Luento 4:

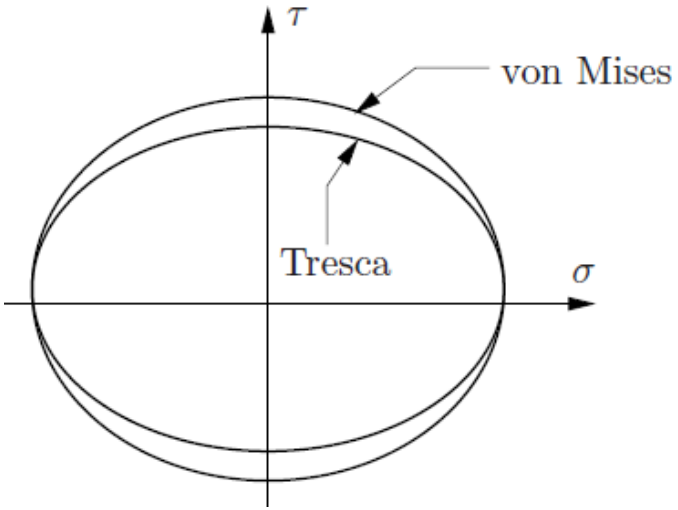
33001 Rakenteiden plastisuusmallit

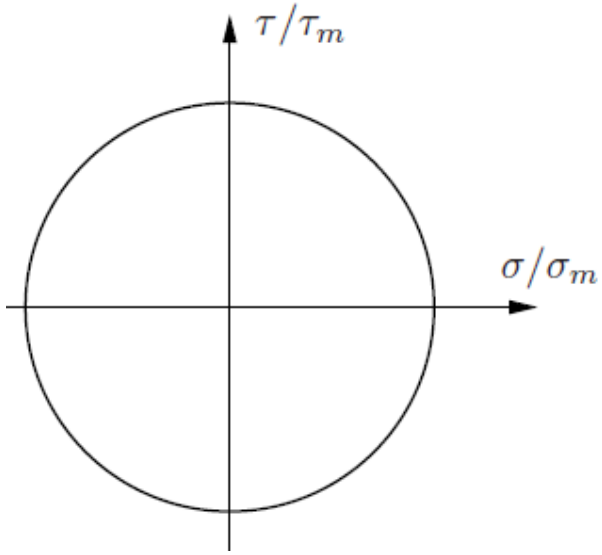
Normaalivoiman ja leikkausvoiman
vaikutus täysplastiseen momenttiin

von Mises myötöehto: $$\sqrt{\sigma^2 + 3\tau^2} = \sigma_m$$

Trescan myötöehto: $$\sqrt{\sigma^2 + 4\tau^2} = \sigma_m$$

$$\left(\frac{\sigma}{\sigma_m}\right)^2 + \left(\frac{\tau}{\tau_m}\right)^2 = 1$$





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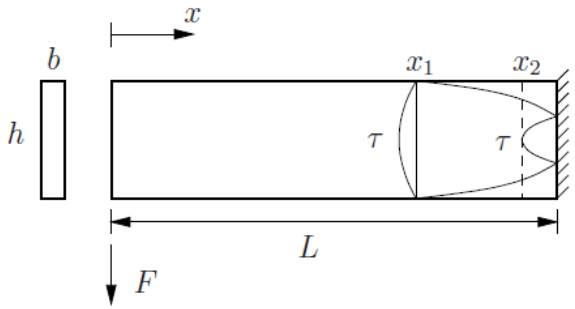


