



Metoda elementów skończonych (MES1)

Wykład 11B. Jednowymiarowe elementy strukturalne
i MPC w programie Ansys

05.2022

Element typu Structural Link

Figure 180.1: LINK180 Geometry

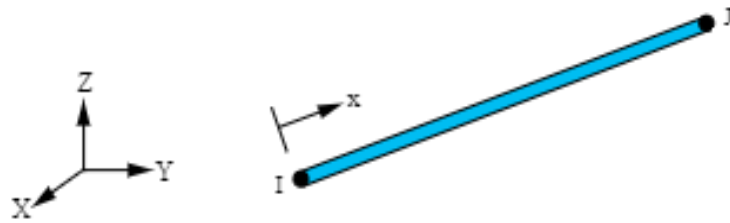


Figure 180.2: LINK180 Stress Output

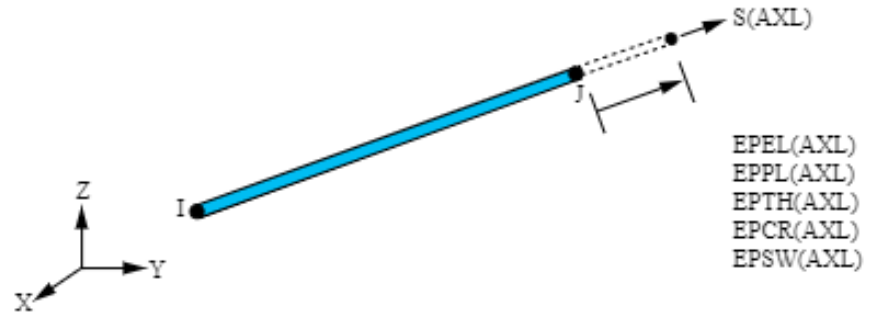
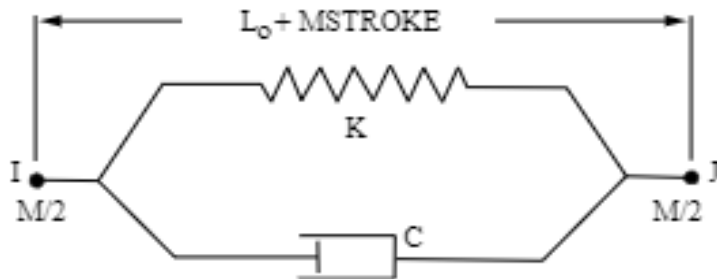


Figure 11.1: LINK11 Geometry



LINK11 may be used to model hydraulic cylinders and other applications undergoing large rotations. The element is a uniaxial tension-compression element with three degrees of freedom at each node: translations in the nodal x, y, and z directions. No bending or twist loads are considered.

Element typu Structural Mass

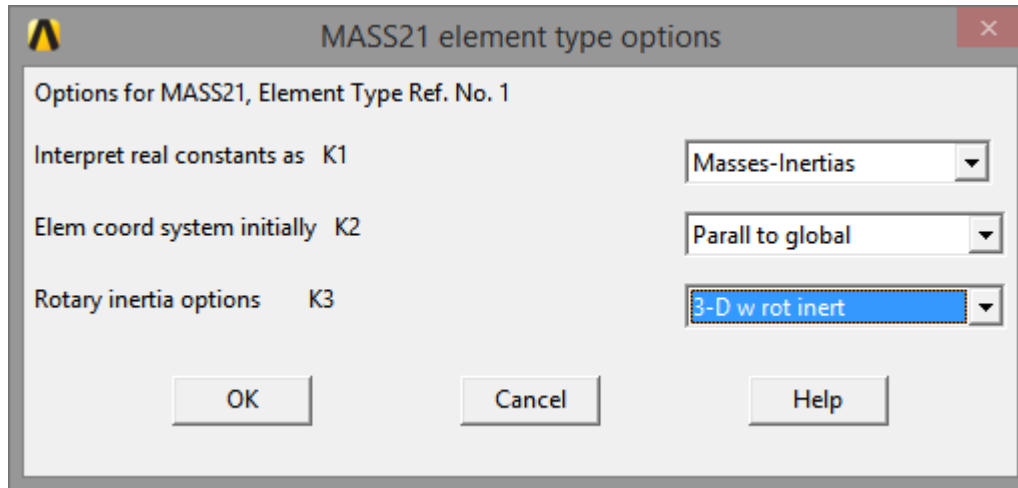
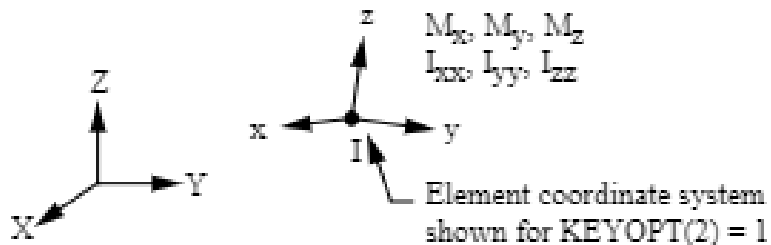


Figure 21.1: MASS21 Geometry



MASS21 is a point element having up to six degrees of freedom: translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z axes. A different mass and rotary inertia may be assigned to each coordinate direction.

Element typu Structural Beam

Figure 188.1: BEAM188 Geometry

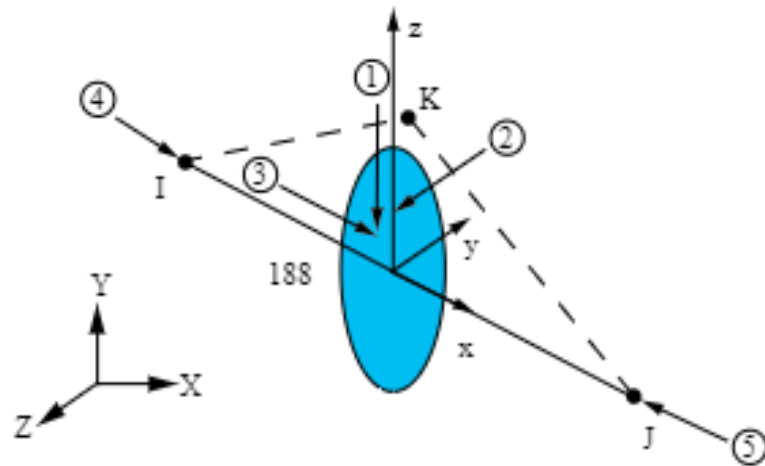
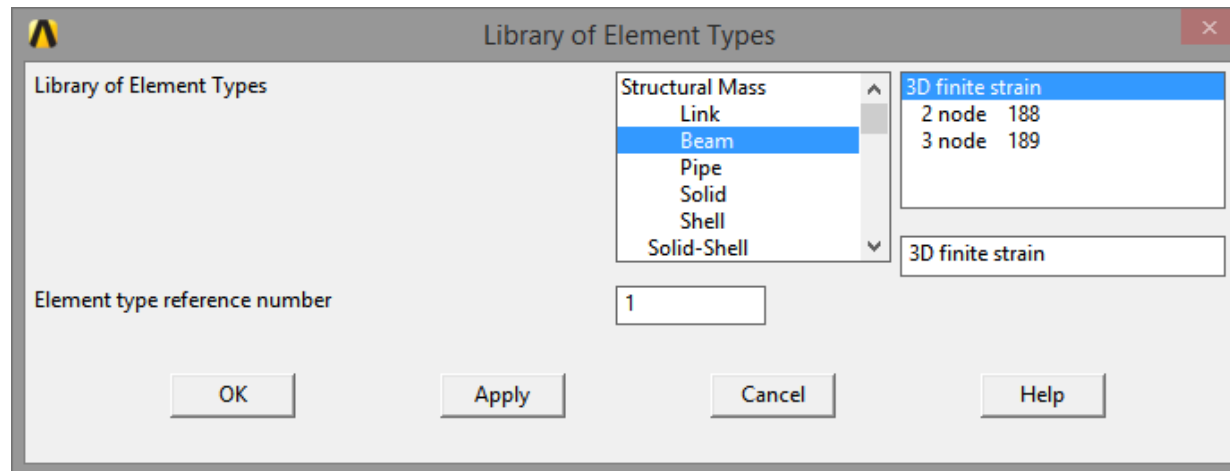
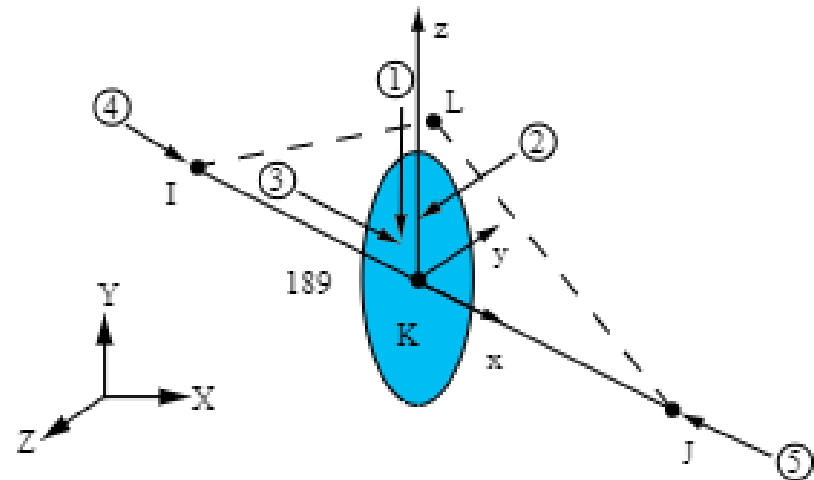
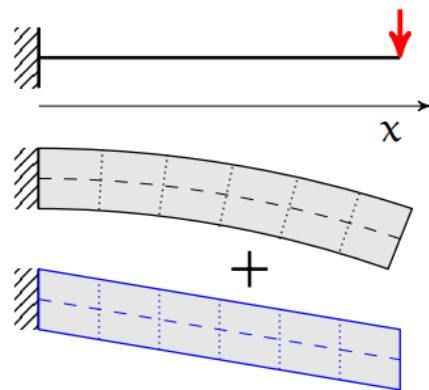


Figure 189.1: BEAM189 Geometry



Teorie belek

W praktyce inżynierskiej problem zginania prętów rozpatrywany jest na gruncie prostej teorii **Eulera-Bernoulliego**. Podstawowym założeniem tej teorii jest, że odcinek prosty i prostopadły do osi pręta przed deformacją, pozostaje prosty i prostopadły po wystąpieniu deformacji. Jest to konsekwencją pominięcia wpływu naprężeń stycznych w przekroju.



Ugięcie wg teorii Eulera-Bernoulliego

$$u_{EB} \sim x^3$$

Dodatek wg teorii Timoshenki

$$u_T \sim x$$

$$u_{max} = \frac{FL^3}{3EJ} + \frac{FL}{kAG}$$

sprawdza się dla
 $1/5 \leq h/b \leq 5$,
 $L/\max(h, b) > 10$

Źródła: http://www.tu.kielce.pl/~rokach/instr/mes1_wyklad_11.pdf
<https://chodor-projekt.net/encyclopedia/belka-timoshenko-sprezyste-podloze/>

Teoria Timoshenki

Płaski przekrój pozostaje płaski, ale nie jest już prostopadły do zdeformowanej osi obojętnej belki.

