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STRESSES IN CIRCULAR PIPES.

WITH SOME NOTES ON THE DESIGN OF LARGE WATER CONDUITS— A CALCULATION OF STRESSES DUE TO INTERNAL WATER PRESSURE, WEIGHT OF THE SHELL, AND BACK-FILL—CIRCULAR PIPE UNSUITED FOR CASES OF LARGE DIAMETER PIPE AND LOW PRESSURE HEAD, OWING TO THE RESULTING BENDING MOMENTS

By T. H. HOGG, B.A.Sc., A.M. Can. Soc. C.E.,

Assistant Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto.

The analysis of the stresses in circular pipes due to the weight of the material in the pipes themselves, to internal and external water pressures, and to different kinds of loading, is a subject to which little attention has been devoted in engineering literature.

When the pipes are relatively small in diameter, the conditions are such as yield to simple approximate methods of investigation. With the larger sizes of conduits and pipes now being used so extensively in water supply and water power systems, however, the question of the weight of the shell itself, and the differences in pressure at the top and bottom of the pipe when conveying water in a horizontal position, become exceedingly important.

This paper is presented in the hope that it will afford some aid to the engineer in the design of such conduits. The results of the analyses contained in it were arrived at while the writer was working under the direction of Mr. R. D. Johnson, of Niagara Falls. The system followed in the development of the theory of the stresses due to water pressure is along similar lines to the work of C. W. Filkins and E. J. Fort, who developed the stresses in circular rings due to the weight of the rings themselves, and due to external water pressure. Their work is published in the "Transactions of the Association of Civil Engineers of Cornell University," for 1896.

The following discussion takes up the analysis of the stresses in circular conduits due to internal water pressure. The method of combining the stresses due to the weight of the shell and to the water pressure is reviewed; the question of the design of large conduits for the carrying of water is dealt with, and the equilibrium shape as the logical one, in preference to the circular, is described.

Stresses Due to Internal Water Pressure.—It is usually assumed in figuring the stresses due to internal water pressure in circular pipes or conduits, lying horizontally, that it is quite sufficient to take into account only the tension induced in the shell, and that the bending moment may be neglected. This is only true when the pressure head is infinite and may be grossly in error when the pressure head is small, and the diameter of the pipe relatively large. When the latter condition exists there is a greater pressure at the bottom than at the top, and this causes large bending moments in the shell.

Throughout this discussion the ring is assumed supported on a knife edge, and water pressure is assumed level with the crown of the pipe. The analysis also assumes a thin ring of homogeneous material, having a constant modulus of elasticity, and that the changes from

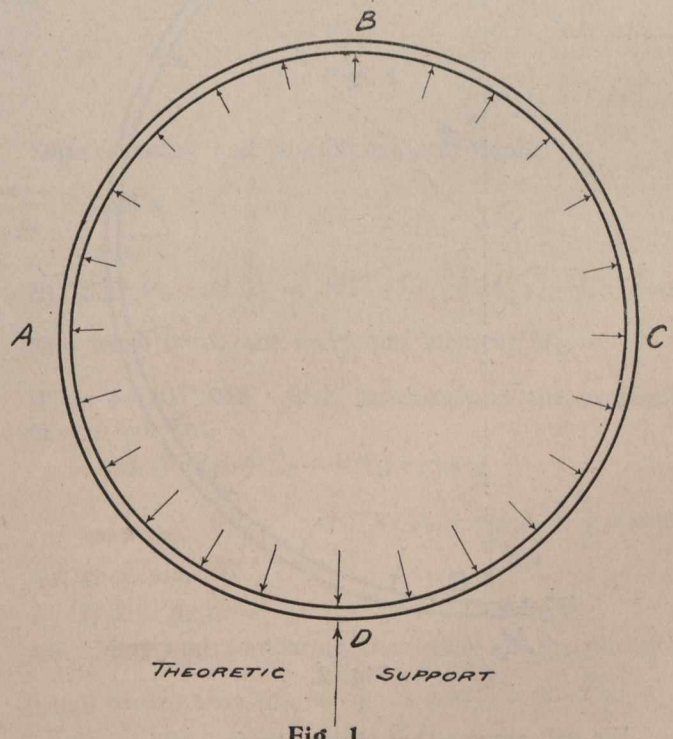

Fig. 1.

a circular form will have little effect upon the dimensions of the ring.

These assumptions are merely to facilitate the application of theory. When the results have been obtained, practical considerations which affect these considerations will be discussed.