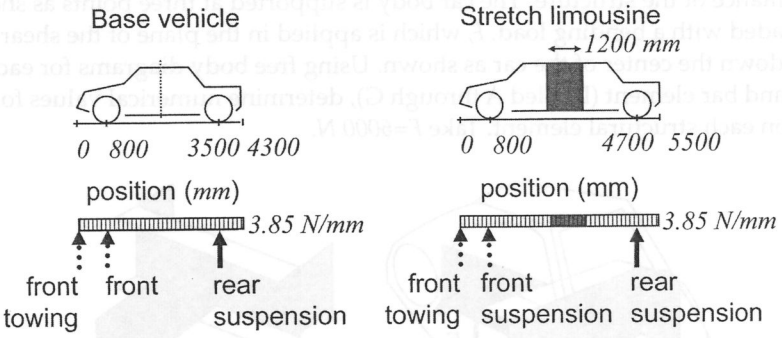
4. Design for Bending

4.1 Bending moment requirements

a) For the base vehicle, sketch the bending moment diagram for the loading shown with supports at the suspensions, and with supports during front towing. Note the following accurately: The maximum bending moment (absolute value); the position where maximum moment occurs; and the basic shape of the bending moment diagram.

b) Complete part a for the stretch limousine made by slicing the base vehicle in half and adding a *1200-mm*-long section welded to the two halves. The same weight per unit length occurs over this center portion.



Exercise 4.1

4.2 Body bending: Backbone structure

One topology for resisting bending loads is a backbone 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 material is steel with $E=207{,}000\ N/mm^2$ and $\sigma_{DESIGN} = 175\ N/mm^2$. Use the basic beam equations.

a) What is the minimum thickness to meet the strength requirement of supporting a *6670-N* load?

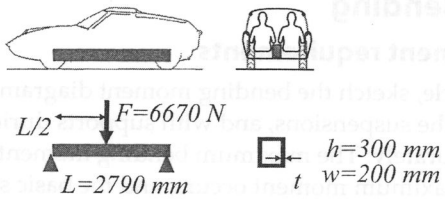
b) What is the minimum thickness if the deflection at center span is to be at most *1mm*?

c) Given the thickness computed in part a, what is the deflection in that case?

d) Given the thickness computed in part b, what is the maximum stress in that case?

e) If we desire to minimize mass (i.e. minimum t), what is the dominant requirement—strength or stiffness?

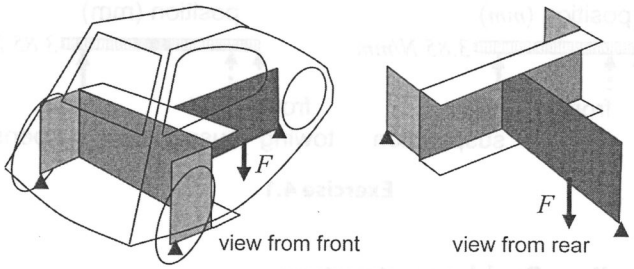
f) How short does the wheel base, L, need to be before the strength and stiffness requirements result in the same thickness?



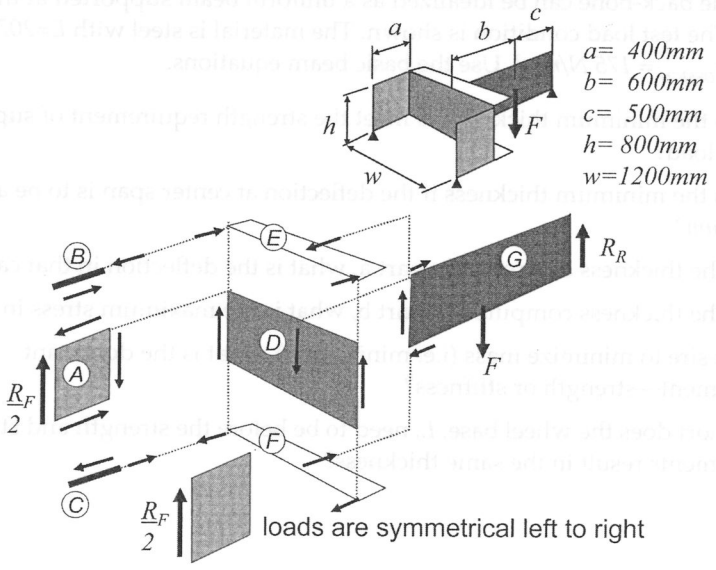
Exercise 4.2

4.3 Load paths for bending

A three-wheel-car concept is shown. The structure is made of shear panels which can only react loads within their plane. We are interested in the bending performance of the structure. The car body is supported at three points as shown and loaded with a bending load, *F*, which is applied in the plane of the shear panel going down the center of the car as shown. Using free body diagrams for each shear panel and bar element (labeled A through G), determine numerical values for the loads on each structural element. Take *F=6000 N*.



Exercise 4.3a



Exercise 4.3b