Name :- Muhammad Hamza Rashid

ID # 7805 Section:- A

Semester :- 6th

Program:- B.Sc Civil Engineering

Subject:- Geotechnical and Foundation Engineering

Submitted To:- Engr. Liaqat Ali

Date:- 27/06/2020

IQRA NATIONAL UNIVERSITY

DEPARTMENT OF CIVIL ENGINEERING

(QUESTION-01)
(PART-A)

Ans:- FORCES ACTING ON DAM:-

Following are the forces acting on a Dam.

1- WATER PRESSURE:-

Water pressure is the major external force acts on a dam. This force exerts pressure in both (Horizontal and Vertical) components on both up-stream and down stream side of a dam.

2- ICE PRESSURE:-

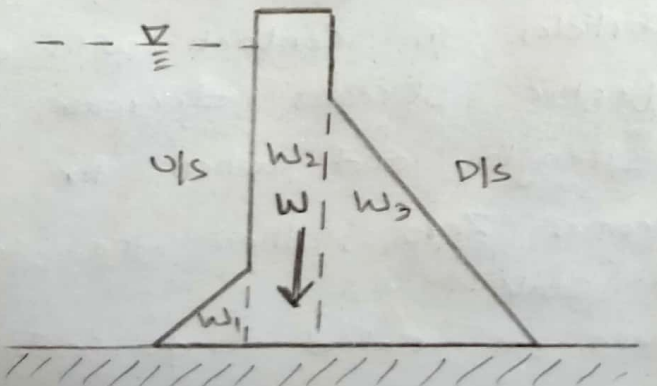
Due to temprature variations, ice is formed on water surface and is subjected to expansion and contraction. So the dam has to resist the force due to ice expansion.

3- SELF WEIGHT OF THE DAM:-

It is also the major resisting force. It acts in the downward direction.

Generally unit length is considered (of dam) and the total weight of the dam is computed by dividing into several triangles and rectangles.

The total weight of the dam acts at the Center of Gravity of its section.



4- WAVE PRESSURE:-

It is the pressure that is exerted on the dam because of the wave generation on the water surface.

It is given by $P_w = 2w(h_w)^2$ and it acts at a distance of $3(h_w/8)$ above the reservoir surface.

5- WIND PRESSURE:-

It is a minor force that exerts pressure on the superstructure of the dam, because of the wind. Normally, wind pressure is taken as 1 to 1.5 KN/m^2.

6- SEISMIC FORCES:-

Force that exerts pressure on dam because of earth quake generation

7- UPLIFT PRESSURE

8- SILT PRESSURE

(PART-B)

B:- Definition of Terms:-

1- LIQUIFICATION OF SOIL:-

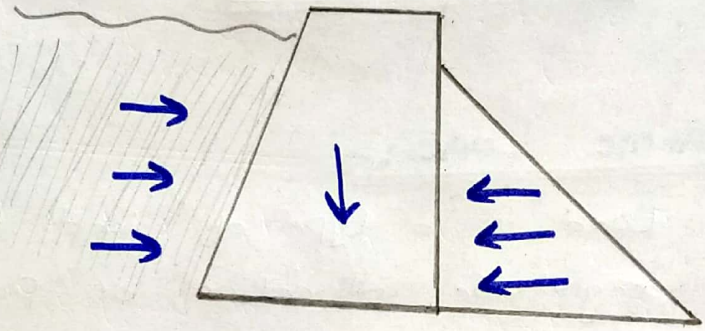
Effective stresses are those stresses which keep the soil particles in contact with each other. If the effective stresses decrease, the soil loose its strength and when the effective stresses becomes zero, then the soil is changed to liquified state.

This phenomena is called Liquification of soil.

2- BUTRESS DAM:-

It is a type of dam that consists of water retaining sloping membrane, that is supported by a series of buttresses at right angles to the axis of the dam.

=> Butress dam uses buttresses to transfer the force of the water to the foundation.



3- INFINITE SLOPE:-

=> Infinite slope is a term used to designate a constant slope of infinite slope.

=> It is the slope which have infinite area and finite depth.

=> The boundaries of these slopes are not well defined.

