NESCO — 2021 (31st December)

1. An intersection located in an urban area has a maximum allowable speed on the approach roads, of 45 mi/hr. The width of the intersection is 48′ for all approaches. The average length of a vehicle is assumed to be 20 ft. What should be the minimum length of a vehicle the red clearance interval for this intersection?

2. The cross section of a beam reinforced with 3 in^2 of steel. Assume the tension steel yields at maximum moment. What is the area of concrete required to balance the steel force when the steel yields? $f_c = 4$ ksi, $f_y = 60$ ksi.

3. Draw a typical qualitative diagram for Alum dosage versus residual turbidity in a coagulation-flocculation-jar test of surface water sample.

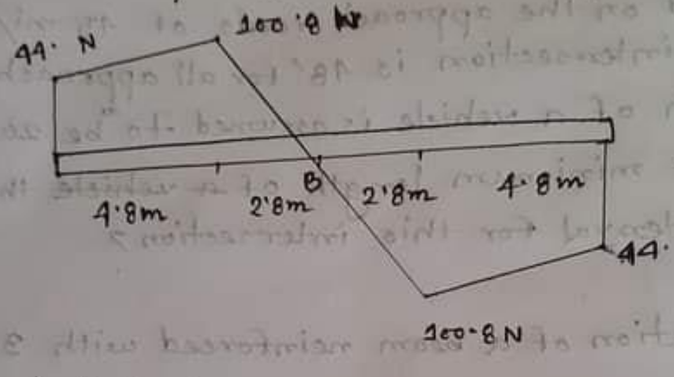
4. Water is flowing in a fire nose with velocity 1 m/s, pressure 200 kPa. At the nozzle, the pressure decreases to atmospheric pressure 101.3 kPa and there is no change in height. Calculate the velocity of water exiting at the end of the nozzle.

5. Draw qualitative diagram of e–logp curve for consolidation of a soil sample test.

6. given, c, τ, σ
   find internation friction angle, ϕ

7. $BOD_5 = 125$ mg/L, $k = 0.22$/day. Find ultimate BOD?

8. SFD of simply supported beam is given. Find maximum



moment of the beam ?

Q-1: An intersection located in an urban area has a maximum allowable speed on the approach roads of 45 mph. The width of the intersection is 48 ft for all approaches. The average length of a vehicle is assumed to be 20 ft. What should be the minimum length of the red clearance interval for this intersection?

Solⁿ: Given, $W = 48'$, $L = 20'$, $u_0 = 45$ mph

$$R = \frac{W+L}{1.47u_0} = \frac{48+20}{1.47 \times 45} = 1.03 \text{ sec (Ans).}$$

Q-2:

The cross section of a beam reinforced with 3 in² of steel. Assume the tension steel yields at maximum moment. What is the area of concrete required to balance the steel force when the steel yeilds? $f_c' = 4$ ksi, $f_y = 60$ ksi.

Solⁿ:

$$\rho_b = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}$$

$$= 0.85 \times 0.85 \times \frac{4}{60} \times \frac{0.003}{0.003 + 0.00207}$$

$$= 0.0285$$

Now, $A_s = \rho b d$ | let, $b = 10''$

$\Rightarrow 3 = 0.0285 \times 10 \times d$

$\Rightarrow d = 10.5''$

$\therefore h = 10.5 + 2.5 = 13''$

$\therefore A_g = b \times h = 10 \times 13 = 130$ in²

Check:

$$c = \frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y} d$$

$$= \frac{0.003}{0.003 + 0.00207} \times 10.5 = 6.213''$$

$a = \beta_1 c$

$= 0.85 \times 6.213$

$= 5.28''$

Now, $C = 0.85 f_c' ab$

$= 0.85 \times 4 \times 5.28 \times 10$

$= 180$ Kips.

Again,

$T = A_s \cdot f_y$

$= 3 \times 60$

$= 180$ Kips.

So, $C = T$.

OK.

Q-3:

Draw a typical qualitative diagram for Alum doses versus residual turbidity in a coagulation-flocculation jar test of surface water sample.

Soln:

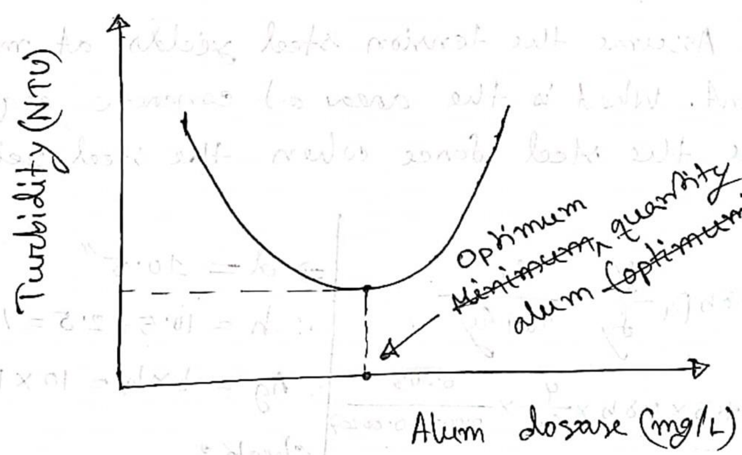


Fig: Turbidity vs. Alum dose.

