

MICHIGAN DEPARTMENT OF TRANSPORTATION
M•DOT
EVALUATION OF TENSAR BITUMINOUS
PAVEMENT REINFORCEMENT
Final Report

J. H. DeFoe

Research Laboratory Section
Materials and Technology Division
Research Project 84 NM-718
Research Report No. R-1307

Michigan Transportation Commission
William C. Marshall, Chairman;
Rodger D. Young, Vice-Chairman;
Hannes Meyers, Jr., Shirley E. Zeller,
Stephen Adamini, Nansi I. Rowe
James P. Pitz, Director
Lansing, October 1990

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OFFICE MEMORANDUM

DATE: January 23, 1991

TO: Recipients of MDOT Research Report No. R-1307

FROM: J. H. DeFoe

SUBJECT: Revision of Recommendations Presented in Research Report R-1307

Please be informed that the recommendations contained in Research Report R-1307 have been changed and should read as follows:

Recommendations

Based on the results of this field trial, further use of Tensar should not be considered. The saw-crack-seal method was also not effective on this project.

Joint repair, such as the conventional full-depth (MDOT Detail 8) used on sections of this job, is the only method that can be recommended on the basis of this evaluation.

This change has been made at the request of the Engineering Operations Committee as a result of their January 8, 1991 meeting.

MATERIALS AND TECHNOLOGY DIVISION

A handwritten signature in cursive script, appearing to read "J. H. DeFoe", written over a horizontal line.

Assistant Supervising Engineer
Soils, Bituminous & Pavement Performance Unit

JHD:pc

cc: J. D. Culp
J. W. Reincke
W. J. MacCreery
D. E. Orne
R. A. Welke
H. L. Wong
C. Roberts

D. T. Vandenberg
G. D. Taylor
M. E. Witteveen
L. K. Heinig
District Engineers
FHWA

ACTION PLAN

1. Committee for the Investigation of New Materials
 - A. The Committee for the Investigation of New Materials should send a letter to the manufacturer and suppliers of this material, Tensar, stating that it will not be considered for further use by MDOT.

2. Materials and Technology Division
 - A. The Research Laboratory Section will terminate this research project (84 NM-718) via a memo to the project file along with distribution of this report to the Committee for the Investigation of New Materials, Design Division, and the districts.

3. Engineering Operations Committee
 - A. No action necessary upon approval of this report.

SUMMARY

'Tensor,' a high tensile strength geogrid material for reinforcing bituminous pavements was evaluated as a bituminous overlay reinforcement in Lenawee County on M 50, which was rehabilitated in 1985. The rehabilitation also included several miles of pavement which were cracked and sealed after sawing to sever the reinforcing steel just prior to overlaying (saw-crack-seal method). Five different methods of preparation for the overlay were used on the 5.4-mile section of highway. The methods were saw-crack-seal without joint repair, joint repair only, joint repair with saw-crack-seal and Tensor reinforcement, joint repair with Tensor reinforcement, and joint repair with saw-crack-seal.

Tensor reduced reflective cracking more than any other treatment but was one of the least cost effective methods. Heaved joints in the saw-crack-seal areas create a roughness which was not present in the other sections where joint repairs were made. The most cost effective measure was the conventional joint repair treatment (MDOT Detail 8) which was second to Tensor in reducing reflective cracking. Reflective cracks in most sections have not started to break off at the edges. The exceptions to this, however, are at the reflected and heaved joints in the saw-crack-seal areas where chunks of bituminous material are loosened and frequently missing due to snow plow and other traffic action.

INTRODUCTION

'Tensor' is a high tensile strength geogrid material made for reinforcing bituminous pavements, and was submitted to the Department's Committee for the Investigation of New Materials in 1984 for evaluation by the Research Laboratory. It is a proprietary product of the Tensor Corp., Morrow, Georgia. A review of the properties of Tensor indicated sufficient potential for success and this field trial was recommended.

