

OFFICE MEMORANDUM



MICHIGAN
STATE HIGHWAY DEPARTMENT

June 25, 1965

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To: W. W. McLaughlin
Testing & Research Engineer

From: E. A. Finney

Subject: Survey of I 94 Bridge Crossing Clinton River Cutoff Canal (B01 of 50111).
Research Project 65 B-78. Research Report No. R-520R.

In accord with your recent request, the I 94 Clinton River Canal bridge was inspected by F. Copple and R. H. Merrill on April 28, 1965. This inspection was made to determine whether popouts and minor cracking noted in a 1963 inspection had become more pronounced after two years of service.

History

The deck was poured between April 16 and May 7, 1959, under the Department's 1957 Standard Specifications. Deck concrete was prepared using 6A coarse aggregate. Gravel test records during construction showed a grand average of deleterious material of about 6 percent (soft non-durable, chert, hard absorbent), with separate daily production values ranging to 9 percent, the maximum amount allowable. On three separate days of production the chert content exceeded the limit of 4 percent. The gravel was obtained from American Aggregates Oxford Pit (63-4).

Grand average air content of the deck concrete was about 5 percent, with daily average values ranging from 4.3 to 5.8 percent. Under 1957 specifications, 4 to 7 percent air was required; the current requirement is 5 to 8 percent. In 1959, the maximum size aggregate for 6A or 6B gravel was restricted to 95 to 100 percent passing the 1-1/2 in. sieve. The current limit for coarse aggregate (6AA) in bridge deck concrete is the same percentage passing the 1-in. sieve.

On March 6, 1963, F. E. Legg reported in a memo to W. W. McLaughlin that popouts and small cracks had appeared in the bridge deck, even though it had not been opened to traffic for four years. In response to Mr. Legg's memo, the bridge was inspected on March 28, 1963 by M. G. Brown and R. H. Merrill. They observed almost no cracking, but reported numerous popouts from chert and iron-bearing clay over the entire deck. In late 1963, the bridge was opened to traffic.

Inspection of April 28, 1965

Deck and median concrete surfaces exhibited numerous randomly scattered popouts (Figs. 1 and 2). The overall popout incidence was as great two years ago, before

the bridge was opened to traffic or had received applications of de-icing chemicals, as now. Further, popouts are as frequent on the surface of the easternmost lane (Fig. 3), which carries less traffic, as on the other six lane surfaces.

Fig. 4 shows the locations of 13 hairline cracks visible on the deck. Ten of these occurred on end spans, diagonally crossing the small tips formed by the acute angle of the skewed pours. This type of cracking has been noted frequently on skewed bridges and research by others has shown that it is generally associated with slab warping of these acute angle corners and subsequent resulting strains. Only one of these tip cracks was visible in 1963 (Fig. 5), at the north abutment line in one southbound lane. Fig. 6 shows the present appearance of the only full-lane-width transverse crack on the deck.

Discussion

Although hairline cracks and relatively large numbers of popouts affect the bridge's appearance, they apparently do not significantly influence its serviceability. The hairline cracks do not appear to have been caused by traffic loading, but may have become more prominent after two years of traffic action.

