THEORY OF ARCHES

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BY

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1890.

PREFACE TO SECOND EDITION.

The original edition of this Monograph was reprinted from the pages of "Van Nostrand's Engineering Magazine," to which it was contributed by the late Prof. W. Allan. It had been primarily prepared by him from a series of notes, which notes had been lithographed for the use of his classes in studying "Rankine's" works.

In printing this second edition, therefore, it has not been thought necessary to make any changes whatever, as the text is simply an amplification and explanation of the "Theory of Arches" as given by Prof. Rankine, and as Prof. Rankine himself has been dead some years, his treatment of the subject as developed in his Manual is probably as complete as it ever will be. It would seem, therefore, that this little book will answer the purposes for which it was intended for all time to come. To the reader and student of Rankine's works it will undoubtedly be found interesting as well as useful.

THE PUBLISHERS.

May, 1890.

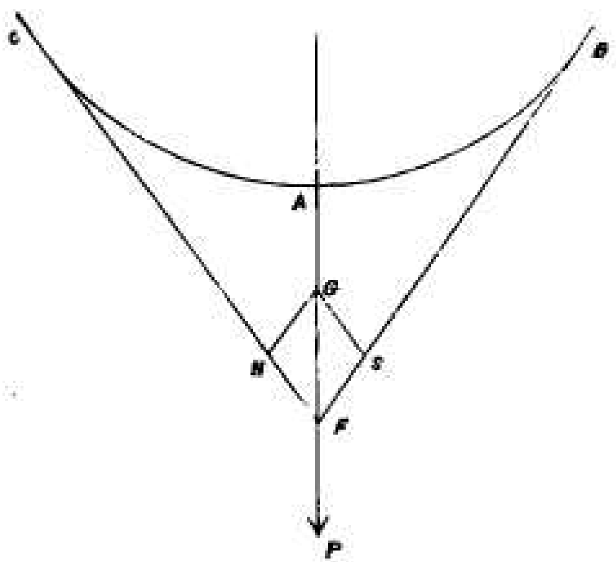
THEORY OF ARCHES.

The following is an amplification and explanation of Professor Rankine's chapters on this subject.

Perhaps the clearest way of developing the "Theory of Arches" is to begin with the consideration of the forces which act upon a suspended chain or cord. The force in the chain or cord is just the opposite of that upon an arch—that is, it is *tension* instead of *compression*, but the relations between the "external" and "internal" forces, or, what is the same, between the loads and the resistances they produce, are strictly analogous.

Let C A B (Fig. 1) be a cord suspended at C and B and loaded in any manner over its whole length. Consider the forces acting on this cord. Suppose it attached to a hook at B and to another at C. A cord without stiffness cannot exert a pull except in the direction of its length; therefore the "pulls" in the rope at C and B, and exerted at these points on the suspending hooks, must be in the direction of the tangents at

Fig. 1.



those points. The load is supposed to be distributed over the cord, but we may find its resultant. Let P be this resultant and P F its direction. The *three* forces, viz., the pulls at C and B, and the resultant of the load, P, are all in the same vertical plane; they are the only forces acting on the cord; and as they are in equilibrium, the *directions of these three forces must meet in one point*, and the forces themselves *must be proportional to the three sides of a triangle drawn parallel to their directions.*

G N F (Fig. 1) is such a triangle. The known directions of the pulls at B and C, and of P, give us the angles in this triangle; and if we know also the magnitude of the load P, represented by the line G F, we can determine that of the pulls at B and C. For

(Pull at B=G N) : G F : : sin GFN : sin GNF.
(Pull at C=N F) : G F : : sin N G F : sin GNF.

The analysis we have made for the whole cord may be applied to any part of it. Thus, if we consider any arc B′ A′ (Fig. 2) of the cord, and the load on that arc, we have three forces in the same plane in equilibrium. For at A′ and B′ the other parts of the cord may