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HIGH FRICTION BITUMINOUS PAVEMENT SURFACES THROUGH APPLICATION OF MDOT'S AGGREGATE WEAR INDEX (AWI)

The frictional properties of a bituminous pavement are largely due to the character of the exposed coarse aggregate particles in the bituminous mix. As traffic rolls over a new road surface, the scuffing action of the tires begins to wear it away and expose the coarse aggregate. This results in the polishing of some types of rock and a gradual degradation and wearing away of other types. The sum of the frictional properties of the various types of rock yields the frictional property of the roadway surface. There is an almost infinite number of possible rock type combinations and quantities, and it's no wonder that the friction levels of Michigan's road surfaces can vary widely. In 1971, a research project was initiated for the purpose of determining the friction properties of various rock types.

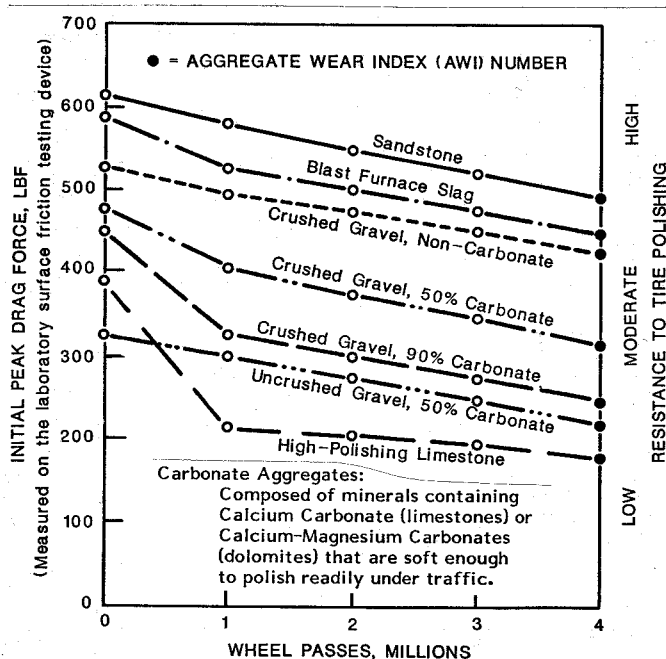
In a cooperative effort with the industry, a circular wear track was developed and built by M&T personnel to duplicate and accelerate the effects of tire polishing of pavement aggregates. Sixteen evaluation slabs for each test run are cast in the laboratory, utilizing different aggregates or combinations of aggregates. These are clamped to a 7-ft diameter concrete pedestal. Two untreaded test tires on automobile wheels are mounted on a horizontal cross-arm, powered by an electric motor, and spring-loaded against the slabs to about 800 lb to simulate vehicle weight. As the arm rotates, the two test tires roll around the circle, over the 16 test slabs. Wheel passes are recorded by a counter that is preset to stop the machine after 500,000 wheel passes.

At this point, the slabs are removed and skid-tested on another lab-built device, consisting of a full-sized smooth test tire mounted on a framework containing a calibrated load cell. The slab is sprayed with water, the wheel is accelerated to 40 mph, and dropped on the test slab. The force generated by the tire-slab contact is measured by the load cell and recorded on a high-speed oscillographic chart recorder. After the friction measurements, the slabs are remounted on the wear track and submitted to another 500,000 wheel passes, and skid-tested again. This is repeated until the test is terminated at 4,000,000 wheel passes. Each 500,000 wheel-pass interval provides a datum point for each aggregate, and these points are charted to generate curves representative of the polishing process. Plots for several different materials, at 1,000,000 wheel pass intervals, are shown in the figure. The wear track became operational in 1975 and has been in constant use since.

During the time the wear track was being developed, a study was conducted to determine the physical properties of the various rock types found in local gravel deposits. Technicians on temporary winter assignment, under the supervision of M&T geologists, separated out 24 rock types from about 30 tons of Michigan gravels. Their separations were then double-checked by the geologists. Each rock type was then tested separately on the wear track, providing us with the frictional and wear or polishing properties of all 24 rock types.

Once 'friction numbers' (after 4,000,000 wheel passes on the wear track) were established for individual rock types,

mixtures of rock types could be assigned a friction number if the percentage of individual rock types that constitute the mixture were known. That is, by taking the percentage of the individual rock types in the mixture, and knowing their friction numbers from the wear track tests of these types, we could mathematically calculate a single friction number for the entire mixture. Friction numbers thus were calculated for a number of mixtures. These same mixtures were then cast into wear track test slabs, subjected to the 4,000,000 wheel passes, and the actual friction numbers from the wear track tests were compared with the computed friction numbers. A statistical analysis was performed of many comparisons and a high correlation of nearly 0.95 was found between the computed friction numbers and the actual wear track values. This was the foundation of the aggregate wear index (AWI).



It takes several weeks to obtain a friction value from the wear track, but with the mathematical determination method reducing this time to hours, we now have a tool to not only determine rapidly and accurately the friction value of a mixture of different aggregates, but also to place minimum friction requirements on aggregates to be used in bituminous roadway surfaces.

A team was established to do this and eventually a specification was generated for selection of aggregates to give a minimum friction number under the expected traffic. There is a variable scale based on average daily traffic per lane and the classification of the roadway type. The highest friction requirement, for example, is placed on roadways

Testing Laboratory
U of M 1913

Research Laboratory
MSU 1939

Investigation and Research Division
1924

Testing and Research Division
1933

Materials and Technology Division
1985

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having a high average daily traffic and located in an urban area. In 1981, a trial paving project on M 33 was approved with an AWI requirement. In 1984, the AWI concept, including computer-generated AWIs, was presented to our aggregate production industry. In 1985 and 1986, AWI requirements were phased-in statewide.

