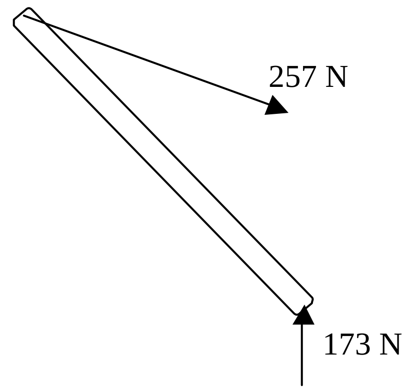
24-261 Statics November 29, 2001
Problem Set #14 Due: December 6, 2001

1. Problem 5.5-21 (Gere, Mechanics of Materials)

2. Problem 5.5-22 (Gere, Mechanics of Materials)

3. Reconsider the bike rack problem with the same loading as in problem set #7. Assume that there is negligible friction at the rubber pads, and so there are only forces acting normal to the car surface at each of the feet. A statics analysis of the entire bike rack, which you need not repeat here, yielded the pad and strap forces. We will focus on the leg to which the strap is attached. The pad force and strap force on that leg are shown to the right. The strap is oriented along a direction which makes an angle of 35? with the horizontal.



Consider now the *bending* of the leg shown. The figure in http://www.andrew.cmu.edu/course/24-261/images/bikerack.html has been redrawn to reflect the link which joins the two legs. Since only bending (not axial loading) is of interest, the subsequent analysis will only be concerned with the forces transverse (perpendicular) to the leg. Resolve both the strap force and the pad force in the direction perpendicular to the leg. Both the link and the pin which joins this leg to the other leg can exert forces on the leg which are transverse to the leg. Using transverse force and moment equilibrium, determine the transverse forces due to the pin and the link. (You will need the drawing to determine the location of the forces and the orientation of the leg.)

With all the transverses loads in equilibrium, now draw the shear force and bending moment diagrams of the leg.

Find the maximum bending stress in the leg, assuming the leg is a hollow tube, with diameter 2 cm and wall thickness 2 mm. Indicate where the maximum stress is tensile and compressive.

Please remember that you are to have learned the material properties in Material Parameters to Memorize on the web site.

On the following page are the equations that will be available to you during Quiz 3.

Equations of possible use

$g = 9.81\ m/s^2$

$? = M/EI$ $\quad\quad$ $? = -My/I$

$? ? = TL/GI_p$ $\quad\quad$ $? = T?/I_p$

$? = PL/EA$ $\quad\quad$ $? = P/A$

$I = bh^3/12$ for rectangular cross-section

$I = ? r^4/4$ for solid circular cross-section

$I_p = ? r^4/2$ for solid shaft or $I_p = ? ?r_2^4 - r_1^4)/2$ for hollow shaft

Parallel Axis theorem

$I = I_c + Ad^2$