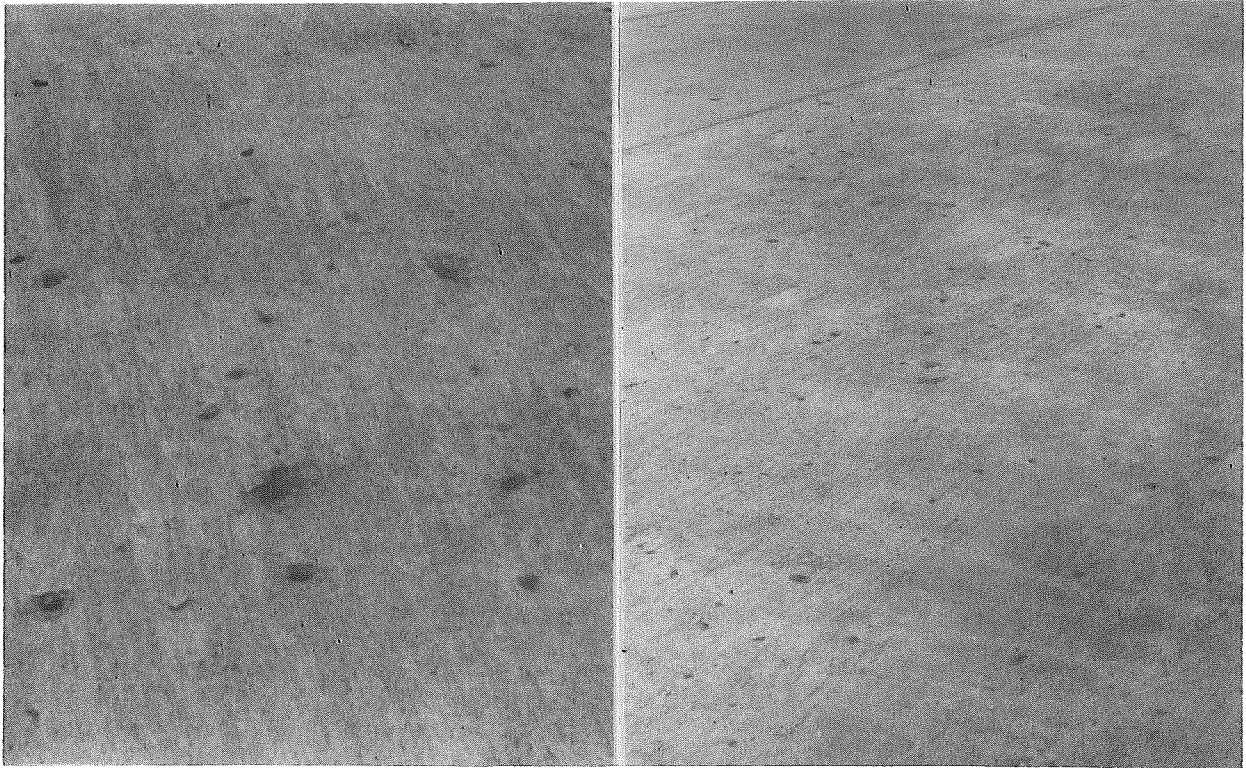
The frequency of popouts appeared to involve two factors: 1) a relatively large quantity of chert and iron-bearing clay in the coarse aggregate, and 2) use of 1-1/2 in. coarse aggregate in the mix. Since these deficiencies are not related to traffic, the popouts and hairline cracks would probably have occurred regardless of whether the bridge was open to traffic. The inspection of 1963 indicated that a majority of popouts had occurred in the first four years, without traffic or winter maintenance. Some cracks observed in 1965 may have been present in 1963, but in an incipient stage and not plainly visible. The large number of popouts is a good example of the need for using premium aggregate (6AA) in exposed structural concrete.

OFFICE OF TESTING AND RESEARCH



E. A. Finney, Director
Research Laboratory Division

EAF:FC:nl



March 1963

April 1965

Figure 1. Typical scattered popouts on roadway pavement, four years after construction but before opening to traffic (left) and after two years of service (right).



March 1963

April 1965

Figure 2. Typical scattered popouts on raised median.



April 1965

Figure 3. Looking south from bridge's easternmost lane, note alignment with shoulder on approach pavement, suggesting lighter traffic on this lane than the other six lanes. Incidence of popouts, however, is approximately the same.

