R-607

DECK RIPPLING ON THE I 75-ROUGE RIVER BRIDGE (B01 of 82194G, C7)
Second Progress Report

L. T. Oehler
G. R. Cudney

Research Laboratory Division
Office of Testing and Research

Research Project 66 F-88
Research Report No. R-607

State of Michigan
Department of State Highways
Lansing, October 1966

INFORMATION RETRIEVAL DATA

REFERENCE: Oehler, L. T. and Cudney, G. R. "Deck Rippling on the I 75-Rouge River Bridge (B01 of 82194G, C7): Second Progress Report." Michigan Department of State Highways Research Report No. R-607. October 1966. Research Project 66 F-88.

ABSTRACT: Inspection of the Rouge River bridge deck and observation of pouring operations are reported. This phenomenon does not appear to be related to concrete slump. In its worst occurrence, amplitudes were up to 7/32 in., with wave length corresponding to bar spacing. Where rippling occurs, valleys appear over the bars immediately after finishing and grow larger and more noticeable with time.

KEY WORDS: bridge decks, finishing, construction equipment, construction operations, concrete bridge decks, concrete finishing, concrete placing.

DECK RIPPLING ON THE I 75 ROUGE RIVER BRIDGE (B01 of 82194G, C7)
Second Progress Report

At the request of W. W. McLaughlin, additional observations have been made concerning rippling of the deck surface on the Rouge River bridge. The first report on this subject was a memorandum from C. J. Arnold of the Research Laboratory to E. A. Finney dated July 18, 1966 (now designated the first progress report in this series). As a result of Bureau of Public Roads comments on the first report, Mr. McLaughlin requested on September 12 that this problem be reviewed further, that the finishing process be observed, and if possible that preventive measures be devised to remove or minimize the rippling phenomenon.

This report consists of observations made September 13, when G. R. Cudney and L. T. Oehler of the Research Laboratory visited the Rouge River bridge with F. E. Legg and R. H. Vogler of the Testing Laboratory, to discuss the problem with D. J. Hines, Resident Engineer.

Mr. Hines said the condition had been noted periodically in pours last year, confined chiefly to gutter areas of the deck. Various changes in construction procedures had been tried, but it appeared impossible to prevent this occurrence. He stated that the rippling did not seem to correlate with slump of concrete--that is, a concrete with a smaller slump did not reduce it.

The worst example is on the main span of the welded plate girder over the river on the southbound roadway (Fig. 1). On this span, the maximum amplitude measured was 7/32-in. The top transverse steel spacing is 6 in. in the negative moment areas over the longitudinal beams and 12 in. between beams. At these negative moment locations, it was possible to note the 6-in. wave length, just as in the positive moment areas, it was possible to observe the 12-in. wave length. Previous observations confirmed that the valley generally coincides with the position of the top transverse reinforcing bar.

A slight crack was noted in the valley of one of the ripples (Fig. 2), leading to more extensive examination of other rippled areas on this deck. Some additional light cracking was found although it was not yet too prevalent on this span.

Placing and finishing were observed on a small pour about 20-ft long which was under construction that day. State personnel said there had been some rippling of the surface of this pour. It appeared to be much smaller in amplitude, however, than on the southbound roadway's main span. The concrete was being placed by a concrete bucket lifted by a crane from the ground to the bridge deck. No vibration of the deck as a whole was experienced while operations were being observed (generally one can feel small vibrations but tends to exaggerate their magnitude). The reinforcing steel was checked during the longitudinal sawing action of the longitudinal finishing machine but no vibration or movement could be detected, even when the finishing machine was within about 4 ft of the point of observation on the bar.

