



Wydział Mechaniczny Energetyki i Lotnictwa
Zakład Wytrzymałości Materiałów i Konstrukcji

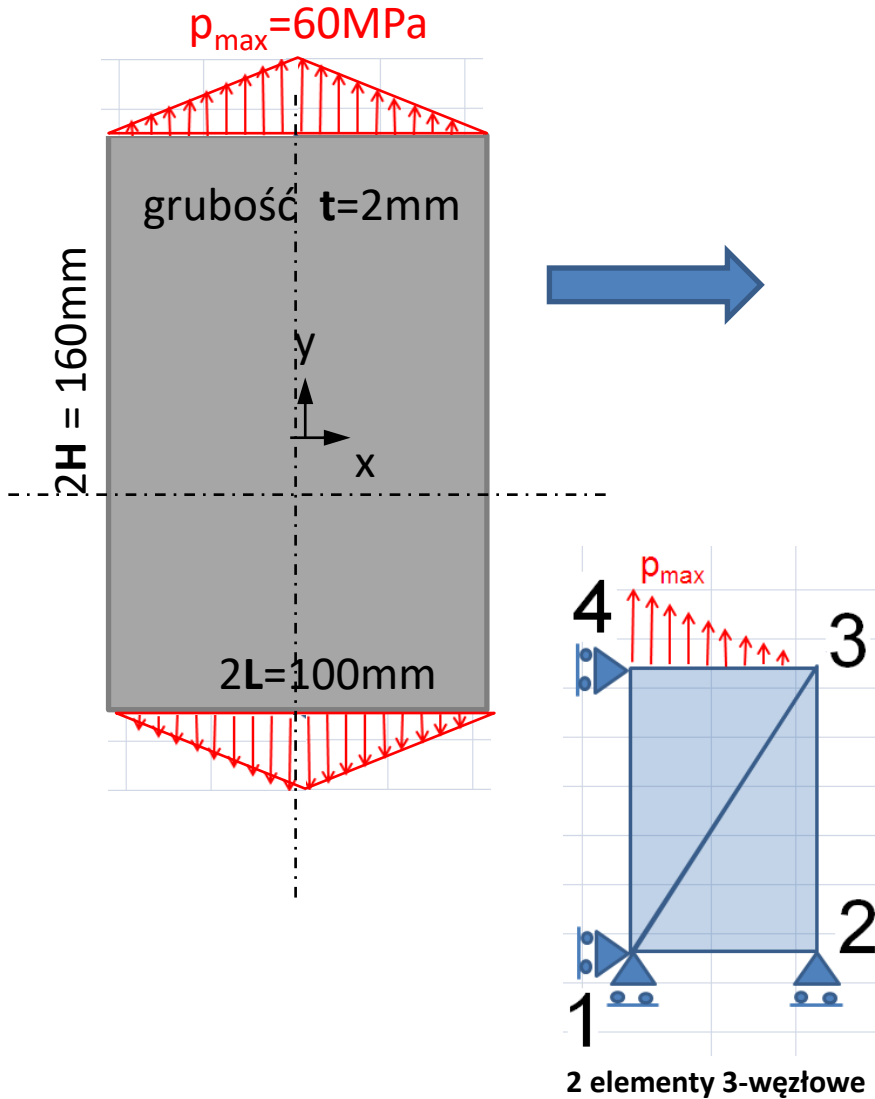


Metoda elementów skończonych (MES2)

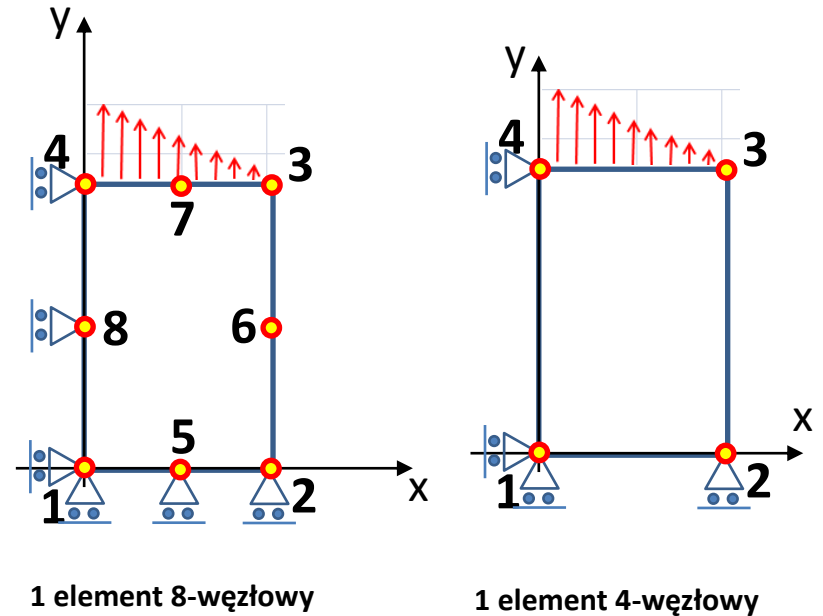
Wykład 2A. Tarcza 2D modelowana różnymi elementami

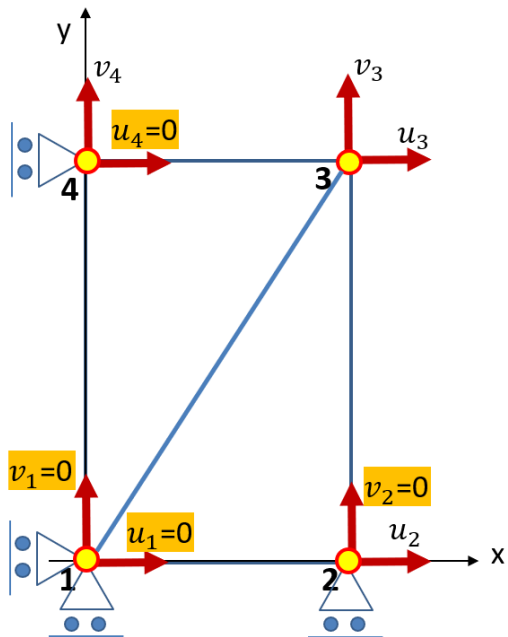
03.2026L

Przykład. 2D tarcza model MES

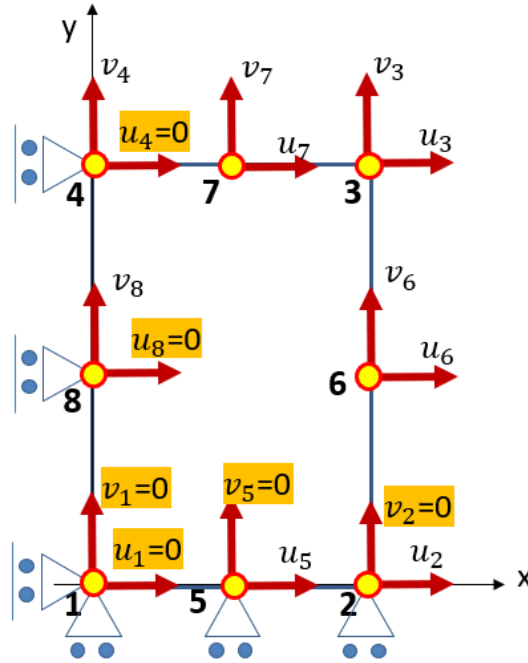


Model ćwiartki tarczy
użyjemy trzech modeli:

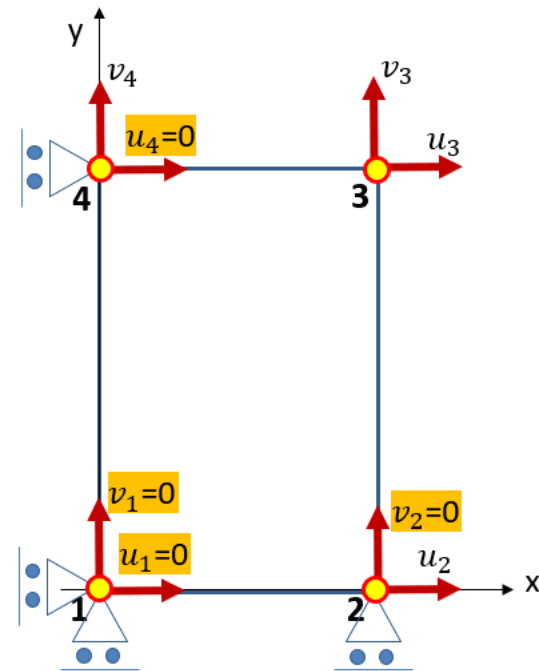




2 elementy 3-węzłowe



1 element 8-węzłowy



1 element 4-węzłowy

funkcje kształtu = znormalizowane pola:

$$N_1(x, y) = \frac{A_1(x, y)}{A_e} = \frac{1}{2A_e} (a_1 + b_1x + c_1y)$$

$$N_2(x, y) = \frac{A_2(x, y)}{A_e} = \frac{1}{2A_e} (a_2 + b_2x + c_2y)$$

$$N_3(x, y) = \frac{A_3(x, y)}{A_e} = \frac{1}{2A_e} (a_3 + b_3x + c_3y)$$

$$N_1(\xi, \eta) = -\frac{1}{4}(1-\xi)(1-\eta)(1+\xi+\eta)$$

$$N_2(\xi, \eta) = -\frac{1}{4}(1+\xi)(1-\eta)(1-\xi+\eta)$$

$$N_3(\xi, \eta) = -\frac{1}{4}(1+\xi)(1+\eta)(1-\xi-\eta)$$

$$N_4(\xi, \eta) = -\frac{1}{4}(1-\xi)(1+\eta)(1+\xi-\eta)$$

$$N_5(\xi, \eta) = \frac{1}{2}(1-\xi^2)(1-\eta)$$

$$N_6(\xi, \eta) = \frac{1}{2}(1+\xi)(1-\eta^2)$$

$$N_7(\xi, \eta) = \frac{1}{2}(1-\xi^2)(1+\eta)$$

$$N_8(\xi, \eta) = \frac{1}{2}(1-\xi)(1-\eta^2)$$

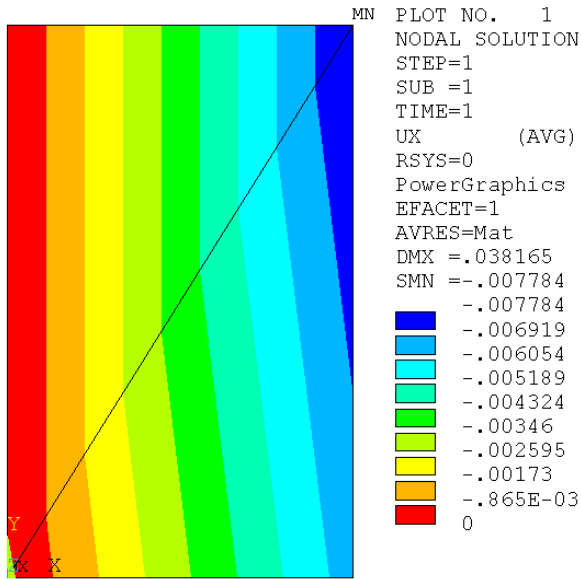
$$N_1(\xi, \eta) = \frac{1}{4}(1-\xi)(1-\eta)$$