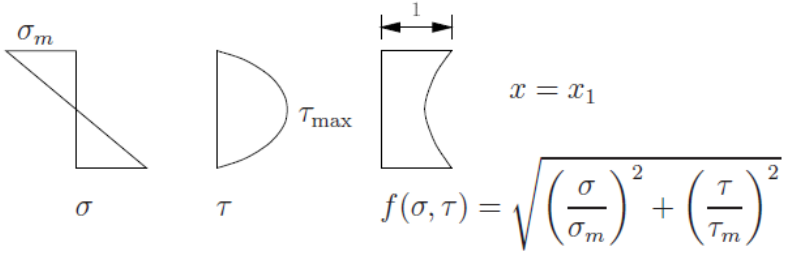
$x = x_1$

$$\tau_{\max} = \frac{3}{2}\frac{F}{bh} \le \tau_m$$

$$F \le \frac{2}{3}\tau_m bh.$$

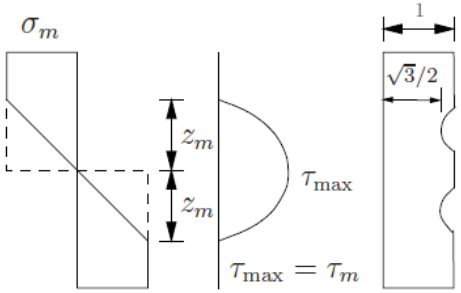
$$M(x_1) = Fx_1 = M_m = \frac{bh^2}{6}\sigma_m$$

$$\frac{x_1}{h} \ge \frac{1}{4}\frac{\sigma_m}{\tau_m}$$

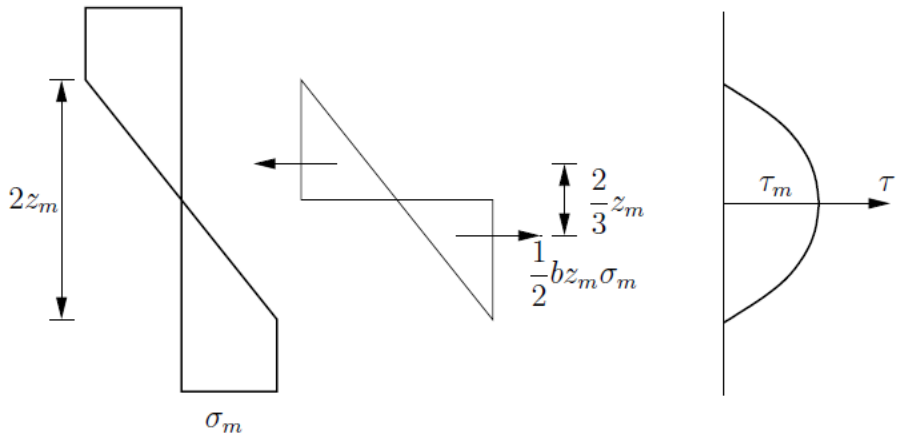


$x = x_2$ $\quad M(x_2) = Fx_2, \quad Q = F$

$$M = b\left(\frac{h^2}{4} - \frac{z_m^2}{3}\right)\sigma_m, \quad Q = \frac{4}{3}bz_m\tau_m$$



$x = x_2$



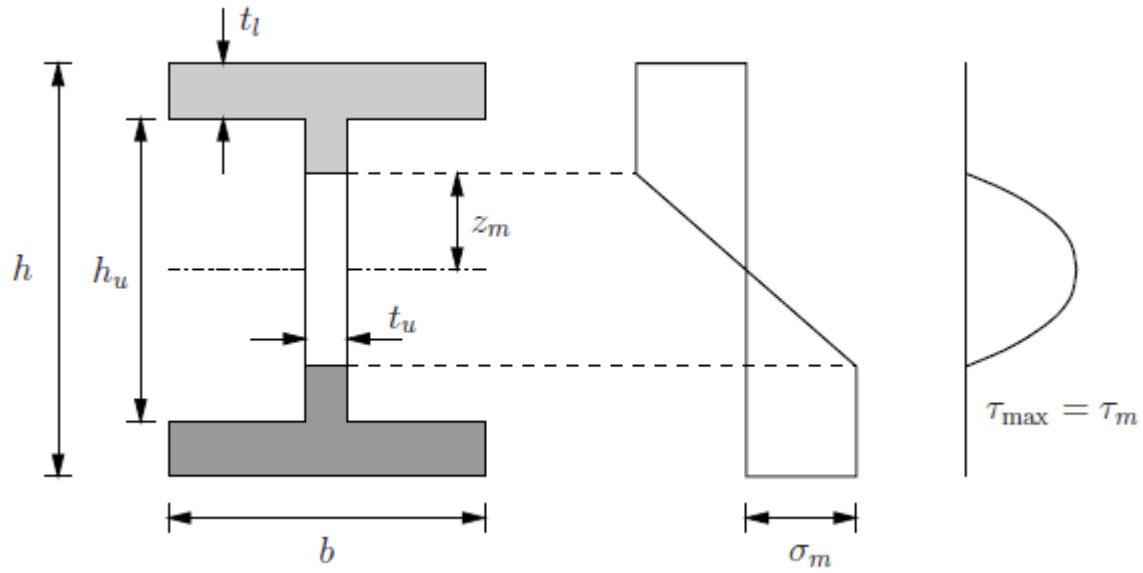
$$M = b\left(\frac{h^2}{4} - \frac{z_m^2}{3}\right)\sigma_m$$

