$$\varepsilon = \frac{u(x+\mathrm{d}x)-u(x)}{\mathrm{d}x} = \frac{\mathrm{d}u}{\mathrm{d}x}$$

$$\sigma = E\,\varepsilon$$

$$\Delta L = u(L) - u_0 = \frac{N\,L}{EA}$$

$$\bar{y}_{\mathrm{N}} = \frac{\sum (EA)_{\mathrm{i}}\,\bar{y}_{\mathrm{i}}}{\sum (EA)_{\mathrm{i}}} \qquad \bar{z}_{\mathrm{N}} = \frac{\sum (EA)_{\mathrm{i}}\,\bar{z}_{\mathrm{i}}}{\sum (EA)_{\mathrm{i}}}$$

$$\frac{\mathrm{d}Q}{\mathrm{d}x} = -q(x) \qquad \frac{\mathrm{d}M_{\mathrm{t}}}{\mathrm{d}x} = Q(x) \qquad \frac{\mathrm{d}^2 M_{\mathrm{t}}}{\mathrm{d}x^2} = -q(x)$$

$$N = \iint \sigma_x \,\mathrm{d}A \qquad M_{\mathrm{tz}} = \iint y\,\sigma_x\,\mathrm{d}A \qquad M_{\mathrm{ty}} = \iint z\,\sigma\,\mathrm{d}A$$

$$\sigma_x = \frac{y\,I_{\mathrm{y}} - z\,I_{\mathrm{yz}}}{I_{\mathrm{y}}\,I_{\mathrm{z}} - I_{\mathrm{yz}}^2}\,M_{\mathrm{tz}} + \frac{z\,I_{\mathrm{z}} - y\,I_{\mathrm{yz}}}{I_{\mathrm{y}}\,I_{\mathrm{z}} - I_{\mathrm{yz}}^2}\,M_{\mathrm{ty}}$$

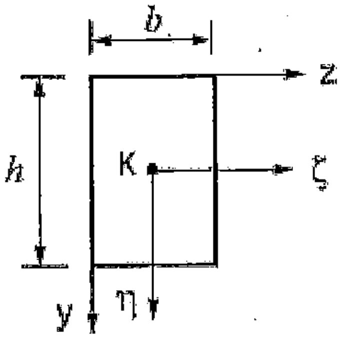
$$I_{\mathrm{y}} = \iint_A z^2\,\mathrm{d}A \qquad I_{\mathrm{z}} = \iint_A y^2\,\mathrm{d}A \qquad I_{\mathrm{yz}} = \iint_A yz\,\mathrm{d}A$$

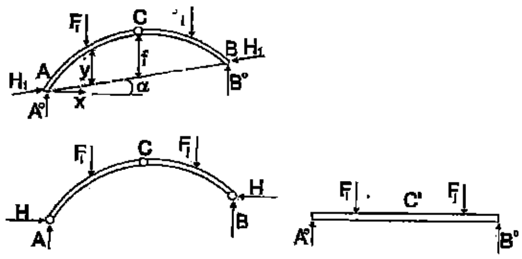
$$\widehat{EI}_{\mathrm{z}}\,v_{,xx} = -M_{\mathrm{tz}} \qquad \widehat{EI}_{\mathrm{z}} = \iint_A y^2\,E(y,z)\,\mathrm{d}A$$

$$\sigma_x(y,z) = E(y,z)\,\frac{M_{\mathrm{tz}}}{\widehat{EI}_{\mathrm{z}}}\,y \qquad \sigma_x(y,z) = E(y,z)\,\frac{N}{\widehat{EA}}$$

$$I_\zeta = \tfrac{1}{12}bh^3$$

$$I_\eta = \tfrac{1}{12}b^3h$$





Kaaren rasitussuureet:

$$M(x) = M^\circ(x) - H_1 * y * \cos\alpha$$
$$Q(x) = Q^\circ(x) * \cos\varphi - H_1 * \sin(\varphi - \alpha)$$
$$N(x) = -Q^\circ(x) * \sin\varphi - H_1 * \cos(\varphi - \alpha)$$

$$\begin{cases} M(x) = M^\circ(x) - H * y \\ Q(x) = Q^\circ(x) * \cos\varphi - H_1 \sin(\varphi - \alpha) \\ N(x) = -Q^\circ(x) * \sin\varphi - H_1 * \cos(\varphi - \alpha) \end{cases}$$

Jos kulma α on nolla eli tuet A ja B ovat samalla tasolla saadaan:

$H = H_1 = M_c^\circ / f \qquad A = A^\circ$ ja $B = B^\circ$

$$\begin{cases} M(x) = M^\circ(x) - H * y \\ Q(x) = Q_o(x) * \cos\varphi - H * \sin\varphi. \\ N(x) = -Q^\circ(x) * \sin\varphi - H * \cos\varphi \end{cases}$$

Muista kuitenkin, että aina pärjää vapaakappale-kuvilla ja tasapainoehdoilla.

$$\frac{d^2 y}{dx^2} = \frac{q(x)}{H}$$

$$W = \mathbf{F} \bullet \mathbf{u} = F_x\, u + F_y\, v + F_z\, w$$

$$y(x) = \frac{q_0}{2H} x^2$$

$$\delta W = \mathbf{F} \bullet \delta \mathbf{u}$$

$$\delta W_q = \int_0^L \mathbf{q} \bullet \delta \mathbf{u}\, dx = \int_0^L (q_x\, \delta u + q_y\, \delta v)\, dx$$

$$\frac{d^2 y}{dx^2} = \frac{q_0}{H} \sqrt{1 + (dy/dx)^2}$$

$$\delta W_{ulk} + \delta W_{sis} = 0, \ \forall \delta v$$

$$\widehat{EI}_y = \sum_{i=1}^{n} E_i (I_{y_i} + \bar{z}_i^2 A_i) \qquad \widehat{EI}_{yz} = \sum_{i=1}^{n} E_i (I_{y_i z_i} + \bar{y}_i \bar{z}_i A_i) \qquad \widehat{EI}_z = \sum_{i=1}^{n} E_i (I_{z_i} + \bar{y}_i^2 A_i)$$

$$\sigma_x(y,z) = E_i \frac{N}{\widehat{EA}} + E_i \frac{\widehat{EI}_y M_{tz} - \widehat{EI}_{yz} M_{ty}}{\widehat{EI}_y \widehat{EI}_z - \widehat{EI}_{yz}^{\;2}} y_i + E_i \frac{\widehat{EI}_z M_{ty} - \widehat{EI}_{yz} M_{tz}}{\widehat{EI}_y \widehat{EI}_z - \widehat{EI}_{yz}^{\;2}} z_i$$

$$\widehat{EA} = \sum_{i=1}^{n} E_i A_i$$

$\Delta L \approx \alpha L \Delta T$