POWER DEVELOPMENT BOARD

Post: Assistant Engineer (Civil)

Exam Taker : BUET

Exam Date: 2023

01.Fill in the gap

i) Void ratio of soft clay is 1.5 and porosity is ?

Solution:

Porosity $\eta = e / (1+e)$

$=1.5/ (1+1.5)$

$=0.6$

ii) The angle of internal friction of soil is 30 degrees. What is the coefficient of active earth pressure?

Solution:

$$K_a = \frac{1-\sin\varphi}{1+\sin\varphi}$$

$$= \frac{1-\sin 30}{1+\sin 30}$$

$$= 0.33$$

iii) What is the value of Nc for deep foundation

Solution:

The factor N~ is a bearing capacity factor for deep circular foundations. According to Skempton (QQ} the value of N~ for a round deep foundation is 9.0.

iv) The unconfined compressive strength of soft clay in undisturbed sample and remolded state are 50 KN/m2 and 25 KN/m2 , sensitivity of the soil clay is?

Solution:

Given,

Qu (undisturbed) = 50 KN/m2

Qu (remolded) = 25 KN/m2

sensitivity of the soil clay = Qu (undisturbed)/ Qu (remolded)

$=50/25$

$=2$

02. The amount of BODs in a sewage found 125 mg/L at temperature 20°C. If k = 0.22/day, then determine the ultimate BOD.

Solution:

$$BOD_5 = BOD_u \left(1 - e^{-k\,t}\right)$$

$$BOD_u = \frac{BOD_5}{(1-e^{-k\,t})} = \frac{125}{(1-e^{-0.22\,x\,5})} = 190 \text{ mg/L}$$

Ans: 190 mg/L

03. A rectangular channel is 10 ft width and 3 ft depth. Determine the velocity & rate of flow if manning's coefficient is, n = 0.015 and bed slope of the channel is, S = 0.003.

Solution:

Area, $A = b\,h = 10 \text{ x } 3 = 30 \text{ ft}^2$

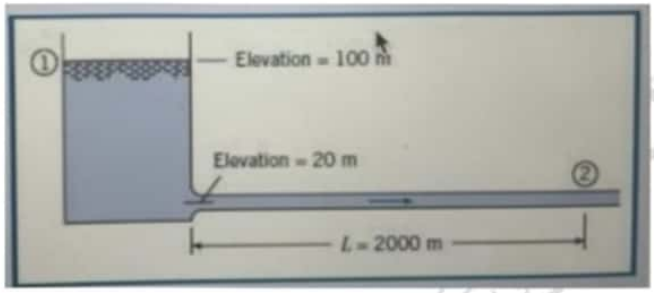
Wetted perimeter, $P = b + 2\,h = 10 + 2 \text{ x } 3 = 16 \text{ ft}$

Hydraulic radius, $R = A/P = 30/16 = 1.875 \text{ ft}$

Velocity, $V = \frac{1}{n} R^{2/3} S^{1/2} = \frac{1}{0.015} \text{ x}(1.875)^{2/3}(0.003)^{1/2} = 5.56 \text{ ft/s}$

Discharge, $Q = A\,V = 30 \text{ x } 5.56 = 16.68 \text{ ft}^3/\text{s}$

04. A horizontal pipe carries cooling water at 10 degree celsius for a thermal power plant from reservoir as shown in the figure below, where L is the length if pipe from the reservoir to the point of carrying. If the pipe diameter is 20cm, Flow velocity is 1.0 m/s and frictional coefficient is 0.015. Find the pressure at the pipe.



