December 24, 1952

TO: W. W. McLaughlin
Testing and Research Engineer

SUBJECT: Joint Failures on Construction Project 63-37, C4,
M-59 between US-24 and Auburn Heights
Research Project 39 F-7(14) - Report 185

Early in 1951 serious concrete failure was observed at several joints on Project 63-37, C4, located on M-59 between US-24 and Auburn Heights. At your suggestion, a complete condition survey was made in the same year.

Nothing conclusive as to the cause of these failures could be learned from the usual observations or field survey, so it was decided to open a joint to determine the condition of the dowels. This was done on October 23, 1952, in the presence of C. B. Laird, LeRoy Oehler, and the writer. Pictures showing the condition of the expansion joint at Station 56+27, which was opened, are attached.

The examination disclosed the following facts:

1. The metal expansion chamber caps were not installed on the dowel bars as required; therefore, the compressive force shattered the concrete and bent the dowel bars.

2. The alignment of the dowel bars was very bad in the vertical as well as the horizontal plane.

3. The dowel bar assembly on the west-bound lane was placed higher than the assembly on the east-bound lane. Consequently, the top of the dowels in the west lane averaged two and one-fourth inches from the surface at the joint. Due to vertical misalignment, the end of one bar was 3/4 inch from the surface. The positioning of the dowels was better in the east lane; the average distance to the top of the dowels was approximately three inches at the joint.

4. The dowel bars were badly rusted and pitted in the vicinity of the expansion joint filler. The reduction in dowel diameter due to rusting was approximately nine percent for the five-year life of the project.

In addition to pavement failure at Station 56+27, discussed above, major pavement failures have occurred at joints located at Stations 25+00, 31+06 and 45+10. These joints were dug out and repaired by Oakland County maintenance forces during the summer of 1952. Consequently, we have been unable to obtain any factual evidence as to what might have caused failure at these three joints. Since the pavement on this project was poured between May 27 and June 16, 1947, we can only assume that these joints were contraction joints, in which case some factor other than the omission of dowel caps would be the cause of failure.

On November 5, 1952, a careful physical examination of all remaining joints on the project (62 in number, exclusive of the four failed joints) was made by W. C. Broughton to determine the presence or absence of expansion joint filler material. This was accomplished by probing each joint with a metal bar.

Only one expansion joint was found among the 62 joints examined, and that was at Station 18+68. This particular joint is one of a series of three joints spaced at 20-foot intervals on the east side of a bridge structure located at Station 17+60. In this series of three joints, placed as common practice to relieve expansion forces, two were constructed as contraction joints and one as an expansion joint. Three similar joints on the west side of the same bridge structure were all constructed as contraction joints.

A review of core length data as shown in the attached table reveals that 25 percent of the pavement was constructed between 7 and 7-1/2 inches in thickness, 50 percent between 7-1/2 and 8 inches, and 25 percent 8 inches or better; or in other words, 75 percent of the pavement was constructed less than the required thickness of 8 inches. The average thickness for the project was 7.77 inches. From this fact we may conclude that in a large number of instances the tops of the dowel bars would be unusually close to the surface, perhaps only 2.25 inches in certain cases. Under normal circumstances this distance should be 3.5 inches.

Traffic conditions on this project are also significant. Included in the large volume of commercial vehicles there is a high concentration of trucks hauling gravel from local pits and from Oxford to Pontiac and Detroit by Route M-59. Data from a 24-hour traffic classification count made in May, 1952, are as follows:

	Passenger, Panel and Pickup	General Commercial Heavy Vehicles	Gravel Trucks	Total Trucks	Total Vehicles
E. lane	4589	551	143	694	5283
W. lane	4430	467	98	565	4995
Total	9019	1018	241	1259	10,278

The above daily truck count on this road is comparable to that of US-16 which had a volume of 1279 units in the Fowlerville area in 1951.

It is reasonable to assume from the facts presented above that early failure of the pavement at certain contraction joints may be due to abnormally high positioning of the dowel bars, resulting from the pavement thickness being less than the design thickness, enhanced by the frequency of heavy axle loadings. A possible gross misalignment of individual dowels, as experienced at the expansion joint opened at Station 56+27, could also be a material aid in hastending cracking and spalling of the concrete in conjunction with the other conditions mentioned.

When weather conditions in the spring permit, we propose to pursue this study further by opening certain contraction joints which are beginning to show stress.