Intent of Study

This study was conducted to show whether or not the Tensor reinforcing would reduce reflective cracking and the severity of accompanying pavement deterioration. The elimination or significant reduction in the amount of reflective cracking in bituminous overlays on portland cement concrete pavements could prolong the service life of overlays by several years. Further, if the severity of deterioration at a reflective crack could be reduced, this would greatly prolong the service life of the overlay.

Method

Tensor geogrid material was installed on a 2000-ft test section for performance comparison with a similar control section receiving a conventional asphalt overlay. Tensor was placed full width, covering both 12-ft lanes of the roadway. Since cracking and sealing of the existing pavement

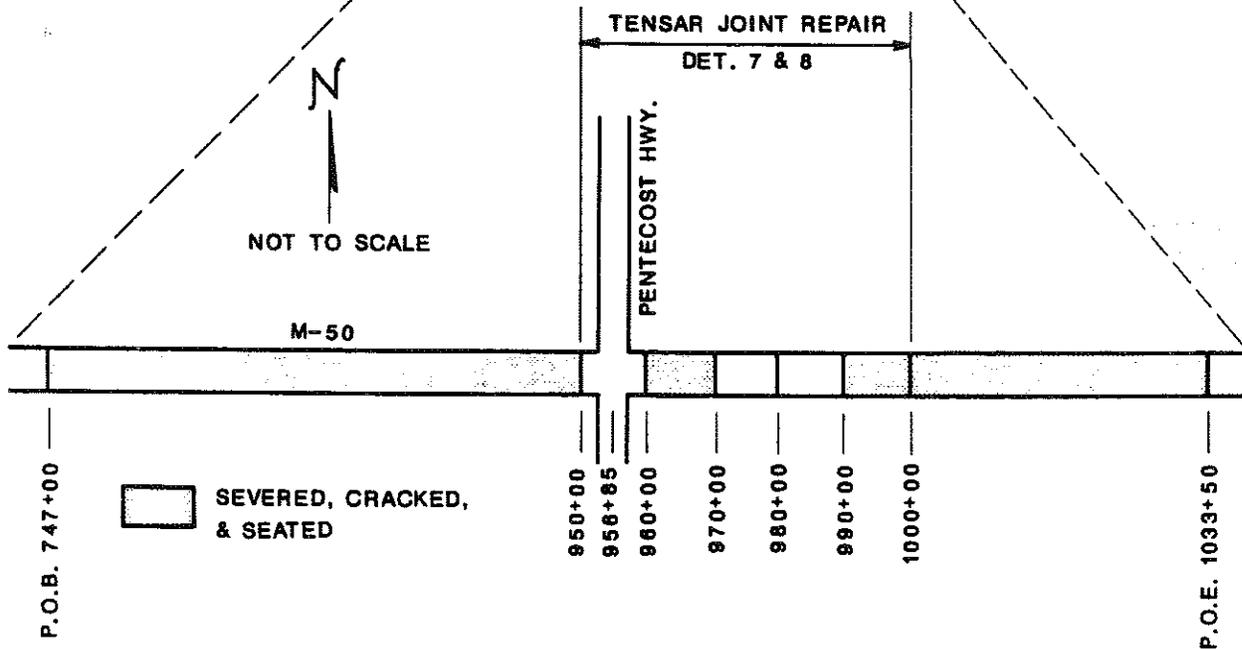
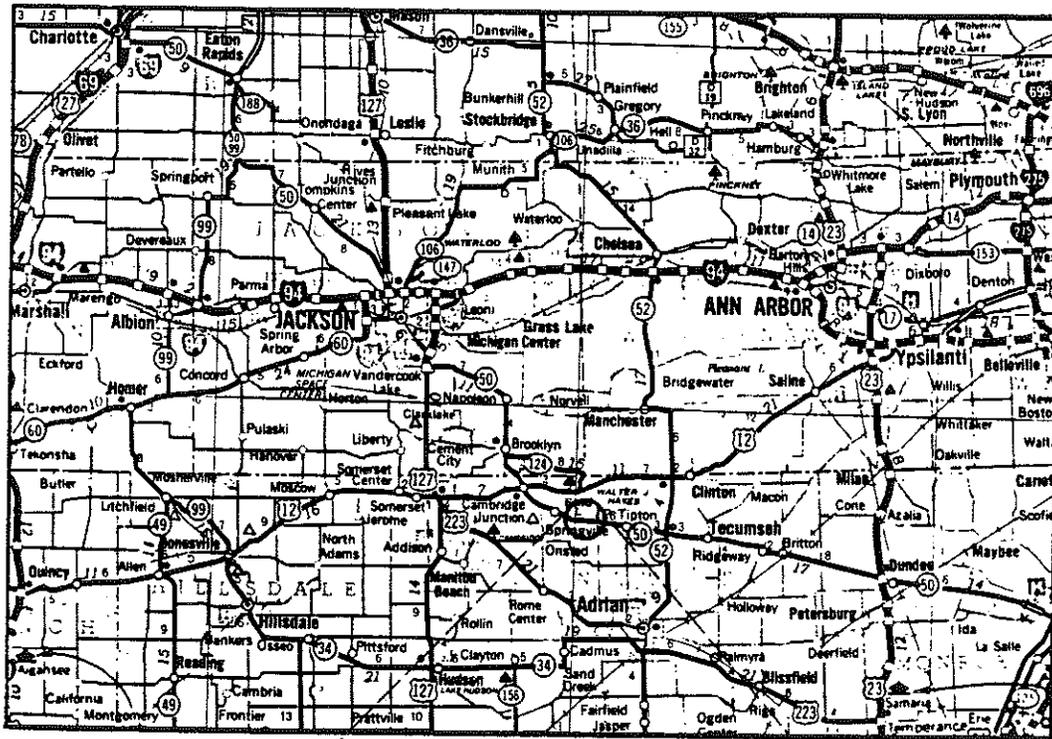


