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Empirical Column Formulae for Brick Piers

Tests at University of Toronto on Piers of Various Lengths Built of Brick of Known Strength to Determine Effect of Slenderness Ratio on Strength of the Piers—Detailed Report of Tests on 14 Piers and 62 Individual Brick

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TORONTO'S Building Department is at present revising its building by-law; when the chapter on brickwork was reached, it was found that the data available on Canadian brickwork was very meagre.

The brick manufactories that supply the Toronto market kindly consented to allow the Department to visit their plants, select brick and have them tested. The results are tabulated on page 229. The numbers in the first column are the key to the manufacturers' names, which are not to be revealed. The brick selected were not the best brick manufactured by the different companies but were the types usually used as backing brick. Only in a few cases did the Department select face or very hard brick, as usually that type of brick is used only for facing.

It was found that absorption affected the strength of brick in compression. Brick having an absorption of 12% and under were on an average of about 38% stronger in compression and 85% stronger in bending than the average brick absorbing more than 12% of moisture.

After the tests summarized on page 229 had been made, it was thought advisable to try to arrive at a relation between the individual brick and brick laid up in piers, so a representative of the Department selected one of the poorest types of brick from one of the leading manufacturers, who kindly donated the brick to build fourteen piers of different heights, the object being to derive a curve, if possible, that would give the strength of brick piers for different heights.

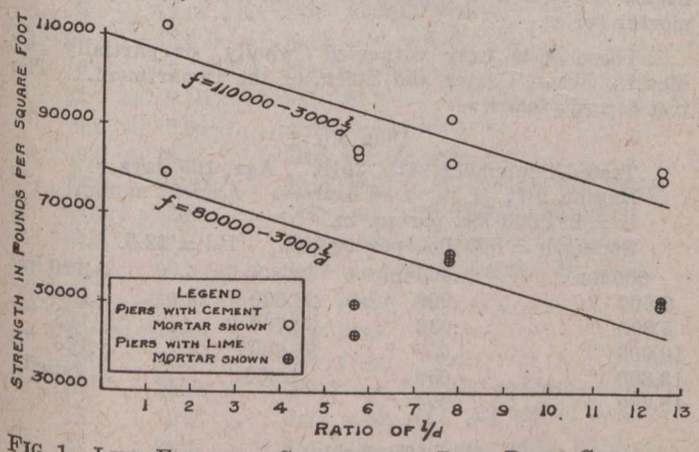

FIG. 1—LINE FORMULAE SUGGESTED BY PROF. PETER GILLESPIE AS RESULT OF TESTS ON BRICK PIERS

It as also decided to let the piers set for a period of about three months, as this was considered the least time that the walls would be called upon to take their full load. It was also decided to build the piers in both lime and cement mortar of the following mixtures:—*Lime Mortar.*—1 part lime to 3 parts sand. *Cement Mortar.*—1 part portland cement, 3 parts sand, and ¼ part hydrated lime (all by bulk).

The piers were laid up during the month of June by an experienced bricklayer. They were 8⅝ ins. square in plan and were built so as to represent a portion of an ordinary brick wall one brick thick bonded by headers every sixth course, according to common practice in Toronto.

In constructing the piers an effort was made to obtain a class of workmanship neither better nor worse than would be expected from men of ordinary skill. The crushing strengths of individual brick and of cubes of mortar 6 ins.

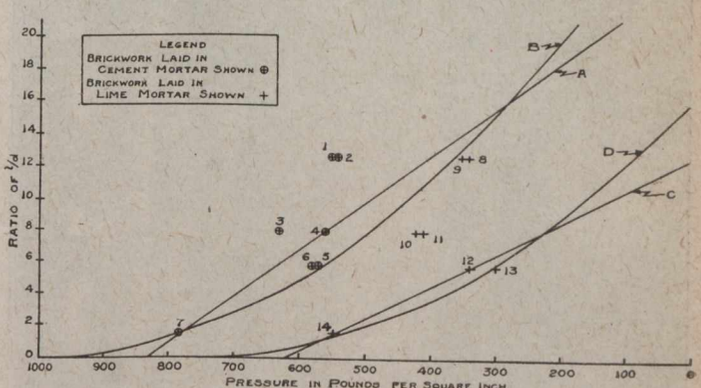

FIG. 2—FORMULAE SUGGESTED BY TORONTO BUILDING DEPT.

"A," $p = 828 - 34\ l/d$ "C," $p = 620 - 50\ l/d$

"B," $p = 1{,}000 - 180\sqrt{l/d}$ "D," $p = 760 - 190\sqrt{l/d}$

l = height of pier in inches

d = least thickness of pier in inches

to a side (the latter at an age of approximately three months), are as follows:—

Modulus of rupture of individual brick, 165 lbs. per sq. in.

Crushing strength of individual brick, 1,000 lbs. per sq. in.

Crushing strength of lime mortar, 235 lbs. per sq. in.

Crushing strength of cement cubes, 1,835 lbs. per sq. in.

The piers were constructed on the 200,000 lb. Riehlé testing machine in the Strength of Materials Laboratory at the University of Toronto, under the direction of Peter Gillespie, associate professor of applied mechanics. Each pier was build on a plate of ¼ in. steel, 13 ins. square, as a base, and capped in plaster of Paris. In addition to the crushing strength of each pier, the amount of shortening due to load and the lateral deflection, if any were obtained.

As mentioned previously, the investigation was to determine, if possible, the relation between strength and slenderness; and for that reason, values of the ratio of length to diameter lying between 1.4 and 12.5 were provided for in the program by varying the length from 1 ft. to 9 ft. A course of bricks including mortar joints averaged 3 ins. in depth.