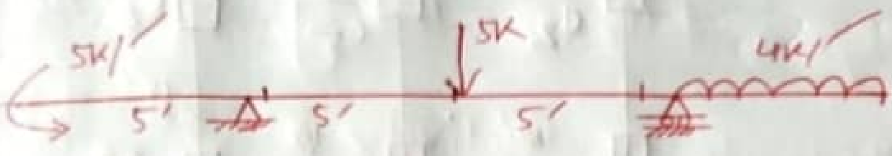
Sylhet Gas Field

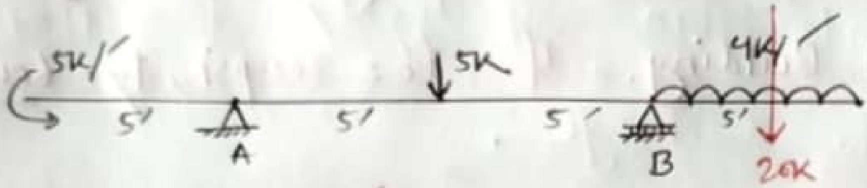
2021

Solved by DESIGN INTEGRITY

Q.1|



Solution:



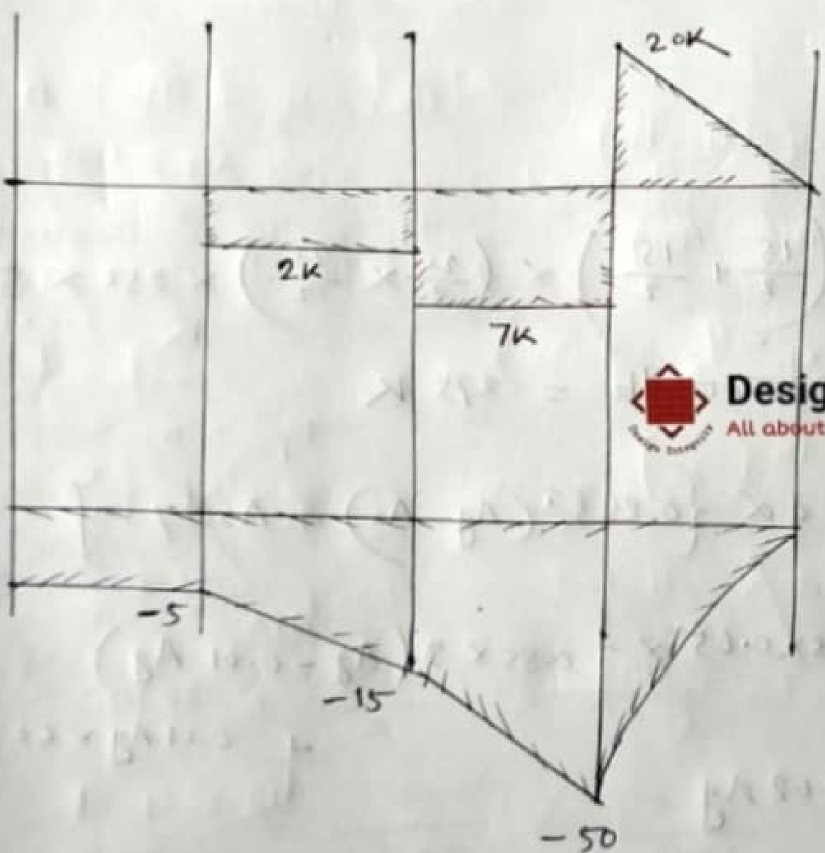
$R_A = -2K (\downarrow)$ $\quad$ $R_B = (27K) \uparrow$

$M_A) + = 0$

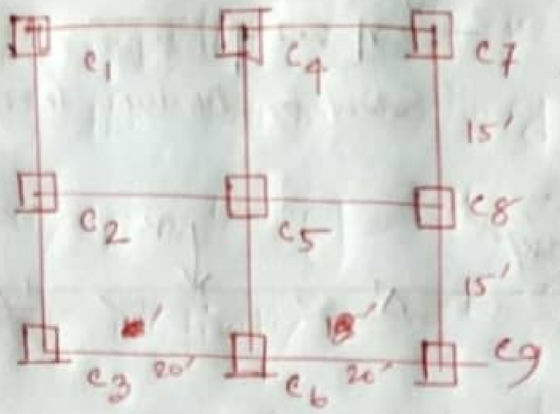
$\Rightarrow 5 \times 5 - 5 + 20 \times 12.5 - R_B \times 10 = 0$