$$N_2(\xi, \eta) = \frac{1}{4}(1+\xi)(1-\eta)$$

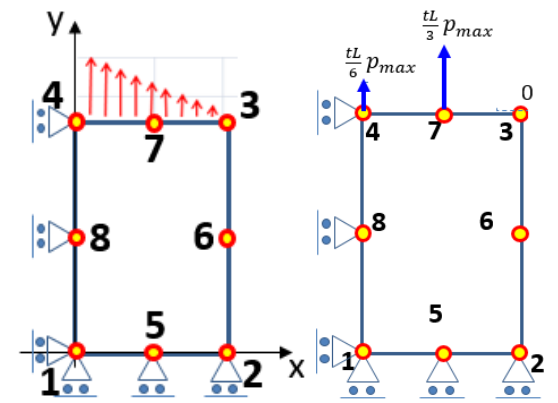
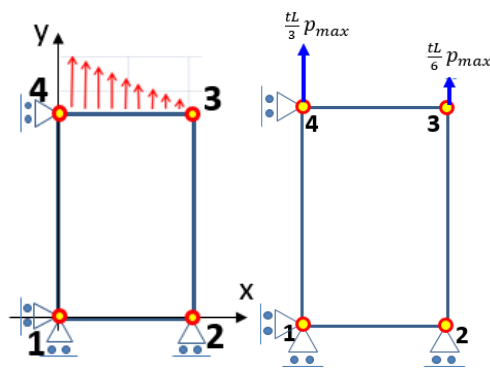
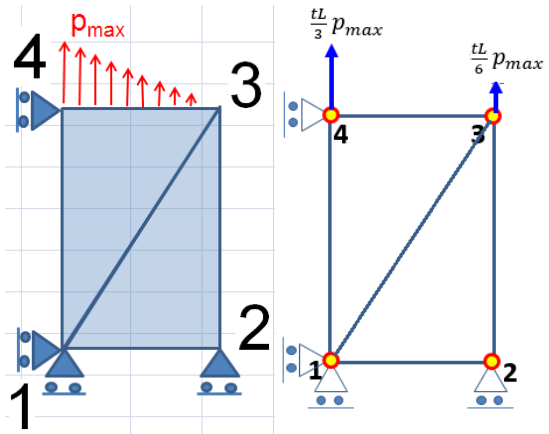
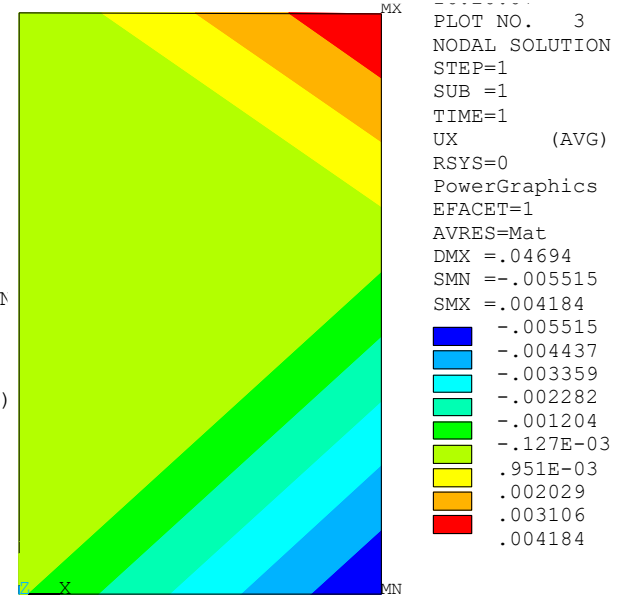
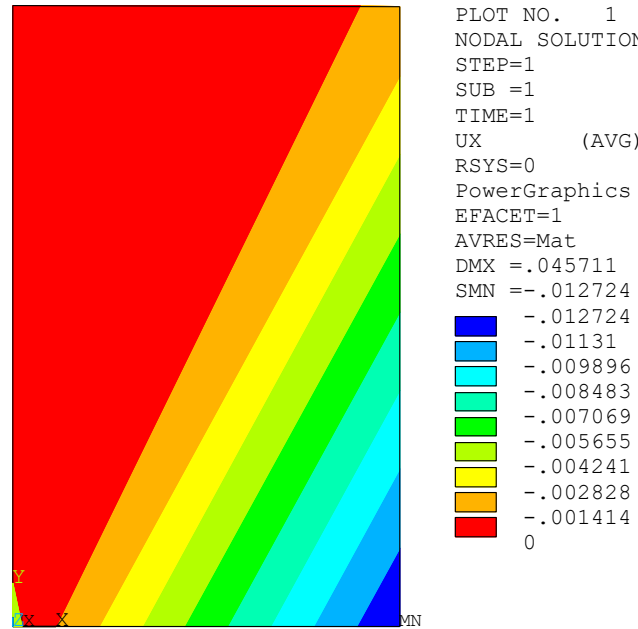
$$N_3(\xi, \eta) = \frac{1}{4}(1+\xi)(1+\eta)$$

$$N_4(\xi, \eta) = \frac{1}{4}(1-\xi)(1+\eta)$$

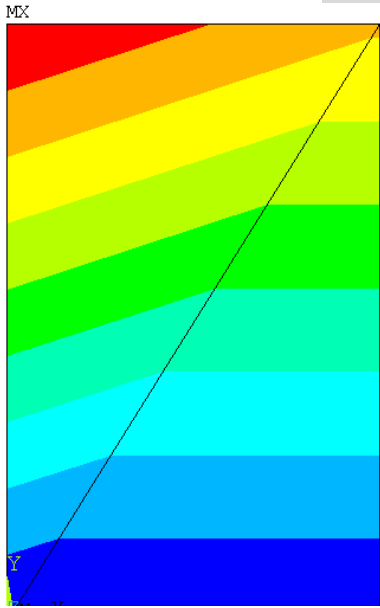
Przemieszczenia na kierunek X



UX displacement



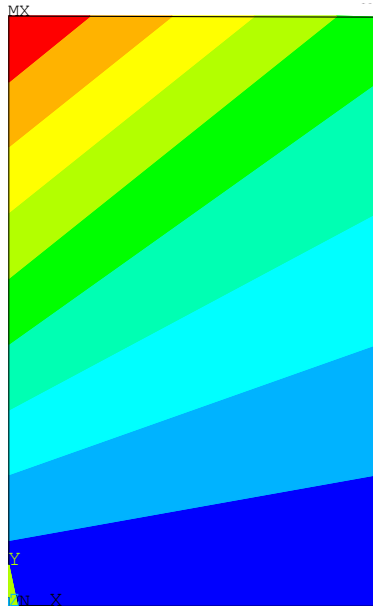
Przemieszczenia na kierunku Y



PLOT NO. 2
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.038165
 SMX =.038165

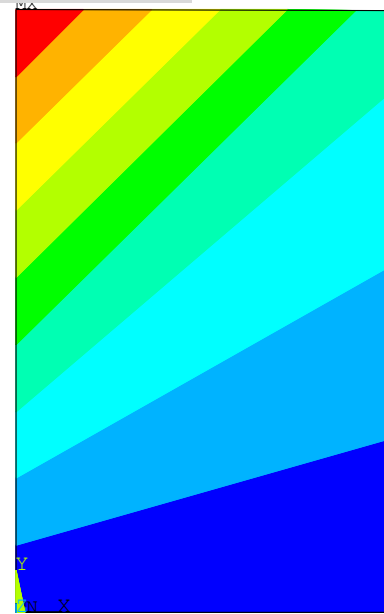
0	.004241
	.008481
	.012722
	.016962
	.021203
	.025444
	.029684
	.033925
	.038165

UY displacement



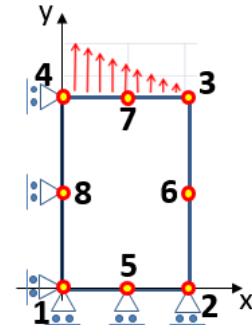
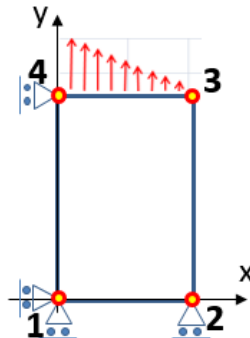
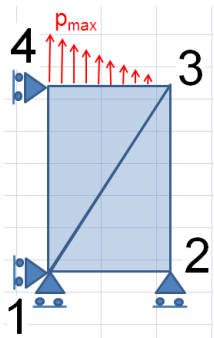
PLOT NO. 2
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.045711
 SMX =.045711

0	.005079
	.010158
	.015237
	.020316
	.025395
	.030474
	.035553
	.040632
	.045711

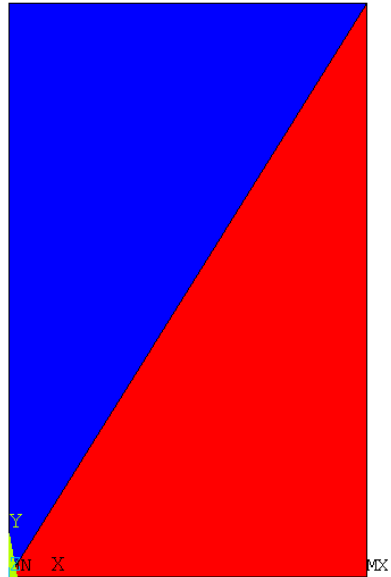


PLOT NO. 4
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.04694
 SMX =.04694

0	.005216
	.010431
	.015647
	.020862
	.026078
	.031293
	.036509
	.041724
	.04694



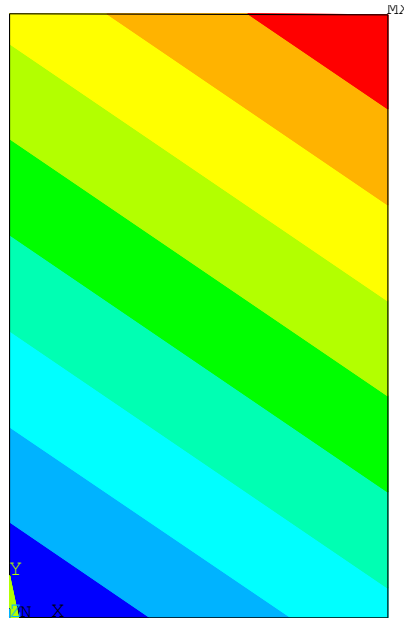
Odształcenia na kierunku X



PLOT NO. 7
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.038165
 SMN =-.156E-03
 SMX =-.130E-03

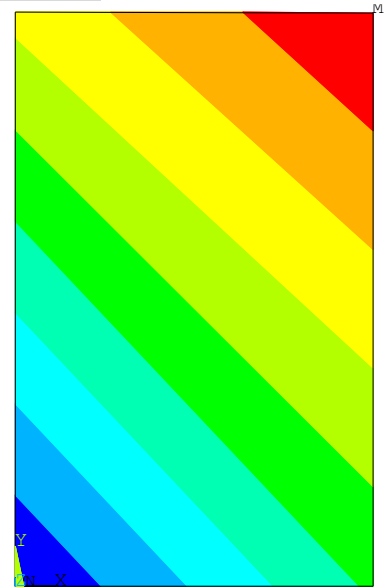
Blue	-.156E-03
Light Blue	-.153E-03
Cyan	-.150E-03
Green	-.147E-03
Light Green	-.144E-03
Yellow-Green	-.141E-03
Yellow	-.139E-03
Orange	-.136E-03
Red-Orange	-.133E-03
Red	-.130E-03

ϵ_x strain



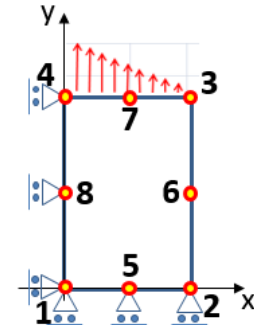
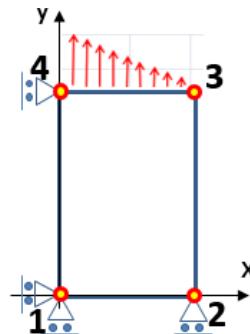
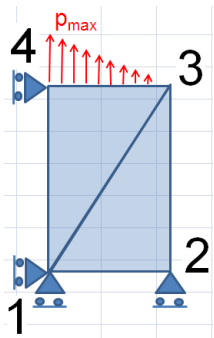
PLOT NO. 3
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.045711
 SMN =-.302E-03
 SMX =.164E-04

Blue	-.302E-03
Light Blue	-.267E-03
Cyan	-.231E-03
Green	-.196E-03
Light Green	-.161E-03
Yellow-Green	-.125E-03
Yellow	-.898E-04
Orange	-.544E-04
Red-Orange	-.190E-04
Red	.164E-04



