POLITECNICO DI MILANO

Finite Element Simulation For Mechanical Design

Exercise: plate with a hole

A. Bernasconi, L. M. Martulli

$p = 1$ MPa $\nu = 0.3$ $E = 10^7$ MPa
Thickness $t = 1$ mm

$r = 7$ mm

$a = 10$ mm

$a = 10$ mm

$$\Phi_\infty = \frac{\Phi_1 h_2^q - \Phi_2 h_1^q}{h_2^q - h_1^q}$$

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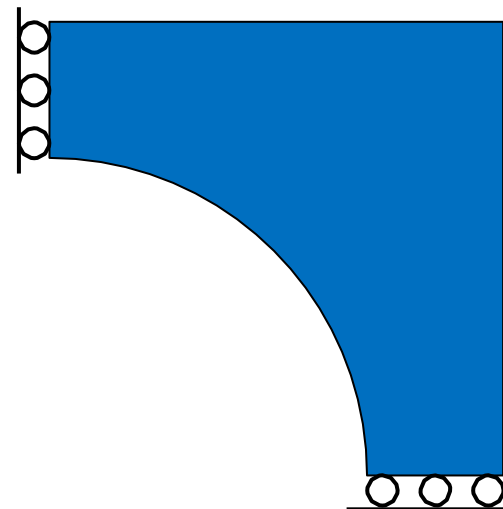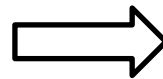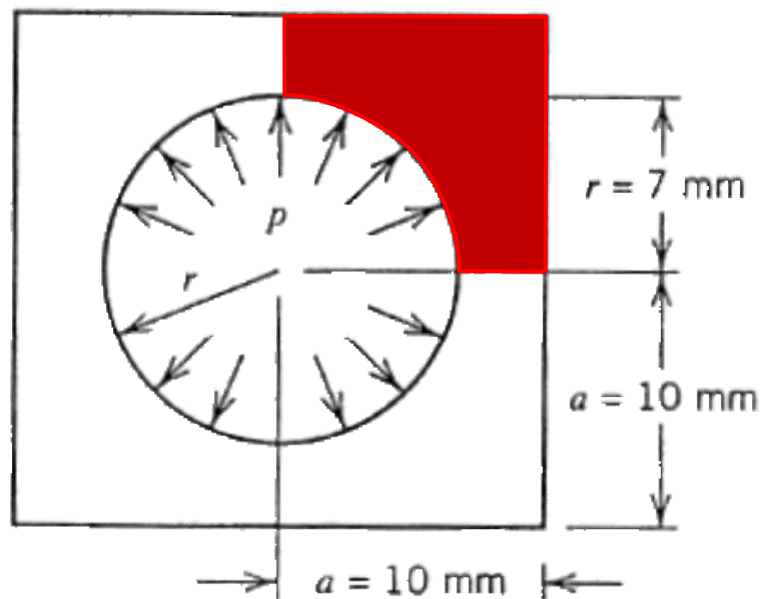
Finite Element Simulation For Mechanical Design

Exercise: another plate with another hole

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Example: plastic deformation of a plate with hole

