REPORT							
ing. Andrea Starnini	Subject	Report N°	Rev.	Date	Sheet		
	Force distribution over nodes on Mecway - Elements with mid side nodes	/	0	17/01/2017	1	of	8
		Job	Compiled by				
		/	Andrea Starnini				

1. Problem

One shell element with mid side nodes (S8 for Calclulix).
Element dimension: 1000 x 1000 mm, thickness 10 mm; E = 210 GPa; v = 0,3

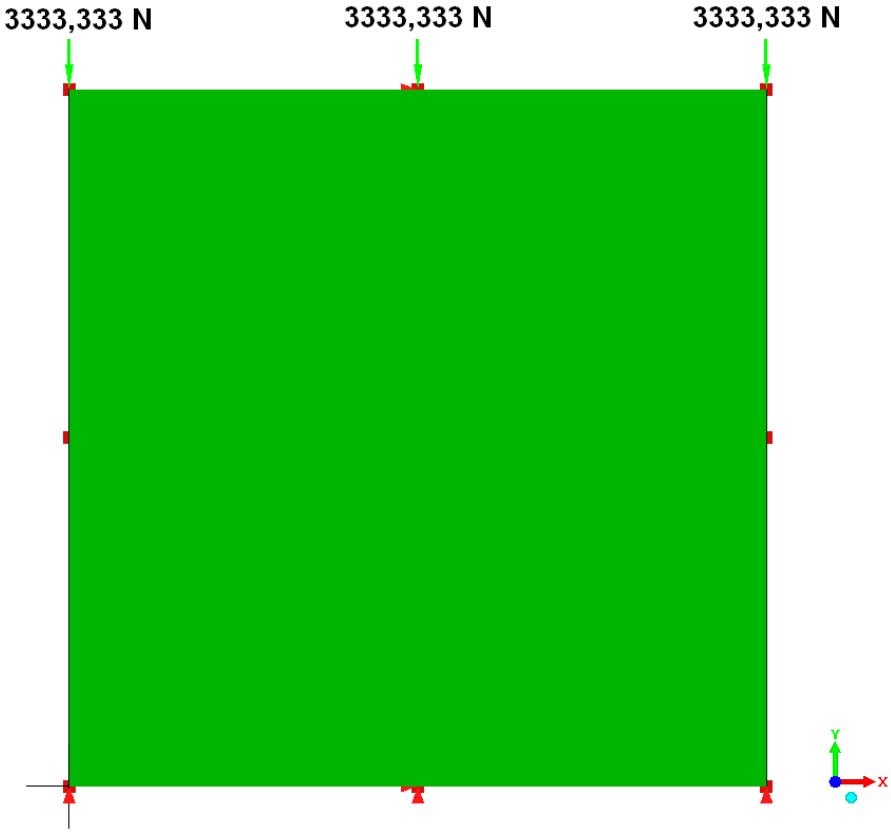
Element subjected to pure compression of 1 MPa:

Total force: $F = 1000 \times 10 \times 1 = 10000$ N

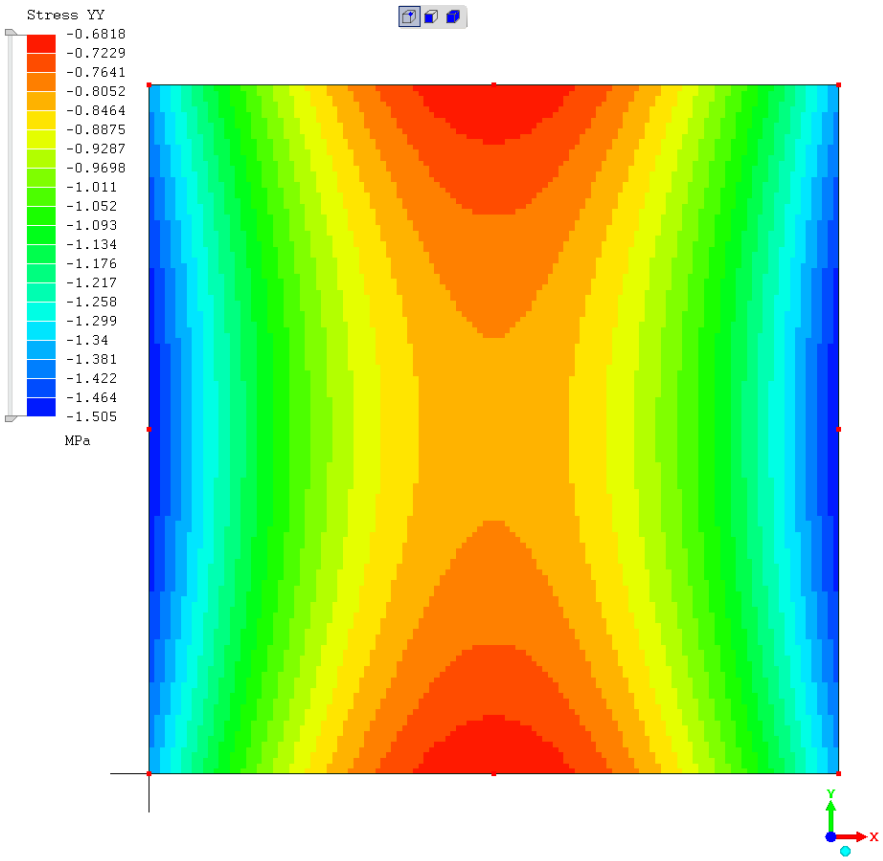
2. Wrong nodal force distribution on one element

