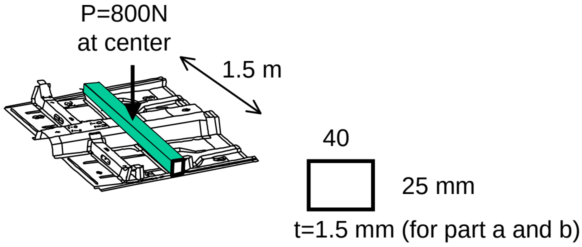
Seat mount Cross Member Number 3 Bar

Exercise 1.1



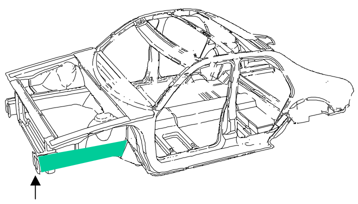
a) Find maximum stress and deflection at the load point for simply supported end conditions

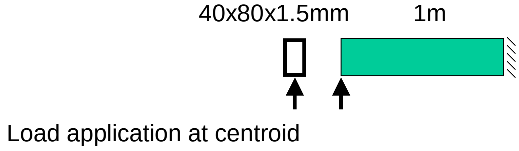
b) Find maximum stress and deflection at the load point for fixed end conditions

c) For the simply supported case with requirements
•k $\geq$ 100N/mm
•$P_{yield} \geq$ 2000N
Determine the required thickness; consider only yielding behavior
Which requirement dominates? (i.e. which requires the greater thickness)

Motor Compartment Rail

Exercise 1.2a

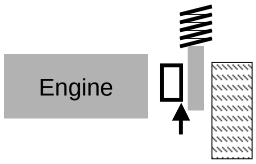




a) Determine the deflection of the tip of the beam and maximum direct stress and location for a 2000N load

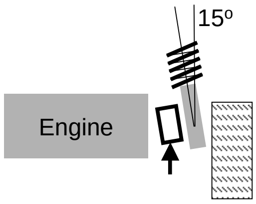
Motor Compartment Rail

Exercise 1.2b,c



Load application point moved to corner of section

b) Determine the deflection of the tip of the beam and maximum direct stress and location for a 2000N load



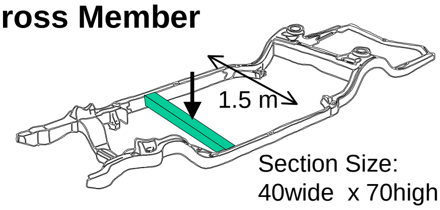
Section rotated 15º.

Load application point through centroid of section

c) Determine the deflection of the tip of the beam and maximum direct stress and location for a 2000N load

Frame Cross Member

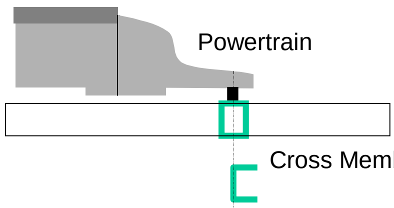
Exercise 1.3



Section Size:
40wide x 70high x 2 mm

Powertrain

Side View



Frame Side Rail

Cross Member

The rear powertrain mount is at the center of a cross member. The maximum vertical load is 1000N.The end condition for the cross member at the frame rails is simply supported. Calculate the deflection at the load point, and maximum direct stress and its location for:

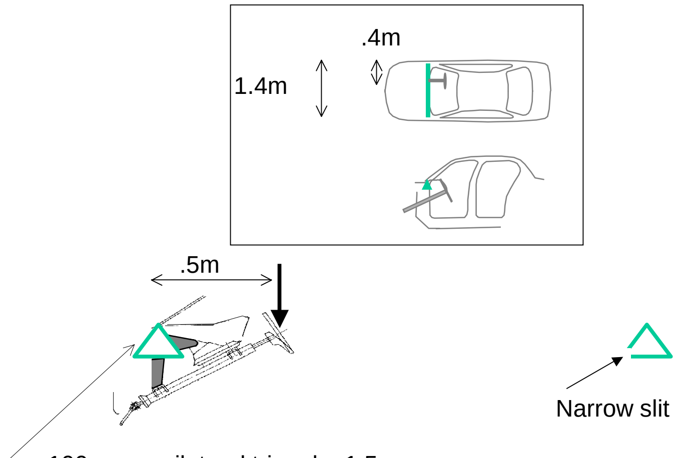
a) closed rectangular cross section with load applied at centroid

b) rear facing C section with load applied at the web with warping unconstrained

c) Same as b) but with warping constrained-use $C_w = \frac{h^2 b^3 t}{12} \frac{(2h+3b)}{(h+6b)}$ where h height, b flange length

