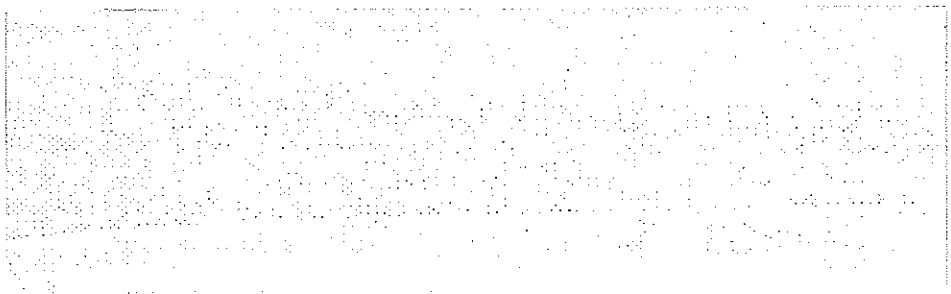
POLISHING RESISTANCE OF ARENACEOUS LIMESTONE FROM THE BAYPORT BEDROCK FORMATION

MATERIALS and TECHNOLOGY DIVISION



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POLISHING RESISTANCE OF ARENACEOUS LIMESTONE FROM THE BAYPORT BEDROCK FORMATION

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Samples of arenaceous (sandy) limestone from two quarries in the Bayport bedrock formation were tested on the MDOT wear track in 1976 and 1977 under Research Project 71 C13, "Study of Aggregate and Mix Requirements for Durable and Skid-Resistant Bituminous Mixtures" (1). Arenaceous limestone was found to be more resistant to tire-polishing than the non-arenaceous carbonate aggregates. Material sampled from a highly arenaceous bedrock ledge in the Wallace Stone Co quarry, Pit No. 32-4 was subsequently tested on the wear track in 1978. The material recorded a polishing resistance approaching that of sandstone, a high-friction aggregate (2). A more detailed investigation of this material was scheduled.

FIELD SAMPLING

Quarries in the Bayport Formation in Arenac, Huron, and Iosco Counties were reviewed for accessibility. The Wallace Stone Co quarry, Pit no. 32-4, in Huron County, was found to contain the most readily accessible bedrock exposures for detailed mapping and sampling and was selected for this study.

Mapping and Sampling

In 1981, a bedrock face in the subject quarry was mapped and marked with 14 sampling stations along a 1,390-ft traverse trending northwest to southeast. The bedrock face extended vertically from 6 to 14 ft above the quarry floor. In 1982, representative ledge rock samples were obtained from the individual beds at the 14 sampling stations. The bedrock members were identified in the field according to apparent visual distinctions, with Bed No. 1 at the base of the sampling face. A separate bench at the top of the face was designated as Bed No. 5. A total of 47 samples were obtained. Figure 1 indicates the beds and sampling stations.

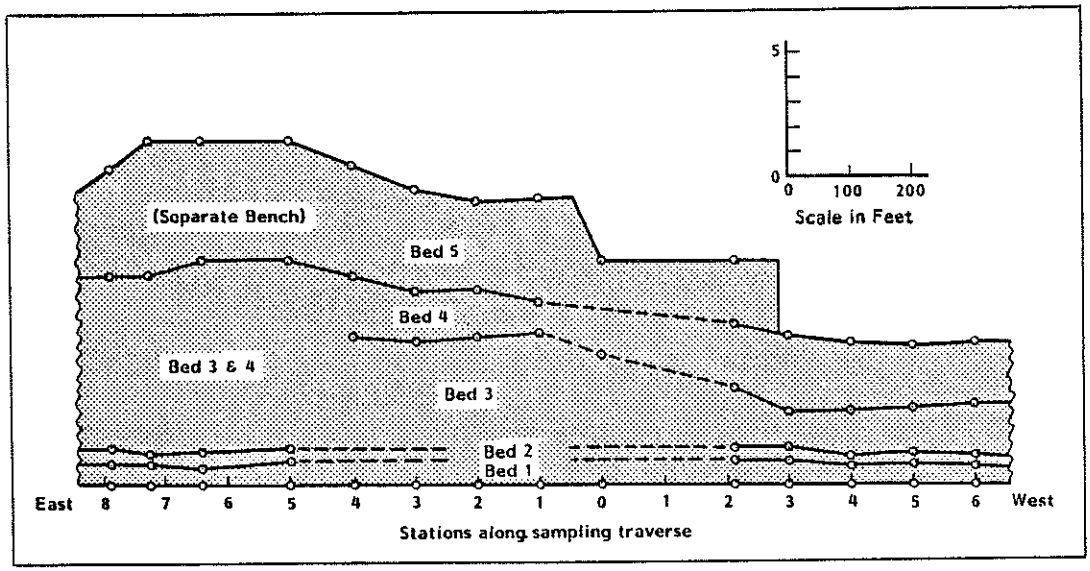

Figure 1. Cross-section of bedrock at sampling site.

