DESIGN OF FOOTINGS IN REINFORCED CONCRETE.

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THE design of footings in a reinforced concrete building presents perhaps more unusual features and difficulties than does any other portion of the building. This is due to a great extent to the fact that very little satisfactory information may be obtained on the subject from texts.

The first step, of course, is the calculation of the column loads. Great care must be exercised in this particular, as unequal pressure on the soil from two adjacent columns will, in all probability, result in cracking of the beams and slabs.

Consider a building, say, five stories high. The load which will come on the wall column footing is usually about 70% dead load which is always present, and about 30% live load which is seldom all present; while the load on an interior column footing is about 40% dead load and 60% live load. From this it is readily seen that unless the above facts have been considered in the design, the load under average conditions is less per square foot on the interior footings than on the exterior footings.

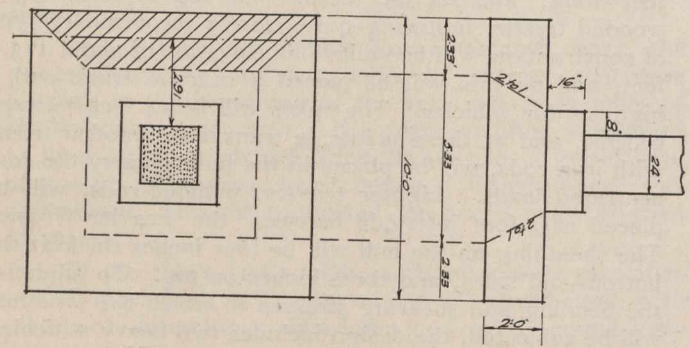

Fig. 1.

The practice of reducing the live load figured on the footing of a building over a certain height eliminates the above to some extent, though it would appear more logical to allow a greater live load reduction on the interior footings than on the exterior footings.

The principle underlying the design of a simple footing is that the portion inside the dotted lines which are at a 30-inch slope from the edge of the cap, in Fig. 1, are considered as self-supporting, and the portions outside these lines, i.e., the shaded portions in plan, are to be carried as cantilevers.

An example of the above is as follows:—

Allowable soil pressure = 4,000 lbs.; load on column = 400,000 lbs.; size of column = 24″ x 24″; size of cap = 3′ 4″ x 3′ 4″ x 16″.

$$\text{Required area of footing} = \frac{\text{load}}{\text{soil}}\ \text{pressure} = \frac{400{,}000}{4{,}000} =$$

100 sq. ft. = 10′ 0″ x 10′ 0″.

Total soil reaction represented by shaded portion:

$$(2.33 \times 2.33) + (2.33 \times 2.17) \times 4{,}000 = 17.5 \times 4{,}000.$$

Since this reaction is to be distributed over 5.17 ft., the reaction per ft. width $= \dfrac{17.5 \times 4{,}000 \text{ lbs.}}{5.17}$. Then area of steel required

$$= \frac{17.5 \times 4{,}000}{5.17} \times \frac{2.91 \times 12}{.86 \times 16{,}000 \times 22}$$

= 1.54 sq. ins.

In the case where the edge of a building extends to the lot line, and it is not permissible to encroach on the neighboring property, it is seen that the load on the footings would be of an eccentric nature which would cause the footing to have an overturning tendency and throw tension into the outer face of the column. This may be overcome by tying the wall column footing to an interior column footing by means of a wide concrete beam. Another method of accomplishing this, of course, would be to employ a raft footing spanning the entire length of the building along the walls. The former, however, is, under average loads, better engineering practice and more economical, and the writer will endeavor to illustrate briefly the designing of a footing by this method.

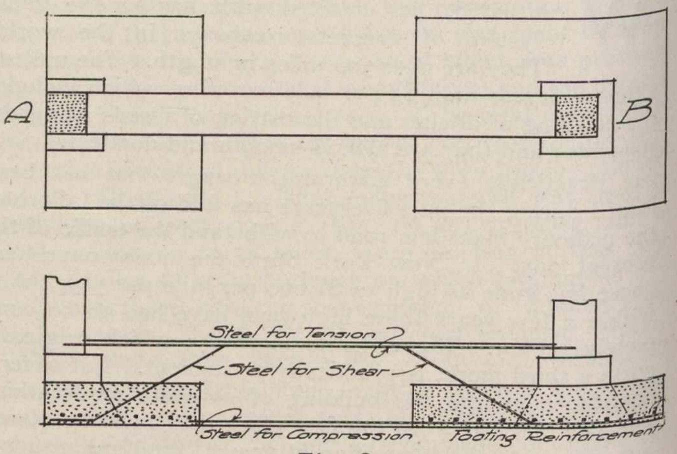

Fig. 2.

In the plan and section shown in Fig. 2, as previously assumed in simple footings, the portions inside the dotted lines are self-sustaining and the remaining portions are carried as cantilevers. The load which the beam will sustain will be the sum of the areas of these cantilevered portions and the area of the beams multiplied by the allowable soil pressure.

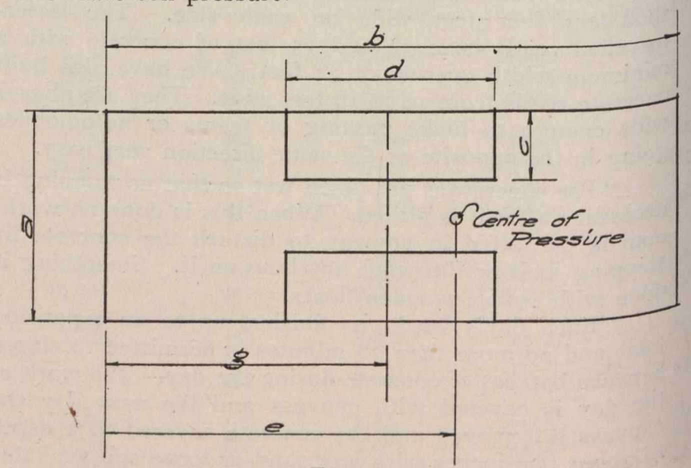

Fig. 3.

The most important adjustment to be made in the design is to have the centre of pressure of the column loads passing through the centre of gravity of the areas supporting them. If these areas do not coincide, the soil will settle on the side which is most heavily loaded, which condition may result in cracking the beams and slabs in the floors above, if not in failure.