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Section A

Paper Geo technical

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Qno 1)

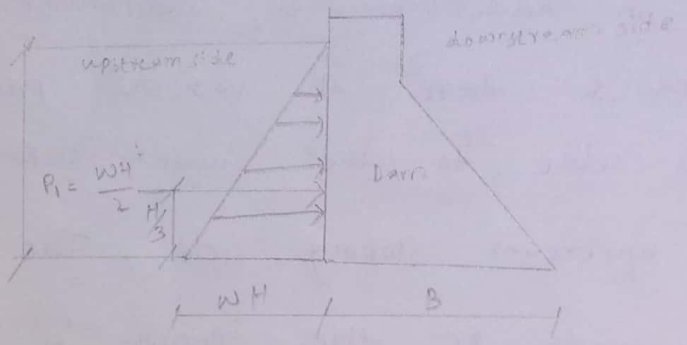
Ans a) Forces acting on Dam:-

1) water pressure
2) uplift pressure
3) wave pressure
4) silt pressure
5) ice pressure
6) self weight of the dam
7) seismic forces.

water pressure:-

It is the pressure of water that acts perpendicular on the upstream face of the dam. For this, there are two cases

(A) Upstream face of the dam is vertical & there is no water on the downstream side of the dam



water pressure on the vertical upstream of a dam.

The total pressure is in horizontal direction & acts on the upstream face at height H/3 from the bottom. The water pressure on

the dam is computed according to eq 1.

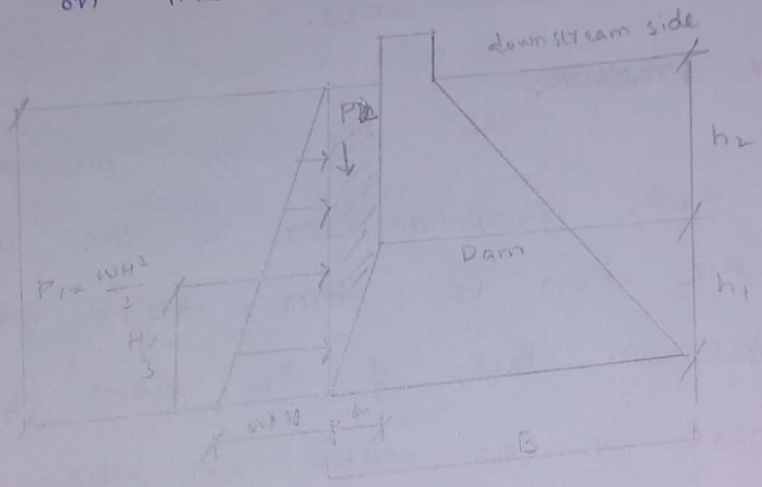
$$P_1 = wH^2/2 \quad \text{eq} - (1)$$

where

w = specific weight of water, usually it is taken as unity

H = height up to which water is stored in m

(B) Upstream face with batter & there is no water on the downstream side as shown.



Here in addition to horizontal water pressure of eq 1. there is vertical pressure of water it is due to the water column resting on the upstream sloping side. The vertical pressure P_2 acts on the length 'b' portion of the base. This vertical pressure is calculated as

$$P_2 = (b \times h_2 \times w) + (0.5 b \times h_1 \times w) \quad (2)$$

(2) Silt pressure:-

4t 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 4 can be computed using equation

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

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 cohesion neglected.

γ = submerged unit weight of silt material

h = height of silt deposited.

3) Wave pressure:-

Waves are generated on the surface of the reservoir by the blowing wind which exert the pressure on the upper part of the dam above the water level This pressure is calculated by the formula

$$P_w = 2.4\, \gamma_w h_w$$

Wave pressure depends upon wave height which is given by

For $F < 32$ km

$$h_w = 0.32\sqrt{F\nu} + 0.763 - 0.27 \times F^{1/4}$$

For $F > 32$ km

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

where h_w = Height of water from the top of crest to the bottom of trough in meters

V = wind velocity in km/hr

F = Fetch or straight length of water expanse in km.

