METHODS OF TESTING CLAY.

A report on the clay and shale deposits of the Western Provinces has recently been printed for the Federal Department of Mines. In this report the authors, Heinrich Rieo and Joseph Keele, give their method of ascertaining the physical qualities of these substances. A report compiled by the following methods is of value in ascertaining the commercial aspect of the raw material. Their method consisted of a determination of plasticity; water required for mixing; tensile strength; air shrinkage; fire shrinkage; color and absorption at different temperatures; and fusing point.

Tensile Strength.—The determination of the tensile strength of the raw material is made because it gives a clue to the clay's ability to stand strains in handling before burning, and possibly also of its bonding power or its ability to stand the addition of non-plastic materials like sand or "grog."

The clays and shales submitted to the physical tests were first thoroughly dried, then ground in a jaw crusher and afterwards sifted through a 20-mesh sieve.

A weighed quantity of the sifted material, sufficient to make the necessary number of test pieces, was mixed with just enough water to give it the greatest plasticity, and thoroughly kneaded and wedged so as to render it perfectly homogeneous and free from cavities. The consistency generally arrived at was about midway in stiffness between a soft-mud and stiff-mud brick in practice.

In making briquettes for the tensile test a small piece of the kneaded clay was clamped into the briquette mould, and struck by the hand until it filled the mould completely, the excess of clay being struck off by a fine wire.

The clay was removed from the mould on a dry clay briquette—a set of them being kept for the purpose—and the wet clay briquette was not handled until it had hardened on its support, so that they were not distorted while soft.

The briquettes when hard were dried to 100° C., the cross section at the waist carefully measured, and then broken in an ordinary tensile strength machine.

Shrinkage.—All clays shrink more or less in drying and burning. The shrinkage that occurs while the clay is drying is termed air shrinkage, while that which occurs during the burning is known as fire shrinkage.

Air Shrinkage.—A portion of the kneaded clay was made into bricklets in a mould 4" × 1½" × ¾" in size. Two fine lines, exactly 3 inches apart, were impressed with a steel stencil on the wet clay bricklet immediately after leaving the mould. When the bricklets were thoroughly dry the distance between these lines was measured, and the percentage of air shrinkage calculated.

Fire Shrinkage.—The burning of the bricklets at the lower cones was done in a down-draft muffle kiln, the fuel used being coke, and the time of burning from 12 to 18 hours. For the higher temperatures a gas-fired muffle kiln was used.

The lines on the burned bricklets were again measured after each successive firing, and the total amounts of shrinkage calculated. The difference between the total shrinkage and the air shrinkage represents the fire shrinkage.

Fusibility.—Small pyramids or cones of the ground clays or shales were burned in the gas-fired furnace until they were deformed or melted (Fig. 1). The temperatures at which the test cones melted are expressed in terms of the standard Seger cones.

A Deville furnace, fired with coke, under air blast was used for determining the fusing points of the more refractory clays, including those which did not fuse until a temperature ranging from cone 18 to cone 32 was reached.

Absorption.—The bricklets were carefully weighed after each burning, and immersed in water to about three-fourths of their thickness. This permits the air from the burned clay body to escape freely, allowing the water to better and more quickly fill the pores. After standing at least 24 hours in water, the saturated bricklets are weighed, the increase in weight recorded, and the percentage of absorption calculated as follows:—

$$\frac{\text{Saturated weight—dry weight}}{\text{Dry weight}} \times 100.$$

Dry-Press Tests.—The clay or shale used for the dry-press test was ground to pass a 20-mesh sieve, and moistened with 5 to 10 per cent. of water. A mould was filled with the damp clay, and pressed in a hand screw-press, the size of the bricklet produced being 4" × 1½" × 1".

Rapid Drying.—For this test the clay or shale was ground to pass a 12-mesh sieve, and kneaded up with sufficient water to a fairly stiff mass, from which a full-sized building brick was made by hand in a wooden mould.

Immediately after coming from the mould the moist brick was placed on a rack in a box open at the bottom and with a perforated top, which stood on a steam-heated radiator. The temperature in this box ranged from 120° to 150° F., which is the heat usually attained in artificial dryers. If the brick cracked under this treatment it was understood that it would not stand rapid drying.

Drying Defects in Certain Clays.—Various Tertiary clays, and some Cretaceous shales found in Alberta and Saskatchewan, have the serious defect of checking while drying.

Clays of this character are usually very fine grained and highly colloidal, absorbing a large percentage of water when tempered for wet moulding. They are exceedingly plastic and sticky when wet, becoming a stiff, soap-like, and sticky mass, which is hard to work.

Generally, within half an hour after leaving the moulds fine cracks appear at the edges of the brick, which quickly spread over the surfaces, and as drying progresses these cracks widen and deepen. In time the outside of the brick becomes bone-dry, but the inside may remain quite moist for several days.

In some clays the cracks which developed in drying closed up completely when the drying was ended, but reappeared again in the burned product.

Several of the clays that displayed this drying defect gave fairly low air and fire shrinkages, were somewhat refractory, and burned to a good, hard body at cone 1.

In several districts they were the only materials available, and, as they might turn out to be sewer-pipe or paving brick clays, it was very desirable to devise some practical method of treatment to make them workable.

Hitherto, whenever brickmakers had to deal with clays which were too "fat" or "strong," as they termed those claps which were highly plastic, they usually added from 10 to 25 per cent. of sand. The sanded clays were found to dry quicker and work easier; the air and fire shrinkages were reduced, and generally a good, burned product is obtained from the mixture.

Apparently, then, the proper remedy to cure the objectionable behaviour of the clays being dealt with was the addition of sand. But when 25 per cent. of sand is added to these clays they crack quite as badly as before. They can be dried with the addition of 40 to 50 per cent. of sand, but this amount is evidently in excess of the bonding power of the clay, because the burned brick made from such a mixture is altogether too porous and weak for any purpose whatever.

It was then found by experiment that if any of these clays be ground and calcined or burned to a red heat, that