Figure 1. Tensar and other test sections on M 50.

were already planned for this construction project, one half of each of the sections of concrete pavement (Tensar and control) was cracked and seated while the other half was simply overlaid. Preconstruction surveys were made to map all cracks and joints and their physical condition was noted.

RESEARCH PROCEDURE

A 5.4-mile rehabilitation project on M 50 in Lenawee County (FRR 46081-19183A) was selected for the evaluation of Tensar geogrid. The planned rehabilitation for this project was completed in 1985. It involved the cracking of the old portland cement concrete pavement into 2 to 3-ft square pieces, then seating the cracked pavement with a 50-ton roller. The cracking and seating were preceded by sawing each of the 99-ft slabs into five equal length sections. Saw cuts were 5-1/2 in. deep to sever the reinforcing steel. A 3000-ft section of this project was selected for placement of Tensar along with a comparative control section. An additional 2000 ft was prepared for another type of geogrid which was withdrawn from the project at the manufacturer's request. Figure 1 shows the location of the Tensar along with the other treatments used on the 5.4-mile project. Altogether there were five different rehabilitation treatments used on this project, even though the main objective of the study was to evaluate the performance of the Tensar material. The five methods of preparation were:

- 1) Saw-crack-seat (no joint repair).
- 2) Joint repair only (MDOT Detail 8, full depth).
- 3) Joint repair, saw-crack-seat, and Tensar.
- 4) Joint repair and Tensar.
- 5) Joint repair and saw-crack-seat.

A condition survey, including crack mapping, was conducted on the old pavement prior to resurfacing as a basis for comparing the effectiveness of the different treatments in retarding reflective cracking. Crack surveys were also made periodically to monitor the relative performance throughout the evaluation. Crack Index (CI)* values for the several treatments are given in the tables below.

The relative effectiveness of the five rehabilitation treatments are compared in Figure 2. As can be seen from the data in Table 1 and Figure 2, none of the treatments completely eliminated reflective cracking. Tensar, however, was more effective than other treatments in delaying reflective crack propagation with the next best treatment being the conventional (MDOT Detail 8) joint repairs. The relative effectiveness of

*Cracking index (CI) is determined by counting the number of full-width (two lane) transverse cracks plus 1/2 the one-lane transverse cracks, in a 500-ft section of pavement.

