible base and overlaid with 2 in. of Type D hot mix asphaltic concrete (HMAC). (See typical section No. 1 of Figure 1.)

Figures 2 and 3 show the original pavement condition before overlay of HMAC surface.

2. Design No. 2 consisted of 4,500 ft of concrete pavement broken up and overlaid with 4 in. of foundation course, 10 in. of flexible base. It was surfaced with 1¼ in. of Type D HMAC. (See typical section No. 2 of Figure 1.)

Figures 4 and 5 show the condition of the concrete pavement prior to construction.

3. Design No. 3 consisted of 3,400 ft of new construction. This required removing the old concrete pavement from the job and preparing the old subgrade for cover with 10 in. of flexible base and 1¼ in. of HMAC. (See typical section No. 3 of Figure 1.)

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

The old concrete pavement of typical section No. 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.

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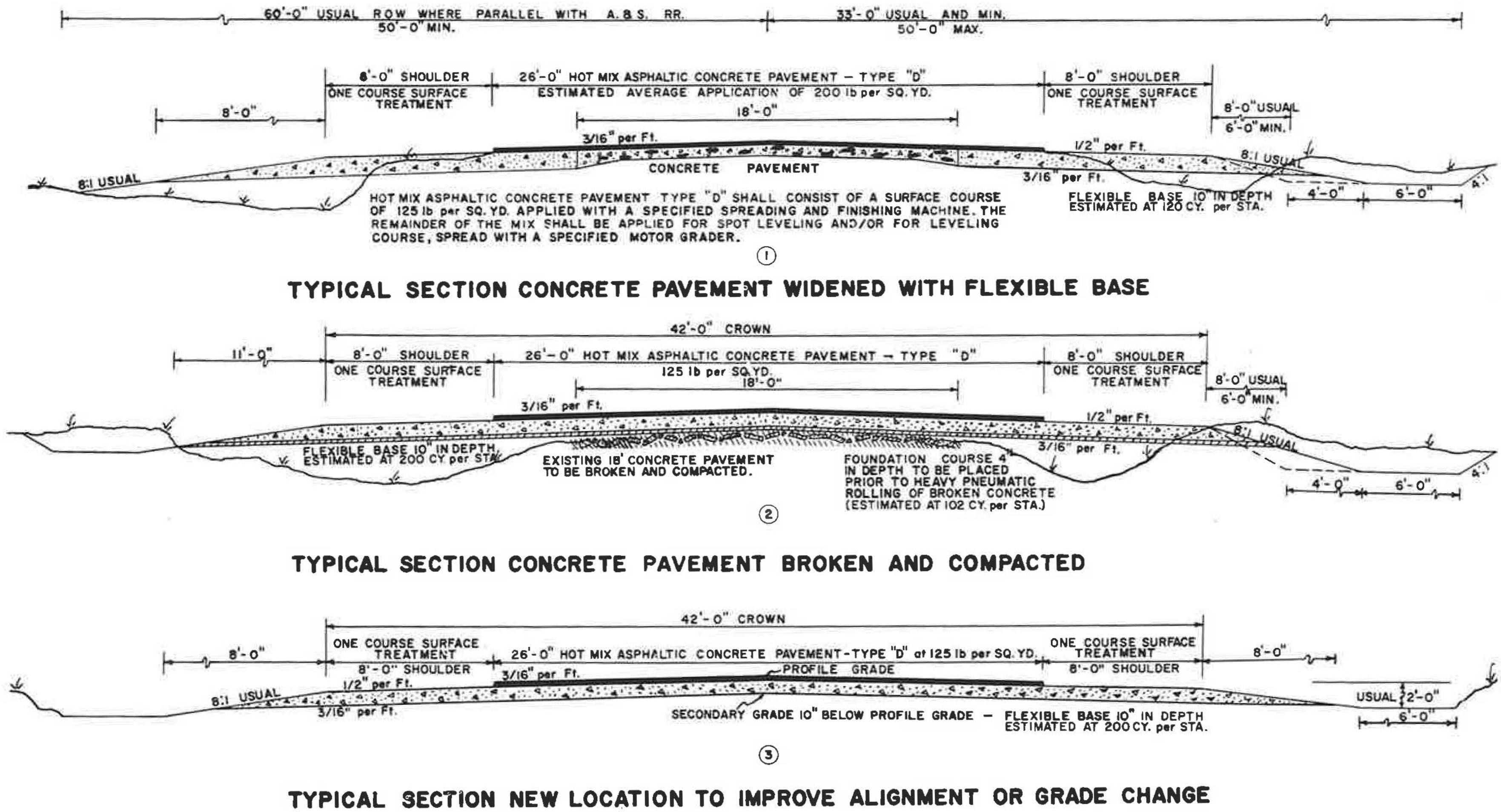


Figure 1. Typical section sheet for highway research project.

