Geotechnical Engg.- II (VIII Sem)

Unit-1

(Part-5 Factors affecting bearing capacity of soils, Effect of water table on bearing capacity)

Factors affecting bearing capacity of soils:

Bearing capacity is governed by a number of factors. The following are some of the more important ones which affect bearing capacity:

(i) Nature of soil and its physical and engineering properties

(ii) Nature of the foundation and other details such as the size, shape, depth below the ground surface and rigidity of the structure

(iii) Total and differential settlements that the structure can withstand without functional failure

(iv) Location of the ground water table relative to the level of the foundation

(v) Initial stresses, if any.

Effect of water table on bearing capacity of soils:

Water in soil is known to affect its unit weight and also the shear parameters c and φ.

When the soil is submerged under water, the effective unit weight γ' is to be used in the computation of bearing capacity the water table is above the base of the footing.

When the water table is above the base of footing, the submerged weight γ' should be used for the soil below the water table for computing the effective pressure are the surcharge. When the water table is located somewhat below the base of the footing the elastic wedge is partly of moist soil and partly of submerged soil, and a suitable reduction factor should be used with wedge term since it uses effective unit weight.

There will be no effect or reduction in the bearing capacity if the water table is located at a sufficient depth below the base of the footing.

The first term, cNc, does not get affected significantly by the location of the water table; except for the slight change due to the small reduction in the value of cohesion in the presence of water.

As a thumb rule, this term may be reduced to half if the water table is just at the base of the footing, and no reduction to be made if the water table is at a depth equal to the width of the footing below the base of the footing. For intermediate positions linear interpolation of the reduction be made.

(i)First method

For any position of water table, the equation is given as under:

$$q_f = c \, . \, N_c + \gamma_1 \, DN_q \, R_{w_1} + \frac{1}{2} \gamma_2 \, BN_\gamma \, . \, R_{w_2}$$

where R_{w1} and R_{w2} are the water reduction factors for water table, computed as follows:

