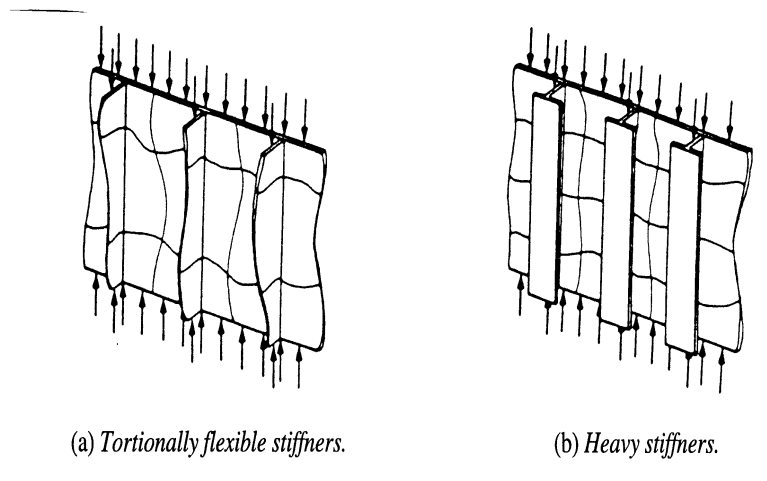
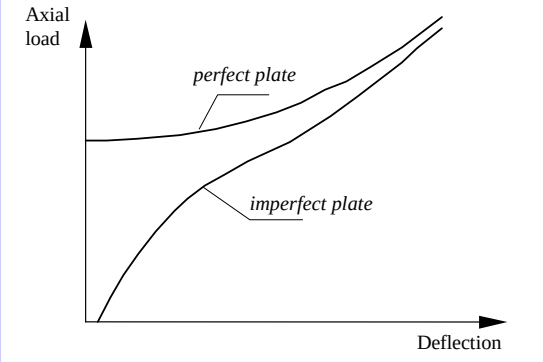
Buckling of stiffened plates
Important parameters

- length/width ratio of the panel
- stiffener geometry and spacing
- aspect ratio for plate between stiffener
- plate slenderness
- residual stresses
- initial distortions
- boundary conditions
- type of loading

Buckling of short panel

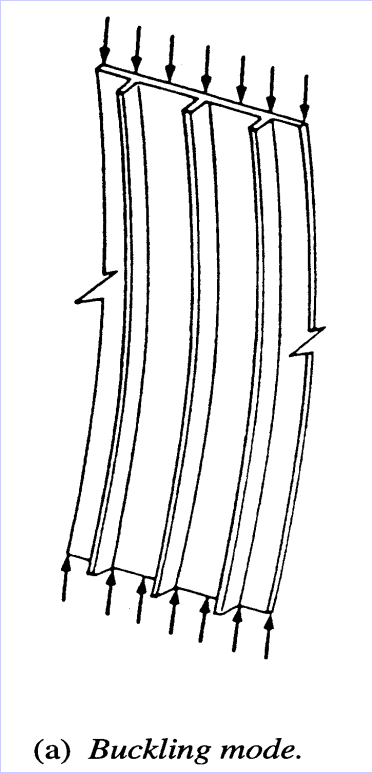


(a) *Tortionally flexible stiffners.* (b) *Heavy stiffners.*

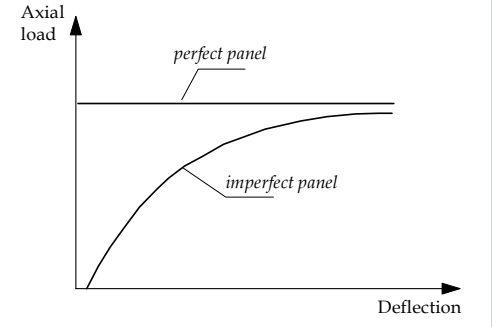


(c) Load-deflection behaviour of plate element.

