$L_1 := 0m$

$L_2 := 5m$

$L_3 := 2m$ $\qquad int_{max} := \dfrac{\max(L_1, L_2, L_3)}{30}$

☐ Continuous Top Flange Bracing

☐ Continuous Bottom Flange Bracing

☐ Include Beam Self Weight

$$w_1 := \begin{pmatrix} 0.9 & 0.2 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \cdot \frac{kN}{m} \quad x_{w1} := \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot m \quad w_2 := \begin{pmatrix} 0.9 & 0.2 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \cdot \frac{kN}{m} \quad x_{w2} := \begin{pmatrix} L_2 + L_3 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad P := \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \cdot kN \quad x_P := \begin{pmatrix} 10 \\ 0 \\ 0 \\ 0 \end{pmatrix} \cdot m$$

$$LC_1 := \begin{pmatrix} 1.4 & 0 & 0 & 0 \\ 1.25 & 0 & 0 & 0 \\ 1.25 & 1.5 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \quad LC_2 := \begin{pmatrix} 1.4 & 0 & 0 & 0 \\ 1.25 & 1.5 & 0 & 0 \\ 1.25 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{pmatrix} \quad LC_3 := \begin{pmatrix} 1.4 & 0 & 0 & 0 \\ 1.25 & 0 & 0 & 0 \\ 1.25 & 1.5 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \quad \begin{bmatrix} \dfrac{L}{\Delta} \end{bmatrix} := \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad x_b := \begin{pmatrix} 1 \\ 3 \\ 0 \\ 0 \end{pmatrix} \cdot m \quad r_b := \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{pmatrix}$$

Interval has to be small enough to be considered fully braced.

$ORIGIN := 1$

$S_1 := \dfrac{L_1}{m} \qquad S_2 := \dfrac{L_1 + L_2}{m}$

$E := 200GPa \quad I := 1000000mm^4$

$$w(x, w_1, w_2, x_1, x_2) := \begin{array}{|l} s_1 \leftarrow x_1 \\ s_2 \leftarrow x_2 - x_1 \\ 0 \ \text{ if } \ x < s_1 \\ 0 \ \text{ if } \ x > s_2 + s_1 \\ w_1 + \dfrac{x - s_1}{s_2} \cdot (w_2 - w_1) \ \text{ otherwise} \end{array}$$

$$q(x) := \left(\sum_{i=1}^{rows(w_1)} w\left(x, {w_1}_{i,1} + {w_1}_{i,2} + {w_1}_{i,3} + {w_1}_{i,4}, {w_2}_{i,1} + {w_2}_{i,2} + {w_2}_{i,3} + {w_2}_{i,4}, {x_{w1}}_i, {x_{w2}}_i\right) \right)$$

$$Nodes_P := \begin{array}{l}
zero \leftarrow r_b^{\langle 1\rangle} - r_b^{\langle 1\rangle} \\
x_1 \leftarrow augment\left(\frac{x_b}{SIUnitsOf(x_b)}, zero, r_b, zero, zero, zero, zero\right) \\
x_2 \leftarrow augment\left[\begin{pmatrix} 0 \\ L_1 \\ L_1 + L_2 \\ L_1 + L_2 + L_3 \end{pmatrix} \frac{1}{SIUnitsOf(L_1)}, \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}\right] \\
zero \leftarrow \frac{x_P^{\langle 1\rangle} - x_P^{\langle 1\rangle}}{SIUnitsOf(x_P)} \\
x_3 \leftarrow augment\left(\frac{x_P}{SIUnitsOf(x_P)}, zero, zero, zero, \frac{P^{\langle 1\rangle}}{SIUnitsOf(P)}, \frac{P^{\langle 2\rangle}}{SIUnitsOf(P)}, \frac{P^{\langle 3\rangle}}{SIUnitsOf(P)}, \frac{P^{\langle 4\rangle}}{SIUnitsOf(P)}\right) \\
x_4 \leftarrow csort(stack(x_1, x_2, x_3), 1) \\
x_5 \leftarrow \left(\left(x_4^T\right)^{\langle 1\rangle}\right)^T \\
j \leftarrow 1 \\
\text{for } i \in 2..rows(x_4) \\
\quad \text{if } x_{4_{i,2}} = 1 \vee x_{4_{i,3}} = 1 \vee x_{4_{i,4}} = 1 \vee x_{4_{i,1}} = 0 \vee x_{4_{i,1}} = \frac{L_1 + L_2 + L_3}{SIUnitsOf(L_1)} \vee x_{4_{i,5}} \neq 0 \vee x_{4_{i,6}} \neq 0 \vee x_{4_{i,7}} \neq 0 \vee x_{4_{i,8}} \\
\qquad j \leftarrow j + 1 \text{ if } x_{4_{i,1}} > x_{5_{j,1}} \\
\qquad x_{5_{j,1}} \leftarrow x_{4_{i,1}} \\
\qquad x_{5_{j,2}} \leftarrow \min\left(x_{5_{j,2}} + x_{4_{i,2}}, 1\right) \\
\qquad x_{5_{j,3}} \leftarrow \min\left(x_{5_{j,3}} + x_{4_{i,3}}, 1\right) \\
\qquad x_{5_{j,4}} \leftarrow \min\left(x_{5_{j,4}} + x_{4_{i,4}}, 1\right) \\
\qquad x_{5_{j,5}} \leftarrow x_{5_{j,5}} + x_{4_{i,5}} \\
\qquad x_{5_{j,6}} \leftarrow x_{5_{j,6}} + x_{4_{i,6}} \\
\qquad x_{5_{j,7}} \leftarrow x_{5_{j,7}} + x_{4_{i,7}} \\
\qquad x_{5_{j,8}} \leftarrow x_{5_{j,8}} + x_{4_{i,8}} \\
x_5
\end{array}$$

