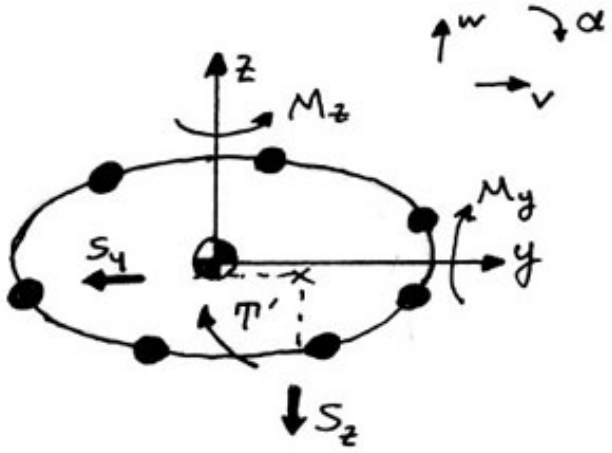
16.20 HANDOUT #4B
Fall, 2002
Shell Beam Theory



Notes

- y, z axes at "modulus - weighted" c.g.
- Q_y, Q_z are static moments about y, z
- S_y, S_z are shear resultants at shear center

a) Axial Stresses

$$\sigma_x = \frac{E}{E_1}\left[\frac{F^{TOT}}{A^*} - \frac{\left(I_{yy}\,M_z^{TOT} - I_{yz}^*\,M_y^{TOT}\right)}{I_{yy}^*\,I_{zz}^* - I_{yz}^{*2}}\,y - \frac{I_{zz}^*\,M_y^{TOT} - I_{yz}^*\,M_z^{TOT}}{I_{yy}^*\,I_{zz}^* - I_{yz}^{*2}}\,z - E_1\alpha\Delta T\right]$$

b) Joint Equilibrium @ stringer A_s

$$q_{out} - q_{in} = -\frac{A_s^*}{A^*}\frac{dF^{TOT}}{dx} + \frac{\left(I_{yy}^*\,S_y^{TOT} - I_{yz}^*\,S_z^{TOT}\right)}{I_{yy}^*\,I_{zz}^* - I_{yz}^{*2}}\,Q_{zs}^* + \frac{\left(I_{zz}^*\,S_z^{TOT} - I_{yz}^*\,S_y^{TOT}\right)}{I_{yy}^*\,I_{zz}^* - I_{yz}^{*2}}\,Q_{ys}^* - E_1\,A_s^*\,\frac{d}{dx}\left(\alpha\Delta T\right)$$

Where:

E_1 = reference modulus

$F^{TOT} = F + F^T$

$$M_z^{TOT} = M_z + M_z^T$$

$$S_y^{TOT} = \frac{dM_z^{TOT}}{dx} = S_y + \frac{dM_z^T}{dx}$$

$$Q_{ys}^* = \int z dA^* = z A_S^*$$

$$I_{yy}^* = \int z^2 dA^*$$

$$dA^* = \frac{E}{E_1} dA$$

etc.