MATES

MICHIGAN DEPARTMENT OF TRANSPORTATION

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TEAR IT OUT OR COVER IT UP? [CONCRETE OVERLAYS]

Tear it out or cover it up is the decision that must be made by those assigned to design a fix for old, worn out concrete pavements. Complete removal and replacement is the most desirable method, but one that is very costly. In certain cases, a long-term solution can be realized by placing a new concrete pavement on top of the old one. Such a pavement is called an overlay.

Concrete overlaying as a method for rehabilitating or extending the service life of an existing pavement was used by the Department from the early thirties through the mid-fifties. During that period, a total of 21 overlays were constructed, some of them to widen narrow pavements on the old roadways. Their thickness—reflecting the lower traffic volumes of that time—ranged from 4 to 6 in., and these 'thin' overlays performed reasonably well for many years. Now with the Interstate and many other heavily traveled routes needing rehabilitation or reconstruction, the concrete overlay has again emerged as an alternative to total reconstruction. Most of the overlays currently being constructed nationwide are 6 to 13 in. thick to handle the predicted volumes of commercial vehicles in the future.

Overlay Types - There are basically two types of overlays, bonded and unbonded. The bonded overlay is placed directly on an existing concrete slab that has been cleaned by scarifying or other means so that the newly applied layer will stick securely to the old pavement. This type is used only when the existing pavement is in good condition, but needs strengthening to carry increased commercial traffic. Unbonded overlays are placed on a separation medium, or 'bond breaker' layer, constructed on the existing concrete pavement prior to concrete placement. The separation, or debonding, layer is designed to allow independent movement of the old and new concrete pavement slabs. The Department's experience is confined to unbonded overlays, thus only this type will be discussed.

Condition of Existing Pavement - As a first step in designing a concrete overlay, the physical condition and structural capacity of the existing pavement must be determined. A visual survey will provide data on the amount of distress present at the joints and cracks. The structural capacity of the pavement must be checked by a falling weight deflectometer or some other measurement system that can determine the support capability of the old slab. The drainage system's adequacy needs to be verified and the number of over and underpasses recorded to determine the amount of pavement removal needed to taper into and out of underpasses, and to maintain clearance under overpasses.

Preparation of Existing Pavement - Experience has shown that severely distressed areas in the existing pavement may provide inadequate support for concrete overlays. These areas have contributed to concrete cracking and premature steel fractures in reinforced overlays in the past. To ensure proper support conditions throughout the length of an overlay, full-depth concrete repairs should be used to replace severely distressed pavement sections. In locations where drainage is a problem, edge drains should be installed to improve the removal of water from the base material.

Debonding Material - The most commonly used debonding medium is a layer of sand-asphalt hot mix, with thickness ranging from 1/2 to 1 in. Its effectiveness is improved by applying two coats of curing compound prior to concrete placement.

Slab Thickness - The required slab thickness is determined by use of available emperical or theoretical equations, involving commercial traffic volume, existing pavement condition, etc.

Reinforced Overlays - Steel reinforcement is used when the overlay design specifies long slab lengths (i.e., over 15 ft). The percentage of steel required is such that when a crack occurs the reinforcement will hold the crack tightly closed, thereby maintaining aggregate interlock for load transfer across the crack. Transverse joints in reinforced overlays are dowelled using 1-1/4-in. dowels on 12-in. centers, and the joint groove shape factor (ratio of width to depth) is in conformance to the movement anticipated at the joints. For slabs over 40 ft long, preformed neoprene seals are effective; whereas for shorter slabs, silicone sealants have shown good performance.

Unreinforced Overlays - These overlays have shorter slab lengths (approximately 15 ft), no reinforcing steel, and may have non-dowelled joints. Aggregate interlock plus support of the underlying concrete slab provide load transfer across the joints. Since the slabs are short, transverse cracking is not as prevalent as it is in long reinforced slabs. The small movements occurring at the joints can be effectively sealed using a silicone sealant.

Joint Location - In unbonded overlays (reinforced or non-reinforced) it is common practice to offset the joints in the overlay from joints or transverse cracks in the old pavement by 3 ft. This offset ensures better load transfer at the overlay joints especially at undowelled joints since the unbroken underlying pavement provides support to both sides of the joint.

Performance of Recent Overlays

In 1984 the Department constructed two 7-in. reinforced, unbonded, dowelled concrete overlays. One is located on US 23 near Dundee and one on I 96 near Portland. Both overlays are separated from the underlying pavement by a 3/4-in. sand-asphalt layer, and both have reinforced concrete shoulders. The original pavement on US 23 was a reinforced jointed pavement placed in 1959-61. It was in poor condition when overlaid, in that there were many joints and cracks that were heavily patched with bituminous cold patch material. Those portions of the original I 96 pavement, placed in 1958, that were continuously reinforced, had previously been sawed into 100-ft slabs to reduce the movement at repairs. The remainder of the existing I 96 pavement was conventionally reinforced, similar to the US 23 pavement, but in somewhat better condition.