$$Q = \frac{4}{3}bz_m\tau_m$$

$$M_p = \sigma_m bh^2/4$$

$$Q_p = bh\tau_m$$

$$\frac{M}{M_p} = 1 - \frac{3}{4}\left(\frac{Q}{Q_p}\right)^2$$



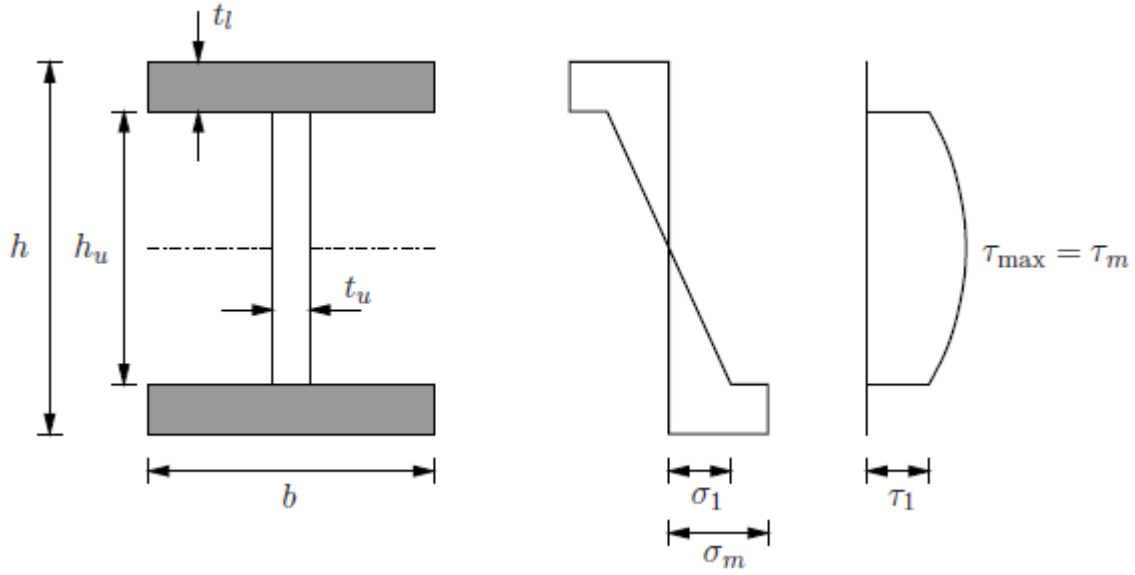
1a) $\dfrac{Q}{Q_{pu}} \leq \dfrac{2}{3}$

