SCIA ENGINEER

VALIDATION MANUAL

FE RESULTS

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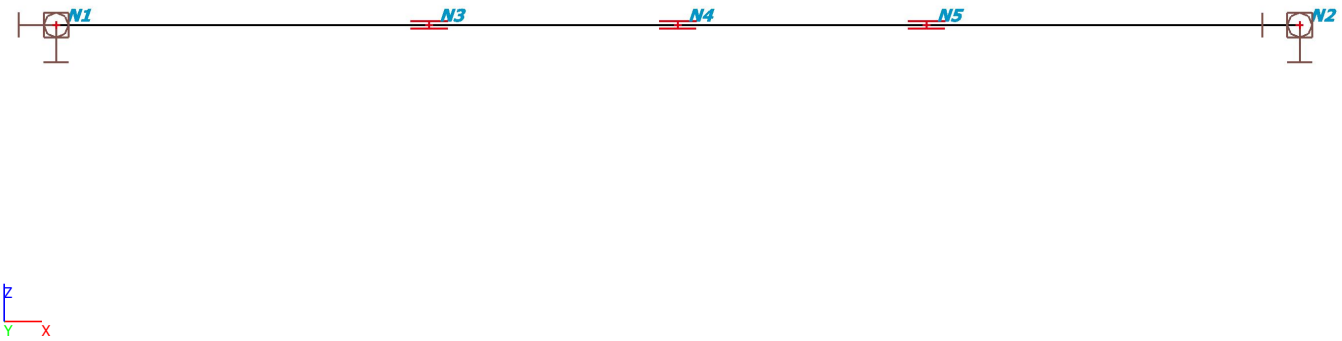
1. TESTCASE DESCRIPTION

Uni-directional bending of an elastic (Euler) beam. Length: L = 1,0 m, fixed ends. Section: Iz=1.7e-8, E=2.1e11

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	Sn1
N2	1.000	0.000	0.000	B1	Sn2
N3	0.300	0.000	0.000	B1	F1
					M1

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N4	0.500	0.000	0.000	B1	
N5	0.700	0.000	0.000	B1	F2
					F3

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS4 - Full rectangular (21; 21)	S 235	1.000	N1	N2	beam (80)

2.4. Nodal supports

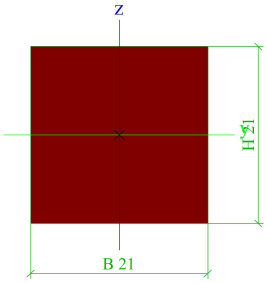
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn2	N2	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

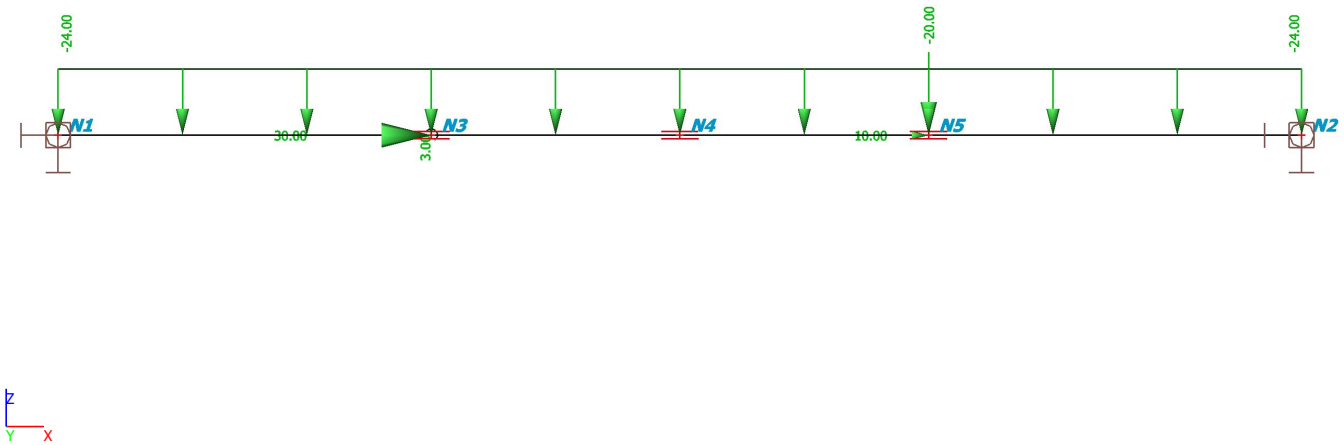
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS4		
Type	Full rectangular	
Detailed	21; 21	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m^2]	4.5166e-04	
A_y [m^2], A_z [m^2]	3.7639e-04	3.7639e-04
A_L [m^2/m], A_D [m^2/m]	8.5010e-02	8.5010e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	11	11
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.7000e-08	1.7000e-08
i_y [mm], i_z [mm]	6	6
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	1.5998e-06	1.5998e-06
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	2.3997e-06	2.3997e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	563.94	563.94
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	563.94	563.94
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	2.8709e-08	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC1 / Tot. value



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N3	LC1	GCS	X	Force	30.00
F2	N5	LC1	GCS	X	Force	10.00
F3	N5	LC1	GCS	Z	Force	-20.00

3.3. Line force

Name	Member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Coor	Orig	Ecc ey [m]
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Loc		Ecc ez [m]
LF1	B1	Force	Z	-24.00	0.000	Rela	From start	0.000
	LC1	LCS	Uniform		1.000	Length		0.000

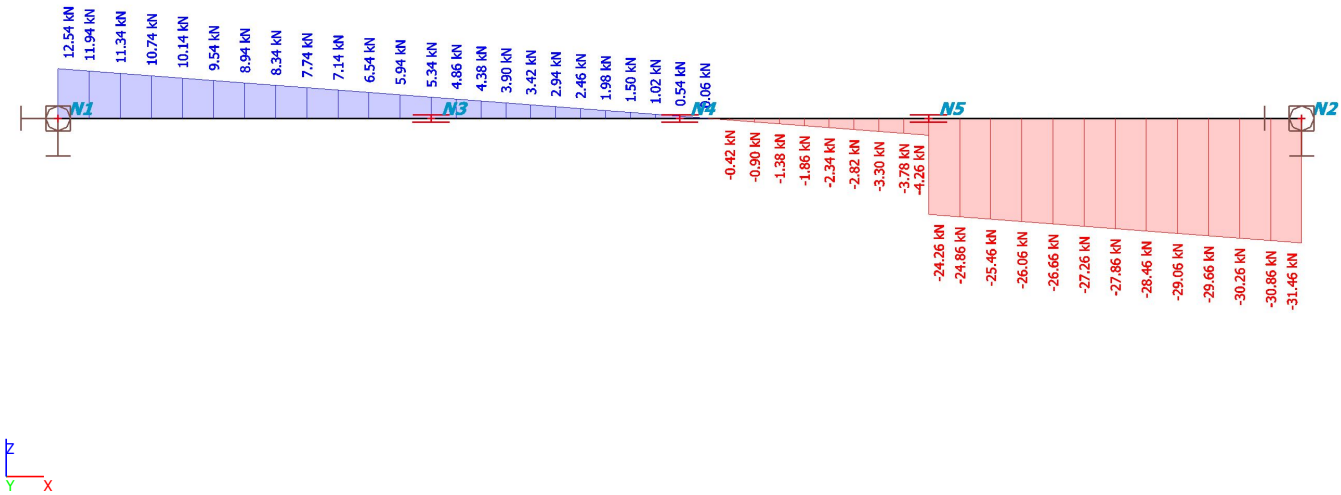
3.4. Moment in node

Name	Node	Load case	System	Dir	Type	Value - M [kNm]
M1	N3	LC1	GCS	My	Moment	3.00

4. RESULTS

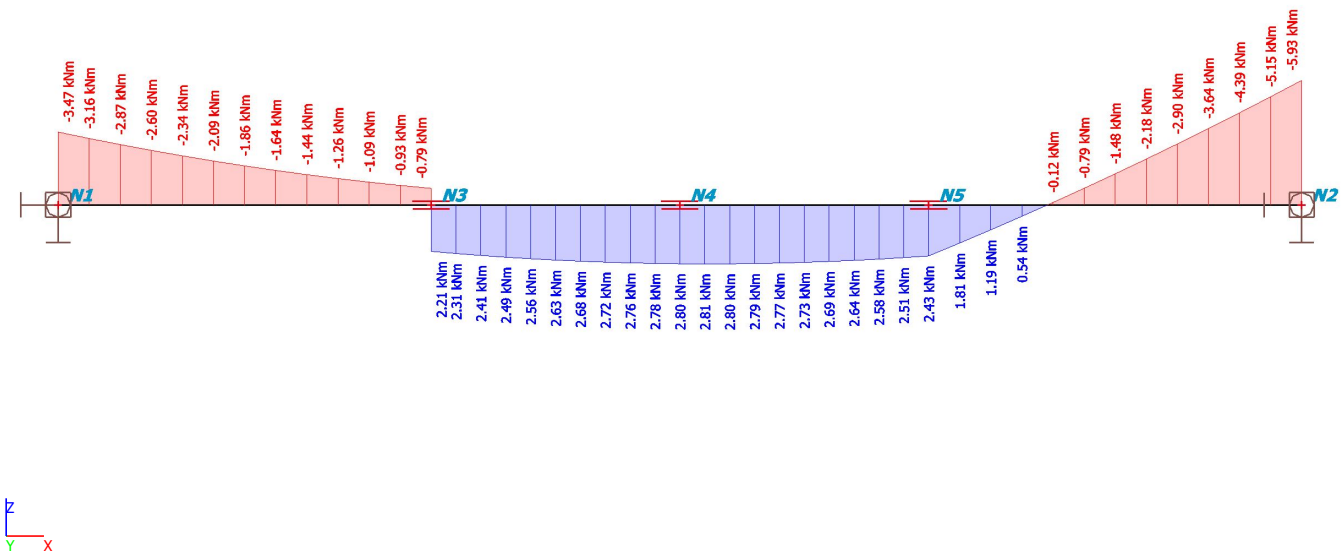
4.1. 1D internal forces; V_z

Values: V_z
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Section
Selection: All



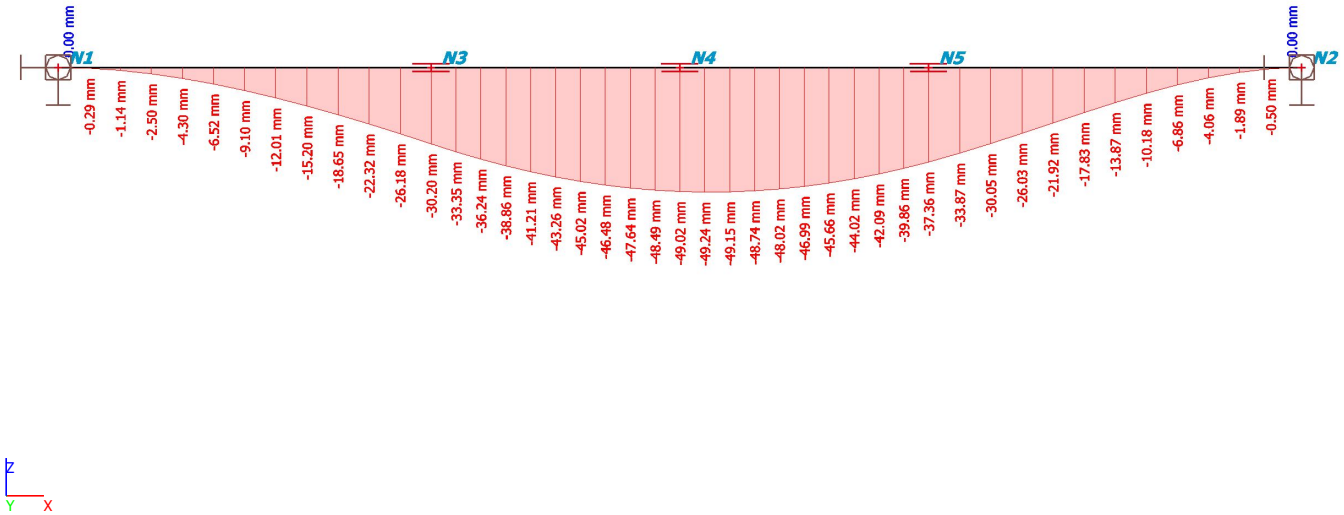
4.2. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Section
Selection: All



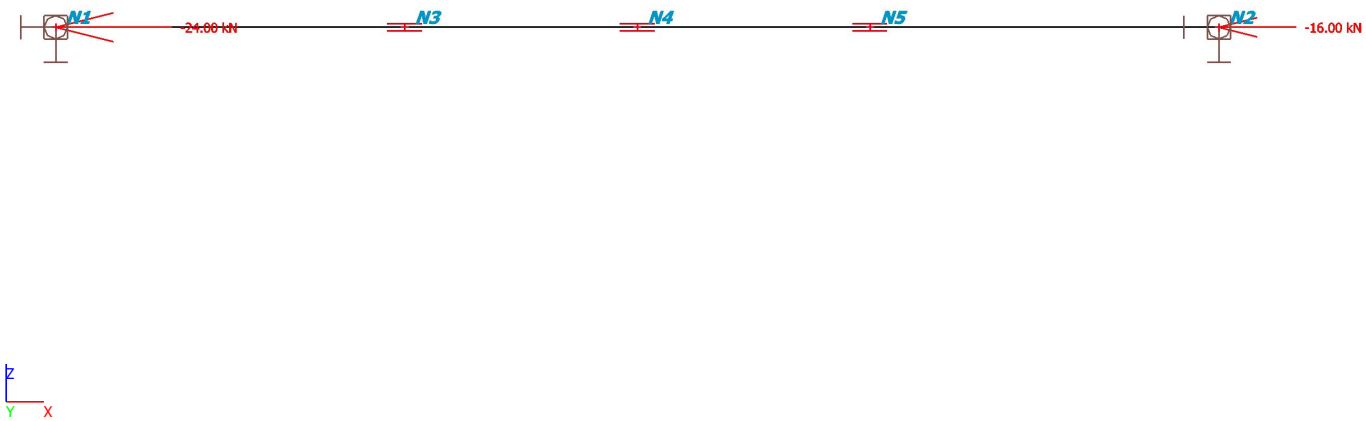
4.3. 1D deformations; u_z

Values: u_z
Linear calculation
Load case: LC1
Coordinate system: Global
Extreme 1D: Section
Selection: All



4.4. Reactions; R_x

Values: R_x
Linear calculation
Load case: LC1
System: Global
Extreme: Global
Selection: All



4.5. Reactions

Linear calculation
Load case: LC1
System: Global
Extreme: Global
Selection: All
Nodal reactions

Name	Case	R_x [kN]	R_y [kN]	R_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]	e_x [mm]	e_y [mm]
Sn2/N2	LC1	**-16.00**	**0.00**	**31.46**	**0.00**	**5.93**	**0.00**	-188.49	0.00
Sn1/N1	LC1	**-24.00**	0.00	**12.54**	0.00	**-3.47**	**0.00**	276.71	0.00

5. EXPECTED AFNOR RESULTS

Shear Force in node N4 = 0,54 kN
Bending Moment in node N4 = 2,80 kNm
Vertical displacement in node N4 = -49,02 mm
Horizontal reaction in node N1 = -24,00 kN

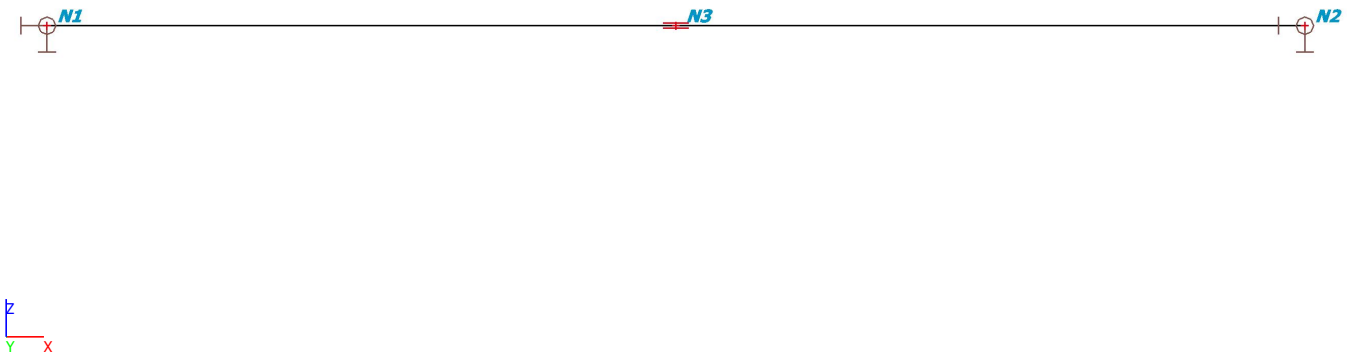
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Influence of shearing stresses (Timoshenko's beam). Length: L = 1,44 m, simply supported ends.
Elastic, linear, isotropic material. Section: Iz=2810e-8, Ax=31e-4, Ay=(31E-4/2.42), E=2.1e11

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	Sn1
N2	1.440	0.000	0.000	B1	Sn2
N3	0.720	0.000	0.000	B1	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Numerical	STEEL	1.440	N1	N2	beam (80)

2.4. Nodal supports

Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Free	Rigid
Sn2	N2	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Free	Rigid

2.5. Materials

Steel EC3

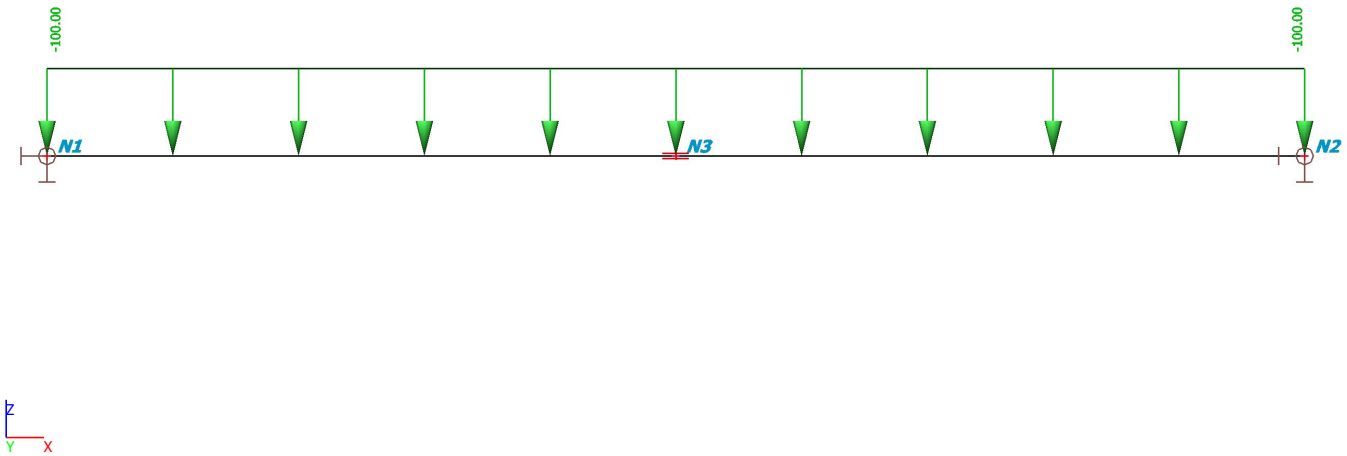
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
STEEL	7850.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS2		
Detailed	Numerical	
A [m^2]	3.1000e-03	
A_y [m^2], A_z [m^2]	1.2810e-03	1.2810e-03
A_L [m^2/m], A_D [m^2/m]	0.0000e+00	0.0000e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	0	0
α [deg]	0.00	
I_y [m^4], I_z [m^4]	2.8100e-05	2.8100e-05
i_y [mm], i_z [mm]	95	95
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	1.7000e-08	1.7000e-08
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	1.7000e-08	1.7000e-08
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	0.00	0.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	0.00	0.00
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	1.0000e+01	0.0000e+00
β_y [mm], β_z [mm]	0	0

3. LOAD

3.1. LC1 / Tot. value



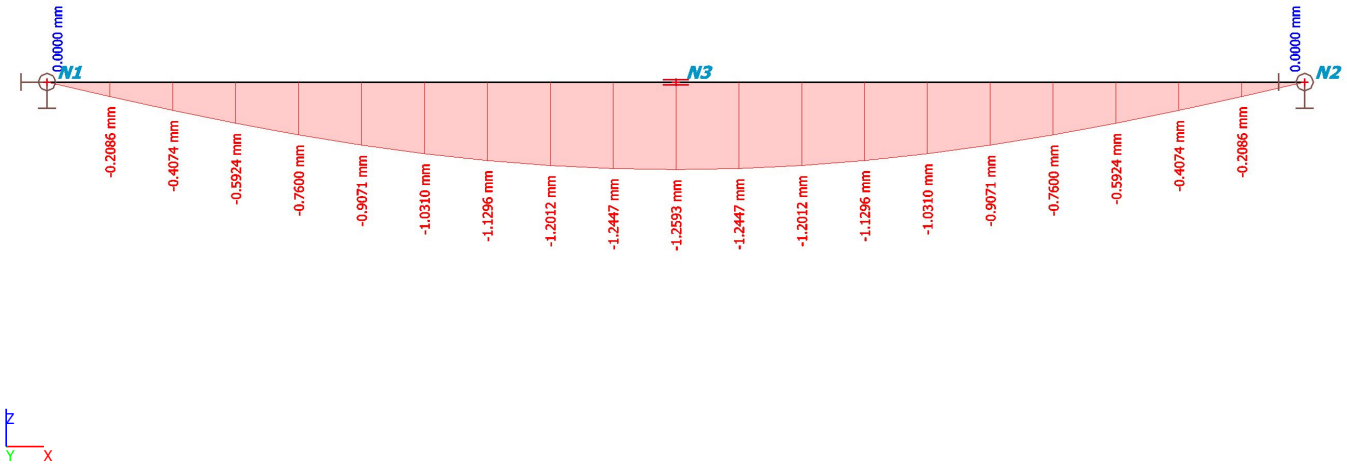
3.2. Line force

Name	Member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Coor	Orig	Ecc ey [m]
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Loc		Ecc ez [m]
LF1	B1	Force	Z	-100.00	0.000	Rela	From start	0.000
	LC1	LCS	Uniform		1.000	Length		0.000

4. RESULTS

4.1. 1D deformations; u_z

Values: u_z
Linear calculation
Load case: LC1
Coordinate system: Global
Extreme 1D: Section
Selection: All



5. EXPECTED AFNOR RESULTS

Vertical displacement in node N3 = -1,2593 mm

REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simple Euler beam under bending with elastic support in the center of length;
Material: elastic, linear, isotropic.
Length: L = 12 m, simply supported at ends and in the middle
Section: Iz=6.3 e-4, E=2.1e11
Stiffness Kz=2.1 e6 N/m

2. MODEL

2.1. Analysis model

2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	Sn1
N2	12.000	0.000	0.000	B1	Sn2
N3	6.000	0.000	0.000	B1	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Rectangle (295; 295)	S 235	12.000	N1	N2	beam (80)

2.4. Nodal supports

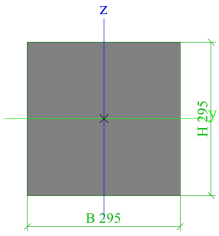
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free
Sn2	N2	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS1		
Type	Rectangle	
Detailed	295; 295	
Item material	S 235	
A [m^2]	8.6948e-02	
A_y [m^2], A_z [m^2]	7.2488e-02	7.2488e-02
A_L [m^2/m], A_D [m^2/m]	1.1795e+00	1.1795e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	147	147
α [deg]	0.00	
I_y [m^4], I_z [m^4]	6.3000e-04	6.3000e-04
i_y [mm], i_z [mm]	85	85
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	4.2731e-03	4.2731e-03
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	6.4096e-03	6.4096e-03
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	1506258.95	1506258.95
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	1506258.95	1506258.95
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	1.0632e-03	8.8484e-08
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2

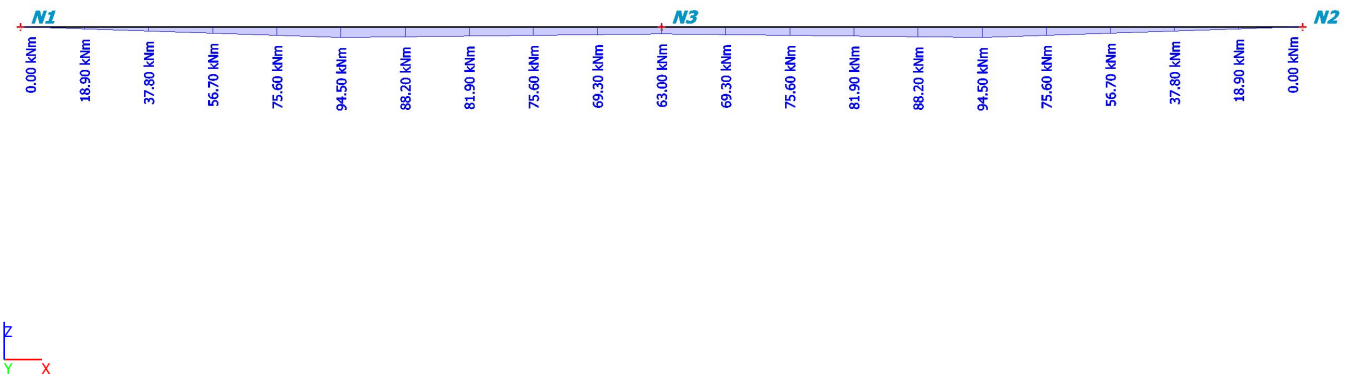
3.2. Point force on beam

Name	Member	System	Value - F [kN]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb1	B1	GCS	-42.00	0.250	Rela	1
	LC2 - charge	Z	Force		From start	
Fb2	B1	GCS	-42.00	0.750	Rela	1
	LC2 - charge	Z	Force		From start	

4. RESULTS

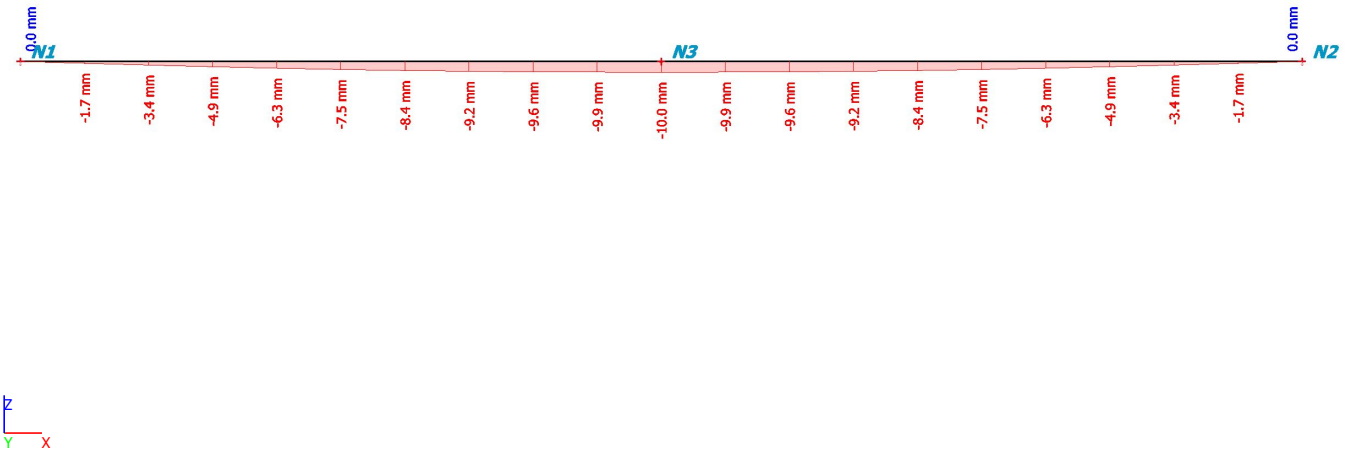
4.1. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All



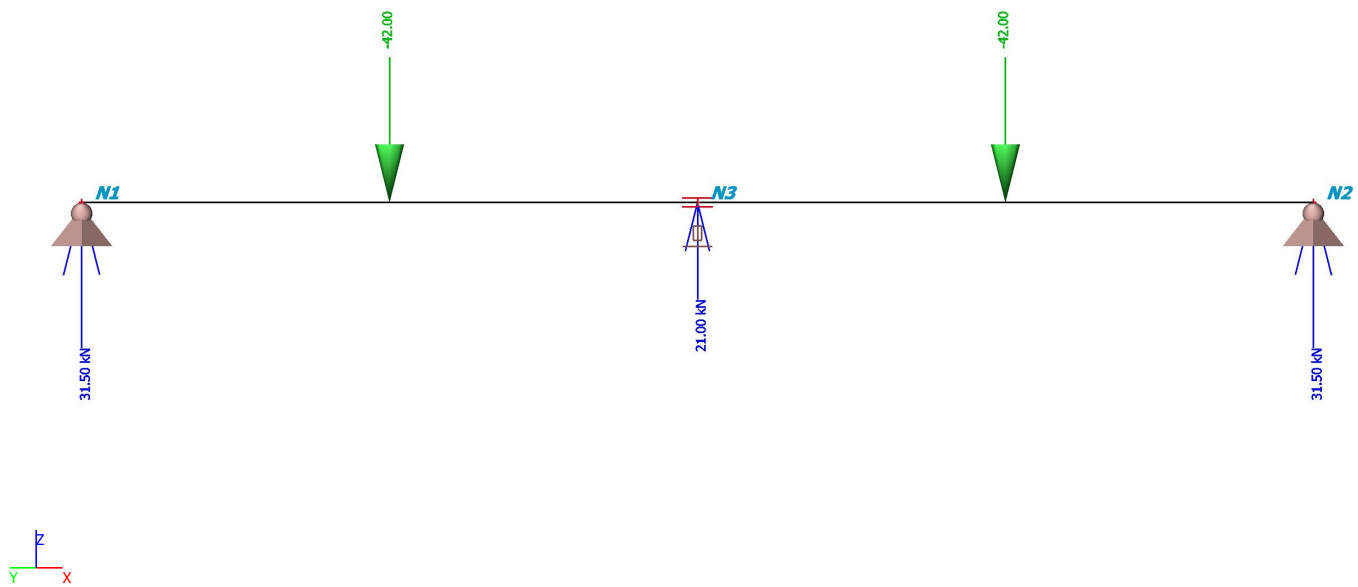
4.2. 1D deformations; u_z

Values: u_z
Linear calculation
Load case: LC2
Coordinate system: Global
Extreme 1D: Section
Selection: All



4.3. Reactions; R_z

Values: R_z
Linear calculation
Load case: LC2
System: Global
Extreme: No
Selection: All



5. EXPECTED AFNOR RESULTS

Bending Moment in node N3 = 63,00 kNm
Displacement Uz in node N3 = -10,00 mm
Vezrtical reaction in node N3 = 21,00 kN

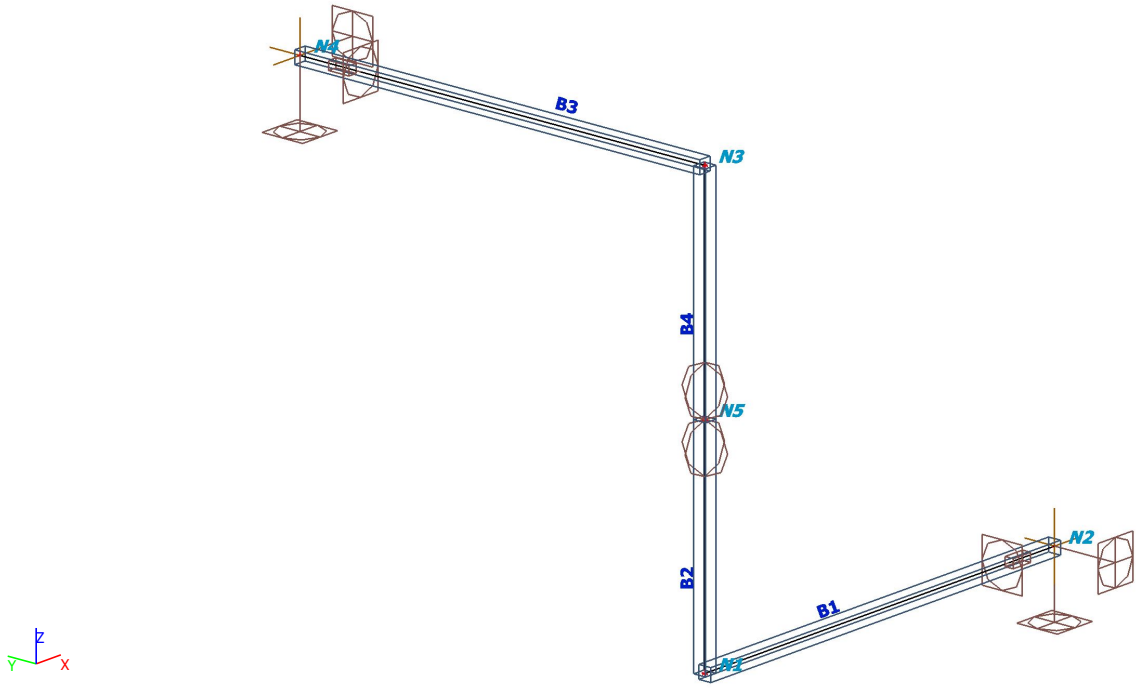
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Spatial bar with elastic supports, under bending and torsion; material: elastic, linear, isotropic (non-compressible bars assumed)

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	
				B2	
N2	2.000	0.000	0.000	B1	
N3	0.000	0.000	2.000	B3	F1
				B4	

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N4	0.000	2.000	2.000	B3	
N5	0.000	0.000	1.000	B2	
				B4	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Full rectangular (59; 59)	S 235	2.000	N1	N2	general (0)
B2	CS1 - Full rectangular (59; 59)	S 235	1.000	N1	N5	general (0)
B3	CS1 - Full rectangular (59; 59)	S 235	2.000	N3	N4	general (0)
B4	CS1 - Full rectangular (59; 59)	S 235	1.000	N5	N3	general (0)

2.4. Hinges

Name	Member	Position	ux	uy	uz	fix	fiy	fiz
H1	B4	Begin	Rigid	Rigid	Rigid	Rigid	Free	Free
H2	B2	End	Rigid	Rigid	Rigid	Rigid	Free	Free

2.5. Point supports on member

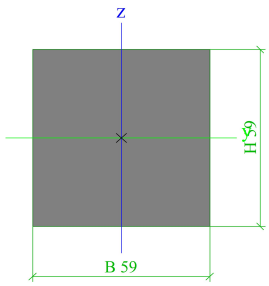
Name	Type	Coor System	Pos x Orig	dx Rep (n)	X	Y	Z	Rx	Ry	Rz
Sb1	Standard	Rela	0.000		Flexible	Rigid	Rigid	Rigid	Flexible	Flexible
		LCS	From end	1						
Sb2	Standard	Rela	0.000		Flexible	Rigid	Rigid	Rigid	Flexible	Flexible
		GCS	From end	1						

2.6. Materials

Steel EC3

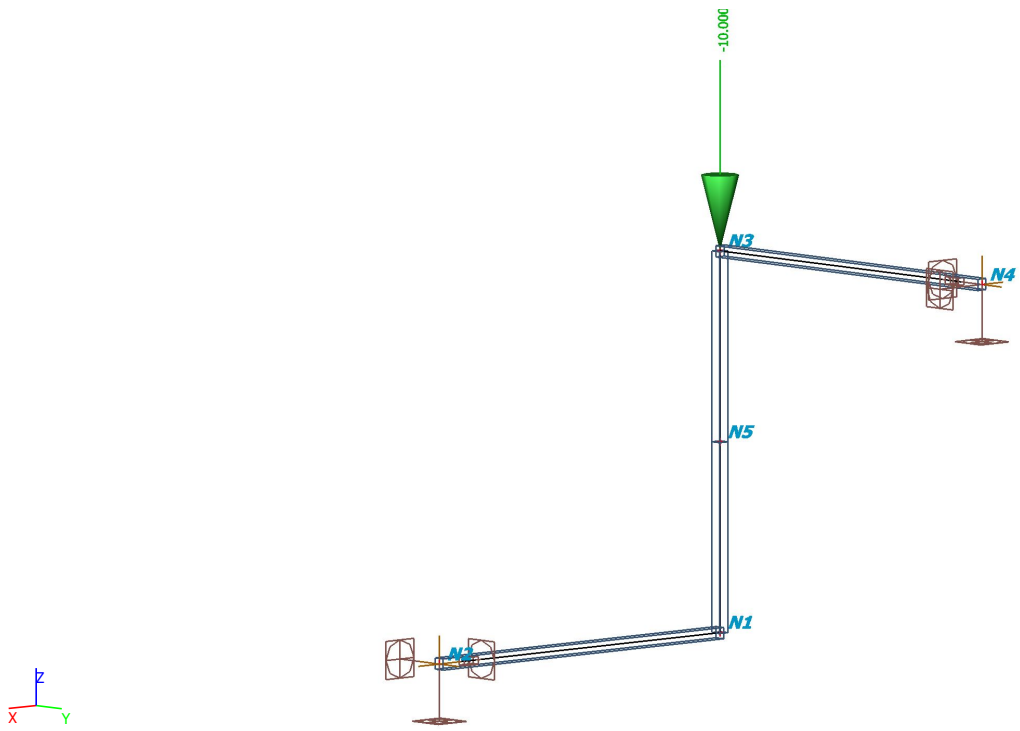
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		7.8750e+04	0.01e-003	40	80	215.0	360.0	

2.7. Cross-sections

CS1		
Type	Full rectangular	
Detailed	59; 59	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m²]	1.0000e-03	
A_y [m²], A_z [m²]	2.8868e-03	2.8868e-03
A_L [m²/m], A_D [m²/m]	2.3543e-01	2.3543e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	29	29
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.0000e-06	1.0000e-06
i_y [mm], i_z [mm]	32	32
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	3.3981e-05	3.3981e-05
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.4714e-05	1.4714e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	3457.83	3457.83
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	3457.83	3457.83
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	2.0000e-06	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Valeur totale



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N3	LC2 - Permanent	GCS	Z	Force	-10.000

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N3, N4

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N4	LC2	**0.00**	**-29.76**	**0.00**	**160.7**	**0.0**	**-59.5**	29.76
N3	LC2	**-138.88**	**-29.78**	**-370.07**	**193.5**	**19.8**	**-74.4**	**396.39**

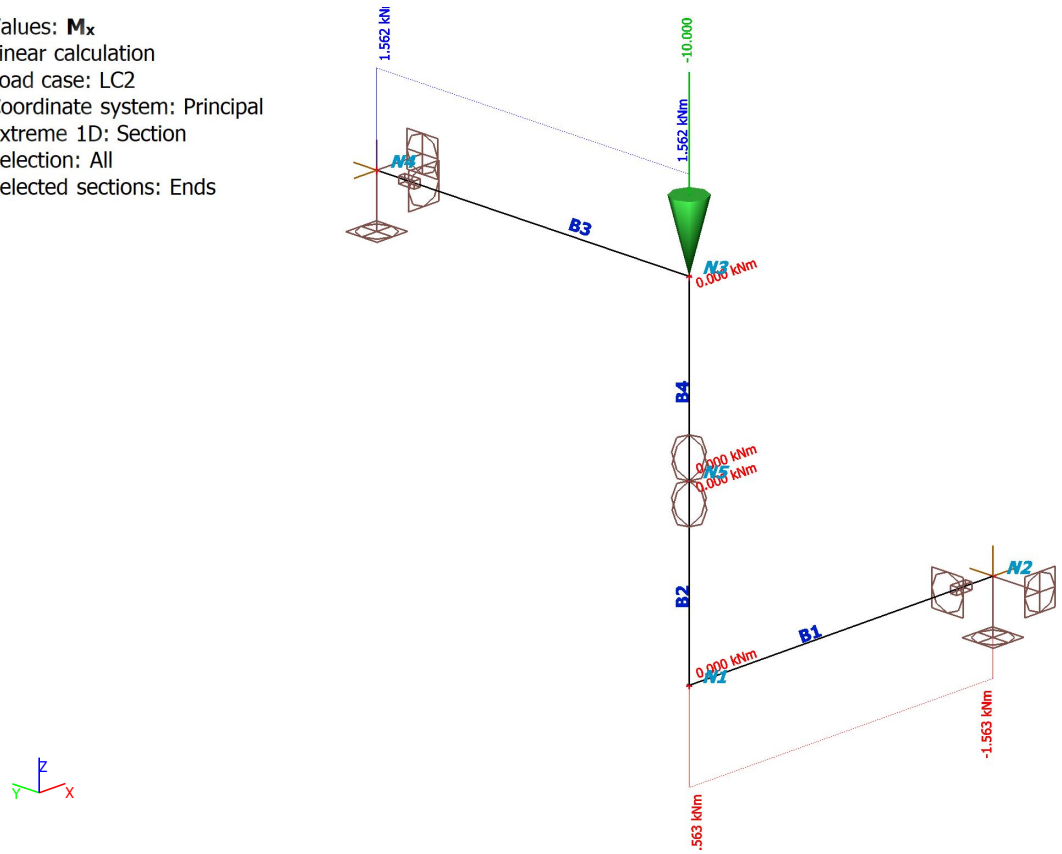
4.2. 1D internal forces

Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Global
Selection: B1, B3
Filter: Cross-section = CS1 - Full rectangular (59; 59)
Selected sections: Inputted

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B1	2.000	LC2	CS1 - Full rectangular (59; 59)	**-1.562**	**1.563**	**-5.000**	**-1.563**	**-8.437**	**3.125**
B3	2.000	LC2	CS1 - Full rectangular (59; 59)	**1.563**	**1.562**	**-5.000**	**1.562**	**-8.438**	**3.125**

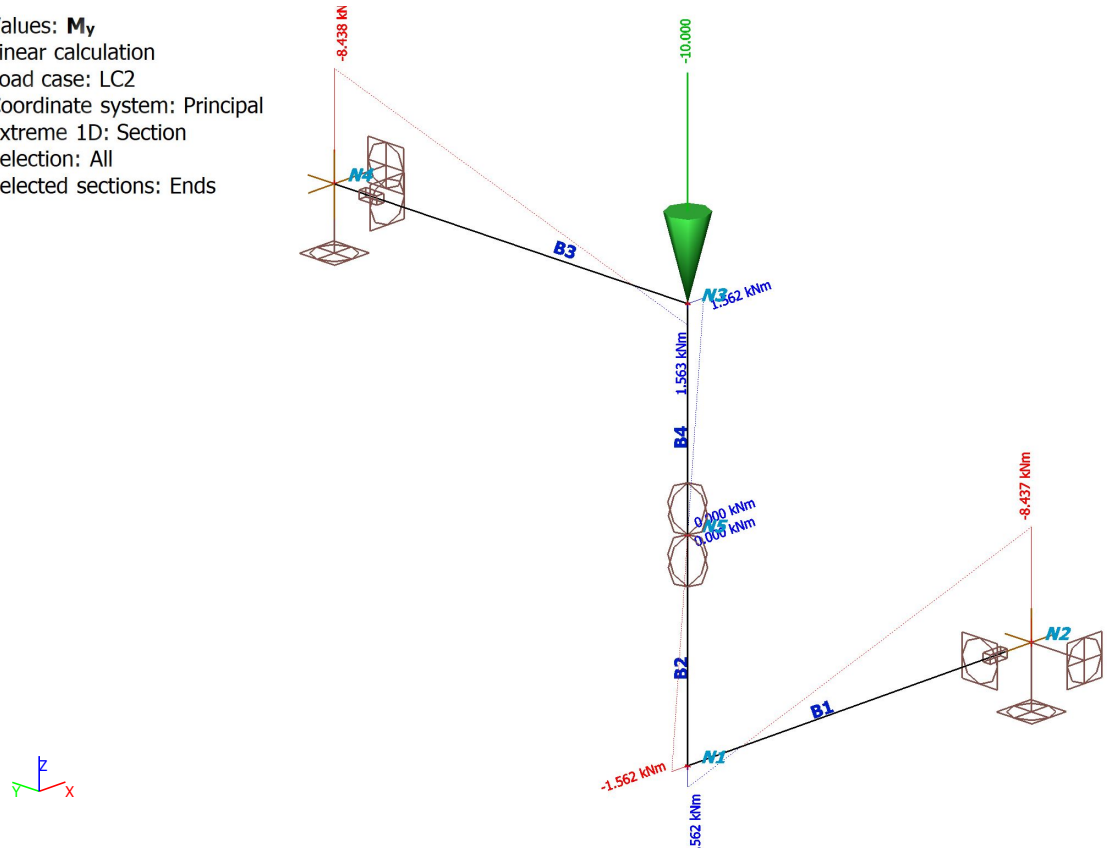
4.3. 1D internal forces; M_x

Values: M_x
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All
Selected sections: Ends



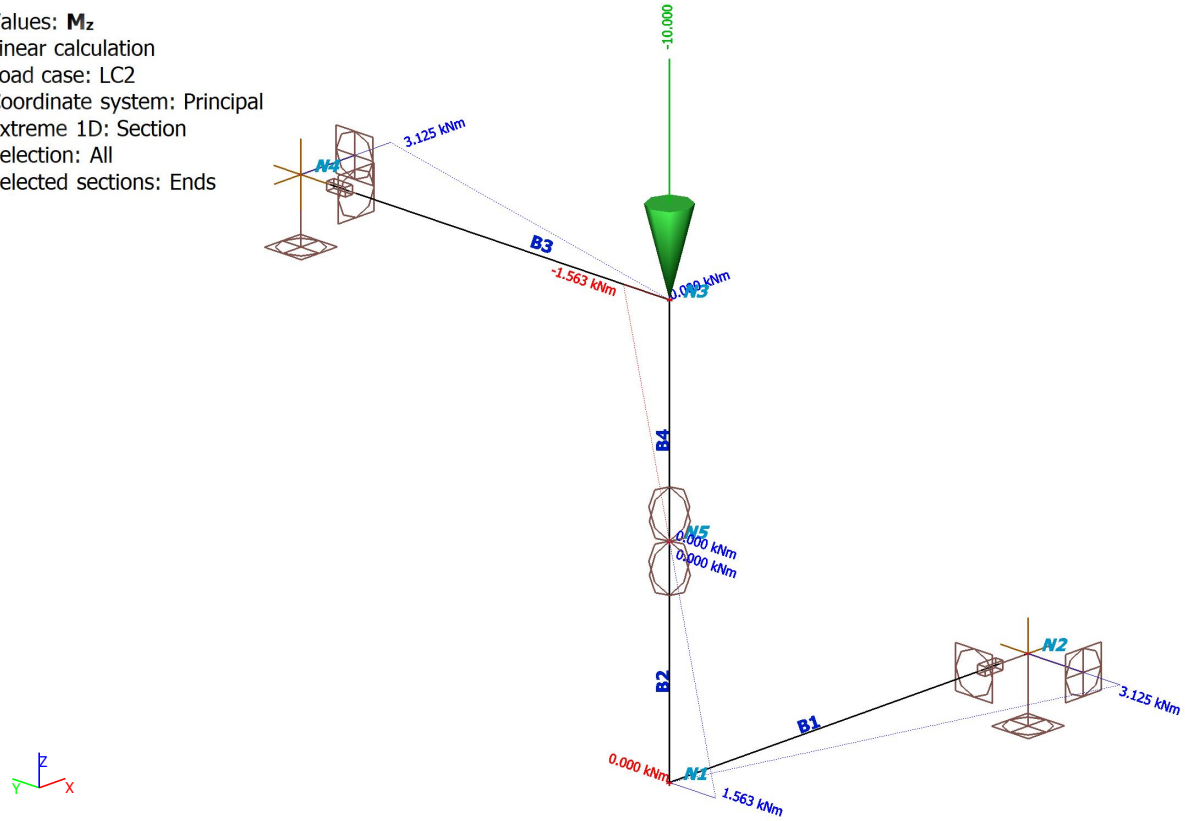
4.4. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All
Selected sections: Ends



4.5. 1D internal forces; M_z

Values: M_z
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All
Selected sections: Ends



5. EXPECTED AFNOR RESULTS

Moment Mx in node N2 = -1,5625 KN
Moment My in node N2 = -8,4375 KN
Moment Mz in node N2 = 3,125 KN
Moment Mx in node N4 = 1,5625 KN
Moment My in node N4 = -8,4375 KN
Moment Mz in node N4 = 3,125 KN
Displacement uy in node N4 =-29,762mm
Rotation Rx in node N4 = 160,71mrad
Displacement uz in node N3 =-370,04mm

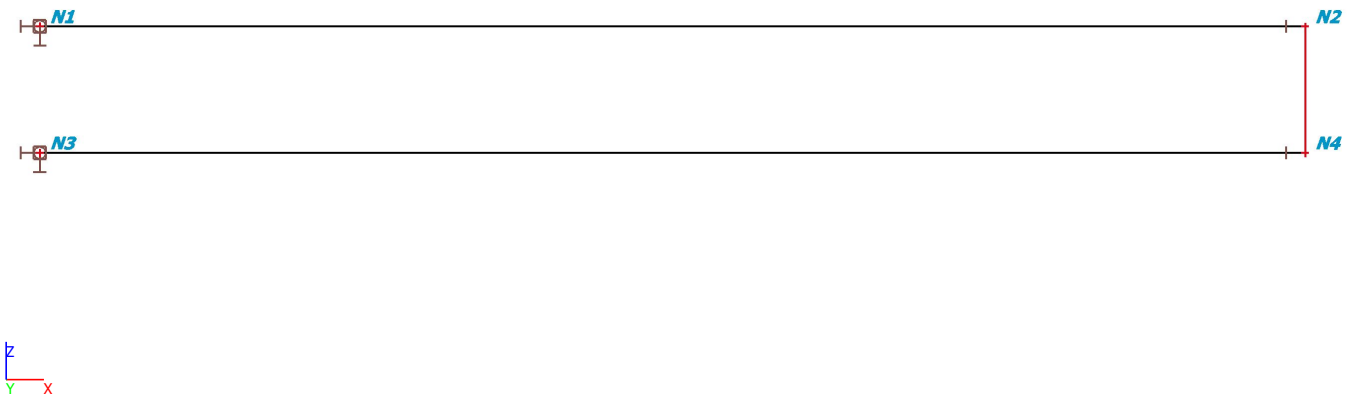
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Beams with rigid link – bending of non-compressible bars
GEOMETRY: Length: L = 2 m, distance 0.2 m, Left ends - fixed, right – rigidly linked
Section: Iz=4/3e-8, Ax=1.0, E=2e11

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	Sn1
N2	2.000	0.000	0.000	B1	BR1
					Sn3
N3	0.000	0.000	-0.200	B2	Sn2
N4	2.000	0.000	-0.200	B2	BR1
					F1
					Sn4

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Rectangle (20; 20)	S 235	2.000	N1	N2	general (0)
B2	CS1 - Rectangle (20; 20)	S 235	2.000	N3	N4	general (0)

2.4. Nodal supports

Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn2	N3	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn3	N2	GCS	Standard	Rigid	Free	Free	Free	Free	Free
Sn4	N4	GCS	Standard	Rigid	Free	Free	Free	Free	Free

2.5. Rigid links

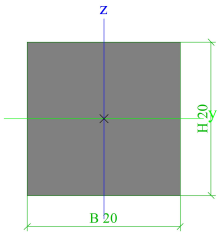
Name	Master	Slave	Hinge on master	Hinge on slave
BR1	N2	N4	×	×

2.6. Materials

Steel EC3

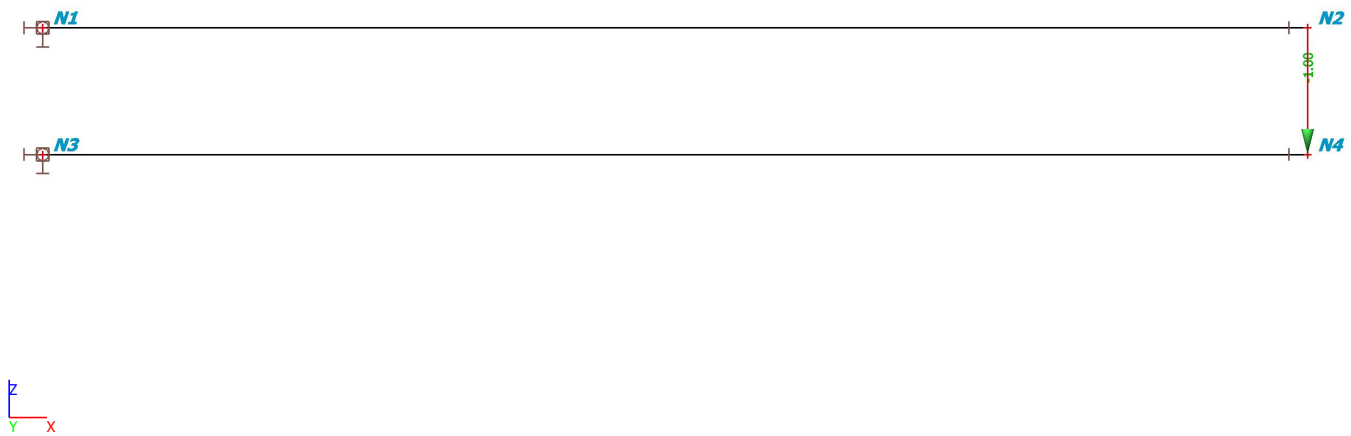
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.7. Cross-sections

CS1		
Type	Rectangle	
Detailed	20; 20	
Item material	S 235	
A [m^2]	4.0000e-04	
A_y [m^2], A_z [m^2]	3.3333e-04	3.3333e-04
A_L [m^2/m], A_D [m^2/m]	8.0000e-02	8.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	10
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.3333e-08	1.3333e-08
i_y [mm], i_z [mm]	6	6
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	1.3333e-06	1.3333e-06
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	2.0000e-06	2.0000e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	470.00	470.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	470.00	470.00
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	2.2517e-08	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2



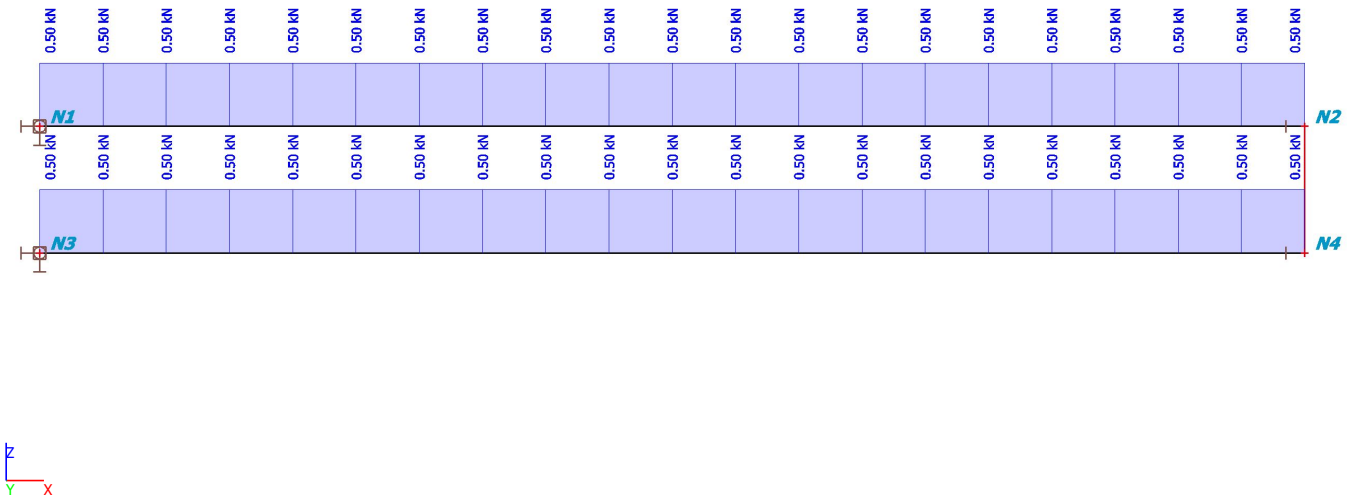
3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N4	LC2 - Charge	GCS	Z	Force	-1.00

4. RESULTS

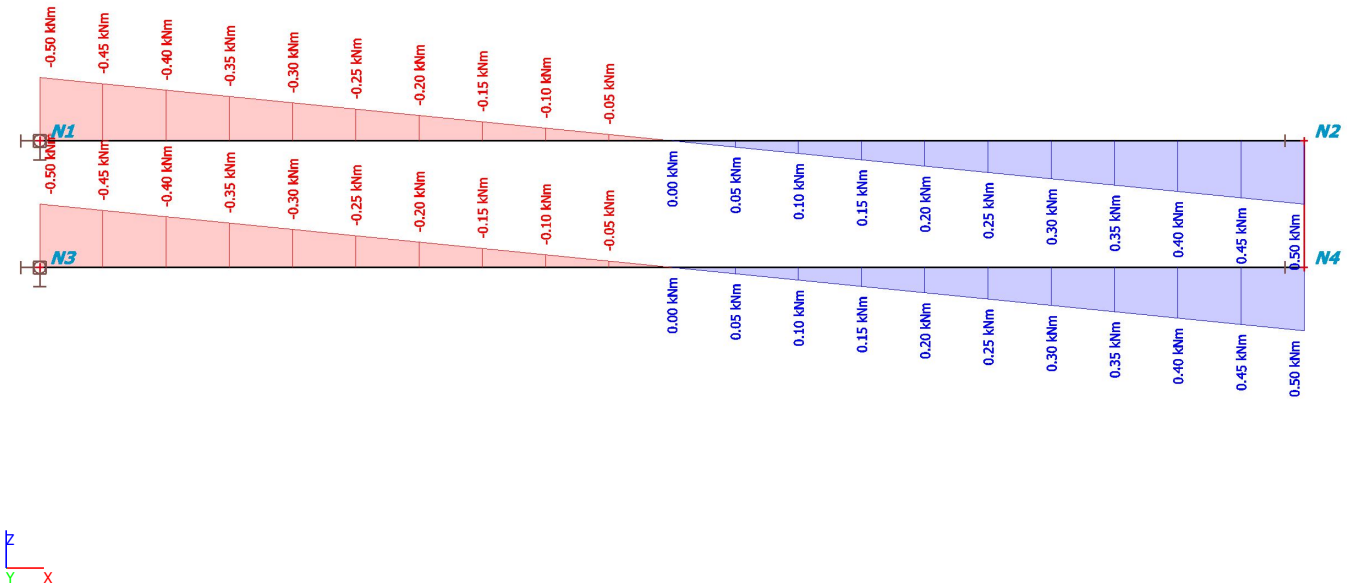
4.1. 1D internal forces; V_z

Values: V_z
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All



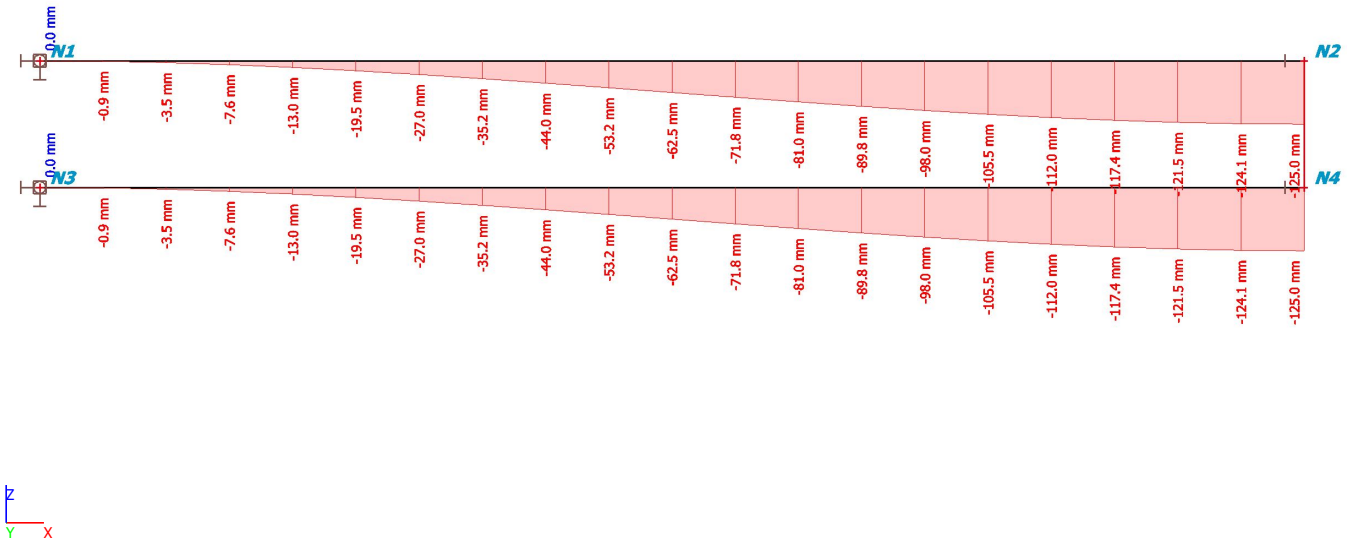
4.2. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All



4.3. 1D deformations; u_z

Values: u_z
Linear calculation
Load case: LC2
Coordinate system: Global
Extreme 1D: Section
Selection: All



5. EXPECTED AFNOR RESULTS

Bending Moment in node N1 & N3 = 0.5 kNm
Displacement Uz in node N2 & N4 = -125 mm
Vezrtical reaction Vz in node N1 & N3 = 0.5 kN

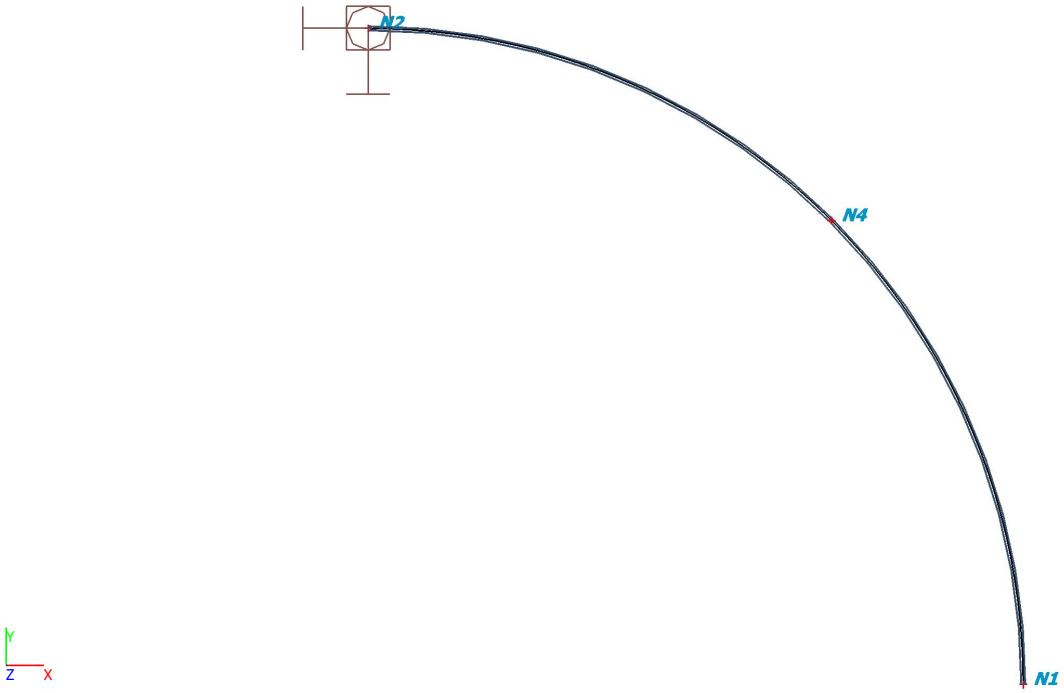
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Bending of a quarter circle, fixed at the end, made from hollow round section; elastic linear material, non-compressible bars assumed
GEOMETRY: Radius of the circle = 3 m, upper end fixed.
Section: R=10mm, thickness=2mm (Ax=1.0), E=2e11

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	3.000	0.000	0.000	B1	M1
N2	0.000	3.000	0.000	B1	Sn1
N4	2.121	2.121	0.000	B1	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - CHS (20; 2)	S 235	4.712	N1	N2	general (0)

2.4. Nodal supports

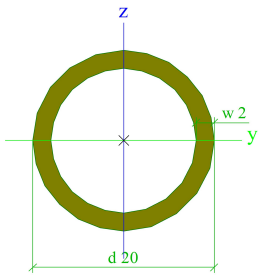
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N2	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

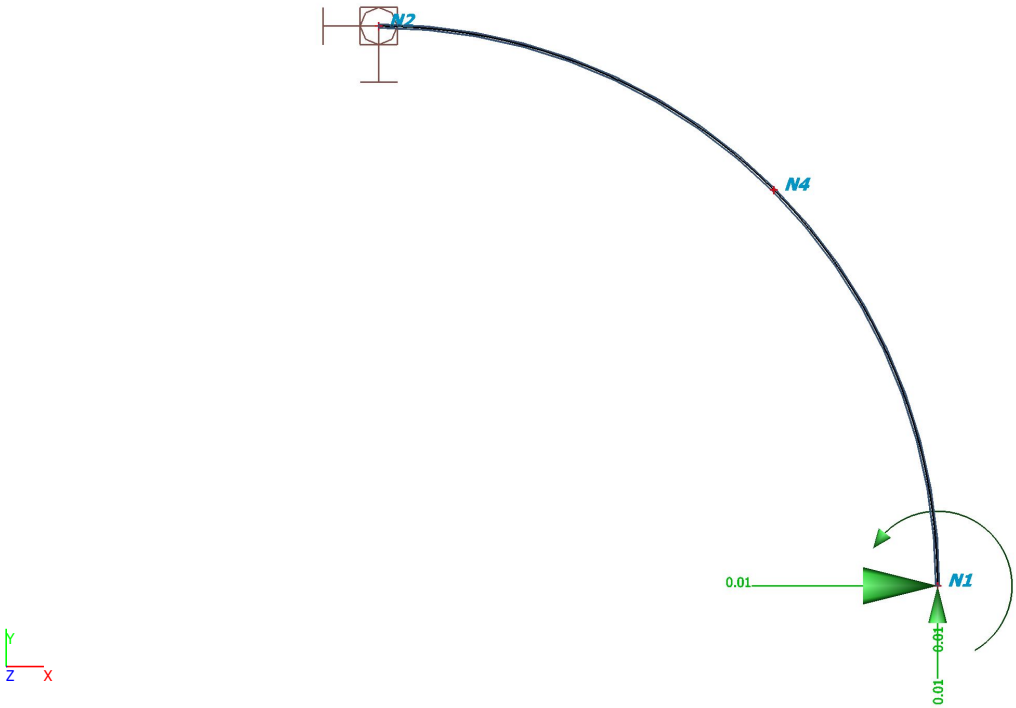
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS2		
Type	CHS	
Detailed	20; 2	
Formcode	3 - Circular hollow section	
Item material	S 235	
A [m^2]	1.1310e-04	
A_y [m^2], A_z [m^2]	7.2000e-05	7.2000e-05
A_L [m^2/m], A_D [m^2/m]	6.2829e-02	1.1309e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	10
α [deg]	0.00	
I_y [m^4], I_z [m^4]	4.6370e-09	4.6370e-09
i_y [mm], i_z [mm]	6	6
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	4.6370e-07	4.6370e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	6.5067e-07	6.5067e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	152.86	152.86
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	152.86	152.86
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	9.1609e-09	1.0996e-45
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Valeur totale



3.2. Point force on beam

Name	Member	System	Value - F [kN]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb1	B1	GCS	0.01	0.000	Rela	1
	LC2 - permanent	X	Force		From start	
Fb2	B1	GCS	0.01	0.000	Rela	1
	LC2 - permanent	Y	Force		From start	

3.3. Moment in node

Name	Node	Load case	System	Dir	Type	Value - M [kNm]
M1	N1	LC2 - permanent	GCS	Mz	Moment	0.01

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N1

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N1	LC2	**379.1**	**241.7**	**0.0**	**0.0**	**0.0**	**165.4**	**449.6**

5. EXPECTED AFNOR RESULTS

Displacement ux in node N1 = 379,1mm
Displacement uy in node N1 = 241,7mm
Rotation RZ in node N1 = 165,4 mrad

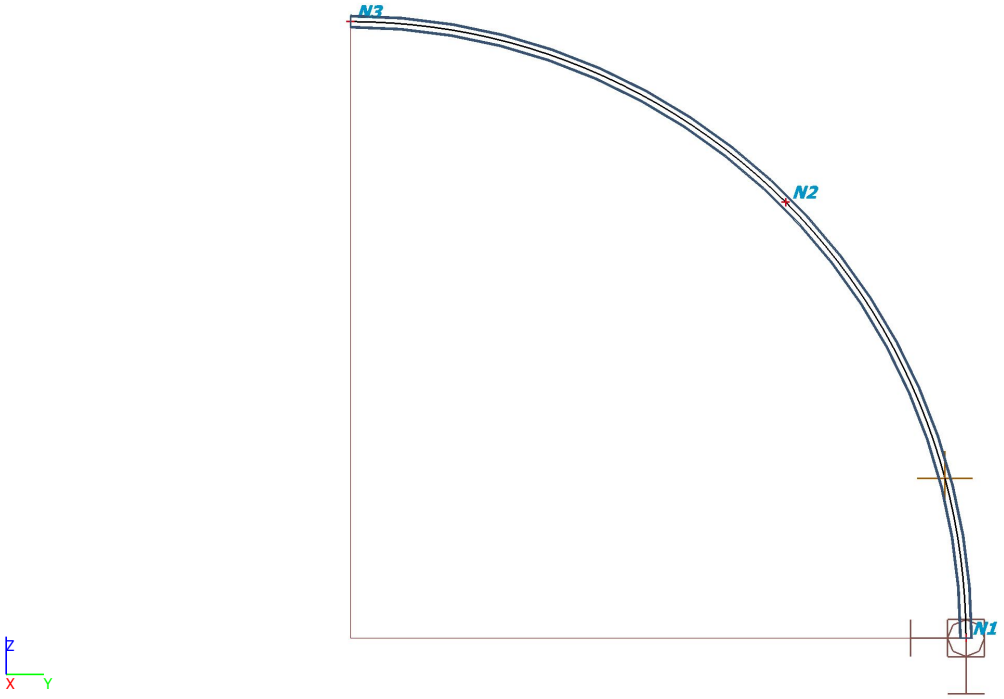
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Bending of a quarter circle, fixed at the end, made from hollow round section; elastic linear material, non-compressible bars assumed
GEOMETRY: Radius of the circle = 3 m, upper end fixed.
Section: R=10mm, thickness=2mm (Ax=1.0), E=2e11

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	1.000	0.000	B1	Sn1
N2	0.000	0.707	0.707	B1	
N3	0.000	0.000	1.000	B1	F1

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - RO20X2	S 235	1.571	N1	N3	general (0)

2.4. Nodal supports

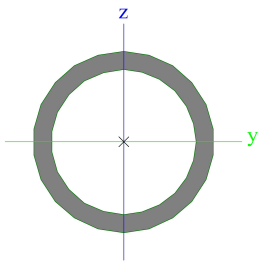
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

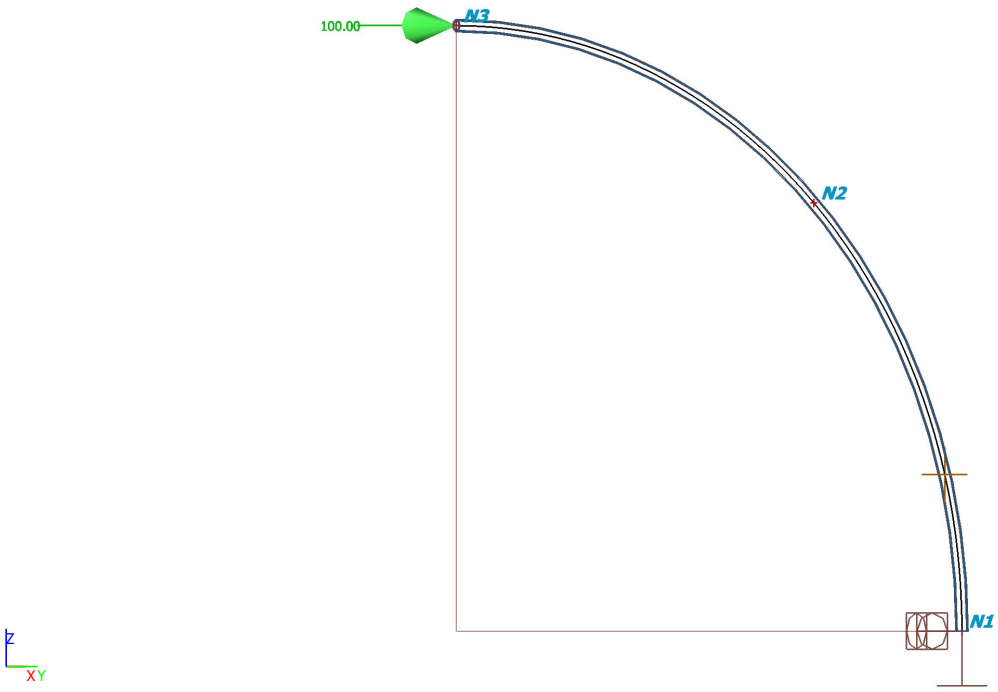
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS1		
Type	RO20X2	
Formcode	3 - Circular hollow section	
Item material	S 235	
A [m^2]	1.1300e-04	
A_y [m^2], A_z [m^2]	7.2000e-05	7.2000e-05
A_L [m^2/m], A_D [m^2/m]	6.2800e-02	1.1309e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	10
α [deg]	0.00	
I_y [m^4], I_z [m^4]	4.6400e-09	4.6400e-09
i_y [mm], i_z [mm]	6	6
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	4.6400e-07	4.6400e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	6.4800e-07	6.4800e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	152.86	152.86
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	152.86	152.86
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	9.2800e-09	1.0996e-45
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Valeur totale



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [N]
F1	N3	LC2 - Charge	GCS	X	Force	100.00

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N3

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N3	LC2	**134.56**	**0.00**	**0.00**	**0.0**	**54.6**	**123.9**	**134.56**

4.2. 1D internal forces

Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS1 - RO20X2
Selected sections: Inputted

Name	dx [m]	Case	Cross-section	N [N]	V_y [N]	V_z [N]	M_x [Nm]	M_y [Nm]	M_z [Nm]
B1	0.262-	LC2	CS1 - RO20X2	**0.00**	**-100.00**	**0.00**	**-74.11**	**0.00**	**96.60**

5. EXPECTED AFNOR RESULTS

Displacement ux in node N3 = 134,62mm
Moment Mx for (O=15°) = 74,11 N.m
Moment Mz for (O=15°) = 96,59 N.m

