

Question No: 1

17. A sheet pile has an embedment depth of 12 m in a homogeneous soil stratum. The coefficient of permeability of soil is 10^{-6} m/s. Difference in the water levels between the two sides of the sheet pile is 4 m. The flow net is constructed with five number of flow lines and eleven number of equipotential lines. The quantity of seepage (in cm^3/s per m, up to one decimal place) under the sheet pile is _____

Key: (1.6)

Exp: $N_f = \text{No. of flow channels} = \text{No. of flow lines} - 1 = 5 - 1 = 4$

$N_d = \text{No. of equipotential drops} = \text{no. of equipotential lines} - 1 = 11 - 1 = 10$

$$q = k \cdot h \frac{N_f}{N_d}$$

$$= 10^{-6} \times 4 \times \frac{4}{10}$$

$$= 1.6 \times 10^{-6} \text{ m}^3/\text{s}$$

$$q = 1.6 \text{ cm}^3/\text{sec. per m. width}$$

Question No: 2

18. While aligning a hill road with a ruling gradient of 6 %, a horizontal curve of radius 50 m is encountered. The grade compensation (in percentage, up to two decimal places) to be provided for this case would be _____

Key: (1.5)

Exp: The grade compensation $= \frac{30 + R}{R} = \frac{30 + 50}{50} = 1.6\%$

$$\text{Maximum grade compensation} = \frac{75}{R} = \frac{75}{50} = 1.5\%$$

$$\text{Grade compensation} = 1.5$$

Question No: 3

29. A hollow circular shaft has an outer diameter of 100 mm and inner diameter of 50 mm. If the allowable shear stress is 125 MPa, the maximum torque (in kN-m) that the shaft can resist is _____

Key: (23.009)

Exp: $\frac{T}{J} = \frac{\tau}{r}$

$$T = \frac{\tau}{r} J$$

$$= \frac{125}{\left(\frac{100}{2}\right)} \left[\frac{\pi}{32} (D_o^4 - D_i^4) \right]$$

$$= \frac{125 \times 2}{100} \left[\frac{\pi}{32} (100^4 - 50^4) \right]$$

$$= 23009711.82 \text{ N-m}$$

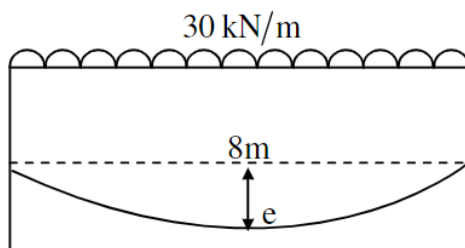
$$= 23.009 \text{ kN-m}$$

Question No: 4

32. A simply supported rectangular concrete beam of span 8m has to be prestressed with a force of 1600kN. The tendon is of parabolic profile having zero eccentricity at the supports. The beam has to carry an external uniformly distributed load of intensity 30 kN/m. Neglecting the self-weight of the beam, the maximum dip (in meters, up to two decimal places) of the tendon at the mid-span to balance the external load should be _____

Key: (0.15)

Exp:



Maximum moment = Pe

$$\frac{w\ell^2}{8} = Pe$$

$$e = \frac{w\ell^2}{8P} = \frac{30 \times 8^2}{8 \times 1600} = 0.15 \text{ m}$$

Question No: 5

42. Water is pumped at a steady uniform flow rate of $0.01 \text{ m}^3/\text{s}$ through a horizontal smooth circular pipe of 100 mm diameter. Given that the Reynolds number is 800 and g is 9.81 m/s^2 , the head loss (in meters, up to one decimal place) per km length due to friction would be_____

Key: (66.67)

Exp: head loss (h_f) = $\frac{fLQ^2}{12d^5}$

$$f = \frac{64}{R_e} = \frac{64}{800} = 0.08$$

$$h_f = \frac{0.08 \times (0.01)^2}{12 \times (0.1)^5} \times 1000$$
$$= 66.67 \text{ per km}$$