Wszystkie programy MES mają elementy belkowe oparte o teorię Timoshenki

Element typu Structural Beam

Figure 188.1: BEAM188 Geometry

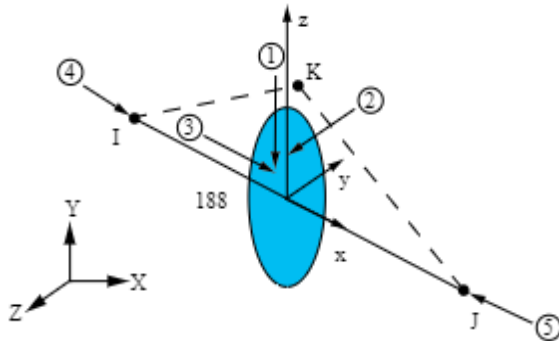


Figure 189.1: BEAM189 Geometry

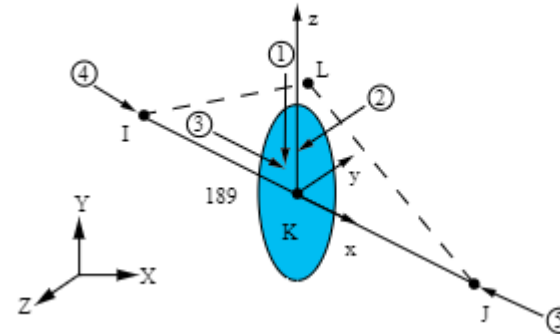
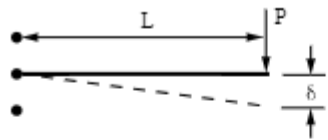


Figure 188.2: Transverse-Shear Deformation Estimation

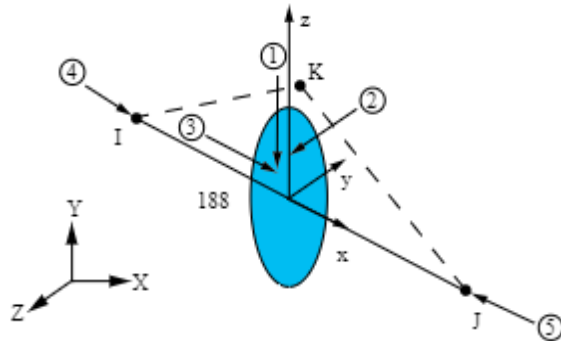


Slenderness Ratio ($GAL^2/(EI)$)	δ Timoshenko / δ Euler-Bernoulli
25	1.120
50	1.060
100	1.030
1000	1.003

Calculate the ratio using some global distance measures, rather than basing it upon individual element dimensions. The following illustration shows an estimate of transverse-shear deformation in a cantilever beam subjected to a tip load. Although the results cannot be extrapolated to any other application, the example serves well as a general guideline. A slenderness ratio greater than 30 is recommended.

Element type Structural Beam

Figure 188.1: BEAM188 Geometry



BEAM188 element type options

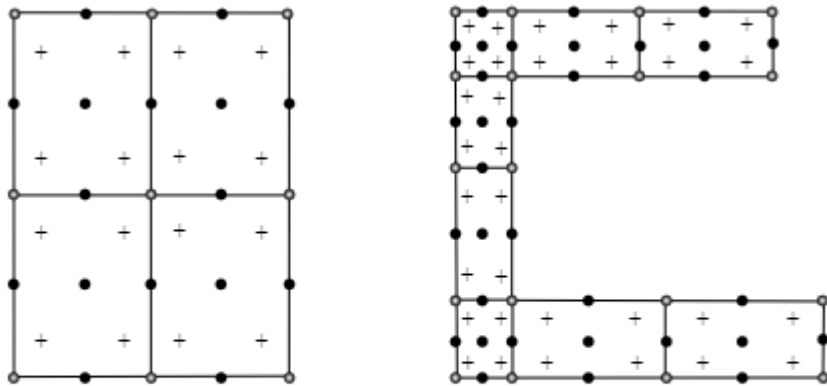
Options for BEAM188, Element Type Ref. No. 1

Degrees of freedom	K1	Disps + Rots (6)
Cross section scaling is	K2	Func of stretch
Element behavior	K3	Linear Form.
Shear stress output	K4	Linear Form. Quadratic Form. Cubic Form.
Section force/strain output	K6	At intgr points
Stress / Strain (sect points) K7		NONE
Stress/Strain (elmt/sect nds) K9		NONE
Section integration	K11	Automatic
Taper section interpretation K12		Linear
Results file format	K15	Avg (corner nds)

OK Cancel Help

Charakterystyki przekroju Element typu Beam

Figure 188.3: Cross-Section Cells



(a) Rectangular section

(b) Channel section

- Section Nodes
- Section Corner Nodes
- + Section Integration Points

Beam Tool
✕

ID

Name

Sub-Type

Offset To

Offset-Y

Offset-Z

W1

W2

W3

t1

t2

t3

0

Coarse
Fine

OK

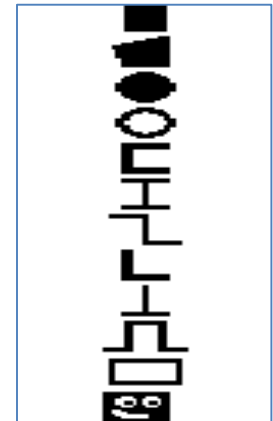
Close

Help

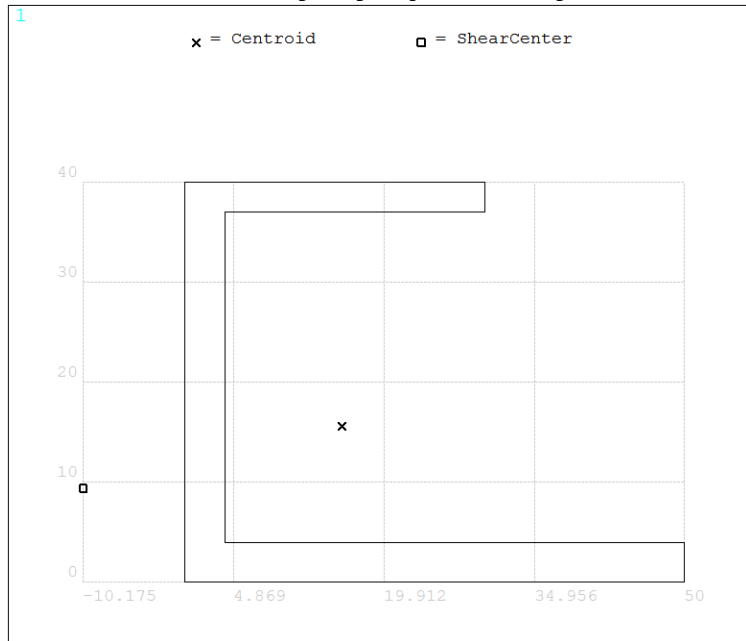
Apply

Preview

Meshview



Przykład wyliczenia charakterystyk przekroju Element typu Beam



SECTION PREVIEW
DATA SUMMARY

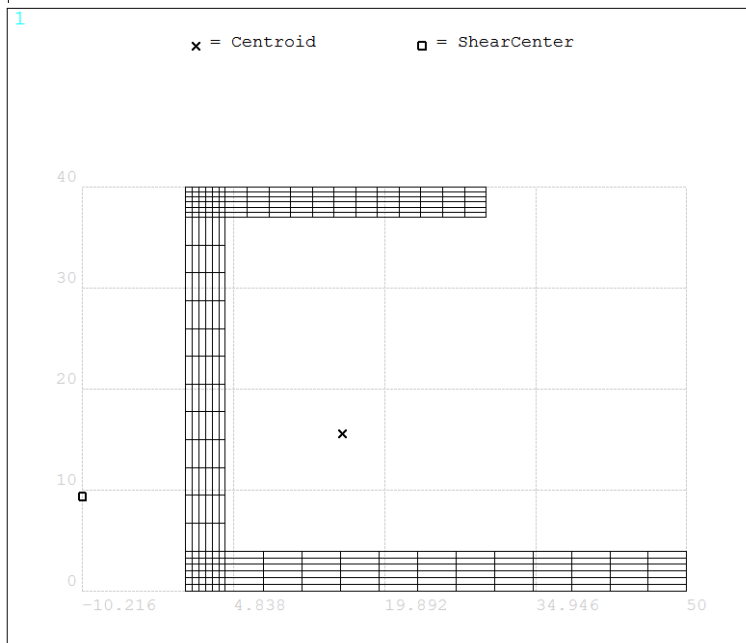
Area = 422
 $I_{yy} = 99671$
 $I_{yz} = -35600.2$
 $I_{zz} = 90709.5$
 Warping Constant = $.115E+08$
 Torsion Constant = 2089.79
 Centroid Y = 15.673
 Centroid Z = 15.5711
 Shear Center Y = -10.1751
 Shear Center Z = 9.31324
 Shear Corr. YY = .534153
 Shear Corr. YZ = .034781
 Shear Corr. ZZ = .26349

Beam Tool

ID: 1
 Name:
 Sub-Type:
 Offset To: Centroid
 Offset-Y: 0
 Offset-Z: 0

W1: 50
 W2: 30
 W3: 40
 t1: 4
 t2: 3
 t3: 4

0
 Coarse Fine
 OK Apply
 Close Preview



SECTION PREVIEW
DATA SUMMARY

Area = 422
 $I_{yy} = 99671$
 $I_{yz} = -35600.2$
 $I_{zz} = 90709.5$
 Warping Constant = $.115E+08$
 Torsion Constant = 2049.35
 Centroid Y = 15.673
 Centroid Z = 15.5711
 Shear Center Y = -10.2158
 Shear Center Z = 9.30517
 Shear Corr. YY = .527199
 Shear Corr. YZ = .034314
 Shear Corr. ZZ = .258845

Beam Tool

ID: 1
 Name:
 Sub-Type:
 Offset To: Centroid
 Offset-Y: 0
 Offset-Z: 0

W1: 50
 W2: 30
 W3: 40
 t1: 4
 t2: 3
 t3: 4

5
 Coarse Fine
 OK Apply
 Close Preview

Przykład zmiany siatki i opcji elementu na przemieszczenia

1 LINES
TYPE NUM
U
ROT
F

ANSYS R19.2
MAY 18 2022 08:02:59
PLOT NO. 7

Belka wspornikowa
Przekrój 30x60mm
Długość 1000mm
Stal
Siła 1000N

1 NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UZ
RSYS=0
DMX =2.4761
SMX =2.4729

ANSYS R19.2
MAY 18 2022 07:58:19
PLOT NO. 1

1 element
Linear Form

Linear Form.
Linear Form.
Quadratic Form.
Cubic Form.

0 .274699 .549397 .824096 1.09879 1.37349 1.64819 1.92289 2.19759 2.47229

1 NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UZ
RSYS=0
DMX =3.0918
SMX =3.0887

ANSYS R19.2
MAY 18 2022 08:00:00
PLOT NO. 3

10 elementów
Linear Form

Linear Form.
Linear Form.
Quadratic Form.
Cubic Form.

