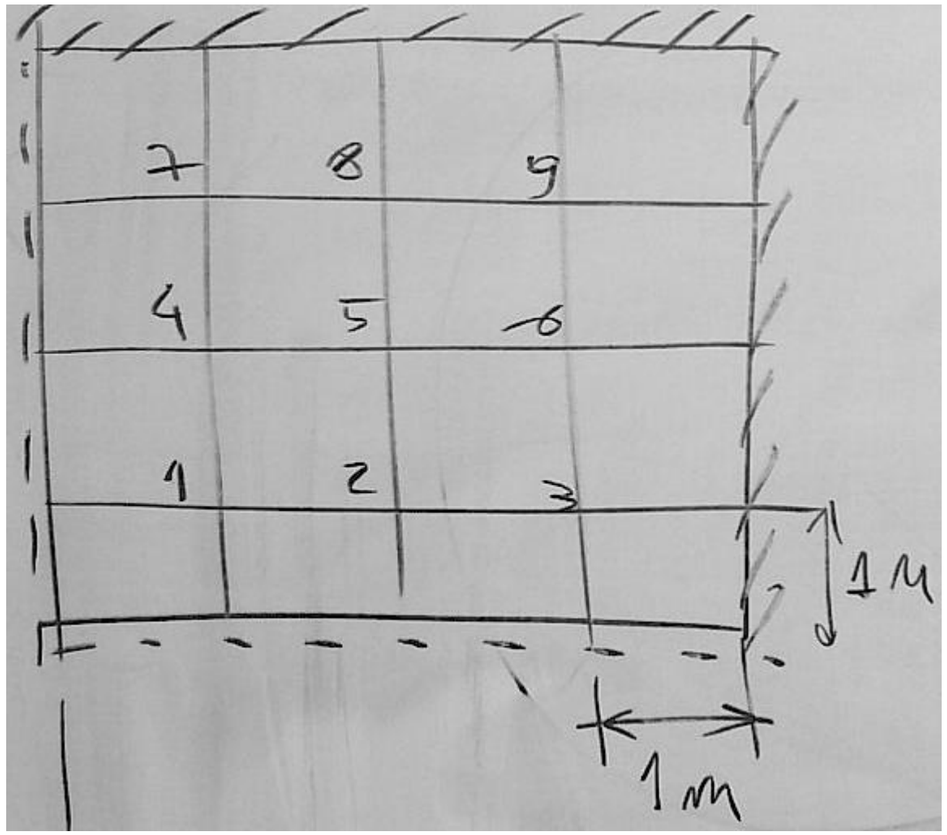
Obliczanie ugięcia płyty za pomocą metody różnic skończonych

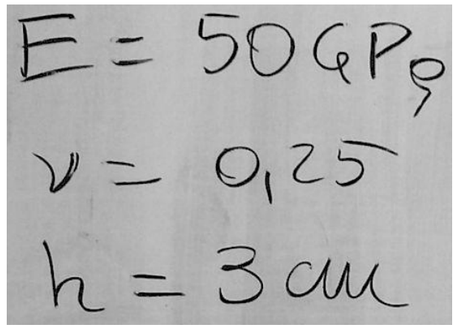
$ORIGIN := 0$

$E := 50GPa$ $\nu := 0.25$ $h := 3cm$ $Lx := 4m$ $Ly := 4m$ $\Delta := 1m$ $Nx := \frac{Lx}{\Delta} = 4$ $Ny := \frac{Ly}{\Delta} = 4$

$p0 := -4kPa$ - *obciążenie użytkowe*

$D := \frac{E \cdot h^3}{12\left(1 - \nu^2\right)} = 120 \cdot kN \cdot m$ - *sztywność płytowa*





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

Tablica z numerami węzłów

$n := max(N) = 9$ $w_n := 0$

Tworzenie układu równań MRS

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

$i := 1 .. 3$ $j := 1 .. 3$

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

$i := 2 .. 8$ $b_i := \frac{1}{2}$

$b_1 := \frac{1}{4}$ $b_3 := \frac{1}{4}$ $b_7 := \frac{1}{4}$ $b_9 := \frac{1}{4}$ $b_5 := 1$

Warunek brzegowy w0=0

$i := 0$

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

Warunki brzegowe My=0 na brzegu y=0

$j := 1 .. 3$ $B_{j,j} := B_{j,j} - 1$

Warunki brzegowe φx=0 na brzegu y=Ly

$j := 7 .. 9$ $B_{j,j} := B_{j,j} + 1$

Warunki brzegowe Mx=0 na brzegu x=0

$j := 1, 4 .. 7$ $B_{j,j} := B_{j,j} - 1$

Warunki brzegowe φy=0 na brzegu x=Lx

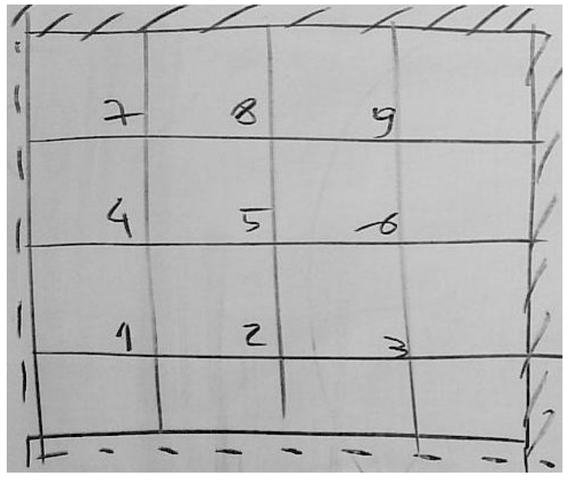
$j := 3, 6 .. 9$ $B_{j,j} := B_{j,j} + 1$

Wartości węzłowe prawej strony układu równań MRS

$$\alpha 0 := \frac{\Delta^4 \cdot p0}{D} = -33.333333 \cdot mm$$

$N =$

	0	1	2	3	4
0	0	0	0	0	0
1	0	1	2	3	0
2	0	4	5	6	0
3	0	7	8	9	0
4	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
0	1	0	0	0	0	0	0	0	0	0
1	-10	18	-8	1	-8	2	0	1	0	0
2	-2	-8	19	-8	2	-8	2	0	1	0
3	-10	1	-8	20	0	2	-8	0	0	1
4	-2	-8	2	0	19	-8	1	-8	2	0
5	4	2	-8	2	-8	20	-8	2	-8	2
6	-2	0	2	-8	1	-8	21	0	2	-8
7	-10	1	0	0	-8	2	0	20	-8	1
8	-2	0	1	0	2	-8	2	-8	21	-8
9	-10	0	0	1	0	2	-8	1	-8	22

$b =$

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

$\alpha\theta = -33.333 \cdot mm$

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