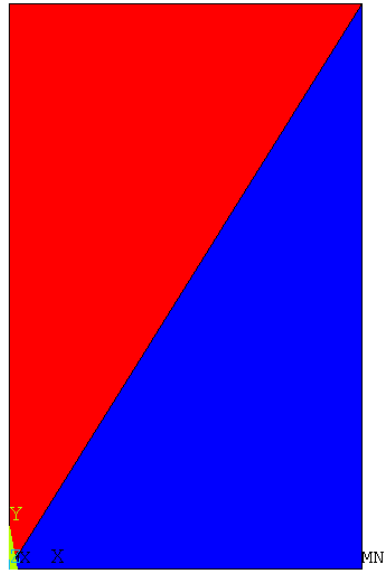
PLOT NO. 12
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.04694
 SMN =-.313E-03
 SMX =.157E-05

Blue	-.313E-03
Light Blue	-.278E-03
Cyan	-.243E-03
Green	-.208E-03
Light Green	-.173E-03
Yellow-Green	-.138E-03
Yellow	-.103E-03
Orange	-.682E-04
Red-Orange	-.333E-04
Red	.157E-05

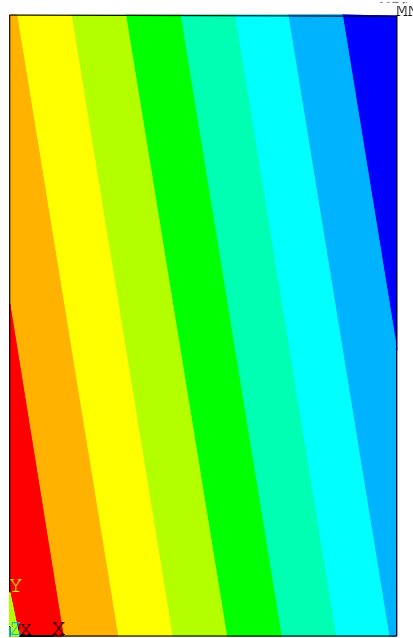


Odształcenia na kierunku Y

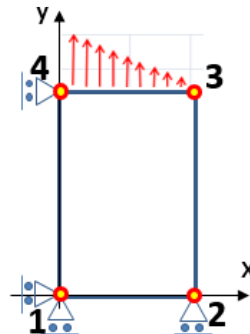
PLOT NO. 8
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.038165
 SMN =.380E-03
 SMX =.477E-03
 .380E-03
 .391E-03
 .402E-03
 .412E-03
 .423E-03
 .434E-03
 .445E-03
 .456E-03
 .466E-03
 .477E-03



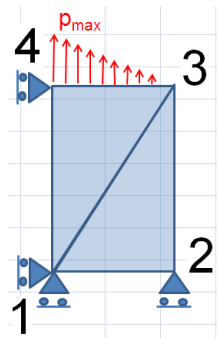
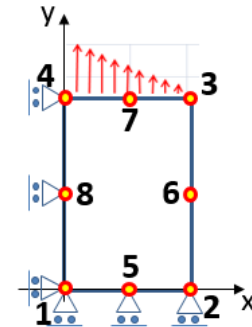
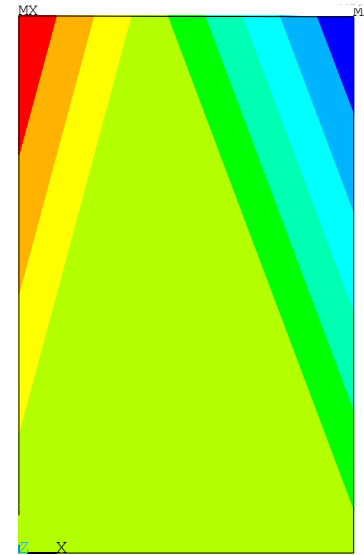
ϵ_y strain



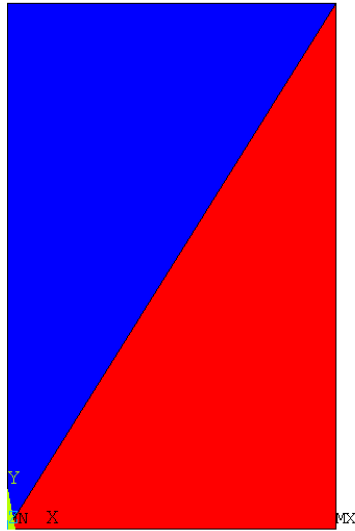
PLOT NO. 4
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.045711
 SMN =.249E-03
 SMX =.609E-03
 .249E-03
 .289E-03
 .329E-03
 .369E-03
 .409E-03
 .449E-03
 .489E-03
 .529E-03
 .569E-03
 .609E-03



PLOT NO. 13
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.04694
 SMN =.238E-04
 SMX =.769E-03
 .238E-04
 .107E-03
 .189E-03
 .272E-03
 .355E-03
 .438E-03
 .520E-03
 .603E-03
 .686E-03
 .769E-03



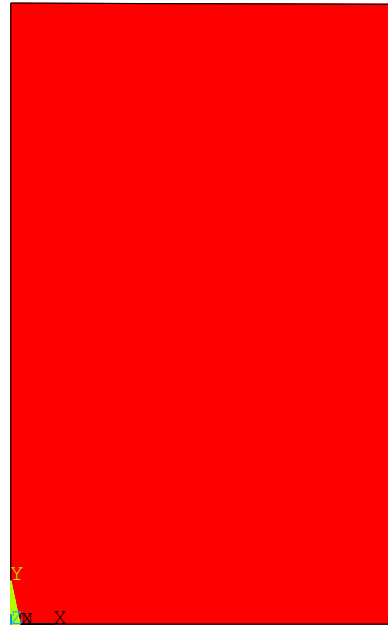
Odształcenia postaciowe



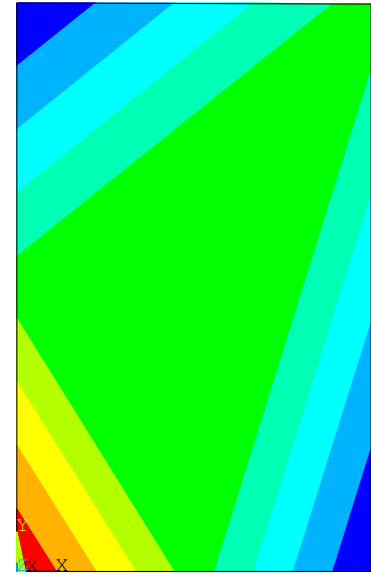
PLOT NO. 1
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.038165
 SMN =-.155E-03
 SMX =-.160E-04

Blue	-.140E-03
Light Blue	-.124E-03
Cyan	-.109E-03
Green	-.933E-04
Light Green	-.779E-04
Yellow	-.624E-04
Orange	-.470E-04
Red-Orange	-.315E-04
Red	-.160E-04

γ_{xy} strain

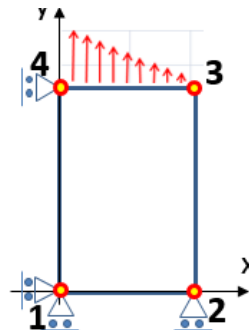
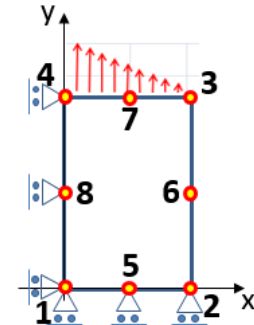
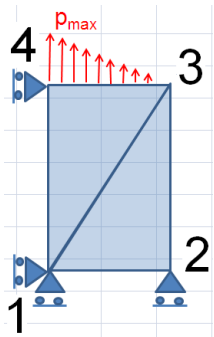


PLOT NO. 5
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELXY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.045711
 SMN =-.159E-03
 SMX =-.159E-03



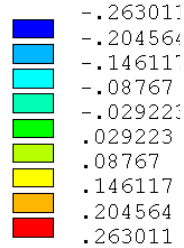
PLOT NO. 14
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 EPELXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.04694
 SMN =-.259E-03
 SMX =.105E-03

Blue	-.259E-03
Light Blue	-.219E-03
Cyan	-.178E-03
Green	-.138E-03
Light Green	-.974E-04
Yellow	-.569E-04
Orange	-.164E-04
Red-Orange	.241E-04
Red	.646E-04
Dark Red	.105E-03

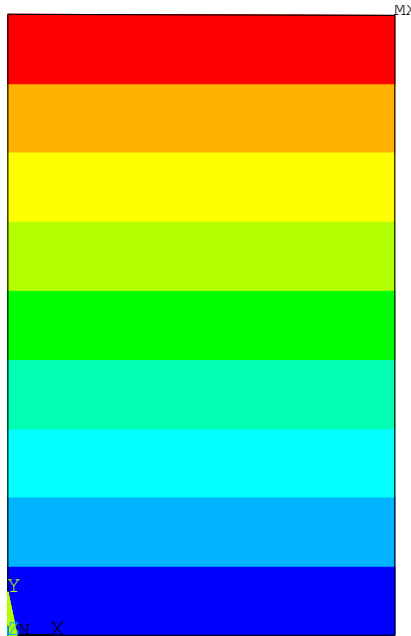


Naprężenia na kierunku X

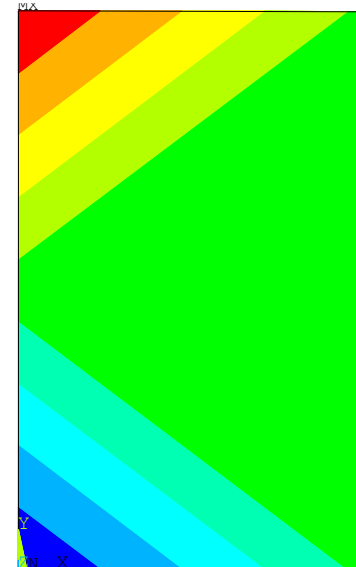
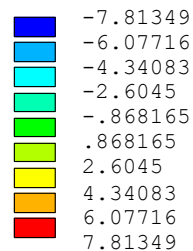
PLOT NO. 3
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.038165
 SMN =-.263011
 SMX =.263011



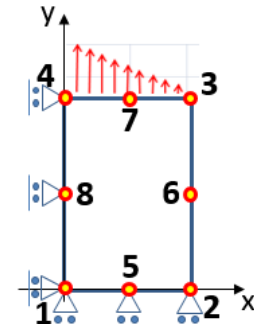
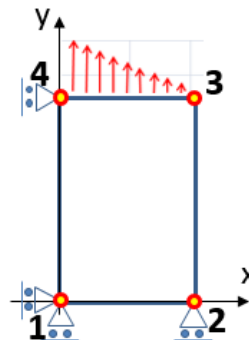
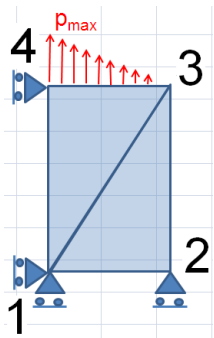
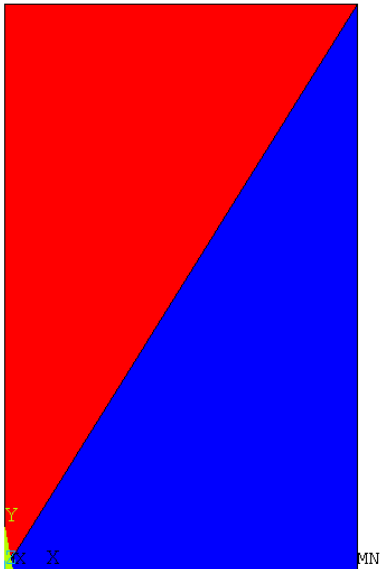
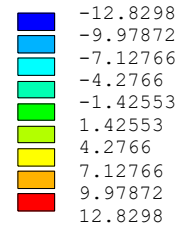
σ_x stress



