A complete design of a footing of this type would be as follows: Let us consider a building in which the columns are spaced 24′ 0″, centre to centre. The load on the wall column "A" is 267,500 lbs., and on the interior column "B" is 504,000 lbs. Distance of centre of pressure from line x-x (Fig. 2)

$$= \frac{\text{moment of loads about x-x}}{\text{sum of loads}}$$

$$= \frac{(504{,}000 \times 24) + (267{,}500 \times 0)}{771{,}500} = 15.679 \text{ ft.}$$

To distribute the area so that the centre of gravity of the area corresponds with the centre of pressure of loads, we will assume a rectangle, a b, with two pieces, c d, deducted from it in such a way that the above condition holds.

Let area required to resist load at given soil pressure = P sq. ft.

Therefore P = a b — 2 c d

$$C = \frac{P + a\,b}{2\,d}$$

$$\text{Moment of whole rectangle (Fig. 3)} = \frac{a\,b^2}{2}$$

Moment of portion to be deducted = 2 c d y

Moment of adjusted portion = (a b — 2 c d) × e

$$\text{Therefore } (a\,b - 2\,c\,d) \times e = \frac{a\,b^2}{2} - 2\,c\,d\,y$$

$$Y = \frac{\frac{a\,b^2}{2} - (a\,b - 2\,c\,d) \times e}{2\,c\,d}$$

By using these formulæ we would proceed as follows:

Total load = 711,500 lbs.

Area required to resist this load with allowable soil pressure of 4,000 lbs. = 192.875 sq. ft.

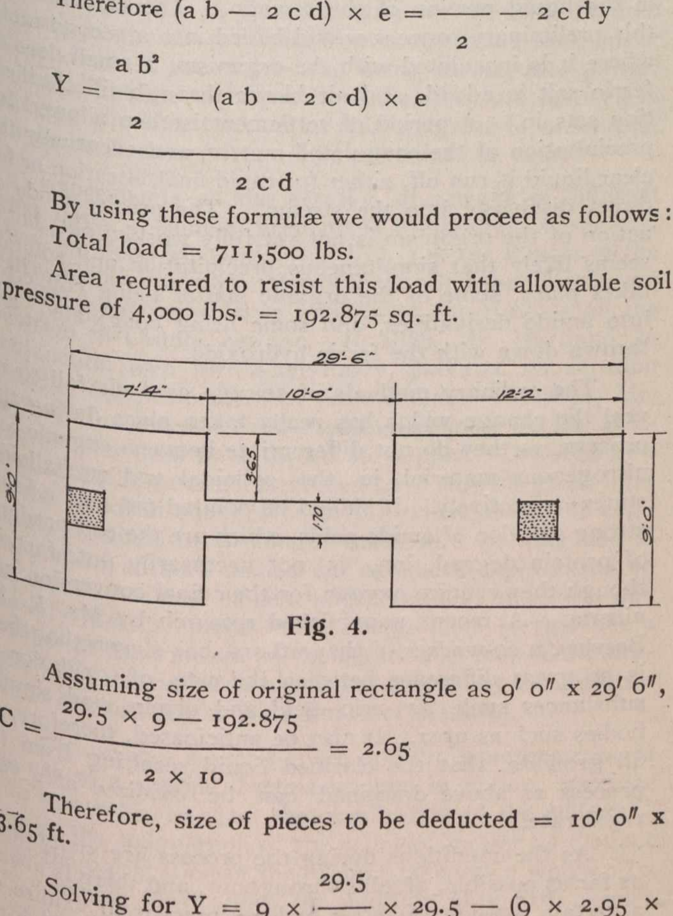

Fig. 4.

Assuming size of original rectangle as 9′ 0″ x 29′ 6″,

$$C = \frac{29.5 \times 9 - 192.875}{2 \times 10} = 2.65$$

Therefore, size of pieces to be deducted = 10′ 0″ x 3.65 ft.

$$\text{Solving for } Y = \frac{9 \times \frac{29.5}{2} \times 29.5 - (9 \times 2.95 \times}{2 \times 10 \times 3.65}$$

$$\frac{15677 - 20 \times 3.65 \times 15.69)}{} = \frac{3920 - (4160 - 1142)}{73} =$$

12.3 ft.

With this information we may now design the shape of the footing. (See Fig. 4.)

The depth of the footing is governed by the shear along the line c—c— and is equal per foot to the area of a strip one foot wide and 3.65 feet long multiplied by the soil pressure = 14,600 lbs.

Safe resisting value of concrete to shear = 60 lbs.

Therefore, resisting shear = 60 lbs. × 22 × 12 = 15,840 lbs.

Therefore the assumed thickness of 24″ is correct.

The area of steel in the footings is found in a way similar to that used previously in simple footings. The reinforcement is placed in one direction only in footing "A" and that at right angles to the beam and both ways in footing "B."

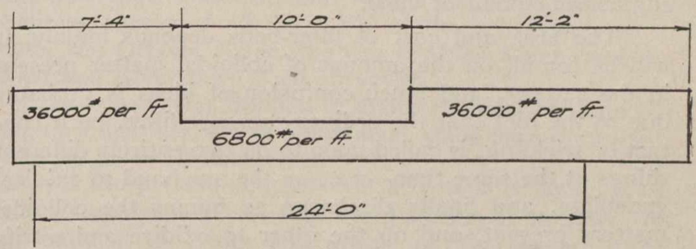

Fig. 5.

In the design of the beam, we have to consider the loading, as shown in the diagram (Fig. 5), found by the method already described. The span of the beam is figured as 24′ 0″.

$$\text{Let reaction} = \frac{36000 \times 7 \times 18.12}{24} = 190{,}000 \text{ pds.}$$

$$\frac{6800 \times 10}{2} = 34{,}000 \text{ pds.}$$

$$\frac{36000 \times 6.08 \times 300}{24} = 27{,}750 \text{ pds.}$$

Total = 251,750 pds.

Maximum bending moment will occur at centre of span and $= (25175 \times 12) - (36000 \times 7.3 \times 8.66) + (6800 \times 5 \times \frac{5}{2}) = 833{,}000$ foot-pounds.

$$\text{Area of steel} = \frac{833000 \times 12}{.86 \times 160 \times 46} - 15.72 \text{ sq. in.}$$

This result is the area of steel required for the entire width of beam.

Therefore, area required per foot of width $= \frac{15.72}{1.7} = 9.25$ sq. in.

As the available depth of concrete will not develop this steel in compression it will be necessary to place additional steel in the compressive side of the beam.

The above is only one of a number of ways of arriving at these results and, as mentioned previously, only one of a number of accomplishing the desired end. It may, however, be stated in conclusion that the type of footing designed by this method has been recently employed in numerous buildings with unvarying success.