Figure 2. Original pavement condition before overlay of HMAC surface.

Figure 3. Original pavement condition before overlay of HMAC surface.

Figure 4. Original pavement condition before it was broken up and recompacted.

Figure 5. Original pavement condition before it was broken up and recompacted.

The contractor used two types of machinery for breaking up the old concrete (Fig. 6).

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 Fig. 7):

HEAVY PNEUMATIC ROLLING

Equipment: Heavy Penumatic 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 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 rolling 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.

The foundation course material was placed on the broken concrete pavement prior to heavy pneumatic rolling. It was pit run and contained large chunks of loosely cemented material. These were broken up by use of a heavy grid roller. Only 35 percent was retained on a 40 mesh sieve (Fig. 8). Thus, the chunks of broken concrete were easily surrounded (Fig. 9).

The heavy pneumatic rolling proved useful because it showed flaws in the seating of the old concrete pavement. Figures 10 and 11 indicate improper seating. These places were reworked to the satisfaction of the engineer before subsequent construction was performed. Figure 12 shows a section of the completed highway.

The first section to show signs of distress was that of section No. 1. Cracks began to show at joints of the old concrete pavement.

These cracks began to show (Fig. 13) within three months after job completion. Crack sealing operations were started (Fig. 14) on this section in January 1958. Figures 15, 16, and 17 show how one particular failure had progressed through March 1959, and Figure 18 shows the general condition of typical section No. 1 in April 1961.

Figure 6. Machinery used in breaking up and compacting old concrete.

Figure 7. Machinery used in breaking up and compacting old concrete.

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

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

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								Sieve Numbers							Grain Diam. In Millimeters			Spec. Grav.	Material
	3	2½	2	1½	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				

Figure 8. Soils and base materials work sheet.

Figure 9. Grid roller used in the compaction process.

Figure 10. A condition indicating improper seating was found here.

Figure 11. A condition indicating improper seating was found here.

Figure 12. A section of completed highway.

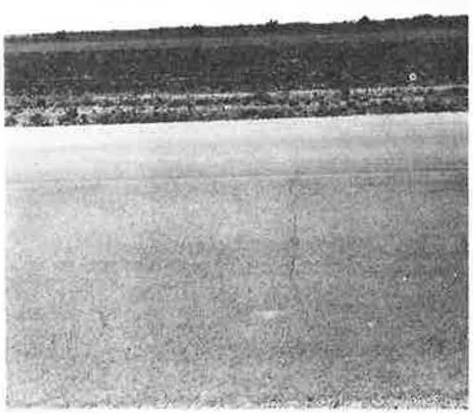


Figure 13. First signs of distress on design section No. 1.

Figure 14. Crack sealing operations in progress.

Figure 15. Progression of a particular cracking pattern through March 1959.

Figure 16. Progression of a particular cracking pattern through March 1959.

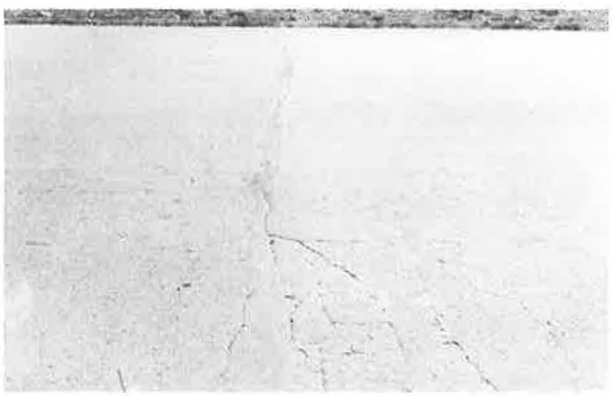


Figure 17. Progression of a particular cracking pattern through March 1959.

Figure 18. Progression of a particular cracking pattern through March 1959.

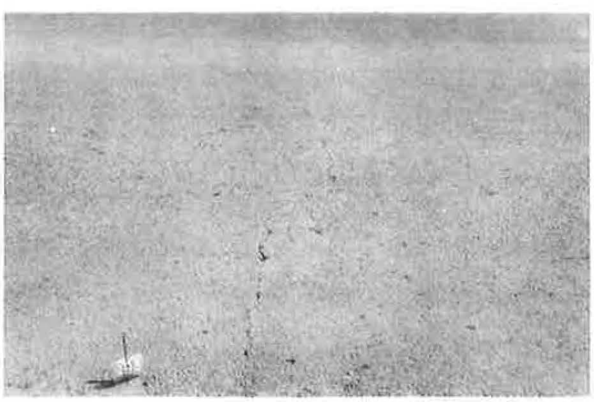


Figure 19. First sign of distress on design section No. 3.