Dividing the total force:

Nodal force: $F_n = \frac{1}{3} 10000 = 3333{,}333$ N



the solution is incorrect.


Stress YY
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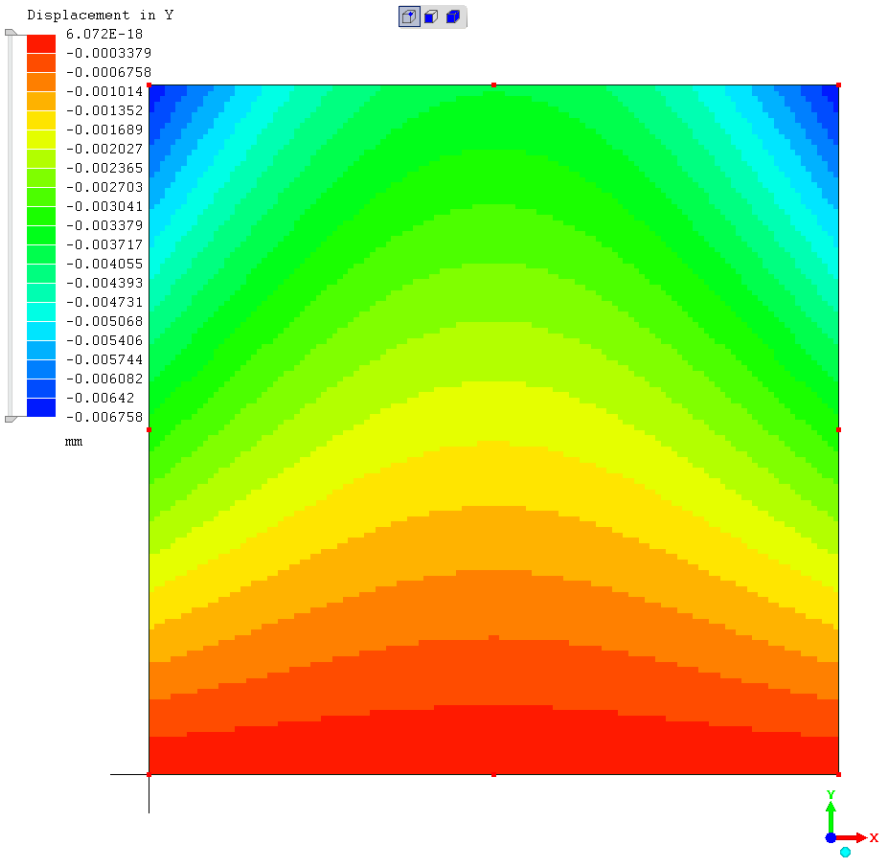
-0.7641
-0.8052
-0.8464
-0.8875
-0.9287
-0.9698
-1.011
-1.052
-1.093
-1.134
-1.176
-1.217
-1.258
-1.299
-1.34
-1.381
-1.422
-1.464
-1.505
MPa
Y
X