PLOT NO. 6
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =-7.81349
 SMX =7.81349



PLOT NO. 5
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.04694
 SMN =-12.8298
 SMX =12.8298

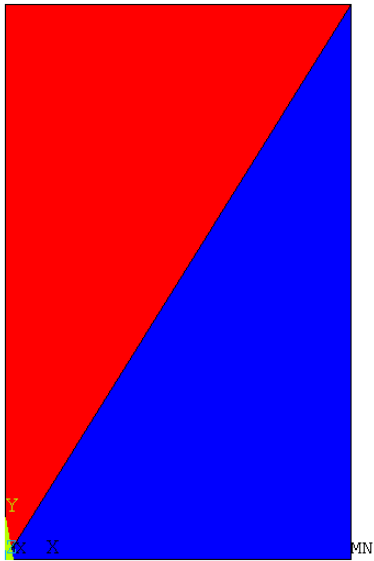


Naprężenia na kierunek Y

PLOT NO. 4
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1

DMX =.038165
 SMN =26.518
 SMX =33.482

26.518
27.292
28.065
28.839
29.613
30.387
31.161
31.935
32.708
33.482

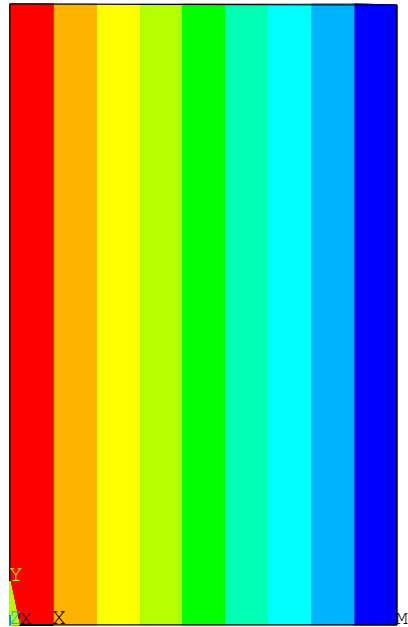


σ_y stress

PLOT NO. 7
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1

DMX =.045711
 SMN =20.0025
 SMX =39.9975

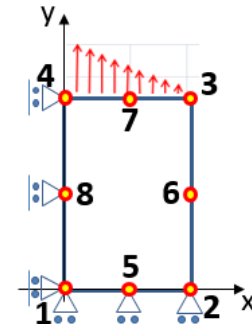
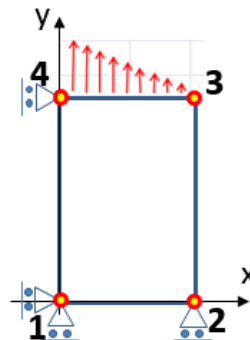
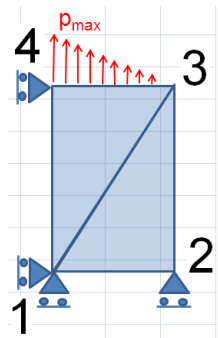
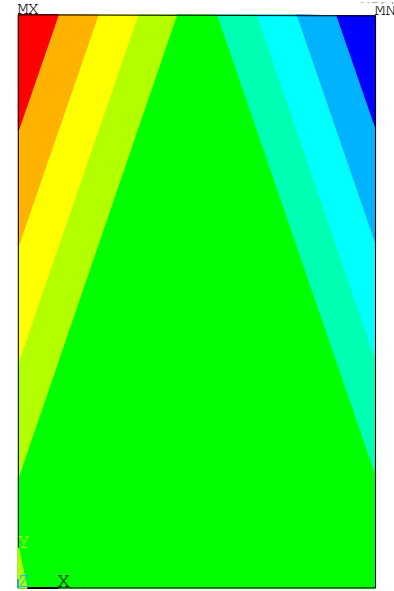
20.0025
22.2242
24.4459
26.6675
28.8892
31.1108
33.3325
35.5541
37.7758
39.9975



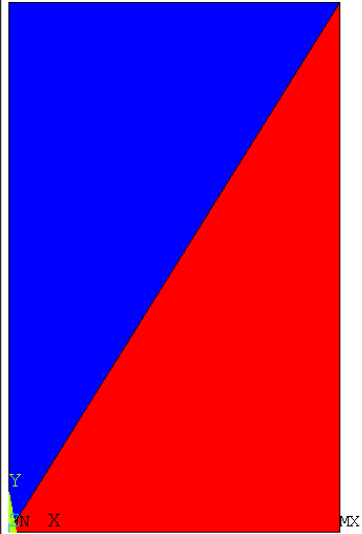
PLOT NO. 6
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1

DMX =.04694
 SMN =1.91405
 SMX =58.086

1.91405
8.15537
14.3967
20.638
26.8793
33.1207
39.362
45.6033
51.8446
58.086

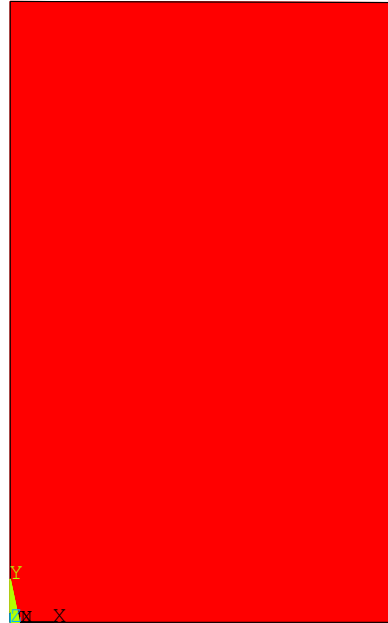


Naprężenia styczne

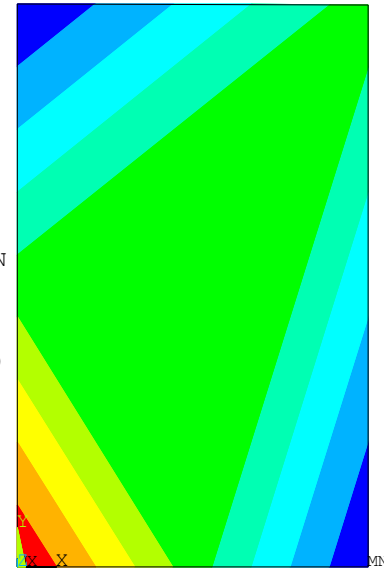


PLOT NO. 5
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.038165
 SMN =-4.074
 SMX =-.420818
 -4.074
 -3.668
 -3.262
 -2.856
 -2.45
 -2.044
 -1.638
 -1.233
 -.826679
 -.420818

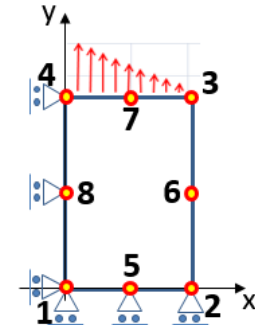
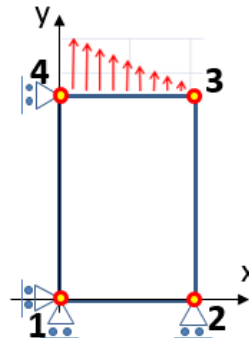
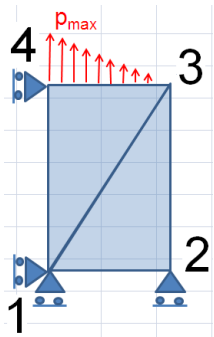
τ_{xy} stress



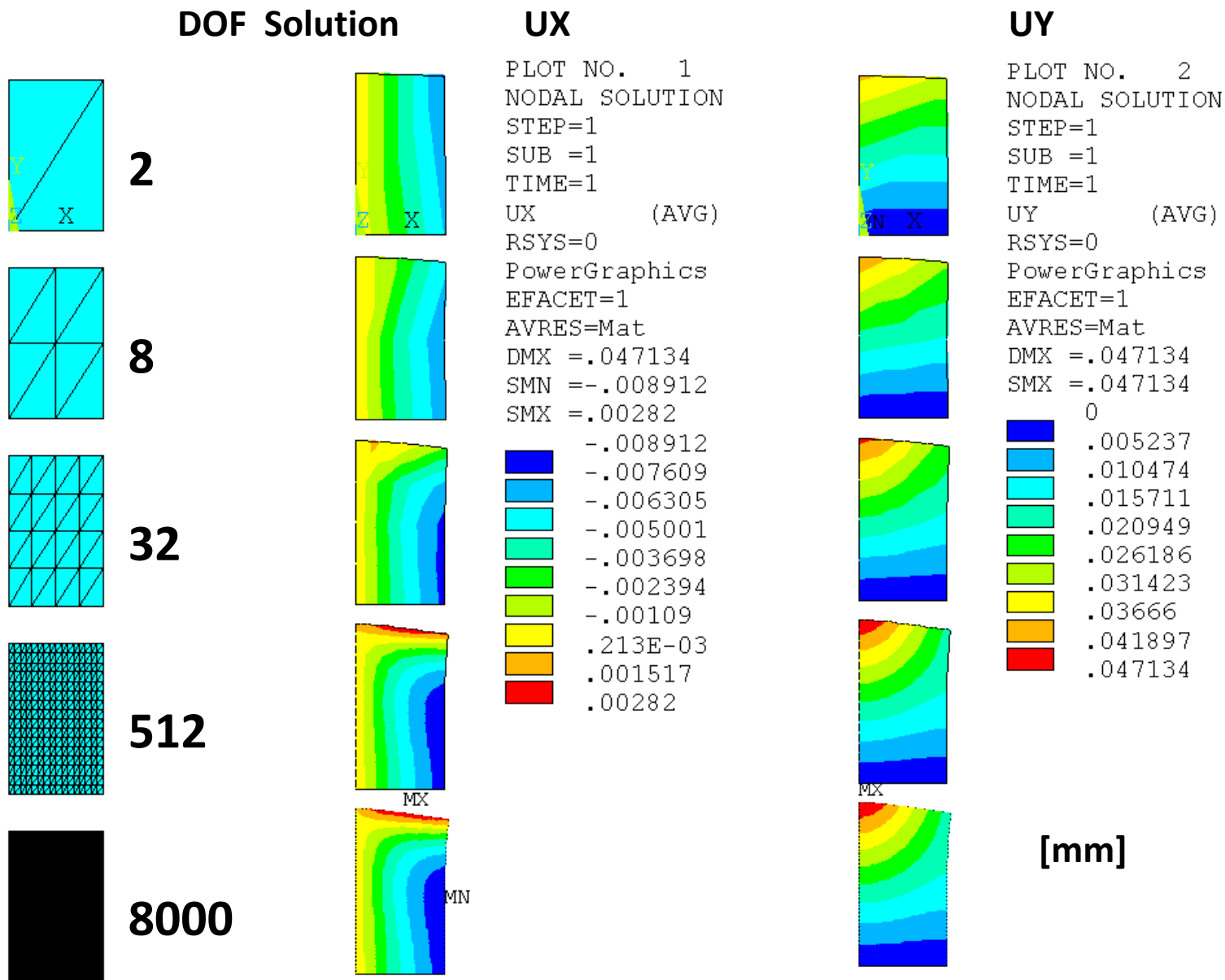
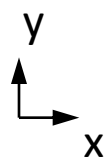
PLOT NO. 8
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =-4.16719
 SMX =-4.16719



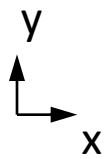
PLOT NO. 7
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.04694
 SMN =-6.81074
 SMX =2.7595
 -6.81074
 -5.74738
 -4.68402
 -3.62066
 -2.5573
 -1.49394
 -.430576
 .632784
 1.69614
 2.7595



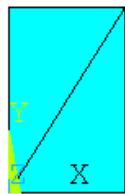
Wpływ dyskretyzacji na jakość wyników (elementy 3-węzłowe)



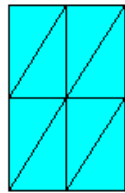
Wpływ dyskretyzacji na jakość wyników (elementy 3-węzłowe)



