



OFFICE MEMORANDUM

DATE: April 26, 1976

TO: L. T. Oehler
Engineer of Research

FROM: R. W. Muethel

SUBJECT: Petrographic Analysis of Coarse Aggregate: Superior Sand and Gravel Pit Pit No. 31-45 (Testing Laboratory Sample 75 A-152). Research Report No. R-998.

On February 13, 1975, 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 by C. Johnson from the Superior Sand and Gravel Pit No. 31-45, location NE of SW, Section 27, T55N-R34W, Houghton County. The sample 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

Petrographic analysis was completed on September 25, 1975. The sample was found to have the following general petrographic composition:

Rock Class	Condition of Particles	Percent of Sample
Igneous	Hard to moderately hard, fresh to moderately weathered, and non-porous to slightly porous	85
Metamorphic	Hard to moderately hard, fresh to highly weathered, and non-porous to slightly porous	4
Sedimentary	Hard to soft, fresh to highly weathered, and non-porous to porous	11

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

TABLE 1
 PETROGRAPHIC COMPOSITION
 Testing Laboratory Sample No. 75 A-152

Rock Type	Sieve Fractions 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	5.8	6.0	7.0	6.9
Diorite	3.2	3.8	2.4	2.6	3.0
Gabbro	10.2	11.4	4.8	6.8	8.3
Basalt	41.0	38.2	38.4	43.8	40.3
Amygdaloidal Basalt	10.6	11.6	13.2	5.6	10.2
Felsite	15.6	17.8	16.2	14.4	16.0
Quartzite	0.2	1.2	1.4	1.6	1.1
Metasediments	2.8	1.0	2.8	1.6	2.0
Schist	1.8	0.2	0.4	1.0	0.9
Limestone	0.6	1.2	1.4	1.8	1.3
Sandstone, Non-Friable	1.8	5.0	8.4	8.2	5.8
Sandstone, Friable	1.8	1.8	2.6	2.8	2.3
Rhyolite Conglomerate	0.2	0.4	0.8	1.0	0.6
Siltstone	0.8	0.0	0.6	0.4	0.5
Chert	0.4	0.6	0.6	1.4	0.8
Totals, Percent	100.0	100.0	100.0	100.0	100.0

Note: Computed sample composition is based upon counts of 500 particles contained in each of the sieve fractions noted.

TABLE 2
 SPECIFIC GRAVITY AND ABSORPTION DATA
 Testing Laboratory Sample No. 75 A-152

Rock Type	Specific Gravity			Absorption, percent	Composition, Percent by Weight
	Bulk, dry	Bulk, ssd	Apparent		
Granite	2.64	2.65	2.66	0.32	7.5
Diorite	2.70	2.71	2.73	0.32	3.0
Gabbro	2.98	2.95	2.96	0.35	10.2
Basalt	2.82	2.85	2.90	0.94	41.8
Amygdaloidal Basalt	2.78	2.82	2.90	1.43	11.5
Felsite	2.65	2.65	2.70	0.70	15.4
Quartzite	2.63	2.64	2.66	0.29	0.6
Metasediments	2.62	2.65	2.71	1.15	2.3
Schist	2.77	2.78	2.80	0.37	1.2
Limestone	2.46	2.55	2.71	3.68	0.9
Sandstone, Non-Friable	2.35	2.42	2.53	2.93	3.1
Sandstone, Friable	2.19	2.31	2.49	5.40	1.4
Rhyolite Conglomerate	2.51	2.57	2.66	2.25	0.3
Siltstone	1.92	2.15	2.50	12.00	0.4
Chert	2.29	2.38	2.54	4.31	0.4
Total Sample	2.74	2.76	2.82	1.02	100.0

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

Detailed Petrography

Petrographic examination was conducted in general conformance with "Petrographic Examination of Aggregates for Concrete," ASTM C 295. Representative portions—500 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 "Specific Gravity and Absorption of Coarse Aggregate," ASTM C 127. Determinations included all material contained in the sample. The following pages contain the rock type descriptions.

TESTING AND RESEARCH DIVISION



Geologist

Materials Research Unit

IGNEOUS ROCKS

Rock Type	Granite	Diorite	Gabbro
Color	mottled pink, white to buff, and dark green to black	mottled white to buff or gray, and dark green to black	mottled buff to dark gray, and dark green to black
Texture	coarse to fine grained	medium to very fine grained	medium to fine grained
Luster	dull to subvitreous	dull to subvitreous	dull
Hardness	hard: Mohs range 7 to 6, general hardness 6	hard to moderate hard: Mohs range 7 to 3, general hardness 6	hard to moderately hard: Mohs range 6 to 3, general hardness 6
Porosity	non-porous	non-porous	non-porous to slightly porous
Particle Shape	angular to rounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to slightly weathered, rough to smooth, and dented to ridged	fresh to moderately weathered, rough to smooth, dented to ridged	fresh to moderately weathered, rough to moderately smooth, dented to ridged
Remarks	A few particles are pegmatitic. A number of granodiorite and syenite particles are included in this category.	A number of quartz diorite particles are included in this category. Many particles contain micaceous material having approximate Mohs hardness 3.	A number of particles are partially chloritized with material having approximate Mohs hardness 3.

