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Geotechnical & Foundation Engg.

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Q#1 A) Force acting on a dam. Explain any 5 in detial.

Ans:-

Following are the forces acting on a dam:-

- Water Pressure;
- Uplift Pressure;
- Wave Pressure;
- Silt Pressure;
- Ice Pressure;
- Self weight of the dam;
- Seismic forces

Water Pressure:- ~~Wat~~

Water pressure is a major external force acting on gravity dam. The horizontal water pressure exerted by the stored water on upstream side of dam can be collected from hydrostatic pressure distribut

Uplift Pressure:-

Water seeping through the pores of the foundation material and water seeping through the ~~dam~~ body of dam and from there to the bottom through the joints between body of the dam and its foundation at the base together exerts an uplift pressure on the base of the dam. It is controlled by constructing weigth of walls under the upstream face for drainage channel.

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Wave Pressure :-

Waves are generated on the surface of the reservoir by the blowing winds, which can cause pressure towards the downstream side. Wave pressure depends on wave heigth. Wave height can be calculated by the equation

$$h_w = 0.032\sqrt{vF} + 0.763 - 0.271\,F^{3/4} \qquad , \text{for } F < 32$$

where ;

h_w = height of water from top of crest to bottom of trough (m).

v = wind velocity (km/h)

F = fetch or straigth length of water expense (km).

Silt Pressure :-

If 'h' is the height of silt deposited, then force exerted by the silt in addition to external water pressure can be represented by Rankine's formula.

$$P_{silt} = \frac{1}{2}\gamma_{sub}\,h^2\,k_a$$; and it acts at h/3 from base.

where

γ_{sub} = submerged unit weigth of silt material

h = height of silt deposited

$k_a = 1 - \sin\theta / 1 + \sin\theta$

Ice Pressure :-

The ice which may be formed on the water surface of the reservoir in cold ~~countries~~ areas may be sometimes melt and expand. The dam face then has to resist force exerted by expanding ice. The force acts linearly along the length of the dam and at the reservoir level. The magnitude of this force varies from 250–1500 kN/m^2.

Q#1 B) Define the following terms

1- Liquification of soil :-

When the effective stresses become zero then the Soil will change into liquified state. Effective stresses are those that which keep the soil particles in contact with each other; if the effective stresses decrease the soil looses its strength.

2. Buttress Dam :-

A dam with a solid, water tight upstream side that is supported at intervals on the downstream side by a series of buttresses or supports. The dam wall may be straight or curved. Most buttress dams are made of reinforced concrete and are heavy. These dams were originally built to retain water for irrigation or mining in areas of scarce or expensive resource but cheap labour.

3. Pier foundation :-

A pier is a vertical column of a relatively larger cross section than a pile. A pier is installed in a dry area by excavating a cylindrical hole of a large diameter to a desired depth and then backfilling with concrete.

4. Dynamic Load :-

It is a force on a structure that changes size, position or direction.

5. Infinite Slope :-

Slope which has great extent with uniform soil conditions at any given depth below the surface.

Q#2A) Define Shallow Foundation? Explain it's types.

Definition

It is the foundation in which the depth of the foundation is less then the breadth of foundation.

Or

Such a foundation in which D_f/B ratio is less than 2.5.

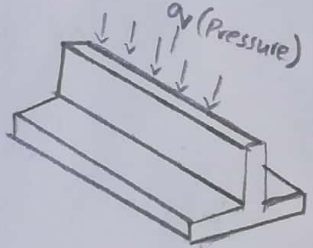
D_f = Depth of foundation

B = Breadth of foundation

Types of Shallow foundations

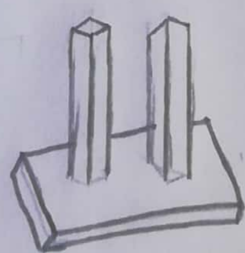
1. Wall footing/Strip footing

It is the footing which runs across the length of the foundation



2. Combined footing

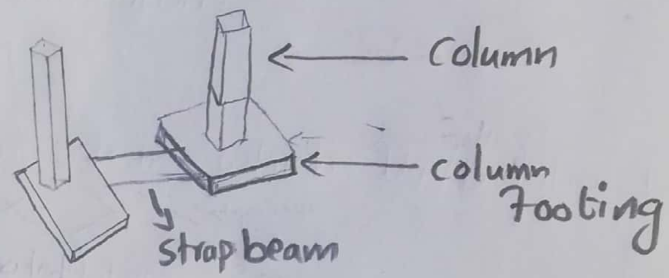
Such footing(s) which is constructed combined for two or more columns to transfer their load to the soil



