STEEL-FIBER-REINFORCED CONCRETE OVERLAY

Progress Report
STEEL-FIBER-REINFORCED CONCRETE OVERLAY

Progress Report

C. J. Arnold

Research Laboratory Section
Testing and Research Division
Research Project 72 F-127
Research Report No. R-878

Michigan State Highway Commission
E. V. Erickson, Chairman; Charles H. Hewitt,
Vice-Chairman, Carl V. Pellonpaa, Peter B. Fletcher
Lansing, August 1973
The information contained in this report was compiled exclusively for the use of the Michigan Department of State Highways. Recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Department policy. No material contained herein is to be reproduced—wholly or in part—without the expressed permission of the Engineer of Testing and Research.
Summary

Condition of the fibrous concrete overlay at the end of nine months has resulted in a decision to remove approximately 3/4 of the installation. Failures are not due to the fibrous concrete concept as such, but relate to thickness and curing.

Background Information

This project is a joint effort by the Michigan Department of State Highways, the Michigan Concrete Pavers Association, and the Federal Highway Administration. This report covers recent developments in the project, and is being issued for the information of all interested parties.

Construction and early performance of the experimental overlay have been reported previously in Research Report No. R-852 (April 1973). The installation has been observed periodically since construction, and has shown continuing, progressive failure. Reasons for the failure are covered in the previous report and will not be reiterated here, except to state that failures were due to insufficient thickness and incomplete curing, and are not failures of the fibrous concrete concept per se. Readers are referred to the original report for further details.

MDSH Construction and Research personnel met at the site on July 18, 1973, to review the condition of the overlay, and decide what action should be taken. Representatives of the Michigan Concrete Pavers Association and the Portland Cement Association were also present.

Discussion

After nine months, the largest deteriorated area is the area where the first failure occurred. Figure 1 shows the extent to which the failure has spread at that location. It is obvious that the extent of the failure is not related to pavement condition underneath the overlay, since much of the area has a sound concrete slab underneath. Fragments at this location show the thickness of the overlay to be only slightly more than 1 in. Figure 2 shows conditions at several other locations. The worst conditions were found in the western, or 120 lb/cu yd, section of the overlay. Similar failures in earlier stages of development were found in the outside lanes of the 200-lb/cu yd section as well.

Soundings with a hammer indicate that the overlay has lost its bond over nearly the entire area. Since no elaborate procedures to obtain bond were used at the time of construction, this probably could be anticipated; however, it was expected that a greater portion of the overlay would remain bonded for a longer period of time. Bond loss seems to be aided by extensive warping of the overlay. In many places the joint edges appear to be raised almost 1/8 in., and more at the corners (Fig. 3). Traffic over these joints causes pounding of the overlay against the underlying slab. The amount of warping is variable throughout the installation, and on July 18,
ranged from near zero, to an isolated maximum in excess of 1/4 in. at a
slab corner on the north side where there is no traffic. This was on a hot
day, when thermal stresses should have tended to warp the surface in the
opposite direction.

We know that all concrete pavement slabs warp with temperature and
moisture gradients. Such warping, under traffic, causes flexural stresses
in the concrete and "rocking" of the slabs. Also, in the case of a rigid
overlay, it causes open space between the slabs at the joints, where dirt
may infiltrate.

Our extensive system of concrete highways will need surface repairs
and overlays at some future point in time. If rigid overlays are to be used
in any case, they will require workable designs. Bonded overlays are not
suitable for use over broken slabs and joints, so the remaining options are
unbonded (or semi-bonded) jointed overlays, and continuously reinforced
overlays. The former presents some problems with joints. The latter
would require a considerable amount of steel, would have to be quite thick
to provide adequate protection for the reinforcement, and also would pre-
sent some construction problems. For these reasons, it was considered
to be useful to keep a portion of the overlay in service for a longer period
of time, to gain additional experience with performance of the joints in the
overlay. The two inside lanes of the 200 lb/cu yd section were in far bet-
ter condition than the remainder of the installation. Therefore, it was ag-
reed that those two lanes of the 200 lb/cu yd section should be left in place
for further observation. The remainder of the overlay is to be removed
and replaced with a bituminous cap. This will be done in conjunction with
scheduled paving operations on the adjacent roadway, probably during Au-
gust or September of 1973. The sections to be removed are shown in Fig-
ure 4.

Conclusion

Approximately 3/4 of the experimental fibrous concrete overlay is to
be removed, and the remaining portion retained for further observation.
The original objectives of the project have not been met because of insuffi-
cient thickness, and incomplete curing of the overlay prior to opening to
traffic.
Figure 1. Extent of failure at the location where initial failure occurred. Photo at lower left shows original pavement; overlay at age 3 months (right); and, overlay at age 9 months (upper left).
Figure 2. Examples of overlay failures, mainly within the western or 120 lb/cu yd section. However, similar failures in earlier stages of development, were noted in the outside two lanes of the 200 lb/cu yd section.

Figure 3. Warping lifts overlay away from underlying slab.
Figure 4. Portion of experimental section to be removed due to progressive failure.