Bangladesh Bank-2018
Assistant Director (CIVIL)
Exam Venue: Central Women's College
Exam taken by: Dhaka University (Arts faculty)

1. (a) Calculate volume of earthwork necessary for a portion of an irrigation canal from the following data by trapezoidal rule.

Chainage (ft)	0	100	200	300	400	500
Area (ft^2)	850	875	860	855	860	865

Solution:

$$\text{Volume}, V = \frac{D}{2}\{A_1 + A_6 + 2(A_2 + A_3 + A_4 + A_5)\}$$

$$V = \frac{100}{2}\{850 + 865 + 2(875 + 860 + 855 + 860)\} = 430750 \text{ cft}$$

1. (b) The length of the line measured with 20 m chain found to be 250 m. It was subsequently found that the chain was 10 cm to long. What is the length of line?

Solution:

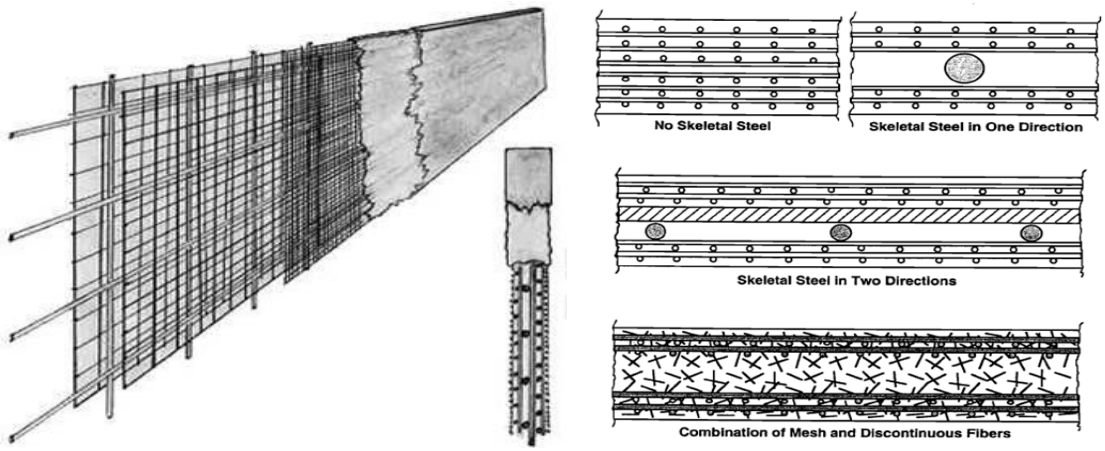
Here, $ML = 500$ m, $L = 20$ m, $L' = 20 + 0.1 = 20.1$ m

$$\text{True length of line } (TL) = \frac{L'}{L} \text{ x } ML = \frac{20.1}{20} \text{ x } 250 = 251.25 \text{ m}$$

2. (a) Sketch typical cross section of Ferro cement. Characteristics of 1st class bricks.

Solution:

"Ferro cement is a type of thin wall reinforced concrete, commonly constructed of hydraulic cement mortar, reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials"



Characteristics of 1st class bricks are given below,

- A good brick should be of proper shape and standard specified size.
- The color of a good brick should be copper red color.
- When a brick is struck by a hammer or against another brick, it should emit a clear metallic ringing sound, it should not be dull.
- The structure should be homogeneous, compact and free from any defects.
- If a brick is dropped from about a height of 1 m on a hard ground or on another brick, it should not break.
- When a brick is scratched with finger nail it should not leave any impression on the brick.
- A good brick (1st Class) should not absorb water by not more than 20% of its own Dry weight when immersed in water for a period of 24 Hours

2. (b) The following materials with given masses are used to produce a batch of concrete. What is the volume of concrete if the air content is 3%? (Air content is the volume of air expressed as a percentage of the concrete volume)

Materials	Cement	Water	SSD (FA)	SSD (CA)
Mass (kg)	279	166	760	1044
SP. Gravity	3.15	1.00	2.60 (bulk SSD)	2.63 (bulk SSD)

Solution:

Material	Mass, kg	Specific gravity	Absolute density, kg/m^3	Absolute volume, m^3
Cement	279	3.15	3150	0.089
Water	166	1.00	1000	0.166
SSD, fine aggregate	760	2.60	2600	0.292
SSD, Coarse aggregate	1044	2.63	2630	0.397
			Total absolute volume =	0.944 m^3

Volume of the concrete V_c is the summation of the absolute volume and the volume of the air V_a.

