

**Formulas need to be memorized****1. Definitions**

$$\text{Equivalent stress } \bar{\sigma} = \sqrt{\frac{3}{2} \sigma'_{ij} \sigma'_{ij}}$$

$$\text{Equivalent plastic strain increment } d\bar{\varepsilon}^p = \sqrt{\frac{2}{3}} d\varepsilon_{ij}^p$$

**2. Observations/Assumptions**

$$\text{Elasticity: } \varepsilon_{ij}^e = \frac{1+\nu}{E} \sigma_{ij} - \frac{\nu}{E} \sigma_{kk} \delta_{ij}$$

$$\text{Von Mises yield criterion: } \bar{\sigma} = Y(\bar{\varepsilon}^p), \text{ where } \sigma_Y = Y(0).$$

$$\text{Flow rule: } d\varepsilon_{ij}^p = \sigma'_{ij} d\lambda.$$

The following formulas are derived based on the above definitions and assumption. Memorisation is helpful.

$$d\lambda = \frac{3}{2} \frac{d\bar{\varepsilon}^p}{\bar{\sigma}}$$

$$d\varepsilon_{ij}^p = \frac{9}{4} \frac{\sigma'_{ij} \sigma'_{kl}}{h \bar{\sigma}^2} d\sigma'_{kl}, \text{ where } h = \frac{dY}{d\bar{\varepsilon}^p}$$

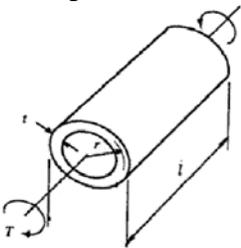
**3. Energy**

$$\text{Specific plastic work (work per volume): } dW^p = \sigma_{ij} d\varepsilon_{ij}^p$$

**4. Capability**

- 1) Einstein notation;
- 2) Principal value and direction of stress and strain.
- 3) Given loading path, calculate the strain (elastic + plastic).

Example:



$$\text{torsion test: shear stress } \begin{bmatrix} 0 & \tau & 0 \\ \tau & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \text{ shear strain } \gamma, \text{ strain tensor } \begin{bmatrix} 0 & \gamma/2 & 0 \\ \gamma/2 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\text{Shear + tension: stress } \begin{bmatrix} \sigma & \tau & 0 \\ \tau & \sigma & 0 \\ 0 & 0 & 0 \end{bmatrix}, \text{ strain } \begin{bmatrix} \varepsilon_{11} & \gamma/2 & 0 \\ \gamma/2 & \varepsilon_{22} & 0 \\ 0 & 0 & \varepsilon_{33} \end{bmatrix}$$