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BRIDGE DECK DETERIORATION
A SUMMARY OF REPORTS

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Bridge Deck Deterioration
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A five-year study of reinforced concrete bridge deck deterioration: diagnosis, treatment, and repair is summarized in the Research Report. The research had as its broad objective the development of methods for detection, treatment, and repair of deteriorated concrete in bridge decks. It is divided into the following four parts:

1. Detection and evaluation of deterioration in reinforced concrete bridge decks. The major effort was given to developing a method, a device, and a procedure for discovering deterioration, identifying its nature, and determining its extent.

2. Treatment of reinforced concrete bridge decks. The objective here was to identify materials that would be effective in stopping or attenuating deterioration and to develop techniques in applying those materials.

3. Development of effective overlays and patches for repairing badly deteriorated decks. The major effort was that of developing methods of preparing the old decks to receive bonded overlays of portland cement and resin overlays and in developing methods of applying patches and overlays to the old concrete.

4. Development of methods for epoxy resin repairing of structural cracks and spalls caused by impact loads. In this phase of the research, methods for injecting epoxy resin in cracks were studied and also the behavior of cracked concrete repaired by epoxy bonding under cyclic loading and freeze-thaw activity.

The procedures followed in the research and the accomplishments realized appear below in the same order as the divisions outlined above.

Detection

A nondestructive device was developed for detecting delaminations in concrete decks. It was proved out in the field on a number of bridges with deteriorating decks in Texas. The device is mounted on a small cart which is manually propelled along the bridge by a single operator. An electrically operated mechanical hammer impacts the pavement. The input signal is transmitted through the concrete to a pickup which rolls on the pavement near the input hammer. The signals are filtered and recorded on a chart strip after conditioning. The trace of

the signal on the chart indicates the condition of the concrete, and it maps deterioration. The device will detect delamination in the concrete on decks without overlays and with asphaltic overlays as thick as 3½ inches.

An acoustic velocity meter was developed to estimate the dynamic modulus and chord modulus of concrete in-situ. This, and three other types of instruments were compared. All four were found useful in locating weak spots or deterioration in bridge decks.

Surface Treatment

Laboratory tests were made on concretes with various surface treatments (1) to determine resistance to water absorption and freeze-thaw scaling and (2) to evaluate skid resistance. Epoxy resin and tung oil coating proved to be the most resistant to water absorption. Air entrained concrete was the most resistant to freeze-thaw scaling. A rubberized hot mix asphaltic concrete overlay applied over a tack coat provided excellent freeze-thaw protection to concrete. Linseed oil mixed with kerosene provided considerable protection against free-thaw scale damage when applied without delay after curing and drying, but it offered few benefits when applied after scaling had begun. Skid resistance measurements with the British Portable Tester on four surfaces treated with absorbants were reduced less, based on the untreated surface condition, by the linseed oil treatment.

Overlay and Patch Repair

Concretes made with polyester resin, epoxy resin, latex modified portland cement, shrinkage compensating cement, and portland cement were investigated for bond and repeated flexing load performance of repairs. The portland cement concretes were plain and wire fiber reinforced. The resin concretes used no bonding agents between the hardened concrete and the plastic overlay concrete. The portland cement concretes were tested with epoxy, grout, and no bonding agent. The best bond, in direct shear tests, was obtained with portland cement-sand grout. The wire fiber reinforced material proved to be the most crack resistant. Field applications of 1⅝- and 2-inch thick plain portland cement concrete overlays have given good service under traffic.

Epoxy Injection Repair

Epoxy injection repairs of cracked concrete restored laboratory specimens to full strength for dry concrete and to near full strength for wet concrete. The wet concrete repair used an epoxy that was formulated to cure under wet conditions. Tests on oiled surfaces were unsuccessful in attaining bond. Limited

field applications proved the feasibility of using a hand operated caulking gun or a pressurized paint pot for forced injection of the epoxy.

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