During the finishing process and longitudinal oscillation of the finishing machine, a cable running transversely and used to change the lateral position of the finishing machine oscillated back and forth through the concrete. This was noted to cause local segregation and deposition of a fluid, plastic, water-mortar component around the cable (Fig. 3). It was thought that perhaps the action of the longitudinal finishing equipment, which displaces the surface concrete several inches during the screeding process, might have a similar effect adjacent to the bar, which in this case was stationary while the concrete moved. However, removing the concrete to the bar indicated no more water or cement paste adjacent to the bar than in areas between bars. Measurement of steel depth from the preceding pour in the northbound roadway indicated concrete cover adjacent to this pour exceeded 2 in. over the transverse steel.

From previous discussions, it was gathered that these ripples occur and are first observed several hours after finishing. However, our observations indicated that small valleys were apparent over the bar immediately after the passage of the finishing equipment (Fig. 4). In certain circumstances they may become larger and more noticeable after a few hours.

During the site visit, rippled surfaces of other bridge decks were mentioned. As a result, on the way back to Lansing, the observation party stopped at the Telegraph Road bridge over I 696, where the concrete deck had been completed two days before with a longitudinal finishing machine. Membrane curing compound had already been placed over the surface, making it more difficult to detect rippling, but by close observation it was noted that several areas of the deck had small amplitude ripples (Fig. 5).

The foregoing remarks are supplemented by an additional study by C. J. Arnold presented in the third progress report on this project, published as Research Report R-608 and entitled "Deck Rippling on Various Michigan Bridges."

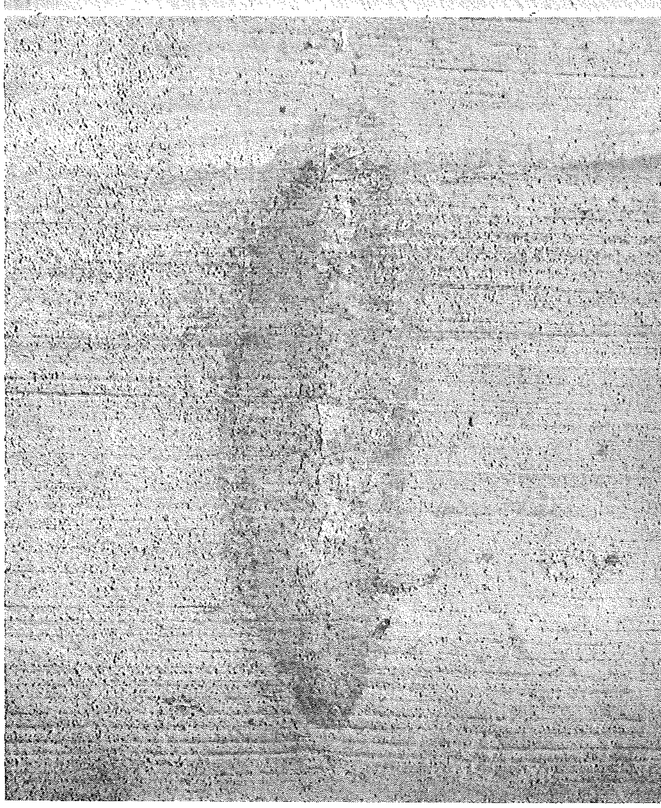


Figure 1 (above). Rippled effect on main southbound span over river.

Figure 2 (left). Light crack developing at the bottom of a ripple, over reinforcing steel.

