

OFFICE MEMORANDUM

DATE: December 27, 1976

TO: L. T. Oehler
Engineer of Research

FROM: R. W. Muethel

SUBJECT: Petrographic Analysis of Coarse Aggregate: Boyd Pit No. 54-54
(Testing Laboratory Sample No. 75 A-1625). Research Report No. R-1036.

On August 22, 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 from the Boyd Pit No. 54-54, location E 1/2 of Section 3, T16N-R9W, Mecosta 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	21
Metamorphic	Hard to moderately hard, fresh to slightly weathered, and non-porous	10
Sedimentary	Hard to soft, fresh to highly weathered, and non-porous to porous	69

Approximately 18 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.

TABLE 1
Petrographic Composition
Testing Labory Sample No. 75 A-1625

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	14.0	15.0	11.3	14.0	13.6
Diorite	2.0	1.7	2.0	0.7	1.6
Gabbro	5.0	3.0	3.3	3.3	3.7
Basalt	3.0	2.3	2.0	0.3	1.9
Felsite	0.3	--	0.3	0.3	0.2
Quartzite	10.0	8.3	4.0	5.7	7.0
Metasediments	4.3	2.0	1.7	3.0	2.7
Tillite	0.7	0.7	0.7	0.3	0.6
Schist	--	--	0.3	--	0.1
Limestone	7.3	6.0	12.3	10.7	9.1
Argillaceous Limestone	3.0	1.0	1.3	0.3	1.4
Cherty Limestone	2.7	1.0	1.3	2.4	1.8
Dolomitic Limestone	2.7	3.0	2.7	2.7	2.7
Dolomite	32.0	36.7	35.4	32.4	34.1
Argillaceous Dolomite	2.7	4.0	4.3	7.3	4.6
Cherty Dolomite	3.0	2.3	1.7	2.3	2.3
Crag	--	--	--	0.3	0.1
Sandstone	2.0	4.0	1.7	3.3	2.7
Siltstone	1.0	2.3	3.7	1.7	2.2
Shale	0.3	--	--	0.7	0.3
Clay Ironstone	0.3	--	0.3	--	0.2
Porous Chert	2.7	6.0	7.7	7.0	5.9
Dense Chert	1.0	0.7	2.0	1.3	1.2
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.

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TABLE 2
Specific Gravity and Absorption Data
Testing Laboratory Sample No. 75 A-1625

Rock Type	Specific Gravity			Absorption, percent	Composition, percent by weight
	Bulk, dry	Bulk, ssd	Apparent		
Granite	2.63	2.64	2.66	0.36	13.7
Diorite	2.84	2.85	2.87	0.32	1.8
Gabbro	2.96	2.97	2.99	0.34	4.6
Basalt	2.86	2.88	2.90	0.46	3.0
Felsite	2.72	2.72	2.72	0.00	0.2
Quartzite	2.62	2.64	2.66	0.48	8.4
Metasediments	2.67	2.69	2.72	0.71	3.7
Tillite	2.66	2.68	2.70	0.64	0.7
Schist	*	*	*	*	TR
Limestone	2.62	2.64	2.68	1.04	7.9
Argillaceous Limestone	2.62	2.67	2.76	1.94	2.3
Cherty Limestone	2.58	2.62	2.69	1.64	1.9
Dolomitic Limestone	2.68	2.72	2.78	1.40	3.2
Dolomite	2.74	2.76	2.81	0.92	34.1
Argillaceous Dolomite	2.58	2.65	2.77	2.68	3.2
Cherty Dolomite	2.63	2.66	2.74	1.53	2.7
Crag	*	*	*	*	TR
Sandstone	2.44	2.51	2.61	2.72	2.6
Siltstone	2.28	2.42	2.66	6.23	1.5
Shale	1.88	2.06	2.28	9.38	0.1
Clay Ironstone	2.81	2.82	2.85	0.47	0.3
Porous Chert	2.32	2.42	2.58	4.40	3.3
Dense Chert	2.56	2.58	2.61	0.71	0.8
Total Sample	2.67	2.69	2.75	1.12	100.0

*No determinations due to insufficient sample.

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 white, pink, and dark green to black	mottled gray to white and dark green to black; and mottled pink to yellowish brown and black	mottled buff to gray, and dark green to black; and mottled gray to green, black, and yellowish brown
Texture	coarse 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
Particle Shape	angular to subrounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to slightly weathered, rough to moderately smooth, dented to ridged	fresh to slightly weathered, rough to moderately smooth, dented to ridged	fresh to moderately weathered, rough to moderately smooth, dented to ridged

IGNEOUS ROCKS (Cont.)

