4.15 MEMBERS OF VARYING DEPTH

The relations for shear, bond, and even moment resistance must be modified for members in which the depth is varying, that is, members in which the bottom and top surfaces are not parallel. The moment effect is not large unless the angle between the faces is at least 10° or 15°, but shear for diagonal tension and bond may be modified as much as 30% by 10° slopes. The 1940 Joint Committee Specification gave the following formula for the effective total shear $\overline{V}_1$ to be used for $\overline{V}$ in the usual relations for v and u:

$$\overline{V}_1 = \overline{V} \pm \frac{\overline{M}}{d} (\tan c + \tan t)$$

where $\overline{V}$ and $\overline{M}$ are the external shear and moment to be resisted, d is the depth to tension steel, and t and c are the slope angles of the top and bottom of the beam as shown in Fig. 4.21. The plus sign before the parenthesis is used when the beam depth decreases as the moment increases, as in Fig. 4.21*a*, and the minus sign is used for the more usual case of increasing depth with increasing moment, as in Fig. 4.21*b*. When the sum of the angles becomes as much as 30°, such a formula becomes very inexact.

4.16 BRACKETS AND SHORT CANTILEVERS

The Code for the first time covers brackets and corbels (limited to a/d of unity or less) and the author includes other short cantilevers as an extension of the same general behavior. Their normal resistance near ultimate consists of a tension tie across the top with an inclined compression strut forming a triangle, with normal bending making only slight variations.

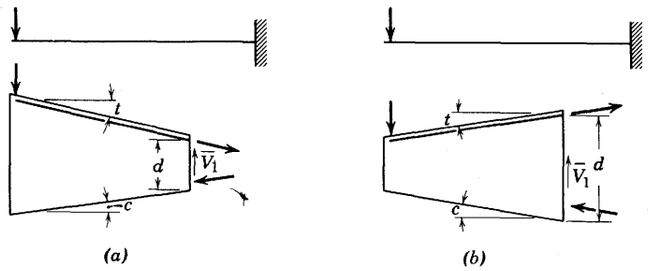

Fig. 4.21. Shear in beams of varying depth.

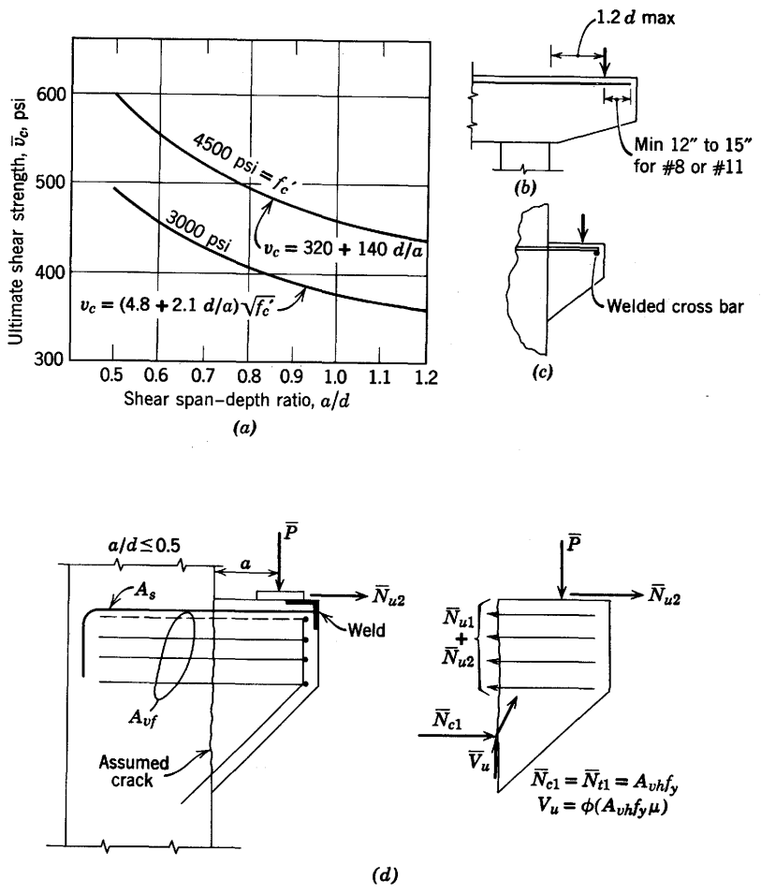

Fig. 4.22. Brackets and short cantilevers. (*a*) Author's unit shear strength, v_c. (*b*) Minimum end anchorage for values in (*a*). (*c*) Preferred end anchorage in short bracket. (*d*) Shear-friction applied to bracket design.

The inclination of this strut would determine the tension in the tie if it were simply a truss; the flexural calculation at the face of the column gives essentially the same tension, but the triangular truss idea emphasizes the anchorage problem; and this anchorage problem is the most critical one unless the bar extensions of Fig. 4.22*b* are possible.

The PCA bracket tests[8] took account of the high shrinkage and expansion stresses frequently occurring from beams supported on brackets. The Code,