Steering column mount

Exercise 1.4



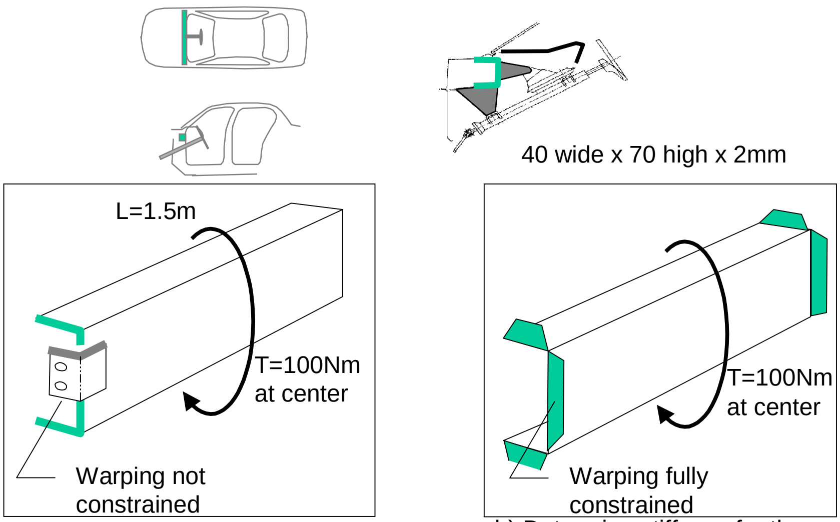
100mm equilateral triangle, 1.5 mm

a) Determine deflection at point of load application under 1KN load with closed section

b) Determine deflection at point of load application under 1KN load with section with narrow slit(unrestrained warping)

Steering column mount C section

Exercise 1.5



a) Determine stiffness for the above conditions

b) Determine stiffness for the above conditions, C_w=4.3837x10^{7}mm^6

Geometrical Analysis of Sections
GAS

Exercise 1.6

a) By scaling the drawings, calculate the nominal section properties for Neon. Use the vertical and horizontal orientation in the drawing for the axis system.

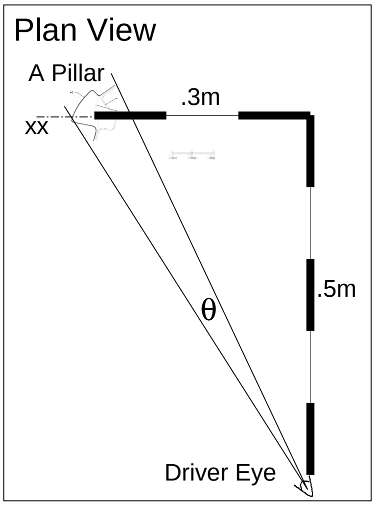
Rocker
A Pillar
Roof Rail
B Pillar -Lower
Hinge Pillar
C Pillar -Upper

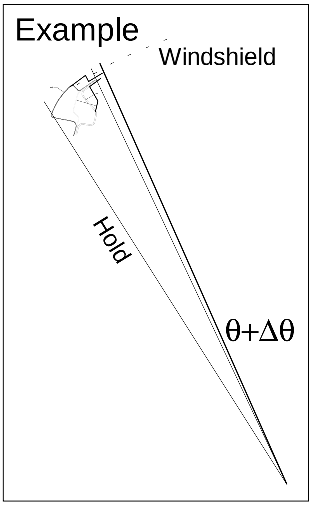
b) Calculate the Effective section properties for the Neon at a uniform compressive load at yield

c) Compare the Effective to Nominal Moments of inertia about the horizontal axis by taking the ratio I_{eff}/I_{nom} for each section

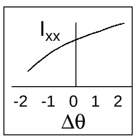
Vision Obscuration Versus A Pillar Size

Exercise 1.7



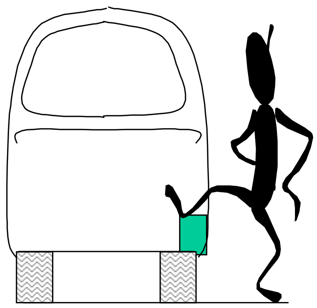


Plot A Pillar I_{xx} vs. vision angle for Neon. Hold rear vision line and increase section along windshield curvature. Maintain weld flange length. Use your judgement otherwise. Go from base section -2° to +2°. Results should look similar to the sketch at right.

