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Convenient Method of Calculating Trash Racks

Table and Formulae by Means of Which Designers Can Readily Determine Lengths of Panels Between Supports for Various Spacings and Sizes of Bars—Structural Details and General Suggestions Regarding the Design of Racks

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IN calculating trash racks, we should assume that they may become completely clogged and will therefore be subject to the full hydrostatic pressure due to the head of water.

As this is the worst possible case that can occur, the structure will be safe if the stress in the bars for this condition is within the elastic limit of the material used, and we can therefore use a stress as high as 30,000 lbs. in our calculations. However, for the basis of these calculations we will assume a stress of 25,000 lbs. with full hydrostatic pressure imposed.

The pressure at any point will be directly proportional to its depth below the surface; i.e., the load on any bar will be represented by a triangle with the point or apex at the surface of the water.

For any given pitch or spacing of bars, then, the free span, or distance between supports for rack bars, is determined from the resisting moment of the bar used.

Using the notation given in Fig. No. 1, the length between the different supports can be determined as follows:—

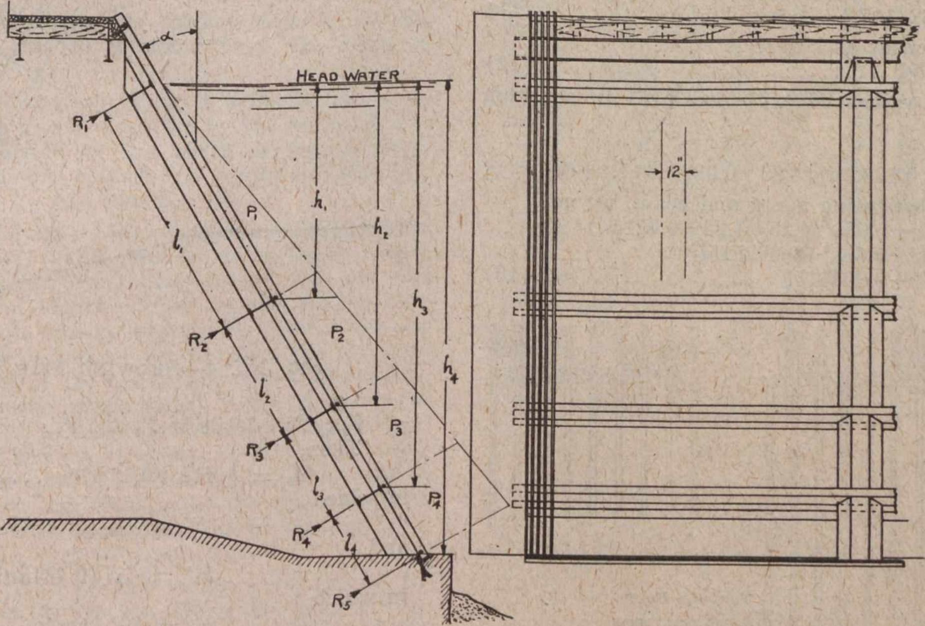

FIG. NO. 1—DIAGRAM INDICATING NOTATIONS IN FORMULAE

We will call these distances panel lengths and indicate them by l_1, l_2, l_3, l_4, etc., all in inches.

The loads P_1, P_2, etc., are for a width equal to the pitch of the bars. For the first panel, or l_1, the moment due to the load can be represented by

$$M_1 = 0.128 P_1 l_1 \quad \text{.......... (1)}$$

where P_1 = total pressure on one bar;

l_1 = distance between supports in inches, considering ends free.

The resisting moment of the bar is

$$M_{r1} = \tfrac{1}{6} bd^2 \times 25{,}000 \quad \text{.......... (2)}$$

Where b = thickness of bar in inches;

d = depth of bar in inches; and the dangerous section will be at a distance

$$x = 0.5774 l_1 \quad \text{.......... (3)}$$

from top support. The spacing bolts should be spaced to avoid this section, so as not to weaken the bar. The load

$$P_1 = 0.434 l_1 p h_1 / (12 \times 2).$$

Therefore,

$$P_1 = 0.0181 l_1^2 p \cos\alpha$$

where p = spacing of bars; $h = l_1 \cos\alpha$; and $\cos\alpha = \cos$ 30 degs., generally 0.866.

By substituting for $\cos\alpha$,

$$P_1 = 0.0157\, l_1^2\, p \quad \text{.......... (4)}$$

Substituting equation (4) in equation (1), we get

$$M_1 = 0.128 \times 0.0157\, l_1^3\, p = 0.00201\, l_1^3\, p \quad \text{.......... (5)}$$

Equating (2) and (5), we get

$$0.00201\, l_1^3\, p = 25{,}000\, bd^2/6 = 4{,}170\, bd^2 \quad \text{.......... (6)}$$

Now by assuming values at will for p, b and d, we have a cubic equation in l_1. By solving for l_1 we have the maximum allowable distance between supports for panel length No. 1. To carry the problem through we will assume a spacing of bars $p = 1\tfrac{1}{4}$ ins., centre to centre, and a bar $\tfrac{1}{4}$ in. by $2\tfrac{1}{2}$ ins.

Substituting these values in equation (6), we get

$$0.00201 l_1^3 \times 1.25 = 4{,}170 \times 0.25 \times 2.5^2 \quad \text{.......... (7)}$$

Therefore, $l_1^3 = (4{,}170 \times 0.25 \times 2.5^2) \div (0.00201 \times 1.25) = 2{,}590{,}000$ .... (8)

Consequently,

$l_1 = (2{,}590{,}000)^{1/3} = 135.5$ ins.

The perpendicular distance, or head, $h_1 = l_1 \cos\alpha = 135.5 \times 0.866 = 117.4$ ins.

Second Panel

Theoretically the second panel, or l_2, should be calculated as a continuous beam if the bars do not end at the lower support of the second panel, but, as frequently is the case, the total length of rack is divided into several panels and would therefore not be continuous, so we will again assume free ends. This assumption will in some cases give us a shorter length for l, but the discrepancy will be on the side of safety.

The load on the second panel will be represented by a trapezoid of which the shorter leg will be the same as the base of the upper triangle (for panel l) and the lower leg will be increased by the increment due to additional head. This loading can be subdivided into two loads, one a parallelogram with height equal to the short leg of the