225

Q-1

a (i)

4

Advantages of drip irrigation

1) Evaporation and seepage losses are eliminated
2) ~~Pest~~ Fertilisers can be applied along with irrigation water
3) No land preparations required, hence economical in later stages.
4) Efficiency of irrigation is more than 90%.
5) Doe:

Disadvantages

1) Rodents may harm the irrigating components
2) Initial cost is high
3) Does not offer frost protection.
4) May affect the farming operations
5) Special equipments are required.

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Q-1

a (ii) Given $[Na^{+}] = 295 mg/l = \frac{295}{23} = 12.83 meq/l$

$[Ca^{+2}] = 120 mg/l = 6 meq/l$

$[Mg^{+2}] = 24/12 = 2 meq/l$

6

Thus, $SAR = \frac{[Na^{+}]}{\sqrt{\frac{Ca^{+2}+Mg^{+2}}{2}}} = \frac{12.83}{\sqrt{\frac{6+2}{2}}} = 6.415$

Since SAR ∈ (0-10)

hence it falls under S1 category.

Electrical conductivity = 200 μmhos/cm @ 25°C < 250 μmho/cm

Thus, classification of water = $\boxed{C_1S_1}$

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Q-1
(b) Rocks for building stones are classified

On the basis of mode of formation

1) Igneous rocks – These are formed by the solidification of molten lava that oozed out of the ground resulting in compact granular structure.

E.g., Granite, Basalt

2) Sedimentary Rocks: These are formed by the stratified deposit of product of weathering such as due to wind or water which result in stratification and solidification of mass.

E.g., ~~sed~~ sandstone, limestone.

3) Metamorphic rocks – Igneous and sedimentary rocks when subjected to intense change in temperature and pressure, they form such rocks
E.g., Marble, Slate, Gneiss.

Physical classification

1) Unstratified Rocks – Igneous rocks fall under this category, they are compact and granular, do not possess any point of split.

2) Stratified rocks: Sedimentary rocks have strata along which they can be split.

3) Foliated rocks – Metamorphic rocks fall under this as they have a tendency to split up in a definite direction only.

Chemical classification

Siliceous Rocks – Silica is the chief component of these rocks, they are hard, durable and not easily weathered. E.g., Granite.

Argillaceous rocks – Clay is predominant. May be dense, compact or may be soft. E.g., Laterites.

Calcareous rocks – $CaCO_3$ is the main component. Due to cementation, these are hard but majorly depend on surrounding atmosphere.
E.g., Limestone.

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Q-1

(c) Given, 1:1.5:3 by dry volume of cement

$W/C = 0.48$

$\gamma_c = 1490 kg/m^3$ SG = 3.15

$\gamma_s = 1700 kg/m^3$ SG = 2.60

$\gamma_{CA} = 1610 kg/m^3$ S.G = 2.62

Thus, ~~1:1.51~~ 1:1.5:3 = 1490 : 1.5×1700 : 3×1610

= 1490 : 2550 : 4830 by mass

Air entrained = 2%

In $1 m^3$ concrete air = $0.02 m^3$.

thus let cement weight = 1490x

Sand = 2550x

Coarse aggregates = 4830x

$$\therefore \frac{W_c}{3150} + \frac{W_s}{2600} + \frac{W_{CA}}{2620} + \frac{0.48 \times W_c}{1000} = 1 - 0.02$$

$$\frac{1490x}{3150} + \frac{2550x}{2600} + \frac{4830x}{2620} + \frac{0.48 \times 1490x}{1000} = 0.98$$

$x = 0.244$,

thus

weight of cement = 363.56 kg

mass of sand = 622.2 kg

mass of coarse aggregates = 1178.52 kg

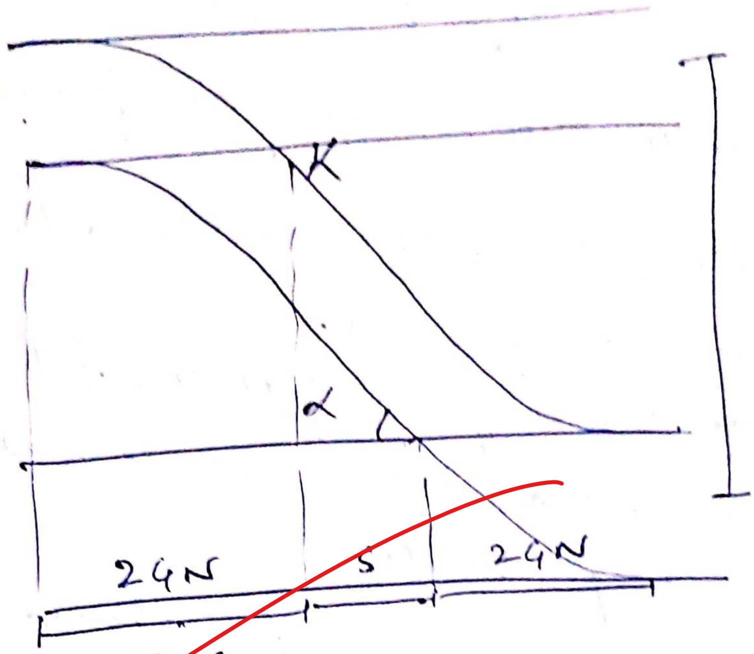
mass of water = 174.51 kg

An.

Q-1

(d) Given,

6



Given, 1 in 8.5 crossing

$N = 8.5 = \cot\alpha$

$G = 1676\,mm$

$\boxed{\alpha = 6.71^\circ}$

$D = 5m.$

Overall length of cross-over

$$L = 24N + 24N + S$$

$$= 4GN + (D-G)N - G\sqrt{1+N^2}$$

Thus $L = 4\times1.676\times8.5 + (5-1.676)\times8.5 - 1.676\sqrt{1+8.5^2}$

$$\boxed{L = 70.893\,m \simeq 71\,m}$$

Overall length of cross-over is 71m.