Displacement in Y
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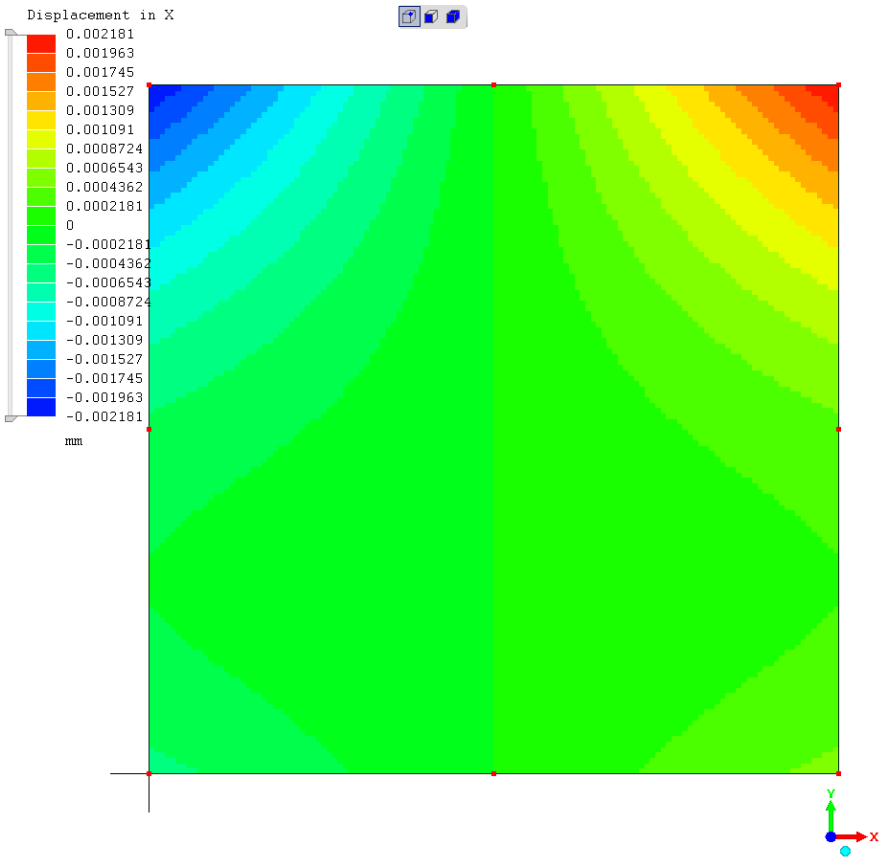
-0.0006758
-0.001014
-0.001352
-0.001689
-0.002027
-0.002365
-0.002703
-0.003041
-0.003379
-0.003717
-0.004055
-0.004393
-0.004731
-0.005068
-0.005406
-0.005744
-0.006082
-0.00642
-0.006758
mm
Y
X



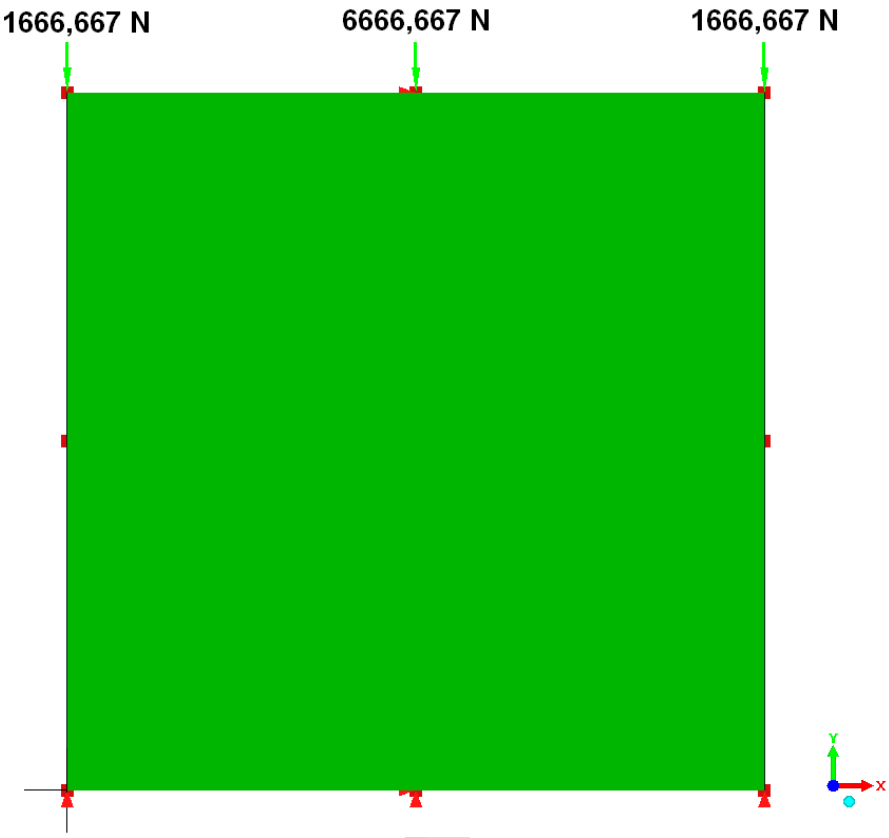
3. Right nodal force distribution on one element

