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M•DOT
FINE AGGREGATE TESTED ON THE
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CIRCULAR WEAR TRACK

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MATERIALS and TECHNOLOGY DIVISION

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FINE AGGREGATE TESTED ON THE MICHIGAN DEPARTMENT OF TRANSPORTATION CIRCULAR WEAR TRACK

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ACTION PLAN

1. Materials and Technology Division

    A. Project completed, no further action necessary.

2. Engineering Operations Committee

    A. Recommended development of new bituminous mix design if warranted by report findings.

SUMMARY

Previous MDOT wear track evaluations have measured the polishing resistance of the coarse aggregate components of bituminous top course mixtures. The MDOT Aggregate Wear Index (AWI) for aggregates in bituminous top course mixtures was implemented to match the polishing resistance of coarse aggregates to the amount of traffic anticipated on trunklines. Recent changes in bituminous mixture designs have resulted in greater use of dense-graded aggregates which are composed of larger percentages of fine aggregates. Inquiry into the frictional performance of fine aggregates prompted the scheduling of a special wear track series to evaluate the polishing characteristics and frictional performance of selected fine aggregates. The polishing tests indicated that the fine aggregates, including high-polishing limestone, exhibited considerably higher frictional performance than the coarse aggregates. The increased frictional performance was found to be due to the smaller particle size rather than sacrificial removal of aggregate from the test specimen surfaces. Based upon the results of this wear track series, the development of bituminous top course mixtures with greater exposure of fine aggregate is recommended. The mixtures would be specially designed with the fine aggregate throughout the mixture to maintain fine aggregate exposure as the surface material is removed by traffic wear. The frictional characteristics of the fine aggregate component of bituminous pavements should be considered when investigating the relationship between aggregate qualities and pavement friction.

INTRODUCTION

In 1974, the MDOT circular wear track was constructed for the initial purpose of testing quarried carbonates and high-carbonate gravels for resistance to tire-polishing. Quarried carbonates and high-carbonate gravels from the available sources were evaluated, followed by investigation of the effects of tire-polishing upon typical glacial gravels, slags, blends, and the rock type components of glacial gravels (1, 2, 3).

The results of the wear track tests on the gravel lithologies led to the implementation of the Department's AWI (Aggregate Wear Index) specification for aggregates used in bituminous top course mixtures. Aggregate Wear Index numbers assigned to the aggregates are used in conjunction with Average Daily Traffic (ADT) values to design bituminous top course mixtures that will resist the anticipated amount of traffic polishing during the service life of the pavements.

The AWI specification provided a systematic means of evaluating aggregates for use in bituminous top course mixtures, based upon the resistance to tire-polishing on the wear track. The specification resulted in the removal of a total ban on the use of quarried limestones, and lessened restrictions on the use of high-carbonate gravels in bituminous top course pavements.

Recent changes in the designs of bituminous top course mixtures have resulted in the use of dense-graded aggregates which contain greater amounts of fine aggregate than the previous mixtures. The increase of fine aggregate exposure on the pavement surfaces has prompted interest in the frictional performance of the fine aggregates as compared to the coarse aggregate components.

This report presents the results of a special fine aggregate wear track test series conducted to determine the frictional performance of selected crushed and uncrushed fine aggregates.

Test Aggregates

The following aggregates were included in the fine aggregate tests conducted as Wear Track Series No. 34:

Aggregate		Size Tested
Steel Furnace Slag	Crushed Fines	No. 8 to No. 30
Blast Furnace Slag	Crushed Fines	No. 8 to No. 30
Control Gravel	Crushed Fines	No. 8 to No. 30
Recycled PCC	Crushed Fines	No. 8 to No. 30
Natural Sand	Uncrushed Fines	No. 8 to No. 30
Control Gravel	Crushed Coarse	3/8-in. to No. 4
Control Limestone	Crushed Fines	No. 8 to No. 30
Control Limestone	Crushed Coarse	3/8-in. to No. 4

The control gravel, included in each wear track series, contains approximately 40 percent carbonate material. The control limestone, also included in each series, is a very fine grained, quarried carbonate with a history of traffic-polishing.

Test Procedure

Test slabs for wear track evaluation of aggregates are cast with portland cement rather than asphaltic cement to avoid the deformation and particle dislodgement experienced with trial asphaltic specimens.

The preparation of wear track test slabs with fine aggregates presented a special problem, since the standard procedure would remove all cement and fine aggregate from the slab surfaces. Exposure of the fine aggregate on the slab surfaces was accomplished by replacement of the standard sand fine aggregate in the mortar with the test aggregate. After casting, the slabs were sprayed with a retardant which permitted removal of surface cement after a 24 hour setting period. The slabs were then cured and tested according to the standard test procedure (4).

Results of the Wear Track Tests

The effects of the wear track polishing are shown in Figure 1 which includes polishing curves for the individual test aggregates. The test