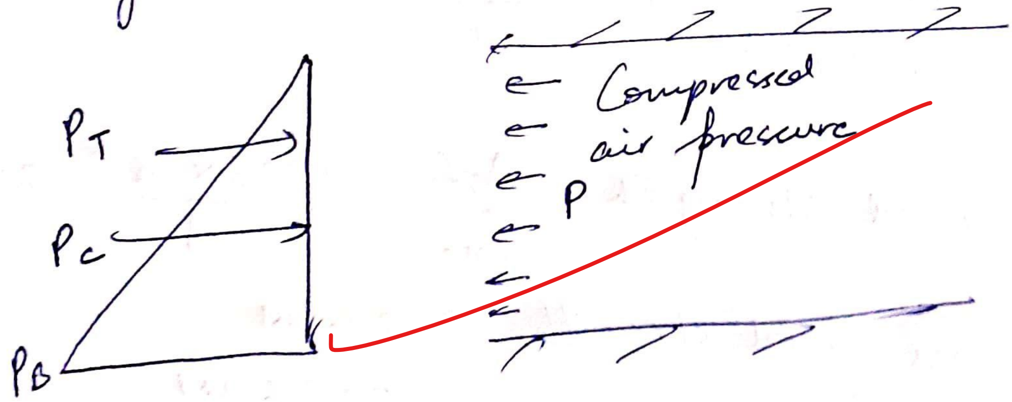
Q-1

(e) Water bearing strata pose numerous problems in various different operations of tunneling being unstable. like in excavation, mucking blasting etc.

Major method adopted through water bearing strata ~~are~~ is <u>Compression air tunneling</u>.

In this, the air is forced through the excavation, which is made air tight through locks.

The air pressure required to force back the percolating water or water mixed soil and keep the tunnel dry varies with the nature of ground and depth of cover.



Q-2

(a)

(i) Given, discharge = $35 m^3/sec = Q$

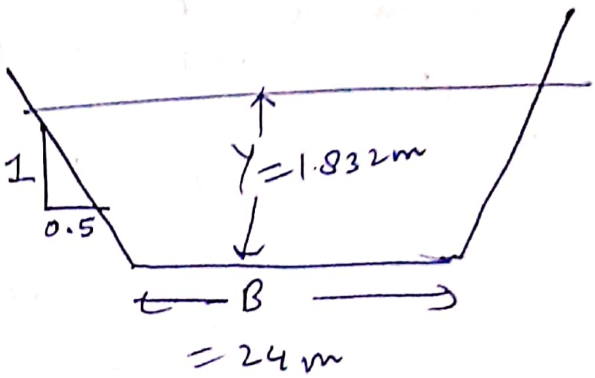
Silt factor = $0.9 = f$

Side slope 0.5H:1V

Velocity = $\left(\frac{Qf^2}{140}\right)^{1/6} = 0.76$ m/sec

Thus area = $\frac{Q}{v} = \frac{35}{0.76} = 45.67 m^2$

Perimeter = $4.75\sqrt{Q} = 4.75\sqrt{35} = 28.1 m$



But, $A = (B+my)y$

$P = B + 2y\sqrt{1+m^2}$

$\therefore$ $45.67 = (B+0.5y)y$

$28.1 = B + 2\sqrt{1.25}\,y$

Solving the above equations, we have,

$$\frac{45.67}{y} - 0.5y + 2\sqrt{1.25}\, y = 28.1$$

$$\boxed{y = 1.832m}$$

Thus, $\boxed{B = 24.013\ m}$

Bed slope $S = \frac{f^{5/3}}{3340\, Q^{1/6}} = \frac{0.9^{5/3}}{3340 \times 35^{1/6}} = \frac{1}{7200}$

Thus provide $B = 24m$, $y = 1.84m$,

Bed slope = 1 in 7200

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Q. 2
(b)

Given, BG track, 3 pairs of driving wheels

Axle load = 22 t

Speed = 80 kmph

Coefficient of friction $\mu = 0.2$

Hauling capacity $= 0.2 \times 22 \times 3 = 13.2$ tonnes.

Resistance due to rolling stock $= 0.0016\,W$

Resistance dependent on speed $= 0.00008\,WV$

Atmospheric resistance $= 0.0000006\,WV^2$

where $W =$ weight of train in tonnes.

thus

$13.2 = 0.0016W + 0.00008 \times 80W + 0.0000006 \times 80^2 \times W$

$\boxed{W = 1114.86 \text{ tonnes}}$

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for rising gradient, 1 in 200,

$$13.2 = 0.0016 \times 1114.86 + 0.00008 \times 1114.86 V + 0.0000006 \times 1114.86 V^2 + \frac{1114.86}{200}$$

Speed, V = 48.128 kmph.

Reduction in speed = 80 − 48.128 = $\boxed{31.872 \text{ kmph}}$

If there is a curve of 4° on rising gradient,

$$\therefore 13.2 = 0.0016 \times 1114.86 + 0.00008 \times 1114.86 V + 0.0000006 \times 1114.86 \times V^2 + \frac{1114.86}{200} + 0.0004 \times 1114.86 \times 4$$

$\boxed{V = 35.86 \text{ kmph}}$

Thus, reduction in speed = 48.128 − 35.86 = $\boxed{12.268 \text{ kmph}}$

Q-2

c (i)

Clamp Burning	Kiln Burning
1) Takes 2-3 months for a batch to burn	1) Takes 12-24 hours for burning
2) No skilled supervision is required	2) Under skilled supervision
3) Temporary structure	3) Permanent structure
4) Non-uniform texture and strength	4) Uniform texture with sharp edges and sound strength.
5) Uncontrolled burning	5) Controlled burning
6) Initial and running cost is low	6) Running cost and initial cost is high
7) Cost of fuel is less	7) Cost of fuel is more i.e. coal is required.

Clamp Burning	Kiln Burning
8) Considerable wastage of heat and fuel not properly utilised	8) fuel gas is dry and wastage is least as raw bricks are pre-heated by gas.
9) Capacity is 20000 - 1 lac per season	9) Avg 25000 bricks per day
10) Suitable for small scale production and non continuous demand	10) Suitable for large scale production

Q-2

c (ii) Le-Chatelier test is used to determine the unsoundness due to free lime only.