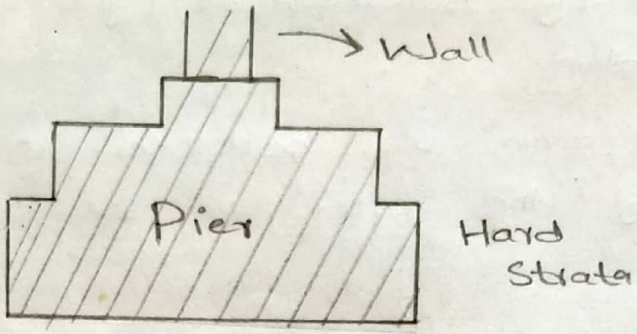
=> For examples, the slopes of embankments and earth dams, Slope of Hills etc.

4- PIER FOUNDATION:-

It is a type of deep foundation, that consists of cylindical columns of larger diameter to support and transfer large superimposed loads to firm strata below.

=> The vertical members have larger diameter as compared to pile, that transmit the load to the underground silt.

=> They are constructed by In-situ Process.



5- DYNAMIC LOAD:-

=> Dynamic Load is a type of load that vary in their magnitude, direction, or position with time.

=> These are time dependent Loads.

=> The type of dynamic Loading in Soil or the foundation of a structure depends on the nature of the source producing it.

(QUESTION - 2)

(PART - A)

Ans :-

SHALLOW FOUNDATION :-

Shallow Foundation is defined by two Geotechnical experts that are :-

- **According To Terzaghi :-**

Shallow foundation is a type of foundation in which the depth of foundation (D_f) is less or equal to the width (B) of the foundation.

Given By :- $$D_f \leq B$$

- **According To Skempton :-**

Shallow foundation is a type of foundation in which the Depth of foundation to width ratio (D_f/B) is less than or equal to 2.5.

$$\frac{D_f}{B} \leq 2.5$$

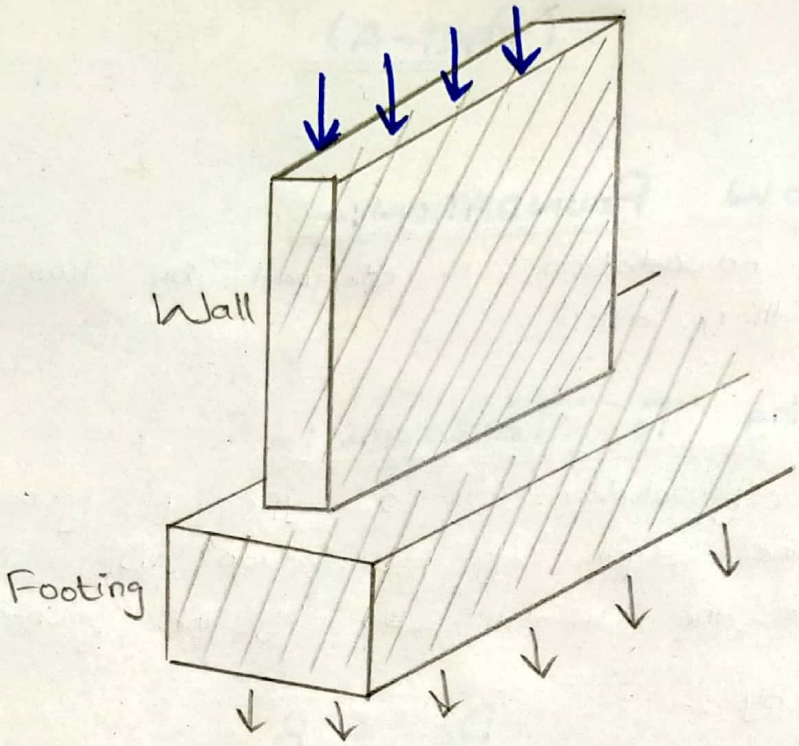
=> Following are the types of Shallow Foundation:

TYPES :-

1- **WALL FOOTING :-**

=> It is also called strip footing.

=> It is the footing which runs across the length of the wall and transfer the load of wall to the ground soil safely.

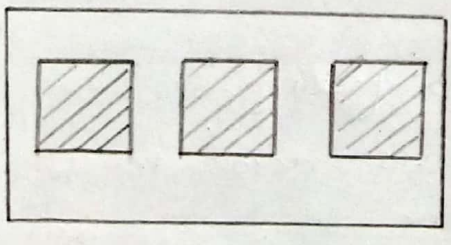


2- COMBINED FOOTING :-

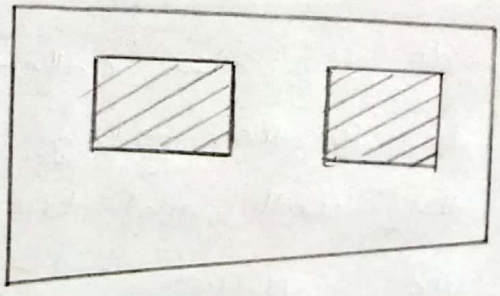
It is a type of footing which is constructed in case of two or more columns that can transfer the load of columns to the natural soil safely.