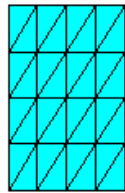
Horizontal stress σ_x



2



8



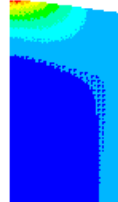
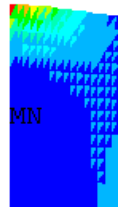
32



512



8000



PLOT NO. 3
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.047134
 SMN =-4.88
 SMX =35.587

Blue	-4.88
Light Blue	-.383303
Cyan	4.113
Light Green	8.609
Green	13.106
Yellow-Green	17.602
Yellow	22.098
Orange	26.595
Red-Orange	31.091
Red	35.587

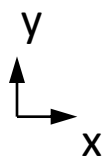


PLOT NO. 7
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.047134
 SMN =-4.784
 SMX =35.587

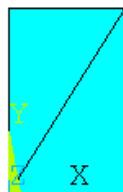
Blue	-4.784
Light Blue	-.298737
Cyan	4.187
Light Green	8.673
Green	13.159
Yellow-Green	17.644
Yellow	22.13
Orange	26.616
Red-Orange	31.102
Red	35.587

[MPa]

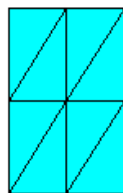
Wpływ dyskretyzacji na jakość wyników (elementy 3-węzłowe)



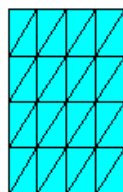
Vertical stress σ_y



2



8



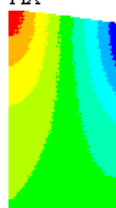
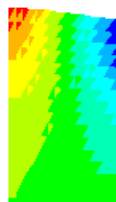
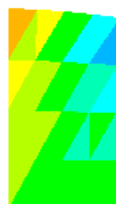
32



512



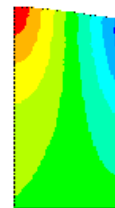
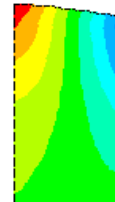
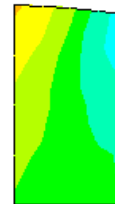
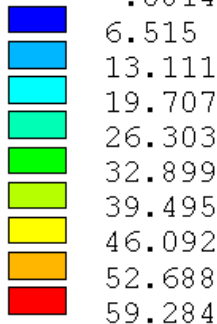
8000



PLOT NO. 4
ELEMENT SOLUTION

STEP=1
SUB =1
TIME=1
SY (NOAVG)

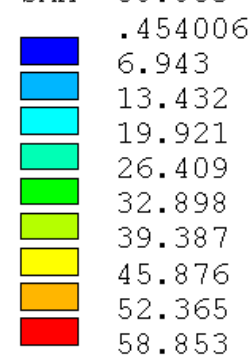
RSYS=0
PowerGraphics
EFACET=1
DMX =.047134
SMN =-.081405
SMX =59.284



PLOT NO. 8
NODAL SOLUTION

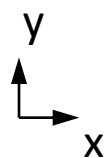
STEP=1
SUB =1
TIME=1
SY (AVG)

RSYS=0
PowerGraphics
EFACET=1
AVRES=Mat
DMX =.047134
SMN =.454006
SMX =58.853

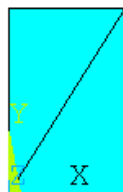


[MPa]

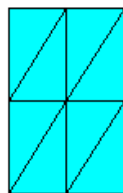
Wpływ dyskretyzacji na jakość wyników (elementy 3-węzłowe)



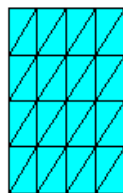
Shear stress τ_{xy}



2



8



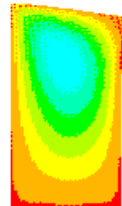
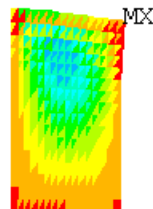
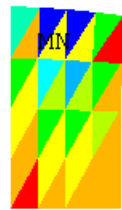
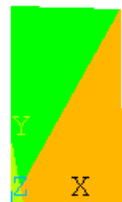
32



512



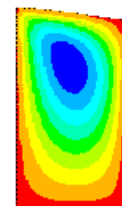
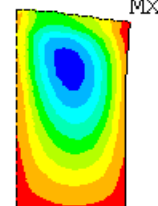
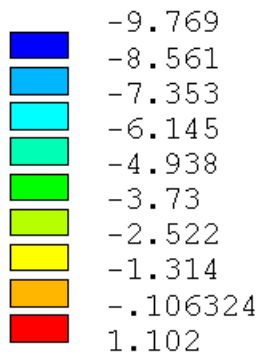
8000



PLOT NO. 5
ELEMENT SOLUTION

STEP=1
SUB =1
TIME=1
SXY (NOAVG)
RSYS=0

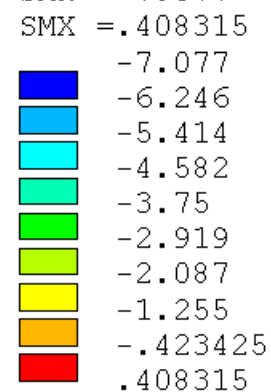
PowerGraphics
EFACET=1
DMX =.047134
SMN =-9.769
SMX =1.102



PLOT NO. 9
NODAL SOLUTION

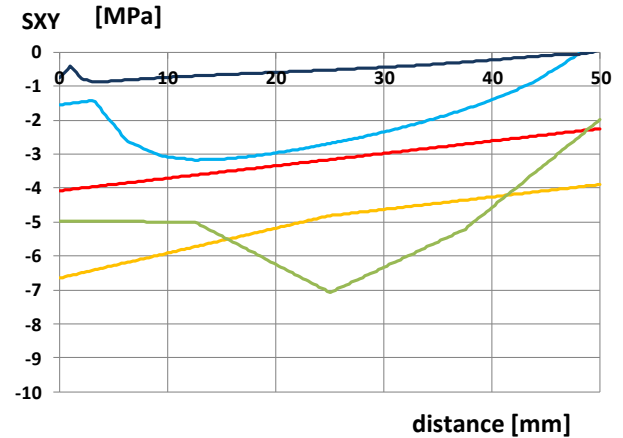
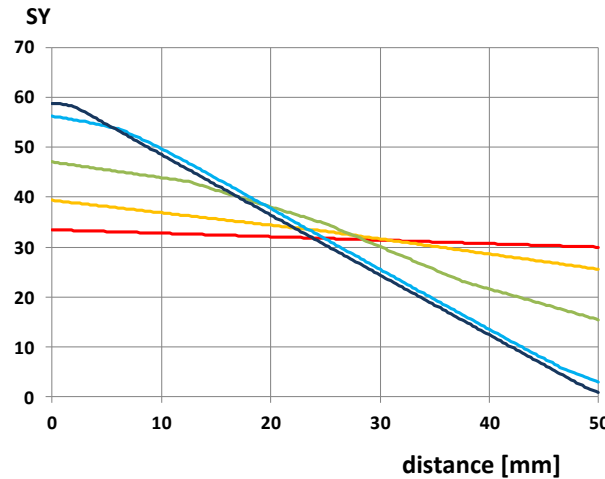
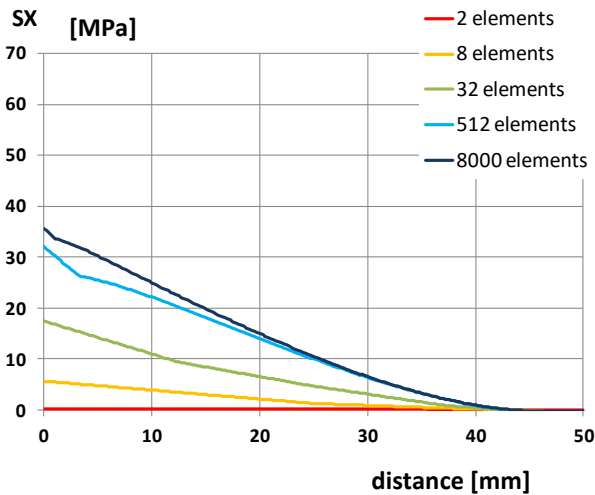
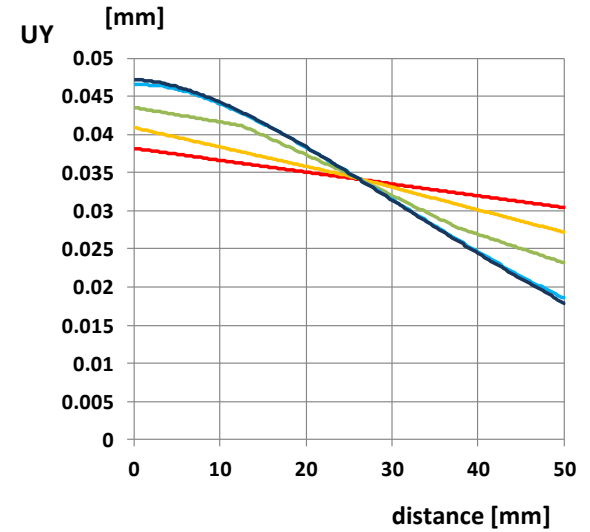
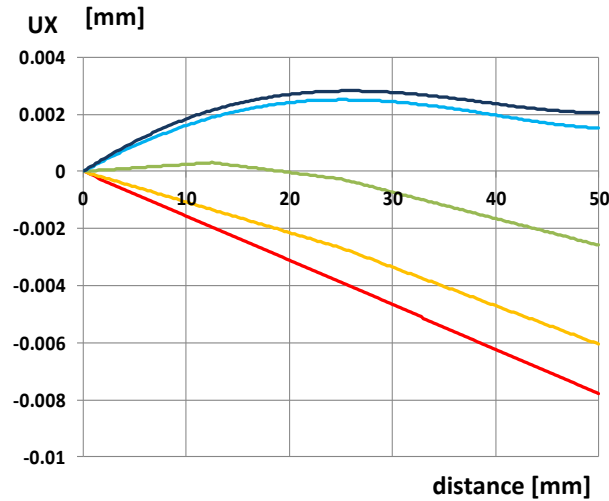
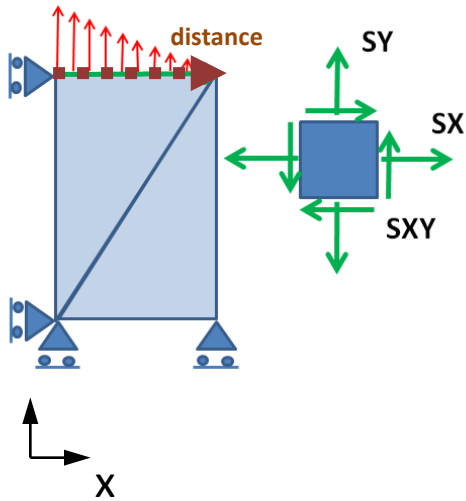
STEP=1
SUB =1
TIME=1
SXY (AVG)
RSYS=0

PowerGraphics
EFACET=1
AVRES=Mat
DMX =.047134
SMN =-7.077
SMX =.408315

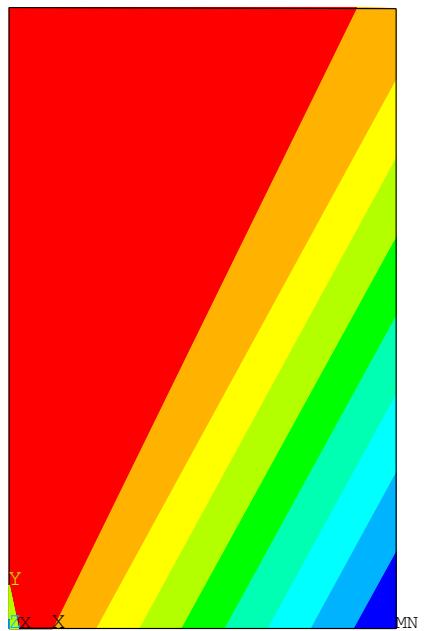
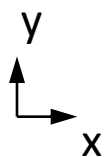