LABORATORY ANALYSES

The samples were submitted to the MDOT Materials and Technology Laboratory for petrographic examination, determination of acid-insoluble residue content, and evaluation of resistance to tire-polishing on the MDOT circular wear track.

Petrographic Analysis

The bedrock ledge samples were examined according to Michigan Test Method MTM 104 "Standard Practice For Petrographic Analysis of Aggregates" (3). After examination the samples were crushed and graded for testing.

Insoluble Residue Analysis

A portion of each sample was subjected to dissolution in hydrochloric acid according to Michigan Test Method 103 "Test Method For Determination of Insoluble Residue in Carbonate Materials" (4). The insoluble residues were sieved to determine gradations, and examined for petrographic content.

Wear Track Tests

In 1983, wear track polishing tests were conducted on three grouped samples representing material obtained from the ends of the sampling traverse and an intermediate location. Wear track tests were conducted according to Michigan Test Method 111 "Method For Determining An Aggregate Wear Index (AWI) of Aggregates for Bituminous Top Courses By Wear Track Polishing Tests" (5).

Wear track polishing tests on blends containing 25 percent arenaceous limestone from the three grouped samples, and 75 percent high-polishing wear track control limestone were completed in 1986.

RESULTS

Petrographic Examination of Ledge Rock Samples

The predominant rock type in the ledge rock samples was identified as variable arenaceous limestone containing discontinuous, shaley traces and partings. The limestone varied from massive to thinly bedded with black shale partings along bedding planes. Silicified coral fragments and exposures of dense, bedded chert were present in a few of the samples.

Petrographic descriptions of the individual samples are included with the sample log in the Appendix.

Insoluble Residue Determinations

The predominant constitutents of the insoluble residues were identified as subrounded, frosted quartz grains concentrated in the No. 100 and No. 200 sieve fractions. Minor amounts of quartz grain clusters, chert, siliceous coral fragments, and black shale fragments were retained on the coarser sieves in some samples. Small amounts of quartz grains were noted in the material finer than No. 200. The insoluble residue finer than No. 200 was predominantly dark brown argillaceous (containing clay minerals), to carbonaceous (rich in carbon) material.

The sand content of the Bayport Limestone at the sampling location tended to increase with depth to a thin limestone member (Bed No. 2) near the quarry floor. Samples from Bed No. 5, the separate bench at the top of the sampling face, contained a moderate amount of quartz grain residue (retained No. 200), whereas samples from Bed Nos. 3 and 4 contained quartz grain residues (retained No. 200) as high as 58 percent.

The general vertical variation in sand content is indicated in Table 1 which presents an average insoluble residue (I.R.) content for each bed based on the individual insoluble residue analyses conducted on samples obtained at the stations along the traverse.

TABLE 1
BEDROCK INSOLUBLE RESIDUE CONTENT

Bed	No. of Samples	I.R. Ret. No. 200, Percent		
		High	Low	Average
5	10	22.4	1.6	14.5
4	9	36.2	3.2	19.0
3&4	5	53.3	29.8	43.1
3	9	57.5	21.0	35.5
2	7	14.4	6.0	10.8
1	7	18.9	2.7	5.4
	47			

The sand content was also found to vary laterally along the sampling traverse, with quartz grain content and grain size increasing from west to east in the lower arenaceous beds.

Figure 2 shows the distribution of the material contained in the insoluble residues from the three grouped samples tested on the wear track. The percentages retained on the noted sieves were based on the original sample weights.