For Uniform Load → The footing will rectangle in shape.

For Non-Uniform Load → The footing will be trapezoidal is shape.



Rectangular



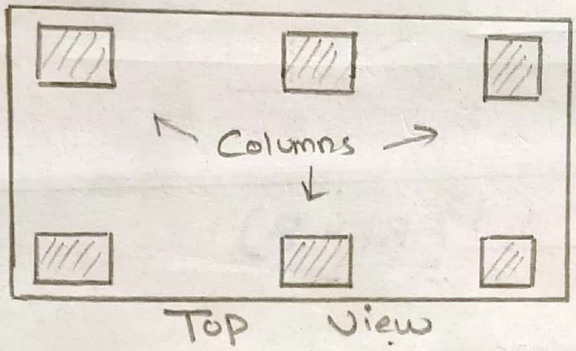
Trapezoidal

3- RAFT FOOTING:-

=> It is also called Mat footing

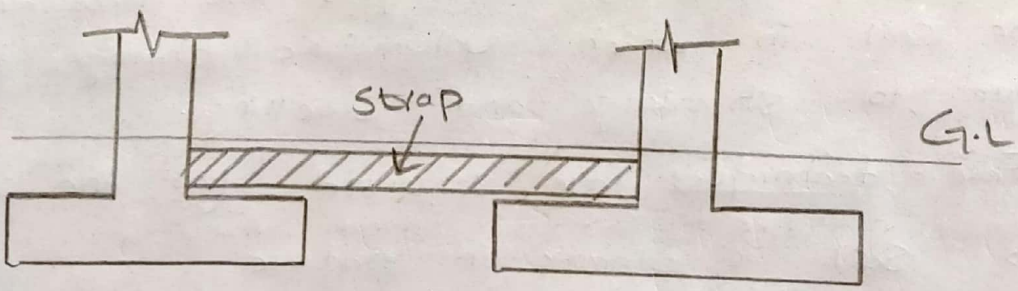
=> This type of footing covers the whole area of the structure.

=> This type of footing is provided when
- the bearing capacity of soil of that area is weak
- the load of super structure is heavy.



4- STRIPPED FOOTING:-

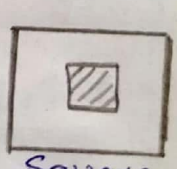
It is a type of footing in which the outer column is connected with the inner column by the help of a beam or a strap.

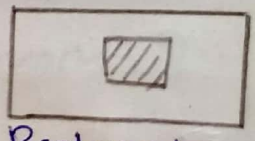


5- COLUMN ISOLATED FOOTING:-

It is a type of footing which is constructed for a single column to transmit the load of column to natural soil safely.


Circular

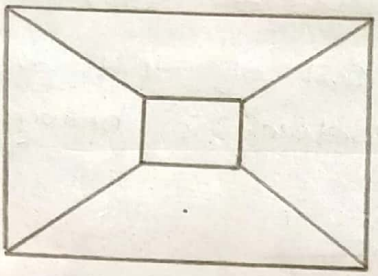

Square


Rectangular

=> Shapes of these footings are :-

6- SLOPPED FOOTING :-

It is a type of footing which have slope on all its sides in all direction.



Top view

Side View

(PART - B)

Ground Improving techniques are the techniques used to enhance the engineering property of soil, in order to increase its bearing capacity.

WHY NECESSARY :-

Ground Improving techniques are necessary for the soil in which volumetric changes take place due to shrinkage and swelling.

=> These techniques are required for the soil which has :-

=> Soil is organic in nature

=> Soil is soft

=> Soil is Sandy and Gravel

METHODS of GROUND IMPROVING TECHNIQUES :-

1- REMOVAL AND REPLACEMENT OF SOIL :-

=> It is the oldest method.

=> In this method, the unsuitable soil is replaced and the same soil is used to refill with higher compaction and better engineering properties.

=> This method is performed on loose soil and is applicable above the ground water table.