0 .343197 .686393 1.02959 1.37279 1.71598 2.05918 2.40238 2.74557 3.08877

1 NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UZ
RSYS=0
DMX =3.0981
SMX =3.0950

ANSYS R19.2
MAY 18 2022 10:03:40
PLOT NO. 1

1 element
Quadratic Form

Quadratic Form.
Linear Form.
Quadratic Form.
Cubic Form.

0 .34389 .68778 1.03167 1.37556 1.71945 2.06334 2.40723 2.75112 3.09501

Przykład zmiany siatki i opcji elementu na naprężenia

1 LINES
TYPE NUM
U
ROT
F

ANSYS
R19.2
MAY 18 2022
08:02:59
PLOT NO. 7

Belka wspornikowa
Przekrój 30x60mm
Długość 1000mm
Stal
Siła 1000N

1 NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SX (AVG)
RSYS=0
DMX =2.47613
SMN =-27.7778
SMX =27.7778

ANSYS
R19.2
MAY 18 2022
07:58:33
PLOT NO. 2

1 element
Linear Form

Linear Form.
Linear Form.
Quadratic Form.
Cubic Form.

-27.7778 -21.6049 -15.4321 -9.25926 -3.08642 3.08642 9.25926 15.4321 21.6049 27.7778

1 NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SX (AVG)
RSYS=0
DMX =3.09187
SMN =-52.7778
SMX =52.7778

ANSYS
R19.2
MAY 18 2022
08:00:13
PLOT NO. 4

10 elementów
Linear Form

Linear Form.
Linear Form.
Quadratic Form.
Cubic Form.

-52.7778 -41.0494 -29.321 -17.5926 -5.8642 5.8642 17.5926 29.321 41.0494 52.7778

1 NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SX (AVG)
RSYS=0
DMX =3.09813
SMN =-55.5556
SMX =55.5556

ANSYS
R19.2
MAY 18 2022
10:03:50
PLOT NO. 2

1 element
Quadratic Form

Quadratic Form.
Linear Form.
Quadratic Form.
Cubic Form.

-55.5556 -43.2099 -30.8642 -18.5185 -6.17284 6.17284 18.5185 30.8642 43.2099 55.5556

Przekroje elementu typu Structural Pipe

Figure 288.1: PIPE288 Geometry

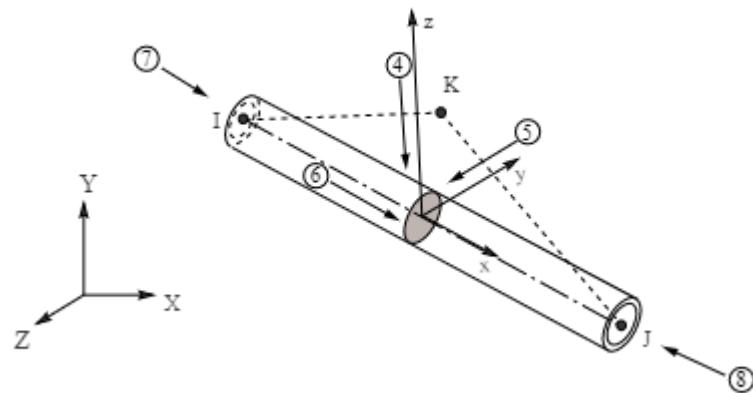
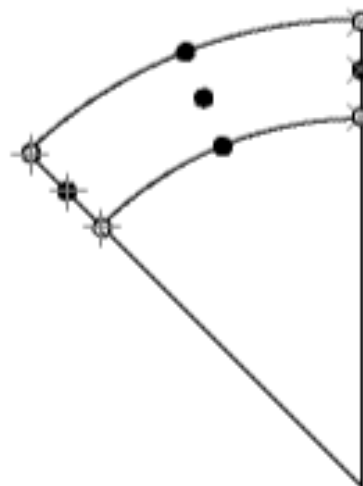


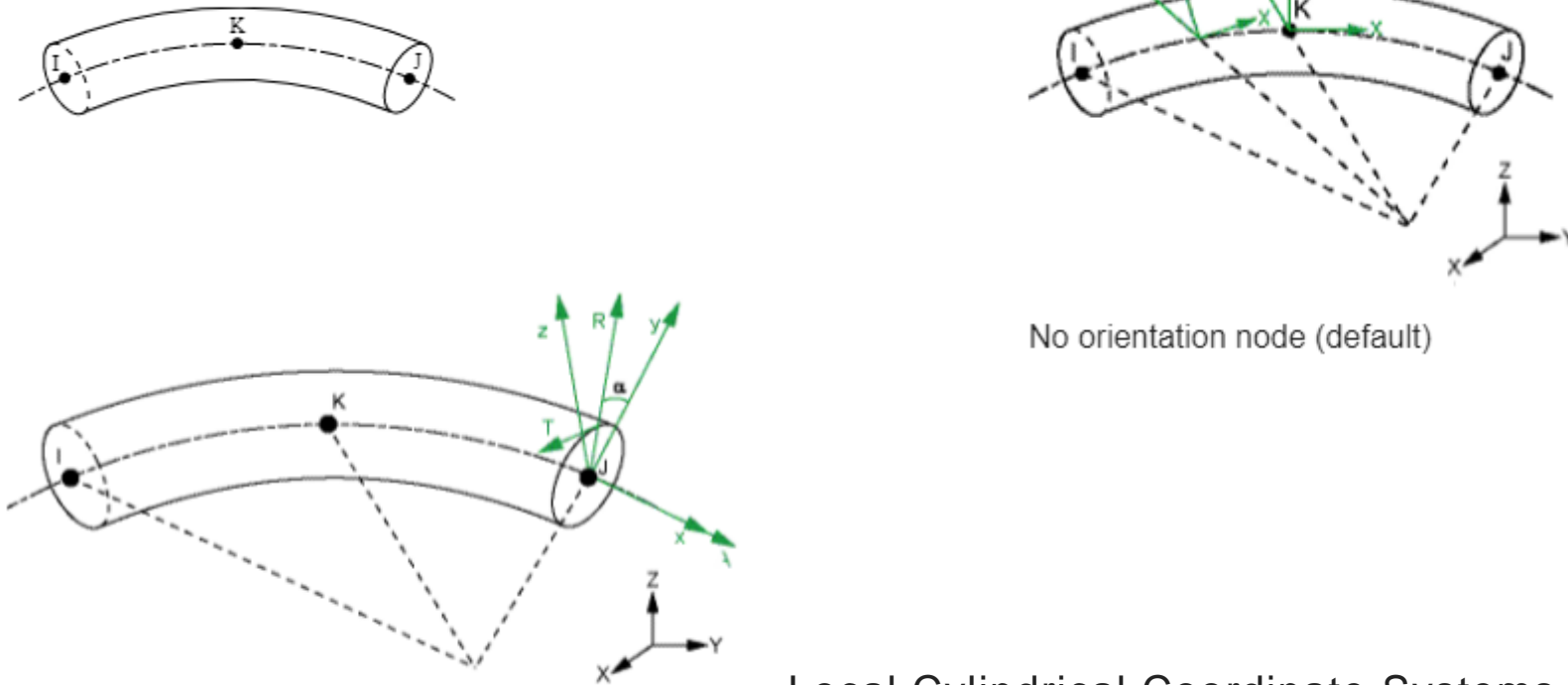
Figure 288.3: Typical Cross-Section Cell



- Section Nodes
- ⊙ Section Corner Nodes
- + Section Integration Points

Element typu Structural Elbow

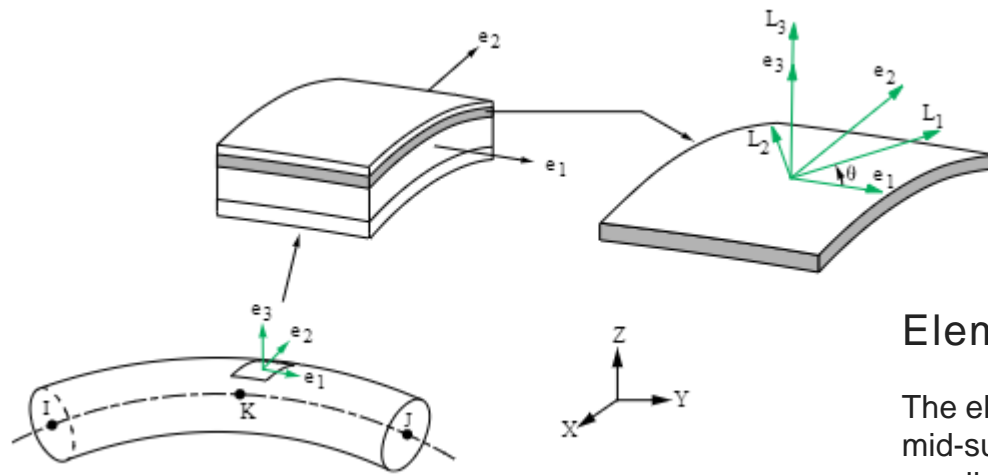
Figure 290.1: ELBOW290 Structural Elbow Geometry



Local Cylindrical Coordinate Systems

The cylindrical coordinate systems (A-R-T) are used for defining internal section motions (that is, axial-A, radial-R, and hoop-T displacements and rotations).

Warstwy w strukturze elementu typu Structural Elbow



Element and Layer Coordinate Systems

The element coordinate systems (e_1 - e_2 - e_3) are defined at the mid-surfaces of the pipe wall. The e_1 , e_2 , and e_3 axes are parallel respectively to cylindrical axes A, T, and R in the undeformed configuration. Each element coordinate system is updated independently to account for large material rotation during a geometrically nonlinear analysis. Support is not available for user-defined element coordinate systems.

The layer coordinate systems (L_1 - L_2 - L_3) are identical to the element coordinate system if no layer orientation angles are specified; otherwise, the layer coordinate system can be generated by rotating the corresponding element coordinate system about the shell normal (axis e_3). Material properties are defined in the layer systems; therefore, the layer system is also called the material coordinate system.

