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Section = A

Subject = Geotechnical Engineering

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Q No (01)

Part (A)

Name the forces acting on dam. Explain any five of them in detail.

Ans

Dam:

A dam made structure which is constructed across rivers composed from different material such as concrete, earth masonary and rock etc. Dam is constructed for hydropowers generation, Irrigation purpose, flood control pressure etc

Forces acting on Dam

① Water pressure
② Wave pressure
③ Silt pressure
④ Ice pressure
⑤ Self weight of the dam
⑥ uplift pressure.

① Water pressure :

The deeper the water, the more horizontal pressure it exerts on the dam. So at the surface of the reservior, the water is exerting no pressure and at the bottom of the reservior the water is exerting maximum pressure.

② Wave pressure : Wave pressure waves are generated on the surface of the reservior by the blowing winds which exert a pressure on the upper part of the

the dam above the water level

③ Silt pressure:- It has define as that silts gets deposited against the upstream face of the dam. and exert the pressure If the upstream face in inclined, the vertical weight of the silt supported on the slope also acts as a virtical force.

④ Ice pressure:-

The ice which may be formed on the water surface of the reservior in cold countries sometimes melt and expand. The magnitude of this force varies from 350 to 1500 kN/sq.m depending upon the temprature variations.

⑤ Uplift pressure:-

It is an upward vertical pressure created due to penetration of the water into the porous material of the dam basement. It is the condition of greater pore water pressure than the overburden pressure of the structure on of the dam.

Part (B)

Define the following terms

① Liquification of Soil:-

The soil liquefaction occurs when a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress such as shaking during an earthquake or other sudden change in stresses condition, in which material that is ordinarily a solid behaves like a liquid.

② Buress Dam:-

A butteress dam or hollow dam is a dam with a solid, water-tight upstream side that is supported at intervals on the downstream side by a series of buttress or supports. The dam wall may be straight or curved. most dam are made of reinforced concrete and are heavy, pushing the dam into the ground.

③ Infinite Slope:-

An infinite slope is simply a vertical line when you plot it on a line graph, and an infinite slope is any line which runs parallel to the y-axis. you can also describe this as any line that does not move along the x-axis but stays fixed at one constant x-axis coordinate, making the change along the x-axis 0. A slope is extend for long distance.

④ Pier foundation:

A pier foundation consists of cylindrical column of large diameter to support and transfer large super-imposed loads to the firm strata below.

⑤ Dynamic load:

The Dynamic load is a method to assess a piles bearing capacity by applying a dynamic load to the pile head (a falling mass) while recording acceleration and strain on the pile head. Dynamic load testing is a high strain dynamic test which can be applied after pile installation for concrete piles.

Q.No (2)

Part (A)

Define shallow foundation. Explain type of shallow foundation in detail with appropriate sketch.

Ans:

Foundation:

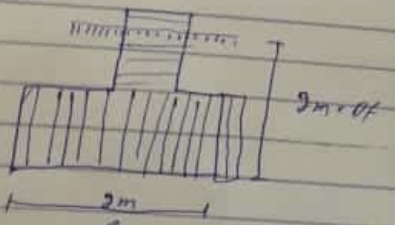
The lowest part of the structure which transmit the load of super structure safely to the soil surface

Types

① Shallow foundation
② deep foundation

① Shallow foundation:

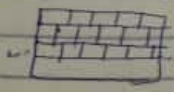
According to terzaghi. The foundation in which the depth of foundation is less than or equal to the breath/ width of foundation is called shallow foundation



Type of shallow foundation

① Wall footing:

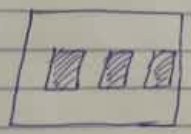
The footing which transfers loads of the wall to the soil safely it is also called the strip footing



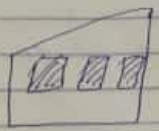
② Combined footing :- The footing which is constructed combined for two or more column to end transfer load of two or more column to the soil safely than it is called combined footing

→ If the load of the column is uniform then the combine footing will be rectangular in shape

→ If the load of the column are not uniform then the shape of the combined footing will be trapezoidal in shape



uniform load (rectangular)

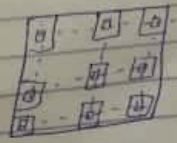


non uniform (trapezoidal)

③ Mat / Raft footing :-

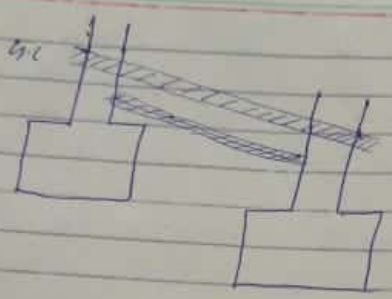
The footing which covers the whole area of the structure is called raft footing

This types of footing is proposed in area which soil weak in bearing capacity. This is also provided which the load of super structure is heavy. It made from concrete for stability.



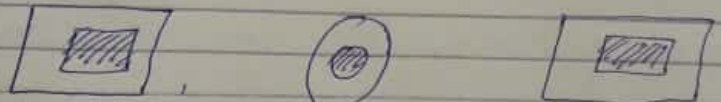
④ Strapped footing :-

The outer column is connected with inner column by mean of tie beams or strapped is called strapped footing



(5) column footing :-

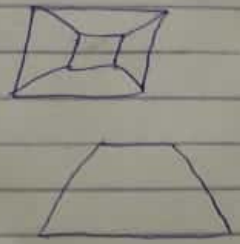
The footing which is constructed for a single column are to transmit load to the soil safely.
It may be circular, square, or rectangular in shape.