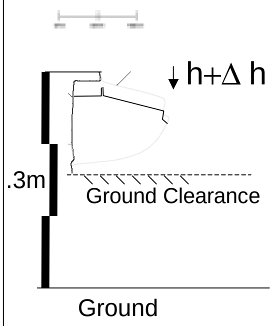


Step Over Height versus Rocker Size — Exercise 1.8

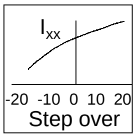
Rear View



Section Detail



Plot rocker I_{xx} vs. step over height for Neon. Hold bottom flange and increase section at top. Maintain weld flange length. Use your judgement otherwise. Go from base section -20mm to +20mm. Results should look similar to the sketch at right.



General Buckling Width-to-Thickness Ratio — Exercise 1.9

a) At what b/t ratio will σ_{yield} and σ_{crit} be equal?

b) For mild steel σ_{yield}=30000psi, what is the numerical b/t ratio at which this occurs?

c) A typical Aluminum alloy has σ_{yield}=50000psi and E=10x10^{6}psi what is b/t ratio where σ_{yield} and σ_{crit} are equal?

General Buckling Coefficient — Exercise 1.10

a) Show that when

$$w = A_{mn}\sin\left(\frac{m\pi x}{a}\right)\sin\left(\frac{n\pi y}{b}\right)$$

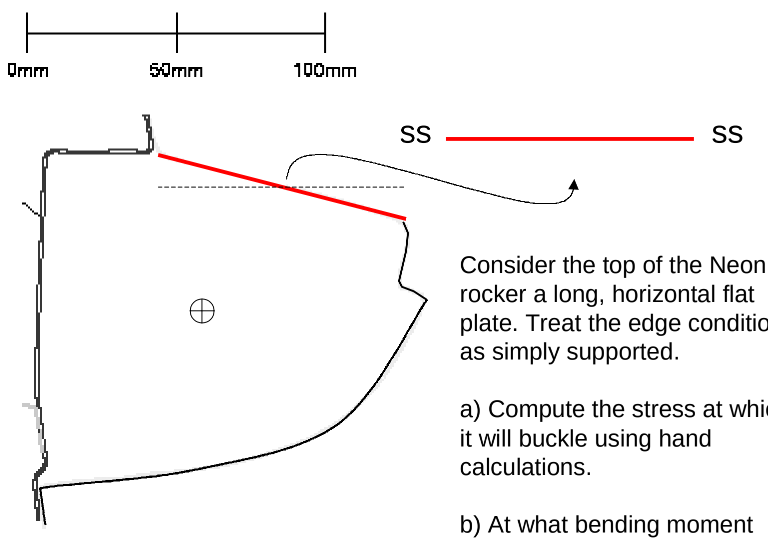
the edge constraints are M_x=0, M_y=0, and M_{xy}=0.

b) Show that when *w* is given as above, the plate equation yields

$$f_{cr} = \frac{D\pi^2}{tb^2}\left[m\left(\frac{b}{a}\right)+\frac{n^2}{m}\left(\frac{a}{b}\right)\right]^2$$

c) Plot the result of b) as [term in brackets above] vs b/a for n=1, m=1,2,3 and for n=2, m=1,2,3 and show that the term in brackets has a lower limit of 4 for these n and m values.