$\therefore R_B = 27K \; (\uparrow)$

$R_A = 2K \; (\downarrow)$

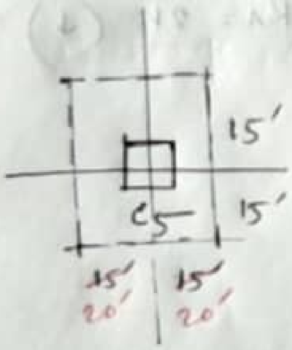


Q.21



A load of 250 psf per floor. the column (C_5) at the ground floor of a 5-storied Building, If f'_c = 3000 psi, f_y = 60000 psi. Design the column.

Solution:



$$P_u = \left(\frac{15}{2} + \frac{15}{2}\right) \times \left(\frac{20}{2} \times \frac{20}{2}\right) \times 250 \times 5$$

$$= 375000 \text{ lb} = 375 \text{ K}$$

$$\therefore \phi P_n = \phi \alpha \{0.85 f'_c (A_g - A_s) + A_s f_y\}$$

Assumed, $A_s = 1\%$
$= 0.01 A_g$

$$= 0.8 \times 0.65 \times \{0.85 \times 3 (A_g - 0.01 A_g) + 0.01 A_g \times 60\}$$

For, Tied Column,

$$= 1.62 A_g$$

$\alpha = 0.8$
$\phi = 0.65$
$f'_c = 3$ ksi
$f_y = 60$ ksi

Now, $1.62 A_g = 375$

$$\therefore A_g = 230.806 \text{ in}^2$$

Column Size = 16" × 16"

$$A_s = 0.01 \times 16 \times 16$$
$$= 2.56 \text{ in}^2$$

Use 6 – 20mm bar

Q.6 Saturated unit weight and moisture content are given $19.3\ KN/m^3$ and 28%. Find void Ratio (e).

Solution:

Given →

$\gamma_{sat} = 19.3\ KN/m^3$

$\omega = 0.28$

$e = ?$

~~Assume G = 2.65~~

$$\gamma_{sat} = \frac{(G+e) \times \gamma_w}{1+e}$$

~~$\Rightarrow 19.3 = \quad 2.65$~~

Now, $\gamma = \frac{W}{V}$

Assume a unit total volume $V = 1 m^3$

$\therefore \gamma_{sat} = W \quad [V = 1]$

Again, $W = W_s + W_w$

$= W_s + \omega_{sat} \times W_s$

$= W_s (1 + \omega_{sat})$

$\therefore W_s = \frac{W}{1+\omega_{sat}} = \frac{19.3}{1+0.28} = 15.07\ KN$

and, $W_w = W - W_s$

$= 19.3 - 15.07$

$= 4.22\ KN$

Since, $\gamma_w = 9.81 \longrightarrow V_w = \frac{W_w}{\gamma_w}$

$= \frac{4.22}{9.81} = 0.43\ m^3$

Q.4) An artesian aquifien 10m thick with pizometric surface 40m above the bottom confining layen is being pumped by a fully penetrating wall. Aquifien is medium sand (Hydraulic conductivity 1.5×10^{-4} m/s). Steady state drawdown of 5m and 1m are observed at nonpumping well located 20m and 200m respectively from pumped well. Determine the dischange.

