Q. Design an irrigation channel to carry a discharge of 11270 cusec. The bed material size is 0.014 cm. Use Lacey's theory for design. Assume reasonable value for missing data.

[SGCL-20]

<u>Solution:</u>

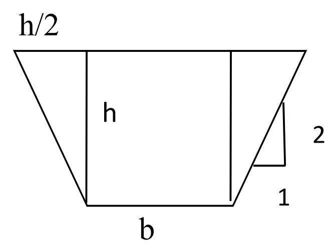
Where, Q = 11270 cusec = 11270/35.3 = 319.26 cumec

d_{mm} = 0.014 cm = 0.14 mm

We know,

$f = 1.76\sqrt{d_{mm}} = 1.76\sqrt{0.14} = 0.66$

$V = [\frac{Qf^2}{140}]^{1/6} = [\frac{319.26 \times 0.66^2}{140}]^{1/6} = 1$ m/s



$A = Q/V = 319.26/1 = 319.26$ m^2

$R = \frac{5V^2}{2f} = \frac{5 \times 1^2}{2 \times 0.66} = 3.79$ m

$P = 4.75\sqrt{Q} = 4.75 \times \sqrt{319.26} = 84.87$ m

For a trapezoidal channel with ½ H : 1 V slopes

$P = b + \sqrt{5}\,h$

$\Rightarrow 84.87 = b + \sqrt{5}\,h$

$\Rightarrow b = 84.87 - 2.24\,h$ …………………… (i)

And, $A = (b + h/2)\,h$

$\Rightarrow 319.26 = bh + h^2/2$

$\Rightarrow 319.26 = 84.87\,h - 2.24\,h^2 + 0.5\,h^2$ [putting the value of b using equation (i)]

$\Rightarrow h^2 - 48.72\,h + 183.48 = 0$

$\therefore h = \frac{48.72 \pm \sqrt{(48.72)^2 - 4 \times 1 \times 183.48}}{2 \times 1} = \frac{48.72 \pm 40.50}{2}$

Neglecting unfeasible (+) ve sign, we get

$h = \frac{48.72 - 40.50}{2} = 4.11$ m **(ans)**

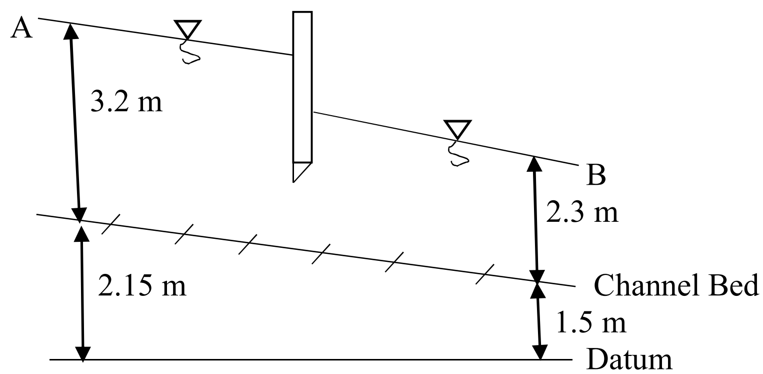
from equation (i), b = 84.87 – 2.24 x 4.11 = 75.66 m **(ans)**

$s = \frac{f^{5/3}}{3340\,Q^{1/6}} = \frac{0.66^{5/3}}{3340 \times (319.26)^{1/6}} = 1/17453$

use a bed slope of 1 in 17453 **(ans)**

Q. Given, width of channel 5 m, head loss due to friction between A & B is 0.32 m. Assume energy and momentum co-efficient as unity (1). Calculate the force acting on the wall.