3

- Consists of small split cylinder of standard dimension with two indicator arms attached to either side (165mm long)
- Cement is gauged with 0.78p water, and filled into mould later covered with glass plate.
- Immersed in water for 24 hours @ 27±2°C.
- When taken out distance between arms is noted
- Then submerge again in water and boil it for 3 hours.
- Remove the mould from water cool it and measure distance between arms.
- The difference is noted.
-

For RHC and SSC, value should be less than 5mm while for other cements, it should not exceed 10mm

Q-3

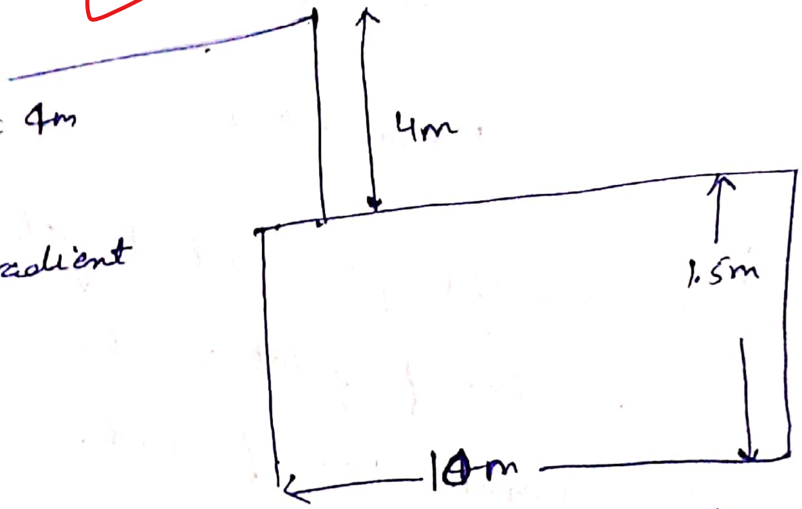
(a)

9

(i) Exit gradient is defined as the amount of head loss in the last square of flow net divided by the length / side of flow field.
Generally, this value comes out to be large, thus, is of much significance.

Given b = 10m, depth of downstream pile = 1.5m,

Head causing flow, H = 4m



As per Khosla, exit gradient

$$i_e = \frac{H}{d} \cdot \frac{1}{\pi\sqrt{\lambda}}$$

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}, \quad \alpha = b/d \quad d = \text{depth of downstream pile}$$

$$\therefore \alpha = \frac{10}{1.5} = 6.67$$

$\boxed{\lambda = 3.87}$, thus $i_e = \frac{4}{1.5} \times \frac{1}{\pi\sqrt{3.87}} = \boxed{0.431}$

Thus, exit gradient $= \boxed{0.431}$ or $\boxed{\frac{1}{2.317}}$

Q-3

a(ii) Given, depth of flow, $D = 5m$

Slope $= 1/3800$

fall velocity $= 0.04\ m/sec = w_0$.

Wide stream, Hydraulic radius $R = Y. = 5m$

Thus $\tau_0 = \gamma_w R S = \dfrac{9.81 \times 5 \times 1}{3800} = 12.9\ N/m^2$

Shear velocity $u_* = \sqrt{\dfrac{\tau_0}{\rho}} = 0.113$

As per Rouse's equation, $\therefore$ C_a: sediment conc @ 0.3m from bed $= 1000$ ppm by weight

$$\frac{C_a}{C_a} = \left[\frac{a(D-Y)}{Y(D-a)}\right]^{w/\kappa u_*}$$

K = von-Karman constant $= 0.4$

$$\frac{C_c}{1000} = \left[\frac{0.3\,(5-2.5)}{2.5\,(5-0.3)}\right]^{\frac{0.04}{0.4 \times 0.113}}$$

Thus sediment concentration @ mid depth

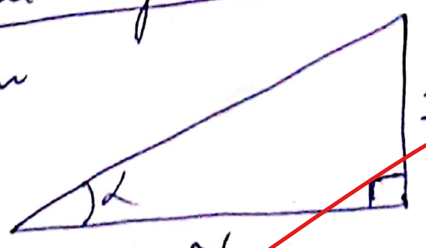
$= \boxed{87.598 \text{ ppm by weight}}$

Q-3

b(i) Various methods of measuring the number of crossing are

1) Right angle method (Cole's method)

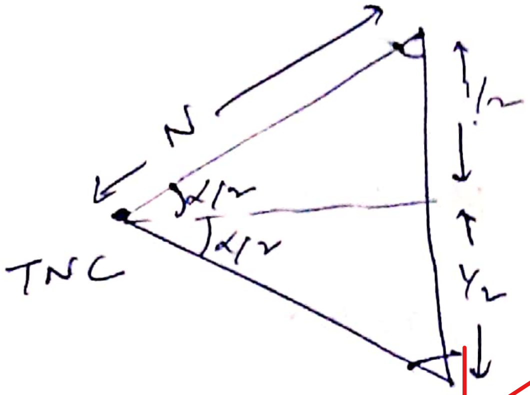
used by Indian Railways.



$\tan\alpha = \dfrac{1}{N}$

$\boxed{N = \cot\alpha}$

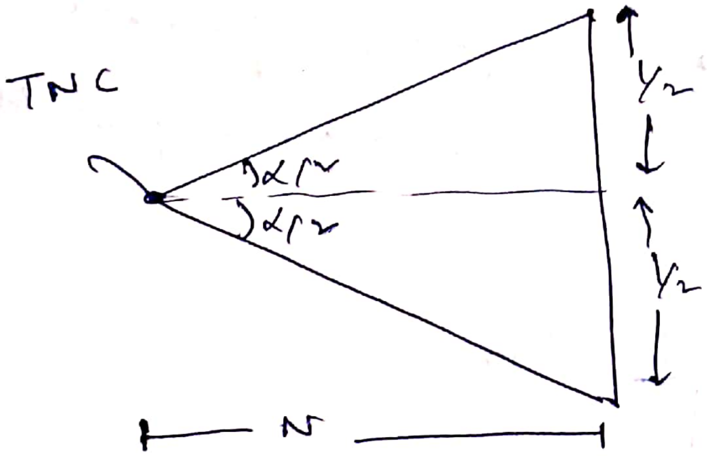
2) Isosceles triangle method



thus, $N = \frac{1}{2} \operatorname{cosec}(\alpha/2)$

3) Center line method

$N = \frac{1}{2} \cot(\alpha/2)$



$$\text{Number of crossing} = \frac{\text{Spread at the leg of crossing}}{\text{Length of crossing from TNC}}$$