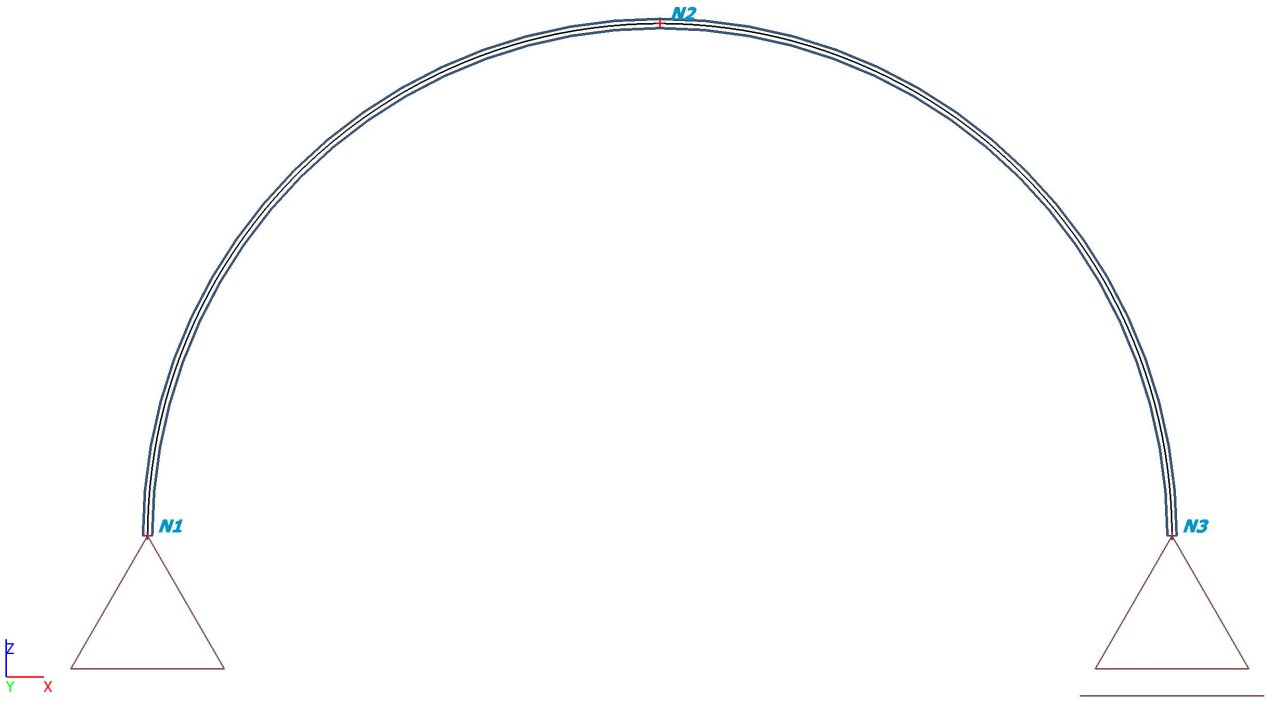
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

A half circle simply supported at the ends, bending of a thin-walled (hollow) round section; material elastic linear isotropic.
GEOMETRY: Radius of the circle = 3 m, upper end fixed.
Section: R=10mm, thickness=2mm (Ax=1.0), E=2e11

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	-1.000	0.000	B1	Sn1
N2	0.000	1.000	B1	
N3	1.000	0.000	B1	Sn2

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - CHS (20; 2)	S 235	3.142	N1	N3	general (0)

2.4. Nodal supports

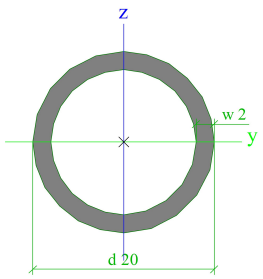
Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Free
Sn2	N3	GCS	Standard	Free	Rigid	Free

2.5. Materials

Steel EC3

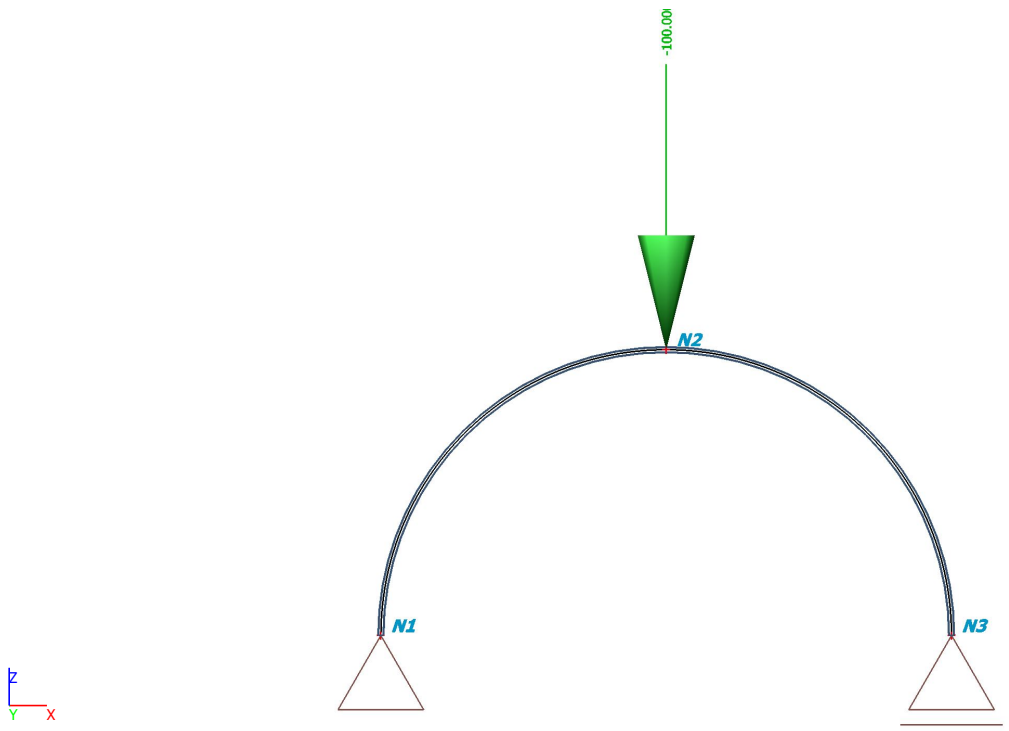
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS1		
Type	CHS	
Detailed	20; 2	
Formcode	3 - Circular hollow section	
Item material	S 235	
A [m²]	1.1310e-04	
A_y [m²], A_z [m²]	7.2000e-05	7.2000e-05
A_L [m²/m], A_D [m²/m]	6.2829e-02	1.1309e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	10
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	4.6370e-09	4.6370e-09
i_y [mm], i_z [mm]	6	6
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	4.6370e-07	4.6370e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	6.5067e-07	6.5067e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	152.86	152.86
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	152.86	152.86
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	9.1609e-09	1.0996e-45
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Valeur totale



3.2. Point force on beam

Name	Member	System	Value - F [N]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb1	B1	GCS	-100.0000	0.500	Rela	1
	LC2 - Permanent	Z	Force		From start	

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: All

Name	Case	U_x [mm]	U_z [mm]	Φ_y [mrad]	U_{total} [mm]
N1	LC2	**0.000**	**0.000**	**30.774**	0.000
N2	LC2	26.960	**-19.213**	0.000	33.106
N3	LC2	**53.921**	0.000	**-30.774**	**53.921**

5. EXPECTED AFNOR RESULTS

Displacement ux in node N3 = 53,912mm
Displacement uz in node N2 = -19,206mm
Rotation ϕy in node N1= -30,774mrad
Rotation ϕy in node N3= 30,774mrad

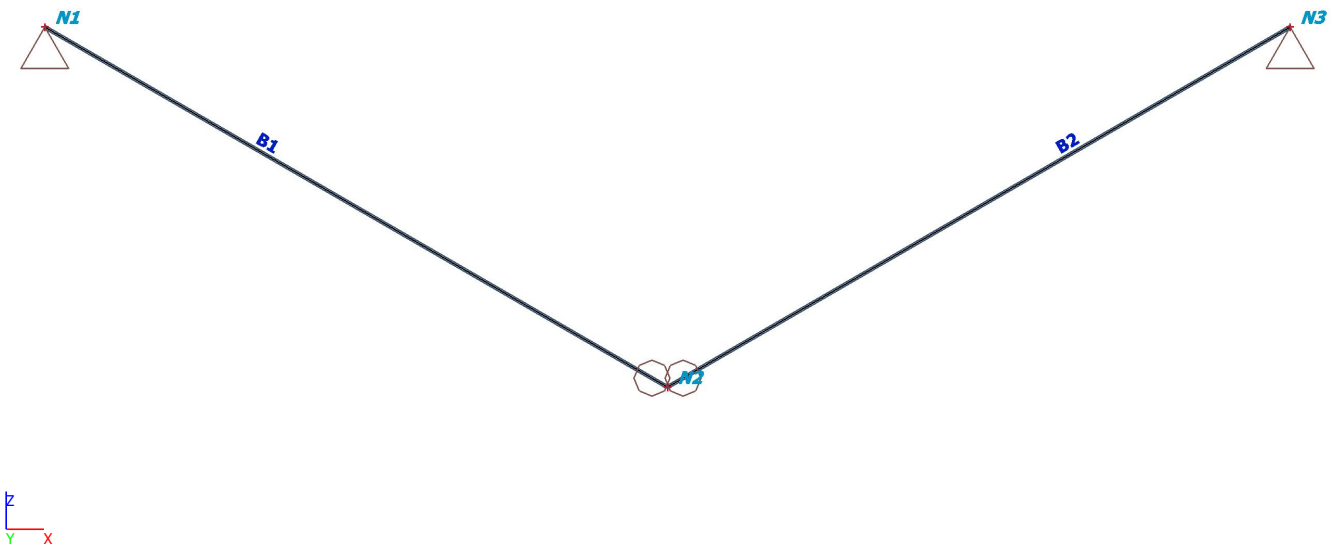
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Truss made of two bars; material: elastic, linear, isotropic.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	Sn1
N2	3.897	-2.250	B1	F1
			B2	
N3	7.794	0.000	B2	Sn2

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS3 - Circle (20)	S 235	4.500	N1	N2	general (0)
B2	CS3 - Circle (20)	S 235	4.500	N3	N2	general (0)

2.4. Hinges

Name	Member	Position	ux	uy	uz	fix	fiy	fiz
H1	B1	End	Rigid		Rigid		Free	
H2	B2	End	Rigid		Rigid		Free	

2.5. Nodal supports

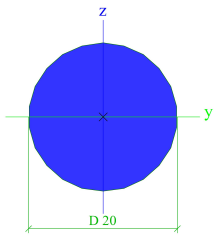
Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Free
Sn2	N3	GCS	Standard	Rigid	Rigid	Free

2.6. Materials

Steel EC3

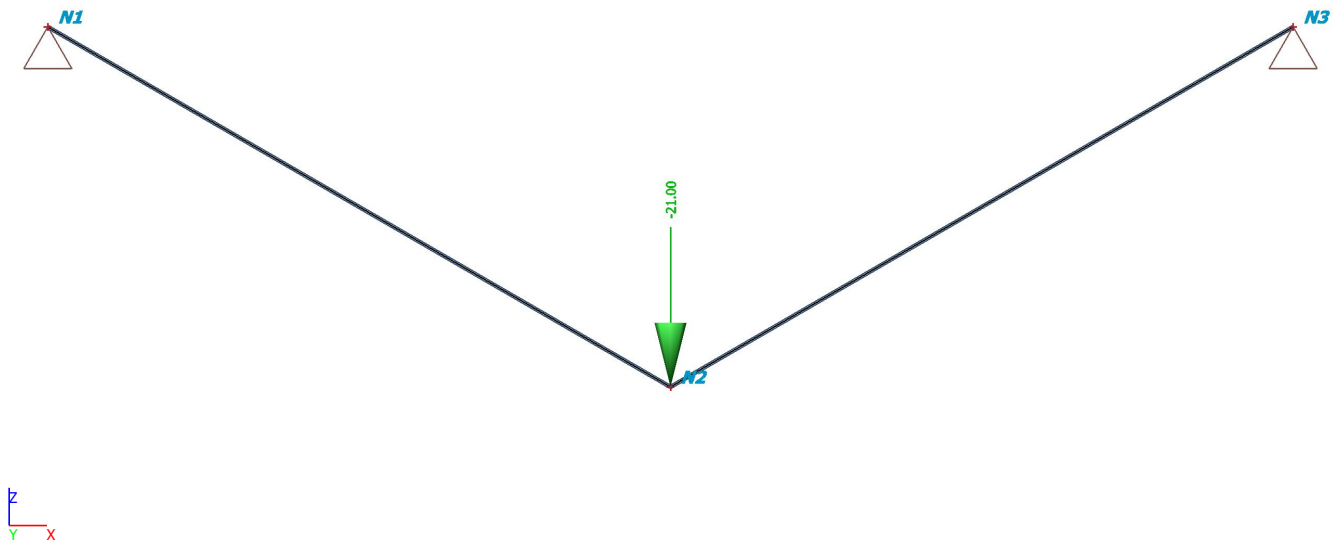
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

2.7. Cross-sections

CS3		
Type	Circle	
Detailed	20	
Item material	S 235	
A [m²]	3.0000e-04	
A_y [m²], A_z [m²]	2.7000e-04	2.7000e-04
A_L [m²/m], A_D [m²/m]	6.1396e-02	6.1396e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	10
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	7.1620e-09	7.1620e-09
i_y [mm], i_z [mm]	5	5
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	7.3290e-07	7.3290e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.2442e-06	1.2442e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	292.30	292.30
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	292.30	292.30
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.4324e-08	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Valeur totale



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N2	LC2 - Permanent	GCS	Z	Force	-21.00

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: All

Name	Case	U_z [mm]
N2	LC2	**-3.0**
N1	LC2	**0.0**

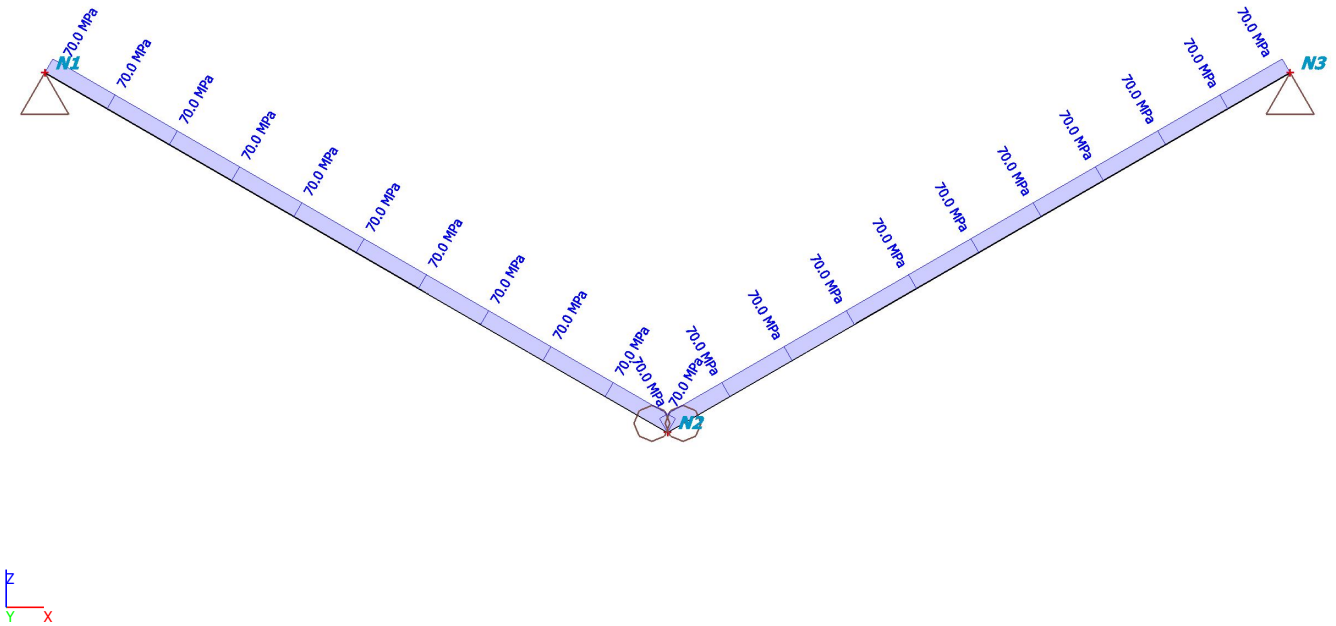
4.2. 1D stresses

Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Member
Selection: B1, B2

Name	dx [m]	Fibre	Case	σ_x [MPa]
B1	0.000	1	LC2	**70.0**
B2	0.000	1	LC2	**70.0**

4.3. 1D stresses; σ_x

Values: σ_x
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Section
Selection: All



5. EXPECTED AFNOR RESULTS

Displacement uz in node N2 = -3mm
Stress σx in the element B1 = 70 Mpa
Stress σx in the element B2 = 70 Mpa

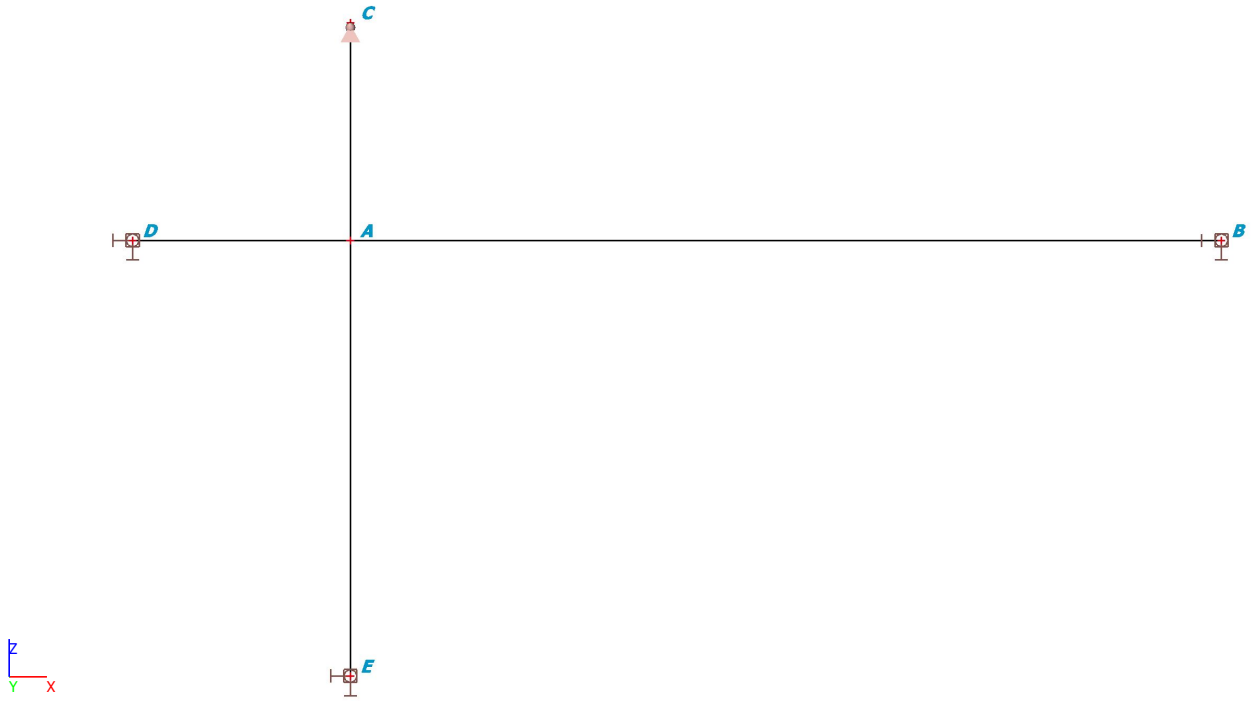
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Frame made of four bars with different moments of inertia; material: elastic, linear, isotropic

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
D	0.000	0.000	0.000	B1	Sn2
A	1.000	0.000	0.000	B1	
				B2	
				B3	
				B5	
B	5.000	0.000	0.000	B2	Sn3

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
C	1.000	0.000	1.000	B3	Sn4
E	1.000	0.000	-2.000	B5	Sn1

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	Section AC et AD - Rectangle (10; 10)	S 235	1.000	D	A	general (0)
B2	Section AB - Rectangle (40; 40)	S 235	4.000	A	B	general (0)
B3	Section AC et AD - Rectangle (10; 10)	S 235	1.000	A	C	general (0)
B5	Section AE - Rectangle (20; 20)	S 235	2.000	A	E	general (0)

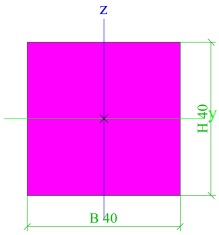
2.4. Nodal supports

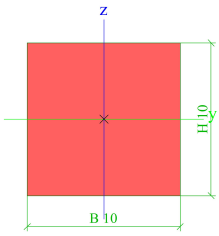
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	E	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn2	D	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn3	B	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn4	C	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free

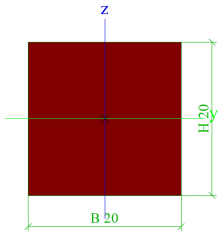
2.5. Materials

Empty table

2.6. Cross-sections

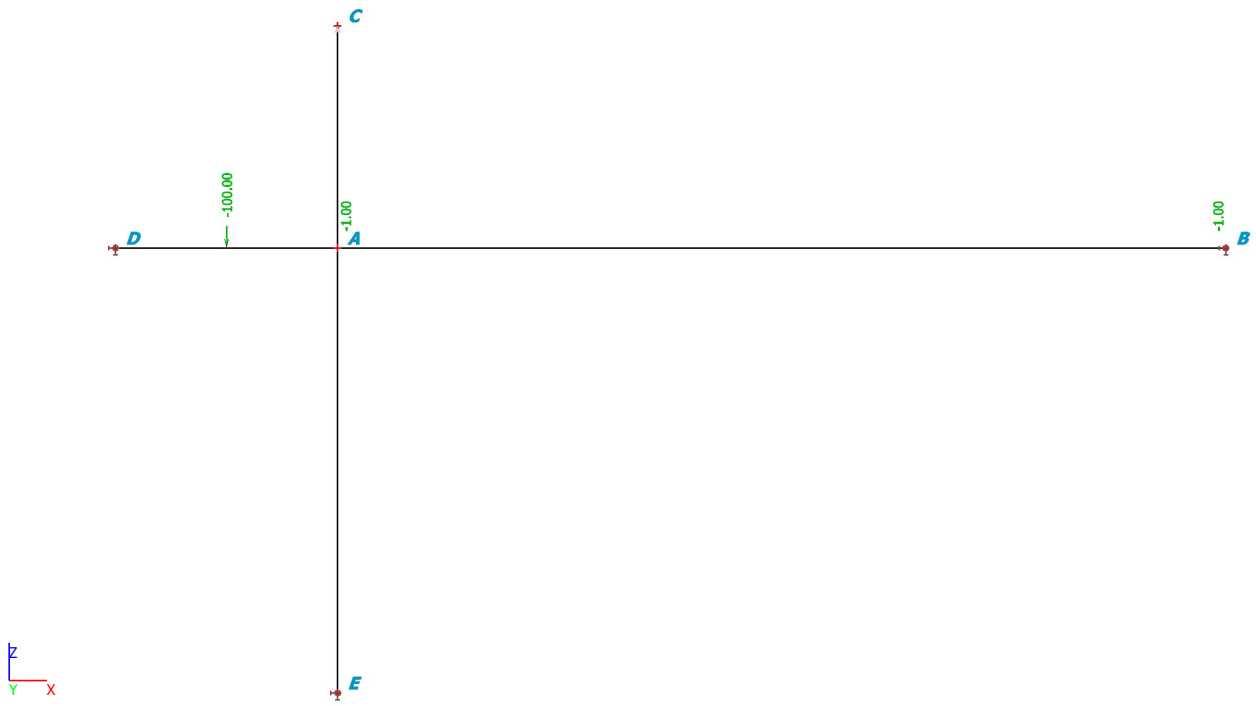
Section AB		
Type	Rectangle	
Detailed	40; 40	
Item material	S 235	
A [m²]	1.6000e-03	
A_y [m²], A_z [m²]	1.3333e-03	1.3333e-03
A_L [m²/m], A_D [m²/m]	1.6000e-01	1.6000e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	20	20
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.1333e-07	2.1333e-07
i_y [mm], i_z [mm]	12	12
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.0667e-05	1.0667e-05
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.6000e-05	1.6000e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	3760.00	3760.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	3760.00	3760.00
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	3.6027e-07	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

Section AC et AD		
Type	Rectangle	
Detailed	10; 10	
Item material	S 235	
A [m²]	1.0000e-04	
A_y [m²], A_z [m²]	8.3333e-05	8.3333e-05
A_L [m²/m], A_D [m²/m]	4.0000e-02	4.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	5	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	8.3333e-10	8.3333e-10
i_y [mm], i_z [mm]	3	3
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.6667e-07	1.6667e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.5000e-07	2.5000e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	58.75	58.75
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	58.75	58.75
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.4073e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

Section AE		
Type	Rectangle	
Detailed	20; 20	
Item material	S 235	
A [m²]	4.0000e-04	
A_y [m²], A_z [m²]	3.3333e-04	3.3333e-04
A_L [m²/m], A_D [m²/m]	8.0000e-02	8.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	10
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.3333e-08	1.3333e-08
i_y [mm], i_z [mm]	6	6
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.3333e-06	1.3333e-06
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.0000e-06	2.0000e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	470.00	470.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	470.00	470.00
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	2.2517e-08	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC1 / Tot. value



3.2. Line force

Name	Member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Coor	Orig	Ecc ey [m]
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Loc		Ecc ez [m]
LF2	B2	Force	Z	-1.00	0.000	Rela	From start	0.000
	LC1	GCS	Uniform		1.000	Length		0.000

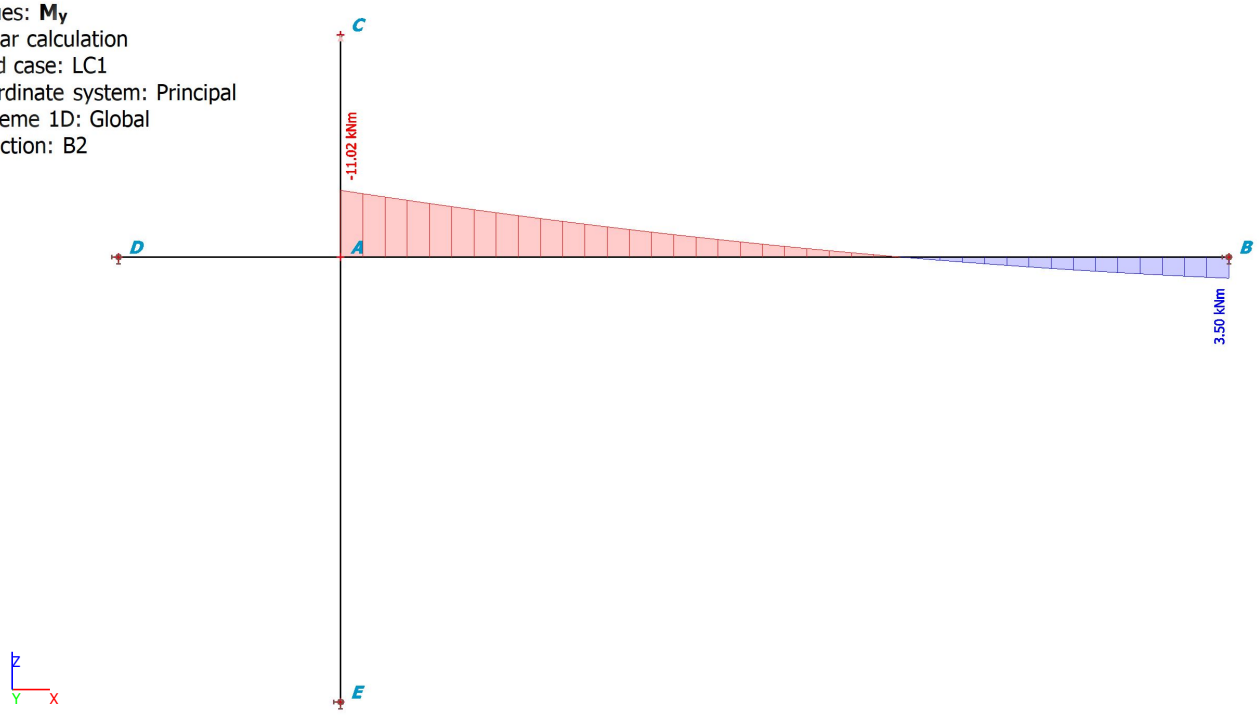
3.3. Point force on beam

Name	Member	System	Value - F [kN]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb2	B1	GCS	-100.00	0.500	Rela	1
	LC1	Z	Force		From start	

4. RESULTS

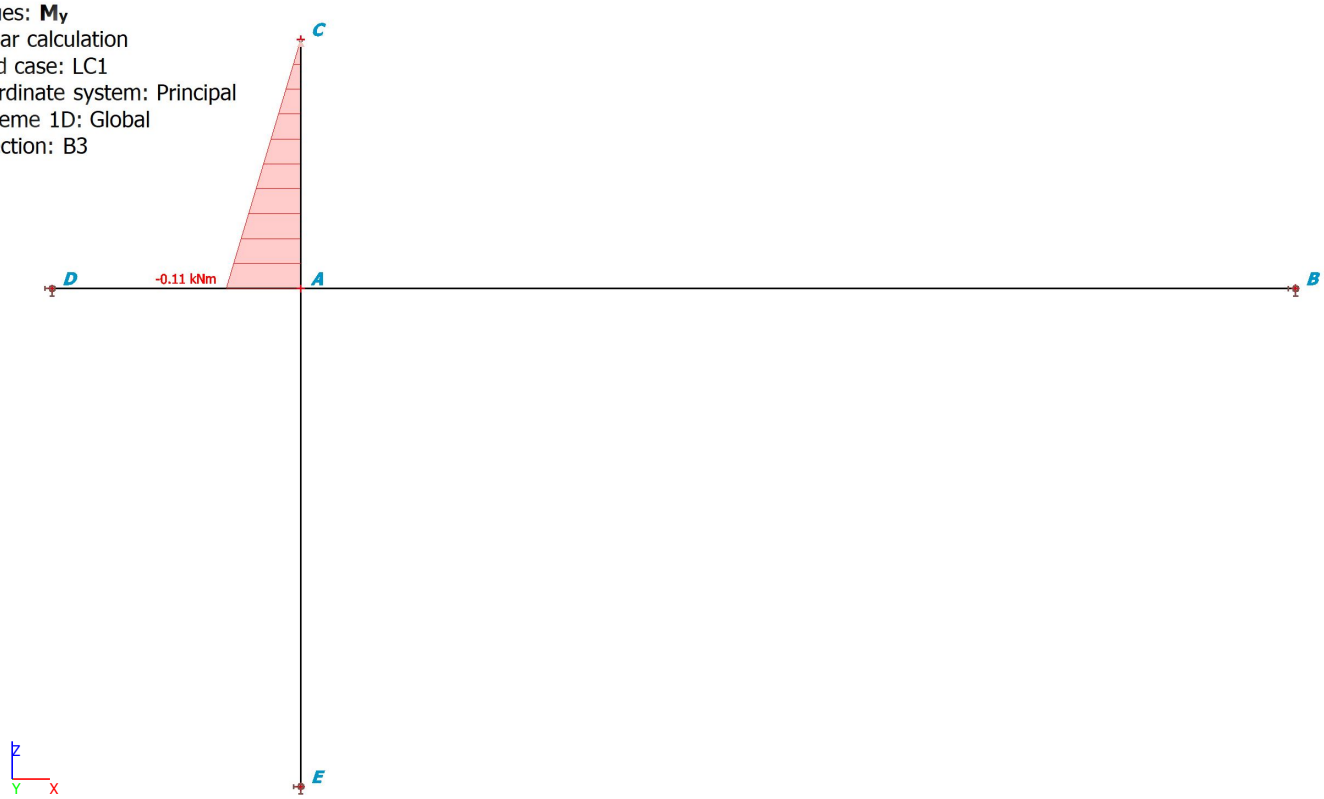
4.1. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Global
Selection: B2



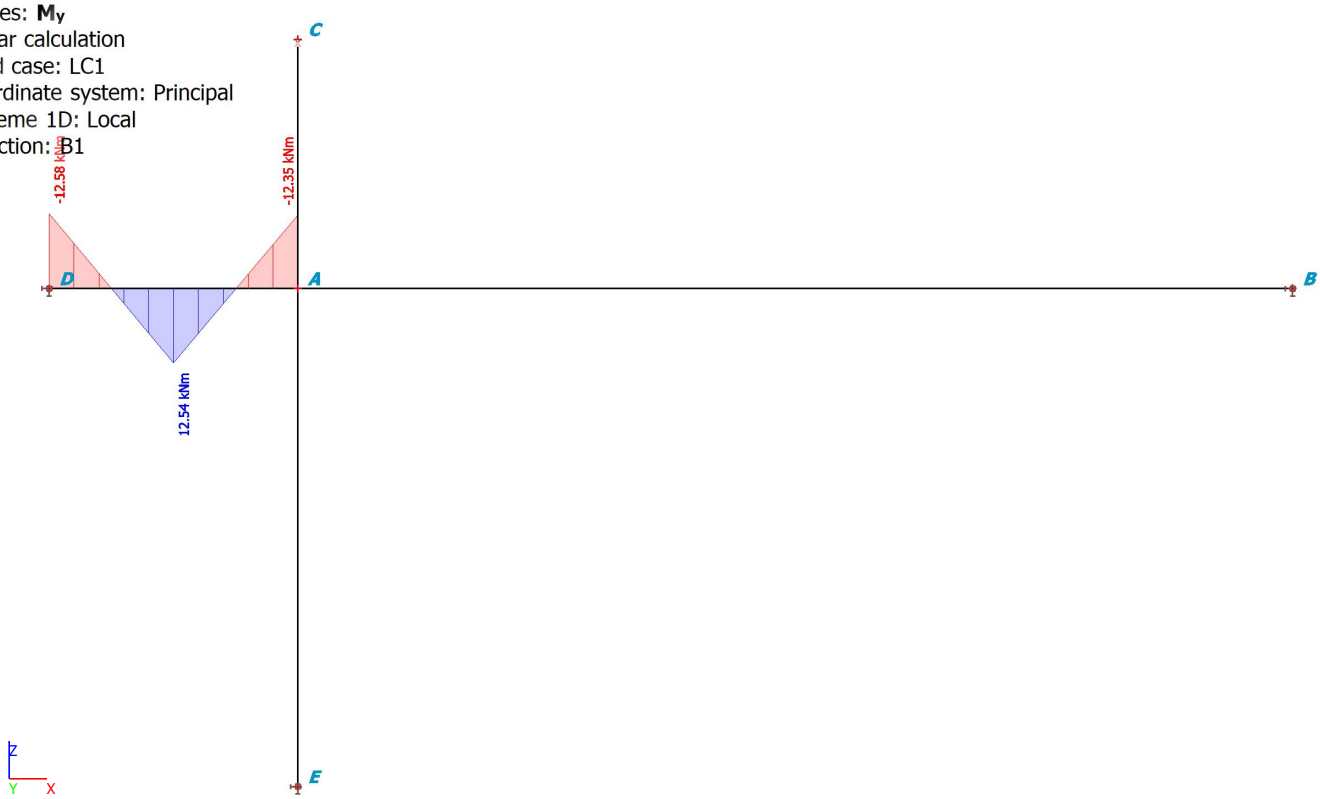
4.2. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Global
Selection: B3



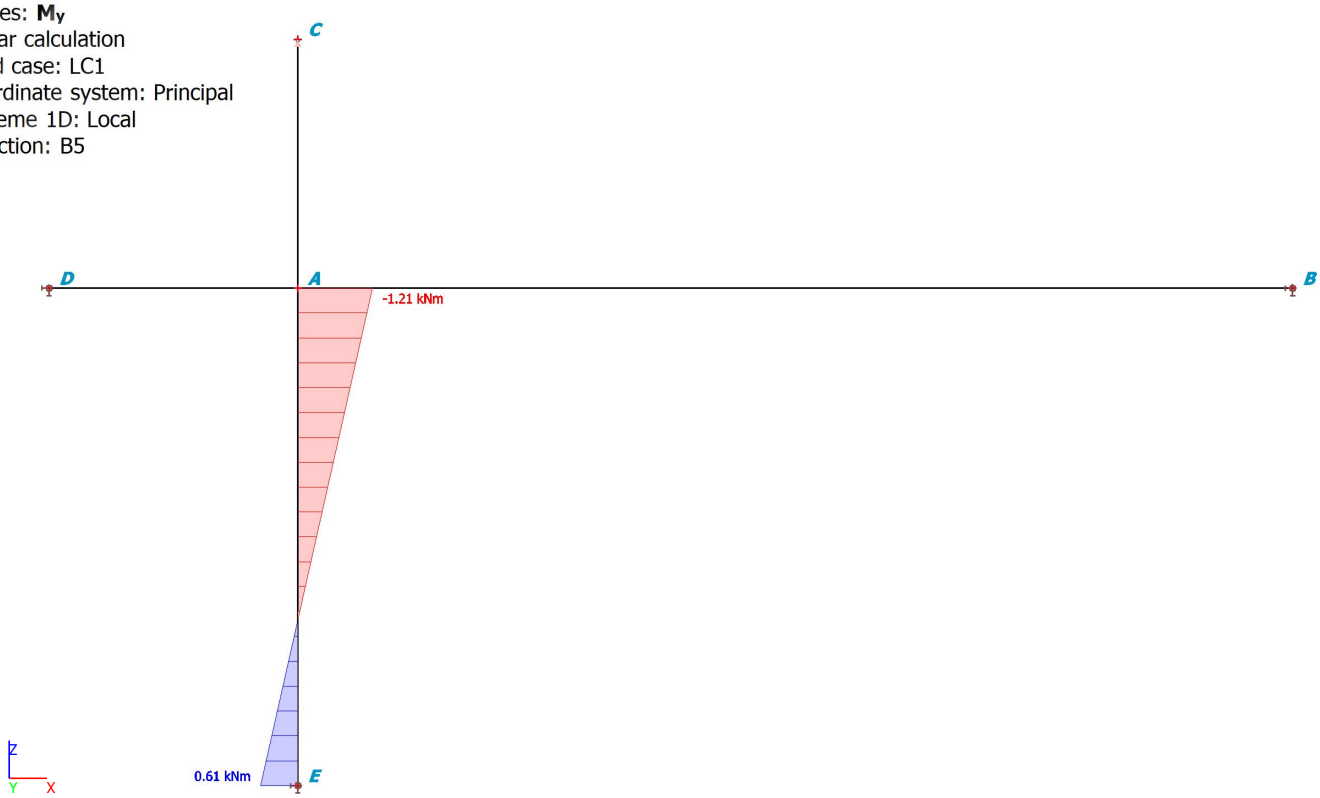
4.3. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Local
Selection: B1



4.4. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Local
Selection: B5



4.5. Displacement of nodes

Linear calculation
Load case: LC1
Extreme: Global
Selection: A

Name	Case	Φ_y [mrad]
A	LC1	**-216.6**

5. EXPECTED AFNOR RESULTS

Bending Moment poutre AB in node A = 11.02 kNm
Bending Moment poutre AC in node A = 0.11 kNm
Bending Moment poutre AD in node A = -12.35 kNm
Bending Moment poutre AE in node A = 1.21 kNm
Rotation phiy in node A = 227.118 mrad

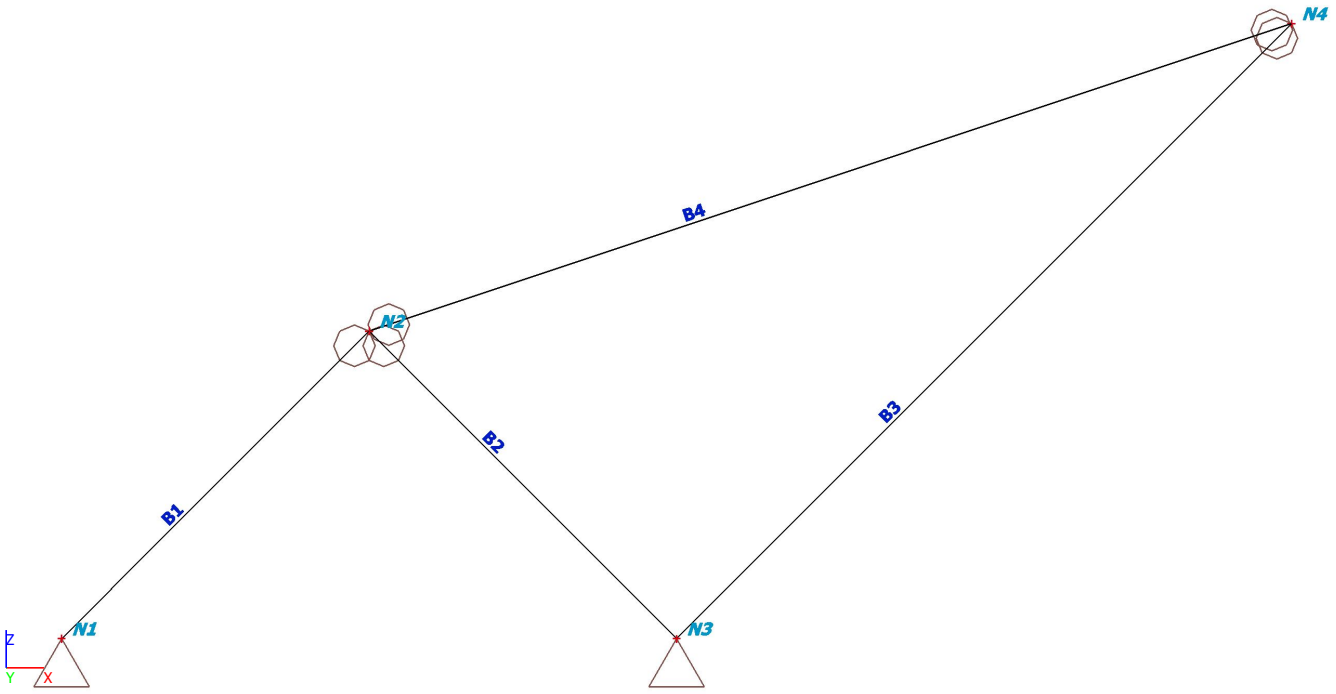
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Truss made of four bars of different cross sections;
material: elastic, linear, isotropic (non-compressible bars assumed).

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	Sn2
N2	0.500	0.500	B1	
			B2	
			B4	
N3	1.000	0.000	B2	Sn1
			B3	
N4	2.000	1.000	B3	F1
			B4	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	Section AC et CB - Circle (16)	S 235	0.707	N1	N2	general (0)
B2	Section AC et CB - Circle (16)	S 235	0.707	N2	N3	general (0)
B3	Section CD et BD - Circle (11)	S 235	1.414	N3	N4	general (0)
B4	Section CD et BD - Circle (11)	S 235	1.581	N2	N4	general (0)

2.4. Hinges

Name	Member	Position	ux	uy	uz	fix	fiy	fiz
H1	B4	Both	Rigid		Rigid		Free	
H2	B3	End	Rigid		Rigid		Free	
H3	B1	End	Rigid		Rigid		Free	
H4	B2	Begin	Rigid		Rigid		Free	

2.5. Nodal supports

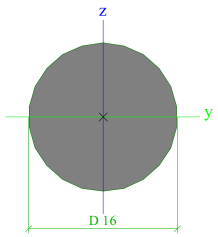
Name	Node	System	Type	X	Z	Ry
Sn1	N3	GCS	Standard	Rigid	Rigid	Free
Sn2	N1	GCS	Standard	Rigid	Rigid	Free

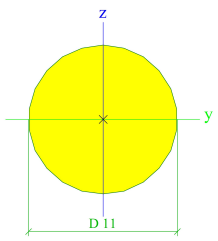
2.6. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	1.9620e+05	0.3	0	40	235.0	360.0	
		7.5462e+04	0.01e-003	40	80	215.0	360.0	

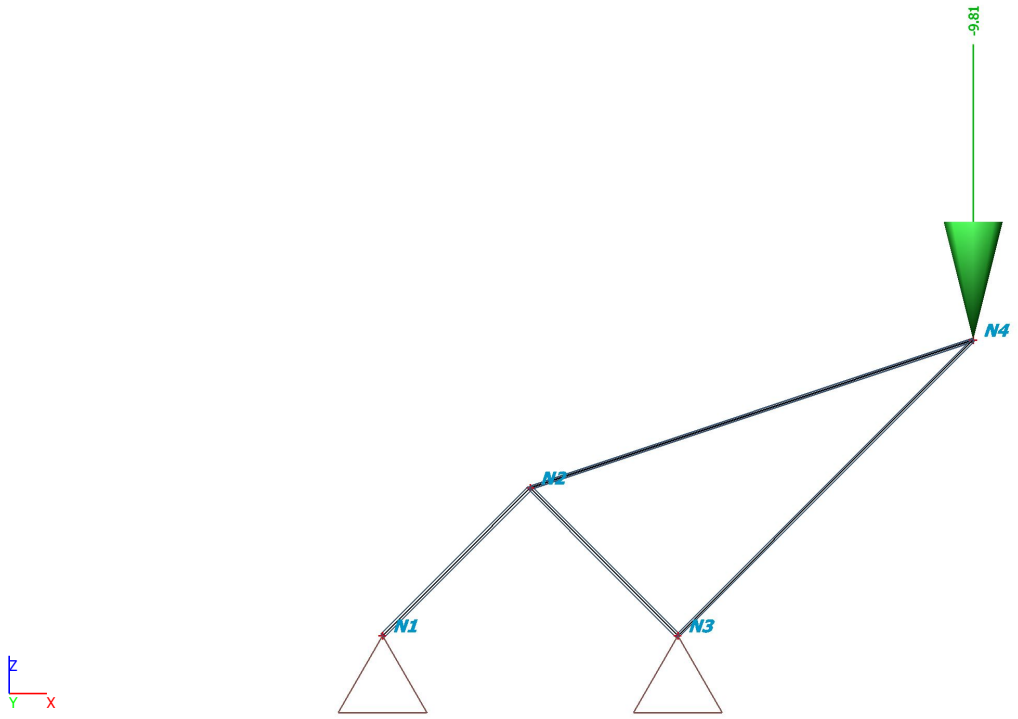
2.7. Cross-sections

Section AC et CB		
Type	Circle	
Detailed	16	
Item material	S 235	
A [m²]	2.0000e-04	
A_y [m²], A_z [m²]	1.8000e-04	1.8000e-04
A_L [m²/m], A_D [m²/m]	5.0130e-02	5.0130e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	8	8
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	3.1831e-09	3.1831e-09
i_y [mm], i_z [mm]	4	4
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	3.9894e-07	3.9894e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	6.7727e-07	6.7727e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	159.11	159.11
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	159.11	159.11
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	6.3662e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

Section CD et BD		
Type	Circle	
Detailed	11	
Item material	S 235	
A [m²]	1.0000e-04	
A_y [m²], A_z [m²]	9.0000e-05	9.0000e-05
A_L [m²/m], A_D [m²/m]	3.5447e-02	3.5447e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	6	6
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	7.9577e-10	7.9577e-10
i_y [mm], i_z [mm]	3	3
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.4105e-07	1.4105e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.3945e-07	2.3945e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	56.25	56.25
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	56.25	56.25
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.5915e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Valeur totale



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N4	LC2 - Permanent	GCS	Z	Force	-9.81

4. RESULTS

4.1. Displacement of node N2

Linear calculation
Load case: LC2
Extreme: Global
Selection: N2

Name	Case	U_x [mm]	U_z [mm]
N2	LC2	**0.26523**	**0.08842**

4.2. Displacement of node N4

Linear calculation
Load case: LC2
Extreme: Global
Selection: N4

Name	Case	U_x [mm]	U_z [mm]
N4	LC2	**3.47916**	**-5.60048**

5. EXPECTED AFNOR RESULTS

Displacement ux in node N2 = 0,26517mm
Displacement uz in node N2 = 0,08839mm
Displacement ux in node N4 = 3,47902mm
Displacement uz in node N4 = -5,60084mm

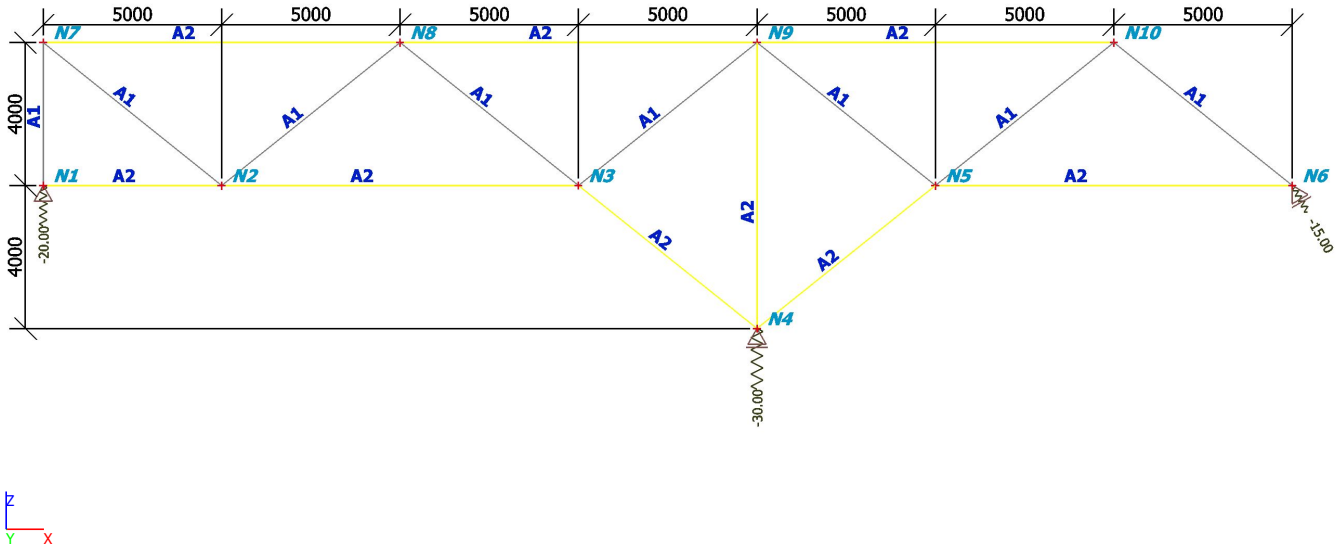
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Triangular system of hinged bar under concentrated load, imposed displacement and thermal load.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	LCS	Data
N1	0.000	0.000	B1 B6	×	Sn2
N2	5.000	0.000	B1 B2 B10 B11	×	
N3	15.000	0.000	B2 B3 B12 B13	×	
N4	20.000	-4.000	B3 B4 B17	×	Sn3
N5	25.000	0.000	B4 B5 B14 B15	×	

Name	Coord X [m]	Coord Z [m]	Member	LCS	Data
N6	35.000	0.000	B5 B16	✓	Sn1
N7	0.000	4.000	B6 B7 B10	×	
N8	10.000	4.000	B7 B8 B11 B12	×	F1
N9	20.000	4.000	B8 B9 B13 B14 B17	×	
N10	30.000	4.000	B9 B15 B16	×	F2

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	A2 - Circle (60)	S 235	5.000	N1	N2	general (0)
B2	A2 - Circle (60)	S 235	10.000	N2	N3	general (0)
B3	A2 - Circle (60)	S 235	6.403	N3	N4	general (0)
B4	A2 - Circle (60)	S 235	6.403	N4	N5	general (0)
B5	A2 - Circle (60)	S 235	10.000	N5	N6	general (0)

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B6	A1 - Circle (42)	S 235	4.000	N1	N7	general (0)
B7	A2 - Circle (60)	S 235	10.000	N7	N8	general (0)
B8	A2 - Circle (60)	S 235	10.000	N8	N9	general (0)
B9	A2 - Circle (60)	S 235	10.000	N9	N10	general (0)
B10	A1 - Circle (42)	S 235	6.403	N7	N2	general (0)
B11	A1 - Circle (42)	S 235	6.403	N2	N8	general (0)
B12	A1 - Circle (42)	S 235	6.403	N8	N3	general (0)
B13	A1 - Circle (42)	S 235	6.403	N3	N9	general (0)
B14	A1 - Circle (42)	S 235	6.403	N9	N5	general (0)
B15	A1 - Circle (42)	S 235	6.403	N5	N10	general (0)
B16	A1 - Circle (42)	S 235	6.403	N10	N6	general (0)
B17	A2 - Circle (60)	S 235	8.000	N4	N9	general (0)

2.4. Nodal supports

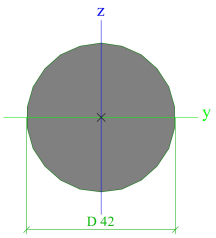
Name	Node	System	Type	X	Z	Ry
Sn1	N6	LCS of node	Standard	Free	Rigid	Free
Sn2	N1	GCS	Standard	Rigid	Rigid	Free
Sn3	N4	GCS	Standard	Free	Rigid	Free

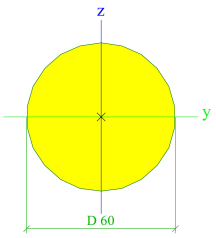
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

A1		
Type	Circle	
Detailed	42	
Item material	S 235	
A [m^2]	1.4100e-03	
A_y [m^2], A_z [m^2]	1.2690e-03	1.2690e-03
A_L [m^2/m], A_D [m^2/m]	1.3310e-01	1.3310e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	21	21
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.5821e-07	1.5821e-07
i_y [mm], i_z [mm]	11	11
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	7.4678e-06	7.4678e-06
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	1.2678e-05	1.2678e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	2978.37	2978.37
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	2978.37	2978.37
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	3.1642e-07	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

A2		
Type	Circle	
Detailed	60	
Item material	S 235	
A [m^2]	2.8200e-03	
A_y [m^2], A_z [m^2]	2.5380e-03	2.5380e-03
A_L [m^2/m], A_D [m^2/m]	1.8824e-01	1.8824e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	30	30
α [deg]	0.00	
I_y [m^4], I_z [m^4]	6.3283e-07	6.3283e-07
i_y [mm], i_z [mm]	15	15
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	2.1122e-05	2.1122e-05
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	3.5858e-05	3.5858e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	8424.09	8424.09
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	8424.09	8424.09
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	1.2657e-06	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

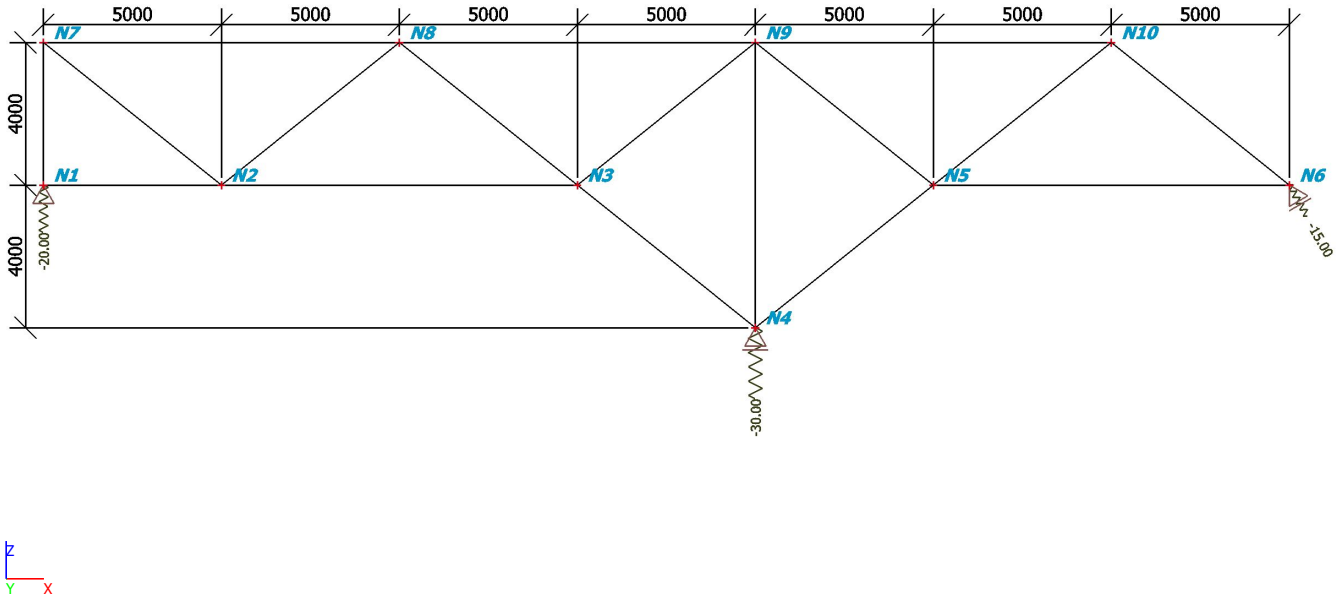
3.1. Load cases

Name	Description Spec	Action type Load type	Load group
LC1	Displacement	Permanent Standard	LG1
LC2	Permanent	Permanent Standard	LG1
LC3	Temperature	Permanent Standard	LG1

3.2. Combinations

Name	Description	Type	Load cases	Coeff. [-]
comb lineaire		Linear - ultimate	LC1 - Displacement	1.000
			LC2 - Permanent	1.000
			LC3 - Temperature	1.000

3.3. LC1 - Displacement

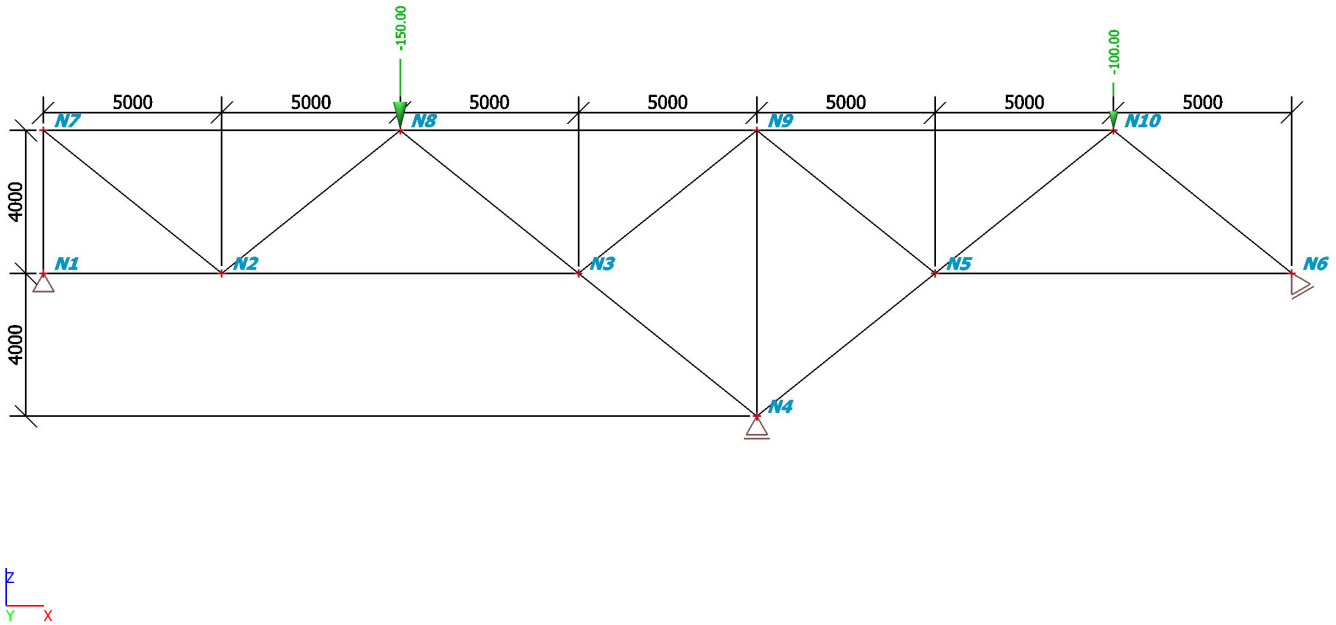


3.4. Point translation

Name	Support in node	Load case	System	Dir	Value - U [mm]
TRS1	Sn1	LC1 - Displacement	LCS	Z	-15.00
TRS2	Sn2	LC1 - Displacement	LCS	Z	-20.00
TRS3	Sn3	LC1 - Displacement	LCS	Z	-30.00

Explanations of symbols	
Load case	Displacement

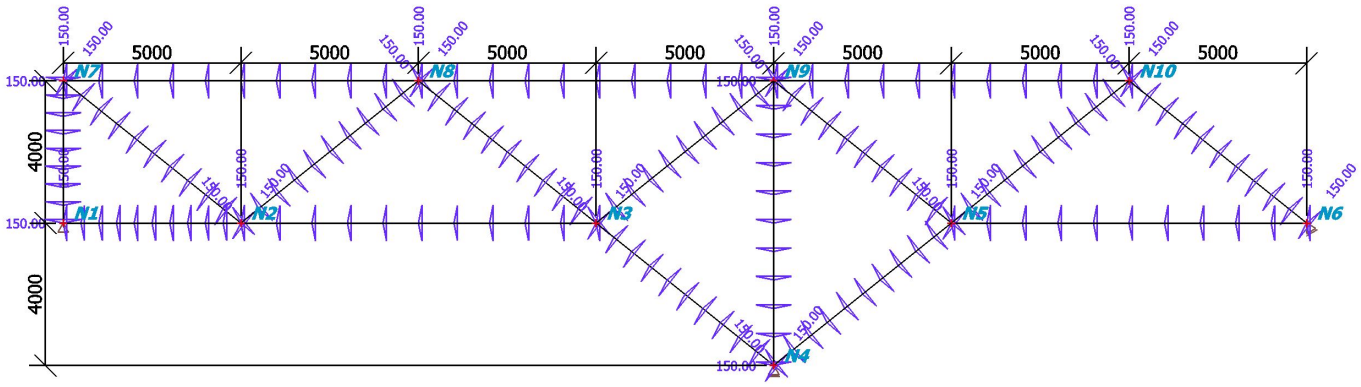
3.5. LC2 - Forces



3.6. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N8	LC2 - Permanent	GCS	Z	Force	-150.00
F2	N10	LC2 - Permanent	GCS	Z	Force	-100.00

3.7. LC3 - Thermal load



3.8. Thermal load

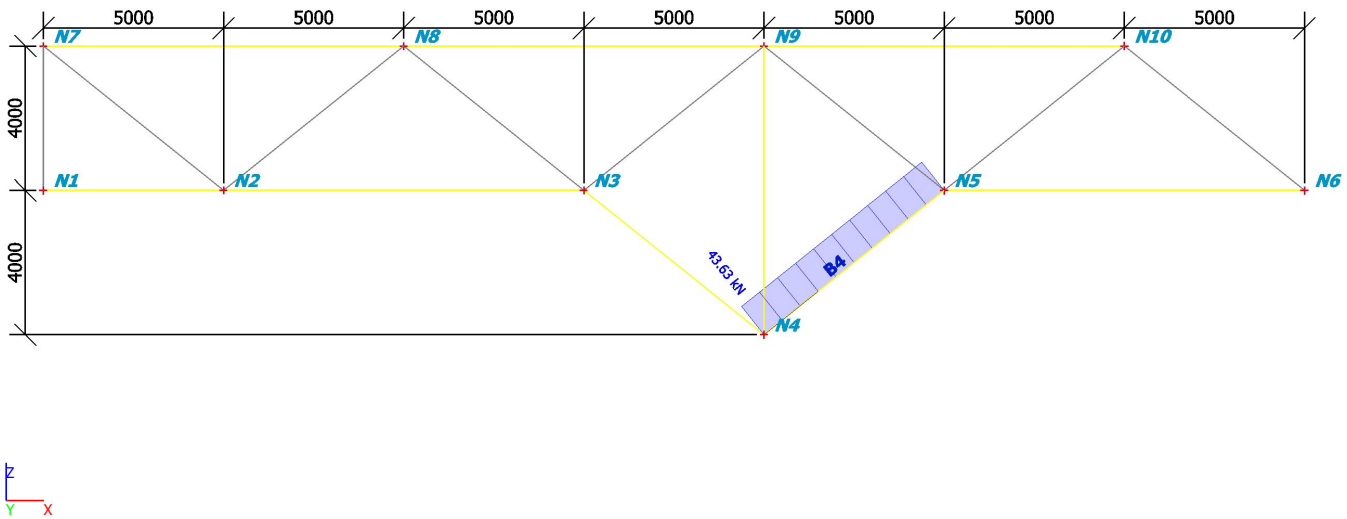
Name	Member	Load case	Pos x_1 / Pos x_2	Coor	Orig	Distribution	Delta [°C]
LT1	B1	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT2	B2	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT3	B3	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT4	B4	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT5	B5	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT6	B6	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT7	B7	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT8	B8	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT9	B9	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT10	B10	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT11	B11	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT12	B12	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT13	B13	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT14	B14	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00

Name	Member	Load case	Pos x_1 / Pos x_2	Coor	Orig	Distribution	Delta [°C]
LT15	B15	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT16	B16	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00
LT17	B17	LC3 - Temperature	0.000 / 1.000	Rela	From start	Constant	150.00

4. RESULTS

4.1. 1D internal forces; N

Values: **N**
Linear calculation
Combination: comb lineaire
Coordinate system: Member
Extreme 1D: Member
Selection: B4



4.2. 1D internal forces

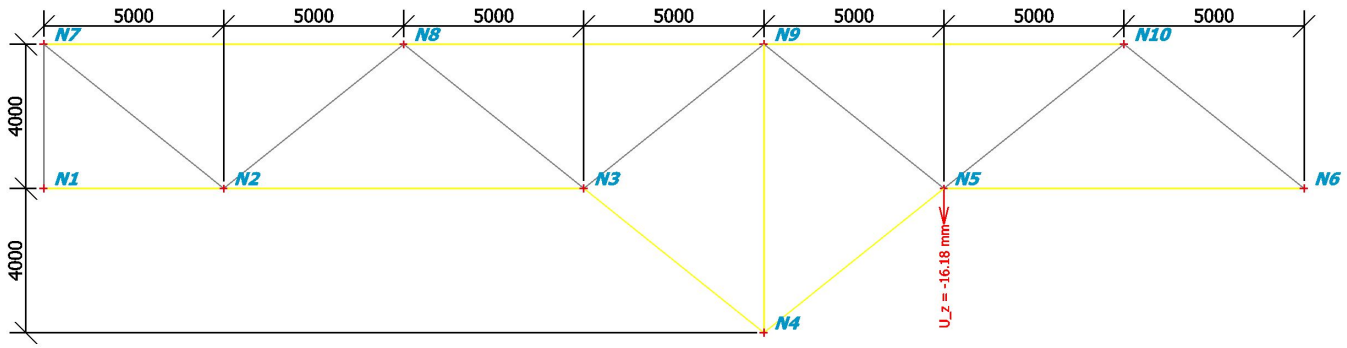
Linear calculation
Combination: comb lineaire
Coordinate system: Member
Extreme 1D: Global
Selection: B4

Name	dx [m]	Case	N [kN]	V_z [kN]	M_y [kNm]
B4	0.000	comb lineaire/1	**43.63**	**0.00**	**0.00**

Name	Combination key
comb lineaire/1	LC1 + LC2 + LC3

4.3. Displacement of nodes; U_z

Values: U_z
Linear calculation
Combination: comb lineaire
Extreme: Global
Selection: N5



4.4. Displacement of nodes

Linear calculation
Combination: comb lineaire
Extreme: Global
Selection: N5

Name	Case	U_z [mm]
N5	comb lineaire/1	**-16.18**

Name	Combination key
comb lineaire/1	LC1 + LC2 + LC3

5. EXPECTED AFNOR RESULTS

Normal force in element B4 = 43.63 kN

Vertical displacement in node N5 = -16.18 mm

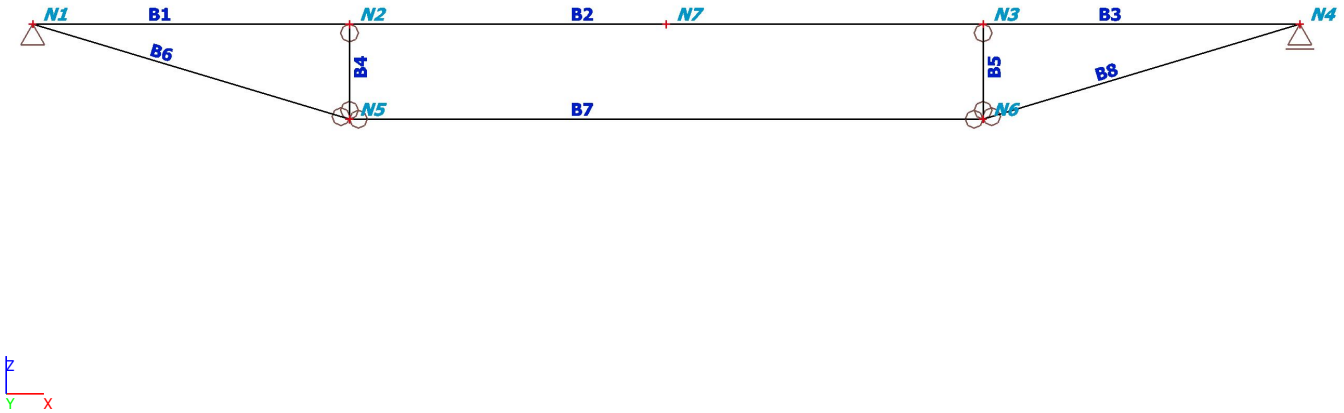
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simply supported beam with truss elements (hinged joints), shortening of bars; elastic, linear, isotropic material.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	Sn1
			B6	
N2	2.000	0.000	B1	
			B2	
			B4	
N3	6.000	0.000	B2	
			B3	
			B5	
N4	8.000	0.000	B3	Sn2
			B8	

Name	Coord X [m]	Coord Z [m]	Member	Data
N5	2.000	-0.600	B4	
			B6	
			B7	
N6	6.000	-0.600	B5	
			B7	
			B8	
N7	4.000	0.000	B2	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	Poutre - Full rectangular (123; 123)	S 235	2.000	N1	N2	general (0)
B2	Poutre - Full rectangular (123; 123)	S 235	4.000	N2	N3	general (0)
B3	Poutre - Full rectangular (123; 123)	S 235	2.000	N3	N4	general (0)
B4	Barre A3 - Full rectangular (59; 59)	S 235	0.600	N2	N5	general (0)
B5	Barre A3 - Full rectangular (59; 59)	S 235	0.600	N3	N6	general (0)
B6	Barre A1 - Full rectangular (67; 67)	S 235	2.088	N1	N5	general (0)
B7	Barre A1 - Full rectangular (67; 67)	S 235	4.000	N5	N6	general (0)
B8	Barre A1 - Full rectangular (67; 67)	S 235	2.088	N6	N4	general (0)

2.4. Nodal supports

Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Free
Sn2	N4	GCS	Standard	Free	Rigid	Free

2.5. Hinges

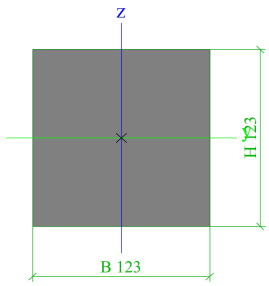
Name	Member	Position	ux	uy	uz	fix	fiy	fiz
H1	B8	Begin	Rigid		Rigid		Free	
H2	B6	End	Rigid		Rigid		Free	
H3	B7	Both	Rigid		Rigid		Free	
H4	B5	Both	Rigid		Rigid		Free	
H5	B4	Both	Rigid		Rigid		Free	

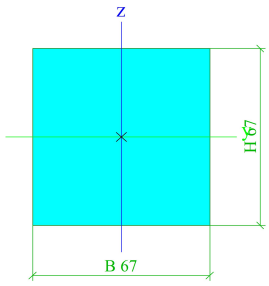
2.6. Materials

Steel EC3

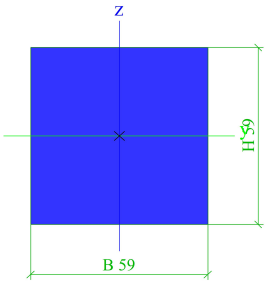
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.4000e+04	0.01e-003	40	80	215.0	360.0	

2.7. Cross-sections

Poutre		
Type	Full rectangular	
Detailed	123; 123	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m^2]	1.5160e-02	
A_y [m^2], A_z [m^2]	1.2633e-02	1.2633e-02
A_L [m^2/m], A_D [m^2/m]	4.9250e-01	4.9250e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	62	62
α [deg]	0.00	
I_y [m^4], I_z [m^4]	2.1740e-04	2.1740e-04
i_y [mm], i_z [mm]	120	120
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	3.5314e-03	3.5314e-03
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	4.6665e-04	4.6665e-04
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	109662.13	109662.13
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	109662.13	109662.13
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	3.2344e-05	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

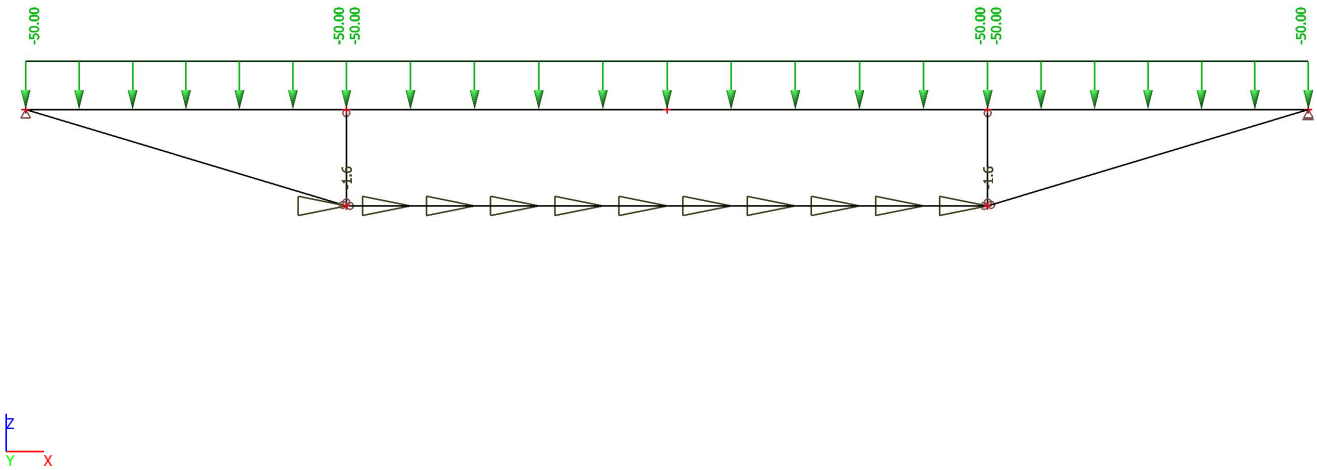
Barre A1		
Type	Full rectangular	
Detailed	67; 67	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m^2]	4.5000e-03	
A_y [m^2], A_z [m^2]	3.7500e-03	3.7500e-03
A_L [m^2/m], A_D [m^2/m]	2.6833e-01	2.6833e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	34	34
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.6875e-06	1.6875e-06
i_y [mm], i_z [mm]	19	19
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	5.0312e-05	5.0312e-05
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	7.5467e-05	7.5467e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	17734.81	17734.81
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	17734.81	17734.81
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	2.8498e-06	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