[MPa]

Wpływ dyskretyzacji na jakość wyników (elementy 3-węzłowe)



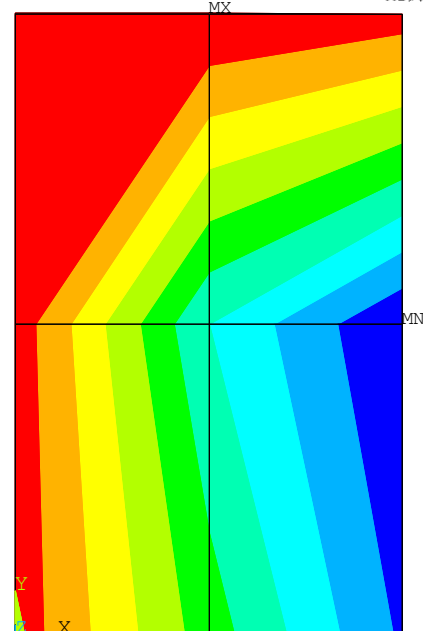
Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)



PLOT NO. 1
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.045711
 SMN =-.012724

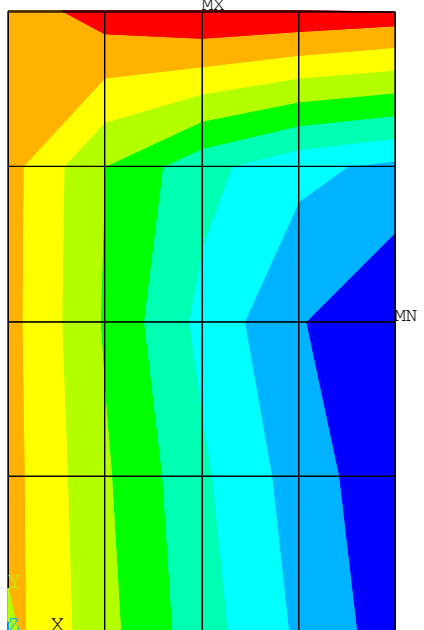
Blue	-.012724
Light Blue	-.01131
Cyan	-.009896
Green	-.008483
Light Green	-.007069
Yellow-Green	-.005655
Yellow	-.004241
Orange	-.002828
Red	-.001414
White	0

UX
 [mm]



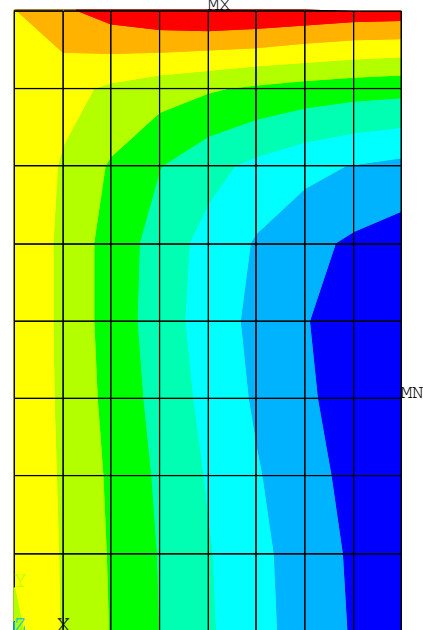
PLOT NO. 10
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046436
 SMN =-.009823

Blue	-.009823
Light Blue	-.008682
Cyan	-.00754
Green	-.006398
Light Green	-.005257
Yellow-Green	-.004115
Yellow	-.002974
Orange	-.001832
Red	-.690E-03
White	.451E-03



PLOT NO. 15
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046861
 SMN =-.009151

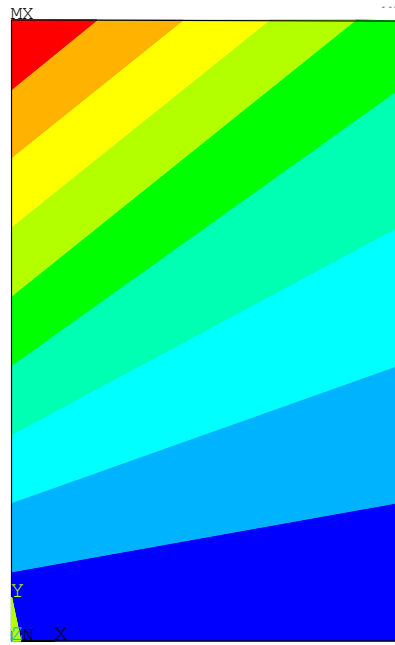
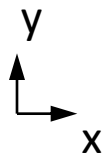
Blue	-.009151
Light Blue	-.007909
Cyan	-.006666
Green	-.005424
Light Green	-.004181
Yellow-Green	-.002938
Yellow	-.001696
Orange	-.453E-03
Red	.789E-03
White	.002032



PLOT NO. 23
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.047071
 SMN =-.008957

Blue	-.008957
Light Blue	-.007671
Cyan	-.006385
Green	-.005099
Light Green	-.003813
Yellow-Green	-.002527
Yellow	-.001241
Orange	.452E-04
Red	.001331
White	.002617

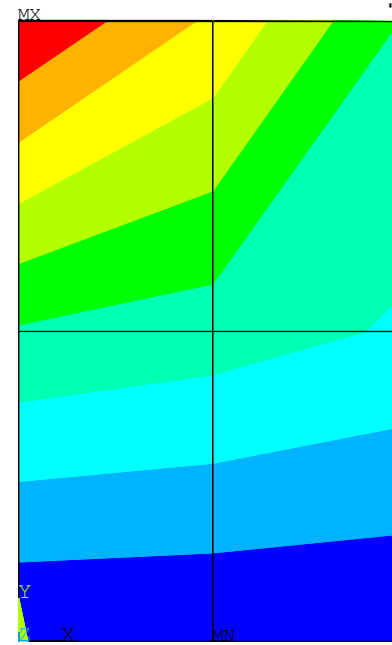
Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)



00:00:00
 PLOT NO. 2
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.045711
 SMX =.045711

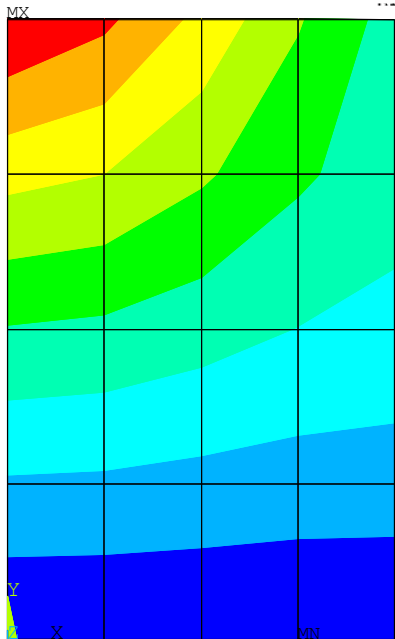
0
.005079
.010158
.015237
.020316
.025395
.030474
.035553
.040632
.045711

**UY
[mm]**



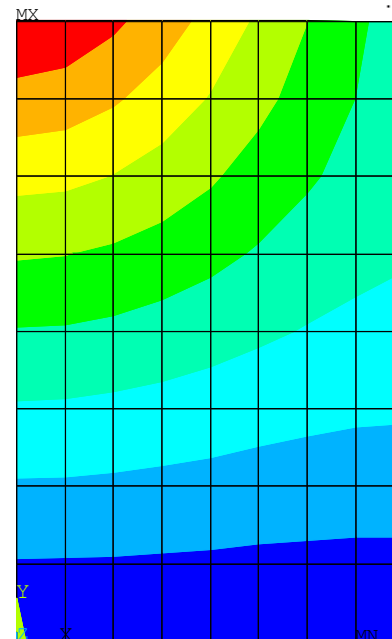
00:00:23
 PLOT NO. 11
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046436
 SMX =.046436

0
.00516
.010319
.015479
.020638
.025798
.030957
.036117
.041276
.046436



00:00:21
 PLOT NO. 16
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046861
 SMX =.046861

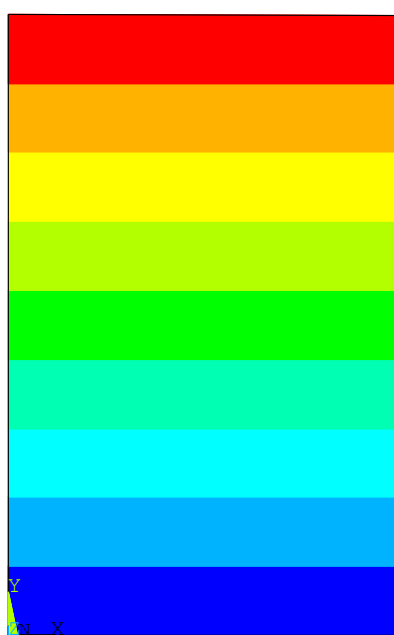
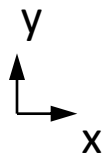
0
.005207
.010414
.01562
.020827
.026034
.031241
.036448
.041654
.046861



00:00:19
 PLOT NO. 24
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 UY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.047071
 SMX =.047071

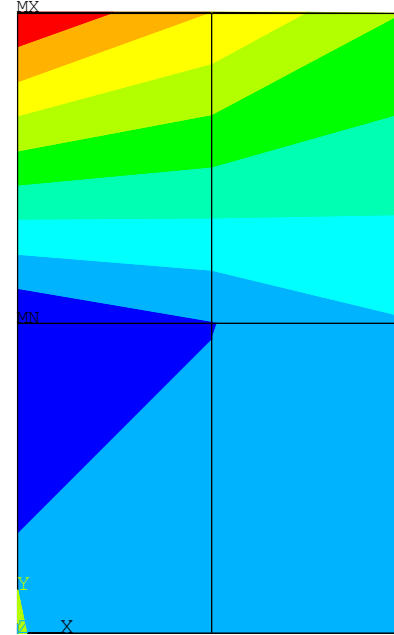
0
.00523
.01046
.01569
.02092
.026151
.031381
.036611
.041841
.047071

Wpływ dyskretyzacji na jakość wyników (elementy 4-wzłowe)

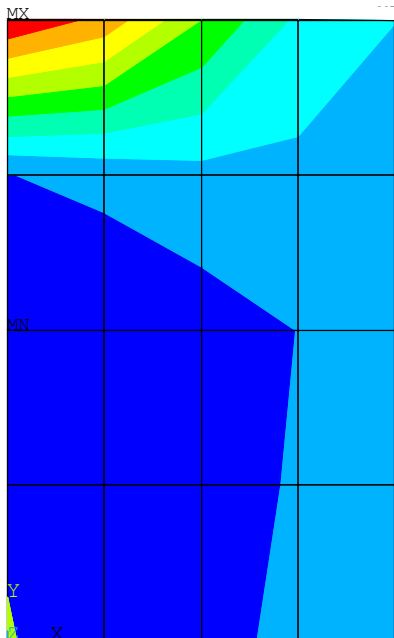


PLOT NO. 6
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =-7.81349
 SMX =7.81349
 -7.81349
 -6.07716
 -4.34083
 -2.6045
 -.868165
 .868165
 2.6045
 4.34083
 6.07716
 7.81349

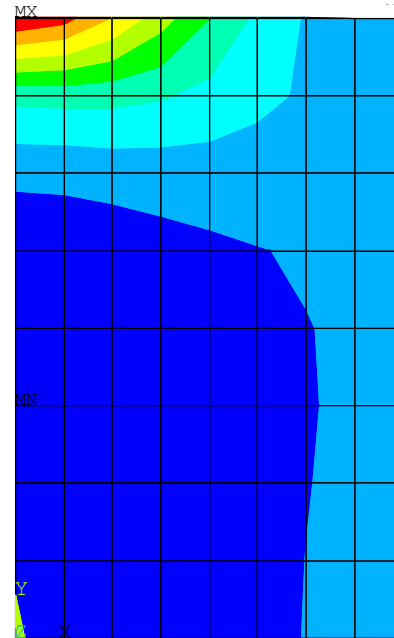
σ_x
 [MPa]
 NODAL
 SOLUTION



PLOT NO. 31
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046436
 SMN =-5.95909
 SMX =14.5388
 -5.95909
 -3.68154
 -1.404
 .873548
 3.15109
 5.42864
 7.70619
 9.98373
 12.2613
 14.5388

