be provided against each of these possible manners of failure.

A number of high masonry dams have been built in France and Algeria according to the principles proposed by the engineers mentioned above. The greatest of these works is the celebrated Furence dam, built in 1862-66 near St. Etienne, France. It is about 170 feet high, and was for many years the greatest work of its kind.

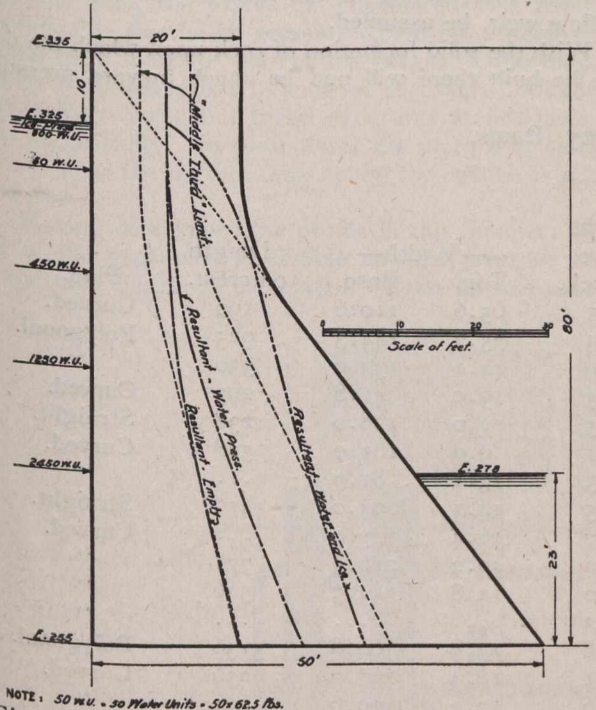

Fig. 6.—Profile Which Accompanied the Consulting Engineer's Report.

Prior to 1884 there was only one high masonry dam in America, viz., the Boyd's Corner dam, 78 feet high, which was built in 1866-72 to form a storage reservoir for the city of New York. From 1888 to the present time a number of high masonry dams have been built in various parts of the world. The greatest of these works with their principal dimensions are given in Table II.

Up to about twelve years ago, the profiles for all masonry dams, with one exception, were determined by considering the water as acting only on the upstream faces of the dams. The failures of three dams built on poor, porous rock, viz.: the Bouzey dam in France in 1895; the Austin dam in Texas in 1900, and the dam at Austin, Pennsylvania, in 1911, drew the attention of engineers to the fact that water might percolate under the base of a dam and exert a strong upward pressure, which would diminish the strength of the dam materially. This led designers to include such an upward force in determining the profile of a masonry dam. The intensity of the uplift depends evidently on the permeability of the rock. It may vary from practically nothing in good sound rock to almost the full head of the reservoir in porous rock, full of seams. The pressure of the water against the upstream face of a dam is easily calculated, but the amount of a possible upward force under the base or in the masonry itself must be decided, of necessity, by the judgment of the designer.

In addition to the action of the water against the upstream face, and possibly, under the base of a dam, we must consider in northern latitudes the thrust which ice may exert against a dam in forming and in expanding during a rise of temperature. When confined, as between two bridge piers, thick ice exerts a great force in expanding. A small masonry dam at Minneapolis, Minnesota, was partly revolved in 1899 by a sheet of ice, 4 feet thick and 300 feet long, lying between the dam and the retaining wall of a canal. The dam was 18 feet high, 5.25 feet wide at the top, and 12 feet at the base. The top of the wall was forced nearly a foot out of line, but, when the ice was cut, the wall returned nearly to its original position. If the ice is only about 12 to 15 inches thick and forms a long sheet, it will buckle and form "reefs" and possibly may not cause a great pressure against a dam. In the present state of knowledge we cannot determine accurately the pressure which ice may exert against a dam, and the allowance to be made for this force in designing the profile of a dam is a matter of judgment which must be based upon the local conditions. The following reservoir walls have been built for the city of New York without making any allowance for ice pressure or any possible upward pressure under the base, and stand successfully without the slightest indication of any weakness, viz.: The Sodom dam, 98 feet high, built in 1888-93; the Titicus dam, 135 feet high, built in 1890-95; and the new Croton dam, 297 feet high, built in 1892 to 1907.

On the other hand, engineers have deemed it advisable of late, to take ice pressure and possible uplift under the dam into account in designing the profile, as will be seen in the following table:

Recent Masonry Dams.

Dam.	Built.	Height, ft.	Ice pressure, lbs. per lin. foot.	Uplift.
Wachusett, Mass. ..	1900-06	228	47.000	
Cross River, N.Y...	1905-09	170	24.000	
Croton Falls, N.Y...	1906-11	173	30.000	
Olive Bridge, N.Y...	1907-13	252	47.000	
Kensico, N.Y.	In construction.			

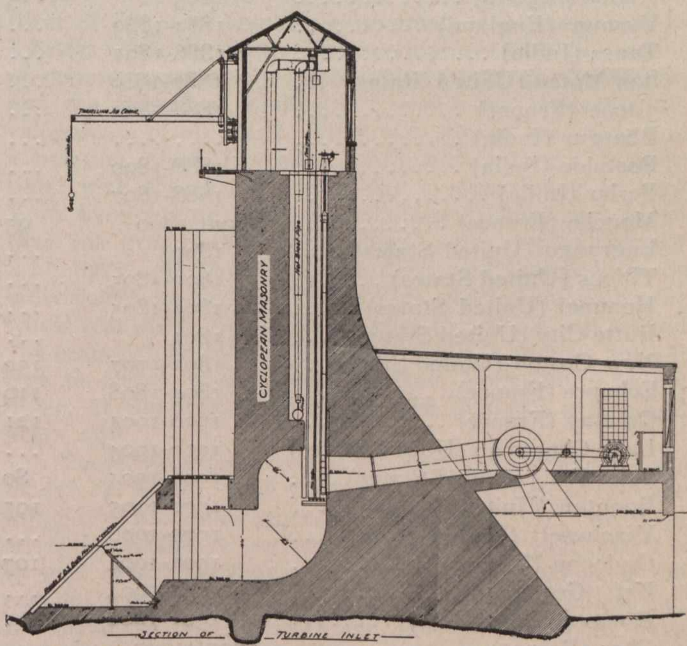

Fig. 7.—Cross-section of Portion of Power House, Showing Turbine Inlet.

In all of the above dams, the upward pressure under the base of the dam was taken as ⅔ of the full head in the reservoir at the upstream side, diminishing to zero at the downstream side.

As to recommendations for the design of the dam across the St. Maurice River, there are two types of construction that might be adopted. The dam might be built