

No matter what measures are taken in order to safeguard the stability of the ground, the country as a whole will retain properties relating to plasticity, and, in my mind a plastic lining of the bottom and the sides of the headrace is more in conformity with actual conditions.

I am convinced that such a lining can be arranged so as to prevent effectively water from entering the ground, even if, contrary to my expectations, cracks should tend to occur in the ground.

As furthermore, comparative estimates have shown that a lining can be arranged for less cost than a flume, I confine myself to indicate in the following how I think the lining should be arranged.

First of all, the debris and all weathered material on the rock should be taken away.

Then porous layers of crushed sound rock, gravel, and coarse sand should be spread out, starting with the coarsest and finishing with the finest layer. The individual pieces of rock may have edges 1 in. to 3 in. long; the sand need not be finer than $\frac{1}{16}$ in.; the gravel may vary between these limits.

The materials should be arranged as in a filter, graded so that the layers of different-sized materials do not mix. The total thickness should be from 8 in. to 12 in.

On top of the sand a plastic layer should be arranged, consisting of bituminous material, and some metallic sheet, such as Robertson's protected metal sheet, arranged in plates overlapping each other. This layer should be protected by concrete slabs, the joints between which should be sealed by hot bituminous material.

The lining should be extended all over the bottom and the sides of the headrace to a height of 2 ft. above the highest computed water-level. The porous layers should reach the same level, but in the upper part of the slopes they should consist of gravel and coarse sand only—this in order to avoid a violent inrush of rain-water.

Where at the sides of the headrace the surface of the rock cannot be laid bare without removal of great masses of soil, retaining-walls may be considered. They should be watertight, and have a watertight connection with the impermeable lining in the bottom of the headrace, and they should be backfilled with earth to the level of the top of the wall.

Along the intake and the spillway structures the impermeable lining in the bottom should be arranged so that its edge will end on a rising grade overlapping the concrete, and so as to allow of minor movements.

A draining-trench filled with crushed sound rock should be arranged under the bottom, in the longitudinal axis of the headrace. At the lower end of the headrace connection should be arranged between this trench and the investigation tunnel that opens out into the air north of the power-station. This tunnel should be concreted to a certain height above its bottom.

Observation-pipes, reaching down to the porous layer under the headrace, should be arranged at the sides of the headrace. The top of these pipes should ordinarily be closed.

From the point of view of absolute security there is no doubt but that it would be advisable to extend the lining to the foot of the cliff that serves as abutment for the main dam; but I cannot advise it, because I believe that there are fair prospects of gaining at less cost a satisfactory result.

I propose that the lining be extended up-stream to a line about 350 ft. up-stream of the last outcrop of columnar rock at present visible in the bottom of the headrace.

At this extremity the lining should end in a trench at right angle to the headrace, and up-stream of the lining the trench should be filled up with concrete, making the surface in transition places as smooth as possible.

At a certain distance down-stream of this trench a gallery is arranged in the bottom and the sides, and in the country adjacent to the sides of the headrace. As the object of this gallery is to remove, partly at least by evaporation, the water that by capillary action or otherwise percolates from the headrace up-stream of the lining, the gallery should open into the air by means of one or more shafts arranged in the country adjacent to the sides of the headrace, and a tunnel connecting the bottom of the gallery with the river-gorge.