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Section A

Semester 6th

Subject Geotechnical Engg

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Final paper.

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Q. No 1
Part (a)

Forces Acting on Dam:-

1. water Pressure
2. uplift pressure
3. wave pressure
4. silt pressure
5. Ice "
6. Self weight of the dam
7. Seismic Forces.

i. **Wave Pressure:-**

wave pressure,

$P_w = 2wh_w^2$

& it acts at a distance of $3h_w/8$ above the reservoir surface.

Waves are generated on the surface of the reservoir by the blowing winds. which exert the pressure on the upper part of the dam above the water level.

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ii. Wind Pressure:-

→ It is a minor force acting on dam

→ Acts on superstructure of the dam

→ Normally, wind pressure is taken as 1 to 1.5 kN/m².

iii. Ice Pressure:-

→ The ice formed on water surface of the reservoir is subjected to expansion & contraction due to temperature variations.

→ Coefficient of thermal expansion of ice is 5 times more than concrete.

→ The dam face has to resist the force due to expansion of ice.

iv. Silt Pressure:- It is the pressure that is caused by the deposition of the silt in the bed of the dam causing at h/3 from the base & can be computed using equation:

$P_{silt} = 0.5\gamma_s h^2 K_a$

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where Ka = Coefficient of active earth pressure of silt which is equal to

$$\frac{1 - \sin\phi}{1 + \sin\phi}$$

ϕ = Angle of internal friction of soil cohesion neglected.

γ = Submerged unit weight of silt material
h = height of silt deposited.

iv. **Seismic Forces:-**

Dynamic load created due to earthquake must be considered in the design of all major dam located in high risk. seismic region earthquake pressure waves in every possible direction. However, It has to be resolved into vertical & horizontal components for the design purposes. The horizontal component had greater effect.

Q. No 1
Part (b)

Define :-

i. **Infinite slope:-** Having constant slope of infinite extend e.g long slope of a mountain face.

ii. **Butress Dam:-** Butress Dam is provided in a region where there is alternate layer of weak & strong rock.

iii **Pier foundation:-** It consists of a cylindrical column of a large diameter to support & transfer large super-imposed loads to the firm strata below through pile foundations transfer the load through friction &/or bearing, pier foundation transfer the load only through bearing.

iv. Liquefaction of soil:-

"A phenomenon whereby a saturated or partially saturated soil substantially losses strength & stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid" is called soil liquefaction.

v. Dynamic load:-

The load which acts on ground by the movement of subjects & sometimes the load due to earthquake can be classified as dynamic load.

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Q. No 2
Part (a)

Shallow Foundation:- It is a type of building foundation that transfers building loads to the earth very near to the surface, rather than to a subsurface layer or a range of depth as does a deep foundation.

$$Df \leq B$$

According to Skempton:- The foundation in which Df/B ratio is less than or equal to 2.5 than the foundation is called shallow foundation.

Types of shallow Foundation:-

1. **Wall Footing:-** The footing which runs across the length of the wall & transfer the load of the wall to the soil safely. it is called wall or strip footing.

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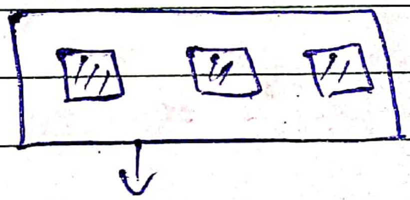
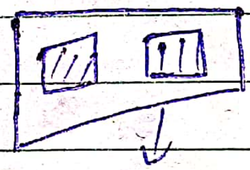
2. Combined footing:-

The footing which is constructed for two or more column & transfer the load of the two or more column to the soil safely then it is called combined footing.

If the load of column is uniform then the combined footing will be rectangular in shape.

If the load of the ~~beam~~ column is not uniform then shape of combined footing will be trapezoidal.