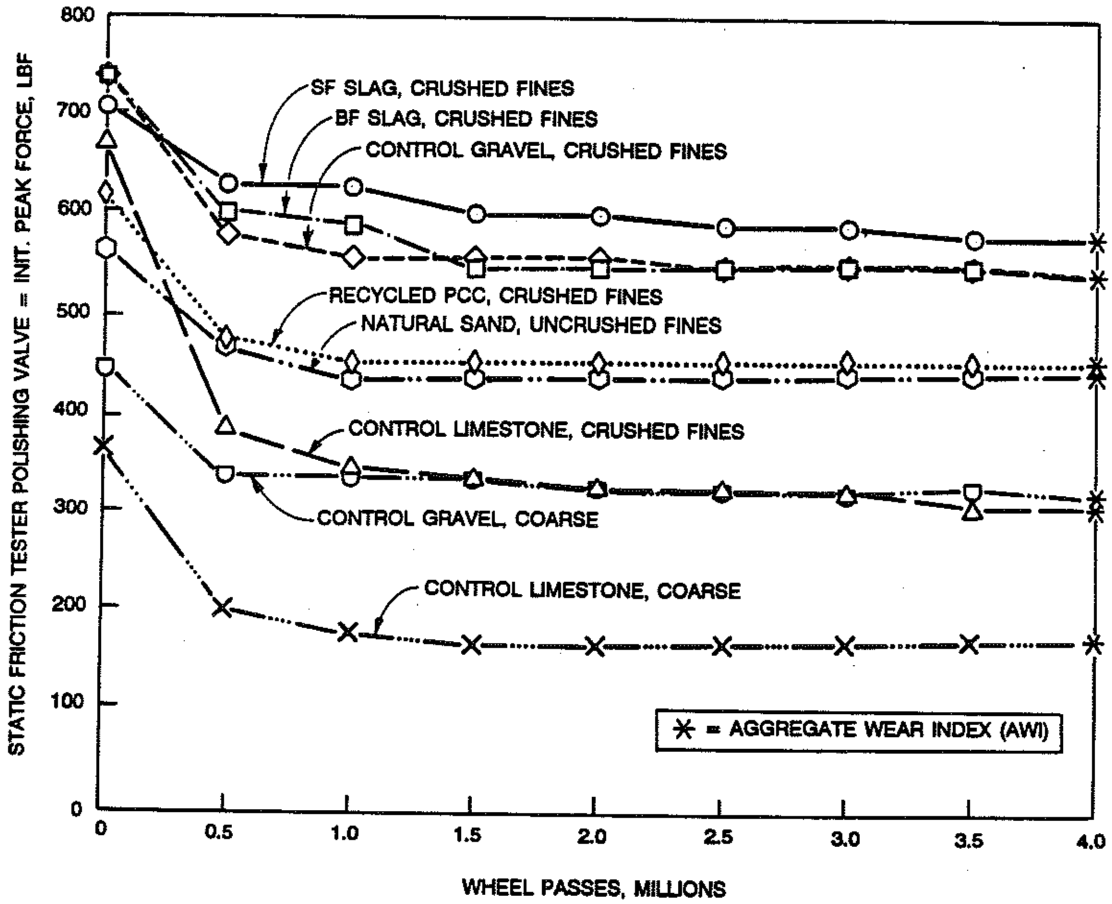

Figure 1. Wear track series No. 34 polishing curves.

results indicate that the fine aggregates recorded intermediate to very high frictional performance. The control gravel and control limestone aggregates, when tested as coarse aggregates, recorded normal control aggregate AWI values. For comparison of the AWI values, the following general AWI categories indicate the expected frictional performance:

AWI	Expected Frictional Performance
>400	High to Very High
300-400	Intermediate to High
200-300	Low to Intermediate
<200	Very Low to Low

The following tabulation includes the AWI values determined by wear track polishing tests:

Aggregate		AWI
Steel Furnace Slag	Crushed Fines	580
Blast Furnace Slag	Crushed Fines	540
Control Gravel	Crushed Fines	540
Recycled PCC	Crushed Fines	460
Natural Sand	Uncrushed Fines	440
Control Gravel	Crushed Coarse	320
Control Limestone	Crushed Fines	310
Control Limestone	Crushed Coarse	170

Condition of Aggregates After Wear Track Polishing

The test slabs with crushed fines incurred a small loss of particles during the first increment of wear track polishing. Examination of the test slab surfaces after successive polishing increments revealed no further loss of aggregate. The following observations summarize the examination of the test slab surfaces after completion of four million wheel-passes of wear track polishing:

Aggregate		Polishing Observed
Steel Furnace Slag	Crushed Fines	Slightly Polished
Blast Furnace Slag	Crushed Fines	Slightly Polished
Control Gravel	Crushed Fines	Carbonates Polished
Recycled PCC	Crushed Fines	Carbonates Polished
Natural Sand	Uncrushed Fines	Carbonates Polished
Control Gravel	Crushed Coarse	Carbonates Polished
Control Limestone	Crushed Fines	Highly Polished
Control Limestone	Crushed Coarse	Highly Polished

CONCLUSIONS

The wear track polishing tests of fine aggregates resulted in the following conclusions:

1) When crushed to fine aggregate size, all of the aggregates, including the high-polishing limestone, recorded at least intermediate frictional performance.

2) Natural sand, which contained rounded particles, recorded high frictional performance.

3) Polishing of the fine aggregate particle surfaces did not significantly reduce the frictional performance of the fine aggregates, in contrast to the considerable degradation of frictional performance exhibited by the coarse aggregates when highly polished.

4) The fine aggregate component of a dense-graded bituminous top course mixture can contribute significantly to high friction performance if adequately exposed on the pavement surface.

RECOMMENDATIONS

Based upon the results of the wear track polishing tests on fine aggregates, the following recommendations are made:

1) The development of bituminous top course pavements containing fine aggregate throughout the mixture should be considered. The use of fine aggregate throughout the mixture would maintain fine aggregate exposure as the surface material is removed by traffic. Wear track or other tests should be conducted to determine how well the fine aggregate mixtures perform when exposed to traffic wear.

2) The frictional characteristics of fine aggregate should be taken into consideration when investigating the relationship between the frictional properties of bituminous pavements and aggregates.

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