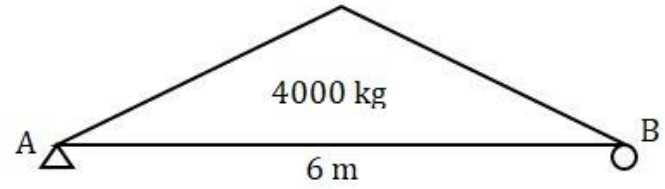
$V_c = 0.944 + V_a$

By definition of air content, $V_a = 0.03\ V_c$

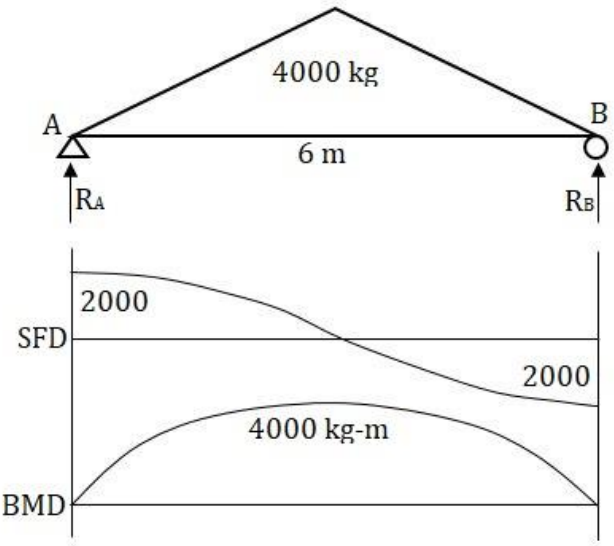
So $V_c = 0.944 + 0.03\ V_c$

Therefore, $0.97\ V_c = 0.944$ and $V_c = 0.944/0.967 = 0.973$ m^3

3. (a) Draw Shear force and bending moment diagram of the following figure.



Solution:

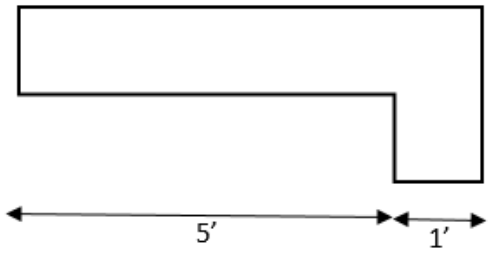


3. (b) Modulus of elasticity of mild steel is 30 x 10^6 psi and its Poisson's ratio is 0.25. Determine the Modulus of rigidity of mild steel.

Solution:

$$G = \frac{E}{2(1+\mu)} = \frac{30 \times 10^6}{2(1+0.25)} = 12 \times 10^6 \text{ psi}$$

4. (a) A one-way slab is supported on RC beam as shown. The working live load is 60 psf. Design the slab. (Given, f_y = 60 ksi, fc' = 4 ksi)



Solution:

Minimum total slab thickness, $h = \frac{L}{10} = \frac{5 \times 12}{10} = 6$ in

Effective depth, $d = 6 - 0.75(\text{cover}) - 0.25$ (estimated half diameter of bar size) $= 5$ in

Dead load, $DL = \frac{6}{12}$ x $150 = 75$ psf

Live load, $LL = 60$ psf

$W_u = 1.4\ DL + 1.7\ LL = 1.4$ x $75 + 1.7$ x $60 = 207$ psf $= 0.207$ ksf

$M_u = \frac{W_u\ L^2}{2} = \frac{0.207 \text{ x } 5^2}{2} = 2.5875$ k − ft

$M_u = \varphi\ A_s\ f_y\ (d - \frac{a}{2})$

$A_s = \frac{2.5875 \text{ x } 12}{0.9 \text{ x } 60 \text{ x } (5 - 0.085)} = 0.116$ in^2/ft (Assume, a $= 0.17$ in)

Check $a = \frac{A_s\ f_y}{0.85\ f_c'\ b} = \frac{0.116 \text{ x } 60}{0.85 \text{ x } 4 \text{ x } 12} = 0.172$ in