$$Nodes_S := \left| \begin{array}{l} R \leftarrow \left(Nodes_P{}^T\right)^{\langle 1 \rangle T} \\ \text{for } i \in 1 .. rows(Nodes_P) - 1 \\ \quad \left| \begin{array}{l} x_1 \leftarrow Nodes_{P_{i,1}} \\ x_2 \leftarrow Nodes_{P_{i+1,1}} \\ n_{int} \leftarrow ceil\left(\dfrac{x_2 - x_1}{\dfrac{int_{max}}{SIUnitsOf(int_{max})}} \right) \\ \text{if } n_{int} > 1 \\ \quad \left| \begin{array}{l} int \leftarrow \dfrac{x_2 - x_1}{n_{int}} \\ \text{for } n \in 1, 2 .. n_{int} - 1 \\ \quad R \leftarrow stack\left[R, \left(x_1 + n \cdot int \;\; 0 \;\; 0 \;\; 0 \;\; 0 \;\; 0 \;\; 0 \;\; 0\right)\right] \end{array} \right. \\ R \leftarrow stack\left[R, \left(Nodes_P{}^T\right)^{\langle i+1 \rangle T}\right] \end{array} \right. \\ R \end{array} \right.$$

$$\left(b_{top} \;\; b_{bot}\right) := \left| \begin{array}{l} j \leftarrow 1 \\ k \leftarrow 1 \\ \text{for } i \in 1 .. rows(Nodes_P) \\ \quad \left| \begin{array}{l} \text{if } Nodes_{P_{i,3}} = 1 \\ \quad \left| \begin{array}{l} b_{t_{j,1}} \leftarrow Nodes_{P_{i,1}} \\ b_{t_{j,2}} \leftarrow 1 \\ j \leftarrow j + 1 \end{array} \right. \\ \text{if } Nodes_{P_{i,4}} = 1 \\ \quad \left| \begin{array}{l} b_{b_{k,1}} \leftarrow Nodes_{P_{i,1}} \\ b_{b_{k,2}} \leftarrow -1 \\ k \leftarrow k + 1 \end{array} \right. \end{array} \right. \\ \left(b_t \;\; b_b\right) \end{array} \right.$$

$$FEA_{mr}(s_1, s_2, s_3, w_1, w_2) := \frac{-1}{60} \cdot w_2 \cdot s_2 \cdot \frac{3 \cdot s_2{}^3 + 15 \cdot s_2{}^2 \cdot s_3 + 10 \cdot s_1{}^2 \cdot s_2 + 30 \cdot s_1{}^2 \cdot s_3 + 10 \cdot s_2{}^2 \cdot s_1 + 40 \cdot s_2 \cdot s_1 \cdot s_3}{(s_1 + s_2 + s_3)^2} \; ... \\ + \frac{-1}{60} \cdot w_1 \cdot s_2 \cdot \frac{2 \cdot s_2{}^3 + 5 \cdot s_2{}^2 \cdot s_3 + 20 \cdot s_1{}^2 \cdot s_2 + 30 \cdot s_1{}^2 \cdot s_3 + 10 \cdot s_2{}^2 \cdot s_1 + 20 \cdot s_2 \cdot s_1 \cdot s_3}{(s_1 + s_2 + s_3)^2}$$