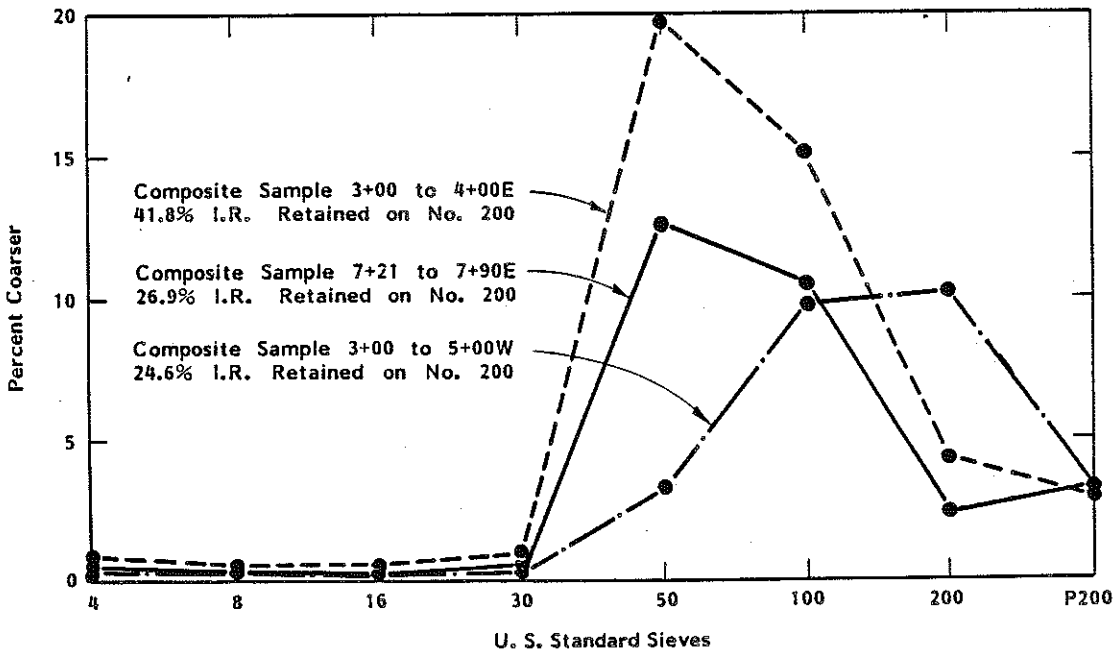

Figure 2. Insoluble residues retained on individual sieves.

Wear Track Polishing Tests

Results of the wear track polishing tests conducted on the Bayport arenaceous limestone samples and blends are listed in Table 2. The tabulation also includes the results of polishing tests conducted on a high-polishing limestone, a typical gravel, and high-friction sandstone. The friction

TABLE 2
RESULTS OF WEAR TRACK AGGREGATE POLISHING TESTS

Aggregate	Aggregate Wear Index
Sandstone (Napoleon Formation), Pit 38-81	570
Highly Arenaceous Limestone, Pit 32-4	480
Highly Arenaceous Limestone, 3+00 to 4+00E, Pit 32-4	430
Highly Arenaceous Limestone, 3+00 to 5+00W, Pit 32-4	410
Highly Arenaceous Limestone, 7+21 to 7+90E, Pit 32-4	380
Crushed Gravel, 40% Carbonate, Pit 47-3	320
Arenaceous Limestone, Bottom Rock, Pit 32-4	310
Arenaceous Limestone, Full Face, Pit 32-4	290
Blend: 25% Highly Arenaceous Limestone, 3+00 to 4+00E, Pit 32-4. 75% High-polishing Limestone, Pit 75-5	270
Blend: 25% Highly Arenaceous Limestone, 3+00 to 5+00W, Pit 32-4 75% High-polishing Limestone, Pit 75-5	260
Blend: 25% Highly Arenaceous Limestone, 7+21 to 7+90E, Pit 32-4. 75% High-polishing Limestone, Pit 75-5	240
High-polishing Limestone, Pit 75-5	170

test results obtained after four million wheel passes on the wear track are reported as Aggregate Wear Index numbers. The Aggregate Wear Index rating system, developed from wear track research, classifies aggregates according to polishing resistance. Values below 200 are typical

of high-polishing aggregates. Values near 300 indicate moderate polishing resistance. Values above 400 indicate high-friction properties. The sandstone and high-polishing limestone in the tabulation indicate the current range of Aggregate Wear Index values on record.

COMMENTS AND RECOMMENDATIONS

The Bayport arenaceous limestone samples from the Wallace Stone Co quarry recorded moderate to high resistance to tire-polishing on the wear track, indicating that the material could provide satisfactory performance in bituminous top course mixtures. Selectively quarried material from the highly arenaceous beds would be of particular use as sprinkle treatment aggregate for bituminous top course applications. The results of the wear track tests on blends of high-polishing limestone and the highly-arenaceous limestone indicate that the highly-arenaceous limestone could be used as a blending agent to upgrade the frictional performance of low-friction aggregates.

REFERENCES

1. Muethel, R. W., "The Michigan Department of Transportation Circular Wear Track - Results of Preliminary Aggregate Polishing Tests (First Progress Report)," MDOT Research Report R-1098, March 1979.

