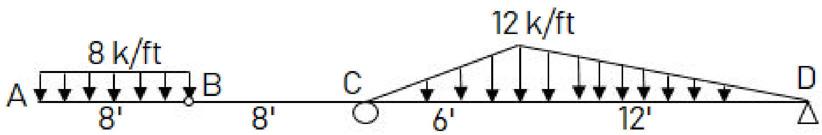
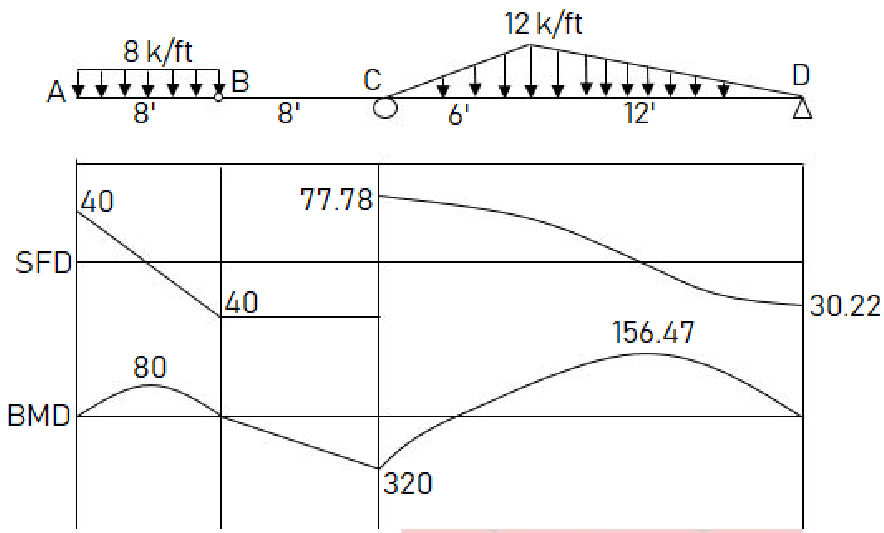
Janata Bank-2017
Post: Assistant Engineer (CIVIL)

1. Draw SFD and BMD of the following beam.



Solution:



2. Design a square tied column to support dead load of 130 kips and live load of 180 kips. Reinforcement ratio must be within 1 to 2%. Assume, $f_c' = 4$ ksi and $f_y = 60$ ksi.

Solution:

$P_u = 1.4\ DL + 1.7\ LL = 1.4 \text{ x } 130 + 1.7 \text{ x } 180 = 488$ kips

Given, $\rho = 0.02$

$P_u = \ \varphi\ \alpha\ A_g\ [0.85\ f_c'\ (1 - \rho) + \rho\ f_y]$

Or, $488 = 0.65 \text{ x } 0.80 \text{ x } A_g \text{ x } [0.85 \text{ x } 4 \text{ x } (1 - 0.02) + 0.02 \text{ x } 60]$

$\therefore\ A_g = \ 207.07 \text{ in}^2$

Square column, $h = \sqrt{207.07} = 14.39 \approx 15$ in

So, 15” x 15” square tied column. $A_g\ = 225 \text{ in}^2$

Again, $P_u = \varphi\ \alpha\ [0.85\ f_c'\ (A_g -\ A_{st}) + A_{st}\ f_y]$

Or, $488 = 0.65 \text{ x } 0.80\ [0.85 \text{ x } 4 \text{ x } (225\ -\ A_{st}) +\ A_{st} \text{ x } 60]$

$\therefore\ A_{st}\ = 3.06 \text{ in}^2$

Area of #6 bar, $A_{st}\ = 0.44 \text{ in}^2$

Use 8 Nos. #6 bar.

3. Determine the number of bolts to transit a dead load force of 25 kips and a live load force of 75 kips through two L8 x 8 x 1 connected to a gusset plate (1 inch thick). All materials are A36 steel. The bolts are ½ inch diameter A35 steel in a bearing type connection with threads excluded from shear plane. Use three bolts across the web of the channel and consider fy = 30 ksi. Apply ASD method.

