

MECH 325
Homework Assignment #4
Due Nov. 29
(Hand in to Box in MECH Office, CEME 2054)

Problem 1 (Question 10-6)

A helical compression spring is to be made of oil-tempered wire of 4-mm diameter with a spring index of $C = 10$. The spring is to operate inside a hole, so buckling is not a problem and the ends can be left plain. The free length of the spring should be 80 mm. A force of 50 N should deflect the spring 15 mm.

- (a) Determine the spring rate.
 - (b) Determine the minimum hole diameter for the spring to operate in.
 - (c) Determine the total number of coils needed.
 - (d) Determine the solid length.
 - (e) Determine a static factor of safety based on the yielding of the spring if it is compressed to its solid length.
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Problem 2 (Question 10-31)

A compression spring is needed to fit over a 0.5-in diameter rod. To allow for some clearance, the inside diameter of the spring is to be 0.6 in. To ensure a reasonable coil, use a spring index of 10. The spring is to be used in a machine by compressing it from a free length of 5 in through a stroke of 3 in to its solid length. The spring should have squared and ground ends, unpeened, and is to be made from cold-drawn wire.

- (a) Determine a suitable wire diameter.
 - (b) Determine a suitable total number of coils.
 - (c) Determine the spring constant.
 - (d) Determine the static factor of safety when compressed to solid length.
 - (e) Determine the fatigue factor of safety when repeatedly cycled from free length to solid length. Use the Gerber-Zimmerli fatigue-failure criterion.
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Problem 3 (Question 8-17)

Two identical aluminum plates are each 2 in thick, and are compressed with one bolt and nut. Washers are used under the head of the bolt and under the nut.

Washer properties: steel; ID = 0.531 in; OD = 1.062 in; thickness = 0.095 in Nut properties: steel; height = $\frac{7}{16}$ in Bolt properties: $\frac{1}{2}$ in-13 UNC grade 8

Plate properties: aluminum; $E = 10.3$ Mpsi; $S_u = 47$ kpsi; $S_y = 25$ kpsi

- (a) Determine a suitable length for the bolt, rounded up to the nearest $\frac{1}{4}$ in.
 - (b) Determine the bolt stiffness.
 - (c) Determine the stiffness of the members.
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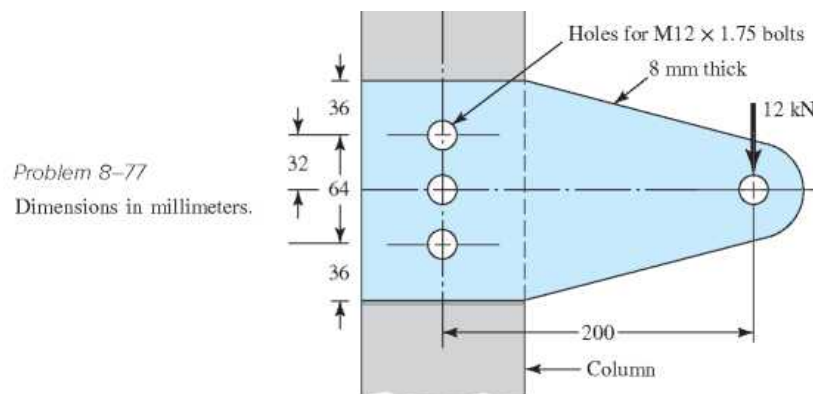
Problem 4 (Question 8-49)

For a bolted assembly with eight bolts, the stiffness of each bolt is $k_b = 1.0$ MN/mm and the stiffness of the members is $k_m = 2.6$ MN/mm per bolt. The bolts are preloaded to 75 percent of proof strength. Assume the external load is equally distributed to all the bolts. The bolts are M6 \times 1 Class 5.8 with rolled threads. A fluctuating external load is applied to the entire joint with $P_{\max} = 60$ kN and $P_{\min} = 20$ kN. Note the fully corrected endurance strength for Class 5.8 bolts is estimated as $S_e = 78.7$ MPa.

- (a) Determine the yielding factor of safety.
 - (b) Determine the overload factor of safety.
 - (c) Determine the factor of safety based on joint separation.
 - (d) Determine the fatigue factor of safety using the Goodman criterion.
 - (e) Comment on the results.
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Problem 5 (Question 8-77)

The cantilever bracket is bolted to a column with three M12 \times 1.75 ISO 5.8 bolts. The bracket is made from AISI 1020 hot-rolled steel. Assume the bolt threads do not extend into the joint. Find the factors of safety for the following failure modes: shear of bolts, bearing of bolts, bearing of bracket, and bending of bracket (top of the bracket at the bolt centerline). Comment on the results



Problem 6 (Fluid Power Question)

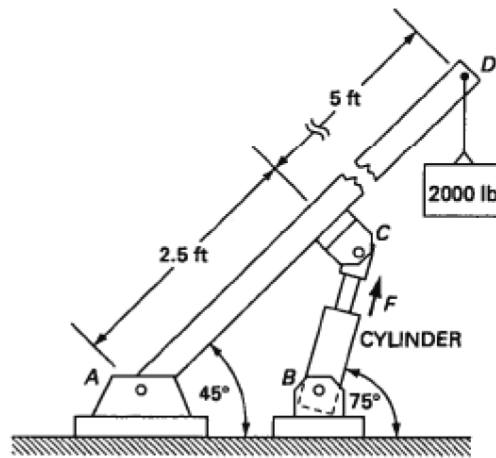


Figure 6-27. System for Exercise 6-27.

- Determine the required force, F , to support the 2000 lb. load in the position shown above.
 - With a working pressure of 1000psi, select an appropriate cylinder size for system (for the position shown).
 - If the extension for the cylinder is 12 inches, determine the required rod diameter for the system (for the position shown).
 - If we wish to lift the load at a rate of 1 foot/sec (at the position shown), what size of pump, piping system, and electric motor are required?
 - If we include the fact that we wish to accelerate the cylinder to its required speed within $\frac{3}{4}$ ", with this change the results above (at the position shown)?
 - Looking at the system, do you expect the required thrust to be higher at the starting position (fully retracted rod) or at the fully extended position? Let's assume the position above is for the 50% point.
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