Rock Type	Basalt	Felsite
Color	medium to dark gray or green; and mottled green, black, and yellowish brown	medium to dark gray; and mottled gray and 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 7 to 6
Porosity	non-porous	non-porous
Particle Shape	angular to subrounded	angular to subrounded
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged.	fresh to slightly weathered, rough, dented to ridged

METAMORPHIC ROCKS

Rock Type	Quartzite	Metasediments	Tillite
Color	white; buff; pink; gray; green; and mottled buff to white, red to brown, and gray to green	medium to dark gray to green; and mottled gray to green and buff to reddish brown	light to medium gray to green
Texture	medium to very fine grained	very fine grained to micro-crystalline	microcrystalline ground mass 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 subrounded	angular to subrounded
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to slightly weathered, rough to moderately smooth, dented to ridged

METAMORPHIC ROCKS (Cont.)

Rock Type	Schist
Color	gray
Texture	very fine grained
Luster	dull
Hardness	moderately hard: Mohs 5
Porosity	non-porous
Particle Shape	angular
Particle Surface	fresh, rough, dented to ridged

SEDIMENTARY ROCKS

Rock Type	Limestone	Argillaceous Limestone	Cherty Limestone
Color	buff; gray; brown; and mottled buff to gray and brown	buff; gray; and mottled buff and gray	mottled buff or 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 to earthy	dull
Hardness	moderately hard: Mohs 3.5 to 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	angular to rounded	angular to subrounded
Particle Surface	fresh to moderately weathered, rough to smooth, dented or pitted to ridged	fresh to moderately weathered, rough to smooth, dented or pitted to ridged	fresh to moderately weathered, rough to moderately smooth
Remarks	A few particles are partially lime-incrusted. A few particles are fossiliferous.		Particles contain chert as nodules, seams, or interstitial material.

SEDIMENTARY ROCKS (Cont.)

Rock Type	Dolomitic Limestone	Dolomite	Argillaceous Dolomite
Color	buff; gray; and mottled buff and gray	buff; gray; and mottled buff and gray	buff; gray; and mottled buff 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	moderately hard: Mohs 4 to 3	moderately hard: Mohs 4 to 3	moderately hard: Mohs 4 to 3.5
Porosity	non-porous to finely porous	non-porous to slightly porous	finely porous
Particle Shape	angular to rounded	angular to rounded	angular to subrounded
Particle Surface	fresh to moderately weathered, rough to smooth, dented or pitted to ridged	fresh to moderately weathered, rough to smooth, dented to ridged	fresh to moderately weathered, rough to smooth, dented or pitted to ridged
Remarks	A few particles are partially lime-incrusted.		

SEDEMENTARY ROCKS (Cont.)

Rock Type	Cherty Dolomite	Crag	Sandstone
Color	buff; gray; and mottled buff to white and gray	mottled buff and dark gray	buff; gray; and reddish to yellowish brown
Texture	very fine grained to micro-crystalline	fine pebbly appearance	fine to very fine grained
Luster	dull	dull	dull
Hardness	hard to moderately hard: Mohs 7 to 4	hard to moderately hard: Mohs 7 to 3	hard: Mohs 7
Porosity	non-porous to slightly porous	non-porous to porous	finely porous to porous
Particle Shape	angular to subrounded	subrounded	angular to rounded
Particle Surface	fresh to moderately weathered, rough to moderately smooth, dented to ridged	slightly weathered, rough, dented	fresh to moderately weathered, rough, dented to ridged
Remarks	Particles contain chert as nodules, seams, silicified fossils, or interstitial material.	Material is composed of lime-cemented sand and fine gravel.	

SEDIMENTARY ROCKS (Cont.)

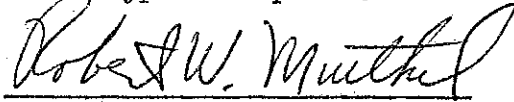
Rock Type	Siltstone	Shale	Clay Ironstones
Color	buff; yellowish to reddish brown; and mottled buff and gray	dark brown	gray; and reddish brown
Texture	very fine grained to micro-crystalline	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull to earthy	dull	dull
Hardness	moderately hard to soft: Mohs 3 to 2.5	soft: Mohs 2.5	moderately hard: Mohs 4 to 3.5
Porosity	finely porous	finely porous	non-porous to finely porous
Particle Shape	subangular to rounded	subrounded	angular
Particle Surface	fresh to highly weathered, rough to smooth, dented to ridged	moderately weathered, smooth, dented	moderately weathered, moderately smooth, dented to ridged
Remarks			Particles are massive clay ironstone and concretion center material.

SEDEMENTARY ROCKS (Cont.)

Rock Type	Porous Chert	Dense Chert
Color	buff; white; gray; and mottled buff to white and gray to brown	medium to dark gray; and mottled gray and white to brown
Texture	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull to earthy	dull to vitreous
Hardness	hard: Mohs 7	hard: Mohs 7
Porosity	finely porous	non-porous to slightly porous
Particle Shape	angular to subrounded	angular to subangular
Particle Surface	fresh to highly weathered, rough to moderately smooth, dented or pitted to ridged	fresh to slightly weathered, rough to smooth, dented to ridged
Remarks	Particles are composed of nodular chert.	Most particles are composed of nodular chert. A few particles are silicified fossils.

Detailed Petrography

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



Geologist

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