EL-MANSOURA UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF PRODUCTION & DESIGN

M. SC. COURSE EXAM.
Sept .2013
ELASTICITY & PLASTICITY

TIME ALLOWED: 3 HOURS

{ OPEN BOOKS }

ATTEMPT ALL PROBLEMS:

PROBLEM #1:

The stress function :

$$\Phi = (S/4c^2)\,[\, c^2xy - cxy^2 - xy^3 + c\ell y^2 + \ell y^3 \,]$$

is proposed as giving the solution for a cantilever ($y = \pm c$, $0 < x < \ell$) loaded by uniform shear along the lower edge, the upper edge and the end $x = \ell$ being free from load. In what respects is this solution imperfect? Compare the expressions for the stresses with those obtainable from elementary tension and bending formulas.

PROBLEM #2:

The stress function:

$$\Phi = (\sigma_0/2)\,[\,(\tfrac{1}{2} r^2 - a^2 \ln r) + (-\tfrac{1}{2} r^2 - \tfrac{1}{2}(a^4 / 2r^2) + a^2)\cos 2\theta\,]$$

is proposed as giving the solution for a large thin plate containing a small circular hole of radius (a) and subjected to simple tension as shown in Fig.1.

(a) Determine the stress field (σ_{rr} , $\sigma_{\theta\theta}$, $\tau_{r\theta}$) in the plate,

(b) Calculate the stress concentration factor at the hole.

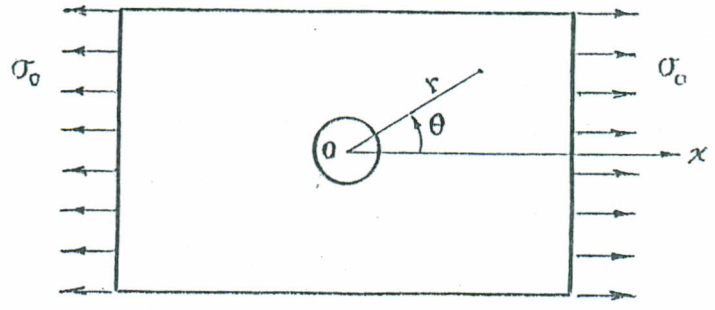

Fig.1

PROBLEM #3:

Consider a material which undergoes linear strain hardening. Its true stress- true strain curve in tension is given by:

$$\sigma = Y + 1.35\, Y_\epsilon$$

The stress – strain curve does not depend on strain rate.

(a) At what value of true strain will necking start?

(b) Suppose a stepped tensile bar (Fig.2) is made from this material. The initial cross-sectional area of region 1 is 0.990 times the initial cross-sectional area of region 2. What is the strain in region 2 when the strain in region 1 reaches 0.200 ?

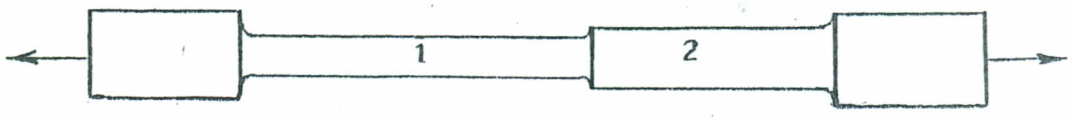

Fig.2

PROBLEM #4:

A steel sheet was deformed plastically. After unloading, it was found that the principal "engineering" strains in the plane of the sheet were $e_1 = 0.172$ and $e_2 = -0.0431$. Assume that the ratio of stresses, $\alpha = \sigma_2 / \sigma_1$, was held constant during unloading and that there was no stress normal to the sheet surface. Also, assume the Von Mises criterion.

(a) Find the ratio, $\alpha = \sigma_2 / \sigma_1$, that prevailed during loading.

(b) Find the ratio, $\overline{\sigma} / \sigma_1$, that prevailed during loading.

(c) Find the effective strain.

(d) Assume that the tensile stress – strain curve for this steel can be approximated by $\sigma = 650\ \epsilon^{0.22}$ (MPa). Find the value of σ_1 just before unloading.

PROBLEM #5:

Write technical notes on each of the following:

(a) Stress invariants.

(b) Bauschinger effect.

(c) Airy stress function.

(d) Slab method for solving plasticity problems.

Best Wishes!

Prof. Dr. M. Shabara