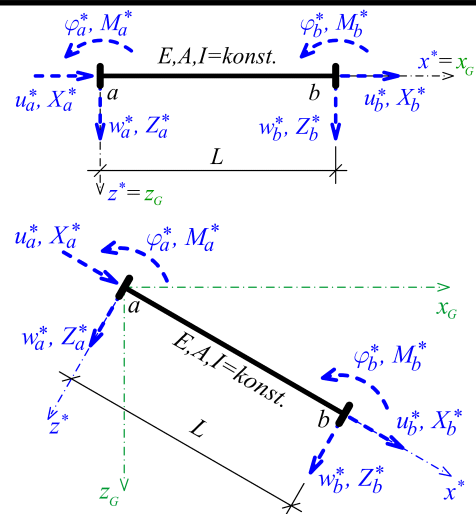


Vetknutí - Vetknutí



Lokální matice tuhosti

$$[K_{a,b}] = \begin{bmatrix} \frac{EA}{L} & 0 & 0 & -\frac{EA}{L} & 0 & 0 \\ 0 & \frac{12EI}{L^3} & -\frac{6EI}{L^2} & 0 & -\frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ 0 & -\frac{6EI}{L^2} & \frac{4EI}{L} & 0 & \frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{EA}{L} & 0 & 0 & \frac{EA}{L} & 0 & 0 \\ 0 & -\frac{12EI}{L^3} & \frac{6EI}{L^2} & 0 & \frac{12EI}{L^3} & \frac{6EI}{L^2} \\ 0 & -\frac{6EI}{L^2} & \frac{2EI}{L} & 0 & \frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix} \begin{matrix} X_a^* \\ Z_a^* \\ M_a^* \\ X_b^* \\ Z_b^* \\ M_b^* \end{matrix}$$



Globální matice tuhosti

$$[K_{a,b}] = \begin{bmatrix} \left(\frac{12EI}{L^3} + Dc^2\right) & Dcs & \frac{6EI}{L^2}s & -\left(\frac{12EI}{L^3} + Dc^2\right) & -Dcs & \frac{6EI}{L^2}s \\ Dcs & \left(\frac{EA}{L} - Dc^2\right) & -\frac{6EI}{L^2}c & -Dcs & -\left(\frac{EA}{L} - Dc^2\right) & -\frac{6EI}{L^2}c \\ \frac{6EI}{L^2}s & -\frac{6EI}{L^2}c & \frac{4EI}{L} & -\frac{6EI}{L^2}s & \frac{6EI}{L^2}c & \frac{2EI}{L} \\ -\left(\frac{12EI}{L^3} + Dc^2\right) & -Dcs & -\frac{6EI}{L^2}s & \left(\frac{12EI}{L^3} + Dc^2\right) & Dcs & -\frac{6EI}{L^2}s \\ -Dcs & -\left(\frac{EA}{L} - Dc^2\right) & \frac{6EI}{L^2}c & Dcs & \left(\frac{EA}{L} - Dc^2\right) & \frac{6EI}{L^2}c \\ \frac{6EI}{L^2}s & -\frac{6EI}{L^2}c & \frac{2EI}{L} & -\frac{6EI}{L^2}s & \frac{6EI}{L^2}c & \frac{4EI}{L} \end{bmatrix} \begin{matrix} X_a \\ Z_a \\ M_a \\ X_b \\ Z_b \\ M_b \end{matrix}$$

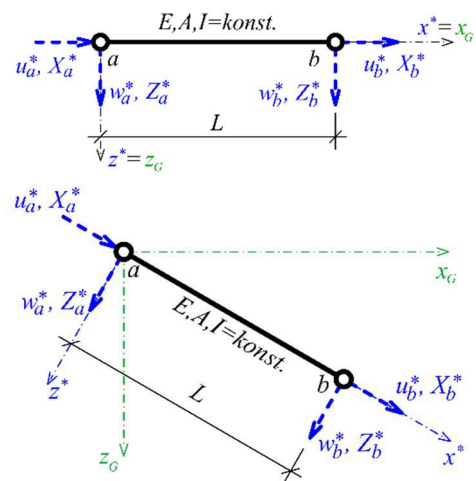
$D = \frac{EA}{L} - \frac{12EI}{L^3}$ $c = \cos(\gamma_{ab})$ $s = \sin(\gamma_{ab})$

