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SUBJECT:-

Geotechical And FOUNDATION Engineering

SUBMITED To:-

"Engineer Liaqat"

Question 1 a.

Q) Name the Forces acting on a dam? Explain any five?

Forces acting on a dam:-

① → Weight of dam
② → Water pressure
③ → Uplift pressure
④ → Wave pressure
⑤ → Earth and silt pressure
⑥ → Earth quake pressure
⑦ → Ice pressure
⑧ → wind pressure
⑨ → thermal loads.

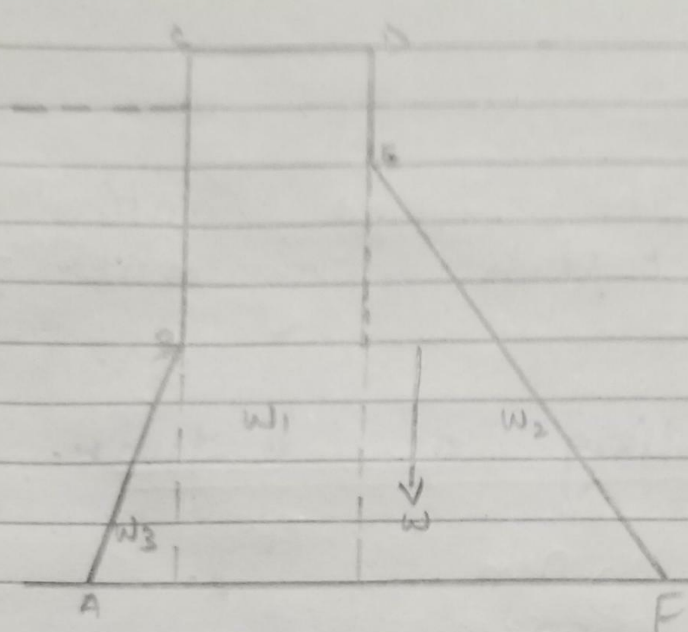
1- Weight of dam:-

This is the major resisting force

1- Generally unit length of dam is considered.
2- The cross section of dam may be divided into several triangles and rectangles and weights w_1, w_2, w_3 etc may be computed.
3- The total weight of the dam acts at C.G of its section.

Mathematical Form:-

weight = Vol per unit length + Density of material.



Water pressure :-

These are the major external force acting on dam

- Pressure Components on both upstream and downstream are
  - → Vertical component
  - → Horizental Component.
- Unit weight of water
  Formula :- $P = \frac{1}{2} \gamma w h^2$
- $\gamma w = 1000 \, kg/m^3$.

Wave pressure :-

- When very high wind flow over the water surface of the reservior. Wave are formed which exerts pressure on the upstream ~~part~~ part of the dam.
- The magnitude of wave depend upon
  - → Velocity of wind
  - → Depth of Reservior
  - → Area of water surface

- It is calculated by the following formula.

→ Pv = 2.4 γw + hw

- Pv = Wave pressure
- γw = Unit weight of the
- hw = Height of wave.

Uplift stream:-

- The water stored on the upstream side of the dam has a tendency to seep through the soil below foundation.
- While seeping, the water exerts a uplift force on the base of the dam depending upon the head of water.
- The uplift pressure reduce the self weight of the dam.
- To reduce the uplift pressure during drainage galleries are provided on the base of the dams.
- It is calculated by the following formula.

$U = 1/2\ \gamma w \times hB$

→ U = uplift pressure
→ γw = Unit weight of water
→ hB = width of the base dam.

Ice presure:-

→ The ice pressure which may be formed on the surface reservior in Cold Countries, may Some times melt and expand.

→ The dam face has then to resists The thrust exerted by the expanding Ice.

→ The force acts linearly along the length of The damn and at the reservier level.

→ The magnitude of this force depending upon the temperature Variation.

→ These magnitude variation varies from 2500 to 1500 KN/m²

→ On an average a value of 500 KN/m² may be allowed under Ordinary Condition.

Ques:- 1b:-

Define the following terms?

