Class 3.—Boulder and sand formation. Coefficient 6 to 9.

The coefficients all are obtained from actual examples given in the table accompanying.

With regard to hydrostatic pressure on the base the following points still require notice.

In Fig. 2, if a hole were bored in the floor CE and a pipe inserted, the water would rise up as far as the existing hydraulic gradient HE, the head acting on the base CE would thus be greater than the triangle HAE, would, in fact, be the trapezium HCEE. This is accounted for by the addition to the external head, which is HA, that due to the displacement. To avoid confusion, the extraneous or active head of water symbolized by H, which always means the difference of levels above and below a weir or regulator, will be kept distinct from that due to displacement or immersion, this latter pressure will be allowed for by reduction in the effective weight of the immersed body. As is well known a solid material immersed in water loses weight to the extent of the area immersed, or if SG be substituted for actual weight and l symbolize the SG of the material in air, that of the same material immersed in water will be $p—I$. Thus if the SG of a block of masonry be $2\frac{1}{4}$ when immersed in water, the reduced weight can be expressed by $2\frac{1}{4}-1=1\frac{1}{4}$.

In the figure when the low water level is at E′ the floor ACEE′ is clearly immersed, and the upward pressure due to displacement will be the weight of the water displaced, that per ft. run, being represented by the thickness t. The weight of the slab per ft. run, also omitting w, is t p, consequently the effective balance downward pressure will be $W=t\ (p—1)$. The whole weight of the floor will be A (p—), A being the area.

When the LWL is at FF the status as regards upward pressure is in no way altered, the excess of upward pressure below the slab being compensated for by a similar increase in the downward pressure. When the LWL is at the level CDE′, the weight of the floor is clearly unimpaired by flotation, when intermediate, the effective weight of that portion of the floor lying below the level has alone to be considered as thus impaired.

When the floor is built well above LWL, as when the LWL is at JJ, the sand substratum being porous, the water level will rise up to the base of the impervious floor thus practically reducing the head from HJ to HC. The acting head therefore cannot be taken as extending below the actual impervious base of the weir, except as regards calculation for base length, or length of creep.

In Fig. 2 it is evident that the value of l is in no way effected, whatever be the position of the vertical drop wall with regard to the horizontal floor. For instance suppose the floor extended backwards to A′ and AA′ made = BE, then the action of the head of water is thrown back from H to H′ the Hyd. gradient will be H′B parallel to H′E, and the statical condition is in no way altered.

This rear projection is termed the rear apron. Its value in design has only recently been recognized. The rear apron is not subjected to any upward pressure, the latter being more than counterbalanced by the downward weight of water lying over it, it is also free from the erosive action of falling water, consequently it can be constructed of less expensive material than the fore apron or floor. On the other hand it must be impervious and must have a water-tight connection with the weir wall otherwise the head may act between it and the weir wall thus practically isolating it from the rest of the work. This actually occurred in the case of Narora weir, to be illustrated later. Another weir, the Chenab, failed by sinkage of the floor, the sand base having been gradually washed out by the undercurrent.

Theoretically, the rear apron would be effective if only a thin impervious layer, but practically it is considered that unless constructed of a definite weight, water passing underneath it would partake of the nature of a surface current and so not be effective in the neutralization of head.

With weirs of ordinary height, with a sand coefficient of 12 to 15, and with a value of H up to 15 feet the economical length of the rear apron will not exceed 3 to 5 H. The reason being that the rear apron performs but one function, namely, statical, whereas the fore apron in addition to this, adds that of an anti-erosive nature, consequently material placed in front of the drop wall is of greater value than that in rear, and if the rear apron is designed too long there will necessarily be excess material in the whole section, which by a more economical distribution could be avoided. The reason for this is that dynamical considerations cannot be lost sight of and the requirements to meet this second governing condition demands a certain minimum length of fore apron symbolised by L which is measured from the toe of the drop wall. This length consists in part of the masonry floor designed to meet the requisite length of creep, i.e., for statical requirements, and when this length falls short of the minimum the balance has to be made up by loose stone rip rap as a further protective covering to the sand. This latter portion is termed the talus.

The value of L is influenced by the erosive power of the current, which again is dependent on the proportional obstruction afforded by the weir, i.e., the height of the masonry crest combined with the shape of its profile, and the velocity of approach at flood times. These several considerations will determine the designer as to what value will be suitable for adoption, having due regard to precedent.

For direct overfalls with flood at LWL the value of L may be taken as from 15 to 20 NF class 1, and 12 to 16 for weirs of class 2. N in this case not being necessarily the maximum statical head but the height of the permanent masonry weir crest above floor level.

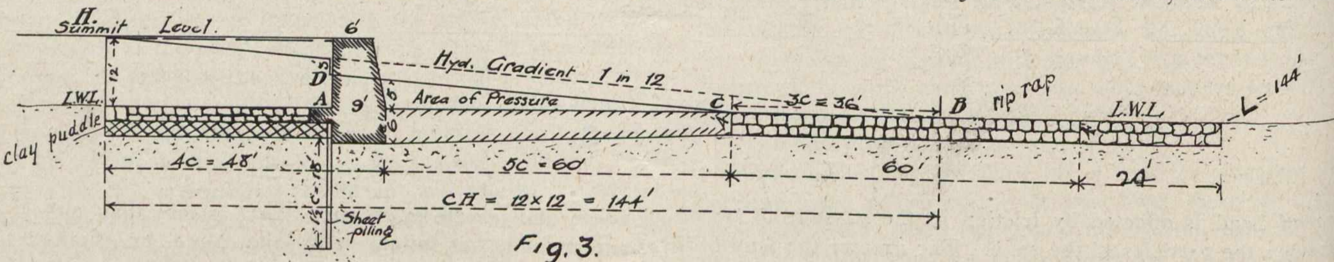

Fig. 3.

The summit level in all modern weirs is raised by means of collapsible crest shutters which fall automatically in flood times to a height varying from 2 to 6 feet above the solid masonry weir crest. This device lessens the permanent obstruction to the normal river waterway.

We have hitherto been considering only a section which has no vertical depressions in the base line. The creep of water beneath an impervious apron is known to hug all vertical sinuosities. Thus if a row of sheet piling or some other impervious curtain were inserted below the base CE in Fig. 2, the line of creep would be forced down one side of the vertical obstruction and up the other. This added length of creep is thus twice the depth of the curtain. The insertion of sheet piling or other form of curtain walling is thus a most valuable means of increasing the length of creep and thus saving that in the expensive horizontal apron.

An example of the method of applying the principles already enunciated will now be given for the design of a weir under assumed conditions, viz.:—

$$H=12 \text{ feet.}$$

River, Class 2 with $C=12$. Whence $l = C \times H = 12 \times 12 = 144$ feet.

The first point to be decided is the length to be given to the rear apron, and the depth of the sheet piling as it is proposed to adopt a curtain below the weir wall. The thickness of the fore apron at the toe of the drop wall which is the