MATES
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RUBBLIZING

Reflective cracking of flexible (bituminous) pavement overlays, above joints and cracks in old rigid (concrete) pavements underneath, causes the lives of the overlays to be considerably shorter than they would be if the cracking could be prevented. Elimination of such cracking would save millions of taxpayers' dollars every year, and the Department continues to search for ways to remedy the problem.

This is the second MATES issue devoted to techniques that the Department is investigating to prevent or delay the appearance of such reflective cracking in flexible overlays on rigid pavements. Issue No. 32 discussed projects built using the crack and seat method, where a considerable amount of reflective cracking still was found to occur. Nearly all of Michigan's trunkline concrete pavements have steel rod "mesh" reinforcement in the concrete. Some of the problems with cracking and seating obviously result from the steel reinforcement continuing to hold the cracked concrete pieces tightly together, in the old concrete pavement beneath the overlay.

Rubblizing Projects

The next step beyond crack and seat is a technique called rubblizing. As the name suggests, the reinforced rigid pavement is reduced to rubble, destroying the continuity of the concrete slab. The intent is to separate the portland cement concrete from the reinforcing steel. Some preliminary work was done on a ramp of I 96 near Portland in 1986. Initial load-deflection testing indicated that the rubblized concrete provided an adequate base support for the overlay. The usual reflected cracks did not appear. Therefore, two much larger projects were selected for construction during the 1987 season.

A five-mile project on I 94 at Battle Creek was intended as the primary experimental section as it is subject to high volumes of heavy trucks. A conventional joint repair and overlay were constructed on the east half and the rubblizing and overlay were done on the west half. Underclearance at bridges was maintained by removing the rubblized concrete, and constructing full-depth bituminous pavement sections where the roadway passed under the bridges. In addition to three different overlay pavement designs on this project, the eastbound roadway was paved with a 6-in. latex modified mix while the westbound was built with a 6-in. conventional mix. Adding latex to bituminous paving mixtures in the Laboratory had indicated an improvement in tensile strength and reduced tendencies for ruts to form in the wheel tracks.

Two and a half miles of a five-mile project on I 75 south of Mackinaw City were also set up for rubblizing and covered with a 5.5-in. overlay. This roadway has considerably less traffic than I 94. No control section was constructed on this project but its performance has been followed by laboratory staff.

Drains were installed adjacent to the edges of the pavement prior to breaking, to assure positive drainage of the rubblized concrete on both projects. A prefabricated drainage system was placed and backfilled. Then the rubblizing process was accomplished by a resonant pavement breaker. The breaker acts on the principal of a tuning fork. A huge steel "tuning fork" is mounted on the front of a diesel powered tractor. A steel plate breaking-shoe at the end of the tuning fork bears against the pavement (Fig. 1). The fork is vibrated by rotating eccentric weights, at a frequency of 44 blows per second. The operator has some control over the force exerted by raising or lowering the breaking-shoe and also can change the size of the shoe to distribute the energy over larger or smaller areas. The speed of forward movement of the machine also provides some control over the energy input to the pavement. Specifications required the surface of the pavement to be broken into nominal 1 to 2-in. pieces. This required the breaking-shoe to be run over 100 percent of the surface area, and sometimes repeated runs over the same area were needed to attain the required breakage. When the surface pieces are 1 to 2 in., the pieces at the bottom of the slab generally are about 1 ft or less in diameter, and the steel reinforcement is effectively separated from the concrete.

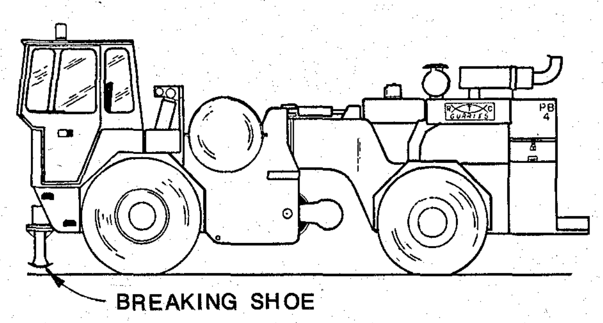

Figure 1.

The appearance of the broken pavement was very different at the two sites. At Battle Creek, the resonator appeared to have separated the mortar from the rounded stones in the old concrete pavement leaving a material with an open gradation. At Mackinaw City the concrete had been made with crushed limestone, and seemed to crack into pieces without separating mortar from the blocky pieces of stone. Following a light rain, the compacting roller caused the surface at Mackinaw to appear more closed and tight, giving the appearance of more stability.

Post-Construction

At Battle Creek ruts up to about 1/4 in. deep began to appear in the eastbound wheel tracks early in the spring of 1988. Investigation revealed that rut depths were the same on the rubblized and control sections. The treatment of the original concrete had not contributed to the problem. Pavement deflection measurements were made at Battle Creek using Benkelman beams and a loaded truck for weight to assess the strength of the rubblized base. Calculations revealed that the rubblized base provided only about one-third as much support for the pavement as had the earlier rubblized base on the I 96 ramp.

