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RESEARCH UPDATE

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ROYSTON 10-AR/PAVEMENT FAILURES AND REPAIR PROCEDURES

HISTORY

Field observations made in 1986 on various bridge deck rehabilitation projects revealed instances where the surface roughness was sufficient to raise doubt that the standard preformed sheet membranes specified for waterproofing bridge decks would perform as well as desired. The roughness included coarse surface textures, depressions and minor surface scaling, plus rough edges around some of the new concrete patches. The search for a tougher waterproofing system resulted in the trial use of Royston 10-AR membrane on one-half of a new Town Highway deck (project, Berlin BRZ 1446(11)) in early November, 1986. The 10-AR membrane features a high tensile strength polypropylene top mesh which gives the product six (6) times the puncture resistance (ASTM E 154) of the standard 10-A membrane. The waterproofing applicator had previously completed a number of 10-AR installations for the Maine DOT with no problems reported. Our observations included removal of the compacted pavement from several locations with no visible damage to the membrane noted.

Based upon the initial trial use, a decision was made to specify the 10-AR membrane on two contracts involving nine (9) interstate and primary route bridge deck rehabilitation projects to be undertaken in 1987.

Field observations made on July 21, 1987, during the 10-AR application on the Coventry RS DECK(13) project revealed a lack of bond between the surface of the membrane and the first course of Type IV bituminous mix. The problem was discussed with Robert Settineri, Royston's Technical Service Manager, who suggested the lack of bond could be overcome by insuring that the mix be compacted quickly while the temperature was still in the 300°F to 325°F range. That procedure was followed on the next installation but no improvement was noted upon its completion. Other modifications were made including a switch to a coarser Type III mix. The 1/2 inch minus mix appeared more stable with less shoving visible beneath the roller, but offered no real indication of any improvement in bond over the 3/8 inch mix. Based upon the problems discussed, the Special Provision substituting 10-AR membrane for Royston 10-A was deleted in mid-September and Written Orders were issued rescinding the use of 10-AR on projects which had called for the change in products.

At approximately the same time, a pavement shoving failure was reported on US Rte 4, BR 65A in Hartford, Vermont. The problem occurred in the right wheel path of the westbound lane on span 3 of the 4 span structure. The failure consisted of a lateral movement or extrusion of the bottom portion of the pavement up the 5/8 inch banked deck which resulted in a depression in the wheel path area and a build-up of mix along the edge of the 12 foot lane. Removal of pavement with a hammer and chisel from both distressed and unaffected areas revealed a lack of bond at all locations.

The distressed area was repaired under the construction contract several weeks later. The procedure included cutting the perimeter of the area to be patched, plus additional shallow cuts to make the pieces manageable for hand removal. The segments were placed in the bucket of a front end loader to expedite the removal. The few areas of the

membrane which were damaged during the operation were repaired with strips of Royston 10-A membrane. A light application of asphalt emulsion was applied on the surface of the membrane with a broom to prevent future slippage of the new bituminous overlay. Cores taken at a later date revealed significant bond between the overlay and the membrane at 2 of 3 locations checked.

A laboratory study was also undertaken in September, 1987, to determine if the mix temperature had any significant effect on pavement/membrane bond. Four inch diameter plywood disks were cut, primed, and covered with 10-AR membrane. The disks were placed in a preheated Marshall mold and 250°F, 300°F and 325°F bituminous mix was compacted on the samples with 50 blows from a standard 10 pound hammer. Examination of the specimens the next day revealed a significant (and satisfactory) bond of the 250°F mix. The bond of the 300°F mix was so great that the plywood disk was destroyed during the removal of the mix. Such results were not expected, but they point out the difference between a confined mix in a mold and a similar mix in the field which tends to shove or creep on the surface of the membrane when exposed to the compaction effort of the roller.

In September, 1987, slight distress was also noted in the travel lane on the center span of Interstate 89, BR 15S in Sharon. The condition remained virtually unchanged through the winter and spring of 1988 until higher than normal ambient temperatures began occurring in mid-June. Again, the distress consisted of lateral movement of the pavement up the banked deck due to the centrifugal force of the vehicles rounding a 3°± curve. A patch was placed on June 17th and a second patch was required on the adjacent span in mid-July.

On July 28th, traffic was detoured off the SB lane and repairs were made by District #4 maintenance personnel on approximately 175 sy of the travel lane on spans 1 and 2. The repair procedure was similar to that used on BR 65A, except a somewhat heavier application of asphalt emulsion was applied on the 10-AR membrane using short bristle brooms.

With continued 90°F± weather in July, pavement failures occurred on the remaining 3 spans of US Rte #4, BR 65A, again in the WB lane only. The repairs were made on 300± sy of the deck on August 1 by maintenance personnel.

While repairing the pavement, two conditions were noted which may have contributed to the failure. The shoving which occurred on span #4 was in the immediate vicinity of a segment of the sheet membrane which was not bonded to the deck. The lack of bond and resulting movement was due to the presence of a 2'± by 8'± portion of the release paper which had not been removed from the bottom of the membrane.