Warunki podparcia w elemencie typu Structural Elbow

Cross-Section Constraints

The constraints on the elbow cross-section can be applied at the element nodes I, J, and K with the following section degrees of freedom labels:

SE – section radial motion (as occurs during expansion or ovalization, for example)

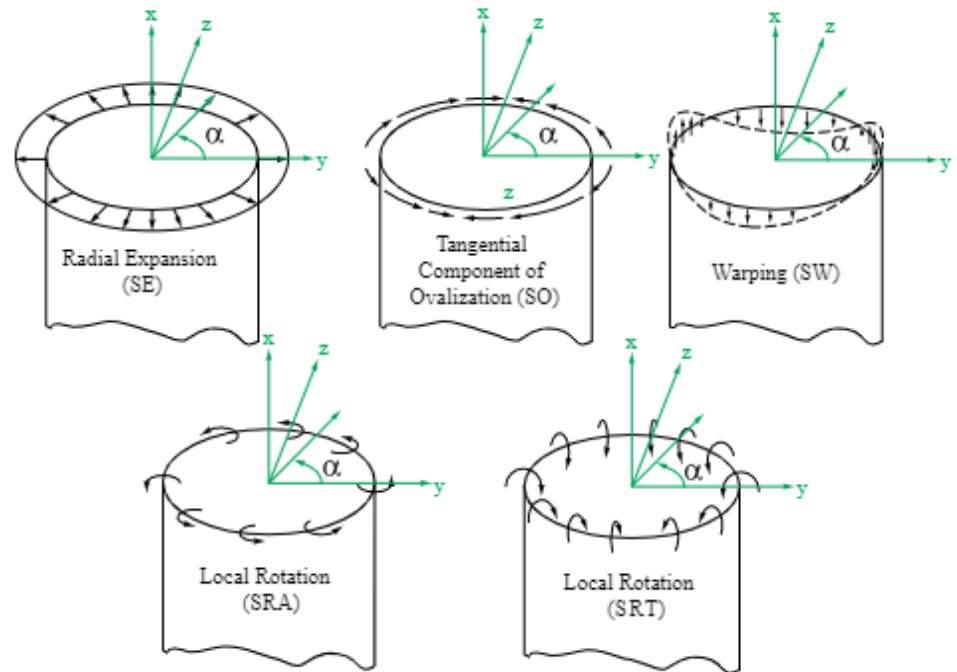
SO – section tangential motion (as occurs during ovalization, for example)

SW – section axial motion (as occurs during warping, for example)

SRA – local shell normal rotation about cylindrical axis A

SRT – local shell normal rotation about cylindrical axis T

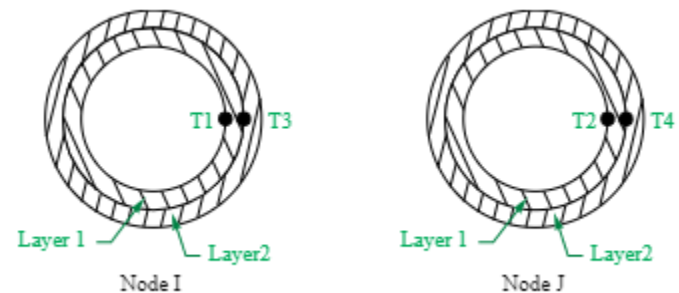
SECT – all section deformation



Only fixed cross-section constraints are allowed via the **D** command. Delete section constraints via the **DDELE** command. For example, to constrain the warping and ovalization of the cross-section at node n , issue this command:

To allow only the radial expansion of the cross-section, use the following commands:

It is not practical to maintain the continuity of cross-section deformation between two adjacent elements joined at a sharp angle. For such cases, ANSYS, Inc. recommends coupling the nodal displacements and rotations but leaving the cross-section deformation uncoupled. The **ELBOW** command can automate the process by uncoupling the cross-section deformation for any adjacent elements with cross-sections intersecting at an angle greater than 20 degrees



Elementy typu Structural Constraints

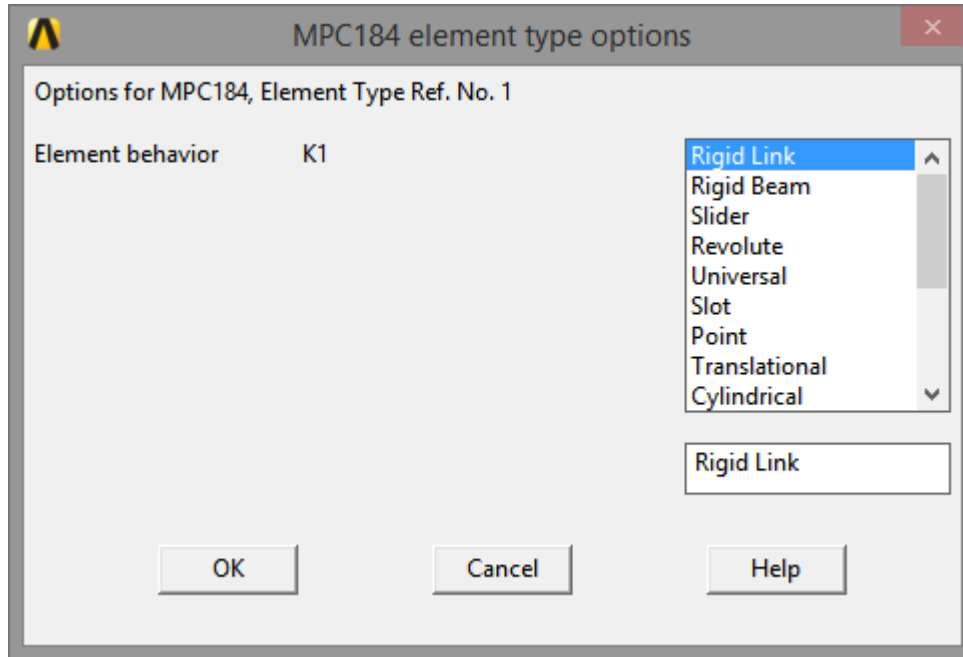
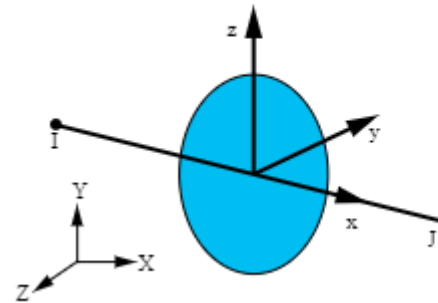


Figure 184link.1: MPC184 Rigid Link/Beam Geometry



Elementy typu Structural Constraints

Joint Elements

Numerical simulations often involve modeling of joints between two parts. These joints or connections may need simple kinematic constraints such as identical displacements between the two parts at the junction or more complicated kinematic constraints that allow for transmission of motion between two flexible bodies. These complex joints may also include some sort of control mechanism like limits or stops, and locks on the components of relative motion between the two bodies. In many instances, these joints may also have stiffness, damping, or friction forces based on the unconstrained components of relative motion between the two bodies. For detailed information on how to use joint elements, see [Connecting Multibody Components with Joint Elements](#) in the [Multibody Analysis Guide](#).

The following types of joint elements are available:

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

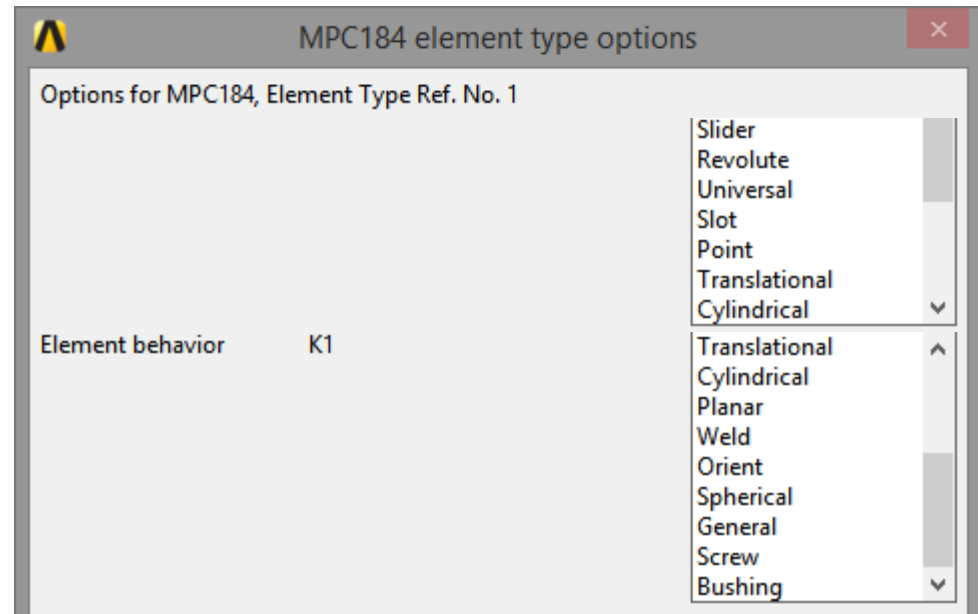
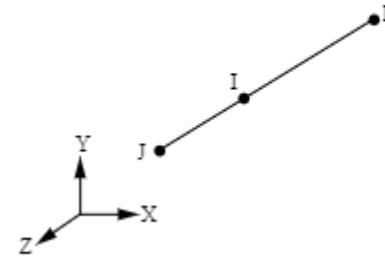
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184slid.1: MPC184 Slider Geometry



Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

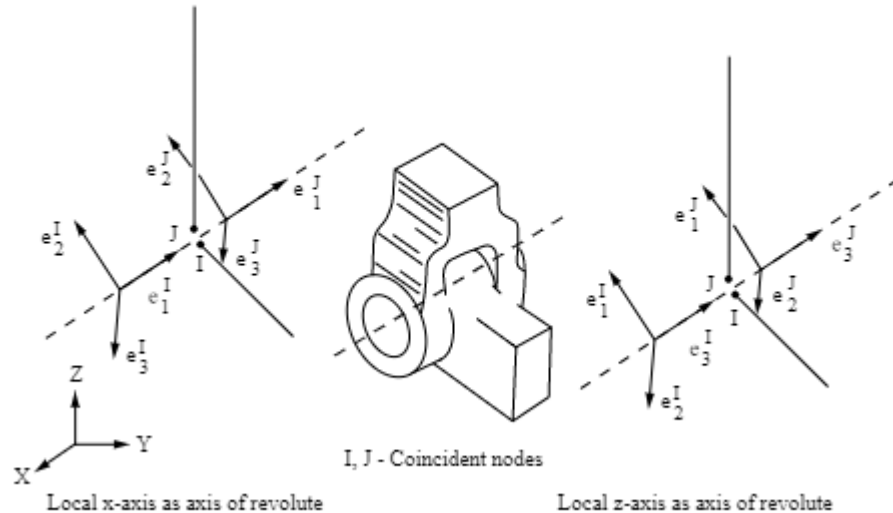
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184revo.1: MPC184 Revolute Joint Geometry



The [MPC184](#) revolute joint is a two-node element that has only one primary degree of freedom, the relative rotation about the revolute (or hinge) axis. This element imposes kinematic constraints such that the nodes forming the element have the same displacements. Additionally, only a relative rotation is allowed about the revolute axis, while the rotations about the other two directions are fixed.