Q-3

b (ii) Given, BRL = 1800m

Elevation of site = 600m

Monthly mean of average daily temp = 15°C (T_a)

Monthly mean of max daily temp = 21.6°C (T_m)

Effective gradient = 0.8%

Correction due to elevation (ICAO)

7% per 300m elevation

thus, correction reqd = $\frac{14\%}{100} \times 1800 = 252m$

Corrected Runway length as per ICAO = 1800 + 252
= 2052m

Temperature correction (ICAO)

Airport Reference temperature

$T_R = T_a + \frac{T_m - T_a}{3} = 15 + \frac{6.6}{3} = 17.2°C$

Atmospheric temp @ 600 m elevation

$= 15 - 0.0065 \times 600 = 11.1°C$

Correction of temp = 1% per 1°C.

for (17.2 − 11.1) = 6.1°C, correction = 6.1%

$= \frac{6.1}{100} \times 2052 = 125.172$ m

Corrected length = 2052 + 125.172 = 2177.17 m

Total correction = $\left(\frac{2177.17 - 1800}{1800}\right) \times 100 = 20.95\% < 35\%$

Hence o.k.

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Correction for gradient (FAA)

20% for every 1% change in gradient

$$= \frac{20}{100} \times 0.8 \times 2177.17 = 348.347\,m$$

Thus, corrected length $= 2177.17 + 348.347$

$= 2525.52\,m$

Thus actual runway length to be provided

$= \boxed{2526\,m}$

Q-3

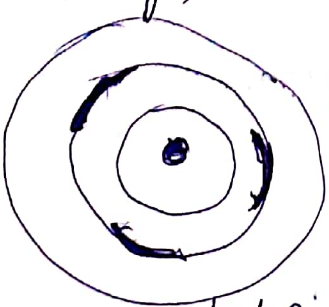
(c) Various defects in timber are

(i) Defects due to natural forces

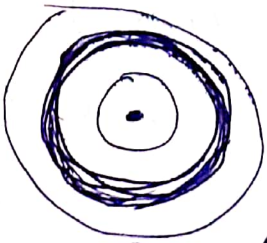
- Knots - Bases of branches which are broken encased by wood.
  When trees grow further, put on more wood, these broken areas are covered with wood forming knots.
- They are source of weakness and low workability

(ii) Shakes - Separation of annual ~~too~~ rings largely reducing the shear strength.

- Cup shake - Formed due to partial separation of annual rings due to severe frost action or non-uniform growth.
- Ring shake - when cup shakes cover the entire ring, it is called ring shake.

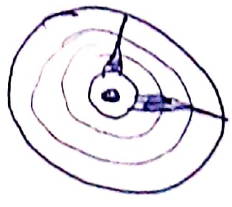


Cup shake



Ring shake

- Heart shake - The cracks elongate from heart wood to the sapwood, wider at the center and diminishing towards sapwood.



Star shakes - Formed due to severe heat and freezing action. Cracks are wider on the outside

- Rind galls (Excrescences) - Due to unsuccessful attempts of formation of branch, a swollen part is formed on the trunk, called Burls / Rind Galls

- Foxiness - Yellowish red stains due to the absence of sunlight, ventilation and damp place, timber get stained.

- Druxiness - White patches are formed on the surface of standing tree.

- Twisting - Due to exposure of young tree to fast blowing winds, the fibres get twisted. They cant be sawed. Used for poles and posts.

- upsets

(ii) Defects due to Fungi

- Brown Rot - The fungi attacks the cellulose and hemicellulose compounds thus rendering it brownish powder-like.
Happens due to absence of ventilation, dampness, no sunlight.

-

- Dry rot - Due to the attack on sapwood, the timber is rendered dry. Thus proper seasoning of timber (water content < 20%) must be stacked in ventilated rooms.

- Wet Rot - Due to the chemical decomposition of timber & it turns into powdery substance.
- Due to alternate wetting and drying
- Lack of Sunlight
- Lack of ventilation.

- White rot
Attack on lignin with fibres.

(ii) Defects due to Conversion

- Torn grain - when a tool or hammer falls on the timber, it leaves mark., called torn grain.

- Chip marks - Due to the blade of finishing machines, these marks are over the surface.

- Diagonal grain - Happens due to improper sawing of timber, resulting in weak and weathering timber

- Waney - Due to improper sawing - blunt portion is left out.

(iv) Defects due to ~~natural~~ Seasoning ~~agents~~

Bow - Curvature in direction of length

Cup - Curvature transverse to length

Split - Separation of fibres along the grain from one to other.

Checks - Separation of fibres not extending from one part to another.

Q-5 (a)

Various types of concrete pumps used in construction industry are:

- Piston type
- Pneumatic pumps
- Squeeze Pressure pumps.

For successful pumping of concrete, following things should be kept in mind:

1) The efficiency should be maximum of the pump
2) Segregation doesn't occur.
3) The pumps impeller may not get clogged.
4) Power consumption of the pump should be as lo
as possible.
5) Economical operation should be maintained.

Q-5

(b) Given, viscous damped system.

Weight of car = 1.6t = 1600kg

$\Delta_{static} = 5\,cm$

Thus, stiffness of suspension $= \dfrac{1600 \times 9.81}{0.05} = \boxed{313920\ N/m}$

for critically damped system,

$C = 2\sqrt{mK}$ where C is damping coefficient

$\boxed{C = 44822.85\ Ns/m}$ Ans.

(b) with 5–80kg passengers,

total weight $= 80 \times 5 + 1600 = 2000\,kg = m'$

Damping ratio $= \dfrac{c}{2\sqrt{m'K}}$

$\xi = \dfrac{c}{2\sqrt{2000 \times 313920}} = \dfrac{44822.85}{50113.47} = \boxed{0.8944}$ Ans

Natural frequency for loaded car $= \sqrt{\dfrac{K}{m'}} = \boxed{12.52\ rad/sec}$ Ans

Damped frequency, $\omega_d = \omega_n\sqrt{1-\xi^2}$

$\omega_d = 12.52\sqrt{1-0.8944^2} = \boxed{5.6\ rad/sec}$ Ans

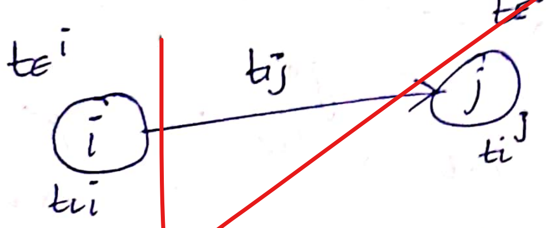
Natural frequency $= \dfrac{12.52}{2\pi} = \boxed{2\ Hz}$

Q-5

C (i) Different types of floats used in networks are

1) **Total float** - It is defined as the maximum available ~~time~~ delay time that can be provided without affecting project completion time.
It affects succeeding and preceding activities.

