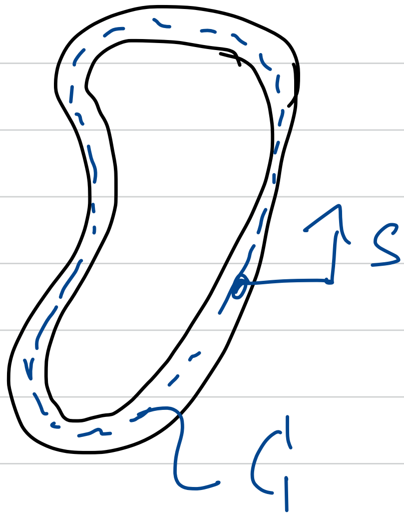
Shearing at Closed Sections

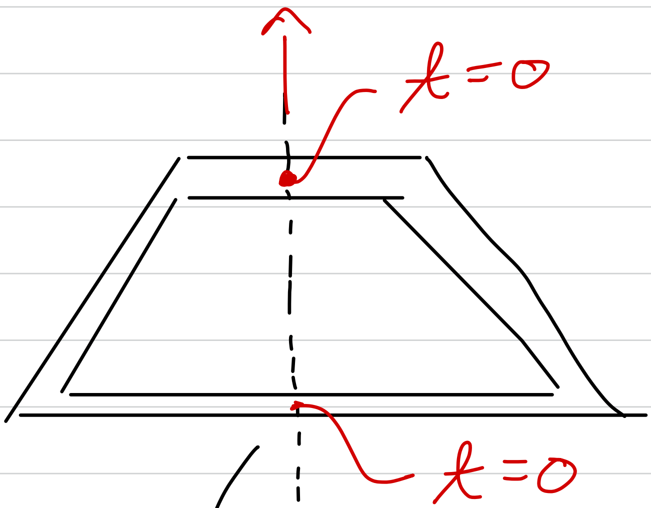


* No boundary condition for c is clearly defined.

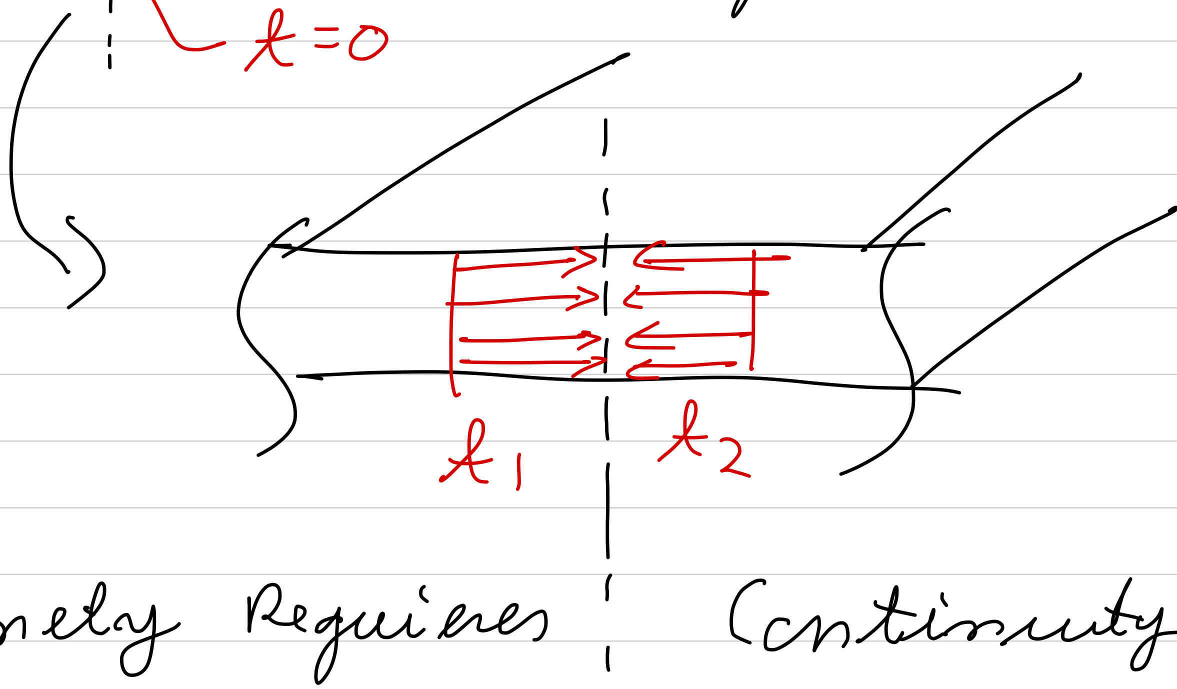
$$f(s) = C + \frac{Q_3(s) H_{23}^c - Q_2(s) H_{33}^c}{\Delta H} V_3$$

$$- \frac{Q_3(s) H_{22}^c - Q_2(s) H_{23}^c}{\Delta H} V_2$$

Symmetry



If we apply a shear force along the symmetry plane, we expect the solution to be symmetric.



