# HIGH MASONRY DAMS

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High Masonry Dams by  E. Sherman Gould



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E. SHERMAN GOULD

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Trieste

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# PREFACE.

THE present volume replaces the original No. 22 of Van Nostrand's Science Series, bearing the same title, by Mr. John B. McMaster.

Mr. McMaster's volume treated mainly of the mathematical calculation of high masonry dams as it was understood at the time at which he wrote. Since then the masterly treatise of Mr. Edward Wegmann, upon the same subject, has so completely superseded all other treatment of the mathematical features involved that it would be useless to revive old methods.

Besides, the present author has long been convinced of the fact that, in view of the many practical limitations which surround the design of a high masonry dam, it is useless to attempt to adhere to a general formula for that great desideratum of all economical engineering design; namely, a SECTION OF EQUAL RESISTANCE.

The mathematical researches of those authors who have investigated this problem have established a vertical section, the basis of which is a right-angled triangle of base equal to two-thirds or three-quarters of its height, as that leading to, or at least looking towards, such a result. The most refined calculations will inevitably bring us back to the neighborhood of this form for at least the first hundred or two hundred feet of any proposed dam, the difference of relation between the base and height of the triangle depending mainly upon the limiting unit stress adopted.

We cannot do better, therefore, than to profit by, rather than to repeat, the labors of those distinguished mathematicians and engineers who have been our pioneers in this work, and start our designs by first laying down such a triangle, surmounting it by a proper practical top width instead of its own sharp apex, and, if its height exceeds 80 to 100 feet, giving a flare to the lower part of its inside face to expand the footing on that side. Then, by simple and well-known processes, we determine the maximum compressive stress upon the material at certain different heights, upon the two assumptions of an empty and a full reservoir, and if they do not prove satisfactory, modify the section accordingly, subordinating the modifications to certain practical conditions previously determined upon.

It will be seen that the dangerous stress in a very high masonry dam is the crushing one. The author has endeavored to treat the question of this particular stress quite fully, beginning with its consideration when uniformly distributed, and showing the manner in which, theoretically, a structure can be proportioned so as to render this stress uniform, no matter to what height it may be raised. In this way the rapid increase of base, after a certain height has been reached, necessary to secure this uniformity of pressure, is clearly shown, indicating that there is a practical limit to the height to which the structure can be raised. The investigation then passes to the consideration of maximum unit stresses when the resultant of pressures cuts the base unsymmetrically, as is the case in dams.

The proper practical section of a high masonry dam having been evolved, the manner of executing the work is then briefly treated of, with a description of the necessary accessories to the dam, in order that the purposes for which it was built may be satisfactorily accomplished. It is hoped that this portion of the book may prove a valuable addition to the subject.

It may be useful to the reader who cares to look farther into the general subject of dam and reservoir building, to mention that considerable additional information is to be found in the second revised edition of "The Designing and Construction of Storage Reservoirs," which forms No. 6 of the present series.

E. S. G.

YONKERS, N. Y., *July*, 1897.

# CHAPTER I.

## Static Stresses.

Let A B C D, fig. 1, represent the vertical section of a rectangular wall of masonry sustaining the pressure of a body of water level with its top.

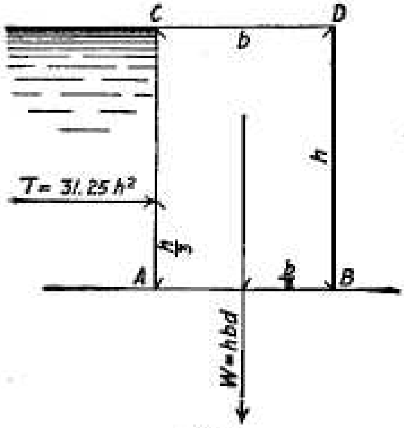


Fig. 1.

The pressure of the water tends first to push the wall forward, bodily, by causing it to slide upon its base. If this tendency is resisted, the next effort of the water-pressure is to overturn the mass by causing it to rotate around the point B.

With what force does the water press, and with what strength does the wall resist?

Considering always a slice of wall and water one foot thick, so that areas in square feet will represent volumes in cubic feet, and, assuming the density of water to be 62.50 lbs. per cubic foot, and representing the height of the wall by $h$, then by well-known principles of hydrostatics, the horizontal thrust T * of the water against the surface A C is:

$$T = 31.25\, h^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

This is the pressure tending to push the wall forward upon its base. The pressure is resisted by the weight of the mass represented by the area A B C D, multi-

* The horizontal thrust is always expressed by (1) no matter what form the surface A C may assume, whether vertical, inclined, plane or curved, $h$ being the depth of water pressing against it.