OPTI 421/521 – Introductory Opto-Mechanical Engineering

Homework 10

1.) Fasteners, modeling in SolidWorks, and bill of materials

Create a model in SolidWorks to attach an 8”x2” x 0.25” thick aluminum plate to a 6” x 6” x 0.5” thick aluminum with at least 6 fasteners. Use each of the following fasteners:

- ¼ -20 hex head cap screw with standard washer
- ¼ -28 socket head cap screw, with countersink
- M6 Phillips round head screw
- ¼ -20 flat head screw
- #10-32 button head screw with Belleville washer

For the threads, use each of the following options:

- Threaded through hole
- Threaded blind hole (the hole does not go all the way through the material
- Clearance hole, with standard washer, lock washer and nut
- Threaded insert (i.e. Helicoil).

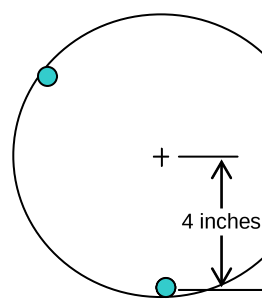
Create an assembly drawing and complete mechanical drawings for both plates, correctly calling out all dimensions, fasteners, holes, threads and countersinks. Use appropriate tolerances.

Create a bill of materials, calling out all of the parts needed AND specifying their part number from Copper State, McMaster-Carr or your favorite supplier.

2) Mirror bonding, stresses

An 8 inch diameter, 1 inch thick BK7 mirror is bonded to a thick aluminum plate using 0.1” thick RTV elastomeric adhesive. Three small 0.8” diameter bonds are made at the edge of the mirror.

This adhesive has approximately
  100 psi shear modulus
  100,000psi bulk modulus
  100 psi adhesive shear strength



a) Calculate the approximate weight of the mirror and use this to calculate the approximate force per bond for 1G.
b) For the case with the mirror supported horizon pointing, determine the shear stress in the bonds. Determine the safety factor for 10 G shock loading in this direction
c) Determine the lateral deflection of the mirror as it is supported as above, due its weight and the shear compliance of the bonds.
d) Determine the resonant frequency of the mirror in the lateral mode
e) For the case with the mirror supported face up, zenith pointing, use the shape factor to determine the approximate axial stiffness of the bond. Determine the resulting deflection due to the weight of the mirror.
f) Determine the resonant frequency of the mirror in the axial mode
g) Determine the moment of inertia and the torsional compliance for the case of the mirror rotating about its axis
h) Calculate the resonant frequency for this case.
i) Calculate the thermal induced strain in the RTV for a 20° C temperature change.
j) Calculate the shear stress in the adhesive due to this strain. Relate this to the strength and provide a safety factor.

3. Design of a 2-axis flexure

Design a flexure that allows rotation about x and y axes, yet is axially stiff in the x direction. Choose materials and geometry. Use finite element modeling or hand calculations to demonstrate performance. Requirements are:

- Supports load of 2 lbs in z direction
- Lowest resonance with 2 lb load must be > 100 Hz in z direction
- Range of motion is +/- 2 mrad, simultaneous about x and y axis. Design for infinite life
- Allowable moment coupled through flexure: 0.1 in-lb about each (x and y) axis.
- Under 10 G shock loading, required safety factors of 2 for yield, 3 for ultimate, 8 for bucking

Design the flexure and use analysis to show performance. Create appropriately dimensioned and toleranced drawings,

4) Rules of Thumb

Provide three rules of thumb using the standard format.