4) Ice Pressure:-

The ice which may beformed on the water surface of the reservoir in cold countries may sometime melt & expand The dam face is subjected on the thrust & exerted by the expanding ice This force acts linearly along the length of the dam & at the reservoir level. The magnitude of these forces varies from 250 to 1500 kN/sq.m depending upon the temprature.

5) Self weight of dam;-

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

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

where γ_m = unit weight of dam material.

Qno 1)

Ans(b) Liquification of soil:-

Soil liquification occur when a saturated or partiall saturated soil substantially loses strength & stiffness in response to an applied stress such as shaking during an earthquake or other sudden change in stress condition, in which material that is ordinarily a solid behaves like a liquid.

Buttress Dam:-

It is a dam with a solid, water tight upstream side that is supported at intervals on the downstream side by a series of buttresses or supports. The dam wall may be straight or curved. Most buttress dams are made of reinforced concrete & are heavy pushing the dam into the ground.

Infinite slope:-

slope which have great extent with uniform soil conditions at any given depth below the surface.

Pier foundation:-

A pier foundation consist of a cylindrical column of large diameter to support & transfer large super-imposed loads to the firm strata below. Though pile foundation transfer the load through friction or a bearing. Pier foundation transfer the load only through bearing.

Dynamic load:-

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

Q no 2)

Ans a) Shallow foundation:-

The foundation in which D/B ratio is less than as 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 & tranfer the load of the wall to the soil safely. It is called wall footing.

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.

3) MAT Footing:- The footing which covers the whole area of the structure is called raft / MAT 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 enter column is connected with the inner column by means of the beam or strap is called strapped footing.

5) column / isolated footing:- The footing which is constructed for a single column & transmit its load to the soil safely. It may be circular, square, rectangular in shape.

(b) Scopped Footing:-

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

Qno2)

Ans(b) Ground improvement ~~tec~~ 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 technique

The soil which is sandy & gravely

The foundation in sanatory dump places also required ground improvement technique

Method of Ground improvement techniques:-

1) Removal & Replacement of soil:-

This is oldest & simple method. This is perfor med on loose soil In this method the unsuitable soil is replaced with compacted fill. In this ~~soil~~ method the same soil 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 consilidation rate. This method also increase the density of soil. In this method densification of soil take place.

3) Vibro compaction;-

It is also called vibrodensification. In this method the compaction takes place at a certain depth in granular soil through vibratory probe. This vibratory probe is run 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 upto a depth of 15 feet. This impact energy is actually applied through hydraulic ramp. The hydraulic ramp weight values from 4-8 tons.

5) 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 slully.

(6) Dry mixing of soil:-

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

Qno3)

Ans 3) Given data:-

$$C = 25 KN/m^2$$

$$\phi = 16^\circ$$

$$G = 2.72$$

$$e = 0.50$$

Required:-

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

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

Solution:-

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

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

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

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

$$F_c = 1.18$$

when there is seepage of water.

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

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

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

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

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

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

$$= 21.04 - 9.8$$

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

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

$$F_c = 0.816.$$

Qno 4)

Ans a) Given

Height = 10 m

$C = 18.8\ kN/m^2$

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

$\Phi = 20^\circ$

$F.O.S = 1.5$

$F\phi = 1.0$

Required:-

Inclination $i = ?$

Solution:-

$$S_N = \frac{C}{F.O.S \times \gamma \times H} = \frac{18.8}{1.5 \times 17 \times 10}$$

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

$\phi = 20^\circ$

then $i = 44$ (from taylor chart)

Qno4)

Ansb) Given :-

Height of water on upstream side = 15 m

Bottom width of the dam = 12 m

Top width = 6m

Unit wt of water = 1000 kg/m^3

Unit wt of concrete = 1450 kg/m^3

Unit wt of silt = 1330 kg/m^3

Angle of friction for silt = $\phi_s = 35^\circ$

Free Board = 3.5 m

Silt Deposite height = 2.5m.

Required:-

Silt pressure = ?

Solution:-

As we know that

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

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

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