E. A. Finney
Ass't Testing and Research Engr.
in charge of Research

EAF:mw

TABLE I

Summary of Core Length Data

No.	Station	Actual Depth of Core, in.	Compressive Strength of Core, psi.	Joints Failed and Removed as of 10/23/52
42	14+22	8.13	6085	
56	18+99	8.03	5970	
43	23+20	7.87	4980	
				25+00
55	29+73	8.18	4560	
				31+00
54	33+76	7.77	4690	
44	36+24	8.03	5875	
53	44+28	7.68	5780	
				45+10
49	47+22	7.63	4800	
48	47+42	7.00	5760	
46	47+62	7.23	5295	
45	47+72	7.30	4925	
47	47+82	7.56	5370	
				56+27 Expansion
52	56+45	7.51	4765	
50	58+32	7.51	5230	
61	61+64	7.82	5940	
57	62+15	7.75	4650	
60	63+25	8.20	5715	
51	64+20	7.77	5340	
58	65+07	7.59	5605	
59	65+50	7.84	5380	
		Ave. 7.77	Ave. 5345	

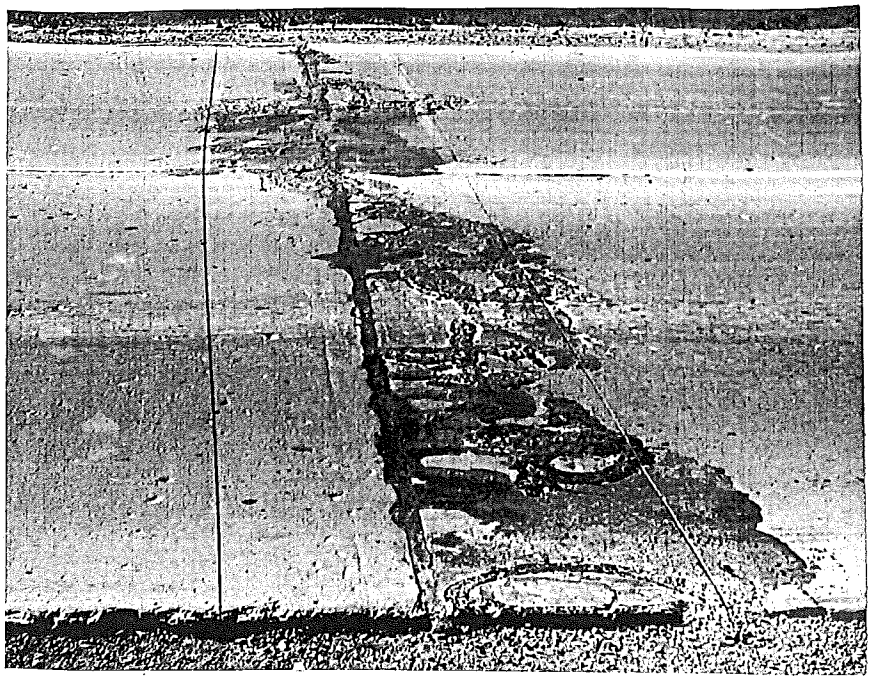

Figure 1. Showing condition of expansion joint before opening.
Sta. 56+27

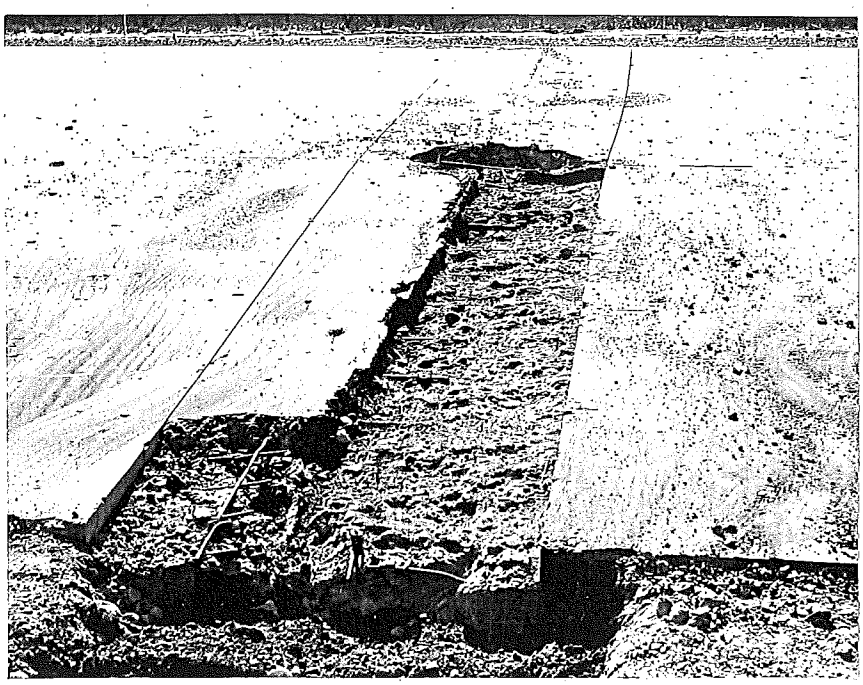

Figure 2. Same joint with spalled concrete partially removed, showing dowels.

