Equation 41 gives the transverse shear at any point x when both ends of the column are fixed.

If $x = 0$, then $\left(\cos \pi \frac{4x - l}{2l}\right) = \cos 90^\circ = 0$ and the end shear $V = 0$.

If $x = \frac{l}{4}$, then $\left(\cos \pi \frac{4x - l}{2l}\right) = \cos 0^\circ = 1$, and the shear becomes

$$V = D' (S_c - S') \frac{A \pi}{l}. \quad \text{[Equation 42.]}$$

Equation 42 gives the transverse shear at a distance $\frac{l}{4}$ from each end of the column, which is a maximum.

Referring to Equation 22,

$$m = 4.$$

Substitute this value for m, and values for S and E. Then,

$$S' = \frac{16{,}000}{1 + \frac{1}{23{,}200} \frac{l^2}{r^2}}. \quad \text{[Equation 43.]}$$

This value of S' to be substituted in Equation 42.

The value of the shears V, obtained in Equations 35, 38 and 42 should be multiplied by the secant of the angle $(90^\circ - \phi)$ and then divided by 2 to give the stress in the end lattice bars $b\,c$.

Reply to Mr. Goodrich.—Referring to Mr. C. M. Goodrich's discussion, would say that he was right in his criticism that A should be $\frac{A}{2}$, and I have corrected this above.

He mentions that the lattice bars are too wide at 2¼″ and suggests 1¾″ for the small columns. This, of course, is a matter of shop practice and depends a great deal upon the size of the rivet that is being used. He states that r is taken for the wrong axis. Upon looking up Cambria, and checking over the r used, I find that in a few places the value for r may be wrong, such as for 7″ channel I took 2.34, and upon carrying the calculations out to the fourth place I find that this should be 2.38, but I am sure this would not affect the results materially.

He says that Mr. Pritchard suggests using 3% of the axial stress, and further on states that the new Quebec bridge lattice takes a shear of 2% of the axial stress, but he doesn't in any place state upon what authority 3% or 2% was taken, nor does he say whether he agrees with this assumption or not, or whether he thinks this value should be taken for all lengths of columns or how the columns should have their ends fixed when the above values are used.

If Mr. Goodrich believes there is a transverse shear equal to 2% of the axial load, then he must also believe there is bending in the column, for we know that

$$\frac{dm}{dx} = V,$$

where V is the vertical shear.

Or, in other words, when there is any possibility of the member acting in any way as a beam, it is not possible to have a shear without a moment except as dx approaches zero.

Therefore, if V is 2% of the load on the column (centrally loaded), it must necessarily follow that it must be a function of the bending of the column, even though the column be less than a ratio of $200 \frac{l}{r}$.

Upon referring to the report of the Royal Commission, Quebec bridge inquiry, I find that Mr. Schneider has assumed that the column will bend into shape of a parabola due to eccentricities of load caused by fabrication, and he has given a formula for the transverse shear as follows:—

$$S_{max} = 8\,C \frac{ar}{d}.$$

Where $C = 70$, d = out to out of flanges; this then resolves itself into

$$S_{max} = \frac{280\,ar}{n},$$

$$\text{where } n = \frac{d}{2}.$$

This is the same equation as given in my first discussion for Equation (d). I also find that the particular member under discussion had a ratio of $\frac{l}{r} = 35$, approximately.

Reply to Mr. Harkness.—Referring to the discussion by Mr. A. H. Harkness, he has pointed out the same error as previously mentioned.

If you take my original Equation 11, which is

$$M = P \Delta \sin \pi \frac{x}{l},$$

and differentiate this, we get

$$dm = P \Delta \cos \pi \frac{x}{l} \cdot \frac{\pi\, dx}{l},$$

$$\text{or } \frac{dm}{dx} = P \Delta \frac{\pi}{l} \cdot \cos \pi \frac{x}{l},$$

which is the transverse shear on the column, and this equation is the same as Equation (2) given by Mr. Harkness. He has, then, substituted for $P \Delta$, the quantity

$$f \frac{Ar^2}{n}.$$

I think his analysis is a neat treatment of the subject, and, as he says, a quicker method of arriving at the result.

Reply to Mr. Molitor.—Mr. Molitor is of the opinion that, due to imperfections of fabrication, it would be impossible to get an exact formula for the stresses in lattice bars. I thoroughly agree with him, and pointed that fact out in my article, but I do think it possible to arrive at a

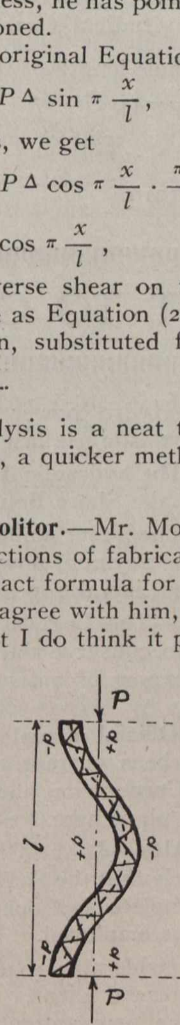

Fig. 8a.

formula that is based on theory and that will give reasonably safe results, and this was my object.

Mr. Molitor derives the old formula,

$$R = \frac{280\,ar}{n},$$

but afterwards discards it, and states in his last paragraph the following:—

"These flanges being subject to compression from end to end, the function of the lacing and batten plates will be to transfer longitudinal shear *from one flange to the other* whenever and wherever the compressive stress is unequally distributed. The maximum value of this