SUBTERRANEAN WATER AND THE CONSTRUCTION OF A CORE-WALL FOR AN EARTH DAM.

A SUMMARY taken from a letter by Mr. Harrison Souder, published in Proceedings of the American Society of Civil Engineers (Vol. XL., page 1569), deals with the Hinckston Run dam, built 13 years ago near Johnstown, Pa., showing the methods and the results of the employment of grout injection to close underlying rock strata against seepage under the dam. Despite the age of the work, the account is of great interest, for it was not until recently that any matter upon this early use of grout injection was published. Mr. Souder's report, as given in *Engineering and Contracting*, June 10, 1914, is reproduced in the following paragraphs.

The original Hinckston Run project called for an earth dam, 60 ft. high, to retain some 400,000,000 gals. of water, with a depth of 45 ft. at the breast. The intention was to build a dam with a clay core, but, as an unlimited quantity of cinder from the steel plant was available, it was decided, after the work was started, to use this as backing for the dam, in place of earth, and eventually to fill the whole valley below with this material, thus rendering the structure practically unbreakable. In view of this and the additional expense incurred in making the cut-off tight, the proposed height of the dam was increased to 80 ft., and later to 85 ft., above the original creek level. This gave a total maximum height above the bottom of the core-wall ditch of 112.8 ft., a depth of water at the breast of 73½ ft., and a capacity of 1,100,000,000 gals. The lake thus formed is 1¼ miles long. The watershed above the dam is 10.75 square miles.

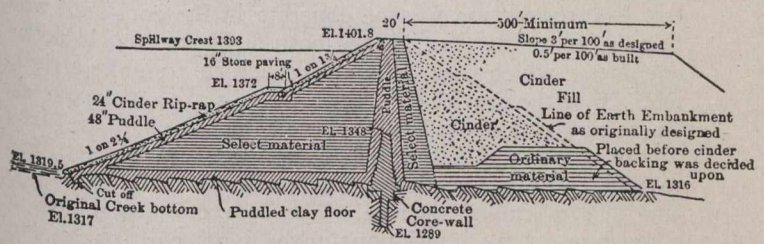

Fig. 1. Maximum Cross Section of Hinckston Run Dam.

The cross-section of the dam as built is shown by Fig. 1. The lower inner slope is 1 on 2¼, with 4 ft. of puddle and 24 ins. of cinder riprap. The slope above the berm is 1 on 1¾ with puddle lining diminishing to 2 ft. thick at the top. The facing is hand-laid stone paving. The puddle wall is 16 ft. thick at the top of the concrete core-wall, and diminishes to 4 ft. at the top of the dam.

When the core-wall ditch had been carried down to hard rock at what was thought to be the proper depth, some test holes were bored through the bottom to determine the character of the rock below. This disclosed a layer of hard sandstone a few feet down, with considerable water flowing below and above it. It was decided to deepen the ditch considerably, in order to get below any rock strata that might come to the surface within the flooded area, and to substitute a concrete core-wall for the clay one originally proposed.

An air compressor plant was installed. This was a 14 x 18-in. Ingersoll-Sergeant machine capable of driving two rock drills and six pneumatic rammers. These rammers were used in tamping concrete and also in puddling clay in such places as could not be covered by a 10-ton steam roller which was also supplied at this time in place of the 3-ton horse roller in use.

The finished ditch averaged in depth 25 ft. below the grubbed surface in the valley, but reached 50 ft. at the ends. The shale was excavated with picks, but the harder rock was loosened with light charges of dynamite, care being taken not to shatter the foundation or open up the seams. The advisability of cutting off the underflow to as great a depth as possible was realized, and it was determined to remove the shale down to the sandstone and try to cut off the flow below by forcing in cement grout under air pressure.

Grout Injection.—Drill holes, 2 ins. in diameter and from 10 to 16 ft. deep, were drilled through the rock, averaging about one hole per linear foot across the valley. Iron pipes, 2 ins. in diameter, 18 ins. long, and threaded on one end, were cemented into these holes. Portland cement grout was poured into them and then air at a pressure of from 30 to 60 lbs. was applied. The first holes were approximately 6 ft. apart. They were drilled generally 10 ft. below bed-rock.

Fig. 2 is a sketch of the first contrivance or receiver devised for applying the grout. It was a cylinder, 8 ins. in diameter and 6 ft. long. A screw flange was provided at top and bottom, and a steel head-plate was bolted to each end, with rubber gasket packing. The top bolt holes were open to allow quick removal of the lid. A 2-in. pipe with plug cocks was provided at the top and bottom. With a short hose, the cylinder was coupled to the pipes in the holes. The cylinder was filled with grout; the valve was opened; the grout ran into the drill holes; and the air pressure was then applied at the top. The contrivance was mounted on a truck running on a track in the bottom of the ditch. After trial it proved to be too slow and cumbersome, and another method was devised and operated satisfactorily. Fig. 3 is a sketch of this final arrangement. The method of grouting was as follows: A 1-in. pipe, long enough to reach to the bottom of the hole, was

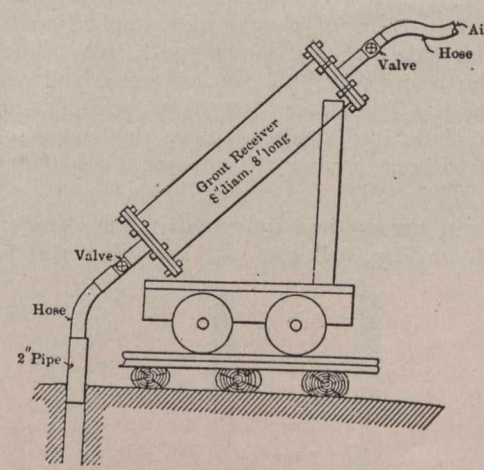

Fig. 2. Grouting Device Tried and Abandoned

inserted and air was applied to blow out water and dirt. Then a tee and the pipe, *C*, were attached to the tube in the drill hole with a sleeve union, as shown. The cock, *A*, was closed, the cock, *B*, was opened, and air was applied, thus forcing the water out of the hole and into the crevices and near-by drill holes; meanwhile, the pipe, *C*, was filled with grout, and the air hose was connected at the top. Then *B* was closed, *A* was opened, and air was gradually applied at the top of *C*, forcing the grout down into the crevices. The pipe was refilled about every 10 minutes until the hole would take no more. The apparatus was then removed and a cap was screwed on the