

Tamano Collapse Limit

- ▶ ISO 10400 collapse limit is based on a collapse limit state equation due to Tamano
- ▶ Interaction Equation similar to Timoshenko
- ▶ Ovality, eccentricity and residual stress included
- ▶ Using as limit state will require specification of above from measurements

Tamano Collapse Limit

$$p_{cult} = \frac{(p_e + p_y)}{2} - \sqrt{\frac{(p_e - p_y)^2}{4} + p_e p_y H_{ult}}$$

$$p_e = 1.080 \frac{2E}{(1 - \nu^2)} \frac{1}{m(m-1)^2}$$

$$p_y = 2\sigma_{ye} \frac{m-1}{m^2} \left(1 + \frac{1.5}{m-1} \right)$$

$$H_{ult} = 0.071\phi + 0.0022\varepsilon - 0.18\bar{\sigma}_r$$

$$\bar{\sigma}_r = \frac{\sigma_r}{\sigma_y}$$

$$\phi = 100 \frac{(OD_{max} - OD_{min})}{OD_{av}}$$

$$m = OD/t$$

$$\varepsilon = 100 \frac{(t_{max} - t_{min})}{t_{av}}$$

Klever Generalized Tamano

$$\Delta p_{ult} = \frac{(p_{eult} + p_{yult}) - \sqrt{(p_{eult} + p_{yult})^2 + 4p_{eult}p_{yult}H_{ult}}}{2(1 - H_{ult})}$$

$$p_{eult} = k_{els} \frac{2E}{(1 - \nu^2)} \frac{1}{(D_{ave} / t_{ave})(D_{ave} / t_{ave} - 1)^2}$$

$$p_{yult} = k_{yls} \frac{2S_y}{(D_{ave} / t_{ave})} \left(1 + \frac{1}{2(D_{ave} / t_{ave})} \right)$$

$$H_{ult} = 0.127\phi + 0.0039\varepsilon - 0.440rs / S_y + h_n$$

- ▶ Derived from Tamano's equation
- ▶ Generalizes the equation for better fit over a wider range of D/t
- ▶ Compared to other limit states for case of zero internal pressure
- ▶ For design, use specified values for
 - k_{els} , k_{yls}
 - H_{ult} , h_n
- ▶ If parameter uncertainties are known, probabilistic strength can be used

ISO 10400 Collapse Changes

- ▶ The ISO 10400 collapse is a generalized expression derived from the works of Dr. Tamano of Nippon Steel, and Dr. Klever of Shell.
- ▶ The limit state was chosen based on its rational formulation and good fit compared with different sets of full scale collapse test data.
- ▶ Collapse depends on ovality, residual stress, and eccentricity in addition to tension, D/t ratio and yield strength.
- ▶ Minimum collapse pressures are based on the statistical scatter of *input parameters* (yield, D/t, etc) instead of the scatter in collapse test data.