Plastic strains

Residual stresses
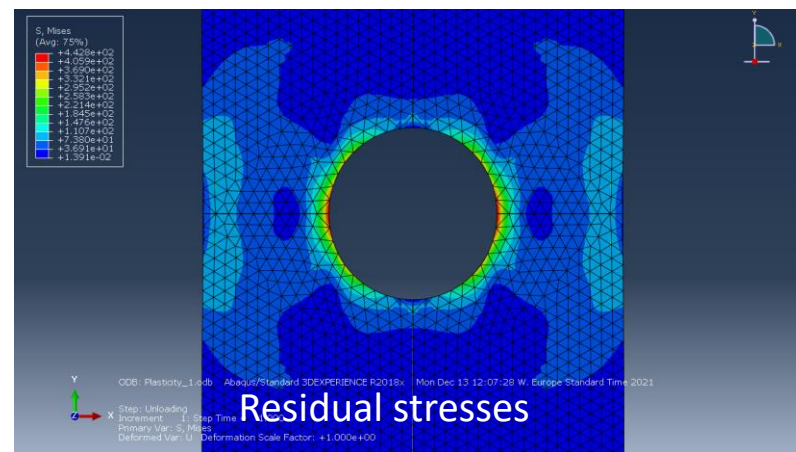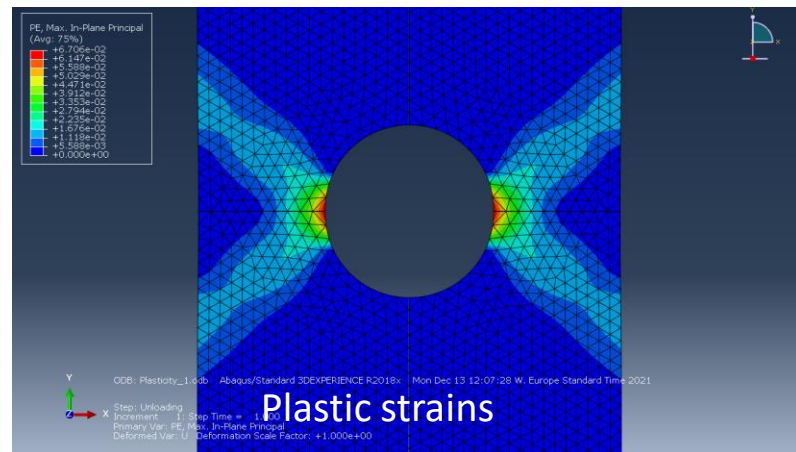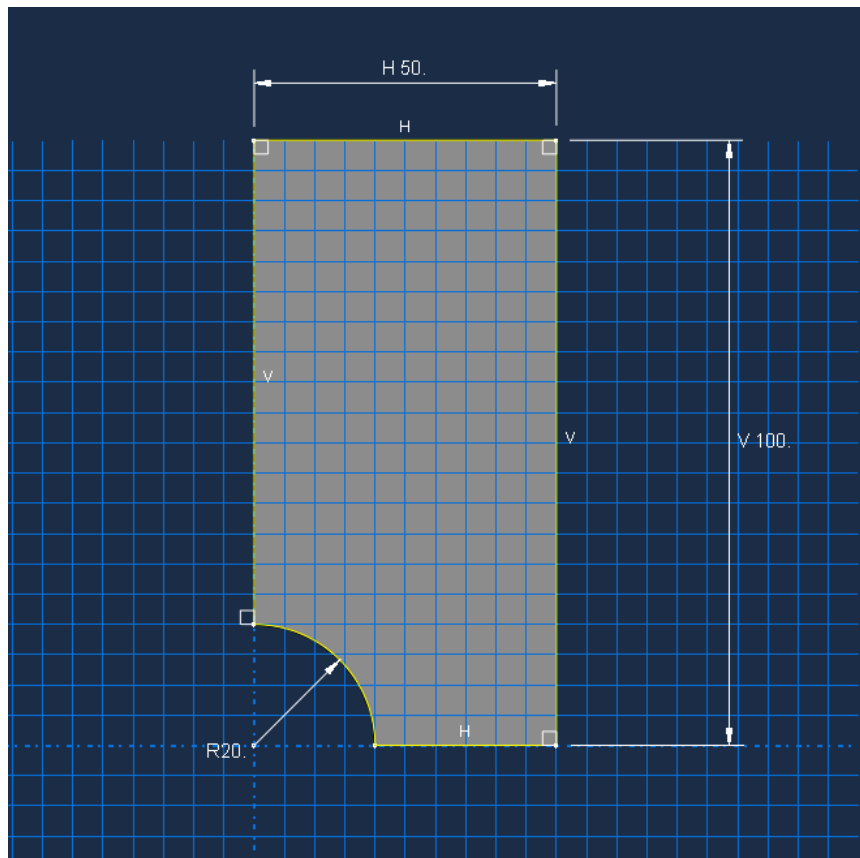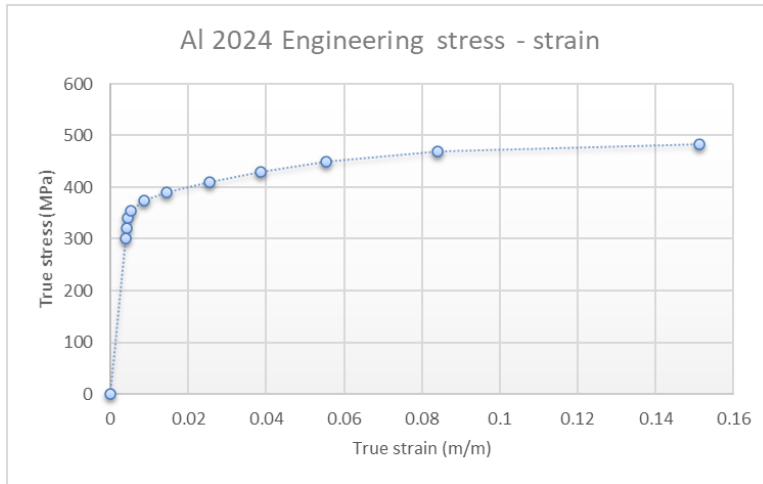
True stress – true strains are needed
They differ from engineering stresses and strains

Example for Al 2024 T3 $R_{p0,2}$ = 355 MPa

$$\sigma_{\mathrm{t}} = \frac{F}{A} = \frac{F}{A_0}\frac{A_0}{A} = \frac{F}{A_0}\frac{L}{L_0} = \sigma(1 + \varepsilon)$$

$$\delta\varepsilon_{\mathrm{t}} = \frac{\delta L}{L} \qquad \varepsilon_{\mathrm{t}} = \ln\left(\frac{L}{L_0}\right) = \ln(1 + \varepsilon)$$

For $\sigma > R_{p0,2}$:

$$\varepsilon_{tr} = \ln(1 + \varepsilon)$$
$$\sigma_{tr} = \sigma(1 + \varepsilon)$$

$$\varepsilon_{tr,pl} = \varepsilon_{tr} - \frac{\sigma_{tr}}{E}$$