(25pt) Prob.1 The assembly shown consists of an aluminum shell (E_a = 70 GPa, α_a = 23.6 × 10^{-6}/°C) fully bonded to a steel core (E_s = 200 GPa, α_s = 11.7 × 10^{-6}/°C) and is unstressed at a temperature of 20°C. Considering only axial deformations, determine the stress in the aluminum shell when the temperature reaches 180°C.

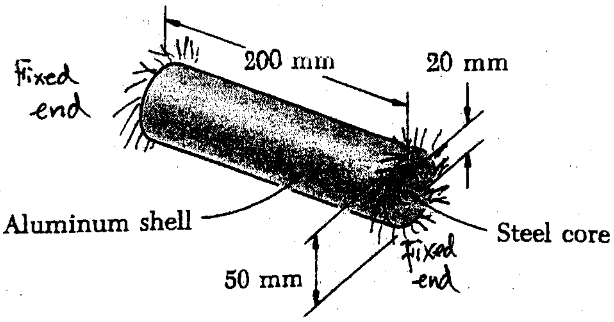


Fig. Prob 1.

(25pt) Prob. 2. The stepped shaft shown must transmit 150 kW. Knowing that the allowable shearing stress in the shaft is 55 MPa and that the radius of the fillet is r = 6 mm, determine the smallest permissible frequency.

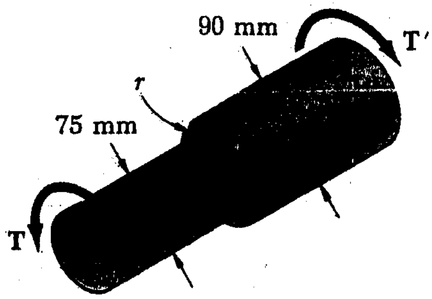
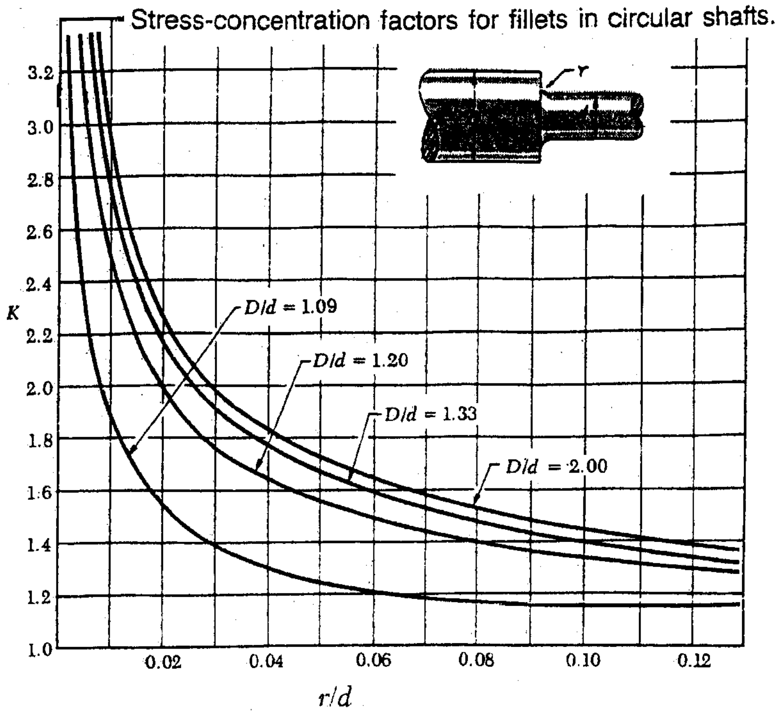


Fig. Prob. 2



Formula:

$$\text{Power} = 2\pi \,\text{freq} \times (\text{Torque})$$

$$1 \text{ watt} = 1 \text{ N}\cdot\text{m/s}$$

$$\tau = \frac{Tc}{J}.$$

編號： 136 國立成功大學九十七學年度碩士班招生考試試題 共 2 頁，第2頁

系所：工程科學系在職專班乙組 科目：材料力學（專班）

本試題是否可以使用計算機： ☑可使用 ， □不可使用 （請命題老師勾選） 考試日期：0301，節次：3

(25pt) **Prob. 3.** A rectangular beam is made of a material for which the modulus of elasticity is E_t in tension and E_c in compression. Show that the curvature in pure bending is

$$\frac{1}{\rho} = \frac{M}{E_r I}$$

where

$$E_r = \frac{4E_tE_c}{(\sqrt{E_t} + \sqrt{E_c})^2}$$

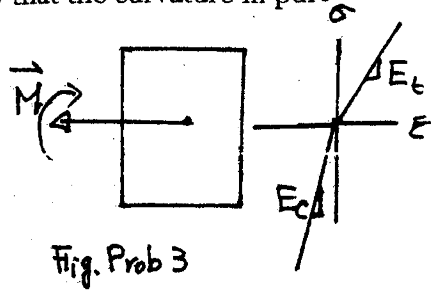
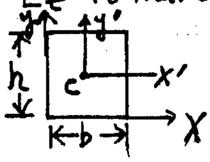


Fig. Prob 3

(Hint: ① Using $n = E_c/E_t$ to make a transformed section.

② $\bar{I}_{x'} = \frac{1}{12}bh^3$, $\bar{I}_{y'} = \frac{1}{12}b^3h$



$I_x = \frac{1}{3}bh^3$, $I_y = \frac{1}{3}b^3h$)

(25pt) **Prob. 4** The change in diameter of a large steel bolt is carefully measured as the nut is tightened. Using the data $E = 200$ GPa and $G = 77$ GPa, determine the internal force in the bolt if the diameter is observed to decrease by 12 μm.

Hint: Three dimensional isotropic, linearly elastic Hooke's law:

$$\varepsilon_x = \frac{\sigma_x}{E} - \nu\frac{\sigma_y}{E} - \nu\frac{\sigma_z}{E}$$

⋮ etc

$$\gamma_{xy} = \frac{\tau_{xy}}{G} = \frac{2(1+\nu)}{E}\tau_{xy}$$

⋮ etc.

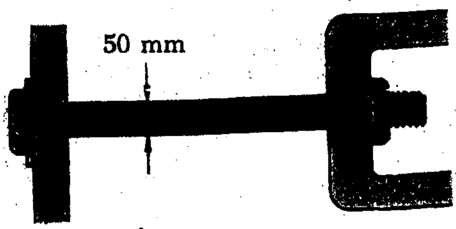


Fig. Prob. 4.