which will evidently give values for D' which are on the safe side, the expression for D' may be simplified to,

$$D' = 80\ DH^2/W_t \qquad (13)$$

But $$W_t = \tfrac{1}{4}\cdot\pi D'^2 \times h \times 150 = 117.8\ hD'^2 \qquad (14)$$

Setting this value of W_t in equation (13) and solving,

$$D' = 0.879\ (DH^2/h)^{\frac{1}{3}} \qquad (15)$$

If h be taken as equal to 0.4 D', a common proportion,

$$D' = 1.14\ (DH^2)^{\frac{1}{4}} \qquad (16)$$

Equation (16) will usually give a sufficiently accurate value for D', though in some cases it may be desirable to make an exact solution by means of equation (12) after the value from equation (16) is obtained.

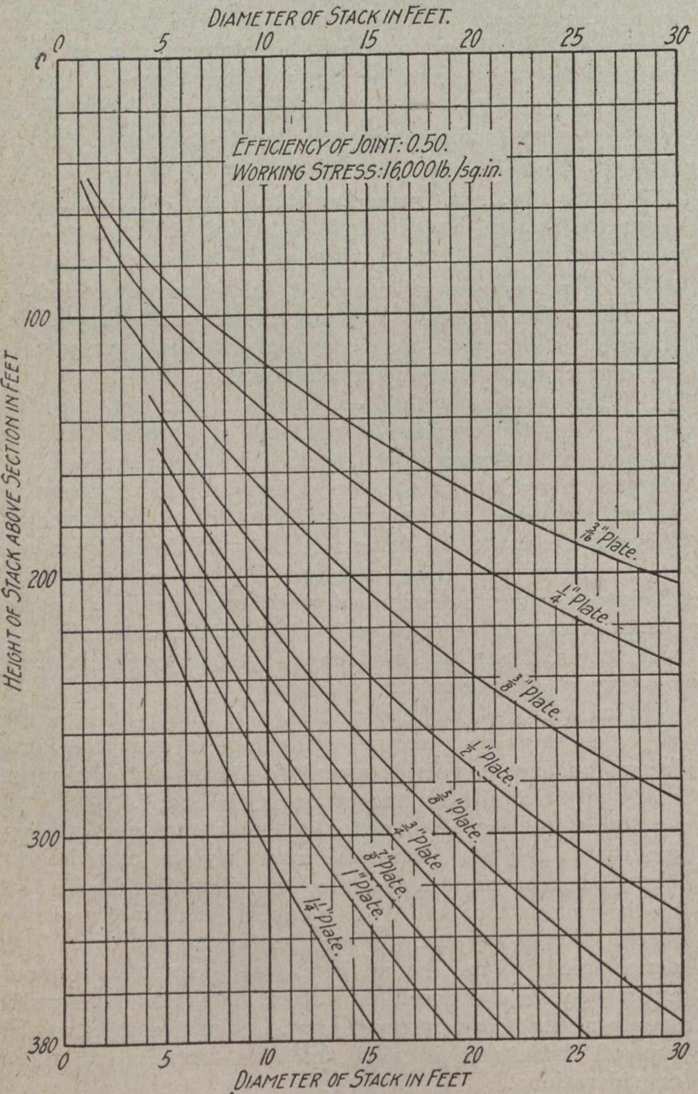

Fig. 2.—Thickness of Plates.

Equation (16) has been plotted in Fig. 4 so that the minimum diameter of foundation for any given height and diameter is easily obtained.

Example: Determine the minimum diameter of concrete foundation for a stack 15 feet in diameter and 175 feet high, assuming that the height of the foundation is 2/5 the diameter. Enter Fig. 4 with the diameter, follow down vertical line through 15 till the height of 175 feet is reached and read 30 feet as the required diameter.

Second Solution: The overturning moment at the top of the foundation is

$$M = 10\ DH^2 \text{ ft. lb.} \qquad (17)$$

The weight of the foundation, as found before, is

$$W_t = 117.8\ hD' \qquad (18)$$

Taking moments about an axis tangent to the leeward side of the foundation, and neglecting the resisting moment due to W_0 and W_1 as small compared with equation (17), the resisting moment is

$$M = W_t D'/2 = 58.9\ hD'^3 \qquad (19)$$

If a safety factor of 2 be taken, equation (19) becomes

$$M = 29.45\ hD'^3 \qquad (20)$$

Solving equations (17) and (20),

$$D = 0.6976\ (DH^2/h)^{\frac{1}{3}} \qquad (21)$$

If h be taken as 0.4 D' again, we have,

$$D' = 0.960\ (DH^2)^{\frac{1}{4}} \qquad (22)$$

It is interesting to note that for a safety factor of approximately 2¼, the two solutions give identical results.

In both solutions the additional surface in the bell has been neglected because it is not only small and has a short arm, but also is usually somewhat protected so that the wind pressure would be less upon it than upon the stack above.

The friction of the soil on the sides of the foundation, which would tend to retard overturning, has been neglected in the above solutions as in some cases the foundation may be placed almost entirely above the surface of the ground. Where the foundation is placed below the ground surface, some saving in volume may be effected by building the foundation as the frustrum of a cone with the larger base at the bottom.

The result obtained by the above solutions insures a design secure against overturning, but the design must be investigated for bearing power of the soil also. As the resultant falls within the kern of the section of the base, the maximum direct pressure on the soil is

$$F = \frac{2(W_0 + W_1 + W_t)}{0.7854\ D'^2} \qquad (23)$$

which must not exceed the safe bearing power of the soil.

Minimum Size of Anchor Bolts.—First Solution: If in Fig. 1 (b), A—B, the gravity axis of the section of bolt circle, be assumed as the axis about which rotation occurs then the bolts on the windward side will be in tension and the stress in each bolt will vary as its distance from the axis, or the resisting moment of each bolt will vary as the square of its distance from the axis. A stack base containing 12 bolts is shown in Fig. 1 (b). Under these conditions bolts 1, 2, 3, 4 and 5 are in tension. The resisting moment, then, of the group of bolts is

$$M = t\Sigma x^2 = t\ [(\tfrac{1}{2}B \sin 30°)^2 \times 2 + (\tfrac{1}{2}B \sin 60°)^2 \times 2 + \tfrac{1}{2}B)]$$
$$= t\ [2(0.25) + 2(0.75) + 1]\ B^2/4 = 0.75\ B^2 t \qquad (24)$$

The moment due to wind pressure is

$$M = \tfrac{1}{2}PDH^2 \qquad (25)$$

therefore

$$t = M/\Sigma x^2 = PDH^2/1.5\ B^2 \qquad (26)$$

The stress in bolt 3, which will be the maximum stress in the group of bolts, is

$$tB/2 = PDH^2/3B \qquad (27)$$

If the fiber stress in a bolt be taken as f, then equating actual stress in bolt 3 to the allowable stress,

$$0.7854 \times f \times b^2 = PDH^2/3B \qquad (28)$$

Solving for b,

$$b = 1.538\ H(PD/fB)^{\frac{1}{2}} \qquad (29)$$

Taking P as 20 lb. per sq. ft. and f as 15,000 lb. per sq. in. the diameter of anchor bolt for a group of 12 bolts is

$$b = 0.0238\ H(D/B)^{\frac{1}{2}} \qquad (30)$$