Barre A3		
Type	Full rectangular	
Detailed	59; 59	
Formcode	7 - Full rectangular section	

Item material	S 235	
A [m^2]	3.4800e-03	
A_y [m^2], A_z [m^2]	2.9000e-03	2.9000e-03
A_L [m^2/m], A_D [m^2/m]	2.3597e-01	2.3597e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	29	29
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.0092e-06	1.0092e-06
i_y [mm], i_z [mm]	17	17
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	3.4215e-05	3.4215e-05
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	5.1323e-05	5.1323e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	12060.82	12060.82
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	12060.82	12060.82
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	1.7043e-06	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Tot. value



3.2. Line force

Name	Member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Coor	Orig	Ecc ey [m]
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Loc		Ecc ez [m]
LF1	B2	Force	Z	-50.00	0.000	Rela	From start	
	LC2 - Permanent	LCS	Uniform		1.000	Length		0.000
LF2	B1	Force	Z	-50.00	0.000	Rela	From start	
	LC2 - Permanent	LCS	Uniform		1.000	Length		0.000
LF3	B3	Force	Z	-50.00	0.000	Rela	From start	
	LC2 - Permanent	LCS	Uniform		1.000	Length		0.000

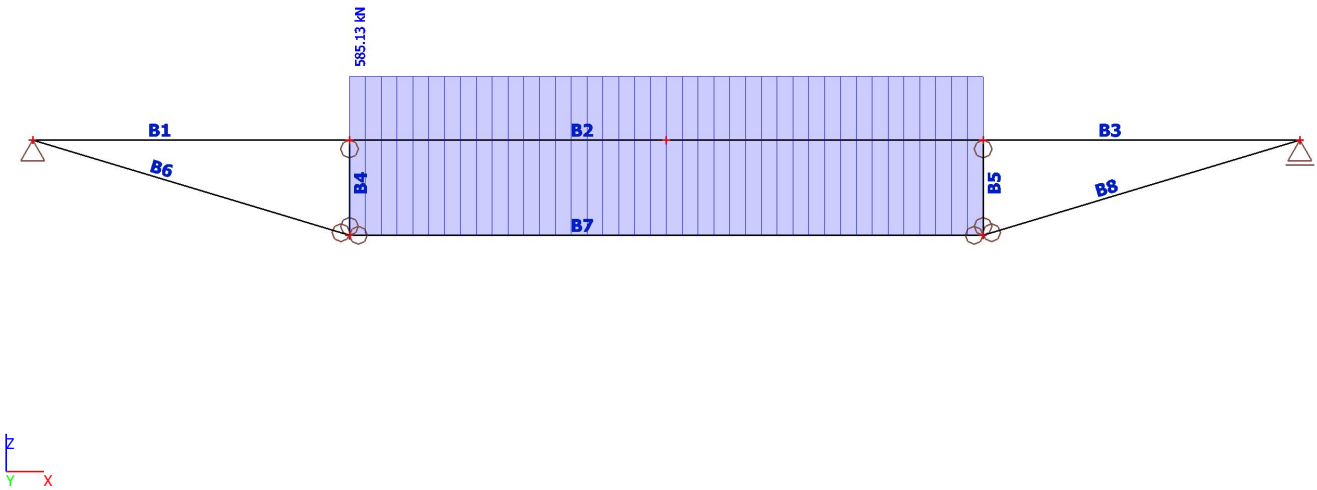
3.3. Line translation

Name	System	Loc	Dir	Distribution	Value - U_1 [mm/m]
LTR1	LCS	Length	X	Uniform	-1.6

4. RESULTS

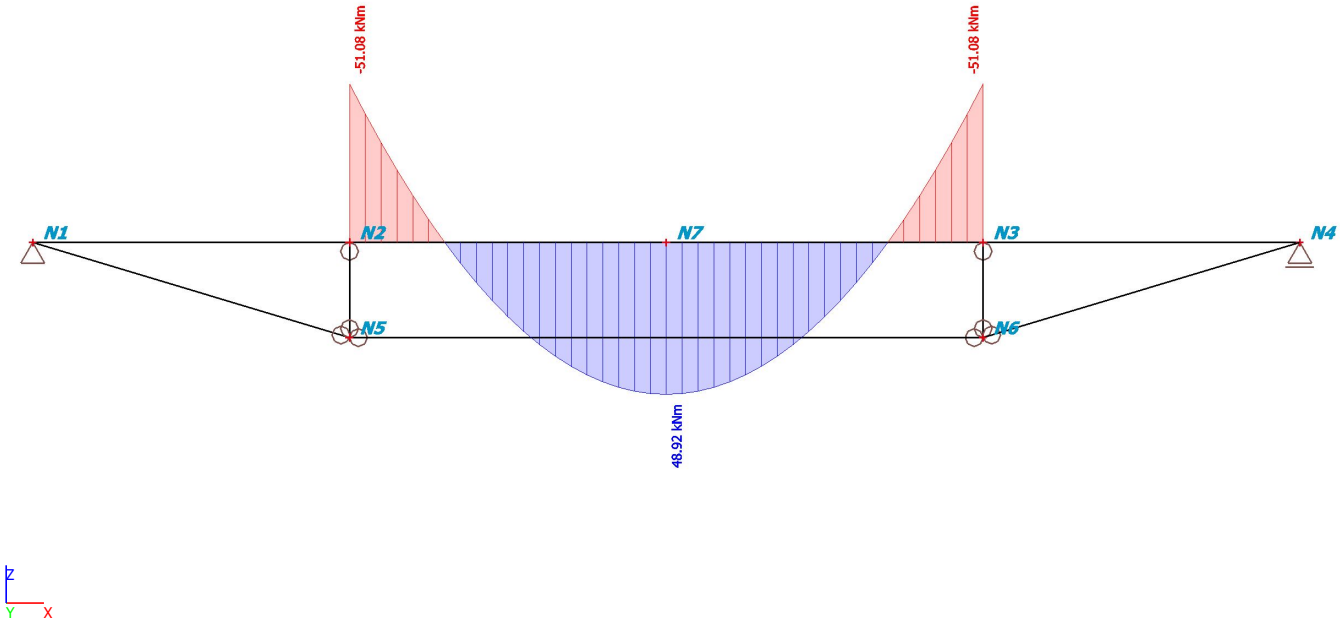
4.1. 1D internal forces; N

Values: **N**
Linear calculation
Load case: LC2
Coordinate system: Member
Extreme 1D: Member
Selection: B7



4.2. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Member
Extreme 1D: Local
Selection: B2



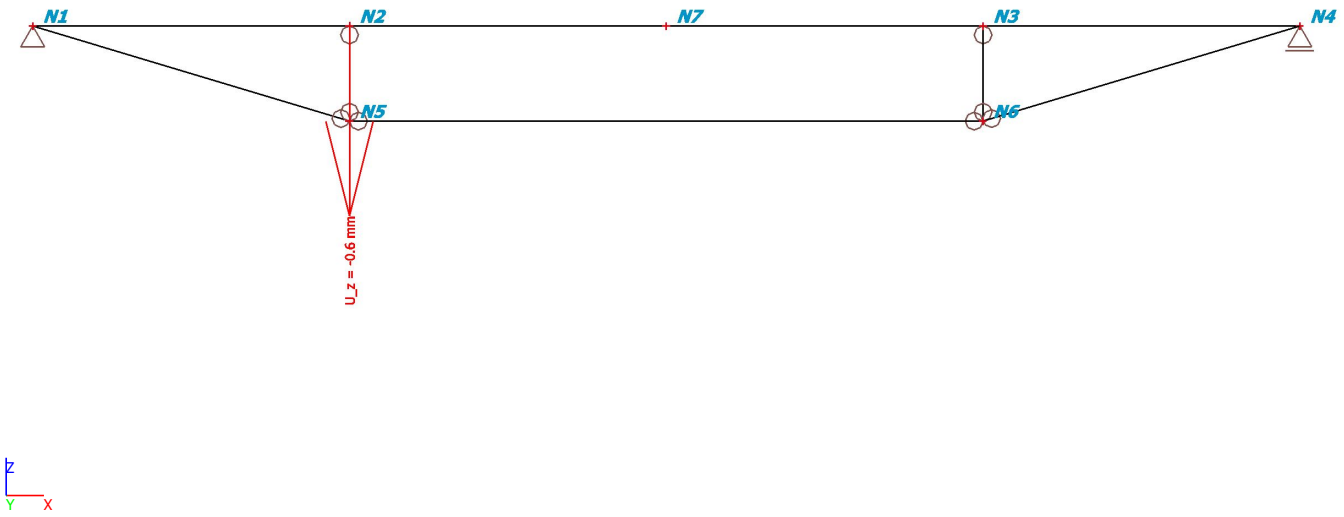
4.3. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N2

Name	Case	U_z [mm]
N2	LC2	**-0.6**

4.4. Displacement of nodes; U_z

Values: U_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: N2



5. EXPECTED AFNOR RESULTS

Shear Force in node B7 = 584.584 kN
Bending Moment in node N7 = 49.249 kNm
Vertical displacement in node N2 = -0.543 mm

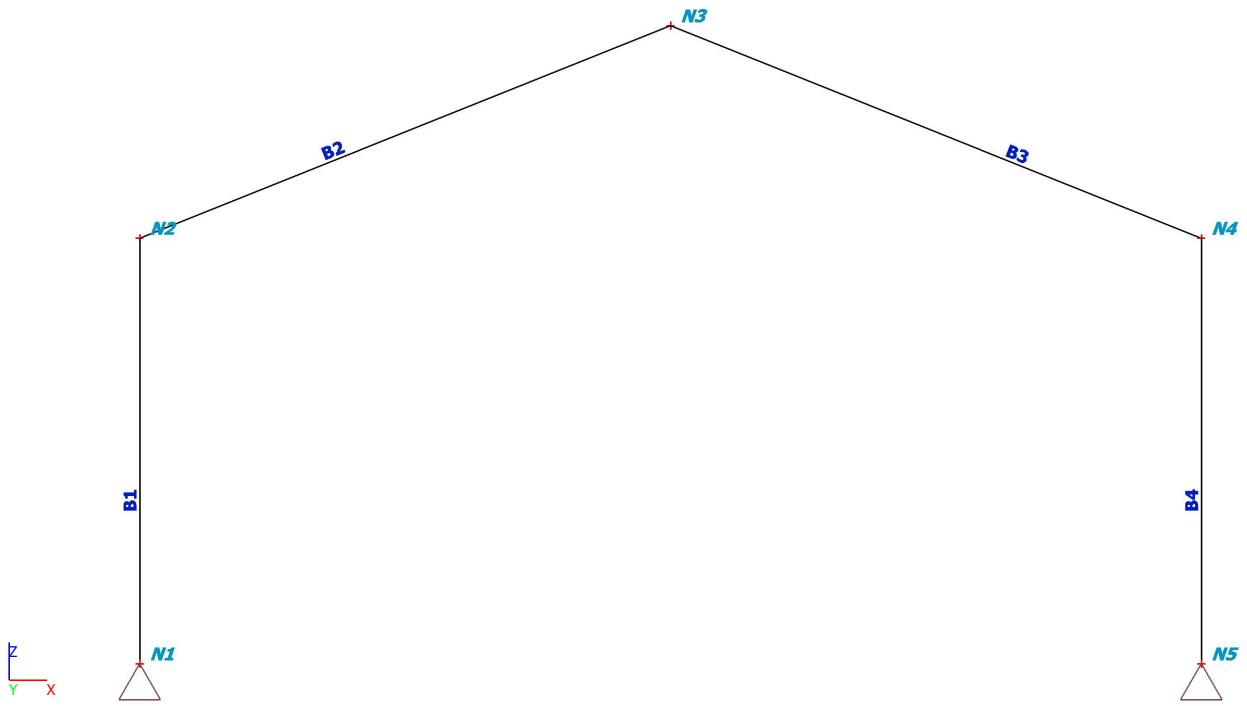
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simply supported symmetrical frame with asymmetric load; material: elastic, linear, isotropic

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	Sn1
N2	0.000	8.000	B1	F2
			B2	M1
N3	10.000	12.000	B2	F1
			B3	

Name	Coord X [m]	Coord Z [m]	Member	Data
N4	20.000	8.000	B3	
			B4	
N5	20.000	0.000	B4	Sn2

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	Poteau - Full rectangular (278; 278)	S 235	8.000	N1	N2	column (100)
B2	Poutre - Full rectangular (234; 234)	S 235	10.770	N2	N3	beam (80)
B3	Poutre - Full rectangular (234; 234)	S 235	10.770	N4	N3	beam (80)
B4	Poteau - Full rectangular (278; 278)	S 235	8.000	N5	N4	column (100)

2.4. Nodal supports

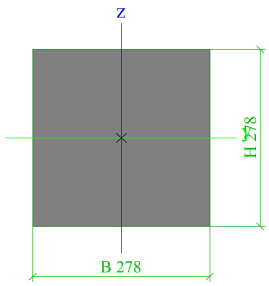
Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Free
Sn2	N5	GCS	Standard	Rigid	Rigid	Free

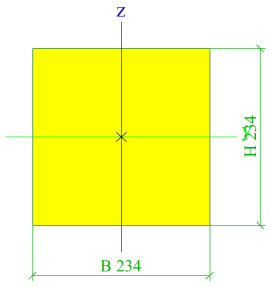
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

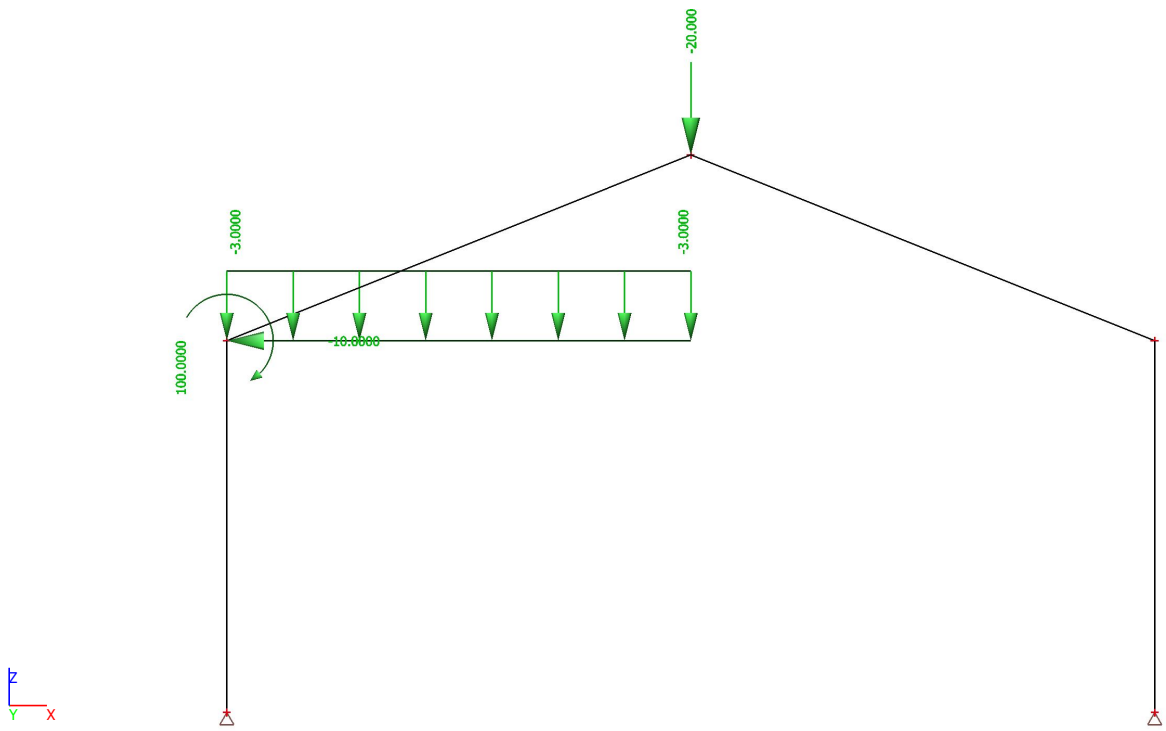
2.6. Cross-sections

Poteau		
Type	Full rectangular	
Detailed	278; 278	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m²]	7.7460e-02	
A_y [m²], A_z [m²]	6.4550e-02	6.4550e-02
A_L [m²/m], A_D [m²/m]	1.1133e+00	1.1133e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	139	139
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	5.0000e-04	5.0000e-04
i_y [mm], i_z [mm]	80	80
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	3.5930e-03	3.5930e-03
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	5.3896e-03	5.3896e-03
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	1266547.00	1266547.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	1266547.00	1266547.00
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	8.4439e-04	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

Poutre		
Type	Full rectangular	
Detailed	234; 234	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m²]	5.4772e-02	
A_y [m²], A_z [m²]	4.5644e-02	4.5644e-02
A_L [m²/m], A_D [m²/m]	9.3614e-01	9.3614e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	117	117
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.5000e-04	2.5000e-04
i_y [mm], i_z [mm]	68	68
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	2.1364e-03	2.1364e-03
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	3.2047e-03	3.2047e-03
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	753093.35	753093.35
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	753093.35	753093.35
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	4.2219e-04	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Tot. value



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N3	LC2 - Permanent	GCS	Z	Force	-20.0000
F2	N2	LC2 - Permanent	GCS	X	Force	-10.0000

3.3. Moment in node

Name	Node	Load case	System	Dir	Type	Value - M [kNm]
M1	N2	LC2 - Permanent	GCS	My	Moment	100.0000

3.4. Line force

Name	Member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Coor	Orig	Ecc ey [m]
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Loc		Ecc ez [m]
LF1	B2	Force	Z	-3.0000	0.000	Rela	From start	
	LC2 - Permanent	GCS	Uniform		1.000	Projection		0.000

4. RESULTS

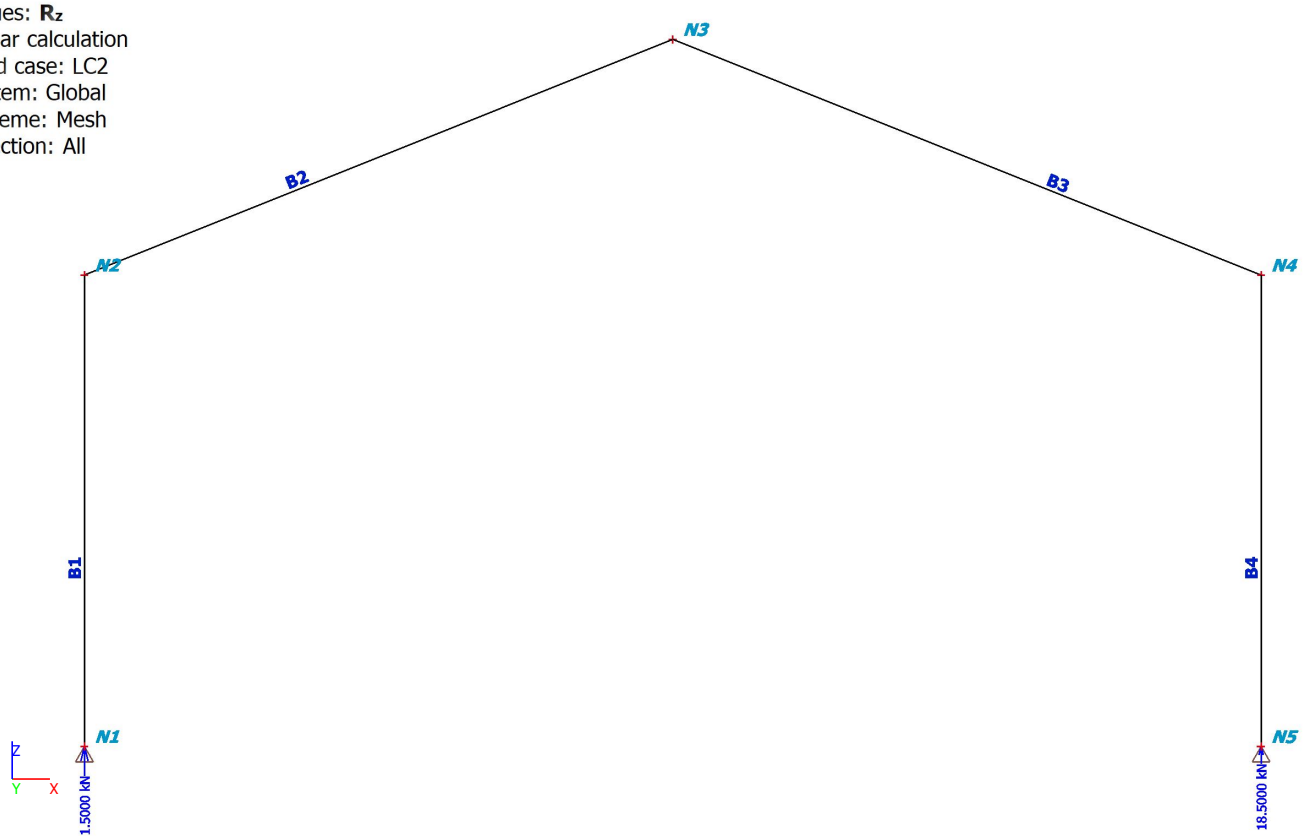
4.1. Reactions

Linear calculation
Load case: LC2
System: Global
Extreme: Global
Selection: Sn1
Nodal reactions

Name	Case	R_x [kN]	R_z [kN]	M_y [kNm]	e_x [mm]
Sn1/N1	LC2	**20.2388**	**31.5000**	**0.0000**	0.00

4.2. Reactions; R_z

Values: R_z
Linear calculation
Load case: LC2
System: Global
Extreme: Mesh
Selection: All



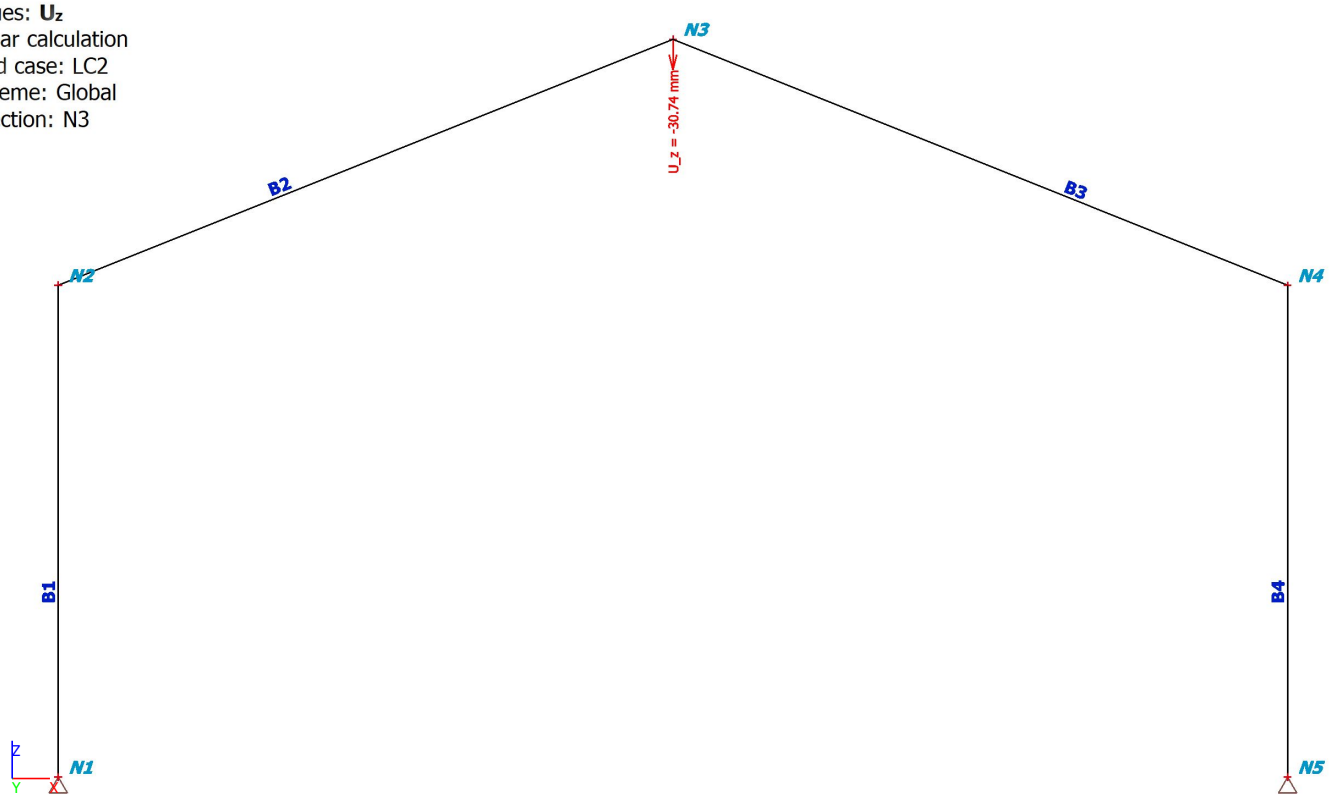
4.3. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N3

Name	Case	U_z [mm]
N3	LC2	**-30.74**

4.4. Displacement of nodes; U_z

Values: U_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: N3



5. EXPECTED AFNOR RESULTS

Vertical displacement in node N3 = -30,72mm
Vertical reaction in node N1= 31,5KN
Horizontal reaction in N1=20,24 KN

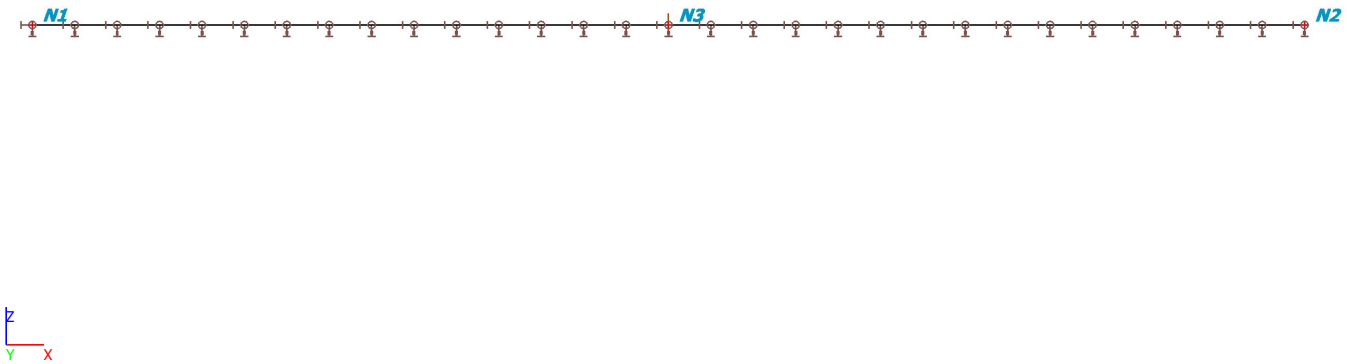
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simple beam on bidirectional, elastic foundation (Winkler's foundation), elastic, linear, isotropic material

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member
N1	0.000	0.000	0.000	B1
N2	4.967	0.000	0.000	B1
N3	2.484	0.000	0.000	B1

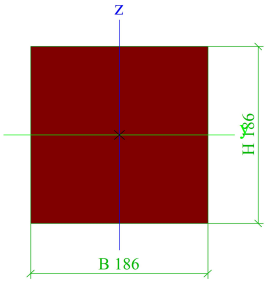
2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Full rectangular (186; 186)	S 235	4.967	N1	N2	general (0)

2.4. Line supports on member

Name	Type	Member	Pos x_1	Coor	X	Y	Z	Rx	Ry	Rz
		System	Pos x_2	Orig						
Slb1	Line	B1	0.000	Rela	Rigid	Rigid	Flexible	Rigid	Free	Free
		LCS	1.000	From start						

2.5. Cross-sections

CS2		
Type	Full rectangular	
Detailed	186; 186	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m²]	3.4641e-02	
A_y [m²], A_z [m²]	2.8868e-02	2.8868e-02
A_L [m²/m], A_D [m²/m]	7.4448e-01	7.4448e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	93	93
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.0000e-04	1.0000e-04
i_y [mm], i_z [mm]	54	54
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.0746e-03	1.0746e-03
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.6119e-03	1.6119e-03
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	378785.90	378785.90
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	378785.90	378785.90
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.6888e-04	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

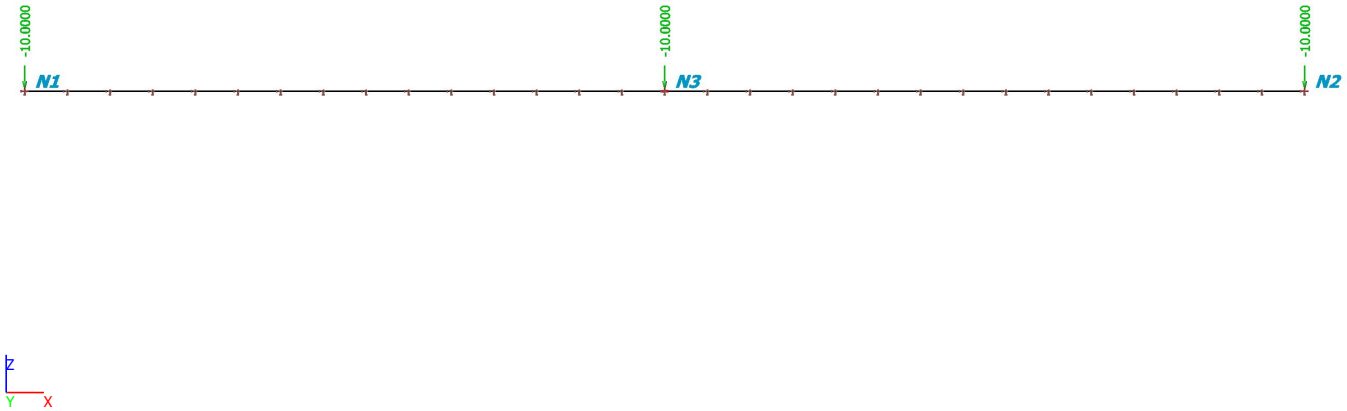
2.6. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC2 / Tot. value



3.2. Point force on beam

Name	Member	System	Value - F [kN]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb1	B1	GCS	-10.0000	0.000	Rela	1
	LC2 - permanent	Z	Force		From start	
Fb2	B1	GCS	-10.0000	0.500	Rela	1
	LC2 - permanent	Z	Force		From start	
Fb3	B1	GCS	-10.0000	1.000	Rela	1
	LC2 - permanent	Z	Force		From start	

4. RESULTS

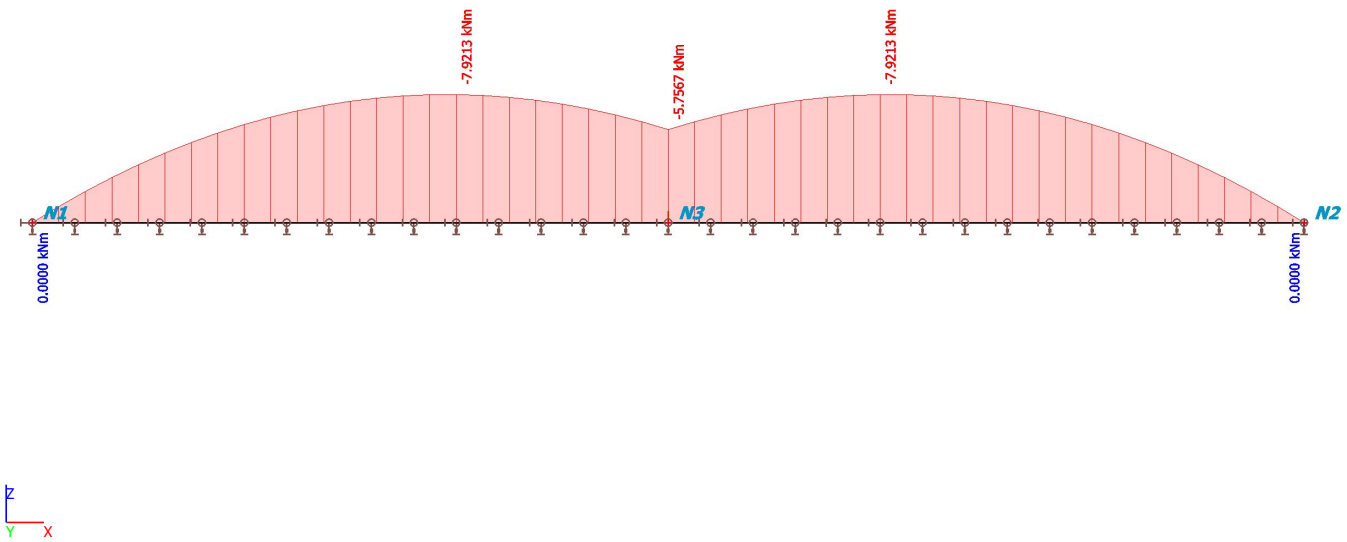
4.1. 1D internal forces

Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Filter: Cross-section = CS2 - Full rectangular (186; 186)
Selected sections: Inputted

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B1	2.484+	LC2	CS2 - Full rectangular (186; 186)	**0.0000**	**0.0000**	**-4.7026**	**0.0000**	**-5.7567**	**0.0000**
B1	2.484-	LC2	CS2 - Full rectangular (186; 186)	0.0000	0.0000	**4.7026**	0.0000	-5.7567	**0.0000**

4.2. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Local
Selection: All



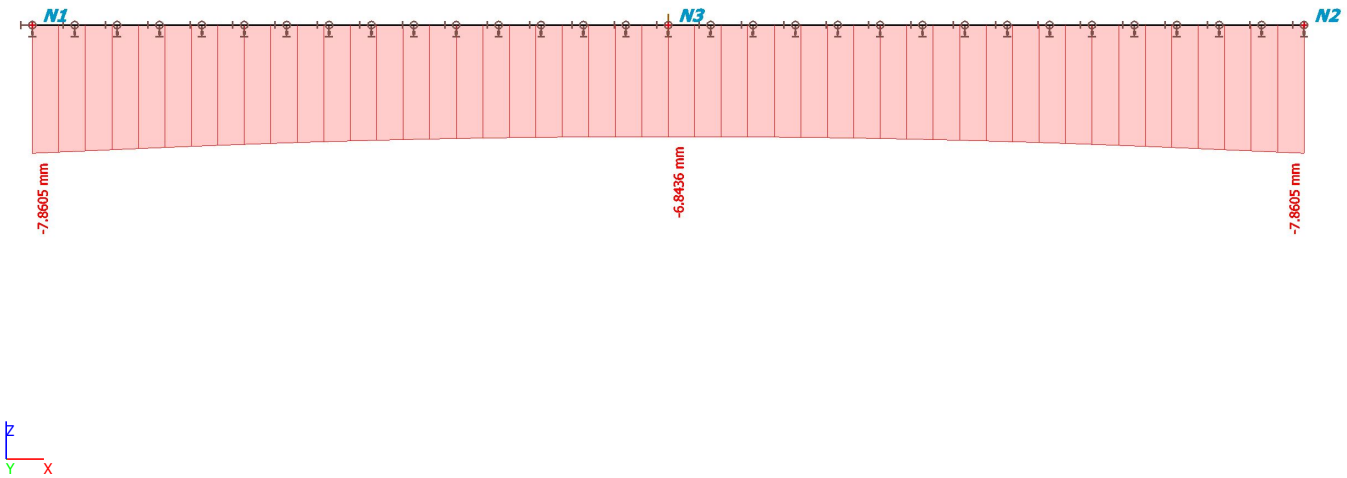
4.3. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N1, N3

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N3	LC2	**0.0000**	**0.0000**	**-6.8436**	**0.000**	**0.000**	**0.000**	6.8436
N1	LC2	0.0000	0.0000	**-7.8605**	0.000	**-0.705**	**0.000**	**7.8605**

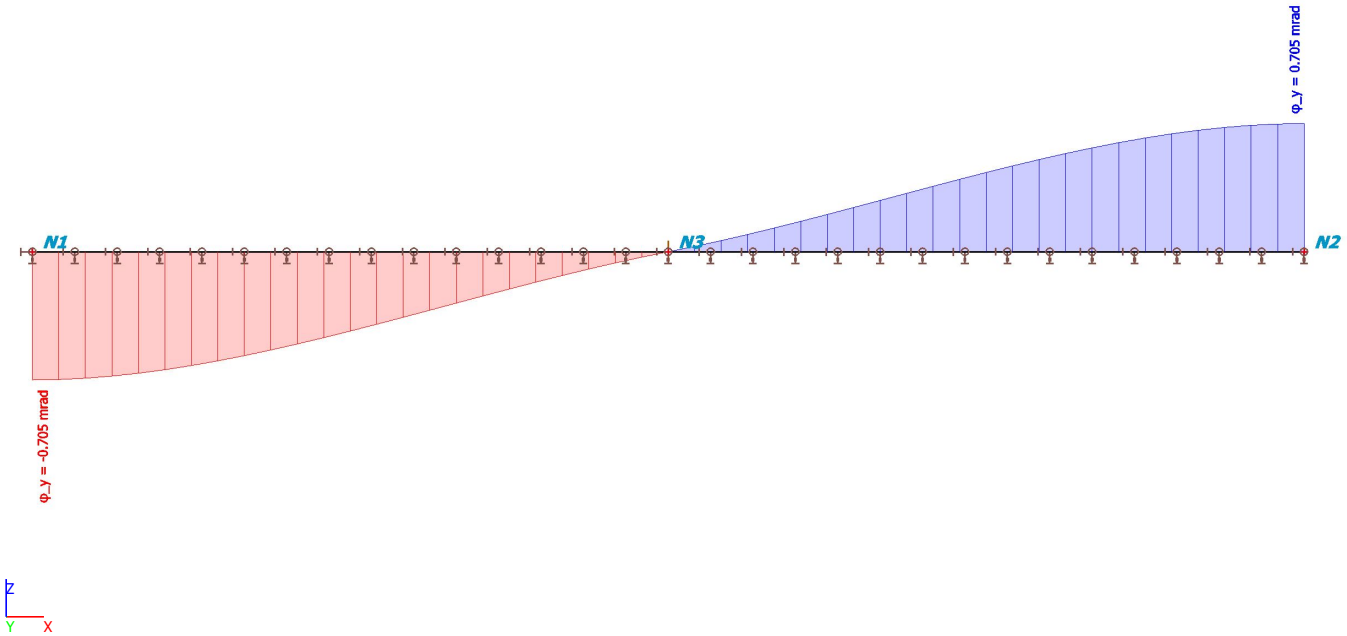
4.4. 1D deformations; u_z

Values: u_z
Linear calculation
Load case: LC2
Coordinate system: Global
Extreme 1D: Local
Selection: All



4.5. 1D deformations; φ_y

Values: φ_y
Linear calculation
Load case: LC2
Coordinate system: Global
Extreme 1D: Local
Selection: All



5. EXPECTED AFNOR RESULTS

Moment My in node N3=5,759 KN.m
Vertical displacement in node N3 = -6,844mm
Vertical displacement in node N1= -7,854mm
Rotation Ry in node N1=0,706mrad

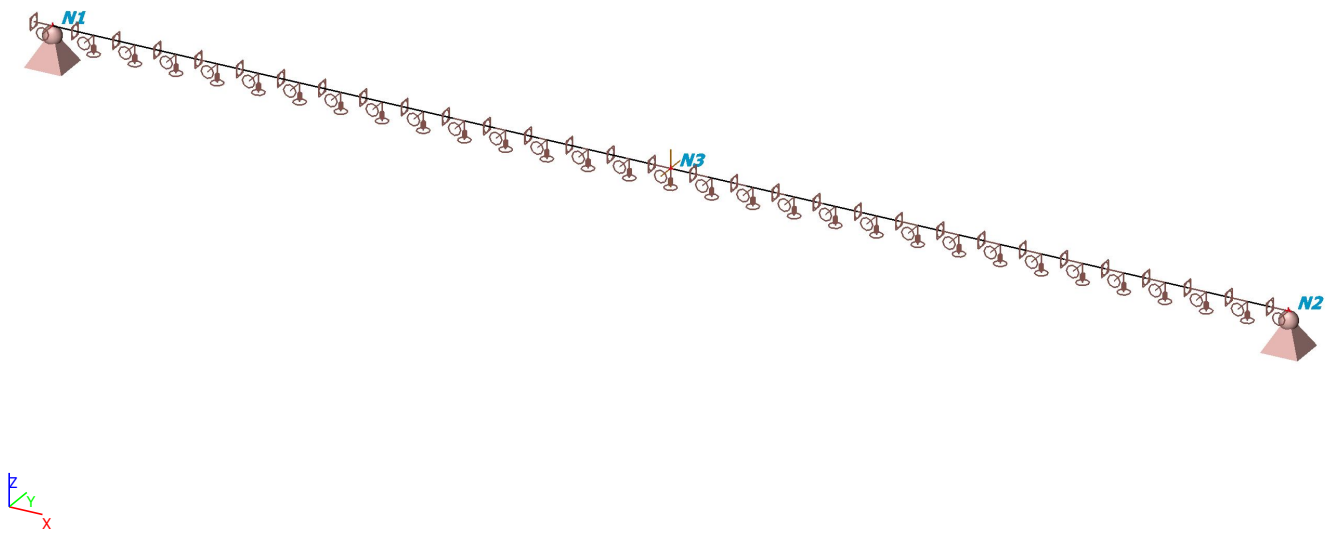
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simple beam on bidirectional, elastic foundation (Winkler's foundation)
elastic, linear, isotropic material

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	Sn1
N2	4.967	0.000	0.000	B1	Sn2
N3	2.484	0.000	0.000	B1	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Full rectangular (186; 186)	S 235	4.967	N1	N2	general (0)

2.4. Nodal supports

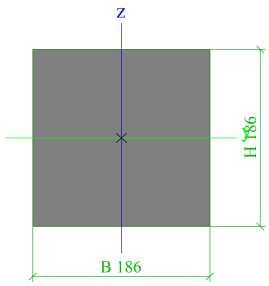
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free
Sn2	N2	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free

2.5. Materials

Steel EC3

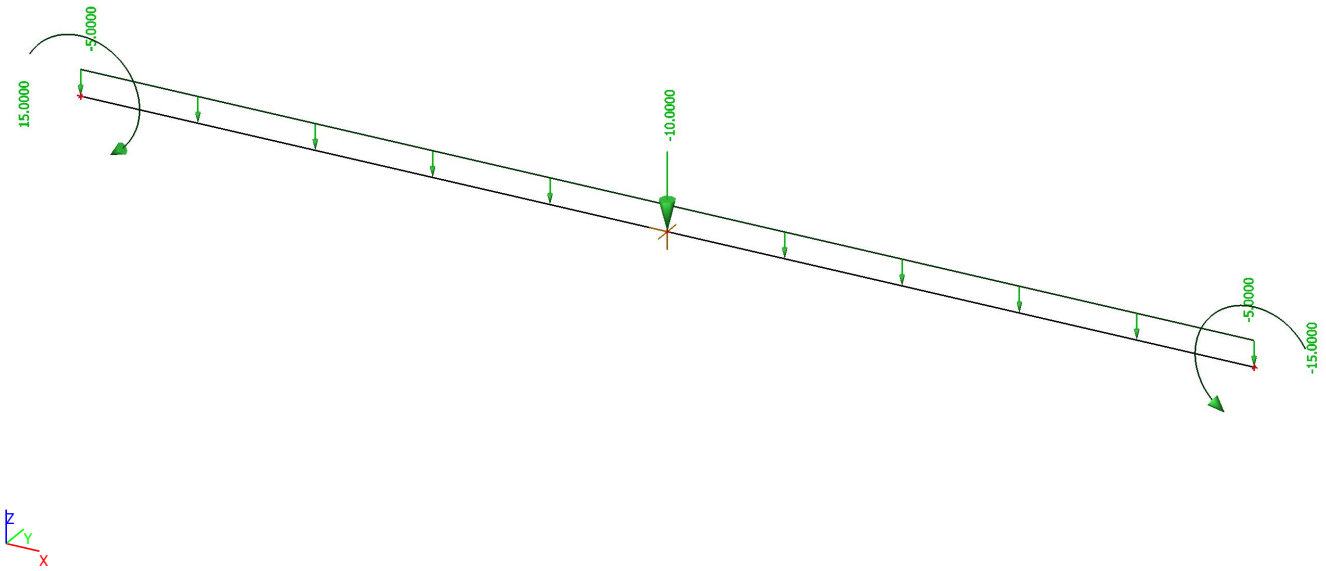
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS1		
Type	Full rectangular	
Detailed	186; 186	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m^2]	3.4641e-02	
A_y [m^2], A_z [m^2]	2.8868e-02	2.8868e-02
A_L [m^2/m], A_D [m^2/m]	7.4448e-01	7.4448e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	93	93
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.0000e-04	1.0000e-04
i_y [mm], i_z [mm]	54	54
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	1.0746e-03	1.0746e-03
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	1.6119e-03	1.6119e-03
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	378785.90	378785.90
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	378785.90	378785.90
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	1.6888e-04	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD

3.1. LC2 / Tot. value



3.2. Point force on beam

Name	Member	System	Value - F [kN]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb1	B1	GCS	-10.0000	0.500	Rela	1
	LC2 - Permanent	Z	Force		From start	

3.3. Moment on beam

Name	Member	System	Value - M [kNm]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	dx
M1	B1	LCS	15.0000	0.000	Rela	1
	LC2 - Permanent	My	Moment		From start	
M2	B1	LCS	-15.0000	1.000	Rela	1
	LC2 - Permanent	My	Moment		From start	

3.4. Line force

Name	Member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Coor	Orig	Ecc ey [m]
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Loc		Ecc ez [m]
LF1	B1	Force	Z	-5.0000	0.000	Rela	From start	0.000
	LC2 - Permanent	LCS	Uniform		1.000	Length		0.000

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N1, N3

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N3	LC2	**0.000**	**0.000**	**-4.233**	**0.0**	**0.0**	**0.0**	**4.233**
N1	LC2	0.000	0.000	**0.000**	0.0	**3.0**	**0.0**	0.000

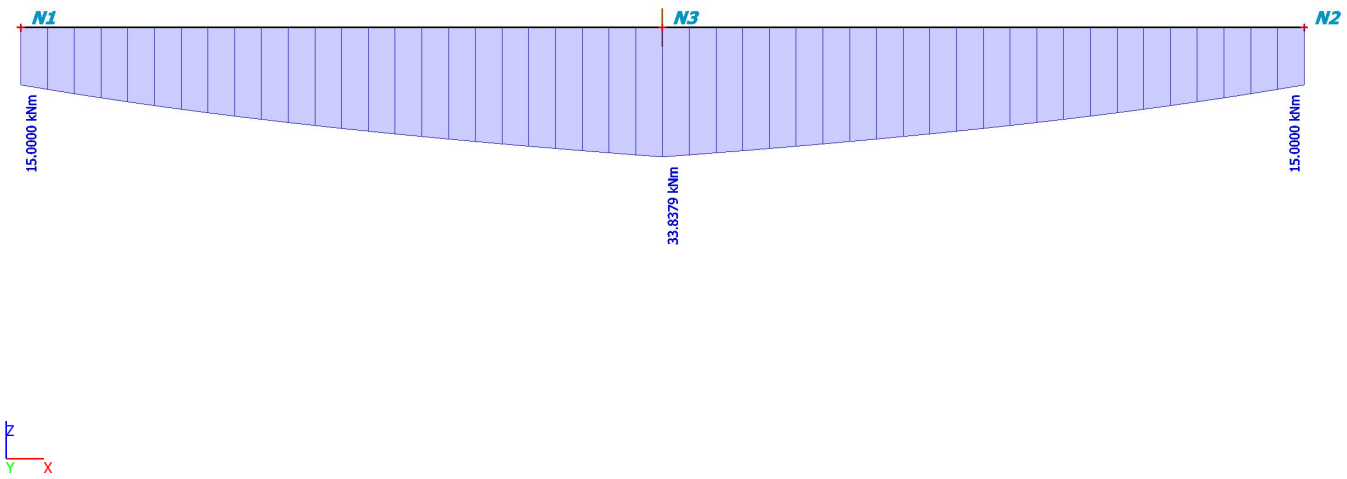
4.2. 1D internal forces

Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Global
Selection: B1
Filter: Cross-section = CS1 - Full rectangular (186; 186)
Selected sections: Inputted

Name	dx [m]	Case	Cross-section	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B1	2.484+	LC2	CS1 - Full rectangular (186; 186)	**0.0000**	**0.0000**	**-5.0747**	**0.0000**	**33.8379**	**0.0000**
B1	2.484-	LC2	CS1 - Full rectangular (186; 186)	0.0000	0.0000	**5.0747**	0.0000	33.8379	**0.0000**

4.3. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Principal
Extreme 1D: Local
Selection: All



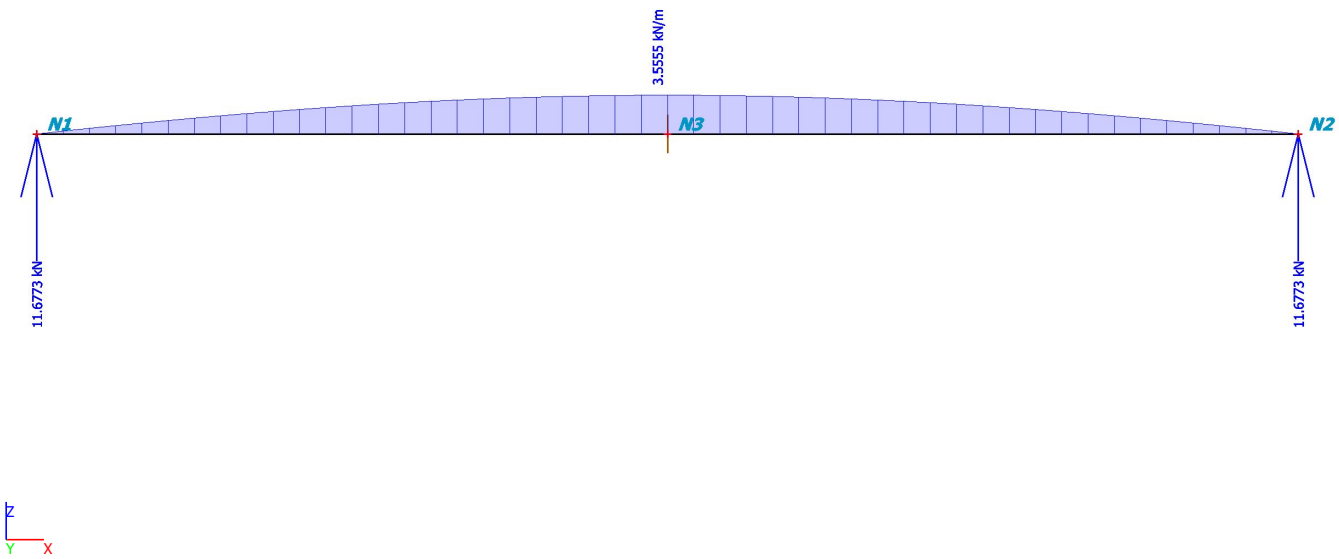
4.4. Reactions

Linear calculation
Load case: LC2
System: Global
Extreme: Global
Selection: Sn1
Nodal reactions

Name	Case	R_x [kN]	R_y [kN]	R_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]	e_x [mm]	e_y [mm]	E/W/N
Sn1/N1	LC2	**0.0000**	**0.0000**	**11.6773**	**0.0000**	**0.0000**	**0.0000**	0.000	0.000	N_RES_OVER01

4.5. Reactions; R_z

Values: R_z
Linear calculation
Load case: LC2
System: Global
Extreme: Global
Selection: All



5. EXPECTED AFNOR RESULTS

Rotation Ry in node N1 = -3,045 mrad
Displacement uz in node N3 =-4,23326mm
Moment My in node N3 = -33,84N.m
Vertical reaction in node N1 = 11,674KN

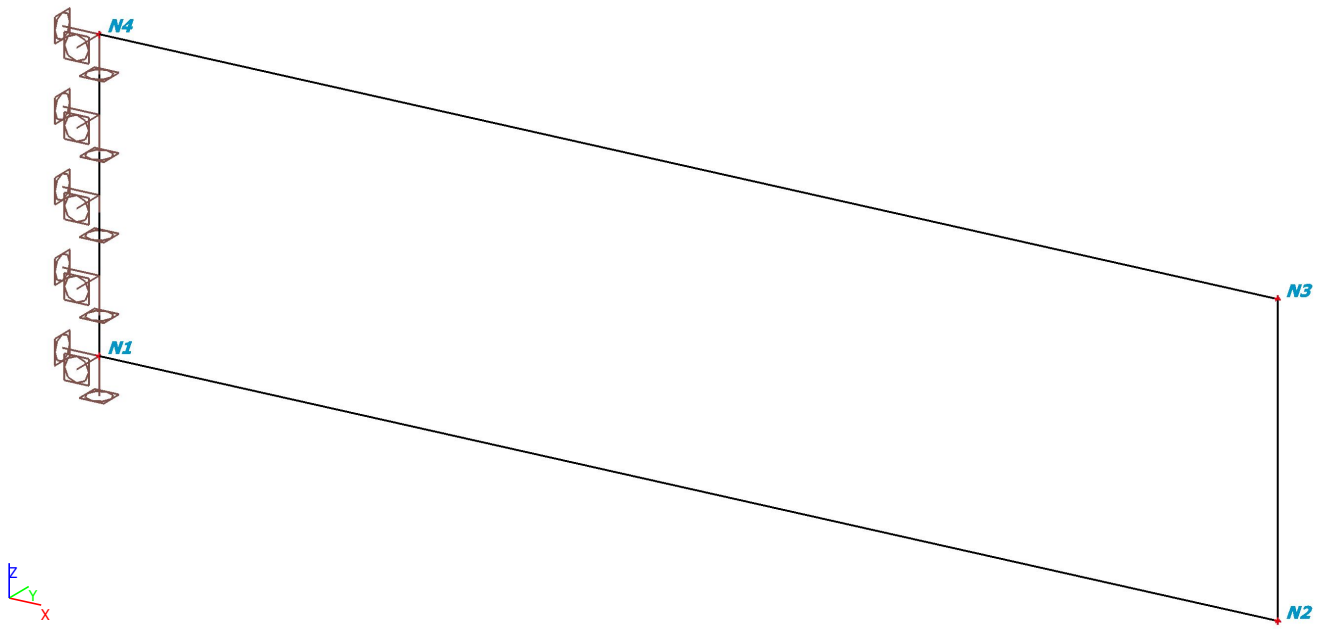
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Rectangular membrane under in-plane shear
Specification: Rectangular shell: in-plane bending and shear.

2. MODEL

2.1. Analysis model



2.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	1

2.3. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						

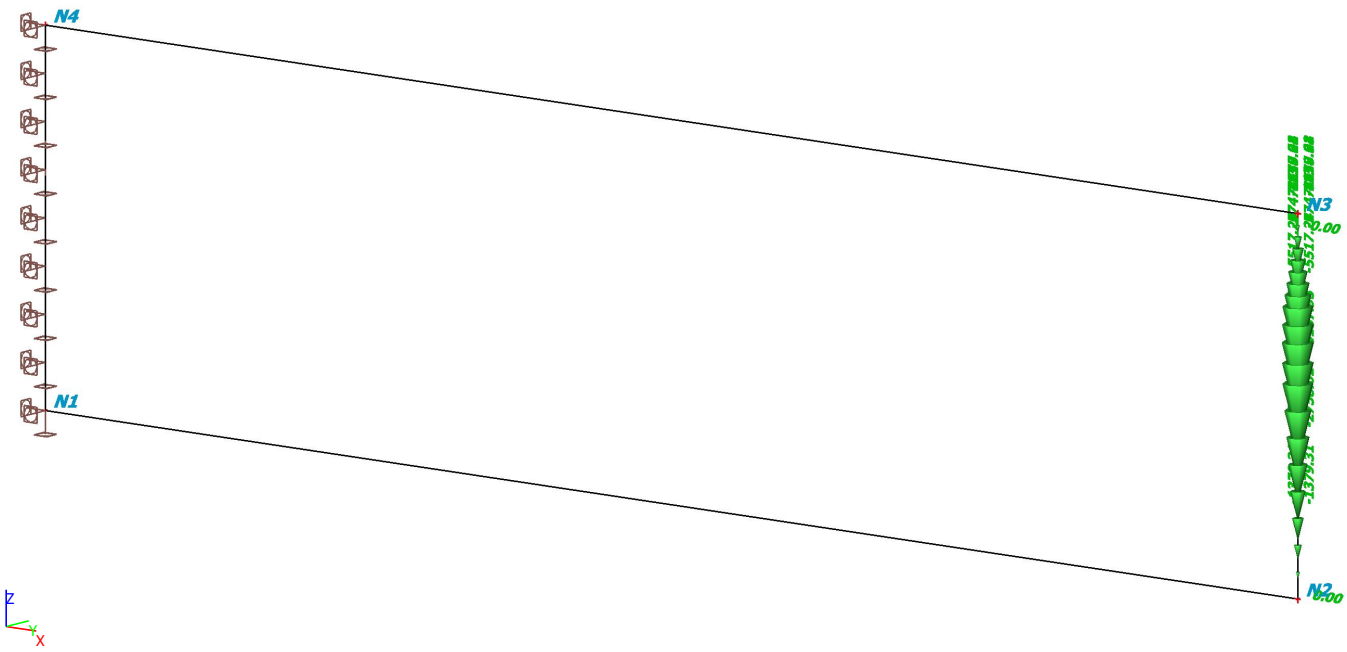
2.4. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	3.0000e+04	0.25	0	40	235.0	360.0	
		1.2000e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



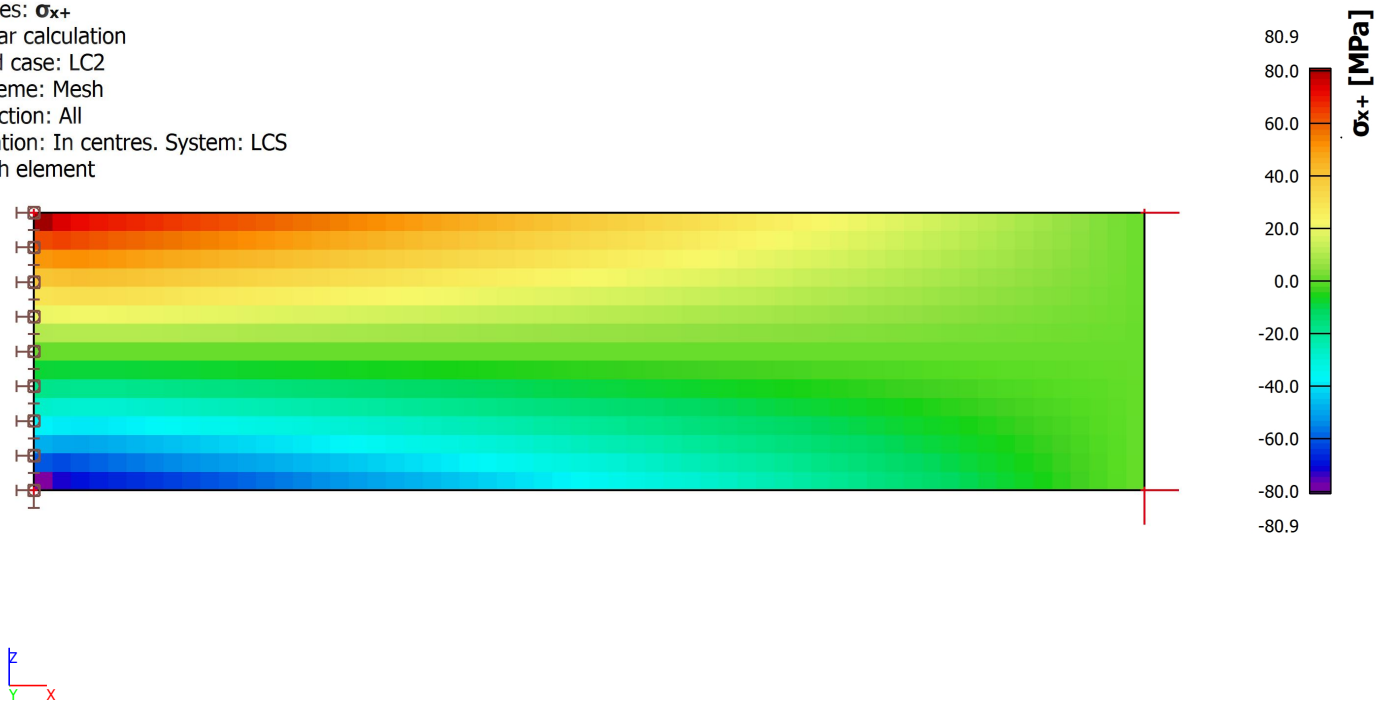
3.2. Line force on 2D member edge

Name	2D member	Type	Dir	Value - P_1 [N/m]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - P_2 [N/m]	Pos x_2	Coor	Orig
LFS2	D1	Force	Z	-1379.31	0.100	Length	2
	LC2 - Permanent	GCS	Trapez	-2758.62	0.200	Rela	From start
LFS3	D1	Force	Z	-2758.62	0.200	Length	2
	LC2 - Permanent	GCS	Trapez	-4137.93	0.300	Rela	From start
LFS4	D1	Force	Z	-4137.93	0.300	Length	2
	LC2 - Permanent	GCS	Trapez	-5517.24	0.400	Rela	From start
LFS5	D1	Force	Z	-5517.24	0.400	Length	2
	LC2 - Permanent	GCS	Trapez	-5747.13	0.500	Rela	From start
LFS7	D1	Force	Z	-1379.31	0.100	Length	2
	LC2 - Permanent	GCS	Trapez	-2758.62	0.200	Rela	From end
LFS8	D1	Force	Z	-2758.62	0.200	Length	2
	LC2 - Permanent	GCS	Trapez	-4137.93	0.300	Rela	From end
LFS9	D1	Force	Z	-4137.93	0.300	Length	2
	LC2 - Permanent	GCS	Trapez	-5517.24	0.400	Rela	From end
LFS10	D1	Force	Z	-5517.24	0.400	Length	2
	LC2 - Permanent	GCS	Trapez	-5747.13	0.500	Rela	From end
LFS20	D1	Force	Z	0.00	0.000	Length	2
	LC2 - Permanent	GCS	Trapez	-1379.31	0.100	Rela	From start
LFS21	D1	Force	Z	0.00	0.000	Length	2
	LC2 - Permanent	GCS	Trapez	-1379.31	0.100	Rela	From end

4. RESULTS

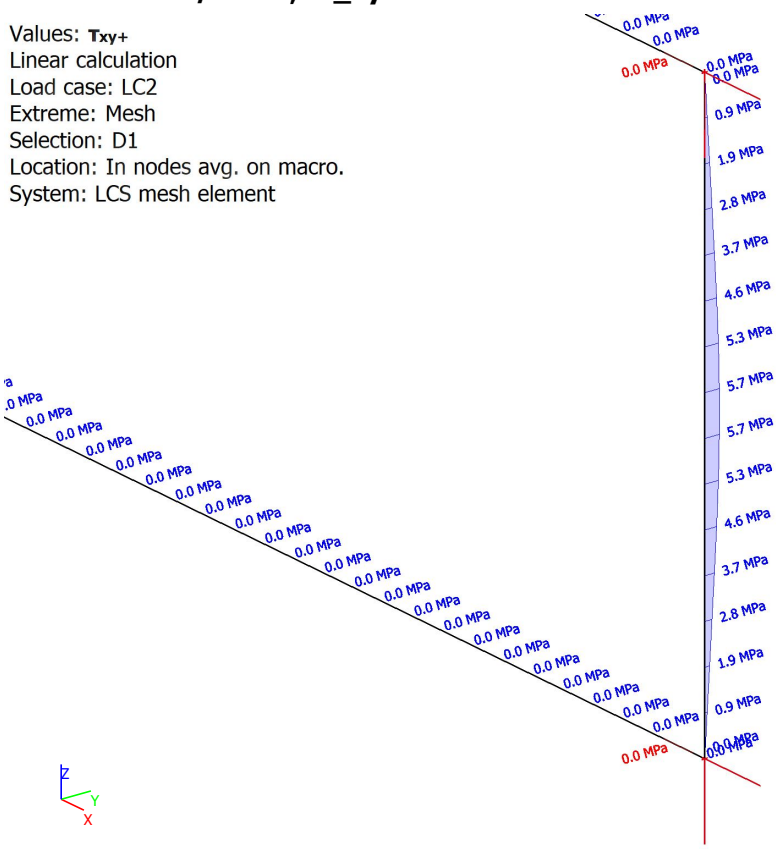
4.1. 2D stress/strain; σ_x+

Values: σ_{x+}
Linear calculation
Load case: LC2
Extreme: Mesh
Selection: All
Location: In centres. System: LCS mesh element



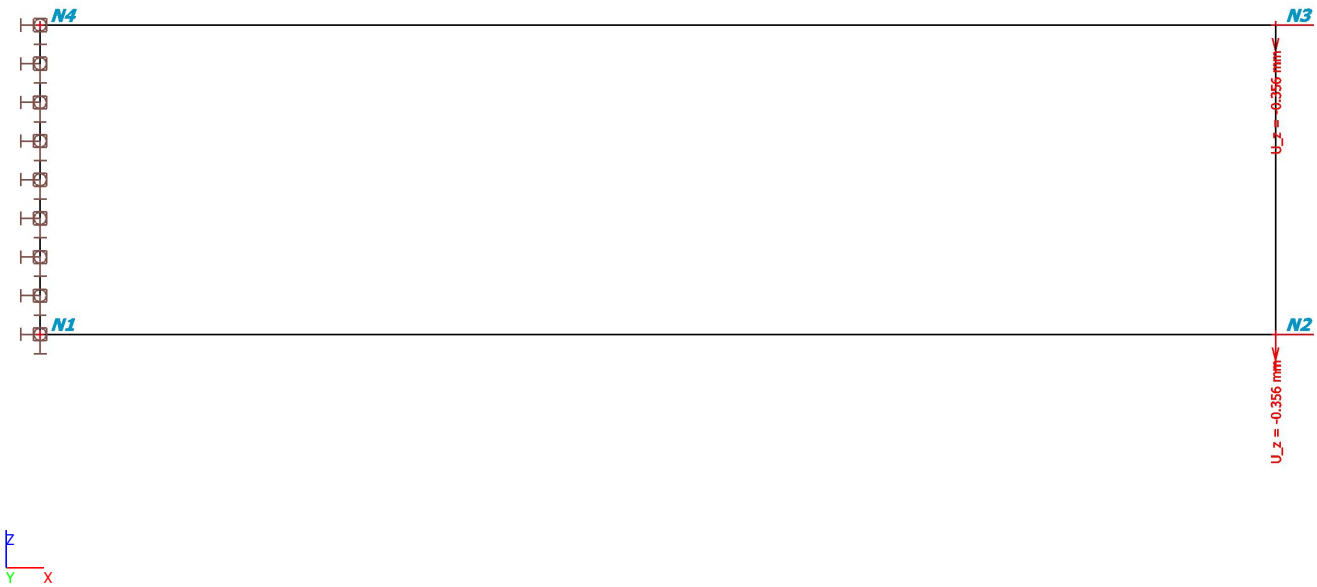
4.2. 2D stress/strain; τ_xy+

Values: τ_{xy+}
Linear calculation
Load case: LC2
Extreme: Mesh
Selection: D1
Location: In nodes avg. on macro.
System: LCS mesh element



4.3. Displacement of nodes; U_z

Values: U_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: N2, N3



4.4. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N2, N3

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N3	LC2	**0.064**	**0.000**	**-0.356**	**0.0**	**10.9**	**0.0**	**0.361**
N2	LC2	**-0.064**	0.000	-0.356	0.0	10.9	**0.0**	0.361

5. EXPECTED AFNOR RESULTS

Max vertical displacement at free end = 0,3573 mm
Max sigmaX stress at fixed end = 80 MPa
Max sigmaXY stress at free end = 5 Mpa

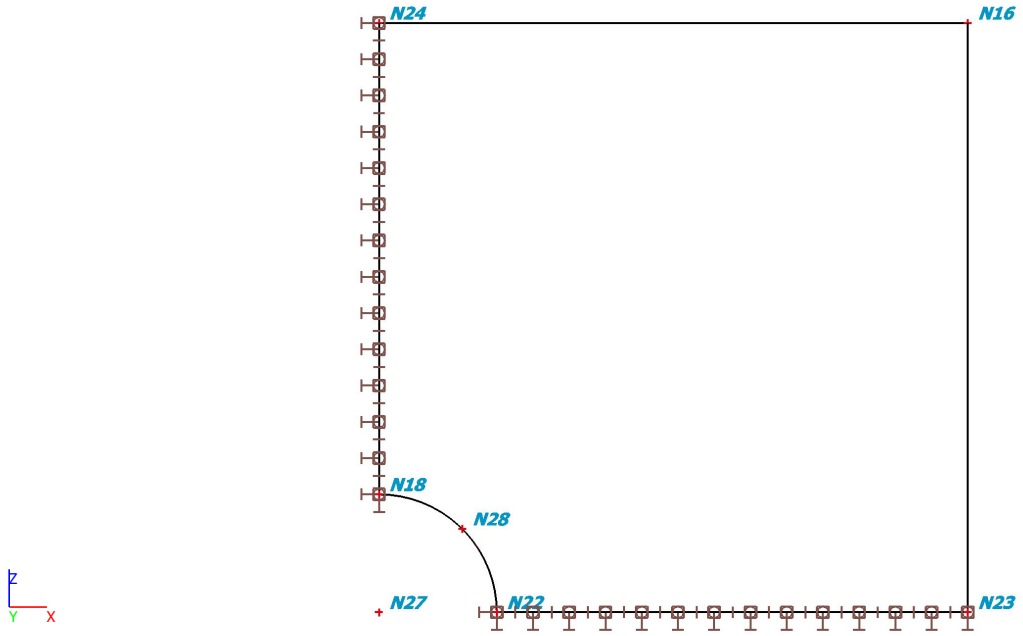
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Tension of perforated membrane
Specification: Simple tension of perforated membrane.