The second condition involved the presence of a fine material, possibly cement dust, on the surface of the membrane. Cement may have been cast over the membrane to prevent the equipment tires from slipping sideways on the banked deck. Since bituminous mixes do not develop adequate bond to the 10-AR membrane, any dusting could have been a factor contributing to the failures. The absence of any failures on the EB lane could relate to the absence of cement dust.

The single variation in the repair procedure was the airless spray application of a tack coat over the 10-AR membrane. The adhesive, supplied and applied by Robert Settineri of Royston Labs, consisted of the asphalt-rubber portion of the membrane in a solvent carrier. The coating was applied at rates of 200± and 325± square feet per gallon. Both applications provided a very tacky surface but did not cause any debonding of the membrane when the hot mix trucks and paver tires traveled over the surface.

RECOMMENDED REPAIR PROCEDURES

The following procedure is recommended for repairing pavement failures on 10-AR decks:

1. Mark out area to be repaired. Do not remove pavement from stable curb line or end dam areas not exposed to traffic since such areas will be difficult to reseal properly. When possible, removal widths should be compatible with the widths to be placed by the paver scheduled for the repair.

2. Saw cut the pavement using a motorized saw capable of maintaining the desired cut depth. The perimeter cut should not exceed 3/4 of the total pavement depth. If the saw penetrates the membrane, due to a variation in pavement thickness, it will be necessary to recut the perimeter and seal any cuts. Make additional saw cuts at 2± foot intervals to make hand removal of the pavement segments manageable. If practical, complete the cutting operation the day before the repair is undertaken to reduce delays when the larger crew is present.

3. Begin the pavement removal at an area of distress. That will reduce the risk of damaging the membrane while trying to lift up the first segments. The beveled face of steel wrecking bars should be used to lift or fold back the pavement. Pick up the pavement segments by hand and place them in the bucket of a front end loader, which will then load the material into dump trucks for transport.

4. Check the surface of the membrane and mark out any areas requiring repair. If damage has resulted in a loss of membrane bond to the deck, cut and remove membrane from such locations.

5. Use brooms and compressed air to remove all dirt and debris from the work area.

6. Cut pieces of membrane from a new roll to accomodate areas requiring repair. The pieces should be cut large enough to allow a 4 to 6 inch overlap beyond damaged areas.

7. Preheat existing membrane with a propane torch to enhance the bond of the repair membrane. Soften the perimeter of the membrane patch and tamp or smooth out the edge using a small trowel.

8. Apply a tack coat over the surface of the membrane to insure adhesion of the new bituminous overlay. The tack coat may consist of asphalt emulsion or an asphalt-rubber adhesive supplied by Royston Laboratories. The asphalt emulsion may be applied with short bristled brooms. Coverage in the range of 75 percent should be adequate. The Royston tack coat may be applied by brushing or with an airless sprayer. A coating rate of 300± square feet per gallon should be adequate.

9. A Type III bituminous concrete should be used on both lifts. An AC 20 asphalt cement is preferred over the standard AC 10, if available. The mix temperature should not exceed 325°D±.

10. Allow the pavement to cool to 130°F± prior to resuming traffic.

The following equipment and materials are recommended to repair 10-AR decks:

Traffic signs, barriers, flagpersons
Marking paint or keil, cloth tape
Mobile pavement saw with water supply, air compressor
Brooms, shovels, bars
Sheet rock knives, propane torch, trowel
Roll(s) of Royston 10-A membrane
Asphalt emulsion or Royston tack coat
Short bristle brooms or airless spray gun and generator
Paver, bituminous mix and compaction equipment

CURRENT STATUS

As of August 5, 1988, distress has been noted on 2 of the 7 remaining structures sealed with the 10-AR membrane. The failures are occurring on I89 BR 15N, which is on a 3°± curve and on Rte 14, BR 131, where traffic is braking on a 3½% grade in anticipation of a stop sign at a T intersection 100 feet off the end of the bridge. Repairs are planned for both decks in late August or September.

SUMMARY

The Royston 10-AR membrane was selected for use due to the excellent puncture resistance of the product. However, the high strength polypropylene top mesh which provides the puncture resistance, also prevented the development of adhesion between the membrane and the bituminous overlay.

Pavement failures, in the form of shoving or lateral displacement, have occurred on 4 of the 9 10-AR decks. Factors which have contributed to the failures include the centrifugal forces from traffic on superelevated (banked) decks, braking action on a grade, high ambient and pavement temperatures and what appears to have been the application of a cement dusting on the membrane on at least one bridge deck.

Removal and replacement of the pavement has been completed on 2 of the 4 problem decks. The application of asphalt emulsion or a Royston tack coat on the surface of the 10-AR membrane is expected to prevent the reoccurrence of the pavement failures.

CONCLUSION & RECOMMENDATION

The Royston 10-AR bridge membrane could probably be used without fear of pavement failure if an adhesive coating, such as asphalt emulsion was applied on the surface of the membrane.

Royston Laboratories, Inc. should modify the 10-AR membrane to include a factory applied coating on the surface of the material to enhance pavement overlay adhesion.

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