$T_F = LFT - EFT = LST - EST = \boxed{t_L^j - t_E^i - t_{ij}}$



2) **Free float** - Defined as the maximum delay provided without affecting the succeeding activity. It is represented as

$F_F = F_T - S_j$ (S_j = slack in event j)

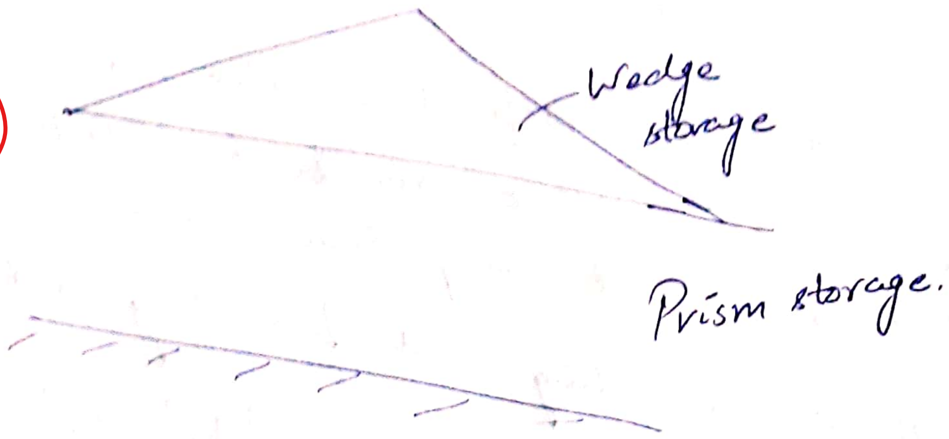
3) **Independent float** - defined as delay time available without affecting preceding and succeeding activity.

$F_{ID} = t_E^j - t_L^i - t_{ij} = \boxed{F_F - S_i}$

4) **Interfering float** - Defined as total float - free float. (S_j)

Q-5

c (ii)



The water level in case of hydrological routing is divided into two parts namely, wedge storage and prism storage.

the part which is parallel to the bed slope is called prism storage where storage is a function of outflow only i.e. $S=f(Q)$, case of linear reservoir.

The part projecting above the prism storage is termed as wedge storage where $S=f(I,Q)$.

Wedge storage can be positive or negative depending on the increasing or decreasing flow.

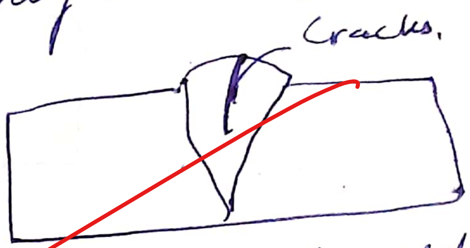
- If a straight line is drawn from downstream side to upstream side and some part is above this line, wedge is positive and vice-versa.

5) Economical

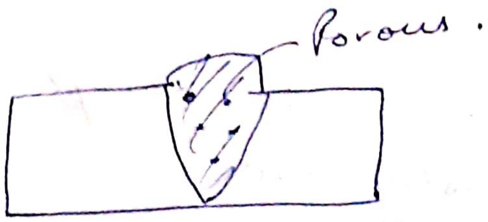
Q-5

(d) Common defects in welding include

1) Hot Cracks - occurring during the crystallisation process.

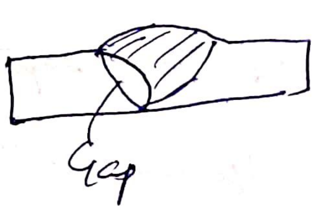


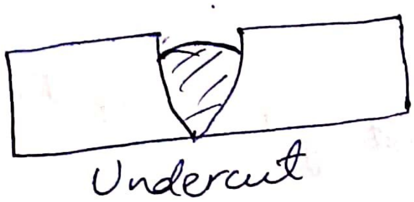
2) ~~E~~ Porosity - occurs as a result of weld metal contamination. The trapped gases create a bubble-filled weld that becomes weak and can with time collapse.



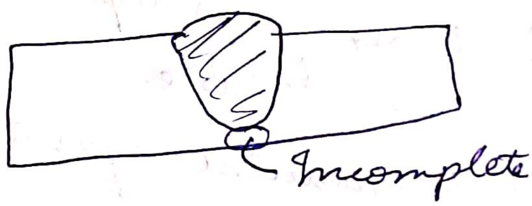
3) <u>Undercut</u> _ Too fast weld speed, or the use of an incorrect angle.
- Electrode is too large, incorrect filler material.

4) <u>Incomplete fusion</u> _ When there is lack of fusion b/w base metal and weld metal.

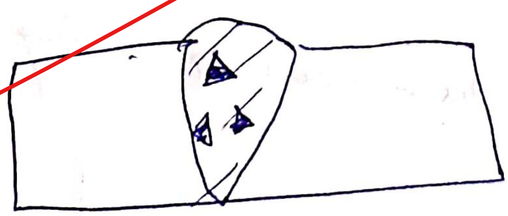




5) <u>Incomplete penetration</u> _ Large electrode diameter_ ~~Misad~~ Misalignment



6) <u>Slag inclusion</u> - Not cleaning the weld pass before starting a new one, weld speed is too fast.