$\rho_{min} = \frac{200}{f_y} = 0.0033$

$A_{s,min} = \rho\ b\ d = 0.0033$ x 12 x $5 = 0.198$ in^2/ft

Using 10 mm bar $= \frac{0.11 \text{ x } 12}{0.198} = 6.66$ in

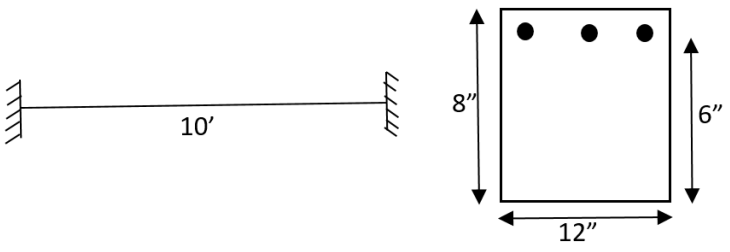
Provide 10 mm bar @ 6.5 in c/c

Transverse direction – Shrinkage and Temperature steel

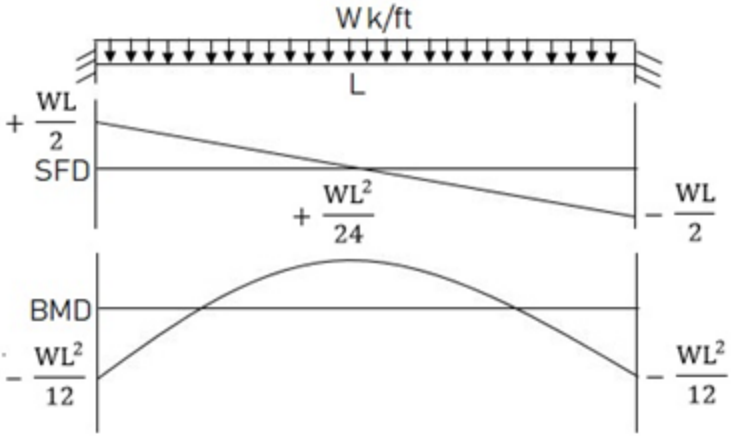
$A_s = 0.0018\ b\ t = 0.0018$ x 12 x $6 = 0.1296$ in^2/ft

Use 10 mm bar @ 10 in c/c

4. (b) The span of a beam 10' long and ends are fixed. The maximum load controlled by the capacity in the negative moment region. Based on the flexural requirements, what is the maximum uniform live load the beam can carry? (f_y = 40ksi, fc'=3.5 ksi, M_n = 140.2 k-in, A_s = 0.62 in^2)



Solution:



Given, $M_n = 140.2$ k–in.

$M_u = \varphi\ M_n = 0.9$ x $140.2 = 126.18$ k − in

For both end fixed beam, $M_u = \frac{W\ L^2}{12}$

$126.18 = \frac{W\ (10 \text{ x } 12)^2}{12}$

$W = 0.105$ kip/inch $= 1.26$ k/ft

Here, Dead load $= \frac{8 \text{ x } 12}{144}$ x $150 = 100$ lb/ft

Total load $= 1.4\ DL + 1.7\ LL$

1.26 x $1000 = 1.4$ x $100 + 1.7$ x LL

$LL = 658.8$ lb/ft

4. (c) What is development length? A RCC beam is to be designed to carry a shear force Vu of 30K. No web reinforcement is to be used, and fc'= 4ksi. What is the minimum cross section if controlled by shear?

Solution:

A development length is the amount of rebar length that is needed to be embedded or projected into concrete to create desired bond strength between the two materials and also to develop required stress in steel at that section.