TABLE 1
HISTORY OF REFLECTIVE CRACKING, M 50

Treatment	Pre-Const.	Cracking Index						46 Mo. % of Pre-Const.
		Service Life, Months						
		8	15	25	33	46		
Saw-Crack-Seat	32.3	6.8	8.0	10.6	14.2	18.3	56.6	
Joint Repair	31.8	9.6	10.0	11.2	13.3	13.6	42.8	
Tensar/Joint Repair/ Saw-Crack-Seat	27.8	0	0	6.0	7.5	9.8	35.2	
Tensar/Joint Repair	37.3	4.0	4.5	7.3	9.5	13.2	35.4	
Joint Repair/ Saw-Crack-Seat	30.0	7.8	9.0	14.0	17.8	20.8	69.3	

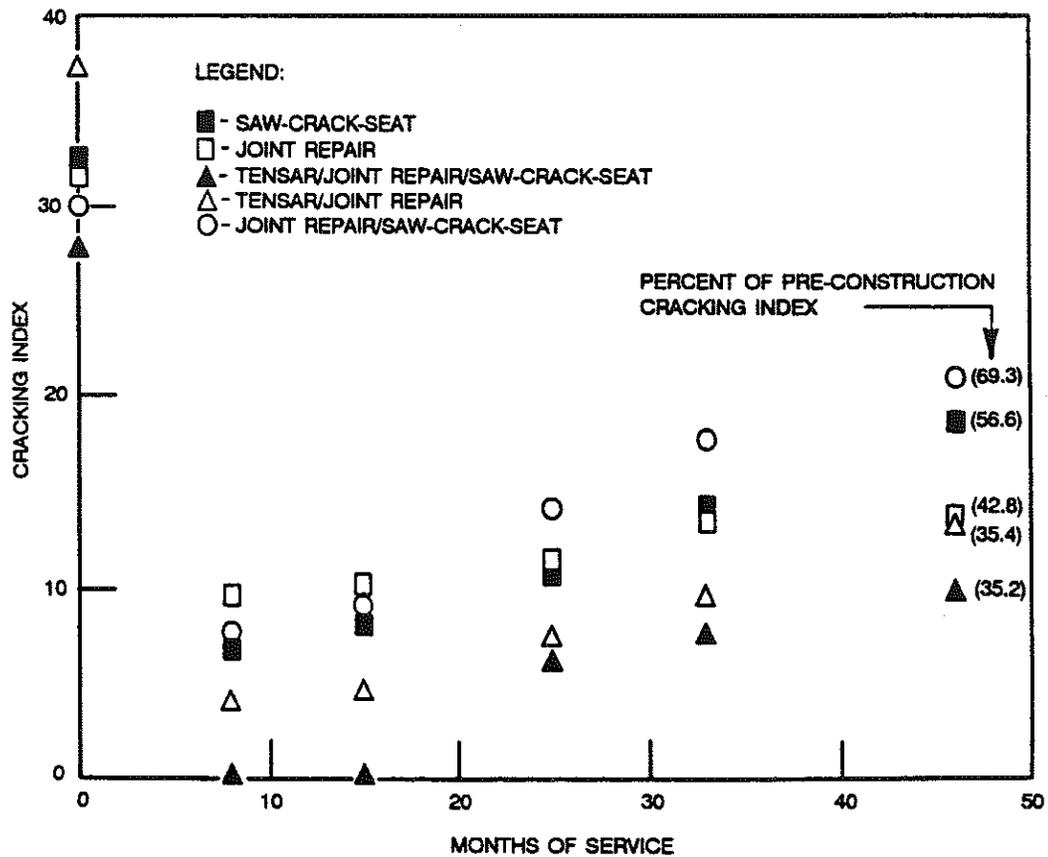


Figure 2. Relative effectiveness of various treatments to prevent reflective cracking.