IGNEOUS ROCKS (Cont.)

Rock Type	Basalt	Amygdaloidal Basalt	Felsite
Color	purplish brown to black; mottled reddish brown and dark green to black	mottled purplish to greenish brown or black, and white, pink, or green	reddish to purplish brown, and gray to green
Texture	fine grained to microcrystalline, and porphyritic	fine to very fine grained matrix enclosing amygdules	fine grained to microcrystalline, and porphyritic
Luster	dull	dull	dull
Hardness	hard to moderately hard; Mohs range 6 to 3, general hardness 3	hard to moderately hard; Mohs range 7 to 3, general hardness 6	hard; Mohs range 7 to 6, general hardness 6
Porosity	non-porous to slightly porous	non-porous to slightly porous	non-porous
Particle Shape	angular to rounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to highly weathered, rough to moderately smooth, dented to ridged	fresh to highly weathered, rough to moderately smooth, dented or pitted to ridged	fresh to slightly weathered, rough to smooth, dented to ridged
Remarks	Many particles are deeply weathered and chloritized. A number of particles are veined or irregularly mineralized. Dolomite and andesite particles are included in this category.	Some particles are partially vesicular. Many particles are partially mineralized with calcite, quartz, or epidote. Many particles are partially chloritized. A number of particles are andesitic.	A number of microsyenite particles are included in this category.

METAMORPHIC ROCKS

Rock Type	Quartzite	Metasediments	Schist
Color	white; buff, pink, and green to gray	gray; purple; and mottled gray and reddish to purplish brown	gray; and greenish gray
Texture	fine to very fine grained	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull to vitreous	dull	dull to silky
Hardness	hard: Mohs 7	hard to moderately hard: Mohs range 7 to 5, general hardness 5	moderately hard: Mohs range 5 to 3-1/2, general hardness 4
Porosity	non-porous	non-porous to slightly porous	non-porous to slightly porous
Particle Shape	angular to subrounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to highly weathered, rough to moderately smooth, dented to ridged	fresh to slightly weathered, rough to moderately smooth, dented to ridged
Remarks		A few particles are ferruginous.	A number of massive greenstone particles are included in this category.

SEDIMENTARY ROCKS

Rock Type	Limestone	Sandstone, Non-friable	Sandstone, Friable
Color	buff to gray	white to buff; pink to reddish brown; mottled pink and white to buff	white to buff; pink to reddish brown; mottled pink and white to buff
Texture	very fine grained to micro-crystalline	medium to fine grained	fine to very fine grained
Luster	dull to earthy	dull	dull
Hardness	moderately hard to soft: Mohs range 3-1/2 to 2-1/2; general hardness 3.5	hard: Mohs 7	hard to moderately hard: Mohs range 7 to 5, general hardness 5
Porosity	non-porous to porous	porous to slightly porous	porous
Particle Shape	angular to rounded	angular to rounded	angular to rounded
Particle Surface	fresh to highly weathered, rough to moderately smooth, dented or pitted to ridged	fresh to moderately weathered, rough, dented	fresh to highly weathered, rough, dented to ridged
Remarks	Many particles are dolomitic. A few particles are deeply weathered.	A number of orthoquartzite particles are included in this category. A number of particles are arkosic.	A number of particles are arkosic.

SEDIMENTARY ROCKS (Cont.)

Rock Type	Rhyolite Conglomerate	Siltstone	Chert
Color	mottled pink and reddish brown	gray; buff; and reddish brown	buff to gray
Texture	fine grained matrix enclosing small pebbles	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull	dull to earthy	dull
Hardness	hard: Mohs range 7 to 6, general hardness 6	moderately hard to soft: Mohs range 3 to 2-1/2, general hardness 2-1/2	hard: Mohs 7
Porosity	non-porous	finely porous	non-porous to slightly porous
Particle Shape	subangular to subrounded	angular to rounded	angular to subangular
Particle Surface	fresh to slightly weathered, rough to smooth, dented	moderately to highly weathered, rough to smooth, dented or pitted to ridged	slightly to highly weathered, rough to smooth, dented or pitted to ridged