國立臺灣大學 109 學年度碩士班招生考試試題

1. The rigid bars AB and BC of Fig. 1 are connected at Point B using a hinge connection and supported using a hinge, a linear elastic spring with a spring constant of β, and a roller at Points A, B, and C, respectively, as shown in Fig. 1. The spring constants of the two rotational springs at Points A and B are both β_R. The lengths of Bars AB and BC are both $L/2$. The structure is subjected to a vertical axial load P. Find the critical axial load P_{cr} of the structure. (20%)

2. The cantilever beam of Fig. 2-1 has a total length of 4 meters and is loaded by a uniformly distributed load with an intensity of q N/m. The beam is supported at the mid-span point B by a linear rotational spring with a spring constant k_R of 5×10^6 N-m, which can provide a resisting moment $M_B = k_R \times \theta_B$ when subjected to a rotational angle of θ_B. The cross section of the beam is shown in Fig. 2-2 and composed of a wood section of 150 mm × 250 mm and two brass plates both with a cross section of 150 mm × 50 mm. The two brass plates are at the top and bottom of the beam. The moduli of elasticity E of the wood and brass in the beam are 15 and 100 GPa, respectively. Ignore the self-weight of the beam. (30%)

(1) Determine the magnitudes and directions of the reactions at Points A and B, namely, M_A, R_A, and M_B. Express the answers as a function of q.

(2) Assume the allowable normal stresses σ of the wood and brass in the beam are 10 and 70 MPa, respectively. Find the maximum value of q so that the stresses in the beam are all allowable.

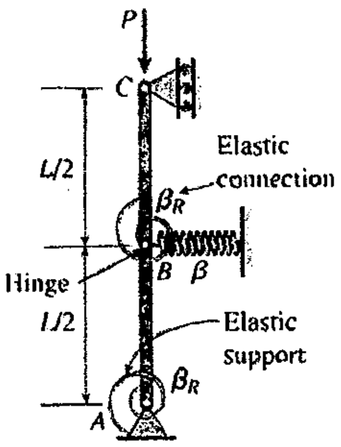

Fig. 1

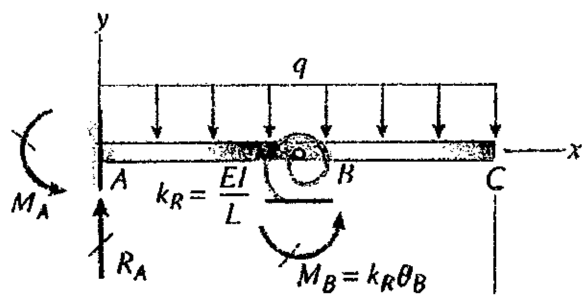

Fig. 2-1

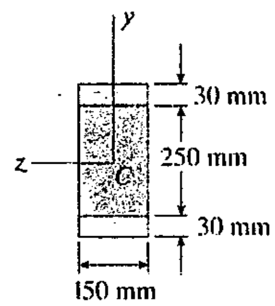

Fig. 2-2

Problems 3 and 4 are in the next page.

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3. The L-shape pipe of Fig. 3 is placed in the vertical x-y plane and subjected to a horizontal force P at Point B in the $-z$ direction. A single strain gauge is attached at Point A, which is on the outer surface of the pipe (see Fig. 3). The strain gauge is attached at an angle of 60° to the longitudinal direction of the pipe and gives a reading of -100×10^{-6}. The pipe has an outer diameter of 60 mm and an inner diameter of 30mm and made of a material with a modulus of elasticity E of 200 GPa and a shear modulus of elasticity G of 75 GPa. Determine (1) the horizontal force P, and (2) the principal stresses at Point A.

(25%)

4. The symmetric three-rod truss of Fig. 4 is subjected to a force P at Point C. The three circular rods have the same cross sectional area of 10 cm^2 and are all made of elastic-perfectly plastic steel with a modulus of elasticity of 200 GPa and a yielding stress of 200 MPa. The length of Rods AC and BC are both 2 meters. (25%)

(1) If P = 200 kN, what is the displacement at Point C?

(2) If P = 300 kN, what is the displacement at Point C?

(3) If P is applied to the truss with its magnitude slowly increased from 0 to 300 kN, and then unloaded from 300 kN to 0, what is the residual displacement at Point C and what are the residual forces in Rods AC and DC?

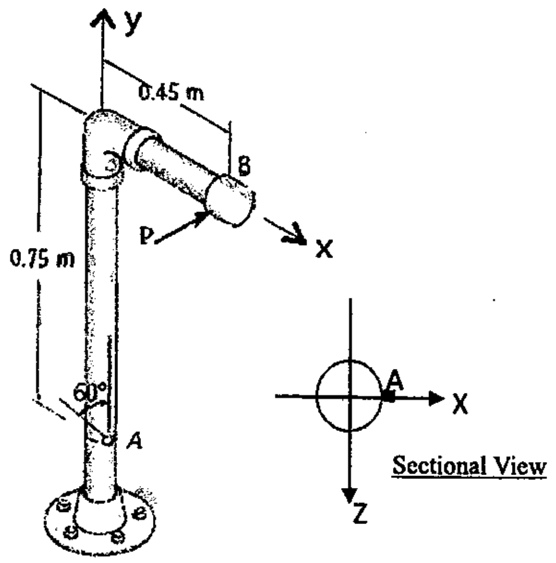

Fig. 3

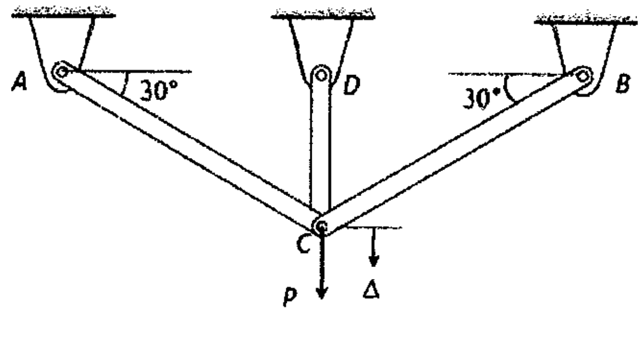

Fig. 4

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