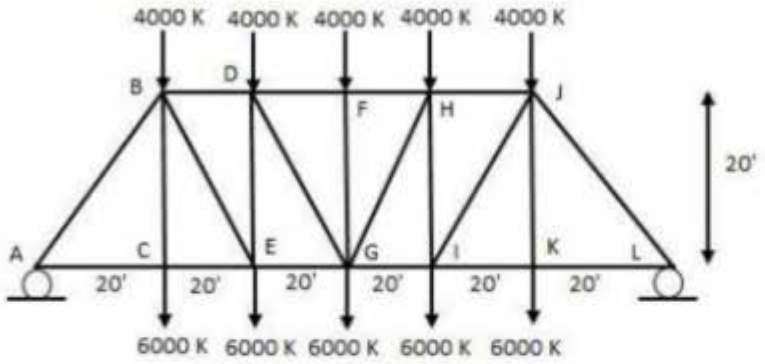
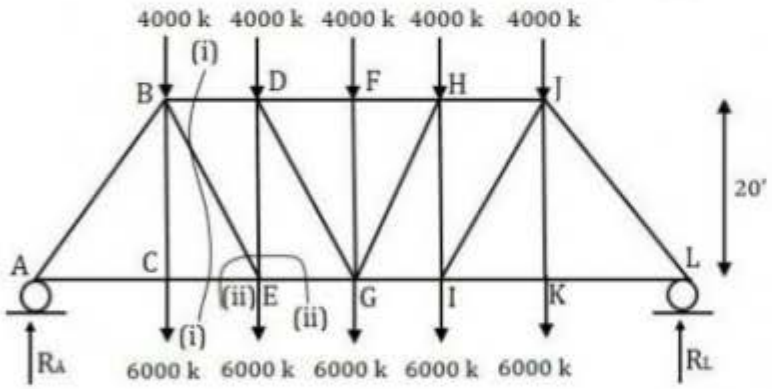
GTCL – 2018
POST: Assistant Engineer
Venue: BUET

1. Determine the member forces of DE and BE



Solution:



$\Sigma M_A = 0$

$10000 \times (20 + 40 + 60 + 80 + 100) - R_L \times 120 = 0$

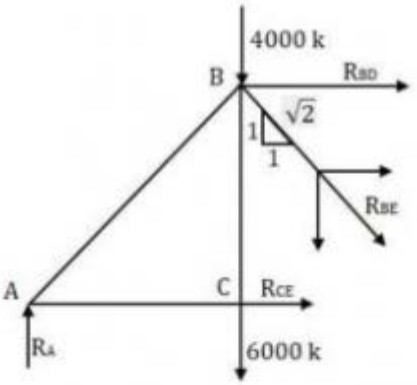
$R_L = 25000$ kip

$\Sigma F_Y = 0$

$25{,}000 - (4000 + 6000) \times 5 + R_A = 0$

$R_A = 25000$ kip

Taking left position of section (i) – (i)



$\Sigma M_B = 0$

$25{,}000 \times 20 - R_{CE} \times 20 = 0$

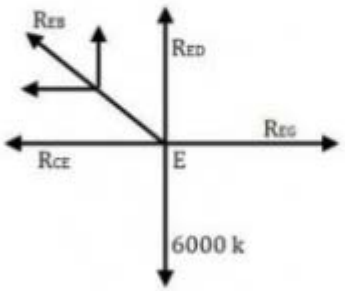
$R_{CE} = 25000$ kip

$\Sigma F_Y = 0$

$25{,}000 - \frac{1}{\sqrt{2}} R_{BE} - 6000 - 4000 = 0$

$R_{BE} = 21213.20$ kip

Taking section (ii) – (ii)