$$M = M_p - \frac{1}{3}\sigma_m t_u z_m^2$$

$$= M_p - \frac{3}{4}\left(\frac{Q}{Q_{pu}}\right)^2 M_{pu}$$

$$\frac{Q}{Q_{pu}} = \frac{4}{3}\frac{z_m}{h_u}$$

$$Q_{pu} = t_u h_u \tau_m$$



1b) $\frac{Q}{Q_{pu}} > \frac{2}{3}$

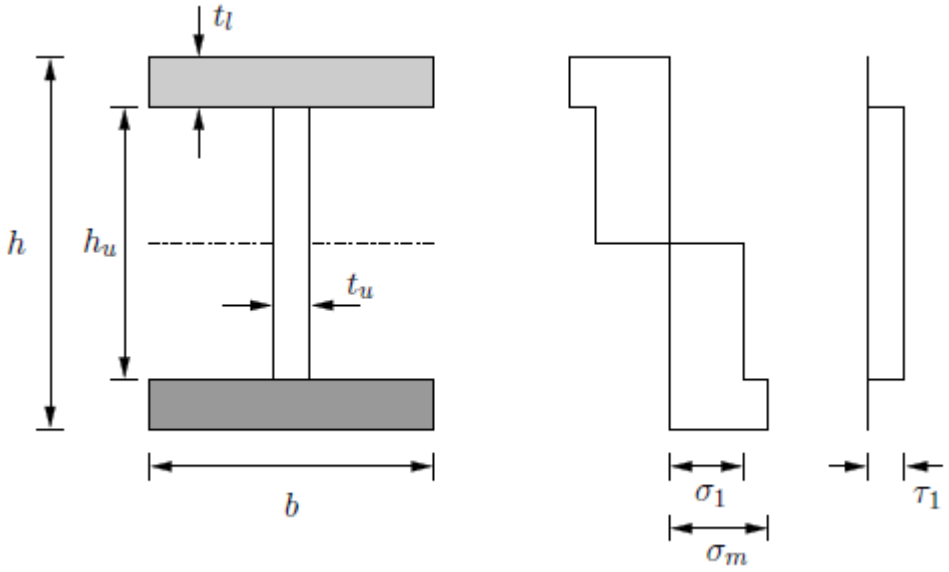
$$M = M_p - \left[1 - \frac{2}{3}\sqrt{1 - \left(3\frac{Q}{Q_{pu}} - 2\right)^2}\right] M_{pu}$$

$$M_{pu} = \frac{t_u (h_u)^2}{4}\sigma_m$$

$$Q = h_u t_u \tau_1 + h_u t_u \left[\frac{2}{3}(\tau_m - \tau_1)\right]$$

$$Q_{pu} = h_u t_u \tau_m$$

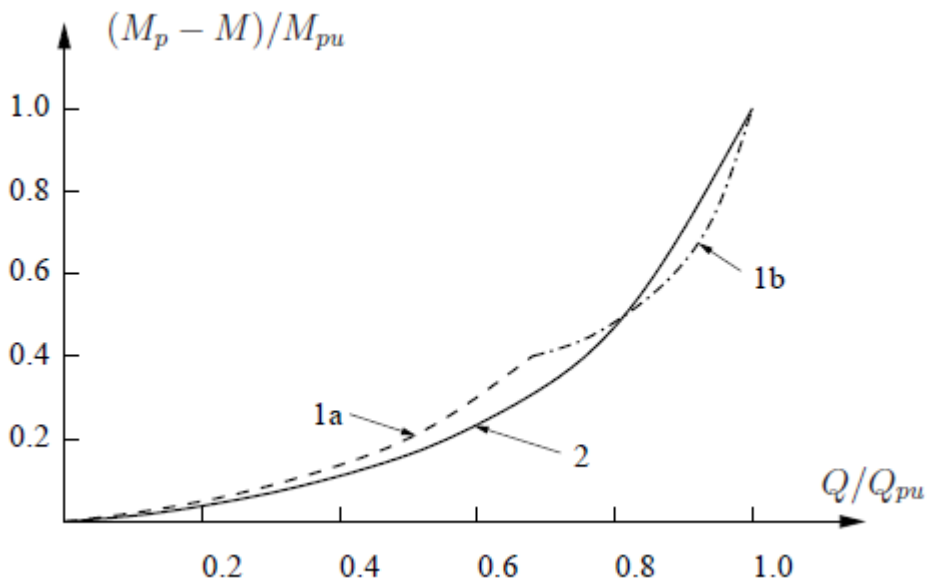
$$\frac{Q}{Q_{pu}} = \frac{1}{3}\left(2 + \frac{\tau_1}{\tau_m}\right)$$



2)

$$M = M_p - \left(\frac{\sigma_m - \sigma_1}{\sigma_m}\right) M_{pu} \qquad Q = \frac{\tau_1}{\tau_m} Q_{pu}$$

$$M = M_p - \left[1 - \sqrt{1 - \left(\frac{Q}{Q_{pu}}\right)^2}\right] M_{pu}$$


$(M_p - M)/M_{pu}$
1.0
0.8
0.6
0.4
0.2
1a
1b
2
Q/Q_{pu}
0.2
0.4
0.6
0.8
1.0