	Lbs. per sq. in.
Concrete in compression in beams subjected to bending	600
Concrete in columns under simple compression	600
Concrete in shear in beams	60
Adhesion * or grip of concrete to metal	100
Steel in tension	16,000
Steel in compression— 15 times the stress in the surrounding concrete.	
Steel in shear	12,000

When the proportions of the concrete differ from those stated above, the stress allowed in compression on the concrete may be taken at one-third the crushing stress of the cubes at 28 days as determined above.

If stronger steel is used, the allowable tensile stress may be taken at one-half the stress at the yield point of the steel, but in no case should it exceed 20,000 lbs. per sq. in.

Beams with Single Reinforcement:

Beams with single reinforcement can be divided into three classes:—

(a) Beams of T form in which the neutral axis falls outside the slab.

(b) Beams of T form in which the neutral axis falls within the slab.

(c) Rectangular beams.

The equations found for (a) are general equations, from which the equations for (b) and (c) may be deduced.

In the calculation of all beams, the area upon which the ratio of tensile reinforcement is taken is considered as a rectangle of breadth equal to the greatest breadth of the beam and of depth equal to the greatest effective depth of the beam.

In designing beams where the rib is monolithic with a slab, the beam may be considered to be of T form. The slab must first be calculated and designed having its own reinforcing bars transverse to the rib. The whole of the slab cannot in general be considered to form part of the upper flange of the T beams. The width, b, of the upper flange may be assumed to be not greater than one-third the span of the beams, or more than three-fourths of the distance from centre to centre of the reinforcing ribs, or more than fifteen times the thickness of slab. The width b of the rib should not be less than one-sixth of the width b, of the flange.

(a) Beams of T section where the neutral axis falls outside the slab.

In this case the small compression in the rib between the underside of the slab and the neutral axis may be neglected. In a homogeneous beam the stresses are proportional to the distances from the neutral axis. In a discrete beam, such as a beam of concrete and steel, on account of the greater rigidity of steel, at a given distance from the neutral axis the stress in the steel will be m times as great as in concrete.

Hence:—

$$\frac{mc}{t}=\frac{n_1 d}{d(1-n_1)}=\frac{n_1}{1-n_1}$$

$$\frac{c}{t}=\frac{n_1}{m(1-n_1)}.$$

The mean compressive stress in the flange is and the total compression is

$$bd_s\frac{c}{2}.\frac{2n-d_s}{n}$$

The area of reinforcement $At = rbd$ and the total tension is

$$trbd$$

Equating total compression and total tension

$$bd_s\frac{c}{2}.\frac{2n-d_s}{n}=trbd$$

$$\frac{c}{t}=\frac{2rn_1}{(2n_1-s_1)s_1}.$$

Equating these two values for $\frac{c}{t}$

$$\frac{n_1}{m(1-n_1)}=\frac{2rn_1}{(2n_1-s_1)s_1}$$

$$n=\frac{s_1^2+2mr}{2(s_1+mr)}.$$

The value of the lever arm is

$$d-\frac{d_s}{3}-\frac{3n-2d_s}{2n-d_s}$$

The compressive resistance moment of the beam is

$$Rc=cbdd_s\frac{(s_1^3+4mrs_1^2-12mrs_1+12mr)}{6(s_1^2+2mr)}$$

The tensile resistance moment is

$$Rt=tbd^2\frac{(s_1^3+4mrs_1^2-12mrs_1+12mr)}{6m(2-s_1)}.$$

To obtain stresses in the concrete and steel equal to c and t respectively, r must have a value

$$\frac{2mcs_1-mcs_1^2-ts_1^2}{2mt}$$

When r exceeds the value given by this equation, the equation to Rc must be used in determining the moment of resistance. When r is less than the above value the equation to Rt must be used.

The following equation gives the value for r, which causes the neutral axis to be at the underside of the slab:—

$$r=\frac{s'^2}{2m(1-s_1)}$$

(b) When the neutral axis falls within the slab, or is at the bottom edge of the slab, the equation for values of n_1, Rc, and Rt can be simplified, and become

$$n=\sqrt{(m^2r^2+2mr)}-mr.$$

To obtain stresses in the concrete and steel equal to c and t respectively

$$r \text{ must equal } \frac{mc^2}{2t(mc+t)}$$

(c) For rectangular beams not of T form, the equations given for T beams under (b) apply.

The ratio of reinforcement may be taken on any other suitable sectional area if the formulæ are modified in accordance.

Slabs Supported or Fixed on More Than Two Sides.

It does not appear that there is either a satisfactory theory or trustworthy experiments from which the strength of rectangular slabs supported or fixed on all four edges can