Q-4:

Water is flowing in a fire ~~pipe~~ hose with velocity of 1 m/s and pressure of 200 KPa. At the nozzle, the pressure decreases to atmospheric pressure of 101.3 KPa and there is no change in height (elevation). Calculate the velocity of water exiting at the end of the nozzle.

Soln: Here, $z_1 = z_2$

$P_1 = 200$ KPa

$v_1 = 1$ m/s

$P_2 = 101.3$ KPa

$v_2 = ?$

$\gamma = 9.81$ KN/m³

$g = 9.81$ m/s²

Now,

$$z_1 + \frac{P_1}{\gamma} + \frac{v_1^2}{2g} = z_2 + \frac{P_2}{\gamma} + \frac{v_2^2}{2g}$$

$$\Rightarrow \frac{200}{9.81} + \frac{(1)^2}{2 \times 9.81} = \frac{101.3}{9.81} + \frac{v_2^2}{2 \times 9.81}$$

$$\Rightarrow v_2 = 14.08 \text{ m/s}$$ (Ans).

Q-5: Draw qualitative e-logp curve for consolidation test.

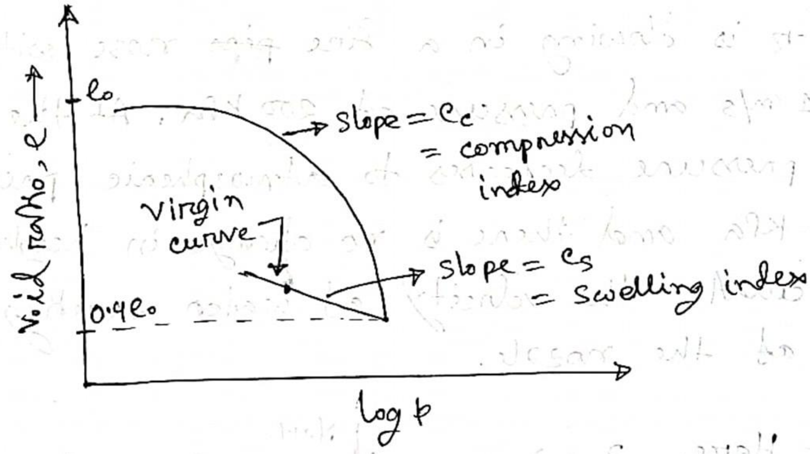


Fig: e-logp diagram.

Q-6: (simillar math)

For a soil sample, given, c = ~~100~~ 50 KPa, σ = ~~200~~ 100 KPa and τ = 80 KPa; find the angle of internal friction.

Soln:

$$\tau = c + \sigma \tan\varphi$$

$$\Rightarrow 80 = 50 + 100 \times \tan\varphi$$

$$\Rightarrow \varphi = 16.7^\circ \text{ (Ans).}$$

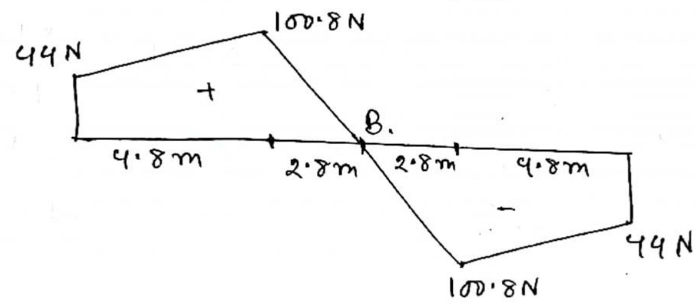
Q–7: $BOD_5 = 125$ mg/L, $K = 0.22$ /day. Find ultimate BOD.

Soln:

$$L_o = \frac{BOD_5}{1-e^{-Kt}} = \frac{125}{1-e^{-0.22\times5}} = 187.4 \text{ mg/L}$$

(Ans).

Q–8: SFD of the simply supported beam is given. Find maximum moment of the beam.



Soln:

The max^m moment will occur, where the shear force will be zero. For this SFD, the max^m moment occurs at B.

Now, M_{max} = Area of SFD (left) or, Area of SFD (right) of the point B.

By taking left portion of point B,

$$M_{max} = \frac{1}{2}\times(44+100.8)\times4.8+\frac{1}{2}\times2.8\times100.8$$

$$= 488.64 \text{ N-m}$$ (Ans).

3.4 Formula for Calculating Change and Clearance Intervals

The kinematic equations for calculating the yellow change and red clearance intervals with the approach speed input in mph and a unit conversion factor applied are as follows:

$$Y = t + \frac{1.47V_{85}}{2a + 64.4g} \qquad \text{(A)}$$

$$R = \left[\frac{W + L}{1.47V_{85}}\right] - t_s \qquad \text{(B)}$$

Where:

V_{85} = 85th percentile approach speed (mph);

1.47 = unit conversion factor to convert ft./sec. to mph;

a = deceleration rate (ft./sec./sec.);

g = approach percent grade, in percent divided by 100;

W = width of intersection (ft.);

L = length of vehicle (ft.); and

t_s = conflicting movement start up delay (sec.).