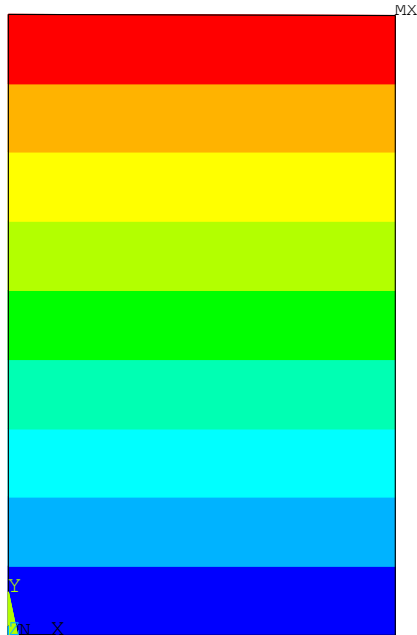
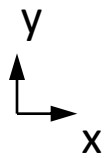


PLOT NO. 20
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046861
 SMN =-4.63339
 SMX =24.1699
 -4.63339
 -1.43302
 1.76735
 4.96772
 8.16809
 11.3685
 14.5688
 17.7692
 20.9696
 24.1699



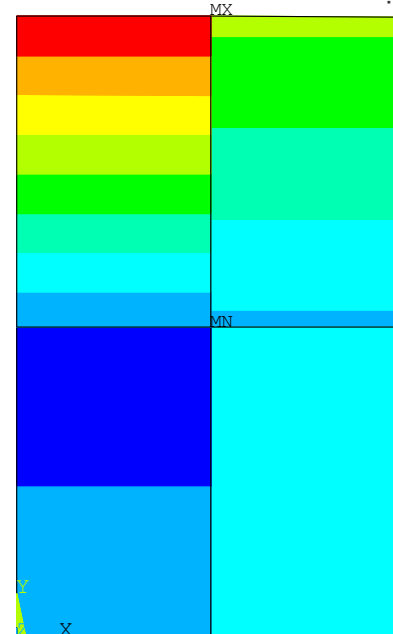
PLOT NO. 25
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.047071
 SMN =-4.69728
 SMX =30.1917
 -4.69728
 -.820734
 3.05582
 6.93237
 10.8089
 14.6855
 18.562
 22.4386
 26.3151
 30.1917

Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)

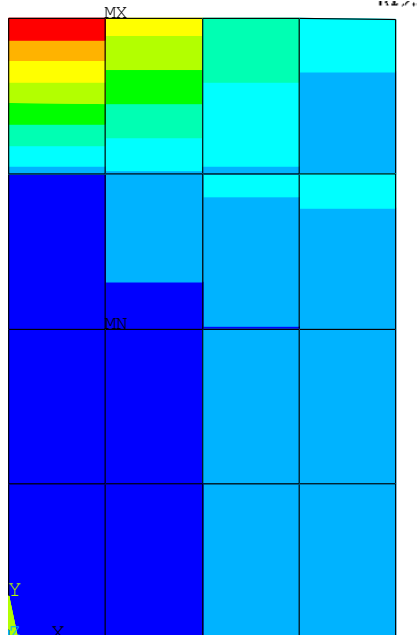


PLOT NO. 6
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =-7.81349
 SMX =7.81349
 -7.81349
 -6.07716
 -4.34083
 -2.6045
 -.868165
 .868165
 2.6045
 4.34083
 6.07716
 7.81349

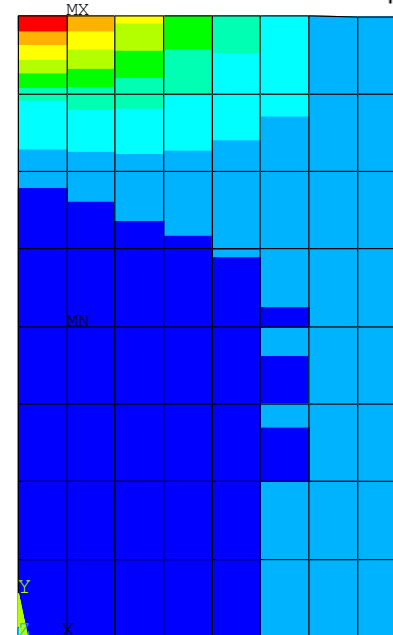
σ_x
 [MPa]
 ELEMENT
 SOLUTION



PLOT NO. 12
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.046436
 SMN =-7.31649
 SMX =14.5388
 -7.31649
 -4.88812
 -2.45975
 -.031386
 2.39698
 4.82535
 7.25372
 9.68209
 12.1105
 14.5388

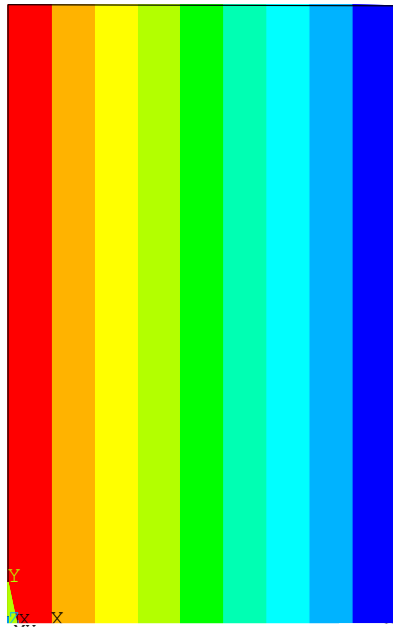
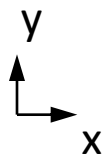


PLOT NO. 17
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.046861
 SMN =-5.58213
 SMX =24.1699
 -5.58213
 -2.27634
 1.02944
 4.33523
 7.64102
 10.9468
 14.2526
 17.5584
 20.8642
 24.1699



PLOT NO. 28
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SX (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.047071
 SMN =-5.14419
 SMX =30.1917
 -5.14419
 -1.21798
 2.70822
 6.63443
 10.5606
 14.4868
 18.413
 22.3393
 26.2655
 30.1917

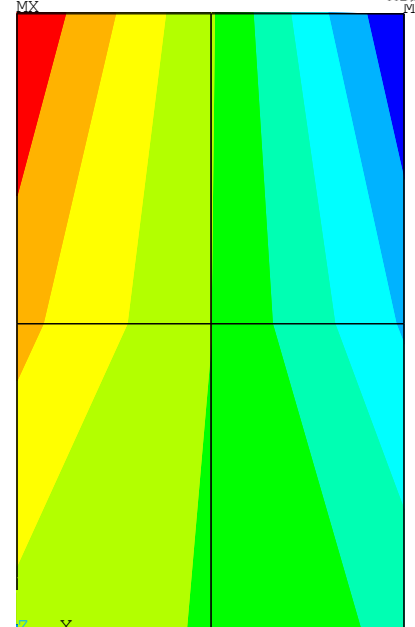
Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)



PLOT NO. 7
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =20.0025
 SMX =39.9975

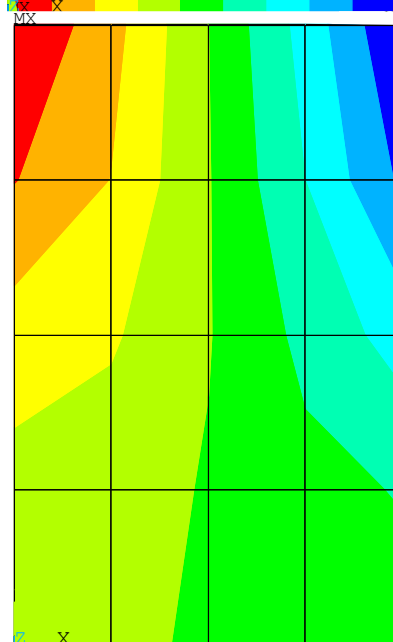
σ_y
 [MPa]
NODAL SOLUTION

- 20.0025
- 22.2242
- 24.4459
- 26.6675
- 28.8892
- 31.1108
- 33.3325
- 35.5541
- 37.7758
- 39.9975



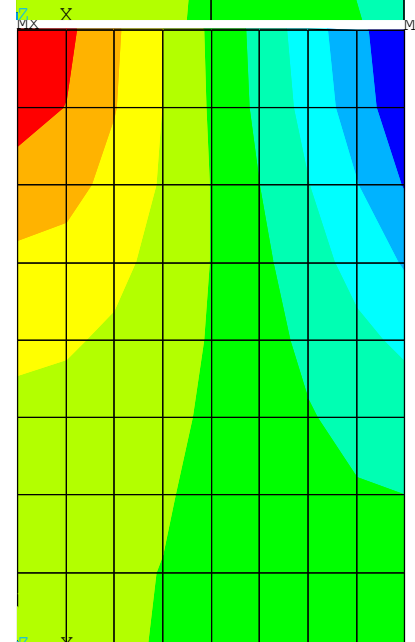
PLOT NO. 32
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046436
 SMN =9.68398
 SMX =47.7465

- 9.68398
- 13.9132
- 18.1423
- 22.3715
- 26.6007
- 30.8298
- 35.059
- 39.2882
- 43.5173
- 47.7465



PLOT NO. 21
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046861
 SMN =3.04724
 SMX =52.8834

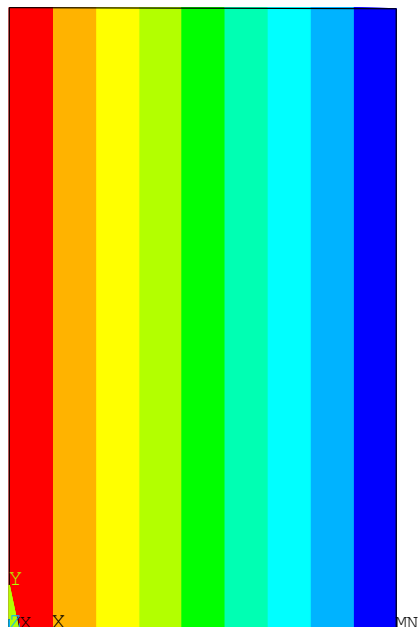
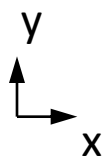
- 3.04724
- 8.5846
- 14.122
- 19.6593
- 25.1967
- 30.734
- 36.2714
- 41.8087
- 47.3461
- 52.8834



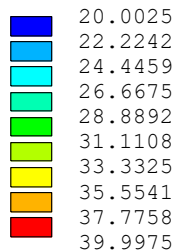
PLOT NO. 26
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.047071
 SMN =.427497
 SMX =56.1359

- .427497
- 6.61732
- 12.8071
- 18.997
- 25.1868
- 31.3766
- 37.5664
- 43.7562
- 49.946
- 56.1359

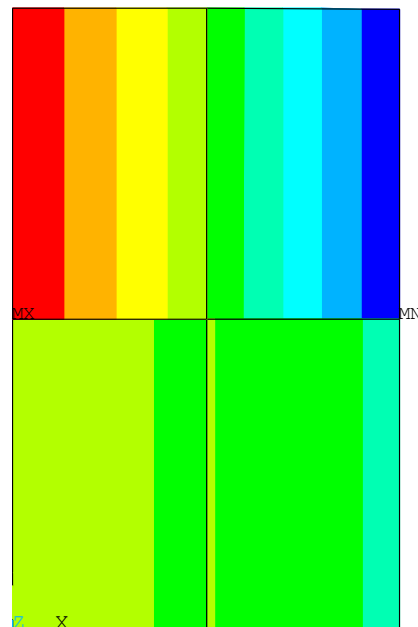
Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)