If the load on both columns are equal in magnitude, then the ~~column~~ footing will be rectangular in shape; and if the magnitude of the columns vary with eachother then the footing will be trapezoidal.

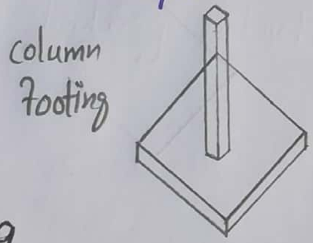
3. Strapped footing

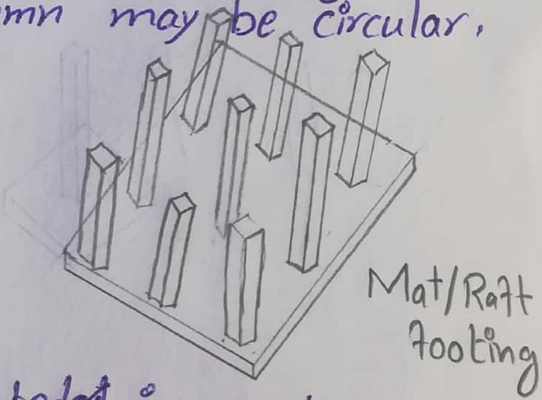
Footing in which the outer column footing is connected with inner column footing by means of tie beam or strap.



4. Column/Isolated footing

Footing which is constructed for a single column to transfer its load to the soil. This column may be circular, rectugular or square in shape.





5. Mat/Raft footing

Footing which is constructed in such a way that it covers the entire area of structure. This type of footing is provided when the soil has weak bearing capacity.

Q#2b Why ground improvment techniques are important? Explain five methods of ground improvement.

Importance of ground improvement techniques

These techniques are important for the soil in which volumetric changes take place due to shrinkage & swelling.

Ground improvement techniques are very essential for soil that is organic in nature, soft soil and the soil which is

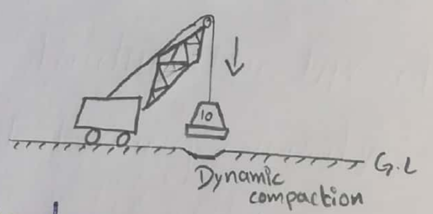
Sandy and gravely.

These techniques are used to enhance the engineering Property of soil in order to increase its bearing capacity, shear strength, permeability and stiffness etc.

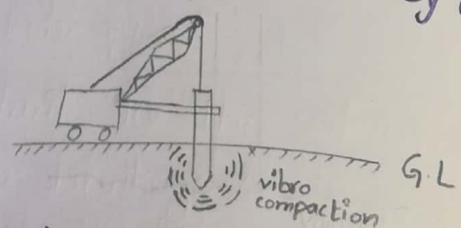
Methods of ground improvement techniques

1. Removal and Replacement of Soil :- This is an old and simple method i.e Performed on loose soil. In this method unsuitable soil is replaced with compacted fill. The same soil is used to refill the higher compaction and achieve better engineering properties. This method is applicable above GWT.

2. Dynamic Compaction :- In this method 'densification of soil' takes place. This method is used to increase the bearing capacity of soil. It also enhances the consolidation rate.

