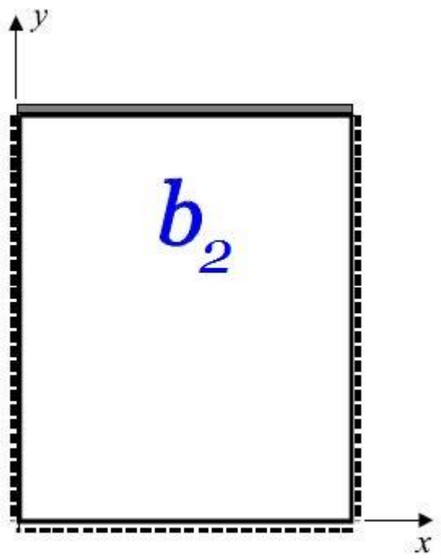
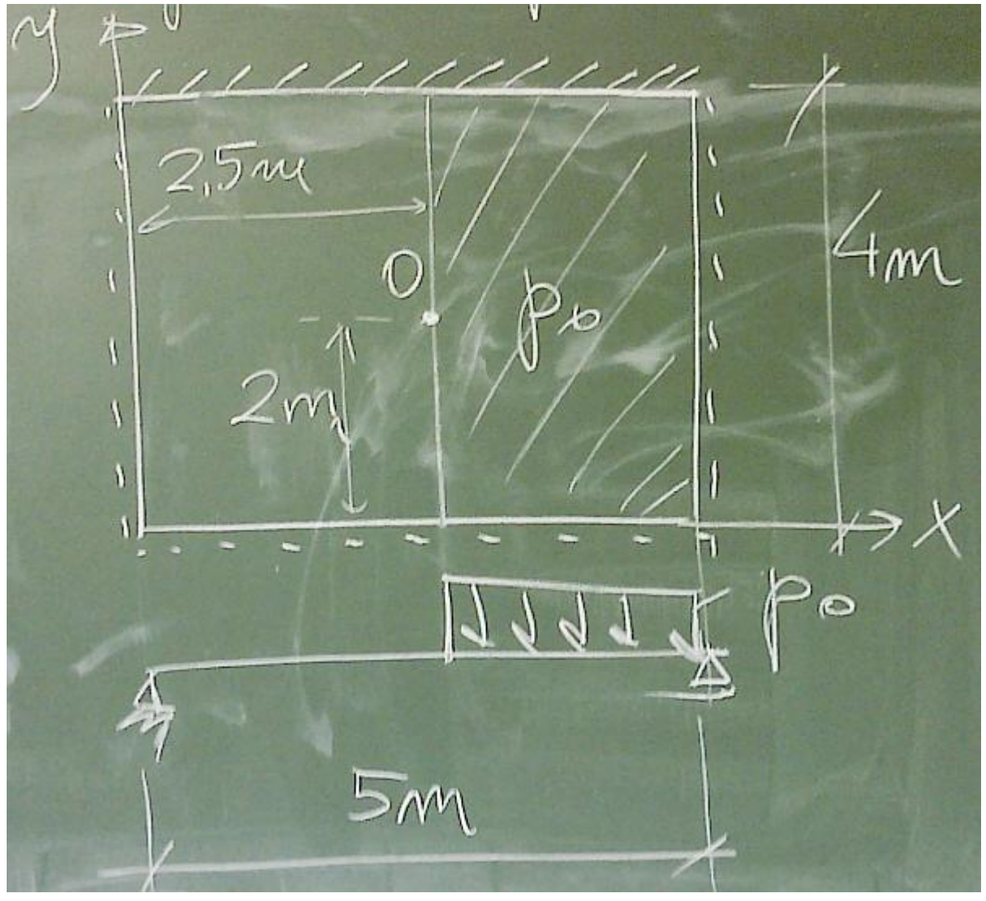
Obliczanie ugięcia płyty podpartej przegubowo na 3 krawędziach a na 1 sztywno zamocowanej - schemat b2

$ORIGIN := 1$

$E := 60GPa$ $\nu := 0.25$ $h := 3cm$

$p0 := -5kPa$ $Lx := 5m$ $Ly := 4m$





- *sztywność płytowa*

$$D0 := \frac{E \cdot h^3}{12\left(1 - \nu^2\right)} = 144 \cdot kN \cdot m$$

Funkcja obciążenia płyty: $q(x) := 1$

Obciążenie ciągłe p0, równomiernie rozłożone na obszarze płyty:
Lx1 < x < Lx2 , 0 < y < Ly i ciężar własny p1

