

OFFICE MEMORANDUM



MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

March 21, 1977

To: L. T. Oehler
Engineer of Research

From: R. W. Muethel

Subject: Petrographic Analysis of Coarse Aggregate: American Aggregates Corp., Milford Pit No. 63-97 (Testing Laboratory Sample No. 76 A-499). Research Report No. R-1054.

On May 4, 1976, a sample of combined crushed and natural gravel coarse aggregate was received by the Department's Testing Laboratory at Ann Arbor. Information accompanying the sample stated that the material was obtained from the American Aggregate Corp., Milford Pit No. 63-97, location north 1/2 of Section 5, T2N-R7E, Oakland County. The material was submitted to the laboratory for freeze-thaw durability testing. Petrographic analysis of a portion of the sample was requested by G. H. Gallup.

Summary

Rock Class	Condition of Particles	Percent of Sample
Igneous	Hard, fresh to moderately weathered, and non-porous to slightly porous on weathered surfaces	18
Metamorphic	Hard to moderately hard, fresh to slightly weathered, and non-porous	17
Sedimentary	Hard to soft, fresh to highly weathered, and non-porous to porous	65

Approximately 23 percent of the sample was found to be contained in rock type categories having absorption values greater than 1.5 percent.

Detailed tabulations of petrographic composition, specific gravity, and absorption are included in Tables 1 and 2.

Detailed Petrography

Petrographic examination was conducted in general conformance with ASTM C295, "Petrographic Examination of Aggregates for Concrete." Repre-

sentative portions--300 particles--of each sieve fraction of the sample were identified megascopically, along with acid testing and a scratch test for hardness, and microscopically with a stereomicroscope. Specific gravity and absorption determinations were performed in general accordance with ASTM C127, "Specific Gravity and Absorption of Coarse Aggregate." Determinations included all material analyzed. The following pages contain the rock type descriptions.

TESTING AND RESEARCH DIVISION

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TABLE 1
 PETROGRAPHIC COMPOSITION
 Testing Laboratory Sample No. 76 A-499

Rock Type	Sieve Fraction Analyzed				Computed Sample Composition
	1 to 3/4 in.	3/4 to 1/2 in.	1/2 to 3/8 in.	3/8 to No. 4	
Granite	9.0	8.7	5.7	7.4	7.7
Diorite	2.3	1.7	1.7	1.3	1.7
Gabbro	6.7	4.0	5.7	6.3	5.7
Basalt	2.3	2.3	1.7	3.7	2.5
Felsite	0.3	1.7	0.7	1.0	0.9
Quartzite	10.7	8.3	9.3	9.7	9.5
Metasediments	3.7	4.7	6.3	4.3	4.7
Tillite	3.0	1.7	3.3	3.3	2.8
Limestone	16.0	20.3	22.0	23.4	20.4
Argillaceous Limestone	2.3	2.0	1.3	2.0	1.9
Cherty Limestone	4.7	3.0	2.7	2.3	3.2
Dolomitic Limestone	3.0	1.7	5.0	3.3	3.3
Dolomite	20.0	20.7	15.7	14.7	17.8
Argillaceous Dolomite	3.7	3.3	3.0	2.0	3.0
Cherty Dolomite	4.0	5.3	2.0	2.3	3.4
Sandstone	1.0	2.0	2.0	2.3	1.8
Siltstone	0.3	1.3	1.3	1.0	1.0
Shale	0.3	0.7	0.7	0.7	0.6
Clay Ironstone	---	1.0	0.3	0.3	0.4
Porous Chert	6.0	3.3	7.3	6.0	5.7
Dense Chert	0.7	2.3	2.3	2.7	2.0
Totals, percent	100.0	100.0	100.0	100.0	100.0

Note: Computed sample composition is based upon counts of 300 particles contained in each of the sieve fractions noted.

TABLE 2
 SPECIFIC GRAVITY AND ABSORPTION DATA
 Testing Laboratory Sample No. 76 A-499

Rock Type	Specific Gravity			Absorption, percent	Composition, Percent by Weight
	Bulk, dry	Bulk, ssd	Apparent		
Granite	2.64	2.65	2.68	0.51	8.1
Diorite	2.89	2.90	2.91	0.29	2.1
Gabbro	2.93	2.95	2.97	0.38	7.0
Basalt	2.89	2.90	2.91	0.19	2.5
Felsite	2.80	2.81	2.82	0.18	0.7
Quartzite	2.66	2.67	2.68	0.29	10.1
Metasediments	2.72	2.73	2.75	0.29	4.6
Tillite	2.73	2.73	2.74	0.21	2.8
Limestone	2.65	2.67	2.70	0.79	17.9
Argillaceous Limestone	2.54	2.59	2.69	2.27	2.1
Cherty Limestone	2.57	2.61	2.68	1.68	4.1
Dolomitic Limestone	2.64	2.69	2.79	2.15	2.9
Dolomite	2.73	2.76	2.80	1.00	20.0
Argillaceous Dolomite	2.60	2.66	2.78	2.50	3.1
Cherty Dolomite	2.62	2.66	2.73	1.55	3.4
Sandstone	2.42	2.49	2.60	2.93	1.2
Siltstone	2.32	2.45	2.68	5.80	0.5
Shale	2.30	2.38	2.51	3.73	0.3
Clay Ironstone	2.42	2.59	2.91	6.96	0.3
Porous Chert	2.51	2.56	2.65	2.13	5.2
Dense Chert	2.57	2.60	2.65	1.08	1.1
Total Sample	2.68	2.70	2.75	1.00	100.0

Note: Values are computed from determinations made on all sample material contained in the categories noted.