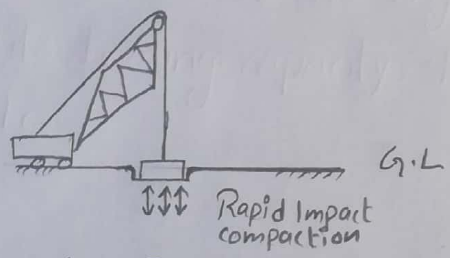


3. Vibro compaction :- This method is also known as 'vibro densification'. In this method the compaction takes place at a certain level/depth in granular soil with the help of vibratory probe. This probe is run by electric motor. The penetration process is efficient by ejecting water at the tips of the probe.



4. Rapid impact compaction :- In this method the impact of energy is applied to the ground surface as a result of which densification of soil takes place upto a depth of 15 feet. This impact energy

is applied through a hydraulic ramp. The hydraulic ramp weigth varies from 4-8 tons



5. Wet soil Mixing :- In this method a Paste of cement is prepared and injected in the soil. This method improves the characteristics of ~~soft~~ weak soil ~~by~~ with the help of cementious binder slurry.

Q#3 Problem Statement

Given Data:-

$C = 25\ kN/m^2$

$\phi = 16°$

$G = 2.72$

$e = 0.50$

Required:-

F_c (FOS) when soil is dry

F_c (FOS) when there is seepage in soil

Sol:-

$$F_c = \frac{C}{\gamma_d \times H \times \sin i \times \cos i} + \frac{\tan\phi}{\tan i}$$

$$\gamma_d = \frac{G_s \times \gamma_w}{1 + e} = \frac{2.72 \times 9.8}{1 + 0.5}$$

$$F_c = \frac{25}{17.8 \times 6 \times \sin(26°) \times \cos(26°)} + \frac{\tan(16°)}{\tan(26°)}$$

$$F_c = 1.18$$

When there is seepage

$$F_c = \frac{c}{\gamma \times H \times \sin i \times \cos i} + \frac{\gamma'}{\gamma} + \frac{\tan \phi}{\tan i}$$

$$\gamma' = \gamma - \gamma_w$$

we know that:

$$\gamma = \frac{G + e}{1 + e} \times \gamma_w$$

$$= \frac{2.72 + 0.5}{1 + 0.5} \times 9.8$$

$$\gamma = 21.04 \text{ kN/m}^3$$

$\therefore$

$$\gamma' = \gamma - \gamma_w$$

$$= 21.04 - 9.8$$

$$\gamma' = 11.24 \text{ kN/m}^3$$

Hence

$$F_c = \frac{25}{21.04 \times 6 \times \sin 26^\circ \times \cos 26^\circ} + \frac{11.24}{21.04} \times \frac{\tan 16^\circ}{\tan 26^\circ}$$

$$F_c = 0.815$$

P.T.O

Q#4 A) Problem Statement

Given Data:

Height = 10m

$C = 18.8 kN/m^2$

$\gamma = 17 kN/m^2$

$\phi = 20°$

F.O.S = 1.5

$F_\phi = 1.0$

Required:

Inclination, i = ?

Sol:-

$$SN = \frac{C}{F.O.S \times \gamma \times H}$$

$$= \frac{18.8}{1.5 \times 17 \times 10}$$

SN = 0.073

Using Taylor chart for $\phi = 20°$

$\phi = 20°$

SN = 0.073

$i = 44°$

P.T.O

Q#4 B) Problem Statement

Given Data:
- height of water on upstream side = 15m
- bottom width of dam = 12m
- Top width = 6m
- unit weight of water = 1000 kg/m^3
- " " " concrete = 1450 kg/m^3
- " " " silt = 1330 kg/m^3
- Angle of friction for silt = $\theta_s = 35^\circ$
- Free board = 3.5m
- Silt deposit height = 2.5m

Required :-

Silt Pressure = ?

Sol:-

We know that

$$P_{silt} = \frac{\gamma_s \times H_s^2}{2} \times \frac{1-\sin\theta}{1+\sin\theta}$$

$$= \frac{1330 \times (2.5)^2}{2} \times \frac{1-\sin 35^\circ}{1+\sin 35^\circ}$$

$$P_{silt} = 1126.30 \text{ kg/m}^3$$