Solution:

Design force = DL + LL = 25 + 75 = 100 K

For ½ inch bolt, $A = \frac{\pi}{4} 0.5^2 = 0.196 \text{ in}^2$

Fv = 30 (Threads excluded from shear plane)

Rv = 0.196 x 30 = 5.88 k/shear surface

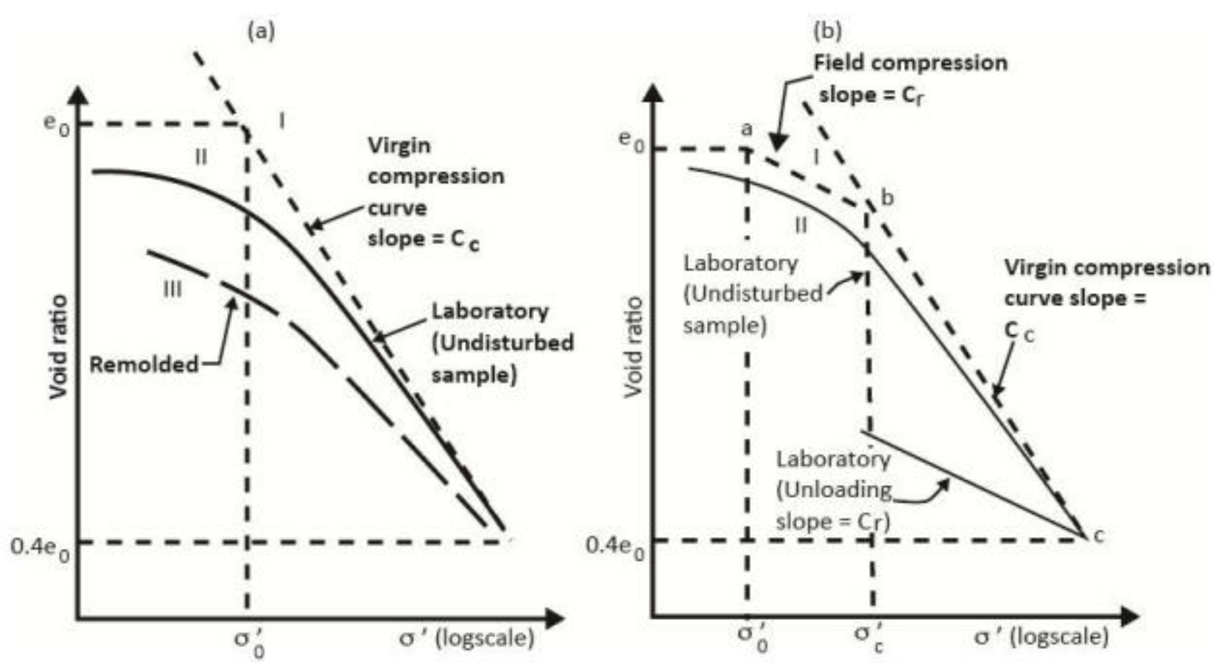
Two shear surface per bolts.

Number of bolts required = $\frac{100}{2 \times 5.88} = 8.5$ = use 9

4. Define virgin consolidation curve. Which one do you prefer as s soil engineer in between laboratory consolidation curve and virgin consolidation curve? Explain with necessary diagram and examples.

Solution:

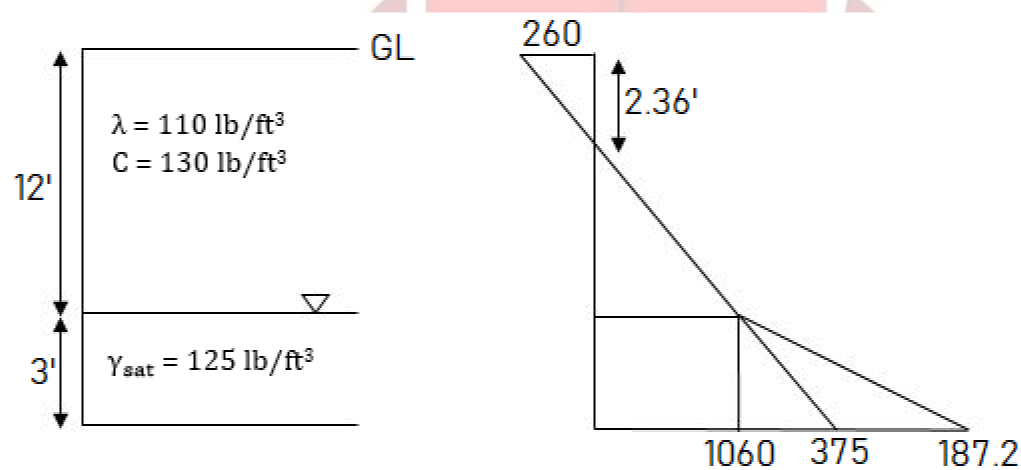
Soil Samples collected from field are somehow disturbed. When consolidation tests are conducted on these samples, we obtain e vs. log σ' plots that are slightly different from those in the field. This is demonstrated in Figure.



