crucial point in the whole design, is determined by the values thus adopted for this reason that the hydrostatic pressure is here first felt and the neutralization of head up to this point should be sufficient to reduce the required depth of floor to reasonable and economical dimensions. The minimum average thickness of the fore apron is obtained by the empirical formula= $\sqrt{18}+1\frac{1}{2}$, varies from 6 ft. as maximum to 3 ft. as minimum. $T = \frac{3h}{2} + 1\frac{1}{2}$. (h = height of solid masonry weir) = 5½ feet nearly.

In designing these weirs it is a great convenience to make all dimensions multiples of the coefficient c, as then each unit represents a neutralization of one foot off the original head. The length of the rear apron should be measured back from the toe of the drop wall. In the design this length is made = 4c = 48 feet. Deducting the base thickness of the weir wall which is 9 feet, the actual length of the rear apron = 3H. This, if anything is somewhat short, a length of 3½ C would give better results. The thickness of the rear apron composed of puddle covered with stone rip rap will be 5 feet, it cannot be less.

Now we come to the sheet piling steel or concrete steel. This is made 1½C or 18 feet in depth consequently the total neutralization of head effected up to the toe of the weir wall is 4 + 3 ft. = 7 feet, leaving 5 feet hydrostatic upward pressure acting here. The SG of the material in the masonry fore apron will be taken as 2 (a common low value). The apron is submerged lying below LWL, its effective SG will therefore be unity. Now the effective weight should (it is deemed) exceed the upward pressure at least by one-fifth, as a precautionary measure, the depth required will be 5 + 1 1-5 = 6 feet of water, corresponding to 6 feet depth of masonry with an effective value p—1 of unity. The length of the fore apron will be the remaining balance of lH, i.e., (12—7 c = 5c), and the terminal thickness, theoretically nil, is made 4 feet for other than statical reasons. This ends the design as regards statical requirements. For anti-erosive purposes the floor will have to be continued as a talus of loose stone pitching for another 60 feet giving a length, measured from toe of drop wall, of 12H = 144 feet. This, as we have seen, is obtained from an empirical rule, and can be varied as experience may dictate. The minimum length of fore apron is 4 to 5H.

The graphical method of design is shown on the same figure and is very simple. From the extremity of the rear apron the total requisite base length, = cH = 12 × 12 = 144 feet is set out to the point B. The line HB then is the hydraulic gradient of 1 in 12. From B set back BC = vertical portion of the base length = 3c or 36 feet, and from the point C draw a line CD parallel HB up to D, its intersection with a continuation of the vertical curtain.

The triangle DAC is the triangle of pressure. The dimensions of the base drop wall are found by the following formula: $\frac{H'}{Vp}$ in which H′ is the height above floor of the head water at the time when the tail water is level with the crest being generally 1½ times the height of the solid drop wall. But when the maximum statical head, i.e., to shutter crest exceeds this H′ will become H and the formula $\frac{H}{Vp}$

We will now give another example of design of a direct overfall weir with floor at LWL, viz., that of an alternative design for the Chenab weir. The actual given conditions are:—

H = 13 c = 15. Whence l must = 13 × 15 = 195 feet.

In this design the original arrangement is followed of having the permanent drop wall of low elevation, the requisite summit level being obtained by the use of steel collapsible crest shutters. As in the existing work, the level of the crest of the drop wall is placed at seven feet above extreme low water, while the remaining 6 feet required to bring the summit level RL 728 is provided by the shutters.

The commencement of the rear apron is placed 4c = 60 feet behind the toe of the weir wall, below which sheet piling 1c or 15 feet in depth is provided. These neutralize 6 feet of head leaving a balance of 13—6 = 7 feet, hence a farther base length of 7 × 15 = 105 has to be provided in the fore apron. This is too long for actual requirements, which is 5 H = 65 feet, consequently another row of sheet piling is introduced at the end of the floor with a depth of ½c, or 7½ feet. This admits of the curtailment of the floor by C or by 15 feet, reducing it to 6c or 90 feet. There are thus two vertical depressions in the base line.

CHENAB Alternative

C = 15 H = 13

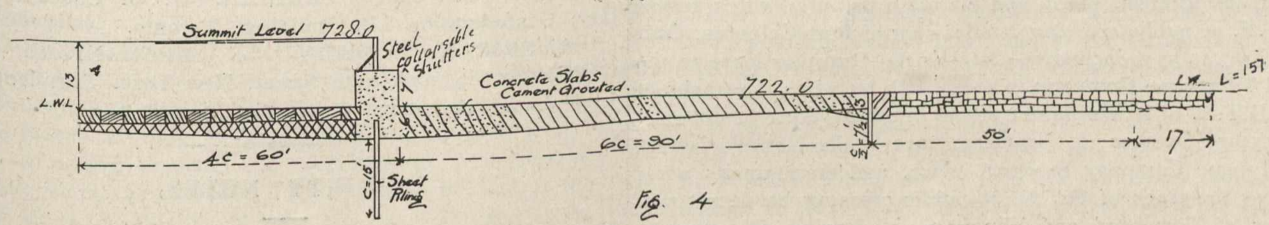

Fig. 4

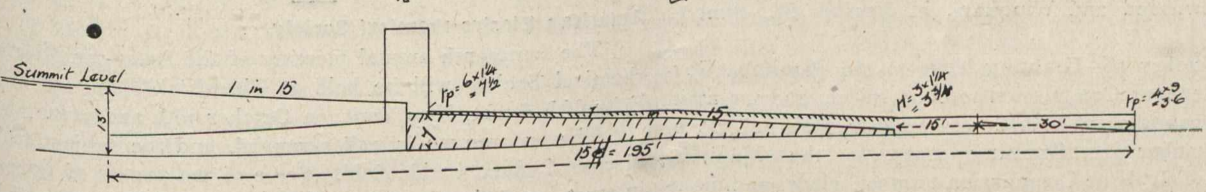

Fig. 4A

The graphical diagram is shown in figure 4A. First, the total required base length or 15H = 15 × 13 = 195 feet is measured off from the commencement of the rear apron, and the hypothenuse is drawn in from the point thus obtained. Secondly, the respective values of the two vertical depressions are set back, viz., 2c = 30 feet, and C = 15 feet. A line parallel to the hydraulic gradient is then drawn from the first-mentioned point up to its intersection with a vertical through the first row of piling. A second parallel cannot be drawn from the second point as the intersection with the vertical is at the same spot, consequently the second step occurs at this very point. The outline of the pressure area below the weir wall is not a triangle, as heretofore, but a trapezium. The value of tp adopted is marked on the diagram. This thickness is hardly sufficient and should be increased from 6 to 7 feet giving a value of tp of 7 × 1¼ = 8.8.

The rear apron is composed of puddle overlaid with concrete slabs, the weir wall is of concrete, the fore apron is of concrete slabs laid on a slope, breaking joint, subsequently cement grouted. This is a novel but economical method of subaqueous construction, and was first adopted at the Colombo breakwater.

This design would, (it is now considered), be improved by increasing the length of the rear apron from 4c to 5c, and cor-

N.B.—The letter p is used for the Greek letter roe in formulae.