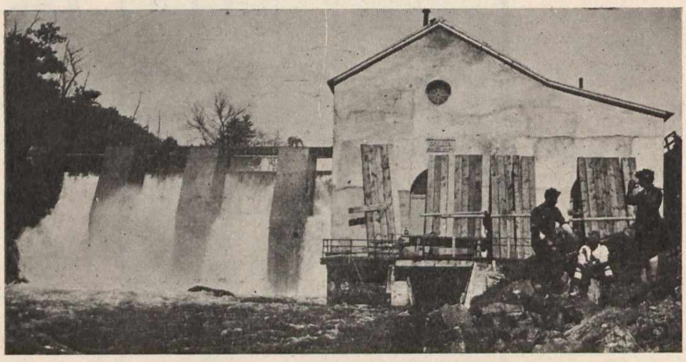
FAILURE OF THE ORILLIA DAM.

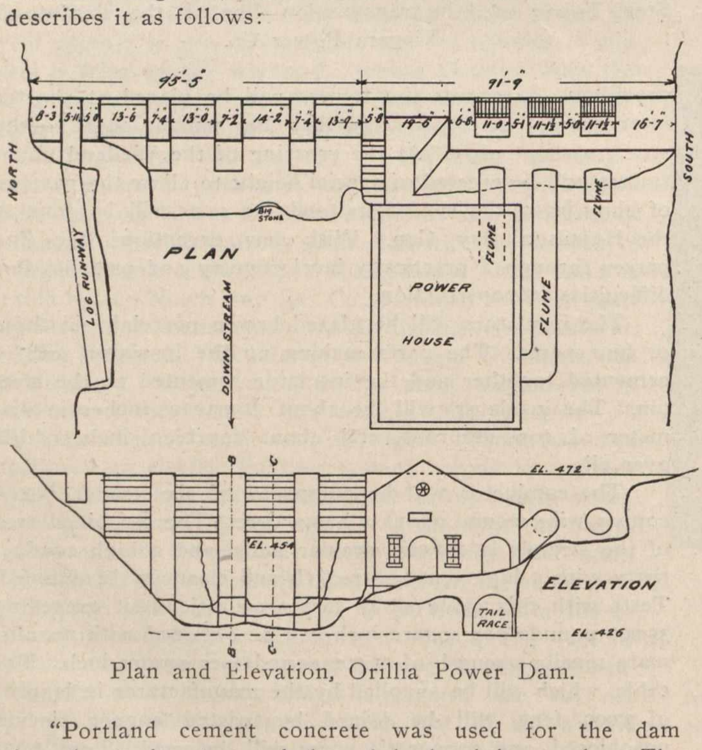
The dam from which power is generated for the town of Orillia is situated in a gorge of the Severn river, 19½ miles from the town. Before the dam was built, there was a fall in the river of about 35 feet at this point, where the banks are formed of granite rock. The construction of the dam was started in the autumn of 1898 by a firm of Buffalo contractors, but their progress was so slow that the work was taken out of their hands and given to another contractor, who appears to have expressed his doubts of the plans handed over to him, partly for the reason that the foundation of one side of the dam was not upon solid granite, but upon portions of the rock that had become disintegrated and reduced to a bed of sand. However, he took over the con-



Orillia Power Dam.

tract and completed the dam, but a considerable and essential portion of the work was carried out in the winter time and in running water, which, it is claimed, washed out the cement. The contractor denies this, and alleges that the break was caused by the washing out of the disintegrated rock at the bottom of one of the sections shown in the accompanying plans. The dam broke away on the 7th April last, during a period of high water, the break having commenced at the bottom, the concrete portion being first carried away and then two sections of the upper works, one after the other.

The dam consisted of two sections, the total length being 185 ft., of which the power house and flumes took up 92 ft. and the spillway portion 93 ft. A correspondent of the Canadian Engineer, who visited the site after the break, describes it as follows:



Plan and Elevation, Orillia Power Dam.

"Portland cement concrete was used for the dam throughout, the stream bed and banks being rock. The south half, or power house portion, containing the gates and flumes were founded upon a ledge of solid rock at the elevation shown, which was well out of the way of the running stream. The north half, or spillway portion, consisting of two types of section, one of which we will call section B-B, running up to the top level of the dam, as a continuous concrete wall, or pier, the other as per section C-C, only to an elevation of 18 feet below the top of dam, and being supplemented by stop logs to bring it to high water level, sections C-C alternating in between sections B-B, as shown.

The area of the section B-B, at the position where it attains the greatest height of wall, viz., 46 feet is 970 sq. feet, which at 140 lbs. per cubic foot, will weigh 135,800 lbs.

The area of adjoining section C-C will equal 590 sq. feet, which at 140 lbs., will weigh 82,600 lbs.

Multiplying B-B by its length of 7 feet 2 inches, and C-C by its length of 14 feet 2 inches, we have 966,600 lbs. + 1,169,610 = 2,136,210 lbs.

Now the total pressure upon such surface, 21 feet 4 in., in length of a dam 46 feet in height, will equal 1,411,107 lbs., giving a co-efficient of friction of .660.

The overturning moment of the water pressure will, upon the length of 21 feet 4 inches, equal $1,411,107 \times \frac{46}{3} =$ 21,636,974 ft. lbs. The stability of the section will equal

$$966,600 \times 12 = 11,599,200$$
$$1,169,610 \times 14 = 16,374,540$$
$$27,973,740 \text{ ft. lbs.}$$

As the co-efficient of friction existing in the structure may possibly have been equal to .660, I will not say positively that the trouble lies here. As the stability moment of 28 millions exceeds the overturning moment of 22 millions, I cannot say that the trouble lies here. But one can quite readily see that the estimated pressure in each case is uncomfortably near to the estimated strength. The dotted line, shown on the elevation, represents the line of breakage, all of the wall above this line having been carried away.

It will be noticed that the break occurred at the part where the greatest height and greatest pressure existed. It may also be pointed out that where the break occurred is also where the greatest difficulty was encountered in depositing the material, a portion of it having been deposited, I am informed, in still water, about six feet in depth, recourse having been had to the open cylinder method of depositing concrete. It is well known that this is not the most desirable method, one great drawback being that small chance is afforded for inspection of the bed of the stream. The bed of the stream at this point is known to have contained a deposit of sand, and loose stones, and it is inconceivable that material should have been put in place without every vestige of such deposit having been removed. It was noticed that when the river was in flood, the water "boiled" at the foot of the dam, but later on this point of boiling occurred some distance down stream, and it is asserted that an opening had occurred through the foot of the dam, underneath one of the sections C-C. As this opening, and the pressure of the stream through it, increased, the point of "boiling" occurred farther down stream, until suddenly one of the piers, B-B, fell outward, and northward, and the whole section, as shown, followed."

Another correspondent, who also visited the dam after the break, attributes the beginning of the trouble to the lack of cement in the concrete, and is of opinion that if the proportion of cement was put in, it was washed out by the running water, the current here being 10 to 15 miles per hour. He says a number of voids were visible in the concrete portion, and not more than half of these voids were filled up with mortar. As the break first occurred at the bottom, it was not a question of the "overturning moment. A fact to which the correspondent calls attention is that on one face of the section still standing a piece of one of the "forms" used in laying the concrete is to be seen, showing that the form had never been removed when the concreting was done, and that the presence of this form would prevent the bonding of the material—a possible cause in itself of the final break of the section.

It appears that the engineer who made the plans did not supervise the work of construction; and there seems to