The [MPC184](#) revolute joint is a two-node element that has only one primary degree of freedom, the relative rotation about the revolute (or hinge) axis. This element imposes kinematic constraints such that the nodes forming the element have the same displacements. Additionally, only a relative rotation is allowed about the revolute axis, while the rotations about the other two directions are fixed.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

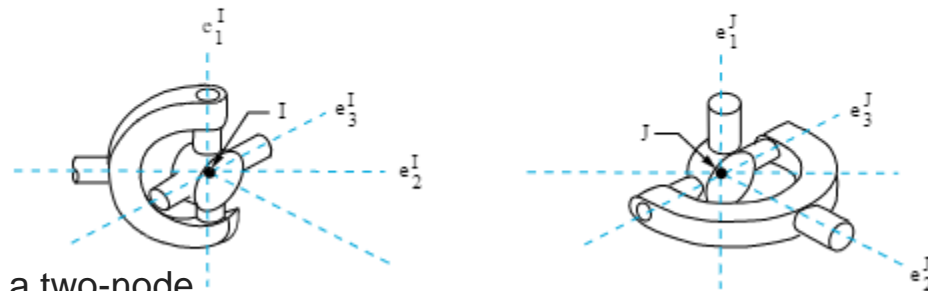
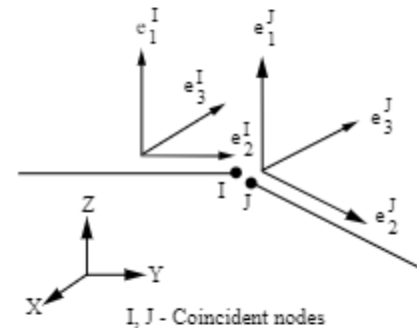
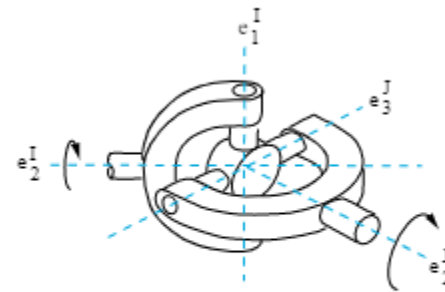
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184univ.1: MPC184 Universal Joint Geometry



The [MPC184](#) universal joint element is a two-node element that has two free relative rotational degrees of freedom. The two nodes forming the element must have identical spatial coordinates.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

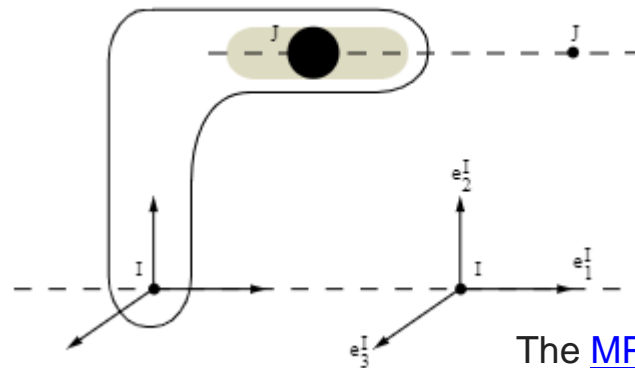
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

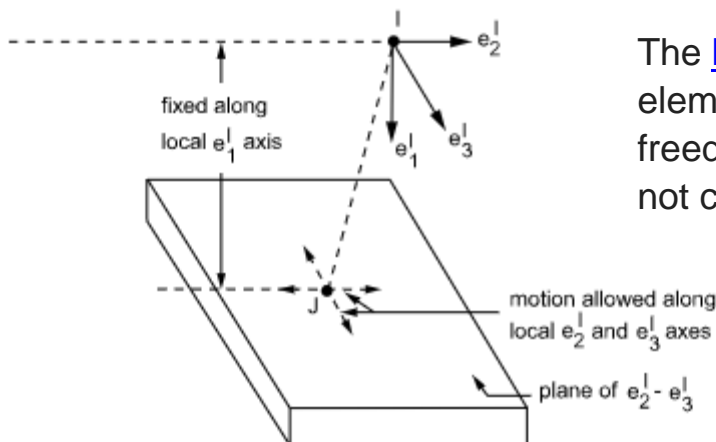
[Screw joint](#)

Figure 184slot.1: MPC184 Slot Joint Geometry



The [MPC184](#) slot joint element is a two-node element that has one relative displacement degree of freedom. The rotational degrees of freedom at nodes I and J are left free.

Figure 184point.1: MPC184 Point-in-plane Joint Geometry



The [MPC184](#) point-in-plane joint element is a two-node element that has two relative displacement degrees of freedom. The relative rotational degrees of freedom are not considered and cannot be controlled.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

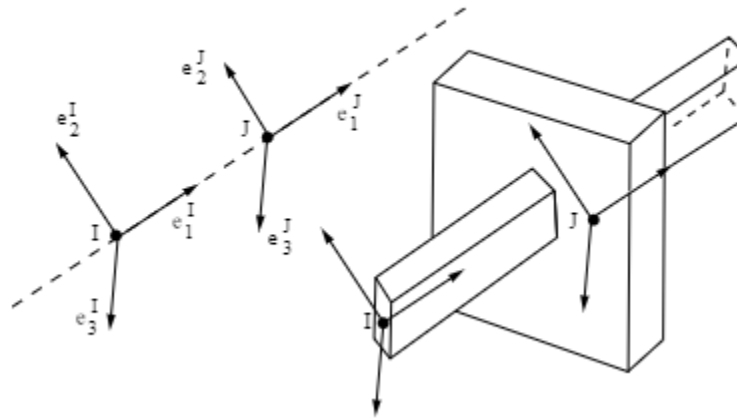
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184tran.1: MPC184 Translational Joint Geometry



The [MPC184](#) translational joint element is a two-node element that has one relative displacement degree of freedom. All other relative degrees of freedom are fixed.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

[Orient joint](#)

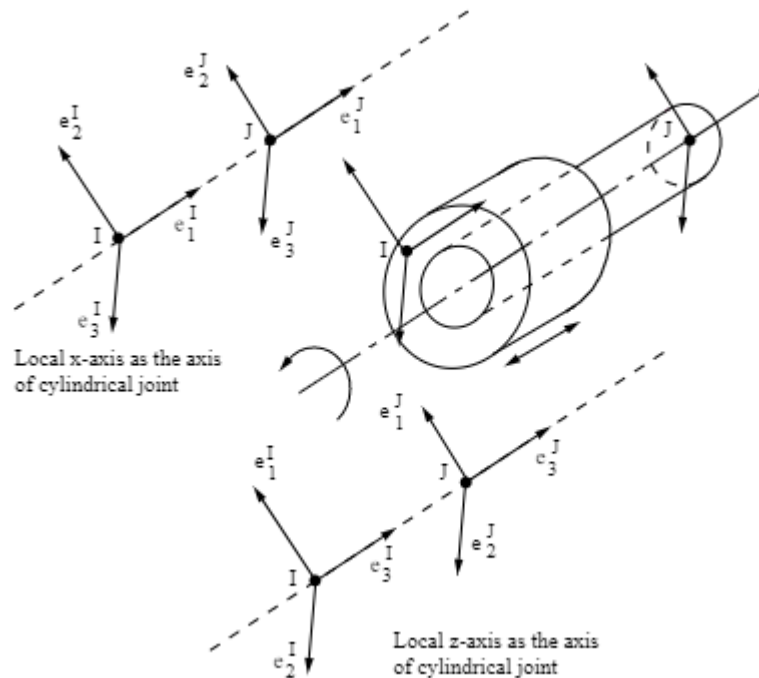
[Spherical joint](#)

[General joint](#)

[Screw joint](#)

The [MPC184](#) cylindrical joint element is a two-node element that has one free relative displacement degree of freedom and one free relative rotational degree of freedom (around the cylindrical or revolute axis). All other relative degrees of freedom are fixed.

Figure 184cyl.1: MPC184 Cylindrical Joint Geometry



The [MPC184](#) revolute joint is a two-node element that has only one primary degree of freedom, the relative rotation about the revolute (or hinge) axis. This element imposes kinematic constraints such that the nodes forming the element have the same displacements. Additionally, only a relative rotation is allowed about the revolute axis, while the rotations about the other two directions are fixed.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

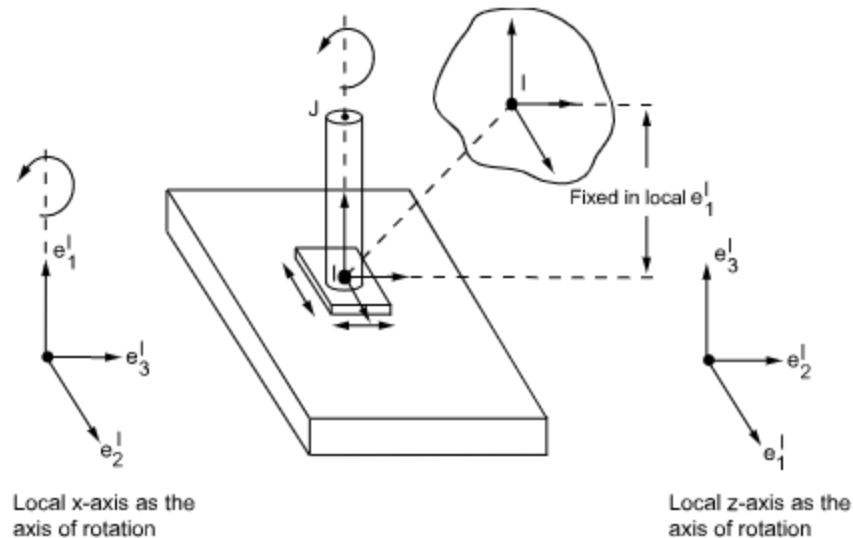
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184plan.1: MPC184 Planar Joint Geometry

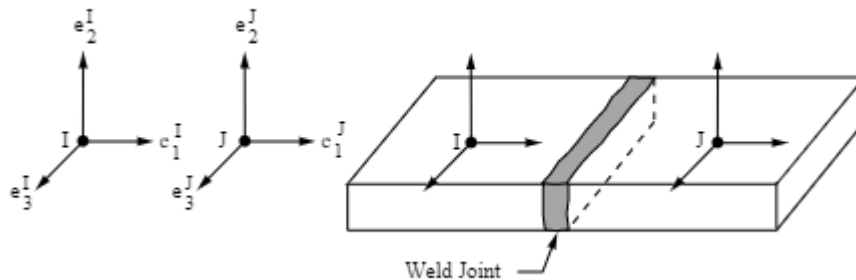


Local x-axis as the axis of rotation

Local z-axis as the axis of rotation

The [MPC184](#) planar joint element is a two-node element that has two relative displacement degrees of freedom and one relative rotational degree of freedom. All other relative degrees of freedom are fixed.

Figure 184weld.1: MPC184 Weld Joint Geometry



The [MPC184](#) weld joint element is a two-node element that has all relative degrees of freedom fixed.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

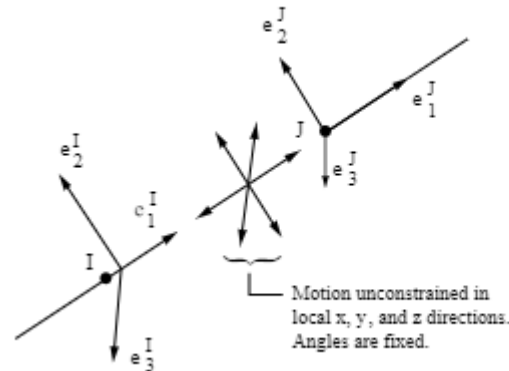
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

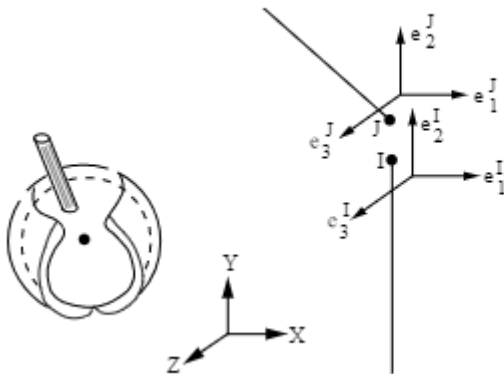
[Screw joint](#)

Figure 184orie.1: MPC184 Orient Joint Geometry



The [MPC184](#) orient joint is a two-node element. In this joint, the relative rotational degrees of freedom are fixed while the displacement degrees of freedom are left free.

