

OFFICE MEMORANDUM



MICHIGAN

STATE HIGHWAY DEPARTMENT

July 22, 1965

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To: G. R. Cudney, Supervisor
Physical Research Section

From: J. E. Simonsen

Subject: Joint Failures on Eastbound I 94 Parma to Jackson (Construction Project 38-48, C9). Research Project 39 F-7(14). Research Report No. R-536.

At your request, I 94 joint failures near Parma were inspected June 10, 1965. This portion of the eastbound roadway was constructed during August and September 1953 and was used for two-way traffic until construction of the west-bound roadway in 1956. The eastbound roadway consists of 9-in. uniform thickness, 24-ft, reinforced concrete slabs, with transverse joints spaced at 99 ft. The load transfer assemblies contain 1-in. diam, 15-in. long bars, spaced at 12-in. centers. A 16-gage metal base plate, 11-1/4 in. wide with a 1/8 by 1 in. parting strip, was installed at the transverse contraction joints. The joint grooves were constructed to the conventional 1/2 by 2 in. dimensions, except from Stas. 540+75 to 605+75 where the grooves were sawed to depths less than 2 in. (under Research Project 51 F-21).

A total of three joint failures were inspected at Stas. 316+40 and 327+03 just west of Parma, and at Sta. 606+75 west of the off-ramp to the rest area. The failure at Sta. 316+40 involved both lanes and had occurred at 3 p.m. on the day of the inspection. The failures at the other two locations had occurred the day before and were confined to the passing lane. At these latter two locations, the traffic lane also had failed the previous year and had been repaired with bituminous material.

A common characteristic of the blow-ups is the shear and tensile failure of the concrete as a result of buckling of the slab at the reduced section below the bottom of the joint groove and above the top of the dowel bar. The failure plane originates at about the level of the dowel and extends from 1 to 8 ft back from the joint. Fig. 1 shows the failure condition at Sta. 316+40, and illustrates the limits of the failure plane at Sta. 327+03.

Observation of the repair at Sta. 327+03 revealed that the dowel bars were out of alignment both laterally and vertically, and that the joint groove was not constructed symmetrically over the base plate parting strip (Fig. 2). The

concrete below the dowel bars was moisture-saturated and completely deteriorated. The area of deterioration is shown photographically and schematically in Fig. 2. The repair crew stated that this condition had been observed for several previously repaired joint failures. This was also probably the case at Stas. 316+40 and 605+75.

A general inspection of pavement in the vicinity of these three failures showed that joint widths ranged from 3/4 up to 1 in. , although the air temperature was above 80 F. A typical joint groove is illustrated in Fig. 3. As can be seen, the seal is ineffective in sealing against moisture and dirt infiltration. During winter ice and snow removal, joint seals in this condition offer little resistance to seepage of chloride solution into the joint. A count of repaired joint failures on the western 3.5 miles of the project revealed that 9.5 percent of the joints had been completely repaired in at least one lane and 2.5 percent extensively patched.

Blow-ups and other evidence of poor joint performance on this project may result from one or more of several causes. Over several years, dirt has infiltrated progressively into the joints preventing joint closure during pavement expansion cycles. In addition to this normal infiltration, water and chloride solution resulting from ice and snow removal has seeped into the joints and could have been trapped by the base plate. Alternate freezing and thawing coupled with the detrimental effect of chloride solution on concrete may have accelerated deterioration of the concrete below the dowel bars. As a result, compressive forces--caused by restraint to concrete expansion resulting from moisture and temperature--are greatly increased, at the same time the concrete area resisting these forces is decreased about 60 percent.

The slab's bottom half is deteriorated and a plane of incomplete bond exists at the level of the reinforcement between lifts. Consequently the critical compressive buckling strength of the remaining section of concrete, due to eccentric loading, is exceeded and failure occurs.