[SGCL-20]



Solution:

Applying Bernoulli's equation between A and B,

$$Z_1 + y_1 + \frac{V_1^2}{2g} = Z_2 + y_2 + \frac{V_2^2}{2g} + h_L$$

⇨ $2.15 + 3.2 + \frac{V_1^2}{2 \times 9.81} = 1.5 + 2.3 + \frac{V_2^2}{2 \times 9.81} + 0.32$

⇨ $V_2^2 - V_1^2 = 24.13$ -----------------(i)

Now, $V_1 = \frac{Q}{b\,y_1} = \frac{Q}{5 \times 3.2} = \frac{Q}{16}$ and, $V_2 = \frac{Q}{b\,y_2} = \frac{Q}{5 \times 2.3} = \frac{Q}{11.5}$

$\therefore (\frac{Q}{11.5})^2 - (\frac{Q}{16})^2 = 24.13$

⇨ $Q = 81.25\ m^3/s$

Again, $V_1 = \frac{81.25}{16} = 5.08$ m/s and, $V_2 = \frac{81.25}{11.5} = 7.07$ m/s

now using momentum equation,

$$M_2 - M_1 = F_1 - F_2 - F_3$$

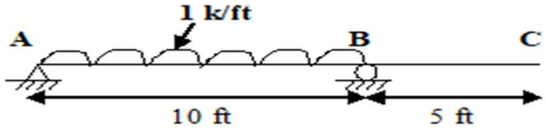
⇨ $\rho\, Q\, \beta_2\, V_2 - \rho\, Q\, \beta_1\, V_1 = \frac{1}{2} \gamma\, y_1^2 - \frac{1}{2} \gamma\, y_2^2 - F$

⇨ $1000 \times 81.25 \times (1 \times 7.07 - 1 \times 5.08) = \frac{1}{2} \times 1000 \times 9.81 \times (3.2^2 - 2.3^2) - F$

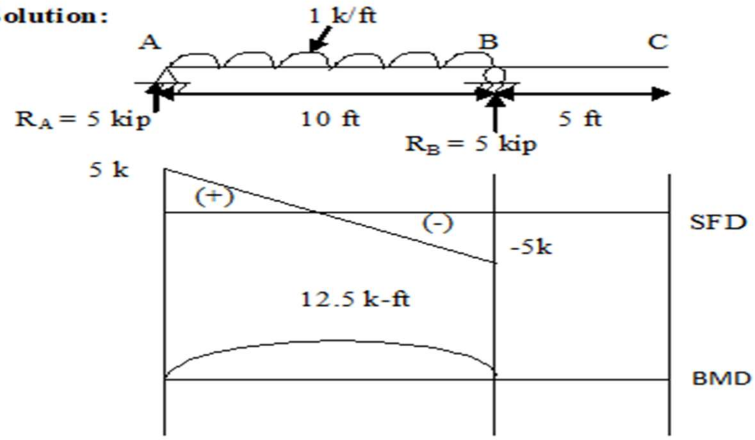
⇨ $F = -\ 137407$ N

The force on the weir plate is equal and opposite to F.