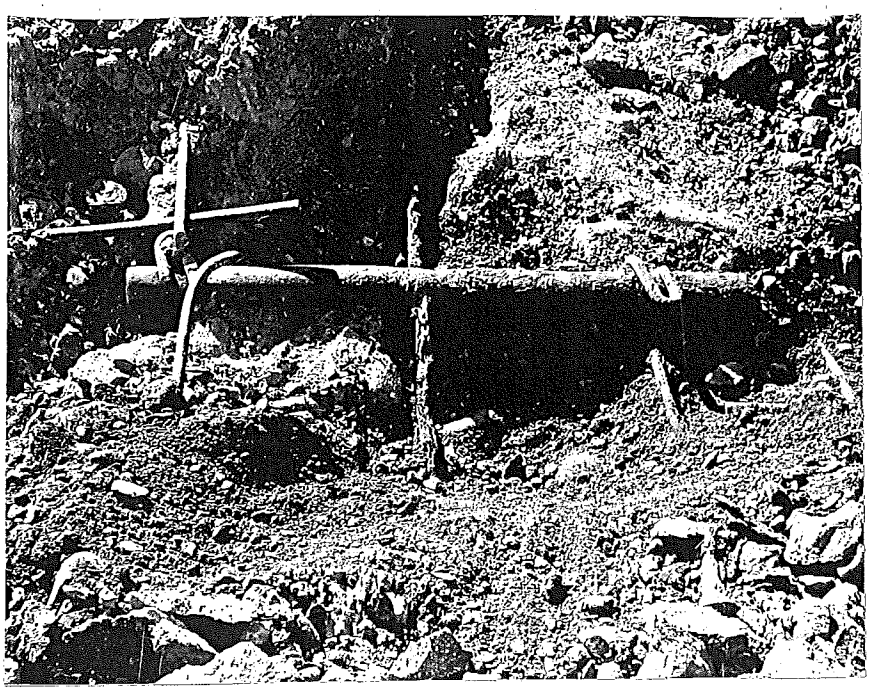

Figure 3. View showing typical condition of dowels - rusted, no caps, and kinked due to excessive compressive forces.

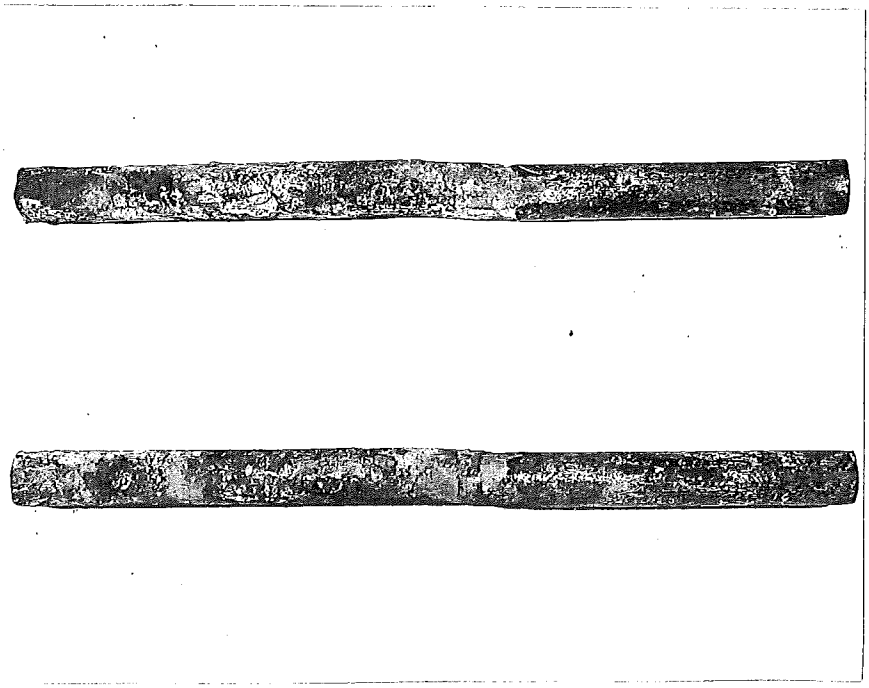

Figure 4. View of two different dowels showing physical condition and kink at center due to compressive forces.