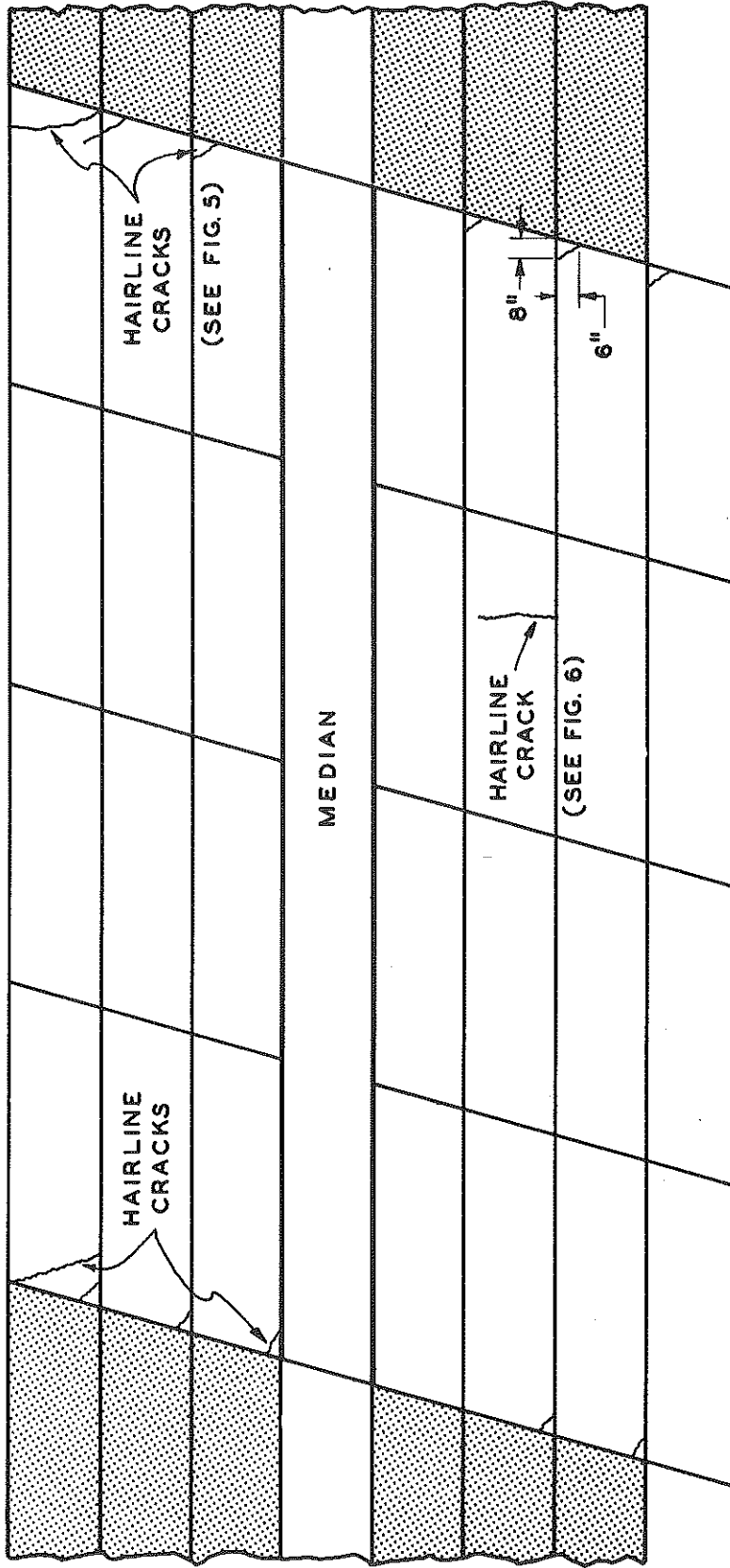


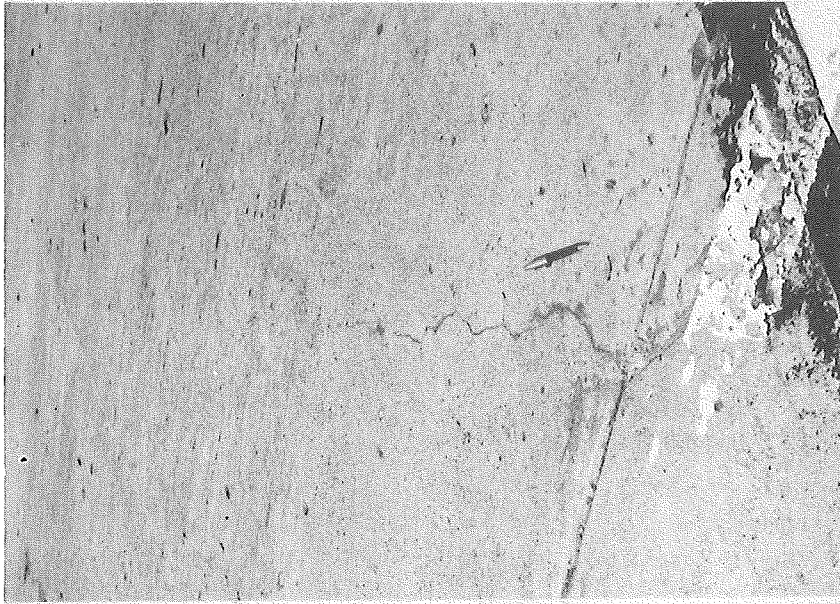
Figure 4. Deck plan showing crack locations.





March 1963

Figure 5. Typical short diagonal crack across tip of skewed pour (foreground), in this case continuing into adjacent pour where it appears longer and more prominent after opening to traffic (right).



April 1965



Figure 6 (right). Transverse crack in northbound roadway.

April 1965