

MATES

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CONCRETE PAVEMENT CRACKING AND SEATING

Traditionally, the primary method for rehabilitating deteriorating concrete pavements is to overlay with a bituminous layer. Unfortunately, this is followed rather closely by another serious maintenance problem called reflection cracking; that is, cracking of the new overlay directly above joints and cracks in the old pavement below. Reflection cracking is caused by horizontal or vertical movement of the underlying concrete pavement. Horizontal movement is usually thermally induced through expansion and contraction of the concrete due to temperature changes, but some additional changes in length occur because of changes in the moisture content. Vertical movement generally is due to traffic loading and can be increased by lack of adequate support by the base, voids beneath the slabs, frost action, and soft or wet subgrades. The bituminous overlay is not elastic enough to accommodate the large differential movements present at most concrete joints and cracks. The result is that the bituminous overlay cracks at the same locations as the cracks and joints in the underlying concrete pavement. The cracks in the overlay are 'reflections' of the cracks in the concrete beneath.

Numerous methods have been employed to prevent, or at least delay, the formation of reflection cracking. These include additional overlay thickness, aggregate separation courses (stabilized and non-stabilized) between the concrete and the overlay, fabrics (strips placed over the joints and cracks or the entire surface), and asphalt/rubber interlayers (a thin elastic layer composed of a mixture of asphalt and ground tire-rubber, intended to absorb the movement of the underlying concrete). All of these methods have met with varying degrees of success (or failure) and the search for a cost effective means of reducing reflection cracking continues.

Two relatively new processes that attempt to reduce reflection cracking are cracking and seating, and an extension of this process called 'rubblizing.' This article will be devoted to the crack and seat process, rubblizing will be covered in a future article. The cracking and seating process produces hairline, full-depth transverse cracks in the old pavement. After cracking, rolling is done to seat the resulting pieces firmly on the base to reduce vertical movement under loads. Cracking is intended to reduce the sizes of the underlying pavement slabs, thereby decreasing localized horizontal movement at each original joint or existing crack due to thermal expansion and contraction.

A disadvantage to cracking the concrete pavement is an accompanying loss of structural strength which must be accounted for in the design of the overlay thickness. The extent of this loss will vary from project to project, depending on the characteristics of the original pavement, the size of the cracked pavement pieces, the construction equipment and procedures used, the strength and stiffness of the existing support provided by the base, and other factors. As yet, structural design data are not available to accurately predict the support that will be provided to the overlay by the broken pavement beneath. Support values obtained on different projects have varied extensively with the highest values being four times as much as the lowest.

Several devices have been used to produce the desired cracks. These include a modified diesel pile driver, wrecking

ball, whip-hammer, and a guillotine type drop-hammer. The more successful and currently used methods are the whip-hammer and guillotine types. The most successful and currently used device for seating is a rubber-tired roller, loaded to provide up to 50 tons gross load.

Although numerous projects have been constructed using the crack and seat technique, most have not incorporated untreated 'control sections' for comparison with the performance of the cracked sections. Therefore, it is impossible to determine what would have happened had the cracking and seating not been done. Although several of these projects are being observed, our monitoring is primarily concerned with a project constructed in 1983 on US 23 north of Dundee in Monroe County which includes a Control Section. This project consisted of sections having eight different designs. Each section is about 2700 ft long. The variables being investigated are spacing of the cracks (2 ft, 3 ft, 4 ft) and overlay thickness (4 to 6 in.). The latest surveys indicate the variable that seems most influential in reducing or delaying reflection cracking is overlay thickness. All sections receiving 6 in. of bituminous overlay are exhibiting less reflection cracking than those that received 4 in. Also, the control (non-cracked and seated) sections are experiencing less cracking than two of the three cracked and seated sections with comparable overlay thickness. This suggests that the success attributed to cracking projects without uncracked comparison sections could well be due to the thicker overlays used on cracked and seated pavements. Therefore, based upon this installation where variables were known and controlled, there appears to be no benefit from cracking and seating of reinforced concrete pavements. In the case of reinforced concrete pavement, the purpose of the reinforcing steel is to prevent opening of intermediate cracks and to concentrate movement at the joints. The result is that the slab still acts as if it were the same size as it was prior to cracking. Experimental projects have been done where the reinforcing steel is cut at regular intervals of 10 to 20 ft. Reflection cracking, however, still occurred.

On experimental jobs where rubblizing was done (extensive cracking sufficient to separate the concrete from the reinforcing steel) it seems to have taken care of the reflection cracking problem. However, other problems are developing, and the rubblizing process is not yet sufficiently predictable for general use. Additional information will be furnished in a future issue.

-Bob Felter

ASBESTOS CONTENT EVALUATION

The term 'asbestos' refers to a group of silicate minerals that crystallize as fibers. It is well documented that humans breathing air contaminated with asbestos may suffer adverse health effects. In order to protect Department personnel, and to ensure that unsafe materials are properly disposed of, the M&T Division operates a program of asbestos content evaluation.

There are six different minerals recognized as asbestos for regulatory purposes by the Environmental Protection Agency (EPA) under the "Asbestos Hazard Emergency Response Act." In 1984, the EPA completed the first national survey of asbestos construction materials in buildings and reported that pipe and boiler coverings contained the highest level of asbestos, an average of about 70 percent pure asbestos.