Solution:

Given that,

Length of Pipe = 2000m

Diameter of the pipe = 20cm

Elevation at point (1) = 100m

Elevation at point (2) = 20m

Based specific weight pressure inside tank P1 = $101.3 \text{ x } 10^3 \text{ N/m2}$

Now Head Loss $h_f = \frac{f\,x\left(\frac{L}{D}\right)x(V)^2}{2g}$

$= \frac{0.015\,x\left(\frac{2000}{0.20}\right)x(1)^2}{2\,x\,9.81}$

$= 7.64 \text{ m}$

$$= \frac{0.015 \times \left(\frac{1}{0.20}\right) \times (1)^2}{2 \times 9.81}$$

$= 7.64$ m

As per , Bernoulli Equations $Z_1+P_1/\gamma+\frac{V1^2}{2g} = Z_2+P_2/\gamma+\frac{V2^2}{2g} + h_f$

- ⇨ $80 + (101.3 \times 10^3)/(9.81 \times 1000) + 0 = 0 + P_2/(9.81 \times 1000) + \frac{1^2}{2 \times 9.81} + 7.64$ [Z1=100-20=80m]
- ⇨ $90.32 = P_2/9810 + 7.69$
- ⇨ $P2 = 9313.06$ N/m2
- ⇨ P2 = 9.31 KPa

Ans: 9.31 KPa

05. The depth of equivalent constant stress of singly reinforced rectangular Beam a = 3.5" and effective depth is 16.5". The ratio of rectangular stress block $\beta_1 = 0.85$. Comment whether the Beam is tensioned controlled or compression controlled.

Solution:

$a = 3.5$ in

$\beta_1 = 0.85$

$$c = \frac{a}{\beta_1} = \frac{3.5}{0.85} = 4.11 \text{ in}$$

$$\varepsilon_t = \frac{d-c}{c}(0.003) = \frac{15.5-4.11}{4.11}(0.003) = 0.0083 > 0.005$$

Therefore, it is a tension-controlled section Beam

06. In a natural state, a moist soil has a volume of 0.2 ft3 and weight 25 lb. The oven dry weight of soil is 20 lb. if the specific gravity is 2.75, calculate dry unit weight, bulk unit weight and water content.

Solution:

$$\text{Water content}, w = \frac{W_w}{W_s} = \frac{W - W_s}{W_s} = \frac{25-20}{20} = 0.25$$

Dry unit weight, $\gamma_d = \frac{W_s}{V} = \frac{20}{0.2} = 100 \text{ lb/ft}^3$

Bulk unit weight, $\gamma_d = \frac{W}{V} = \frac{25}{0.2} = 125 \text{ lb/ft}^3$

07. A sample of dry sand was tested in direct shear apparatus under a normal load of 36 kg. The sample failed under a shearing load of 58 lb. The sample size was 2" x 2". What is the angle of internal friction?

Solution:

For cohesionless soil, $c = 0$

Shear stress, $\tau = \frac{R}{A} = \frac{58}{2 \text{ x } 2} = 14.5 \text{ psi}$

Normal stress, $\sigma = \frac{N}{A} = \frac{36 \text{ x } 2.205}{2 \text{ x } 2} = 19.84 \text{ psi}$

Shear strength, $\tau = c + \sigma \tan \varphi$

$14.5 = 0 + 19.84 \tan \varphi$

$\varphi = tan^{-1}\left(\frac{14.5}{19.84}\right) = 36.16^0$

08. A driver travelling at 65 mi/h down grade 3% on a highway observes a Truck 800ft ahead of him that is completely blocking the road, and he applied break. Coefficient of friction is 0.29. What will be the final distance between two vehicles.

Solution:

$$S = 1.47\, V\, t + \frac{V^2}{30\left(\frac{a}{g} - G\right)}$$

⇨ S = 1.47x65x2.5+ [65^2 / 30 (0.29-.03)]

⇨ S = 780.54 ft

Final distance between two vehicles = 800-780.54 =19.46 ft

09. Find the fineness modulus from the following sieve.

Sieve Size	% Retained
#4	0
#8	1

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Sieve Size	% Retained
#4	0
#8	1
#16	4
#30	12
#40	23
#50	30
#100	20
#200	6
Pan	4
Total	500

Solution:

Sieve Size	% Retained	% Cumulative Retained
#4	0	0
#8	1	1
#16	4	5
#30	12	17
#40	23	40
#50	30	70
#100	20	90
#200	6	96
Pan	4	100
Total		

olved by:

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