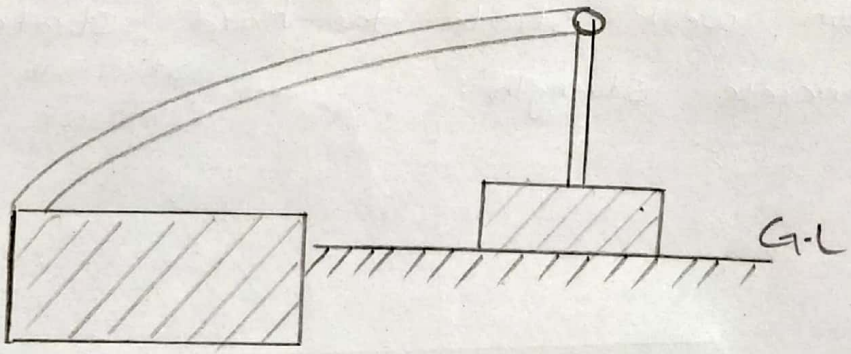
2- Dynamic Compaction:-

=> It is also an efficient method of Ground Improving techniques.

=> In this method, the actual densification of soil takes place.

=> This method is used to :-

- Increase the consolidation rate
- Increase the bearing capacity of soil
- Increase the density of soil.



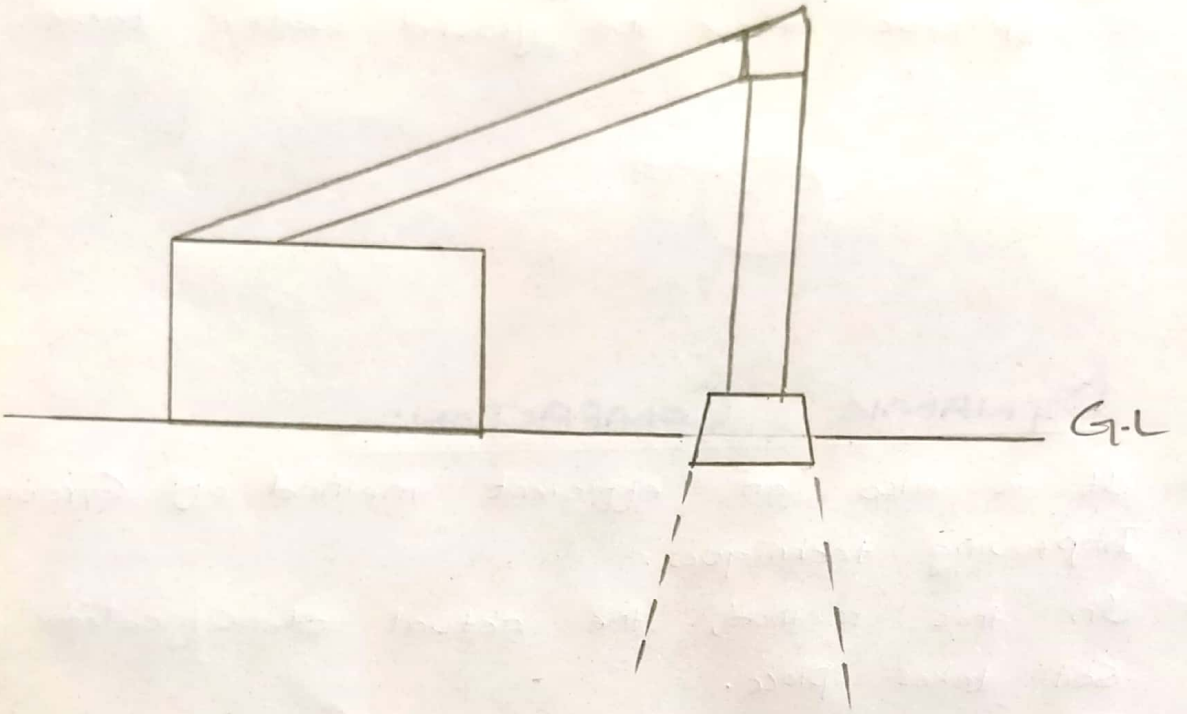
3- Rapid Impact Compaction:-

=> In this method of Ground Improving technique, Impact energy is applied to the ground surface as a result of which, densification

of soil takes place.