Q-5
(e)

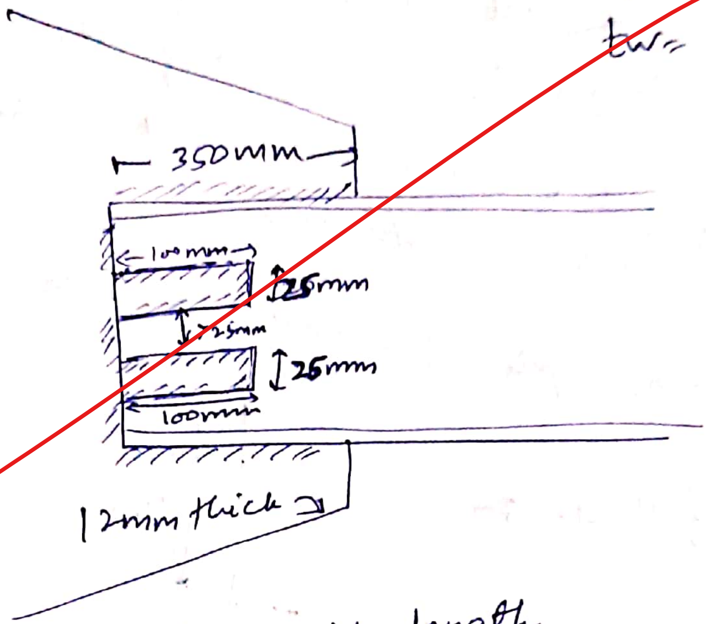
12

Given ISLC 300, Fe 410

Factored load = 900 kN

t_f = 11.6 mm

t_w = 6.7 mm.



Strength of weld per unit length

Maximum size of fillet weld = 6.7 − 1.5 = 5.2 mm

Provide 5 mm size of weld.

Thus $\dfrac{f_u l_w t_e}{\sqrt{3}\,\gamma_{mb}} = \dfrac{410 \times 5 \times 0.7}{\sqrt{3} \times 1.25} = 662.79$ N/mm length (assume shop welding)

Thus total length reqd = $\dfrac{900 \times 10^3}{662.79}$ = 1357.89 mm

But maximum length available = 350×2 + 300 = 1000 mm

Let's provide slots of size 100 mm × 25 mm (2 slots)

hence length available now = 350×2 + 300 + 4×100

= 1400 mm > 1357.89 mm

hence, provide 5 mm weld size.

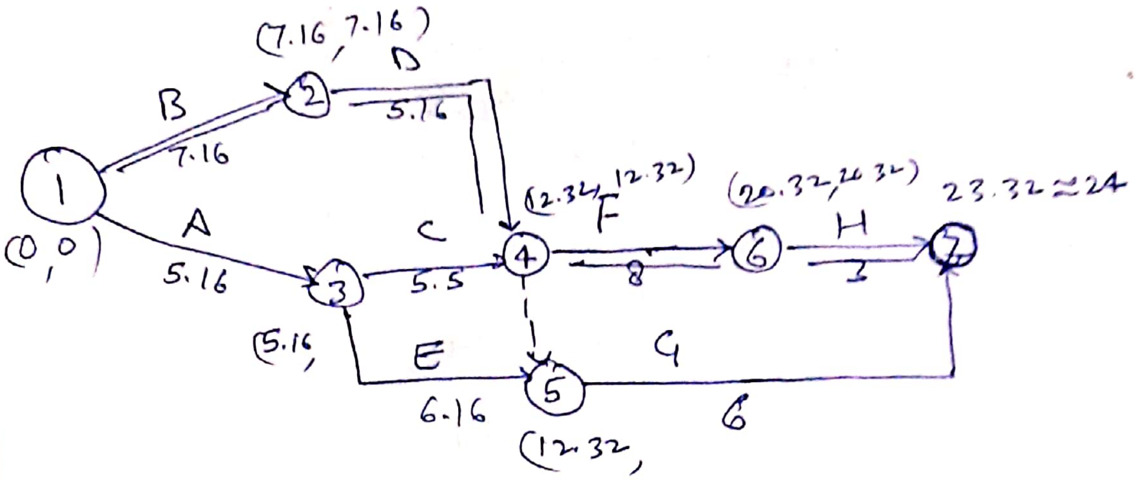
Q-6

(a)

20

Activity	Expected time $\left(\frac{t_o + 4t_m + t_p}{6}\right)$ (weeks)	Variance (weeks^2) $\left(\frac{t_p - t_o}{6}\right)^2$
A	5.16	0.6944
B	7.16	0.25
C	5.5	0.6944
D	5.16	0.6944
E	6.16	0.6944
F	8	1
G	6	1
H	3	1.77

Project Network



Thus completion time of project (expected) = 24 days.

Expected time $t_e = \dfrac{t_o + 4t_m + t_p}{6}$

$\boxed{1-2-4-6-7 \text{ is critical path}}$

or B–D–F–H is critical path.

Probability of completion @ end of 25 weeks

$Z = \dfrac{x - \mu}{\sigma}$, $\mu = 24\ (23.32)$

$$\sigma = \sqrt{\sigma_B^2 + \sigma_D^2 + \sigma_F^2 + \sigma_H^2}$$

$$\sigma = \sqrt{0.25 + 0.6944 + 1 + 1.77} = 1.92 \text{ weeks}$$

$$\therefore Z = \frac{25 - 23.32}{1.92} = 0.875$$

from interpolation, for $Z = 0.875$

Probability $= 74.9 + \dfrac{9.5}{0.34} \times 0.205 = \boxed{80.628\%}$

Thus, probability of completion by 25 weeks $= \boxed{80.628\%}$.

Q-6

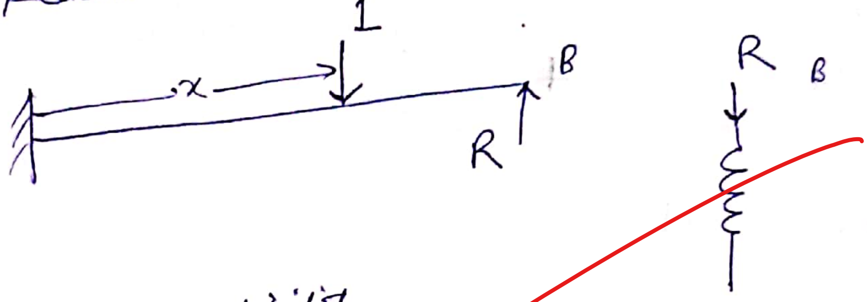
$EI = \text{constant}$

b (i)

10

Let Reaction at B be R when a unit load is applied.