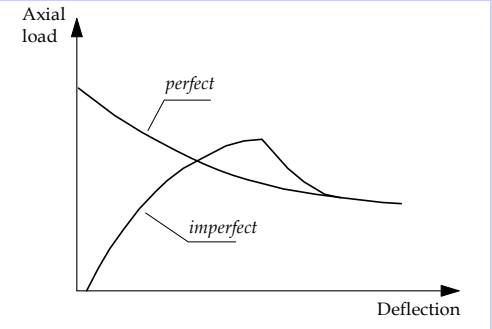
Buckling of long panel



(a) ***Buckling mode.***

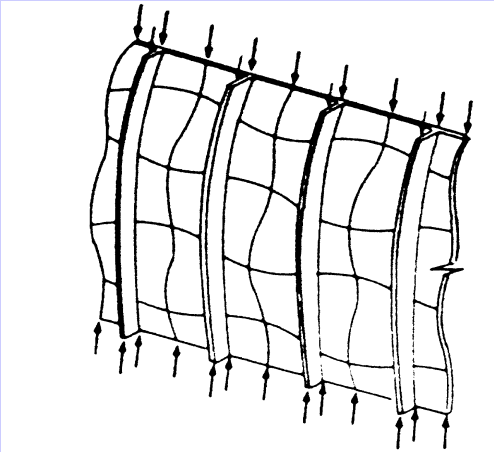


(b) *Heavy stiffeners.*

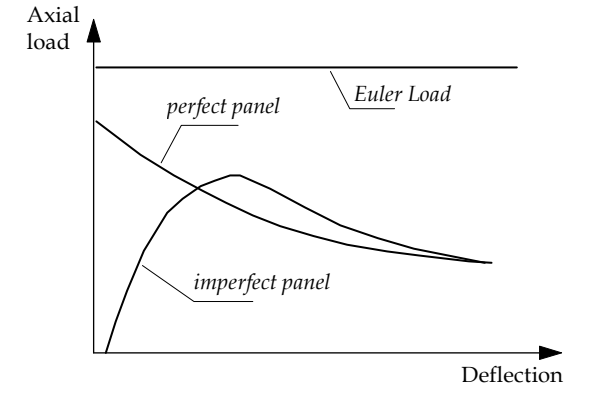


(c) *Torsional buckling of stiffeners.*

Buckling of optimum panel



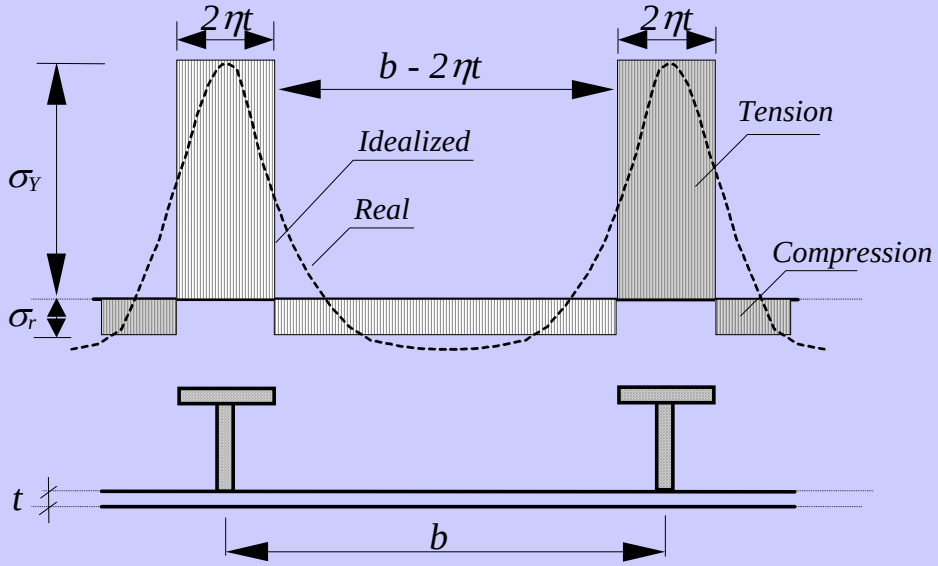
(a) ***Buckling mode.***



(b) *Load-deflection behaviour.*

Post-buckling capacity of plates

Influence of in-plane restraint of long edges



Compressive stress $\frac{\sigma_r}{\sigma_Y} = \frac{2\eta}{\frac{b}{t} - 2\eta}$

