國立成功大學77學年度工程科學研究所入學考試(材料力學試題) 共2頁 第1頁

1. The couple $\overline{M}$ acts in a vertical plane and is applied to a beam oriented as shown by Fig 1. Determine (a) the angle that the neutral axis forms with the horizontal plane. (b) the maximum tensile stress in the beam. (20%)

2. A brass ring of 120mm outside diameter fits exactly inside a steel ring of 120mm inside diameter when the temperature of both rings is $To^{o}C$, as shown by Fig.2. Find out the thickness ratio t_b/t_s suth that the steel ring is just yield when the temperature of both rings are raised to $To+\Delta T^{o}C$. Maximum shear stress criteria is used for yielding. (20%)

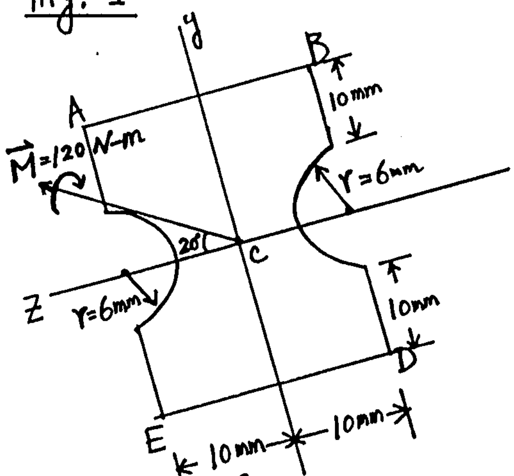
3. For the given angle shape with uniform thickness t and vertical loading V , as shown in Fig.3 , assume the shear stress distribution in the horizontal leg τ_h and the vertical leg τ_V are parabolic with zeros at A and B . (a) show that the coordinate of centroid C , ($\bar{x}$, $\bar{y}$) is $\left(\frac{a}{2}\frac{\alpha}{1+\alpha}, \frac{b}{2}\frac{1}{1+\alpha}\right)$ where α is the ratio A_h/A_V of the cross section areas of the horizontal and vertical legs. (b) show that τ_h is zers at point E and is maximum at point F. (c) show that τ_V is maximum at point H and (d) the maximum value can be expressed in terms of V and the geometric parameters a , b , t and α only. (20%)

(Hint) (i) Line FH of maximum shearing stress is located on the neutral axis which passes through C .
(ii) Sketch τ_h and τ_V before proceeding the solutions of problem.

4. A device is designed , as shown in Fig.4 , to stop impact due to an object with mass m and impact velocity v . This device is made of material with Young's modulus E and has a uniform cross section with diameter d and moment of inertia I . Assume R$\gg$d so that the axial and shear strain energy is very small compared against the strain energy of bending moment. If the kinetic energy (KE) of impact is completely absorbed by the device, then the vertical deflection Δ_V and the horizontal deflection Δ_h due to impact can be denoted by $\Delta_V = C_V\sqrt{KE}$ and $\Delta_h = C_h\sqrt{KE}$. Compute those proportional parameters C_V and C_h in terms of R,E and I . (20%)

5. In tensile test machine, misalignment along the loading chain (ie. grip system and specimen) introduces eccentric load on the specimen. The degree of eccentricity ζ is defined as σ_b/σ_o here σ_b is the maximum bending stress and σ_o is the average axial stress in specimen . Consider a round bar as a specimen whose surface is bounded by 4 SR-4 strain gages separated 90^{o} from each other. The axial strain reading is denoted as ε_A , ε_B , ε_C and ε_D . Supposed the axial load be applied at point P as shown in Fig.5 and the material be linearly elastic , (1) Explain why ε_o (the average axial strain) $= \frac{1}{2}(\varepsilon_A + \varepsilon_C) = \frac{1}{2}(\varepsilon_B + \varepsilon_D)$? (2) If $y > x$, then ε_B is the largest positive strain and ε_A the 2nd largest positive strain. (3) Find $\zeta = \left(\frac{\varepsilon_B}{\varepsilon_o} - 1\right)/\cos\theta$. (20%)

Fig. 1



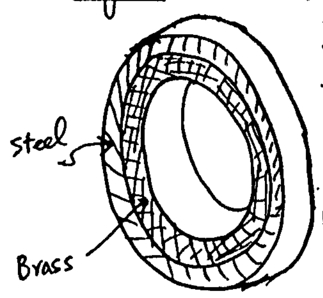
$I_y = 14.77 \times 10^{-9}\,m^4$

$I_z = 53.6 \times 10^{-9}\,m^4$

$\cos 20° = 0.9397$

$\sin 20° = 0.3420$

Fig. 2



Steel:

Thickness t_s

Young's modulus E_s

Thermal Coefficient of Expansion α_s

Tensile yield stress σ_Y

Brass:

t_b

$E_b = \frac{1}{2}E_s$

$\alpha_b > \alpha_s$

Fig. 3

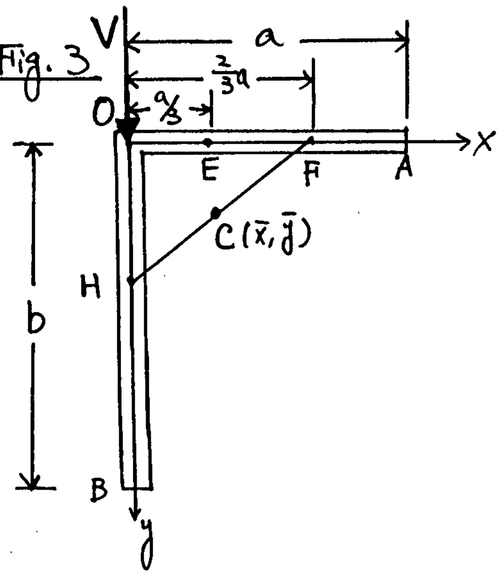


Fig. 4

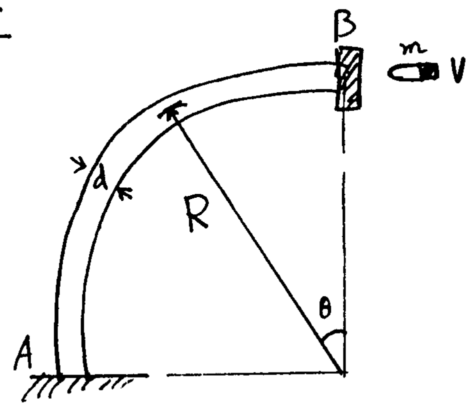


Fig. 5