Figure 184sphe.1: MPC184 Spherical Joint Geometry



The [MPC184](#) spherical joint element is a two-node element with the relative displacement degrees of freedom constrained. The relative rotational degrees of freedom are left unconstrained. These rotations cannot be controlled. The kinematic constraints are imposed using the Lagrange multiplier method.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

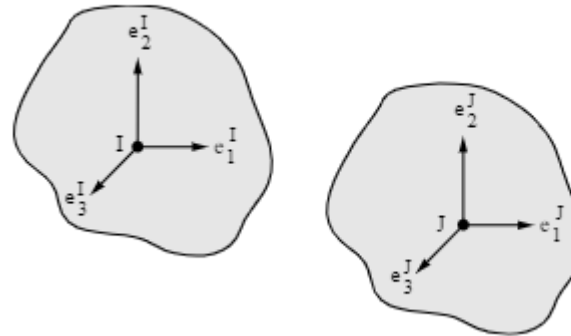
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184gen.1: MPC184 General Joint Geometry



The [MPC184](#) general joint is a two-node element. By default, no relative degrees of freedom are fixed. However, you can specify which relative degrees of freedom need to be constrained. By specifying as many relative degrees of freedom to be constrained as needed, you can simulate different joint elements.

Elementy typu Structural Constraints

[x-axis Revolute joint](#)

[z-axis Revolute joint](#)

[Universal joint](#)

[Slot joint](#)

[Point-in-plane joint](#)

[Translational joint](#)

[x-axis Cylindrical joint](#)

[z-axis Cylindrical joint](#)

[x-axis Planar joint](#)

[z-axis Planar joint](#)

[Weld joint](#)

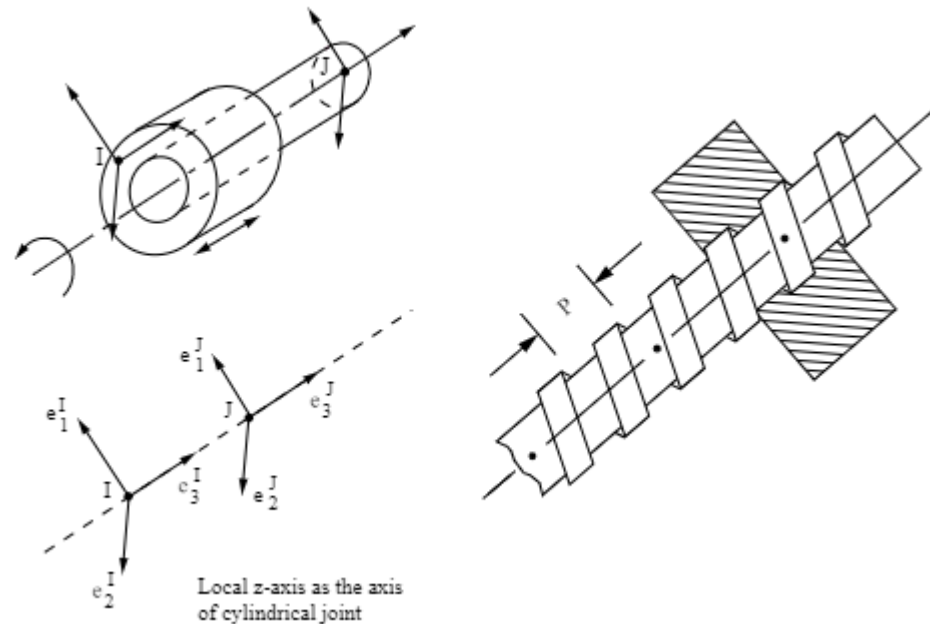
[Orient joint](#)

[Spherical joint](#)

[General joint](#)

[Screw joint](#)

Figure 184scr.1: MPC184 Screw Joint Geometry



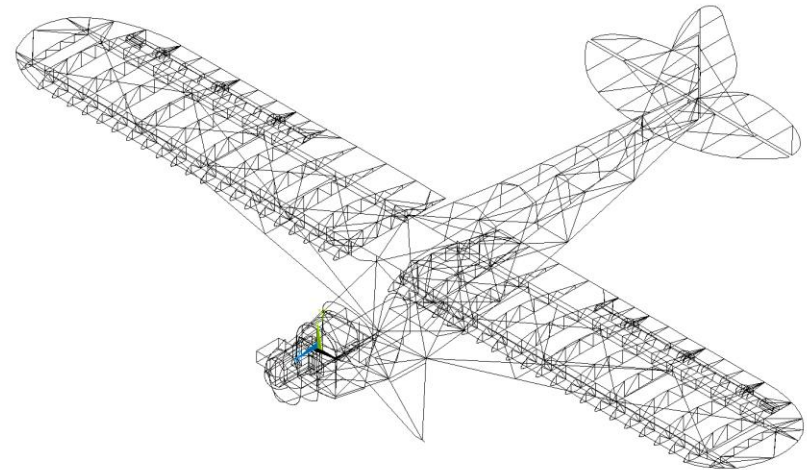
The [MPC184](#) screw joint element is a two-node element which is very similar to the cylindrical joint element in construction. Whereas the cylindrical Joint element has two free relative degrees of freedom, the screw Joint has only one. In a screw joint, the “pitch” of the screw relates the relative rotation angle (around the cylindrical or screw axis) to the relative translational displacement along the axis of the screw. All other relative degrees of freedom are fixed



LINES
TYPE NUM

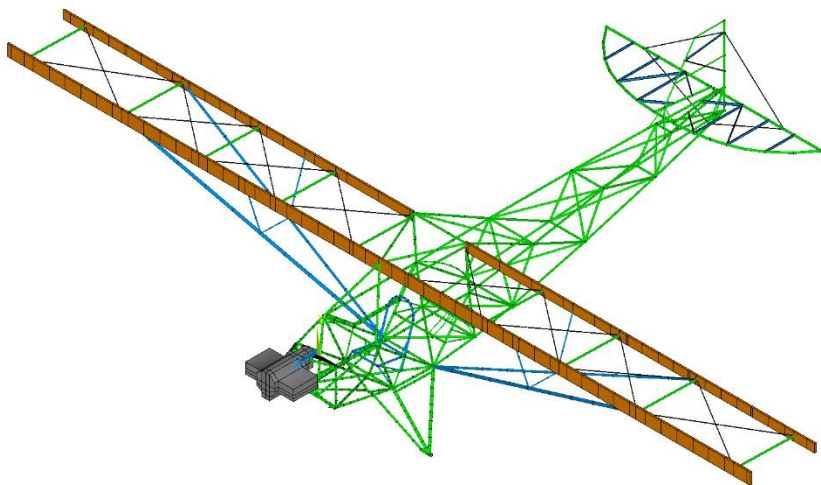
Struktura samolotu lekkiego Piper L-4

ANSYS
MAY 12 2002
16:32:00
PLOT NO. 1

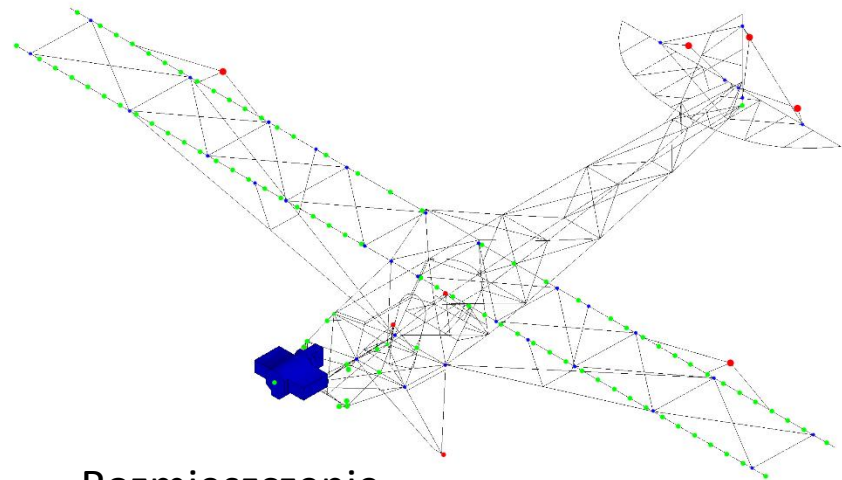


ELEMENTS

ANSYS
MAY 14 2002
18:06:41
PLOT NO. 1

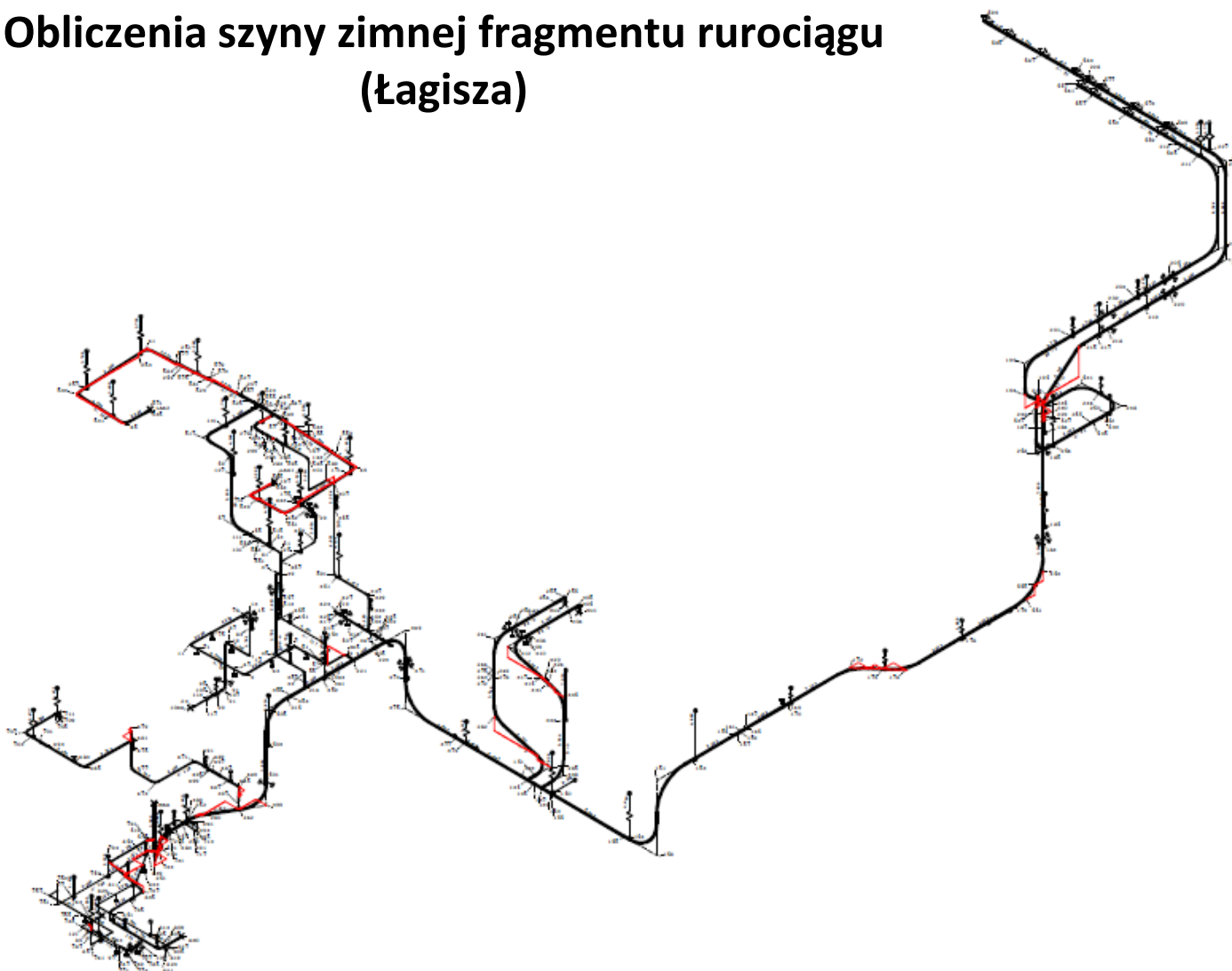


Model belkowy MES



Rozmieszczenie
mas skupionych
w modelu zastępczym

Obliczenia szyny zimnej fragmentu rurociągu (łagisza)