Curve I in shows the nature of the e vs. log σ’ variation that an undisturbed normally consolidated clay (present effective overburden pressure; void ratio) in the field would exhibit. This is called the virgin compression curve. A laboratory consolidation test on a carefully recovered sample would result in e vs. log plot such as curve II. Due to obtain approximately corrected result laboratory compression curve is preferred to obtain actual form of virgin compression curve. As example the compression index as determined from the laboratory e-log σ’ curve different from that encountered in the field. Primary reason is that soil remolds to some degree during field exploration. The virgin compression curve intersects the laboratory compression curve at $0.42\, e_0$. Knowing the value of e_0 *and* pc (Pre-Consolidation Pressure) can be easily construct the virgin compression curve to calculate compression index.

5. A retaining wall has to support 15 ft soil above its base level and the water table is 12 ft below the ground level. The backfill material is pure clay having λ = 110 lb/ft^3 and λ_{sat} = 125 lb/ft^3. The value of cohesion, C= 130 lb/ft^3, determine the stresses at different location and draw the pressure diagram.

Solution:



For pure clay, Ø = 0, Ka = 1

At top = $2\,C\,\sqrt{K_a} = 2 \times 30 \times \sqrt{1} = 260$ lb/ft^2

Location of zero stress, $Z_c = \dfrac{2\,C}{\gamma\sqrt{K_a}} = \dfrac{2 \times 130}{110\,\sqrt{1}} = 2.36'$

At 12’ (top of water) = $K_a\,\gamma\,H - 2\,C\,\sqrt{K_a}$

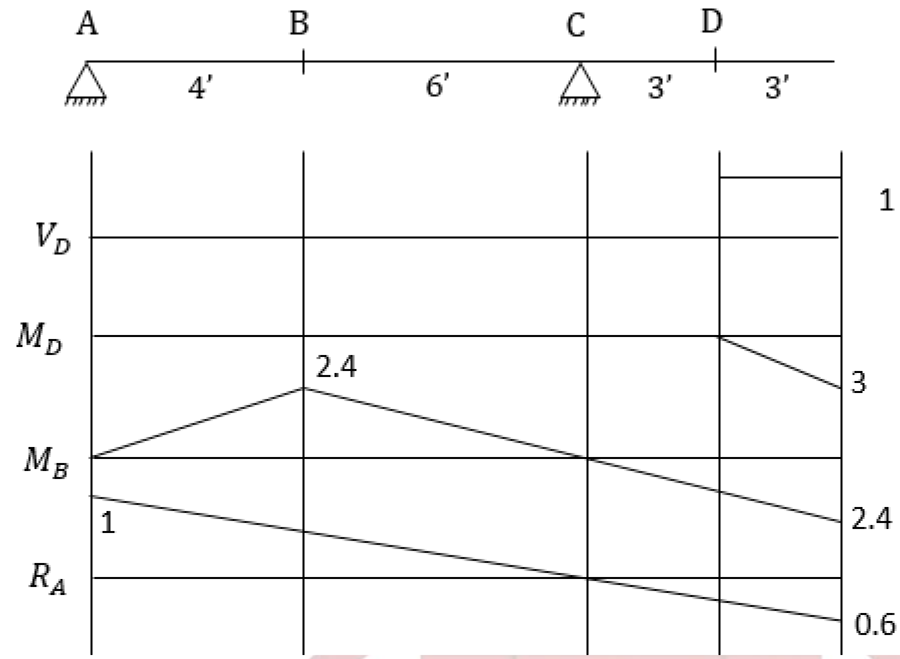
$= 1 \times 110 \times 12 - 2 \times 130 \times \sqrt{1} = 1060$ lb/ft^2

At bottom, due to saturated water = $K_a \gamma_{sat} H = 1 \times 125 \times 3 = 375$ lb/ft^2

Water pressure = $\gamma_w H = 62.4 \times 3 = 187.2$ lb/ft^2

6. Draw IL for shear at D (V_D), bending moments at D (M_D) and B (M_B) and support reaction at A (R_A) for the beam in the figure below.