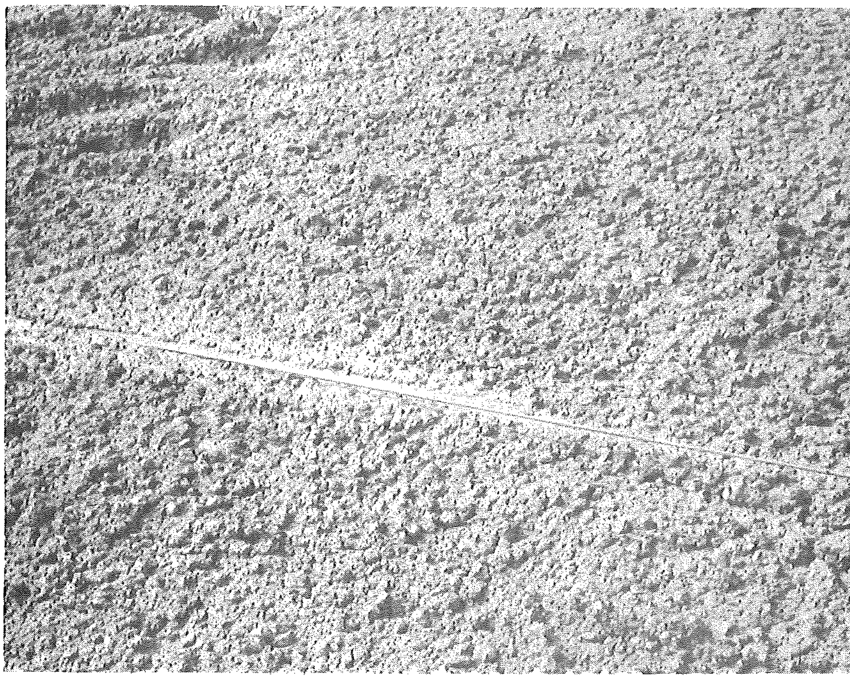
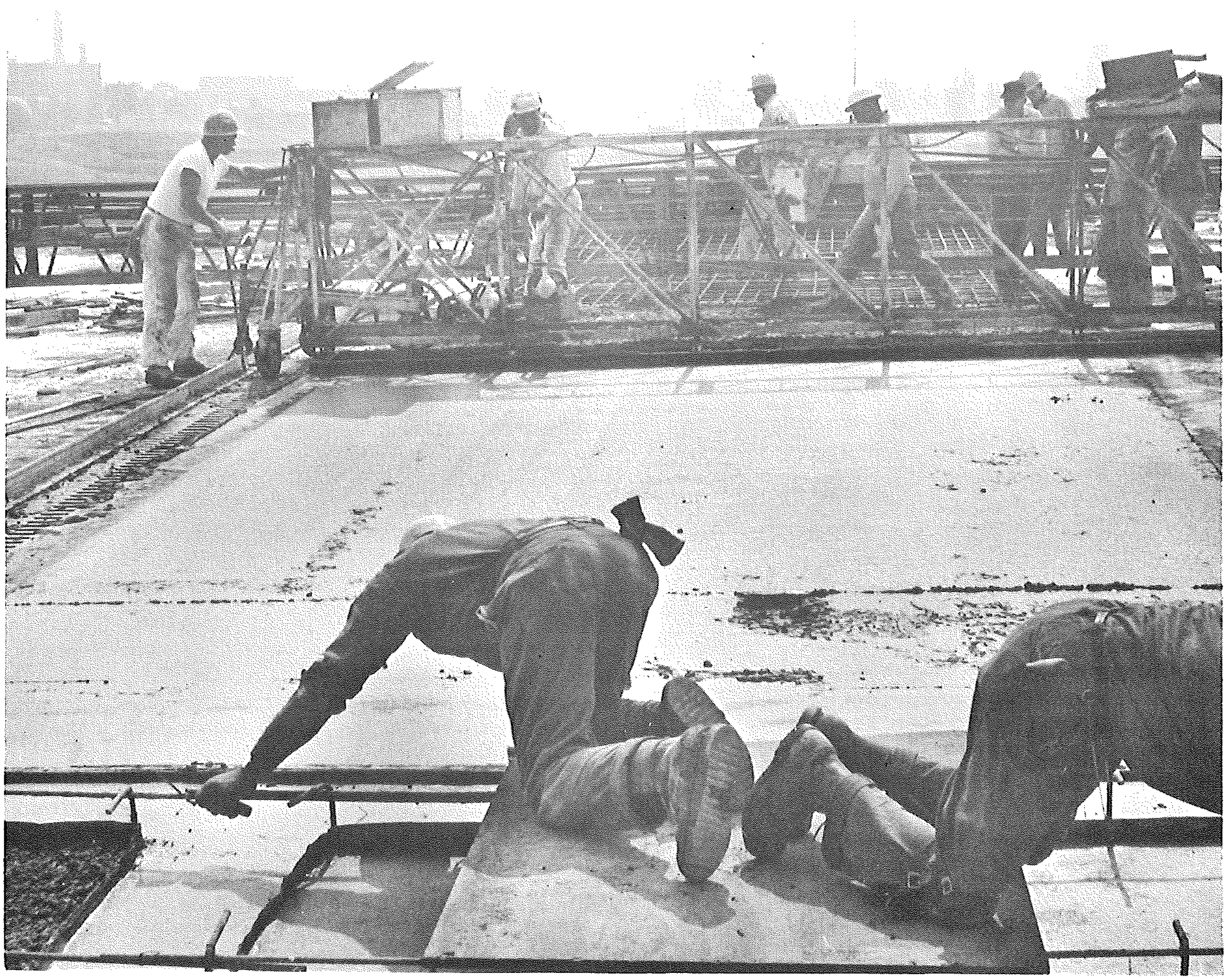


Figure 3 (left). Movement of cable attached to longitudinal finishing machine vibrates the concrete, causing local segregation and depositing water, cement, and fine aggregate immediately adjacent to the cable.

Figure 4 (below). Depressions over the bars visible for four consecutive transverse bars, immediately after passage of finishing equipment.



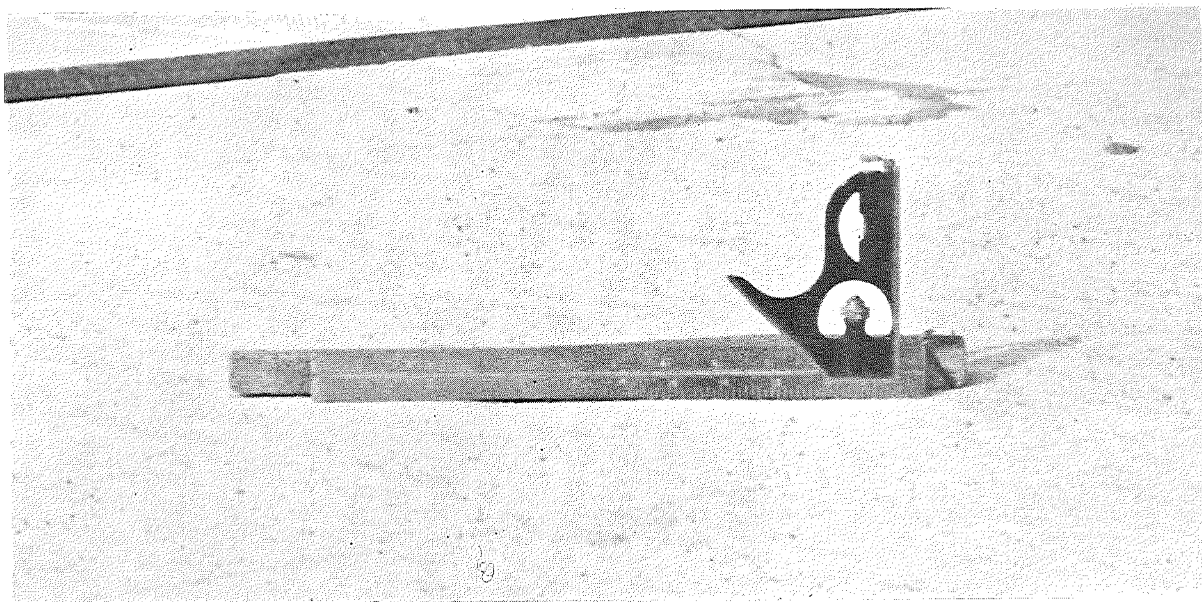


Figure 5. Depressions over two transverse bars on the southbound roadway (left), and over four transverse bars on the northbound roadway (below) of the Telegraph Road structure over I 696.