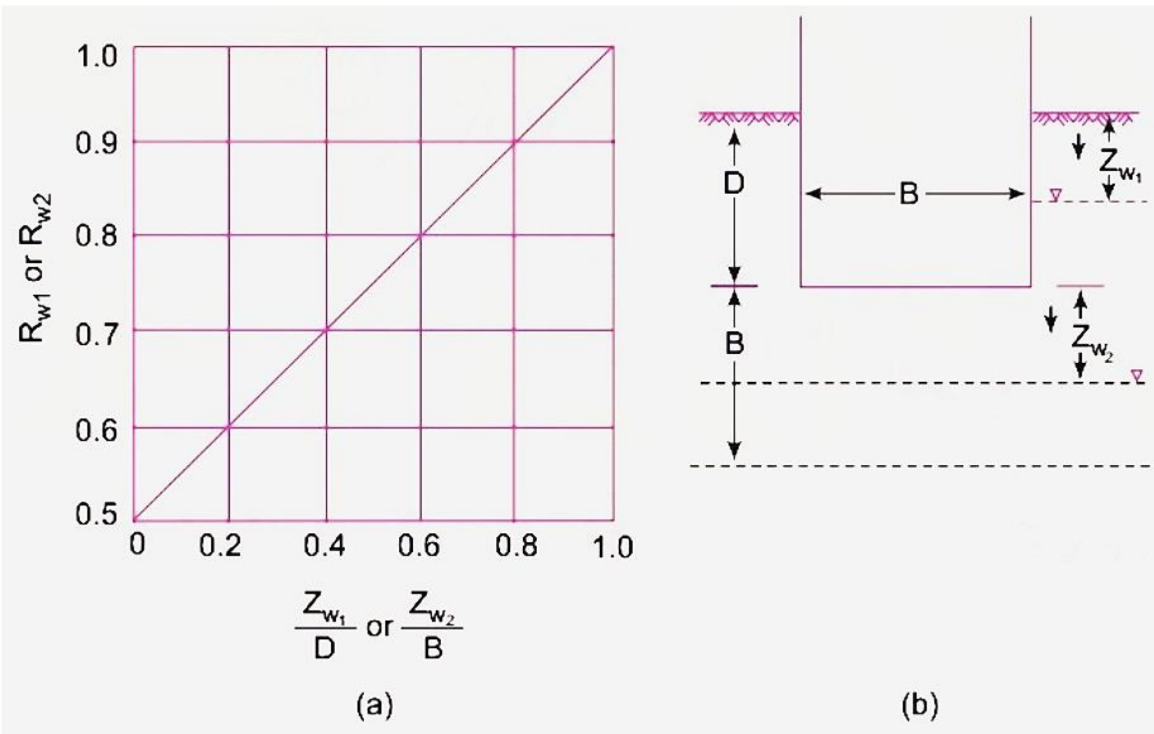


Fig. 1 Water Reduction Factors

$$R_{w_1} = 0.5\left(1 + \frac{Z_{w_1}}{D}\right)$$

$$Z_{w_1} = 0,\ R_{w_1} = \frac{1}{2}\ ;\ \text{At } Z_{w_1} = D,\ R_{w_1} = 1$$

$$R_{w_2} = 0.5\left(1 + \frac{Z_{w_2}}{B}\right)$$

$$Z_{w_2} = 0,\ R_{w_2} = 0.5\ ;\ \text{At } Z_{w_2} = B,\ R_{w_2} = 1$$

where, γ_1 = avg. unit wt. of surcharge soil situated above the water table.

γ_2 = avg. unit wt. of the soil in the wedge zone, situated within the depth B below the base of the footing.

When the water table is just at the base of the footing, $\gamma_2 = \gamma_{sat}$

When the water table is at the ground surface, both γ_1 and γ_2 are the saturated weights.

(ii) Second method (IS Code Method):

q_f can be computed using only one reduction factor, by the equation:

$$q_f = cN_c + \bar{\sigma} N_q, + \frac{1}{2}\gamma B N_\gamma R_w$$

where $\bar{\sigma}$ = effective unit weight of the soil situated above the base

$$R_w = R_{w_2} = 0.5\left(1 + \frac{Z_{w_2}}{B}\right)$$

When the water table is situated at a depth D_1 below the ground level ($D_1 < D$) or D_2 above the base of the footing (such that $D_1+D_2=D$), we have

$$\bar{\sigma} = (\gamma D_1 + \gamma_{sat} D_2) - \gamma w\ .\ D_2 = \gamma D_1 + \gamma' D_2$$

Knowing $\bar{\sigma}$ and R_w ($= R_{w_2}$), q_f can be computed.

This method is preferred to method in which two reduction factors R_{w1} and R_{w2} are used.

(iii) Third method:

In this method no water reduction factor is used but effective Unit Weight (γ_e) is used for the soil in the wedge zone.

Thus, we have $$q_f = cN_c + \bar{\sigma} N_q + \frac{1}{2} \gamma_e B N_\gamma$$

The wedge zone has a depth $H = 0.5\ B \tan(45° + \phi/2)$. Hence, when the water table is within this wedge zone, γ_e can be computed from the expression

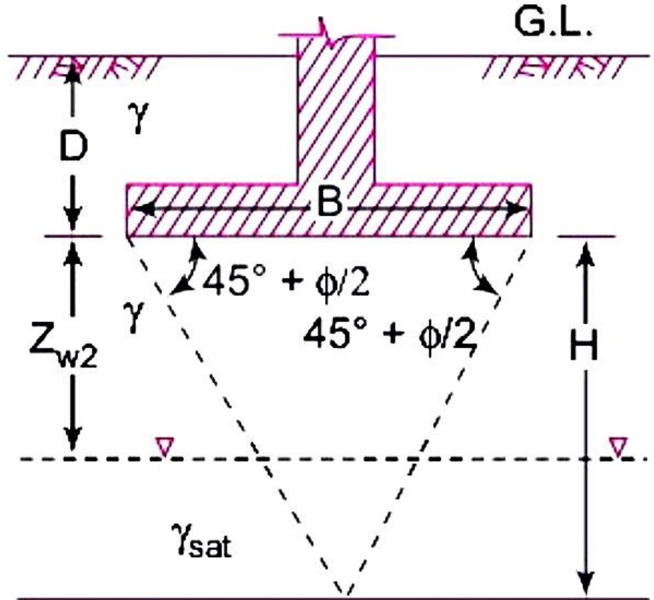
$$\gamma_e = \left(2H - z_{w_2}\right) \frac{z_{w_2}}{H^2} \gamma + \frac{\gamma'}{H^2} (H - z_{w_2})^2$$

Alternatively, taking $H = B$, the effective unit weight γ_e in the wedge term can be computed as under :

$$\gamma_e = \frac{\gamma\, z_{w_2} + \gamma'\left(B - z_{w_2}\right)}{B} = \gamma' + (\gamma - \gamma') \frac{z_{w_2}}{B}$$

when $Z_{w_2} = 0, \gamma_e = \gamma$ (as expected)

when $Z_{w_2} = B, \gamma_e = \gamma$ (as expected).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γ
D
B
45° + ϕ/2
γ
Z_{w2}
45° + ϕ/2
H
γ_{sat}