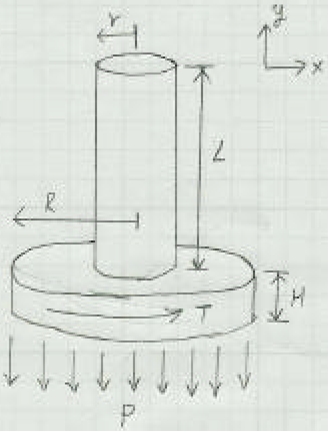
Problem Set #7 Solution



GIVEN:

$r = 1m$

$L = 10m$

$R = 3m$

$T = 240\ MN \cdot m$

$H = 1m$

$P = 10\ MPa$

$E = 200\ GPa$

$\nu = 0.3$

$\sigma_{1\,max} = 300\ MPa$

Part I : Calculations

① Find $\sigma_{y,max}$ from the Pressure P (at the joint of rod & disc)

$$\sigma_{y,max} = \frac{P(\pi R^2)}{\pi r^2} = \frac{(10\times10^6\ N/m^2)(3m)^2}{(1m^2)} = \boxed{90\ MPa}$$

② Find τ_{max} from the torque T

$$\tau_{xy} = \frac{Tr}{J}, \quad J = \frac{1}{2}\pi r^4$$

$$= \frac{2Tr}{\pi r^{4}} = \frac{2T}{\pi r^3} = \frac{2(240\times10^6\ N\cdot m)}{\pi\ (1m)^3} = \boxed{152.7\ MPa}$$

$\sigma_x = 0$

③ Using the equation from the handout, find σ_1, σ_2

$$\sigma_1 = \frac{\sigma_x+\sigma_y}{2} + \sqrt{\left[\frac{\sigma_x-\sigma_y}{2}\right]^2 + \tau_{xy}^2} = \boxed{203\ MPa}$$

$$\sigma_2 = \frac{\sigma_x+\sigma_y}{2} - \sqrt{\left[\frac{\sigma_x-\sigma_y}{2}\right]^2 + \tau_{xy}^2} = \boxed{-113\ MPa}$$

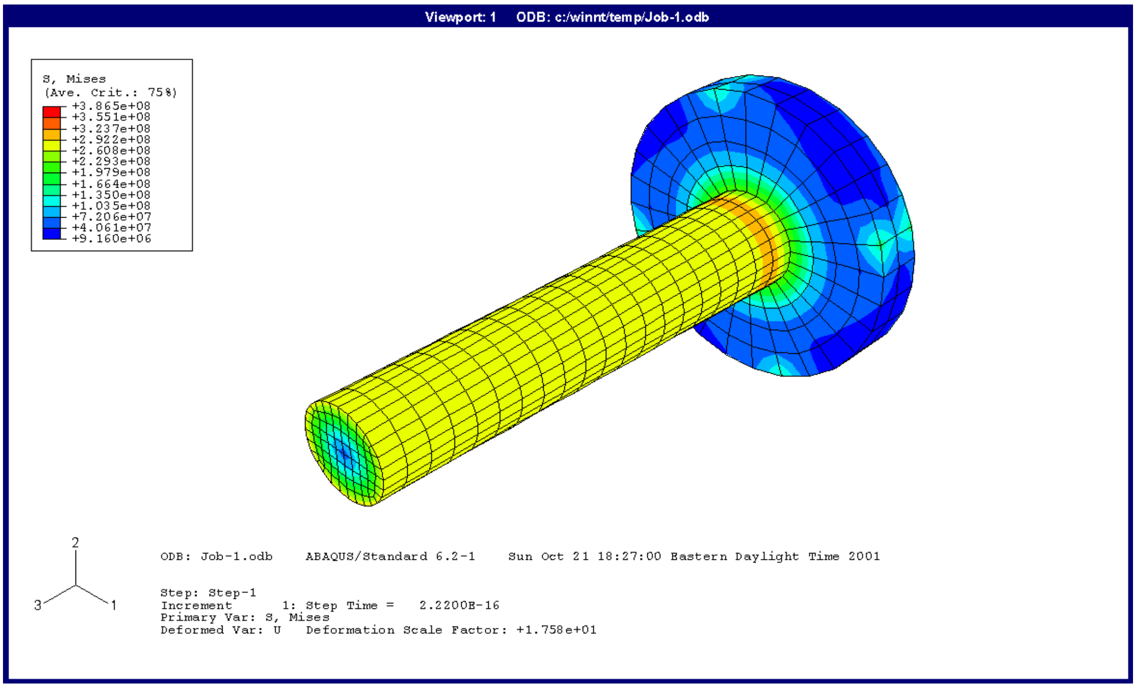
* Comments

1. Observing the result, the maximum principal stress was much higher than the pen and paper calculation.

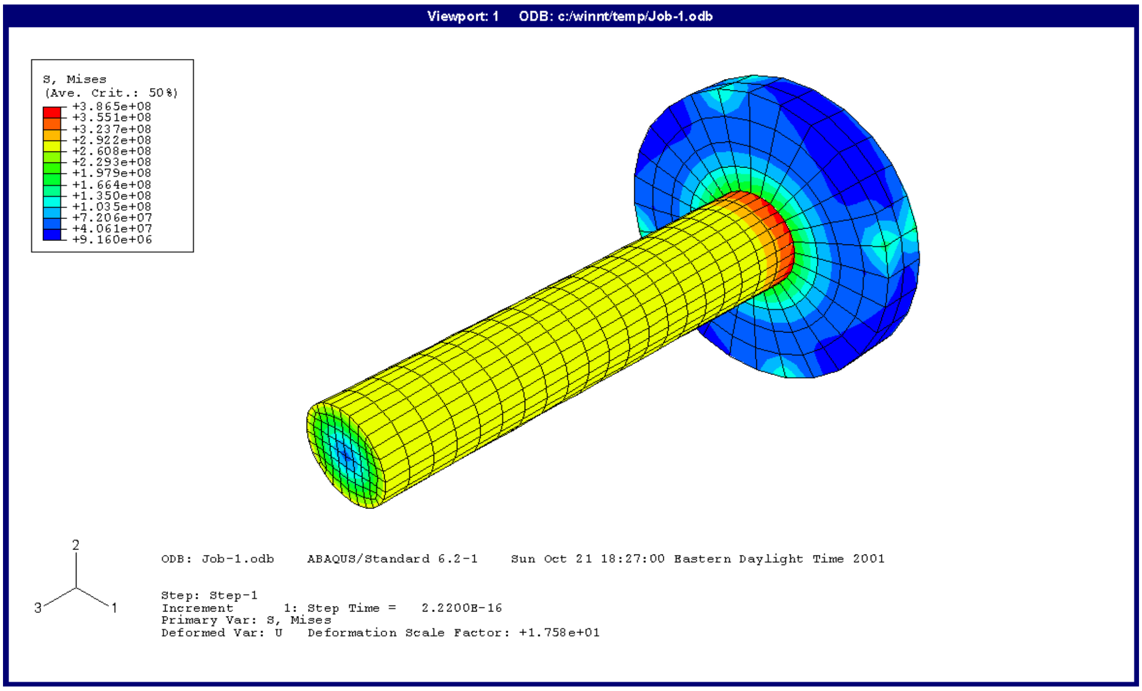
2. This is due to the fact that there are stress concentration on the sharp corners at the intersection of the disc and the rod. This will not satisfy the design requirement.

3. In order to prevent this phenomena from happening, one must remove the sharp corners by introducing fillets at the disk-axel intersection.

Von Mises Stress (75% Node Average)



Von Mises Stress (50% Node Average)



Max. Principal Stress