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CERAMIC TESTING AND RESEARCH LABORATORIES
OTTAWA

by
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This pamphlet has been prepared and is issued to show the nature of the tests and investigations undertaken: the equipment with which the laboratories are provided: the conditions under which tests are made: and practical instructions as to sampling.

The Nature and Purpose of the Tests
and Investigations Undertaken.

The work dealing with ceramics, for which these well-equipped laboratories have been provided, may be briefly stated as consisting of the testing of clays and other mineral substances to determine their usefulness for the manufacture of bricks, pottery or other ceramic wares; the devising of processes for utilizing such raw materials; the investigation of various phases of the ceramic industry, and in other ways aiding the industries concerned whereby better or wider ranges of ware may be produced, or the cost of production reduced.

Testing of Clay Samples.

The Division is prepared to carry out two types of tests on samples of clay or shale, namely, preliminary or small scale tests, and semi-commercial or large scale tests.

Preliminary Tests.

The preliminary or small scale test is conducted on a sample of clay or shale weighing but a few pounds, to determine the physical properties of the clay, in order to classify it as to its suitability for the manufacture of the various types of clay products.

The sample is first examined as to texture, and for the presence of sandy matter or pebbles, and then tested with acid to determine whether it contains a large percentage of carbonate of lime.

It is then ground and tempered with water until the best working condition is reached. The amount of water required to attain this condition is recorded. The sample is then moulded by hand into a number of briquettes which are dried and later burned to various temperatures. Small cones are also made up for use in determining the temperature at which the sample will fuse.

Chief of the Division of Ceramics and Road Materials.

The following points are noted and reported upon:

Texture of clay or shale.

Presence of high or low percentage of carbonate of lime.

Presence of sandy matter or pebbles.

Amount of water required to produce best working body.

Working quality.

Behaviour in drying rapidly.

Percentage of shrinkage during drying.

Percentage of shrinkage developed when burned to various temperatures.

Hardness, texture, porosity, soundness and colour after burning to various temperatures.

In special cases other tests are performed; for example, to determine suitability for pottery by actual trial on the potters' wheel or by casting ware, determination of suitability for taking a salt glaze, or determination of vitrification range.

Semi-commercial Tests.

Under special circumstances, when required, large scale tests on samples of clay are undertaken to determine with a greater degree of certainty their suitability for manufacturing brick or other ware, and the most desirable method to adopt in manufacturing. The procedure is similar to that in the small scale tests, but mechanical processes replace hand moulding where possible, and in addition to the small sized briquettes, full sized brick or tile are made and burned. For this purpose samples of several hundred pounds are sometimes required.

Special Tests.

Various problems related to the manufacturing of clay ware are referred by Manufacturers to this Division, with a view to obtaining technical aid in overcoming faults inherent to the raw materials or developed during manufacture.

Such of these problems as are worthy of investigation are undertaken in so far as equipment and time will permit.

Testing of Brick and Tile.

In order to determine their structural value, brick are subjected to the standard tests as adopted by the American Society for Testing Materials. These include the determination of crushing strength, transverse strength and porosity. In the case of structural tile, crushing strength and porosity are determined.

For these tests ten brick or five tile are required.

Research Work.

In addition to the testing of clays and clay products and the working out of special problems, investigational work of more general interest is conducted in the Ceramic Laboratories. As an example of the nature of these researches, the following may be cited:

Compounding of special ceramic bodies for use in making electrical heating devices.

Study of the effect of high temperatures on foundry moulding sands; and devising a method for measuring the refractoriness of sands.

Investigation of the suitability of high lime magnesite for the manufacture of refractory brick for metallurgical purposes.

Equipment of the Laboratories.

The Ceramic Laboratories are equipped with grinding, screening and mixing apparatus; machinery for the manufacture of brick, tile and pottery, and furnaces for burning ceramic wares and for the determination of the fusion temperature of clays, etc. There is also testing apparatus for determining the strength of building materials up to a limit of 200,000 pounds load.

The major items of equipment are as follows:

- 1, small Jaw crusher, power driven.
- 1, small Disc pulverizer, power driven.
- 1, coffee mill type Disc grinder, hand power.
- 1, combined 3' wet or dry pan grinder, power driven.
- 1, Per-Se sieving machine - set standard screens.
- 1, 10" double cylinder, porcelain-lined pebble mill, power driven.
- 1, 8" double porcelain jar pebble mill, power driven.
- 1, 8" slip blunger, power driven.
- 1, 8-cell centrifuge, power driven.
- 1, 6-cell filter press, hand power.
- 1, small sized auger brick and tile machine, power driven.

1, small sized plunger type brick and tile machine, hand power.

Interchangeable dies for making full sized brick, and various shapes of tile to fit the two last-mentioned machines.

1, large dry press or repress machine with various shaped dies, hand power.

2, small sized dry presses, hand power.

Sundry dies and moulds for hand moulding of clay ware and test pieces.

1, potters' wheel, power driven.

1, electric drier.

1, 12" x 18" electric hot plate.

1, Hoskins high temperature carbon resistor electric furnace.

1, Hoskins base metal resistor electric kiln, 12" x 9" x 18".

1, down-draft gas brick kiln, 9" x 9" x 18".

1, special electric fusion furnace.

1, Seger gas fusion furnace.

1, Palo high temperature gas muffle kiln, 5" x 3" x 7".

1, Revelation pottery kiln, oil fired, 13" x 20" x 53".