$$FEA_{ml}(s_1,s_2,s_3,w_1,w_2) := \frac{1}{60}\cdot w_1\cdot s_2\cdot\frac{3\cdot s_2^{\,3} + 15\cdot s_2^{\,2}\cdot s_1 + 10\cdot s_3^{\,2}\cdot s_2 + 30\cdot s_3^{\,2}\cdot s_1 + 10\cdot s_2^{\,2}\cdot s_3 + 40\cdot s_2\cdot s_3\cdot s_1}{(s_3+s_2+s_1)^2}\ \dots$$
$$+\frac{1}{60}\cdot w_2\cdot s_2\cdot\frac{2\cdot s_2^{\,3} + 5\cdot s_2^{\,2}\cdot s_1 + 20\cdot s_3^{\,2}\cdot s_2 + 30\cdot s_3^{\,2}\cdot s_1 + 10\cdot s_2^{\,2}\cdot s_3 + 20\cdot s_2\cdot s_3\cdot s_1}{(s_3+s_2+s_1)^2}$$

$$FEA_{vr}(s_1,s_2,s_3,w_1,w_2) := \frac{1}{20}\cdot w_1\cdot s_2\cdot\frac{3\cdot s_2^{\,3} + 5\cdot s_2^{\,2}\cdot s_3 + 10\cdot s_1^{\,3} + 30\cdot s_1^{\,2}\cdot s_2 + 30\cdot s_1^{\,2}\cdot s_3 + 15\cdot s_2^{\,2}\cdot s_1 + 20\cdot s_1\cdot s_2\cdot s_3}{(s_1+s_2+s_3)^3}\ \dots$$
$$+\frac{1}{20}\cdot w_2\cdot s_2\cdot\frac{7\cdot s_2^{\,3} + 15\cdot s_2^{\,2}\cdot s_3 + 10\cdot s_1^{\,3} + 30\cdot s_1^{\,2}\cdot s_2 + 30\cdot s_1^{\,2}\cdot s_3 + 25\cdot s_2^{\,2}\cdot s_1 + 40\cdot s_1\cdot s_2\cdot s_3}{(s_1+s_2+s_3)^3}$$

$$FEA_{vl}(s_1,s_2,s_3,w_1,w_2) := \frac{1}{20}\cdot w_2\cdot s_2\cdot\frac{3\cdot s_2^{\,3} + 5\cdot s_2^{\,2}\cdot s_1 + 10\cdot s_3^{\,3} + 30\cdot s_3^{\,2}\cdot s_2 + 30\cdot s_3^{\,2}\cdot s_1 + 15 s_2^{\,2}\cdot s_3 + 20\cdot s_3\cdot s_2\cdot s_1}{(s_3+s_2+s_1)^3}\ \dots$$
$$+\frac{1}{20}\cdot w_1\cdot s_2\cdot\frac{7\cdot s_2^{\,3} + 15 s_2^{\,2}\cdot s_1 + 10 s_3^{\,3} + 30 s_3^{\,2}\cdot s_2 + 30\cdot s_3^{\,2}\cdot s_1 + 25\cdot s_2^{\,2}\cdot s_3 + 40\cdot s_3\cdot s_2\cdot s_1}{(s_3+s_2+s_1)^3}$$

$FEA(LC, split) :=$

$R_{L_{rows(Nodes_S)\cdot 2,3}} \leftarrow 0$

$R_{R_{rows(Nodes_S)\cdot 2,3}} \leftarrow 0$

for $i \in 1 .. rows(Nodes_S) - 1$

$x_i \leftarrow Nodes_{S_{i,1}}$

$x_j \leftarrow Nodes_{S_{i+1,1}}$

$m \leftarrow 1$ if $x_i \le \frac{L_1}{SIUnitsOf(L_1)}$

$m \leftarrow 2$ if $\frac{L_1}{SIUnitsOf(L_1)} < x_i \le \frac{L_1 + L_2}{SIUnitsOf(L_1 + L_2)}$

$m \leftarrow 3$ if $x_i > \frac{L_1 + L_2}{SIUnitsOf(L_1 + L_2)}$

$n \leftarrow 1$ if $x_i < \frac{L_1}{SIUnitsOf(L_1)}$

$n \leftarrow 2$ if $\frac{L_1}{SIUnitsOf(L_1)} \le x_i < \frac{L_1 + L_2}{SIUnitsOf(L_1 + L_2)}$