More recently, longitudinal cracks with associated transverse cracks have appeared in the wheel paths in a limited area in the rubblized section. The appearance is similar to cracking that occurs on other projects where traffic loading exceeds the ability of the base to provide support for the pavement. Basically, a stiffer or stronger support

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is required for the pavement to withstand such heavy truck loadings.

Bituminous pavements normally are placed in two or more layers (leveling and wearing course). Sometimes a base course is placed beneath the two. The top or wearing course was not installed at Mackinaw City in the fall of 1987, and traffic ran on the leveling course throughout the winter. Early in the spring, a significant amount of longitudinal cracking was noted, most of which was in the wheel paths. Saw cuts were made across several cracks and the slab and base removed. It was noted that larger (6 to 10 in.) pieces of concrete occurred in the old pavement surface on one side of the crack, while on the other side the pavement had been broken to a smaller size. Apparently this non-uniformity underneath caused the pavement to crack under the repeated passage of trucks.

Future of Rubblizing

While there have been problems with the first attempts at rubblizing, it has been noted that reflective cracking essentially is prevented by the rubblizing process. If rubblizing can be improved to provide the needed uniformly stiff support, then major improvements in performance of bituminous surfaces may result. Based on early results, it appears to warrant some additional study.

These investigations, discussions at post-construction meetings and subsequent evaluations, have resulted in changes in the Special Provision for Rubblizing. Additional effort will be required in rolling the rubblized base prior to paving on future jobs. Additional projects on lower traffic routes have been set up to further improve the process. There is little doubt that reflective cracking has been eliminated. The trade-off has been the loss of base support. Further measurements are planned and additional efforts will be made to raise the strength and stiffness of the rubblized base. A new, falling weight deflectometer vehicle has been obtained by this Division. This instrument allows faster and more accurate load-deflection tests to be made. These tests will aid considerably in our ability to determine pavement support conditions for the rubblized projects, and will be used extensively on other types of pavements as well. This new instrument is another important addition to M&T's pavement evaluation capacity.

-Larry Heinig

THE TRUCK WEIGHT QUESTION

A question frequently asked of us in MDOT is, "Why doesn't one truck weighing 164,000 lb (legal gross load limit in Michigan) cause more pavement damage than two 80,000-lb trucks (legal gross limit in many states)?"

The answer is that pavement damage is related to wheel loads. Trucks weighing 164,000 lb must spread the load among 11 axles, most of which cannot legally exceed 13,000 lb. For the 80,000-lb trucks, the load would be spread over only five axles (two sets of tandems and a steering axle). The tandems normally would be loaded to 34,000 lb each, with the steering axle at 12,000 lb. Therefore, the individual axle weights would be four each at 17,000 lb, plus one at 12,000 lb, for the total 80,000-lb gross load.

Load equivalency factors published by the American Association of State Highway and Transportation Officials (AASHTO) show that one 17,000-lb axle load causes almost three times as much damage as a 13,000-lb axle load. The same AASHTO tables show that one 18,000-lb axle load causes as much damage as about 5,000 automobiles. Our engineers have estimated that it would take about 2-1/4 of the 80,000-lb trucks to carry the same cargo as one 164,000-lb truck. Each additional truck must be towed by a tractor weighing about 16,000 lb that would also add to pavement load damage. Michigan truck registration figures for recent years show that about 13 percent of the trucks are licensed to carry more than 80,000 lb, but less than 1 percent of them are configured in such a way that they may carry the full 164,000-lb legal load. An additional 3-1/2 percent are licensed for 145,000 to 160,000-lb loads.

In addition to the question of load damage, there is the safety issue. Limiting gross vehicle weights to 80,000 lb would increase the number of trucks on the highway system, thereby increasing exposure to accidents.

Recently, the Transportation Research Board did an analysis of a Federal proposal to allow larger gross vehicle weights spread over more axles, with each axle carrying less weight than presently allowed. This so-called "Turner Proposal" would allow a gross vehicle weight of 110,000 lb with most axles being limited to 12,000 lb. It was concluded that annual pavement rehabilitation costs would decline by $250 million while bridge costs would increase $75 million per year. It is estimated that shippers would save $3.4 billion per year under the Turner Proposal. This proposal is currently being evaluated by AASHTO before recommending it to Congress.

Michigan has been designing bridges to carry the heavier loads for years. Under a previous law, Michigan trucks were allowed to have 13 axles and legally could carry gross loads of 169,000 lb. Departmental research at that time (early 1960's) showed that bridge design criteria were sufficiently conservative that the bridges were not overstressed by the 169,000-lb loads.

-Chuck Arnold
-Fred Copple

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) on a portion of I 69 near Charlotte. The material was rated by maintenance crews handling the material and by Materials and Technology staff. It was found that the new pelletized form of CMA is easier to use than the flaked form of the material used in the previous field trial, but still is troublesome due to its caking on equipment. The CMA was somewhat less effective than salt even when applied in much greater amounts, but 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

Measurement and Payment for Bituminous Mixtures Using Slag, 4.00(12), dated 01-12-89. The pay weight adjustment when using blast or steel furnace slag has been deleted. Data collected over the past three years indicate that the unit weights of mixtures containing slag are not significantly different than those without slag.

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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