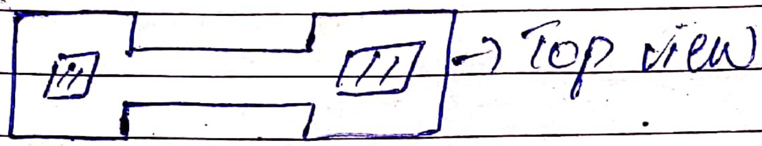


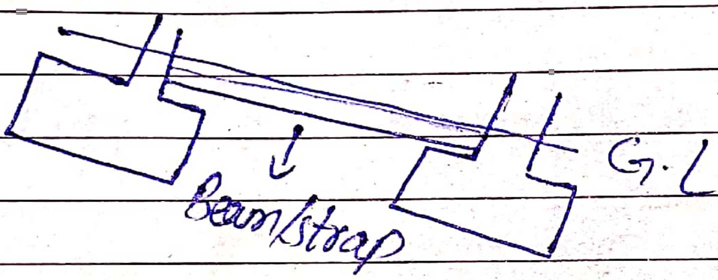


3. Raft / MAT Footing:-

The footing which covers the whole area of the structure is called raft footing. This type of footing is proposed in area which have soil weak in bearing capacity. This is also provided when the load of super structure is heavy.

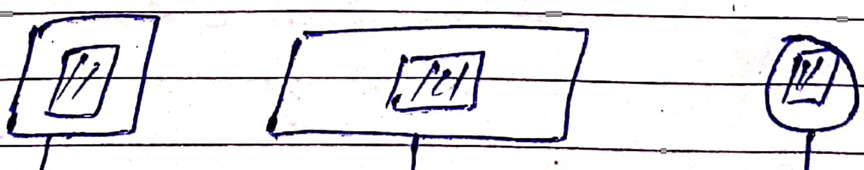
4. Strapped Footing:- The footing in which the outer column is connected with the inner column by means of the beam or strap is called strapped footing.





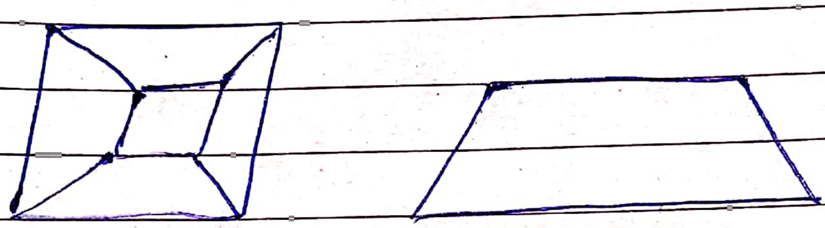
5. Colomn /Isolated footing:-

The footing which is constructed for a single column & transmit the load to the soil safely. it may be circular, square, rectangular in shape.



6. Slopped Footing:-

The footing which have slope in all direction as in all sides is called as slopped footing.



Selection of foundation:-

Selection of foundation depends upon the following.

→ Type of soil & condition of soil.

→ It depend upon the load of super structure.

→ The depth at which the safe bearing capacity exist.

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Q.No 2
Part (b)

Ground improvement tchniques:-

It is the techniques which are used to enhance the engineering property of soil in order to bear heavy structural load.
The main properties are shear strength, permeability, bearing capacity & stiffness etc.

Need of Ground improvement techniques:-

The soil in which volumetric changes take place due to shrinkage & swelling such soil needs ground improvment technique.

→ The soil which is organic in nature
→ The soft soil also required ground improvement techniques.

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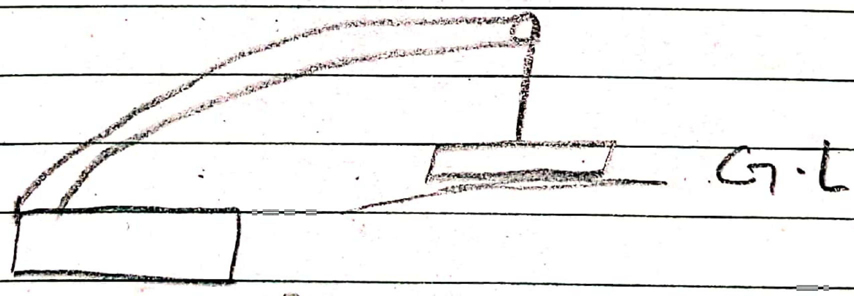
Method of Ground improvement techniques:-

1. Removal & Replacement of soil:-

This is an oldest & simple method. This method is performed on loose soil.
In this method the unsuitable soil is replaced with compacted fill. In this method the same oil is used to refill the higher compaction & better engineering properties.

2. Dynamic compaction:-

This method is used to increase the bearing capacity of soil. This also increase the consolidation rate. This method also increase the density of soil.



3. Dry Mixing of soil:-

Dry soil mixing is ground improvement techniques by which the characteristics of weak

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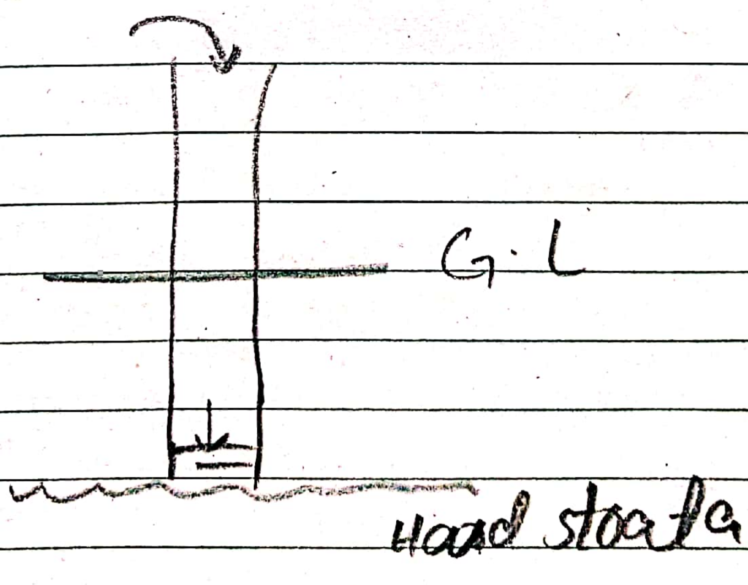
soil are improved by using dry cementitious binder.

4. **Wet Soil Mixing:-** In this method of ground improvement technique a paste of cement is prepared & inserted in the soil. This method is used to improve the characteristics of weak soil by using cementitious binder slurry.

5. **Vibro Concrete Column:-** Vibro concrete columns is a ground improvement technique which transfer the load from weak strata to hard strata by using strength concrete.



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Q. No 3

Given data:-

$c = 25 \, KN/m^2$
$\phi = 26^\circ$
$G = 2.72$
$e = 0.50$

Required:-

Fc (F.O.S) when soil is dry
Fc (F.O.S) when there is seepage in soil.

Solution:-

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

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

$$\gamma_d = 17.8 \, KN/m^3$$

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

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$FC = 1.18$

when there is seepage of water

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

$\gamma' = \gamma - \gamma_w$

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

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

$\gamma = 21.04\ kN/m^3$

$\gamma' = \gamma - \gamma_w$

$= 21.04 - 9.8$

$\gamma' = 11.24\ kN/m^3$

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

$FC = 0.816$

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Q. No 4

Given data:-

Height, H = 10m

$C = 18.8\ KN/m^2$

$\gamma = 17\ KN/m^3$

$\phi = 20°$

F.O.S = 1.5

$F\phi = 1.0$

Required:-

Inclination = ?

Sol:-

$$S_N = \frac{C}{FOS \times \gamma \times H}$$

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

$$S_N = 0.073$$

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Using Taylor chart for

$\phi = 20°$

$S_N = 0.073$

$i = 44°$ → From Taylor chart.

Q.No 4
Part (b)

Given data:-

height of water on upstream side = 15m

Bottom width of the dam = 19m

Top width = 6m

Unit weight of water = 1000 kg/m³

unit weight of concrete = 1450 kg/m³

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Unit weight of silt = 1330 kg/m^3

Angle of friction for silt = ϕ_s = 35°

Free Board = 3.5m

Silt Deposite height = 2.5m.

Required :-

Silt pressure = ?

Sol:-

we know that

$$P_s = \frac{\gamma_s \times H_s^2}{2} \times \frac{1 - \sin\phi}{1 + \sin\phi}$$

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

$$P_s = 1126.30 \text{ kg/m}$$