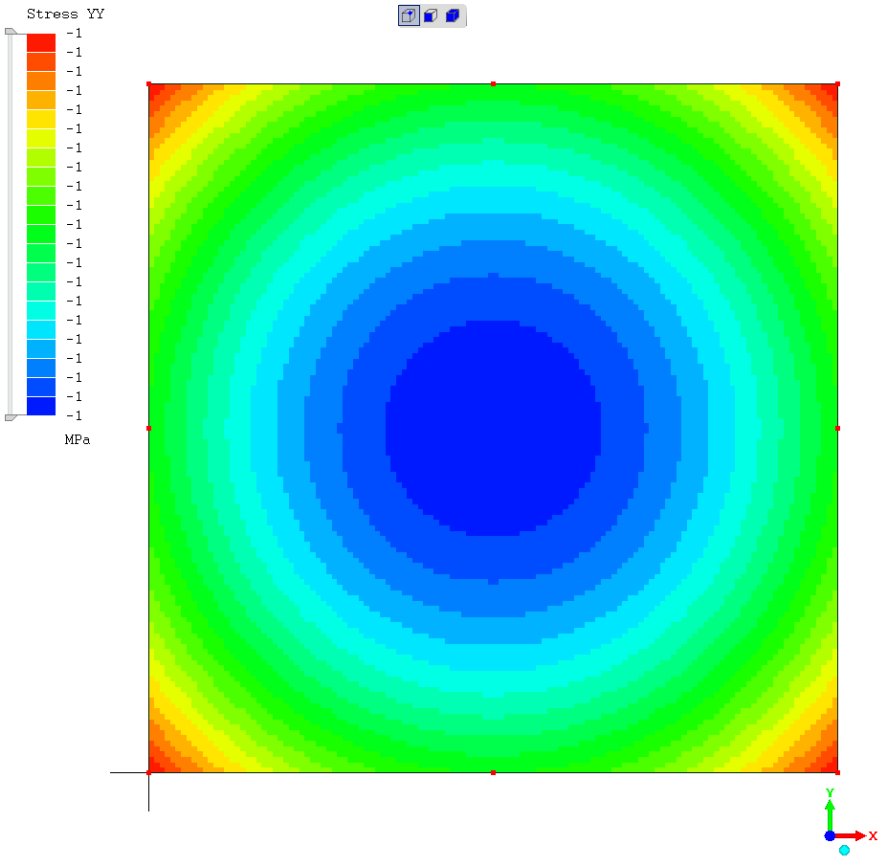
The right force distribution is the following:

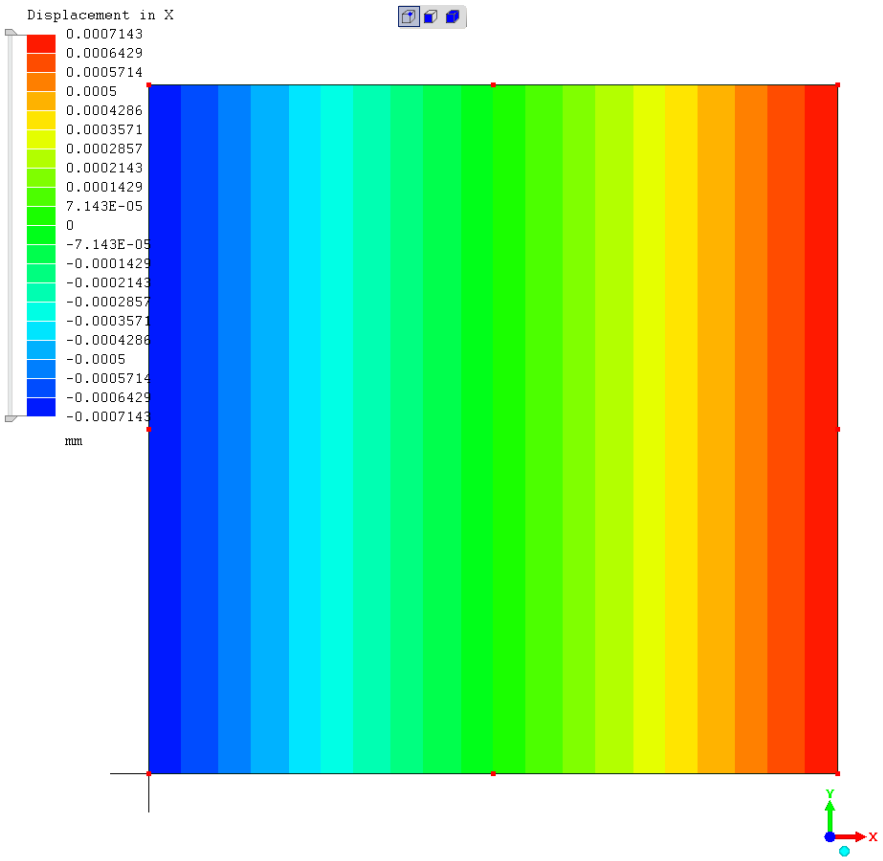
Mid side node: $F_{mn} = \frac{2}{3}10000 = 6666,667\ N$

Corner nodes: $F_{cn} = \frac{1}{6}10000 = 1666,667\ N$

Stress in yy direction equal 1 MPa and x displacements are symmetrical.


1666,667 N
6666,667 N
1666,667 N
Y
X


Stress YY
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
-1
MPa
Y
X


Displacement in X
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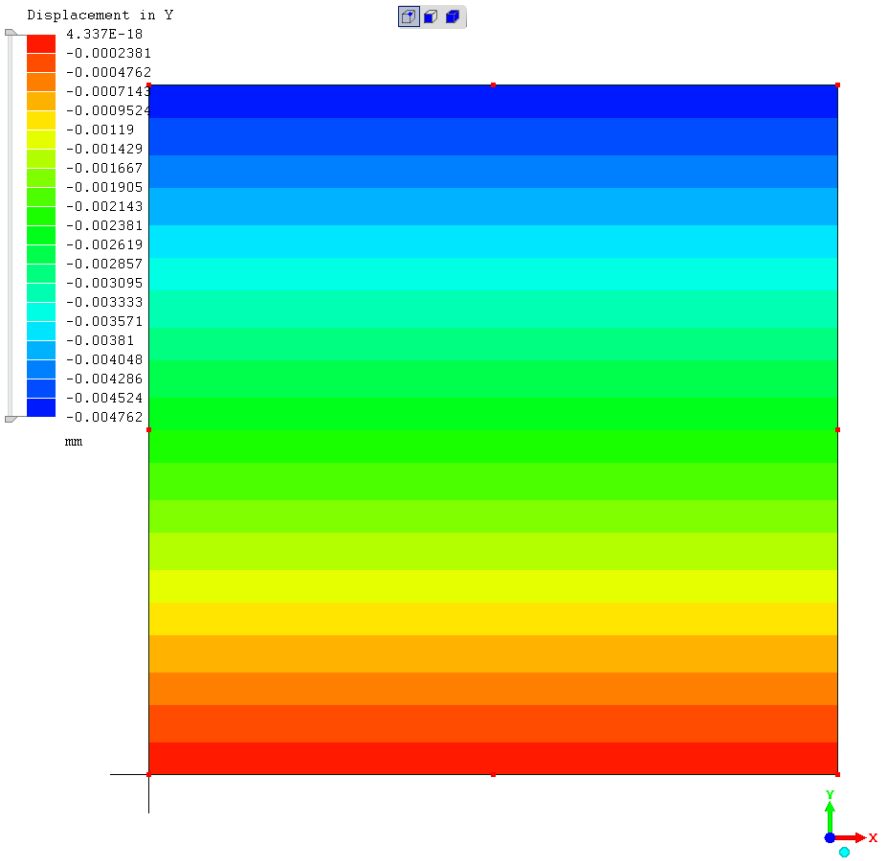
0.0006429
0.0005714
0.0005
0.0004286
0.0003571
0.0002857
0.0002143
0.0001429
7.143E-05
0
-7.143E-05
-0.0001429
-0.0002143
-0.0002857
-0.0003571
-0.0004286
-0.0005
-0.0005714
-0.0006429
-0.0007143
mm
Y
X


