$$\frac{d^4}{dx^4}w=\frac{q}{EJ} \qquad \boxed{1}-\boxed{-4}-\boxed{6}-\boxed{-4}-\boxed{1} * \frac{W}{h^4}=\frac{q}{EJ}$$

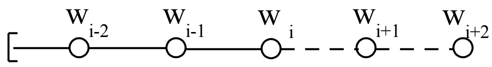
$$\frac{d^3}{dx^3}w \approx \qquad \boxed{-1}-\boxed{2}-\boxed{0}-\boxed{-2}-\boxed{1} * \frac{W}{2h^3}$$

$$\frac{d^2}{dx^2}w \approx \qquad \boxed{0}-\boxed{1}-\boxed{-2}-\boxed{1}-\boxed{0} * \frac{W}{h^2} \qquad W=\begin{Bmatrix} w_{i-2} \\ w_{i-1} \\ w_i \\ w_{i+1} \\ w_{i+2} \end{Bmatrix}$$

$$\frac{d}{dx}w \approx \qquad \boxed{0}-\boxed{-1}-\boxed{0}-\boxed{1}-\boxed{0} * \frac{W}{2h}$$

---

1. Swobodny koniec



$$\frac{d^2}{dx^2}w=0 \qquad \frac{d^2}{dx^2}w \approx \boxed{1}-\boxed{-2}-\boxed{1} * \frac{W}{h^2}$$

$$w_{i-1}-2w_i+w_{i+1}=0 \Rightarrow w_{i+1}=-w_{i-1}+2w_i$$

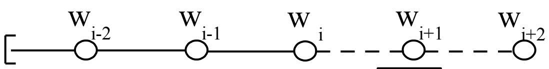
$$\frac{d^3}{dx^3}w=0 \qquad \boxed{-1}-\boxed{2}-\boxed{0}-\boxed{-2}-\boxed{1} * \frac{W}{2h^3}$$

$$-w_{i-2}+2w_{i-1}+0w_i-2w_{i+1}+w_{i+2}=0 \qquad w_{i+2}=w_{i-2}-2w_{i-1}+2w_{i+1}$$

$$w_{i+2}=w_{i-2}-2w_{i-1}+2\left(-w_{i-1}+2w_i\right)=w_{i-2}-4w_{i-1}+4w_i$$

---

w punkcie w i-1

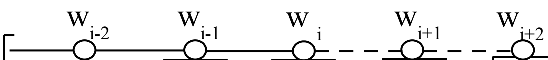


$$\boxed{1}-\boxed{-4}-\boxed{6}-\boxed{-4}-\boxed{1}$$

$$\boxed{0}-\boxed{-1}-\boxed{2} \qquad w_{i+1}=-w_{i-1}+2w_i$$

---

w punkcie w i



$$\boxed{1}-\boxed{-4}-\boxed{6}-\boxed{-4}-\boxed{1}$$

$$\boxed{1}-\boxed{0}-\boxed{-4} \quad \left\{ \begin{array}{l} \boxed{0}-\boxed{4}-\boxed{-8} \\ \boxed{1}-\boxed{-4}-\boxed{4} \end{array} \right. \qquad \begin{array}{l} w_{i+1}=-w_{i-1}+2w_i \\ w_{i+2}=w_{i-2}-4w_{i-1}+4w_i \end{array}$$

---

dla dwóch pierwszych równań

wiersz w 1 $\quad \boxed{-4}-\boxed{0}-\boxed{1}$

wiersz w 2 $\quad \boxed{2}-\boxed{-1}-\boxed{0}$

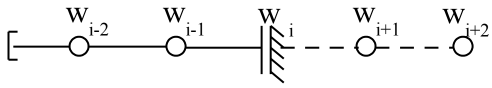
dla dwóch ostatnich równań

wiersz w i-1 $\quad \boxed{0}-\boxed{-1}-\boxed{2}$

wiersz w i $\quad \boxed{1}-\boxed{0}-\boxed{-4}$

METODA RÓŻNIC SKOŃCZONYCH

2. Utwierdzenie z przesuwem



$$\frac{d}{dx}w = 0 \qquad \frac{d}{dx}w \approx \boxed{-1}-\boxed{0}-\boxed{1} * \frac{W}{h^2}$$

$$-w_{i-1} + 0w_i + w_{i+1} = 0 \Rightarrow \ w_{i+1} = w_{i-1}$$

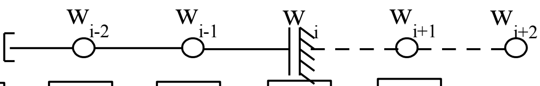
$$\frac{d^3}{dx^3}w = 0 \qquad \boxed{-1}-\boxed{2}-\boxed{0}-\boxed{-2}-\boxed{1} * \frac{W}{2h^3}$$