2. MODEL

2.1. Analysis model



2.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D5	Calque1	plate (90)	Standard	S 235	constant	1

2.3. Supports on 2D member edge

Name	Edge	Orig Coor	Pos x_1 / Pos x_2	X	Y	Z	Rx	Ry	Rz
Sle8	1	From start	0.000	Free	Rigid	Rigid	Rigid	Rigid	Rigid
		Rela	1.000						
Sle9	1	From start	0.000	Rigid	Rigid	Free	Rigid	Rigid	Rigid
		Rela	1.000						

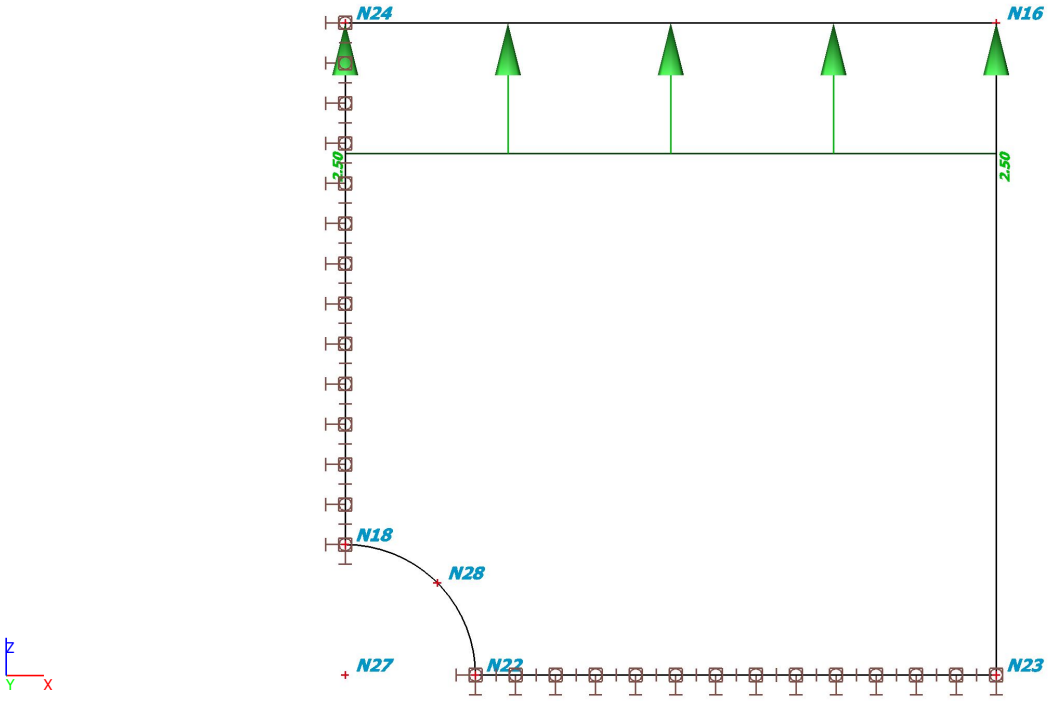
2.4. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa] / G_{mod} [MPa]	μ / α [m/mK]	Lower limit [mm]	Upper limit [mm]	F_y [N/mm²]	F_u [N/mm²]	Colour
S 235	7850.00	3.0000e+04	0.25	0	40	235.0	360.0	
		1.2000e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



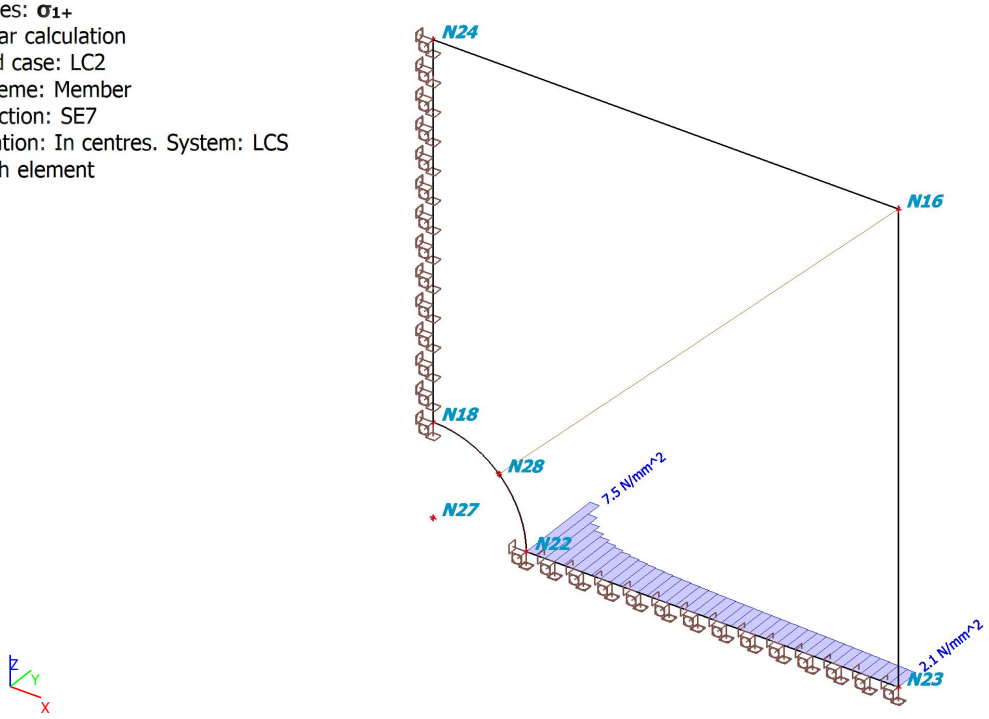
3.2. Line force on 2D member edge

Name	2D member	Type	Dir	Value - P_1 [N/mm]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - P_2 [N/mm]	Pos x_2	Coor	Orig
LFS3	D5	Force	Z	2.50	0.000	Length	2
	LC2 - Permanent	GCS	Uniform		1.000	Rela	From end

4. RESULTS

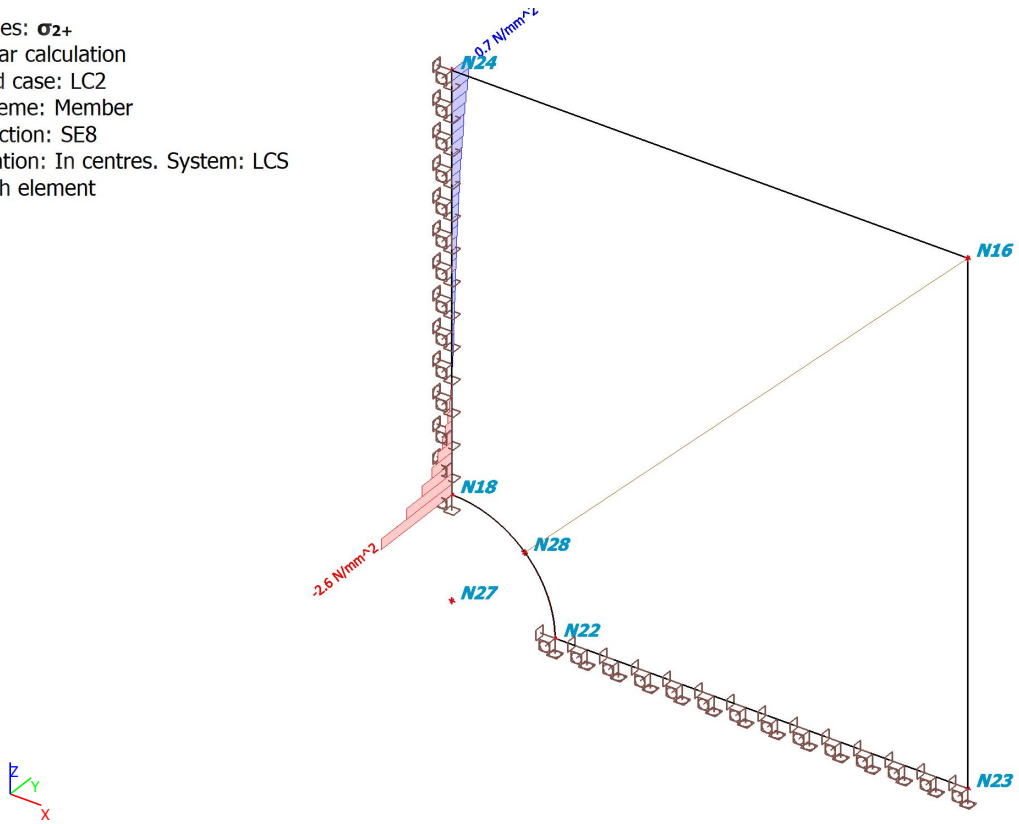
4.1. 3D Stress (a,0)

Values: σ_{1+}
Linear calculation
Load case: LC2
Extreme: Member
Selection: SE7
Location: In centres. System: LCS
mesh element



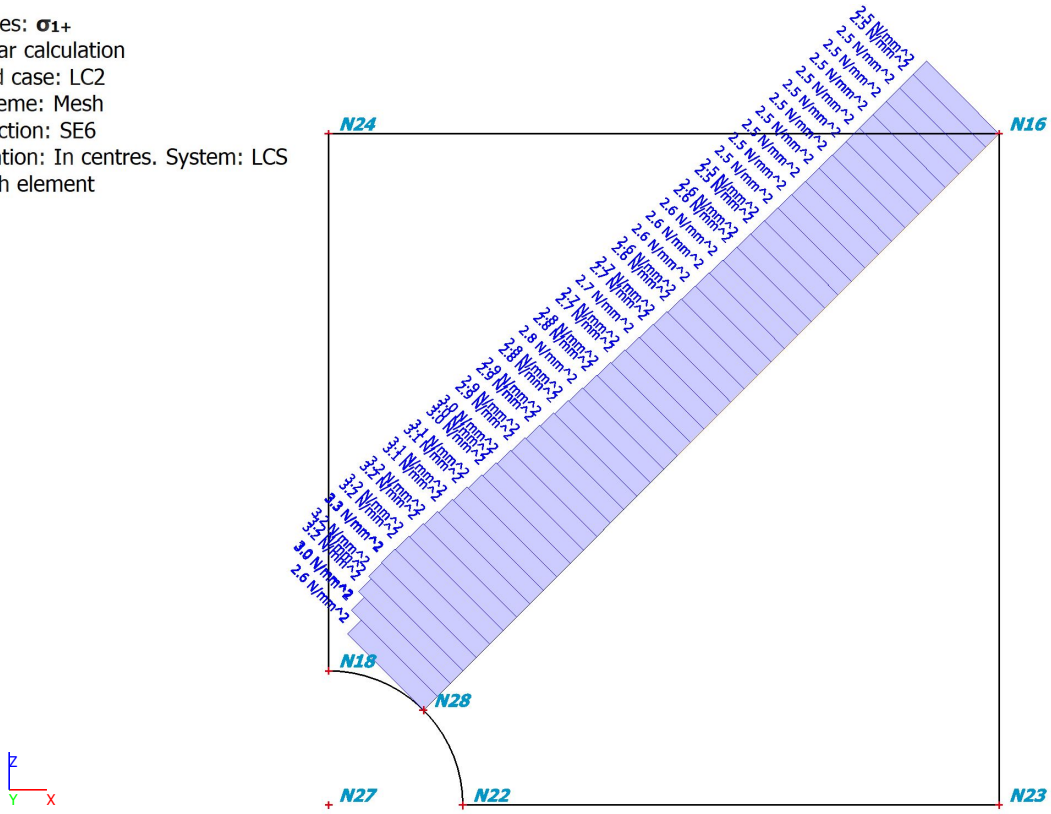
4.2. 3D Stress (a,pi/2)

Values: σ_{2+}
Linear calculation
Load case: LC2
Extreme: Member
Selection: SE8
Location: In centres. System: LCS
mesh element



4.3. 3D stress (a, pi/4)

Values: σ_{1+}
Linear calculation
Load case: LC2
Extreme: Mesh
Selection: SE6
Location: In centres. System: LCS mesh element



4.4. 2D stress/strain

Linear calculation
Load case: LC2
Extreme: Global
Selection: SE7, SE8
Location: In centres. System: LCS mesh element
Principal stress - Results on sections and edges:

Name	Mesh	Position [mm]	Case	σ_{1+} [N/mm²] σ_{1-} [N/mm²]	σ_{2+} [N/mm²] σ_{2-} [N/mm²]	σ_{E+} [N/mm²] σ_{E-} [N/mm²]	α+ [deg] α- [deg]	$\tau_{max,b}$ [N/mm²]
SE8	Element: 54	260.631 0.000 61.000	LC2	**-0.1** **-0.1**	-1.7 -1.7	1.6 1.6	88.74 88.74	0.0
SE8	Element: 30	260.631 0.000 60.000	LC2	-0.1 -0.1	**-2.6** **-2.6**	2.5 2.5	-88.31 -88.31	0.0
SE7	Element: 2257	273.631 0.000 50.000	LC2	4.7 4.7	**1.0** **1.0**	4.3 4.3	89.86 89.86	**0.0**
SE8	Element: 2426	260.631 0.000 64.000	LC2	0.4 0.4	-0.5 -0.5	**0.8** **0.8**	83.63 83.63	0.0
SE7	Element: 50	270.631 0.000 50.000	LC2	**7.5** **7.5**	0.3 0.3	**7.3** **7.3**	87.59 87.59	**0.0**

5. EXPECTED AFNOR RESULTS

For (a,0) (Node N22):
Sigma = 7,5 Mpa

For (a,PI/4) (Node N18):
Sigma = 2,5 Mpa

For (a,PI/2) (Node N28):
Sigma = -2,5 Mpa

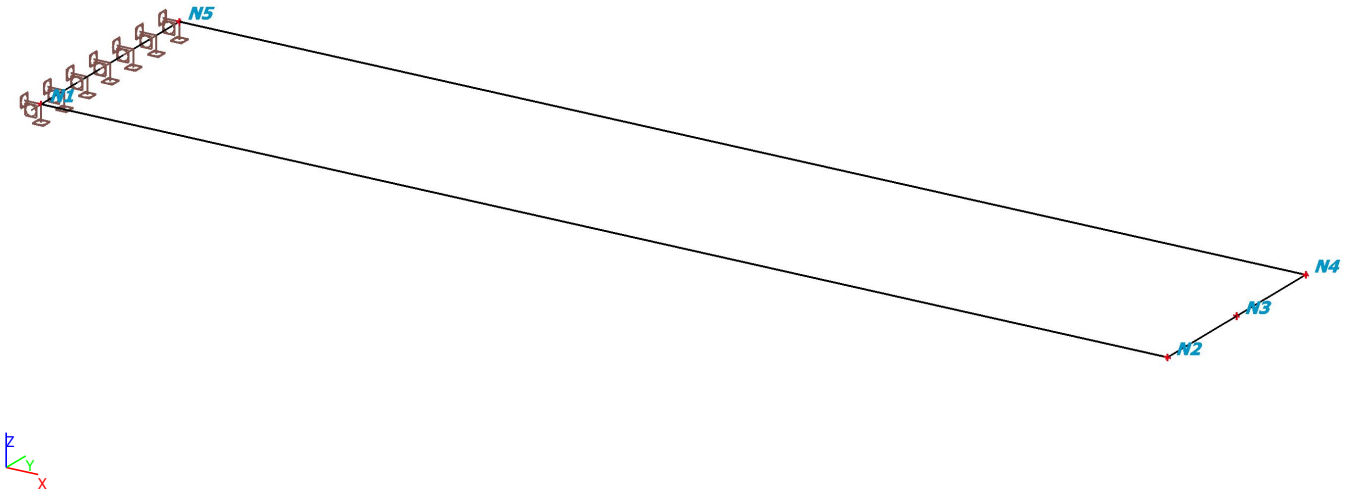
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Cantilever slab under uniform pressure

2. MODEL

2.1. Analysis model



2.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	5

2.3. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	1.000	0.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N3	1.000	0.100	0.000
N4	1.000	0.200	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N5	0.000	0.200	0.000

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	5	Rela	1.000						

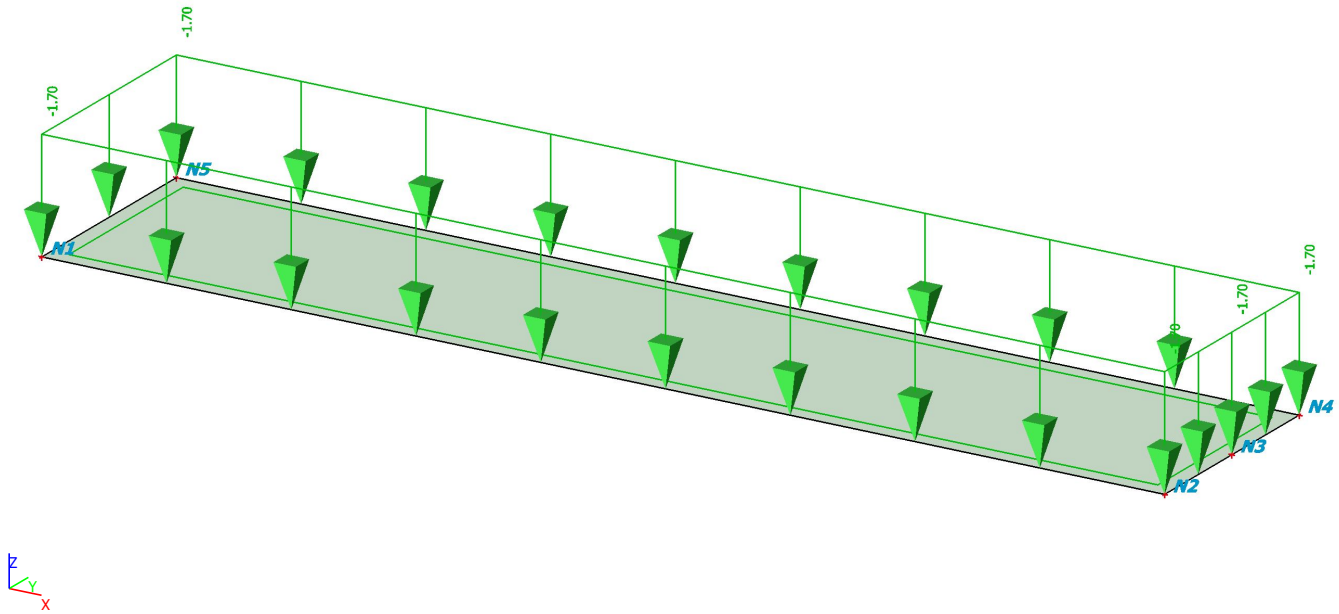
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC2 / Tot. value



3.2. Surface load

Name	Dir	Type	Value [kN/m²]	2D member	Load case	System	Loc
SF1	Z	Force	-1.70	D1	LC2 - permanent	LCS	Length

4. RESULTS

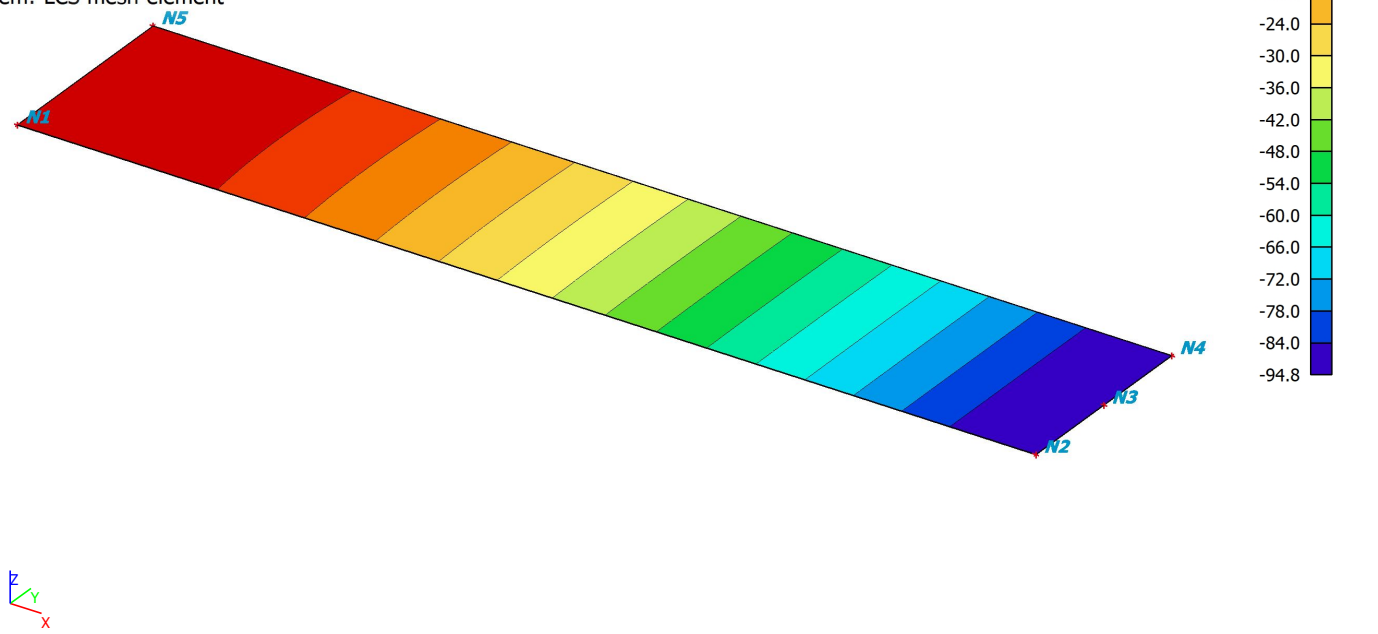
4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N2, N4

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N4	LC2	**0.0**	**0.0**	**-94.8**	**0.1**	**127.1**	**0.0**	**94.8**
N2	LC2	0.0	0.0	-94.8	**-0.1**	127.1	**0.0**	94.8

4.2. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



5. EXPECTED AFNOR RESULTS

Vertical displacement uz in node N2 &N4 = -97,3 mm

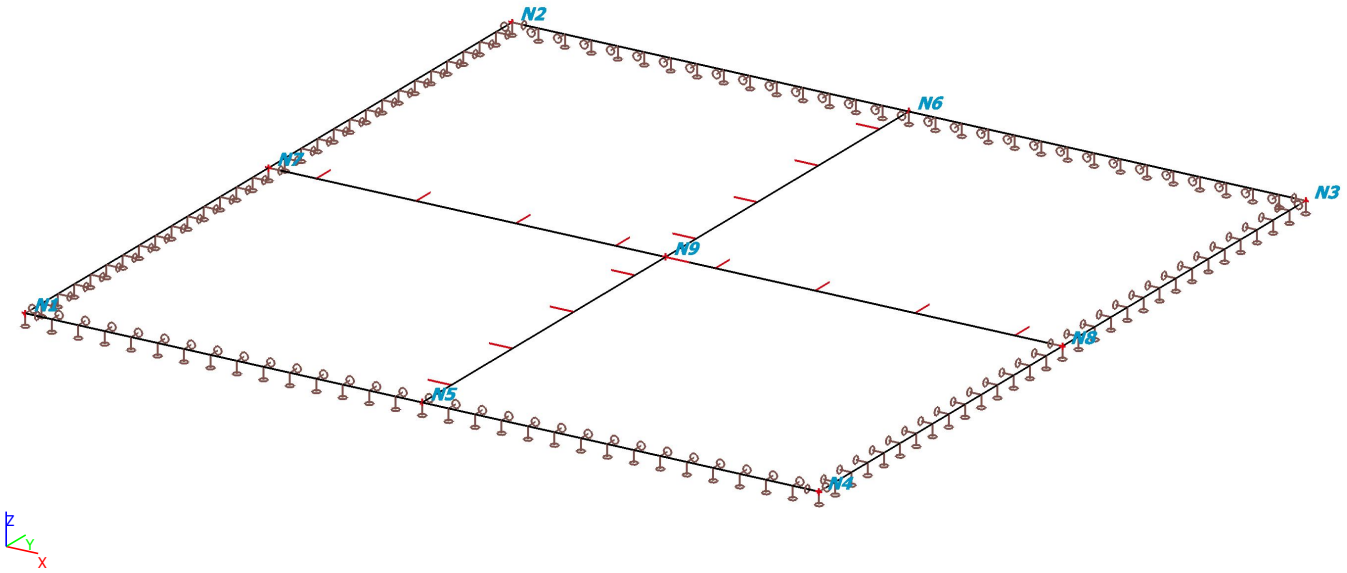
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simply supported square plate under self weight

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	0.000	1.000	0.000
N3	1.000	1.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N4	1.000	0.000	0.000
N5	0.500	0.000	0.000
N6	0.500	1.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N7	0.000	0.500	0.000
N8	1.000	0.500	0.000
N9	0.500	0.500	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	10

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Free	Rigid	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle2	D1	From start	0.000	Free	Rigid	Rigid	Free	Free	Free
	2	Rela	1.000						
Sle3	D1	From start	0.000	Free	Rigid	Rigid	Free	Free	Free
	3	Rela	1.000						
Sle4	D1	From start	0.000	Free	Rigid	Rigid	Free	Free	Free
	4	Rela	1.000						

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7950.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

3. RESULTS

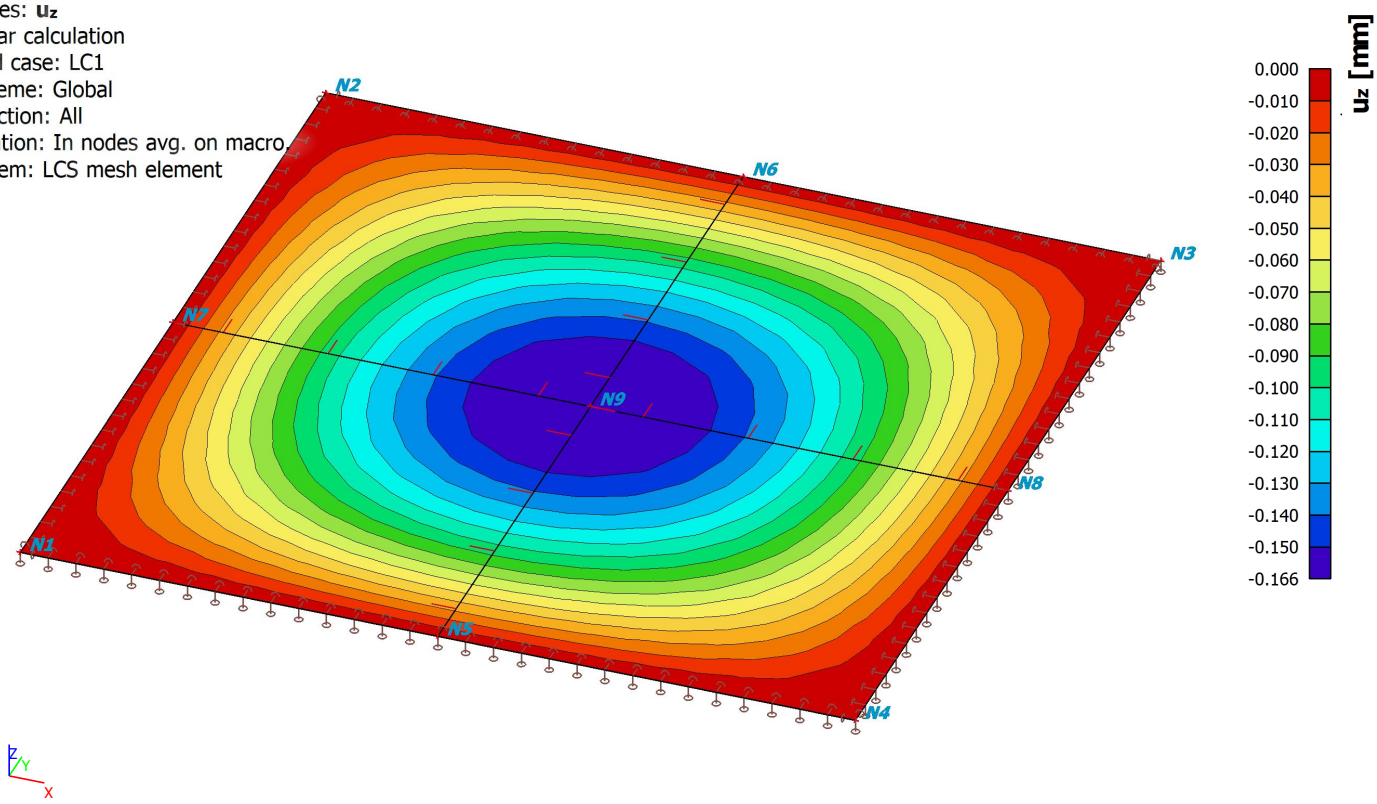
3.1. Displacement of nodes

Linear calculation
Load case: LC1
Extreme: Global
Selection: N9

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N9	LC1	**0.000**	**0.000**	**-0.166**	**0.0**	**0.0**	**0.0**	**0.166**

3.2. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg. on macro
System: LCS mesh element



4. EXPECTED AFNOR RESULTS

Vertical displacement uz in node N9= -0,158 mm

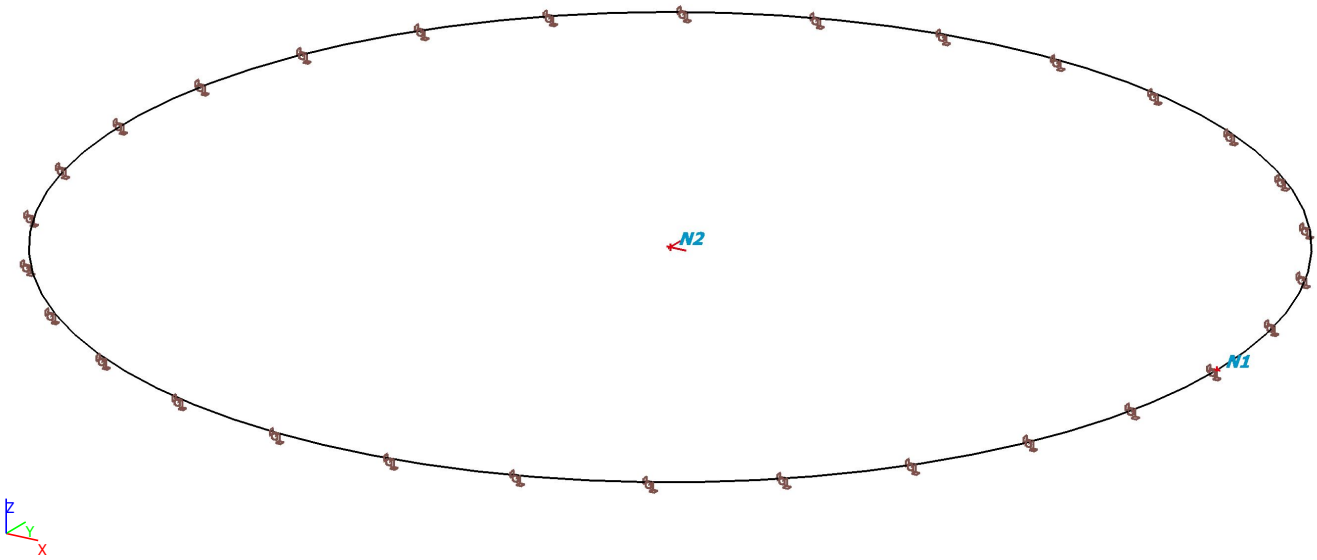
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Circular plate with clamped edges under uniform load

2. MODEL

2.1. Analysis model



2.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	5

2.3. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	1.000						

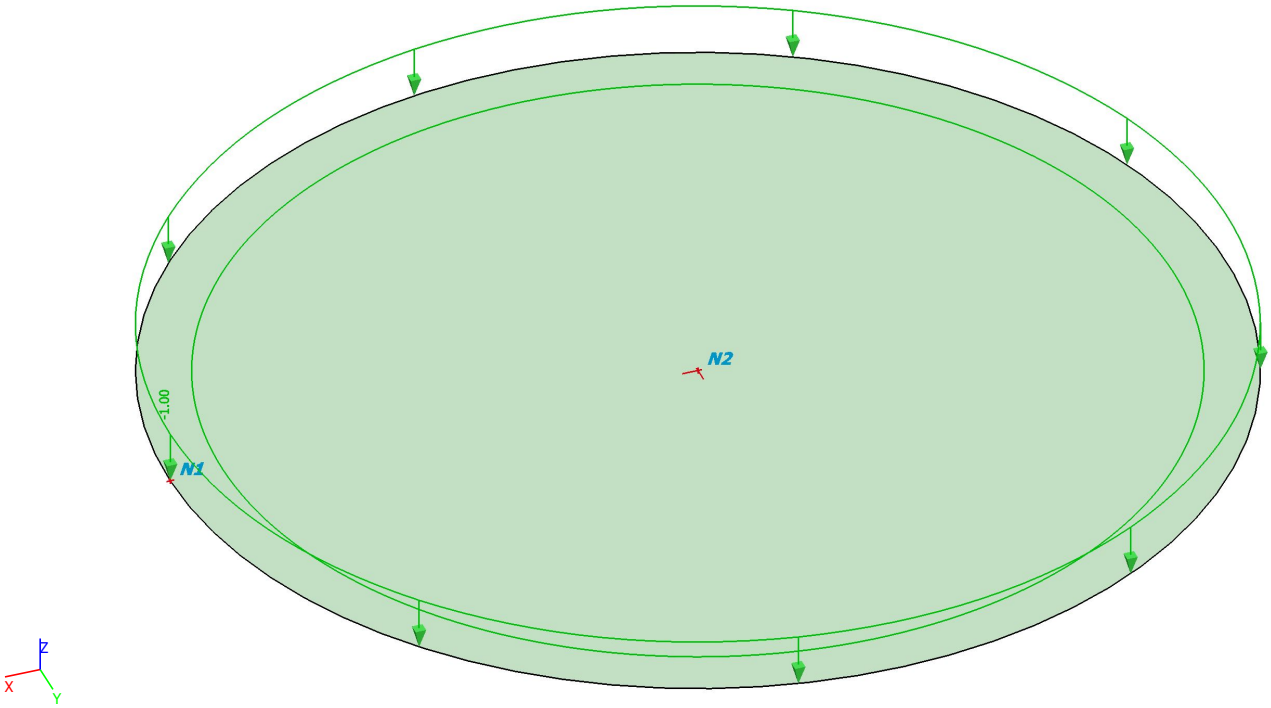
2.4. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC2 / Tot. value



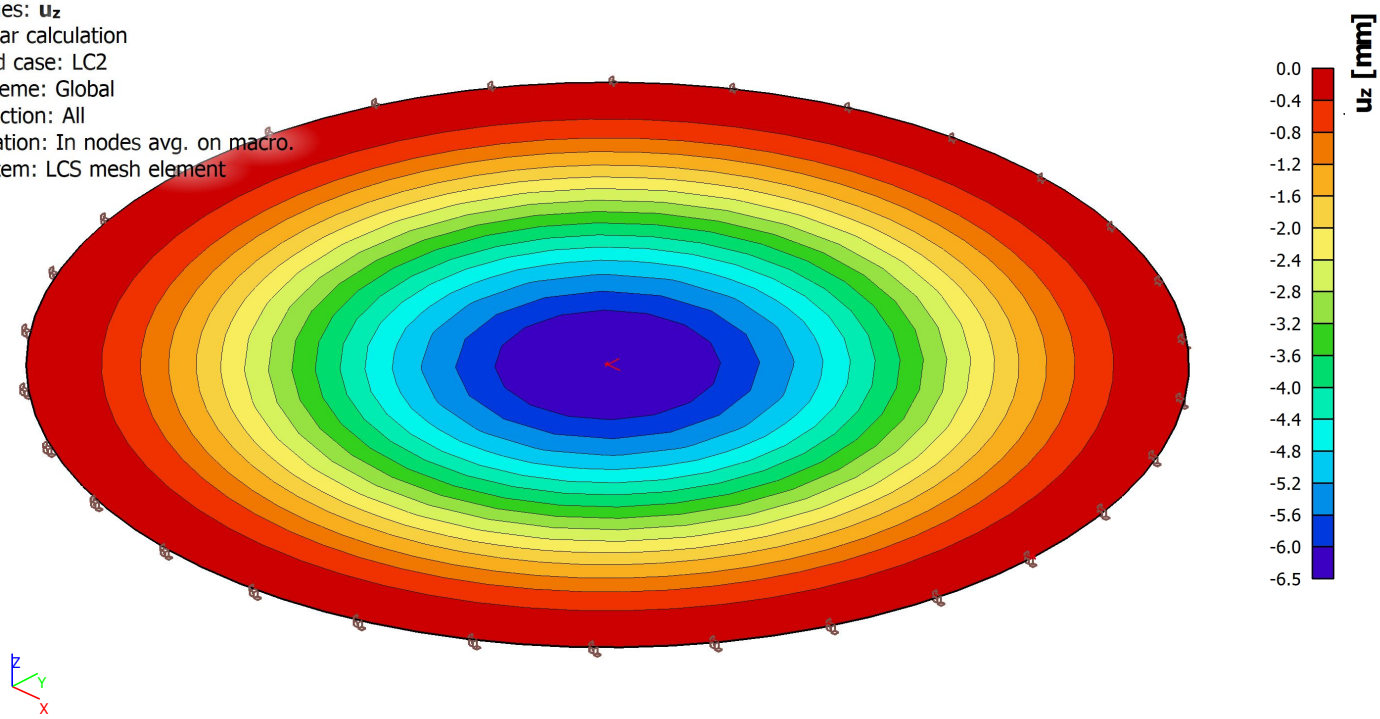
3.2. Surface load

Name	Dir	Type	Value [kN/m²]	2D member	Load case	System	Loc
SF1	Z	Force	-1.00	D1	LC2 - PERMANENT	LCS	Length

4. RESULTS

4.1. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.2. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N2

Name	Case	U_x [mm]	U_y [mm]	U_z [mm]	Φ_x [mrad]	Φ_y [mrad]	Φ_z [mrad]	U_{total} [mm]
N2	LC2	**0.0**	**0.0**	**-6.5**	**0.0**	**0.0**	**0.0**	**6.5**

5. EXPECTED AFNOR RESULTS

Vertical displacement uz in node N2 (the center) = -6,5 mm

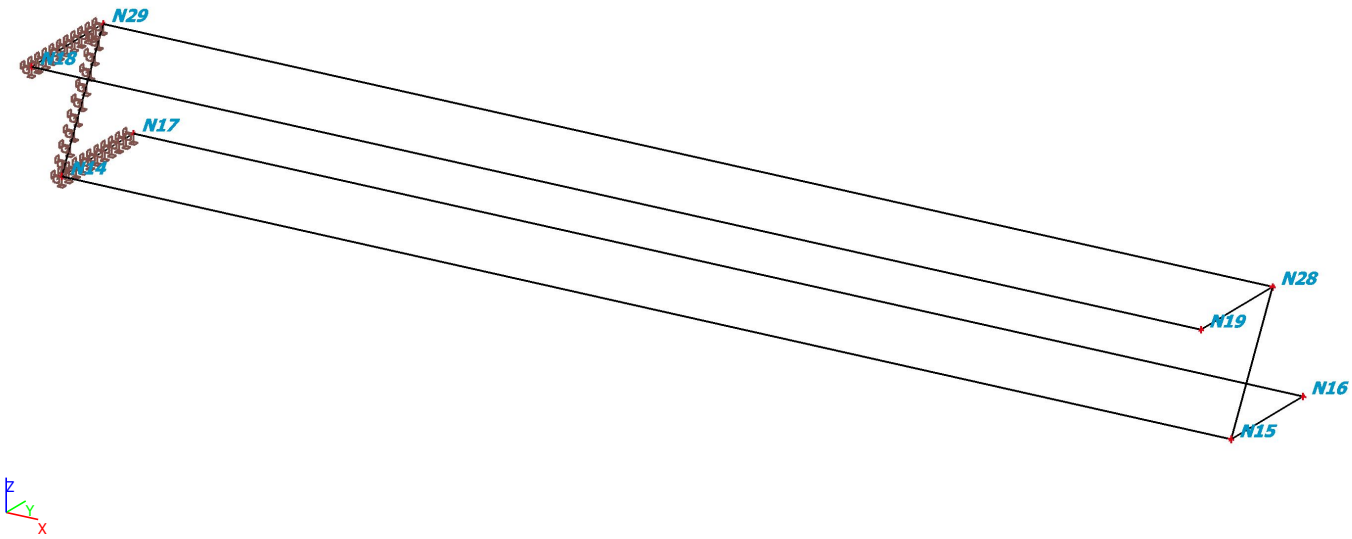
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Beam of Z-section

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N14	-3.000	3.000	0.000
N15	7.000	3.000	0.000
N16	7.000	4.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N17	-3.000	4.000	0.000
N18	-3.000	2.577	1.000
N19	7.000	2.577	1.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N28	7.000	3.577	1.000
N29	-3.000	3.577	1.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D4	Calque1	plate (90)	Standard	S 235	constant	10
D5	Calque1	plate (90)	Standard	S 235	constant	10
D6	Calque1	plate (90)	Standard	S 235	constant	10

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle9	D4	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.200						
Sle10	D4	From start	0.200	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.400						
Sle11	D4	From start	0.400	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.600						
Sle12	D4	From start	0.600	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.800						
Sle13	D4	From start	0.800	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						
Sle14	D5	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.200						

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle15	D5	From start	0.200	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.400						
Sle16	D5	From start	0.400	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.600						
Sle17	D5	From start	0.600	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	0.800						
Sle18	D5	From start	0.800	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						
Sle19	D6	From start	0.800	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	1.000						
Sle20	D6	From start	0.600	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	0.800						
Sle21	D6	From start	0.400	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	0.600						
Sle22	D6	From start	0.200	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	0.400						
Sle23	D6	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	0.200						

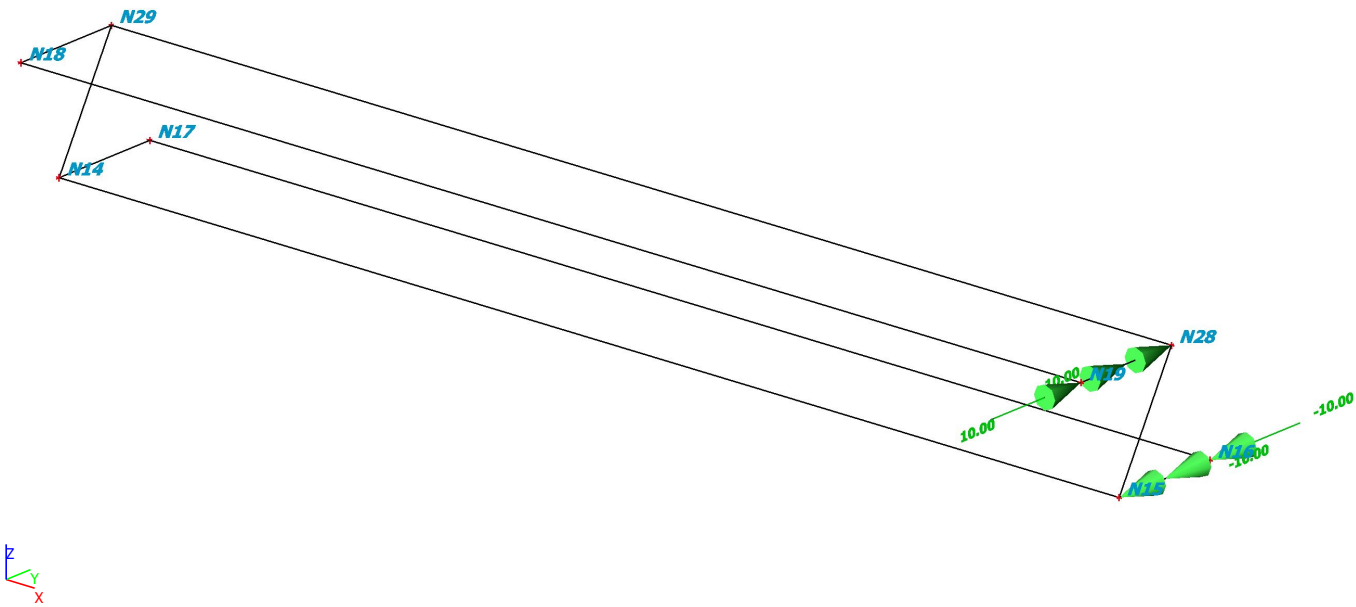
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC2 / Tot. value



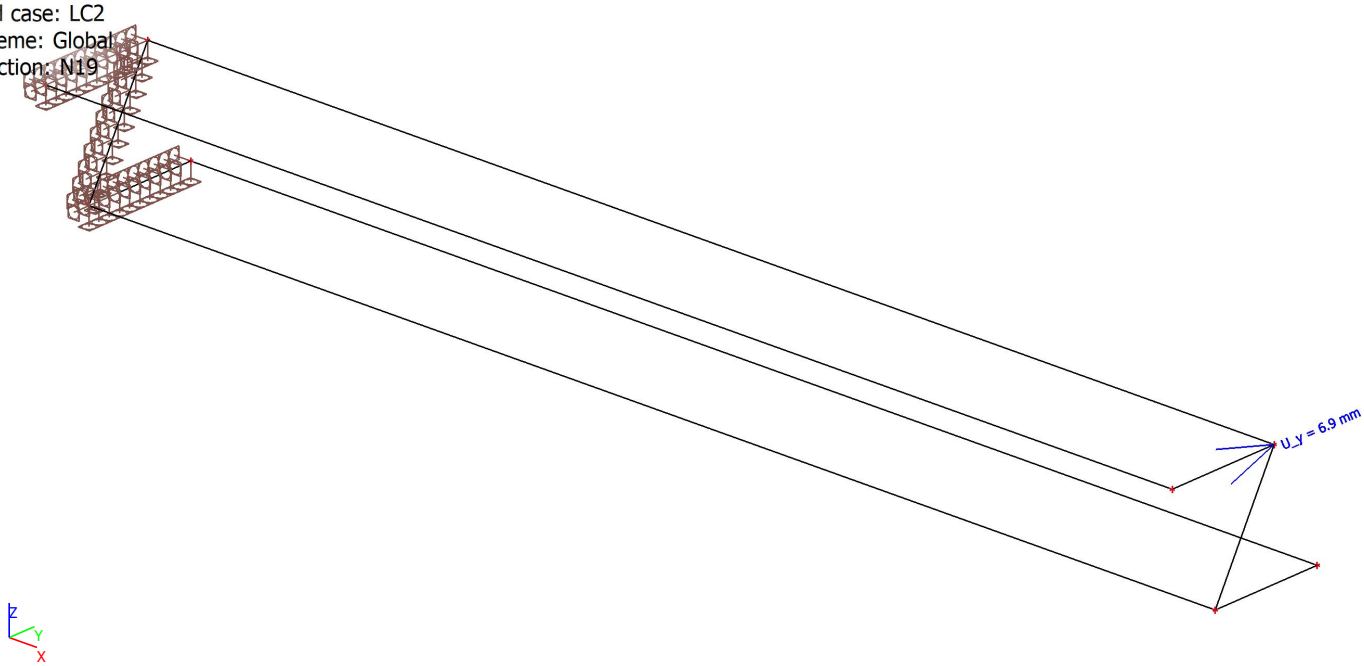
3.2. Line force on 2D member edge

Name	2D member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Coor	Orig
LFS3	D4	Force	Y	-10.00	0.000	Length	2
	LC2 - Permanent	LCS	Uniform		1.000	Rela	From start
LFS4	D5	Force	Y	10.00	0.000	Length	2
	LC2 - Permanent	LCS	Uniform		1.000	Rela	From start

4. RESULTS

4.1. Displacement of nodes; U_y

Values: U_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: N19



4.2. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Node
Selection: N19

Name	Case	U_y [mm]
N19	LC2	**6.9**

5. EXPECTED AFNOR RESULTS

Displacement uy in node N19= -7,15 mm

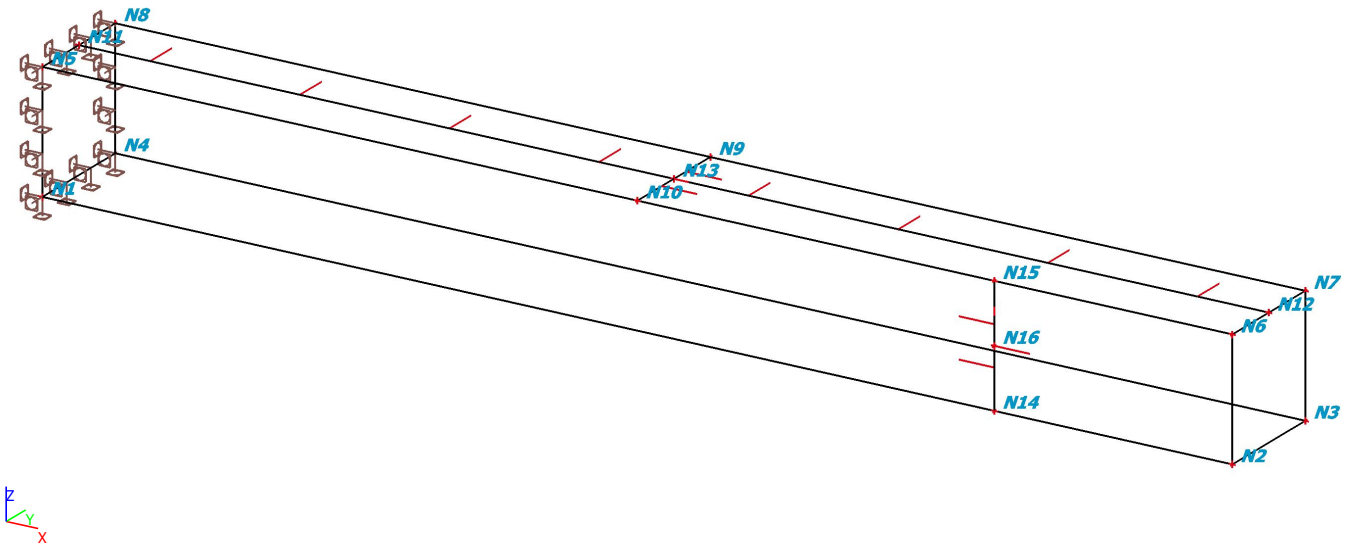
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Shell - Box section - Shear - Torsion.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	1.000	0.000	0.000
N3	1.000	0.100	0.000
N4	0.000	0.100	0.000
N5	0.000	0.000	0.100
N6	1.000	0.000	0.100

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N7	1.000	0.100	0.100
N8	0.000	0.100	0.100
N9	0.500	0.100	0.100
N10	0.500	0.000	0.100
N11	0.000	0.050	0.100
N12	1.000	0.050	0.100

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N13	0.500	0.050	0.100
N14	0.800	0.000	0.000
N15	0.800	0.000	0.100
N16	0.800	0.000	0.050

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	5
D2	Calque1	plate (90)	Standard	S 235	constant	5
D3	Calque1	plate (90)	Standard	S 235	constant	5
D4	Calque1	plate (90)	Standard	S 235	constant	5

2.4. Supports on 2D member edge

Name	2D member Edge	Orig Coor	Pos x_1 Pos x_2	X	Y	Z	Rx	Ry	Rz
Sle1	D2	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						
Sle2	D3	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	1.000						
Sle3	D4	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	1.000						
Sle4	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						

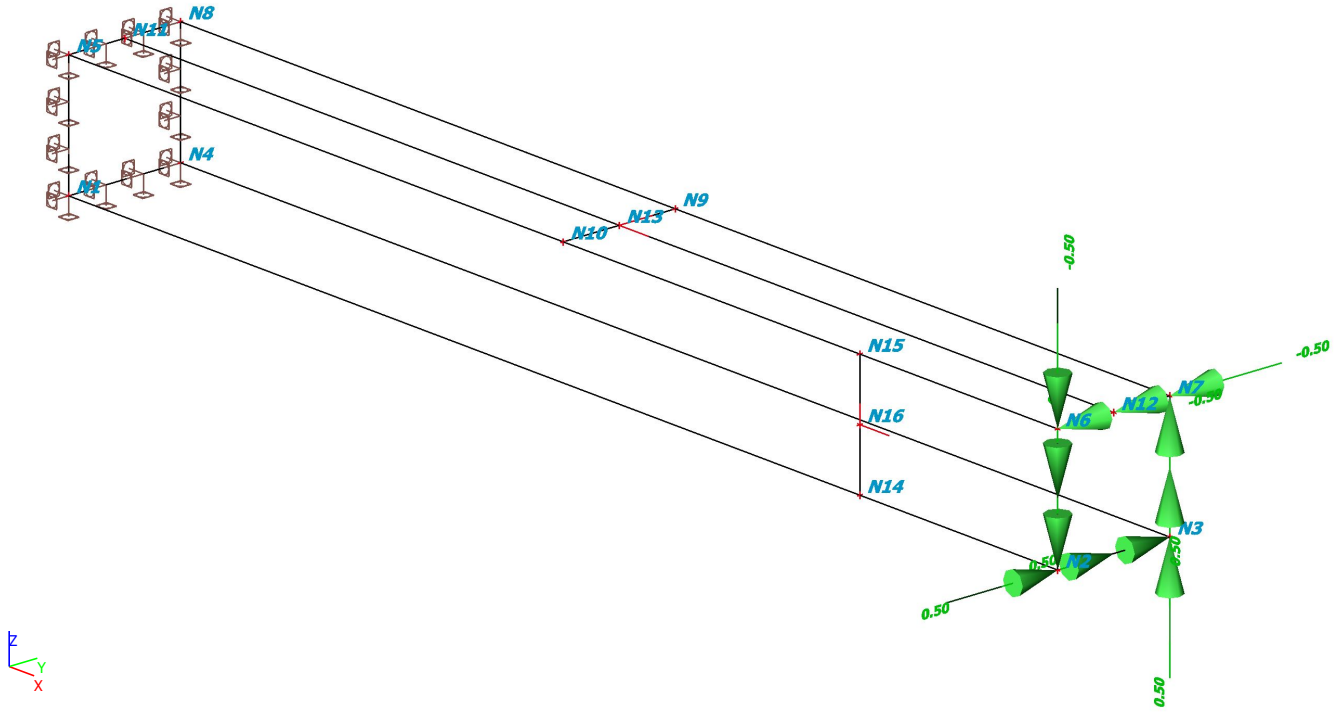
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.0	360.0	
		8.0769e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



3.2. Line force on 2D member edge

Name	2D member	Type	Dir	Value - P_1 [kN/m]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - P_2 [kN/m]	Pos x_2	Coor	Orig
LFS1	D2	Force	Y	-0.50	0.000	Length	2
	LC2 - permanent	GCS	Uniform		1.000	Rela	From start
LFS2	D3	Force	Z	-0.50	0.000	Length	3
	LC2 - permanent	GCS	Uniform		1.000	Rela	From start
LFS3	D1	Force	Y	0.50	0.000	Length	2
	LC2 - permanent	GCS	Uniform		1.000	Rela	From start
LFS4	D4	Force	Z	0.50	0.000	Length	3
	LC2 - permanent	GCS	Uniform		1.000	Rela	From start

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Node
Selection: N13, N16

Name	Case	U_y [mm]	U_z [mm]	Φ_x [mrad]
N13	LC2	**-0.0006160**	**0.0000000**	**0.0123250**
N16	LC2	**0.0000000**	**-0.0009860**	**0.0197290**

5. EXPECTED AFNOR RESULTS

Displacement uy in node N13= -0,617 e-3 mm
Rotation Φx in node N13=0,0123 e-3 rad
Displacement uZ in node N16= -0,987 e-3 mm
Rotation Φx in node N13 =0,0197 e-3 rad

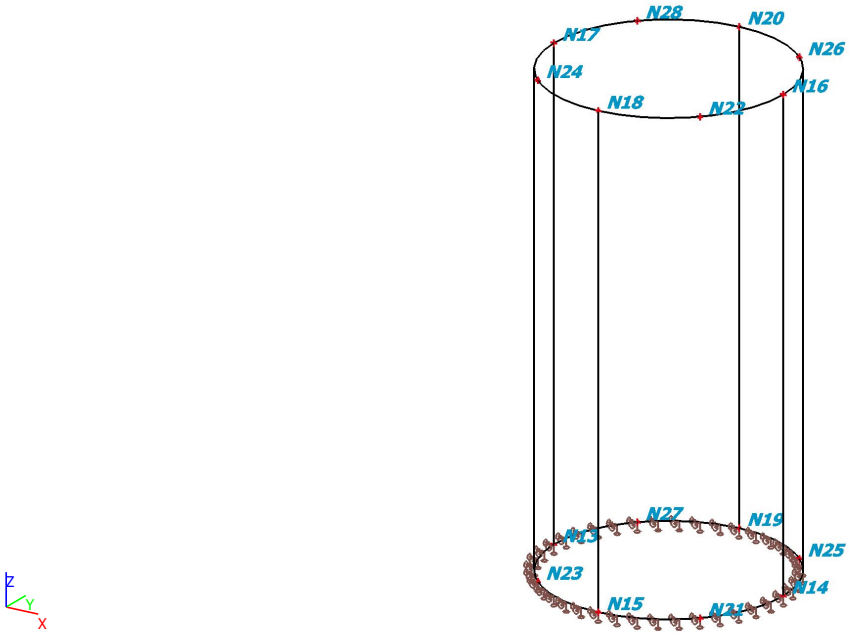
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Thin-walled cylinder under uniform radial pressure
Specification: Shell - Cylinder - Material: elastic - Pressure

2. MODEL

2.1. Analysis model



2.2. Noeuds

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N13	-0.707	0.707	0.000
N14	1.293	0.707	0.000
N15	0.293	-0.293	0.000
N16	1.293	0.707	4.000
N17	-0.707	0.707	4.000
N18	0.293	-0.293	4.000

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N19	0.293	1.707	0.000
N20	0.293	1.707	4.000
N21	1.000	0.000	0.000
N22	1.000	0.000	4.000
N23	-0.414	0.000	0.000
N24	-0.414	0.000	4.000

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N25	1.000	1.414	0.000
N26	1.000	1.414	4.000
N27	-0.414	1.414	0.000
N28	-0.414	1.414	4.000

2.3. Surfaces

Nom	Calque	Type	Type d'élément	Matériau	Type d'épaisseur	Ep. [mm]
D6	Calque1	wall (80)	Standard	S 235	constante	20
D7	Calque1	wall (80)	Standard	S 235	constante	20
D8	Calque1	wall (80)	Standard	S 235	constante	20
D9	Calque1	wall (80)	Standard	S 235	constante	20

2.4. Appuis aux bords

Nom	Macro 2D	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Bord	Coor	Pos x_2						
Sle11	D6	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle12	D8	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle13	D9	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle14	D7	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre

Nom	Macro 2D	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Bord	Coor	Pos x_2						
	1	Rela	1.000						

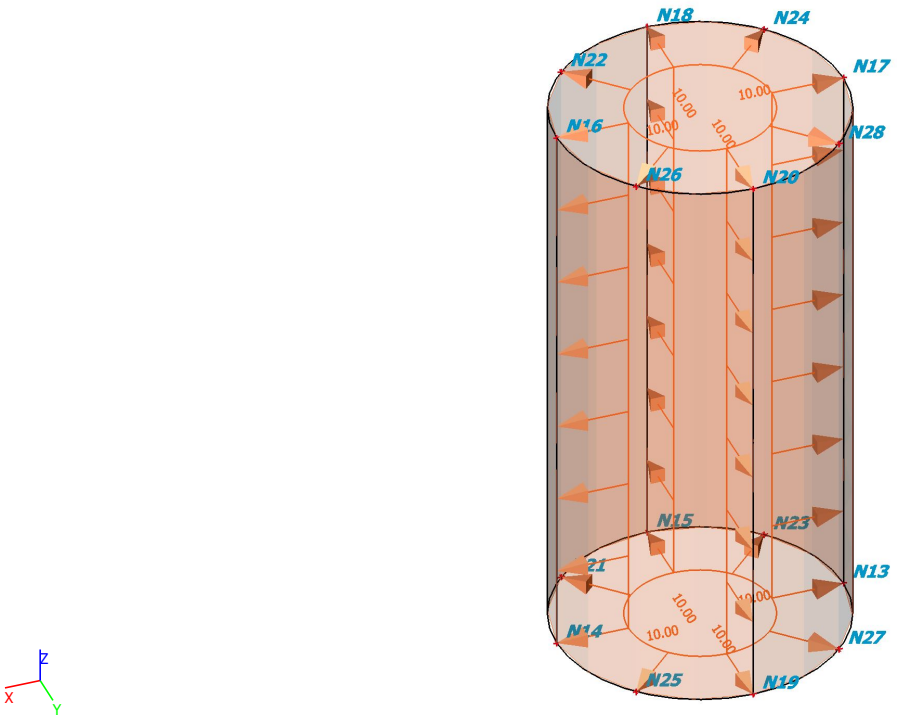
2.5. Matériaux

Acier EC3

Nom	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [kPa]	F_u [kPa]	Couleur
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235000.000	360000.000	
		8.0769e+04	0.01e-003	40	80	215000.000	360000.000	

3. LOAD

3.1. LC1 / Tot. value



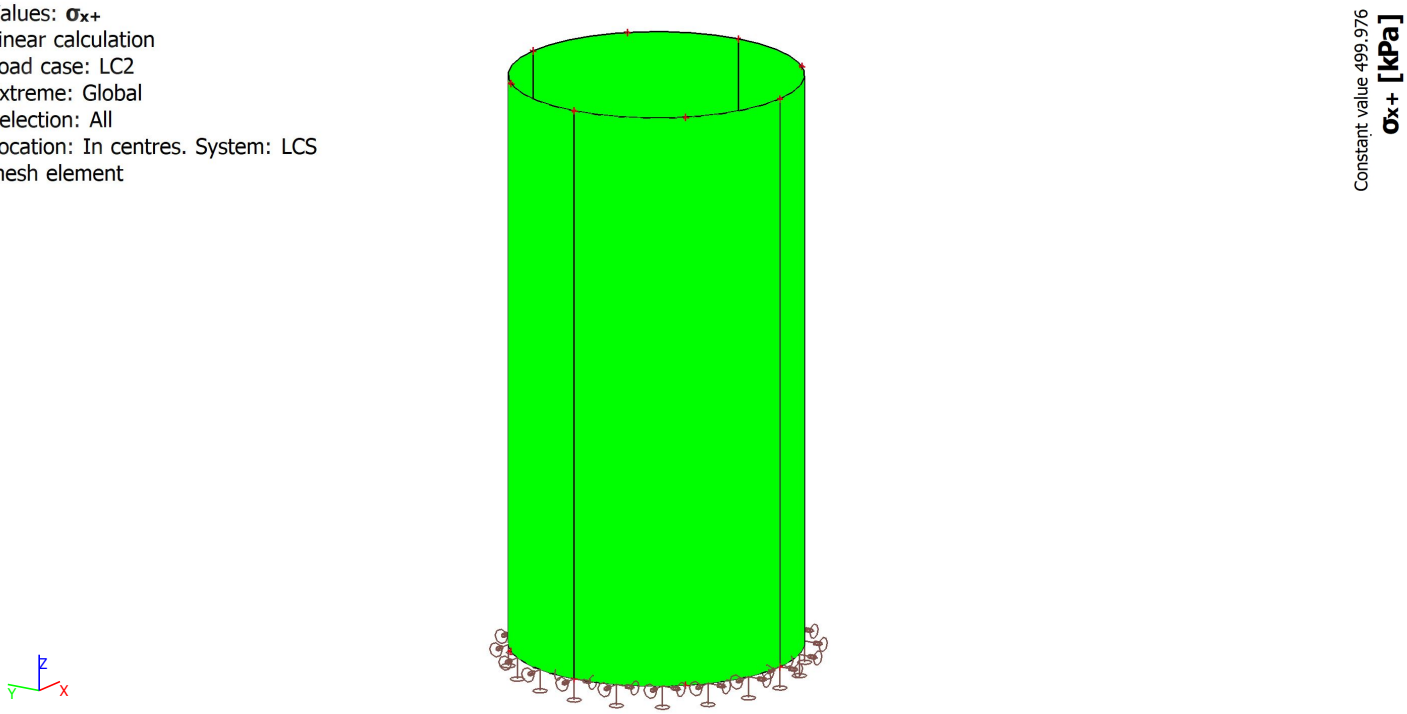
3.2. Charge libre surfacique

Nom	Cas de charge	Dir	Type	Distribution	q [kN/m²]	Validité	Sélectionner	Système	Position
FF1	LC2 - Permanent	Z	Force	Uniforme	10.00	Tout	Auto	SCL élément	Longueur

4. RESULTS

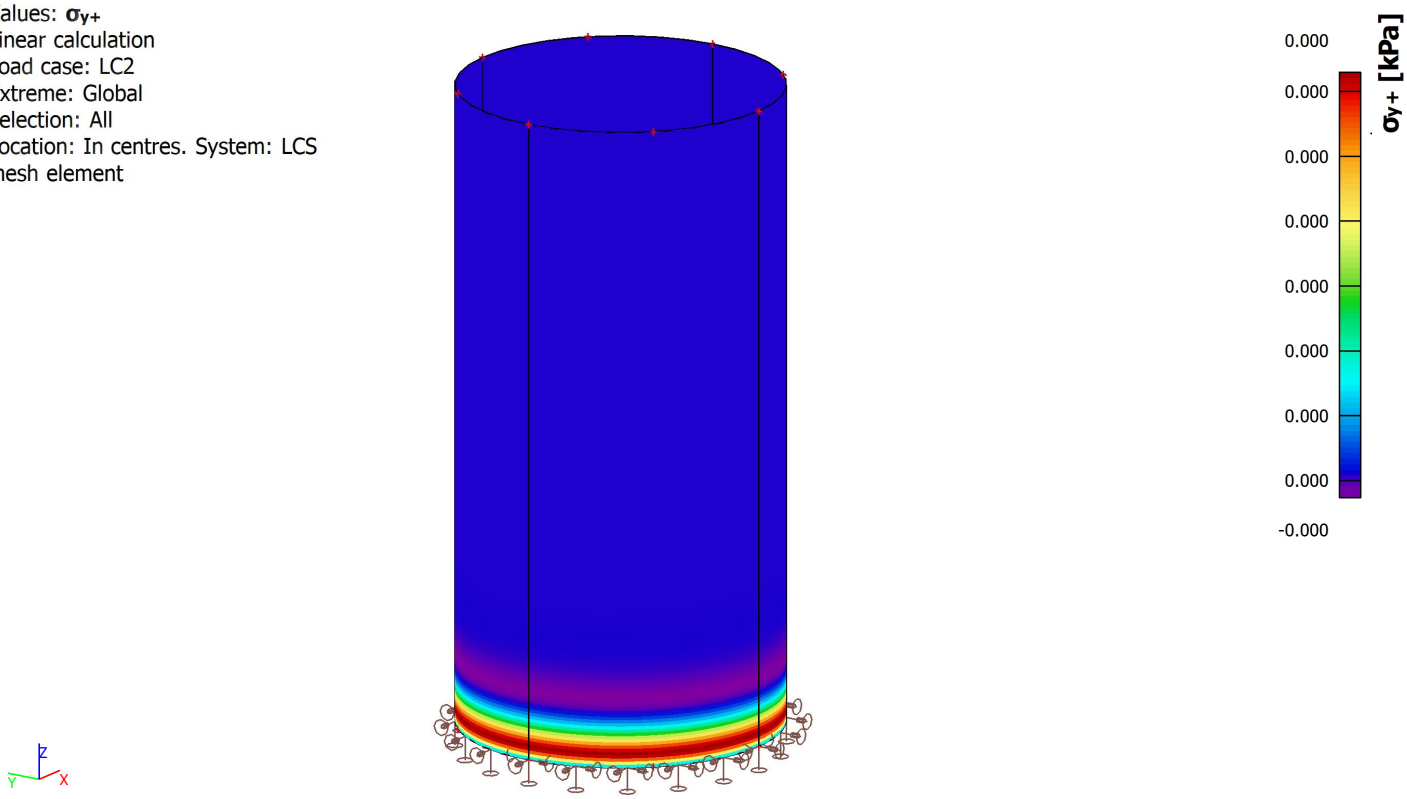
4.1. 2D stress/strain; σ_x+

Values: σ_{x+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.2. 2D stress/strain; σ_y+

Values: σ_{y+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.3. Contraintes/déformations 2D

Calcul linéaire
Cas de charge: LC2
Extrême: Global
Sélection: Tout
Position: Aux centres. Système: SCL maillage EF
Contrainte de base

Nom	Maillage	Position [m]	Cas	σ_{x+} [kPa] σ_{x-} [kPa]	σ_{y+} [kPa] σ_{y-} [kPa]	τ_{xy+} [kPa] τ_{xy-} [kPa]	τ_{xz} [kPa]	τ_{yz} [kPa]
D7	Elément: 16001	0.283 -0.293 0.010	LC2	**499.976** **499.976**	0.000 0.000	**0.000** **0.000**	**0.000**	**0.000**
D6	Elément: 1684	0.362 -0.290 0.430	LC2	499.976 **499.976**	**0.000** **0.000**	0.000 0.000	0.000	0.000
D6	Elément: 321	0.303 -0.293 0.090	LC2	499.976 499.976	**0.000** **0.000**	0.000 0.000	0.000	0.000
D6	Elément: 641	0.303 -0.293 0.170	LC2	**499.976** 499.976	0.000 0.000	0.000 0.000	0.000	**0.000**

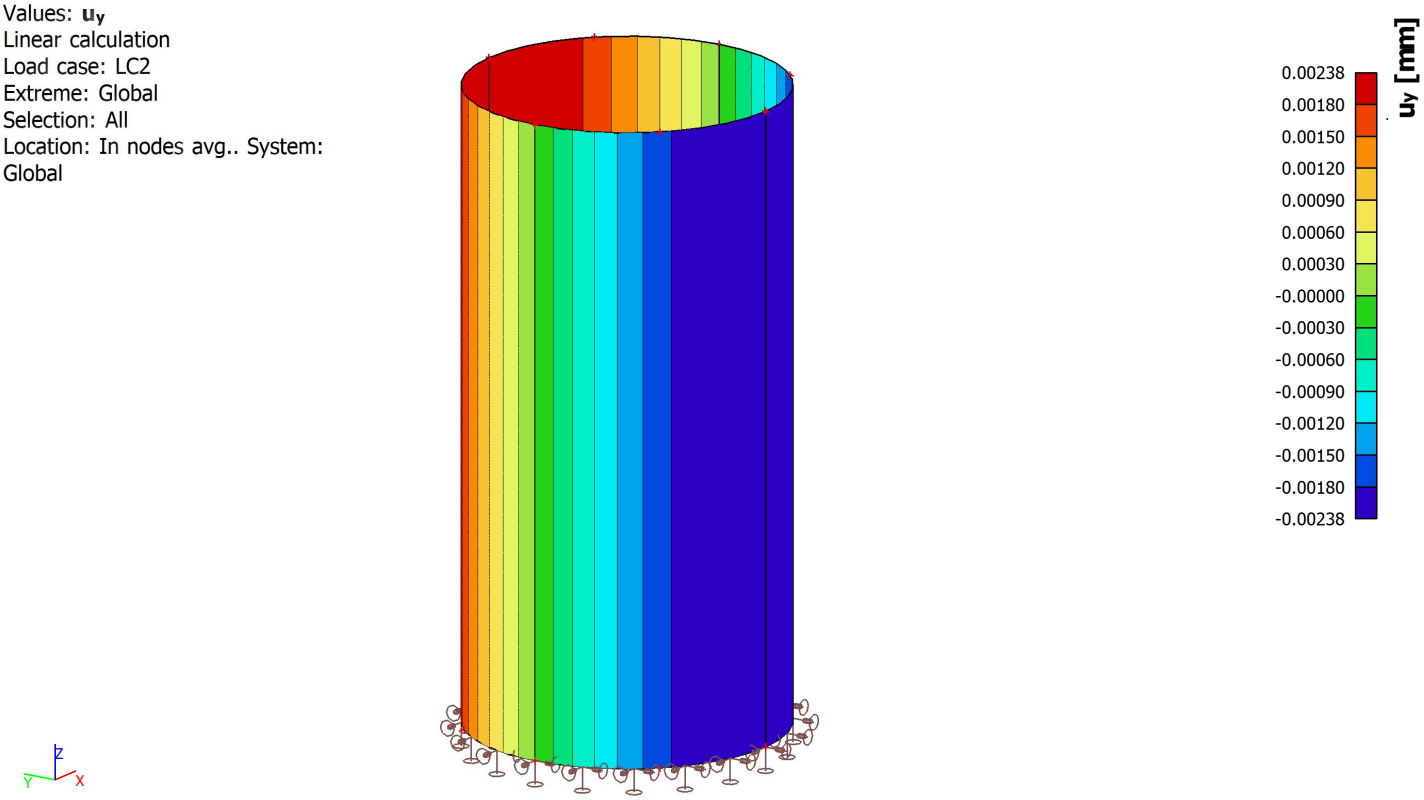
4.4. Déplacements 2D

Calcul linéaire
Cas de charge: LC2
Extrême: Global
Sélection: Tout
Position: Aux noeuds, moyenne sur macro. Système: SCL maillage EF

Nom	Maillage	Position [m]	Cas	u_x [mm]	u_y [mm]	u_z [mm]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U_{total} [mm]
D6	Elément: 15921 Noeud: 16201	0.313 -0.293 4.000	LC2	**0.00000**	**-0.00286**	**0.00238**	**0.0**	**0.0**	**0.0**	**0.00372**
D6	Elément: 1 Noeud: 1	0.293 -0.293 0.000	LC2	0.00000	**0.00000**	0.00238	0.0	0.0	0.0	**0.00238**

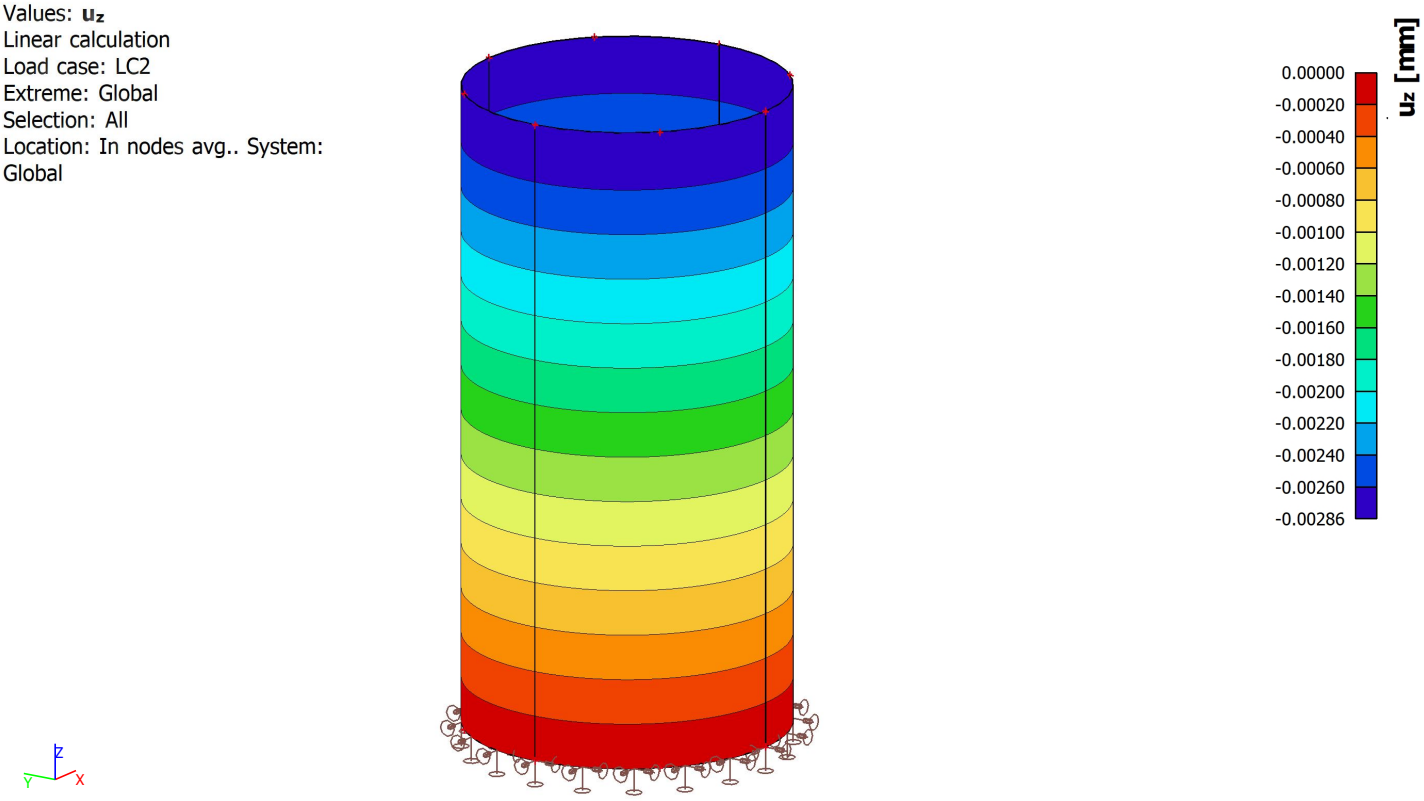
4.5. 2D displacement; u_y

Values: u_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



4.6. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

σx = 500 kPa

σy = 0 kPa

Radial displacement = 2,38*e-3 mm

Vertical displacement = -2,86*e-3 mm

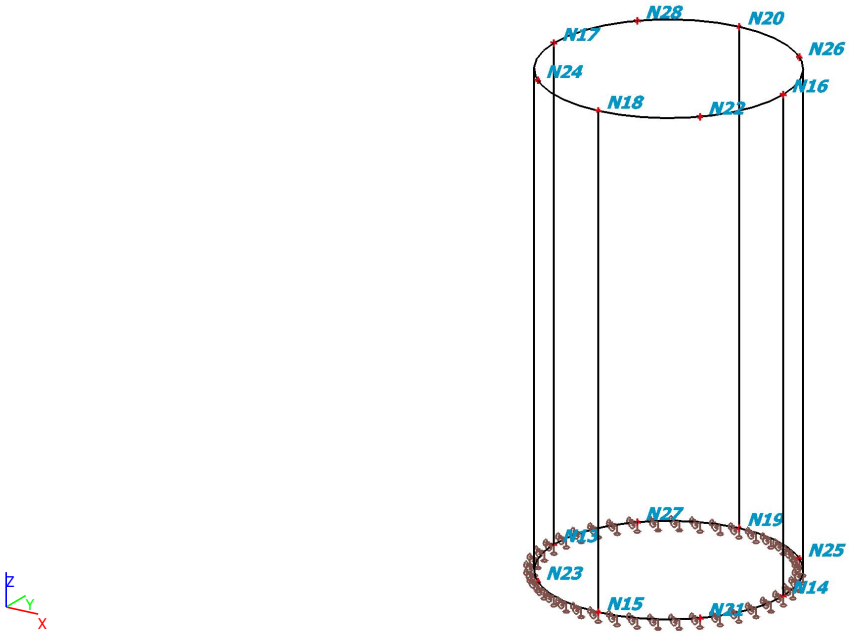
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Thin-walled cylinder under uniform axial load
Specification: Shell - Cylinder - Material: elastic - axial load

2. MODEL

2.1. Analysis model



2.2. Noeuds

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N13	-0.707	0.707	0.000
N14	1.293	0.707	0.000
N15	0.293	-0.293	0.000
N16	1.293	0.707	4.000
N17	-0.707	0.707	4.000
N18	0.293	-0.293	4.000

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N19	0.293	1.707	0.000
N20	0.293	1.707	4.000
N21	1.000	0.000	0.000
N22	1.000	0.000	4.000
N23	-0.414	0.000	0.000
N24	-0.414	0.000	4.000

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N25	1.000	1.414	0.000
N26	1.000	1.414	4.000
N27	-0.414	1.414	0.000
N28	-0.414	1.414	4.000

2.3. Surfaces

Nom	Calque	Type	Type d'élément	Matériau	Type d'épaisseur	Ep. [mm]
D6	Calque1	wall (80)	Standard	S 235	constante	20
D7	Calque1	wall (80)	Standard	S 235	constante	20
D8	Calque1	wall (80)	Standard	S 235	constante	20
D9	Calque1	wall (80)	Standard	S 235	constante	20