Reduction factor $R_r = 1 - \frac{\sigma_r}{\sigma_Y}\frac{E_t}{E} = 1 - \frac{2\eta}{\frac{b}{t} - 2\eta}\frac{2(\beta - 1)}{\beta}, 1 < \beta < 2.5$

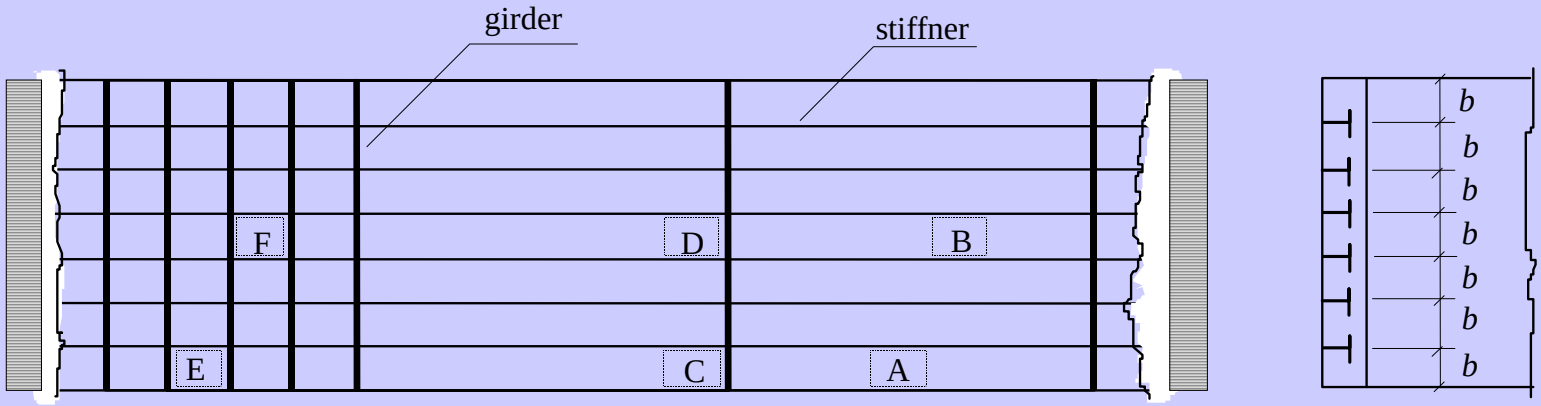
DnV Class. Note 30.1

$$\frac{b_e}{b} = \frac{\sigma_{xu}}{\sigma_Y} = \frac{1.8}{\beta} - \frac{0.8}{\beta^2} \qquad \beta \geq 1$$

$$\frac{b_e}{b} = 1 \qquad \beta \leq 1$$

Post buckling capacity of plates

Influence of boundary conditions



Boundary conditions depend on location of plate element

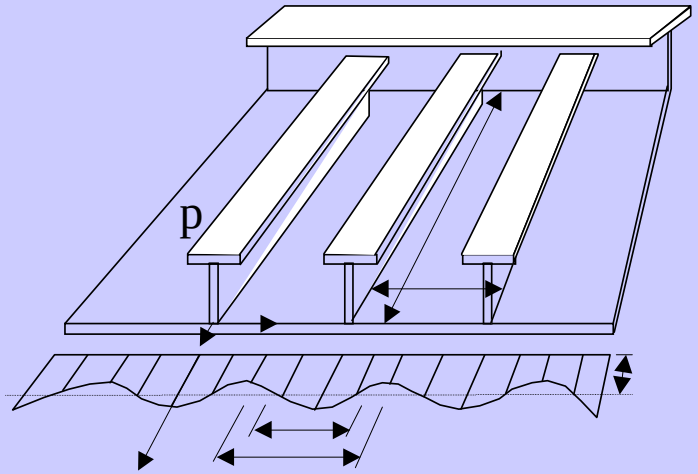
Classification example: Ship bottom

A: unrestrained

B: constrained

F: restrained

Effective Width Concept



Effective width, long plate

$$\frac{b_e}{b} = \frac{\sigma_{xm}}{\sigma_y} = \begin{cases} \frac{2}{\beta} - \frac{1}{\beta^2} \beta \geq 1 \\ 1 \beta \leq 1 \end{cases}$$

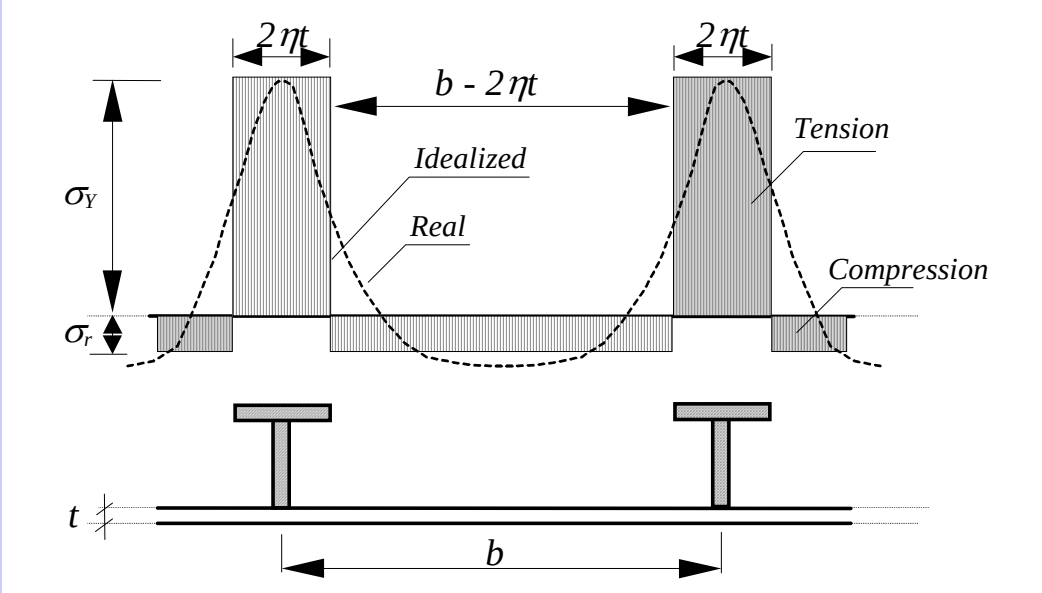
Effective width, short plate

$$\frac{a_e}{a} = \frac{\sigma_{ym}}{\sigma_Y} = \frac{0.9}{\beta^2} + \frac{1.9}{\alpha\beta}\left(1 - \frac{0.9}{\beta^2}\right), \alpha = \frac{a}{b}$$

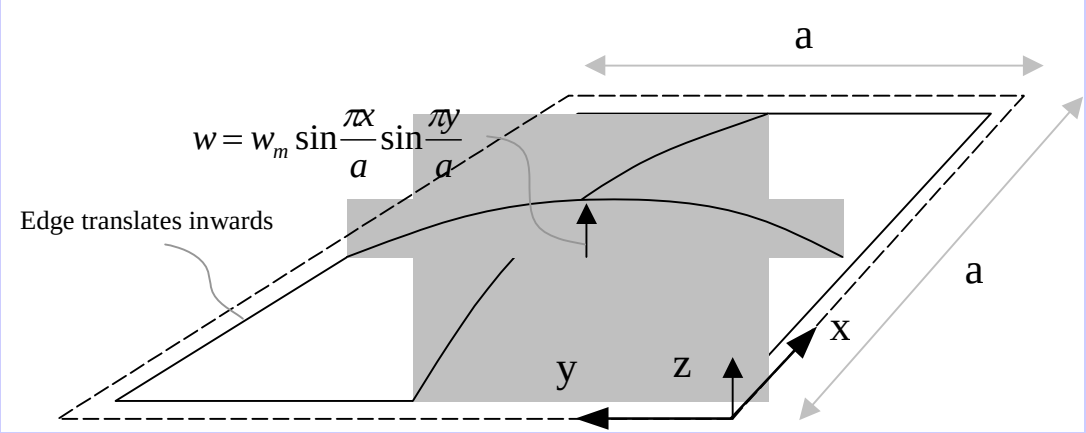
Plate slenderness

$$\beta = \frac{b}{t}\sqrt{\frac{\sigma_Y}{E}}$$

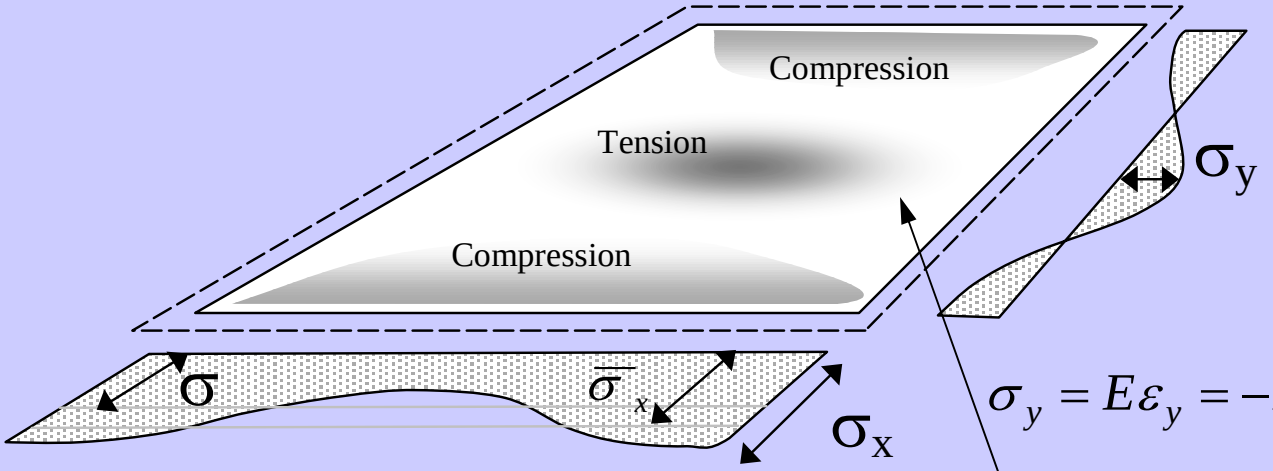
Influence of residual stresses



Simple model for post-buckling capacity