The probability of a particular joint's failing is somewhat increased by misalignment of the various joint components, coupled with concrete pouring at low temperatures without providing expansion joints. For example, the failures at Stas. 316+40 and 327+03 occurred in sections poured September 22-23, when the mean 24-hr air temperatures were 50 and 54 F, respectively; yet, no expansion joints were installed.

G. R. Cudney

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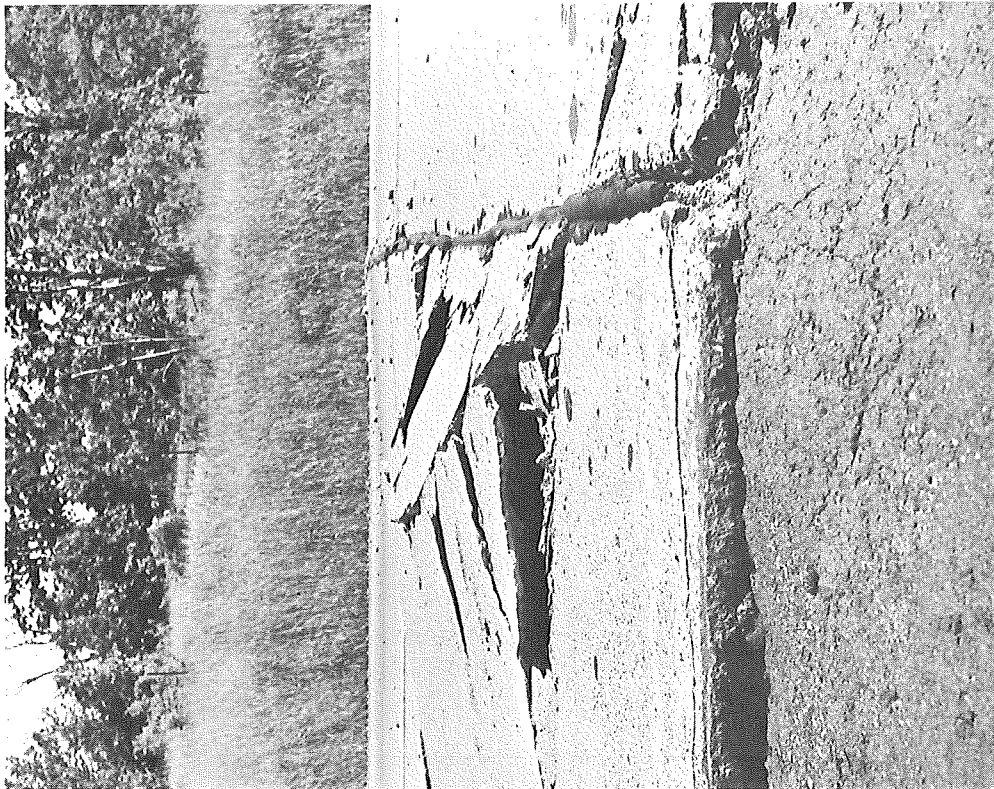
The performance history on this project is not good. The record shows 13 blow-ups, 2467 transverse cracks in the traffic lane, and 1884 in passing lane. Possible effects of materials are being investigated in relation to this poor record.

OFFICE OF TESTING AND RESEARCH

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Sta. 316+40 EB



Sta. 327+03 EB

Figure 1. Appearance of one joint immediate after blowup (left), and limits of horizontal failure plane during repair at another (right).

