If the heavy fore-curtain had been placed underneath the drop wall, the work, although overstrained, would probably have lasted out without failure.

The repairs to this work consisted, as shown on the section Fig. 5, of a considerable extension of the rear apron from the original 30 feet to 85 feet, this reduced the pressure on the floor to 5 feet, which is just sufficient (vide diagram Fig. 15A). Further, the grouting of the rip vap was not renewed as an impervious continuation of the floor, this reduced the triangle of pressure. With the object of further assisting the stability of the floor, which was probably already more or less undermined, a mass of concrete 2 feet deep was thrown

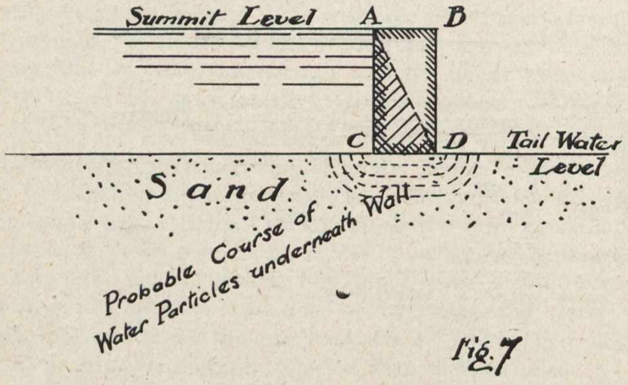

Fig. 7

over its lower end, continuing also some distance over the following rip vap.

An alternative section for this work is given in Fig. 6. The length of the rear apron is made=4 c, i.e., 60 feet measured back from the toe of the weir wall, added to which is the vertical obstruction of sheet piling, having a value of 2c., total 6c. The neutralization of head effected (h) will thus be 6 feet, leaving (H–h)=13–6=7 feet upward pressure at this point. This is provided against by a floor 8 feet thick with p=unity. The floor is made 5c., or 75 feet long and tapers to a thickness of 3 feet. This effects a further reduction of head of 5 feet, leaving 2 feet head to be disposed of. As this would necessitate a further length of 2×15=30 feet of impervious floor, which is hardly necessary for anti-erosive purposes, the masonry floor will be cut short here and the 2 feet head still remaining accounted for by a raising of the end wall 1 foot above floor level, the remaining 1 foot being met by shallow sheet piling 7 feet deep.

The stone pitching that follows will slope down from this raised level of RL 574 to 570, with an average thickness of 4 feet.

The distance of the end of talus below the weir wall is determined by erosive consideration for which empirical rules only can be given, which is for Class 1 Types B & D, L=15H =150. It is actually 160 feet.

Fig. 6a is the pressure diagram which requires no comment after the lengthy explanations given in the preceding case. Fig. 6b is explanatory of the method adopted of retaining the hyd. gradient of 1 in 15, while still further reducing the length of the masonry floor, and disposing of a balance head of 3 feet. The section would be improved by increasing the rear apron to 5c.=75 feet, and correspondingly reducing the fore apron. The thickness at the foot of the weir wall can remain the 8 feet it now is or else 1 foot of head can be knocked off by deepening the curtain.

The previous examples have all been cases where the weir has as appendage an impervious floor which is subjected to hydrostatic pressure, and we will now endeavour to show that the principles of length of base causing effectual neutralization of head and consequent reduction of the velocity in the passing current to a safe limit, apply also in the case of a weir, the material of which is not impervious.

Fig. 7 represents a wall upholding water to its crest, the hydraulic gradient is AD and the pressure area on the base in the triangle ACD. Unless CD equals at least 10 times

---

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

AC failure will result by the substratum being washed out, i.e., by piping. Now, as in Fig. 8 let a mass of loose rubble stone be deposited below the wall. The weight of this stone will evidently have an appreciable effect in preventing the disintegration and removal of the sand below the foundation. Besides which the water will not have a free egress consequently it will rise in the interstices of the mass to a certain height, EE, which is indeterminate as it depends on the obstruction caused to the flow. The resulting hydraulic gradient will then be AE, flatter than AD in Fig. 7, but still not flat enough to prevent disintegration.

In Fig. 9 a rear apron is shown and the loose stone fore-apron is extended to the point F. The sand below will continue to disintegrate and be carried up into the loose stone filling. During this process the stone filling will sink into the hollows thus formed and continue to do so until equilibrium results, i.e., until the lower part forms a practically close mass of sand and stone more or less impervious or at least offering a greater hindrance to percolation than the pure sand below. This will result in the hydraulic gradient eventually extending from A to H, or to near the latter point.

In the mean time the resistance thus afforded will give time for the rear apron to be silted up by deposit from the river. When this is accomplished, the commencement of the hydraulic slope will be thrown back to A^1, or even further and eventually stable equilibrium will result. The base line GF, or something short of it, for it will not extend to the extreme toe of the section, will represent the effective length of percolation. Thus we see that weirs can be successfully constructed of loose stone material if settlement is allowed and provided for. The undermining process, it is clear, cannot go on indefinitely, and if the effective base, i.e., excluding the extreme toe, and including the rear apron is made the proper ratio to H, i.e., l=cH, stability will be insured. The depths of the loose stone filling in the fore must, however, be such that its weight when immersed, or when dry, is at least equal to the head of water to which at any time it may be subjected.

In this figure a further development is effected by the introduction of vertical body walls of masonry in the pervious mass of the fore-apron.

These impervious obstructions materially assist the statical stability of the foundation, so much so that if the outer slope of the apron equals or is flatter than the safe hydraulic gradient and the walls are properly spaced, the base length of the prism is as effective as if it were an impervious floor.

In the figure the water through the rear apron and passing underneath the breast wall will rise in the stone filling up to the crest of the wall F, its level at E being somewhat

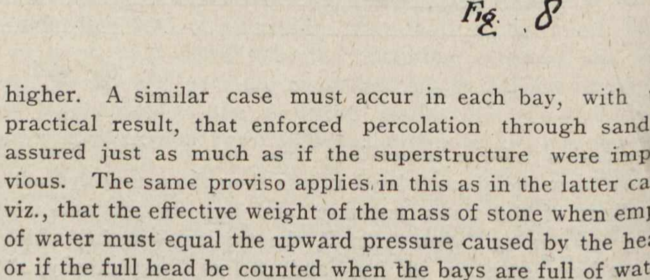

Fig. 8

higher. A similar case must accur in each bay, with the practical result, that enforced percolation through sand is assured just as much as if the superstructure were impervious. The same proviso applies in this as in the latter case, viz., that the effective weight of the mass of stone when empty of water must equal the upward pressure caused by the head, or if the full head be counted when the bays are full of water, the combined weight of the loose stone plus that of the water per foot run must exceed that of the full head neglecting the internal rise of water level. In this section the head is reduced gradually in steps, but when the river is at low level and no water passes over the crest, a freshet might throw a