(*a*) That the beam is symmetrical with respect to a certain plane.

(*b*) That the material of the beam is homogeneous.

(*c*) That sections which are plane before bending remain plane after bending.

(*d*) That the ratio of longitudinal stress to the corresponding strain is the ordinary (i. e. Young's) modulus of elasticity, notwithstanding the lateral connection of the elementary layers.

(*e*) That these elementary layers expand and contract freely under tensile and compressive forces.

In each case, the skin stress at the point of fracture in lbs. per sq. in has been determined by means of the formula,

$$f = \frac{3}{2} \frac{l\,(2\,W_1 + W_2)}{b\,d^2}$$

W_1-lbs. being the weight at an end, W_2-lbs. half the weight of the beam, l-ins. the length of the beam between the two end centres of pressure, b-ins. the breadth and d-ins. the depth at the section of fracture.

In practice, the breaking weight, $W_1 + \frac{1}{2} W_2$, is usually determined from the formula,

$$W_1 + \tfrac{1}{2} W_2 = C \frac{b\,d^2}{l},$$

C being the co-efficient of rupture. Hence, $f = 3$ C.

It may perhaps be well to point out that a very small error in estimating the depth of a beam may lead to a considerable error in the calculated skin stress. Thus from the formula just given it appears that if Δf be the change in the skin stress corresponding to a change Δd in the depth, then

$$\Delta f = -\,2\frac{f}{d}\Delta\,d,$$

and the skin stress will be increased or diminished by this amount according as the estimated depth is too small or too great by the amount Δd.

For instance, in the case of the Spruce Beam No. *L*, the calculated skin stress, disregarding the diminution of depth due to compression, is 5123 lbs. The initial depth (d) of the beam was 17.5 ins, and the amount of the compression (Δd) 2 ins. Thus the error (Δf) in the skin stress is

$$\Delta f = -\,2\frac{5123}{17.5}2 = 1171 \text{ lbs. per sq. in.},$$

and the actual stress becomes 5123 + 1171 = 6294 lbs. per sq. in., showing an increase of 22.8 per cent.

Now, in every example of transverse testing, the material is more or less compressed at the central support. The central support in the following examples was a hardwood block of 20 ins. diameter. The amount of the compression at this support depends not only upon the nature of the material of the beam and upon the character of the support, but also very especially upon the ratio of the length of the beam to its depth. In calculating the skin stress corresponding to the breaking weight, therefore, three assumptions may be made :—

1st. That the compression at the support may be disregarded.

2nd. That the effective depth of the beam may be taken as equal to the initial depth minus the amount of the compression, and that the usual law may be assumed to hold good for the whole of this effective depth.

3rd. That the compression portion of the beam is alone affected, so that the so called neutral plane remains in the same position relatively to the tension face of the beam from the commencement of the test to the end.

Calculations based upon these three assumptions have been made in several of the following cases, and it will be observed that in all cases the skin stress calculated upon the first assumption is invariably less than the skin stress determined upon either of the remaining assumptions. Thus any error is on the safe side.

It should be remembered, however, that it is possible, and even probable, that neither of these assumptions is even approximately correct, at all events, beyond the limit of elasticity, which in the case of timber still remains indefinite. The portion in compression doubtless acquires