

MATES

MICHIGAN DEPARTMENT OF TRANSPORTATION

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WHY COVER NEW CONCRETE ON BRIDGE DECKS?

Overlaying pavements and bridge decks historically has been done only to rehabilitate a distressed surface. A look at the construction of bridges on our State Trunkline system, however, shows that in many cases new decks are overlaid even before being opened to traffic. A logical question would be, "Why not design the bridge so the deck can be placed full-thickness in one operation?" To answer this question, let us begin by discussing the problem that the overlay is intended to solve.

To some degree, concrete used in bridge decks can be penetrated by water, which can carry dissolved chlorides (deicing salts) down to the steel reinforcement. The chloride-laden water will promote corrosion that will eventually cause spalling of the deck forming a pothole. Spalling is caused by expansion of the steel bars as they rust. To combat this, overlays can be used to provide a denser, less easily penetrated layer, and thus reduce the chloride intrusion. The overlay material is not used for the full deck thickness as it is considerably more expensive than normal concrete.

Not every new bridge is a candidate for an overlay, rather they are used on the more heavily travelled, and more damage susceptible bridges that carry more than 50,000 vehicles each day. Such bridges are also more difficult and expensive to repair, because of traffic control costs and disruptions of traffic. The following brief discussion covers the overlay materials that have been used by the Department.

Latex Modified Concrete (LMC) is a concrete mixture to which is added an emulsion (latex) consisting of water and synthetic rubber. This emulsion essentially replaces much of the water in the concrete. The LMC must be finished and curing must start promptly to prevent shrinkage cracks. After two days of moist curing to develop strength through hardening of the portland cement, the LMC is exposed to the air and permitted to dry so that the latex can seal the pores in the concrete.

The LMC is normally placed with 1-1/2 in. minimum thickness, providing a layer that substantially reduces the ability of water to penetrate it, as compared to normal deck concrete. It has been used for many years and performs satisfactorily except when shrinkage cracks form due to poor curing. LMC is susceptible to drying shrinkage caused by bright sunlight, high temperatures, and wind. Another problem can arise when satisfactory bond is not obtained with the underlying concrete (usually due to poor surface preparation). The LMC costs about \$350/cu yd (including placing and curing), compared to \$150/cu yd for ordinary (MDOT Grade 45D) bridge deck concrete.

Iowa Overlay - Low Slump, High Density (LSHD) Concrete used extensively by the Iowa Department of Transportation, is based on the premise that the ability of water to penetrate the concrete is related to the water content of the original mix. Thus a mix with a very low water content will have a low slump and if properly consolidated, will have a high density and not be porous to water penetration. The problem is that low slump concrete is difficult to consolidate and screed, and can easily result in a lower density (more porous) than desired, and may provide a poor riding surface. Because of this, the procedure is no longer used by the Department.

The LSHD overlay was generally thicker (2 in.) than LMC, but was found to provide less resistance to chloride intrusion than the 1-1/2-in. LMC application. About 26 bridges were overlaid in Michigan using the LSHD method.

Modified Iowa Overlay. With the development of high-range water reducers (also called 'superplasticizers,' see MATES Issue No. 5) the Iowa mix was modified to increase the slump with the high-range water reducers while still keeping the water content low. This procedure permitted a more workable concrete mix that would be easier to consolidate and which could be screeded more easily to provide a smoother riding surface. The modified concrete is similar to the original LSHD concrete with regard to chloride penetration. The modified mix was used on 18 bridges. These overlays are still under study, but excessive shrinkage cracking has occurred, and it appears that better curing methods are required.

Microsilica Concrete Overlay involves the use of a new admixture, microsilica (also called condensed silica fume) which has recently been developed. It is a byproduct of the silicon carbide abrasives industry and the metallic silicon industry, and its particle size is finer than that of tobacco smoke. It provides significant strength increase in concrete and substantially reduces water penetration (it is even less permeable than LMC). Experimental overlays on two bridges were conducted in 1986 and evaluation is in progress. This material, like the Modified Iowa Overlay, contains high-range water reducers and thus exhibits more shrinkage than desirable. Some of the results so far look favorable, but some details have to be worked out.

Covering of Older Bridge Decks. These same types of overlays have also been used on bridge decks that have been contaminated by chlorides, causing corrosion of the reinforcing steel. The rehabilitation process requires removing the top portion of the concrete to get rid of most of the chloride (to below the top reinforcing steel layer if necessary) and then applying the overlay. This is not a perfect solution, since there is still some chloride in the concrete that remains, but the overlay does add 1-1/2-in. to the thickness of the deck, adding strength, replacing the riding surface, and restricting further chloride penetration. This adds appreciably to the life of the deck.

Using overlays as a protective covering for bridges with high traffic volume is one of the major steps the Department has taken to prolong the life of these structures, so vital to our highway system. It is not, however, the only one. In the Department's efforts to improve the durability, and thus extend the life of bridge decks, other remedial policies have been incorporated. In new decks built after the mid-70's, we changed to a concrete containing seven sacks of cement, rather than six, for every cubic yard of concrete and added a water reducer to provide less permeable concrete. At the same time, we required a greater thickness of concrete cover over the top reinforcing steel, so that there is less tendency for cracking along the bar, and because of the extra thickness, it takes more time for any chlorides to reach the steel. We have provided protection for the reinforcement itself by requiring an epoxy coating on the steel to provide a barrier to chlorides that might penetrate the deck. Integration of these improvements into the design and construction of our bridges provides a significant increase in the life of these vital elements of our highway system.