FBD



Thus, from compatibility,

$$\frac{1 \cdot x^3}{3EI} + \frac{x^2}{2EI}\cdot(l-x) - \frac{Rl^3}{3EI} = \frac{Rl^3}{24EI}$$

$$\frac{x^3}{3EI} + \frac{x^2(l-x)}{2EI} = \frac{3}{8}\frac{Rl^3}{EI}$$

Thus,
$$R = \frac{8x^3}{9l^3} + \frac{4x^2(l-x)}{3l^3}$$

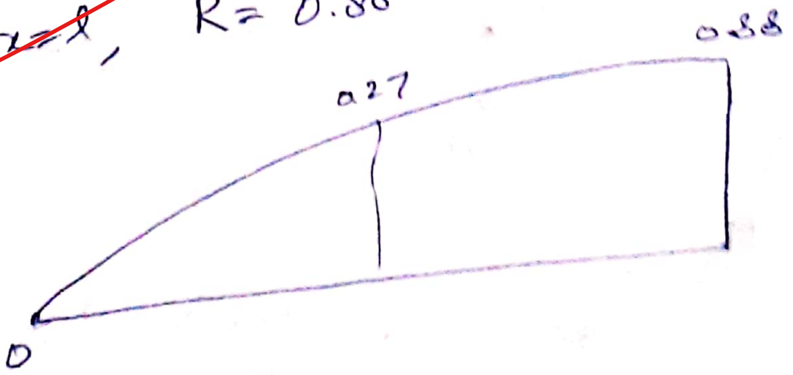
$$R = \frac{8x^3 + 12lx^2 - 12x^3}{9l^3} = \boxed{\frac{12x^2 l - 4x^3}{9l^3}}$$

@ $x = 0$, $R = 0$

@ $x = l/2$, $R = \dfrac{12 \times l^3/4 - 4 \times l^3/8}{9l^3} = 0.27$

@ $x = l$, $R = 0.88$

ILD



Thus, $M_A = R \times l - 1.x$

$$M_A = \frac{12x^2 l - 4x^3}{9l^2} - x$$

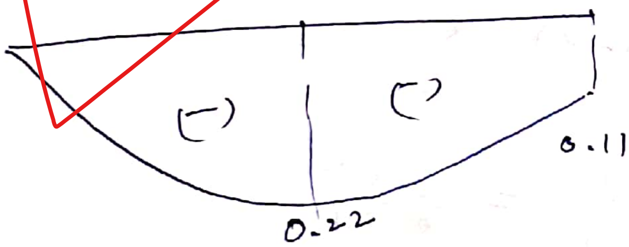
$$M_A = \frac{12x^2 l - 4x^3 - 9l^2 x}{9l^2}$$

@ $x = 0$, $M_A = 0$

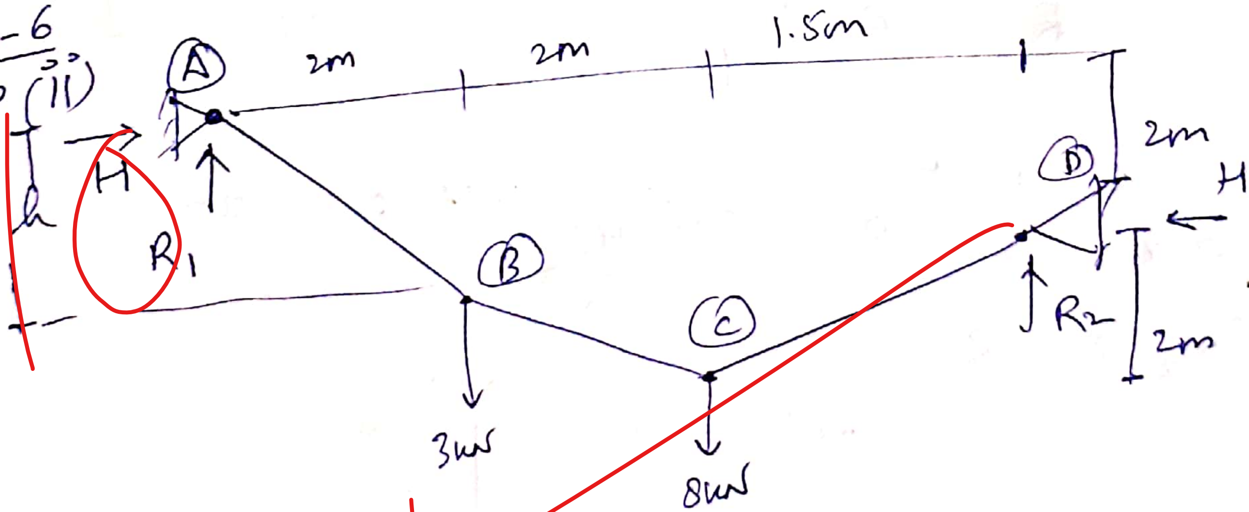
@ $x = l/2$, $M_A = \dfrac{12 \times l^3/4 - 4 \times l^3/8 - 9l^3/2}{9l^2} = -0.22$

@ $x = l$, $M_A = -0.11$

ILD



Q-6
6 (ii)



$\Sigma F_v = 0$ $\boxed{R_1 + R_2 = 11}$ -- (i)

$\Sigma M_D = 0$ $R_1 \times 5.5 - 3 \times 3.5 - 8 \times 1.5 + H \times 2 = 0$

$\boxed{5.5 R_1 + 2H = 22.5}$ -- (ii)