2. Muethel, R. W., "The Michigan Department of Transportation Circular Wear Track - Results of Supplemental Aggregate Polishing Tests (Interim Progress Report)." MDOT Research Report R-1228, April 1984.

3. "Standard Practice for Petrographic Analysis of Aggregates," Michigan Test Method MTM 104.

4. "Test Method For Determination of Insoluble Residue in Carbonate Materials," Michigan Test Method MTM 103.

5. "Test Method For Determining An Aggregate Wear Index (AWI) of Aggregates for Bituminous Top Courses by Wear Track Polishing Tests," Michigan Test Method MTM 111.

APPENDIX

LOG OF LEDGE SAMPLES
Wallace Stone Co Pit No. 32-4

Sampling Station	Bed	Thick-ness, ft	I.R. Ret. 200, percent	Description of Ledge Sample
6+00W	4	2.4	16.4	Light brown arenaceous limestone
	3	2.2	21.0	Light brown arenaceous limestone
	2	0.3	14.4	Brown slightly arenaceous limestone, black shale traces
	1	0.9	3.3	Brown limestone, few quartz grains
5+00W	4	2.5	24.2	Light brown arenaceous limestone
	3	1.9	22.7	Light brown arenaceous limestone
	2	0.4	10.9	Brown slightly arenaceous limestone, shaley
	1	0.9	2.7	Brown limestone, few quartz grains
4+00W	4	2.6	27.5	Light brown arenaceous limestone, shaley, chert traces
	3	2.0	16.9	Light brown arenaceous limestone
	2	0.4	9.1	Brown slightly arenaceous limestone
	1	0.8	2.7	Brown limestone, few quartz grains
3+00W	4	3.1	22.1	Light brown arenaceous limestone
	3	1.5	26.5	Light brown arenaceous limestone
	2	0.6	6.0	Brown slightly arenaceous limestone
	1	1.0	2.8	Brown limestone, few quartz grains
2+15W	5	2.5	3.7	Light brown limestone, few quartz grains
	4	2.5	36.2	Light brown arenaceous limestone
	3	2.6	35.3	Light brown arenaceous limestone
	2	0.5	11.8	Brown mottled slightly arenaceous limestone
	1	1.0	2.7	Brown limestone, few quartz grains
0+00	5	2.1	1.6	Light brown limestone, shale and fossil fragments
	3&4	7.0	29.8	Light brown arenaceous limestone
	1&2	—	—	N.S.
1+00E	5	4.0	24.0	Light brown arenaceous limestone
	4	4.2	3.2	Light brown limestone, few quartz grains
	3	7.5	42.0	Light brown highly arenaceous limestone
	1&2	—	—	N.S.
2+00E	5	4.0	3.8	Light brown limestone, few quartz grains, fossil fragments
	4	2.7	11.2	Light brown slightly arenaceous limestone, shaley
	3	8.0	48.1	Light brown highly arenaceous limestone, shale traces
	1&2	—	—	N.S.
3+00E	5	4.0	18.2	Light brown arenaceous limestone, fossil fragments
	4	3.5	10.1	Light brown arenaceous limestone, shale traces
	3	7.8	49.1	Light brown highly arenaceous limestone
	1&2	—	—	N.S.
4+00E	5	4.0	22.4	Light brown arenaceous limestone
	4	3.5	19.9	Light brown arenaceous limestone
	3	6.1	57.5	Light brown highly arenaceous limestone
	1&2	—	—	N.S.
5+00E	5	4.8	16.6	Light brown arenaceous limestone, shale traces
	3&4	7.8	34.7	Light brown arenaceous limestone, shale traces
	2	0.5	13.4	Brown mottled slightly arenaceous limestone, shale traces
	1	0.9	18.9	Brown arenaceous limestone, black shale at top
6+35E	5	4.8	21.4	Light brown arenaceous limestone
	3&4	7.9	48.4	Light brown highly arenaceous limestone
	2	0.7	N.S.	Brown mottled limestone
	1	0.6	N.S.	Brown limestone
7+21E	5	5.4	21.3	Light brown arenaceous limestone, fossil fragments
	3&4	7.4	53.3	Light brown highly arenaceous limestone
	2	0.5	N.S.	Brown mottled limestone
	1	0.7	N.S.	Brown limestone
7+90E	5	4.3	11.6	Light brown slightly arenaceous limestone, shale traces
	3&4	7.1	49.1	Light brown highly arenaceous limestone, shale traces
	2	0.6	10.0	Brown mottled slightly arenaceous limestone, shale traces
	1	0.9	4.9	Brown limestone, few quartz grains, black shale at top

N.S. = Not accessible for sampling