Figure 20. A typical failure pattern on design section No. 3, in 1961.

Figure 21. The general condition of design section No. 3 in 1961.

Figure 22. A typical failure pattern on design section No. 2 in 1959.

Figure 23. An isolated condition of design section No. 2 in 1964.

Figure 24. A typical failure condition showing distress of design section No. 2 in 1964.

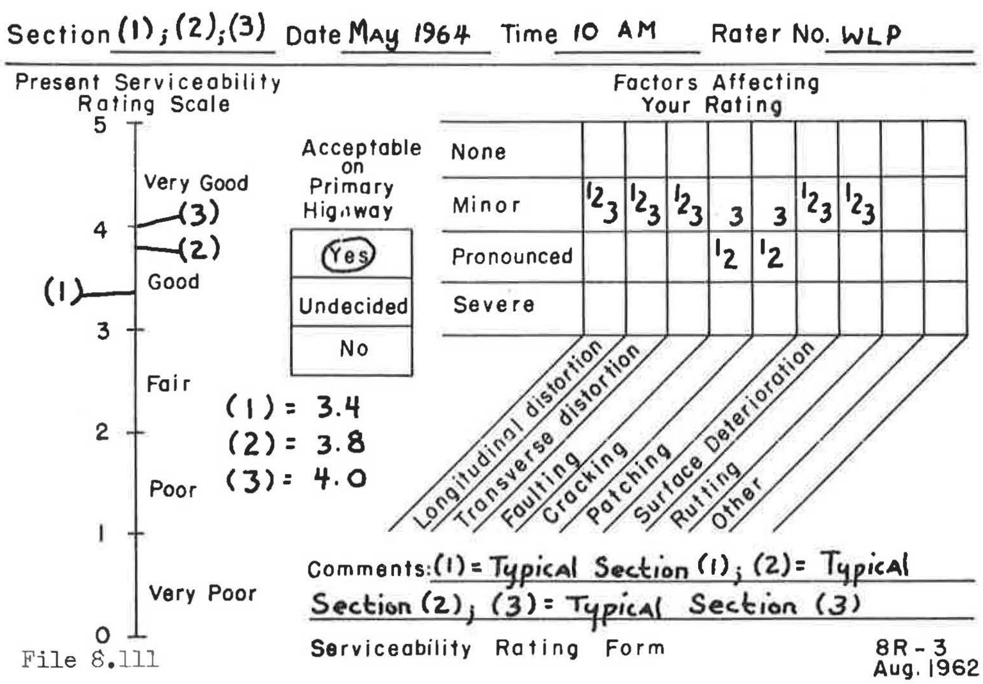


Figure 25. Serviceability rating form used in rating the project.

TABLE 1

HIGHWAY FAILURE HISTORY

Year	Design No. 1	Design No. 2	Design No. 3
	T L M	T L M	T L 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 L1 M2B	T2 L1 M2B	T2 L2 M2B

Note: Refer to Figures 27 and 28 for explanation of symbols T, L and M.

TABLE 2

CONSTRUCTION COST INDEX

Typical Section	Description	Cost per Mile
No. 1	HMAC overlay	$20,500
No. 2	Broken concrete	$30,880
No. 3	New structure	$37,880

TABLE 3

MAINTENANCE COST INDEX

Typical Section	Description	Cost per Mile
No. 1	HMAC overlay	$840
No. 2	Broken concrete	$420
No. 3	New structure	$280

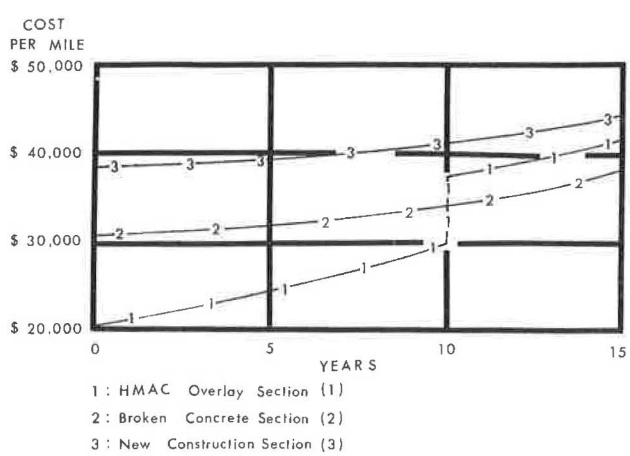


Figure 26. Total cost of construction and maintenance projected to 15 years.