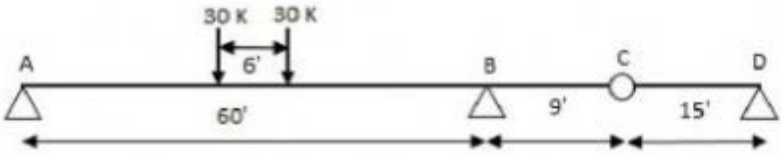
$\Sigma F_Y = 0$

$\frac{1}{\sqrt{2}} R_{EB} + R_{ED} - 6000 = 0$

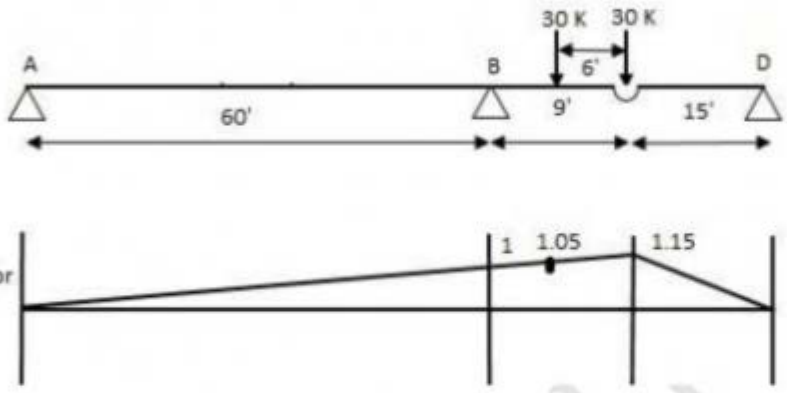
$\frac{1}{\sqrt{2}} \times 21213.2 - 6000 + R_{ED} = 0$

$R_{ED} = 24000$ kip

2. A group of moving load consists of a pair of 30 kips load acting 6' constant apart on a beam shown below. Determine the maximum reaction at support B.



Solution:



$$\text{Co} - \text{efficient at C} = \frac{69}{60} = 1.15$$

$$\text{Co} - \text{efficient at left load} = \frac{63}{60} = 1.05$$

$$\text{RB, max} = 1.15 \times 30 + 1.05 \times 30 = 66 \text{ kip}$$

3. Find the hydrogen ion concentration and hydroxide ion concentration in tomato juice having P^H of 4.1

Solution:

$$pH = -\log [H^+]$$

$$4.1 = -\log [H^+]$$

$$[H^+] = 10^{-4.1} = 7.94 \times 10^{-5} \text{ mol/L}$$

$$pH + pOH = 14$$

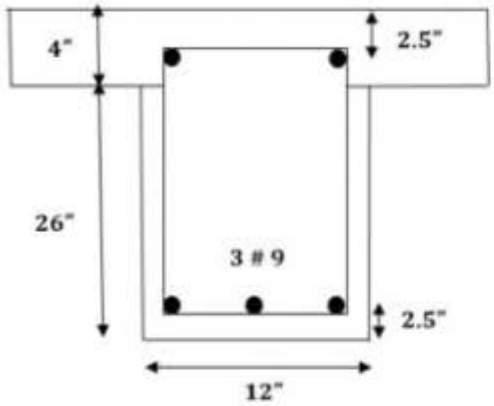
$$pOH = 14 - 4.1 = 9.9$$

$$pOH = -\log [OH^-]$$

$$[OH^-] = 10^{-9.9} = 1.16 \times 10^{-10} \text{ mol/L}$$

4. A reinforced concrete T-beam has a cross section in the positive region of span as shown below. The beam has a 30-ft span and is cast integrally with a floor slab that is 4 in. thick. The clear distance between webs is 18 in. Determine the design positive moment capacity. Given $f_c' =$ 3000 psi and $f_y = 60000$ psi.

Solution:



$b_e \leq$ Web width + 16 (slab thickness) $= 12 + 16 \times 4 = 76$ in.