Symmetry Requires

$$t_1 = t_2$$

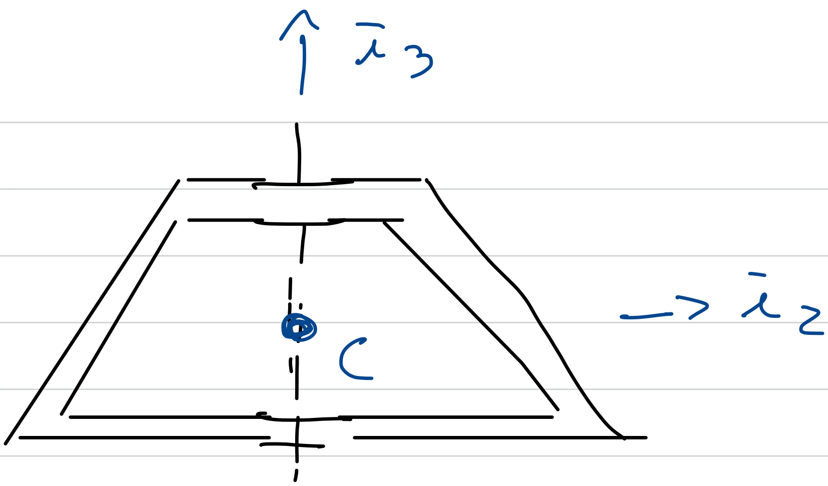
Continuity

$$t_1 + t_2 = 0$$

$$t_1 = -t_2$$

Only solution is

$$\boxed{t_1 = t_2 = 0 \quad @ \text{ Symmetry Plane}}$$

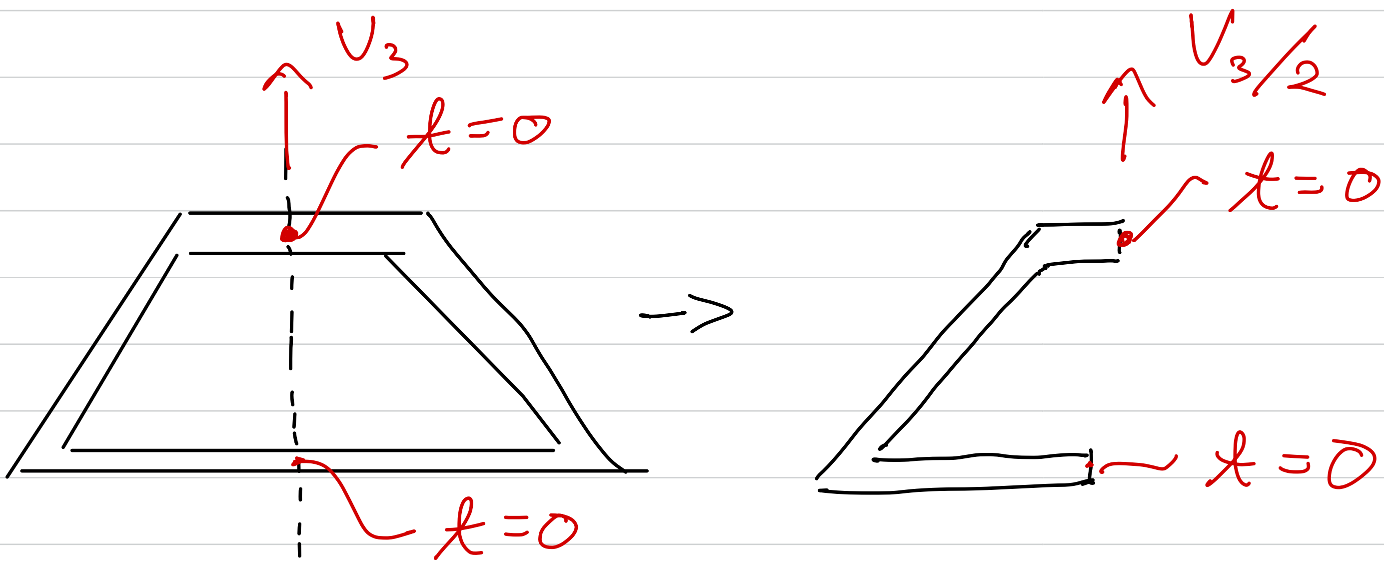


Load not applied about sym plane!

