MATERIALS & RESEARCH DIVISION

Reviewed By:

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R. F. Nicholson, P.E.
Materials & Research
Engineer

Prepared By:

R. I. Frascoia

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RESEARCH UPDATE

Performance Of Waterproofing Membranes In Retarding Rebar Corrosion Activity

Reference - Work Plan 86-R-10, Bridge Deck Performance Following Rehabilitation.

Research Problem Statement - Bridge decks in Vermont and elsewhere are being rehabilitated in an attempt to extend their useful life which has been threatened by the intrusion of deicing salts with concrete scaling, spalling and reinforcing steel corrosion resulting. At this time, there is no concensus nationwide on the extent of rehabilitation required to restore and extend the service life of bridge decks. Specific areas in question include how much chloride contaminated concrete must be removed, can rebars with voltage potentials over -0.35 volts be left untreated and will the placement of a good waterproofing membrane stop or significantly retard rebar corrosion activity? The latter item is the subject of this Update.

History - In 1973, 35 year old Bridge #178 at MM 2.35 on Route 100 in Waitsfield was widened to better accommodate traffic. The contract did not include the rehabilitation of the southbound lane which revealed moderate to severe concrete deterioration and visual evidence of rebar corrosion upon removal of the bituminous riding surface. Copper-copper sulfate half-cell readings disclosed active corrosion on 84% of the lane with readings averaging -0.40 volts.

In August of 1973, both the new and old portions of the deck were waterproofed with two coats of WITCO T-830, a two component tar modified polyurethane. The squeegee application averaged 46 mils in thickness. Outgassing of moisture vapor from the concrete resulted in numerous bubbles and pinholes in the cured material. Most were in the 1/32" to 1/8" size range while a few ranged up to 1/2" in diameter. Electrical resistivity tests taken on the membrane produced values from 10,000 to 160,000 ohms per square foot (many agencies have a 500,000+ ohms requirement for acceptance of a membrane system). Less than ideal initial performance of the polyurethane in this and other lab and field trials resulted in no further use of the product after 1973.

Status - In 1983 the same structure, Bridge #178 was included in a bridge deck rehabilitation program. A condition survey conducted in April, 1984 by Materials & Research personnel

revealed that corrosion activity had dropped from the 84% level recorded in 1973 to 7% of the southbound deck area. This had occurred even though recovered pulverized samples of the southbound lane averaged 3.6 pounds of chloride per cubic yard of concrete at the rebar level. Chloride contents on the northbound lane constructed in 1973 had not risen above the base level of 50± ppm. At the time, it was thought that the low level of active corrosion could have been due to a difficulty in obtaining readings through the polyurethane membrane even though there were numerous pinholes in the material. In September of 1986, the deck rehabilitation began with the removal of the bituminous pavement and polyurethane membrane. At that point, the resident engineer for the Agency retested for corrosion activity. Areas where concrete delamination had occurred were also marked out based upon soundings made with a chain drag and hammer. Once again the half-cell test revealed very little corrosion activity present on the deck. At the same time the delamination survey revealed that approximately 25% of the concrete surface on the southbound lane had experienced fracturing. Due to the delamination problem, Class II removal of concrete to a point 3/4" beneath the top mat of steel was required on 17% of the southbound lane. The resulting action disclosed reinforcing steel in varying stages of deterioration. Approximately 80% of the exposed bars had significant corrosion with loss of rebar section sufficient to require replacement of 32 linear feet of reinforcing steel.

Discussion - The high level (84%) of corrosion activity recorded in 1973 on the southbound lane of Bridge #178 had already resulted in significant rebar and concrete damage. The half-cell readings taken in April, 1984 and September, 1986 indicated that the majority of the corrosion activity had stopped. It could be assumed that the change in corrosion activity was due to the application of the polyurethane membrane in 1973. If that assumption is true, it is possible that deck rehabilitation procedures may not require the removal of chloride contaminated concrete from areas with high corrosion values (>-.35 volts) when a waterproofing membrane system is to be placed. Exceptions would include locations where the corrosion activity has already resulted in delamination of the concrete surface.

Followup - Performance information from additional field test sites is required to substantiate the findings reported here.

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