$b_e \leq$ Average clear distance to adjacent webs + Web width $= 18 + 12 = 30$ in.

$$b_e \leq \frac{\text{Span length}}{4} = \frac{30 \times 12}{4} = 90 \text{ in.}$$

Effective flange width, $b_e = 30$ in

$A_s = 3 \times 1 = 3 \text{ in}^2$

$$a = \frac{A_s f_y}{0.85 f_c' b_e} = \frac{3 \times 60}{0.85 \times 3 \times 30} = 2.35"$$

$a < h_f$, so rectangular section analysis.

$$c = \frac{a}{\beta_1} = \frac{2.35}{0.85} = 2.76"$$

$d = 30" - 2.5" = 27.5"$

$$\varepsilon_t = \frac{d - c}{c}(0.003) = \frac{27.5 - 2.76}{2.76}(0.003) = 0.026 > 0.005$$

As $\varepsilon_t > 0.005$, so tension controlled section and $\varphi = 0.9$

$$M_u = \varphi A_s f_y \left(d - \frac{a}{2}\right) = 0.9 \times 3 \times 60 \left(27.5 - \frac{2.35}{2}\right) = 4264.65 \text{ k} - \text{in}$$

5. In 300 m^3 sedimentation tank water is flowing in at rate 1000 m^3/day. What is the detention time in hours?

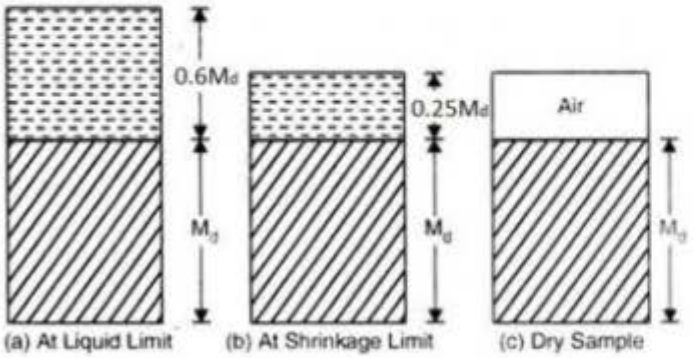
Solution:

$V = 300 \text{ m}^3, Q = 1000 \text{ m}^3/\text{day} = 41.67 \text{ m}^3/\text{hr}$

Detention time, $t = \frac{V}{Q} = \frac{300}{41.67} = 7.2$ hr

6. Clay sample has atterberg limits: Liquid limit = 60, Plastic limit = 40. Shrinkage limit = 25. The sample Shrink from 15 cm^3 to 9.57 cm^3, when the moisture content is decreased from LL to the SL. What is the dry specific gravity of the clay sample?

Solution:



Difference of volume of water content = $15 - 9.5 = 5.43$ cm^3
Difference of mass of water = 5.43 g

Now, $(0.6 - 0.25)\ M_d = 5.43$

$M_d = 15.51$ g
Mass of water at shrinkage limit = 0.25 x 15.51 = 3.87 g
Volume of water at shrinkage limit = 3.87 cc

Volume of solids = $9.57 - 3.87 = 5.7$ cm^3

Hence, $\rho_s = \frac{M_d}{V_s} = \frac{15.57}{5.7} = 2.72$

$G_s = \frac{\gamma_s}{\gamma_w} = \frac{\rho_s}{\rho_w} = \frac{2.72}{1} = 2.72$

7. Determine the fineness modulus and percent of silt and clay of the sample.

Sieve size	Percent retained
No. 4	0
No. 8	1
No. 16	4
No. 30	12
No. 40	13
No. 50	30
No. 100	34
No. 200	4
Pan	2

Solution:

Sieve size	Percent retained	Cumulative % retained	% finer
No. 4	0	0	100
No. 8	1	1	99
No. 16	4	5	95
No. 30	12	17	83
No. 40	13	30	70
No. 50	30	60	40
No. 100	34	94	6
No. 200	4	98	2
Pan	2	100	0

$$\text{F.M} = \frac{0 + 1 + 5 + 17 + 60 + 94}{100} = 1.77$$

% of silt and clay = 2 – 0 = 2%

8. In a reciprocal levelling, two points A and B are taken on opposite banks of a river. The two station C and D & their measurement point are given below table, find the reduced level of B if the reduced level of A is 108.82 m.

