19 December 2001

Instructions

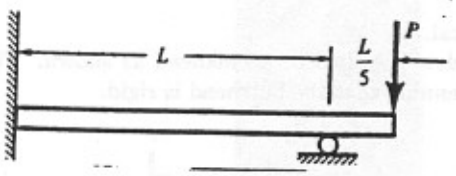
This examination is CLOSED BOOK

Calculators may be used.

Candidates should attempt 5 (FIVE) of the 7 (SEVEN) QUESTIONS

All questions are of equal value. Formula Sheets are only allowed if they have been 'OKed' prior to the exam. TIME allowed is 3 (THREE) hours

1.Find the maximum transverse deflection of the beam shown below. Would



the addition of a torque about the long axis affect that deflection?
Note that when using singularity functions, a concentrated upward acting transverse force F_o at $x = a$ is denoted as

$$F_o < x - a >^{-1}$$

and that the transverse deflection y can be found from the Euler–Bernoulli equation

$$EI\frac{d^4y}{dx^4} = w(x)$$

and that w is the intensity of the transverse load at any point x along the beam.

2. Design a compression coil spring to provide a force change of 500 newtons when the amount of axial compression changes by 0.15m. The actual maximum load will be 750 newtons and should be regarded as static. The steel wire available can be considered to have a ultimate tensile strength of ~~10000MPa~~. Remember that

$$K_s = 1 + \frac{0.615}{C}$$

$$\tau = \frac{8FCK_s}{\pi d^2}$$

$$k = \frac{dG}{8NC^3}$$

3. Design a circular cross section shaft for a fatigue application.

The shaft is supported by two bearings that can be considered to provide simple support with 90 inches between the bearings.

The shaft is to carry a negligible constant torsional load of and a has a transverse load of 1400 pounds at mid span due supporting a none rotating mass. Size the shaft for a steel with $S_u = 200,000psi$, $S_y = 150,000psi$, $S_n = 80,000psi$.

Detail design has lead to a 1.15 k_t at the point of maximum bending stress and the k_t in torsion is 2.0.

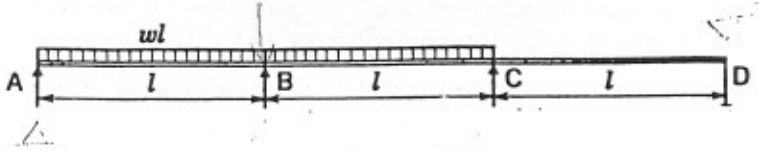
$$k_f = 1 + (k_t - 1)q$$

Consider the shaft to be machined and q to be 0.90. Size the shaft assuming for a safety factor N of 3. State any assumptions.

Use the Soderberg relationship for fatigue

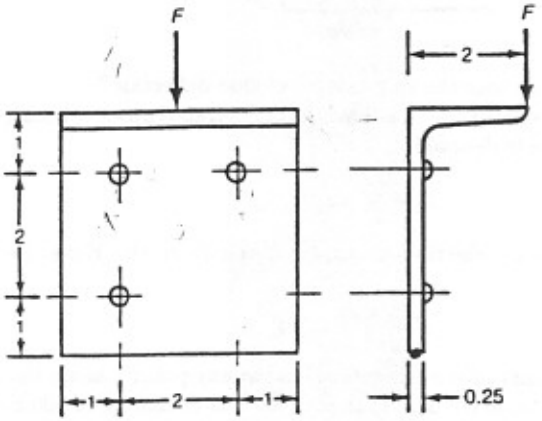
$$\frac{\sigma_m}{S_y} + k_f \frac{\sigma_a}{S_n} = \frac{1}{N}$$

4. Draw shear and moment diagrams for the beam shown below. Find the point(s) of maximum deflection and assuming that the beam is made of steel and has a 1 inch wide by three inches deep rectangular cross–section find the maximum bending stresses and deflections given that the cross section of the

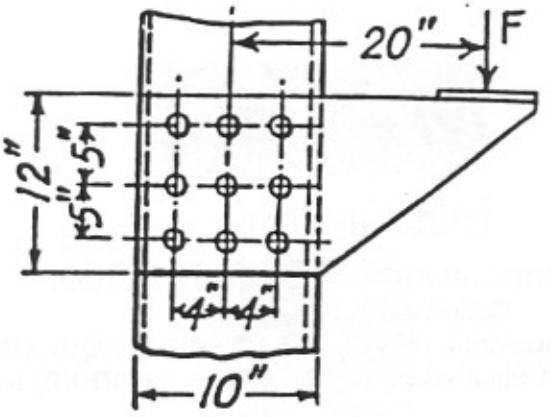


beam is 10 degrees from vertical.

5. The bracket shown below is bolted to a bulkhead as shown. Find the loads carried by each bolt assuming that the bulkhead is rigid.



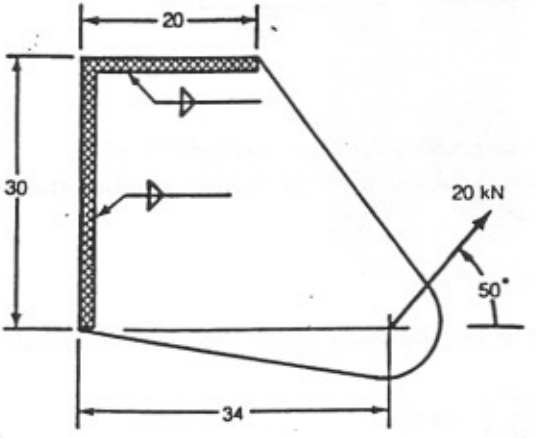
6. Find the loads on each of the rivets in the joint shown below. Note all rivets are of equal diameter and are made of the same material. How would you



change the analysis if the rivets were not the same diameter?

7. Design a weld for the problem illustrated below. The rod used is E70XX

[mm]



and the tensile yield stress can be taken to be 57ksi.