-Ralph Vogler

MATERIALS AND TECHNOLOGY ENGINEERING AND SCIENCE

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You'll notice some minor changes in format on this month's MATES. MDOT has recently embarked upon a plan to give a 'family look' to all of its publications. This will evolve over time until all MDOT publications share certain common characteristics that will identify them as ours. As you can see, the changes in MATES format are minor ones, and are physical in nature; our policy of providing practical information concerning matters pertinent to highway design, construction, maintenance, research, etc. will continue unchanged. Feedback, incidentally, has been very gratifying and has confirmed that we're filling a need. We say once again, if you have any suggestions for topics that you'd like to see treated in MATES, please let us know.

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.

SAFETY NOTE: Nuclear Density Gauge Operators

The United States Nuclear Regulatory Commission states that vigorous efforts should be made to keep the radiation exposure of the unborn at the very lowest level practicable during the entire pregnancy. If you have questions contact Phil Bowerman at 517-322-1234.

NEW MATERIALS ACTION

The New Materials Committee recently:

Approved the following for trial installations:

Jenne Structural Sealing Joint System
Spikma Curbstones

Approved the following products:

Ultra-Drain Prefabricated Drainage System
PDS 25 Prefabricated Drainage System

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

PERSONNEL CHANGES

It is always with mixed emotions that we congratulate our retirees; it's gratifying to see them free to embark on new adventures, or to pursue long-time interests. On the other hand, their contributions and expertise will be greatly missed. **Eleanore Hagerman**, our Division Office Manager, retires after 30 years of service to the State of Michigan, and 12 years with M&T. Eleanore, and her husband Steve, also recently retired from MDOT, won the Michigan Lottery recently, and will now have the opportunity to enjoy their good fortune...**Marv Fongers**, the Senior Electronics System Specialist with our Instrumentation and Data Systems Unit of the Research Laboratory, has retired after 31 years with MDOT. Marv started as an Electronics Technician in 1957 at the old Research Laboratory on the MSU campus, and remained with M&T in the electronics area for his entire career...**Dave Stepp**, who spent 10 years with the Research Lab's Materials Research Unit in the materials investigation area as an Engineering Technician has also retired...**Wayne Frederick**, another retiree who started in the old Research Lab, leaves his post as head of the Spectrochemistry and Photometry Unit. Wayne started with M&T as a Lab Aide in 1956, and has spent his entire MDOT career in the chemistry area...All of these people have contributed toward strengthening the transportation industry in Michigan in their various capacities. We take this opportunity to offer our profound thanks for their years of service to the Division and the Department, and to wish them the very best in the years ahead.

SPECIFICATION UPDATE

Electrical Grounding System, 5.03 (9b), dated 10-31-86. The changes that this revision makes are in materials and in construction methods and the changes were required to include the latest technology and to reflect current practice. Further, the pay unit was changed from lump sum to each.

Guard Rail Anchorage, Cable - Departing End, 6.13(4a), dated 03-13-87. This revision adds the pay item: Thrie Beam Guard Rail Anchorage, Cable - Departing End. This pay item includes the terminal end shoe - Thrie beam.

Solvent Used in Making Field Extractions, 7.10(19), dated 04-13-87. This new specification is notification to the Contractor regarding the change in solvent to be used in making field extraction tests on bituminous mixtures. The reason for the change to Bioact DG-1 solvent from trichlorethylene solvent is that Bioact DG-1 produces a non-hazardous waste.

Environmental Protection Requirements for Bituminous Plants, Concrete Plants, and Crushing Plants, 1.07(3), dated 05-20-87. This new specification requires the Contractor to obtain an air quality permit for portable plants prior to installing the plants. The permit is required under the current Michigan Department of Natural Resources air quality regulations.

Schedule of Retained Earnings, 1.09(8), dated 06-02-87. The change that this new specification makes is that the Department may reduce the amount of retained earnings to 2 percent when the Engineer has given notice that the project has attained 90 percent completion instead of 95 percent.

Delineator Reflectors, 8.26(4a), dated 07-13-87. This specification is revised to permit use of delineators with either a plastic housing or no housing as an alternate to delineators with aluminum housing; also, the reflective lens is specified to have a nominal area of 7 sq in. rather than minimum area of 7 sq in. The changes were made to bring products, that are currently in use, in conformance with specifications.

We deeply regret to record the sudden and unexpected passing of **Reginald Craft** on June 4th at age 47. Reggie came to the Testing Lab in Ann Arbor in 1963, having transferred from the Construction Division. In 1973, he came to work in the Bituminous Technical Services Unit, where he was employed as a Technician in the Analytical Lab. He will be remembered as a conscientious worker and technician, but Reggie was an asset in other ways as well. He was a cheerful man, always willing to be of help to others, and to offer an optimistic word or two. With Reggie's untimely passing we have lost an excellent employee, a father and husband, and a friend.

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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