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Section:- A
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Question No:- 1 (a)

Forces Acting on A Dam

1. Water Pressure
2. Uplift pressure
3. Wave pressure
4. Silt pressure
5. Ice pressure.
6. Self weight of dam.
7. Seismic forces.

1. Water Pressure:-

This pressure tends to ~~e~~act prependicularly on upstream face of the dam. The water pressure on dam is computed by the equation

$$P_1 = \frac{wH^2}{2}$$

w = sp. weight of water.
H = height upto which water is stored in 'm'
P = pressure.

2. Self weight of Dam:-

The weight of dam & its foundation is a major resisting force. It can be computed using the equation

$$W = \gamma_m \text{ Volume}$$

where;

γ_m = unit weight of pressure

3. **Silt Pressure** :-

The weight of dam & its foundation is a major resisting force. It acts at h/3 from the base and can be computed using eq;

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

where;

k_a = 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.

γ_s = submerged unit weight of silt material.

h = height of silt deposited.

4. **Wave Pressure** :-

Blowing winds cause the generation of waves on surface of reservious, which exerts a pressure on the upper part of the dam above the water level.

$$P_w = 2.4 \gamma_w h_w$$

for $F < 32km$:-

$$h_w = 0.32 \sqrt{FV} + 0.763 - 0.271 \times F^{1/4}$$

For $F \geq 32km$;

$$h_w = 0.32 \sqrt{VF}.$$

5. **Ice pressure:-**

The ice which may be formed on the water surface of reseviour in cold countries may sometimes melt & expand. The dam face is subjected to thrust & exerted by expanding ice.

Question 1 # Part (b)

Define the following:-

a. **Liquification of Soil:-**

It is phenomenon where a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquakes shaking or other sudden change in stress condition causing it to behave like a liquid. It is of 2 types.

- Flow liquification.
- Cyclic Mobility.

b. **Buttress Dam:-**

It is a derivation of a gravity dam with introduction of intermediate space.

- The face of dam is held by a series of supports or buttresses that are placed at intervals on downstream side
- The buttresses work to combat the force of reseviour water from trying to push the dam over.

c) Infinite Slope :-

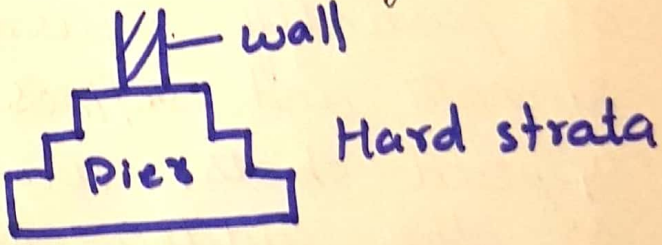
Having constant slope of infinite extent & eg long slope of mountain face.

assumptions;

- ↳ Slope is planar & of infite extent.
- ↳ Faibure surface is parallel to slope surface
- ↳ Water surface is parallel to slope surface

4) Pier Foundation :-

A pier is a vertical column of a relatively larger cross-section than a pile. A pier is installed in an adry area by excavating a cylindrical hole of larger dia to the desired depth and then backfilling it with concrete.



5) Dynamic Load :-

Dynamic load vary in magnitude, direction of position with time.

⇒ These are time dependent loads.

⇒ The type of dynamic loading in soil or the foundation of structure depends on the nature of source providing it.

Question No#2(a).

Shallow Foundation :-

↳ The foundation in which depth is less or equal to width of foundation. (according to terzaghi)

↳ The foundation in which Df/B ratio is less or equal to ~~width of foundation~~ 2.5 than the foundation is called shallow foundation.

Types :-

1. **Wall Footing** :- The footing which runs acerss the length of wall and transfers the load of wall to the soil safely.

2. **Combined Footing** :- The footing which is constructed for two or more columns and transfers the load of the two or more column to the soil safely is called combined footing.

3. **Raft/Mat Footing** :- The footing covering the whole area of structure is called raft footing. This footing is proposed in areas having soil weak in bearing capacity.

4. **Strapped Footing** :- The outer column is connected with the inner column in this type of footing.

5. **Column / Isolated Footing :-**

it is constructed for a single column and transmits its load to the soil safely. It may be circular, square, rectangular in shape

6. **Slopped Footing :-**

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

Question No:- 2(b)

Ground Improvement Techniques :-

Used for enhancing engineering properties of soil in order to bear heavy structural loads. Properties include shear strength, permeability, bearing capacity & stiffness etc.