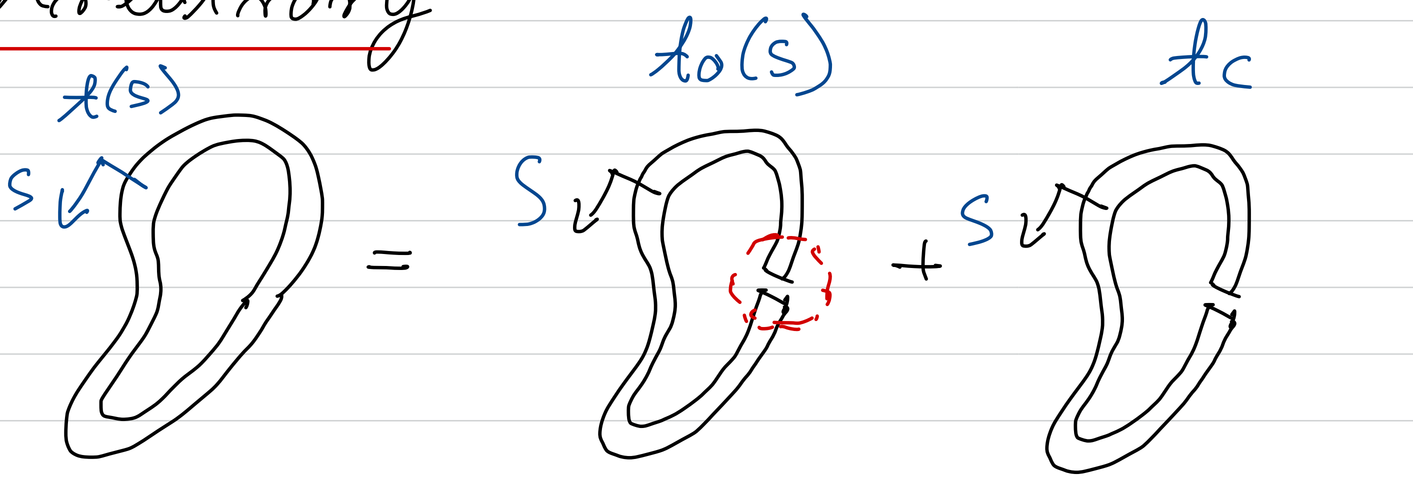
$\longrightarrow V_2$

* If $V_2 \neq 0$, the above argument is no longer valid!

* Left and right sides can be solved using the analysis developed for open-sections.