assumed displacement field



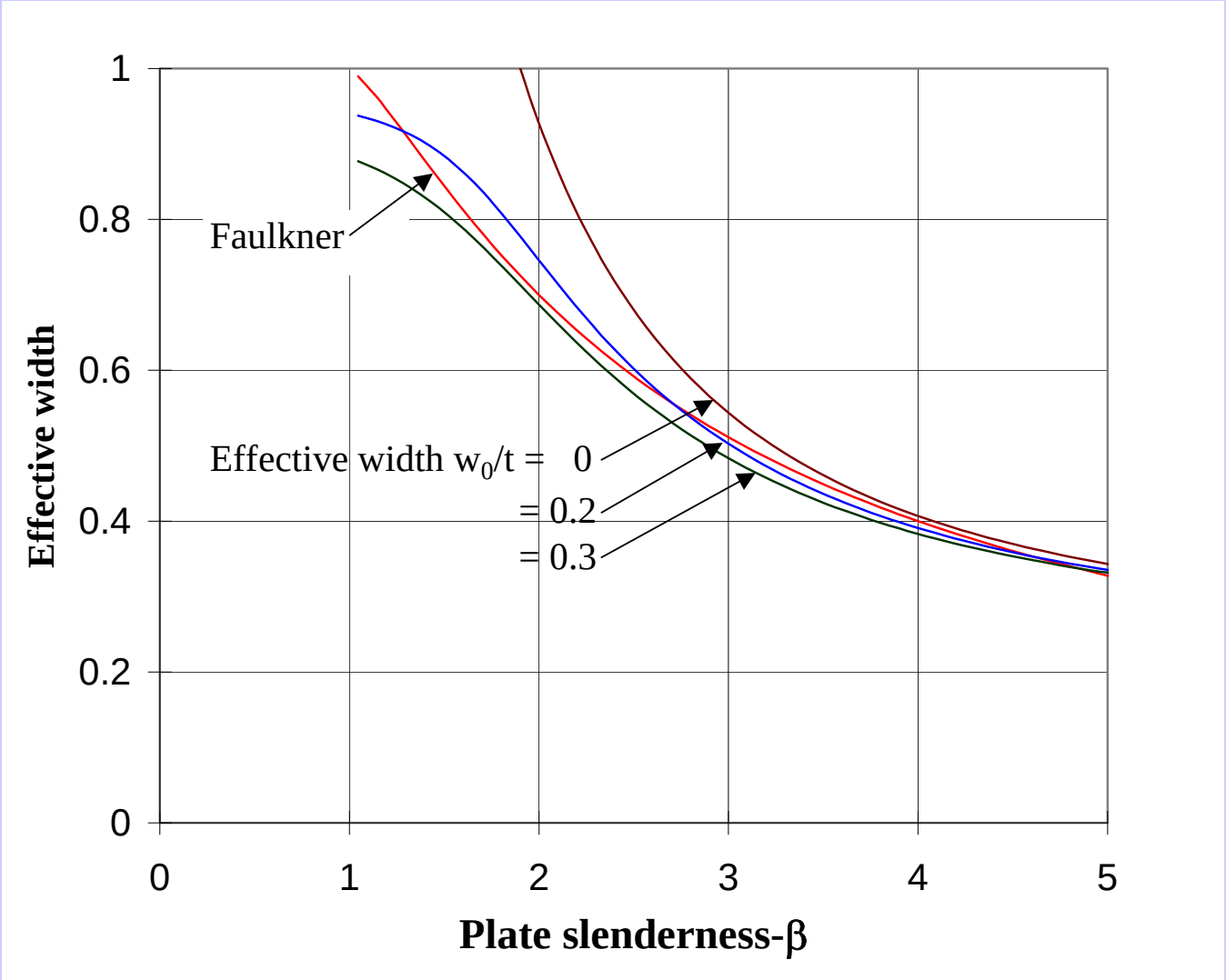
Stress distribution along boundaries



$$\sigma_y = E\varepsilon_y = -E\frac{\pi^2}{8}\left(\frac{w_m}{a}\right)^2 \cos\frac{2\pi x}{a}$$