The second section to show signs of distress was that of section No. 3. Figure 19 shows the type of distress first noticed in March 1959. This condition progressed to that shown in Figure 20 by April 1961; and Figure 21 shows the general condition of this section in April 1961.

The section of highway represented by typical section No. 2 had begun showing signs of distress by March 1959 (Fig. 22). By April 1961, the general condition of this section was good with the exception of one particular failure shown in Figure 23. It is believed that this failure resulted from faulty structure support. Comparison should be made between Figures 5, 10, and 23.

Figure 24 shows a typical failure prior to seal coat application 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 application of the seal coat.

The serviceability rating form (Fig. 25) shows the rating or each section in 1964 before the seal coat was applied.

Table 1 gives the history of cracking for the most severe failures of each section. Table 2 gives the base and surfacing construction cost of this facility. Table 3 gives the average maintenance cost index per mile per year for maintaining this facility during the past seven years since construction.

Figure 26 shows the relationship indicating total cost of construction and maintenance for the three sections projected to a 15-yr life. After 10 years it would be advisable to spend an estimated $8,000 per mile on the HMAC pavement overlay section No. 1 for level up and surface course of asphaltic concrete. The same would be true for the other two sections after 15 or 20 years.

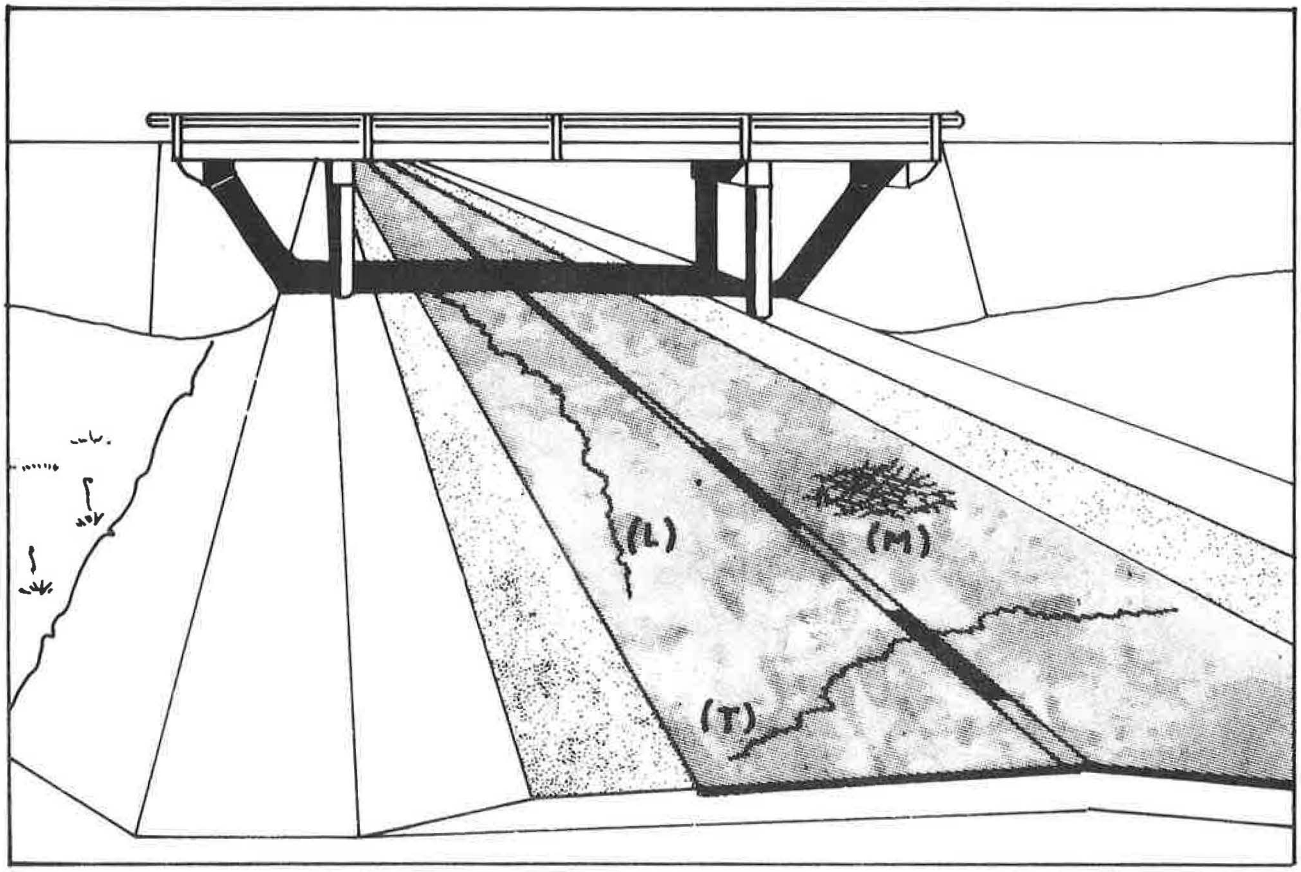
SUMMARY

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

1. 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.