* **Liquefaction of soil:-**

Soil liquefaction occur when a saturated or partially saturated soil substantially loses strength and stifness is response to an applied stress such such a shaking during an earthquakes or other charge in stress condition in which material that is ordinarily a solid behave like a liquid.

* **Buttress Dam:-**

A buttress dam is a dam with a solid water tight upstream side that is supported at interval on the down stream side by ~~side~~ series of butters or supports. The dam wall may be stright or curved. Most butteris dams are made of reinforced concret and are heavy.

Infinite slope:-

An infinite slope is a simply ~~verified~~ vertical line. when you plot it on a line graph. an any line which runs parallel to the y-axis the line that does not move along the x-axis but stay fixed at one constant x-axis Coordinate.

Dier foundation:-

A deep foundation is a type of foundation that transfer building load to the earth further down from the surface than a shallow foundation does to a subsurface layer or a range depths.

Dynamic load:-

Dynamic load is the load which is non static such as wind load or moving live load.

Question 2a:-

Define shallow Foundation. Explain types of shallow foundation in detail with appropriate sketch?

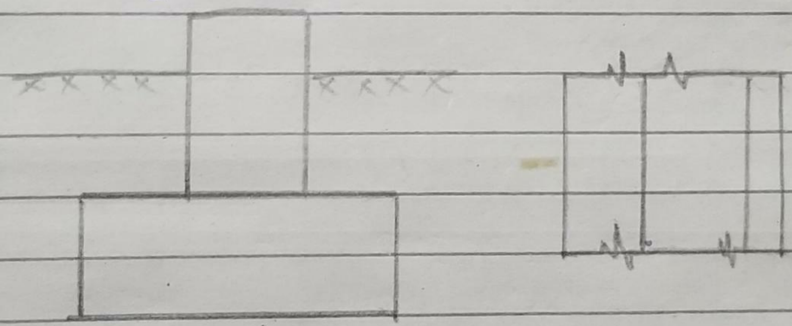
Shallow foundation:-

Shallow foundation is a type of building foundation that transfer building load to the earth surface. If the bearing capacity of soil is enough to carry the structural load or without any settlement of underlying soil layer than shallow foundation is to be provided.

→ **Different types of foundation:-**

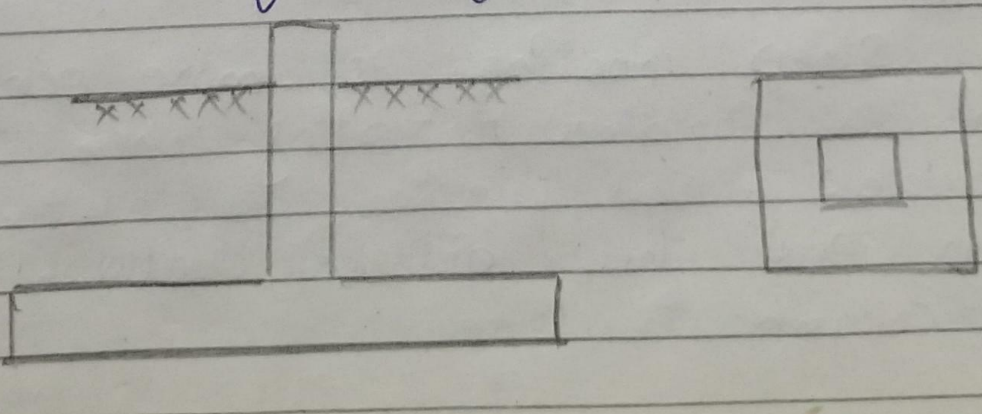
Strip footing:-

A strip footing is provided for a load bearing wall. A strap footing is also provided for a row of coloumns which are so closely spaced that their spread footing overlap or nearly touch each other. In such a ~~case~~ cause, it is more economical to provide a strip footing than to provide a no. of spread footing in one line.



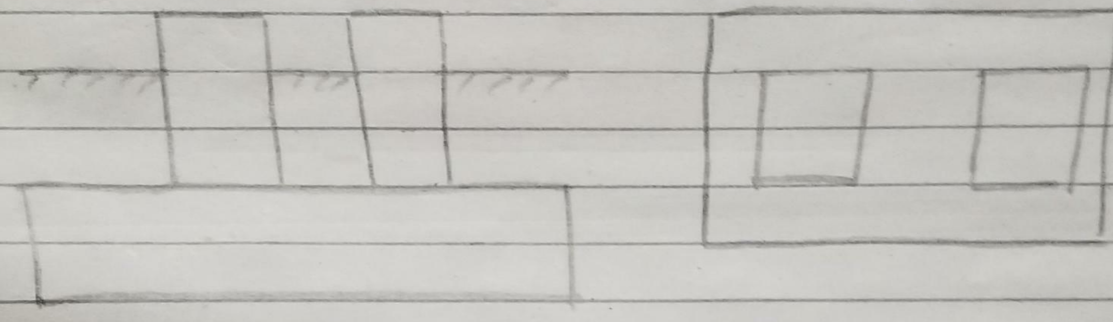
Spread footing:-

Spreading footing is provided to support an individual footing is provided to support an individual coloumn. Spread footing is circular, square or rectangular slab of uniform thickness.



→ Combined footing :-

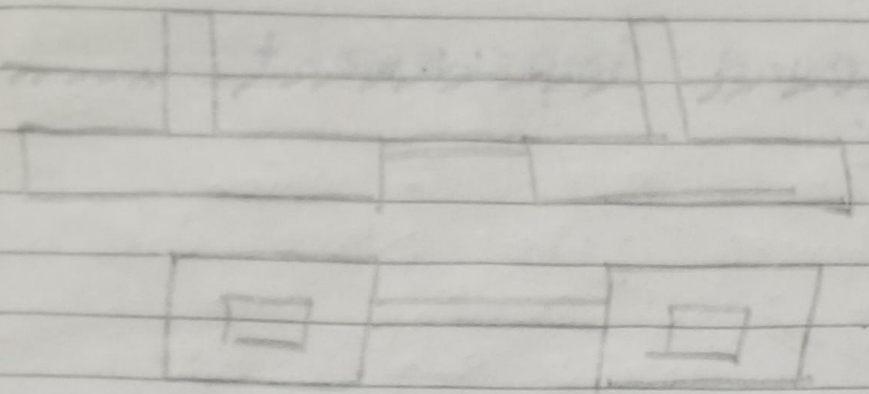
A combined footing support two coloumns. It is used when the two coloumn are close to each other that their individual, footing would over lap. A combined footing is also provided when the property line are so close to one coloumn that a spread footing would be eccentrically loaded when kept entirely with in the property line



Strap footing :-

A strap footing consists of two isulated footing connected with a structural strap. The strap connects the ~~the~~ two footing such that they behave as one unit. The strap is designed as a rigid beam.

Strap footing is more ecnomical than a combined footing. When the allowable soil pressure is relatively high and the distance between the coloumn is large.



Mat or Raft Foudation:-

A mat is a large slabe supporting a number of coloums and walls under the entire structure or a large part of the structure. A mat is required when the allowable soil pressure is low that individual footing should overlap or nearly touch each other.

Question 2 b:-

Why ground improvement techniques are important. Explain Five method?

Ground Improvement Techniques:-

Ground improvement techniques are 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 and stifness etc

→ Need of Ground improvement techniques:-

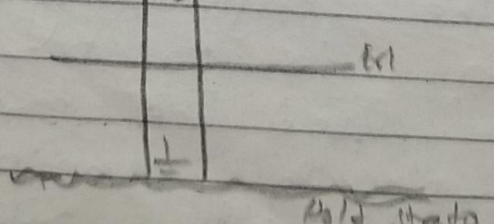
The soil in which volumetric changes take place due to shrinkage and swelling such soil needs ground improvement technique.

→ The soil which is organic in nature
→ The soft soil also required ground improvement techniques.
→ The soil which is sandy and gravely. The foundation in sanatory dimp places also required ground improvement techniques.

Method of Ground Improvement Techniques :-

* Vibro Concrete Coloumns:-

Vibro Concrete coloumn is a ground improvement technique which transfer the load from weak strata to the hard strata by using strength concrete.