Solution:



7. The corner of a building is situated next to inner side of a two-lane horizontal curve with a radius of 50 m on a rural highway. Each lane is 3 m With 2 m shoulder. The corner is 0.8 m away from the shoulder. Is it safe to drive at a speed of 90 kmph on this curve? If not, how would you remedy the problem? Assume. Perception-reaction time = 2.5 sec and declaration rate = 3.3 m/sec^2.

Solution

Radius of inside lane, $R = 50 - \frac{3}{2} = 48.5$ m

Horizontal Sightline Offset (HSO) = $\frac{3}{2} + 2 + 0.8 = 4.3$ m

We know,

$HSO = R\,[1 - \cos(28.65 \times \frac{SSD}{R})]$

$SSD = V\,t_{pr} + \frac{V^2}{2\,a} = (\frac{90 \times 1000}{3600} \times 2.5) + \frac{(\frac{90}{3.6})^2}{2 \times 3.3} = 157.197$ m

For safety, the available sight distance should be equal to SSD.

Therefore the building should be located at a distance, $= R\,[1 - \cos(28.65 \times \frac{SSD}{R})]$

$= 48.5\,[1 - \cos(28.65 \times \frac{157.197}{48.5})]$

$= 50.92$ m > Available distance (4.3 m)

The building is not located at safe distance.

8. Let there is a community with a population of 35,000. The solid waste generation rate is 6.5 lb/capita-day. There is a necessity to design a landfill for the community. Estimate the required landfill area. Consider that, the compacted specific weight of solid wastes in landfill 800 lb/yd^3 and average depth of compacted solid waste is 20 ft.

Solution:

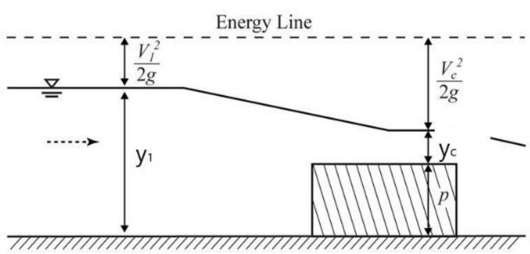
Daily Solid waste generation rate = 35000 x 6.5 = 227500 lb/day

Volume required = $\frac{227500}{800}$ = 284.375 yd^3/day

Area required = $\frac{284.375}{20 \times 0.33}$ = 42.69 yd^2/day

= 42.69 x 365 = 15585 yd^2/year

9. Determine the height of broad crested weir (P) from given data. Width of flume = 25 cm, actual discharge=7020.5 cm^2/sec. Ignore head loss.



Solution:

Given, Q = 7020.5 cm^3/s, B = 25 cm, h_1 = 17.33 cm, P =?

$Y_c = \sqrt[3]{\frac{\alpha Q^2}{g b^2}} = \sqrt[3]{\frac{1 \times 7020.5^2}{981 \times 25^2}}$ = 4.32 cm

$U_c = \frac{Q}{A_c} = \frac{7020.5}{25 \times 4.32}$ = 65.07 cm/s

$U_1 = \frac{Q_1}{A_1} = \frac{7020.5}{25 \times 17.33}$ = 16.20 cm/s

$h_1 + \frac{U_1^2}{2g} + Z_1 = Y_c + \frac{U_c^2}{2g} + P$

Or, $17.33 + \frac{16.20^2}{2 \times 9.81} + 0 = 4.32 + \frac{65.07^2}{2 \times 9.81} + P$

∴ P = 10.99 cm

10. The following consecutive staff reading was taken using a dumpy level: 0.705, 1.655, 0.890, 3.015 and 1.655. The first reading was taken on a benchmark whose RL is 150.605m. Calculate the reduced levels of the stations by the rise and fall method.

Solution:

Station	B.S	I.S	F.S	Rise	Fall	R.L
01	0.705					150.605
02		1.655			0.95	149.655
03		0.899		0.756		150.411
04		3.015			2.116	148.295
05			1.655	1.36		149.655

Check:

Σ B.S - Σ F.S = 0.705 – 1.655 = - 0.95

Last R.L – First R.L = 149.655 – 150.605 = - 0.95

Σ Rise - Σ Fall = 2.116 – 3.066 = -0.95