Subject Code & Name**: 23AST205 AEROSPACE STRUCTURES**

UNIT: **3. SHEAR FLOW IN CLOSED SECTIONS**

TOPIC: **2. Bredt – Batho formula in closed section**

Let us suppose the origins where the shear flow has unknown values $q_{s,o}$

Then for closed section

$$q_s = \frac{-\bar{S}_x}{I_{yy}} \int x t\, ds - \frac{\bar{S}_y}{I_{xx}} \int y t\, ds + q_{s,o}$$

$$q_s = q_b + q_{s,o}$$

$$q_{s,o} = -\frac{M}{2A}$$

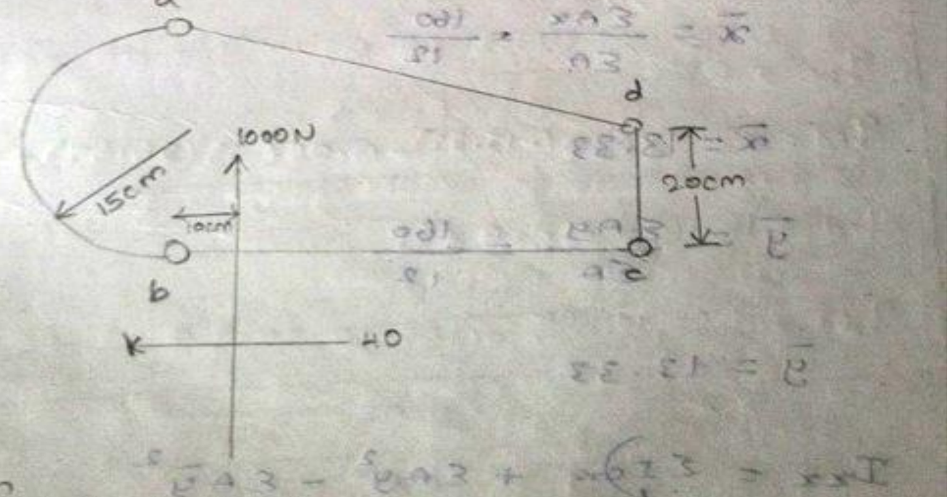
M → Unbalanced Moment

q_b → basic shear flow equation for open tube

$q_{s,o}$ → unknown shearflow equation at origin of 's' co-ordinates.

The value of shearflow at origin of 's' is found by making a cut at that point and equating applied the initial moments taken abo[ut] some convinience point.

) plot shear flow for given closed section.

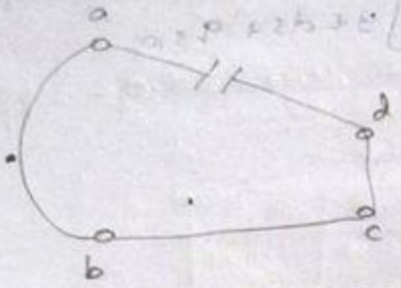


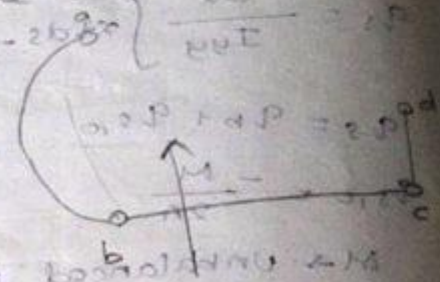
given

$a = b = 4cm^2$

Solu:-

To solve the above problem, make a cut between stringers a and d to make it as open section. The section becomes,





Boom	Area	x	y	Ax	Ay	Ax^2	Ay^2	Axy
a	4	0	30	0	120	0	3600	0
b	4	0	0	0	0	0	0	0
c	2	40	0	80	0	3200	0	0
d	2	40	20	80	40	3200	800	~~3200~~ 1600
Σ	12	80	50	160	160	6400	4400	1600

$$\bar{x} = \frac{\Sigma Ax}{\Sigma A} = \frac{160}{12}$$

$$\bar{x} = 13.33$$

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{160}{12}$$

$$\bar{y} = 13.33$$

$$I_{xx} = \Sigma I_{xx_0} + \Sigma A y^2 - \Sigma A \bar{y}^2$$

$$I_{xx} = 4400 - 12(13.33)^2$$

$$I_{xx} = 2267.74 \text{ cm}^4$$

$$I_{yy} = \Sigma I_0 dy + \Sigma A x^2 - \Sigma A \bar{x}^2$$

$$I_{yy} = 6400 - 12(13.33)^2$$

$$I_{yy} = 4267.73 \text{ cm}^4$$

$$I_{xy} = \Sigma Axy - \Sigma A\bar{x}\bar{y}$$

$$I_{xy} = 1600 - 12(13.33)(13.33)$$

$$I_{xy} = -532.26 \text{ cm}^4$$

$S_x = 0$; $S_y = 1000$

$$\bar{S}_x = \frac{S_x - S_y \frac{I_{xy}}{I_{xx}}}{1 - \frac{I^2_{xy}}{I_{xx} I_{yy}}}$$

$$\bar{S}_x = \frac{0 - \left[1000 \times \frac{(-532.26)}{2267.74}\right]}{1 - \frac{(-532.26)^2}{2267.74 \times 4267.73}}$$