Displacement in Y
4.337E-18
-0.0002381
-0.0004762
-0.0007143
-0.0009524
-0.00119
-0.001429
-0.001667
-0.001905
-0.002143
-0.002381
-0.002619
-0.002857
-0.003095
-0.003333
-0.003571
-0.00381
-0.004048
-0.004286
-0.004524
-0.004762
mm
Y
X

4. General case of more elements

Elements on edge: N_e

Nodes on edge: $N_n = 2N_e + 1$

Mis side nodes: $N_{mn} = N_e$

Inside corner nodes: $N_{icn} = N_e - 1$

Corner nodes: $N_{cn} = 2$

Force acting on every mid side node: $f_{mn} \frac{2}{3} \frac{F}{N_{mn}}$

Total force acting on mid side nodes: $\sum f_{mn} = F_{mn} = \frac{2}{3} F$

Force acting on inside corner node: $f_{icn} = \frac{1}{3} \frac{F}{N_{icn} + 1}$

Total force acting on inside corner nodes: $\sum f_{icn} = F_{icn} = \frac{1}{3} \frac{F}{N_{icn} + 1} N_{icn}$

Force acting on corner node: $f_{cn} = \frac{f_{icn}}{2} = \frac{1}{6} \frac{F}{N_{icn} + 1}$

Rapid calculus:

$f_{mn} \frac{2}{3} \frac{F}{N_{mn}}$ $\quad$ $f_{icn} = \frac{1}{2} f_{mn}$ $\quad$ $f_{cn} = \frac{1}{2} f_{icn}$

5. Example

Elements on edge: $N_e = 10$

Nodes on edge: $N_n = 2N_e + 1 = 21$

Mis side nodes: $N_{mn} = N_e = 10$

Inside corner nodes: $N_{icn} = N_e - 1 = 9$

Corner nodes: $N_{cn} = 2$

Same plate 1000 x 1000 x 10, total force 10000 N:

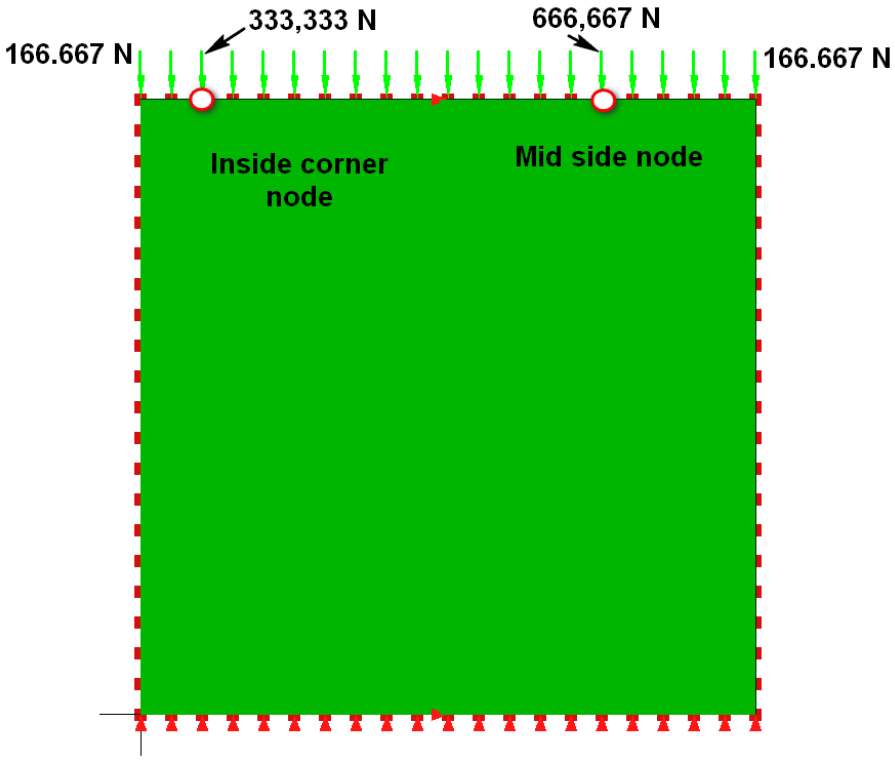
Force acting on every mid side node: $f_{mn} \frac{2}{3} \frac{F}{N_{mn}} = 666,667 \text{ N}$

