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BOND AND DURABILITY OF CONCRETE AND RESINOUS OVERLAYS

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TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas

Bond and Durability of Concrete and Resinous Overlays

by

Howard L. Furr and Leonard L. Ingram

Overlays suitable for repairing concrete bridge decks damaged by scaling and spalling are the subject of the report. The material contained in the present report extends information contained in TTI Research Report 130-1. Four series of tests were made to determine shear strength of materials bonding the overlay to the deck, freeze-thaw durability of the overlay materials, stiffening effect of the overlays, and the effect of cold temperature on the flexural response of overlaid laboratory beams.

Shear of overlays bonded to 7 in. concrete cubes was tested in direct shear parallel to the interface of overlay and cube. The concrete surfaces were sandblasted prior to application of bonding agents. Portland cement concrete applied over cement grout averaged 541 psi shear bond stress, epoxy developed 448 psi, and two proprietary products averaged 458 and 382 psi for one of the materials using two different cements and 344 psi for the other material. Portland cement concrete overlays applied to base concrete with no bonding agent were reported in an earlier report. The lowest average shear bond strength of those overlays was 129 psi. No significant difference was found between bond strength of air-entrained and non air-entrained overlays, both bonded with cement grout. The cement grout was not air entrained.

Two sets of freeze-thaw durability tests were made. The first, to test the bonding materials, was a standard ASTM C-290 test, and the other, made to test durability of the overlay materials, was made under ponded brine. The ASTM C-290 test involved cement grout, epoxy, and latex modified concrete from which the coarse material was removed. Of three specimens of each material, all withstood the 300 freeze-thaw cycles except two of the latex modified material. Complete separation of overlay from the base concrete developed in the latter material at 183 cycles for one specimen and 246 cycles for another, while the third specimen withstood the 300-cycle test without failure.

The freeze-thaw tests made on the overlay material under ponded brine produced moderate scaling on all materials except the latex modified cement concrete, which showed only very slight scaling. The concretes were air entrained and the specimens were subjected to approximately 50 freeze-thaw cycles.

Overlaid beams were tested to determine the stiffening effect of concrete overlays from 1 to 2 in. thick, and of resinous overlays of 1/2 in. thickness. The beams were 7 in. wide by 5 in. deep before application of the overlay. They were reinforced with one #4 reinforcing bar at the top and at the bottom. The concentrated load was applied at the center of the 8 ft-0 in. simple span. The concrete overlays increased the ratio of load-to-deflection at midspan, $P \div \Delta$, from two to four times that of the base beam. The epoxy and polyester materials increased the stiffness from 1.1 to 1.8 times the value for the base beam.

A test was made to determine if failure would develop from repetitious loading of the beam at the same time that ambient temperature was lowering from 70°F to 20°F. The load was calibrated to produce 20 ksi tension in the bottom steel and it was applied at the rate of 11 cps. All overlays were 1 1/2 in. thick plain concrete bonded with grout. Four temperature cycles and 2 million load cycles produced no distress in either the overlay, the bonding agent, or the base beam in any of the four specimens tested. The only effect of the load and temperature cycling was a slight reduction in stiffnesses of the overlaid beams.

A 1 1/2 in. thick overlay of plain concrete was placed on one test beam while it was being load cycled through a total amplitude of 0.044 in. The cyclic loading was maintained through 1,100,000 cycles at 400 cycles per minute while the beams cured. At 24-hour age the amplitude had reduced from the initial value of 0.044 in. to 0.008 in. because of the stiffening effect of the hardened overlay. Three cracks developed in the overlay near midspan due to tension in the top fibers on the upward stroke of the loader but no unbonding was found. Cylinders cast and cured while mounted on the vibrating beam had greater strength than those cured on the floor beside the test beam.

The study concluded that concrete overlays can develop high bond in shear, 380 to 540 psi, on a concrete base prepared by sandblasting. Also, both epoxy and cement grout bonding agents effectively withstand alternating freeze-thaw temperatures. Concrete overlays measurably stiffen beams when adequately bonded, and they may be applied without harm while the base concrete is undergoing low frequency, low amplitude vibration.

The effects of age on beam or overlay were not studied.

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R. L. Lewis, Chairman
Research & Development Committee
Texas Highway Department—File D-8
11th and Brazos
Austin, Texas 78701
(Phone 512-475-2971)