$$-w_{i-2} + 2w_{i-1} + 0w_i - 2w_{i+1} + w_{i+2} = 0 \qquad w_{i+2} = w_{i-2} - 2w_{i-1} + 2w_{i+1}$$

$$w_{i+2} = w_{i-2} - 2w_{i-1} + 2w_{i-1} = w_{i-2}$$

---

w punkcie w $_{i-1}$



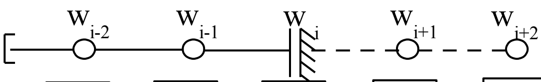
$$\boxed{1}-\boxed{-4}-\boxed{6}-\boxed{-4}-\boxed{1}$$

$$\boxed{0}-\boxed{1}-\boxed{0}$$

$$w_{i+1} = w_{i-1}$$

---

w punkcie w $_i$



$$\boxed{1}-\boxed{-4}-\boxed{6}-\boxed{-4}-\boxed{1}$$

$$\boxed{1}-\boxed{-4}-\boxed{0} \quad \left\{ \begin{array}{l} \boxed{0}-\boxed{-4}-\boxed{0} \\ \boxed{1}-\boxed{0}-\boxed{0} \end{array} \right.$$

$$w_{i+1} = w_{i-1}$$

$$w_{i+2} = w_{i-2}$$

---

dla dwóch pierwszych równań

wiersz w $_1$ $\quad \boxed{0}-\boxed{-4}-\boxed{1}$

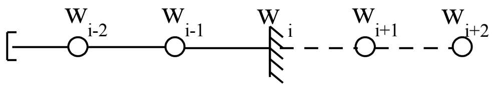
wiersz w $_2$ $\quad \boxed{0}-\boxed{1}-\boxed{0}$

dla dwóch ostatnich równań

wiersz w $_{i-1}$ $\quad \boxed{0}-\boxed{1}-\boxed{0}$

wiersz w $_i$ $\quad \boxed{1}-\boxed{-4}-\boxed{0}$

3. Pełne utwierdzenie



$w_i = 0$

$$\frac{d}{dx} w = 0 \qquad \frac{d}{dx} w \approx \boxed{-1} - \boxed{0} - \boxed{1} * \frac{W}{h^2}$$

$$-w_{i-1} + 0w_i + w_{i+1} = 0 \Rightarrow w_{i+1} = w_{i-1}$$

dla dwóch pierwszych równań

wiersz w $_1$ $\quad \boxed{0} - \boxed{-4} - \boxed{0}$

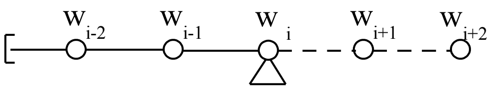
wiersz w $_2$ $\quad \boxed{0} - \boxed{1} - \boxed{0}$

dla dwóch ostatnich równań

wiersz w $_{i-1}$ $\quad \boxed{0} - \boxed{1} - \boxed{0}$

wiersz w $_i$ $\quad \boxed{0} - \boxed{-4} - \boxed{0}$

4. Podpora przegubowa



$w_i = 0$

$$\frac{d^2}{dx^2} w = 0 \qquad \frac{d^2}{dx^2} w \approx \boxed{1} - \boxed{-2} - \boxed{1} * \frac{W}{h^2}$$

$$w_{i-1} - 2w_i + w_{i+1} = 0 \Rightarrow w_{i+1} = -w_{i-1}$$

dla dwóch pierwszych równań

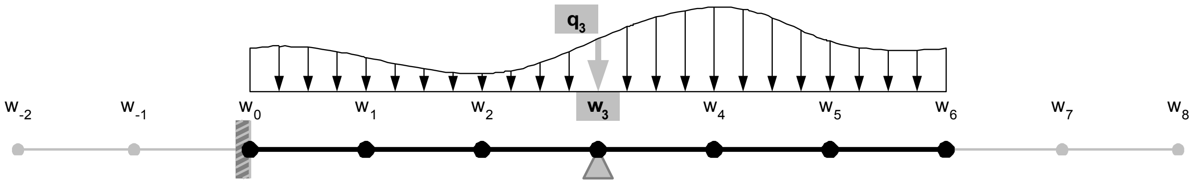
wiersz w $_1$ $\quad \boxed{0} - \boxed{4} - \boxed{0}$

wiersz w $_2$ $\quad \boxed{0} - \boxed{-1} - \boxed{0}$

dla dwóch ostatnich równań

wiersz w $_{i-1}$ $\quad \boxed{0} - \boxed{-1} - \boxed{0}$

wiersz w $_i$ $\quad \boxed{0} - \boxed{4} - \boxed{0}$



$$\frac{d^4}{dx^4}w(x)=\frac{q(x)}{EI(x)} \qquad \frac{d^4}{dx^4}w(x)\cong\frac{1}{h^4}\ \boxed{1}-\boxed{-4}-\boxed{6}-\boxed{-4}-\boxed{1}$$

