THE CONSTRUCTION OF DAMS.*

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THERE are many things to be considered in designing dams, and especially one of the commonly called "gravity type," or, rather, of the solid masonry type, which will be here called the mass type; the gravity type will be that as constructed by Beardsley and Ambursen and Ransome.

In making examination of a dam site, test pits or borings should be made for a good distance above the dam site to determine the composition of the soil or strata under the dam, the trend of the stream, if on rock, noting if these are at right angles to the stream or with the stream, and if the stone is subject to water holes; also the character of the ledge, whether seamy or not, and if it shows rapid disintegration where exposed to the atmosphere, and if under water, that it is easily worn away by the action of the water, as in some limestones.

In some cases it will be found that in the bed of the river there are two classes of stone, one portion of which is soft and the other hard.

A careful examination of the banks should be made for suitable abutments and abutment foundations, and the quality of the soil composing them; also the slope of the underlying rocks, so that steps may be taken to prevent seepage through and eventually a washout.

There are several ways that have been employed by engineers in determining the proper length of crest, all of which are more or less efficient when properly applied,

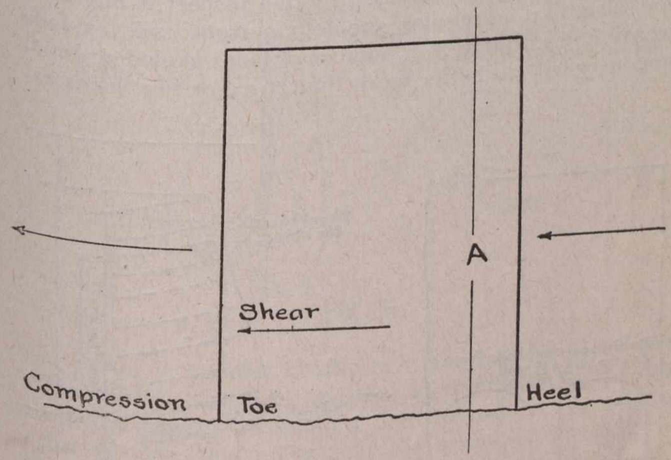

Fig. 1.

as are also certain empirical rules, where run-off data cannot be obtained, such as basing the run-off on a certain number of feet per second per square mile, certain instances of which will be given here.

In one case that came to the writer's notice the dam was constructed on a basis of three feet of crest per square mile of area which is hilly and steep, based on a rule that there should be on normal conditions at least one foot of spillway length for each square mile of drainage area, and this multiplied by three can take care of flood conditions. This dam failed many times, causing great property damage, but was finally constructed so that the spillway section would have a crest equal to taking the run-off at 20 cu. ft. per sq. mile at a velocity of one foot, and dividing this result by an assumed depth at the crest, considering it as a rectangular section, no allowance being made for the well-known weir action and of velocity of approach over such a crest. No trouble has since been experienced. This determination was made after an examination of the stream's banks for height of water, its depth at this point as compared with the width and depth of water at other points and for several hundred feet above and below; also noting the heights to which débris had landed; from information given by people living along the stream as to flood heights; from the drainage area and from rainfall data which had before for some reason given results too small, to some extent probably due to the character of the drainage area, its topography, and the condition of the soil at certain times.

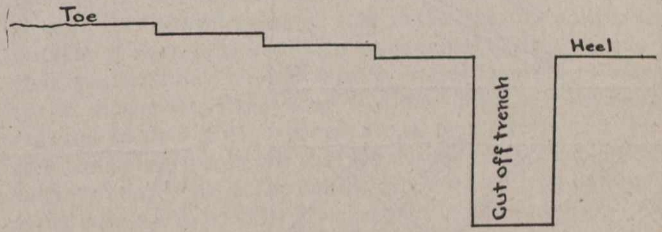

Fig. 2.

With 20 cu. ft. at a velocity of one foot per second and the banks 5 ft. high, it was assumed that the water reached 5 ft., but with 20 cu. ft. used as a basis and the dam lengthened to 146 ft., and estimating a crest depth under these conditions of 3 to 4 ft., this stream has since been measured for surface velocity during high water and an average velocity, on the surface, of 10 ft. per second obtained, with a depth of 20 in. at a point far back of the crest so that the increased velocity of the water at the crest of the dam did not affect it. Undoubtedly the velocity of the water varied at various depths, but this could not be obtained.

Assuming the average velocity at 10 ft. per second, and a sectional area of 146 ft. by 20 in., the approximate discharge per square mile in this case was 99 cu. ft. per second, and the greatest depth of water so far noted on the crest of this dam has been 3 ft. It is possible under these conditions that the velocity was from 15 to 20 ft. per second, but this could not be measured at the time, on account of lack of preparation.

In another case a dam was constructed for a crest depth of 5 ft. for a drainage area of about 300 sq. miles. This dam was 200 ft. long at the spillway, with about 1,000 ft. of earthen embankment about 18 ft. higher than the spillway section. The 5 ft. depth at the crest has been exceeded many times, and the gauge has shown a depth of 11½ ft. on the crest, which was beyond data based upon the government report's gauge readings at that time, and would be about on the approximate basis of 7 cu. ft. per second per sq. mile.

From an examination of many streams, watersheds, and dams, it would seem that one may expect to find that the run-off will vary from 50 to 100 ft. or more per second, and in some cases it has been considerably more than the maximum amount noted for a hilly section, that will give a quicker crest rise than a flat section will do, owing to the fact that the water cannot spread over any large area.

It may be assumed that a certain portion of the flood reaches the crest in the first hour, a certain portion in the second hour, and so on to five or six hours, or more, but this cannot be accurately determined beforehand with the data we have to-day.

Every effort should be made to obtain data from other dams on the same watershed, if any, or on similar water-

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