is assumed on the upstream face, but the writer nevertheless believes it quite possible to develop a form of masonry dam in which the weight of water and possible back fill is utilized to add stability, and may propose something of that sort in the future. He surely believes that the ordinarily accepted coefficient of friction as indicated above and the factor of safety of two against overturning, should not be accepted as sufficient..

In earth dams, the writer believes, of course, that the section should be something like that shown in Fig. 4.

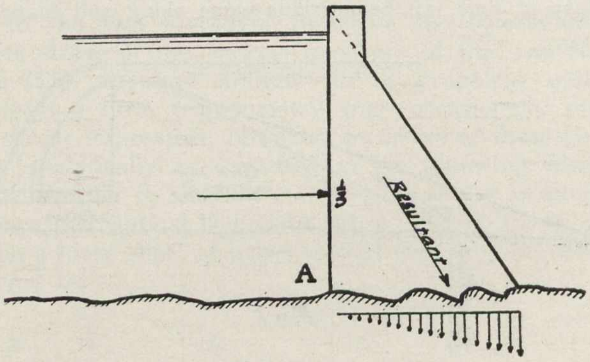

Fig 3

Typical Cross Section of Masonry Dam.

The same idea applies to an earth dam, a rock fill dam or like structure with a cut-off planking, reinforced concrete, steel plate, or common puddle. In every case water-tightness should, if possible, be secured as near the water itself as possible, and the vertical components of the hydrostatic pressure should be equal to or exceed the horizontal ones. Western engineers have already followed this idea to some extent in earth and in rock fill dams with planking.

Designers of concrete dams have usually followed the standard masonry profile or something near it. It is human nature, in engineering matters as in other affairs, to follow and develop an established idea, sound or unsound, to its utmost limits, while a new one or a very old and forgotten one, must make its way slowly.

Happily, Bainbridge with his steel dam, and Ambursen with his concrete dam, and the idea of the reinforced concrete

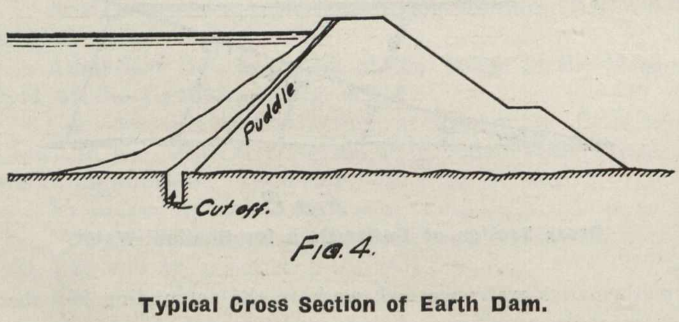

Fig. 4.

Typical Cross Section of Earth Dam.

retaining wall came along, so that it is now in order to consider a dam having a water-tight face capable of taking tension. Bainbridge's dam consists of a series of inclined bents covered on the upstream side with water-tight concave plates. (See Journal W. S. E. Vol. X, p. 615.) In this dam, water pressure is of course taken normal to the water-tight face (Fig. 5). The column loads are taken directly to the rock bottom, and tension of face plates is taken up by anchor rods, as indicated. If not founded on rock, the design must be altered radically, as indicated further on.

Although the Ambursen dam (Fig. 6) utilizes the weight of water to some extent, in my opinion it does not, as ordinarily constructed, provide much greater stability against sliding than the standard profile, though it does thoroughly provide against hydrostatic uplift by the open construction of its base. The main idea of Ambursen's patent was apparently to so construct the water face of his dam with reference to the cross walls that the direction of water pressure at any point should fall within the base.

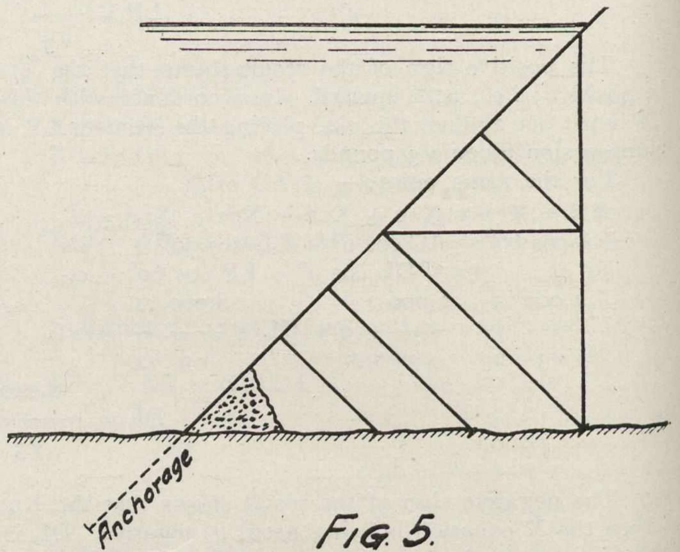

Fig. 5.

Cross Section of Bainbridge Steel Dam.

Of course, the calculation of stability of a steel dam on rock bottom, with given factors of safety, is very much simpler and more certain than even the design of a steel railroad bridge, and the writer believes that the time is coming when the merits of this construction will be much more appreciated by engineers than is the case at present.

In designing the cross section of a steel dam about 100 feet high, the writer accidentally hit on the idea of making

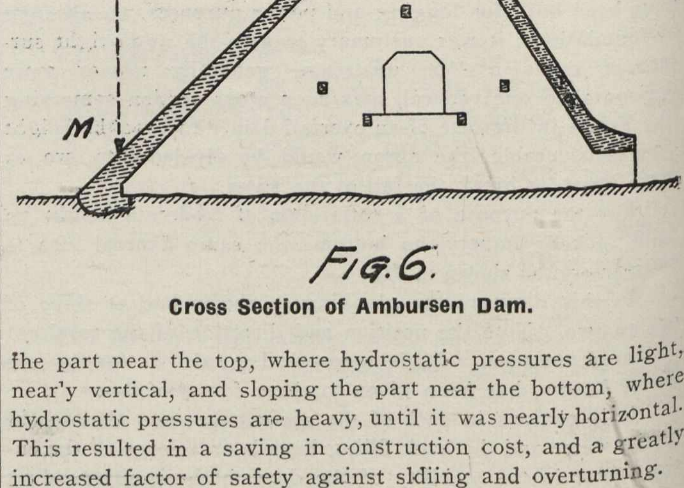

Fig. 6.

Cross Section of Ambursen Dam.

the part near the top, where hydrostatic pressures are light, nearly vertical, and sloping the part near the bottom, where hydrostatic pressures are heavy, until it was nearly horizontal. This resulted in a saving in construction cost, and a greatly increased factor of safety against sldiing and overturning.

The idea illustrated in Figs. 7 and 8, where the plating on the lower section is supported directly in concrete, cheap masonry, or other filling, while the upper part is of steel con-