If no web reinforcement is to be used, the cross sectional dimensions must be selected so that the applied shear V_u is no larger than one-half the design shear strength $\varphi\ V_c$

Web reinforcement is not required if $V_u < \frac{\varphi\ V_c}{2}$

Thus, $V_u = \frac{1}{2}\ \varphi\ (2\ \lambda\ \sqrt{f_c'}\ b_w\ d)$

$b_w\ d = \frac{30{,}000}{0.75 \text{ x } 1 \text{ x } \sqrt{4000}} = 632.45$ in^2

Consider width of the beam, $b_w = 18$ in

depth of the beam $d = 35.13 \approx 35.5$ in and $h = 35.5 + 2.5 = 38$ in

Check: $\varphi\ V_c = 2\ \varphi\ \lambda\ \sqrt{f_c'}\ b_w\ d = 2$ x 0.75 x 1 x $\sqrt{4000}$ x 35.5 x $18 = 60620$ lb $= 60.62$ kip

$\frac{\varphi\ V_c}{2} = 30.31 > V_u$ (Web reinforcement is not required)

Minimum cross section controlled by shear is 18" x 38"

5. (a) Moist soil sample total volume 1.2 m^3 and total mass 2350 kg, Specific gravity 2.71 and water content 8.6%. Find i) Porosity ii) Degree of saturation.

Solution:

Bulk unit weight, $\gamma = \frac{W}{V} = \frac{2350}{1.2} = 1958.33 \text{ kg/m}^3 = 19.21 \text{ kN/m}^3$

Dry unit weight, $\gamma_d = \frac{\gamma}{1+w} = \frac{19.21}{1+0.086} = 17.68 \text{ kN/m}^3$

We know, $\gamma_d = \frac{G_s \gamma_w}{1+e}$

Void ratio, $e = \frac{G_s \gamma_w}{\gamma_d} - 1 = \frac{2.71 \text{ x } 9.81}{17.68} - 1 = 0.502$

We know, $S\ e = w\ G_s$

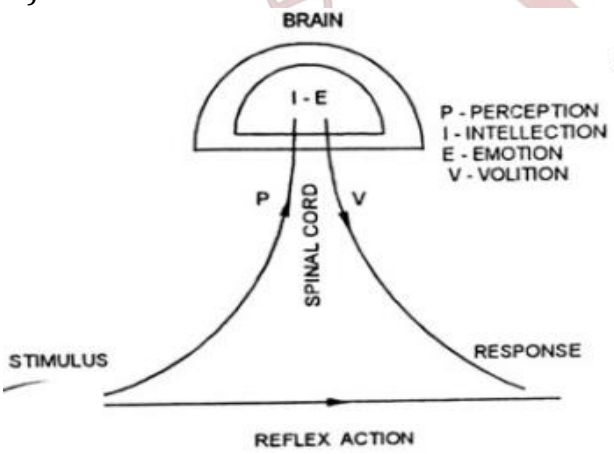
Degree of saturation, $S = \frac{w\ G_s}{e} = \frac{0.086 \text{ x } 2.71}{0.502} = 0.464 = 46.4\%$

5. (b) What is PIEV? General requirements of a Traffic Control device.

Solution:

PIEV: According to this theory the total reaction time of the driver is split into four pans -

i) Perception
ii) Intellection
iii) Emotion and
iv) Volition



To be effective, a traffic control device should meet five basic requirements:

i) Fulfill a need,
ii) Command attention,
iii) Convey a clear, simple meaning,
iv) Command respect from road users, and
v) Give adequate time for proper response

5. (c) Radius of a horizontal circular curve is 100 m. The design speed is 50 kmph and design co-efficient of lateral friction is 0.15. Calculate super elevation required if full lateral friction is assumed to develop.

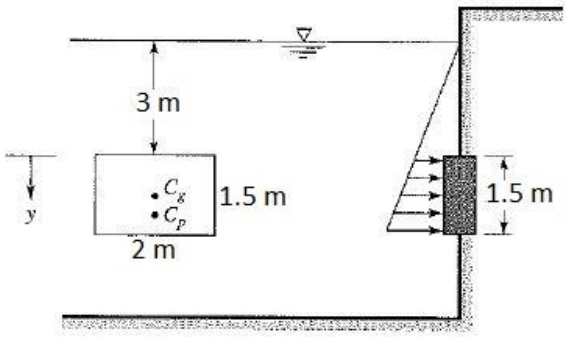
Solution:

We know, $e + f = \dfrac{V^2}{127\ R}$ $\quad (Where\ V\ is\ in\ km/hr)$

$$e = \frac{50^2}{127 \text{ x } 100} - 0.15 = 0.047$$

6. (a) A rectangular gate 2 m wide and 1.5 m high is in a vertical plane. The gate is immersed vertically downwards, the top side being at a depth of 3 m below the free surface. Find the force exerted by the water on the gate and the position of center of pressure.