→ Wet Soil mixing:-

In this method of ground improvement technique a paste of cement is prepered and inserted in the soil. This method is used to improve the characteristics of a week soil by using cementitious binder slurry.

→ Dry Mixing of soil:-

Dry soil mixing is ground improvement technique by which the characteristic of weak soil are improved by use dry cementitious binder.

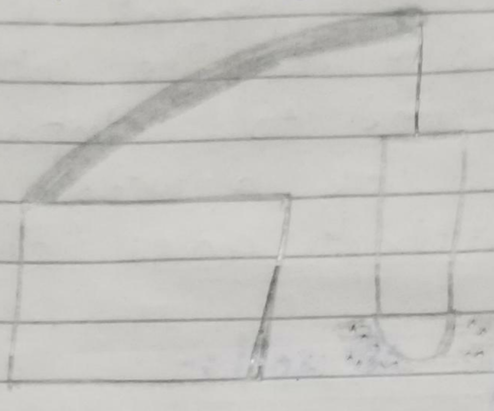
→ Dynamic Compaction:-

This method is used to increase the bearing capacity of soil. This also increase the considation rate. This method also increase the density of soil. In this method actually densification of soil take place.

→ Vibro Compaction:-

It is also called vibro densification. In this method the compaction take place at a certain depth in granulal soil through vibratory pobe. The vibrotory pobe is run by electric motors.

The penetration of probe is entance by ejecting ~~water~~ water at the tip of probe.



Que 3:-

A infintely long slope having
- - - - - - safety
would result?

Given data:-

$C = 25\ kN/m^2$
$\theta = 16^\circ$
$G = 2.72$
$e = 0.50$

Required:-

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

Solution:-

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

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

$$\boxed{\gamma_d = 17.8\ kN/m^3}$$

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

$\Rightarrow$ $F_c = 1.18$

Where the seepage of water :-

$$F_c = \frac{C}{\gamma \times H \times \sin i \times \cos i} + \frac{\gamma'}{\gamma} * \frac{\tan \theta}{\tan i}$$

$\gamma' = \gamma - \gamma_w$

$$\gamma = \frac{G + e}{1 + e} \times \gamma_w = \frac{2.72 + 0.5}{1 + 0.5} \times 9.8$$

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

$\gamma' = \gamma - \gamma_w$

$\gamma' = 21.04 - 9.8$

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

$$Fc = \frac{25}{21.04 \times 6 \times \sin(26) \times \cos(26)} + \frac{11.94}{21.04} \times \frac{\tan(16)}{\tan(26)}$$

$$Fc = 0.816$$

Question 4(a):-

It is proposed to construct a 10m highway embankment with the following soil properties.

Given data:-

Height = 10m

$C = 18.8 \; kN/m^2$

$\gamma = 17 \; kN/m^2$

$\phi = 20°$

F.O.S = 1.5

$F\phi = 1.0$

Req:-

Inclination = $i = ?$

Sol:-

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

= Putting values

$\Rightarrow$ ~~Q~~ $\frac{18.8}{1.5 \times 17 \times 10}$

So

$$\boxed{SN = 0.073}$$

Using tylor Chart:-

$\phi = 20^\circ$
$SN = 0.073$

So

$$\boxed{i = 44^\circ}$$

Question 4 b:-

Considering the Following data find silt pressure ?

Given data:-

- Height of water on upstream = 15m
- Bottom width of dam = 19m
- Top width = 6m
- Unit weight of water = 1000 kg/m³
- Unit weight of concrete = 1450 kg/m³
- Unit weight of silt = 1330 kg/m³
- Free board = 3.5m
- Angle of friction for soil = θ = 35°
- Silt deposited height = 2.5m.

Req:-

Silt pressure = ?

Sol:-

Silt pressure =

$$P_s \Rightarrow \frac{\gamma_s \times H^2}{2} \times \frac{1-\sin\theta}{1+\sin\theta}$$

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

$$\Rightarrow 4156.25 \times 0.22$$

$P_s = 1122.18$ kg/m