2.4. Appuis aux bords

Nom	Macro 2D	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Bord	Coor	Pos x_2						
Sle11	D6	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle12	D8	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle13	D9	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle14	D7	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre

Nom	Macro 2D	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Bord	Coor	Pos x_2						
	1	Rela	1.000						

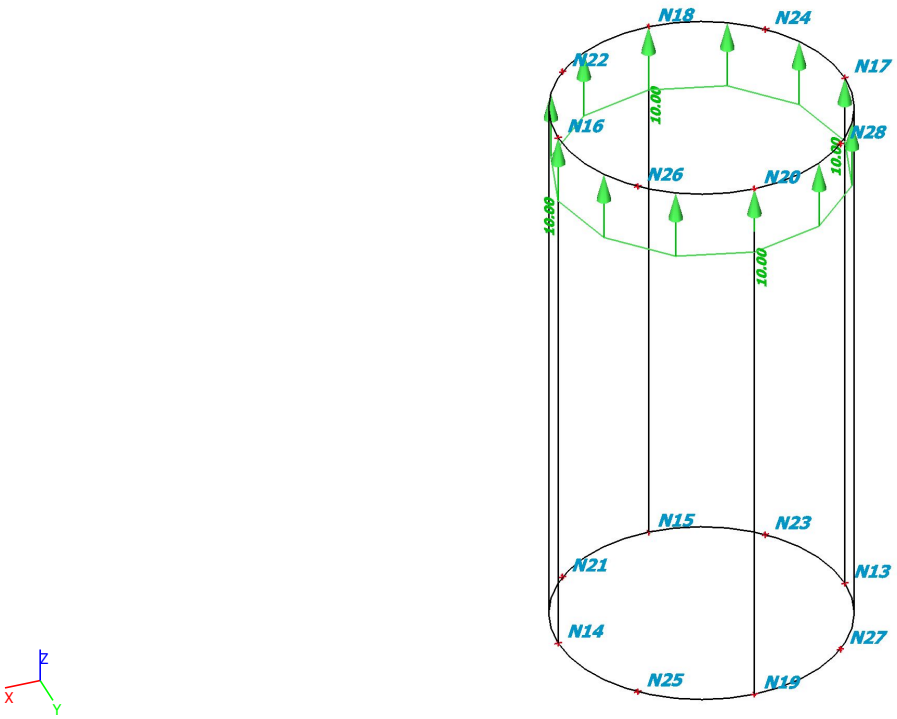
2.5. Matériaux

Acier EC3

Nom	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [kPa]	F_u [kPa]	Couleur
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235000.000	360000.000	
		8.0769e+04	0.01e-003	40	80	215000.000	360000.000	

3. LOAD

3.1. LC1 / Tot. value



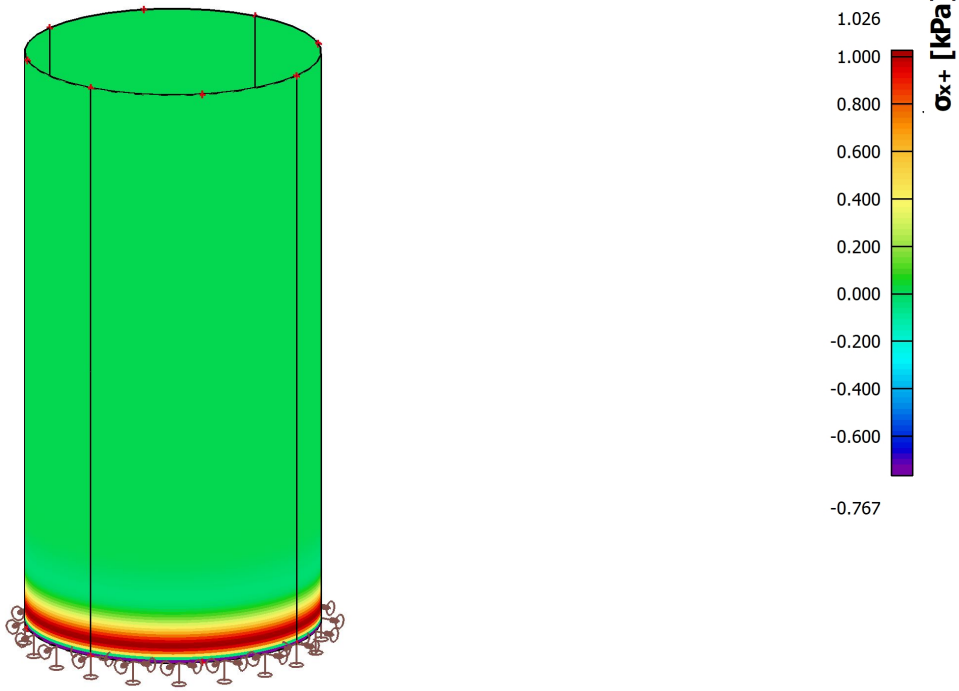
3.2. Charge répartie sur un bord

Nom	Macro 2D	Type	Dir	Valeur - P_1 [kN/m]	Pos x_1	Pos	Bord
	Cas de charge	Système	Distribution	Valeur - P_2 [kN/m]	Pos x_2	Coor	Orig
LFS1	D7	Force	Z	10.00	0.000	Longueur	3
	LC2 - Permanent	SCG	Uniforme		1.000	Rela	Depuis le départ
LFS2	D8	Force	Z	10.00	0.000	Longueur	3
	LC2 - Permanent	SCG	Uniforme		1.000	Rela	Depuis le départ
LFS3	D9	Force	Z	10.00	0.000	Longueur	3
	LC2 - Permanent	SCG	Uniforme		1.000	Rela	Depuis le départ
LFS4	D6	Force	Z	10.00	0.000	Longueur	3
	LC2 - Permanent	SCG	Uniforme		1.000	Rela	Depuis le départ

4. RESULTS

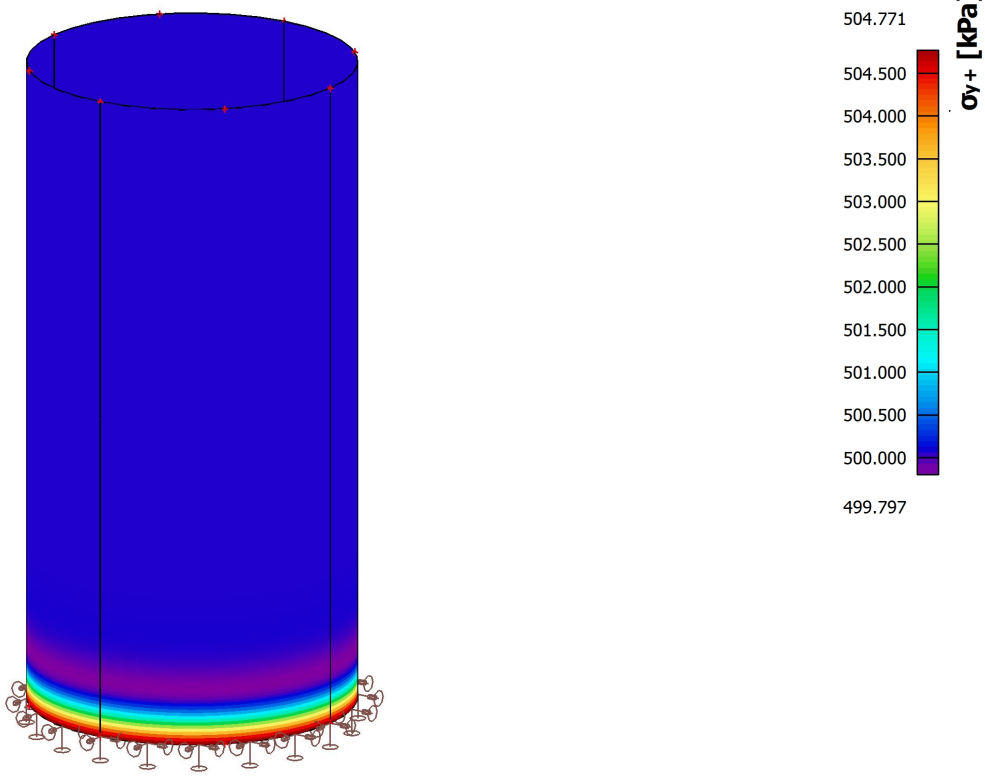
4.1. 2D stress/strain; σ_x+

Values: σ_{x+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.2. 2D stress/strain; σ_y+

Values: σ_{y+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.3. Contraintes/déformations 2D

Calcul linéaire
Cas de charge: LC2
Extrême: Global
Sélection: Tout
Position: Aux centres. Système: SCL maillage EF
Contrainte de base

Nom	Maillage	Position [m]	Cas	σ_{x+} [kPa] σ_{x-} [kPa]	σ_{y+} [kPa] σ_{y-} [kPa]	τ_{xy+} [kPa] τ_{xy-} [kPa]	τ_{xz} [kPa]	τ_{yz} [kPa]
D6	Elément: 419	0.648 -0.228 0.110	LC2	**1.026** -0.446	502.454 497.546	0.000 0.000	0.000	-0.135
D6	Elément: 888	0.440 -0.282 0.230	LC2	0.514 **0.376**	500.231 499.769	0.000 0.000	0.000	-0.047
D6	Elément: 1361	0.303 -0.293 0.350	LC2	0.045 0.167	**499.797** **500.203**	0.000 0.000	0.000	0.000
D6	Elément: 2	0.322 -0.292 0.010	LC2	**-0.767** **-3.629**	504.770 **495.230**	0.000 0.000	0.000	-0.035
D6	Elément: 4	0.362 -0.290 0.010	LC2	-0.767 -3.629	504.770 495.230	0.000 **0.000**	0.000	-0.035
D6	Elément: 80	1.293 0.697 0.010	LC2	-0.767 -3.629	504.771 495.230	**0.000** 0.000	**0.000**	-0.035
D6	Elément: 1	0.303 -0.293 0.010	LC2	-0.767 -3.629	**504.771** 495.230	**0.000** **0.000**	**0.000**	-0.035
D6	Elément: 326	0.401 -0.287 0.090	LC2	0.953 -0.851	503.007 496.993	0.000 0.000	0.000	**-0.140**
D6	Elément: 1681	0.303 -0.293 0.430	LC2	-0.038 0.043	499.865 500.135	0.000 0.000	0.000	**0.006**

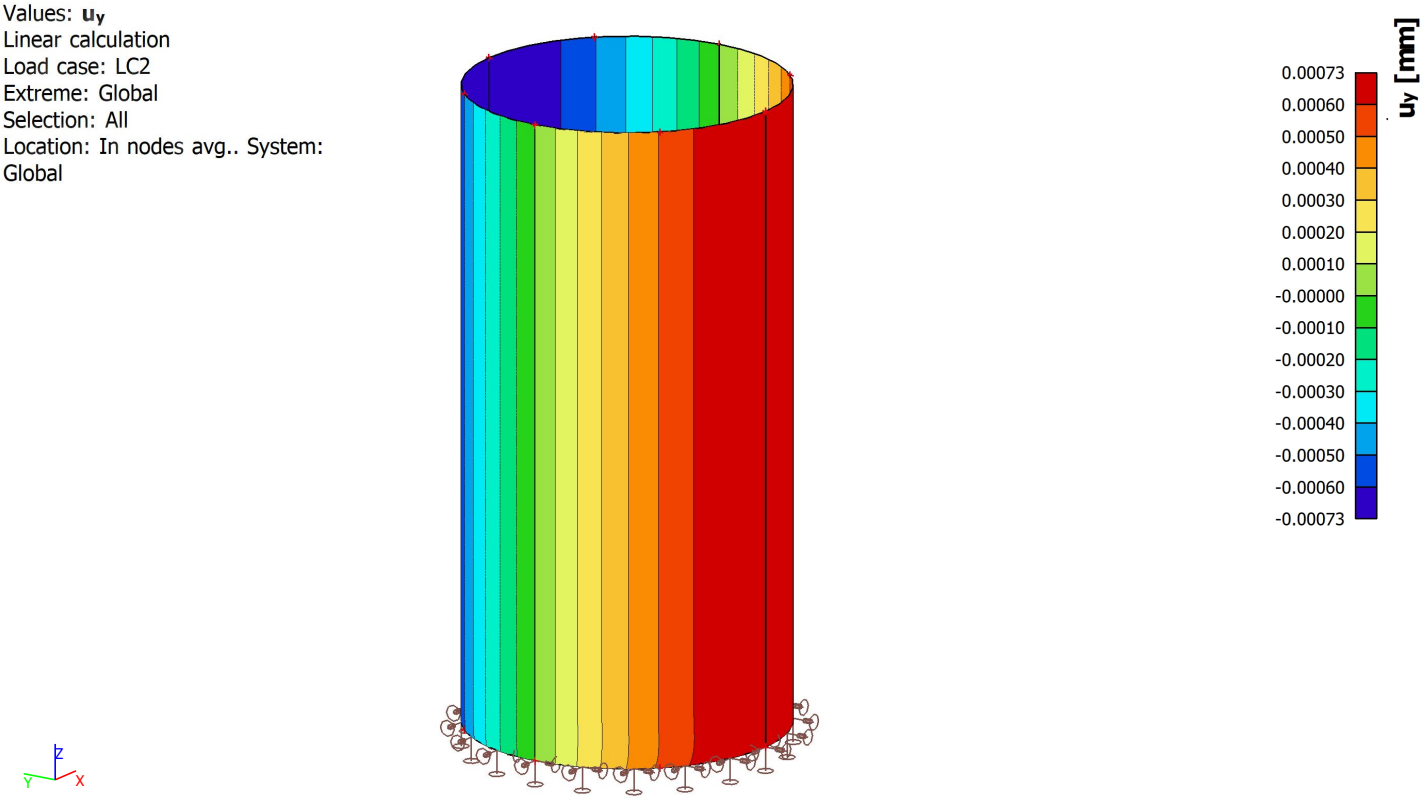
4.4. Déplacements 2D

Calcul linéaire
Cas de charge: LC2
Extrême: Global
Sélection: Tout
Position: Aux noeuds, moyenne sur macro. Système: SCL maillage EF

Nom	Maillage	Position [m]	Cas	u_x [mm]	u_y [mm]	u_z [mm]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U_{total} [mm]
D6	Elément: 1 Noeud: 161	0.313 -0.293 0.020	LC2	0.00000	**0.00005**	-0.00072	0.0	0.0	0.0	**0.00072**
D6	Elément: 15921 Noeud: 16201	0.313 -0.293 4.000	LC2	**0.00000**	**0.00952**	**-0.00071**	**0.0**	**0.0**	**0.0**	**0.00955**

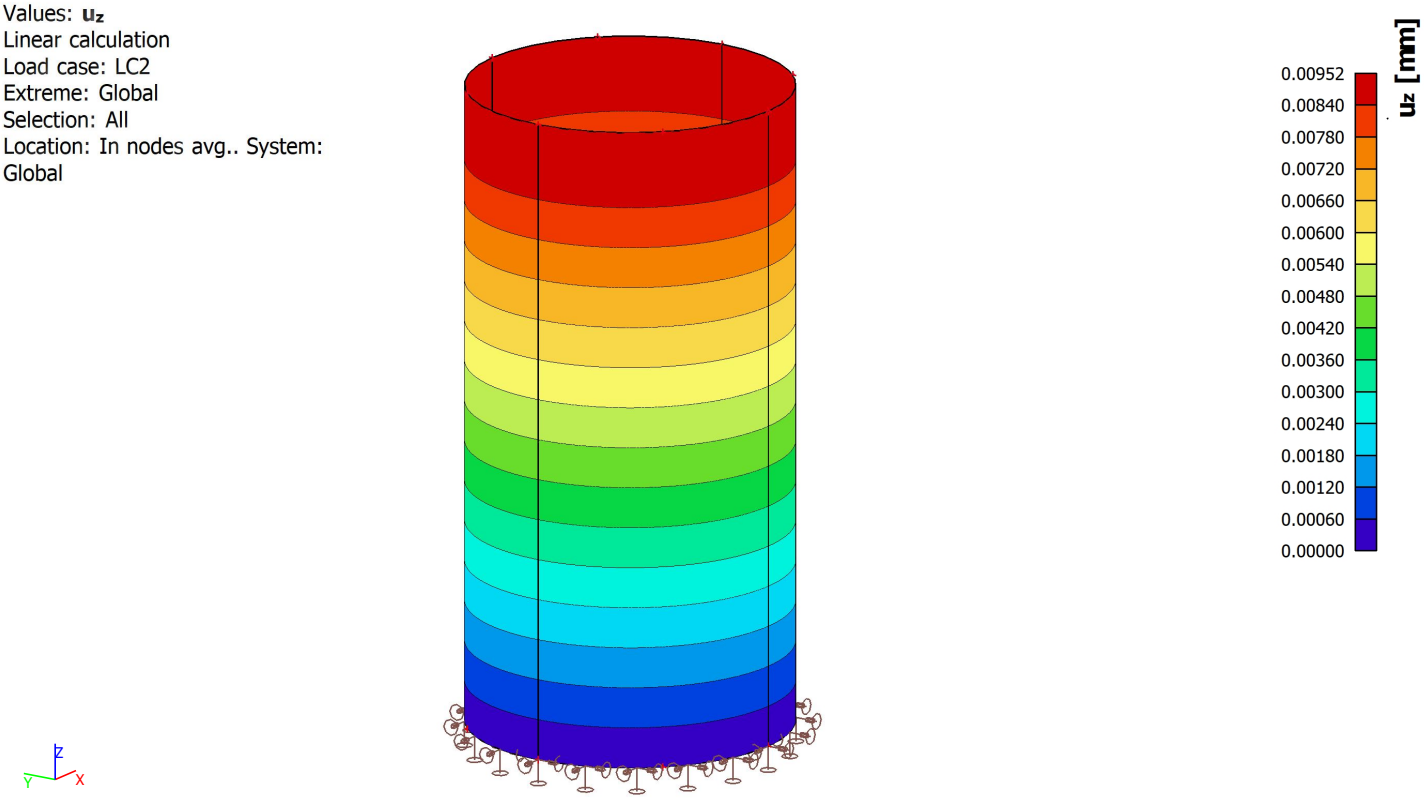
4.5. 2D displacement; u_y

Values: u_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



4.6. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

σx = 0 kPa

σy = 500 kPa

Radial displacement = -7.14*e-3 mm

Vertical displacement = 9.52*e-3 mm

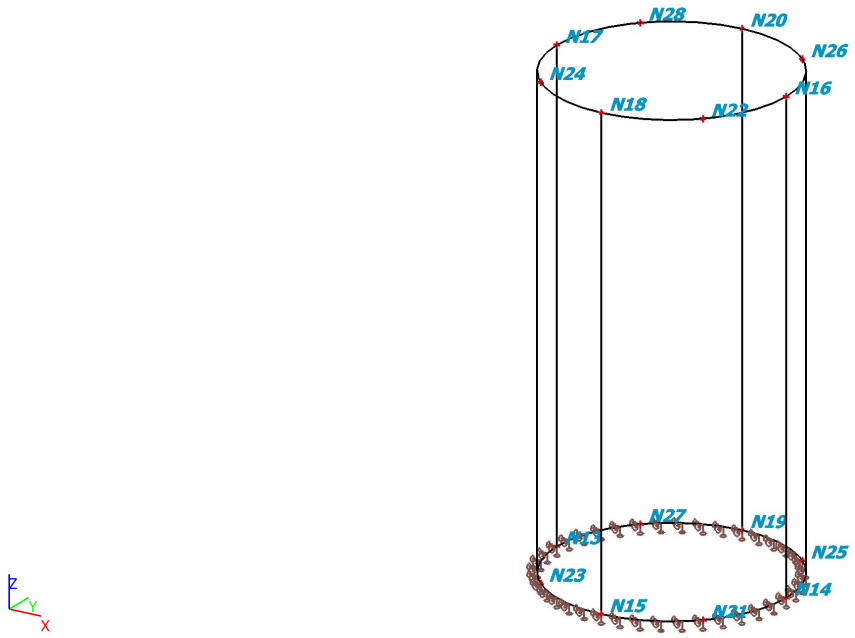
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Thin-walled cylinder under hydrostatic pressure
Specification: Shell - Cylinder - Material: elastic - Pressure

2. MODEL

2.1. Analysis model



2.2. Noeuds

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N13	-0.707	0.707	0.000
N14	1.293	0.707	0.000
N15	0.293	-0.293	0.000
N16	1.293	0.707	4.000
N17	-0.707	0.707	4.000
N18	0.293	-0.293	4.000

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N19	0.293	1.707	0.000
N20	0.293	1.707	4.000
N21	1.000	0.000	0.000
N22	1.000	0.000	4.000
N23	-0.414	0.000	0.000
N24	-0.414	0.000	4.000

Nom	Coord X [m]	Coord Y [m]	Coord Z [m]
N25	1.000	1.414	0.000
N26	1.000	1.414	4.000
N27	-0.414	1.414	0.000
N28	-0.414	1.414	4.000

2.3. Surfaces

Nom	Calque	Type	Type d'élément	Matériau	Type d'épaisseur	Ep. [mm]
D6	Calque1	wall (80)	Standard	S 235	constante	20
D7	Calque1	wall (80)	Standard	S 235	constante	20
D8	Calque1	wall (80)	Standard	S 235	constante	20
D9	Calque1	wall (80)	Standard	S 235	constante	20

2.4. Appuis aux bords

Nom	Macro 2D	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Bord	Coor	Pos x_2						
Sle11	D6	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle12	D8	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle13	D9	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre
	1	Rela	1.000						
Sle14	D7	Depuis le départ	0.000	Flexible	Flexible	Rigide	Libre	Libre	Libre

Nom	Macro 2D	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Bord	Coor	Pos x_2						
	1	Rela	1.000						

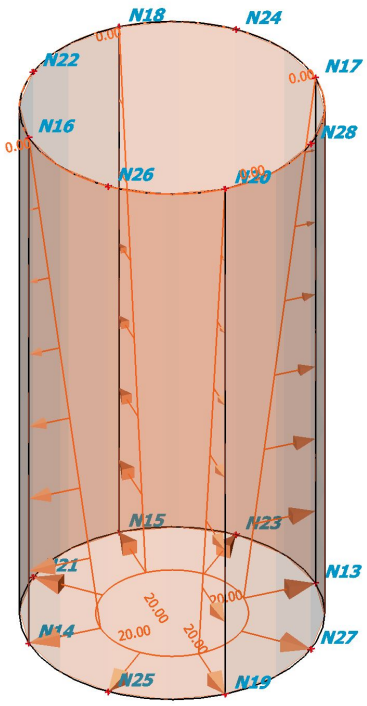
2.5. Matériaux

Acier EC3

Nom	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [kPa]	F_u [kPa]	Couleur
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235000.000	360000.000	
		8.0769e+04	0.01e-003	40	80	215000.000	360000.000	

3. LOAD

3.1. LC1 / Tot. value



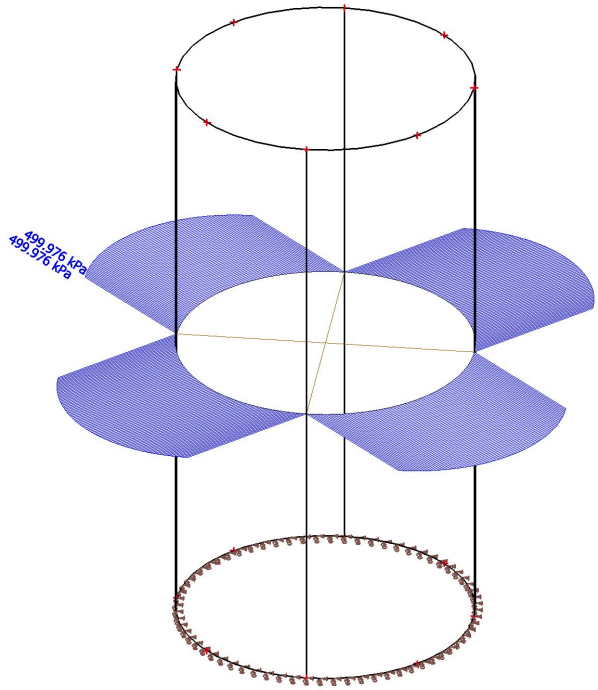
3.2. Charge libre surfacique

Nom	Cas de charge	Dir	Type	Distribution	q1 [kN/m²]	q2 [kN/m²]	Validité	Sélectionner	Système	Position
FF1	LC2 - Permanent	Z	Force	Dir Y	0.00	20.00	Tout	Auto	SCL élément	Longueur

4. RESULTS

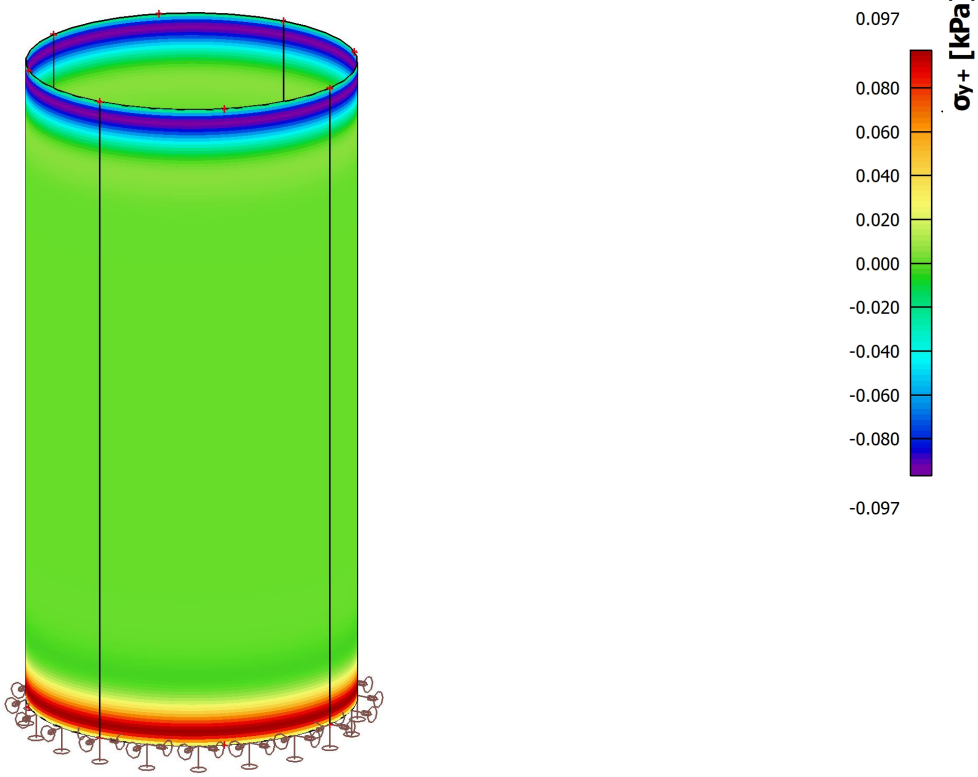
4.1. 2D stress/strain; σ_x+

Values: σ_{x+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.2. 2D stress/strain; σ_y+

Values: σ_{y+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS mesh element



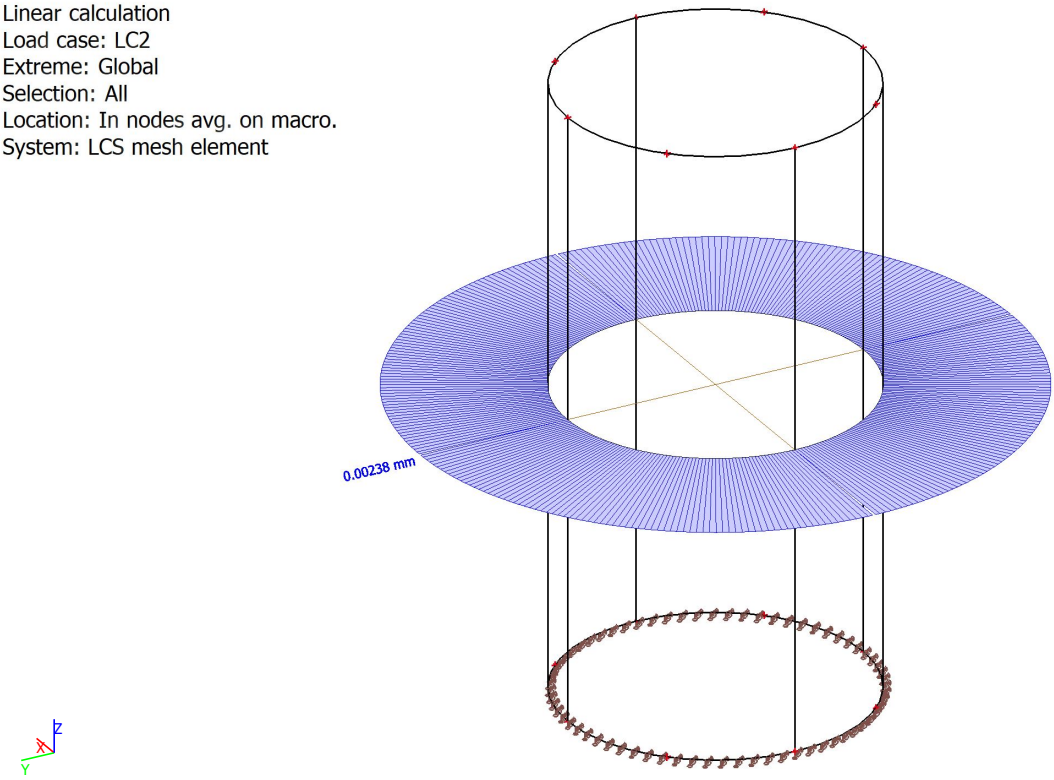
4.3. Déplacements 2D

Calcul linéaire
Cas de charge: LC2
Extrême: Global
Sélection: Tout
Position: Aux noeuds, moyenne sur macro. Système: SCL maillage EF
Résultats dans les coupes:

Nom	Maillage	Position [m]	Cas	u_z [mm]
SE1	Elément: 39921	0.293 1.707 2.000	LC2	**0.00238**

4.4. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



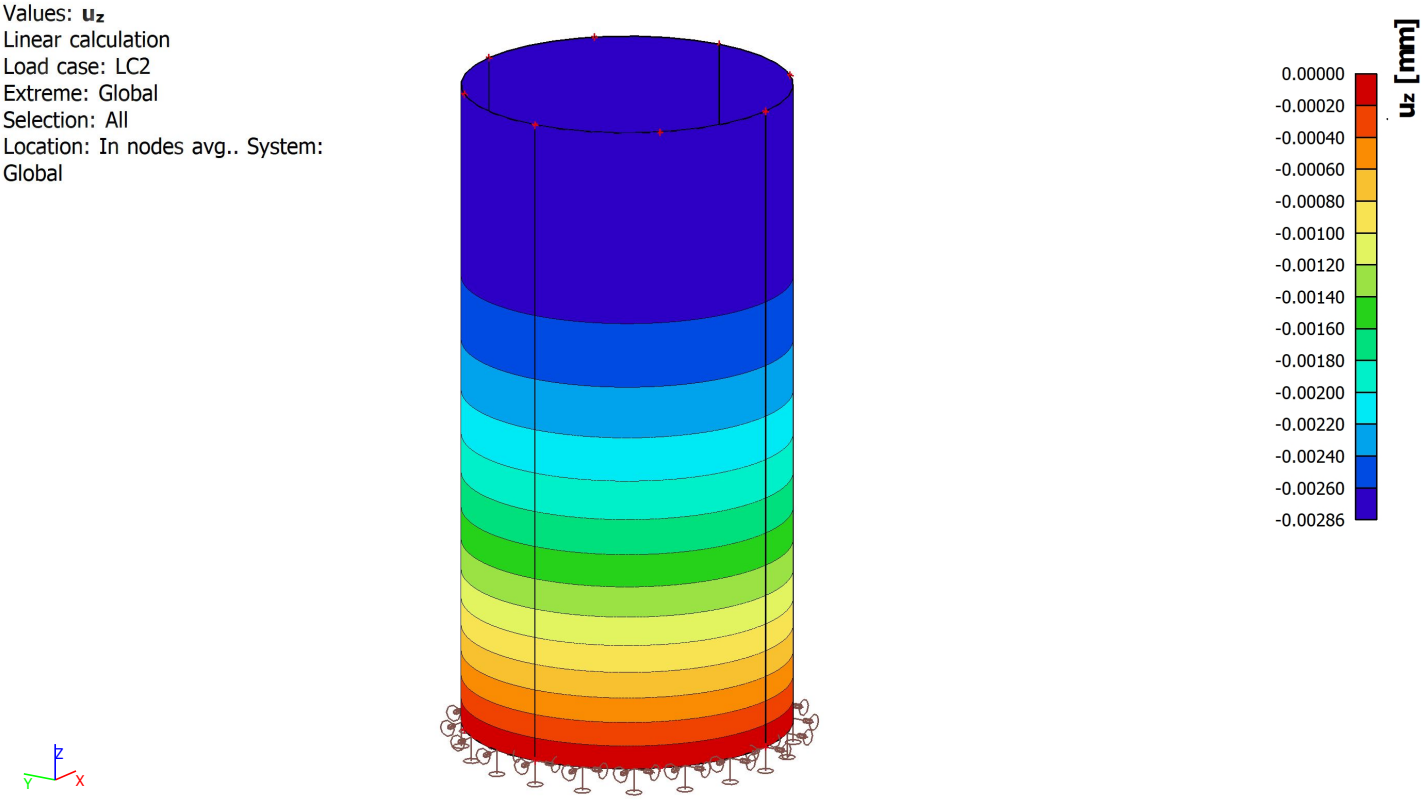
4.5. Déplacements 2D

Calcul linéaire
Cas de charge: LC2
Extrême: Global
Sélection: Tout
Position: Aux noeuds, moyenne sur macro. Système: SCL maillage EF

Nom	Maillage	Position [m]	Cas	u_y [mm]
D6	Elément: 15761 Noeud: 16039	0.313 -0.293 3.960	LC2	**-0.00286**
D6	Elément: 1 Noeud: 1	0.293 -0.293 0.000	LC2	**0.00000**

4.6. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

σx (at mid-height) = 500 kPa

σy (on whole height) = 0 kPa

Radial displacement (at mid-height) = 2,38*e-3 mm

Vertical displacement (at top) = -2,86*e-3 mm

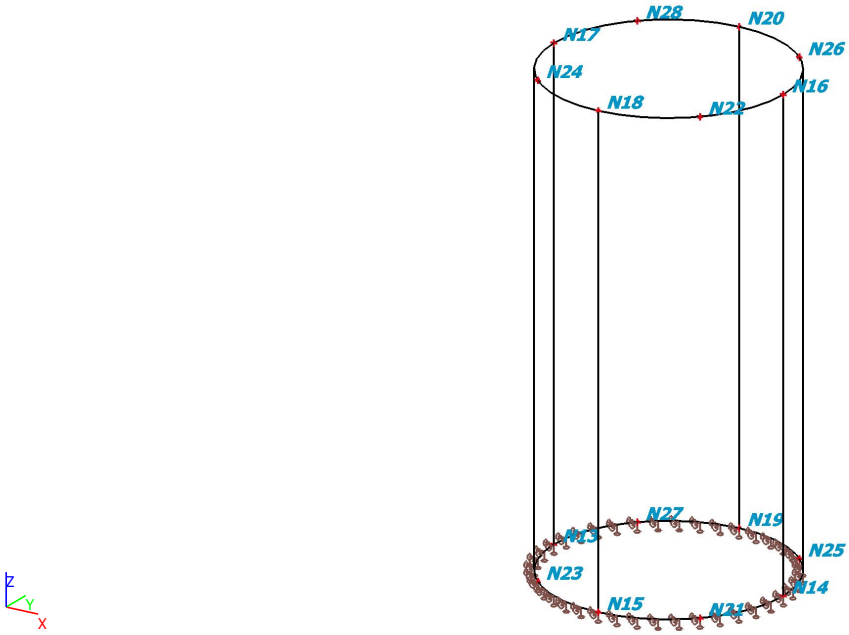
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Thin-walled cylinder under selfweight
Specification: Shell - Cylinder - Material: elastic

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N13	-0.707	0.707	0.000
N14	1.293	0.707	0.000
N15	0.293	-0.293	0.000
N16	1.293	0.707	4.000
N17	-0.707	0.707	4.000
N18	0.293	-0.293	4.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N19	0.293	1.707	0.000
N20	0.293	1.707	4.000
N21	1.000	0.000	0.000
N22	1.000	0.000	4.000
N23	-0.414	0.000	0.000
N24	-0.414	0.000	4.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N25	1.000	1.414	0.000
N26	1.000	1.414	4.000
N27	-0.414	1.414	0.000
N28	-0.414	1.414	4.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D6	Calque1	wall (80)	Standard	S 235	constant	20
D7	Calque1	wall (80)	Standard	S 235	constant	20
D8	Calque1	wall (80)	Standard	S 235	constant	20
D9	Calque1	wall (80)	Standard	S 235	constant	20

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle11	D6	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle12	D8	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle13	D9	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle14	D7	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
	1	Rela	1.000						

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [kPa]	F_u [kPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235000.000	360000.000	
		8.0769e+04	0.01e-003	40	80	215000.000	360000.000	

3. LOAD

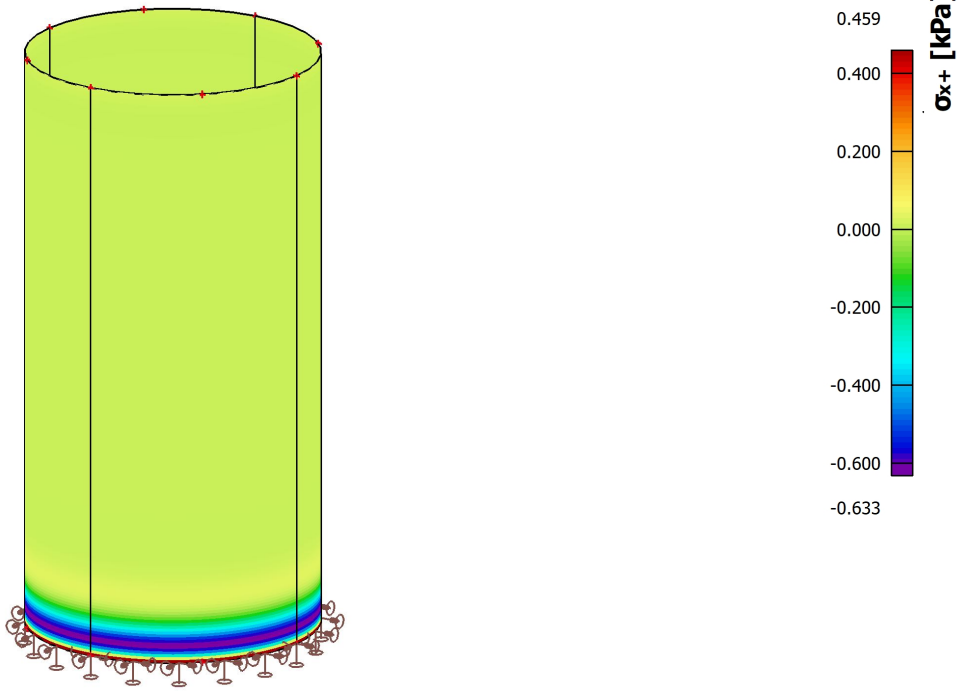
3.1. Load cases

Name	Description	Action type	Load group	Direction
	Spec	Load type		
LC1	Poids propre	Permanent	LG1	-Z
		Self weight		

4. RESULTS

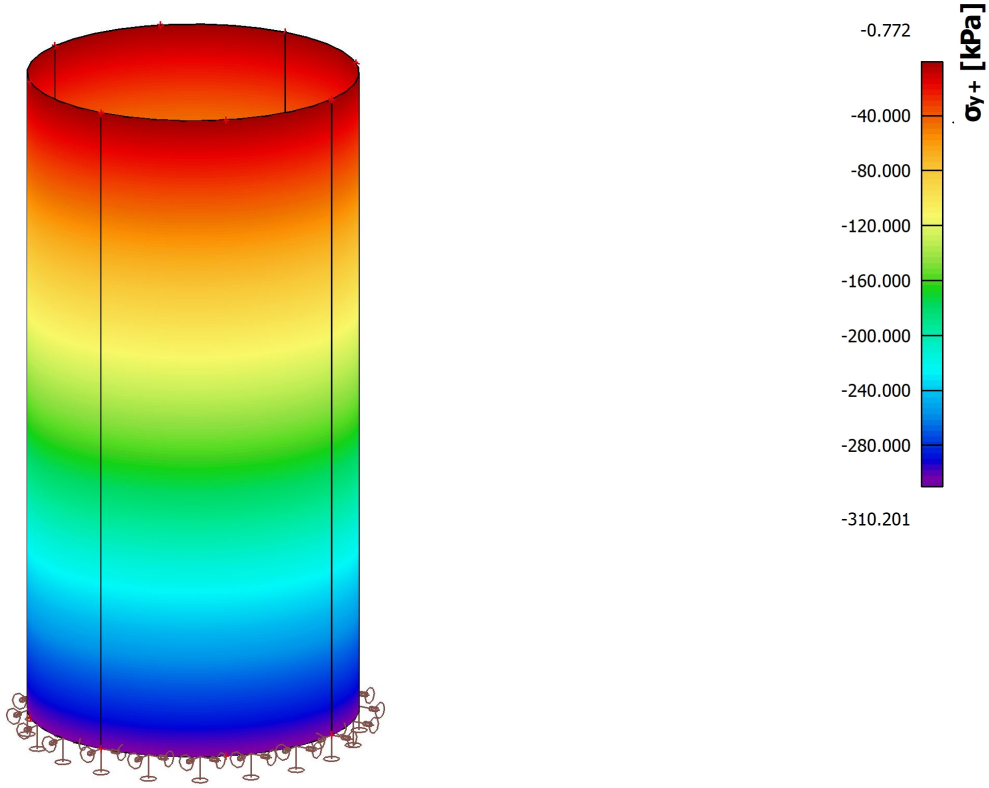
4.1. 2D stress/strain; σ_x+

Values: σ_{x+}
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.2. 2D stress/strain; σ_y+

Values: σ_{y+}
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.3. 2D stress/strain

Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In centres. System: LCS mesh element
Basic stress

Name	Mesh	Position [m]	Case	σ_{x+} [kPa] σ_{x-} [kPa]	σ_{y+} [kPa] σ_{y-} [kPa]	τ_{xy+} [kPa] τ_{xy-} [kPa]	τ_{xz} [kPa]	τ_{yz} [kPa]
D6	Element: 415	0.574 -0.253 0.110	LC1	**-0.633** 0.269	-301.066 -298.060	0.000 0.000	0.000	0.083
D6	Element: 887	0.420 -0.285 0.230	LC1	-0.315 **-0.231**	-290.461 -290.183	0.000 0.000	0.000	0.029
D6	Element: 2	0.322 -0.292 0.010	LC1	**0.459** **2.221**	-310.201 -304.327	0.000 0.000	0.000	0.023
D6	Element: 15921	0.303 -0.293 3.990	LC1	0.013 0.015	**-0.772** **-0.768**	0.000 0.000	0.000	0.001
D6	Element: 317	1.290 0.638 0.070	LC1	-0.479 0.834	-304.831 -300.456	0.000 **0.000**	0.000	0.085
D7	Element: 16721	0.283 -0.293 0.190	LC1	-0.462 -0.198	-293.843 -292.962	0.000 **0.000**	0.000	0.047
D6	Element: 1	0.303 -0.293 0.010	LC1	0.459 2.221	-310.201 -304.327	**0.000** 0.000	**0.000**	0.023
D6	Element: 80	1.293 0.697 0.010	LC1	0.459 2.221	**-310.201** **-304.327**	**0.000** 0.000	**0.000**	0.023
D6	Element: 1681	0.303 -0.293 0.430	LC1	0.024 -0.026	-274.837 -275.003	0.000 0.000	0.000	**-0.004**
D6	Element: 329	0.459 -0.279 0.090	LC1	-0.589 0.517	-302.947 -299.260	0.000 0.000	0.000	**0.086**

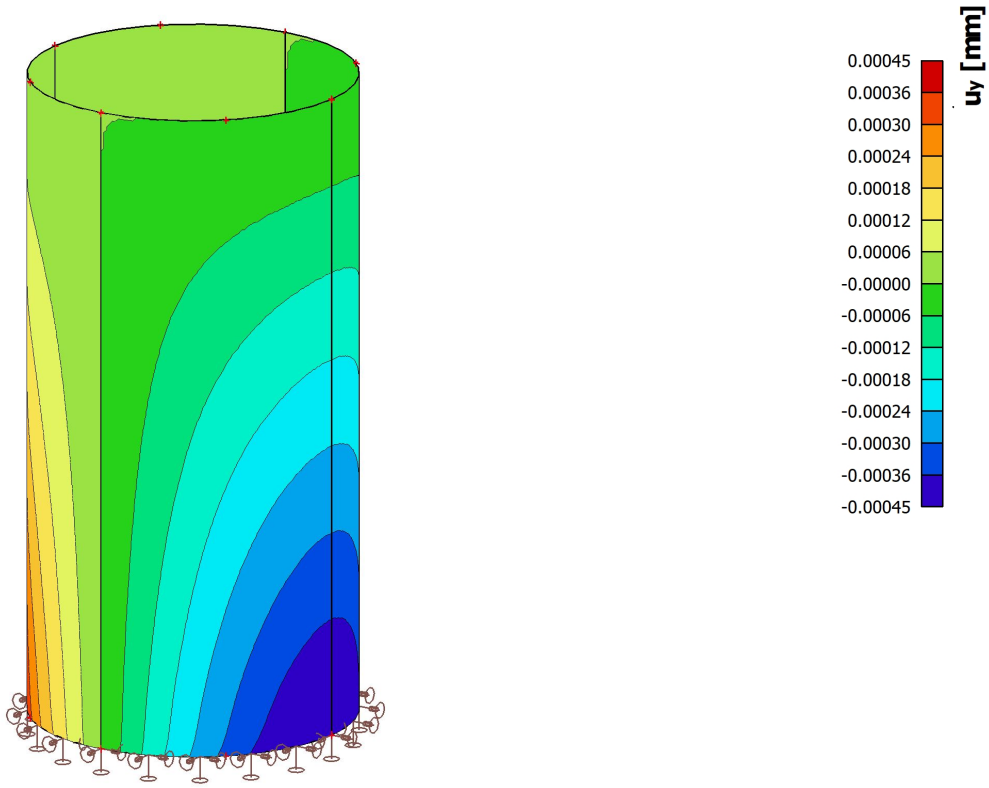
4.4. 2D displacement

Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element

Name	Mesh	Position [m]	Case	u_x [mm]	u_y [mm]	u_z [mm]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U_{total} [mm]
D6	Element: 15921 Node: 16201	0.313 -0.293 4.000	LC1	**0.00000**	**-0.00293**	**0.00000**	**0.0**	**0.0**	**0.0**	**0.00293**
D6	Element: 81 Node: 163	0.313 -0.293 0.040	LC1	0.00000	**-0.00006**	0.00044	0.0	0.0	0.0	**0.00044**

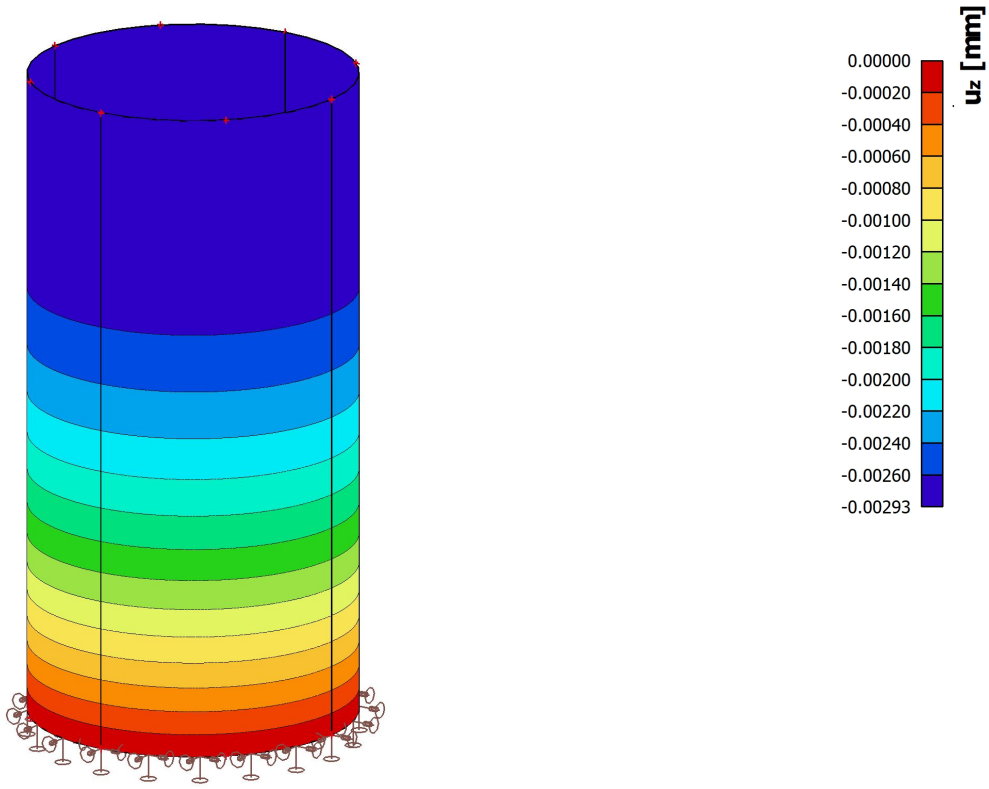
4.5. 2D displacement; u_y

Values: u_y
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



4.6. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

σx (Whole height)= 0 kPa

σy (at bottom)= -314 kPa

Radial displacement = 4.49*e-4 mm

Vertical displacement = -2.99 e-3 mm

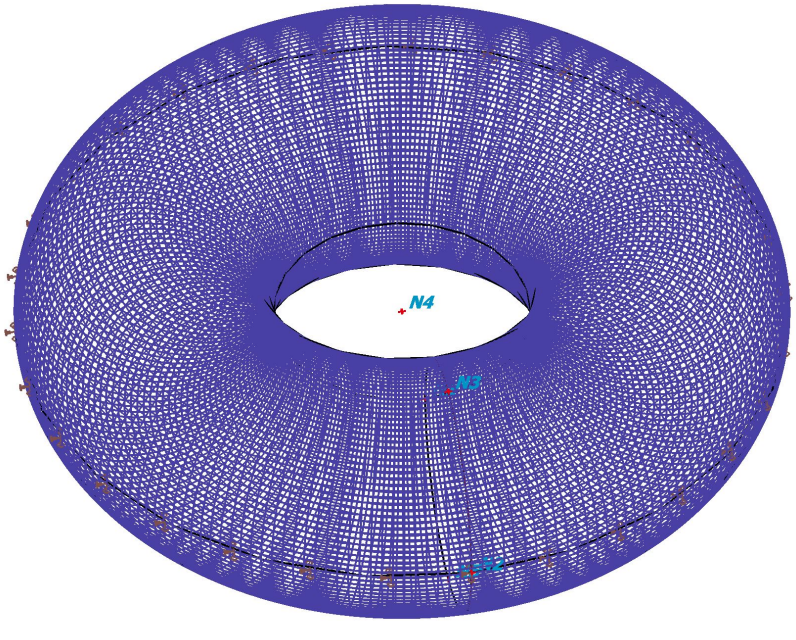
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Torus under uniform internal pressure

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	1.000	0.000	0.000
N2	3.000	0.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N3	2.000	0.000	1.000
N4	0.000	0.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N5	2.000	0.000	-1.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	shell (98)	Standard	S 235	constant	20
D2	Calque1	shell (98)	Standard	S 235	constant	20

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	2	Rela	1.000						

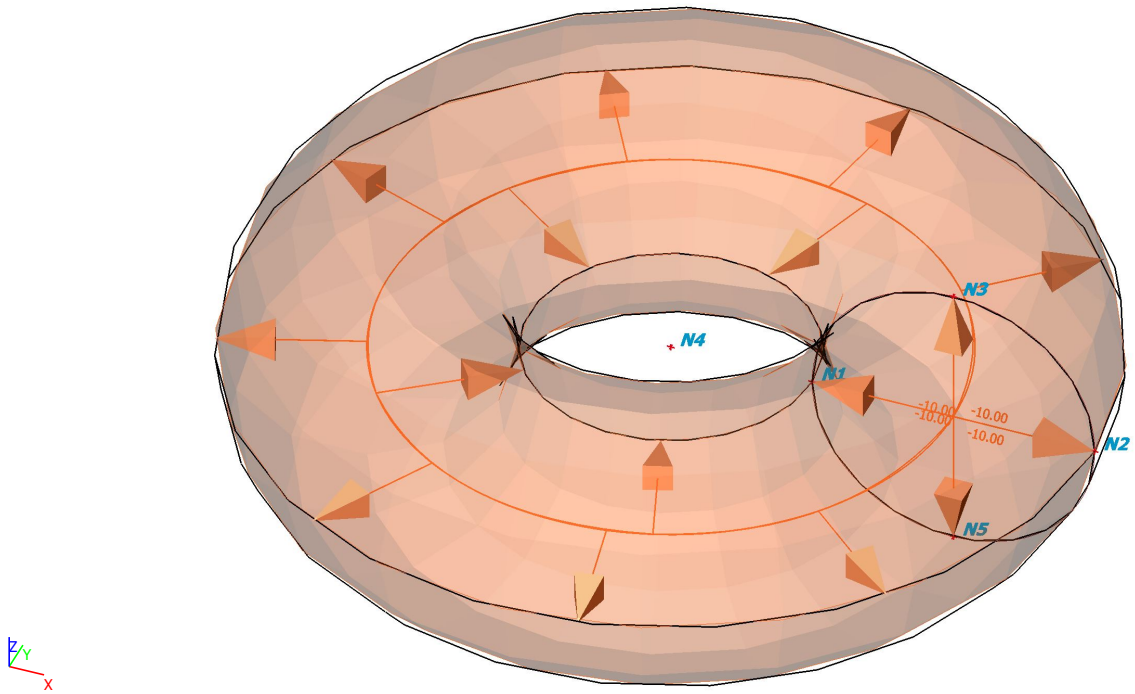
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.00	360.00	
		8.0769e+04	0.01e-003	40	80	215.00	360.00	

3. LOAD

3.1. LC2 / Tot. value



3.2. Load cases

Name	Description	Action type	Load group
	Spec	Load type	
LC2	PERMANENT	Permanent	LG1
		Standard	

3.3. Generated free loads

Name	Load case	2D member	Dir	Type load	Original Load	q [kN/m²]	System
			Distribution	Type		Value - P [kN/m]	Location
GFF1	LC2 - PERMANENT	D1	Z	Surface	FF1	-10.00	Member LCS
			Uniform	Force			Length
GFF2	LC2 - PERMANENT	D2	Z	Surface	FF1	-10.00	Member LCS
			Uniform	Force			Length

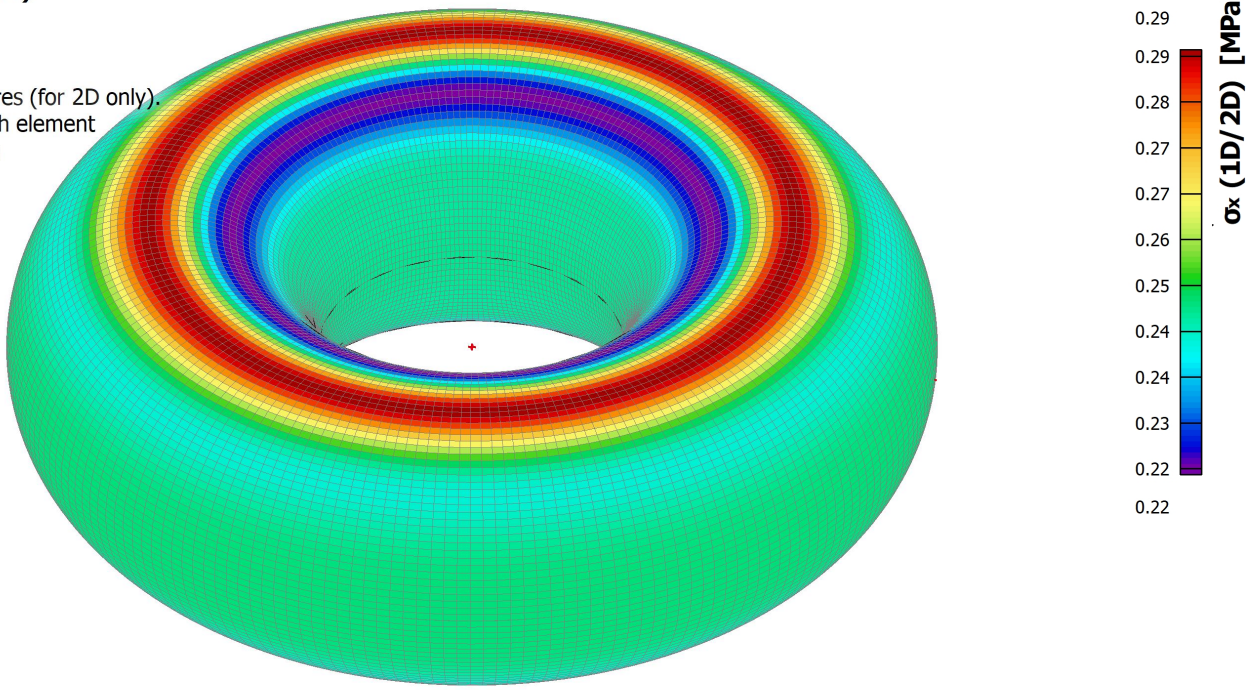
3.4. Free surface load

Name	Load case	Dir	Type	Distribution	q [kN/m²]	Validity	Select	System	Location
FF1	LC2 - PERMANENT	Z	Force	Uniform	-10.00	All	Auto	Member LCS	Length

4. RESULTS

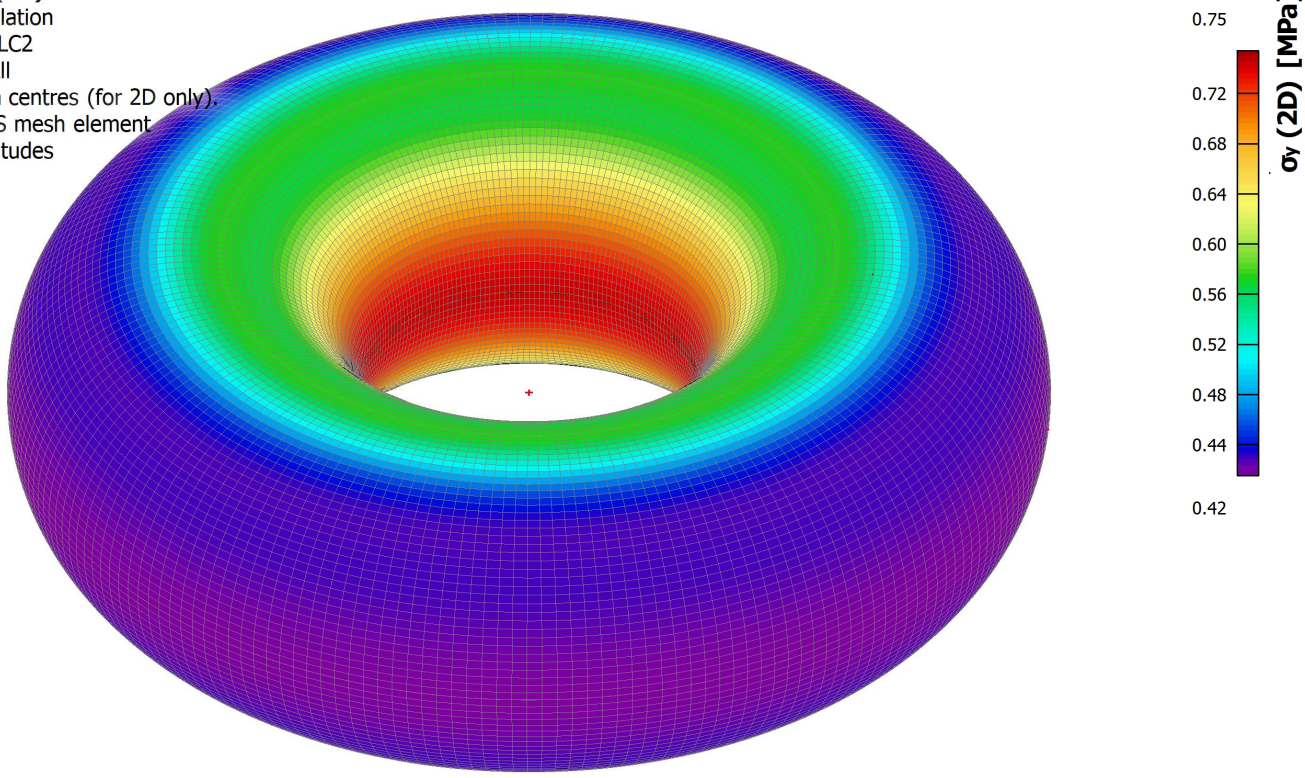
4.1. 3D stress; σ_x (1D/2D)

Values: **σ_x (1D/2D)**
Linear calculation
Load case: LC2
Selection: All
Location: In centres (for 2D only).
System: LCS mesh element
Basic magnitudes



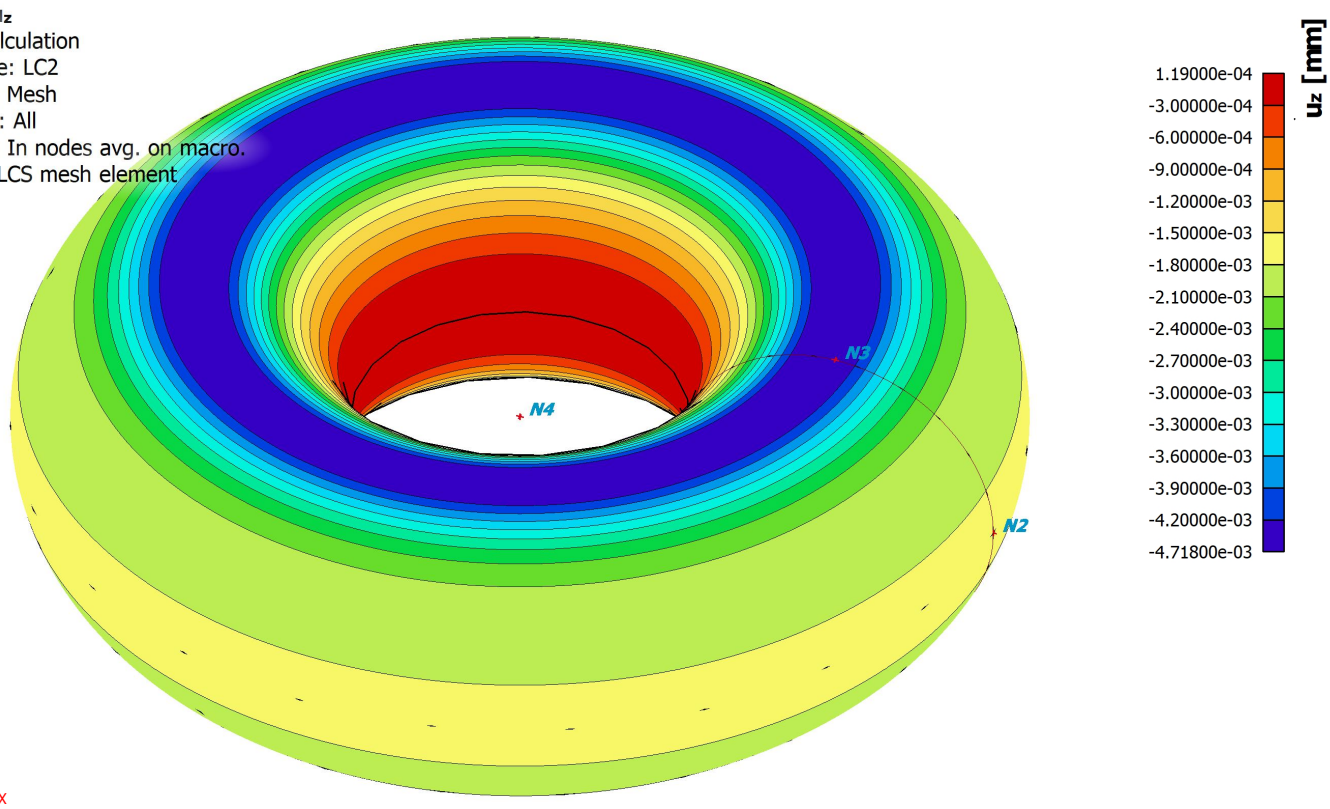
4.2. 3D stress; σ_y (2D)

Values: **σ_y (2D)**
Linear calculation
Load case: LC2
Selection: All
Location: In centres (for 2D only).
System: LCS mesh element
Basic magnitudes



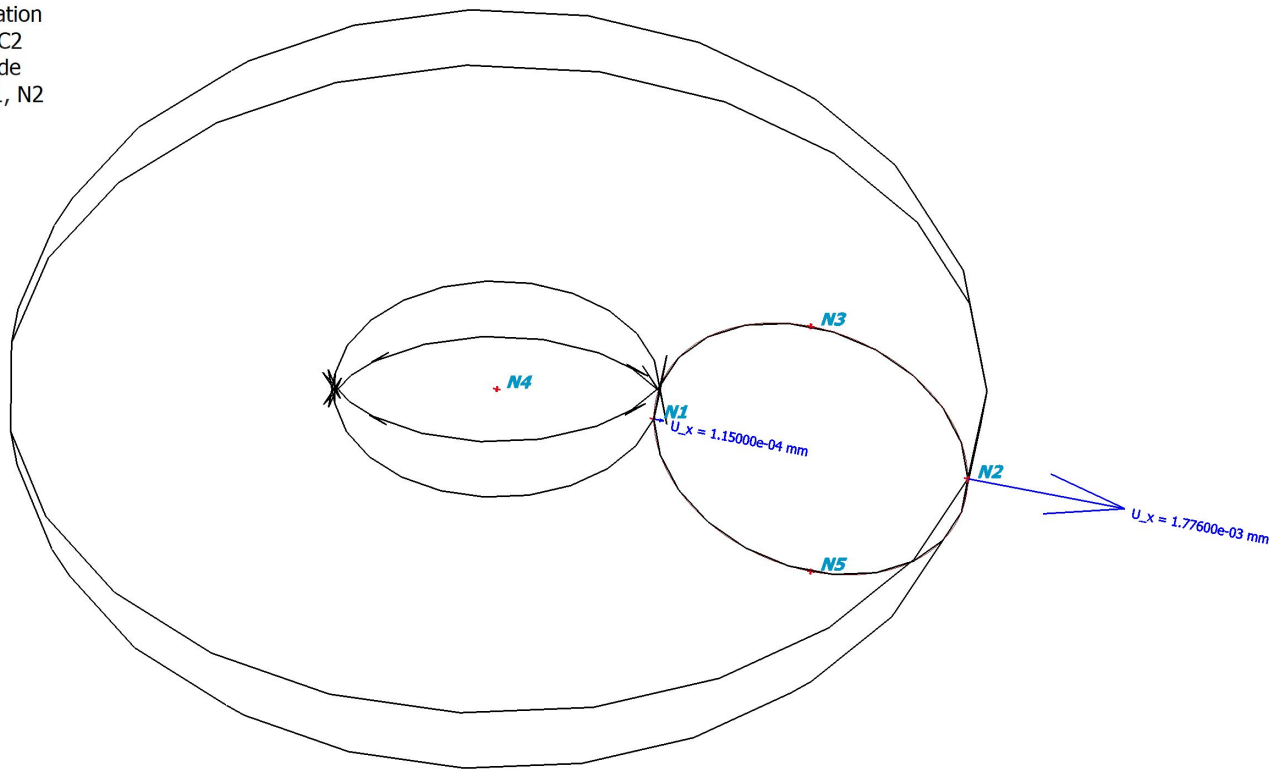
4.3. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Mesh
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.4. Displacement of nodes; U_x

Values: U_x
Linear calculation
Load case: LC2
Extreme: Node
Selection: N1, N2



4.5. 3D stress

Linear calculation
Load case: LC2
Selection: All
Location: In centres (for 2D only). System: LCS mesh element
Basic magnitudes
Results on 2D member
Extreme 2D: Global

Name	Mesh	Position [m]	Case	σ_{x+} [MPa] σ_{x-} [MPa]	σ_{y+} [MPa] σ_{y-} [MPa]	τ_{xy+} [MPa] τ_{xy-} [MPa]	τ_{xz} [MPa]	τ_{yz} [MPa]
D1	Element: 5617	1.733 0.025 0.963	LC2	**0.22** 0.24	0.50 0.57	0.00 0.00	0.00	0.00
D1	Element: 7993	2.266 0.033 0.963	LC2	**0.27** 0.28	0.48 0.46	0.00 0.00	0.00	0.00
D1	Element: 7129	2.073 0.030 0.997	LC2	0.26 **0.29**	0.45 0.52	0.00 0.00	0.00	0.00
D1	Element: 13609	2.999 0.044 0.025	LC2	0.25 0.25	**0.42** **0.42**	0.00 0.00	0.00	0.00
D1	Element: 1	1.000 0.015 0.025	LC2	0.25 0.25	**0.75** **0.74**	0.00 0.00	0.00	0.00
D1	Element: 651	1.012 0.074 0.171	LC2	0.25 0.25	0.75 0.74	**0.00** 0.00	0.00	0.00
D1	Element: 649	1.015 0.015 0.171	LC2	0.25 0.25	0.75 0.74	**0.00** 0.00	0.00	0.00
D1	Element: 5837	1.766 0.232 0.975	LC2	0.22 0.25	0.48 0.57	0.00 **0.00**	0.00	0.00
D1	Element: 5921	-1.502 0.957 0.975	LC2	0.22 0.25	0.48 0.57	0.00 **0.00**	**0.00**	0.00
D1	Element: 4834	-1.112 1.080 0.893	LC2	0.24 **0.22**	0.57 0.57	0.00 0.00	**0.00**	0.00
D1	Element: 6697	1.975 0.029 0.999	LC2	0.24 0.28	0.45 0.55	0.00 0.00	0.00	**0.00**
D1	Element: 7345	2.122 0.031 0.992	LC2	0.26 0.29	0.46 0.51	0.00 0.00	0.00	**0.00**

4.6. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Global
Selection: N1, N2

Name	Case	U_x [mm]
N1	LC2	**1.15000e-04**
N2	LC2	**1.77600e-03**

5. EXPECTED AFNOR RESULTS

σx (Whole torus)= 0.25 MPa

σy (Max)= 0.75 MPa

σy (Min)= 0.42 MPa

Radial (external) displacement (N1 ux)= 1.19*e-4 mm

Radial (internal) displacement (N2 ux)= 1.79*e-3 mm

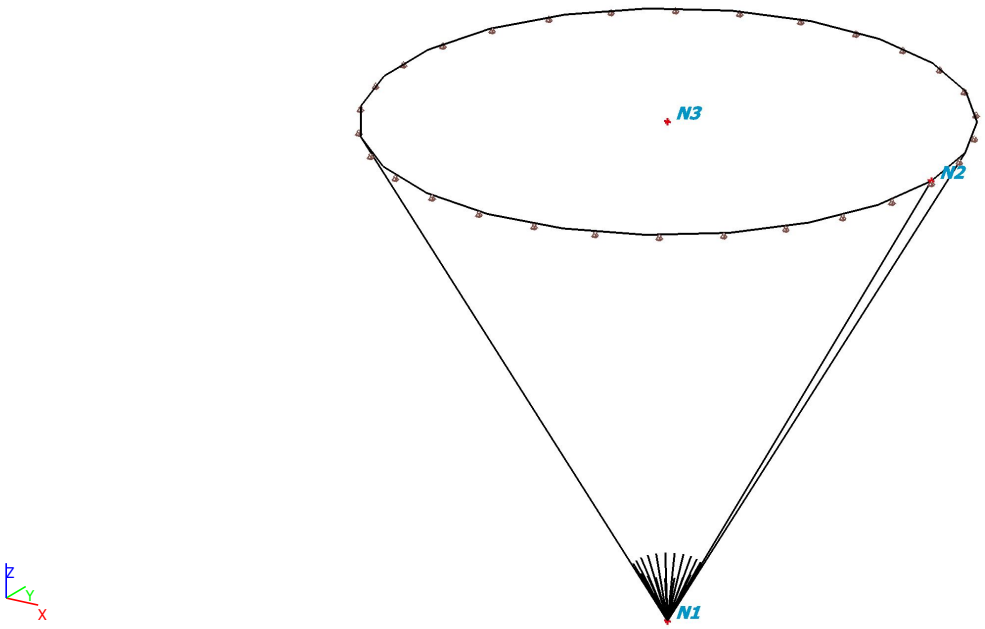
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Thin-walled cone subjected to uniform internal pressure
Specification: Shell - Cone - Material: elastic - Pressure.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	1.000	0.000	1.732
N3	0.000	0.000	1.732

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	shell (98)	Standard	S 235	constant	20

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	2	Rela	1.000						

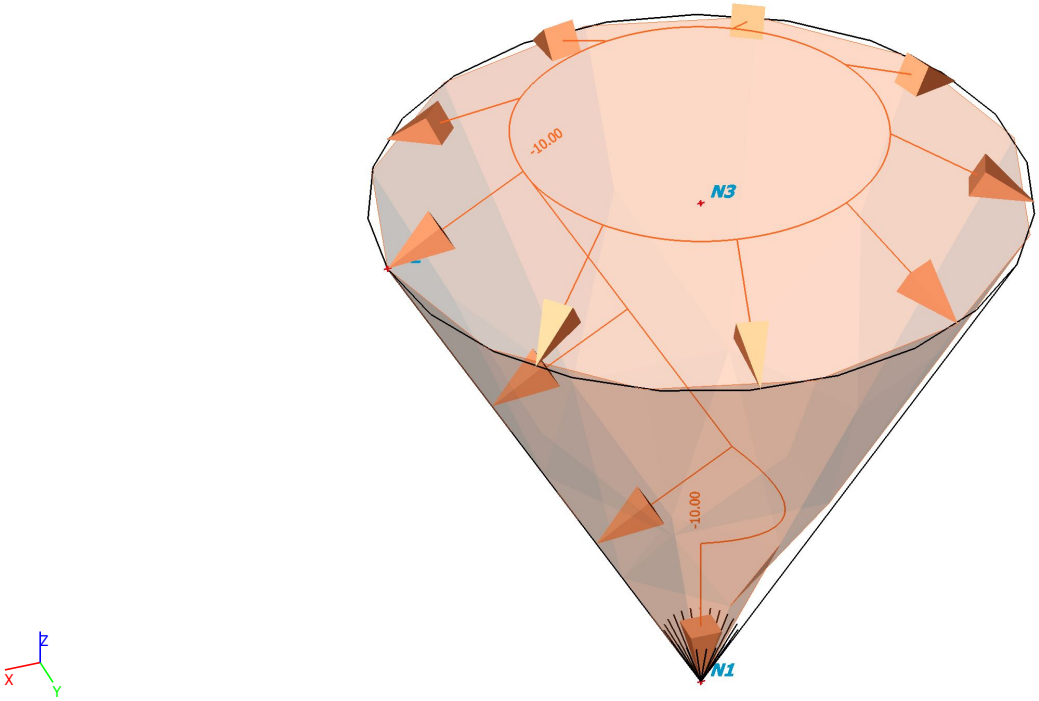
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.000	360.000	
		8.0769e+04	0.01e-003	40	80	215.000	360.000	