Solution:

Given

Thickness of Aquifien
$m = 10m$

Hydraulic Conductivity
$K = 1.5 \times 10^{-4}$ m/s

$r_1 = 20m$

$r_2 = 200m$

$h_1 = 40 - 5 = 35m$

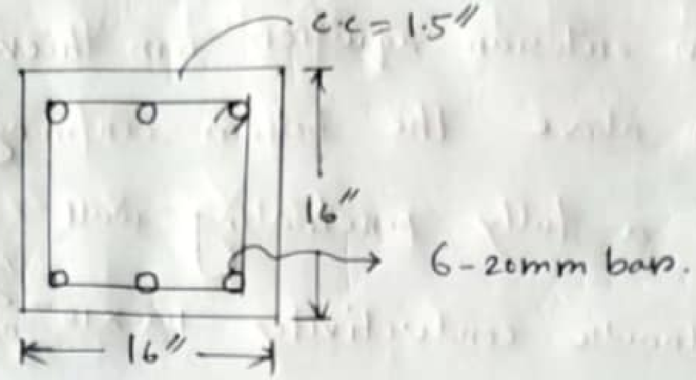
$h_2 = 40 - 1 = 39m$

Dischange $Q = \dfrac{2\pi K m (h_2 - h_1)}{\ln (r_2/r_1)}$

$= \dfrac{2\pi \times 1.5 \times 10^{-4} \times 10 \times (39 - 35)}{\ln \left(\frac{200}{20}\right)}$

$= 0.0163 \ m^3/s$

Ans



Q.3| A sample water plant has raw water inflow $0.6 m^3/s$ and has been found through experimentation that all particle settle at a rate of $V_s = 0.004$ m/s. A proposed rectangular setting tank has an effective settlement zone L = 20m H = 2m, W = 6m.

i) Determine surface overflow rate

ii) What fraction of particle can be expected to be removed from Tank.

Solution:

Given

$Q = 0.6 m^3/s$

$V_s = 0.04$ m/s

L = 20m

H = 2m

W = 6m

i) $SOR = \frac{Q}{A}$

$= \frac{Q}{L \times B} = \frac{0.6}{20 \times 6}$

$V_o = 5 \times 10^{-3}$ m/s

ii) Percentage of removal $= \frac{V_s}{V_o} \times 100$

$= \frac{4 \times 10^{-3}}{5 \times 10^{-3}} \times 100$

$= 80\%$ — Ans

Theoretical Part

Q 8. prove that for a constant rate of discharge and a constant value of friction factor f, the frictional
head loss in a pipe varies as the fifth power of the diameter.

The head loss Δh (or h_f) expresses the pressure loss due to friction in terms of the equivalent height of a column of the working fluid, so the pressure drop is

$$\Delta p = \rho g \, \Delta h,$$

where

Δh is the head loss due to pipe friction over the given length of pipe
g is the local acceleration due to gravity (m/s^2).

It is useful to present head loss per length of pipe (dimensionless):

$$S = \frac{\Delta h}{L} = \frac{1}{\rho g} \cdot \frac{\Delta p}{L},$$

where L is the pipe length (m).

Therefore, the Darcy–Weisbach equation can also be written in terms of head loss:[6]

$$S = f_D \cdot \frac{1}{2g} \cdot \frac{\langle v \rangle^2}{D}.$$

In terms of volumetric flow

The relationship between mean flow velocity <v> and volumetric flow rate Q is

$$Q = A \cdot \langle v \rangle,$$

where:

Q is the volumetric flow (m^3/s).
A is the cross-sectional wetted area (m^2).

In a full-flowing, circular pipe of diameter D_c,

$$Q = \frac{\pi}{4} D_c^2 \langle v \rangle.$$

Then the Darcy–Weisbach equation in terms of Q is

$$S = f_D \cdot \frac{8}{\pi^2} \cdot \frac{Q^2}{D^5}.$$

Hydraulic gradient, $\frac{dh}{dl}$ is given by

$$\frac{dh}{dl} = \frac{-16.3}{50} = -0.326$$

Average flow rate $Q = \frac{45.2}{3 \text{ min}}$

$$= 15.07 \text{ cm}^3/\text{min}$$

$$= 0.0217 \text{ m}^3/\text{day}$$

Applying Darcy's Law,

$$Q = -KA\frac{dh}{dl}$$

$$\Rightarrow K = -\frac{Q}{A\left(\frac{dh}{dl}\right)}$$

$$= -\frac{0.0217}{(0.00283) \times (-0.326)}$$

$$= 23.5 \text{ m}^3/\text{day}$$

Ans.