Observations, measurements, examination of cores, and load tests indicate that the overall performance of the five year old overlays has been satisfactory. Substantial variation in joint movements shows that the bituminous debonding layer does not allow totally independent movement in the two concrete layers. Comparison of the location of cracks or joints in the two pavements show that cracks that have formed in the overlay are likely to be near a crack or joint in the old pavement. Load testing with a falling weight deflectometer showed a substantial increase

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in load transfer efficiency at joints and a significant decrease in mid-slab deflection in the overlays as compared to an adjacent 9-in. recycled pavement placed on a 4-in. open-graded base. This confirms the increased load bearing capacity of the old pavement beneath, supporting the new overlay pavement.

Based on the performance to date of the two overlays, it is concluded that concrete overlays are a viable alternative to reconstruction when the existing facility can accommodate the extra overlay thickness. Clearance under bridges, however, generally is not sufficient to allow a 7 to 8-in. overlay, so special pavement removal and replacement usually is required. This adds considerable costs to a job, especially if there are many bridges.

Careful consideration should be given during the design process to the condition of the existing pavement and to the volume of commercial traffic the overlay will carry. This is necessary to ensure that the overlay will be of adequate thickness. Severely deteriorated and bituminous-patched areas in the existing pavement should be repaired to minimize premature failures at such locations. In addition to using a sand-asphalt layer or similar substance for debonding purposes, the application of two coats of curing compound to the asphalt surface enhances independent movement between the two layers. An offset of 3 ft between joints or cracks in the two concrete layers should be maintained to improve load transfer efficiency of the overlay joints.

-Jens Simonsen

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.

PAUL MILLIMAN RETIRES

Paul started his career with the Materials and Technology (then Testing and Research) Division in December 1950 as an Aggregate Inspector A1 for the Research Laboratory, then located on the campus of Michigan State University. He served in many positions during his career with the laboratory, and had been head of the Physical Research Unit, the Lab's largest, for 14 years when he left the Division. Paul left in November 1980 to become head of the Engineering Services Division. After the retirement of Kent Allemeier, Paul returned to his old home as Materials and Technology Division Engineer in April 1985. We wish Paul and his wife Nancy many wonderful years in which to fulfill a new set of pursuits and goals in a well-earned retirement.

NEW MATERIALS ACTION

The New Materials Committee recently:

Approved

- Interlocking Paving Stones - Unilock
- EP-IS 650 Crack Injection System - Hilti

Approved for Trial Installation

- Flexx 2020 Flexible Delineator
- Pavetech Bridge Joint System
- PACE Rubber Railroad Crossing
- Contech Hel-Cor CL "HCCL" Pipe

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

JAMES D. CULP NEW DIVISION ENGINEER

With the retirement of Paul Milliman, Jim Culp has been named Materials and Technology Division Engineer. Like his predecessor, Jim worked for M&T for several years, left for another position in the Department, and now returns as head of the Division. Jim joined the Department in April 1970 as a Civil Engineer 7, in Bridge Design. In November 1971, he moved to the M&T Division's Research Laboratory Section to work in the Structures Unit. When he left the Division in June 1985 he was supervising engineer of fabrication inspection for steel and concrete bridges, and our specialist in bridge structures and welding. At that time, Jim became the Department's staff specialist for bridges in the Construction Division, overseeing the statewide bridge construction program. Last summer he joined the Jackson District office as District Construction Engineer, overseeing all construction activities in the north half of the District. A graduate of Michigan State University, with a B.S. and M.S. in Civil Engineering, Jim not only brings education and expertise to the job, but also his vigor and enthusiasm. We're pleased to see him return.

So long MDOT MATES readers--

Before entering that great new phase of life called retirement, I felt a need, as one of my final work duties, to thank all you loyal MATES readers. Your continuing and enthusiastic interest, suggestions and support have encouraged our staff to press on with their efforts to give you carefully prepared technical articles of direct application, or value, to your work — be assured their efforts will continue.

As for me, I am looking forward to retirement with relish. I anticipate new things to do, new places to go, new interests, new friends and associates—a whole new life style and substance. My years of working with all of you have been filled with accomplishment, satisfaction and great fun, but now it is time for me to move on.

My wish for each of you is that your career proves to be as enjoyable and rewarding.

Paul

Paul Milliman
M&T Division Engineer

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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