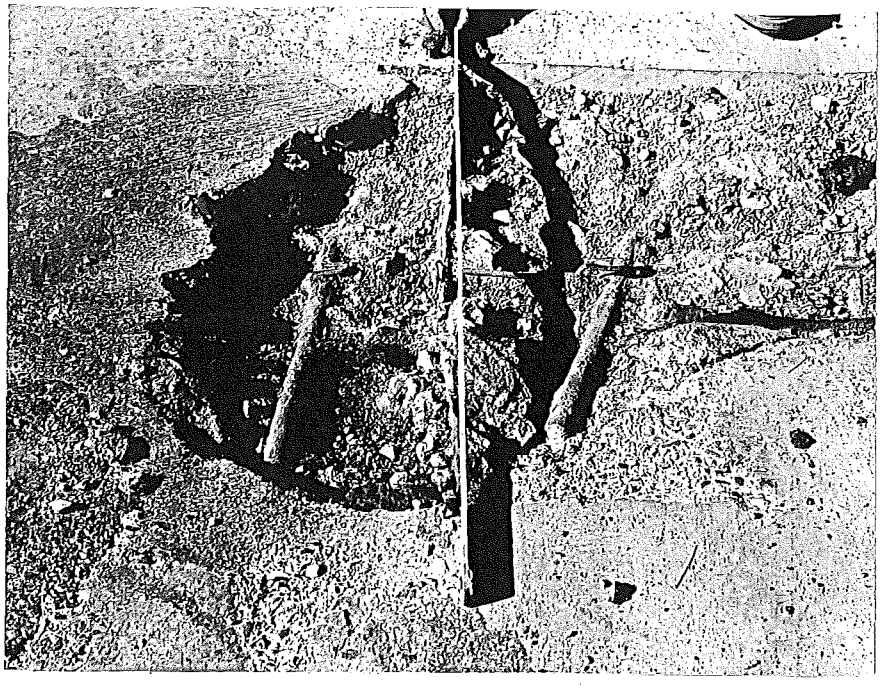

Figure 5. View showing horizontal misalignment of two dowels next to center joint.

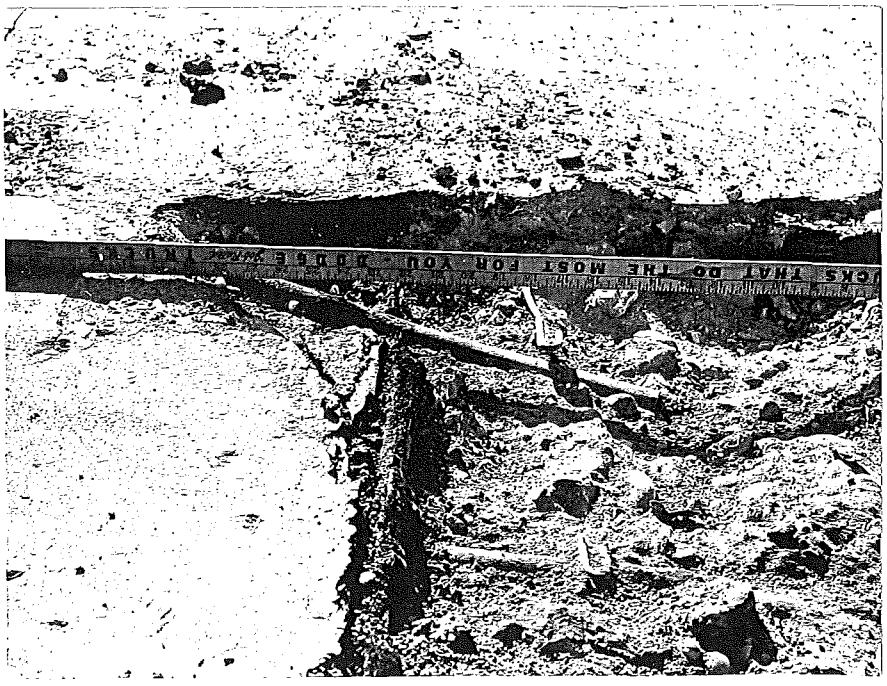

Figure 6. Side view of Fig. 5, showing misalignment in vertical direction and dowel slipped out of clip.