$Lx1 := 2.5m$ $Lx2 := 5m$

Q - wypadkowa obciążenia ciągłego

$$Q0 := p0 \cdot Ly \cdot \left(\int_{Lx1}^{Lx2} q(x)\ dx \right) \qquad Q0 = -50 \cdot kN$$

Metoda Levy'ego

Rozwinięcie obciążenia w pojedynczy szereg Fouriera

$N := 11$ $N0 := 1$

$i := 1 .. N$

$\alpha_i := \frac{i \cdot \pi}{Lx}$ $p_i := \frac{2}{Lx} \cdot \left(\int_{Lx1}^{Lx2} p0 \cdot \sin(\alpha_i \cdot x)\ dx \right)$

$E_i := \frac{p_i}{D0 \cdot (\alpha_i)^4}$ $\lambda_i := \alpha_i \cdot Ly$ $th_i := \tanh(\lambda_i)$ $sh_i := \sinh(\lambda_i)$ $ch_i := \cosh(\lambda_i)$

$p_i =$

	1
1	-3.183
2	3.183
3	-1.061
4	0.000
5	-0.637
6	1.061
7	-0.455
8	0.000
9	-0.354
10	0.637
11	-0.289

$\cdot kPa$

$E_i =$

	1
1	-141.830019
2	8.864376
3	-0.583663
4	0.000000
5	-0.045386
6	0.036479
7	-0.008439
8	0.000000
9	-0.002402
10	0.002837
11	-0.000881

$\cdot mm$

$\lambda_i =$

	1
1	2.513
2	5.027
3	7.540
4	10.053
5	12.566
6	15.080
7	17.593
8	20.106
9	22.619
10	25.133
11	27.646

$th_i =$

0.986963
0.999914
0.999999
1.000000
1.000000
1.000000
1.000000
1.000000
1.000000
1.000000
1.000000

$sh_i =$

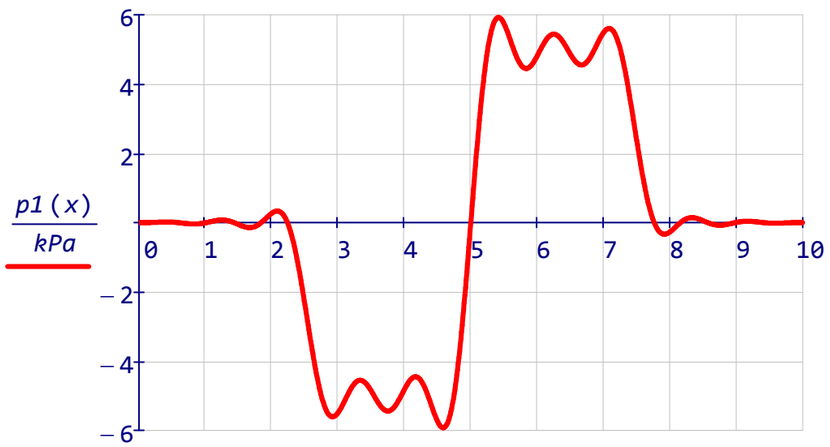
$6.132141 \cdot 10^{0}$
$7.619974 \cdot 10^{1}$
$9.407476 \cdot 10^{2}$
$1.161380 \cdot 10^{4}$
$1.433757 \cdot 10^{5}$
$1.770013 \cdot 10^{6}$
$2.185132 \cdot 10^{7}$
$2.697607 \cdot 10^{8}$
$3.330272 \cdot 10^{9}$
$4.111316 \cdot 10^{10}$
$5.075536 \cdot 10^{11}$

$ch_i =$

$6.213143 \cdot 10^{0}$
$7.620630 \cdot 10^{1}$
$9.407482 \cdot 10^{2}$
$1.161380 \cdot 10^{4}$
$1.433757 \cdot 10^{5}$
$1.770013 \cdot 10^{6}$
$2.185132 \cdot 10^{7}$
$2.697607 \cdot 10^{8}$
$3.330272 \cdot 10^{9}$
$4.111316 \cdot 10^{10}$
$5.075536 \cdot 10^{11}$

Obciążenie przybliżone szeregiem Fouriera

$$p1(x) := \sum_i \left(p_i \cdot \sin\left(\alpha_i \cdot x\right)\right)$$



Funkcja ugięcia płyty przybliżona szeregiem Fouriera

$$B_i := -E_i \qquad C_i := \frac{E_i}{2} \qquad D_i := E_i \cdot \frac{\frac{th_i}{2} + \frac{1}{sh_i} - \frac{1}{th_i}}{1 + \lambda_i \cdot th_i - \frac{\lambda_i}{th_i}}$$

$$A_i := E_i \cdot \left(\frac{-1}{sh_i} - \frac{\lambda_i}{2} + \frac{1}{th_i}\right) - D_i \cdot \frac{\lambda_i}{th_i}$$