AWI values now are routinely determined by a geologist for all bituminous mixtures used for the top layer of pavement, processed through the Testing Laboratory. If a gravel pit or quarry source does not have a satisfactory AWI, the contractor has the option of using another, better source, obtaining the required AWI by blending coarse aggregates with high friction material, or by using a coarse aggregate meeting AWI specifications as a sprinkle treatment. This last method is a system whereby a high friction aggregate is precoat with bitumen and sprinkled in a single surface layer immediately behind the paver. It is rolled in and becomes part of the roadway surface. This is done for some projects to attain the required frictional properties in the roadway using locally available, low friction aggregate, while minimizing the amount of high friction aggregate that must be hauled to the site from a distant source.

In summary, the AWI system is another tool to assure safer roads for the motoring public. It makes it possible for pavement designers to provide long-term, satisfactory frictional performance. The options of blending or sprinkle treatment permit the optimum use of available aggregates from both the safety and economics perspectives. With the trend toward higher speeds and increased traffic volumes, the need for polish-resistant bituminous pavements is becoming increasingly important. The AWI is another example of the Department's dedication to quality and safety for the traveling public.

-Don Malott

EVALUATION OF REINFORCEMENT FABRICS TO RETARD REFLECTIVE CRACKING

In recent years, considerable experimental work with fabrics as reinforcement for asphalt overlays has been underway across the nation in search of a practical solution to the problem of reflection cracking in bituminous resurfacing. Reflection cracks are cracks in a new surface that 'reflect' through from joints and cracks in old surfaces below, and are caused by vertical and horizontal movements due to traffic, or temperature and moisture variations in the existing pavement beneath the asphaltic overlay. Because of these movements, the working joints and cracks in the underlying pavement 'reflect' through the overlay, generally after one or two years of service. Prevention or reduction of reflection cracking is critical to the service life of the rehabilitated pavement.

An investigation was designed by the Research Laboratory to place six different types of commercially available fabric strips as reinforcement over conventionally repaired joints and cracks in a 43 year old reinforced concrete pavement being prepared for asphalt resurfacing (Eastbound I-94BL in Kalamazoo between Howard and Michigan). Its purpose was to determine reflection crack performance of these fabric-treated and untreated conventionally repaired joints (used as controls for comparison) in the asphalt overlay. The trial project consisted of a mile-long section of concrete pavement exhibiting substantial transverse joint failures and cracks where repairs were required before resurfacing. Both longitudinal and transverse joints were treated with fabric for the evaluation.

In general, the fabric strip treatment over each test site required 1 to 2-ft wide strips for longitudinal joints (lengthwise of the pavement) and cracks and 2 to 6-ft wide strips for repaired transverse joints (crosswise of the pavement). Transverse joints and cracks were fabric treated (reinforced) before the longitudinal joints according to the manufacturers' recommendations. The fabric strips covered the entire length of the longitudinal test joint throughout each test section and the entire width of the transverse test joints and cracks at each test section. The first portion of the overlay was placed in the fall of 1981 and the project was completed in the spring of 1982.

Since completion of the resurfacing project in May 1982, annual detailed crack surveys have been made during cold weather when existing working cracks and joints in the old pavement open up. Reflection cracks, visible under dry surface conditions and generally located directly over the underlying fabric treated joints and cracks, were expressed in terms of percentages of the total length of test joints and cracks in the old pavement that have reflected through the new overlay. After three and one-half years, 54 percent of the transverse joints and cracks have reflected through the overlay in the conventional non-reinforced overlay sections. In comparison, 34 percent of the joints and cracks in the fabric reinforced sections have reflected through. For the individual fabrics, however, only 14 percent of the cracks and joints in the most effective fabric had reflected through, while for the least effective as much as 62 percent reflected through. Total cost for applying the fabrics ranged from \$3.30/sq yd to \$13.50/sq yd of fabric.

Results of this field trial show that all but one of the materials reduced (but did not completely prevent) reflective cracking as compared with conventional crack and joint sealing treatments. Data from the study are being evaluated to determine the relative cost effectiveness of the different fabrics for inhibiting both transverse and longitudinal reflection cracks.

-Jack DeFoe

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.

NEW PERSONNEL

We have the pleasure of welcoming four new staff members to the M&T Division. Mike Krause, Transportation Engineer VIII, has come aboard to fill the position of Assistant Specifications Engineer. Judy Ruskowski, Transportation Engineer VII, joins the District Support Section as a member of the newly established Environmental Unit. Larry White, Transportation Engineer VII, also joins the District Support Section as a member of their Geotechnical Testing Unit, replacing Paul Marttila, who has transferred to Metro. Greg Cooper, Engineering Technician II, is a new member of the Testing Laboratory, employed in the Concrete Lab. All are valuable additions to the M&T/MDOT staff, and we look forward to working with them.

SPECIFICATION UPDATE

Open-Graded Aggregate 8G, 8.02(8), dated 07-01-87. This new specification deletes the uniformity coefficient requirement, footnote (h) of Table 8.02-1 of the 1984 Standard Specifications, for open-graded aggregate 8G. The reason is that some producers of open-graded aggregate 8G have to add fine materials in order to meet the uniformity coefficient and since the addition of fines defeats the purpose of a free draining material, the coefficient was deleted.

Plastic Drum Alternates for Type II Barricades, 6.31(8c), dated 07-10-87. Three additional plastic barrels were added to the list of approved alternates to steel drums: Bar-L-Cade II, PB-55 Econo Drum, and PB-85 The Commander.

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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