Kloub - Kloub



Lokální matice tuhosti

$$[K_{a,b}] = \begin{bmatrix} \frac{EA}{L} & 0 & 0 & -\frac{EA}{L} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{EA}{L} & 0 & 0 & \frac{EA}{L} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{matrix} X_a^* \\ Z_a^* \\ M_a^* \\ X_b^* \\ Z_b^* \\ M_b^* \end{matrix}$$

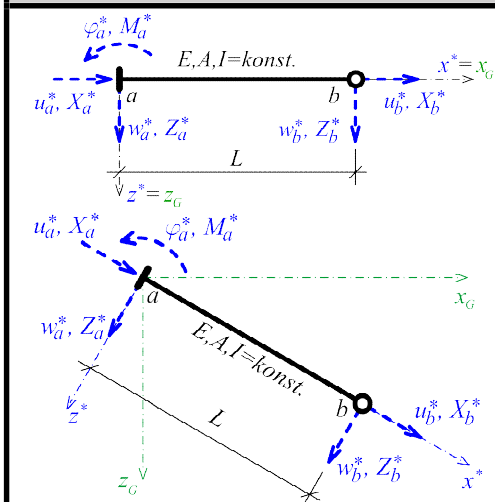


Globální matice tuhosti

$$[K_{a,b}] = \begin{bmatrix} \frac{EA}{L}c^2 & \frac{EA}{L}cs & 0 & -\frac{EA}{L}c^2 & -\frac{EA}{L}cs & 0 \\ \frac{EA}{L}cs & \frac{EA}{L}s^2 & 0 & -\frac{EA}{L}cs & -\frac{EA}{L}s^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{EA}{L}c^2 & -\frac{EA}{L}cs & 0 & \frac{EA}{L}c^2 & \frac{EA}{L}cs & 0 \\ -\frac{EA}{L}cs & -\frac{EA}{L}s^2 & 0 & \frac{EA}{L}cs & \frac{EA}{L}s^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{matrix} X_a \\ Z_a \\ M_a \\ X_b \\ Z_b \\ M_b \end{matrix}$$

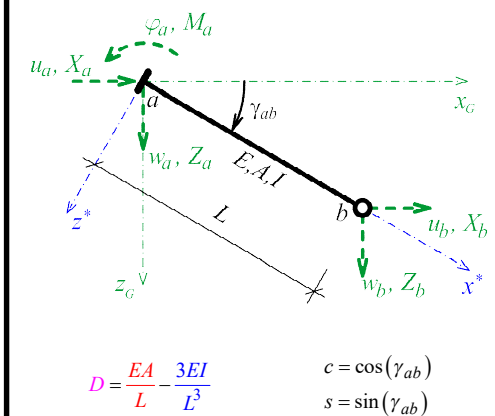
$c = \cos(\gamma_{ab})$ $s = \sin(\gamma_{ab})$

Vetknutí - Kloub



Lokální matice tuhosti

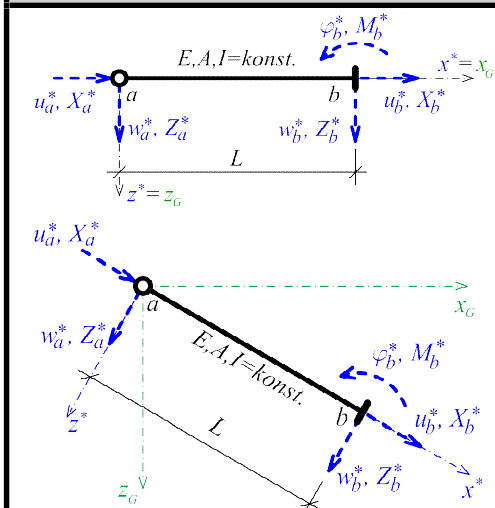
$$[K_{a,b}^*] = \begin{bmatrix} \frac{EA}{L} & 0 & 0 & -\frac{EA}{L} & 0 & 0 \\ 0 & \frac{3EI}{L^3} & -\frac{3EI}{L^2} & 0 & -\frac{3EI}{L^3} & 0 \\ 0 & -\frac{3EI}{L^2} & \frac{3EI}{L} & 0 & \frac{3EI}{L^2} & 0 \\ -\frac{EA}{L} & 0 & 0 & \frac{EA}{L} & 0 & 0 \\ 0 & -\frac{3EI}{L^3} & \frac{3EI}{L^2} & 0 & \frac{3EI}{L^3} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{matrix} X_a^* \\ Z_a^* \\ M_a^* \\ X_b^* \\ Z_b^* \\ M_b^* \end{matrix}$$



Globální matice tuhosti

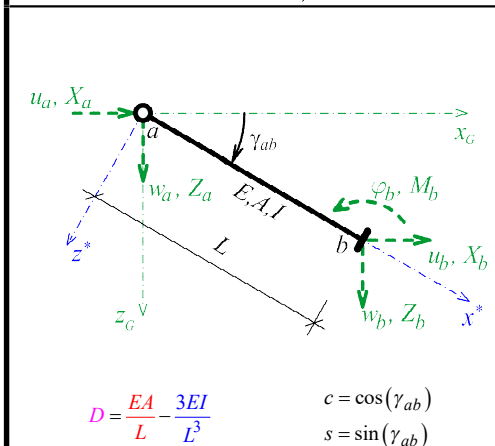
$$[K_{a,b}] = \begin{bmatrix} \left(\frac{3EI}{L^3} + Dc^2\right) & Dcs & \frac{3EI}{L^2}s & -\left(\frac{3EI}{L^3} + Dc^2\right) & -Dcs & 0 \\ Dcs & \left(\frac{EA}{L} - Dc^2\right) & -\frac{3EI}{L^2}c & -Dcs & -\left(\frac{EA}{L} - Dc^2\right) & 0 \\ \frac{3EI}{L^2}s & -\frac{3EI}{L^2}c & \frac{3EI}{L} & -\frac{3EI}{L^2}s & \frac{3EI}{L^2}c & 0 \\ -\left(\frac{3EI}{L^3} + Dc^2\right) & -Dcs & -\frac{3EI}{L^2}s & \left(\frac{3EI}{L^3} + Dc^2\right) & Dcs & 0 \\ -Dcs & -\left(\frac{EA}{L} - Dc^2\right) & \frac{3EI}{L^2}c & Dcs & \left(\frac{EA}{L} - Dc^2\right) & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{matrix} X_a \\ Z_a \\ M_a \\ X_b \\ Z_b \\ M_b \end{matrix}$$

Kloub - Vetknutí



Lokální matice tuhosti

$$[K_{a,b}^*] = \begin{bmatrix} \frac{EA}{L} & 0 & 0 & -\frac{EA}{L} & 0 & 0 \\ 0 & \frac{3EI}{L^3} & 0 & 0 & -\frac{3EI}{L^3} & -\frac{3EI}{L^2} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{EA}{L} & 0 & 0 & \frac{EA}{L} & 0 & 0 \\ 0 & -\frac{3EI}{L^3} & 0 & 0 & \frac{3EI}{L^3} & \frac{3EI}{L^2} \\ 0 & -\frac{3EI}{L^2} & 0 & 0 & \frac{3EI}{L} & \frac{3EI}{L} \end{bmatrix} \begin{matrix} X_a^* \\ Z_a^* \\ M_a^* \\ X_b^* \\ Z_b^* \\ M_b^* \end{matrix}$$



Globální matice tuhosti

$$[K_{a,b}] = \begin{bmatrix} \left(\frac{3EI}{L^3} + Dc^2\right) & Dcs & 0 & -\left(\frac{3EI}{L^3} + Dc^2\right) & -Dcs & \frac{3EI}{L^2}s \\ Dcs & \left(\frac{EA}{L} - Dc^2\right) & 0 & -Dcs & -\left(\frac{EA}{L} - Dc^2\right) & -\frac{3EI}{L^2}c \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\left(\frac{3EI}{L^3} + Dc^2\right) & -Dcs & 0 & \left(\frac{3EI}{L^3} + Dc^2\right) & Dcs & -\frac{3EI}{L^2}s \\ -Dcs & -\left(\frac{EA}{L} - Dc^2\right) & 0 & Dcs & \left(\frac{EA}{L} - Dc^2\right) & \frac{3EI}{L^2}c \\ \frac{3EI}{L^2}s & -\frac{3EI}{L^2}c & 0 & -\frac{3EI}{L^2}s & \frac{3EI}{L^2}c & \frac{3EI}{L} \end{bmatrix} \begin{matrix} X_a \\ Z_a \\ M_a \\ X_b \\ Z_b \\ M_b \end{matrix}$$

Tabulka 8.1 Primární lokální vektory koncových sil prutu $\{R_{a,b}\}$

Oprava: Ing. Zbyněk Vlk, Ph.D. - 2025

(a)	(8.1a/1)	(8.1a/2)	(8.1a/3)	(8.1a/4)	(8.1a/5)	(8.1a/6)	(8.1a/7)	(8.1a/8)	(8.1a/9)	(8.1a/10)
Obdélník, průřez: $\Delta T_0 = (\Delta T_d + \Delta T_h)/2$ $\Delta T_1 = \Delta T_d - \Delta T_h$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$
	$-\frac{b}{l}F_x$ $-b^2\frac{3l-2b}{l^3}F_z$ $\frac{ab^2}{l^2}F_z$ $-\frac{a}{l}F_x$ $-a^2\frac{3l-2a}{l^3}F_z$ $-\frac{a^2b}{l^2}F_z$	$-\frac{1}{2}F_x$ $-\frac{1}{2}F_z$ $\frac{1}{8}F_zl$ $-\frac{1}{2}F_x$ $-\frac{1}{2}F_z$ $-\frac{1}{8}F_zl$	0 $-\frac{6ab}{l^3}M$ $b\frac{2l-3b}{l^2}M$ 0 $\frac{6ab}{l^3}M$ $a\frac{2l-3a}{l^2}M$	0 $-\frac{3M}{2l}$ $\frac{1}{4}M$ 0 $\frac{3M}{2l}$ $\frac{1}{4}M$	0 0 $-M_1$ 0 0 $-M_2$	$-\frac{1}{2}nl$ $-\frac{1}{2}ql$ $\frac{1}{12}ql^2$ $-\frac{1}{2}nl$ $-\frac{1}{2}ql$ $-\frac{1}{12}ql^2$	$-\frac{2al-a^2}{2l}n$ $-\frac{2al^3-2a^3l+a^4}{2l^3}q$ $\frac{6a^2l^2-8a^3l+3a^4}{12l^2}q$ $-\frac{a^2}{2l}n$ $-\frac{2a^3l-a^4}{2l^3}q$ $-\frac{4a^3l-3a^4}{12l^2}q$	$-\frac{1}{8}nl$ $-\frac{3}{32}ql$ $\frac{5}{192}ql^2$ $-\frac{3}{8}nl$ $-\frac{13}{32}ql$ $-\frac{11}{192}ql^2$	$-\frac{2n_a+n_b}{6}l$ $-\frac{7q_a+3q_b}{20}l$ $\frac{3q_a+2q_b}{60}l^2$ $-\frac{n_a+2n_b}{6}l$ $-\frac{3q_a+7q_b}{20}l$ $-\frac{2q_a+3q_b}{60}l^2$	$EA\alpha_T\Delta T_0$ 0 $\frac{EI}{h}\alpha_T\Delta T_1$ $-EA\alpha_T\Delta T_0$ 0 $-\frac{EI}{h}\alpha_T\Delta T_1$
(b)	(8.1b/1)	(8.1b/2)	(8.1b/3)	(8.1b/4)	(8.1b/5)	(8.1b/6)	(8.1b/7)	(8.1b/8)	(8.1b/9)	(8.1b/10)
Obdélník, průřez: $\Delta T_0 = (\Delta T_d + \Delta T_h)/2$ $\Delta T_1 = \Delta T_d - \Delta T_h$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$	$\bar{X}_{a,b}^*$ $\bar{Z}_{a,b}^*$ $\bar{M}_{a,b}^*$
	$-\frac{b}{l}F_x$ $-b\frac{3l^2-b^2}{2l^3}F_z$ $ab\frac{l+b}{2l^2}F_z$ $-\frac{a}{l}F_x$ $-a^2\frac{3l-a}{2l^3}F_z$ 0	$-\frac{1}{2}F_x$ $-\frac{11}{16}F_z$ $\frac{3}{16}F_zl$ $-\frac{1}{2}F_x$ $-\frac{5}{16}F_z$ 0	0 $-\frac{3}{2}\frac{l^2-b^2}{l^3}M$ $\frac{l^2-3b^2}{2l^2}M$ 0 $3\frac{l^2-b^2}{2l^3}M$ 0	0 $-\frac{9M}{8l}$ $\frac{1}{8}M$ 0 $\frac{9M}{8l}$ 0	0 $-\frac{3M}{2l}$ $\frac{1}{2}M$ 0 $\frac{3M}{2l}$ 0	$-\frac{1}{2}nl$ $-\frac{5}{8}ql$ $\frac{1}{8}ql^2$ $-\frac{1}{2}nl$ $-\frac{3}{8}ql$ 0	$-\frac{2al-a^2}{2l}n$ $-\frac{8al^3-4a^3l+a^4}{8l^3}q$ $\frac{(2al-a^2)^2}{8l^2}q$ $-\frac{a^2}{2l}n$ $-\frac{4a^3l-a^4}{8l^3}q$ 0	$-\frac{1}{8}nl$ $-\frac{23}{128}ql$ $\frac{7}{128}ql^2$ $-\frac{3}{8}nl$ $-\frac{41}{128}ql$ 0	$-\frac{2n_a+n_b}{6}l$ $-\frac{16q_a+9q_b}{40}l$ $\frac{8q_a+7q_b}{120}l^2$ $-\frac{n_a+2n_b}{6}l$ $-\frac{4q_a+11q_b}{40}l$ 0	$EA\alpha_T\Delta T_0$ $-\frac{3EI}{2hl}\alpha_T\Delta T_1$ $\frac{3EI}{2h}\alpha_T\Delta T_1$ $-EA\alpha_T\Delta T_0$ $\frac{3EI}{2hl}\alpha_T\Delta T_1$ 0

Tabulka 8.1 Primární lokální vektory koncových sil prutu $\{R_{a,b}^*\}$ (pokračování)

Oprava: Ing. Zbyněk Vlk, Ph.D. - 2025

(c) Obdélník, průřez: $\Delta T_0 = (\Delta T_d + \Delta T_h)/2$ $\Delta T_1 = \Delta T_d - \Delta T_h$	(8.1c/1)	(8.1c/2)	(8.1c/3)	(8.1c/4)	(8.1c/5)	(8.1c/6)	(8.1c/7)	(8.1c/8)	(8.1c/9)	(8.1c/10)
(d) Obdélník, průřez: $\Delta T_0 = (\Delta T_d + \Delta T_h)/2$ $\Delta T_1 = \Delta T_d - \Delta T_h$	(8.1d/1)	(8.1d/2)	(8.1d/3)	(8.1d/4)	(8.1d/5)	(8.1d/6)	(8.1d/7)	(8.1d/8)	(8.1d/9)	(8.1d/10)

Transformace vektorů

z lokálních do globálních souřadnic

$$\left\{ \bar{\mathbf{R}}_{a,b}^* \right\} \rightarrow \left\{ \bar{\mathbf{R}}_{a,b} \right\}$$

$$\left\{ \bar{\mathbf{R}}_{a,b} \right\} = \left\{ \begin{array}{c} \bar{X}_a^* \cos \gamma_{ab} - \bar{Z}_a^* \sin \gamma_{ab} \\ \bar{X}_a^* \sin \gamma_{ab} + \bar{Z}_a^* \cos \gamma_{ab} \\ \bar{M}_a^* \\ \hline \bar{X}_b^* \cos \gamma_{ab} - \bar{Z}_b^* \sin \gamma_{ab} \\ \bar{X}_b^* \sin \gamma_{ab} + \bar{Z}_b^* \cos \gamma_{ab} \\ \bar{M}_b^* \end{array} \right\}$$

z globálních do lokálních souřadnic

$$\left\{ \mathbf{r}_{a,b} \right\} \rightarrow \left\{ \mathbf{r}_{a,b}^* \right\}$$

$$\left\{ \mathbf{r}_{a,b}^* \right\} = \left\{ \begin{array}{c} u_a \cos \gamma_{ab} + w_a \sin \gamma_{ab} \\ -u_a \sin \gamma_{ab} + w_a \cos \gamma_{ab} \\ \varphi_a \\ \hline u_b \cos \gamma_{ab} + w_b \sin \gamma_{ab} \\ -u_b \sin \gamma_{ab} + w_b \cos \gamma_{ab} \\ \varphi_b \end{array} \right\}$$