Legenda :

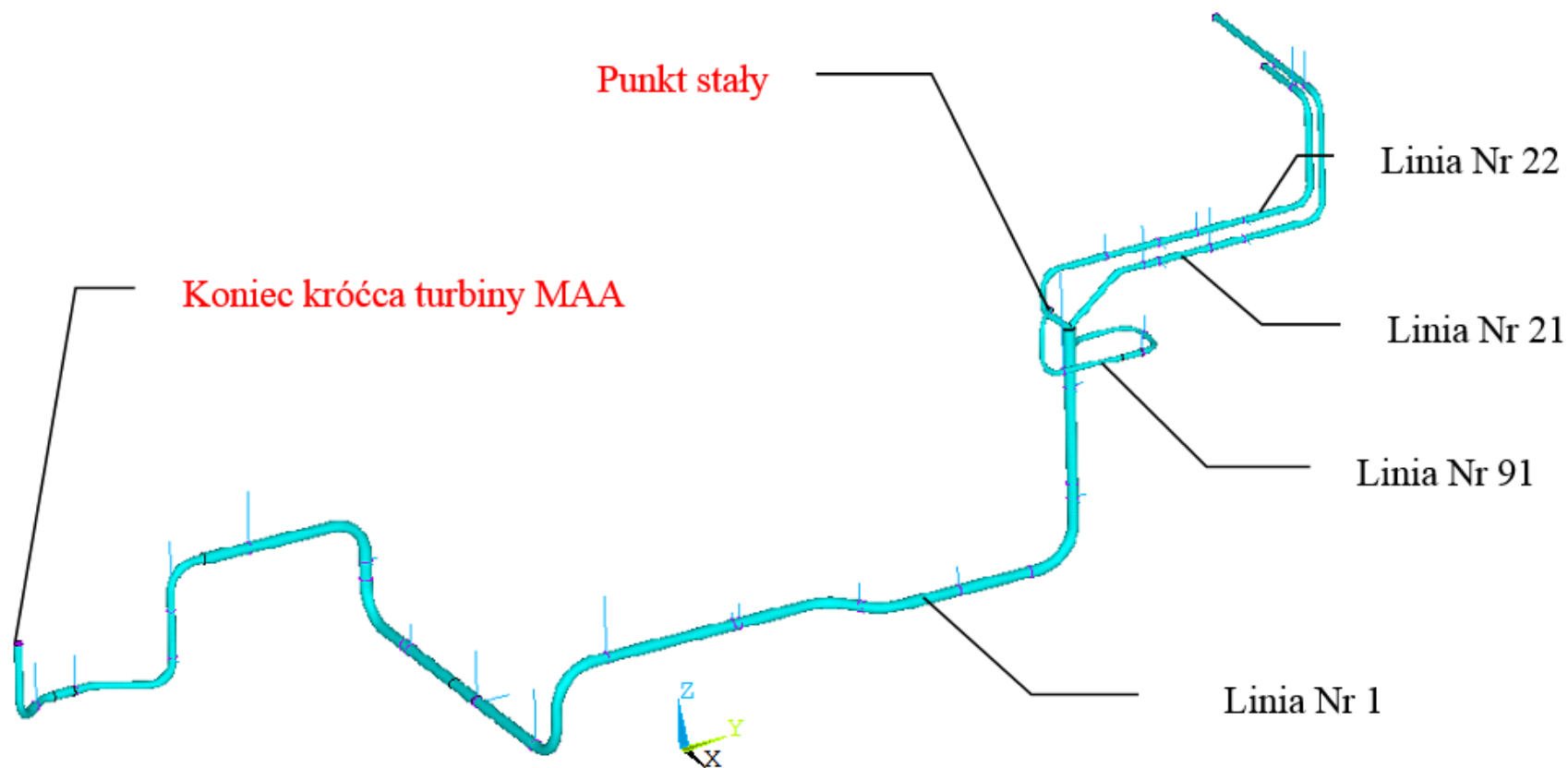
X	Węzeł przelotowy	Ø	Średnica (średnica)
T	W-20/20/20	W	Węzeł 3-dobowy
p	W-20/20/20	W	Węzeł 3-dobowy
w	Węzeł	W	Węzeł 3-dobowy
T	Węzeł 3-dobowy	W	Węzeł 3-dobowy



JB	projekt	projekt	projekt
auftrag	projekt	projekt	projekt
projekt	projekt	projekt	projekt
in schaltung	projekt	projekt	projekt