$A_i =$		$B_i =$		$C_i =$		$D_i =$	
-80.253936	$\cdot mm$	141.830019	$\cdot mm$	-70.91501	$\cdot mm$	54.156558	$\cdot mm$
8.190491		-8.864376		4.432188		-4.320742	
-0.578388		0.583663		-0.291831		0.291214	
0		0		0		0	
-0.045381		0.045386		-0.022693		0.022692	
0.036479		-0.036479		0.018239		-0.018239	
-0.008439		0.008439		-0.004219		0.004219	
0		0		0		0	
-0.002402		0.002402		-0.001201		0.001201	
0.002837		-0.002837		0.001418		-0.001418	
-0.000881		0.000881		-0.00044		0.00044	

$$f(i,y) := A_i \cdot \sinh(\alpha_i \cdot y) + B_i \cdot \cosh(\alpha_i \cdot y) + C_i \cdot \alpha_i \cdot y \cdot \sinh(\alpha_i \cdot y) + D_i \cdot \alpha_i \cdot y \cdot \cosh(\alpha_i \cdot y)$$

$$f0(i,y) := f(i,y) + E_i$$

$$D0 = 144 \cdot kN \cdot m$$

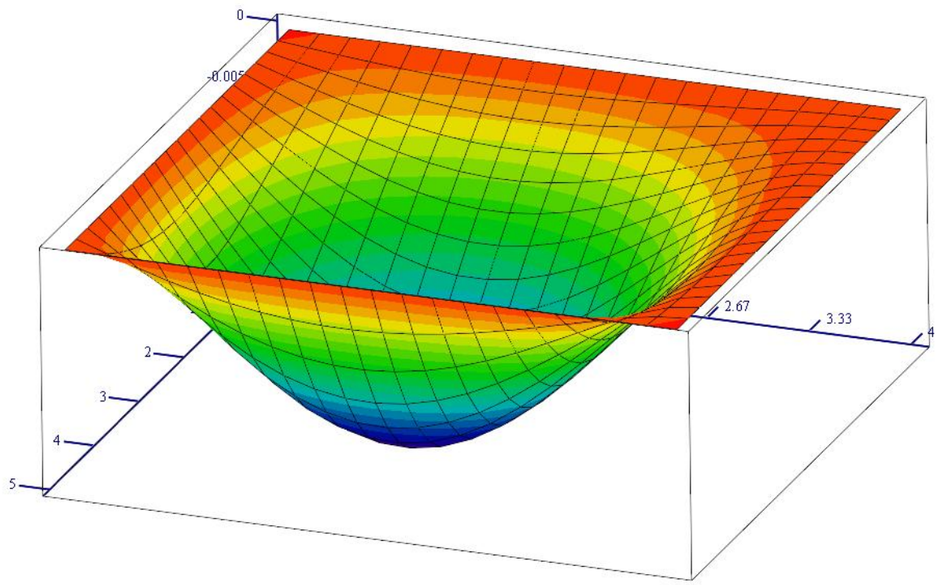
Dwa sposoby definicji funkcji ugięcia:

$$w0(x,y) := \sum_{i=1}^{N0} \left(f0(i,y) \cdot \sin(\alpha_i \cdot x) \right)$$

$$w0\left(\frac{Lx}{2}, \frac{Ly}{2}\right) = -16.681 \cdot mm$$

$$w(x,y) := \sum_{i=1}^{N} \left(f0(i,y) \cdot \sin(\alpha_i \cdot x) \right)$$

$$w\left(\frac{Lx}{2}, \frac{Ly}{2}\right) = -16.237 \cdot mm$$



w

$p_i =$

-3.183	$\cdot kPa$
3.183	
-1.061	
0.000	
-0.637	
1.061	
...	

$E_i =$

-141.830019	$\cdot mm$
8.864376	
-0.583663	
0.000000	
-0.045386	
0.036479	
...	

$A_i =$

-80.253936	$\cdot mm$
8.190491	
-0.578388	
0	
-0.045381	
0.036479	
...	

$B_i =$

141.830019	$\cdot mm$
-8.864376	
0.583663	
0	
0.045386	
-0.036479	
...	

$C_i =$

-70.91501	$\cdot mm$
4.432188	
-0.291831	
0	
-0.022693	
0.018239	
...	

$D_i =$

54.156558	$\cdot mm$
-4.320742	
0.291214	
0	
0.022692	
-0.018239	
...	