2. The cost of construction did vary considerably. Section No. 1, which was overlaid with HMAC pavement, cost about two-thirds as much as the section where concrete was broken up and resurfaced. The HMAC pavement overlay cost just over one-half as much as the new structure.

3. 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



L_1, L_2, L_3 Longitudinal Cracking Pattern

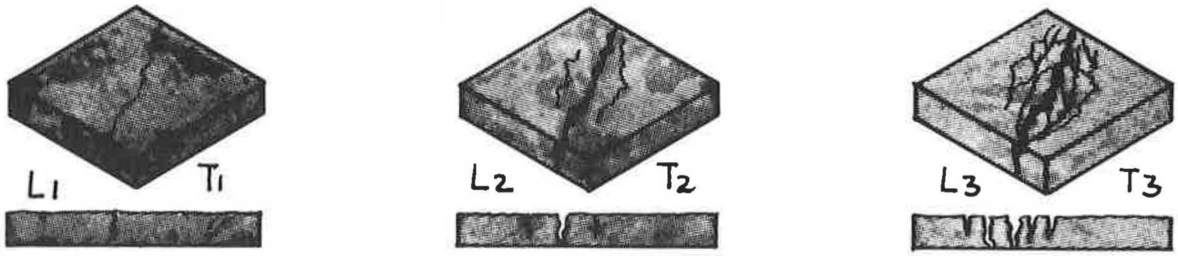
T_1, T_2, T_3 Transverse cracking Pattern

M_1, M_2, M_3 Map Cracking Pattern

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

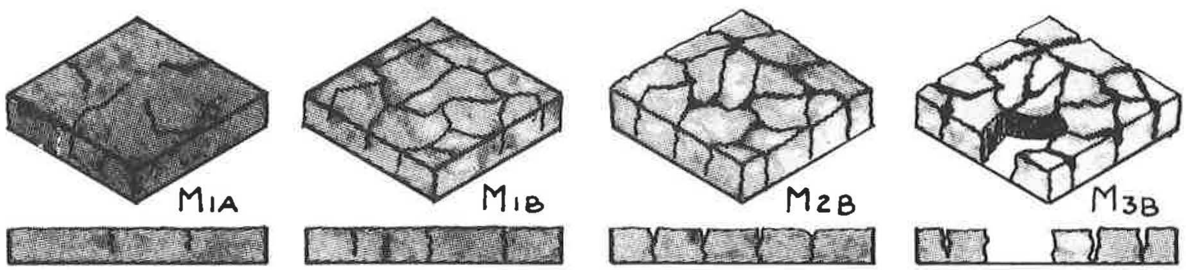
Figure 27. A pavement failure pattern guide.

Longitudinal & Transverse Cracking Pattern

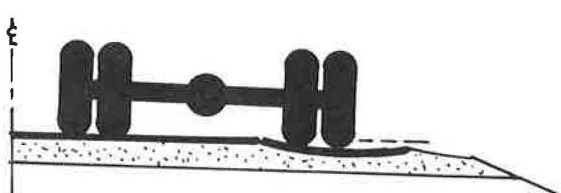


L1 , T1	Slight	Hairline Cracks
L2 , T2	Moderate	Cracks beginning to Spall
L3, T3	Severe	Disintegration of Material

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. A pavement failure nomenclature guide.

into the following pattern. The new structure, section No. 3, has required least maintenance. The broken concrete, section No. 2, has required about 160 percent more maintenance than the new structure. The one that was overlaid with HMAC pavement has required approximately 300 percent more maintenance than the new structure.

Two other projects in this area, US 380 in Stonewall County and Route 351 in Taylor County, have been constructed using the same design as that of section No. 2 where the old concrete pavement was broken up and strengthened with new base material. The construction and maintenance costs of these projects parallel those of this report. Finally, salvaging an old concrete pavement by breaking it up and resurfacing it as in design No. 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 life expectancy of the facility is good and compares favorably with other designs usually costing much more.

ACKNOWLEDGMENTS

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