ELEMENTS
TYPE NUM

ANSYS
JUL 12 2010
22:16:01
PLOT NO. 27



Line 1&91, 21&92, 22&93 <Model_Shell_hanged_NNNN.db> ciez=53.8bar, T330

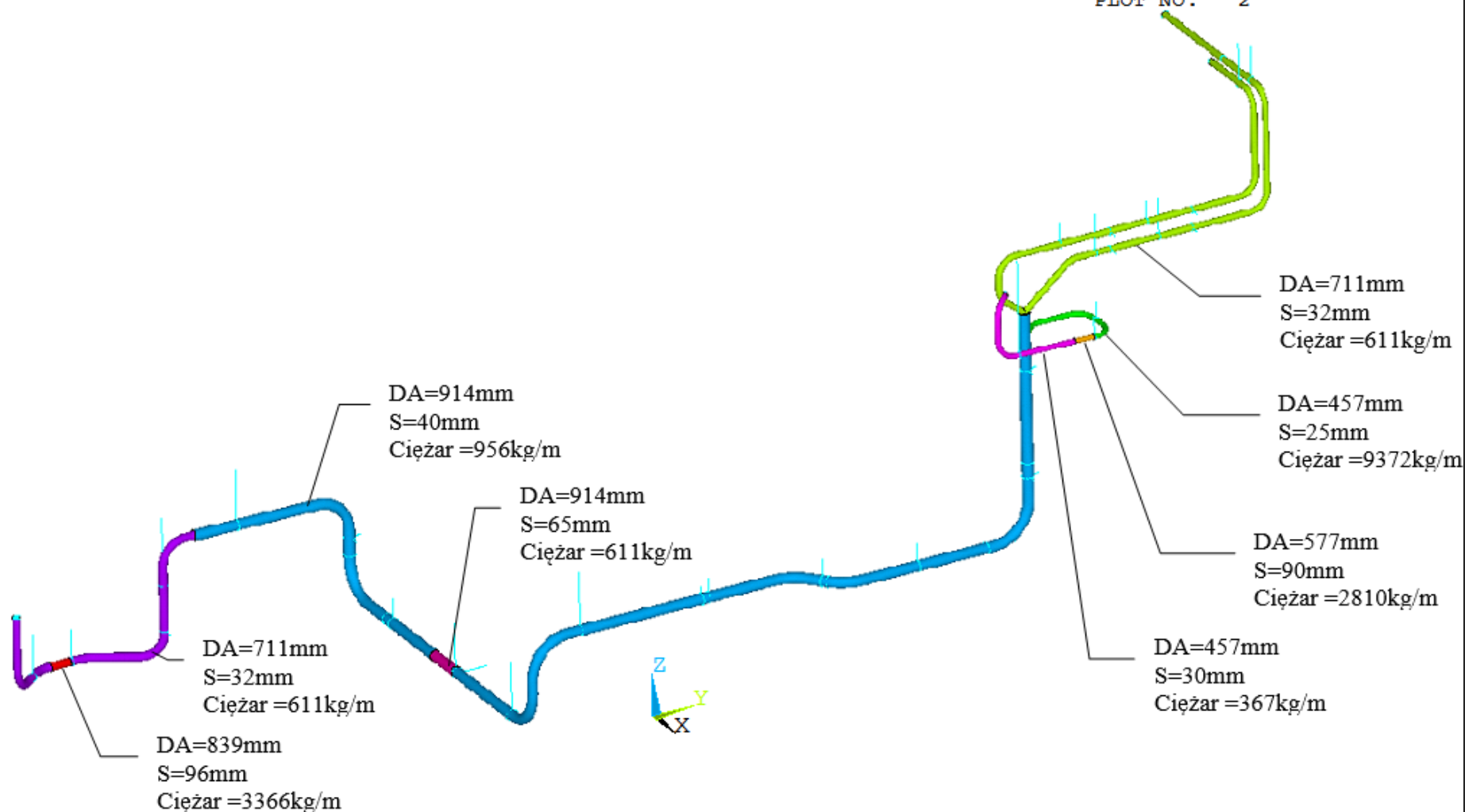
Rys.2. Analizowany fragment instalacji

ELEMENTS

MAT NUM

ANSYS

JUL 12 2010
22:04:56
PLOT NO. 2



Line 1&91, 21&92, 22&93 <Model_Shell_hanged_NNNN.db> ciez=53.8bar, T330

Rys.3. Parametry geometryczne rur i obciążenie masowe na jednostkę długości

ELEMENTS
REAL NUM
U
ACEL

Wieszak:
LH=5.634m
CH=1 e20 kN/m

ANSYS

JUL 12 2011

PAGE NO 8/100

Wieszak:
LH=3.484m
CH=266.65 kN/m

Wieszak:
LH=2.69m
CH=333.33 kN/m

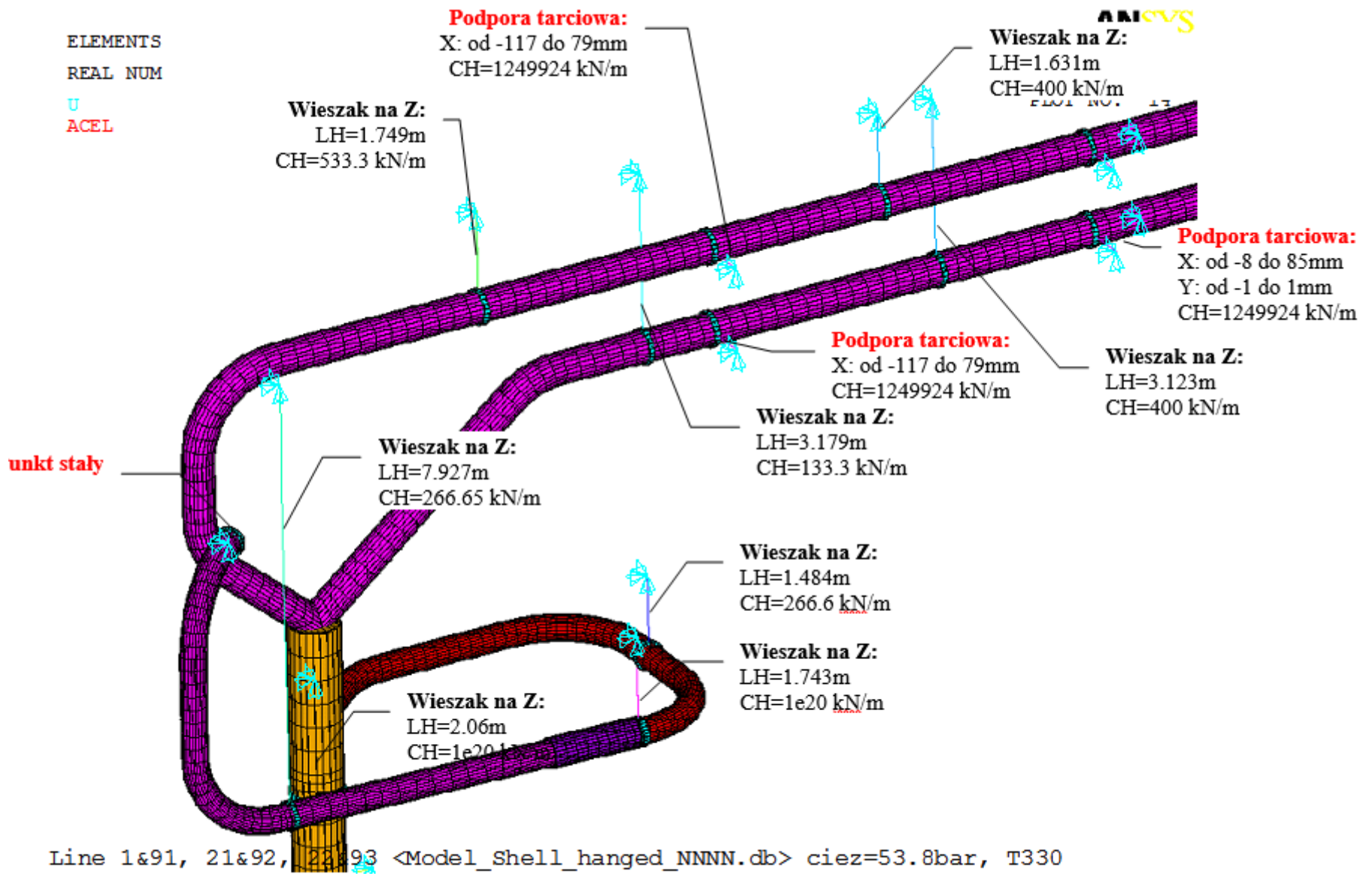
Podpora tarciowa:
X: od -28 do 0mm
CH=2022084 kN/m

Line 1&91, 21&92, 22&93 <Model_Shell_hanged_NNNN.db> ciez=53.8bar, T330

ELEMENTS
REAL NUM
U
ACEL**Wieszak:**
LH=4.533m
CH=666.65 kN/m**Wieszak:**
LH=5.634m
CH=1 e20 kN/m**Podpora tarciova:**
X: od -20 do 30mm
Y: od 0 do 170mm
CH=3341584 kN/m**Wieszak na Z:**
LH=1.63m
CH=1e20 kN/m

Line_1_91, 21&92, 22&93 <Model_Shell_hanged_NNNN.db> ciez=53.8bar, T330

Rys.4. Parametry mocowań



Rys.7. Parametry mocowań (c.d.)

NODAL SOLUTION

STEP=1
SUB =1
TIME=1
USUM (AVG)
RSYS=0
DMX =.171825
SMX =.171825

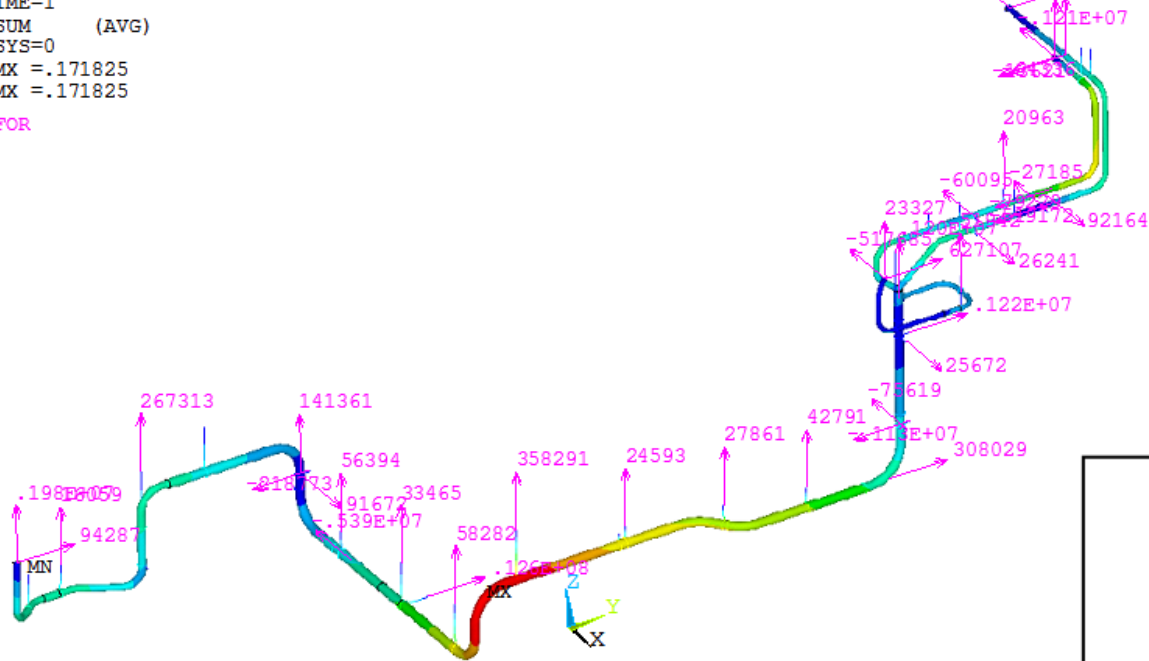
RFOR

ANSYS

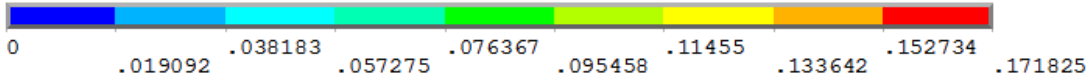
JUL 13 2010

11:50:21:31

PLOT NO: 9091



Ciężar własny
Ciśnienie 53.8bara
Temperatura 330°C



<Model_Shell_hanged_X.db>:L 1&91, 21&92, 22&93: ciez,53.8bar, T330

Rys.8. Przemieszczenia wypadkowe (w metrach)
i reakcje w punktach mocowań (w Niutonach)

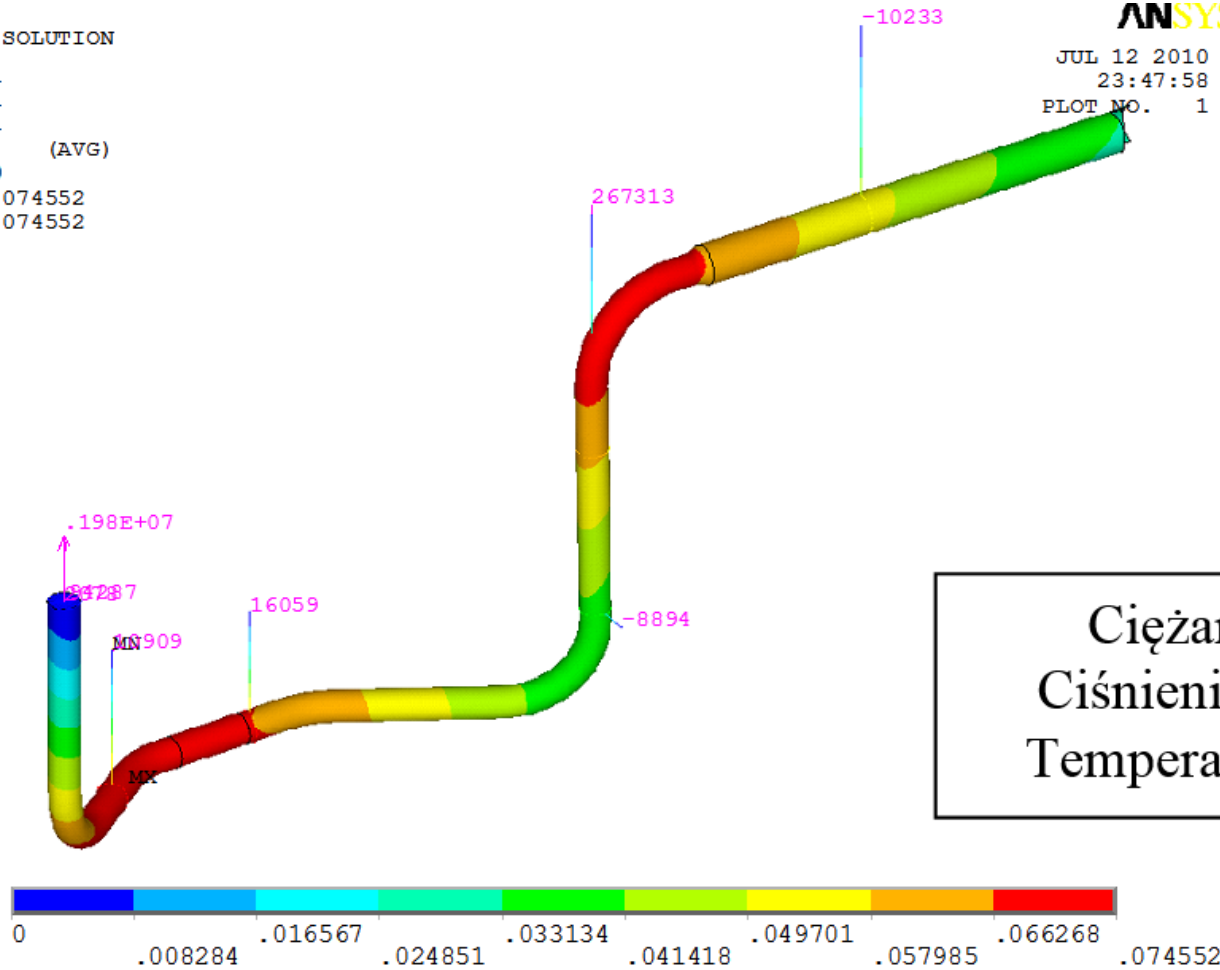
ANSYS

JUL 12 2010
23:47:58
PLOT NO. 1

NODAL SOLUTION

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SUB =1
TIME=1
USUM (AVG)
RSYS=0
DMX =.074552
SMX =.074552

RFOR



<Model_Shell_hanged_X.db>:L 1&91, 21&92, 22&93: cieź,53.8bar, T330

Rys.9. Przemieszczenia wypadkowe (w metrach)
i reakcje w punktach mocowań (w Niutonach)