$n \leftarrow 3$ if $x_i \ge \frac{L_1 + L_2}{SIUnitsOf(L_1 + L_2)}$

for $j \in 1 .. rows(w_1)$

$$x_{1g} \leftarrow \frac{x_{w1_j}}{\text{SIUnitsOf}\left(x_{w1_j}\right)}$$

$$x_{2g} \leftarrow \frac{x_{w2_j}}{\text{SIUnitsOf}\left(x_{w2_j}\right)}$$

$$w_{1g} \leftarrow \frac{w_{1_{j,LC}}}{\text{SIUnitsOf}\left(w_{1_{j,LC}}\right)}$$

$$w_{2g} \leftarrow \frac{w_{2_{j,LC}}}{\text{SIUnitsOf}\left(w_{2_{j,LC}}\right)}$$

$\text{if } \max(x_{1g}, x_{2g}) > x_i \wedge \min(x_{1g}, x_{2g}) < x_j$

$\quad \text{if } x_{1g} < x_i$

$\quad\quad s_1 \leftarrow 0$

$\quad\quad w_a \leftarrow w(x_{1g}, w_{1g}, w_{2g}, x_{1g}, x_{2g})$

$\quad \text{otherwise}$

$\quad\quad s_1 \leftarrow x_{1g} - x_i$

$\quad\quad w_a \leftarrow w(x_{1g}, w_{1g}, w_{2g}, x_{1g}, x_{2g})$

$\quad \text{if } x_j < x_{2g}$

$\quad\quad s_2 \leftarrow x_j - x_i$

$\quad\quad w_b \leftarrow w(x_j, w_{1g}, w_{2g}, x_{1g}, x_{2g})$

$\quad \text{otherwise}$

$\quad\quad s_2 \leftarrow x_{2g} - x_i$

$\quad\quad w_b \leftarrow w(x_{2g}, w_{1g}, w_{2g}, x_{1g}, x_{2g})$

$\quad s_3 \leftarrow \left|x_j - x_i\right| - s_1 - s_2$

$\quad R_{R_{2\cdot i-1,m}} \leftarrow R_{R_{2\cdot i-1,m}} + -FEA_{vl}(s_1, s_2, s_3, w_a, w_b)$

$\quad R_{R_{2\cdot i,m}} \leftarrow R_{R_{2\cdot i,m}} + -FEA_{ml}(s_1, s_2, s_3, w_a, w_b)$

$\quad R_{L_{2\cdot i+1,n}} \leftarrow R_{L_{2\cdot i+1,n}} + -FEA_{vr}(s_1, s_2, s_3, w_a, w_b)$

$\quad R_{L_{2\cdot i+2,n}} \leftarrow R_{L_{2\cdot i+2,n}} + -FEA_{mr}(s_1, s_2, s_3, w_a, w_b)$

$\left(R_L^{\langle 1\rangle} + R_L^{\langle 2\rangle} + R_L^{\langle 3\rangle} \quad R_R^{\langle 1\rangle} + R_R^{\langle 2\rangle} + R_R^{\langle 3\rangle}\right) \text{ if split} = 0$

$\left(R_L^{\langle 1\rangle} \quad R_L^{\langle 2\rangle} \quad R_L^{\langle 3\rangle} \quad R_R^{\langle 1\rangle} \quad R_R^{\langle 2\rangle} \quad R_R^{\langle 3\rangle}\right) \text{ otherwise}$

```
Assemble(M, OverWrite) := | for i ∈ 1 .. rows(M)
                          |   | m ← M_{i,1}
                          |   | for j ∈ M_{i,2} .. M_{i,2} + rows(m) − 1
                          |   |   for k ∈ M_{i,3} .. M_{i,3} + cols(m) − 1
                          |   |     Output_{j,k} ← 0
                          | for i ∈ 1 .. rows(M)
                          |   | m ← M_{i,1}
                          |   | for j ∈ M_{i,2} .. M_{i,2} + rows(m) − 1
                          |   |   for k ∈ M_{i,3} .. M_{i,3} + cols(m) − 1
                          |   |     | Output_{j,k} ← m_{j−M_{i,2}+1, k−M_{i,3}+1}  if OverWrite = 1
                          |   |     | Output_{j,k} ← m_{j−M_{i,2}+1, k−M_{i,3}+1} + Output_{j,k}  otherwise
                          | Output
```