3. LOAD

3.1. LC2 / Tot. value



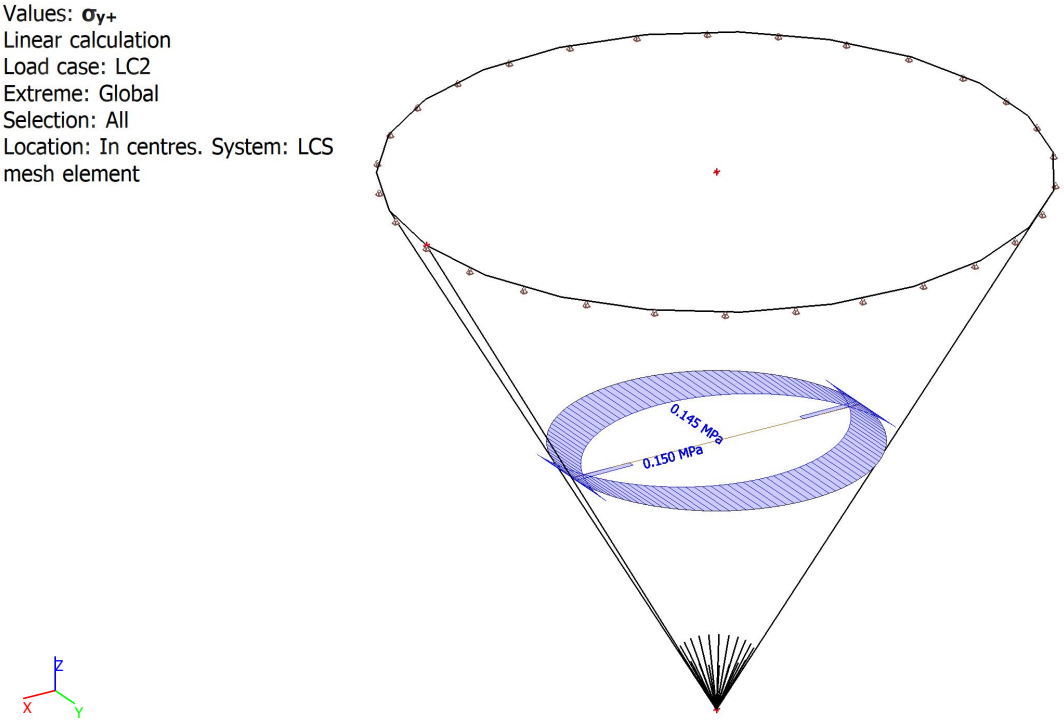
3.2. Free surface load

Name	Load case	Dir	Type	Distribution	q [kN/m²]	Validity	Select	System	Location
FF1	LC2 - Permanent	Z	Force	Uniform	-10.00	All	Auto	Member LCS	Length

4. RESULTS

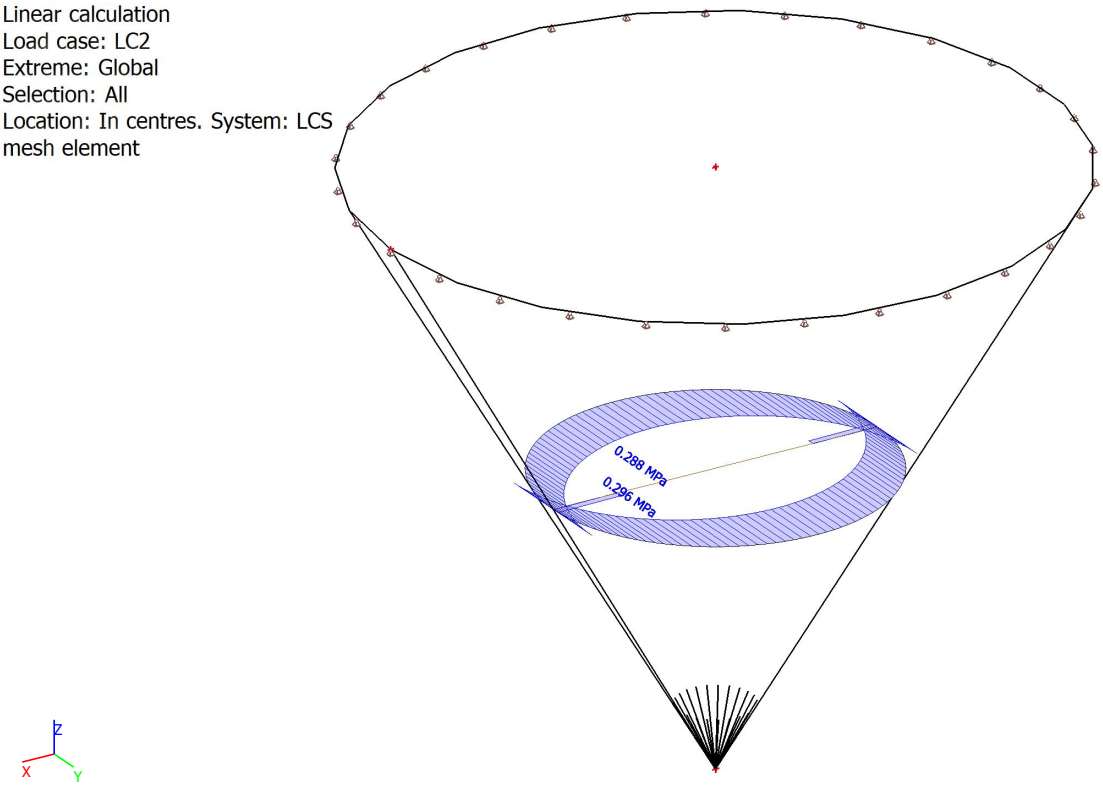
4.1. 2D stress/strain; σ_y+

Values: σ_{y+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



4.2. 2D stress/strain; σ_x+

Values: σ_{x+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS
mesh element



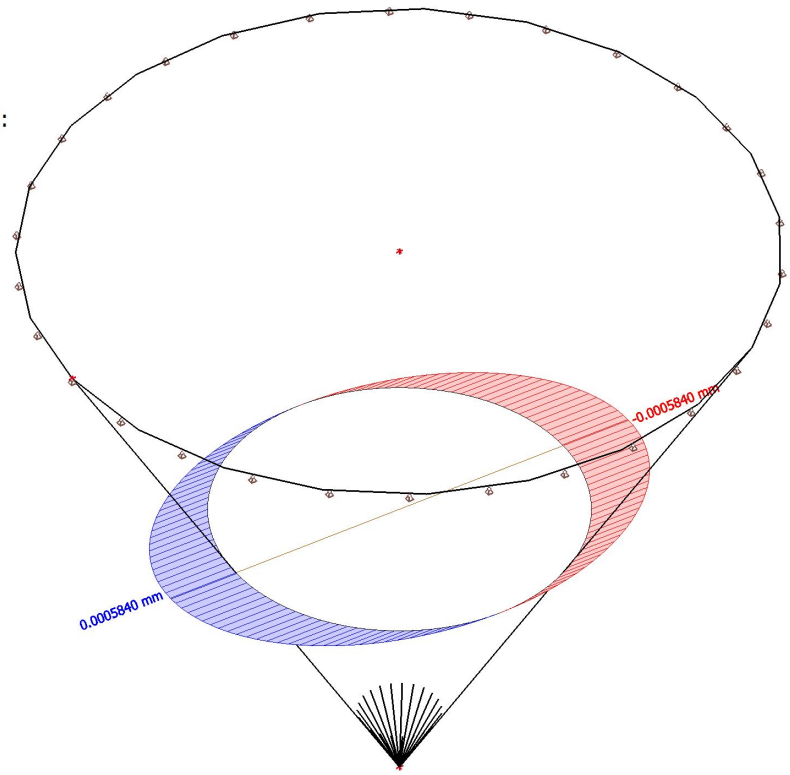
4.3. 2D stress/strain

Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. System: LCS mesh element
Basic stress - Results on sections:

Name	Mesh	Position [m]	Case	σ_{x+} [MPa] σ_{x-} [MPa]	σ_{y+} [MPa] σ_{y-} [MPa]	τ_{xy+} [MPa] τ_{xy-} [MPa]	τ_{xz} [MPa]	τ_{yz} [MPa]
SE1	Element: 3377	-0.478 -0.147 0.866	LC2	0.288 **0.282**	0.145 0.140	0.000 0.000	0.000	0.000
SE1	Element: 3660	0.312 0.391 0.866	LC2	**0.296** **0.289**	0.150 0.142	0.000 0.000	0.000	0.000
SE1	Element: 3351	0.012 -0.500 0.866	LC2	**0.288** 0.282	**0.145** 0.140	0.000 0.000	0.000	0.000
SE1	Element: 3345	0.159 -0.474 0.866	LC2	0.288 0.282	0.145 **0.140**	**0.000** 0.000	0.000	0.000
SE1	Element: 3632	-0.012 0.500 0.866	LC2	0.296 0.289	0.150 0.142	**0.000** 0.000	0.000	0.000
SE1	Element: 3670	0.399 0.302 0.866	LC2	0.296 0.289	0.150 0.142	0.000 **0.000**	0.000	0.000
SE1	Element: 3333	0.399 -0.302 0.866	LC2	0.288 0.282	0.145 0.140	0.000 **0.000**	0.000	0.000
SE1	Element: 3600	-0.367 0.340 0.866	LC2	0.296 0.289	0.150 0.142	0.000 0.000	**0.000**	0.000
SE1	Element: 3367	-0.349 -0.358 0.866	LC2	0.288 0.282	0.145 0.140	0.000 0.000	**0.000**	0.000
SE1	Element: 3320	0.500 0.000 0.866	LC2	0.288 0.282	0.145 0.140	0.000 0.000	0.000	**0.000**
SE1	Element: 3696	0.500 0.004 0.866	LC2	0.296 0.289	**0.150** **0.142**	0.000 0.000	0.000	**0.000**

4.4. 2D displacement; u_x

Values: u_x
Linear calculation
Load case: LC2
Extreme: Member
Selection: All
Location: In nodes avg.. System: Global



4.5. 2D displacement

Linear calculation
Load case: LC2
Extreme: Member
Selection: SE1
Location: In nodes avg.. System: Global
Results on sections:

Name	Mesh	Position [m]	Case	u_x [mm]	u_y [mm]
SE1	Element: 3350	0.012 -0.500 0.866	LC2	**0.0000150**	**-0.0005840**

5. EXPECTED AFNOR RESULTS

Results of the mid-height element:

σy = 0.144 MPa
σx = 0.289 MPa
Displacement radial = 0,5842 e-6 m

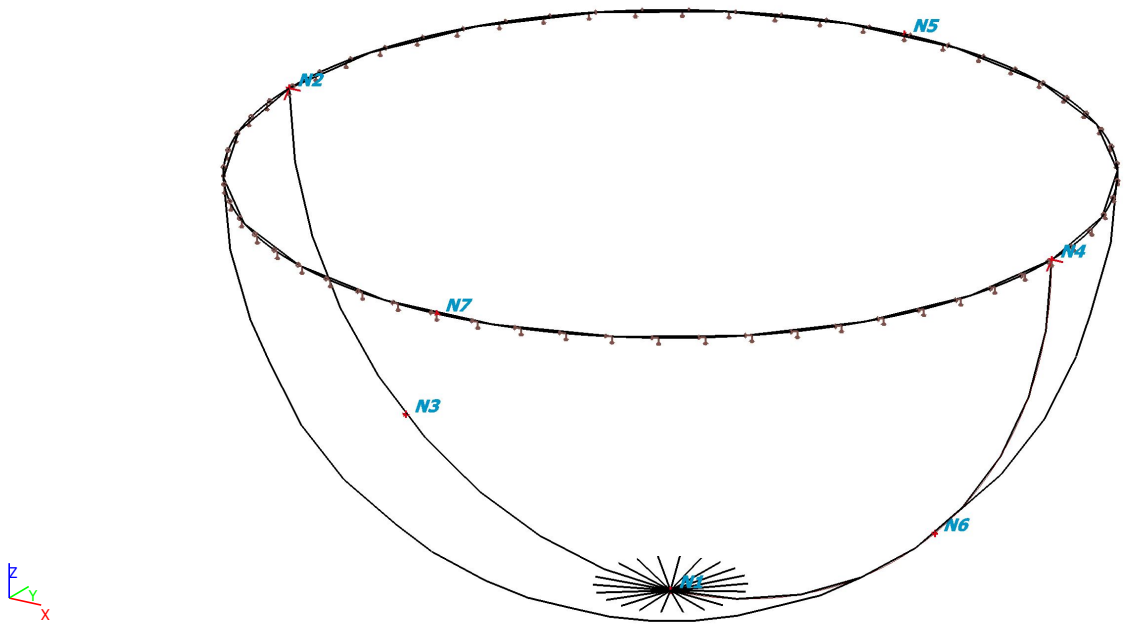
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Spherical shell subjected to a pressure
Codification: Shell - spherical cup - Material: elastic - Uniform pressure

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	-1.000
N2	-1.000	0.000	0.000
N3	-0.694	0.000	-0.720

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N4	1.000	0.000	0.000
N5	0.000	1.000	0.000
N6	0.694	0.000	-0.720

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N7	0.000	-1.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	shell (98)	Standard	S 235	constant	20
D3	Calque1	shell (98)	Standard	S 235	constant	20

2.4. Line supports on member

Name	Type	Member System	Pos x_1 / Pos x_2	Coor Orig	X	Y	Z	Rx	Ry	Rz
Slb1	Line	B3	0.000	Rela	Rigid	Free	Rigid	Free	Free	Free
		LCS	1.000	From start						
Slb2	Line	B1	0.000	Rela	Rigid	Free	Rigid	Free	Free	Free
		LCS	1.000	From start						

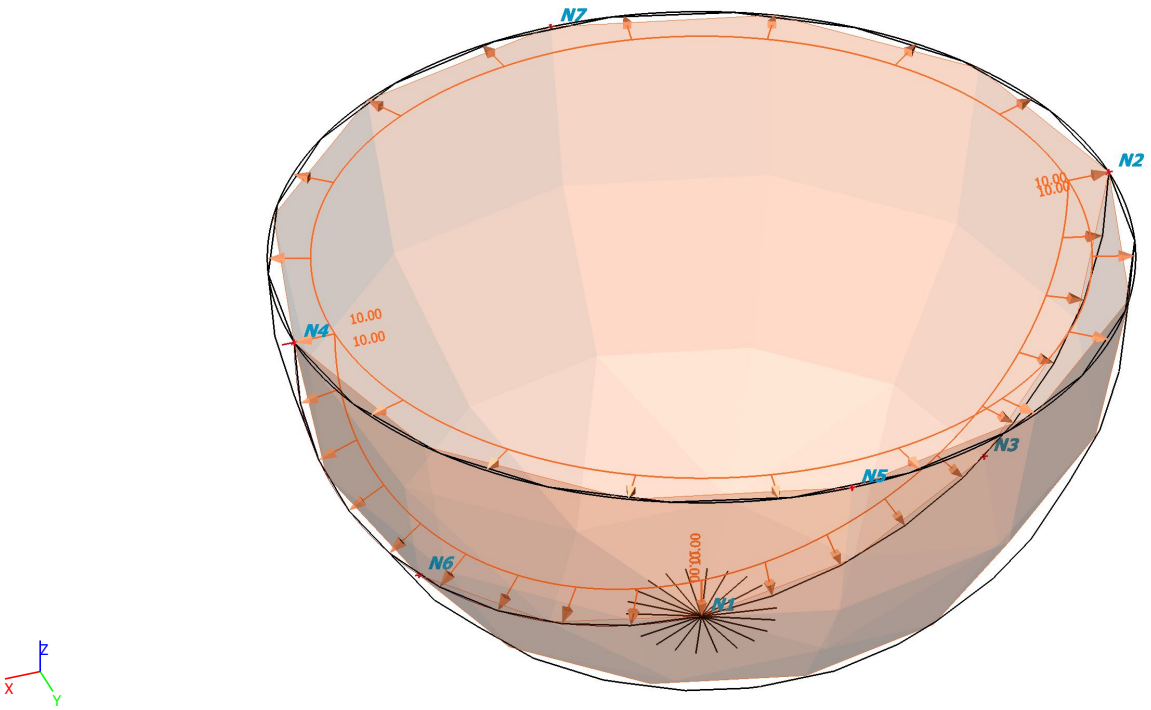
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0	40	235.00	360.00	
		8.0769e+04	0.01e-003	40	80	215.00	360.00	

3. LOAD

3.1. LC1 / Tot. value



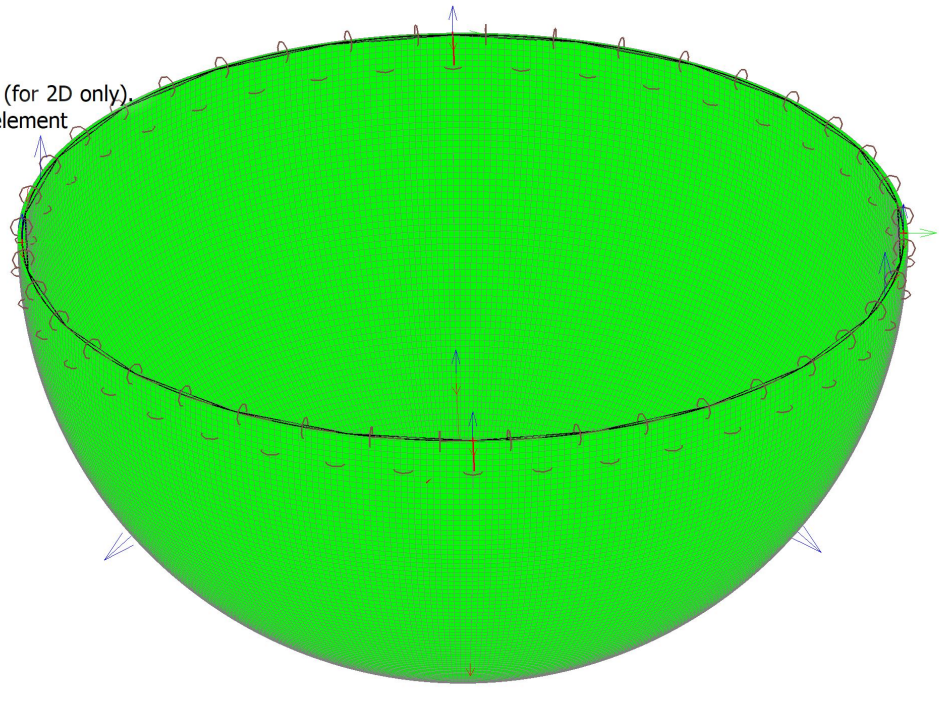
3.2. Free surface load

Name	Load case	Dir	Type	Distribution	q [kN/m²]	Validity	Select	System	Location
FF1	LC2 - Permanent	Z	Force	Uniform	10.00	All	Auto	Member LCS	Length

4. RESULTS

4.1. 3D stress; σ_y (2D)

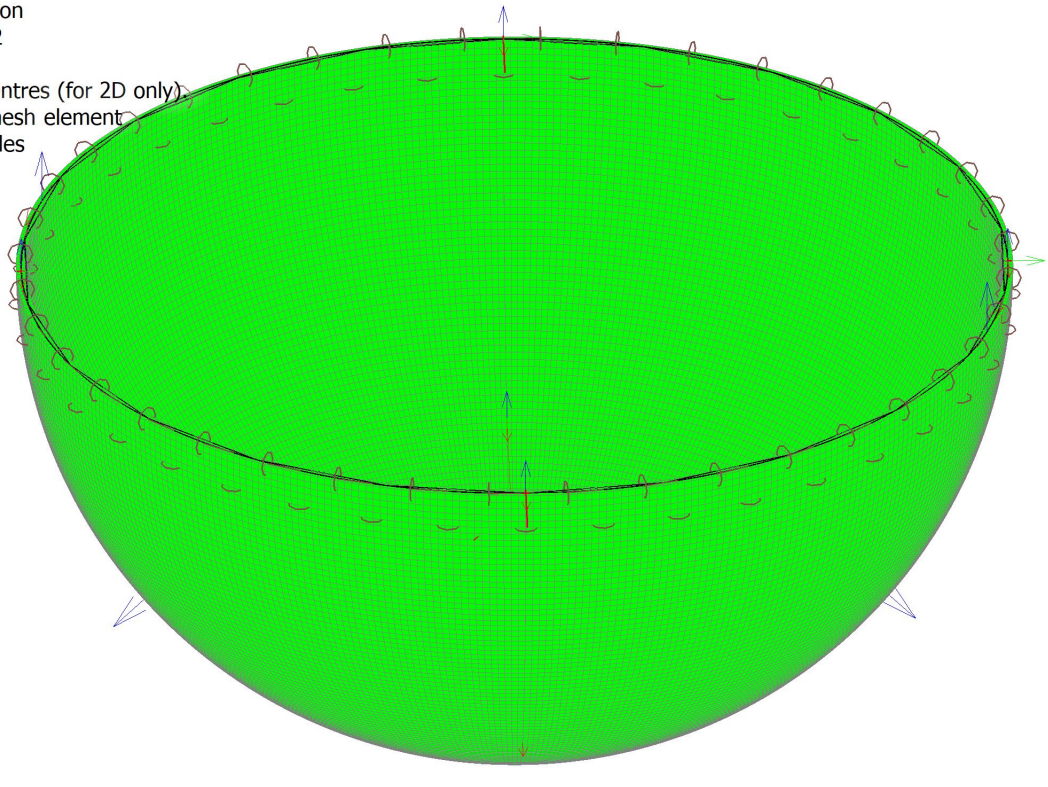
Values: **σ_y (2D)**
Linear calculation
Load case: LC2
Selection: All
Location: In centres (for 2D only)
System: LCS mesh element
Basic magnitudes



Constant value 0.25
σ_y (2D) [MPa]

4.2. 3D stress; σ_x (1D/2D)

Values: **σ_x (1D/2D)**
Linear calculation
Load case: LC2
Selection: All
Location: In centres (for 2D only)
System: LCS mesh element
Basic magnitudes



Constant value 0.25
σ_x (1D/2D) [MPa]

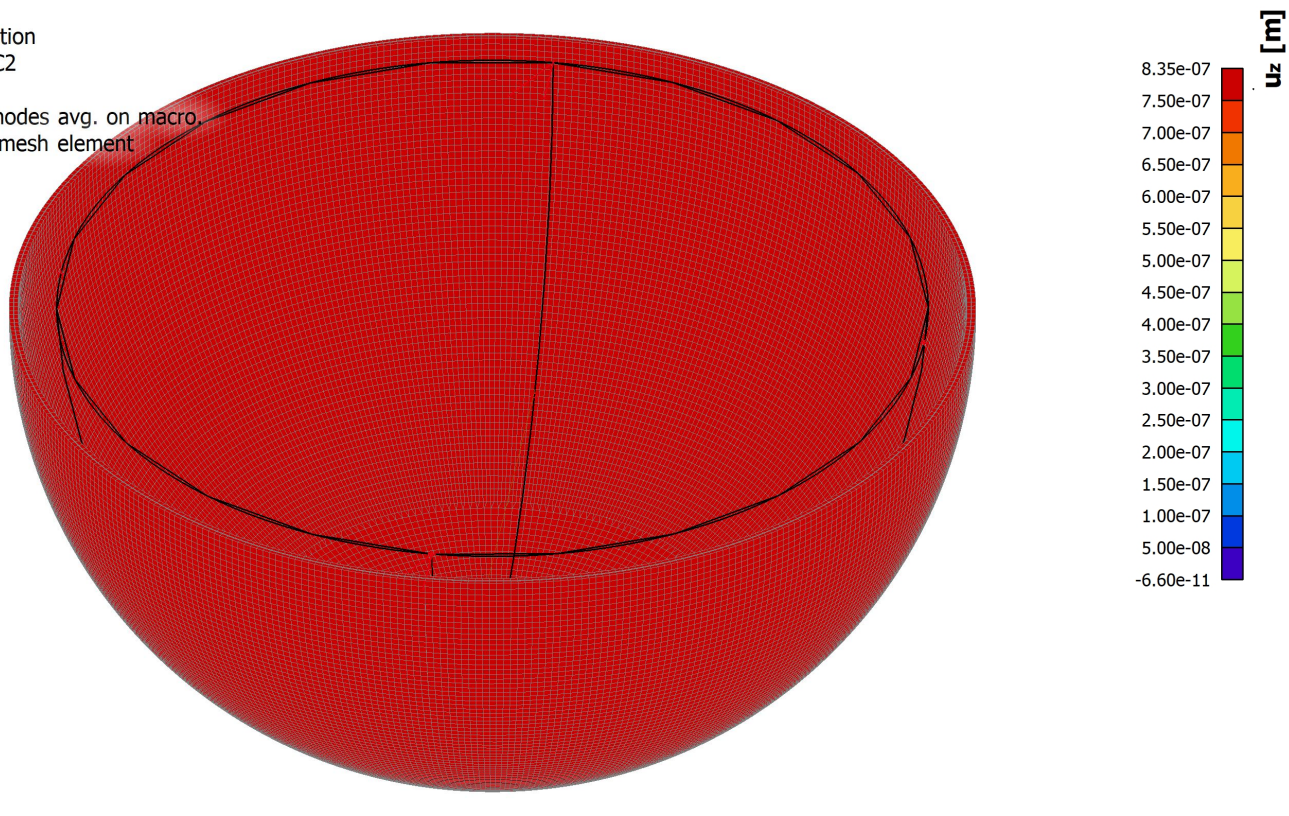
4.3. 2D stress/strain

Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Basic stress - Results on sections:

Name	Mesh	Position [m]	Case	σ_{x+} [MPa] σ_{x-} [MPa]	σ_{y+} [MPa] σ_{y-} [MPa]
SE1	Element: 23876	-0.707 0.000 -0.707	LC2	0.25 0.25	**0.25** **0.25**
SE1	Element: 23665	0.707 0.000 -0.707	LC2	**0.25** **0.25**	**0.25** **0.25**

4.4. 3D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.5. 3D displacement

Linear calculation
Load case: LC2
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Results on 2D member:
Extreme 2D: Global

Name	Mesh	Position [m]	Case	ux+ [m] ux- [m]	uy+ [m] uy- [m]	uz+ [m] uz- [m]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U total+ [m] U total- [m]
D1	Element: 17344 Node: 4	0.000 1.000 0.000	LC2	**0.00e+00 0.00e+00**	**9.83e-12 -9.83e-12**	**8.27e-07 8.25e-07**	**0.0**	**0.0**	**0.0**	**8.27e-07 8.25e-07**

5. EXPECTED AFNOR RESULTS

$\forall\theta$; $\sigma x = \sigma y = 0.25$ MPa

$\theta = 90°$; δR (uz) = 8,33 e-7 m

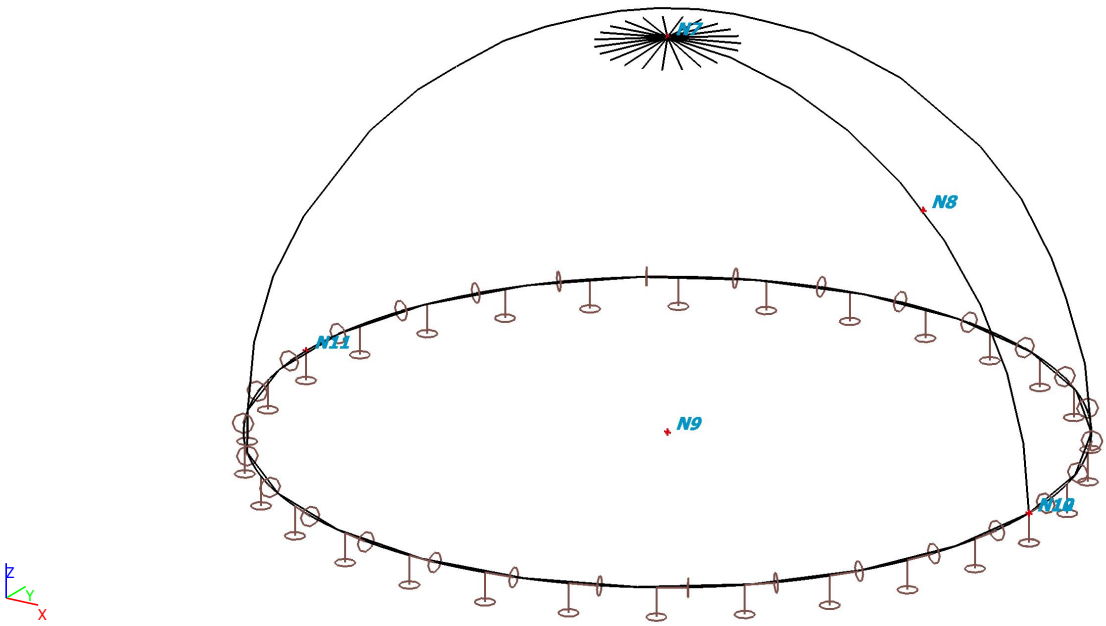
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Spherical shell subjected to a moment
Specification: Shell - spherical cup - Material: elastic - Uniform moment.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	1.048	0.000	0.000
N7	0.048	0.000	1.000
N8	0.755	0.000	0.707

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N9	0.048	0.000	0.000
N10	1.048	0.000	0.000
N11	-0.952	0.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N12	1.048	0.001	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D2	Calque1	shell (98)	Standard	S 235	constant	20

2.4. Line supports

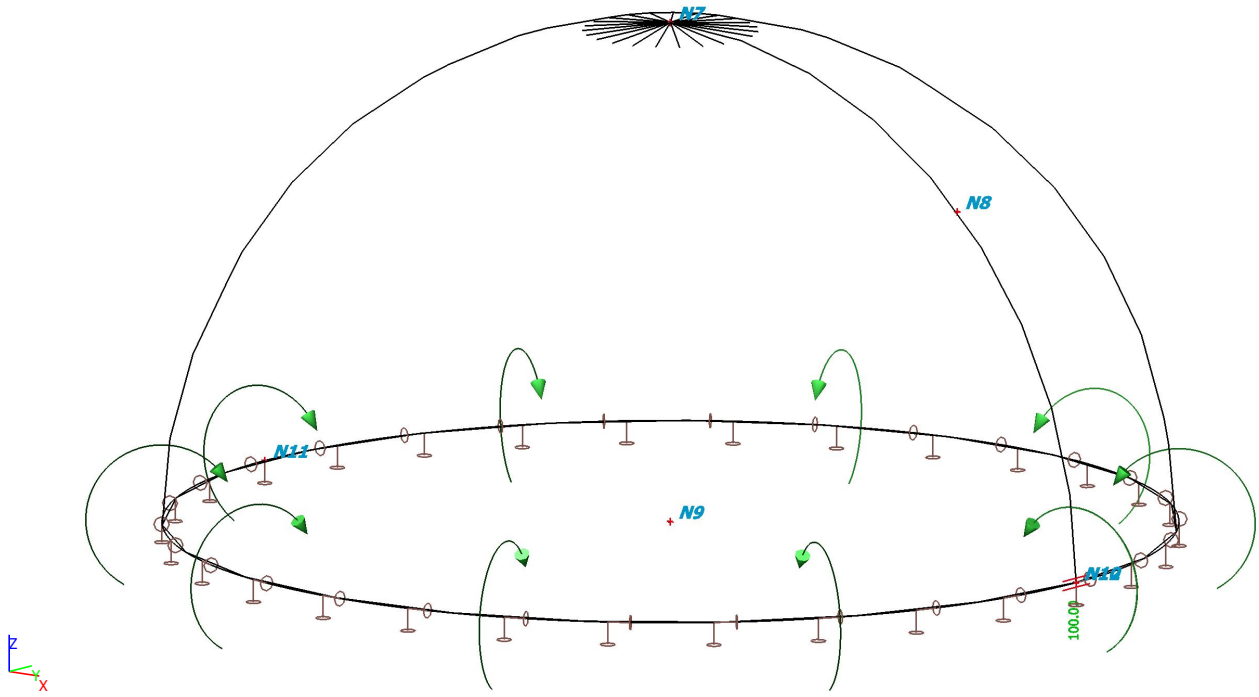
Name	Type	Pos x_1	Coor	X	Y	Z	Rx	Ry	Rz
		Pos x_2	Orig						
Slb1	Line	0.000	Rela	Rigid	Free	Rigid	Free	Free	Free
		1.000	From start						

2.5. Materials

Empty table

3. LOAD

3.1. LC1 / Tot. value

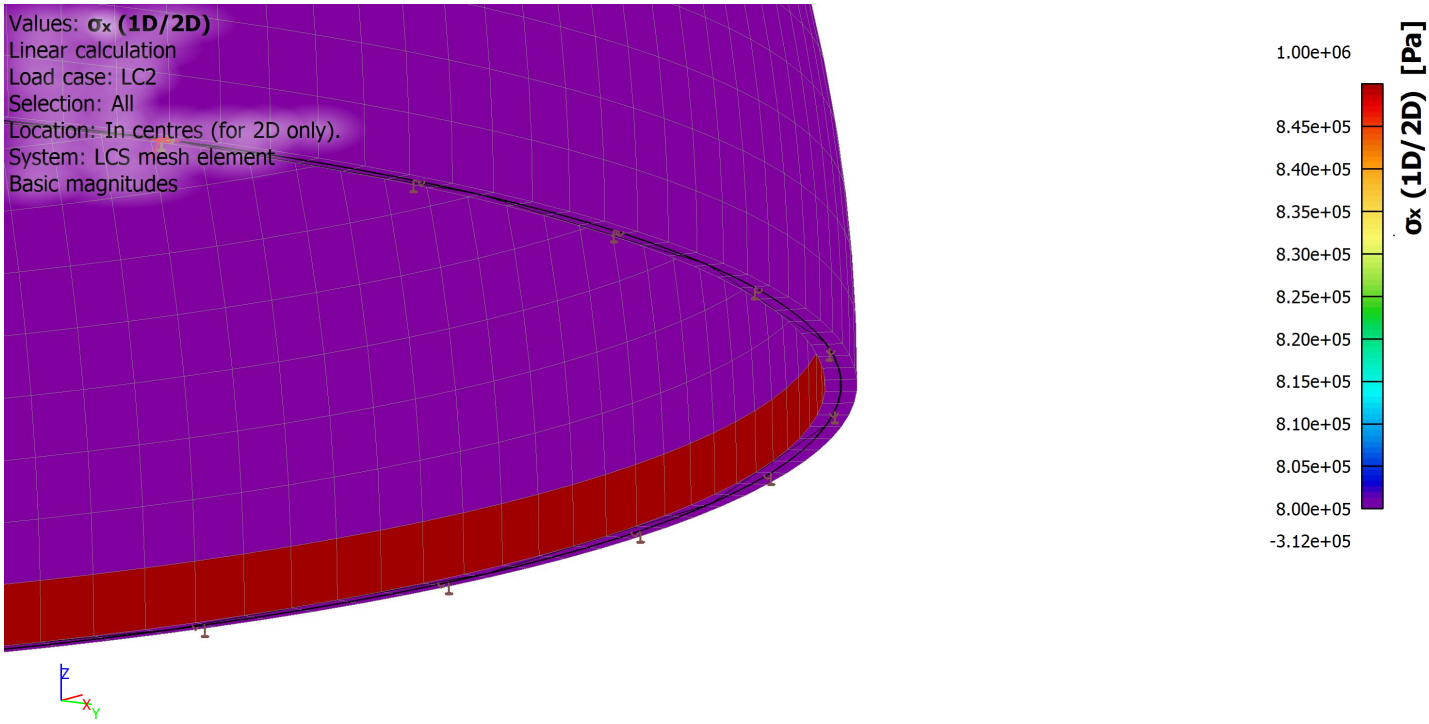


3.2. Line moment

Name	Type	Dir	Value - M_1 [Nm/m]	Pos x_1	Coor	Orig
	System	Distribution	Value - M_2 [Nm/m]	Pos x_2	Loc	
LM1	Moment	Mx	100.00	0.000	Rela	From start
	LCS	Uniform		1.000	Length	

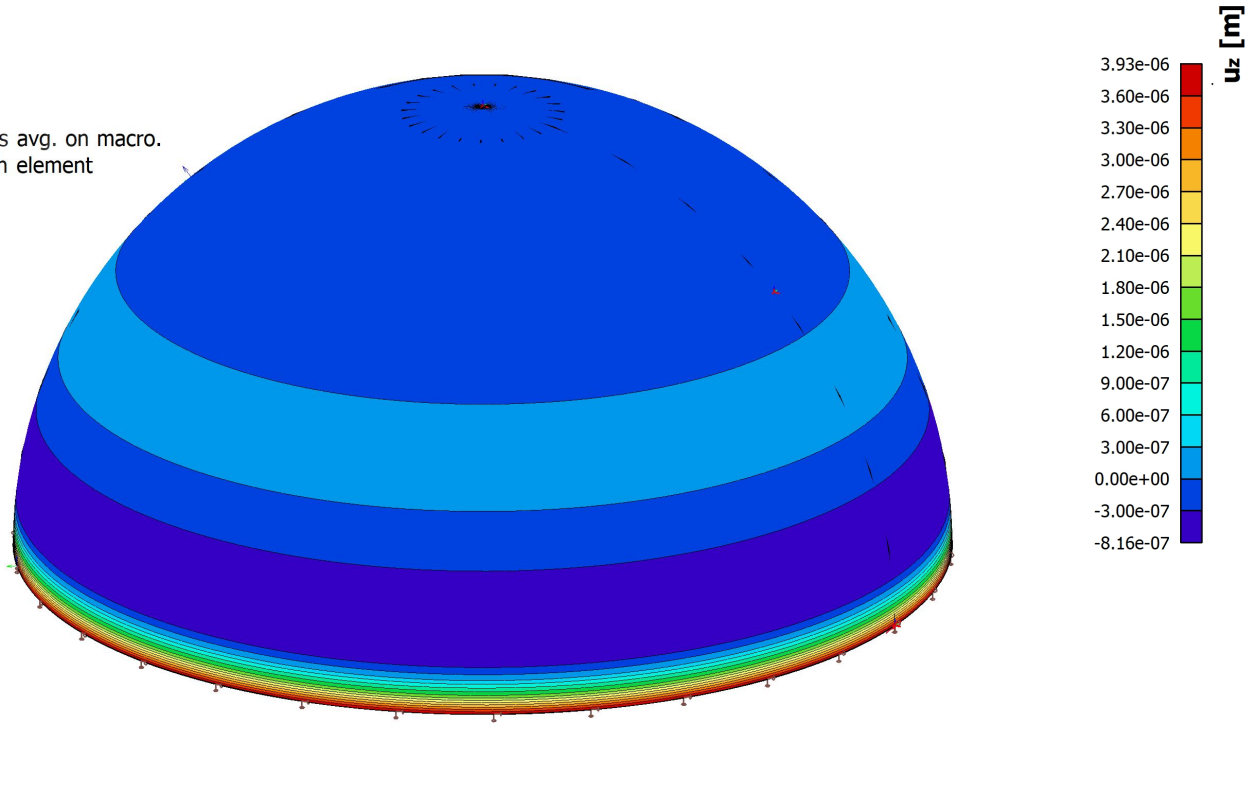
4. RESULTS

4.1. Horizontal stress on edge



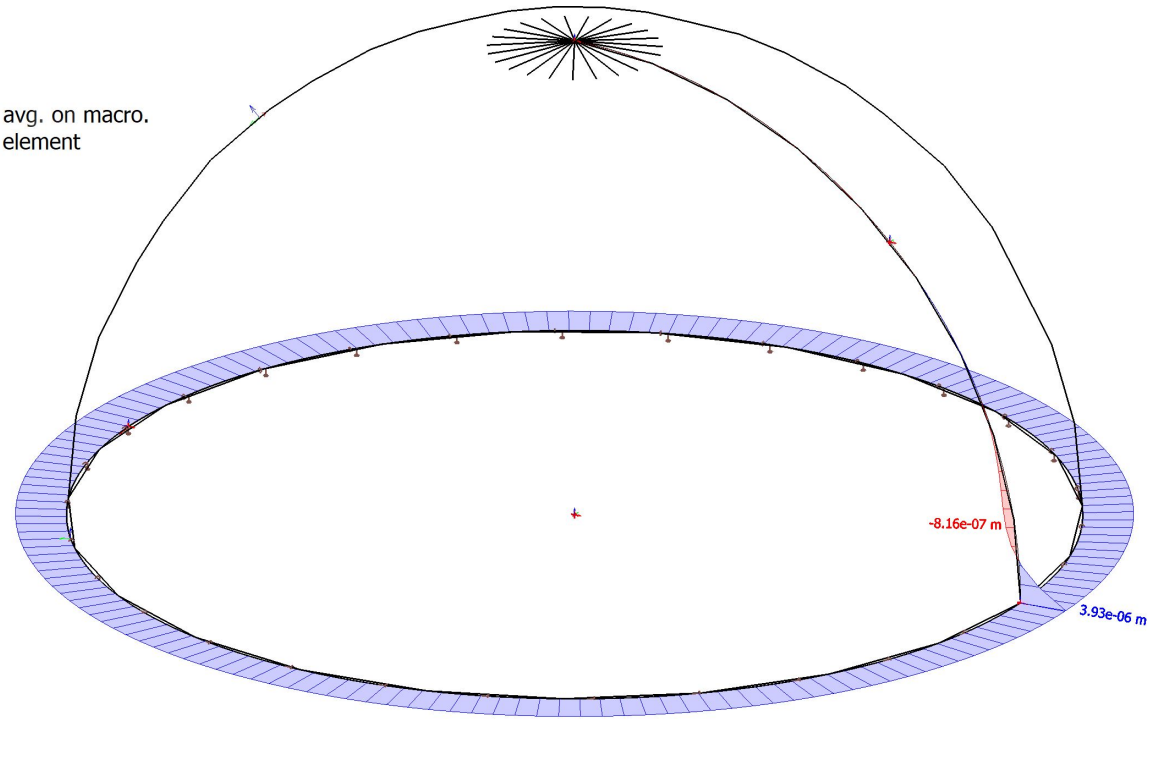
4.2. Displacement δR (m)

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.3. Displacement δR (m) on edge

Values: u_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Results on edges:

Name	Mesh	Position [m]	Case	u_x [m]	u_y [m]	u_z [m]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U_{total} [m]
D2/Edge 1	Element: 3660	1.010 0.000 0.271	LC2	**0.00e+00**	**4.70e-08**	**-4.70e-07**	**0.0**	**0.0**	**0.0**	**4.72e-07**
D2/Edge 2	Element: 4820	0.048 1.000 0.000	LC2	0.00e+00	4.50e-08	**3.93e-06**	**0.1**	0.0	**0.0**	**3.93e-06**

5. EXPECTED AFNOR RESULTS

Horizontal stress (at the extremity) = 8.26 e5 Pa
Horizontal stress (exterior plane) = 8.11 e5 Pa
RAdial displacement (at the extremity) = 3.93 e-6 m

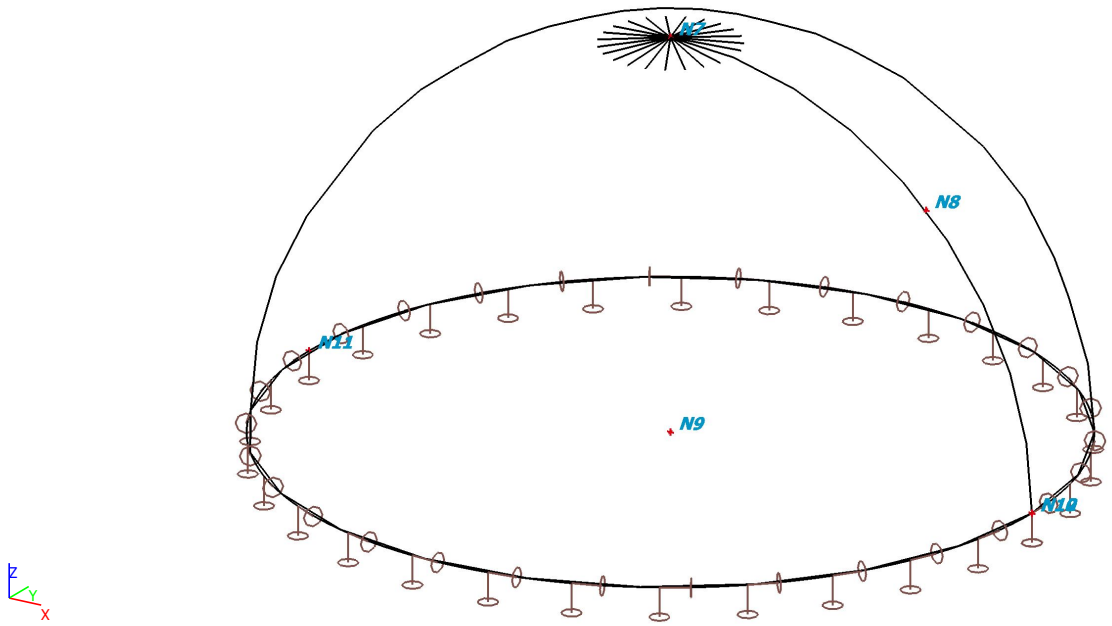
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Spherical shell
Specification: Shell - spherical cup - Material: elastic – Self weight

2. MODEL

2.1. Analysis model



2.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D2	Calque1	shell (98)	Standard	S 235	constant	20

2.3. Line supports

Name	Type	Pos x_1	Coor	X	Y	Z	Rx	Ry	Rz
		Pos x_2	Orig						
Slb1	Line	0.000	Rela	Rigid	Free	Rigid	Free	Free	Free
		1.000	From start						

2.4. Materials

Empty table

3. LOAD

3.1. Load cases

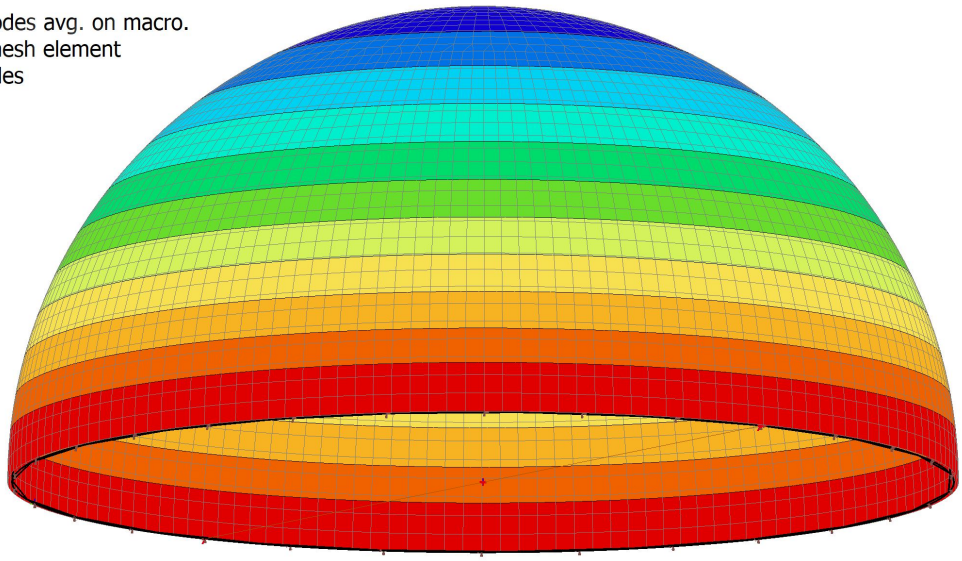
Name	Description	Action type	Load group	Direction
	Spec	Load type		
LC1	Poids propre	Permanent	LG1	-Z
		Self weight		

Shell is subjected to its selg-weight

4. RESULTS

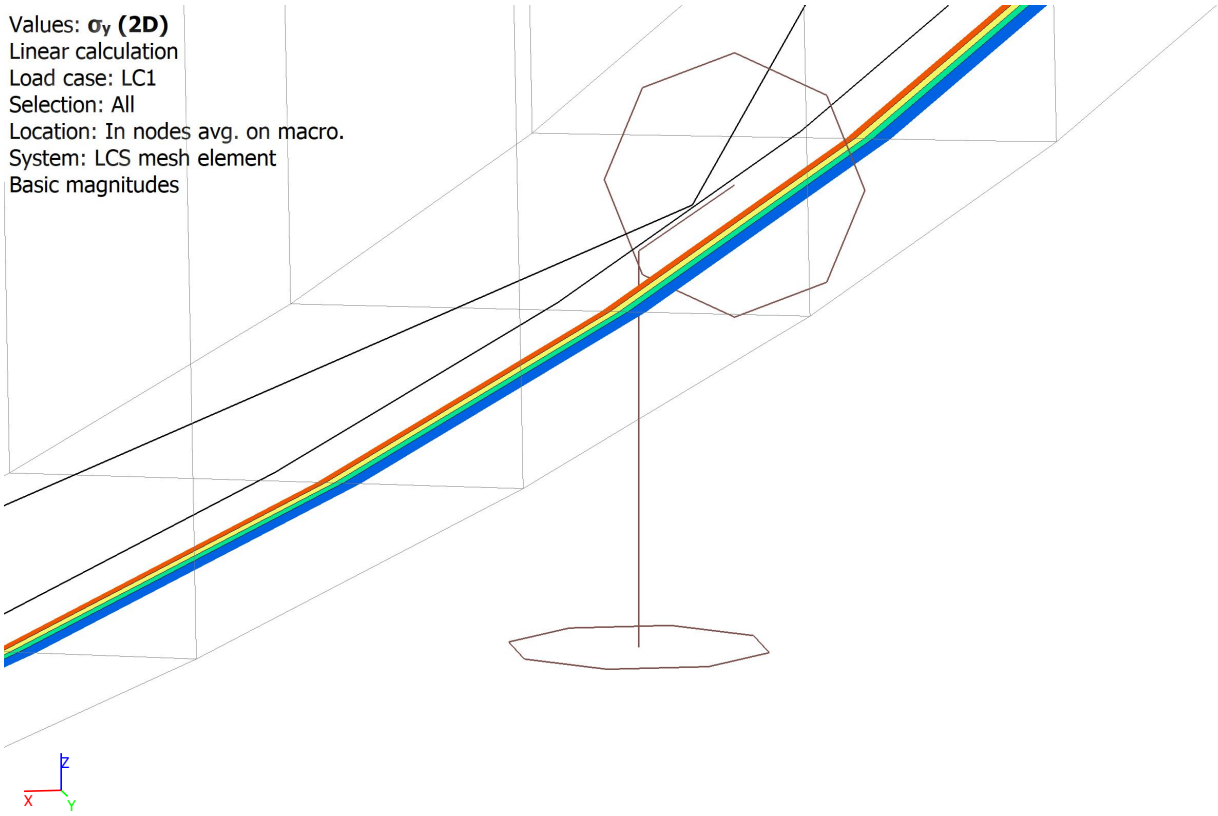
4.1. Horizontal stress

Values: σ_x **(1D/2D)**
Linear calculation
Load case: LC1
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element
Basic magnitudes



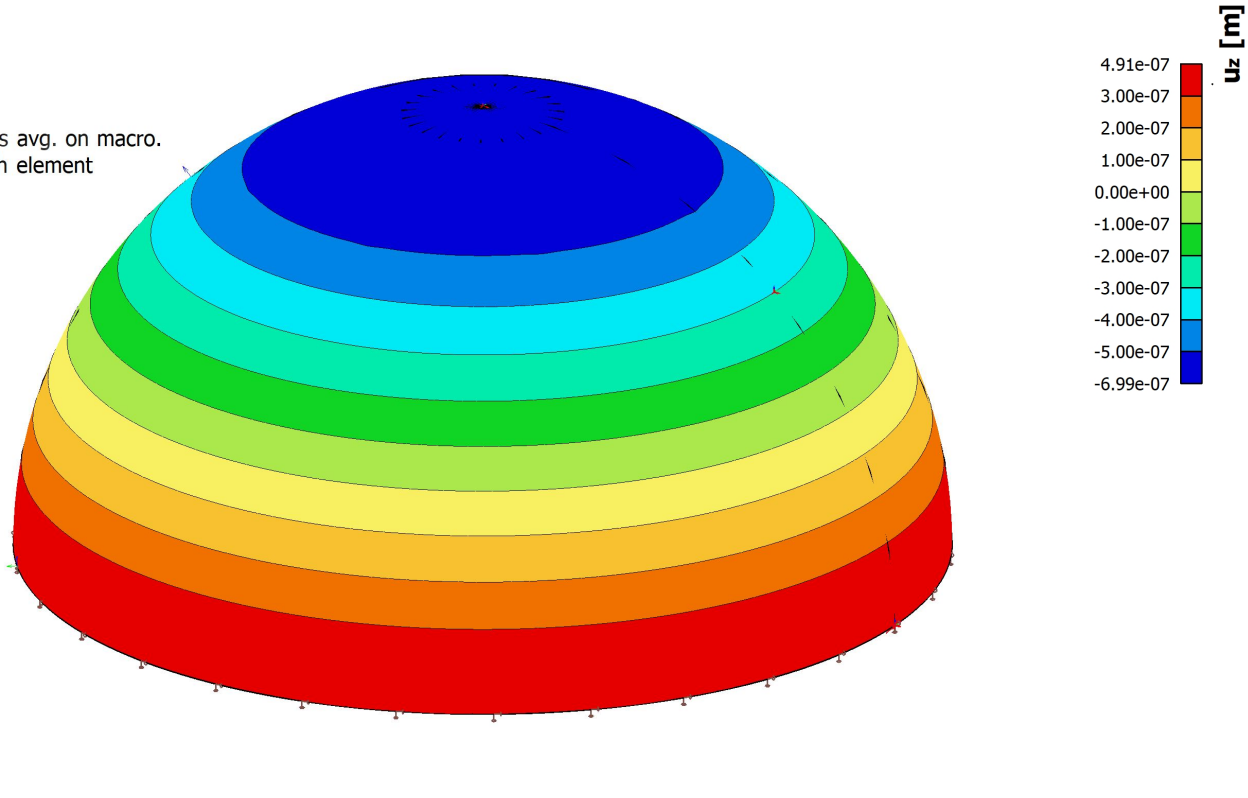
4.2. Vertical stress on edge

Values: σ_y **(2D)**
Linear calculation
Load case: LC1
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element
Basic magnitudes



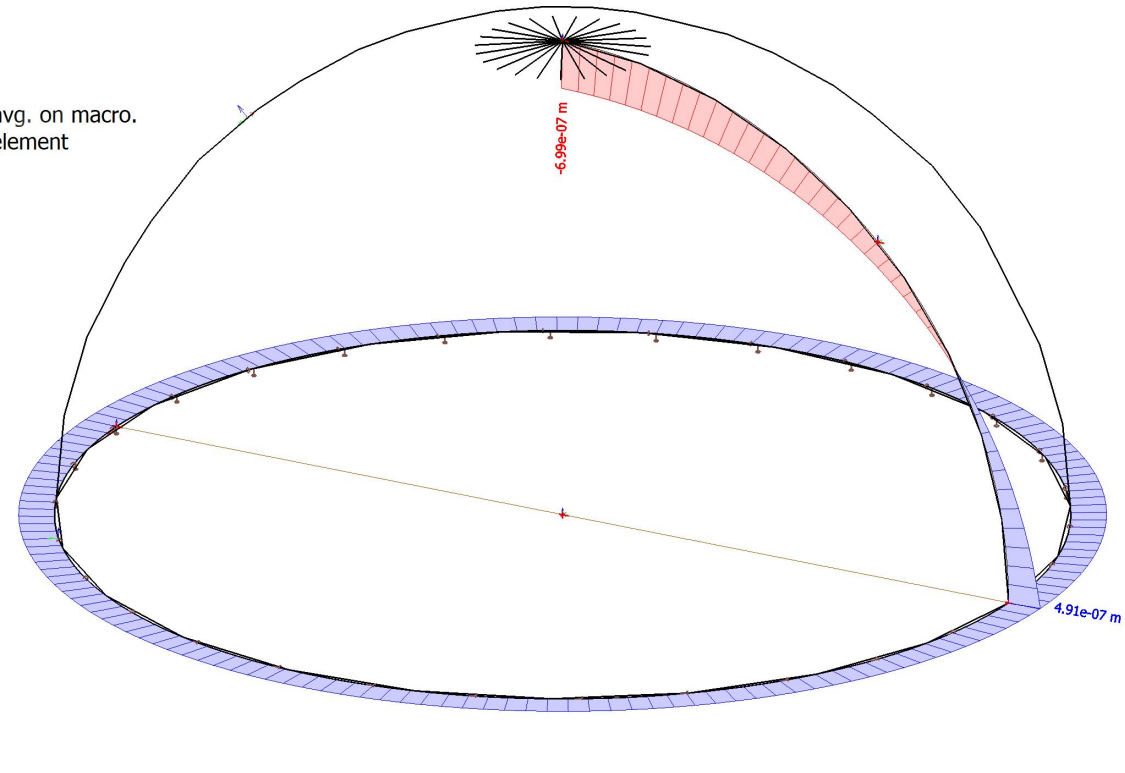
4.3. Displacement δR (m)

Values: u_z
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.4. Displacement δR (m) on edge

Values: u_z
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



4.5. 2D displacement

Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Results on sections:

Name	Mesh	Position [m]	Case	u_x [m]	u_y [m]	u_z [m]	φ_x [mrad]	φ_y [mrad]	φ_z [mrad]	U_{total} [m]
SE1	Element: 4780	1.048 0.000 0.000	LC1	**0.00e+00**	**1.00e-09**	**4.91e-07**	**0.0**	**0.0**	**0.0**	**4.91e-07**

5. EXPECTED AFNOR RESULTS

At the extremity :

Horizontal stress : 7.85 e4 Pa
Vertical stress: -7.85 e4 Pa
Radial displacement: 4.86 e-7 m

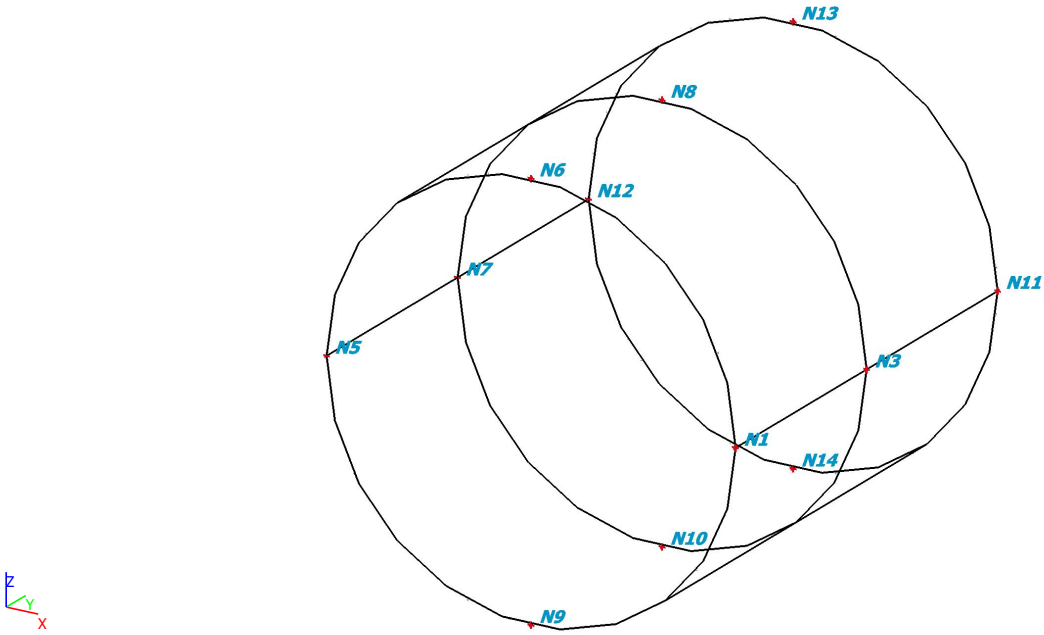
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Cylindrical shell subjected to concentrated force -
Codification: Cylindrical shell - Material: elastic - Concentrated forces.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	4.953	0.000	0.000
N3	4.953	5.175	0.000
N5	-4.953	0.000	0.000
N6	0.000	0.000	4.953

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N7	-4.953	5.175	0.000
N8	0.000	5.175	4.953
N9	0.000	0.000	-4.953
N10	0.000	5.175	-4.953

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N11	4.953	10.350	0.000
N12	-4.953	10.350	0.000
N13	0.000	10.350	4.953
N14	0.000	10.350	-4.953

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S3	Calque1	shell (98)	Standard	Material	constant	94
S4	Calque1	shell (98)	Standard	Material	constant	94
S5	Calque1	shell (98)	Standard	Material	constant	94
S6	Calque1	shell (98)	Standard	Material	constant	94

2.4. Supports on 2D member edge

Name	2D member Edge	Orig Coor	Pos x_1 Pos x_2	X	Y	Z	Rx	Ry	Rz
Sle1	S3	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	1	Rela	1.000						
Sle2	S5	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	3	Rela	1.000						
Sle3	S6	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	3	Rela	1.000						
Sle4	S4	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	1	Rela	1.000						

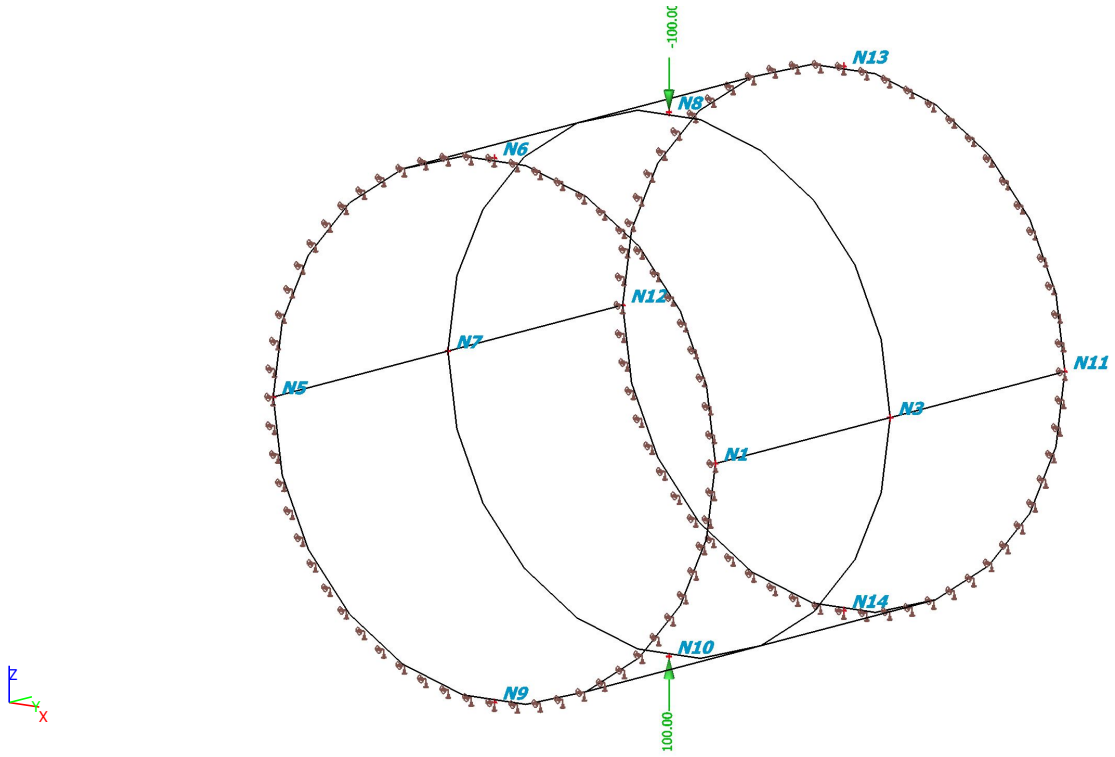
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7850.00	1.0500e+01	0.3125	0	40	235.0	360.0	
		4.0000e+00	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [N]
F1	N8	LC1	GCS	Z	Force	-100.00
F2	N10	LC1	GCS	Z	Force	100.00

4. RESULTS

4.1. Displacement of nodes

Linear calculation
Load case: LC1
Extreme: Global
Selection: N8

Name	Case	U_z [mm]
N8	LC1	**-113.543**

5. EXPECTED AFNOR RESULTS

Displacement uz in N8 = -113,9 e-3 m

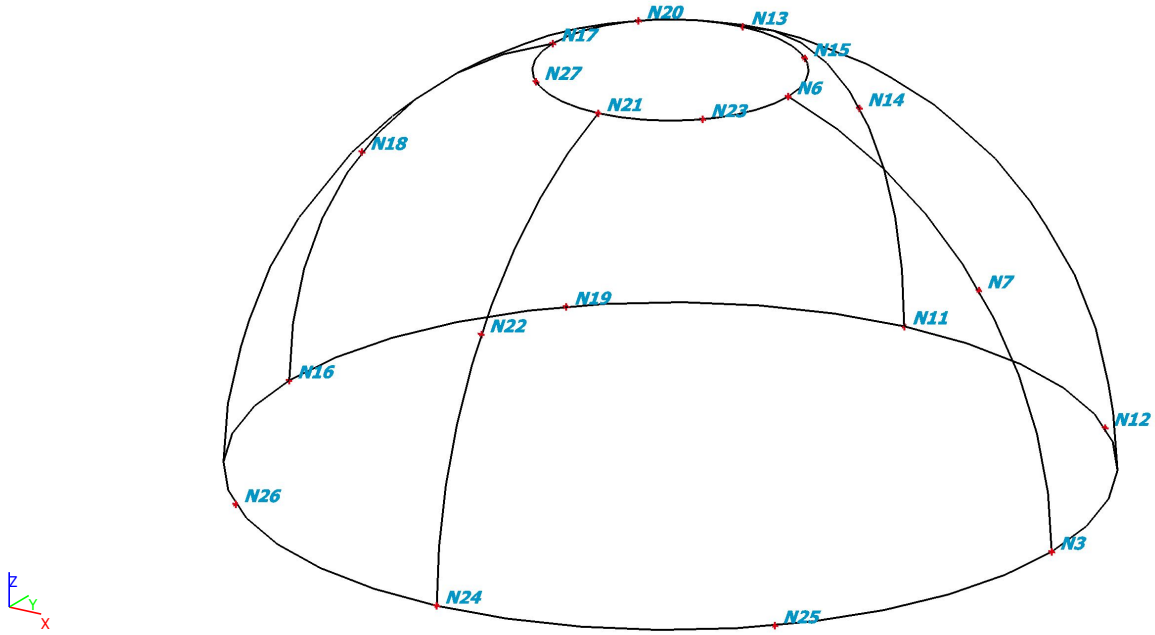
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Spherical shell with an opening
Codification: Spherical shell - Material: elastic - Concentrated forces

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N3	10.000	0.000	0.000
N6	3.091	0.000	9.510
N7	8.090	0.000	5.878
N11	0.000	10.000	0.000
N12	7.071	7.071	0.000
N13	0.000	3.091	9.510
N14	0.000	8.090	5.878

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N15	2.186	2.186	9.510
N16	-10.000	0.000	0.000
N17	-3.091	0.000	9.510
N18	-8.090	0.000	5.878
N19	-7.071	7.071	0.000
N20	-2.186	2.186	9.510
N21	0.000	-3.091	9.510

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N22	0.000	-8.090	5.878
N23	2.186	-2.186	9.510
N24	0.000	-10.000	0.000
N25	7.071	-7.071	0.000
N26	-7.071	-7.071	0.000
N27	-2.186	-2.186	9.510

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S3	Calque1	shell (98)	Standard	Material	constant	40
S4	Calque1	shell (98)	Standard	Material	constant	40
S5	Calque1	shell (98)	Standard	Material	constant	40
S6	Calque1	shell (98)	Standard	Material	constant	40

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle5	S4	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	3	Rela	1.000						
Sle6	S6	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	3	Rela	1.000						
Sle7	S3	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	3	Rela	1.000						

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle8	S5	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free
	3	Rela	1.000						

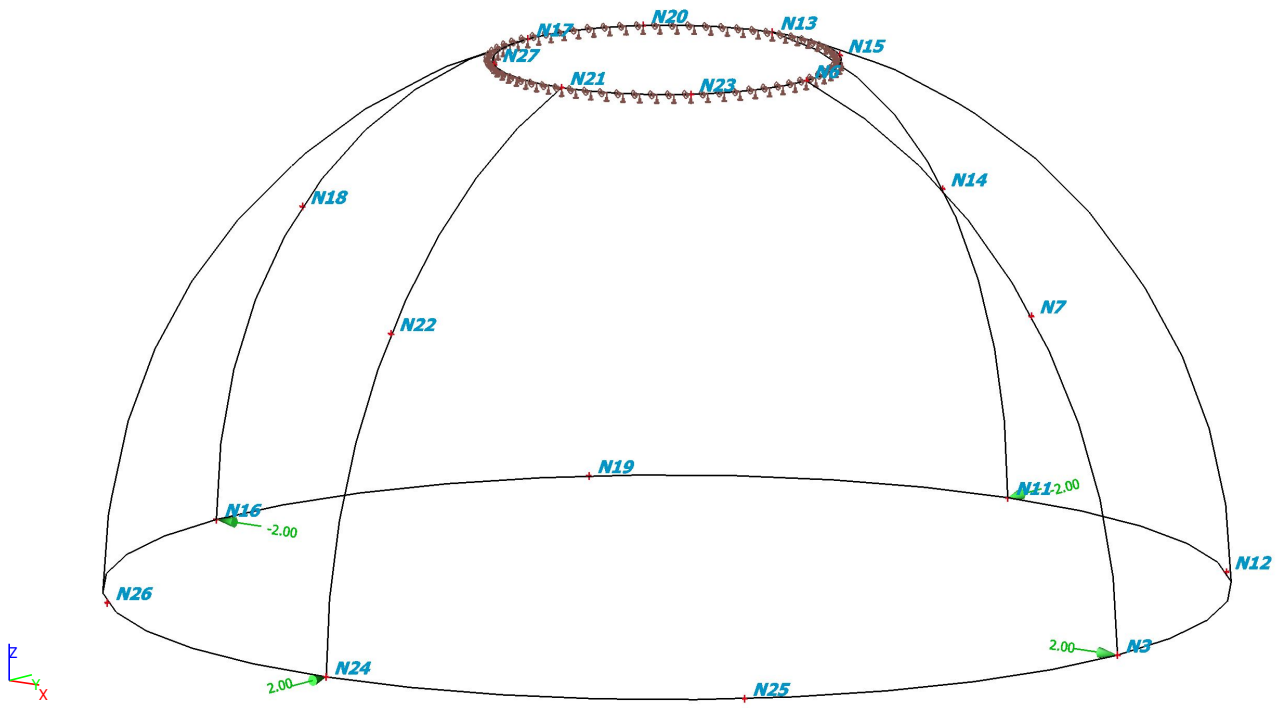
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [Pa]	F_u [Pa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7850.00	6.2850e+01	0.3	0	40	235000000.0	360000000.0	
		2.4173e+01	0.01e-003	40	80	215000000.0	360000000.0	

3. LOAD

3.1. LC1 / Tot. value



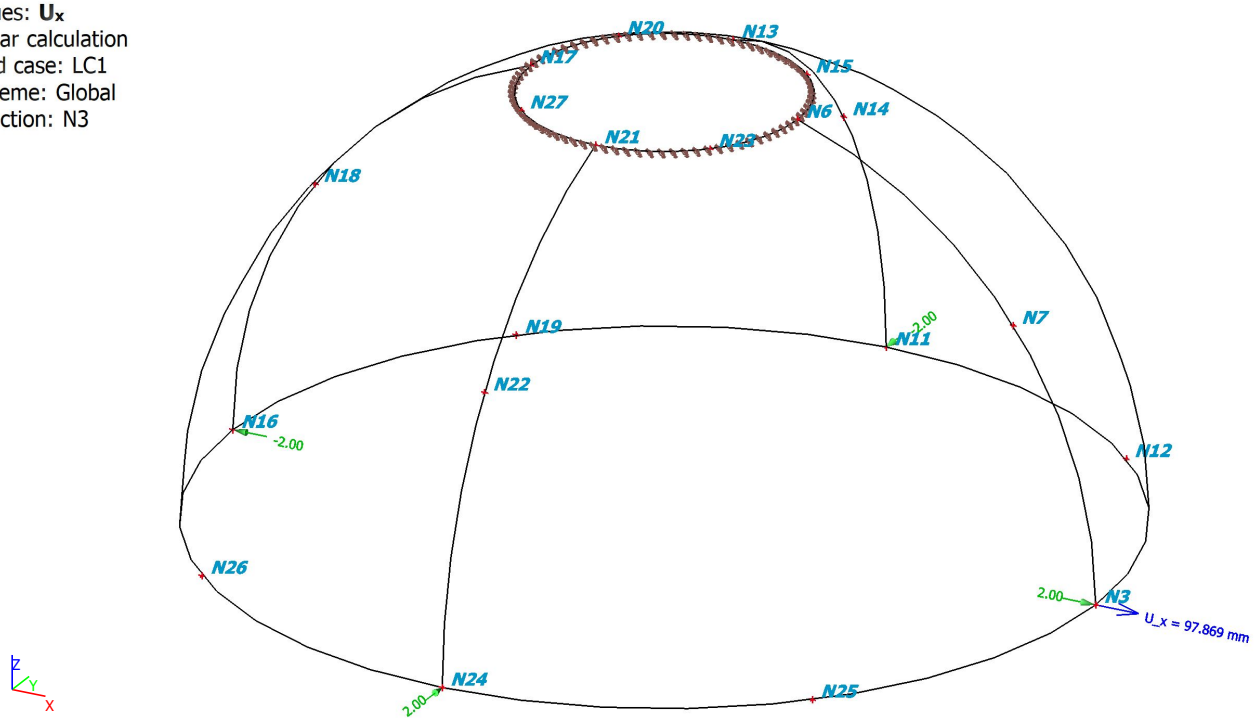
3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [N]
F3	N11	LC1	GCS	Y	Force	-2.00
F4	N3	LC1	GCS	X	Force	2.00
F5	N16	LC1	GCS	X	Force	-2.00
F6	N24	LC1	GCS	Y	Force	2.00