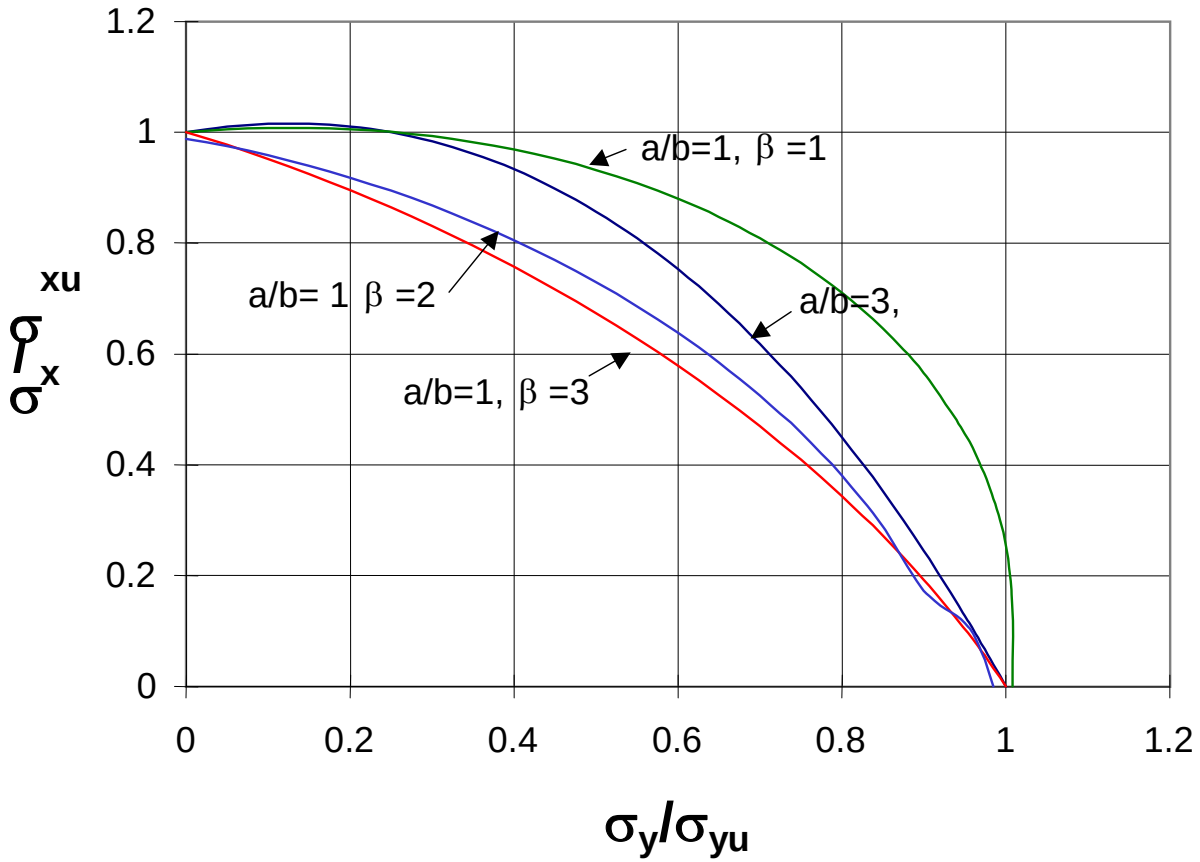
$$\Delta\sigma_x(y) = -Et\frac{\pi 2}{16}\left(\frac{w_m}{a}\right)^2\left\{1+2\cos\frac{2\pi y}{a}\right\}$$

Effective width -simple model



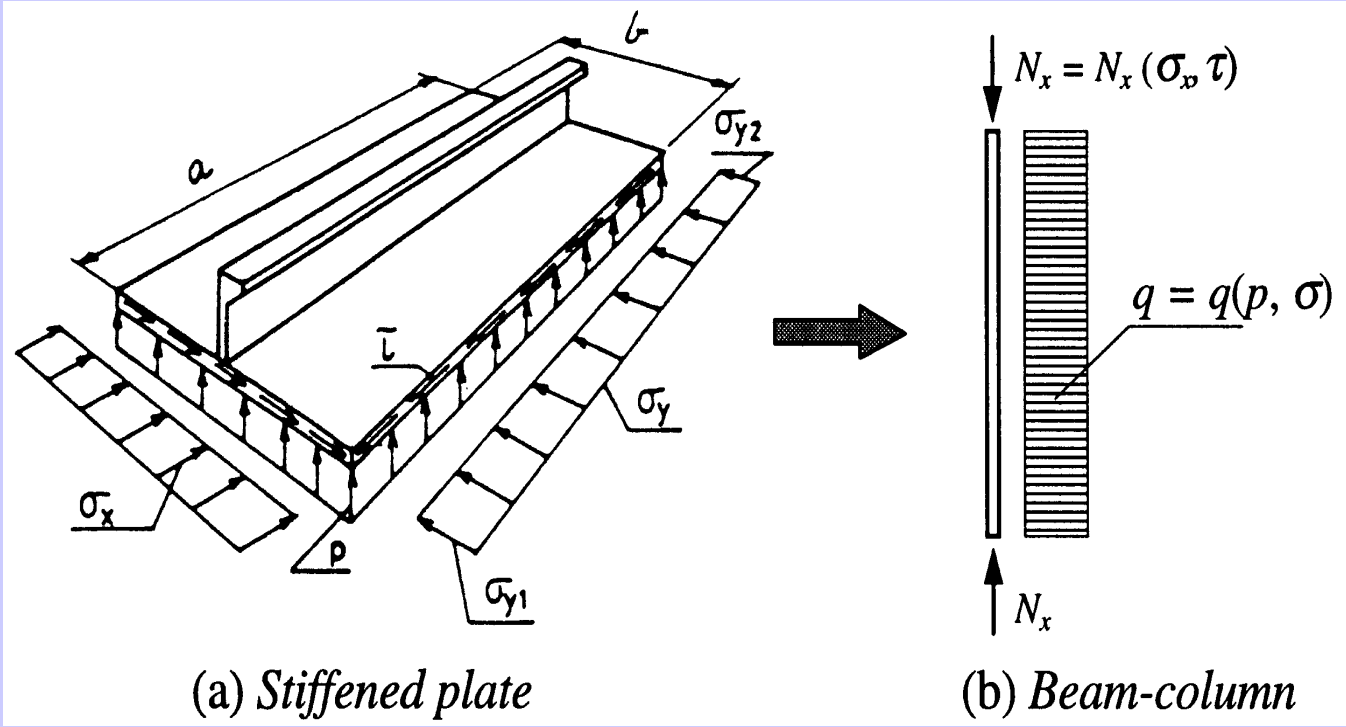
Post-buckling capacity of plates

Interaction curve for bi-axial compression (DnV)



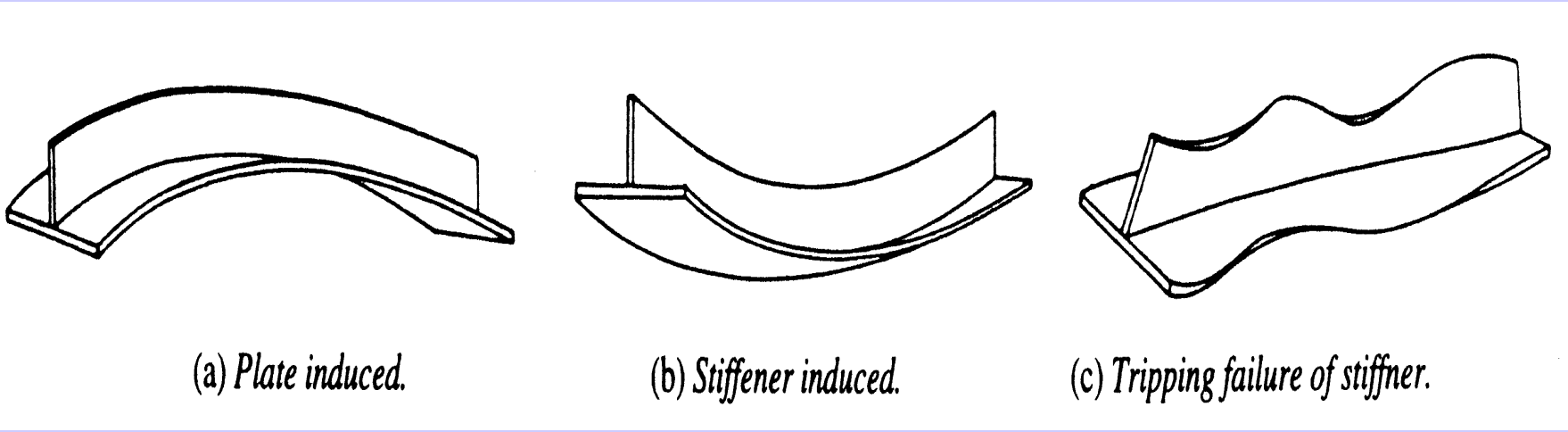
Stiffened plate

Equivalent beam-column model



(a) *Stiffened plate* (b) *Beam-column*

Interframe collapse modes for stiffened plates



(a) *Plate induced.*

(b) *Stiffener induced.*

(c) *Tripping failure of stiffner.*