$$k(L) := \frac{\frac{E}{\text{SIUnitsOf}(E)} \cdot \frac{I}{\text{SIUnitsOf}(I)}}{L^3} \cdot \begin{pmatrix} 12 & 6 \cdot L & -12 & 6 \cdot L \\ 6 \cdot L & 4L^2 & -6L & 2 \cdot L^2 \\ -12 & -6L & 12 & -6 \cdot L \\ 6 \cdot L & 2 \cdot L^2 & -6 \cdot L & 4 \cdot L^2 \end{pmatrix}$$

```
K := | K_{rows(Nodes_S), rows(Nodes_S)} ← 0
     | n ← Nodes_S
     | for i ∈ 1 .. rows(n) − 1
     |   | L ← n_{i+1,1} − n_{i,1}
     |   | k_i ← k(L)
     |   | K ← Assemble[ ( K     1          1       ) , 0 ]
     |   |               ( k_i   i·2 − 1    i·2 − 1 )
     | K
```

```
BC(K, Vector) := | Skip_i ← 0
                 | k ← 2  if  L_2 = 0
                 | k ← 1  otherwise
                 | i ← 1
                 | while  i ≤ rows(K)
                 |   | Node ← floor((i − 1)/2) + 1
                 |   | DOF ← i − (Node − 1)2
                 |   | if  Nodes_{S_{Node,2}} ≠ 1 ∨ DOF = 2
                 |   |   | Skip_j ← 0
                 |   |   | j ← 1
                 |   |   | while  j ≤ cols(K)
                 |   |   |   | Node ← floor((j − 1)/2) + 1
                 |   |   |   | DOF ← j − (Node − 1)2
                 |   |   |   | if  Nodes_{S_{Node,2}} ≠ 1 ∨ DOF = 2 ∨ Vector = 1
                 |   |   |   |   | K_BC_{i−Skip_i, j−Skip_j} ← K_{i,j}
                 |   |   |   |   | Map_{i−Skip_i, j−Skip_j} ← i  if  Vector = 1
                 |   |   |   |   | Map_{i−Skip_i, j−Skip_j} ← concat(num2str(i), "-", num2str(j))  otherwise
                 |   |   |   |   | j ← j + 1
                 |   |   |   | otherwise
                 |   |   |   |   | Skip_j ← Skip_j + k
                 |   |   |   |   | j ← j + k
                 |   |   | i ← i + 1
                 |   | otherwise
                 |   |   | Skip_i ← Skip_i + k
                 |   |   | i ← i + k
                 | ( K_BC )
                 | ( Map  )
```

$$F_{node}(LC, span) := \left| \begin{array}{l} P_{in} \leftarrow -Nodes_S^{\langle LC+4 \rangle} \\ P_{out_{1,3}} \leftarrow 0 \\ \text{for } i \in 1..rows(P_{in}) \\ \quad \left| \begin{array}{l} x \leftarrow Nodes_{S_{i,1}} \\ j \leftarrow 1 \text{ if } x < \dfrac{L_1}{SIUnitsOf(L_1)} \\ j \leftarrow 2 \text{ if } \dfrac{L_1}{SIUnitsOf(L_1)} \le x \le \dfrac{L_1 + L_2}{SIUnitsOf(L_1)} \\ j \leftarrow 3 \text{ if } x > \dfrac{L_1 + L_2}{SIUnitsOf(L_1)} \\ P_{out_{i \cdot 2-1, j}} \leftarrow P_{in_i} \\ P_{out_{i \cdot 2, j}} \leftarrow 0 \end{array} \right. \\ P_{out} \leftarrow P_{out}^{\langle 1 \rangle} + P_{out}^{\langle 2 \rangle} + P_{out}^{\langle 3 \rangle} \text{ if } span = 0 \\ \text{otherwise} \\ \quad \left| \begin{array}{l} P_{out}^{\langle 1 \rangle} \text{ if } span = 1 \\ P_{out}^{\langle 2 \rangle} \text{ if } span = 2 \\ P_{out}^{\langle 3 \rangle} \text{ if } span = 3 \end{array} \right. \end{array} \right.$$

$$F(FEA_L, FEA_R, F_N) := F_N + FEA_L + FEA_R$$

$$\left[K_{BC}^{-1} \right] := \left| \begin{array}{l} K_{BC} \leftarrow BC(K, 0)_1 \\ K_{BC}^{-1} \end{array} \right.$$

$$d(FEA_L, FEA_R, F_N) := \left| \begin{array}{l} d_{rows(Nodes_S) \cdot 2} \leftarrow 0 \\ R \leftarrow BC(F(FEA_L, FEA_R, F_N), 1) \\ d_{BC} \leftarrow \left[K_{BC}^{-1} \right] \cdot R_1 \\ Map \leftarrow R_2 \\ \text{for } i \in 1..rows(Map) \\ \quad d_{Map_i} \leftarrow d_{BC_i} \\ d \end{array} \right.$$