Since, Soil is fully saturated $V_v = V_w$

$$= 0.43 m^3$$

So, $V_s = V - V_v$

$$= 1 - 0.43$$

$$= 0.56 m^3$$

Now, Void Ratio $e = \frac{V_v}{V_s}$

$$= \frac{0.43}{0.56}$$

$$= 0.75$$

Ans

Q.7 | A Field sample of an unconfined aquifer is packed in a test cyllinder. Length and diameter of cyllinder are 50cm and 6cm respectively. Field sample tested for a period of 3m under a constant head difference of 16.3 cm. As a result of 45.2cm³ of water is ~~collected~~ colleted at the outlet. Determine the hydraulic conductivity.

Solution:

Cross-sectional area of Sample $A = \frac{\pi d^2}{4}$

$$= \frac{\pi \times (0.06)^2}{4}$$

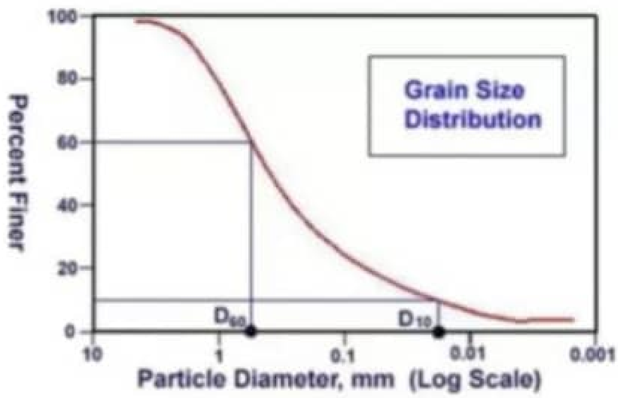
$$= 0.00283 m^2$$

9. Define (a) i) Effective Grain Size and ii) Optimum Moisture Content

Effective Grain Size

Effective Grain Size means the diameter of filter sand or other aggregate that corresponds to the 10 percentile finer by dry weight on the grain size distribution curve. Effective Grain Size means the ninety per cent retained size of a sediment as determined from a grain size analysis.

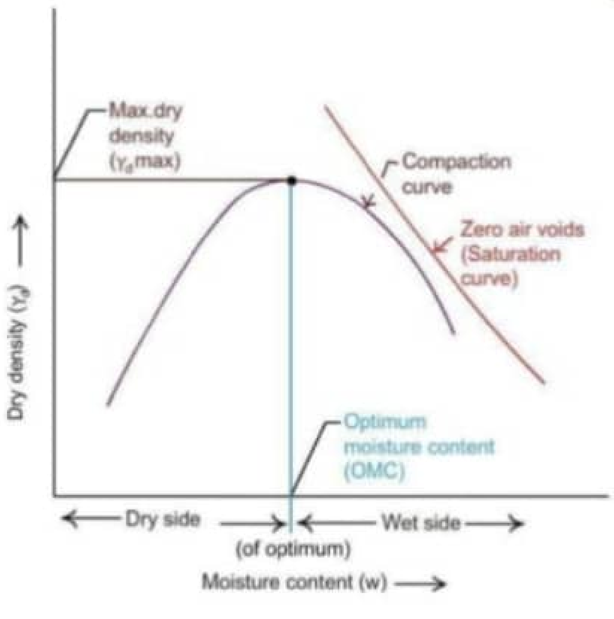
Denoted by D_{10}



Optimum Moisture Content

The Optimum moisture content (OMC) or Optimum Water Content (OWC) is the moisture C of compaction energy applied to the soil.

Denoted by OMC



Q.11

Question: A crest vertical curve is to be designed to join a +3% grade with a -2% grade section of a two-lane highway. Determine the minimum length of the curve if the de speed of the highway is 60 mi/h, $S < L$, and a perception-reaction time of 2.5 sec. deceleration rate for braking (a) is 11.2 ft /sec². ($SGFL - 2021$)

