THE DESIGN OF REINFORCED CONCRETE T-BEAMS.

By E. G. W. Montgomery,
Bridges Branch, Department of Highways, Saskatchewan.

To those who are called upon to design reinforced concrete T-beams, it is hoped the following simple, yet accurate, method will commend itself. It is equally applicable to the design of important or unimportant beams, and needs no elaborate tables to help out its findings.

Without going into reasons in this brief treatment of the subject, it might be stated that to commence the design of a T-beam by assuming a width of flange, is to begin wrongly. It will presently be shown that the ratio of width of flange to width of stem, being dependent on

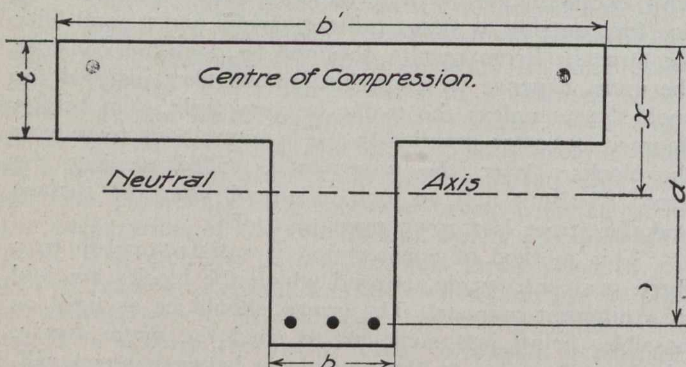

Fig. 1.

the position of the centre of compression, can be (as it ought to be) directly derived from a consideration of that position. The actual dimensions are then obtained in two short steps.

Beginning, then, by predetermining the position of the centre of compression, a short and simple procedure leads to a T-section that is equally strong in tension and compression—a section in which the stresses remain as originally assumed.

In the following equations the position of the centre of compression is measured from the top of the slab, and the equations are general for any T-section.

1. When centre of compression is at $\frac{2}{5}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(5x - 6t)}{t^2(4t - 3x)} \quad - \quad - \quad - \quad \text{and "}t\text{"}$$

must lie between $\frac{3}{4}x$ and $\frac{5}{6}x$ - - - (1)

2. When centre of compression is at $\frac{1}{2}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(2x - 3t)}{t^3} \quad - \quad - \quad - \quad \text{and "}t\text{"}$$

must be less than $\frac{2}{3}x$ - - - - - (2)

3. When centre of compression is at $\frac{3}{5}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(5x - 9t)}{t^2(t + 3x)} \quad - \quad - \quad - \quad \text{and "}t\text{"}$$

must be less than $\frac{5}{9}x$ - - - - (3)

4. When centre of compression is at $\frac{4}{5}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(5x - 12t)}{t^2(9x - 2t)} \quad - \quad - \quad - \quad \text{and "}t\text{"}$$

must be less than $\frac{5}{12}x$ - - - - (4)

When the centre of compression lies somewhere between $\frac{1}{5}t$ and $\frac{2}{5}t$, the neutral axis falls within the slab, and the design for a simple beam obtains. Such a section would have practical value only for small beams.

Equivalent area under compression =

$$A_c = bx + [t(b^1 - b)(2 - \frac{t}{x})] \quad - \quad - \quad - \quad (5)$$

$$B.M. = M.R. = \frac{A_c \times f_c}{2} \times \text{lever arm} \quad - \quad - \quad (6)$$

$$A_s = \frac{A_c \times f_c}{2 f_s} = \frac{B.M.}{f_s \times \text{lever arm}} \quad - \quad - \quad - \quad (7)$$

$$b \times d \geqq \frac{\text{Max. Shear}}{120} \quad - \quad - \quad - \quad - \quad - \quad (8)$$

To illustrate the method of treatment, suppose it be required to design a T-section for a bending moment of

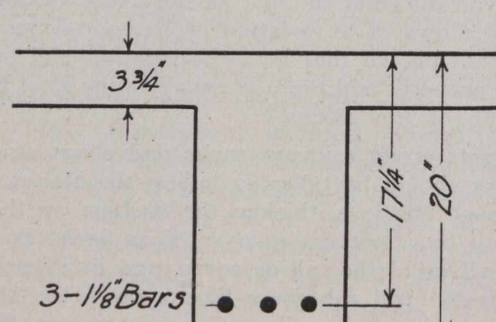

Fig. 2.

722,000 in.-lbs. and maximum shear of 19,000 lbs.—the further data being: Span = 19 feet; spacing = 6 feet; slab = 3¾ in.; f_c = 650 lbs.; f_s = 16,000 lbs. (The example is taken from second edition "Taylor & Thompson, etc.," *vide* pp. 469 and 470.)

Commence by locating the centre of compression at, say, $\frac{t}{2}$. Then from equation (2) x must be greater than $\frac{3}{2}t$.

Assume $x = 6.5''$, then $d = 17.167''$ and lever arm =

$$17.167'' - \frac{3\frac{3}{4}''}{2} = 15.292''.$$