4. RESULTS

4.1. Displacement of nodes; U_x

Values: U_x
Linear calculation
Load case: LC1
Extreme: Global
Selection: N3



4.2. Displacement of nodes

Linear calculation
Load case: LC1
Extreme: Global
Selection: N3

Name	Case	U_x [mm]
N3	LC1	**97.869**

5. EXPECTED AFNOR RESULTS

Displacement ux in N3 = 94 e-3 m

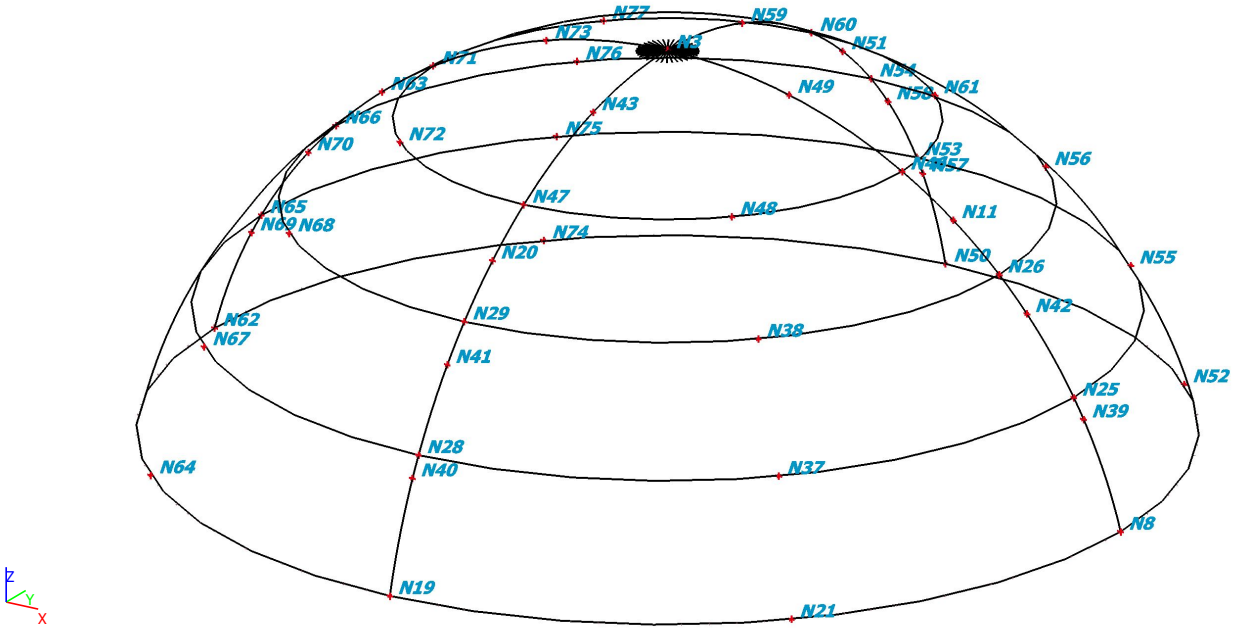
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Spherical dome subjected to uniform external pressure
Specification: Spherical shell - Material: elastic - pressure

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N3	0.000	0.000	2.540
N8	2.453	0.000	0.657
N11	1.546	0.000	2.015
N19	0.000	-2.453	0.657
N20	0.000	-1.546	2.015
N21	1.735	-1.735	0.657
N25	2.200	0.000	1.270
N26	1.796	0.000	1.796
N28	0.000	-2.200	1.270
N29	0.000	-1.796	1.796
N37	1.555	-1.555	1.270
N38	1.270	-1.270	1.796
N39	2.253	0.000	1.173
N40	0.000	-2.253	1.173
N41	0.000	-1.946	1.633
N42	1.946	0.000	1.633
N43	0.000	-0.657	2.453

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N46	1.270	0.000	2.200
N47	0.000	-1.270	2.200
N48	0.898	-0.898	2.200
N49	0.657	0.000	2.453
N50	0.000	2.453	0.657
N51	0.000	1.546	2.015
N52	1.735	1.735	0.657
N53	0.000	2.200	1.270
N54	0.000	1.796	1.796
N55	1.555	1.555	1.270
N56	1.270	1.270	1.796
N57	0.000	2.253	1.173
N58	0.000	1.946	1.633
N59	0.000	0.657	2.453
N60	0.000	1.270	2.200
N61	0.898	0.898	2.200
N62	-2.453	0.000	0.657

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N63	-1.546	0.000	2.015
N64	-1.735	-1.735	0.657
N65	-2.200	0.000	1.270
N66	-1.796	0.000	1.796
N67	-1.555	-1.555	1.270
N68	-1.270	-1.270	1.796
N69	-2.253	0.000	1.173
N70	-1.946	0.000	1.633
N71	-1.270	0.000	2.200
N72	-0.898	-0.898	2.200
N73	-0.657	0.000	2.453
N74	-1.735	1.735	0.657
N75	-1.555	1.555	1.270
N76	-1.270	1.270	1.796
N77	-0.898	0.898	2.200

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S1	Calque1	shell (98)	Standard	Material	constant	13
S3	Calque1	shell (98)	Standard	Material	constant	13
S5	Calque1	shell (98)	Standard	Material	constant	13
S6	Calque1	shell (98)	Standard	Material	constant	13
S7	Calque1	shell (98)	Standard	Material	constant	13

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S8	Calque1	shell (98)	Standard	Material	constant	13
S9	Calque1	shell (98)	Standard	Material	constant	13
S10	Calque1	shell (98)	Standard	Material	constant	13
S11	Calque1	shell (98)	Standard	Material	constant	13
S12	Calque1	shell (98)	Standard	Material	constant	13
S13	Calque1	shell (98)	Standard	Material	constant	13
S14	Calque1	shell (98)	Standard	Material	constant	13
S15	Calque1	shell (98)	Standard	Material	constant	13
S16	Calque1	shell (98)	Standard	Material	constant	13
S17	Calque1	shell (98)	Standard	Material	constant	13
S18	Calque1	shell (98)	Standard	Material	constant	13

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	S15	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	3	Rela	1.000						
Sle2	S11	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	3	Rela	1.000						
Sle3	S1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	3	Rela	1.000						
Sle4	S7	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	3	Rela	1.000						

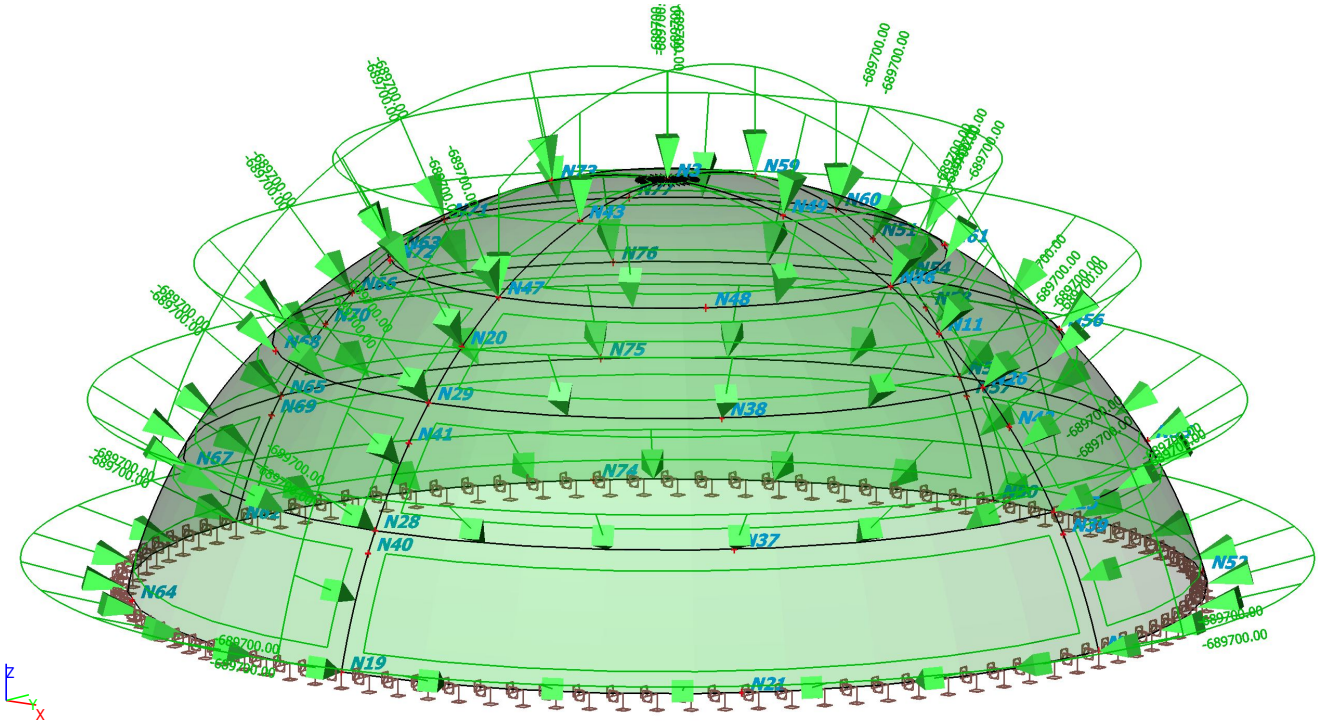
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7850.00	6.8970e+04	0.2	0	40	235.0	360.0	
		2.8738e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



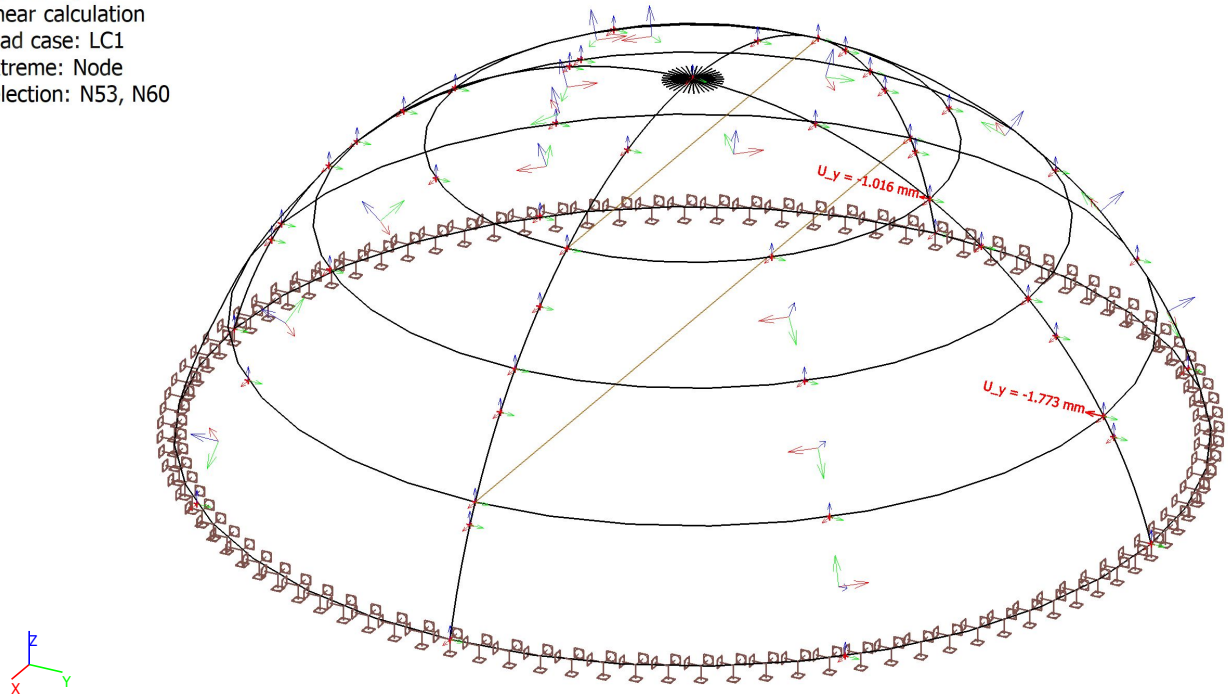
3.2. Surface load

Name	Dir	Type	Value [N/m²]	2D member	Load case	System	Loc
SF1	Z	Force	-689700.00	S1	LC1	LCS	Length
SF2	Z	Force	-689700.00	S3	LC1	LCS	Length
SF3	Z	Force	-689700.00	S5	LC1	LCS	Length
SF4	Z	Force	-689700.00	S6	LC1	LCS	Length
SF5	Z	Force	-689700.00	S7	LC1	LCS	Length
SF6	Z	Force	-689700.00	S8	LC1	LCS	Length
SF7	Z	Force	-689700.00	S9	LC1	LCS	Length
SF8	Z	Force	-689700.00	S10	LC1	LCS	Length
SF9	Z	Force	-689700.00	S11	LC1	LCS	Length
SF10	Z	Force	-689700.00	S12	LC1	LCS	Length
SF11	Z	Force	-689700.00	S13	LC1	LCS	Length
SF12	Z	Force	-689700.00	S14	LC1	LCS	Length
SF13	Z	Force	-689700.00	S15	LC1	LCS	Length
SF14	Z	Force	-689700.00	S16	LC1	LCS	Length
SF15	Z	Force	-689700.00	S17	LC1	LCS	Length
SF16	Z	Force	-689700.00	S18	LC1	LCS	Length

4. RESULTS

4.1. Déplacement des noeuds; U_y

Values: U_y
Linear calculation
Load case: LC1
Extreme: Node
Selection: N53, N60



4.2. Displacement of nodes

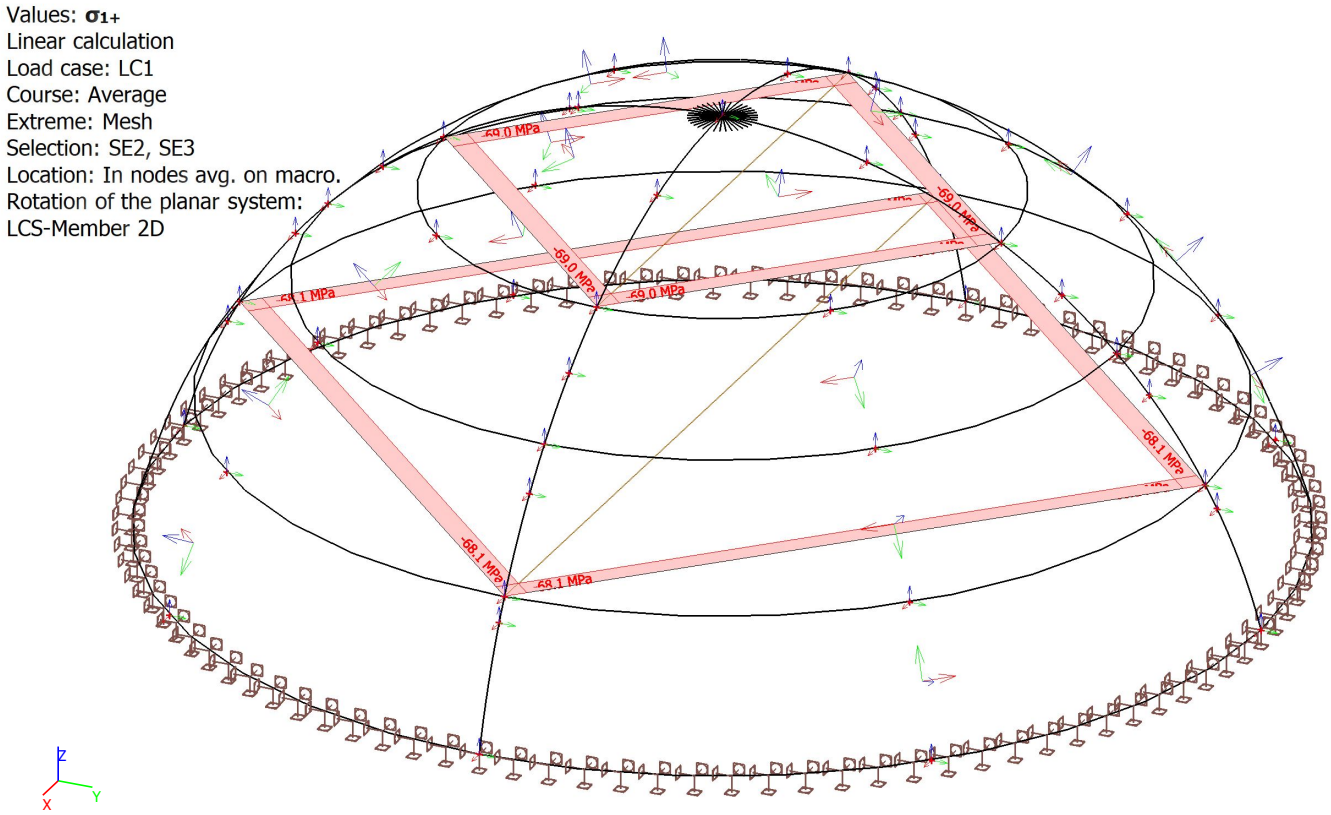
Linear calculation
Load case: LC1
Extreme: Global
Selection: N53, N60

Name	Case	U_y [mm]
N53	LC1	**-1.773**
N60	LC1	**-1.016**

For Ψ =15° ; u = -1,776 mm

For Ψ =45° ; u = -1,017 mm

4.3. Contraintes/déformations 2D; σ_1+



For Ψ =15° ; σ = -68,1 MPa

For Ψ =45° ; u = -69,0 MPa

5. EXPECTED AFNOR RESULTS

For Ψ =15° ; σ = -74 MPa ; u= -1,73 e-3 m

For Ψ =45° ; σ = -68 MPa ; u= -1,02 e-3 m

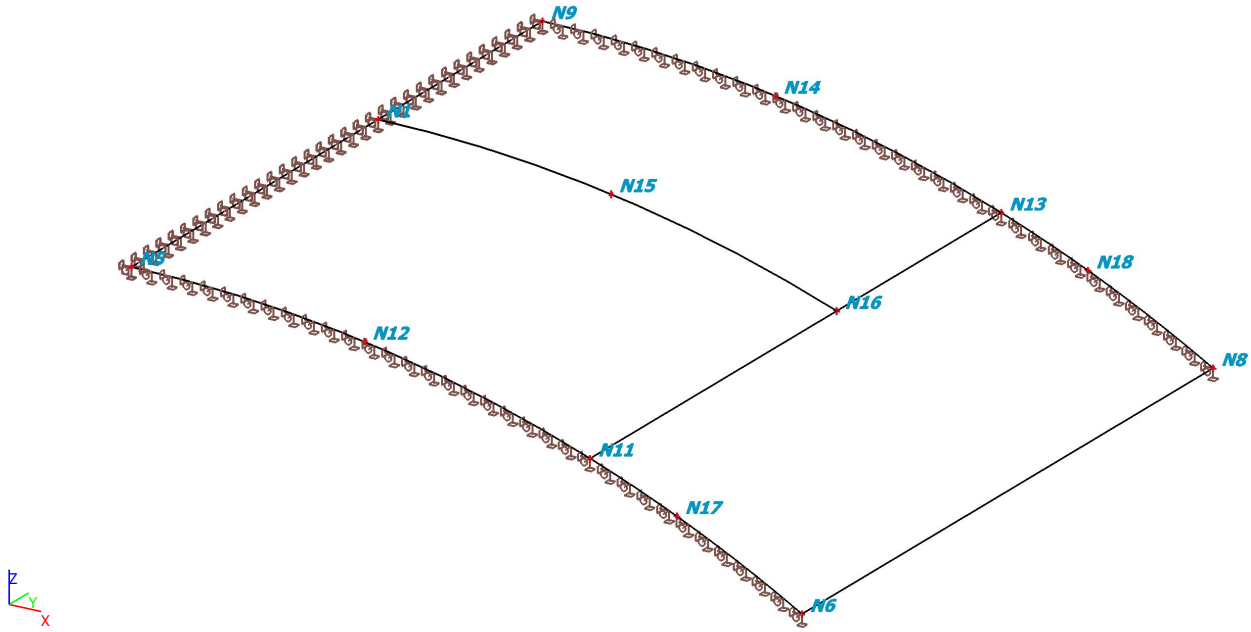
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Cylindrical membrane in bending and membrane behavior.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N5	0.000	0.000	1.000
N6	0.500	0.000	0.866
N8	0.500	0.500	0.866
N9	0.000	0.500	1.000
N11	0.342	0.000	0.940

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N12	0.174	0.000	0.985
N13	0.342	0.500	0.940
N14	0.174	0.500	0.985
N1	0.000	0.300	1.000
N15	0.174	0.300	0.985

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N16	0.342	0.300	0.940
N17	0.407	0.000	0.914
N18	0.407	0.500	0.914

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S5	Calque1	shell (98)	Standard	S 275	constant	10
S6	Calque1	shell (98)	Standard	S 275	constant	10
S7	Calque1	shell (98)	Standard	S 275	constant	10

2.4. Supports on 2D member edge

Name	2D member Edge	Orig Coor	Pos x_1 Pos x_2	X	Y	Z	Rx	Ry	Rz
Sle1	S5 4	From start Rela	0.000 1.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sle2	S6 4	From start Rela	0.000 1.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sle3	S5 1	From start Rela	0.000 1.000	Free	Rigid	Free	Rigid	Free	Rigid
Sle4	S7 1	From start Rela	0.000 1.000	Free	Rigid	Free	Rigid	Free	Rigid
Sle5	S6 3	From start Rela	0.000 1.000	Free	Rigid	Free	Rigid	Free	Rigid

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle6	S7	From start	0.000	Free	Rigid	Free	Rigid	Free	Rigid
	3	Rela	1.000						

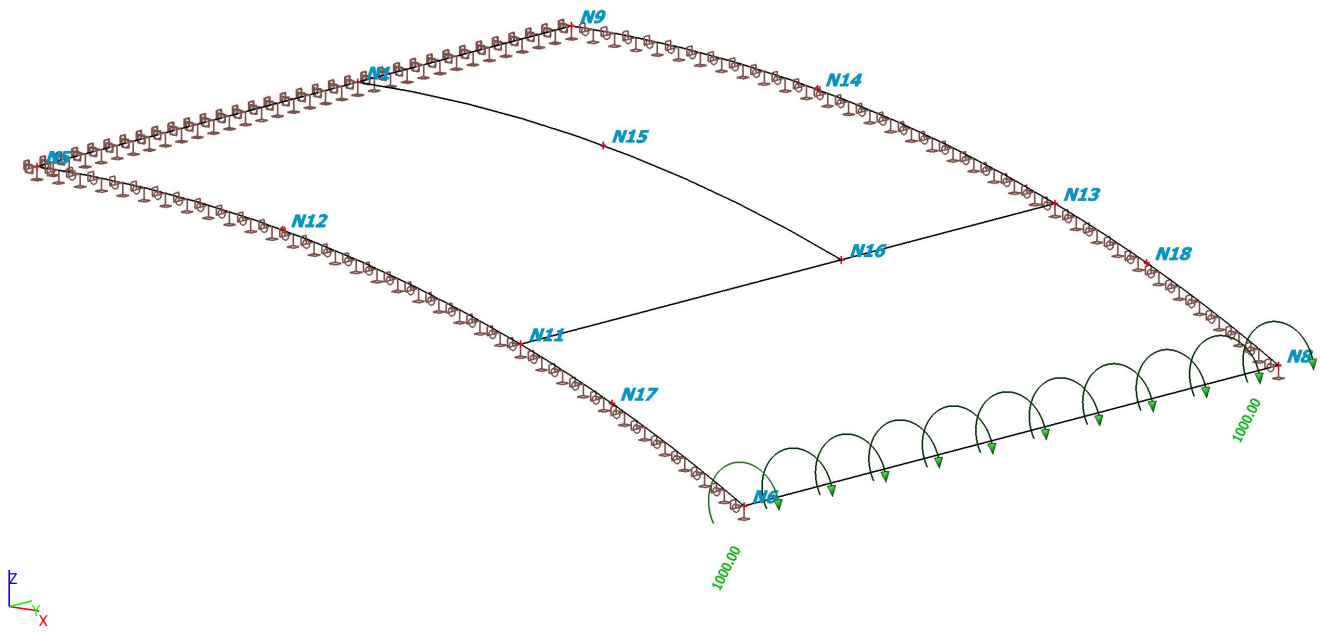
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 275	7850.00	2.1000e+05	0.3	0	40	275.0	430.0	
		8.0769e+04	0.01e-003	40	80	255.0	410.0	

3. LOAD

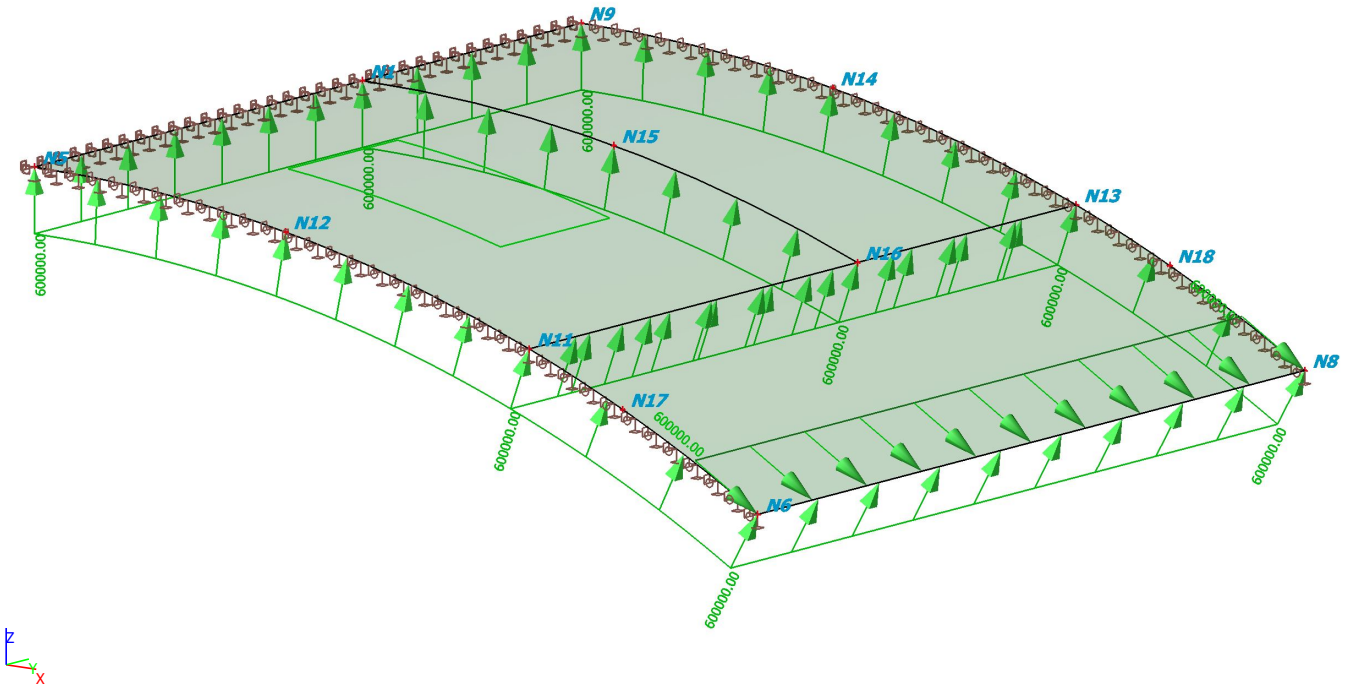
3.1. LC1 - Bending



3.2. Line moment on 2D member edge

Name	2D member	Type	Dir	Value - M_1 [Nm/m]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - M_2 [Nm/m]	Pos x_2	Coor	Orig
LMS1	S7	Moment	Mx	1000.00	0.000	Length	2
	LC1	LCS	Uniform		1.000	Rela	From start

3.3. LC1 - Membrane



3.4. Line force on 2D member edge

Name	2D member	Type	Dir	Value - P_1 [N/m]	Pos x_1	Loc	Edge
	Load case	System	Distribution	Value - P_2 [N/m]	Pos x_2	Coor	Orig
LFS3	S7	Force	X	600000.00	0.000	Length	2
	LC2	UCS	Uniform		1.000	Rela	From end

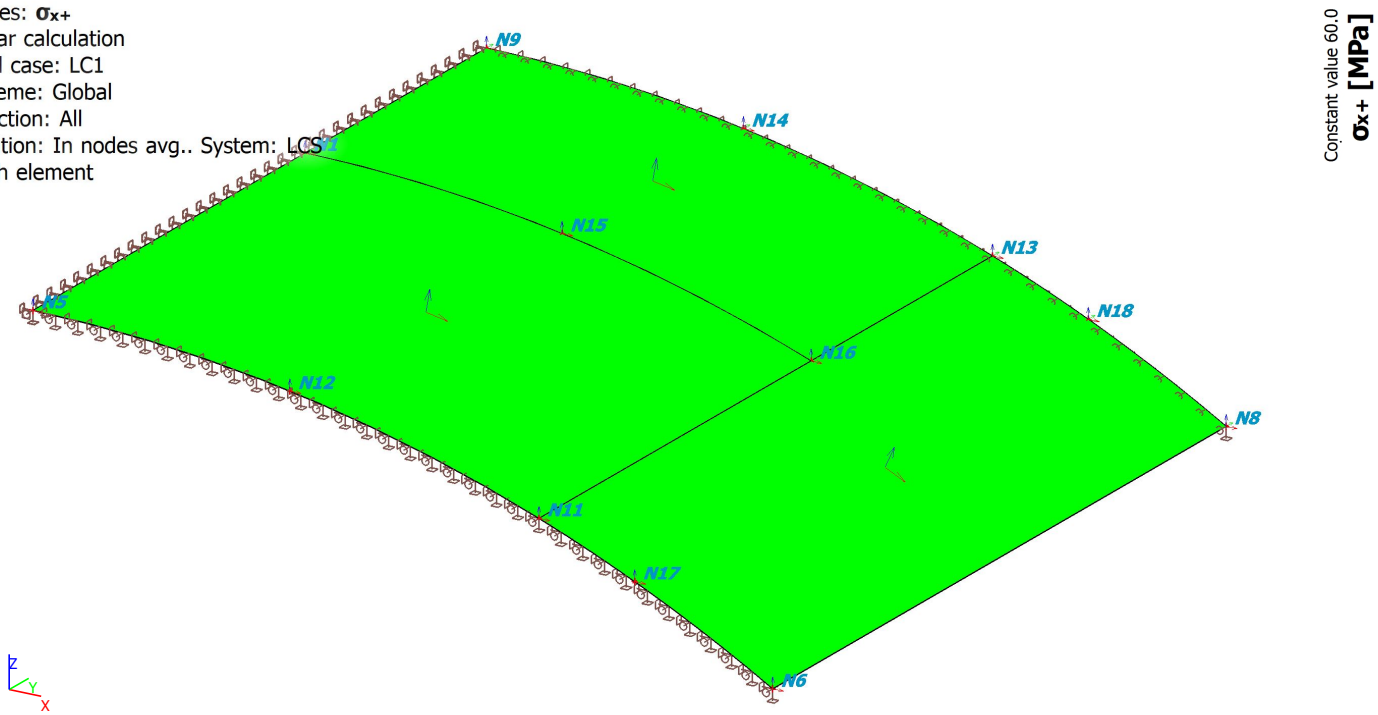
3.5. Surface load

Name	Dir	Type	Value [N/m²]	2D member	Load case	System	Loc
SF3	Z	Force	600000.00	S5	LC2	LCS	Length
SF4	Z	Force	600000.00	S6	LC2	LCS	Length
SF5	Z	Force	600000.00	S7	LC2	LCS	Length

4. RESULTS

4.1. LC1 - BENDING

Values: σ_{x+}
Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg.. System: LCS mesh element



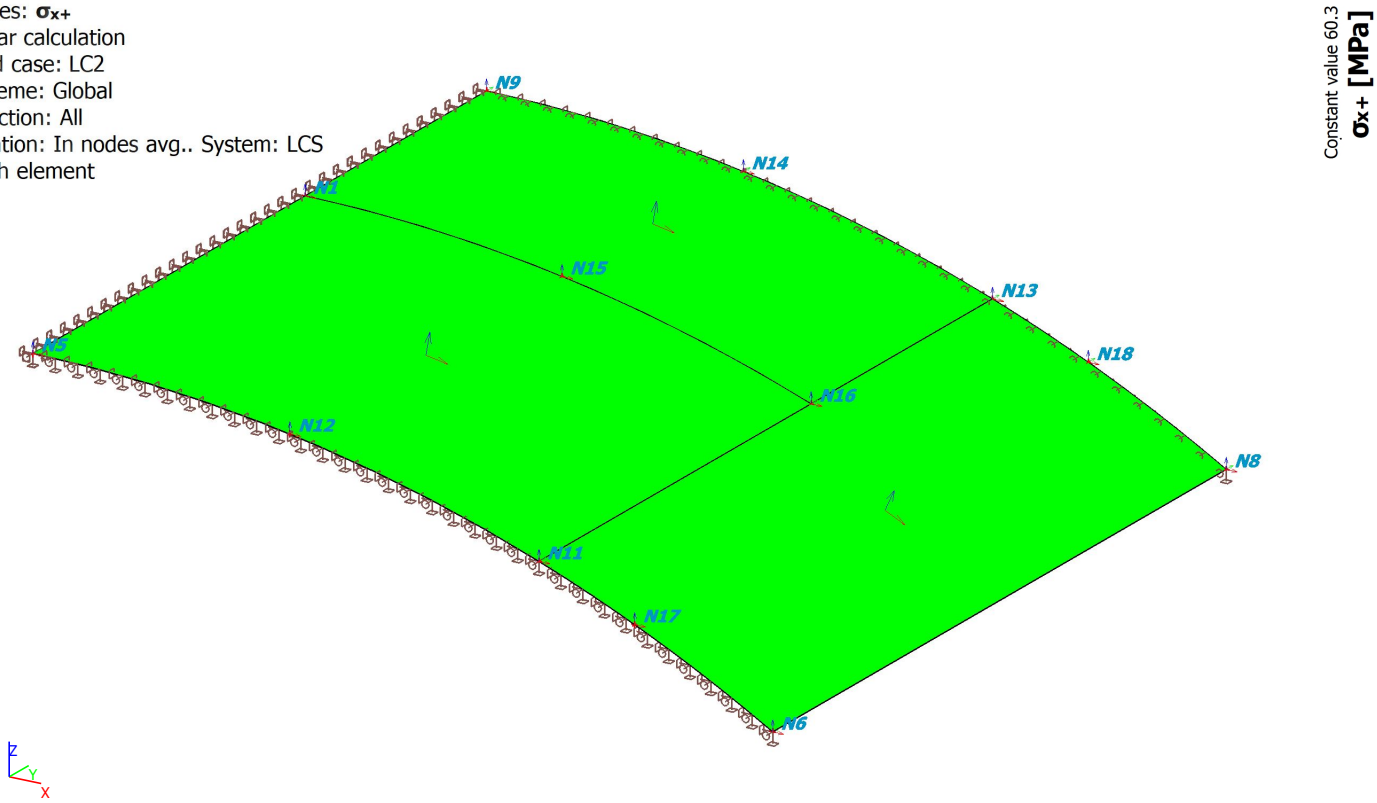
4.2. 2D stress/strain

Linear calculation
Load case: LC1
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Basic stress

Name	Mesh	Position [m]	Case	σ_{x+} [MPa]
S5	Element: 30 Node: 1	0.000 0.000 1.000	LC1	**60.0**
S5	Element: 1 Node: 6	0.000 0.300 1.000	LC1	**60.0**

4.3. LC2 - MEMBRANE

Values: σ_{x+}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg.. System: LCS mesh element



4.4. 2D stress/strain

Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Basic stress

Name	Mesh	Position [m]	Case	σ_{x+} [MPa]
S7	Element: 1818 Node: 11	0.500 0.000 0.866	LC2	**60.3**
S7	Element: 1801 Node: 3	0.342 0.000 0.940	LC2	**60.3**

5. EXPECTED AFNOR RESULTS

LC1 - BENDING
σx+ = 60 MPa

LC2 - MEMBRANE
σx+ = 60 MPa

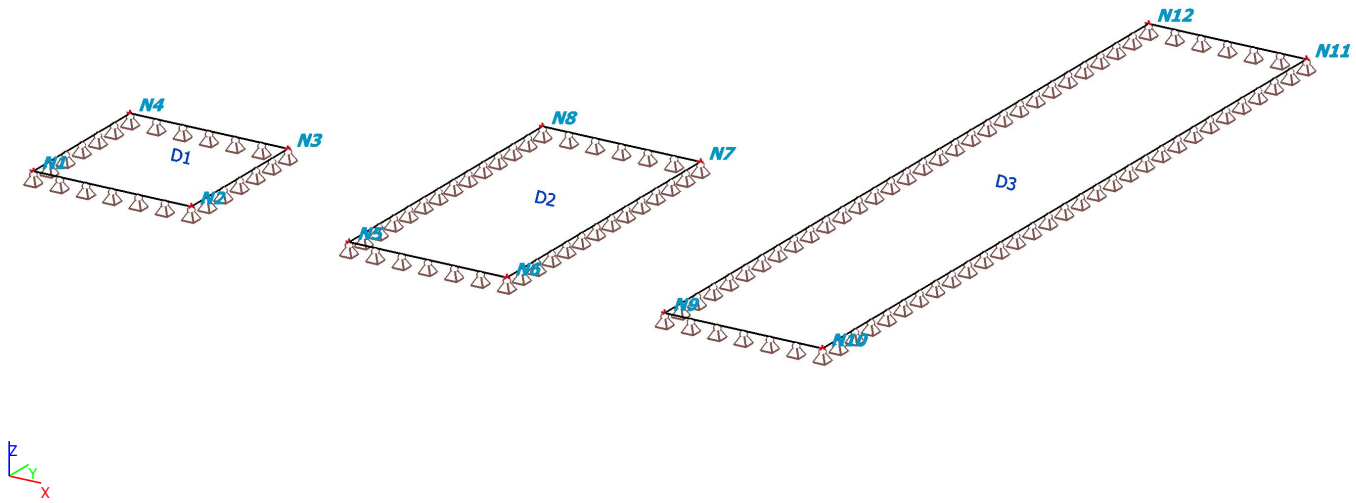
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simply supported rectangular plate with uniform load
Specification: Plate - Pressure - Simple support.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	1.000	0.000	0.000
N3	1.000	1.000	0.000
N4	0.000	1.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N5	2.000	0.000	0.000
N6	3.000	0.000	0.000
N7	3.000	2.000	0.000
N8	2.000	2.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N9	4.000	0.000	0.000
N10	5.000	0.000	0.000
N11	5.000	5.000	0.000
N12	4.000	5.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	10
D2	Calque1	plate (90)	Standard	S 235	constant	10
D3	Calque1	plate (90)	Standard	S 235	constant	10

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle2	D1	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	2	Rela	1.000						
Sle3	D1	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	3	Rela	1.000						
Sle4	D1	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	4	Rela	1.000						
Sle5	D2	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	1	Rela	1.000						

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle6	D2	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	2	Rela	1.000						
Sle7	D2	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	3	Rela	1.000						
Sle8	D2	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	4	Rela	1.000						
Sle9	D3	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle10	D3	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	2	Rela	1.000						
Sle11	D3	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	3	Rela	1.000						
Sle12	D3	From start	0.000	Rigid	Rigid	Rigid	Free	Free	Free
	4	Rela	1.000						

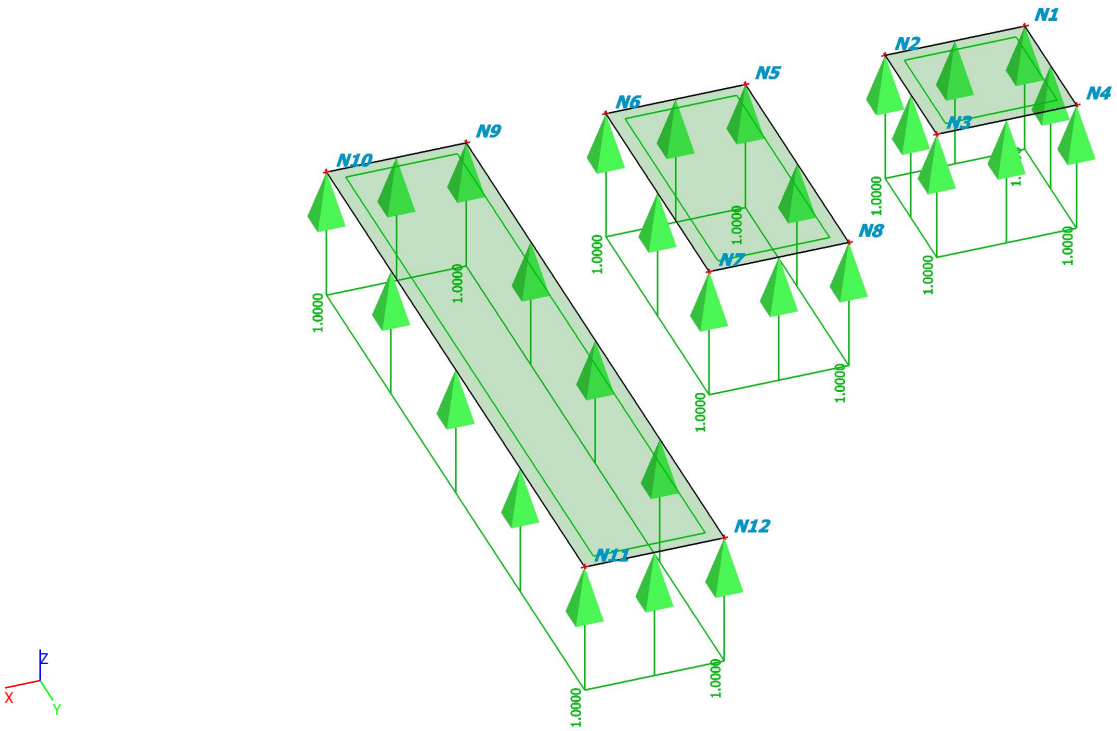
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	1.0000e+01	0.3	0	40	235.0	360.0	
		3.8462e+00	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



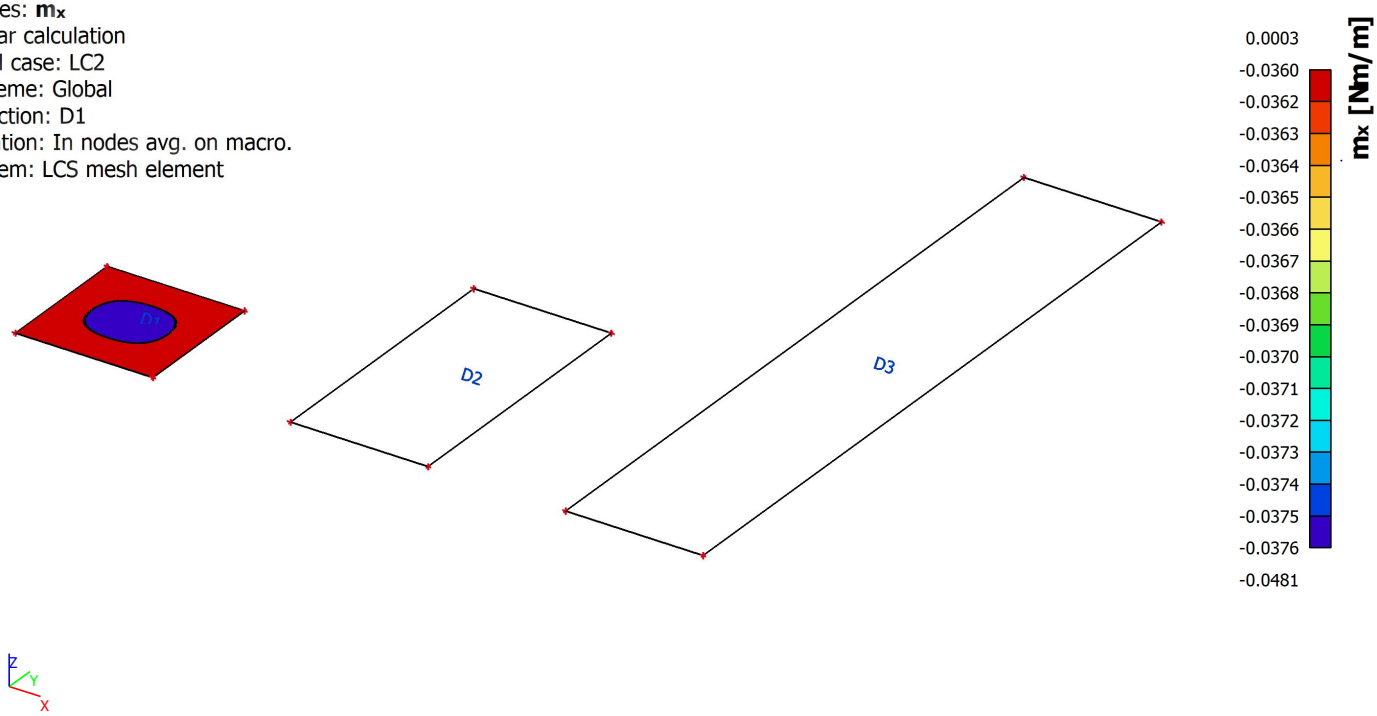
3.2. Surface load

Name	Dir	Type	Value [N/m²]	2D member	Load case	System	Loc
SF1	Z	Force	1.0000	D3	LC2	GCS	Length
SF2	Z	Force	1.0000	D2	LC2	GCS	Length
SF3	Z	Force	1.0000	D1	LC2	GCS	Length

4. RESULTS

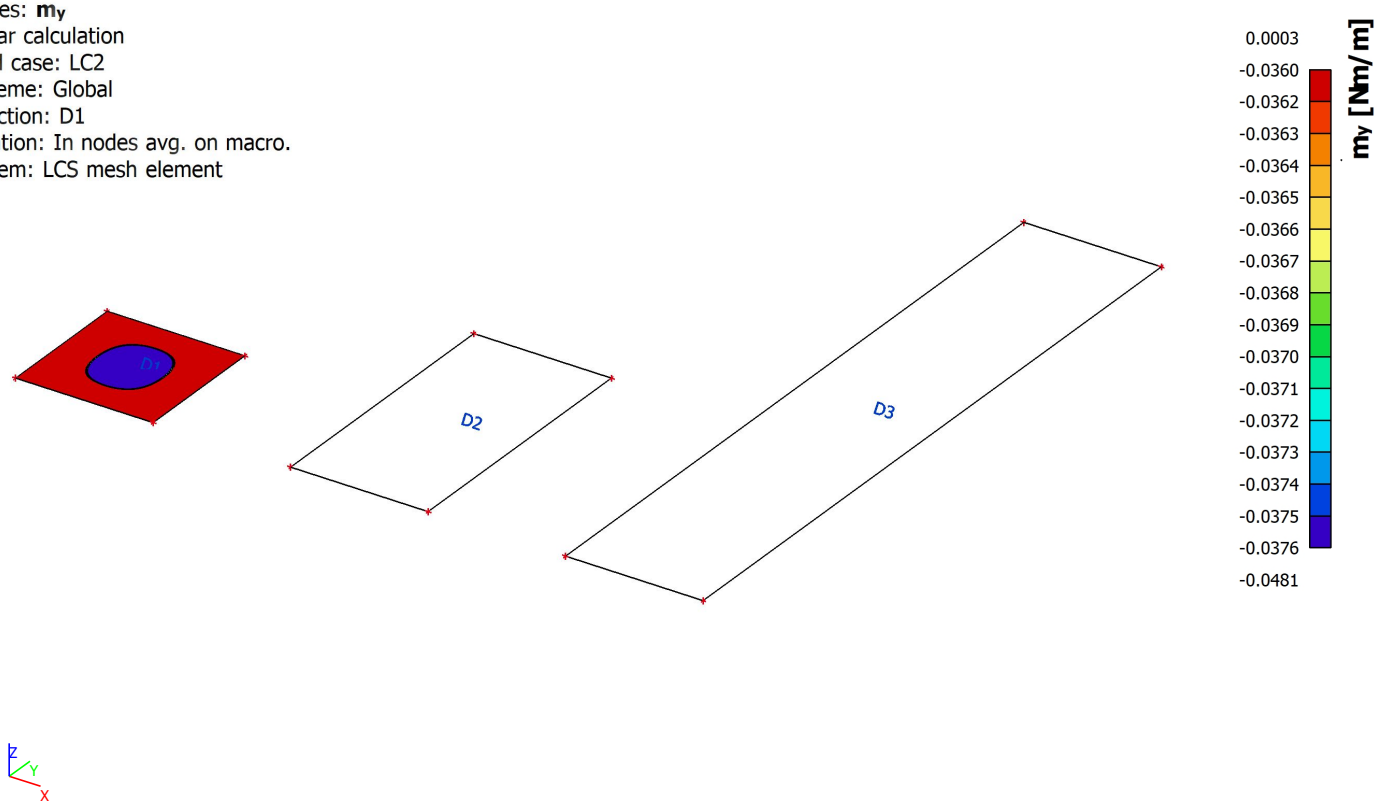
4.1. 2D internal forces; m_x

Values: m_x
Linear calculation
Load case: LC2
Extreme: Global
Selection: D1
Location: In nodes avg. on macro.
System: LCS mesh element



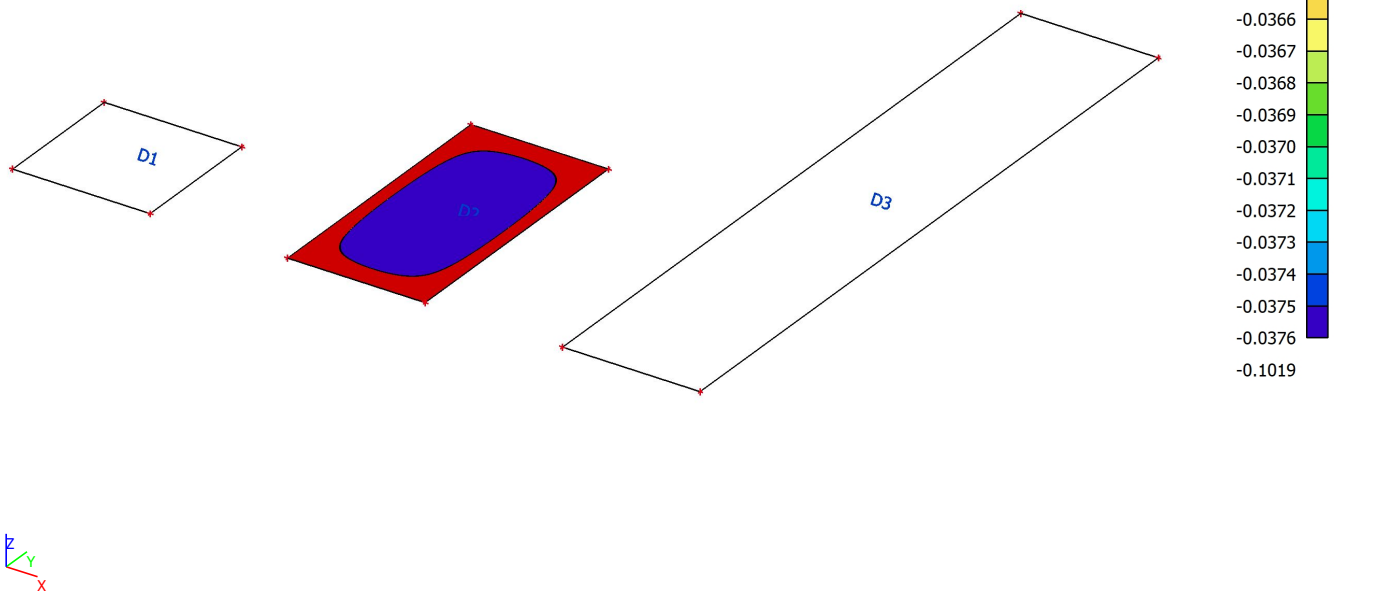
4.2. 2D internal forces; m_y

Values: m_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: D1
Location: In nodes avg. on macro.
System: LCS mesh element



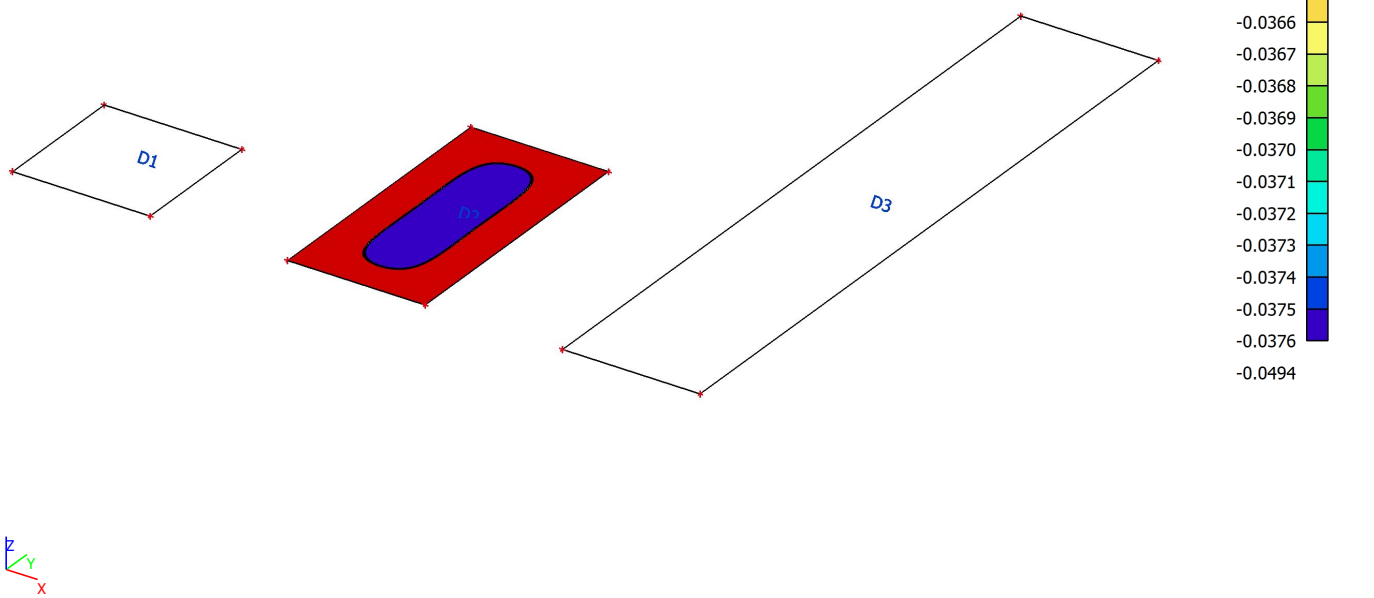
4.3. 2D internal forces; m_x

Values: m_x
Linear calculation
Load case: LC2
Extreme: Global
Selection: D2
Location: In nodes avg. on macro.
System: LCS mesh element



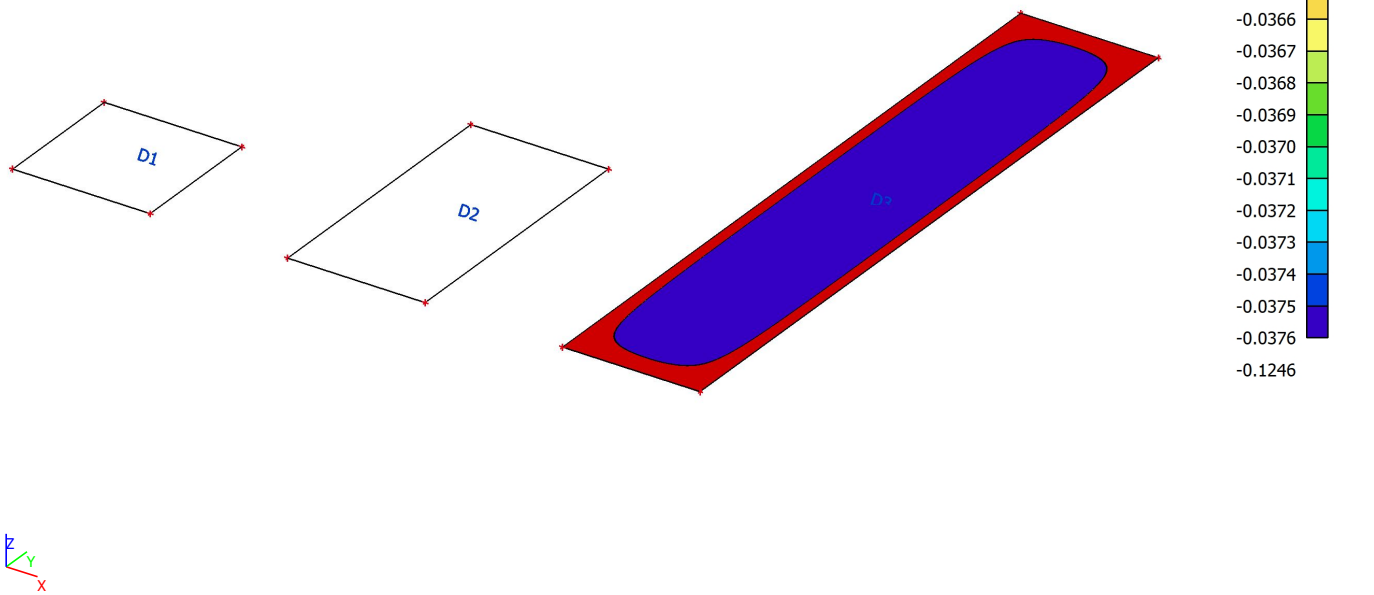
4.4. 2D internal forces; m_y

Values: m_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: D2
Location: In nodes avg. on macro.
System: LCS mesh element



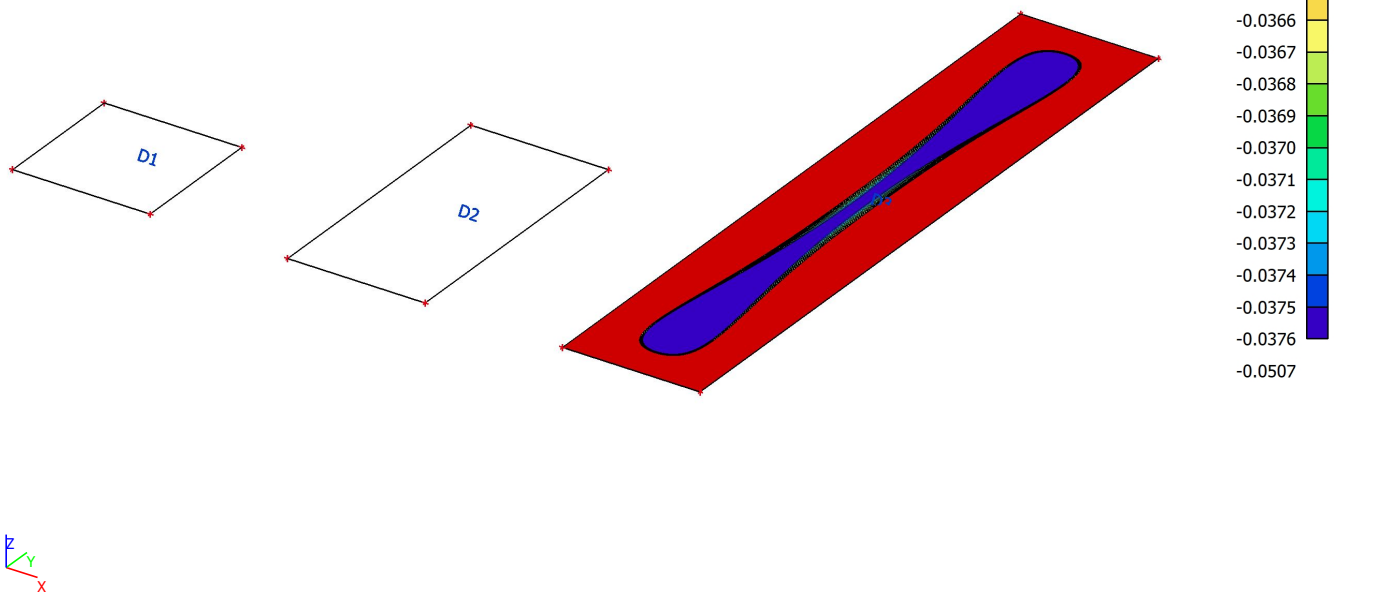
4.5. 2D internal forces; m_x

Values: m_x
Linear calculation
Load case: LC2
Extreme: Global
Selection: D3
Location: In nodes avg. on macro.
System: LCS mesh element



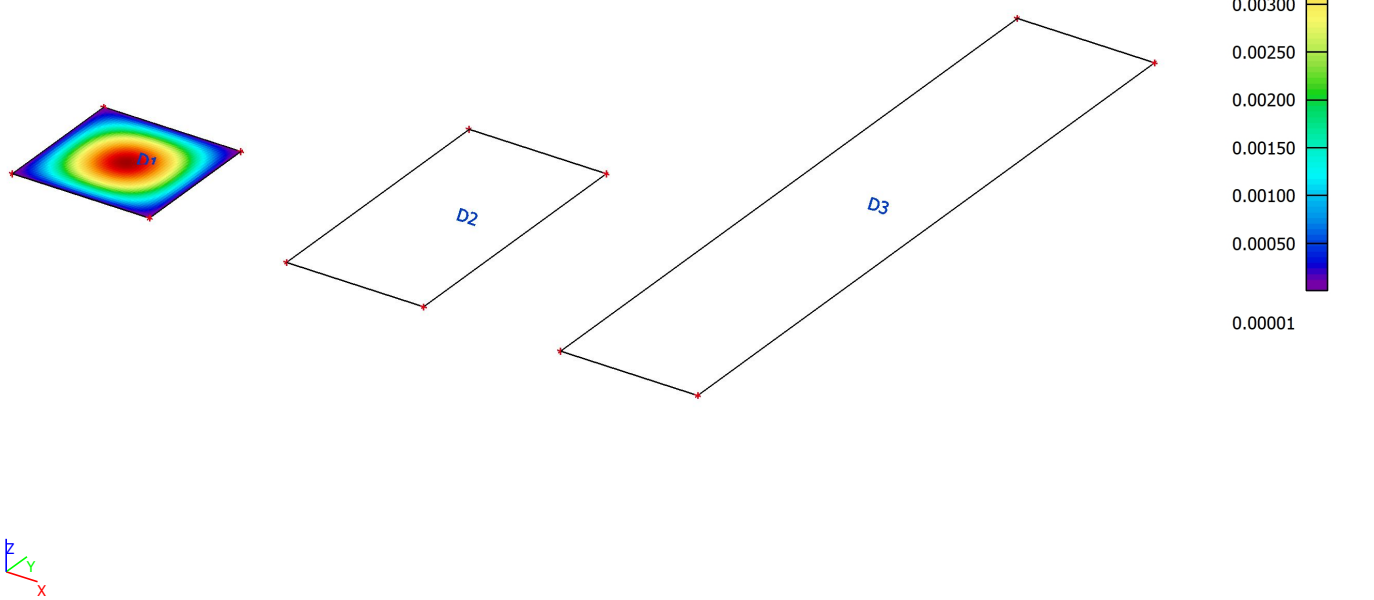
4.6. 2D internal forces; m_y

Values: m_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: D3
Location: In nodes avg. on macro.
System: LCS mesh element



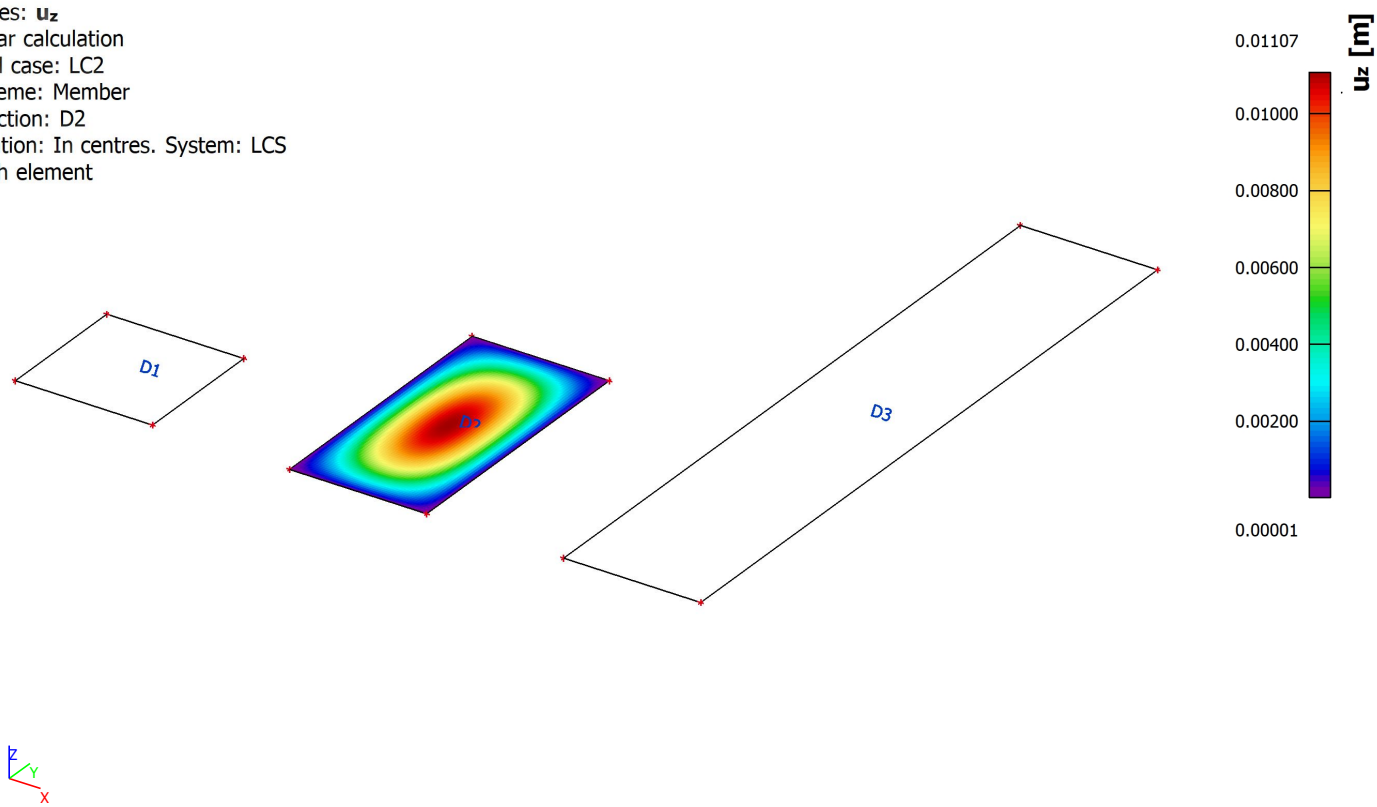
4.7. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Member
Selection: D1
Location: In centres. System: LCS
mesh element



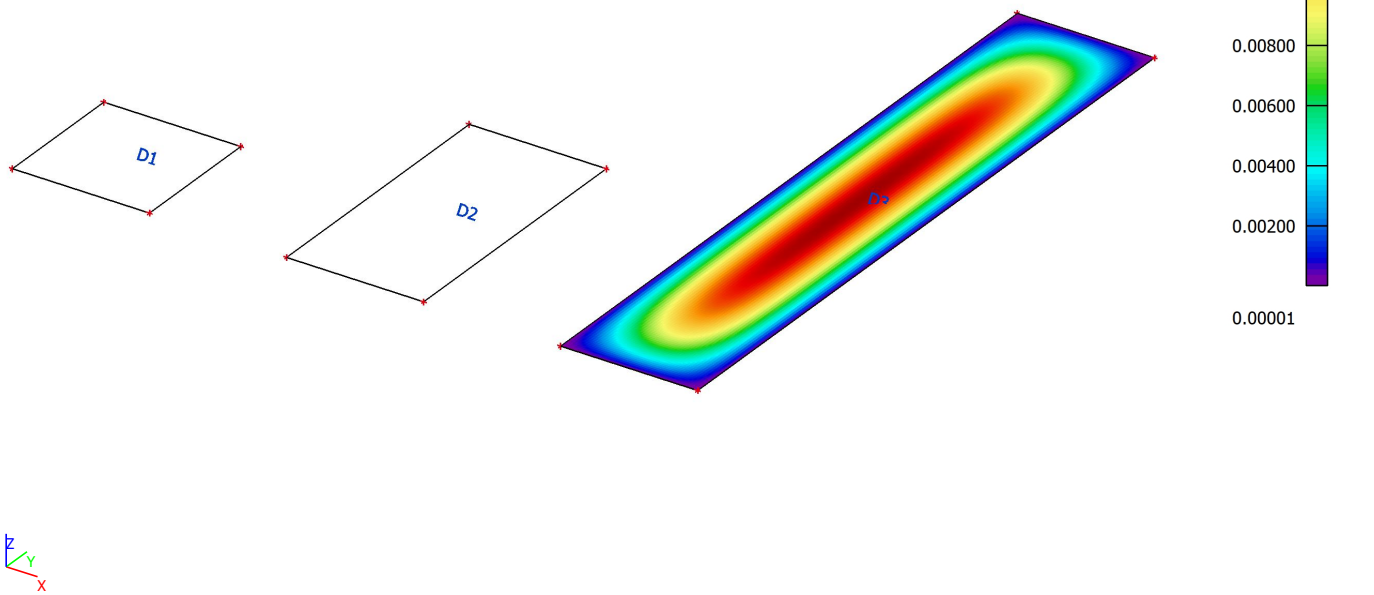
4.8. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Member
Selection: D2
Location: In centres. System: LCS
mesh element



4.9. 2D displacement; u_z

Values: u_z
Linear calculation
Load case: LC2
Extreme: Member
Selection: D3
Location: In centres. System: LCS
mesh element



4.10. 2D internal forces

Linear calculation
Load case: LC2
Extreme: Member
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Basic magnitudes

Name	Mesh	x [m]	y [m]	z [m]	Case	m_x [Nm/m]	m_y [Nm/m]
D1	Element: 1151; Node: 1226	0.000	0.480	0.000	LC2	**0.0003**	-0.0001
D1	Element: 1225; Node: 1301	0.500	0.500	0.000	LC2	**-0.0481**	**-0.0481**
D1	Element: 24; Node: 49	0.480	0.000	0.000	LC2	-0.0001	**0.0003**
D2	Element: 4975; Node: 5177	2.500	1.000	0.000	LC2	**-0.1019**	-0.0464
D2	Element: 4251; Node: 4439	2.000	0.720	0.000	LC2	**0.0004**	-0.0003
D2	Element: 2501; Node: 5	2.000	0.000	0.000	LC2	-0.0494	**-0.0494**
D2	Element: 2522; Node: 2646	2.440	0.000	0.000	LC2	0.0000	**0.0003**
D3	Element: 13675; Node: 14102	4.500	2.480	0.000	LC2	**-0.1246**	-0.0377
D3	Element: 9501; Node: 9845	4.000	0.820	0.000	LC2	**0.0004**	-0.0003
D3	Element: 7501; Node: 9	4.000	0.000	0.000	LC2	-0.0507	**-0.0507**
D3	Element: 7525; Node: 7803	4.500	0.000	0.000	LC2	0.0000	**0.0003**

5. EXPECTED AFNOR RESULTS

Plate D1 :

Max deflection : 0.0443
Mx max = 0.0479
My max = 0.0479

Plate D2 :

Max deflection : 0.1106
Mx max = 0.1017
My max = 0.0464

Plate D3 :

Max deflection : 0.1416
Mx max = 0.1246
My max = 0.0375

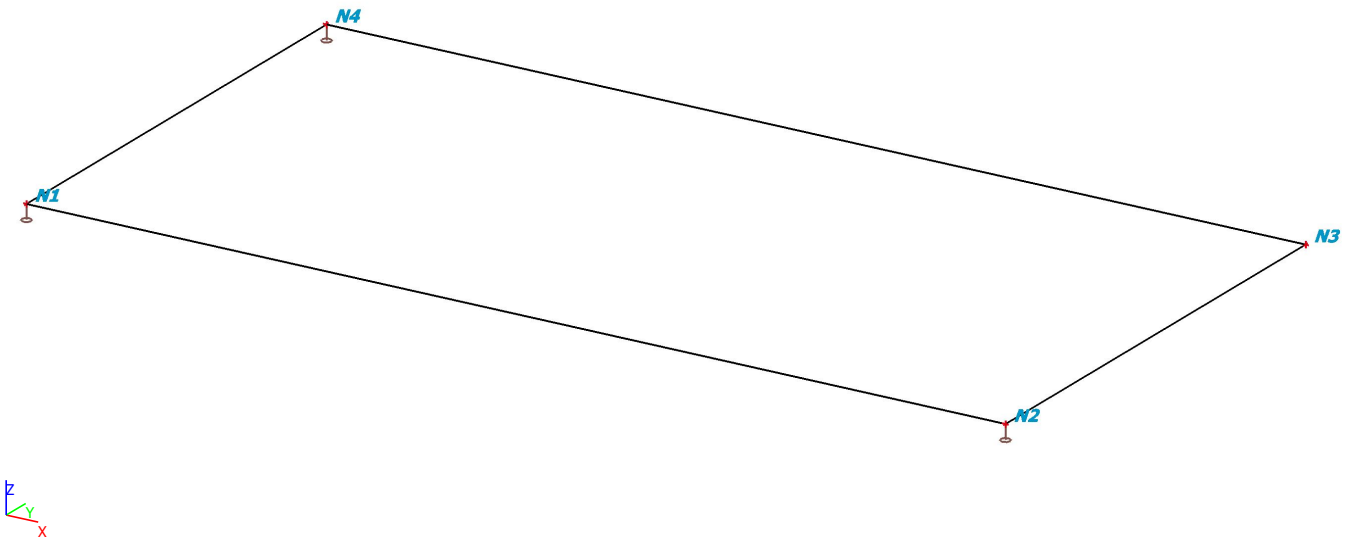
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Simply supported rectangular plate with bending moment
Specification: Plate - Pressure - Simple support – Nodal moment

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	40.000	0.000	0.000
N3	40.000	20.000	0.000
N4	0.000	20.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	1000

2.4. Nodal supports

Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Free	Free	Rigid	Free	Free	Free
Sn2	N4	GCS	Standard	Free	Free	Rigid	Free	Free	Free
Sn3	N2	GCS	Standard	Free	Free	Rigid	Free	Free	Free

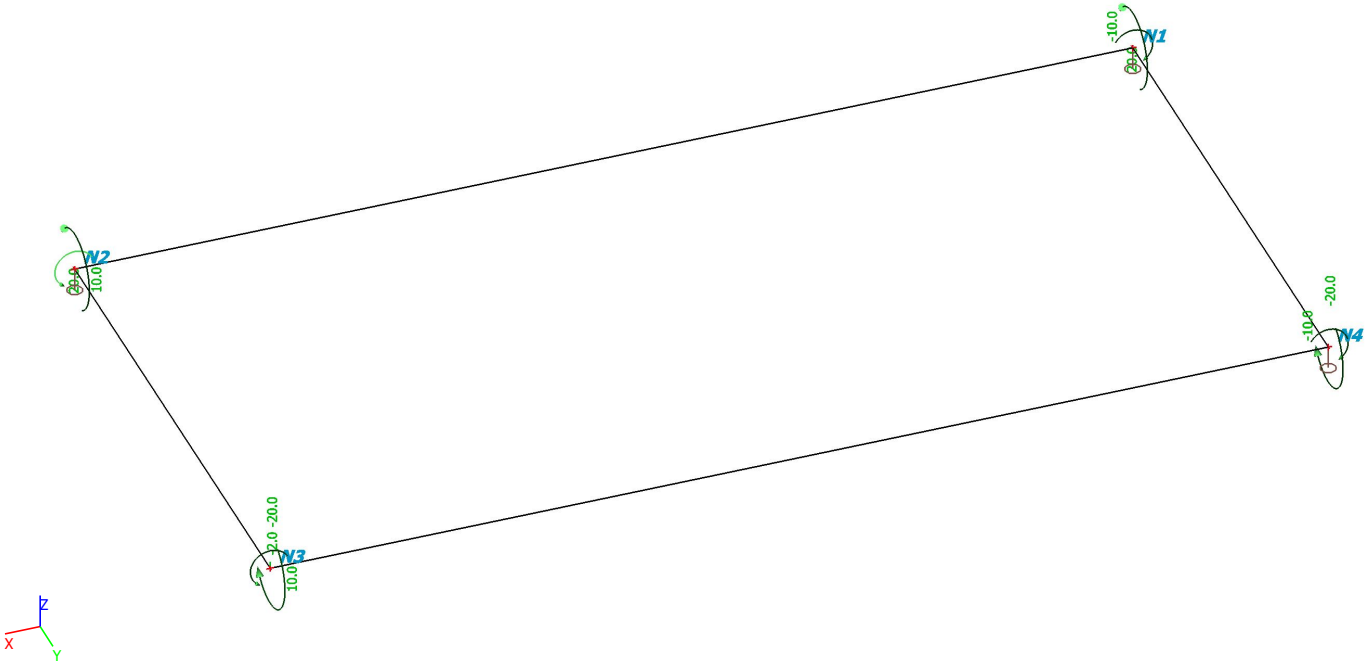
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	1.0000e-03	0.3	0	40	235.0	360.0	
		3.8462e-04	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [N]
F1	N3	LC2 - Permanent	GCS	Z	Force	-2.0

