Experimental Stress Analysis

Assignment # 6

Strain Gauges

1. What is the basic information a strain gauge provides?

2. What do you understand by strain sensitivity of a conductor and strain response of a strain gauge? What approximations are involved in actual strain measurement?

3. Define gauge factor and transverse sensitivity of a strain gauge. How is the gauge factor obtained by the manufacturer?

4. Why a strain gauge needs to be supported by a carrier? What are the different carrier materials available? Do these carrier materials play a role in strain gauge instrumentation? Substantiate your answer with a case study.

5. What are the different glues available for pasting a strain gauge? What aspects decide their selection?

6. In strain gauge instrumentation, the effect of change in temperature needs to be carefully accounted for. Why? How heat generation and heat dissipation can be managed in a strain gauge installation? Substantiate your answer with the help of a schematic of a graph.

7. How do you measure
   - Component of strain
   - Strain tensor
   - Shear strain
   - Normal stress

   using a strain gauge? For each of these cases mention the type of gauge, how many channels are required and how the strain gauges are to be connected in the measuring circuit.

8. Estimate the error involved if a strain gauge is pasted on a 0.5 mm thick cantilever beam whose grid plane is at a height of 0.05 mm above the surface of the beam. How does the error changes if the cantilever beam is of 50 mm thickness?

9. In precision measurements, accounting for transverse sensitivity of a strain gauge is important. The strain gauge manufacturer has come up with a new configuration of the strain gauge to suit the application and its transverse-sensitivity factor K_t needs to be evaluated. The manufacturer has pasted two strain gauges on a tension specimen in the axial and transverse directions to make the determination. The ratio of the transverse to axial strain is C which is found to be not equal to the Poisson's ratio of the material. (Note: In a stress gauge one wants the transverse sensitivity to be equal to the Poisson's ratio!) Can you develop an expression for K_t from these readings?

10. A structural member is loaded as shown in Fig. 1. It is required to measure the strain introduced at point C, which is 1.25 m from the free end. At your disposal you have access to only rectangular rosettes. Show by neat sketches, how will you paste and connect the elements of the gauges in a Wheatstone bridge to measure the following.
    i. State of strain at point C.
    ii. Strain introduced by bending and torsion separately.

iii. What is the maximum amplification of the signal you can get for measuring the bending and torsional strain? How will you achieve the same?

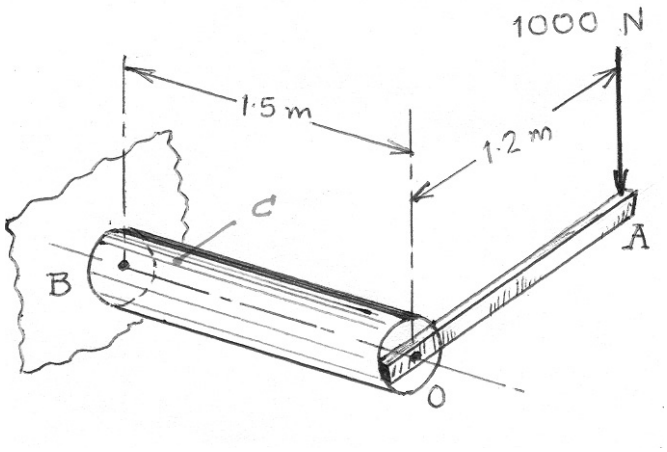

Fig. 1

11. The readings of a 45° strain rosette are

$\varepsilon_0 = 100 \times 10^{-6}$ $\varepsilon_{45} = 200 \times 10^{-6}$ $\varepsilon_{90} = 900 \times 10^{-6}$

Find the magnitude of the principal strains in the plane of the rosette.