Arbitrary

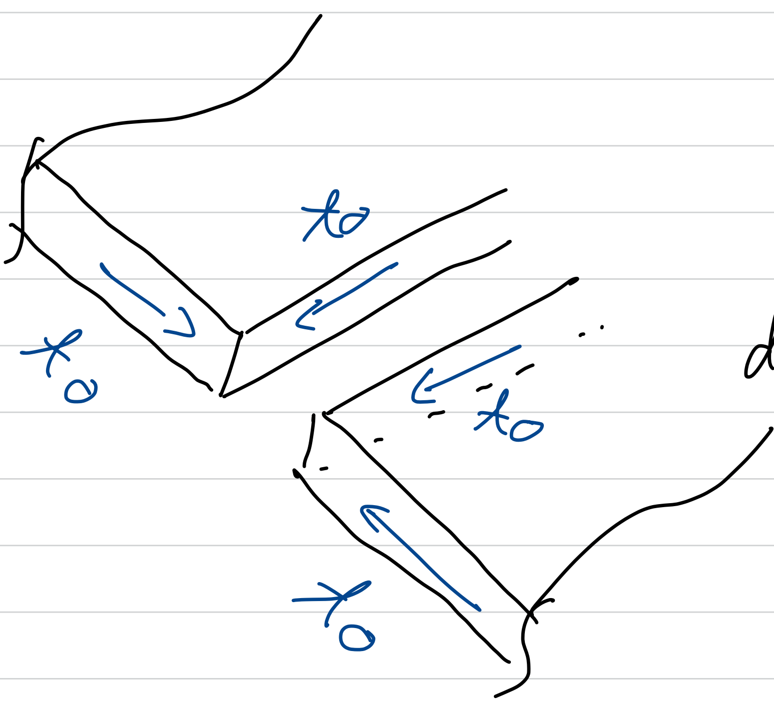


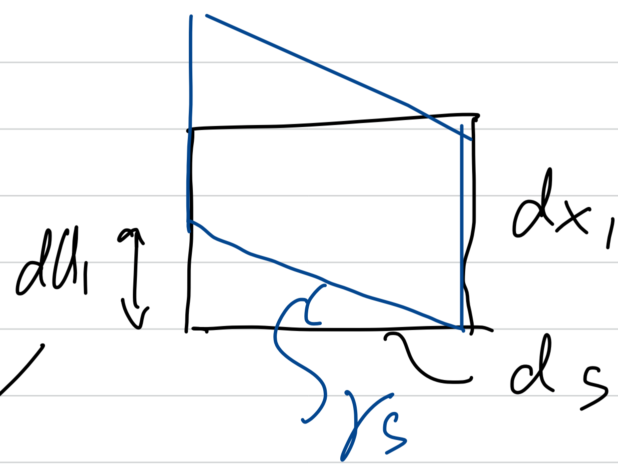
Shear-Flow in the open section

t_c = constant

Closing Shear Flow

$$t(s) = t_0(s) + t_c$$





* Shear flow creates a finite relative axial displacement across the cut

$$du_1 = \gamma_s \cdot ds = \frac{\tau_s}{G} ds$$

$$du_1 = \frac{t_0(s)}{G \cdot t} ds$$

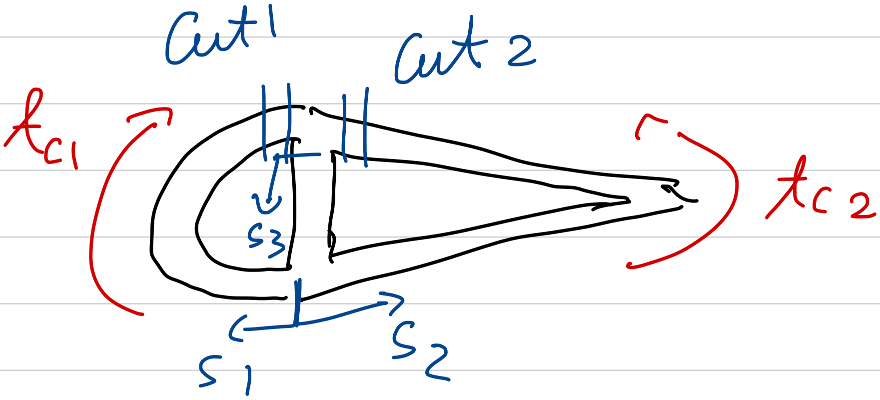
$$u_0 = \int_{C_1'} \frac{t_0(s)}{Gt} ds$$

* A constant shear flow t_c is applied to eliminate u_0

$$u_T = \int_{C_1'} \frac{t_0(s) + t_c}{Gt} ds = 0$$

$$\boxed{t_c = - \frac{\int_{C_1'} \frac{t_0(s)}{Gt} ds}{\int_{C_1'} \frac{1}{Gt} ds}}$$

Shearing of Multi-Cellular Structures.



* Open-Section Shear Flows

$t_0(s_1)$, $t_0(s_2)$, $t_0(s_3)$

* Closing Flows

t_{c1} & t_{c2}

* Displacement Condition for each cut

$$u_{T1} = \int_{C_1^{(1)}} \frac{t_0(s_1) + t_{c1}}{Gt} \, ds_1$$

$$+ \int_{C_1^{(3)}} \frac{t_0(s_3) + (t_{c1} + t_{c2})}{Gt} \, ds_3$$

$$= 0$$

$$u_{T2} = \int_{C_1^{(2)}} \frac{\tau_0(s_2) + \tau_{c2}}{Gt}\, ds_2 + \int_{C_1^{(3)}} \frac{\tau_0(s_3) + (\tau_{c1} + \tau_{c2})}{Gt}\, ds_3 = 0$$

* Two equation which can be solved for the two unknowns τ_{c1} & τ_{c2}