Princip virtuálních sil (PVs)

Obecný výraz pro doplňkovou virtuální práci vnitřních sil (tah-tlak, ohyb a smyk v rovině xz):

$$\delta W^*_{\text{int}} = \int_0^L \delta M(x)\kappa(x)\mathrm{d}x + \int_0^L \delta N(x)\varepsilon_{\text{s}}(x)\mathrm{d}x + \int_0^L \delta Q(x)\gamma_{\text{s}}(x)\mathrm{d}x$$

Obecné vztahy mezi vnitřními silami a přetvořením segmentu prutu:

$$\kappa = \frac{M}{EI} + \alpha_T \frac{\Delta T_d - \Delta T_h}{h}$$

křivost

$$\varepsilon_{\text{s}} = \frac{N}{EA} + \alpha_T \Delta T_{\text{s}}$$

relativní protažení střednice

$$\gamma_{\text{s}} = \frac{Q}{GA^*}$$

smykové zkosení

Silová metoda

$$\delta_{if} = \sum_p \int_0^{L_p} \left(\frac{\bar{M}_i(x)\bar{M}_f(x)}{EI} + \frac{\bar{N}_i(x)\bar{N}_f(x)}{EA} + \frac{\bar{Q}_i(x)\bar{Q}_f(x)}{GA^*} \right)\mathrm{d}x$$

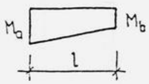
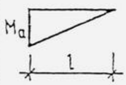
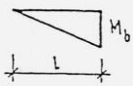
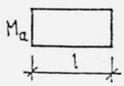
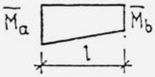
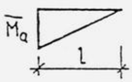
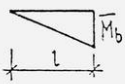
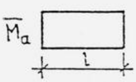
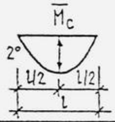
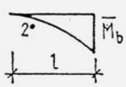
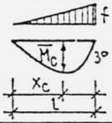
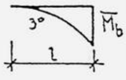
$$\delta_{ij} = \sum_p \int_0^{L_p} \left(\frac{\bar{M}_i(x)\bar{M}_j(x)}{EI} + \frac{\bar{N}_i(x)\bar{N}_j(x)}{EA} + \frac{\bar{Q}_i(x)\bar{Q}_j(x)}{GA^*} \right)\mathrm{d}x$$

$$\begin{aligned}
&\delta_{11}X_1 + \delta_{12}X_2 + \ldots + \delta_{1s}X_s = -\delta_{1f} \\
&\delta_{21}X_1 + \delta_{22}X_2 + \ldots + \delta_{2s}X_s = -\delta_{2f} \\
&\ldots. \\
&\delta_{s1}X_1 + \delta_{s2}X_2 + \ldots + \delta_{ss}X_s = -\delta_{sf}
\end{aligned}$$

$$\begin{aligned}
M &= \bar{M}_f + X_1\bar{M}_1 + X_2\bar{M}_2 + \ldots + X_s\bar{M}_s \\
N &= \bar{N}_f + X_1\bar{N}_1 + X_2\bar{N}_2 + \ldots + X_s\bar{N}_s \\
Q &= \bar{Q}_f + X_1\bar{Q}_1 + X_2\bar{Q}_2 + \ldots + X_s\bar{Q}_s
\end{aligned}$$

TABULKA I

HODNOTY $\int_0^l M\overline{M}\,dx$

$\overline{M}$ \ M				
	$\frac{1}{6}[M_a(2\overline{M}_a+\overline{M}_b)+M_b(2\overline{M}_b+\overline{M}_a)]l$ platí i pro [illegible] a pro [illegible]	$\frac{1}{6}M_a(2\overline{M}_a+\overline{M}_b)l$	$\frac{1}{6}M_b(\overline{M}_a+2\overline{M}_b)l$	$\frac{1}{2}M_a(\overline{M}_a+\overline{M}_b)l$
	$\frac{1}{6}(2M_a+M_b)\overline{M}_a l$	$\frac{1}{3}M_a\overline{M}_a\cdot l$	$\frac{1}{6}M_b\overline{M}_a\cdot l$	$\frac{1}{2}M_a\overline{M}_a\cdot l$
	$\frac{1}{6}(M_a+2M_b)\overline{M}_b\cdot l$	$\frac{1}{6}M_a\overline{M}_b l$	$\frac{1}{3}M_b\overline{M}_b\cdot l$	$\frac{1}{2}M_a\overline{M}_b\cdot l$
	$\frac{1}{2}(M_a+M_b)\overline{M}_a\cdot l$	$\frac{1}{2}M_a\overline{M}_a\cdot l$	$\frac{1}{2}M_b\overline{M}_a\cdot l$	$M_a\overline{M}_a\cdot l$
	$\overline{M}_c=\frac{1}{8}fl^2$ $\frac{1}{3}(M_a+M_b)\overline{M}_c\cdot l$	$\frac{1}{3}M_a\overline{M}_c\cdot l$	$\frac{1}{3}M_a\overline{M}_c\cdot l$	$\frac{2}{3}M_a\overline{M}_c\cdot l$
	$\frac{1}{12}(M_a+3M_b)\overline{M}_b\cdot l$	$\frac{1}{12}M_a\overline{M}_b\cdot l$	$\frac{1}{4}M_b\overline{M}_b\cdot l$	$\frac{1}{3}M_a\overline{M}_b\cdot l$
	$\overline{M}_c=\frac{\sqrt{3}}{27}fl^2,\ x_c=\frac{\sqrt{3}}{3}l$ $[\frac{21}{40}M_a+\frac{3}{5}M_b]\overline{M}_c\cdot x_c$	$\frac{21}{40}M_a\overline{M}_c x_c$	$\frac{3}{5}M_b\overline{M}_c x_c$	$\frac{9}{8}M_a\overline{M}_c x_c$
	$\frac{1}{20}(M_a+4M_b)\overline{M}_b l$	$\frac{1}{20}M_a\overline{M}_b l$	$\frac{1}{5}M_b\overline{M}_b l$	$\frac{1}{4}M_a\overline{M}_b\cdot l$