$$\bar{S}_x = 241.71 \text{ N}$$

$$\bar{S}_y = \frac{S_y - S_x \frac{I_{xy}}{I_{yy}}}{1 - \frac{I^2_{xy}}{I_{xx} I_{yy}}}$$

$$\bar{S}_y = \frac{1000 - \left[0 \times \frac{(-532.26)}{2267.74}\right]}{1 - \frac{(-532.26)^2}{2267.74 \times 4267.73}}$$

$$\bar{S}_y = 1020.18 \text{ N}$$

$$q = \frac{-S_y}{I_{xx}} \Sigma A_i y_i - \frac{S_x}{I_{yy}} \Sigma A_i x_i$$

$$q = -\frac{1030.18}{2267.74} \Sigma A_i y_i - \frac{241.71}{4267.73} \Sigma A_i x_i$$

$$\boxed{q = -0.45 \Sigma A_i y_i - 0.05 \Sigma A_i x_i}$$

	A	B	C	D
A	4	4	2	2
x	-13.33	-13.33	26.67	26.67
y	16.67	-13.33	-13.33	6.67

$$q_{ab} = -0.45(4)(16.67) - 0.05(4)(-13.33)$$

$$q_{ab} = -30.27 + 3.017$$

$$q_{ab} = -27.26$$

$$q_{bc} = -0.45(4)(-13.33) - 0.05(4)(-13.33) + q_{ab}$$

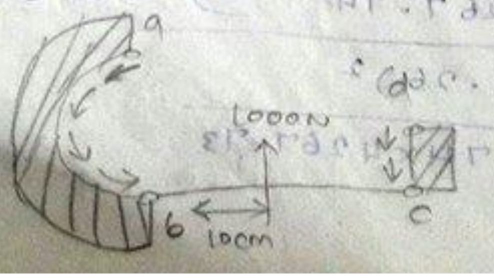
$$q_{bc} = 24.20 + 3.017 - 27.26$$

$$q_{bc} = 0$$

$$q_{cd} = -0.45(2)(-13.33) - 0.05(2)(26.67) + q_{bc}$$

$$q_{cd} = 12.10 - 3.019 + 0$$

$$q_{cd} = 9.05 \text{ N/cm}$$



$$q_s = q_b + q_{s,0}$$

$$q_{s,0} = \frac{-M}{2A}$$

$$A = \frac{1}{2}\pi r^2 + \frac{1}{2} bh$$

$$A = \left[\frac{1}{2} \times \pi \times 15^2 + \frac{1}{2} \times (40 \times 10) + (40 \times 20)\right]$$

$$A = 1353.42 \, cm^2$$

Moment about 'b' (Unbalanced Moment)

$$M = \left(-1000 \times 10 - 2\underbrace{\left(\frac{\pi r^2}{2}\right)}_{\rightarrow 2Aq} \times 27.26\right) + 9.08 \times 40 \times 20$$

$$= 10000 - 27.26 \times \pi \times 15^2 + 9.08 \times 800$$

$$= -2736 - 27.26 \times \pi \times 15^2$$

$$M = -22004.95 \, N/cm$$

$$q_{s,0} = 8.129 \, N/cm$$

$$q_{s,0} = q_{ad}$$

Shear flow of closed section

$$q_s = q_b + q_{s,0}$$

$$q_{ab} = -27.26 + 8.13$$

$$q_{ab} = -19.13$$

$q_{bc} = 0 + 8.13$

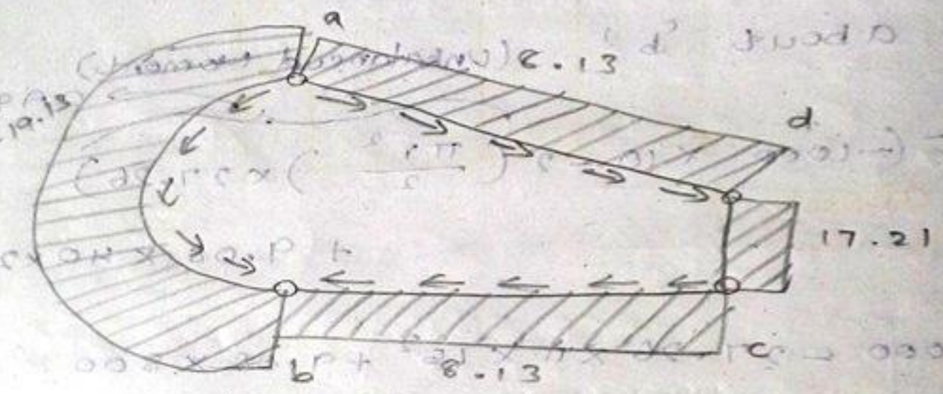
$q_{bc} = 8.13 \text{ N/cm}$

$q_{cd} = 9.08 + 8.13$

$q_{cd} = 17.21 \text{ N/cm}$

$$q_{s,0} = \frac{-(-22004.95)}{2 \times 1353.45}$$

$$\boxed{q_{s,0} = 8.13 \text{ N/cm}}$$



3-14 Torsional effect of Multicell tube:-

Assumption:-

1. Angle of twist is equal for all cells.

$$\theta_1 = \theta_2 = \theta_3 = \theta.$$

2. Material is homogeneous.
3. It obeys hooks law.
4. Beam is subjected to torque alone.

for single cell

$$T = 2Aq$$


SEE YOU NEXT CLASS!