LATERAL FLEXURE OF STRUCTURAL MEMBERS.

THE subject of lateral flexure of hollow pieces is considered by M. Henri Lossier in a paper appearing in March 6th, 1915, issue of Le Génie Civil. It is shown how errors in calculation may be made, and avoided. Referring to the diagrams, the writer points out that steel or reinforced concrete pieces of construction often involve elements under compression, constituted by two parallel members A, united at equal intervals by cross-pieces B, so as to form a rigid structure. At M, for instance, is shown an iron structure in which the members A consist of channel irons and B (see N) of double pieces of sheet metal. In O the members are angle iron and the cross pieces sheet metal, crossing each other at right angles. In either case each unit carries with it at least two rivets. R shows a hollow element of length L, containing four equal rectangles and being under the action of an axial compression P.

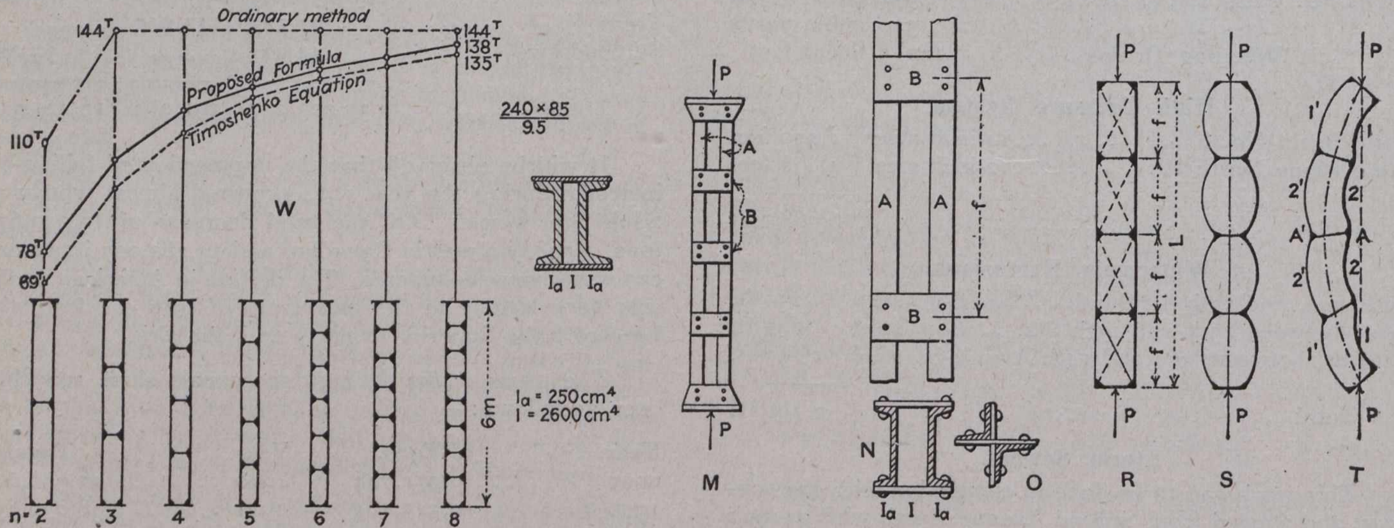

Fig. 1.—Diagrams of Lateral Flexure of Hollow Pieces.

It is usual to compute the stresses on such an element by considering it as being similar to a solid prism having the same moment of inertia and then taking its resistance to lateral flexure as being equal to that of a trunk or length f, taken between two consecutive cross-pieces. Such a method of computation, which would be all right if the cross-pieces were supplemented by diagonal members (indicated in Fig. R by dotted lines), would be correct for this case only if the flexure of the element occurred as indicated in Fig. S, that is, with the axis remaining rectilineal all through the deformation. Actually, however, the flexure will occur by a lateral bending of the axis, as shown in Fig. T.

Because of such a deformation the following takes place: (a) The normal stresses, of which the initial value for each member is $P/2$, undergo a decrease in the convex member A' and a corresponding increase in the concave member A. This effect has its maximum value in the central trunks 2-2'.

Because of the absence of diagonal stays and rigidity of the structure, secondary flexures occur both in the members and cross-pieces; these flexures, which are functions of the shearing stresses, reach their maximum values in the end trunks 1-1'.

The author recommends, therefore, for the calculation of such elements, the following formula and states that the fatigue of members will increase indefinitely as long as the stress P exceeds the critical value of P_f equal to

$$P_f = \frac{\pi^2 EI}{L^2}\left[\frac{\alpha}{1+\dfrac{I+2I_A}{2.5n^2 I_A}\cdot\alpha}\right]$$

where E is the modulus of elasticity of material, L length of flexure, I_A the moment of inertia of the member A, I the moment of inertia of the entire element,—that is the two members, A, $n = \dfrac{L}{f}$. α is a variable coefficient which is a function of the number of sections n, and has the following values:

n = 2	3	4	5	6	7	8	.... ∞
α 1.62	1.22	1.11	1.07	1.05	1.04	1.03	1.00

This formula is not new and its first member is simply the Euler formula, giving the bending resistance of a solid prism having a moment of inertia equal to I. The second part, which will be referred to later on as k, has a coefficient smaller than unity, towards which it tends as the number of sections increases, so that for $n = \infty$, $k = 1$. In other words, k represents the ratio of the resistance of a hollow prism to that of a solid prism. The author recommends, therefore, the adoption of the following rule: In a piece under compression, consisting of two parallel members connected into a rigid structure by cross-pieces located at equal distances from one another, the coefficient of permissible work is equal to the coefficient for a solid prism of the same moment of inertia multiplied by a coefficient k, less than unity, and given by the formula

$$k = \frac{\alpha}{1+\dfrac{I+2I_A}{2.5n^2 I_A}\cdot\alpha}$$

From a numerical example, the author obtains curves shown in Fig. W, in which he uses for the upper curve (ordinary method) the Euler formula; next, the full drawn out curve represents what he would obtain with the formula proposed in this article, and finally the third curve is obtained by the Timoshenko formula, which the present writer uses in the form

$$P_{cr} = \frac{1}{\dfrac{L^2}{E.I.\pi^2} + \dfrac{f^2}{24E.I_A}}$$

obtained by neglecting the deformation of the cross-pieces. This figure shows that with the exception of very small values of n, it gives results fairly close to those obtained