Station	Reading station point	
	A	B
C	5.79	5.12
D	4.96	4.18

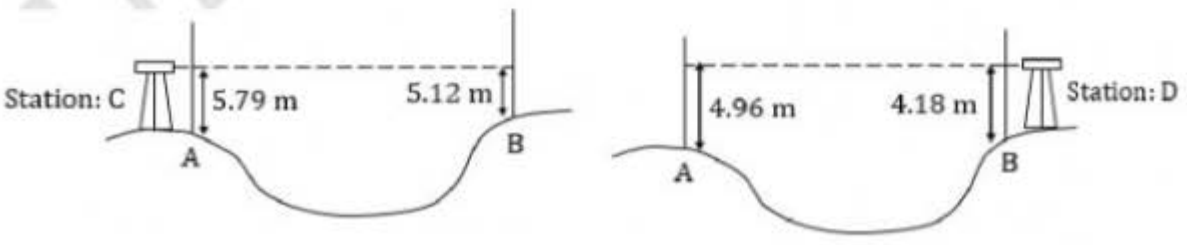
Solution:

When the instrument is at C,
Apparent difference in elevation A and B = 5.79 – 5.12 = 0.67 (B higher)

When the instrument is at D,
Apparent difference in elevation A and B = 4.96 – 4.18 = 0.78 (B higher)

$$\text{True difference of elevation} = \frac{0.67 + 0.78}{2} = 0.725 \text{ m (B higher)}$$

True elevation of B = 108.82 + 0.725 = 109.54 m



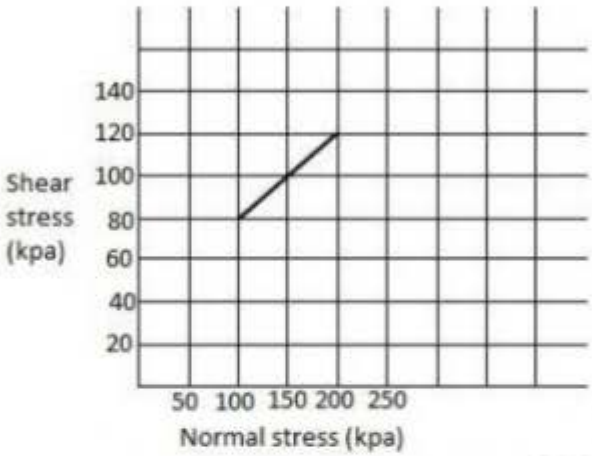
9. The radius of a tyre imprint is approximately to a circle of 150 mm. what is the, maximum loading duration on a particular point of pavement by a truck moving at a speed of 60 kmph?

Solution:

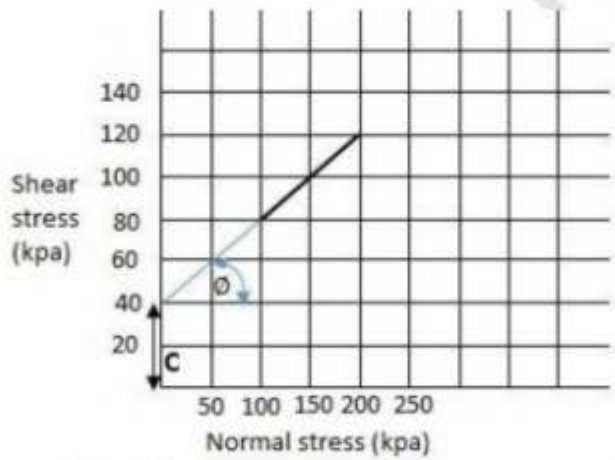
Duration is the time required to cross the diameter of the tyre imprint.

Therefore, the time required is $= \frac{2 \times 150}{\frac{60 \times 10^6}{3600}} = 0.018\ s$

10. Find the internal angle of friction and cohesion.



Solution:



$$tan\ \varphi = \frac{F_2 - F_1}{N_2 - N_1} = \frac{120 - 80}{200 - 100} = 0.40$$

$$\varphi = tan^{-1}(0.40) = 21.80$$

Now, $F_1 = C + N_1\ tan\ \varphi$

$80 = C + 100 \times \tan 21.80$

$C = 40\ \text{kPa}$