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Mechanical Design II Homework 01

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Mechanical Design 2

Class Section 01

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Problem 1

An aluminum cylinder (E=70 GPa, ν=0.33) with outer diameter of 300 mm and inner diameter of 100 mm is to be press-fitted over a solid steel shaft (E=200 GPa, ν=0.29). Maximum diametral interference at the interface between aluminum cylinder and steel shaft is 0.093 mm. Calculate the resulting contact pressure at the interface.

Solution:

For this question, we are asked to calculate the resulting contact pressure at the interface.

$$\delta = \frac{\delta_d}{2} = \frac{0.093\ \text{mm}}{2} = 4.65 \times 10^{-5}\ \text{m}$$

$$E_o = 70 \times 10^9\ \text{Pa}$$

$$v_o = 0.33$$

$$E_i = 200 \times 10^9\ \text{Pa}$$

$$v_o = 0.29$$

$$c = \frac{300 \times 10^{-3}\ \text{m}}{2}$$

$$R = \frac{100 \times 10^{-3}\ \text{m}}{2}$$

$$a = 0$$

$$P = \frac{\delta}{R\left[\frac{1}{E_o}\left(\frac{c^2+R^2}{c^2-R^2}+v_o\right)+\frac{1}{E_i}\left(\frac{R^2+a^2}{R^2-a^2}-v_i\right)\right]}$$

$$= \frac{(4.65 \times 10^{-5}\ \text{m})}{\left(\frac{100 \times 10^{-3}\ \text{m}}{2}\right) \times \left\{\frac{1}{(70 \times 10^9\ \text{Pa})}\left[\frac{\left(\frac{300 \times 10^{-3}\ \text{m}}{2}\right)^2+\left(\frac{100 \times 10^{-3}\ \text{m}}{2}\right)^2}{\left(\frac{300 \times 10^{-3}\ \text{m}}{2}\right)^2-\left(\frac{100 \times 10^{-3}\ \text{m}}{2}\right)^2}+0.33\right]+\frac{1}{(200 \times 10^9\ \text{Pa})}\left[\frac{\left(\frac{100 \times 10^{-3}\ \text{m}}{2}\right)^2+0^2}{\left(\frac{100 \times 10^{-3}\ \text{m}}{2}\right)^2-0^2}-0.29\right]\right\}}$$

$$= 35.60\ \text{MPa}$$

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