# OFFICE MEMORANDUM

DATE: June 24, 1976

TO: L. T. Oehler
Engineer of Research

FROM: R. W. Muethel

SUBJECT: Petrographic Analysis of Coarse Aggregate: Lindberg Pit No. 22-69 (Testing Laboratory Sample 75 A-410). Research Report No. R-1010

On April 16, 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 M. Stockinger from the Lindberg Pit No. 22-69, location SW of SW, Section 5, T40N - R30W, Dickinson 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 May 24, 1976. The sample was found to have the following general petrographic composition:

| Rock Class | Condition of Particles | Percent of Sample |
|---|---|---|
| Igneous | Hard to soft, fresh to highly weathered, and non-porous to slightly porous on weathered surfaces. | 37 |
| Metamorphic | Hard to soft, fresh to highly weathered, and non-porous to finely porous. | 58 |
| Sedimentary | Hard to soft, fresh to highly weathered, and non-porous to porous. | 5 |

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

TABLE 2
SPECIFIC GRAVITY AND ABSORPTION DATA
(Testing Laboratory Sample No. 75 A-410)

| Rock Type | Specific Gravity | | | Absorption, percent | Composition, percent by weight |
|---|---|---|---|---|---|
| | Bulk, dry | Bulk, ssd | Apparent | | |
| Granite | 2.66 | 2.67 | 2.68 | 0.32 | 16.4 |
| Diorite | 2.71 | 2.72 | 2.73 | 0.28 | 4.5 |
| Gabbro | 2.99 | 3.00 | 3.02 | 0.27 | 13.1 |
| Basalt | 2.86 | 2.88 | 2.92 | 0.68 | 6.6 |
| Felsite | 2.59 | 2.63 | 2.70 | 1.55 | 0.7 |
| Quartzite | 2.61 | 2.62 | 2.64 | 0.38 | 44.3 |
| Metasediments | 2.67 | 2.72 | 2.79 | 1.66 | 3.5 |
| Schist | 2.61 | 2.66 | 2.75 | 1.92 | 4.9 |
| Limestone | 2.68 | 2.68 | 2.68 | ----- | 0.1 |
| Dolomite | 2.67 | 2.72 | 2.79 | 1.56 | 5.7 |
| Sandstone | 2.27 | 2.41 | 2.64 | 6.12 | 0.2 |
| Total Sample | 2.69 | 2.71 | 2.73 | 0.58 | 100.0 |

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

TABLE 1
PETROGRAPHIC COMPOSITION
(Testing Laboratory Sample No. 75 A-410)

| 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 | 17.0 | 19.0 | 9.7 | 13.7 | 14.8 |
| Diorite | 4.7 | 3.3 | 5.0 | 4.0 | 4.3 |
| Gabbro | 11.3 | 10.4 | 11.3 | 10.3 | 10.8 |
| Basalt | 6.7 | 5.0 | 6.7 | 9.0 | 6.9 |
| Felsite | 0.7 | 1.0 | 0.7 | 1.3 | 0.9 |
| Quartzite | 44.4 | 50.0 | 52.3 | 45.4 | 48.0 |
| Metasediments | 3.6 | 4.3 | 4.0 | 3.3 | 3.8 |
| Schist | 5.3 | 3.0 | 4.0 | 9.0 | 5.3 |
| Limestone | ---- | 0.3 | 0.3 | 0.3 | 0.2 |
| Dolomite | 6.0 | 3.7 | 5.7 | 3.7 | 4.8 |
| Sandstone | 0.3 | ---- | 0.3 | ---- | 0.2 |
| Total Sample | 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.

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.

TESTING AND RESEARCH DIVISION

R. W. Mueller

Geologist
Materials Research Unit

IGNEOUS ROCKS

| Rock Type | Granite | Diorite | Gabbro |
|---|---|---|---|
| Color | mottled pink, white to buff, and dark green to black; and mottled white to buff and gray to black | mottled white, gray, and dark green to black | mottled buff to gray, reddish brown, and dark green to black |
| 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 range 6 to 7, general hardness 6 | hard: Mohs range 6 to 7, general hardness 6 | hard: Mohs 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, dented to ridged | fresh to moderately weathered, rough to moderately smooth, dented to ridged |

IGNEOUS ROCKS (Cont.)

| Rock Type | Basalt | Felsite |
|---|---|---|
| Color | black; reddish brown; and mottled dark gray and dark green to black | pink; and mottled buff and pink or gray |
| Texture | very fine grained to micro-crystalline | very fine grained to micro-crystalline |
| Luster | dull | dull |
| Hardness | hard to soft: Mohs range 6 to 2-1/2, general hardness 6 | hard: Mohs range 6 to 7, general hardness 6 |
| Porosity | non-porous to slightly porous on weathered surfaces | non-porous |
| Particle Shape | angular to subrounded | angular to rounded |
| Particle Surface | fresh to highly 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 chloritized. Included in this category are a few particles of andesitic dolerite. | |

METAMORPHIC ROCKS

| Rock Type | Quartzite | Metasediments | Schist |
|---|---|---|---|
| Color | white; pink to reddish brown; and mottled white or pink and gray | dark gray to green; reddish brown; and mottled gray and reddish brown | gray; green; reddish brown; buff; and mottled gray and reddish brown |
| Texture | medium to very fine grained; and massive | very fine grained to micro-crystalline | very fine grained to micro-crystalline |
| Luster | vitreous to dull | dull | dull to silky |
| Hardness | hard: Mohs 7 | hard to soft: Mohs 7 to 2-1/2, general hardness 5 | moderately hard to soft: Mohs 5 to 2-1/2, general hardness 4 |
| Porosity | non-porous | non-porous to slightly porous | non-porous to finely porous |
| Particle Shape | angular to subrounded | angular to rounded | angular to tabular |
| Particle Surface | fresh to slightly weathered, rough to moderately smooth, dented to ridged | fresh to moderately weathered, rough to moderately smooth, dented to ridged | fresh to highly weathered, rough to smooth, dented to ridged |
| Remarks | | One particle is partially lime encrusted. | Most particles are chloritic or micaceous. |

SEDIMENTARY ROCKS

| Rock Type | Limestone | Dolomite | Sandstone |
|---|---|---|---|
| Color | buff to gray | buff; gray; and mottled buff and gray | reddish brown |
| Texture | very fine grained to micro-crystalline | very fine grained to micro-crystalline | fine to very fine grained |
| Luster | dull | dull | dull |
| Hardness | moderately hard to hard: Mohs 3 to 7, general hardness 3 | moderately hard to soft: Mohs 3-1/2 to 2-1/2, general hardness 3-1/2 | hard: Mohs 7 |
| Porosity | non-porous | non-porous to slightly porous | finely porous |
| Particle Shape | angular to subrounded | angular to rounded | angular to rounded |
| Particle Surface | fresh to slightly weathered, rough, dented to ridged | fresh to highly weathered, rough to smooth, dented or pitted to ridged | fresh to slightly weathered, rough, dented to ridged |
| Remarks | One particle of cherty limestone is included in this category. | A few particles are slightly arenaceous or argillaceous. | |