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$\Sigma M_C = 0$ (from right)

$$H \times 2 + R_2 \times 1.5 = 0$$

$$\boxed{1.5 R_2 + 2H = 0} \quad \text{---(iii)}$$

On solving (i)(ii) and (iii) we have,

$$\boxed{R_1 = 5.57\,kN, \quad R_2 = 5.43\,kN, \quad H = -4.07\,kN}$$

Tension in CD $= \sqrt{4.07^2 + 5.43^2} = \cancel{46.05\,kN}$ 6.78 kN

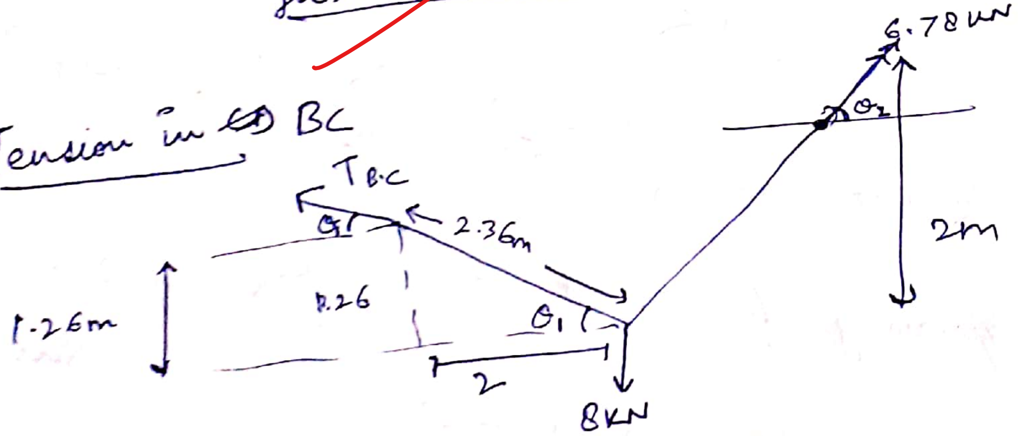
Tension in AB $= \sqrt{4.07^2 + 5.57^2} = 6.90\,kN$

also, $\Sigma M_B = 0$ (from left)

$$\therefore \; -4.07 \times h + 5.57 \times 2 = 0$$

$$\boxed{h = 2.737 \approx 2.74\,m} \quad \text{Ans.}$$

Tension in ~~CD~~ BC



$$T_{BC} \sin\theta + 6.78 \sin\theta_2 = 8$$

$$T_{BC}\left(\frac{1.26}{2.36}\right) + 5.43 = 8$$

$$\boxed{T_{BC} = 4.813\,kN}$$

Thus, $T_{AB} = 6.9\,kN$, $T_{BC} = 4.813\,kN$, $T_{CD} = 6.78\,kN$, $h = 2.74\,m$

Ans.

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Q-6
(c) Given factored load $P_u = 300 kN$
Length $= 3m$.

ISA $(100 \times 75 \times 8)$ $A_g = 1336 mm^2$

20mm bolts @ 8.8

∴ Shearing strength of bolt

$$T_{dsb} = \frac{800}{\sqrt{3} \times 1.25} \left(0.78 \frac{\pi}{4} \times 20^2\right) = 90.544 kN$$

Bearing strength

Assume pitch $= 2.5 \times 20 = 50mm$,
edge distance $= 1.5 d_o = 33mm$, take 35mm

$$T_{db} = \frac{2.5 k_b d t f_u}{1.25}$$

$$k_b = \min\left\{\frac{35}{3 \times 22}, \frac{50}{3 \times 22} - 0.25, \frac{800}{410}, 1\right\}$$

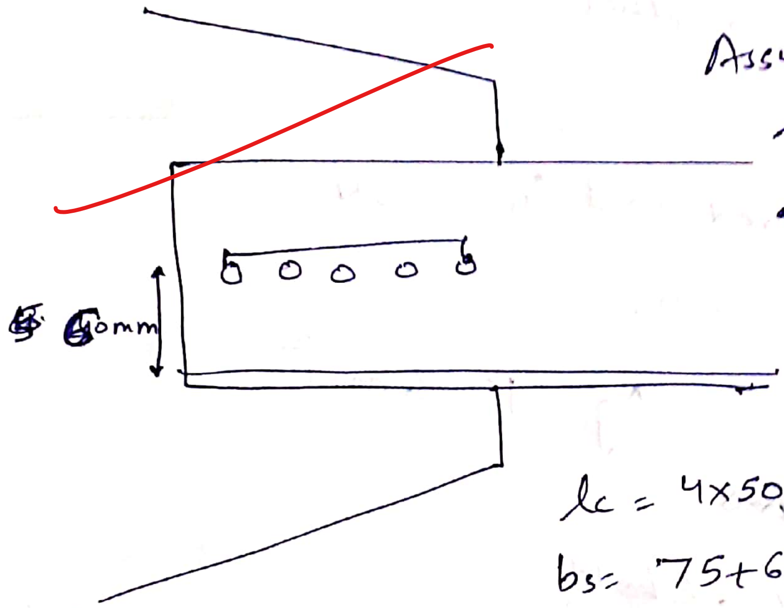
$$\{0.53, 0.5, 1.95, 1\} = 0.50$$

$$T_{db} = \frac{2.5 \times 0.5 \times 20 \times 8 \times 410}{1.25} = 65.6\ kN$$

Thus bolt value = $\boxed{65.6\ kN}$

Thus no. of bolts required = $\frac{300}{65.6} = 4.57$

Provide 5 bolts



Assuming 100mm leg is connected and take g = 60mm

$l_c = 4 \times 50 = 200\ mm$

$b_s = 75 + 60 - 8 = 127\ mm$

$$\beta = 1.4 - 0.076 \frac{w}{t} \cdot \frac{b_s}{l_c} \cdot \frac{f_y}{f_u}$$

$$0.7 \leq \beta < \frac{0.9 f_u / \gamma_{m1}}{f_y / \gamma_{m0}}$$

$$\beta = 1.4 - 0.076 \times \frac{75}{8} \times \frac{127}{200} \times \frac{250}{410} = 1.124$$

$0.7 < \beta < 1.29$ hence O.K.

Tensile capacity

$$T_{dn} = \frac{0.9 A_{nc} f_u}{\gamma_{m1}} + \frac{\beta A_{go} f_y}{\gamma_{m0}}$$

$$T_{dn} = \frac{0.9 \times \left(100 - 22 - \frac{8}{2}\right) \times 8 \times 410}{1.25} + \frac{1.12 \times \left(75 - \frac{8}{2}\right) \times 8 \times 250}{1.1}$$

$$T_{dn} = 174758.4 + 144581.81$$

$$\boxed{T_{dn} = 319.340 \text{ kN}} > 300 \text{ kN}$$

Gross section yield strength = $\frac{A_g f_y}{\gamma_{m0}} = \frac{1336 \times 250}{1.1} = 303.6$ kN

Thus, gross yield strength = 303.6 kN

Hence, tensile strength of member = 303.6 kN

thus, section is safe.