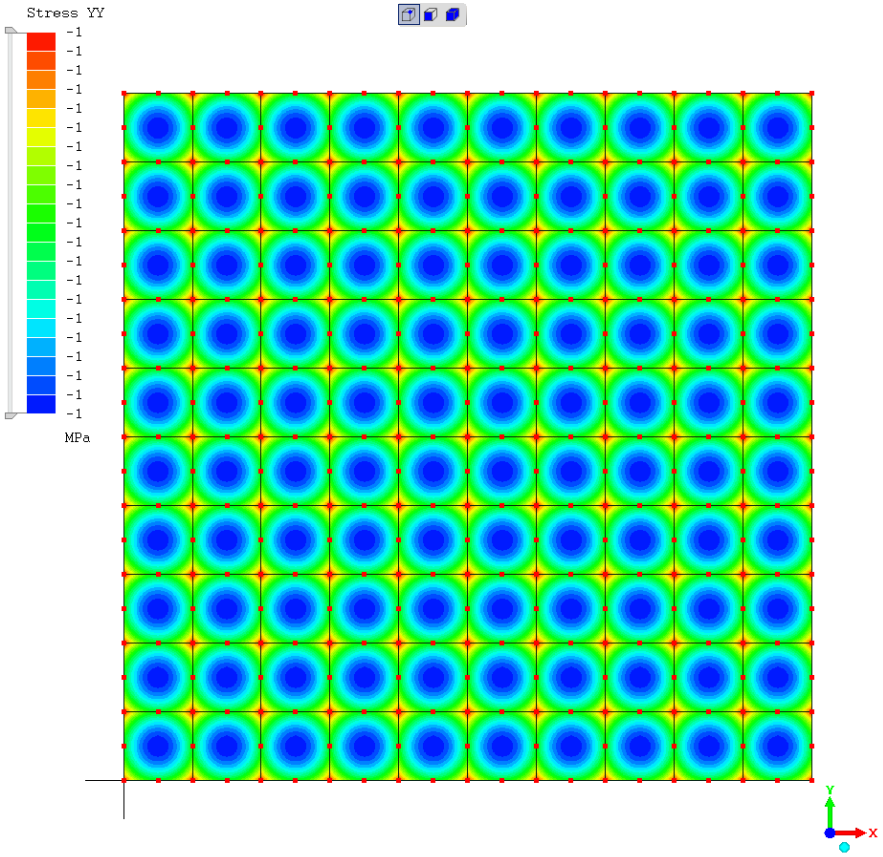
Total force acting on mid side nodes: $\sum f_{mn} = F_{mn} = \frac{2}{3} F = 6666,667 \text{ N}$

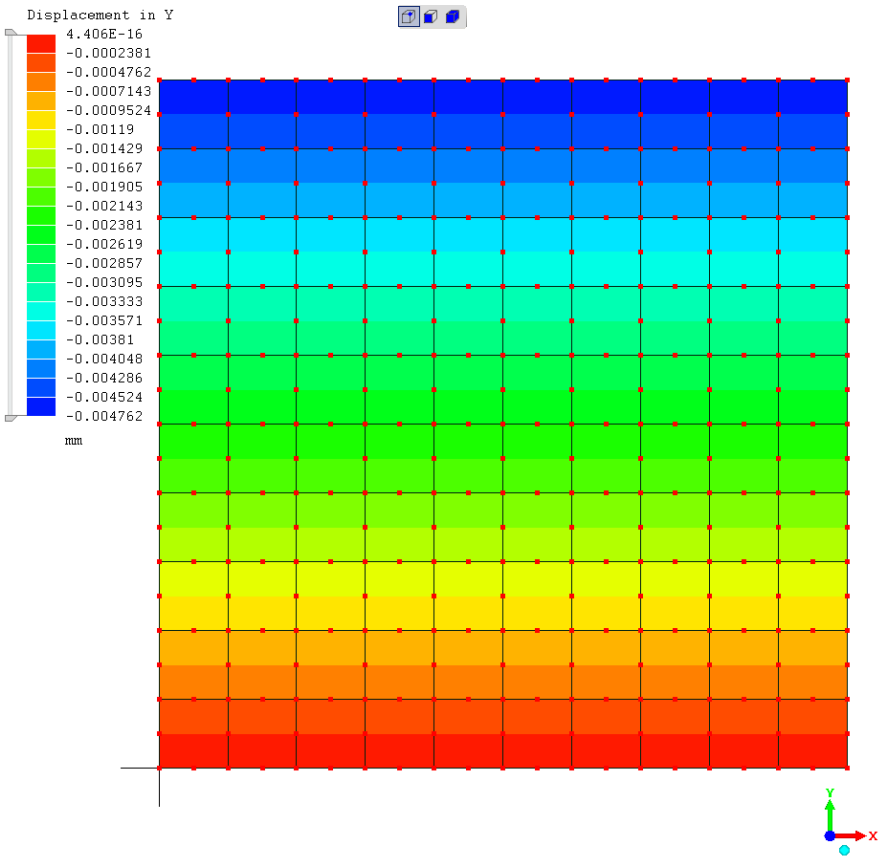
Force acting on inside corner node: $f_{icn} = \frac{1}{3} \frac{F}{N_{icn} + 1} = 333,333 \text{ N}$