Importance :-

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

- The soil which is organic in nature.
- Soft soil also requires this technique.
- Sandy & gravely soil.

Methods of this technique include;

1. **Removal And Replacement of Soil :-**
   - Performed on loose soil

↳ unsuitable soil is replaced ① with compacted fill.

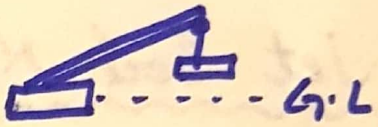
↳ Same soil is used to refill the higher compaction and better engineering properties

2) Dynamic Compaction:-

↳ Used for increasing bearing capacity of soil.

↳ Also increases the density of soil.

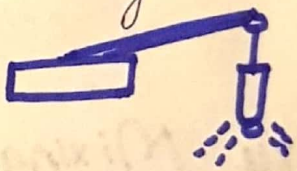
↳ Densification of soil takes place in this method.



3) Vibro Compaction:-

↳ Compaction takes place at a certain depth in granular soil through vibratory probe.

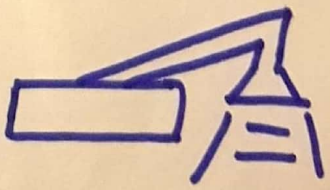
↳ This vibratory probe is run by an electric motor.



4) Rapid Impact Compaction:-

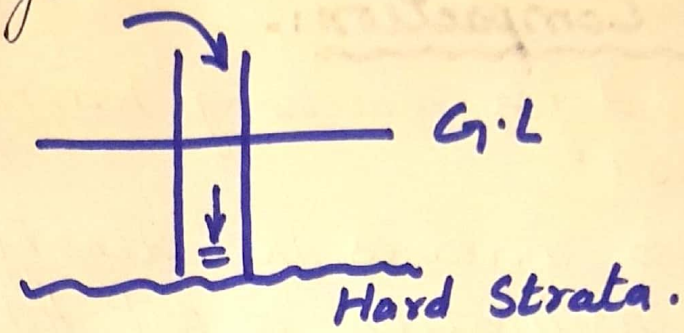
↳ Densification takes place ~~due to~~ upto 15' depth when impact energy is applied to ground surface.

↳ Impact energy is applied through hydraulic ramp., its value is 4-8 tons.



5) Vibro Concrete Column :-

↳ Transfers load from weak strata to hard strata by using concrete strength.



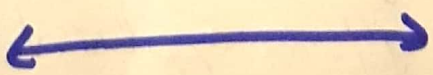
6) Wet Soil Mixing :-

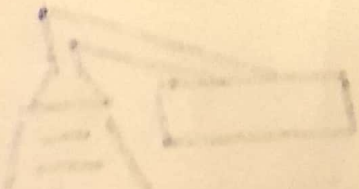
↳ Paste of cement is prepared and inserted in the soil.

↳ This method is used to improve the characteristics of weak soil by using cementitious binder slurry.

7) Dry Mixing of Soil :-

The characteristics of weak soil are improved by using dry cementitious binder.





Question No # 3:-

Given Data:-

$C = 25 KN/m^2$

$\phi = 16^\circ$

$G_1 = 2.72$

$e = 0.5$

Required Data:-

F_c (F.O.S) when soil is dry = ?

F_c (F.O.S) when there is seepage in soil = ?

Solution:-

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

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

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

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

$$\boxed{F_c = 1.18}$$

when there is a seepage of water.

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

Required :-

Inclination, $i = ?$

Solution :-

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

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

$$SN = 0.073$$

Using Taylor's Chart for

$$\phi = 20^\circ$$

$$SN = 0.073$$

$$\Rightarrow \boxed{i = 44^\circ}$$ Answer.

Question #4(b) :-

Given Data:-

$H = 15m$

Bottom $w = 12m$

Top width $= 6m$

Unit weight of water $= 1000 kg/m^3$

Unit weight of concrete $= 1450 kg/m^3$

Angle of friction, $\phi = 35^\circ$

Free Board $= 3.5m$

silt deposite height $= 2.5m$.

Required:

silt pressure = ?

Solution :-

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

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

$$\boxed{P_s = 1126.30 \text{ kg/m}}$$ **Answer**