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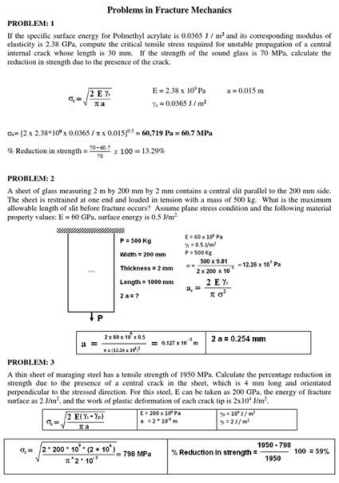

Problems in Fracture Mechanics

PROBLEM: 1

If the specific surface energy for Polmethyl acrylate is 0.0365 J / m² and its corresponding modulus of elasticity is 2.38 GPa, compute the critical tensile stress required for unstable propagation of a central internal crack whose length is 30 mm. If the strength of the sound glass is 70 MPa, calculate the reduction in strength due to the presence of the crack.

$\sigma_c = \sqrt{\frac{2\,E\,\gamma_s}{\pi\,a}}$ $E = 2.38 \times 10^9$ Pa $a = 0.015$ m $\gamma_s = 0.0365$ J / m²

$\sigma_c = [2 \times 2.38*10^9 \times 0.0365 / \pi \times 0.015]^{0.5} = 60{,}719$ Pa $= 60.7$ MPa

% Reduction in strength $= \frac{70-60.7}{70} \times 100 = 13.29\%$

PROBLEM: 2

A sheet of glass measuring 2 m by 200 mm by 2 mm contains a central slit parallel to the 200 mm side. The sheet is restrained at one end and loaded in tension with a mass of 500 kg. What is the maximum allowable length of slit before fracture occurs? Assume plane stress condition and the following material property values: E = 60 GPa, surface energy is 0.5 J/m²

$E = 60 \times 10^9$ Pa, $\gamma_s = 0.5$ J/m², $P = 500$ Kg, $\sigma = \frac{500 \times 9.81}{2 \times 200 \times 10^{-3}} = 12.26 \times 10^6$ Pa, $a_c = \frac{2\,E\,\gamma_s}{\pi\,\sigma^2}$

$a_c = \frac{2 \times 60 \times 10^9 \times 0.5}{\pi \times (12.26 \times 10^6)^2} = 0.127 \times 10^{-3}$ m | 2 a = 0.254 mm

PROBLEM: 3

A thin sheet of maraging steel has a tensile strength of 1950 MPa. Calculate the percentage reduction in strength due to the presence of a central crack in the sheet, which is 4 mm long and orientated perpendicular to the stressed direction. For this steel, E can be taken as 200 GPa, the energy of fracture surface as 2 J/m², and the work of plastic deformation of each crack tip is 2×10^3 J/m².

$\sigma_c = \sqrt{\frac{2\,E(\gamma_s + \gamma_p)}{\pi\,a}}$ | $E = 200 \times 10^9$ Pa, $a = 2 \times 10^{-3}$ m | $\gamma_s = 2$ J / m², $\gamma_p = 2 \times 10^3$ J / m²

$\sigma_c = \sqrt{\frac{2 * 200 * 10^9 * (2 + 10^3)}{\pi * 2 * 10^{-3}}} = 798$ MPa | % Reduction in strength $= \frac{1950 - 798}{1950} 100 = 59\%$

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