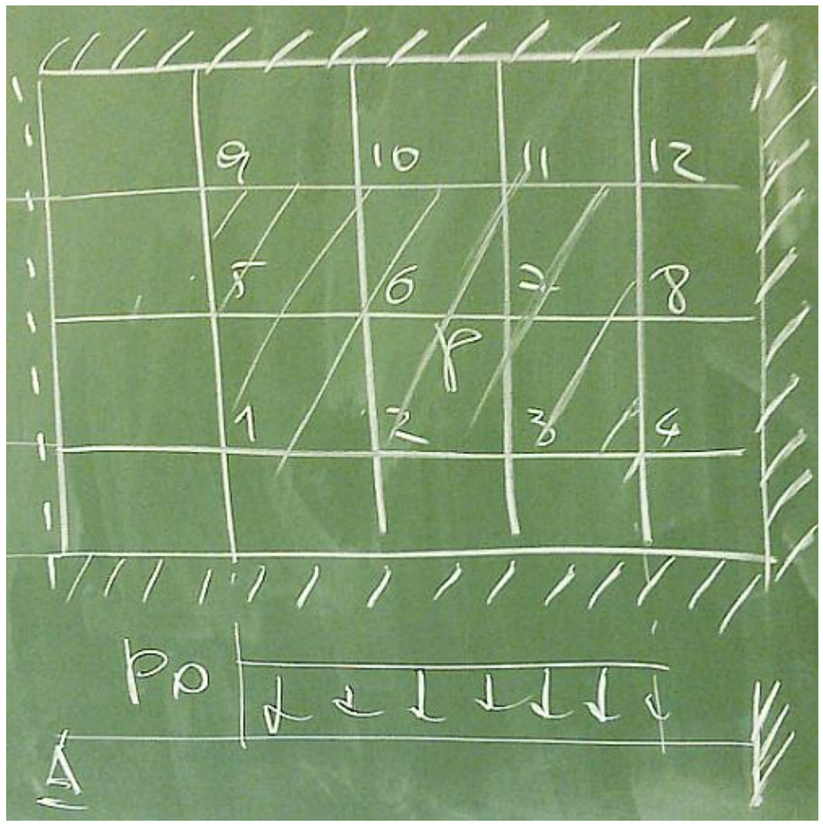
Obliczanie ugięcia płyty za pomocą metody różnic skończonych

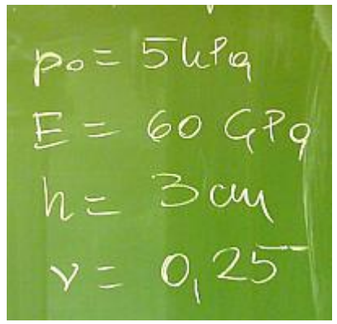
$ORIGIN := 0$

$E := 60GPa$ $\quad \nu := 0.25$ $\quad h := 3cm$ $\quad Lx := 5m$ $\quad Ly := 4m$ $\quad \Delta := 1m$ $\quad Nx := \frac{Lx}{\Delta} = 5$ $\quad Ny := \frac{Ly}{\Delta} = 4$

$p0 := -5kPa$ $\quad$ - *obciązenie użytkowe*

$D := \frac{E \cdot h^3}{12\left(1 - \nu^2\right)} = 144 \cdot kN \cdot m$ $\quad$ - *sztywność płytowa*





$$N := \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 3 & 4 & 0 \\ 0 & 5 & 6 & 7 & 8 & 0 \\ 0 & 9 & 10 & 11 & 12 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Tablica z numerami węzłów

$n := max(N) = 12 \qquad w_n := 0$

Tworzenie układu równań MRS

$A_{n,n} := 0 \qquad b_n := 0$

$i := 1 .. \ 3 \qquad j := 1 .. \ 4$

$$B := \sum_i \left(\sum_j Bilaplasjan(A, N, i, j) \right)$$

$i := 2 .. \ 11 \quad b_i := \frac{1}{2}$

$b_1 := \frac{1}{4} \quad b_4 := \frac{1}{4} \quad b_9 := \frac{1}{4} \quad b_{12} := \frac{1}{4} \quad b_6 := 1 \quad b_7 := 1$