$$\Delta\left(FEA_L, FEA_R, F_N\right) := \begin{array}{|l} d \leftarrow d\left(FEA_L, FEA_R, F_N\right) \\ \text{for } i \in 1, 3 .. \text{rows}(d) \\ \quad R_{\text{rows}(R)+1} \leftarrow d_i \\ R \end{array}$$

$$VM\Delta\left(FEA_L, FEA_R, F_N\right) := \begin{array}{|l} E \leftarrow \dfrac{E}{\text{SIUnitsOf}(E)} \\ I \leftarrow \dfrac{I}{\text{SIUnitsOf}(I)} \\ n \leftarrow Nodes_S \\ L \leftarrow n_{2,1} - n_{1,1} \\ d_g \leftarrow d\left(FEA_L, FEA_R, F_N\right) \\ \text{for } i \in 1, 3 .. \text{rows}\left(d_g\right) - 1 \\ \quad \Delta_{\text{ceil}\left(\frac{i}{2}\right)} \leftarrow d_{g_i} \\ d_i \leftarrow \text{submatrix}\left(d_g, 1, 4, 1, 1\right) \\ V_1 \leftarrow \dfrac{E \cdot I}{L^3} \cdot d_i \cdot \begin{pmatrix} 12 \\ 6L \\ -12 \\ 6L \end{pmatrix} - FEA_{R_1} \\ M_1 \leftarrow \dfrac{-E \cdot I}{L^3} \cdot d_i \cdot \begin{pmatrix} 6 \cdot L \\ 4L^2 \\ -6L \\ 2 \cdot L^2 \end{pmatrix} + FEA_{R_2} \\ L \leftarrow n_{\text{rows}(n),1} - n_{\text{rows}(n)-1,1} \\ d_i \leftarrow \text{submatrix}\left(d_g, \text{rows}(n) \cdot 2 - 3, \text{rows}(n) \cdot 2, 1, 1\right) \\ V_{\text{rows}(n)} \leftarrow \dfrac{E \cdot I}{L^3} \cdot d_i \cdot \begin{pmatrix} 12 \\ 6L \\ -12 \\ 6L \end{pmatrix} + FEA_{L_{\text{rows}\left(FEA_L\right)-1}} \\ M_{\text{rows}(n)} \leftarrow \dfrac{E \cdot I}{L^3} \cdot d_i \cdot \begin{pmatrix} 6 \cdot L \\ 2L^2 \\ -6L \\ 4 \cdot L^2 \end{pmatrix} - FEA_{L_{\text{rows}\left(FEA_L\right)}} \\ \text{for } i \in 2 .. \text{rows}(n) - 1 \\ \quad \begin{array}{|l} L_1 \leftarrow n_{i,1} - n_{i-1,1} \\ L_2 \leftarrow n_{i+1,1} - n_{i,1} \\ d_{i1} \leftarrow \text{submatrix}\left(d_g, i \cdot 2 - 3, i \cdot 2 - 3 + 3, 1, 1\right) \end{array} \end{array}$$

$$d_{i2} \leftarrow \text{submatrix}(d_g, i\cdot 2 - 1, i\cdot 2 - 1 + 3, 1, 1)$$

$$V_1 \leftarrow \frac{E\cdot I}{L_1^{\,3}}\cdot d_{i1}\cdot\begin{pmatrix}12\\6L_1\\-12\\6L_1\end{pmatrix} + FEA_{L_{2\cdot i-1}}$$

$$V_2 \leftarrow \frac{E\cdot I}{L_2^{\,3}}\cdot d_{i2}\cdot\begin{pmatrix}12\\6L_2\\-12\\6L_2\end{pmatrix} - FEA_{R_{2\cdot i-1}}$$

$$V_i \leftarrow V_1 \ \text{ if } \ |V_1| > |V_2|$$

$$V_i \leftarrow V_2 \ \text{ otherwise}$$

$$M_i \leftarrow \frac{-E\cdot I}{L_2^{\,3}}\cdot d_{i2}\cdot\begin{pmatrix}6\cdot L_2\\4L_2^{\,2}\\-6L_2\\2\cdot L_2^{\,2}\end{pmatrix} - FEA_{L_{2\cdot i}}$$

$$(\text{round}(V) \quad \text{round}(M) \quad \Delta)$$

$$\kappa(M_1, M_2) := \begin{array}{|l} M_{large} \leftarrow \max(|M_1|, |M_2|) \\ M_{small} \leftarrow \min(|M_1|, |M_2|) \\ \kappa \leftarrow 1 \ \text{ if } \ M_1 = 0 \wedge M_2 = 0 \\ \kappa \leftarrow \dfrac{M_{small}}{M_{large}}\cdot \text{sign}(M_1)\cdot\text{sign}(M_2)\cdot -1 \ \text{ otherwise} \end{array}$$