Q. Draw the SFD and BMD of the following figure? [SGCL-20, DESCO-19]

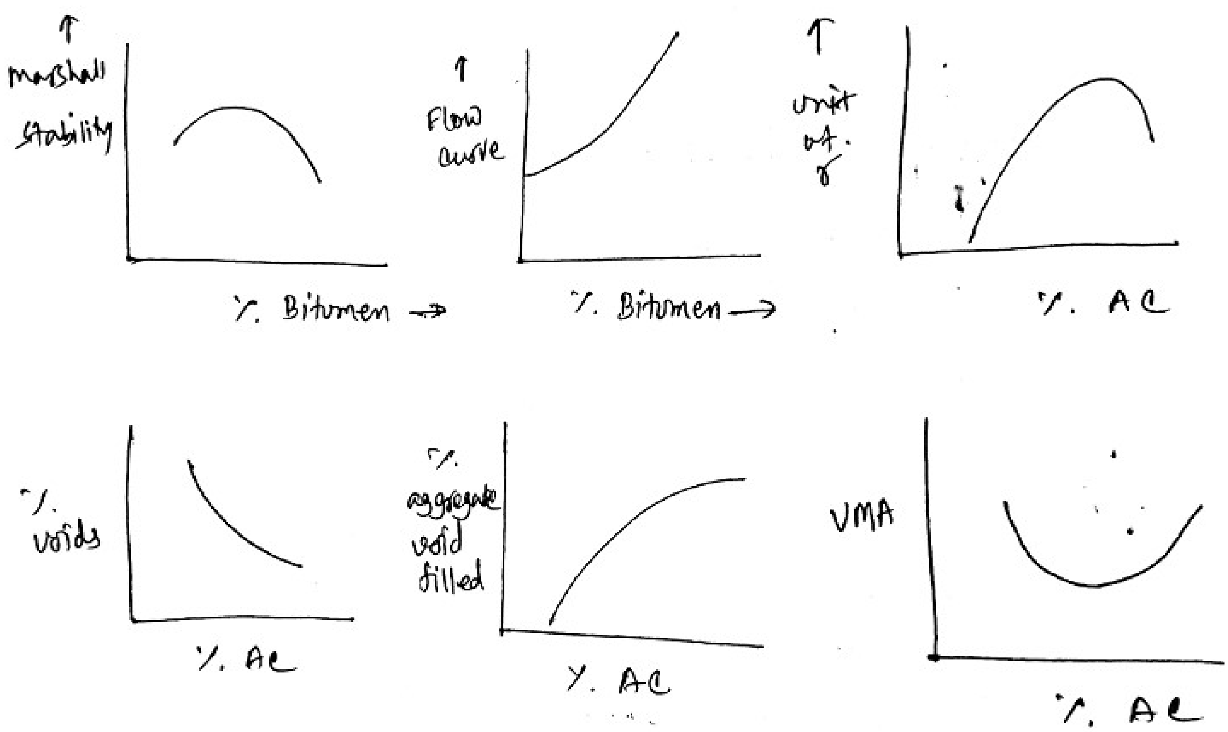


Solution:



Q. Sketch the qualitative test property curve for the hot mix design data by Marshall Method. [BCIC-18, SGCL-18, 20, BPDB-15]

Marshall mix design



Q. What is BOD and COD? [BMA-18, JOC-18, SGCL-20, 18]

BOD (Biochemical oxygen demand): The amount of oxygen required by micro-organisms while stabilizing decomposable organic matter under aerobic condition.

COD (Chemical oxygen demand): The amount of oxygen required by oxidizing agent while stabilizing all type of organic and inorganic matter.

Q. Sieve analysis performed on a soil, Find F.M. [SGCL-20]

Sieve size	#4	#8	#16	#30	#40	#50	#100	#200	pan
% return	0	1	4	13	30	16	6	2	4

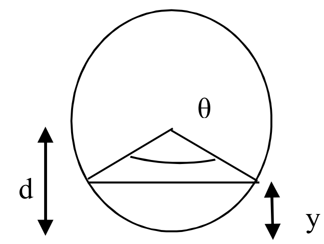
Solution:

Sieve	% of return	% of cumulative return
No. 4	0	0
No. 8	1	1
No. 16	4	5
No. 30	13	18
No. 40	30	48
No. 50	16	64
No. 100	6	70
No. 200	2	-
Pan	4	-

$\therefore$ F.M. $= \frac{1+5+18+64+70}{100} = \frac{158}{100} = 1.58$ **(Ans.)**

Q. A sewer of dia 400 mm is laid on a grade of 0.015 with manning's n = 0.013. What is the discharge and velocity of the sewer when the depth of flow is 100 mm. [SGCL-20]

Solution:



We know, $y = \frac{1}{2}(1 - \cos\frac{\theta}{2})\, d$

$\Rightarrow 100 = \frac{1}{2}(1 - \cos\frac{\theta}{2}) \times 400$

$\Rightarrow \theta = 120^0 = 2.09^{r}$

$A = \frac{1}{8}(\theta - \sin\theta)\, d^2 = \frac{1}{8}(2.09 - \sin 120^0) \times (\frac{400}{1000})^2 = 0.024\ m^2$

$R = \frac{1}{4}(1 - \frac{\sin\theta}{\theta})\, d = \frac{1}{4}(1 - \frac{\sin 120}{2.09}) \times (\frac{400}{1000}) = 0.06\ m$

Velocity, $V = \frac{1}{n} R^{2/3} S^{1/2} = \frac{1}{0.013} \times (0.06)^{2/3} \times (0.015)^{1/2} = 1.44$ m/s **(ans)**

Discharge, $Q = VA = 1.44 \times 0.024 = 0.035\ m^3/s$ **(ans)**