Buckling Stress for a Section Element — Exercise 1.11

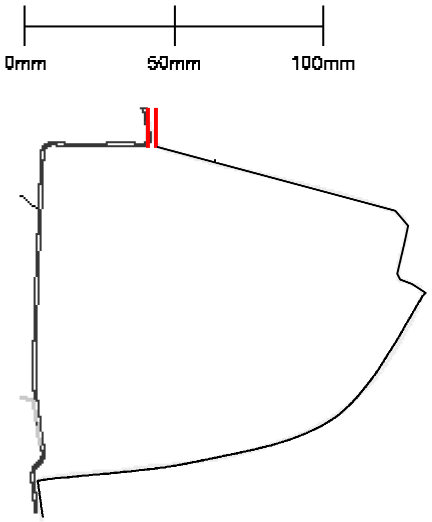


Consider the top of the Neon rocker a long, horizontal flat plate. Treat the edge conditions as simply supported.

a) Compute the stress at which it will buckle using hand calculations.

b) At what bending moment does a) occur?

Buckling Stress for a Section Element — Exercise 1.12

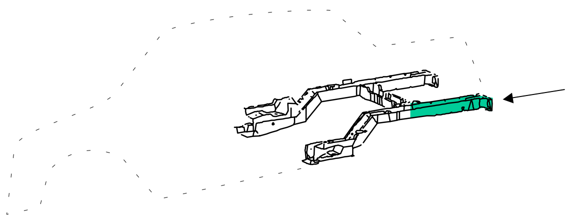


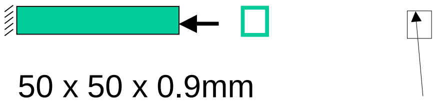
Consider the top flange of the Neon rocker. Treat each flange as an independent long, flat plate(ignore spot welds). Treat the edge conditions as shown.

a) Compute the stress at which it will buckle using hand calculations.

b) At what bending moment does a) occur?

Rear Rail with Bumper Loading — Exercise 1.13

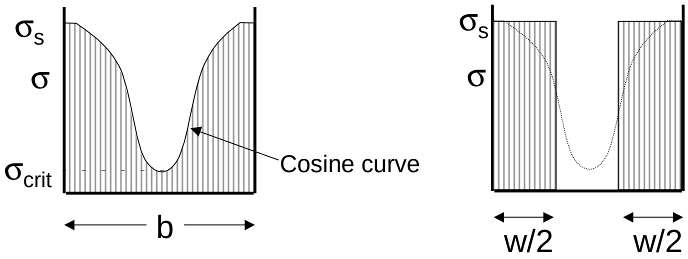




a) At what bumper load will the plate elements in the rear rail buckle?
b) The flat sides of the section are replaced with curved elements of R=200mm. Compute the new bumper load where the plate elements buckle.

General Buckling Effective Width

Exercise 1.14



$$P = \int_0^b \sigma t dx \qquad P = \sigma_s w t$$

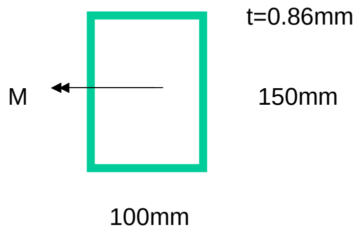
a) Assume the stress is distributed in a cosine function with the maximum stress σ_s and minimum stress σ_{crit} as shown above. Determine the effective width assuming the maximum stress acts uniformly over the effective width w and both elements react the same force P.

$$w(\sigma_s) = \frac{b}{2}\left(1 + \frac{\sigma_{crit}}{\sigma_s}\right)$$

b) Plot the effective width w versus the maximum stress-to-critical stress ratio.
c) For a flat plate with simply supported edges where b=100mm and t=.86mm, plot the effective width versus applied compressive stress.

Effective Width

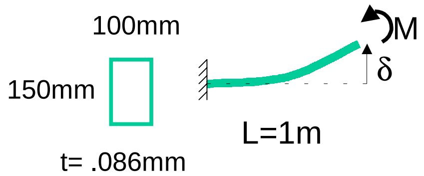
Exercise 1.15



Using hand calculations,
a) At what bending moment, M_{crit}, will top cap just buckle?
b) What is the effective width of the top cap at 1.1 σ_{crit} , 1.5 σ_{crit} , 2.0 σ_{crit} ?
c) What is the effective I_{xx} at 2.0 σ_{crit} ?
d) What is the moment at which the effective section is at yield?

Effective Properties after Buckling

Exercise 1.16



Determine the moment-tip deflection curve for the beam shown. The result should look similar to the graph below. Consider only plate buckling behavior of the upper cap of the section.
Plot the range $0 < M < 5 M_{crit}$.