$$\omega_2(M_1, M_2, M_3, end_{br}) := \begin{array}{|l} M_{end\_max} \leftarrow \max(|M_1|, |M_2|) \\ \omega \leftarrow 1 \ \text{ if } \ |M_3| > M_{end\_max} \vee end_{br} = 0 \\ \text{otherwise} \\ \quad \begin{array}{|l} \kappa \leftarrow \kappa(M_1, M_2) \\ \omega \leftarrow \min(1.75 + 1.05\cdot\kappa + 0.3\cdot\kappa^2, 2.5) \end{array} \\ \omega \end{array}$$

$ML\omega_2(M_{field}) :=$

$$\begin{pmatrix} R_{1,1} & R_{1,2} & R_{1,3} \end{pmatrix} \leftarrow \begin{pmatrix} \max\left(\overrightarrow{|M_{field}|}\right) & 0 & 1 \end{pmatrix}$$

$n_{lb} \leftarrow 1$

$lb_{br} \leftarrow 0$

for $i \in 1 .. rows(Nodes_S)$

$\quad (Flange_{CL} \;\; Flange_{CR}) \leftarrow (1 \;\; 1)$ if $M_{field_i} > 0$

$\quad (Flange_{CL} \;\; Flange_{CR}) \leftarrow (2 \;\; 2)$ if $M_{field_i} < 0$

$\quad$ if $M_{field_i} = 0$

$\quad\quad (M_L \;\; M_R) \leftarrow (0 \;\; 0)$

$\quad\quad k \leftarrow i - 1$

$\quad\quad$ while $M_L = 0 \wedge k \geq n_{lb}$

$\quad\quad\quad M_L \leftarrow M_{field_k}$ if $M_{field_k} \neq 0$

$\quad\quad\quad k \leftarrow k - 1$

$\quad\quad k \leftarrow i + 1$

$\quad\quad$ while $M_R = 0 \wedge k \leq rows(Nodes_S)$

$\quad\quad\quad M_R \leftarrow M_{field_k}$ if $M_{field_k} \neq 0$

$\quad\quad\quad k \leftarrow k + 1$

$\quad\quad M_R \leftarrow M_L$ if $M_R = 0$

$\quad\quad M_L \leftarrow M_R$ if $M_L = 0$

$\quad\quad$ trace("{0}, {1}, {2}, {3},{4},{5}" , $Nodes_{S_{i,1}}, Flange_{CL}, Flange_{CR}, M_{field_i}, M_L, M_R$)

$\quad\quad Flange_{CR} \leftarrow 1$ if $M_R > 0$

$\quad\quad Flange_{CR} \leftarrow 2$ otherwise

$\quad\quad Flange_{CL} \leftarrow 1$ if $M_L > 0$

$\quad\quad Flange_{CL} \leftarrow 2$ otherwise

$\quad\quad$ trace("{0}, {1}, {2}, {3},{4},{5}" , $Nodes_{S_{i,1}}, Flange_{CL}, Flange_{CR}, M_{field_i}, M_L, M_R$)

$\quad Braced_R \leftarrow 1$ if $\left[\left(TF_{braced} = 1 \vee Nodes_{S_{i,3}} = 1\right) \wedge Flange_{CR} = 1\right] \vee \left[\left(BF_{braced} = 1 \vee Nodes_{S_{i,4}} = 1\right) \wedge Fla$

$\quad Braced_R \leftarrow 0$ otherwise

$\quad Braced_L \leftarrow 1$ if $\left[\left(TF_{braced} = 1 \vee Nodes_{S_{i,3}} = 1\right) \wedge Flange_{CL} = 1\right] \vee \left[\left(BF_{braced} = 1 \vee Nodes_{S_{i,4}} = 1\right) \wedge Fla$

$\quad Braced_L \leftarrow 0$ otherwise

$\quad$ if $Braced_L = 1 \vee i = 1 \vee i = rows(Nodes_S)$

$\quad\quad$ if $i - n_{lb} > 1$

$\quad\quad\quad M_1 \leftarrow M_{field_{n_{lb}}}$

$\quad\quad\quad M_2 \leftarrow M_{field_i}$

$\quad\quad\quad M_3 \leftarrow \max\left(\overrightarrow{|submatrix(M_{field}, n_{lb}, i, 1, 1)|}\right)$