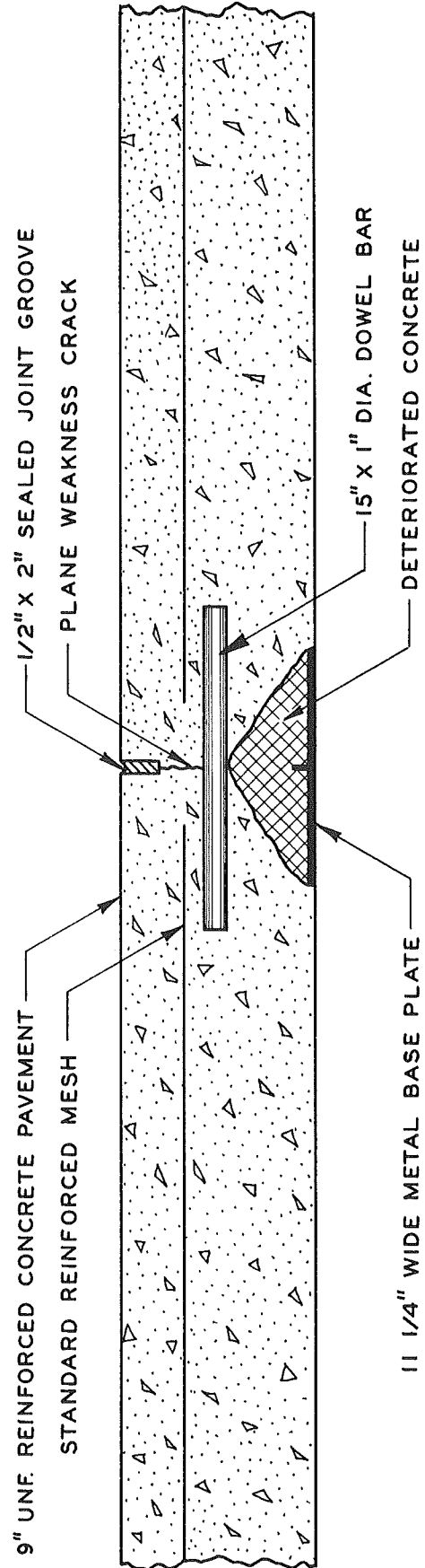
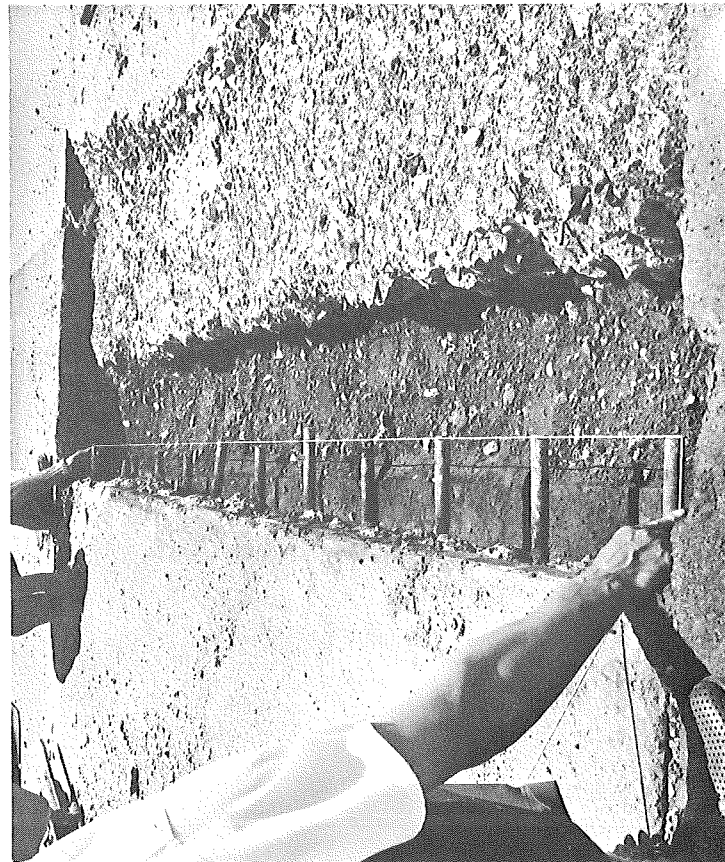


Figure 2. At Sta. 327+03 EB, dowel and joint groove misalignment observed during repair (upper left), concrete deterioration found below dowel bars (upper right), and schematic cross-section of deterioration (below).



Figure 3. Typical joint width and sealant condition.