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Reinforced Brick Columns Tested at Lehigh University

Results of first series of tests show strength varying from 2,500 to 4,500 lb. per sq.in., reveal importance of vertical reinforcement, superiority of cement mortar and solid over-perforated brick, and advisability of using lateral ties

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FIFTEEN brick columns recently tested at the Fritz Engineering Laboratory at Lehigh University, and comprising a pilot series for a more extensive investigation of the use of reinforced-brick masonry for columns, furnish some interesting and significant data. The columns were 12½ in. square by 10 ft. high. Three had no reinforcement, five had vertical reinforcement only, and seven had both vertical and lateral reinforcement. The bricks, of the new de-aired type, had an excellent physical appearance, showing no laminations or irregularities. Both solid bricks and perforated bricks were used. The average compressive strength of the solid brick was 13,760 lb. per sq.in. flat, 10,680 lb. per sq.in. on edge, and 10,070 lb. per sq.in. on end. Corresponding values for the perforated brick were 7,520, 5,080 and 4,840 on the gross area. The tests were carried out under the sponsorship of Judson Vogdes, representative of the National Brick Manufacturers Research Foundation and consultant to the Lehigh Brick Works, which, through Robert K. Mosser, supplied all materials and built the test columns.

The program of tests and the results obtained are given in the accompanying table. Attention is called to the fact that for columns in which 1:3 cement mortar was used the maximum strength was in no case less than 700,000 lb., or 4,500 lb. per sq.in., regardless of the amount of reinforcement or type of brick. The columns that had 1:1:6 cement-lime mortar gave considerably less strength, varying from as low as 410,500 lb. to as high as 671,000 lb., or from stresses of about 2,600 to about 4,300 lb. per sq.in. One of the columns had strength in excess of the capacity of the 800,000-lb. testing machine, so that a special loading rig, which provided for the doubling of the capacity of the machine, was constructed and used.

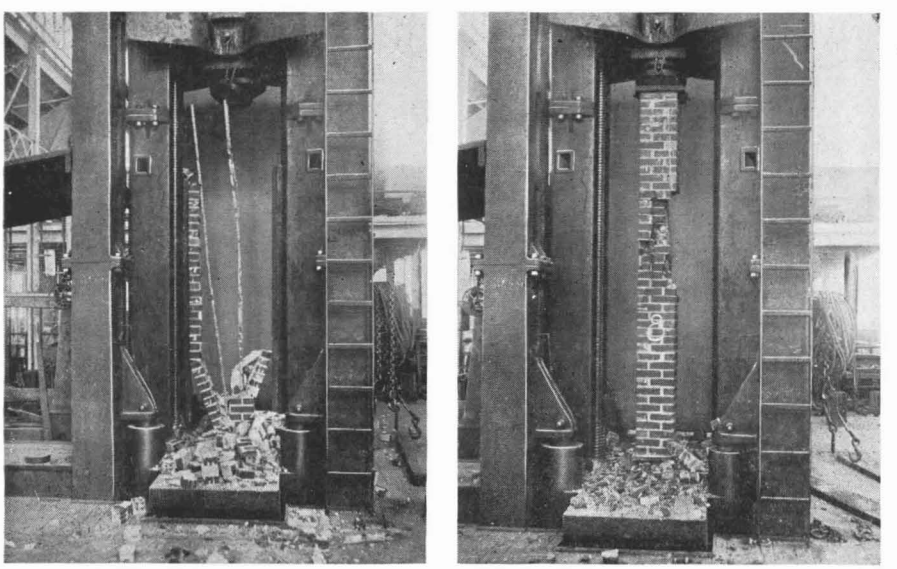
While the results were intended only for assisting in the design of further investigations, they indicated certain relationships that may be pointed out at this time. The longitudinal reinforcement increased the strength of the columns but did not seem to contribute its full yield-point strength of 137,000 lb. This was particularly true for columns having no lateral ties. The workmanship of the mason affected the strength of the column to a marked degree. A variation in strength of as much as 100,000 lb. may be attributed to the workmanship. The age of the columns did not seem to have any effect on the strength of the columns using cement mortar, but increased the strength of columns using cement-lime mortar. In general, the strength of the columns with cement mortar was about 200,000 lb. in excess of the strength of the columns in which cement-lime mortar was used. The columns utilizing perforated bricks gave lower strength than those having solid bricks. With cement-lime mortar the difference between the strengths of perforated and solid brick columns was about 150,000 lb. With cement mortar the difference was considerably less.

While the lateral ties did not seem to have a marked effect upon the strength of the columns, the type of failure was materially affected, as shown in the accompanying illustration. Before the maximum load was reached on any of the columns tested, cracking sounds were heard, and inspection revealed that vertical cracks had appeared. These cracks followed the vertical joints and fractured the brick along the line of cracking. The reinforced-brick columns showed a much greater toughness before failure occurred than did the plain columns. The latter collapsed completely under load. This series of tests would seem to indicate that reinforced-brick columns may be so constructed that they give very high strength and ample warning of impending failure.

RESULTS OF BRICK COLUMN TESTS
(Columns 12½ in. square by 10 ft. high)

Mortar	Reinforcement, Per Cent Vertical	Reinforcement, Per Cent Lateral	Age, Days	Max. Load, Lb.	Type of Brick
1:3 cement	0	0	7	738.000	Solid
1:3 cement	0	0	28	800.000†	Solid
1:1:6 lime	0	0	28	410.500	Perf.
1:3 cement	2.0	0	7	800.000†	Solid
1:3 cement	2.0	0	28	810.000†	Solid
1:3 cement	2.0	0	28	708,700	Perf.
1:1:6 lime	2.0	0	28	628.200	Solid
1:1:6 lime	2.0	0	28	473.500	Perf.
1:3 cement	2.0	Ties*	7	800 000†	Solid
1:3 cement	2.0	Ties*	28	752.000	Solid
1:3 cement	2.0	Ties*	28	732.500	Perf.
1:1:6 lime	2.0	Ties*	7	483.400	Solid
1:1:6 lime	2.0	Ties*	7	584.200	Solid
1:1:6 lime	2.0	Ties*	28	671.000	Solid
1:1:6 lime	2.0	Ties*	28	527.700	Perf.

* ¼-in.-diameter lateral ties in every third joint.
† Failed under repeated loading.



Comparison of failures of reinforced-brick columns with and without lateral ties. The use of ties did not increase the strength, but it did obviate complete collapse, as shown at the left.