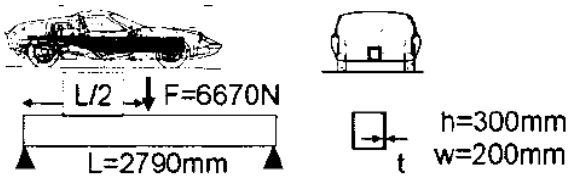
1. One topology for resisting bending load is a back bone beam down the center of the vehicle. The back-bone can be idealized as a uniform beam supported at the axle position. The test load condition is shown. The basic equation for maximum stress is $\sigma = Mc/I$ and for maximum deflection of a center loaded span is $\delta = FL^3/(48EI)$. Assume the material is steel with E = 207,000 N/mm^2, $\sigma_{allowable}$ = 175 N/mm^2. [Use $I_{xx} = h^2t(3b+h)/6$]

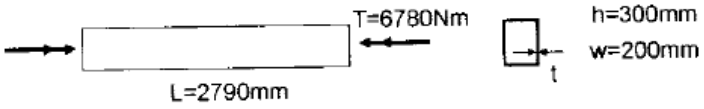


(1) Compute the minimum thickness to meet the strength requirement of supporting a 6,670 N load. (5 pts)

(2) Compute the minimum thickness if the deflection at center span is to be at most 1 mm. (5 pts)

(3) How short does the wheel base L need to be before strength and stiffness criteria require the same thickness? (10 pts)

The twisted ditch torque is 6780 Nm with an allowable shear stress $\tau_{allowable}$ = 86 N/mm^2. Also, the stiffness requirement for torsion is 12,000 Nm/degree measured between the axles (L = 2790 mm). Assume the material is steel with G = 83,000 N/mm^2.



[for closed section: $J_{eff} = \dfrac{4A^2}{\oint \frac{dS}{t}}$, $\theta = \dfrac{Tl}{GJ_{eff}}$, $\tau = \dfrac{T}{2At}$]

(4) Compute the required thickness to meet the twisted ditch strength requirement. (5 pts)

(5) Compute the required thickness to meet the torsional stiffness requirement. (5 pts)

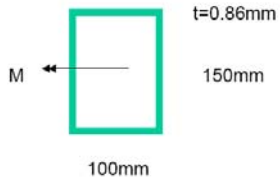
(6) Which is the dominant requirement? (5 pts)

2. Describe techniques to inhibit plate buckling. (15 pts)

3. Determine the following:

(1) At what bending moment, M_{cr}, will the top cap just buckle? . (10 pts)

(2) What is the effective width of the top cap when $\sigma_s = 2.0\sigma_{cr}$? . (10 pts)



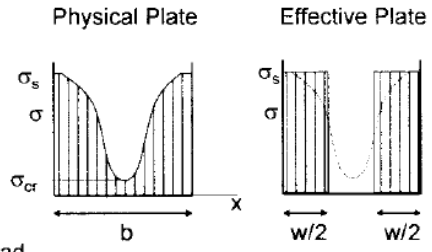
$$\sigma_{cr} = k\frac{E\pi^2}{12\left(1-\nu^2\right)}\frac{1}{(b/t)^2}$$

data :

$E = 207\times10^3\, N/mm^2$

$\nu = 0.3$

$k = 4$



Compressive load reacted by plate: $P = \int_0^b \sigma\, t\, dx$ $\qquad P = \sigma_s wt$

$$\sigma = \left(\frac{\sigma_s+\sigma_{cr}}{2}\right)+\left(\frac{\sigma_s+\sigma_{cr}}{2}\right)\cos\frac{2\pi x}{b}$$

4. Fill in the part names. (3 pts each)