Relative Effectiveness

The relative effectiveness of the several treatments is presented in Table 3 which shows reflective cracking after 46 months of service along with the cost per square yard of the rehabilitation methods. Cost effectiveness can be compared by considering the ratio of unit cost to the percentage of reflective cracks which were prevented (using the preconstruction CI for each section as a base). This effectiveness ratio is the last column in Table 3 and shows that joint repairs, prior to overlayment, are the most cost effective, i.e., having the lowest cost effectiveness ratio. Saw-crack-seat would be the second most effective according to this criterion; however, the roughness of each 99-ft joint makes this undesirable. Also, the number of transverse cracks has been increased by a factor of four, greatly increasing the potential for future surface disintegration.

TABLE 3
EFFECTIVENESS OF THE REHABILITATION METHODS

Treatment (Including 330#/sy bit)	Unit Cost ¹ \$/sy	C I (% of Pre-Const)	Cost Effectiveness	
			Ratio ²	Ranking
Saw-Crack-Seat	4.59	56.6	10.58	2
Joint Repair	4.36	42.8	7.62	1 best
Tensar/Joint Repair/ Saw-Crack-Seat	8.41	35.2	12.99	4
Tensar/Joint Repair	7.78	35.4	12.04	3
Joint Repair/ Saw-Crack-Seat	4.99	69.3	16.25	5 worst

¹Including cost of 330#/sy bituminous surfacing at \$3.97/sy.

²Cost effectiveness ratio = $\text{Unit Cost} \div \left[1 - \frac{\text{C I (\% of Pre-Const)}}{100} \right]$

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Tensar reduced reflective cracking more than any other treatment but was one of the least cost effective methods. Heaved joints in the saw-crack-seat areas create a roughness which was not present in the other sections where joint repairs were made.

Tensar and joint repair were as effective as Tensar, joint repair, and saw-crack-seat in the reduction of reflective cracking.

The most cost effective measure was the conventional joint repair treatment (MDOT Detail 8) which was second to Tensar in reducing reflective cracking.



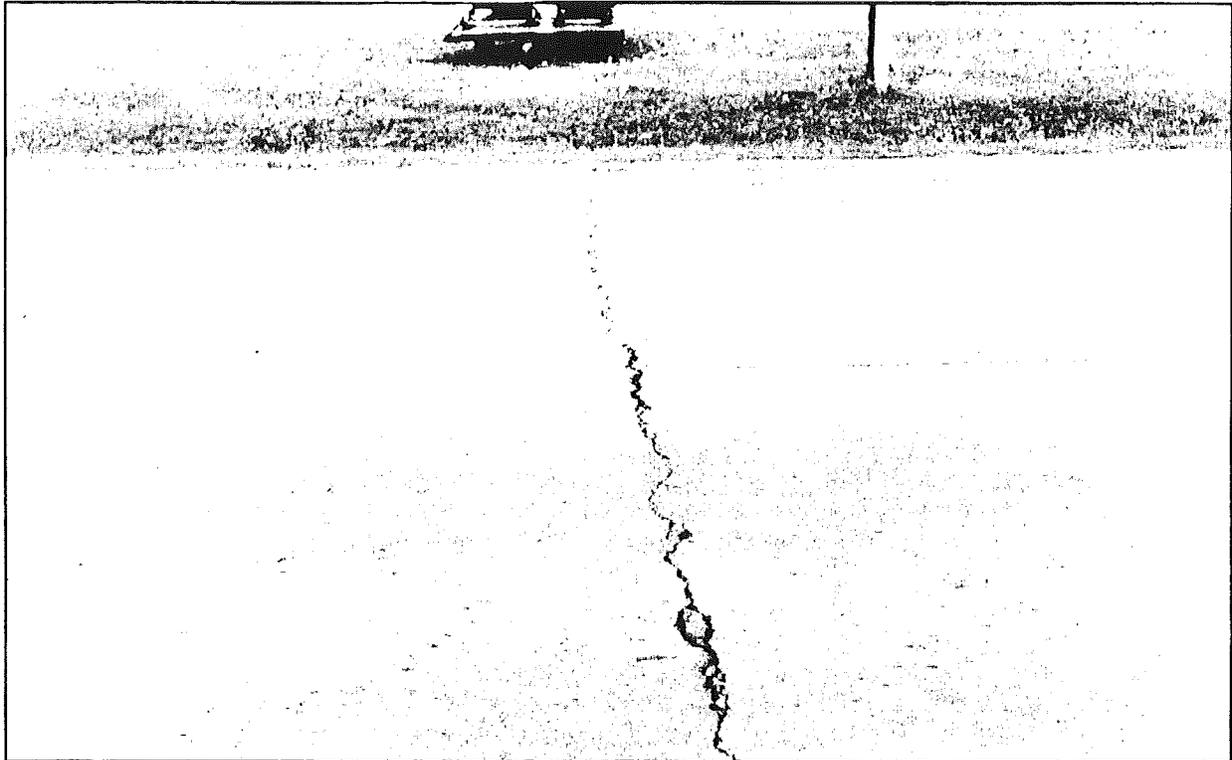
Reflection cracks at saw cut and old joint typical of the saw-crack-seat treatment.

