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CONCRETE PAVEMENT REPAIRS

A concrete pavement, like most other products, wears out and sustains localized damage and needs periodic repair to prolong its service life. Generally speaking, concrete pavements are relatively maintenance-free the first eight to ten years after construction. Then a few repairs are needed at isolated spots and, as time goes on, the number of repairs required to maintain a reasonably smooth pavement increases. Once the number of repairs reaches 60 to 80 per mile it is no longer economical to continue to repair, and overlaying or reconstruction should be considered.

There are four different types of concrete pavement in use on Michigan's highways: jointed plain concrete pavement (JPCP) with and without dowelled joints, jointed reinforced concrete pavement (JRCP) with dowelled joints, and continuously reinforced concrete pavement (CRCP). Each pavement type ages in a different manner and each type requires different repair methods. The majority of the Department's concrete pavements are of the JRCP type and the repair methods described in this article were developed specifically for that pavement type.

Most of the areas needing early repair are at joints but, as the pavement ages, problems also develop at transverse cracks in the interior portion of the slabs. This deterioration is essentially caused by three factors: crumbling of concrete joint faces, intrusion of contaminants into the joints and cracks, and expansion of the slabs during hot, moist weather. The contamination consists of saltwater from ice and snow removal and incompressibles such as sand and silt entering the joints through aging seals. Saltwater, coupled with frost action, attacks the concrete at the bottom of the joint essentially reducing it to rubble over a period of years (Fig. 1). This deterioration is more rapid for some types of coarse aggregate in the concrete than for others. The incompressibles that have entered the joints and cracks resist the slab's returning to its original length during expansion caused by rising temperatures and moisture in the slab. Therefore, high compressive forces build up in the pavement during the springtime when extra moisture and higher temperatures cause joints to close on materials that infiltrated during the winter. When reduced slab cross-section at deteriorated joints can no longer resist the generated compressive forces, a crushing-type failure occurs. To repair these failures, it is necessary to replace a section of the slab with new concrete. The majority of these failures can be restored with a 6-ft long repair.

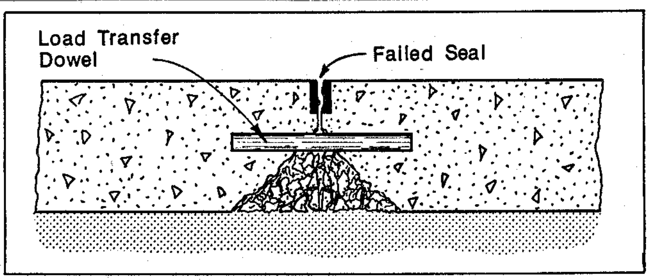

Figure 1.

Prior to 1970, slab repairs were cast in-place using a concrete mix that required a three-day lane closure for curing the concrete. This resulted in massive traffic jams during rush hour periods and it was evident that a more rapid repair method was needed. As a result, the Department developed a repair method using precast slabs that could be installed between rush hours and opened to traffic immediately. Later, a concrete mix was developed that gained sufficient strength for traffic exposure in four to eight hours. This led to cast-in-place concrete repairs that, in early years, were placed without load-transfer dowels. These patches were quite durable, but since there were no dowels, truck traffic coupled with water beneath the slabs, caused rearrangement of the base beneath the patches, and developed vertical offsets causing bumps at each patch. Further development of drilling procedures allowed the placement of dowels in repairs that then could bear traffic and still retain their smoothness. The dowelled repair is the Department's current standard method.

The entire repair procedure is as follows:

Repair Limit Layout - The length of the repair area is laid out perpendicular to the centerline of the roadway and marked on the pavement, the other limits being the shoulder or curb/pavement joint and the interior edge of the center lane joint.

Sawing - The repair limits are sawed full-depth using a diamond bladed saw. The use of full-depth saw cuts ensures that the distressed slab section can be removed without damaging the edges of the existing slab. Additional saw cuts may be made within the repair limits to relieve any compression in the slab and thereby facilitate removal of the failed concrete section.

Slab Removal - The distressed slab section is lifted out to prevent disturbing the existing base. This is accomplished by attaching a cable sling to lift-pins installed in holes drilled through sound areas of the slab and then lifting it out either by crane or front-end loader. Any debris left on the base is removed by hand tools or careful use of mechanical equipment, so that the existing compacted base is left in place.

Joint Construction - The transverse joints between new and old slabs are constructed by installing steel dowels in holes drilled into the end faces of the existing slab. These holes are machine-drilled and five dowels, spaced 12 in. apart, are inserted in each wheeltrack. A hole clearance of 1/16 in. is permitted to ensure that the dowels can be inserted in the holes and are free to slide during joint movements. Tie bars through the longitudinal joint are used only when the repair slab is over 20 ft long.

Forming - A form, either wood or steel, is required at the shoulder/pavement joint to establish a neat straight edge in line with the existing pavement edge. This requires a small amount of shoulder excavation to make room for the form. Once the form is removed the shoulder is restored in kind. Forming at lane joints is not necessary unless the adjacent lane is to be repaired at a later date; in which case, a piece of 1/4-in. bituminous joint filler or 1-in. styrofoam is placed against the adjacent lane to prevent the new slab from sticking or mechanically locking into the old broken slab in the other lane.