Solution:



Area, $A = 2 \text{ x } 1.5 = 3 \text{ m}^2$

Location of CG, $\bar{y} = 3 + \dfrac{1.5}{2} = 3.75$ m

Resultant force on gate, $F = \gamma\ A\ \bar{y} = 9.81 \text{ x } 3 \text{ x } 3.75 = 110.3625$ KN

Moment of inertia about CG, $I_G = \dfrac{b\ h^3}{12} = \dfrac{2 \text{ x } 1.5^3}{12} = 0.5625 \text{ m}^4$

Centre of pressure, $h^* = \bar{y} + \dfrac{I_G}{A\ \bar{y}} = 3.75 + \dfrac{0.5625}{3 \text{ x } 3.75} = 3.8$ m

6. (b) Design stable alluvial channel using Lacey's theory. The channel is to carry 10 m^3/s through 1 mm sand.

Solution:

Here, $Q = 10\ m^3/s, d = 1$ mm

$f = 1.76\ \sqrt{d_{mm}} = 1.76\ \sqrt{1} = 1.76$

$$V = \left(\frac{Q\ f^2}{140}\right)^{1/6} = \left(\frac{10 \text{ x } 1.76^2}{140}\right)^{1/6} = 0.77 \text{ m/s}$$

$A = \frac{Q}{V} = \frac{10}{0.77} = 12.99\ \text{m}^2$

$P = 4.75\sqrt{Q} = 4.75\sqrt{10} = 15.02\ \text{m}$

For a trapezoidal channel with $\frac{1}{2}H$: 1 V side slope

$$D = \frac{P - \sqrt{P^2 - 6.944\ A}}{3.472} = \frac{15.02 - \sqrt{15.02^2 - 6.944 \text{ x } 12.99}}{3.472} = 0.97\ \text{m}$$

$B = P - \sqrt{5}\ D = 15.02 - \sqrt{5} \text{ x } 0.97 = 12.85\ \text{m}$

Bed slope, $S = \frac{f^{5/3}}{3340\ Q^{1/6}} = \frac{1.76^{5/3}}{3340 \text{ x } 10^{1/6}} = 0.000523$

Hence, the channel has a bed width $B = 12.85$ m and a depth of 0.97 m.

Use a bed slope of 1 in 1910.

6. (c) Define Duty and Delta. Show the relationship between Duty and Delta.

Solution:

Duty: Number of hectares of land that can be irrigated by 1 cumec of water throughout the base period of a crop. Denoted by D. Unit is hectare/area

Delta: It's the total depth of water in cm required by a crop to come to its maturity is called delta. Denoted by Δ. Unit is meter

Relation between Delta and Duty:

Total depth of water applied, $\Delta = \frac{\text{Volume}}{\text{Area}} = \frac{8640\ \text{B}}{10^3 \text{D}} = \frac{8.64\ \text{B}}{\text{D}}$ meters

7. (a) Ten 5 ml samples of waste water one placed in 300 ml BOD bottles and diluted to full volume. Half of the bottles are tasted immediately and the average initial concentration of dissolved oxygen = 7.9 mg/L the remaining bottles are incubated for 5 days after which the average dissolved oxygen is determined to be 4.5 mg/L (K_1 = 0.13 day-1) Find out- i) Standard BOD ii) Ultimate carbonaceous BOD.

Solution:

Total sample = 10 x 5 = 50 ml.

$P = \frac{50}{300} = 0.1667$

$BOD_5 = \frac{D_O - D_5}{P} = \frac{7.9 - 4.5}{0.1667} = 20.39\ \text{mg/L}$

Now, $BOD_5 = BOD_u(1 - 10^{-k_1 t})$

$20.39 = BOD_u\ (1 - 10^{-0.13\ x\ 5})$

Ultimate carbonaceous BOD, $BOD_u = 26.27$ mg/L

7. (b) Project consisting of six activities.

Activity	A	B	C	D	E	F
Immediate predecessors	-	-	B	A,C	A	D,E
Duration	5	1	2	4	6	3

Construct the project network. Find out the earliest time and the late time.

Solution: