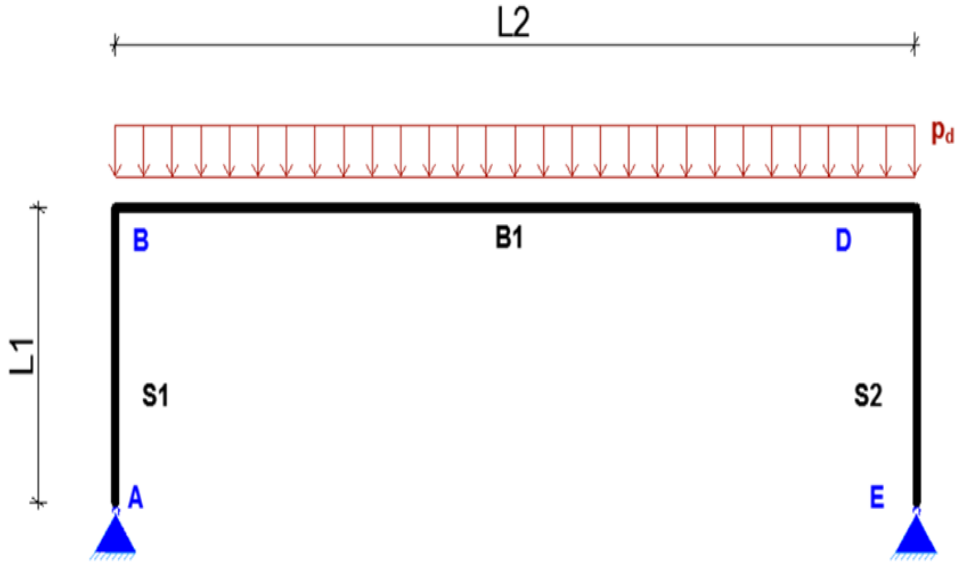
Opgave 4.51. Løsningsforslag. 2 charniers ramme med fordelt last.

```
> restart
```
Loading LinearAlgebra
UseSystem(*system*, *opts*)

```
with(LinearAlgebra) :
interface(rtablesize = 12)
```

10 **(1)**



Forudsætninger

$$\varphi 1 := 2\cdot\left(\frac{x}{L}\right)^3 - 3\cdot\left(\frac{x}{L}\right)^2 + 1 :$$

$$\varphi 2 := -x\cdot\left(\left(\frac{x}{L}\right)^2 - 2\cdot\left(\frac{x}{L}\right) + 1\right) :$$

$$\varphi 3 := -2\cdot\left(\frac{x}{L}\right)^3 + 3\cdot\left(\frac{x}{L}\right)^2 :$$

$$\varphi 4 := -x\cdot\left(\left(\frac{x}{L}\right)^2 - \left(\frac{x}{L}\right)\right) :$$

$$L := L2$$

$L2$ **(1.1)**

Stivhedsmatrice for et ramme element:

$$K = \begin{bmatrix} \frac{E\,A}{L} & 0 & 0 & -\frac{E\,A}{L} & 0 & 0 \\ 0 & \frac{12\,I\,E}{L^3} & -\frac{6\,I\,E}{L^2} & 0 & -\frac{12\,I\,E}{L^3} & -\frac{6\,I\,E}{L^2} \\ 0 & -\frac{6\,I\,E}{L^2} & \frac{4\,I\,E}{L} & 0 & \frac{6\,I\,E}{L^2} & \frac{2\,I\,E}{L} \\ -\frac{E\,A}{L} & 0 & 0 & \frac{E\,A}{L} & 0 & 0 \\ 0 & -\frac{12\,I\,E}{L^3} & \frac{6\,I\,E}{L^2} & 0 & \frac{12\,I\,E}{L^3} & \frac{6\,I\,E}{L^2} \\ 0 & -\frac{6\,I\,E}{L^2} & \frac{2\,I\,E}{L} & 0 & \frac{6\,I\,E}{L^2} & \frac{4\,I\,E}{L} \end{bmatrix} :$$

$$T = \begin{bmatrix} \cos(v) & \sin(v) & 0 & 0 & 0 & 0 \\ -\sin(v) & \cos(v) & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & \cos(v) & \sin(v) & 0 \\ 0 & 0 & 0 & -\sin(v) & \cos(v) & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} :$$

Stivhedsmatricer lokalt

$$K11 := \begin{bmatrix} \frac{E\,A1}{L1} & 0 & 0 & -\frac{E\,A1}{L1} & 0 & 0 \\ 0 & \frac{12\,E\,I1}{L1^3} & -\frac{6\,E\,I1}{L1^2} & 0 & -\frac{12\,E\,I1}{L1^3} & -\frac{6\,E\,I1}{L1^2} \\ 0 & -\frac{6\,E\,I1}{L1^2} & \frac{4\,E\,I1}{L1} & 0 & \frac{6\,E\,I1}{L1^2} & \frac{2\,E\,I1}{L1} \\ -\frac{E\,A1}{L1} & 0 & 0 & \frac{E\,A1}{L1} & 0 & 0 \\ 0 & -\frac{12\,E\,I1}{L1^3} & \frac{6\,E\,I1}{L1^2} & 0 & \frac{12\,E\,I1}{L1^3} & \frac{6\,E\,I1}{L1^2} \\ 0 & -\frac{6\,E\,I1}{L1^2} & \frac{2\,E\,I1}{L1} & 0 & \frac{6\,E\,I1}{L1^2} & \frac{4\,E\,I1}{L1} \end{bmatrix} :$$

$$K21 := \begin{bmatrix} \frac{E\,A2}{L2} & 0 & 0 & -\frac{E\,A2}{L2} & 0 & 0 \\ 0 & \frac{12\,E\,I2}{L2^3} & -\frac{6\,E\,I2}{L2^2} & 0 & -\frac{12\,E\,I2}{L2^3} & -\frac{6\,E\,I2}{L2^2} \\ 0 & -\frac{6\,E\,I2}{L2^2} & \frac{4\,E\,I2}{L2} & 0 & \frac{6\,E\,I2}{L2^2} & \frac{2\,E\,I2}{L2} \\ -\frac{E\,A2}{L2} & 0 & 0 & \frac{E\,A2}{L2} & 0 & 0 \\ 0 & -\frac{12\,E\,I2}{L2^3} & \frac{6\,E\,I2}{L2^2} & 0 & \frac{12\,E\,I2}{L2^3} & \frac{6\,E\,I2}{L2^2} \\ 0 & -\frac{6\,E\,I2}{L2^2} & \frac{2\,E\,I2}{L2} & 0 & \frac{6\,E\,I2}{L2^2} & \frac{4\,E\,I2}{L2} \end{bmatrix} :$$

$$K31 := \begin{bmatrix} \frac{E\,A1}{L1} & 0 & 0 & -\frac{E\,A1}{L1} & 0 & 0 \\ 0 & \frac{12\,E\,I1}{L1^3} & -\frac{6\,E\,I1}{L1^2} & 0 & -\frac{12\,E\,I1}{L1^3} & -\frac{6\,E\,I1}{L1^2} \\ 0 & -\frac{6\,E\,I1}{L1^2} & \frac{4\,E\,I1}{L1} & 0 & \frac{6\,E\,I1}{L1^2} & \frac{2\,E\,I1}{L1} \\ -\frac{E\,A1}{L1} & 0 & 0 & \frac{E\,A1}{L1} & 0 & 0 \\ 0 & -\frac{12\,E\,I1}{L1^3} & \frac{6\,E\,I1}{L1^2} & 0 & \frac{12\,E\,I1}{L1^3} & \frac{6\,E\,I1}{L1^2} \\ 0 & -\frac{6\,E\,I1}{L1^2} & \frac{2\,E\,I1}{L1} & 0 & \frac{6\,E\,I1}{L1^2} & \frac{4\,E\,I1}{L1} \end{bmatrix} :$$

Stivhedsmatricer globalt

$$T := \begin{bmatrix} \cos(v) & \sin(v) & 0 & 0 & 0 & 0 \\ -\sin(v) & \cos(v) & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & \cos(v) & \sin(v) & 0 \\ 0 & 0 & 0 & -\sin(v) & \cos(v) & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} :$$

$v1 := \frac{1}{2}\pi$

$$\frac{1}{2}\pi \tag{3.1}$$

$$T1 := \begin{bmatrix} \cos(v1) & \sin(v1) & 0 & 0 & 0 & 0 \\ -\sin(v1) & \cos(v1) & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & \cos(v1) & \sin(v1) & 0 \\ 0 & 0 & 0 & -\sin(v1) & \cos(v1) & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} :$$

$K12 := T1^{+}.K11.T1$:
$v2 := 0$

$$0 \tag{3.2}$$

$v3 := -\frac{\pi}{2}$

$$-\frac{1}{2}\pi \tag{3.3}$$

$$T3 := \begin{bmatrix} \cos(v3) & \sin(v3) & 0 & 0 & 0 & 0 \\ -\sin(v3) & \cos(v3) & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & \cos(v3) & \sin(v3) & 0 \\ 0 & 0 & 0 & -\sin(v3) & \cos(v3) & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & -1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{3.4}$$

$K32 := T3^{+}.K31.T3$

$$\begin{bmatrix} \frac{12\,E\,I1}{L1^3} & 0 & -\frac{6\,E\,I1}{L1^2} & -\frac{12\,E\,I1}{L1^3} & 0 & -\frac{6\,E\,I1}{L1^2} \\ 0 & \frac{E\,A1}{L1} & 0 & 0 & -\frac{E\,A1}{L1} & 0 \\ -\frac{6\,E\,I1}{L1^2} & 0 & \frac{4\,E\,I1}{L1} & \frac{6\,E\,I1}{L1^2} & 0 & \frac{2\,E\,I1}{L1} \\ -\frac{12\,E\,I1}{L1^3} & 0 & \frac{6\,E\,I1}{L1^2} & \frac{12\,E\,I1}{L1^3} & 0 & \frac{6\,E\,I1}{L1^2} \\ 0 & -\frac{E\,A1}{L1} & 0 & 0 & \frac{E\,A1}{L1} & 0 \\ -\frac{6\,E\,I1}{L1^2} & 0 & \frac{2\,E\,I1}{L1} & \frac{6\,E\,I1}{L1^2} & 0 & \frac{4\,E\,I1}{L1} \end{bmatrix} \quad \textbf{(3.5)}$$

Det samlede system

$$> \quad P_1 := \begin{bmatrix} 1&0&0&0&0&0 \\ 0&1&0&0&0&0 \\ 0&0&1&0&0&0 \\ 0&0&0&1&0&0 \\ 0&0&0&0&1&0 \\ 0&0&0&0&0&1 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \end{bmatrix} : ; P_2 := \begin{bmatrix} 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 1&0&0&0&0&0 \\ 0&1&0&0&0&0 \\ 0&0&1&0&0&0 \\ 0&0&0&1&0&0 \\ 0&0&0&0&1&0 \\ 0&0&0&0&0&1 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \end{bmatrix} : ; P_3 := \begin{bmatrix} 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 0&0&0&0&0&0 \\ 1&0&0&0&0&0 \\ 0&1&0&0&0&0 \\ 0&0&1&0&0&0 \\ 0&0&0&1&0&0 \\ 0&0&0&0&1&0 \\ 0&0&0&0&0&1 \end{bmatrix} :$$

$$>$$

$$K1 := P_1.K12.P_1^{+}$$

$$\begin{bmatrix}
\frac{12\,E\,I1}{L1^3} & 0 & \frac{6\,E\,I1}{L1^2} & -\frac{12\,E\,I1}{L1^3} & 0 & \frac{6\,E\,I1}{L1^2} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \frac{E\,A1}{L1} & 0 & 0 & -\frac{E\,A1}{L1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\frac{6\,E\,I1}{L1^2} & 0 & \frac{4\,E\,I1}{L1} & -\frac{6\,E\,I1}{L1^2} & 0 & \frac{2\,E\,I1}{L1} & 0 & 0 & 0 & 0 & 0 & 0 \\
-\frac{12\,E\,I1}{L1^3} & 0 & -\frac{6\,E\,I1}{L1^2} & \frac{12\,E\,I1}{L1^3} & 0 & -\frac{6\,E\,I1}{L1^2} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -\frac{E\,A1}{L1} & 0 & 0 & \frac{E\,A1}{L1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\frac{6\,E\,I1}{L1^2} & 0 & \frac{2\,E\,I1}{L1} & -\frac{6\,E\,I1}{L1^2} & 0 & \frac{4\,E\,I1}{L1} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix} \quad \textbf{(4.1)}$$

$K2 := P_2.K21.P_2^{+}$

$$\begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \frac{E\,A2}{L2} & 0 & 0 & -\frac{E\,A2}{L2} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \frac{12\,E\,I2}{L2^3} & -\frac{6\,E\,I2}{L2^2} & 0 & -\frac{12\,E\,I2}{L2^3} & -\frac{6\,E\,I2}{L2^2} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -\frac{6\,E\,I2}{L2^2} & \frac{4\,E\,I2}{L2} & 0 & \frac{6\,E\,I2}{L2^2} & \frac{2\,E\,I2}{L2} & 0 & 0 & 0 \\
0 & 0 & 0 & -\frac{E\,A2}{L2} & 0 & 0 & \frac{E\,A2}{L2} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -\frac{12\,E\,I2}{L2^3} & \frac{6\,E\,I2}{L2^2} & 0 & \frac{12\,E\,I2}{L2^3} & \frac{6\,E\,I2}{L2^2} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -\frac{6\,E\,I2}{L2^2} & \frac{2\,E\,I2}{L2} & 0 & \frac{6\,E\,I2}{L2^2} & \frac{4\,E\,I2}{L2} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix} \quad \textbf{(4.2)}$$

$K3 := P_3.K32.P_3^{+}$

$$\left[\begin{array}{cccccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{12\,E\,I1}{L1^3} & 0 & -\frac{6\,E\,I1}{L1^2} & -\frac{12\,E\,I1}{L1^3} & 0 & -\frac{6\,E\,I1}{L1^2} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{E\,A1}{L1} & 0 & 0 & -\frac{E\,A1}{L1} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -\frac{6\,E\,I1}{L1^2} & 0 & \frac{4\,E\,I1}{L1} & \frac{6\,E\,I1}{L1^2} & 0 & \frac{2\,E\,I1}{L1} \\
0 & 0 & 0 & 0 & 0 & 0 & -\frac{12\,E\,I1}{L1^3} & 0 & \frac{6\,E\,I1}{L1^2} & \frac{12\,E\,I1}{L1^3} & 0 & \frac{6\,E\,I1}{L1^2} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -\frac{E\,A1}{L1} & 0 & 0 & \frac{E\,A1}{L1} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -\frac{6\,E\,I1}{L1^2} & 0 & \frac{2\,E\,I1}{L1} & \frac{6\,E\,I1}{L1^2} & 0 & \frac{4\,E\,I1}{L1}
\end{array}\right] \qquad \textbf{(4.3)}$$

Den samlede stivhedsmatrice

> $K := K1 + K2 + K3 :$

$$u := \left[\begin{array}{c} 0 \\ 0 \\ r1 \\ \mathrm{u2v} \\ \mathrm{u2l} \\ \mathrm{r2} \\ u3v \\ u3l \\ r3 \\ 0 \\ 0 \\ r4 \end{array}\right]:$$

$$Uvir := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \int_0^{L2} \varphi 1 \cdot pd \, dx \\ \int_0^{L2} \varphi 2 \cdot pd \, dx \\ 0 \\ \int_0^{L2} \varphi 3 \cdot pd \, dx \\ \int_0^{L2} \varphi 4 \cdot pd \, dx \\ 0 \\ 0 \\ 0 \end{bmatrix} :$$

Modificeret system

$$pm := \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} :$$

$$Kmod := pm^{+}.K.pm$$

$$\left[\left[\frac{4 \, E \, I1}{L1}, -\frac{6 \, E \, I1}{L1^2}, 0, \frac{2 \, E \, I1}{L1}, 0, 0, 0, 0 \right], \right. \qquad \textbf{(5.1)}$$

$$\left[-\frac{6\,E\,I1}{L1^2},\ \frac{12\,E\,I1}{L1^3}+\frac{E\,A2}{L2},\ 0,\ -\frac{6\,E\,I1}{L1^2},\ -\frac{E\,A2}{L2},\ 0,\ 0,\ 0 \right],$$

$$\left[0,\ 0,\ \frac{E\,A1}{L1}+\frac{12\,E\,I2}{L2^3},\ -\frac{6\,E\,I2}{L2^2},\ 0,\ -\frac{12\,E\,I2}{L2^3},\ -\frac{6\,E\,I2}{L2^2},\ 0 \right],$$

$$\left[\frac{2\,E\,I1}{L1},\ -\frac{6\,E\,I1}{L1^2},\ -\frac{6\,E\,I2}{L2^2},\ \frac{4\,E\,I1}{L1}+\frac{4\,E\,I2}{L2},\ 0,\ \frac{6\,E\,I2}{L2^2},\ \frac{2\,E\,I2}{L2},\ 0 \right],$$

$$\left[0,\ -\frac{E\,A2}{L2},\ 0,\ 0,\ \frac{12\,E\,I1}{L1^3}+\frac{E\,A2}{L2},\ 0,\ -\frac{6\,E\,I1}{L1^2},\ -\frac{6\,E\,I1}{L1^2} \right],$$

$$\left[0,\ 0,\ -\frac{12\,E\,I2}{L2^3},\ \frac{6\,E\,I2}{L2^2},\ 0,\ \frac{E\,A1}{L1}+\frac{12\,E\,I2}{L2^3},\ \frac{6\,E\,I2}{L2^2},\ 0 \right],$$

$$\left[0,\ 0,\ -\frac{6\,E\,I2}{L2^2},\ \frac{2\,E\,I2}{L2},\ -\frac{6\,E\,I1}{L1^2},\ \frac{6\,E\,I2}{L2^2},\ \frac{4\,E\,I1}{L1}+\frac{4\,E\,I2}{L2},\ \frac{2\,E\,I1}{L1} \right],$$

$$\left[0,\ 0,\ 0,\ 0,\ -\frac{6\,E\,I1}{L1^2},\ 0,\ \frac{2\,E\,I1}{L1},\ \frac{4\,E\,I1}{L1} \right] \Bigg]$$

$$Umod := \begin{bmatrix} Uvir_3 \\ Uvir_4 \\ Uvir_5 \\ Uvir_6 \\ Uvir_7 \\ Uvir_8 \\ Uvir_9 \\ Uvir_{12} \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ \frac{1}{2}\, L2\, pd \\ -\frac{1}{12}\, L2^2\, pd \\ 0 \\ \frac{1}{2}\, L2\, pd \\ \frac{1}{12}\, L2^2\, pd \\ 0 \end{bmatrix} \quad \textbf{(5.2)}$$

$umod := Kmod^{-1}.Umod$:

$$u1 := \begin{bmatrix} 0 \\ 0 \\ umod_1 \\ umod_2 \\ umod_3 \\ umod_4 \\ umod_5 \\ umod_6 \\ umod_7 \\ 0 \\ 0 \\ umod_8 \end{bmatrix} :$$

$evalf_3(u1)$:
$evalf_3(K.u1 - Uvir)$:

Eksempel. Samme profil som bjælke og søjler.

$L2 := 2 \cdot L1$

$$2\, L1 \quad \textbf{(6.1)}$$

$I2 := I1$

$$I1 \tag{6.2}$$

$A2 := A1$

$$A1 \tag{6.3}$$

$u1 :$
$(K.u1 - Uvir)$

$$\left[\left[\frac{1}{L1^2}\left(6\,E\,I1\left(-\frac{1}{144}\,\frac{\left(40\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\right.\right.\right. \tag{6.4}$$

$$\left.+\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\right)\right)-\frac{1}{L1^3}\left(12\,E\,I1\left(\right.$$

$$-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$\left.+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)+\frac{1}{L1^2}\left(6\,E\,I1\left(\right.$$

$$-\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$\left.\left.+\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)\right],$$

$$\left[-L1\,pd\right],$$

$$\left[\frac{1}{L1}\left(4\,E\,I1\left(-\frac{1}{144}\,\frac{\left(40\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\right.\right.\right.$$

$$\left.+\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\right)\right)-\frac{1}{L1^2}\left(6\,E\,I1\left(\right.$$

$$-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$\left.+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)+\frac{1}{L1}\left(2\,E\,I1\left(\right.$$

$$-\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\ \frac{\left(16\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}\ \Bigg)\Bigg)\Bigg],$$

$$\Bigg[-\frac{1}{L1^2}\ \Bigg(6\ E\ I1\ \Bigg(-\frac{1}{144}\ \frac{\left(40\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{\left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)\ I1\ A1\ E}$$

$$+\frac{1}{144}\ \frac{\left(88\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{\left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)\ I1\ A1\ E}\ \Bigg)\Bigg)+\Bigg(\frac{12\ E\ I1}{L1^3}$$

$$+\frac{1}{2}\ \frac{E\ A1}{L1}\ \Bigg)\ \Bigg(-\frac{1}{144}\ \frac{\left(64\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ L1\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}$$

$$+\frac{1}{144}\ \frac{\left(64\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ L1\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}\ \Bigg)-\frac{1}{L1^2}\ \Bigg(6\ E\ I1\ \Bigg($$

$$-\frac{1}{144}\ \frac{\left(112\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}$$
$$+\frac{1}{144}\ \frac{\left(16\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}\ \Bigg)\Bigg)-\frac{1}{2}\ \frac{1}{L1}\ \Bigg(E\ A1\ \Bigg($$
$$-\frac{1}{144}\ \frac{\left(64\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ L1\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}$$
$$+\frac{1}{144}\ \frac{\left(64\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ L1\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}\ \Bigg)\Bigg)\Bigg],$$

$$\Bigg[\frac{\left(\frac{E\ A1}{L1}+\frac{3}{2}\ \frac{E\ I1}{L1^3}\right)\ L1^2\ pd}{A1\ E}-\frac{3}{2}\ \frac{1}{L1^2}\ \Bigg(E\ I1\ \Bigg($$

$$-\frac{1}{144}\ \frac{\left(112\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}$$
$$+\frac{1}{144}\ \frac{\left(16\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}\ \Bigg)\Bigg)-\frac{3}{2}\ \frac{I1\ pd}{L1\ A1}$$
$$-\frac{3}{2}\ \frac{1}{L1^2}\ \Bigg(E\ I1\ \Bigg(-\frac{1}{144}\ \frac{\left(16\ A1^2\ I1\ L1^6+96\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}$$
$$+\frac{1}{144}\ \frac{\left(112\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{E\ A1\ I1\ \left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)}\ \Bigg)\Bigg)-L1\ pd\Bigg],$$

$$\left[\frac{1}{L1}\left(2\,E\,I1\left(-\frac{1}{144}\,\frac{\left(40\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\right.\right.\right.$$

$$\left.\left.\left.+\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\right)\right)-\frac{1}{L1^2}\left(6\,E\,I1\left(\right.\right.\right.$$

$$-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$\left.\left.\left.+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)+\frac{1}{L1}\left(6\,E\,I1\left(\right.\right.\right.$$

$$-\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$
$$\left.\left.\left.+\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)+\frac{1}{L1}\left(E\,I1\left(\right.\right.\right.$$
$$-\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$
$$\left.\left.\left.+\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)+\frac{1}{3}\,L1^2\,pd\right],$$

$$\left[-\frac{1}{2}\,\frac{1}{L1}\left(E\,A1\left(-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right.\right.\right.$$

$$\left.\left.\left.+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)\right)+\left(\frac{12\,E\,I1}{L1^3}\right.$$

$$\left.+\frac{1}{2}\,\frac{E\,A1}{L1}\right)\left(-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right.$$

$$\left.+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\right)-\frac{1}{L1^2}\left(6\,E\,I1\left(\right.\right.$$

$$-\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)-\frac{1}{L1^2}\Bigg(6\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}$$

$$+\frac{1}{144}\,\frac{\left(40\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\Bigg)\Bigg)\Bigg],$$

$$\Bigg[-\frac{3}{2}\,\frac{I1\,pd}{L1\,A1}+\frac{3}{2}\,\frac{1}{L1^2}\Bigg(E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)$$

$$+\frac{\left(\frac{E\,A1}{L1}+\frac{3}{2}\,\frac{E\,I1}{L1^3}\right)\,L1^2\,pd}{A1\,E}+\frac{3}{2}\,\frac{1}{L1^2}\Bigg(E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)-L1\,pd\Bigg],$$

$$\Bigg[\frac{1}{L1}\Bigg(E\,I1\,\Bigg(-\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)-\frac{1}{L1^2}\Bigg(6\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)+\frac{1}{L1}\Bigg(6\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)+\frac{1}{L1}\Bigg(2\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}$$

$$+\frac{1}{144}\,\frac{\left(40\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\Bigg)\Bigg)-\frac{1}{3}\,L1^2\,pd\Bigg],$$

$$\Bigg[-\frac{1}{L1^3}\Bigg(12\,E\,I1\,\Bigg(-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)+\frac{1}{L1^2}\Bigg(6\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)+\frac{1}{L1^2}\Bigg(6\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}$$

$$+\frac{1}{144}\,\frac{\left(40\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}\Bigg)\Bigg)\Bigg],$$

$$\Bigg[-L1\,pd\Bigg],$$

$$\Bigg[-\frac{1}{L1^2}\Bigg(6\,E\,I1\,\Bigg(-\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(64\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,L1\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)+\frac{1}{L1}\Bigg(2\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(16\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}$$

$$+\frac{1}{144}\,\frac{\left(112\,A1^2\,I1\,L1^6+384\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{E\,A1\,I1\,\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)}\Bigg)\Bigg)+\frac{1}{L1}\Bigg(4\,E\,I1\,\Bigg($$

$$-\frac{1}{144}\,\frac{\left(88\,A1^2\,I1\,L1^6+96\,A1\,I1^2\,L1^4+144\,I1^3\,L1^2\right)\,pd}{\left(8\,A1\,I1\,L1^3+6\,I1^2\,L1\right)\,I1\,A1\,E}$$

$$+\frac{1}{144}\ \frac{\left(40\ A1^2\ I1\ L1^6+384\ A1\ I1^2\ L1^4+144\ I1^3\ L1^2\right)\ pd}{\left(8\ A1\ I1\ L1^3+6\ I1^2\ L1\right)\ I1\ A1\ E}\ \Bigg)\Bigg)\Bigg]$$

simplify

$$=$$

$$\begin{bmatrix} -\frac{L1^3\ pd\ A1}{4\ A1\ L1^2+3\ I1} \\ -L1\ pd \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \frac{L1^3\ pd\ A1}{4\ A1\ L1^2+3\ I1} \\ -L1\ pd \\ 0 \end{bmatrix} \tag{6.5}$$

Som det ses afhænger den vandrette reaktion både af inertimoment og areal.

Eksempel 1. HEA200:

$A1 := 5380$

$$5380 \tag{7.1}$$

$A2 := A1$:

$I1 := 36.9 \cdot 10^6$

$$3.69000000\ 10^7 \tag{7.2}$$

$I2 := I1$:

$E := 210000$

$$210000 \tag{7.3}$$

$L1 := 5000$

$$5000 \tag{7.4}$$

$L2 := 2 \cdot L1$

$$10000 \tag{7.5}$$

$v1$

$$\frac{1}{2}\ \pi \tag{7.6}$$

$v2$

$$0 \tag{7.7}$$

$v3$

$$-\frac{1}{2}\,\pi \tag{7.8}$$

$pd := 10$

$$10 \tag{7.9}$$

$u1$:
$K.u1 - Uvir$

$$\begin{bmatrix} -12497.42849 \\ -50000. \\ 0.01 \\ -0.003347 \\ 0. \\ -0.06 \\ 0.00335 \\ 0. \\ 0.01 \\ 12497.42849 \\ -50000. \\ -0.01 \end{bmatrix} \tag{7.10}$$

Teknisk Ståbi

$$H := \frac{pd \cdot L2^2}{4 \cdot L1 \cdot \left(2 \cdot \frac{1}{2} + 3\right)}$$

$$12500 \tag{7.11}$$

$$L := \frac{1}{2} \cdot pd \cdot L2$$

$$50000 \tag{7.12}$$

Eksempel 2. HEA 1000:

$A1 := 34700$

$$34700 \tag{8.1}$$

$A2 := A1$:
$I1 := 5538 \cdot 10^6$

$$5538000000 \tag{8.2}$$

$I2 := I1$:
$E := 210000$

$$210000 \quad \textbf{(8.3)}$$

$L1 := 5000$

$$5000 \quad \textbf{(8.4)}$$

$L2 := 2 \cdot L1$

$$10000 \quad \textbf{(8.5)}$$

$v1$

$$\frac{1}{2}\,\pi \quad \textbf{(8.6)}$$

$v2$

$$0 \quad \textbf{(8.7)}$$

$v3$

$$-\frac{1}{2}\,\pi \quad \textbf{(8.8)}$$

$pd := 10$

$$10 \quad \textbf{(8.9)}$$

$u1 :$
$K.u1 - Uvir$

$$\begin{bmatrix} -\frac{21687500000}{1743307} \\ -50000 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \frac{21687500000}{1743307} \\ -50000 \\ 0 \end{bmatrix} \quad \textbf{(8.10)}$$

at 5 digits $\longrightarrow$

$$\begin{bmatrix} -12440. \\ -50000. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 0. \\ 12440. \\ -50000. \\ 0. \end{bmatrix} \quad \textbf{(8.11)}$$

Teknisk Ståbi

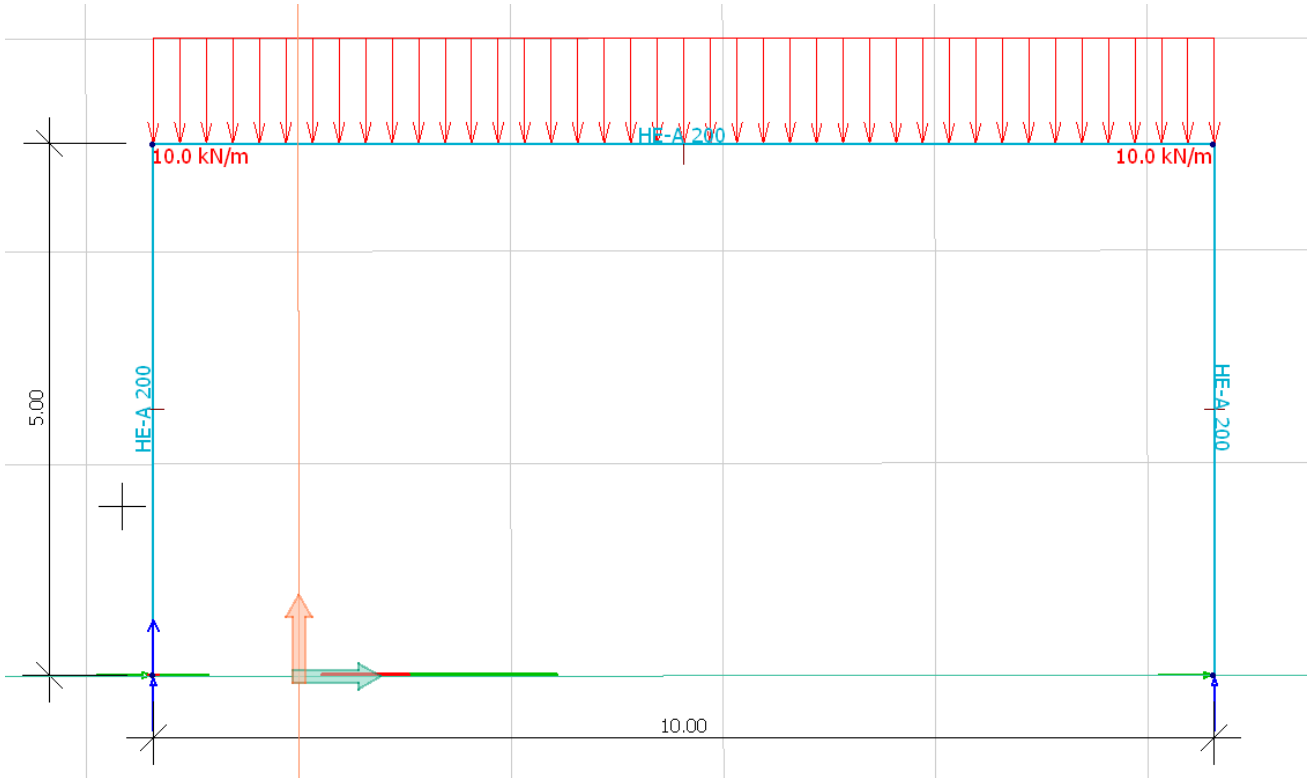
$$H := \frac{pd \cdot L2^2}{4 \cdot L1 \cdot \left(2 \cdot \frac{1}{2} + 3\right)}$$

$$12500 \quad \textbf{(8.12)}$$

$$L := \frac{1}{2} \cdot pd \cdot L2$$

$$50000 \quad \textbf{(8.13)}$$

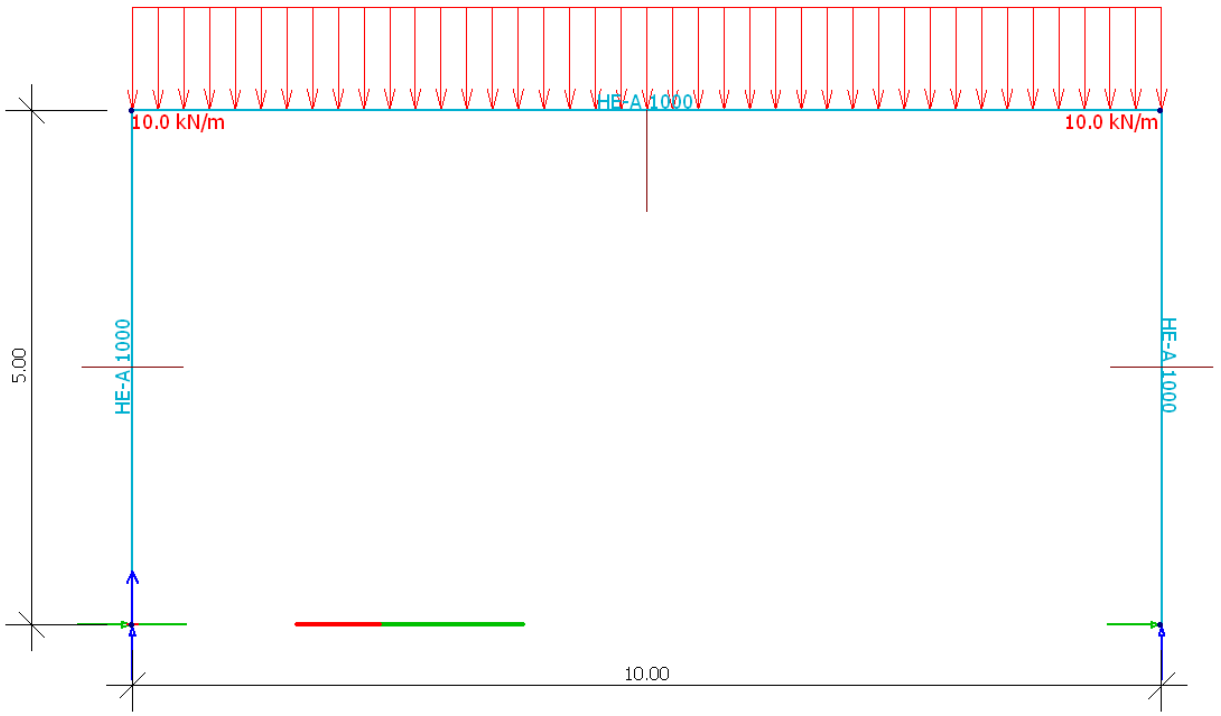
FEM.Design. Eksempel 1. HEA200



Point support group, reactions, Load comb.: Lodret

ID	x	y	z	Node	Fx'	Fy'	Fz'	Mx'	My'	Mz'
[-]	[m]	[m]	[m]	[-]	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
S.1	0.000	0.000	0.000	1	-12.468	0.000	-50.000	0.000	0.000	0.000
S.2	10.000	0.000	0.000	5	12.468	0.000	-50.000	0.000	0.000	0.000

FEM-Design. Eksempel 2. HEA1000



Point support group, reactions, Load comb.: Lodret

ID	x	y	z	Node	Fx'	Fy'	Fz'	Mx'	My'	Mz'
[-]	[m]	[m]	[m]	[-]	[kN]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
S.1	0.000	0.000	0.000	1	-12.113	0.000	-50.000	0.000	0.000	0.000
S.2	10.000	0.000	0.000	5	12.113	0.000	-50.000	0.000	0.000	0.000