Placing Reinforcement - Conventional plain wire reinforcement is used in all repairs to hold the slabs tightly together in case they crack. The reinforcement serves no structural purpose, but since the slabs are opened to traffic after the concrete reaches approximately 1800 psi compressive strength, they are more susceptible to cracking than normal concrete pavement and the early opening to traffic justifies the reinforcement cost. The reinforcement mats are placed on chairs at mid-depth of the slab to ensure their proper location.

Concrete Placement - The replacement concrete has nine-sacks of cement per cu yd of mix, with calcium chloride added for accelerating set and strength-gain. The calcium chloride is added at the site and mixed into the concrete in the ready-mix truck's drum. Once the slump of a load has been established no additional water may be added to increase the slump. Consolidation with hand-held probe vibrators is required, and the concrete is struck-off at least twice with a vibratory screed resting on the existing concrete slab edges. The surface is finished by floating and then textured to match the adjacent pavement surface. Curing is accomplished by applying a white-pigmented curing compound to prevent loss of the water that is required for the chemical reaction within the concrete.

Joint Sealing - A transverse joint groove is formed by inserting a wooden forming strip along the existing slab edges. This strip is removed after the concrete takes its initial set, leaving a groove for joint sealing material. Prior to sealing with a hot-poured rubber-asphalt sealant, the groove is blast-cleaned with abrasives and then cleaned with oil-free compressed air. A bond breaking tape is installed in the bottom of the groove and the sealant pumped into the groove, leaving it slightly below the slab surface.

Opening to Traffic - Test beams are cast and broken prior to opening the repairs to monitor the strength development. Traffic is allowed on the repairs when a flexural strength of 300 psi is obtained. This is obtained after four to eight hours, depending upon temperature.

One of the more important factors in obtaining good performing repairs is the base. It must be left undisturbed so that it has the same support value as the base under the existing pavement. Care must be exercised to ensure that the dowel holes are drilled to proper size and alignment, and it is imperative that the concrete be well consolidated and finished properly to meet the elevation of the existing pavement slab to ensure a smooth riding repair. Finally, the aggregate used in the concrete into which the loose dowels are inserted must be durable and have good abrasive characteristics, otherwise the dowels may wear the holes oblong which could result in faulting of the joints. All of these factors, properly controlled, provide durable, smooth riding repairs that greatly extend the useful lives of our existing concrete pavements.

-Jens Simonsen

GETTING THE LEAD OUT

In the past, Michigan's bridges were routinely painted with red-lead based coatings. Because of the potential health hazard involved with using lead-based paints, as well as the development of durable lead-free coatings, MDOT is now completely removing the lead-based coatings from our bridges and applying the new paint system (MATES Issue No. 3).

In order to remove the old lead-based paint, the structure must be sand-blasted clean. The results of the sandblasting process is a residue consisting of spent abrasive particles and particles of the old paint. In some instances, the lead contained in this residue exceeds the amount that the Federal Environmental Protection Agency (EPA) considers a possible health hazard. In the case of 'leachable lead' (lead that could escape from the material into the environment due to rainfall or other moisture conditions), any material containing more than five parts per million (ppm) is considered to be a 'hazardous waste.' Should the residue contain more than 5 ppm leachable lead, it must be deposited in a special facility that is specifically designed to receive hazardous waste. Dumping in such a facility is very expensive compared to disposal in an ordinary landfill.

The Spectroscopy Unit of the Research Laboratory Section has set up a program for analyzing the spent abrasive/paint residue so that the residue from those cleaning jobs containing less than 5 ppm are not needlessly shipped to costly, special disposal sites, while also ensuring that any residue that exceeds this amount is safely disposed of at such sites.

Samples are taken on the job site by District personnel using a standard sampling method. These are shipped to the Research Laboratory where our chemists extract the lead from the samples by means of a standardized EPA test method. The amount of lead present is then detected by means of sophisticated atomic absorption equipment.

In 1988, abrasive/paint samples from 70 structures were analyzed at the lab for lead content. Twenty-eight were determined to contain slightly over 5 ppm leachable lead, while 42 contained less than 5 ppm. Thus, the Division has been able to save the Department considerable money by diverting harmless waste from expensive disposal facilities, while still fulfilling the Department's policy of protecting Michigan's people and environment from possible harm.

-Parker Fairey

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

Evaluation of Improved Calcium Magnesium Acetate as an Ice Control Agent - *Final Report*, Research Report No. R-1296, by J. H. DeFoe. The report describes the field handling properties of a pelletized form of calcium magnesium acetate (CMA) used as a deicer on a portion of I 69 near Charlotte. The material was rated by maintenance crews handling it and by Materials and Technology staff. It was found that the new pelletized form of CMA is easier to use than the flaked form used in the previous field trial, but still is troublesome due to 'caking' on equipment. The CMA was somewhat less effective than salt in melting snow and ice even when applied in much greater amounts. However, it did remove the snow from the roadway. Calcium magnesium acetate is a useful alternative material for ice and snow control for special applications where salt use must be limited; however, costs are extremely high at the present time.

SPECIFICATION UPDATE

Prestress Strand, 8.05(1), dated 01-12-89. This supplemental specification covers the requirements for identifying, certifying, handling, and storing prestress strand.

Glass Beads for Use in Pavement Marking, 8.17(5), dated 01-26-89. This supplemental specification consolidates several special provisions for glass beads into a single specification.

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.

Technology Transfer Unit
Materials and Technology Division
Michigan DOT
P.O. Box 30049
Lansing, Michigan 48909
Telephone (517) 322-1637