

layer of clay and to prove its continuity before covering up a part of it.

There is one instance of a trench having been filled for a portion of its length with concrete when it was discovered in the open trench farther on that a pervious bed of rock ran in below the finished work. That this discovery was made when the work was so far advanced entailed a great additional expense, for it was necessary to put in a downward extension of the existing stop wall by a process of tunnelling. The total depth of this particular wall from the surface of the ground was over 200 feet.

A case like the above is apt to make engineers insist on seeing the bottom from end to end before commencing filling. Few engineers who have not had experience of this work realize what this means.

If there is a big deposit of loose material above the impervious ground it may mean having enough timber to fix a trench four or five thousand feet long by fifty feet in depth. The timber in this may be tied up for possibly

wider upper part could be formed of puddle clay. This forecast turned out to be fairly correct but a long stretch of trench had to be put down through running sand and mud and the pressure exerted by this ground on the timbers after two years put them badly out of shape and made it nearly impossible to withdraw them through a clay filling. It also made it very doubtful if a clay core would keep its thickness after the struts were taken out, so the general type was departed from for a long stretch of trench and concrete brought up to within 15 feet of the surface. (This point may not appear very clear to the reader at present, but it will be brought out in discussing the timbering.)

The clause of the specification relating to the timbering of the trench read as follows: "The trench shall be secured with timber of sufficient strength to prevent slipping or cracking of the ground, and be so arranged that, commencing at the bottom it can be withdrawn plank by plank as the puddle or concrete is filled in; the sheeting shall for this purpose be placed horizontally, and

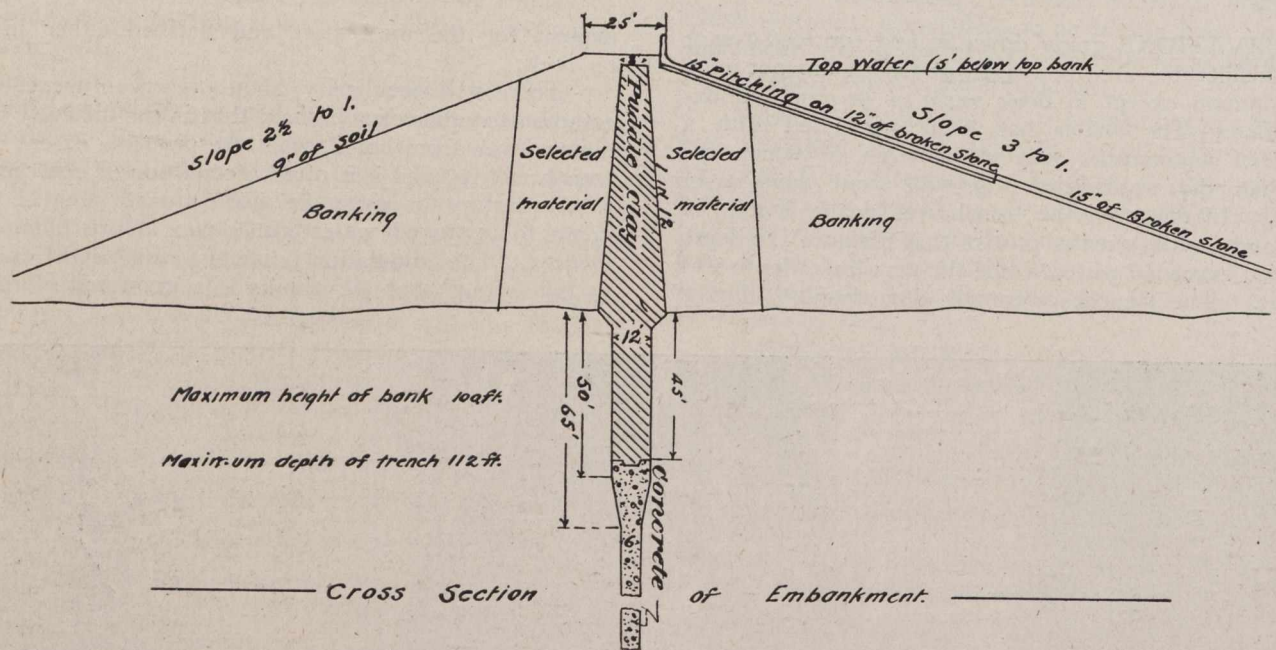


Fig. 2.—Cross-section of a Reservoir Embankment, Showing Core Wall of Concrete and Puddle Clay.

two years and all this time the contractor has a certain amount of anxiety as to the safety of his men.

The timber has all to be placed in position and, as a rule, it has all to be taken out again. Timber which has been in position for more than a year is not easy to handle, especially if the struts have so embedded themselves in the walings that they have to be sawn through to get them free.

The description of a particular piece of work is usually more interesting than generalization on a number of instances. Hence the following particulars having reference to a reservoir trench in Britain, on which the author acted as contractor's engineer, are given. The amount of the contract was over a million dollars, so the work was extensive enough to bring out some interesting points.

Fig. 2 shows a typical cross-section of the embankment with its core wall of concrete and clay and gives the ruling dimensions of the trench and bank. It was expected that rock would be met with at 50 feet or less from the surface, and so it would be possible to go down with the narrow portion and fill it with concrete while the

shall be not less than 3 inches in thickness, supported by walings and soldiers at least 4 inches and 6 inches respectively and struts having a sectional area of not less than 70 square inches."

A commencement was made with the excavation of the trench, using the horizontal method of timbering, and this worked well in good ground as was to be expected, but whenever soft ground was reached trouble arose.

An example of horizontal timbering is shown in Fig. 3.

The vertical soldiers covered five planks as a rule, except for the first five or six feet, where longer soldiers were used to permit the placing of two struts against them. It was necessary to have two struts against the top soldiers as any disturbance of surface conditions might put soldiers singly supported out of the vertical, for they would pivot on the strut end.

Except in very firm ground the procedure adopted was to excavate for the depth of one plank at a time, temporarily support this plank and lightly strut it and continue in this way till five planks were standing on "temporaries," as the men called them.