Warunek brzegowy w0=0

$i := 0$

$k := 0 .. \ n \qquad B_{i,k} := 0 \qquad B_{i,i} := 1 \qquad b_i := 0$

Warunki brzegowe φx=0 na brzegu y=0

$j := 1 .. \ 4 \qquad B_{j,j} := B_{j,j} + 1$

Warunki brzegowe φx=0 na brzegu y=Ly

$j := 9 .. \ 12 \qquad B_{j,j} := B_{j,j} + 1$

Warunki brzegowe Mx=0 na brzegu x=0

$j := 1, 5 .. \ 9 \qquad B_{j,j} := B_{j,j} - 1$

Warunki brzegowe φy=0 na brzegu x=Lx

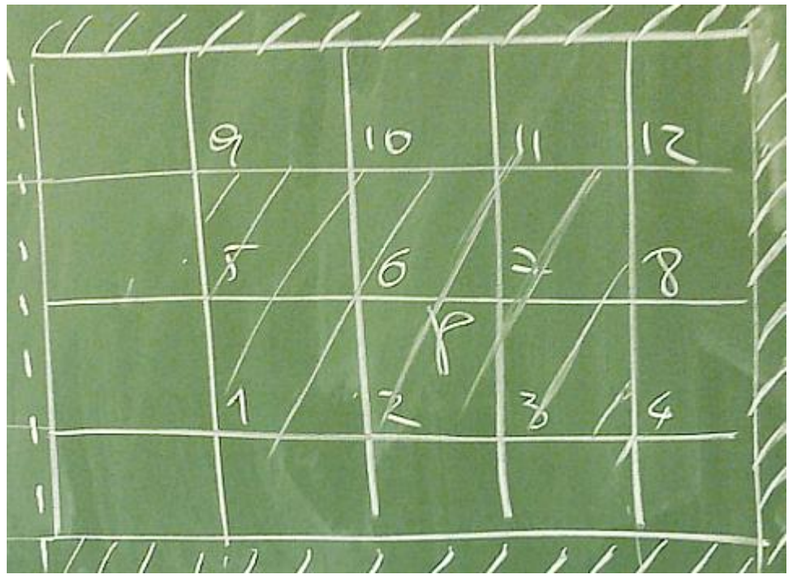
$j := 4, 8 .. \ 12 \qquad B_{j,j} := B_{j,j} + 1$

Wartości węzłowe prawej strony układu równań MRS

$$\alpha 0 := \frac{\Delta^4 \cdot p0}{D} = -34.722222 \cdot mm$$

$N =$

	0	1	2	3	4	5
0	0	0	0	0	0	0
1	0	1	2	3	4	0
2	0	5	6	7	8	0
3	0	9	10	11	12	0
4	0	0	0	0	0	0



Układ równań MRS

$B \cdot w = \alpha\theta \cdot b$

$B =$

	0	1	2	3	4	5	6	7	8	9	10	11	12
0	1	0	0	0	0	0	0	0	0	0	0	0	0
1	-10	20	-8	1	0	-8	2	0	0	1	0	0	0
2	-3	-8	21	-8	1	2	-8	2	0	0	1	0	0
3	-3	1	-8	21	-8	0	2	-8	2	0	0	1	0
4	-10	0	1	-8	22	0	0	2	-8	0	0	0	1
5	-2	-8	2	0	0	19	-8	1	0	-8	2	0	0
6	3	2	-8	2	0	-8	20	-8	1	2	-8	2	0
7	3	0	2	-8	2	1	-8	20	-8	0	2	-8	2
8	-2	0	0	2	-8	0	1	-8	21	0	0	2	-8
9	-10	1	0	0	0	-8	2	0	0	20	-8	1	0
10	-3	0	1	0	0	2	-8	2	0	-8	21	-8	1
11	-3	0	0	1	0	0	2	-8	2	1	-8	21	-8
12	-10	0	0	0	1	0	0	2	-8	0	1	-8	22

$b =$

	0
0	0
1	0.25
2	0.5
3	0.5
4	0.25
5	0.5
6	1
7	1
8	0.5
9	0.25
10	0.5
11	0.5
12	0.25

$\alpha\theta = -34.722 \cdot mm$

$$
\begin{aligned}
&Bilaplasjan(A, N, i, j) := \\
&\quad a \leftarrow N_{i,j} \\
&\quad A_{a,a} \leftarrow A_{a,a} + 20 \\
&\quad A_{a,N_{i,j-1}} \leftarrow A_{a,N_{i,j-1}} - 8 \\
&\quad A_{a,N_{i,j+1}} \leftarrow A_{a,N_{i,j+1}} - 8 \\
&\quad A_{a,N_{i-1,j}} \leftarrow A_{a,N_{i-1,j}} - 8 \\
&\quad A_{a,N_{i+1,j}} \leftarrow A_{a,N_{i+1,j}} - 8 \\
&\quad A_{a,N_{i-1,j-1}} \leftarrow A_{a,N_{i-1,j-1}} + 2 \\
&\quad A_{a,N_{i+1,j-1}} \leftarrow A_{a,N_{i+1,j-1}} + 2 \\
&\quad A_{a,N_{i-1,j+1}} \leftarrow A_{a,N_{i-1,j+1}} + 2 \\
&\quad A_{a,N_{i+1,j+1}} \leftarrow A_{a,N_{i+1,j+1}} + 2 \\
&\quad A_{a,N_{i+2,j}} \leftarrow A_{a,N_{i+2,j}} + 1 \quad \text{if } i < Ny - 1 \\
&\quad A_{a,N_{i-2,j}} \leftarrow A_{a,N_{i-2,j}} + 1 \quad \text{if } i > 1 \\
&\quad A_{a,N_{i,j-2}} \leftarrow A_{a,N_{i,j-2}} + 1 \quad \text{if } j > 1 \\
&\quad A_{a,N_{i,j+2}} \leftarrow A_{a,N_{i,j+2}} + 1 \quad \text{if } j < Nx - 1 \\
&\quad A
\end{aligned}
$$