1, double chamber, large experimental kiln, gas fired,
upper chamber, 24" x 18" x 30",
lower chamber, 18" x 12" x 30".

1, Hoskins base metal thermocouple pyrometer.

1, Tycos rare metal thermocouple pyrometer.

1, Thwing radiation pyrometer.

1, Leeds and Northrup optical pyrometer.

Thermometers, pyrometric cones, etc.

Scales and balances.

Elutriators.

2, volumeters.

Complete testing apparatus for moulding sands.

1, Olsen Universal Testing Machine, capacity 200,000 pounds, with equipment for tension, compression and transverse tests, motor driven.

5.

1, Olsen Automatic Cement Testing Machine, capacity 2000 pounds, with equipment for tension, compression and transverse tests, motor driven.

1, Olsen Hydraulic Compression Testing Machine, capacity 200,000 pounds.

1, Olsen Cold Bend Testing Machine, motor driven.

Cement Testing Apparatus, including moulds, tanks, damp closet, etc.

Conditions Governing Work.

No charge is made for small scale tests on clays and shales.

In submitting samples for preliminary tests the following instructions should be observed:

1. The sample should be carefully taken so as to truly represent the bed or beds of clay, and should weigh at least five pounds.
2. Care should be taken to avoid the introduction of any foreign matter into the sample. Very small amounts of some materials will have a marked effect upon the properties of a clay.
3. The sample should be placed in a clean wooden or tin box, or in a clean cotton bag.
4. If more than one sample is sent at a time, each should bear a distinguishing mark.
5. The parcel or box should bear the name and address of the sender, and should be addressed to:

For Ceramic Laboratory,
Sussex Street.

The Director,
Mines Branch,
Department of Mines,
Ottawa, Ont.

6. The transportation charges must be prepaid whether sent by express or mail.
7. The Director of the Mines Branch should be notified by mail that the sample has been sent, and a definite statement should be made as to the location from which the sample was taken, whether it was from a developed property or not, and exactly what information is sought concerning it.

Applications for large scale tests or for special investigations should state all details possible regarding the object of such work and give such other information as will aid in arriving at a decision as to the justification for undertaking it.

Practical Instructions as to Sampling.

Many people send a few ounces of clay to a testing laboratory and expect to be told all about its properties and uses. At least five pounds of clay should be submitted, and even then the testing is only preliminary to testing a larger sample.

Few clay or shale deposits are uniform in character throughout their entire thickness, and the selection of samples for testing is, therefore, a matter of some importance. If the deposit appears to be uniform the sample should represent an average of the depth of the face it is proposed to work. The average sample should be supplemented by two or three other samples taken from different depths, as appearances are in many cases misleading in clay investigation. Many persons pick a small sample of clay from the surface of a deposit and send it to be tested. Tests on such samples are mostly useless. The body of material, when opened up for working, may give results entirely different from the thin veneer of weathered clay overlying it. In a locality where industries have been for a long time working satisfactorily on a widespread material and uniform in character, the necessary information may be obtained merely by inspection of a suitable site in the vicinity of the older plants. This proceeding is often, but not always, safe where the manufacture of common brick only is concerned. Where any of the highest class of clay products are to be made, the cheapest method is to take every possible precaution at the outset of the enterprise.

The following method of sampling shale and clay deposits is approved by the Committee on Standards, American Ceramic Society.

Preliminary Sampling.

A face of the body of clay to be sampled shall be carefully stripped of loose or foreign materials, and a series of parallel trenches cut, each a straight line, so as to make as nearly as may be a vertical section entirely across the outcrop. In the case of stratified or bedded deposits which are inclined, the direction of these trenches shall be, preferably, across the dip, so that a proportionate amount of clay will be obtained from each individual layer. Each trench shall be about 12 inches wide and deep enough to produce at least 100 pounds of material. Where natural outcrops are not available for a sampling, preliminary trials may be made with a hand auger, and test pits dug to the necessary depth to expose a section (or face) of the clay.

As this may yield more material than is necessary for even a complete series of tests, the clay from the different trenches shall be reduced to lumps not exceeding 2 inches in diameter, mixed together and reduced by quartering to about 100 pounds which is to be sent to the testing laboratory. The quartering shall be done on a sail cloth at least 8 feet square.

If the deposit shows distinct difference as regards structure, colour or texture, each bed showing these individual differences shall be sampled separately, provided these beds are sufficiently thick to be mined by themselves or can be thrown out if undesirable.

Where the clay is stored in stock piles the sample may be taken from these, provided they are representative. At least one-half of the sample shall be taken from the lower third of the pile.

In the case of those clays which are being purified a sample of both the crude material and the clay as prepared for the market shall be taken.

The samples collected as outlined above shall be placed in clean, tight-weave, strong sacks and carefully labelled by means of two tags, each bearing the proper identification marks. One folded tag shall be placed within the sack and the other securely attached to the outside.

Extended Sampling.

After a clay proves satisfactory in the preliminary testing, the surrounding tract must be surveyed and systematically sampled. A topographical survey of the tract shall be made. Holes shall be drilled or dug through the deposit not more than 100 feet apart. A record shall be kept of the thickness of each stratum encountered. By plotting these results to scale, the shape, size and dip of the strata can be estimated.

A few larger holes shall be dug at the extremities of the properties or at any points of doubtful value in order to get samples large enough for a complete series of tests. These shall be taken under the direction of "Preliminary Sampling".