國立成功大學

113學年度碩士班招生考試試題

編　號：65

系　所：機械工程學系

科　目：材料力學

日　期：0201

節　次：第 1 節

備　註：可使用計算機

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Problem 1　(20 Pts)

In the Super Mario Adventures video game, Mario must break the bricks above him to advance successfully to the next level. Some bricks are made of brittle material that cannot resist tensile stress. Hence, it can be observed that the brick destroyed by Mario will separate along a specific direction (Fig. 1(a)). The external force is generated by the jump of Mario, which can be considered a compressive force. The support reaction acting upon the brick boundary can be treated as the shear force. The internal stress of the brick can be described as shown in Fig. 1(b). Please use what you have learned in Mechanics of Materials to indicate which plane and direction occurred on the brick failure.

Problem 2　(15 Pts)

A shear spring is made by bonding the rubber annulus to a rigid fixed ring and a plug. When an axial load P is placed on the plug, showing that the slope at point y in rubber is $dy/dr = -\tan\gamma = -\tan(P/(2\pi hGr))$. We can write $dy/dr = -P/(2\pi hGr)$ for small angles. Integrate this expression and evaluate the constant of integration using the condition that $y = 0$ at $r = r_0$. From the result, compute the deflection $y = \delta$ of the plug. (Fig. 2)

Problem 3　(15 Pts)

The metal sheet has a thickness t and width w, and its modulus of elasticity varies linearly from E_1 at the top to E_2 at the bottom. As a result, for any vertical position y, measured from the top surface, $E = [(E_2 - E_1)/w]y + E_1$. Determine the position d where the axial force P must be applied so that the bar stretches uniformly over its cross section. (Fig. 3)

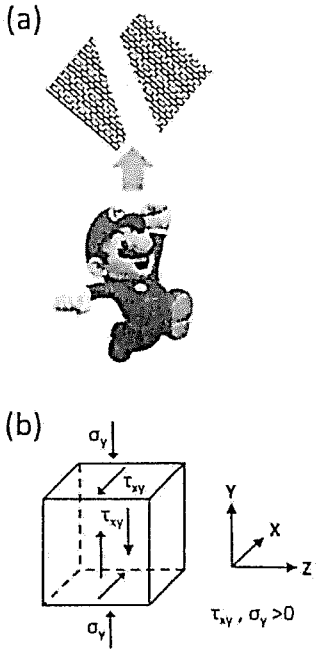

Fig. 1

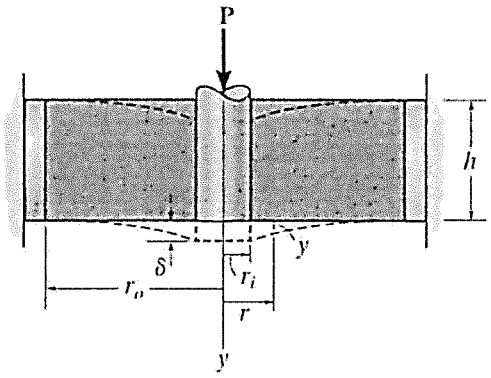

Fig. 2

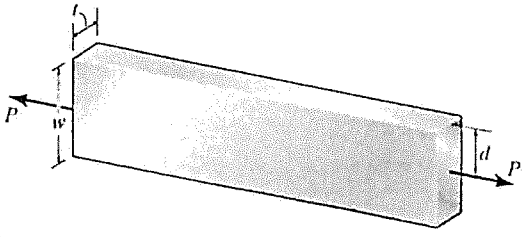

Fig. 3

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Problem 4　(15 Pts)

A rubber cube of dimension $a \times a \times a$ is press-fitted into the U-shaped slot of a smooth rigid block (Fig. 4). The width of the slot is $0.999a$. The Young's modulus and Poisson's ratio of the rubber are E and ν, respectively. Assuming a compressive load P is applied uniformly on the top surface of the rubber cube, determine (a) the principal stresses in the rubber, and (b) the volume change of the rubber.

Problem 5　(20 Pts)

The governing equation for the transverse deflection v of the column (EI is constant) as shown in Fig. 5 is given by $EI\frac{d^4v}{dx^4}+P\frac{d^2v}{dx^2}=0$. (a) What are the four boundary conditions required to solve for the transverse deflection? (b) Determine the transverse deflection of the column and the critical load for buckling.

Problem 6　(15 Pts)

The frame as shown in Fig. 6 has a constant flexural rigidity EI. Determine the support reactions at locations A and B by using the Castigliano's second theorem (alternative solution approach is not allowed).

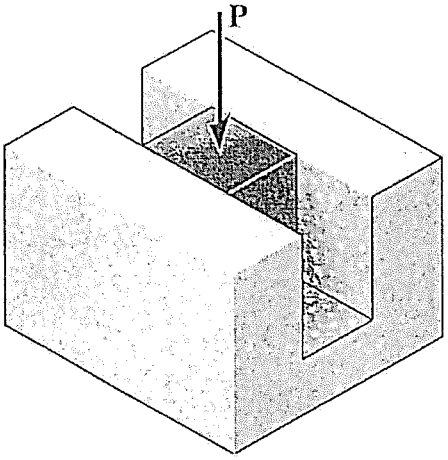

Fig. 4

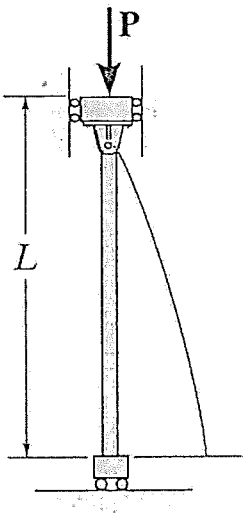

Fig. 5

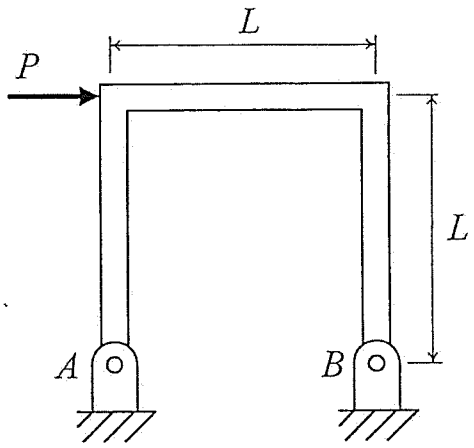

Fig. 6