IGNEOUS ROCKS

Rock Type	Granite	Diorite	Gabbro
Color	mottled pink, white to buff, and dark green to black	mottled white to buff and gray or green to black	mottled buff, gray or green to black, and yellowish brown
Texture	medium to very fine grained	medium to very fine grained	medium to very fine grained
Luster	dull to subvitreous	dull	dull
Hardness	hard: Mohs 7 to 6	hard: Mohs 7 to 6	hard: Mohs 5.5 to 6
Porosity	non-porous	non-porous	non-porous to slightly porous on weathered surfaces
Particle Shape	angular to subrounded	subangular to subrounded	angular to rounded
Particle Surface	fresh to slightly weathered, rough to moderately smooth, dented to ridged	slightly weathered, rough to moderately smooth, dented to ridged	fresh to moderately weathered, rough to moderately smooth, dented to ridged
Remarks		A few particles are partially lime-incrusted.	

IGNEOUS ROCKS (Cont.)

Rock Type	Basalt	Felsite
Color	dark gray or green to black; and mottled dark gray to green and black	gray to green
Texture	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull	dull
Hardness	hard: Mohs 5, 5 to 6	hard: Mohs 6 to 7
Porosity	non-porous	non-porous
Particle Shape	subangular to subrounded	subangular to subrounded
Particle Surface	slightly weathered, rough to moderately smooth, dented	slightly weathered, rough to smooth, dented

METAMORPHIC ROCKS

Rock Type	Quartzite	Metasediments	Tillite
Color	white; pink; buff; gray; green; and mottled buff to pink and gray to green	medium to dark gray or green	light to medium gray to green
Texture	medium to very fine grained	very fine grained to micro-crystalline	microcrystalline groundmass with a porphyritic appearance
Luster	vitreous to dull	dull	dull
Hardness	hard: Mohs 7	hard to moderately hard: Mohs 7 to 5	hard to moderately hard: Mohs 7 to 5
Porosity	non-porous	non-porous	non-porous
Particle Shape	angular to rounded	angular to rounded	subangular to rounded
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to slightly weathered, rough to smooth, dented to ridged	slightly weathered, rough to moderately smooth, dented

SEDIMENTARY ROCKS

Rock Type	Limestone	Argillaceous Limestone	Cherty Limestone
Color	buff; gray; and mottled buff and gray	buff; and mottled buff and gray	mottled buff to white and gray
Texture	fine grained to micro-crystalline	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull	dull to earthy	dull
Hardness	moderately hard: Mohs 3	moderately hard to soft: Mohs 3 to 2.5	hard to moderately hard: Mohs 7 to 3
Porosity	non-porous to slightly porous	finely porous	non-porous to finely porous
Particle Shape	angular to rounded	subangular to rounded	subangular to rounded
Particle Surface	fresh to moderately weathered, rough to smooth, dented or pitted to ridged	slightly to highly weathered, rough to smooth, dented	slightly to moderately weathered
Remarks			Chert is present as nodules, silicified fossils, or disseminated material.

SEDIMENTARY ROCKS (Cont.)

Rock Type	Dolomitic Limestone	Dolomite	Argillaceous Dolomite
Color	buff	gray; buff; and mottled buff and gray	buff
Texture	very fine grained to micro-crystalline	fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull	dull	dull to earthy
Hardness	moderately hard: Mohs 3.5 to 3	moderately hard: Mohs 4 to 3.5	moderately hard to soft: Mohs 3.5 to 2.5
Porosity	non-porous to slightly porous	non-porous to slightly porous	finely porous
Particle Shape	subrounded to rounded	angular to rounded	subangular to rounded
Particle Surface	slightly to moderately weathered, rough to smooth, dented	fresh to slightly weathered, rough to smooth, dented or pitted to ridged	slightly to highly weathered, rough to smooth, dented
Remarks		A number of particles contain small solution cavities.	

SEDIMENTARY ROCKS (Cont.)

Rock Type	Cherty Dolomite	Sandstone	Siltstone
Color	buff; gray; and mottled buff and gray	buff; gray; and reddish brown	buff; gray; and reddish brown
Texture	very fine grained to micro-crystalline	fine to very fine grained	very fine grained
Luster	dull	dull	dull to earthy
Hardness	hard to moderately hard: Mohs 7 to 3.5	hard to moderately hard: Mohs 7 to 5	moderately hard to soft: Mohs 3 to 2.5
Porosity	non-porous to slightly porous	porous	finely porous
Particle Shape	angular to rounded	subrounded to rounded	subangular to rounded
Particle Surface	fresh to moderately weathered, rough to smooth, dented to ridged	slightly to moderately weathered, rough, dented	slightly to highly weathered, rough to smooth, dented
Remarks	Chert is present as nodules, siliceous seams, and disseminated material.		

SEDIMENTARY ROCKS (Cont.)

Rock Type	Shale	Clay Ironstone	Porous Chert
Color	dark brown to black	reddish brown	buff; and mottled buff, white, and gray
Texture	very fine grained to micro-crystalline	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull	dull	dull
Hardness	soft: Mohs 2.5	moderately hard; Mohs 4	hard to moderately hard: Mohs 7 to 8
Porosity	non-porous to finely porous	finely porous	finely porous
Particle Shape	rounded to discoidal	subangular to rounded	subangular to subrounded
Particle Surface	slightly weathered, moderately smooth to smooth, dented	slightly to moderately weathered, moderately smooth to smooth	slightly to highly weathered, rough to smooth, dented
Remarks		Particles are clay ironstone concretions and fragments	Some particles contain carbonate exposures.

SEDIMENTARY ROCKS (Cont.)

Rock Type	Dense Chert
Color	gray; and mottled gray and buff to white
Texture	very fine grained to micro-crystalline
Luster	dull to vitreous
Hardness	hard; Mohs 7
Porosity	non-porous to slightly porous
Particle Shape	angular to subrounded
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged