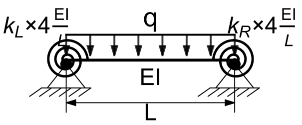
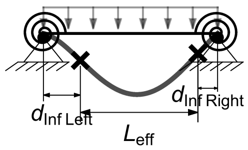
$$K^{\text{beam no axial}} = \begin{pmatrix} \frac{12\,EI}{L^3} & -\frac{6\,EI}{L^2} & -\frac{12\,EI}{L^3} & -\frac{6\,EI}{L^2} \\ -\frac{6\,EI}{L^2} & \frac{4\,EI}{L} & \frac{6\,EI}{L^2} & \frac{2\,EI}{L} \\ -\frac{12\,EI}{L^3} & \frac{6\,EI}{L^2} & \frac{12\,EI}{L^3} & \frac{6\,EI}{L^2} \\ -\frac{6\,EI}{L^2} & \frac{2\,EI}{L} & \frac{6\,EI}{L^2} & \frac{4\,EI}{L} \end{pmatrix} \qquad K^{\text{column no axial}} = \begin{pmatrix} \frac{12\,EI}{L^3} & \frac{6\,EI}{L^2} & -\frac{12\,EI}{L^3} & \frac{6\,EI}{L^2} \\ \frac{6\,EI}{L^2} & \frac{4\,EI}{L} & -\frac{6\,EI}{L^2} & \frac{2\,EI}{L} \\ -\frac{12\,EI}{L^3} & -\frac{6\,EI}{L^2} & \frac{12\,EI}{L^3} & -\frac{6\,EI}{L^2} \\ \frac{6\,EI}{L^2} & \frac{2\,EI}{L} & -\frac{6\,EI}{L^2} & \frac{4\,EI}{L} \end{pmatrix}$$

$$K^{\text{truss member}} = \frac{EA}{L}\begin{pmatrix} c^2 & c\,s & -c^2 & -c\,s \\ c\,s & s^2 & -c\,s & -s^2 \\ -c^2 & -c\,s & c^2 & c\,s \\ -c\,s & -s^2 & c\,s & s^2 \end{pmatrix}$$

$$K^{\text{beam member}} = \begin{pmatrix} \frac{c^2 EA}{L} + \frac{12\,EI\,s^2}{L^3} & -\frac{12\,c\,EI\,s}{L^3} + \frac{c\,EA\,s}{L} & \frac{6\,EI\,s}{L^2} & -\frac{c^2 EA}{L} - \frac{12\,EI\,s^2}{L^3} & \frac{12\,c\,EI\,s}{L^3} - \frac{c\,EA\,s}{L} & \frac{6\,EI\,s}{L^2} \\ -\frac{12\,c\,EI\,s}{L^3} + \frac{c\,EA\,s}{L} & \frac{12\,c^2 EI}{L^3} + \frac{EA\,s^2}{L} & -\frac{6\,c\,EI}{L^2} & \frac{12\,c\,EI\,s}{L^3} - \frac{c\,EA\,s}{L} & -\frac{12\,c^2 EI}{L^3} - \frac{EA\,s^2}{L} & -\frac{6\,c\,EI}{L^2} \\ \frac{6\,EI\,s}{L^2} & -\frac{6\,c\,EI}{L^2} & \frac{4\,EI}{L} & -\frac{6\,EI\,s}{L^2} & \frac{6\,c\,EI}{L^2} & \frac{2\,EI}{L} \\ -\frac{c^2 EA}{L} - \frac{12\,EI\,s^2}{L^3} & \frac{12\,c\,EI\,s}{L^3} - \frac{c\,EA\,s}{L} & -\frac{6\,EI\,s}{L^2} & \frac{c^2 EA}{L} + \frac{12\,EI\,s^2}{L^3} & -\frac{12\,c\,EI\,s}{L^3} + \frac{c\,EA\,s}{L} & -\frac{6\,EI\,s}{L^2} \\ \frac{12\,c\,EI\,s}{L^3} - \frac{c\,EA\,s}{L} & -\frac{12\,c^2 EI}{L^3} - \frac{EA\,s^2}{L} & \frac{6\,c\,EI}{L^2} & -\frac{12\,c\,EI\,s}{L^3} + \frac{c\,EA\,s}{L} & \frac{12\,c^2 EI}{L^3} + \frac{EA\,s^2}{L} & \frac{6\,c\,EI}{L^2} \\ \frac{6\,EI\,s}{L^2} & -\frac{6\,c\,EI}{L^2} & \frac{2\,EI}{L} & -\frac{6\,EI\,s}{L^2} & \frac{6\,c\,EI}{L^2} & \frac{4\,EI}{L} \end{pmatrix}$$

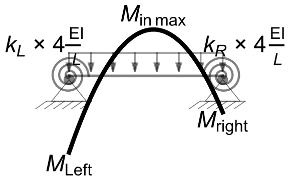


$$\frac{d_{\text{inf left}}}{L} \approx \frac{0.92\,k_L}{3+4\,k_L}$$



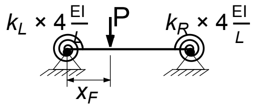
$$\frac{d_{\text{inf right}}}{L} \approx \frac{0.92\,k_R}{3+4\,k_R}$$

$$M_{\text{in max}} = \frac{qL_{\text{eff}}^2}{8}$$

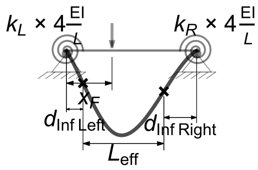


$$M_{\text{left}} = \frac{q d_{IL}\,(L_{\text{eff}} + d_{IL})}{2}$$

$$M_{\text{right}} = \frac{q d_{IR}\,(L_{\text{eff}} + d_{IR})}{2}$$

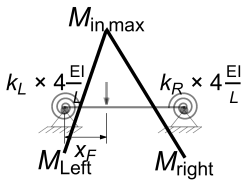


$$\frac{d_{\text{inf left}}}{L} \approx \frac{3\,k_L}{2+4\,k_L}\;\frac{x_f/L}{1+x_f/L}$$



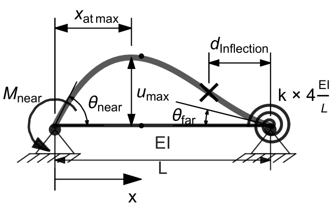
$$\frac{d_{\text{inf right}}}{L} \approx \frac{3\,k_R}{2+4\,k_R}\;\frac{1-x_f/L}{1+\left(1-x_f/L\right)}$$

$$M_{\text{in max}} = \frac{P\left(x_f - d_{IL}\right)\left(L - x_f - d_{IR}\right)}{L_{\text{eff}}}$$



$$M_{\text{left}} = \frac{P\,d_{IL}\left(L - x_f - d_{IR}\right)}{L_{\text{eff}}}$$

$$M_{\text{right}} = \frac{P\,d_{IR}\left(x_f - d_{IL}\right)}{L_{\text{eff}}}$$



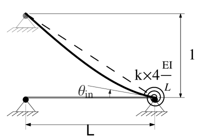
$$\frac{M_{\text{far}}}{M_{\text{near}}} = \frac{2k}{3+4k}$$

$$\frac{d_{\text{inflection}}}{L} = \frac{2\,k}{3+6\,k}$$

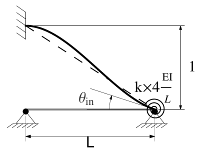
$$\frac{x_{\text{at max}}}{L} \approx \frac{0.42+0.33k}{1+k}$$

$$\frac{u_{\text{at max}}}{\theta_{\text{near}}\,L} \approx \frac{0.19+0.15k}{1+k}$$

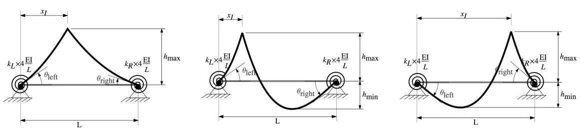
$$\frac{\theta_{\text{far}}}{\theta_{\text{near}}} = \frac{1}{2+2k}$$



$$\theta_{\text{in}} = \frac{3}{3+4\,k} \times \frac{1}{L}$$



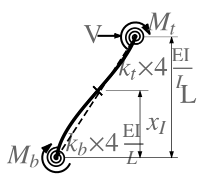
$$\theta_{\text{in}} = \frac{3}{2+2\,k} \times \frac{1}{L}$$



(a) (b) (c)

$\frac{2\,k_L}{3+6\,k_L}\,L \le x_I \le \left(1 - \frac{2\,k_R}{3+6\,k_R}\right)L \Rightarrow$ influence line of bending moment like fig (a) above otherwise fig (b) or (c)

To get $h_{\max}$ use unit point force at influence point and find moment there. $\theta_{\text{left}} = \frac{(3+4\,k_R) - (3+6\,k_R)\,(x_I/L)}{3+4\,k_L+4\,k_R+4\,k_L\,k_R}$; $\theta_{\text{right}} = \frac{(3+4\,k_L) - (3+6\,k_L)\,(1-x_I/L)}{3+4\,k_L+4\,k_R+4\,k_L\,k_R}$



$$k_{sh} = \frac{(k_b + k_t + 4\,k_b\,k_t)}{\left(\,(3+4\,k_b+4\,k_t+4\,k_b\,k_t) + 3\,(1+2\,k_t)\,(M_b/(V\,L)) + 3\,(1+2\,k_b)\,(M_t/(V\,L))\right)}\;\frac{12\,EI}{L^3}$$

$$\begin{pmatrix} M_{\text{inner top}} \\ M_{\text{inner bottom}} \end{pmatrix} = \begin{pmatrix} +\frac{k_t + 2\,k_b\,k_t}{k_b+k_t+4\,k_b\,k_t} \\ -\frac{k_b + 2\,k_b\,k_t}{k_b+k_t+4\,k_b\,k_t} \end{pmatrix} V\,L + \begin{pmatrix} +\frac{k_t}{k_b+k_t+4\,k_b\,k_t} \\ +\frac{k_t}{k_b+k_t+4\,k_b\,k_t} \end{pmatrix} M_b + \begin{pmatrix} -\frac{k_b}{k_b+k_t+4\,k_b\,k_t} \\ -\frac{k_b}{k_b+k_t+4\,k_b\,k_t} \end{pmatrix} M_t$$

Note: In the first iteration, we assume: $M_b = M_t = 0$