

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

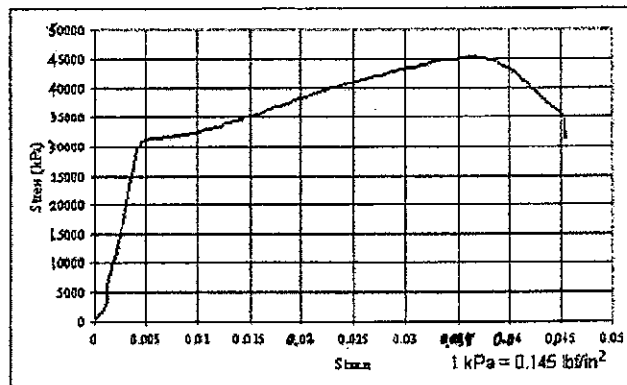
**Prob. 1 (25 Points)**

Consider a simply supported slender rectangular beam (length  $L$ , width  $b$ , thickness  $h$ , moment of inertia  $I$ , made of material with Young's modulus  $E$ ) subjected to a concentration load  $P$  at mid-span.

- (a) Please sketch the bending and shear force diagrams. (5 Pts)
- (b) If the shear force is neglected, please calculate the associated bending strain energy. (10 Pts)
- (c) Please calculate the strain energy associated with the shear force with a form factor of 1.2. (10 Pts)

**Prob. 2 (25 Points)**

The followings are the uniaxial tensile testing results for a given specimen. (x-axis ranges from 0 – 0.05; y-axis ranges from 0 – 50000 kPa in case if the printing is not clear) Please answer the following questions.

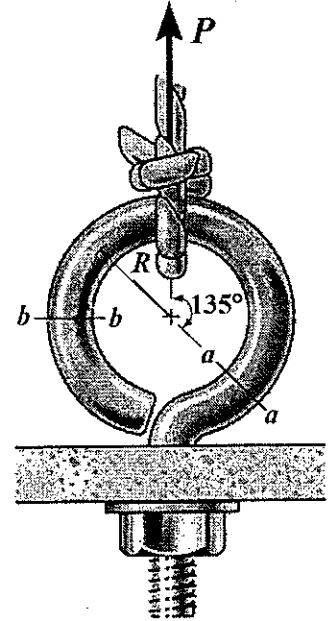


- (a) Please estimate the Young's modulus and yield strength of the structure. (4 Pts)
- (b) Please determine the toughness of the material. (4 Pts)
- (c) Please sketch the essential true stress-strain curve. (4 Pts)
- (d) If this specimen can be idealized as a uniaxial geometry with a diameter of 1 cm and a length of 10 cm, please estimate the axial stiffness of this specimen. (4 Pts)
- (e) (nothing related to part (a)-(d)) A certain isotropic material yields in uniaxial tension at the stress of 140 MPa. At a certain point in a structure made of this material, two of the three principal stresses are 20MPa tensile and 90 MPa compressive. If there is to be no yielding, what is the allowable range of the third principal stress according to the Tresca criterion? (9 Pts)

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**Prob. 3 (20 Points)**

The eye bolt as shown has a circular cross-section of radius  $r$ ,  $r \ll R$ , and is subjected to a pull force  $P$ . determine the maximum and minimum normal stresses at the  $a-a$  and  $b-b$  cross-sections.



**Prob. 4 (30 Points)**

The general displacement and strain solutions (in cylindrical or polar coordinates) for a thick-walled cylinder with cross-section as shown under axisymmetric condition are given by

$$u_r = A_1 r + \frac{A_2}{r}, \quad u_\theta = 0,$$

$$\varepsilon_{rr} = A_1 - \frac{A_2}{r^2}, \quad \varepsilon_{\theta\theta} = A_1 + \frac{A_2}{r^2}, \quad \varepsilon_{r\theta} = 0,$$

where  $A_1$  and  $A_2$  are constants to be determined from the boundary conditions.

(a) Knowing that the equations of the generalized Hooke's law in the  $(r, \theta, z)$  coordinates are in the same forms as those in the  $(x, y, z)$  coordinates, and assuming plane strain condition for the cylinder, determine the stresses  $\sigma_{rr}$  and  $\sigma_{\theta\theta}$  in terms of  $A_1, A_2$ , the Young's modulus  $E$ , and the Poisson's ratio  $\nu$ .

(10 Pts)

(b) Assuming that the thick-walled cylinder is under uniform inner pressure  $p$  (at  $r = a$ ) and rigid support on the outer wall (at  $r = b$ ), and that  $b = 2a, \nu = 1/3$ , determine  $A_1$  and  $A_2$ , and the maximum first principal stress in the cylinder. (20 Pts)