$\quad\quad\quad$ if $|M_3| > 0$

$j \leftarrow rows(R) + 1$

$R_{j,1} \leftarrow M_3$

$R_{j,2} \leftarrow Nodes_{S_{i,1}} - Nodes_{S_{nlb,1}}$

$end_{br} \leftarrow 1 \;\; \text{if} \;\; Braced_L = 1 \wedge lb_{br} = 1$

$end_{br} \leftarrow 0 \;\; \text{otherwise}$

$R_{j,3} \leftarrow \omega_2(M_1, M_2, M_3, end_{br})$

$R_{j,4} \leftarrow Nodes_{S_{nlb,1}}$

$R_{j,5} \leftarrow Nodes_{S_{i,1}}$

$n_{lb} \leftarrow i$

$lb_{br} \leftarrow Braced_R$

R

$$Beams := \begin{pmatrix} "108" & "14" & "11" & "29" & "W\ 1700\ x\ 98" \\ "055" & "55" & "45" & "51" & "W\ 310\ x\ 45" \\ "007" & "88" & "09" & "32" & "W\ 1700\ x\ 90" \\ "109" & "10" & "10" & "10" & "W\ 310\ x\ 24" \\ "010" & "10" & "10" & "10" & "W\ 310\ x\ 24" \end{pmatrix}$$

$(V \;\; M \;\; \Delta_{plot}) :=$

$R \leftarrow VM\Delta\left(FEA(1,0)_{1,1}, FEA(1,0)_{1,2}, F_{node}(1,0)\right)$

$V \leftarrow R_{1,1}$

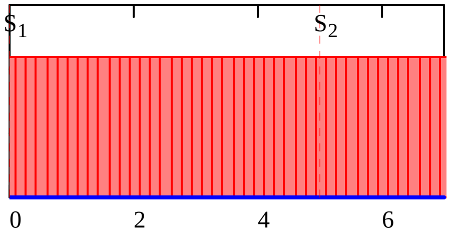
$M \leftarrow R_{1,2}$

$\Delta \leftarrow R_{1,3}$

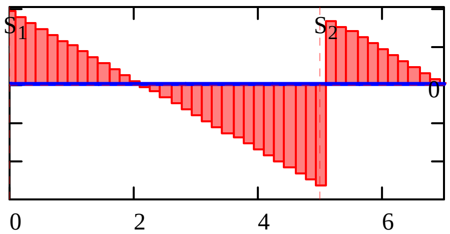
$(V \;\; M \;\; \Delta)$

$$\Delta_{scale} := max\left(\overrightarrow{|\Delta_{plot}|}\right)$$

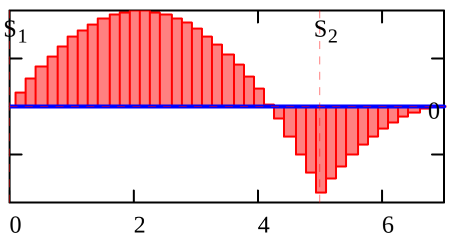
Distibuted Loads



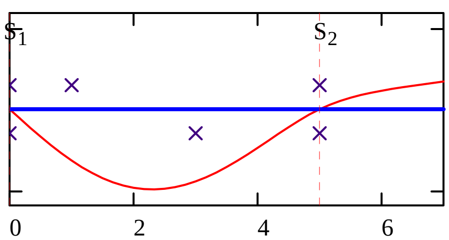
Shear



Moment



Deflection



Fix slow downs in code as a result of duplicating code runs. Initiat all matrices

$ML\omega_2(M) = ▮$

$\left(ML\omega_2(M) \quad \max\left(\overrightarrow{|V|}\right)\right) = ▮$

```
Pad(number) := | R ← num2str(round(number))
               | R ← "999"  if  strlen(R) > 3
               | while strlen(R) < 3
               |   R ← concat("0" , R)
```

Pad(45) = "045"

M =

	1
1	0.00
2	302.00
3	580.00
4	832.00
5	1060.00
6	1262.00
7	1440.00
8	1592.00
9	1720.00
10	1822.00
11	1900.00
12	1952.00
13	1980.00
14	1982.00
15	1960.00
16	...

V =

	1
1	1890.00
2	1740.00
3	1590.00
4	1440.00
5	1290.00
6	1140.00
7	990.00
8	840.00
9	690.00
10	540.00
11	390.00
12	240.00
13	90.00
14	-60.00
15	-210.00
16	...

$\neq 0$

*

$\text{ınge}_{CR} = 2$

$\text{nge}_{CL} = 2$