+1 w_{-2}	–4 w_{-1}	+6 w_0	–4 w_1	+1 w_2	w_3	w_4	w_5	w_6	w_7	w_8	=	$h^4\ q_0/EI_0$
w_{-2}	+1 w_{-1}	–4 w_0	+6 w_1	–4 w_2	+1 w_3	w_4	w_5	w_6	w_7	w_8	=	$h^4\ q_1/EI_1$
w_{-2}	w_{-1}	+1 w_0	–4 w_1	+6 w_2	–4 w_3	+1 w_4	w_5	w_6	w_7	w_8	=	$h^4\ q_2/EI_2$
w_{-2}	w_{-1}	w_0	+1 w_1	–4 w_2	+6 w_3	–4 w_4	+1 w_5	w_6	w_7	w_8	=	$h^4\ q_3/EI_3$
w_{-2}	w_{-1}	w_0	w_1	+1 w_2	–4 w_3	+6 w_4	–4 w_5	+1 w_6	w_7	w_8	=	$h^4\ q_4/EI_4$
w_{-2}	w_{-1}	w_0	w_1	w_2	+1 w_3	–4 w_4	+6 w_5	–4 w_6	+1 w_7	w_8	=	$h^4\ q_5/EI_5$
w_{-2}	w_{-1}	w_0	w_1	w_2	w_3	+1 w_4	–4 w_5	+6 w_6	–4 w_7	+1 w_8	=	$h^4\ q_6/EI_6$

Warunki brzegowe:

1) swobodny koniec: M=0, Q=0
2) utwierdzenie: w=0, ϕ=0
3) podpora (koniec belki): w=0, M=0
4) podpora (nie na końcu): w=0

ad 1) M=0, czyli $\frac{d^2}{dx^2}w(x)=0$, stąd: $w_7=2w_6-w_5$

Q=0, czyli $\frac{d^3}{dx^3}w(x)=0$, stąd: $w_8=4w_6-4w_5+w_4$

ad 2) ϕ=0, czyli $\frac{d}{dx}w(x)=0$, stąd: $w_{-1}=w_1$

w=0, czyli odrzucam odpowiedni wiersz i kolumnę

ad 4) odrzucam odpowiedni wiersz i kolumnę

+6 w_0	(–4–4) w_1	+1 w_2	w_3	w_4	w_5	w_6	=	$h^4\ q_0/EI_0$
–4 w_0	(+6+1) w_1	–4 w_2	+1 w_3	w_4	w_5	w_6	=	$h^4\ q_1/EI_1$
+1 w_0	–4 w_1	+6 w_2	–4 w_3	+1 w_4	w_5	w_6	=	$h^4\ q_2/EI_2$
w_0	+1 w_1	–4 w_2	+6 w_3	–4 w_4	+1 w_5	w_6	=	$h^4\ q_3/EI_3$
w_0	w_1	+1 w_2	–4 w_3	+6 w_4	–4 w_5	+1 w_6	=	$h^4\ q_4/EI_4$
w_0	w_1	w_2	+1 w_3	–4 w_4	(+6–1) w_5	(–4+2) w_6	=	$h^4\ q_5/EI_5$
w_0	w_1	w_2	w_3	(+1+1) w_4	(–4+4-4) w_5	(+6-8+4) w_6	=	$h^4\ q_6/EI_6$

$$\begin{bmatrix} +6 & -8 & +1 & & & & \\ -4 & +7 & -4 & +1 & & & \\ +1 & -4 & +6 & -4 & +1 & & \\ & +1 & -4 & +6 & -4 & +1 & \\ & & +1 & -4 & +6 & -4 & +1 \\ & & & +1 & -4 & +5 & -2 \\ & & & & +2 & -4 & +2 \end{bmatrix} \begin{bmatrix} w_0 \\ w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} h^4\ q_0/EI_0 \\ h^4\ q_1/EI_1 \\ h^4\ q_2/EI_2 \\ h^4\ q_3/EI_3 \\ h^4\ q_4/EI_4 \\ h^4\ q_5/EI_5 \\ h^4\ q_6/EI_6 \end{bmatrix}$$