Total force acting on inside corner nodes: $\sum f_{icn} = F_{icn} = \frac{1}{3} \frac{F}{N_{icn} + 1} N_{icn} = 3000 \text{ N}$

Force acting on corner node: $$f_{cn} = \frac{f_{icn}}{2} = \frac{1}{6}\frac{F}{N_{icn}+1} = 166,667\ N$$






Displacement in Y
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-0.0002381
-0.0004762
-0.0007143
-0.0009524
-0.00119
-0.001429
-0.001667
-0.001905
-0.002143
-0.002381
-0.002619
-0.002857
-0.003095
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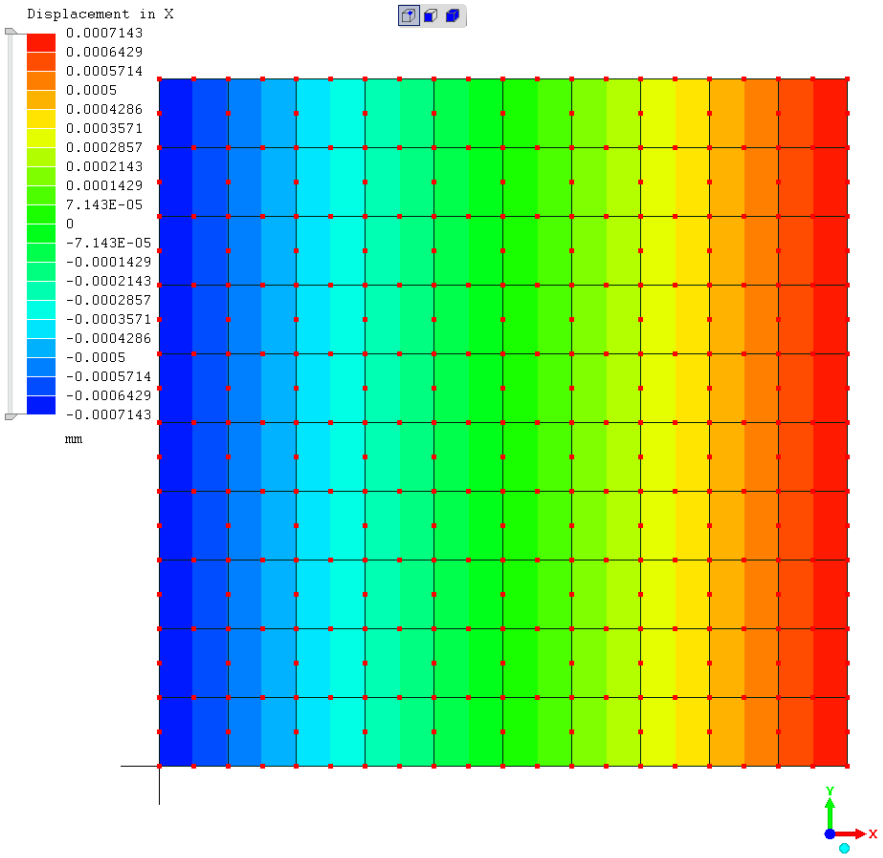
-0.004048
-0.004286
-0.004524
-0.004762
mm
Y
X


Displacement in X
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0.0006429
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7.143E-05
0
-7.143E-05
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-0.0005
-0.0005714
-0.0006429
-0.0007143
mm
Y
X