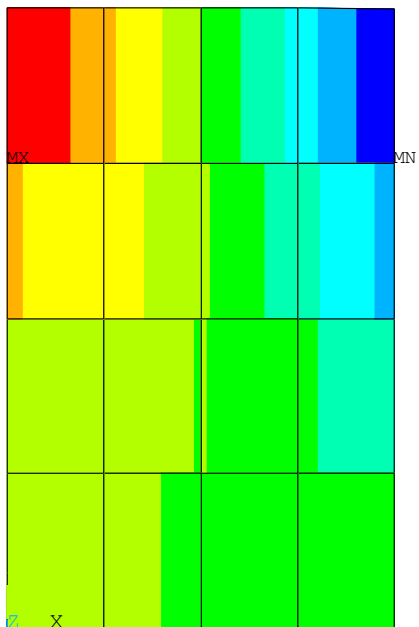
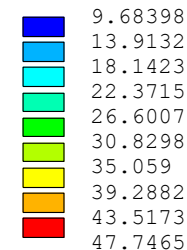
PLOT NO. 7
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =20.0025
 SMX =39.9975



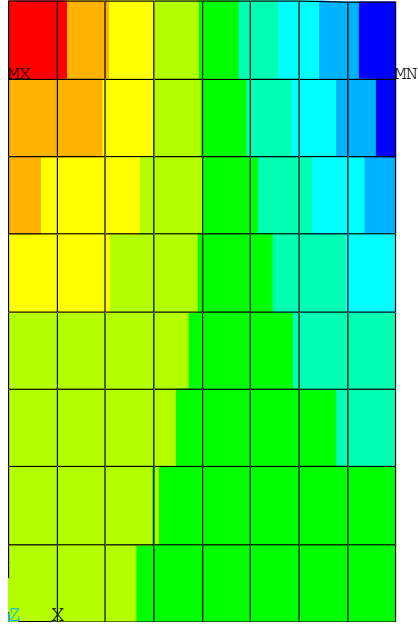
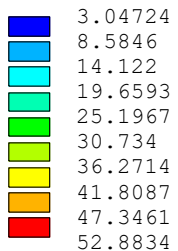
σ_y
 [MPa]
 ELEMENT SOLUTION



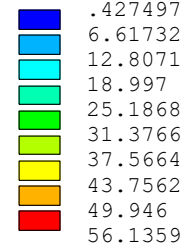
PLOT NO. 13
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.046436
 SMN =9.68398
 SMX =47.7465



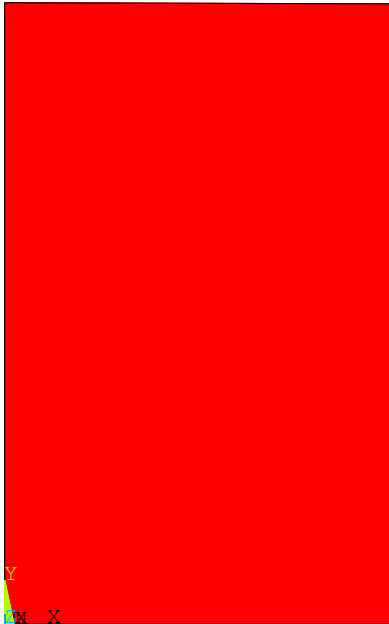
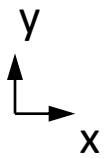
PLOT NO. 18
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.046861
 SMN =3.04724
 SMX =52.8834



PLOT NO. 29
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.047071
 SMN =.427497
 SMX =56.1359

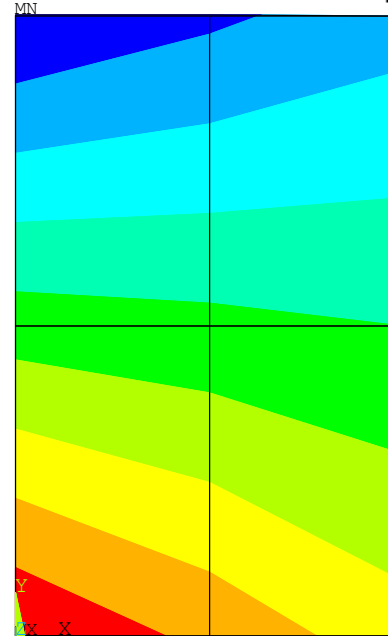


Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)



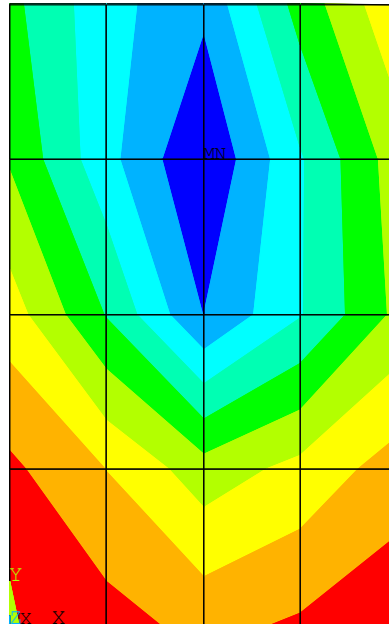
PLOT NO. 8
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =-4.16719
 SMX =-4.16719

τ_{xy}
 [MPa]
 NODAL
 SOLUTION



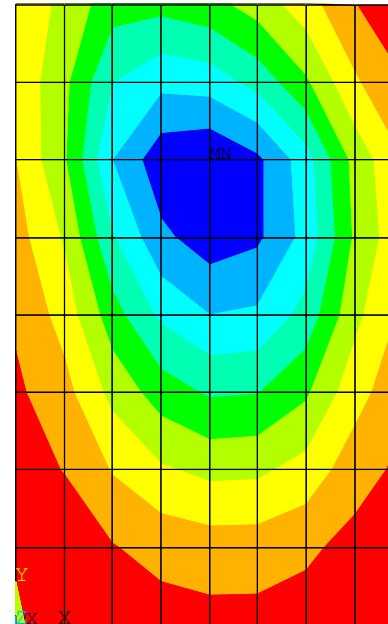
PLOT NO. 33
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046436
 SMN =-4.70816
 SMX =-1.65009

Blue	-4.70816
Light Blue	-4.36837
Cyan	-4.02859
Green	-3.6888
Light Green	-3.34902
Yellow-Green	-3.00923
Yellow	-2.66944
Orange	-2.32966
Red-Orange	-1.98987
Red	-1.65009



PLOT NO. 22
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.046861
 SMN =-5.49877
 SMX =-.425279

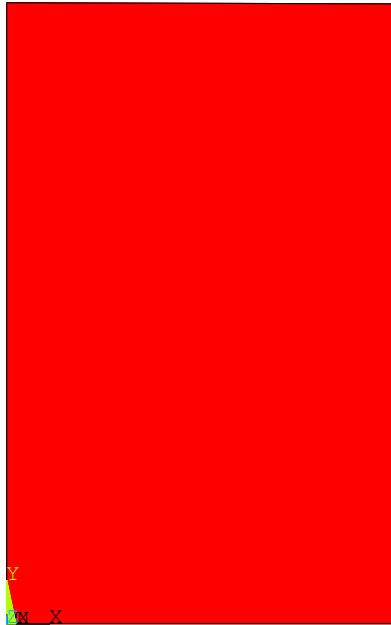
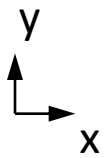
Blue	-5.49877
Light Blue	-4.93504
Cyan	-4.37132
Green	-3.8076
Light Green	-3.24388
Yellow-Green	-2.68016
Yellow	-2.11644
Orange	-1.55272
Red-Orange	-.989
Red	-.425279



PLOT NO. 27
 NODAL SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (AVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.047071
 SMN =-6.68
 SMX =-.106963

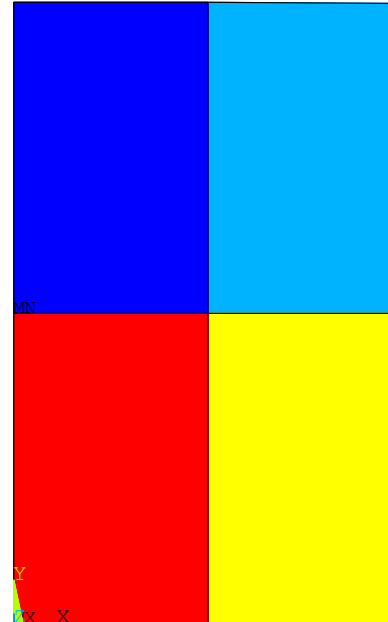
Blue	-6.68
Light Blue	-5.94966
Cyan	-5.21933
Green	-4.48899
Light Green	-3.75865
Yellow-Green	-3.02831
Yellow	-2.29798
Orange	-1.56764
Red-Orange	-.837301
Red	-.106963

Wpływ dyskretyzacji na jakość wyników (elementy 4-węzłowe)



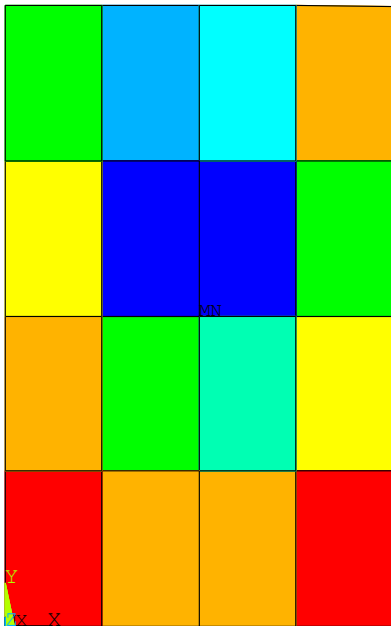
PLOT NO. 8
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.045711
 SMN =-4.16719
 SMX =-4.16719

τ_{xy}
 [MPa]
 ELEMENT
 SOLUTION



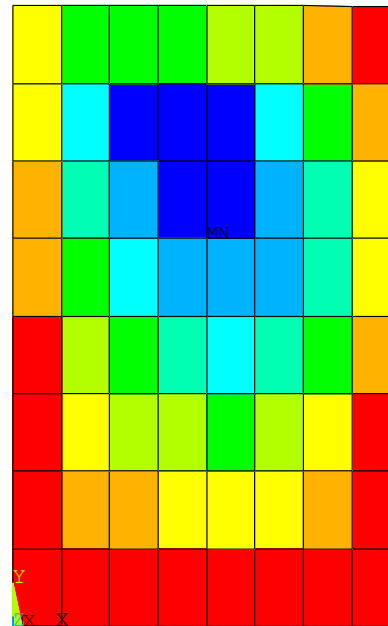
PLOT NO. 14
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.046436
 SMN =-4.70816
 SMX =-1.65009

Dark Blue	-4.70816
Light Blue	-4.36837
Cyan	-4.02859
Light Green	-3.6888
Green	-3.34902
Yellow-Green	-3.00923
Yellow	-2.66944
Orange	-2.32966
Red-Orange	-1.98987
Red	-1.65009



PLOT NO. 19
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.046861
 SMN =-6.33246
 SMX =-.425279

Dark Blue	-6.33246
Light Blue	-5.6761
Cyan	-5.01975
Light Green	-4.3634
Green	-3.70704
Yellow-Green	-3.05069
Yellow	-2.39434
Orange	-1.73799
Red-Orange	-1.08163
Red	-.425279



PLOT NO. 30
 ELEMENT SOLUTION
 STEP=1
 SUB =1
 TIME=1
 SXY (NOAVG)
 RSYS=0
 PowerGraphics
 EFACET=1
 DMX =.047071
 SMN =-6.83544
 SMX =-.106963

Dark Blue	-6.83544
Light Blue	-6.08783
Cyan	-5.34022
Light Green	-4.59261
Green	-3.84501
Yellow-Green	-3.0974
Yellow	-2.34979
Orange	-1.60218
Red-Orange	-.854572
Red	-.106963