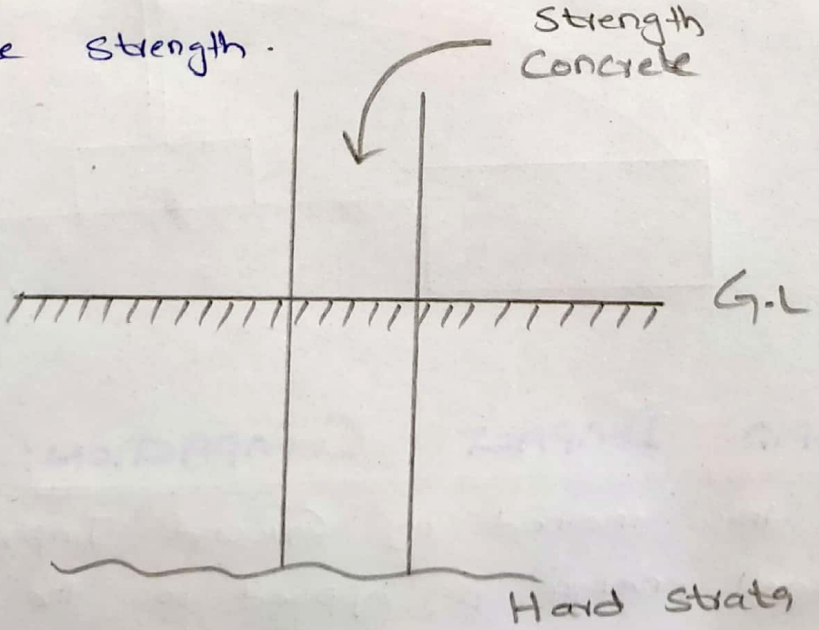
=> The impact energy is applied to a depth of 15'.

=> A Hydraulic Pump/ramps weight varies 4-8 tons is used for the application of Impact energy.



4- VIBRO CONCRETE COLUMN :-

=> It is a Ground Improving technique in which a Vibro Concrete Column transfer the load from weak strata to hard strata by using Concrete strength.



5- Dry Mixing of Soil :-

-> It is an efficient technique of Ground Improvement.

=> In this method, the characteristics of weak soil are improved by using dry cementitious binder.

=> Cementitious material is used as a binder.

(Question - 03)

Given Data :-

Inclination Angle (i) = 26°

Specific Gravity (G_s) = 2.72

Void Ratio (e) = 0.50

Depth of Soil = 6m

Cohesion (c) = 25 kN/m²

Angle of Internal Friction (ϕ) = 16°

Required :-

Factor of Safety (F.O.S) when the soil is dry

Factor of Safety (F.O.S) when there is seepage in soil.

Solution :-

First we have to find the dry density (γ_d)

By using formula,

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

where

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

Putting values in the above formula,

$$\gamma_d = \frac{2.72 \times 9.8}{1 + 0.50} = 17.77 \rightarrow \boxed{17.8 \text{ KN/m}^3}$$

Now, from the first formula $\left(\because \gamma_{soil} = 9.8 \text{ KN/m}^3\right)$

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

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

$$\boxed{F_c = 1.18}$$

=> Now when there is seepage of water, so F.O.S will be,

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

where

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

=> Also

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

$$= \frac{2.72 + 0.50}{1 + 0.50} \times 9.8$$

$$= 21.037 \rightarrow 21.04$$

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

=> Now

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

$$= 21.04 - 9.8 \Rightarrow \boxed{\gamma' = 11.24 \text{ KN/m}^3}$$

Now putting all the values in F.O.S formula,

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

$$\Rightarrow \boxed{F_c = 0.816}$$

(QUESTION - 04)

(PART - A)

GIVEN DATA:-

Highway Embankment (H) = 10m

Cohesion (c) = 18.8 kN/m²

Unit weight of Soil (γ) = 17 kN/m³

Angle of Friction (ϕ) = 20°

Factor of Safety (F.O.S) = 1.5

F_ϕ = 1.0

REQUIRED :-

Inclination Angle for the embankment (i) = ?

SOLUTION:-

By using Taylor Stability Number formula,

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

$$= \frac{18.8}{1.5 \times 17 \times 10} = 0.073$$

$$\Rightarrow \boxed{S_N = 0.073}$$

Now:-

By using Taylor chart for the values

$\phi = 20°$

$S_N = 0.073$

$i = 44°$ → From Taylor chart.

(PART-B)

GIVEN DATA :-

Height of water on upstream side (H) = 15m

Bottom width of the Dam = 12m

Top width = 6m

Unit weight of water = 1000 kg/m³

Unit weight of Concrete = 1450 kg/m³

Unit weight of Silt = 1330 kg/m³

Angle of friction for Silt (ϕ_s) = 35°

Free Board = 3.5m

Silt Deposit Height = 2.5

REQUIRED :-

Silt Pressure (P_s) = ?

SOLUTION :-

By using formula,

Silt pressure is given by :-

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

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

$$\boxed{P_s = 1126.30 \text{ Kg/m}}$$

END !