The Spectroscopy Unit of the Research Section has been involved with identifying the presence of asbestos in construction materials since 1981, and has developed a method of identification using infrared spectroscopy. Over the years we have tested for the presence of asbestos in samples taken from in-place construction materials; mainly for MDOT, but also for the Departments of Labor and Natural Resources. The laboratory analyzes samples from

Departmental real estate purchases scheduled for condemnation, Department facilities being renovated or remodeled, or where employees are concerned about particular materials in their work environment. Testing for asbestos is just another small, but significant way in which the M&T Division contributes to the Department's commitment to environment.

-Vija Troms

TECHADVISORIES

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

MDOT RESEARCH PUBLICATIONS

Bridge Girder Butt Welds - Resistance to Brittle Fracture, Fatigue, and Corrosion, Research Report No. R-1284, by James Culp. Welded butt joints, typical of those used in the flange splicing of steel plate girders (bridge beams) were welded by the electroslag, electrogas, and submerged arc processes in ASTM A36 and A588 steel plates. A series of mechanical and physical tests was conducted on the weldments. The tests revealed that electroslag and electrogas weldments were lower in fracture toughness than submerged arc weldments. Submerged arc weldments were much more ductile in the presence of a flaw. During the course of this project, a modified ASTM E399 type of fracture toughness test was developed which circumvents problems encountered in fracture testing of submerged arc weldments where large residual compressive stress zones prevent the growth of a straight fatigue crack front.

Comparison of Cracked and Uncracked Flexible Pavements in Michigan - Final Report, Research Report No. R-1293, by J. H. DeFoe. The purpose of this study was to try to identify factors influencing the performance of flexible pavements in Michigan. Nine flexible pavements, consisting of bituminous surfacing placed over aggregate base and granular subbase, were investigated to determine the relationship between pavement performance and the characteristics of their constituent materials. Field measurements included crack surveys, rut depth and deflection measurements, and core sampling. Core samples were tested in the laboratory for tensile and thermal properties, and resilient modulus values over a wide range of temperatures. Recovered asphalts from the cores were tested for penetration and viscosity in order to determine temperature susceptibility. The cores were also analyzed for asphalt content, air voids, aggregate gradation, and thermal expansion coefficient. Recommendations resulting from the study call for the use of softer grades of asphalt, limiting the temperature susceptibility of the asphalts, and controlling the potential for in-service hardening of the asphalts through strict enforcement of the specifications.

Low-Slump High-Density (LSHD) Concrete Bridge Deck Overlay, Research Report No. R-1294, by J. E. Simonsen. This report covers our 10-year evaluation of LSHD overlays. The report notes that this material was difficult to apply and finish properly, was more labor-intensive, and required longer curing times. Lab tests indicated shrinkage to be considerably more than latex modified concrete. Bond strength of the material was good. Average chloride content at 1-1/2 to 2-in. depths has reached 4 lb/cu yd at 11 years of age. Extensive map cracking of the surfaces has developed and some delamination. The LSHD concrete is somewhat more permeable than latex modified concretes, but bonding properties to the underlying concrete are generally adequate. Based on measurements of corrosion acti-

vity, there apparently has been no increase in the areas of active bar corrosion since the overlays were placed. The report recommends that LSHD concrete overlays no longer be approved for use.

Corrosion Evaluation of Calcium Magnesium Acetate (CMA), Salt (NaCl), and CMA/Salt Solutions, Research Report No. R-1295, by R. McCrum. This study documents the corrosiveness of a water solution of CMA compared with that of an equivalent (for deicing purposes) concentration of NaCl in water in identical laboratory exposure environments for the major metals used in Michigan's highway system. Tests were also run using distilled water alone, simulated acid rain, a commercial rust inhibitor with magnesium chloride ($MgCl_2$) added, the same inhibitor with NaCl and CMA, and CMA/NaCl mixtures at various weight ratios. Detailed results are reported for bridge steels, steel bar reinforcement, steel prestressing strand, some aluminum alloys, galvanizing, some galvanic couples, and electroslag and submerged arc weldments in samples of weathering steel. The results show that CMA was definitely less corrosive than NaCl and only slightly more corrosive than distilled water alone. Results of the CMA/NaCl mixes are similar to CMA alone at longer exposure durations. The $MgCl_2$ and rust inhibitor mix provided superior corrosion performance to distilled water alone, and the NaCl and rust inhibitor mix provided corrosion performance similar to that of CMA/NaCl mixes. In summary, CMA, CMA/NaCl mixes, $MgCl_2$ with rust inhibitor, and NaCl with a rust inhibitor all show much promise as deicing salt alternatives.

NEW MATERIALS ACTION

The New Materials Committee recently:

Approved

Terrafix Interlocking Blocks for Slope Protection
Dywidag Extruded Coupler Splices for Reinforcing Bars
Interlock #10 Block for Slope Protection
Erosion Control Block for Slope Protection
Air Spill Barricade
Sealtight Cold Applied Saf Seal Joint Sealer
Jeene Structural Sealing Joint System for Bridges

Approved for Trial Installation

Sucker Rods (Fiberglass Fence Posts)
DeKowe 700 and 900 Erosion Control and Stabilization Mats

It should be noted that some products may have restrictions regarding use. For details please contact Don Malott at (517) 322-5687.

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

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