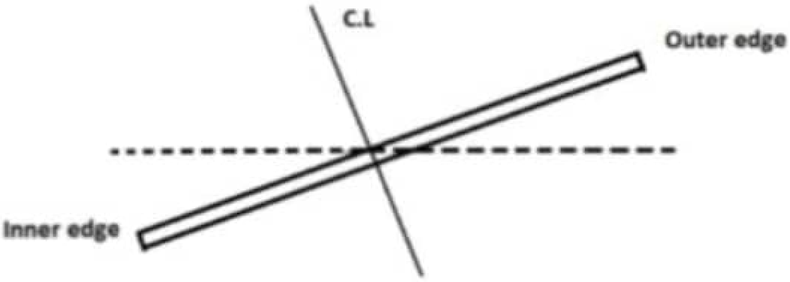
<u>Solution:</u>

Since the grade changes constantly on a vertical curve, the worst-case value for G of 3 used to determine the braking distance.

$$S = 1.47\,V\,t + \frac{V^2}{30\left(\frac{a}{g} - G\right)} = 1.47 \times 60 \times 2.5 + \frac{60^2}{30\left(\frac{11.2}{32.2} - 0.03\right)} = 598.1 \text{ ft}$$

The minimum length of the vertical curve,

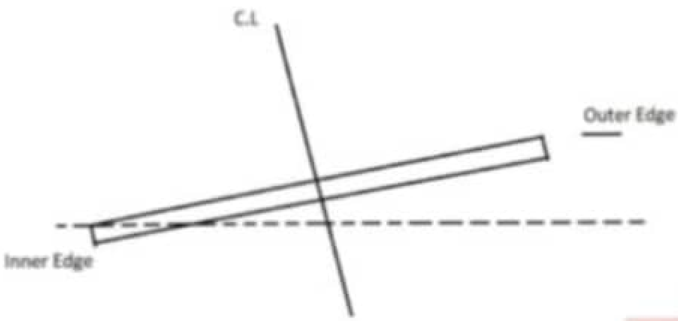
$$L_{min} = \frac{A\,S^2}{2158} = \frac{5 \times 598.1^2}{2158} = 828.8 \text{ ft}$$



Rotation About Centre Line

B. Revolving Pavement About The Inner Edge

In this method, the surface of the road is rotated about the inner edge, raising the center and outer edge.



C. Revolving Pavement About The Outer Edge

In this method, the surface of the road is rotated about the outer edge depressing the center and inner edge.

Q.10 Explain diagrammatically the method of attaining superelevation considering a crowned pavement revolved about the profile of the inside edge.

Solution:

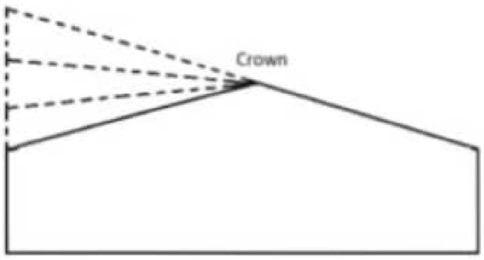
Superelevation is provided in the following two methods.

Elimination of the crown of the cambered section.
Rotation of pavement to attain full superelevation.

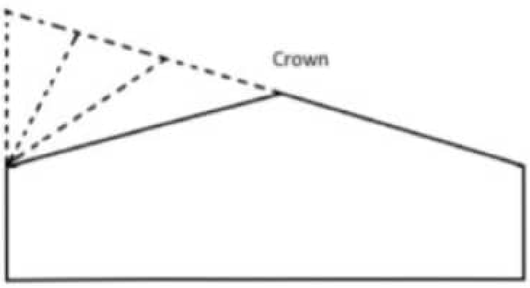
1. Elimination of The Crown of The Cambered Section

In this method, the outer half of the camber is gradually decreased. This may be done by two methods.

In the first method, the outer half of the camber is rotated about the crown at the desired rate such that the surface falls on the same plane as the inner half.



In the second method, the crown is progressively shifted outwards. This method is not usually adopted.



2. Rotation of Pavement To Attain Full Superelevation

In this stage, superelevation is gradually provided over the full width of the carriageway so that the required superelevation is available at the beginning of the circular curve. The different method employed for attaining the superelevation is as follows:

A. Revolving Pavement about The Center Line

In this method the surface of the road is rotated about the center line of the carriageway, gradually lowering the inner edge and rising the upper edge. The level of the center line is kept constant. This method is widely used.