Moment of force (1) = 8,320 × 2.33 = 19,400
Moment of force (2) = 1,120 × 5.57 = 6,250
Moment of force (3) = 2,370 × 4.65 = 11,000

$$\Sigma x = 11{,}810 \qquad \Sigma m = 36{,}650$$

$$y = \frac{\Sigma m}{\Sigma x} = \frac{36{,}650}{11{,}810} = 3.10 \text{ feet,}$$

equal distance of resultant vertical force from axis of moments.

The position and intensity of the two forces affecting the stability of the wall are shown in Fig. 5. The resultant, "R," is found by solution of the triangle of forces equal to 17,500 lbs., and cuts the base 2.45 feet from the toe.

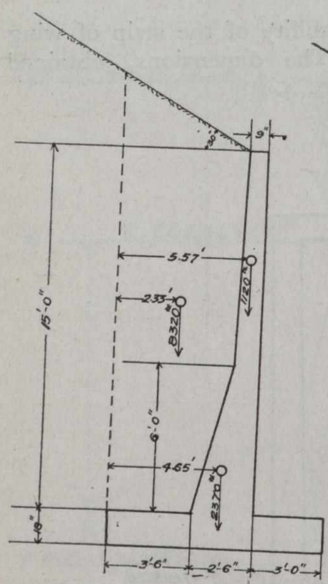

Fig. 4.—Resultant Vertical Force Due to Weight of Wall and of Earth on Base.

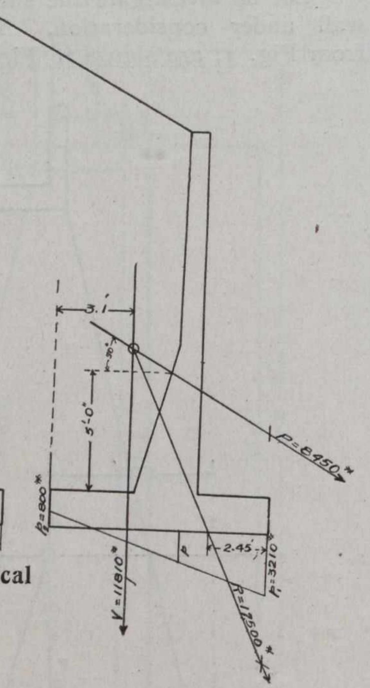

Fig. 5.—Positions and Intensity of Forces Shown in Fig. 4.

To find pressure on foundation at toe of wall, we shall assume, as in parallel case previously considered, that the effective width of supporting base = 2.45 × 3 = 7.35 feet. Hence, average pressure $= \frac{11{,}810}{7.35} = 1{,}605$ lbs.

The pressure at the toe equals twice the average pressure = 1,605 × 2 = 3,210 lbs., which is far within the bearing capacity of the assumed foundation.

Base—The base should be of sufficient width to properly distribute the load within the safe bearing capacity of the foundation. At the buttresses or any intermediate point the three-foot projection beyond face wall is subjected to an average upward soil pressure of 6,520 lbs. per square foot. This projection is assumed to act as a cantilever, and as the centre of gravity of the upward forces is found to be 1.58 feet from front of face wall, the moment in clockwise direction = 6,520 × 3 × 1.58 × 12 = 371,000 in. pds. Moment in opposite direction due to weight of projection = 12,100 in. pds. Hence, net moment = 371,000 — 12,100 = 358,900 in. pds. But, 108 b. d.^{2} = 358,900, from which d. = 16.6 inches, as compared with total depth of 18 inches, as per Fig. 1.

Area of steel required = .008 × 16.6 × 12 = 1.60 sq. ins. Area of steel from drawing equals 1-inch square bars at 8-in. o.c., equals 1.5 square inches per foot of base. The proper spacing of steel, according to our investigation, would be 1-in. square bars at 7-in. o.c.

Consider the shear at this section, thickness of base being 18 inches. The average shear on 12 inches equals

$$\frac{6{,}520 \times 3}{18 \times 12} = 90.5 \text{ lbs.}$$

As this exceeds the allowable shear in concrete, namely, 60 lbs. per square inch, it is necessary to supply shear reinforcement, apart from the area required to resist tension.

The base between buttresses behind the face wall is figured as a beam supported by the buttresses, to resist the upward or downward pressures, as the case may be. At any section between buttresses we have a net upward pressure behind the wall of 1,950 lbs. per square foot, and an average downward pressure of 2,000 lbs. per square foot on rear foot of base. As span is 13.5 feet,

$$\text{moment} = \frac{2{,}000 \times (13.5)^2 \times 12}{10} = 438{,}000 \text{ in. pds.}$$

But, 108 b. d.^{2} = 408,000

$$d.^2 = \frac{408{,}000}{108 \times 12} = 337$$

d. = 18.35 inches.

Area of metal required = 18.35 × 12 × .008 = 1.76 square inches, as compared with total depth of 18 inches and area of 1.57 square inches of metal supplied, as per Fig. 1.

In order to take care of the reversal of stress in the rear of the footing it would be advisable to place reinforcing steel at the top and bottom of base plate.

The front and rear projections of base, in case of wing walls, are both designed as cantilever beams. Considering the front projection of the section shown in Fig. 5, we find that the average upward pressure to which the projection is subjected, equals 2,550 lbs. per square foot. The centre of gravity of these upward forces is found to be 1.63 feet from the face of the wall. Therefore, moment of upward forces equals (2,550 × 3) × (1.63 × 12) = 150,000 in. pds.

Resisting moment due to dead weight of projection equals (3 × 1.5 × 150) × 18 = 12,100 in. pds.

Therefore, net moment = 150,000 — 12,100 = 137,900 in. pds. But, 108 b. d.^{2} = 137,900, from which d. = 10.3 inches.

Area of metal required per foot of wall equals 10.3 × 12 × .008 = .99 square inches.

Area supplied in Fig. 1 equals 1 square inch, and total depth of beam equals 18 inches, from which it appears that there is an excess of concrete at this point.

The design of the rear cantilever is exactly similar to the above and, as may be seen from the figure, the pressures are considerably less than in the case of the front projection. Hence it is evident that, if the same section be used throughout, it will be excessively strong, but perhaps permissible as it facilitates the construction.

The Transcontinental Railway Company, Ottawa, Ont., have recently purchased from the International Engineering Works, Limited, six locomotive boilers, 100 h.p. each. These boilers are to be installed in their various stations and roundhouses along the line.