Square circular rectangular

(6) Stepped footing

The footing which have slope in all direction or in all sides is called as stepped footing



Part (B) Q.No (3)

Why ground improvement techniques are important. Explain five methods of ground improvement in detail along with appropriate sketch.

Ans

Ground Improvement techniques:

Ground improvement techniques are the techniques which are used to enhance the engineering property of soil in order to deal heavy structural load The main properties are shear strength, permeability, bearing capacity and stiffness etc

Need of Ground Improvement Techniques:

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

- The soil which is organic in nature
- The soft soil also required ground improvement techniques
- The soil which is sandy and gravel. The required ground improvement techniques

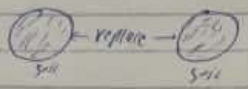
Methods of Ground Improvement techniques.

① Remove and Replacement of Soil:

This is an oldest and simple method. This method is performed on loose soil

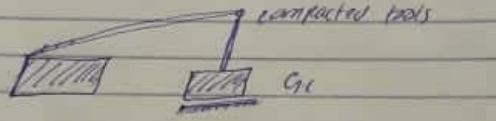
In this method the insolable soil is replaced with compacted fill. In this method the same soil is used to refill the higher

compaction and better engineering properties. This method is applicable above the ground water table



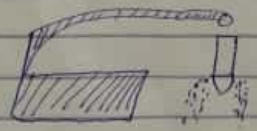
② Dynamic compaction:

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



③ Vibro compaction

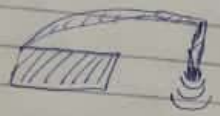
It is also called vibro densification. In this method the compaction take place at a certain depths in granular probe is by an electric motor. The penetration of probe is enhance by ejecting water at the tip of probe



④ Rapid Impact compaction:

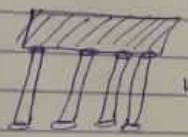
Impact energy is applied to surface of ground as a result of which densification of soil take place

place upto a depth of 15 feet. The impact energy is actually applied through hydraulic ramp. The hydraulic ramp weight value from 4-8 ons



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.



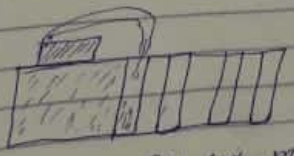
Vibro concrete column

⑥ Wet soil mixing:

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

① Dry mixing of soil:

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



Dry soil mixing

Q NO (3)

An infinity long slope having an inclination of 26° in an area is underlain by firm cohesive soil (G_s 2.72, e = 0.50). There is a thin weak layer of soil 6m below and parallel to the slope surface is C = 35 KN/m², ϕ = 16°. Compute the factors of safety when the slope is dry. If ground water flow could occur parallel to the slope on the ground surface, what factor of safety would result.

Given Data

$C = 35 KN/m^2$
$\phi = 16°$
$e = 0.50$
$G_s = 2.72$

Required.

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

Solution

$$Fc = \frac{C}{\gamma d \times H \times \sin i \times \cos i} + \frac{\tan\phi}{\tan i}$$

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

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

$$\boxed{\gamma d = 17.8 \ KN/m^3}$$

$$F_c = \frac{25}{17.8 \times 6 \times \sin(90) \times \cos(90)} + \frac{\tan(16^\circ)}{\tan(26)}$$

$$\boxed{F_c = 1.18}$$

When there is seepage of water

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

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

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

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

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

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

$$\gamma' = 21.04 - 9.8$$

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

$$F_c = \frac{25}{21.04 \times 6 \times \sin(90^\circ) \times \cos(90^\circ)} + \frac{11.24}{21.04} \times \frac{\tan(16^\circ)}{\tan(26^\circ)}$$

$$\boxed{F_c = 0.816}$$

Q No

Part (A)

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

$C = 18.8 kN/m^2$

$\gamma = 17 kN/m^3$

$\phi = 30°$

What is the inclination required for the embankment if the design FOS 1.5 and $F_\phi = 1.0$

Given Data

$H = 10m$

$C = 18.8 kN/m^2$

$\gamma = 17 kN/m^3$

$\phi = 30°$

$FOS = 1.5$

$F\phi = 1.0$

Required

Inclination $i = ?$

Solution

We know that

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

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

$$\boxed{S_N = 0.073}$$

(15)

Using taylor chart

$\phi = 30°$

$SN = 0.073$

Then

$i = 44$ (From taylor chart)

Part (B) Q No (4)

Considering the following data bout, silt, pressure

- Height of water on upstream side = 15m
- Bottom width of the dam = 12m
- Top width = 6m
- Unit weight of water = 1200 kg/m³
- Unit weight of concrete = 1450 kg/m³
- Unit weight of silt = = 1330 kg/m³
- Angle of friction for the silt = $\phi_s = 35°$
- Free Board = 3.5m
- Silt Depolite height = 2.5m

Required :

Silt pressure = ?

Solution:

As we know that

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

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

$$\boxed{P_s = 1206.30 \text{ kg/m}}$$