Reflection cracks at Detail 8 joint repair in control section.



Reflection cracks at joint repair in a saw-crack-seat section.

Figure 4. Typical condition of pavement sections after four years of service.



Reflection crack over joint in Tensar treated saw-crack-seat section.



Reflection cracks in Tensar treated section.

Figure 3. Condition of Tensar test sections after four years of service.

the treatments is shown in the last column of Table 1 where the CI after 46 months is expressed as a percentage of the CI which existed on the old roadway prior to reconstruction. Tensar sections reflected 35 percent of the original transverse cracks and joints whereas the saw-crack-seat treatment resulted in 57 percent, with 69 percent when joints had also been repaired. The increased percentage associated with joint repair is due to the fact that the one original joint is replaced by two after being repaired.

It is important to note that CI values measured before rehabilitation ranged from 27.8 to 32.3 (Table 1) which shows that the several test sections were quite similar prior to this evaluation.

The condition of the reflected joints and cracks is as important as crack reflection itself. Each joint in the saw-crack-seat portions of the project not only reflected through the new overlay but also heaved and formed a bump over each old joint at 99-ft intervals, resulting in an extremely rough ride.

Figures 3 and 4 show typical reflective cracking in the several comparative situations on this project after five years of service. The upper photo in Figure 3 shows a typical reflection crack in the portion of the Tensar section which had been sawn, cracked, and seated; the lower photo depicts one of several reflection cracks in the non-cracked-and-seated portion of the Tensar section.

Typical reflection cracks occurring in the non-Tensar stretches of the project are illustrated in Figure 4. The upper photo shows a typical joint which is badly heaved (center of picture) along with one of the four cracks that occur in each slab over the saw cuts. The middle and lower photos show the cracking that developed at the conventional (MDOT Detail 8) joint repairs. Of the distresses shown in Figures 3 and 4, only the heaved joints are severe enough to cause serious ride discomfort. The height of the heaved joints averaged 1/2 in. and, occurring every 99 ft, caused a very rough ride. Measurements of the height of the heaved joints are summarized in Table 2.

TABLE 2
HEAVING OF JOINTS IN THE SAW, CRACK, AND SEAT SECTIONS

Direction	Joint Heave, In.					
	Inner Wheel Path		Center of Lane		Outer Wheel Path	
	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
Eastbound	0.41	0.09	0.52	0.11	0.52	0.14
Westbound	0.52	0.12	0.55	0.08	0.53	0.15

Individual measurements (144 in all) ranged from 0.27 in. to 1.01 in. with an overall average of 0.51 in.

Joint repairs should be made prior to overlayment to eliminate the roughness due to heaving at the old joints.

Reflective cracks in all sections have not yet started to break-off at the edges. The exceptions to this, however, are the reflected and heaved joints in the saw-crack-seat areas where chunks of bituminous material are loosened and frequently missing due to snow plow and other traffic action.

Recommendations

Based on the results of this field trial, further use of Tensar should not be considered. The saw-crack-seat method is also not effective and its use should not be continued.

Joint repair, such as the conventional full depth (MDOT Detail 8) used on sections of this job, is the only method that can be recommended on the basis of this evaluation.