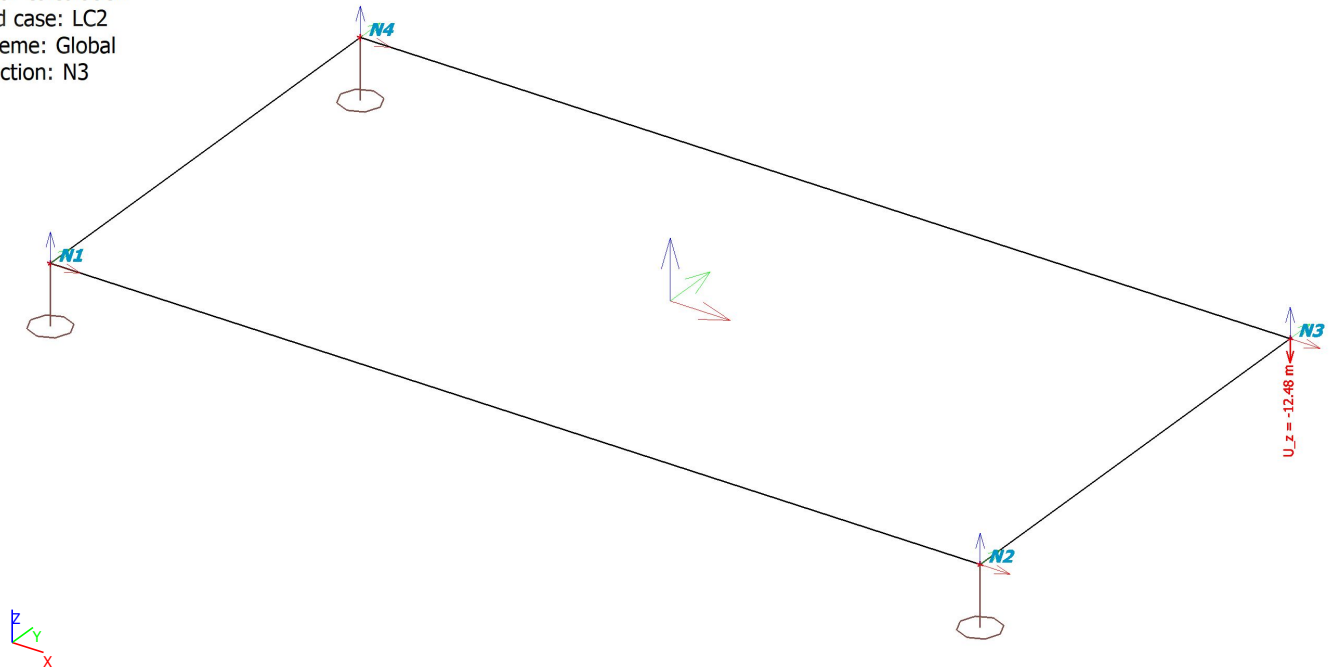
3.3. Moment in node

Name	Node	Load case	System	Dir	Type	Value - M [Nm]
M1	N2	LC2 - Permanent	GCS	My	Moment	10.0
M2	N3	LC2 - Permanent	GCS	My	Moment	10.0
M3	N1	LC2 - Permanent	GCS	My	Moment	-10.0
M4	N4	LC2 - Permanent	GCS	My	Moment	-10.0
M5	N2	LC2 - Permanent	GCS	Mx	Moment	20.0
M6	N1	LC2 - Permanent	GCS	Mx	Moment	20.0
M7	N4	LC2 - Permanent	GCS	Mx	Moment	-20.0
M8	N3	LC2 - Permanent	GCS	Mx	Moment	-20.0

4. RESULTS

4.1. Displacement of nodes; U_z

Values: U_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: N3



4.2. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Node
Selection: N3

Name	Case	U_z [m]
N3	LC2	**-12.48**

5. EXPECTED AFNOR RESULTS

Displacement uz in node N3= -12,48 mm

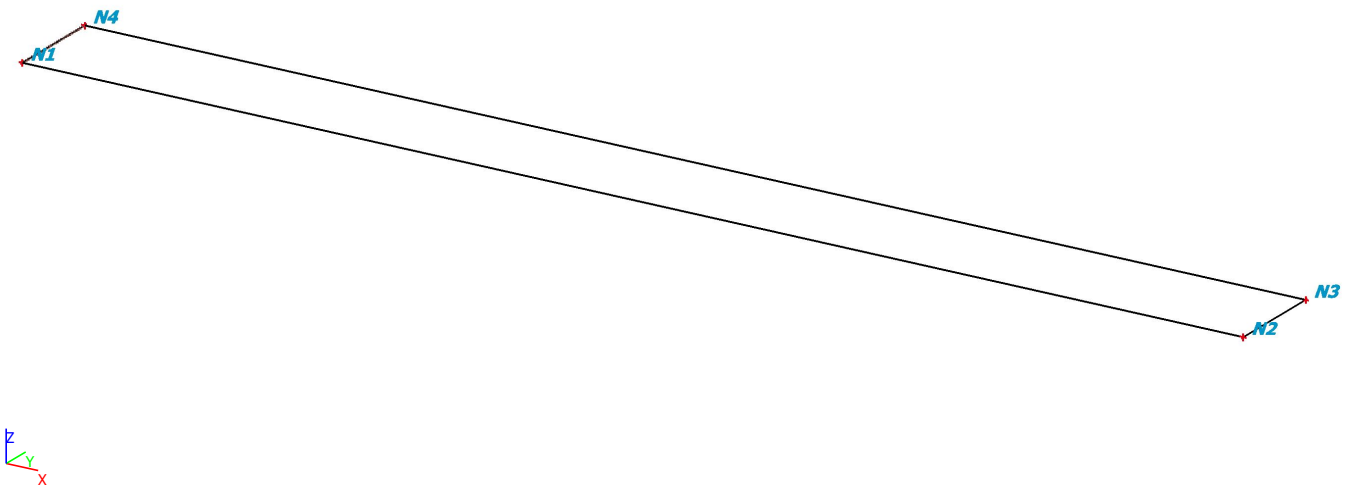
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Plate under perpendicular shear with one edge fixed

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	12.000	0.000	0.000
N3	12.000	1.000	0.000
N4	0.000	1.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	50

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle2	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						

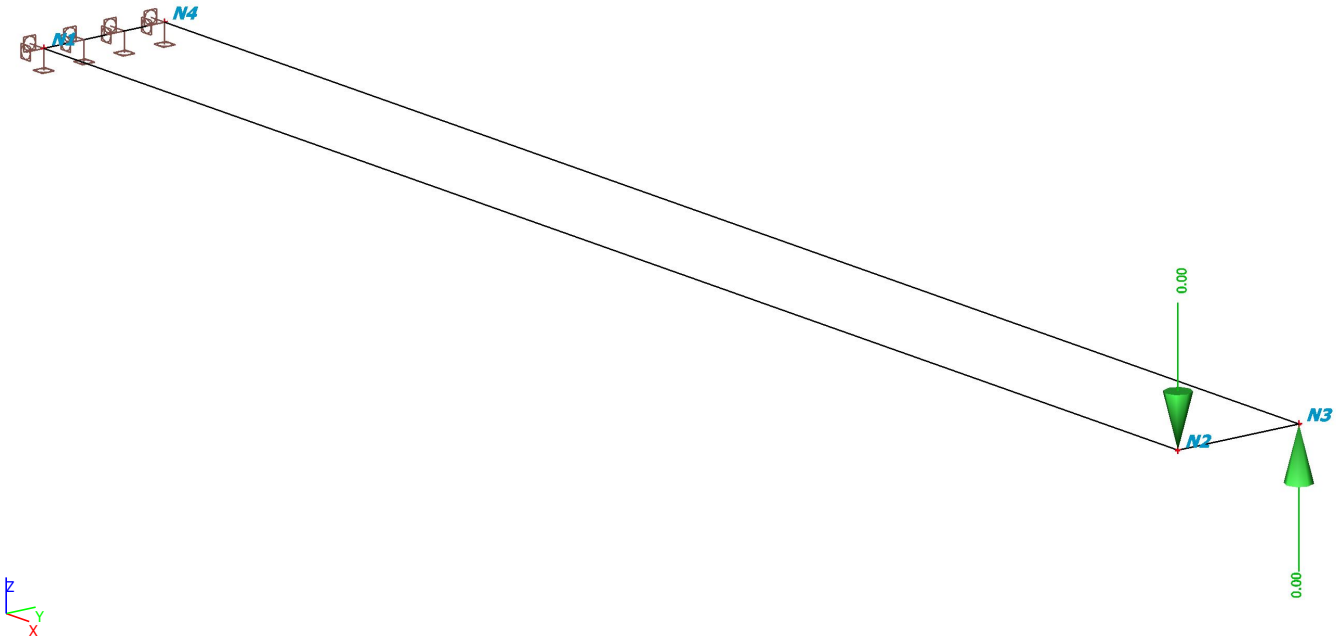
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	1.0000e+01	0.25	0	40	235.0	360.0	
		4.0000e+00	0.01e-003	40	80	215.0	360.0	

3. LOAD

3.1. LC1 / Tot. value



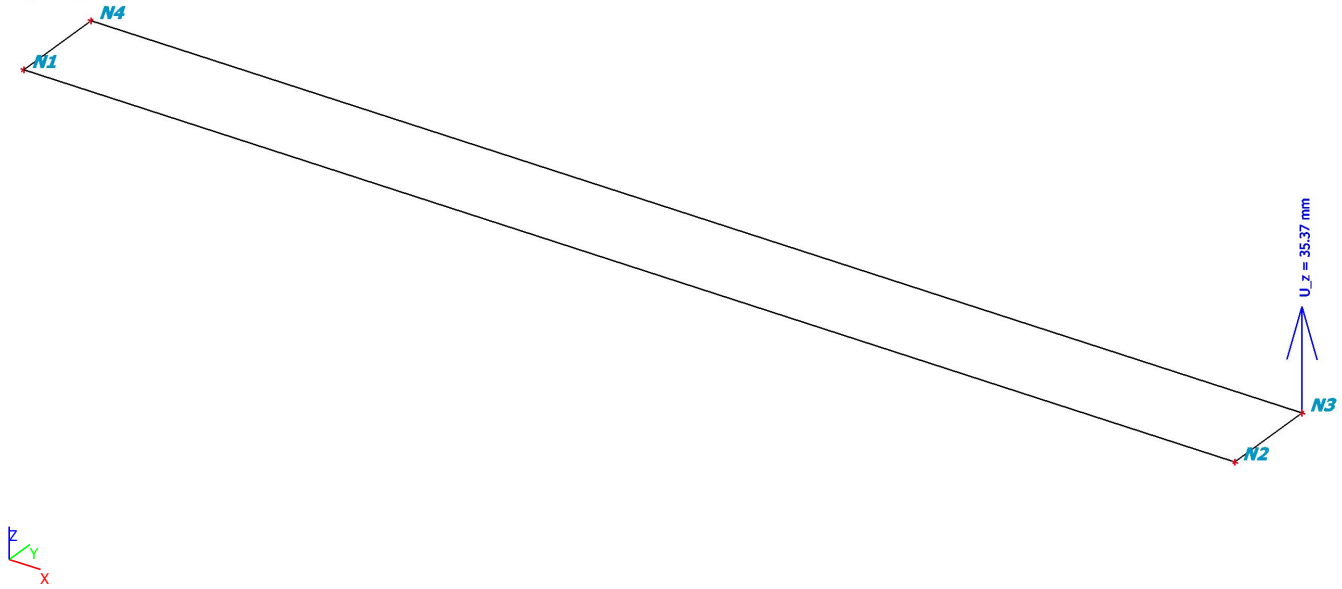
3.2. Point force in node

Name	Node	Load case	System	Dir	Type	Value - F [kN]
F1	N2	LC2 - Permanent	GCS	Z	Force	0.00
F2	N3	LC2 - Permanent	GCS	Z	Force	0.00

4. RESULTS

4.1. Displacement of nodes; U_z

Values: U_z
Linear calculation
Load case: LC2
Extreme: Global
Selection: N3



4.2. Displacement of nodes

Linear calculation
Load case: LC2
Extreme: Node
Selection: N3

Name	Case	U_z [mm]
N3	LC2	**35.37**

5. EXPECTED AFNOR RESULTS

Displacement uz in node N3= 35,37mm

REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a simply supported beam with and without prestress

2. MODEL

2.1. Analysis model

2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	Sn1
N2	2.000	0.000	B1	Sn2
N3	4.000	0.000	B2	Sn3
N4	6.000	0.000	B2	Sn4

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS3 - Rectangle (50; 50)	S 235 modified	2.000	N1	N2	beam (80)
B2	CS3 - Rectangle (50; 50)	S 235 modified	2.000	N3	N4	beam (80)

2.4. Nodal supports

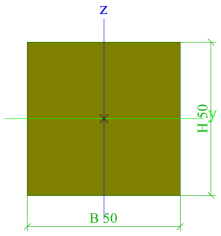
Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Free
Sn2	N2	GCS	Standard	Free	Rigid	Free
Sn3	N3	GCS	Standard	Rigid	Rigid	Free
Sn4	N4	GCS	Standard	Free	Rigid	Free

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235 modified	7800.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.6. Cross-sections

CS3		
Type	Rectangle	
Detailed	50; 50	
Item material	S 235 modified	
A [m^2]	2.5000e-03	
A_y [m^2], A_z [m^2]	2.0833e-05	2.0833e-05
A_L [m^2/m], A_D [m^2/m]	2.0000e-01	2.0000e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	25	25
α [deg]	0.00	
I_y [m^4], I_z [m^4]	5.2083e-07	5.2083e-09
i_y [mm], i_z [mm]	14	1
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	2.0833e-05	2.0833e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	3.1250e-05	3.1250e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	7343.75	7343.75
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	7343.75	7343.75
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	8.7957e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD and MASS

3.1. LC1 / Tot. value

3.2. Point force on beam

Name	Member	System	Value - F [kN]	Pos x	Coor	Rep (n)
	Load case	Dir	Type		Orig	Regularly
Fb2	B1	GCS	-100.00	0.000	Rela	1
	LC2 - Permanent	X	Force		From end	

3.3. Mass groups

Name	Load case
MG1	LC1 - Poids propre

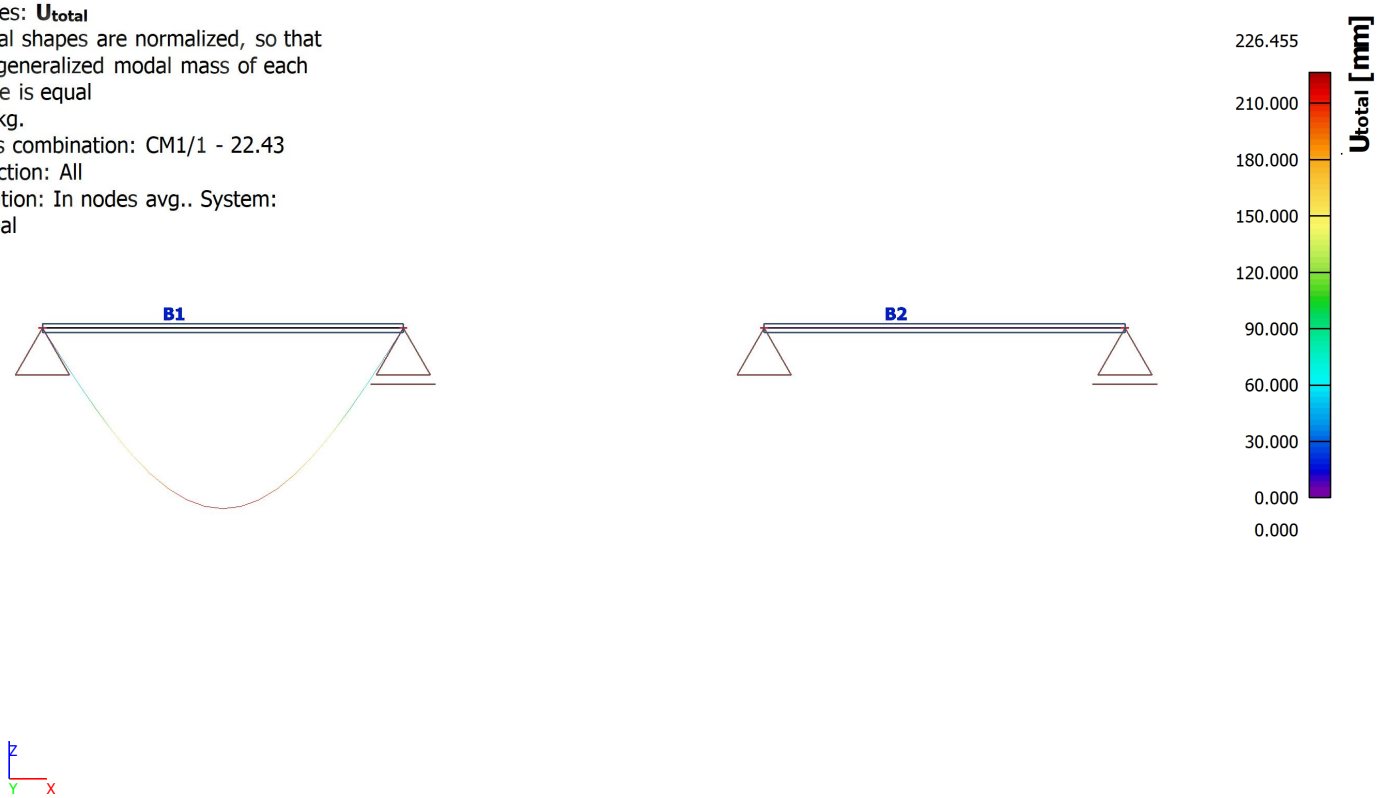
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	22.43	140.95	19866.96	0.04
2	28.70	180.33	32519.53	0.03
3	109.08	685.34	469694.71	0.01
4	114.81	721.32	520303.68	0.01

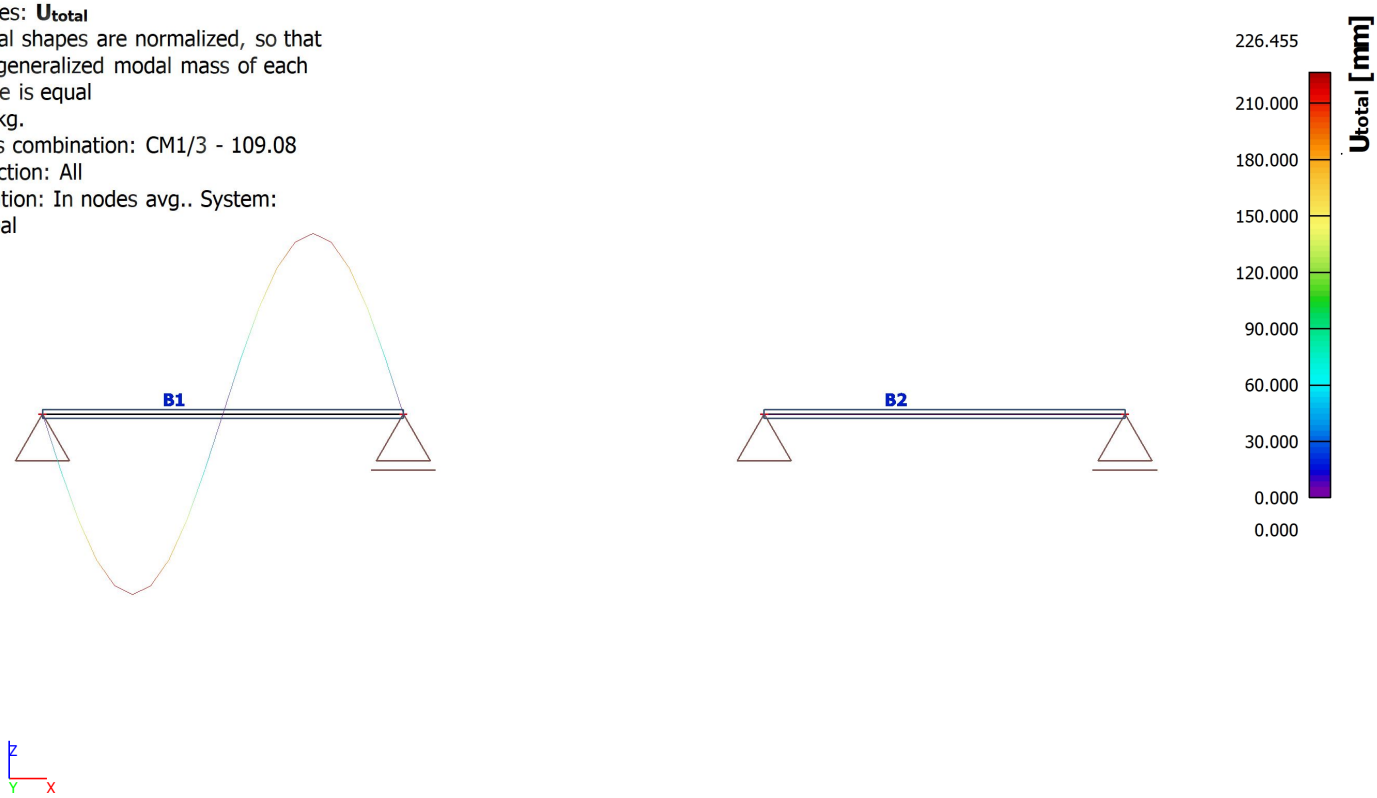
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 22.43
Selection: All
Location: In nodes avg.. System: Global



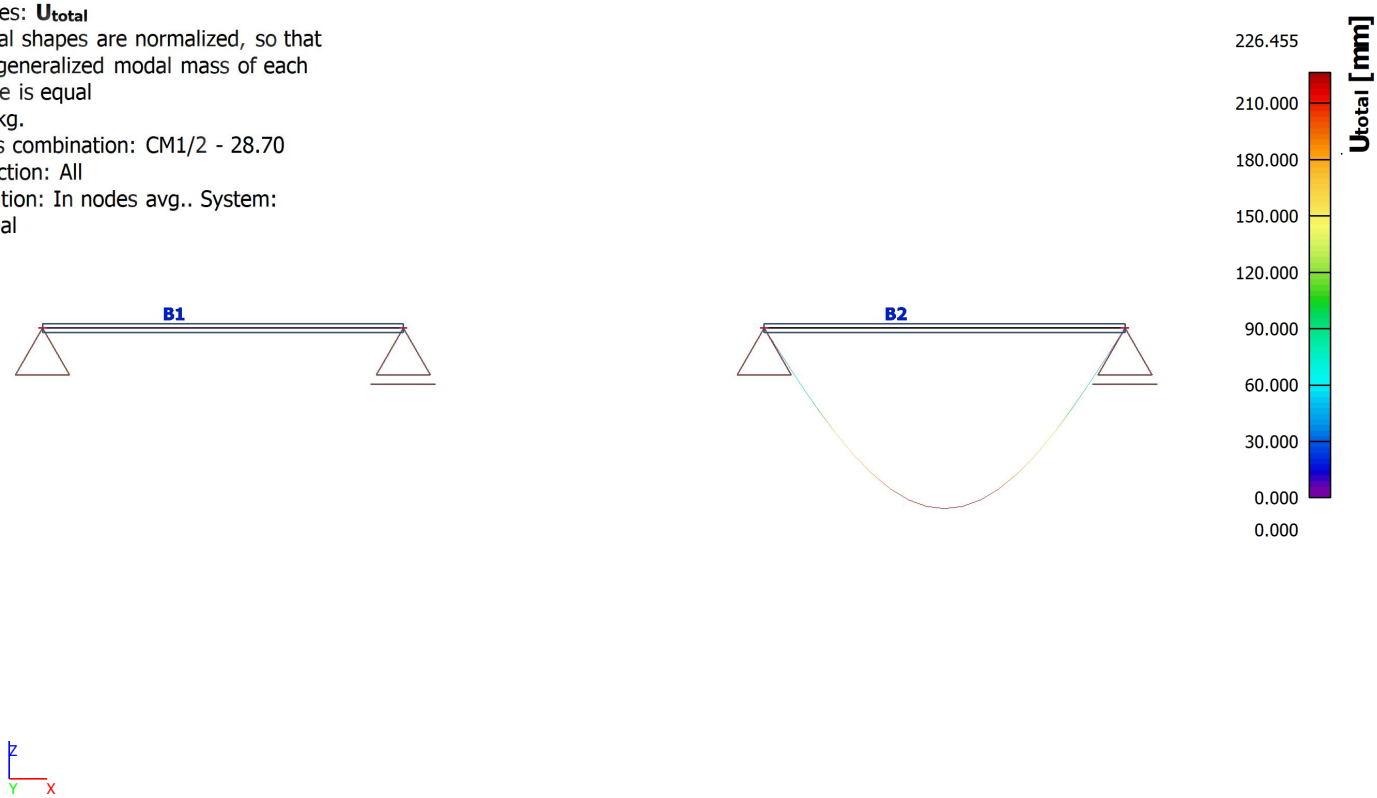
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/3 - 109.08
Selection: All
Location: In nodes avg.. System: Global



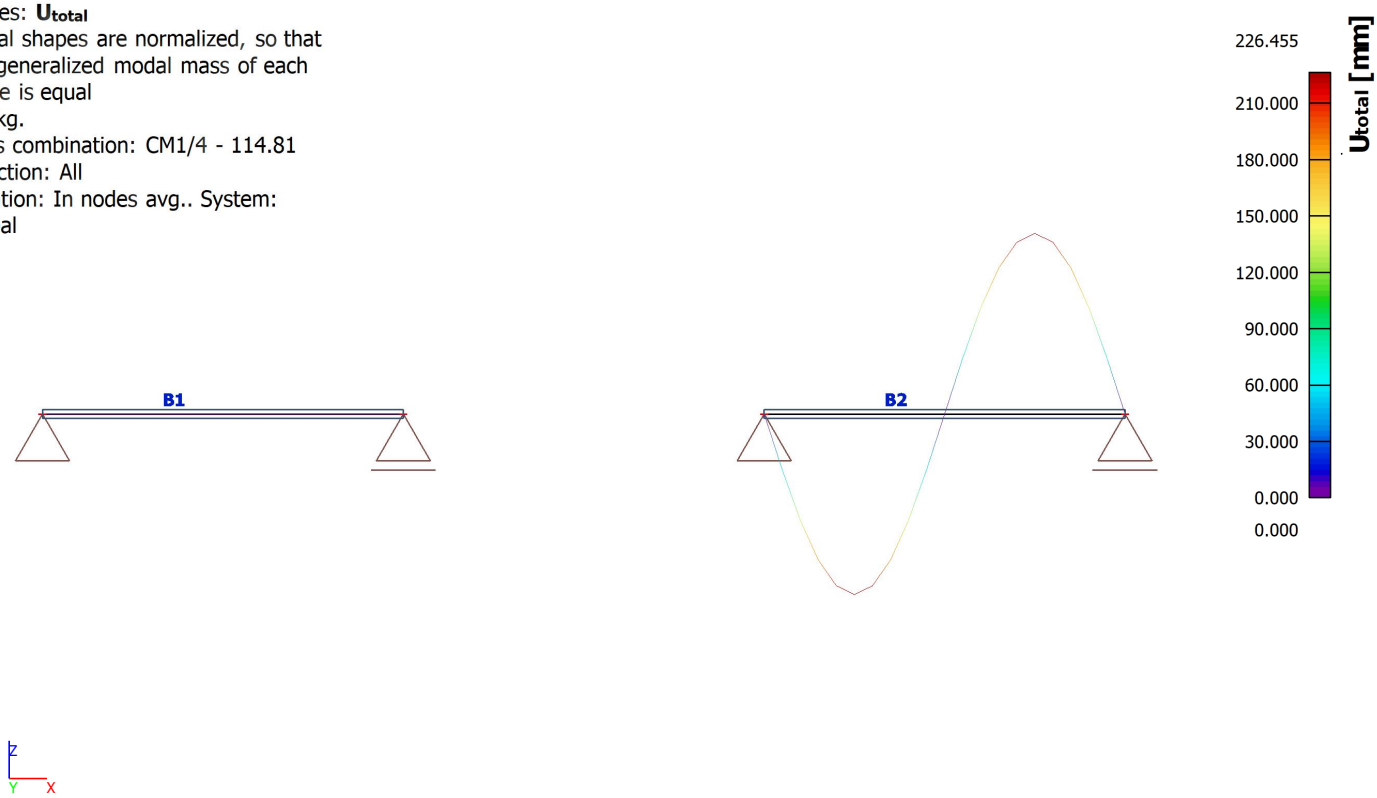
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/2 - 28.70
Selection: All
Location: In nodes avg.. System: Global



4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 114.81
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Beam B1 (with initial stress):

f1 = 22.434 Hz
f2 = 109.080 Hz

Beam B2 (without initial stress):

f1 = 28.702 Hz
f2= 114.807 Hz

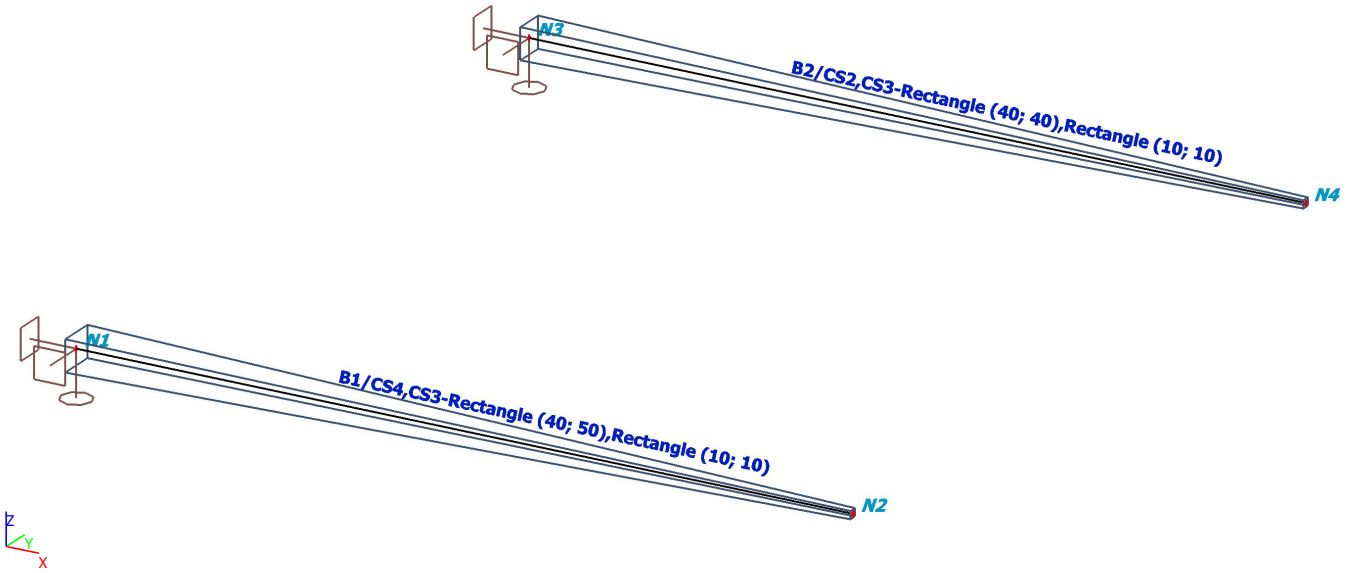
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of cantilever beams with variable cross-sections

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Member	Data
N1	0.000	0.000	B1	Sn1
N2	1.000	0.000	B1	
N3	-0.001	1.020	B2	Sn2
N4	0.999	1.020	B2	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - IPE240	S 235	1.000	N1	N2	beam (80)
B2	CS1 - IPE240	S 235	1.000	N3	N4	beam (80)

2.4. Arbitrary members

AP			
Member	B1		
Coor	Rela		
length 1, Css1(1), Css2(1)	1.000	CS4 - Rectangle (40; 50)	CS3 - Rectangle (10; 10)
length 2, Css1(2), Css2(2)	0.000	CS3 - Rectangle (10; 10)	
AP1			
Member	B2		
Coor	Rela		
length 1, Css1(1), Css2(1)	1.000	CS2 - Rectangle (40; 40)	CS3 - Rectangle (10; 10)
length 2, Css1(2), Css2(2)	0.000	CS3 - Rectangle (10; 10)	

2.5. Nodal supports

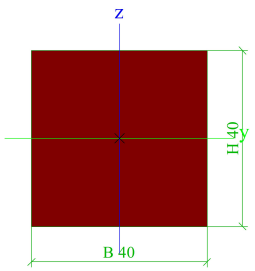
Name	Node	System	Type	Z	Rx	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid
Sn2	N3	GCS	Standard	Rigid	Rigid	Rigid

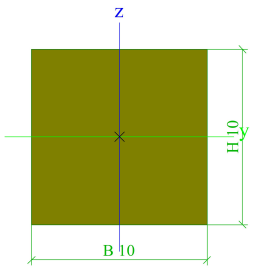
2.6. Materials

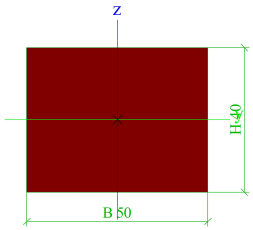
Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7800.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

2.7. Cross-sections

CS2		
Type	Rectangle	
Detailed	40; 40	
Item material	S 235	
A [m²]	1.6000e-03	
A_y [m²], A_z [m²]	1.3333e-03	1.3333e-03
A_L [m²/m], A_D [m²/m]	1.6000e-01	1.6000e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	20	20
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.1333e-07	2.1333e-07
i_y [mm], i_z [mm]	12	12
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.0667e-05	1.0667e-05
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.6000e-05	1.6000e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	3760.00	3760.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	3760.00	3760.00
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	3.6027e-07	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

CS3		
Type	Rectangle	
Detailed	10; 10	
Item material	S 235	
A [m²]	1.0000e-04	
A_y [m²], A_z [m²]	8.3333e-05	8.3333e-05
A_L [m²/m], A_D [m²/m]	4.0000e-02	4.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	5	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	8.3333e-10	8.3333e-10
i_y [mm], i_z [mm]	3	3
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.6667e-07	1.6667e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.5000e-07	2.5000e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	58.75	58.75
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	58.75	58.75
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.4073e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

CS4		
Type	Rectangle	
Detailed	40; 50	
Item material	S 235	
A [m²]	2.0000e-03	
A_y [m²], A_z [m²]	1.6667e-03	1.6667e-03
A_L [m²/m], A_D [m²/m]	1.8000e-01	1.8000e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	25	20
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.6667e-07	4.1667e-07
i_y [mm], i_z [mm]	12	14
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.3333e-05	1.6667e-05
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.0000e-05	2.5000e-05
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	4700.00	4700.00
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	5875.00	5875.00
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	5.4984e-07	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

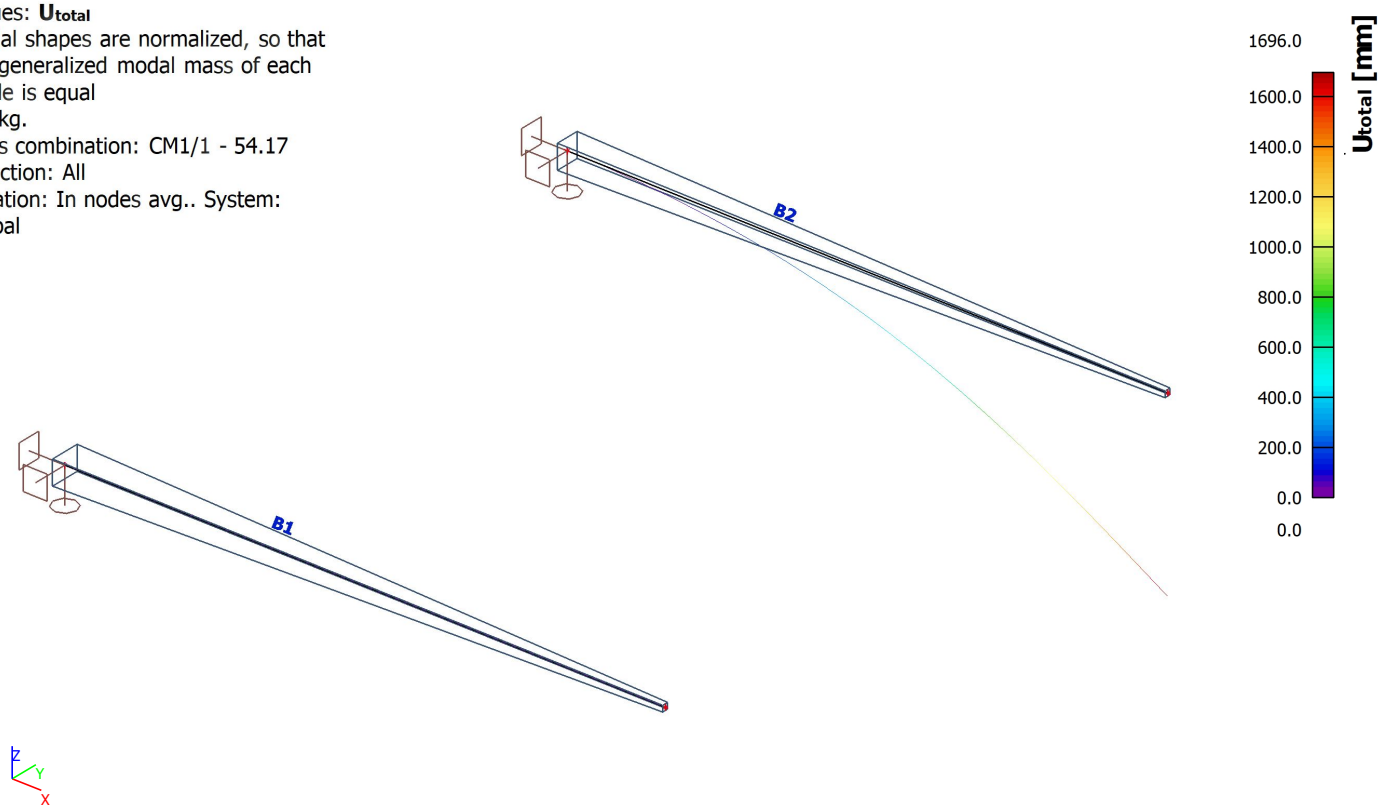
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [$1/s^2$]	T [s]
Mass combination : CM1				
1	54.17	340.38	115857.84	0.02
2	56.54	355.26	126211.87	0.02
3	171.88	1079.91	1166197.97	0.01
4	175.73	1104.11	1219056.10	0.01
5	384.23	2414.09	5827850.07	0.00
6	388.78	2442.72	5966859.14	0.00
7	696.70	4377.38	19161477.29	0.00
8	701.68	4408.64	19436098.30	0.00
9	1111.04	6980.67	48729819.45	0.00
10	1116.28	7013.62	49190809.39	0.00

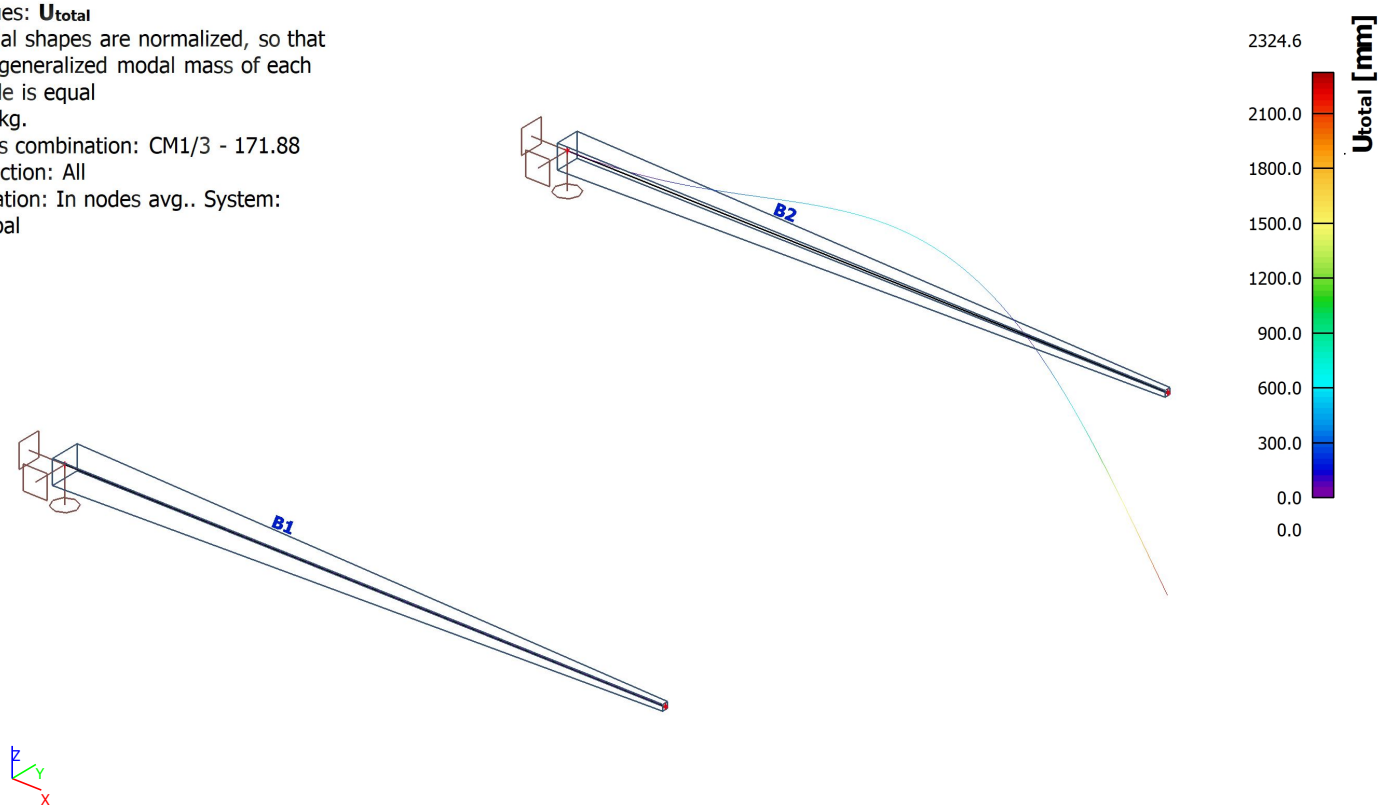
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/1 - 54.17
Selection: All
Location: In nodes avg.. System: Global



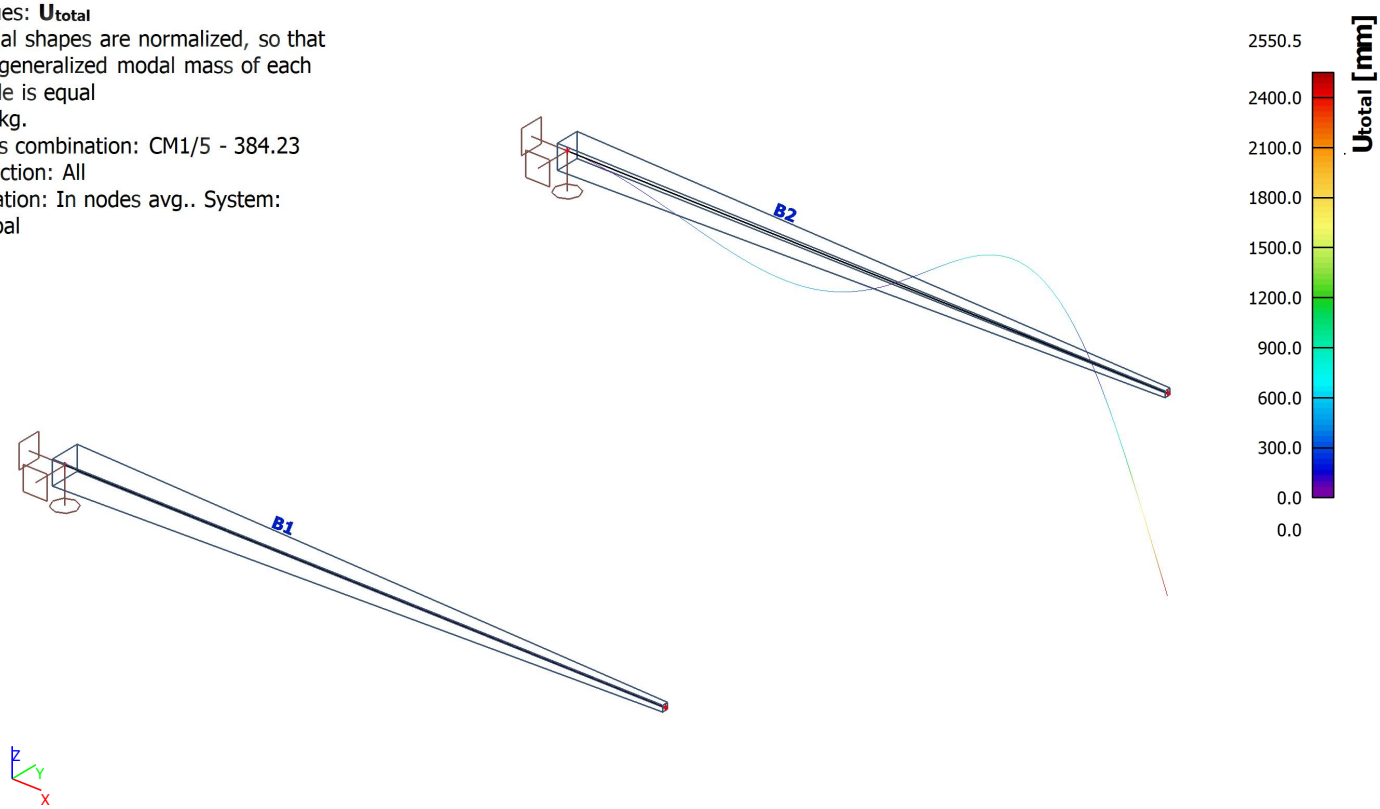
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/3 - 171.88
Selection: All
Location: In nodes avg.. System: Global



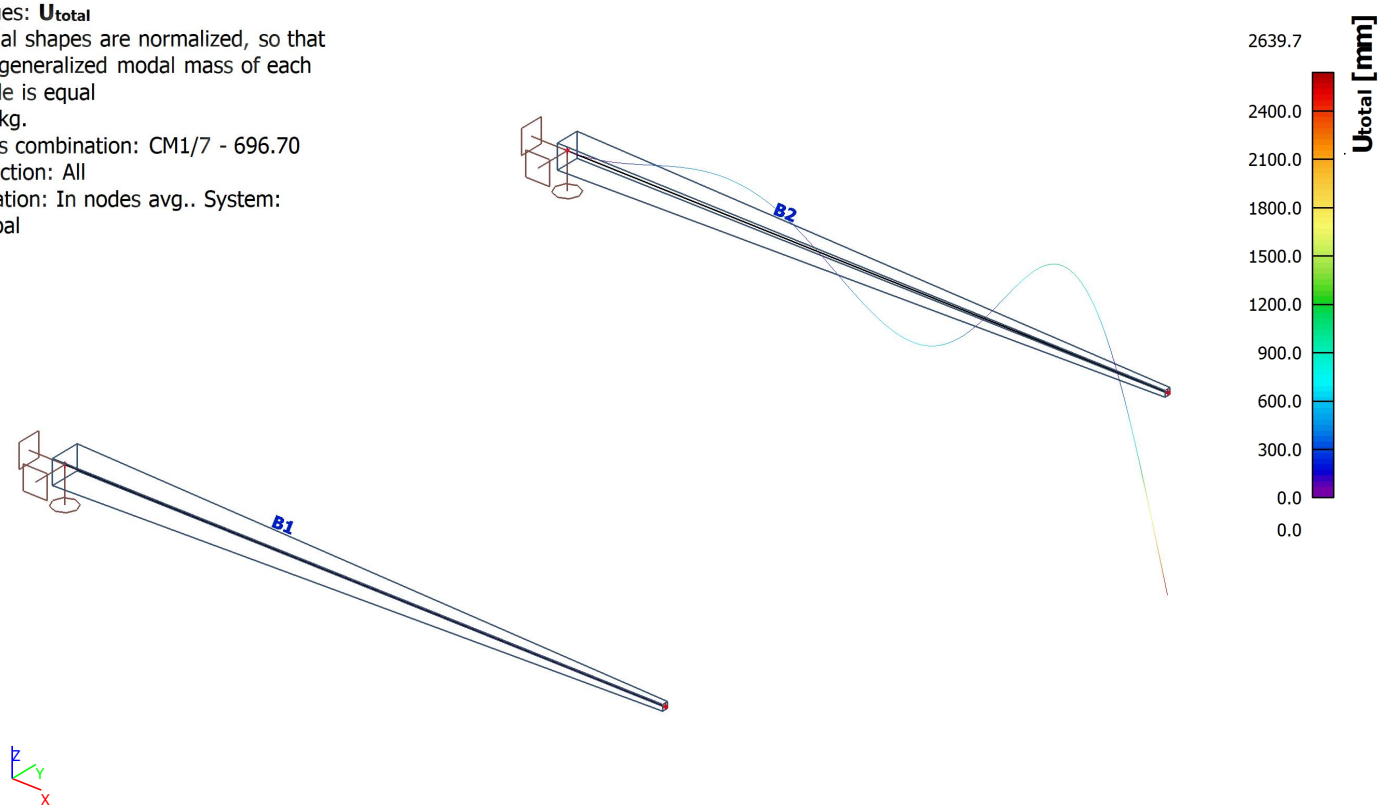
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/5 - 384.23
Selection: All
Location: In nodes avg.. System: Global



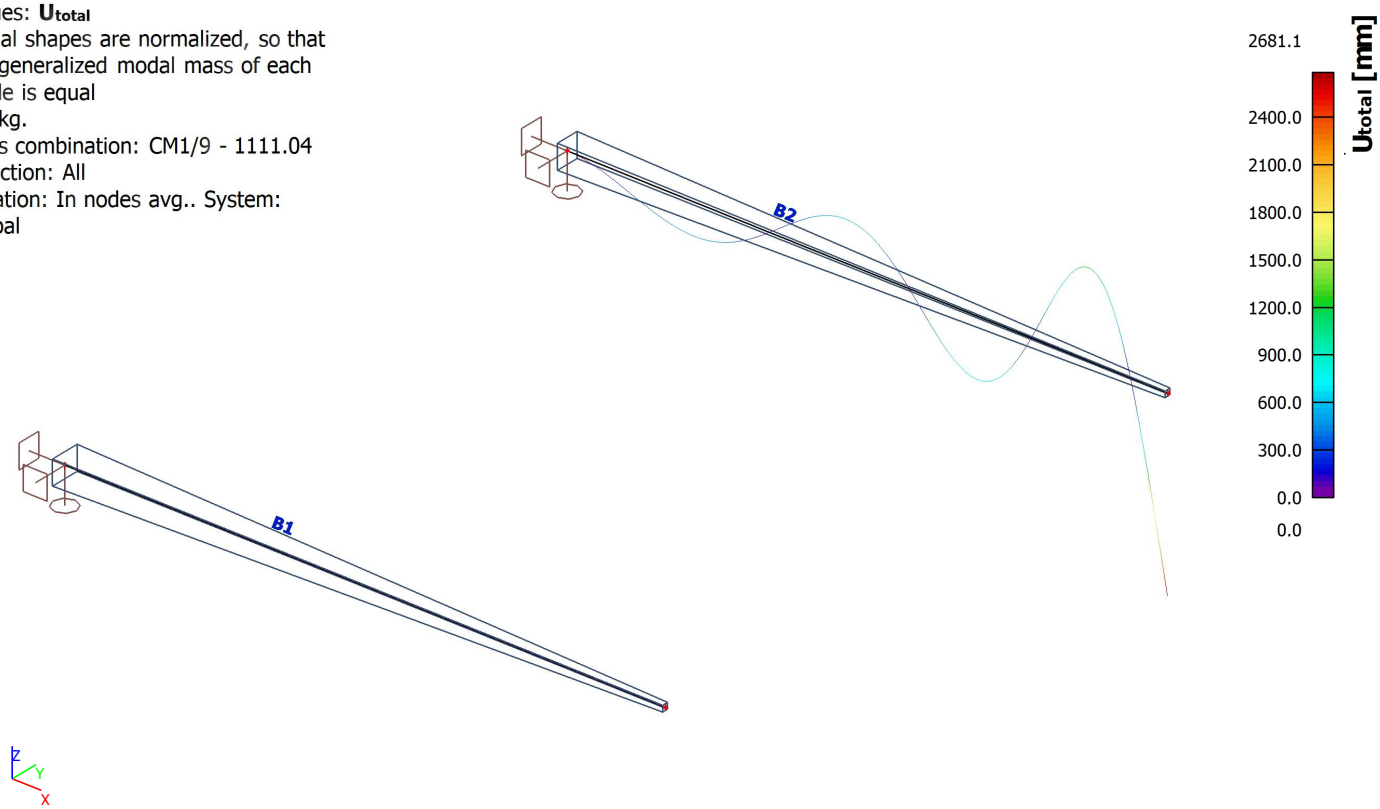
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/7 - 696.70
Selection: All
Location: In nodes avg.. System: Global



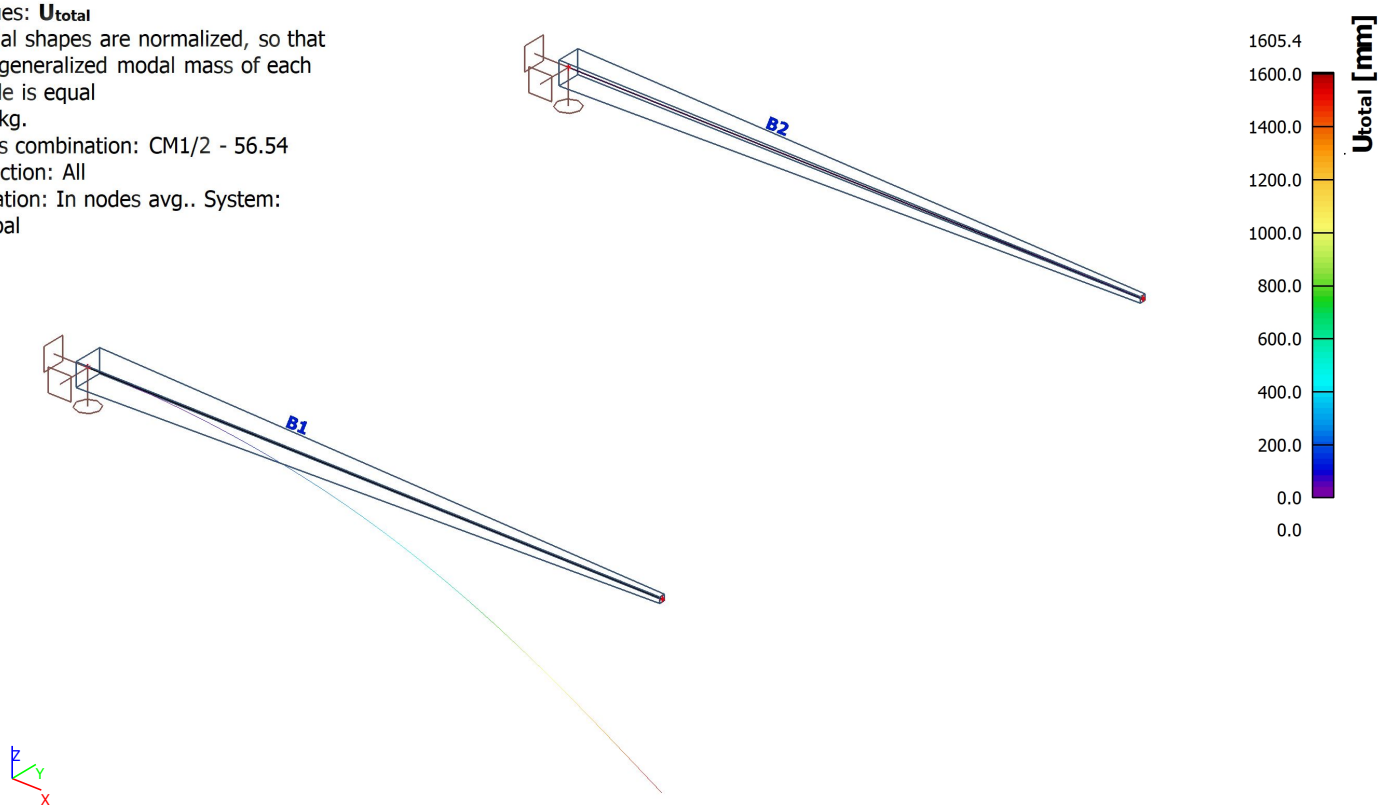
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/9 - 1111.04
Selection: All
Location: In nodes avg.. System: Global



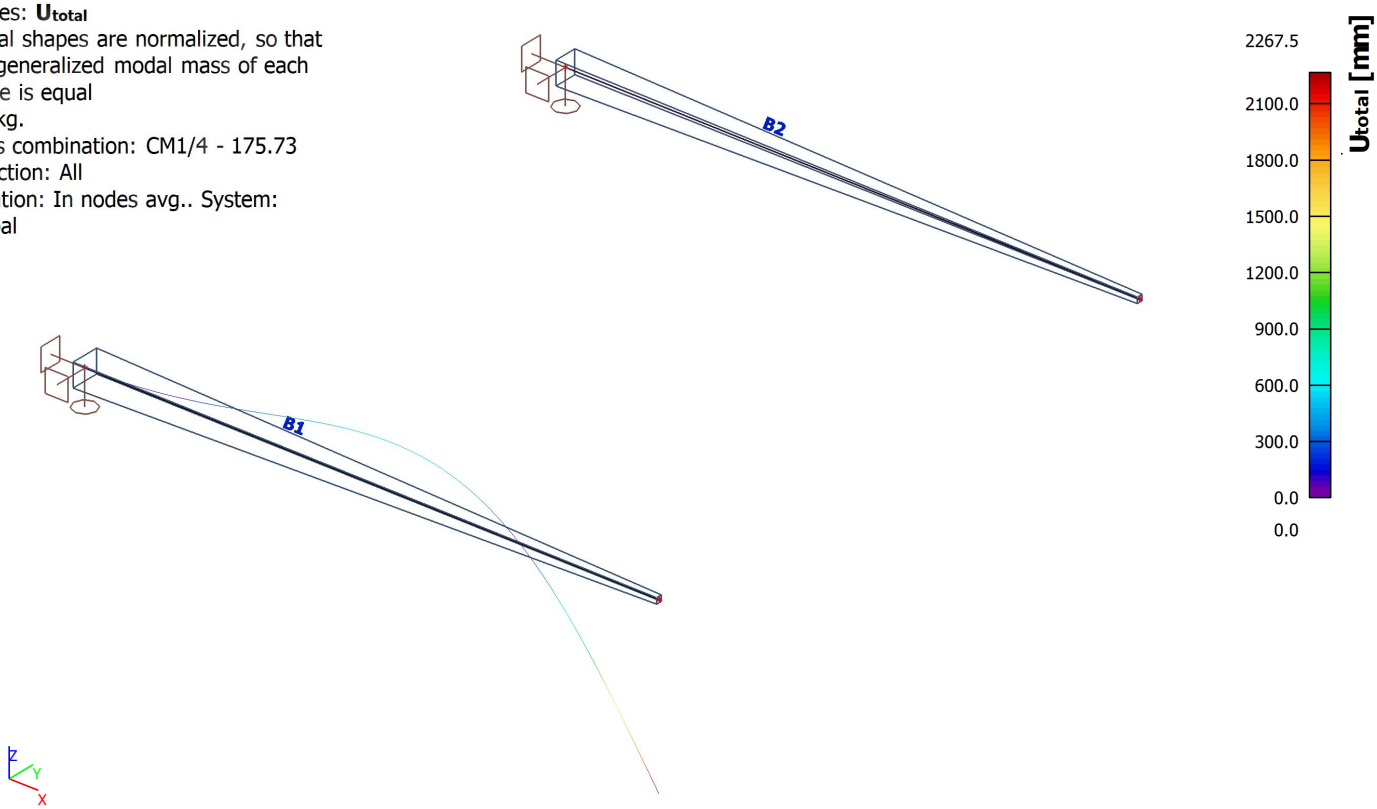
4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/2 - 56.54
Selection: All
Location: In nodes avg.. System: Global



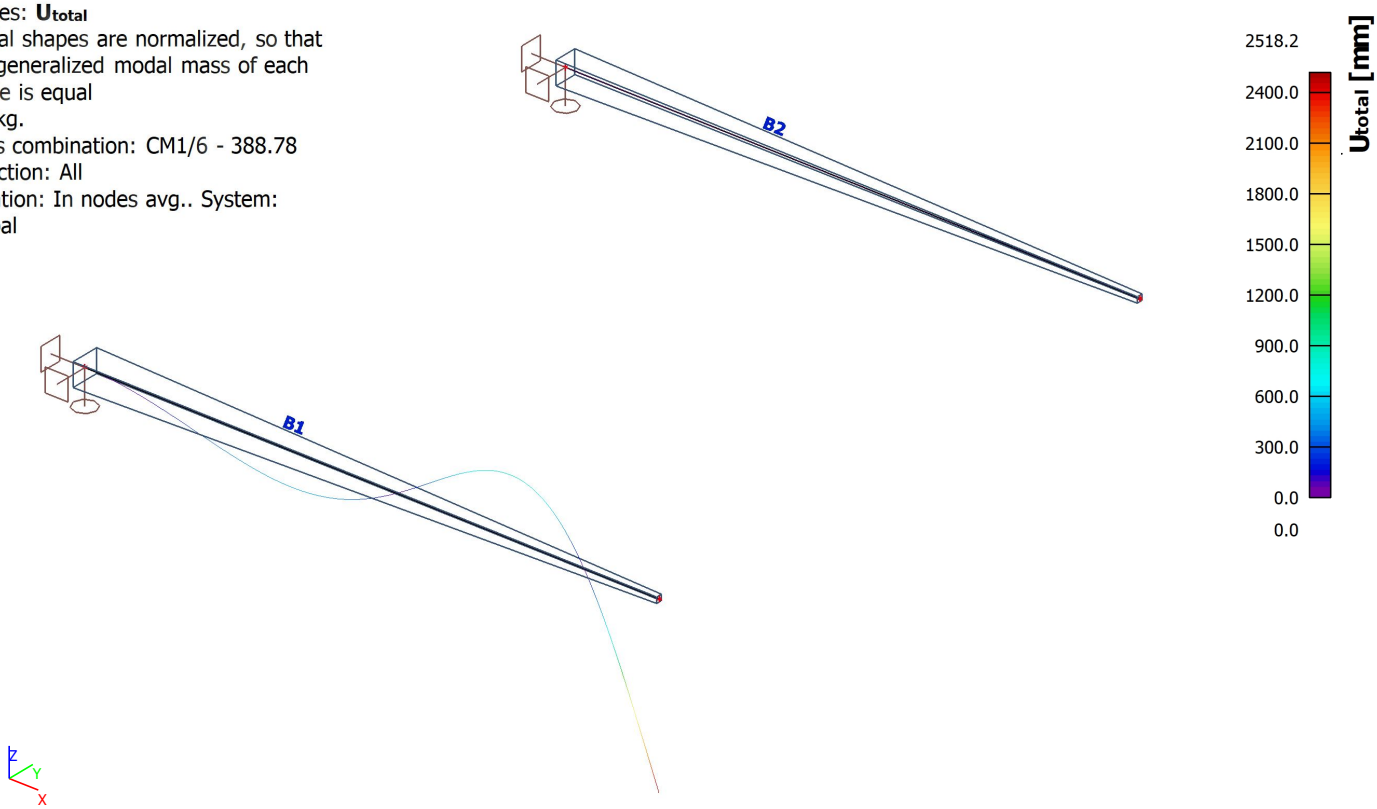
4.8. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 175.73
Selection: All
Location: In nodes avg.. System: Global



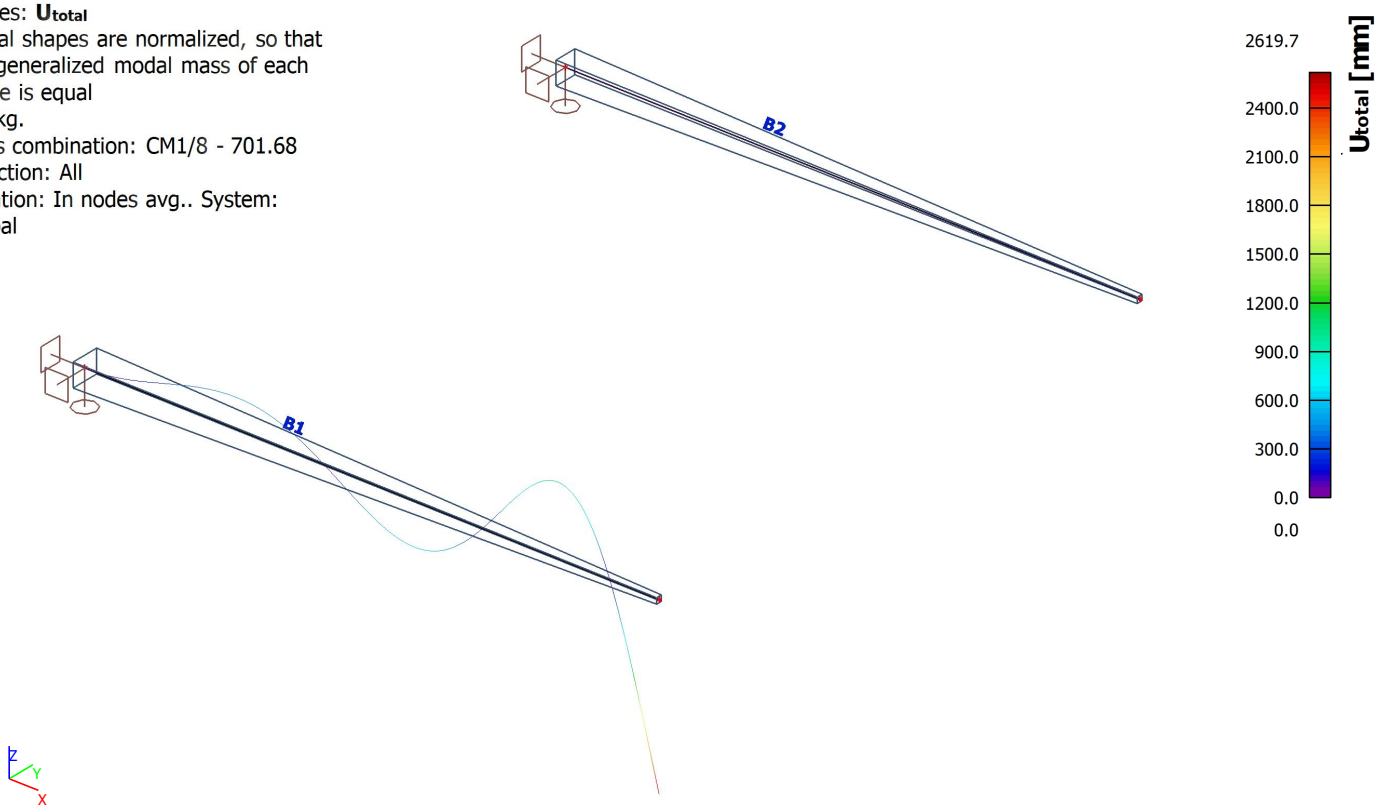
4.9. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/6 - 388.78
Selection: All
Location: In nodes avg.. System: Global



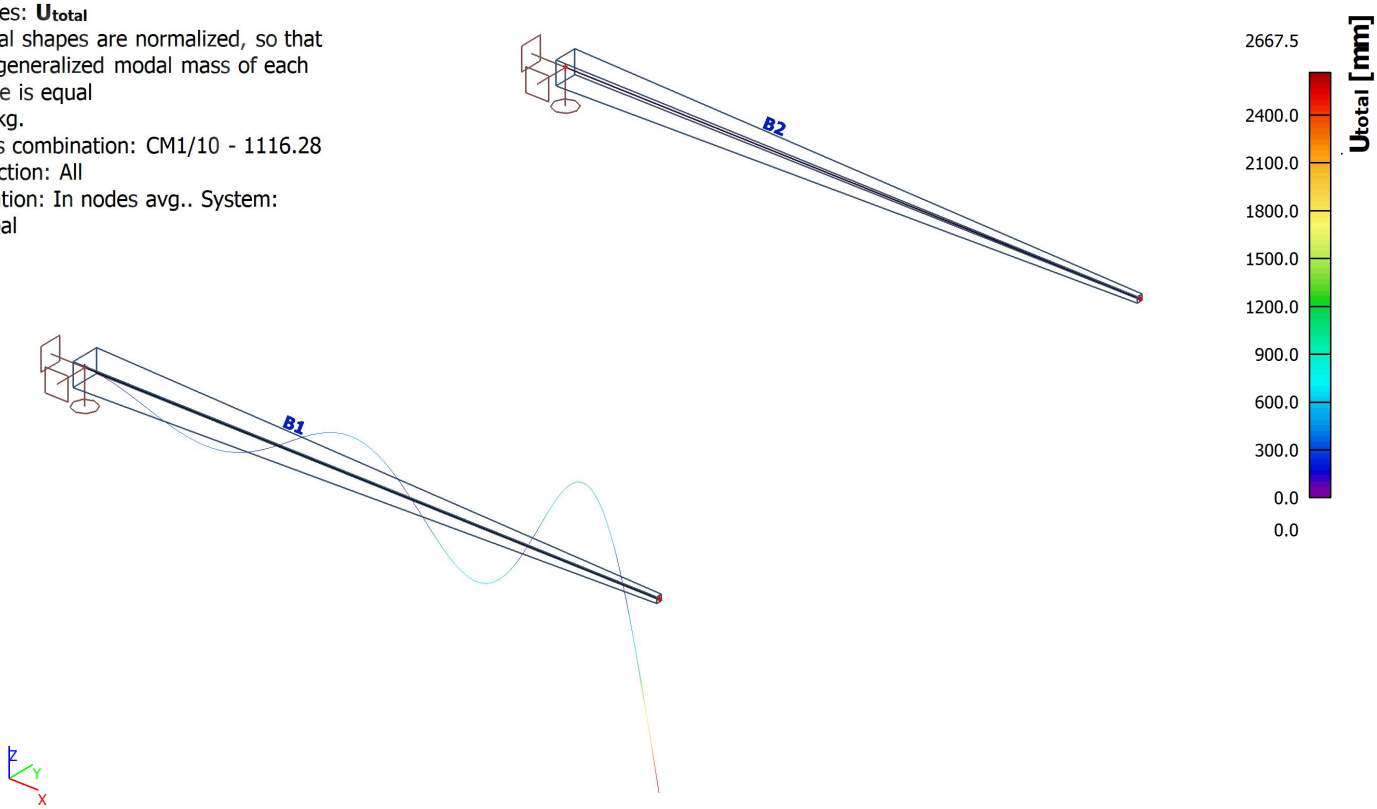
4.10. 3D displacement; U_total

Values: **U_{total}**
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/8 - 701.68
Selection: All
Location: In nodes avg.. System: Global



4.11. 3D displacement; U_total

Values: **U_{total}**
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/10 - 1116.28
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Beam B1:

f1 = 56.55 Hz
f2 = 175.79 Hz
f3 = 389.01 Hz
f4 = 702.36 Hz
f5 = 1117.63 Hz

Beam B2:

f1 = 54.18 Hz
f2 = 171.94 Hz
f3 = 384.40 Hz
f4 = 697.24 Hz
f5 = 1112.28 Hz

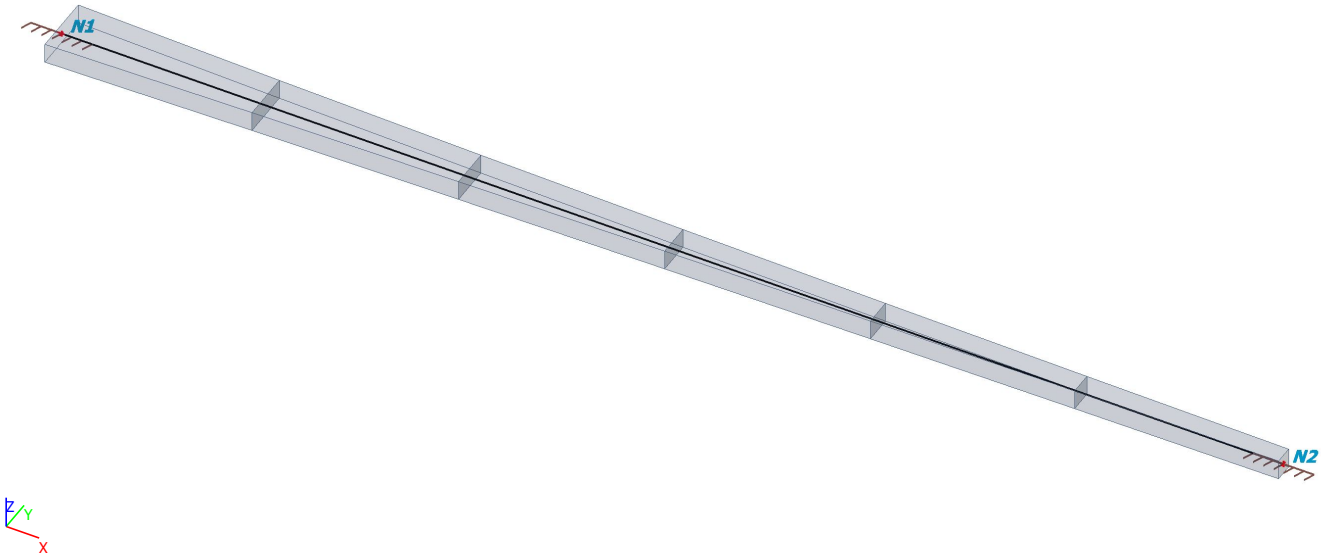
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a fixed beam with variable cross-section.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	Sn1
N2	0.600	0.000	B1	Sn2

2.3. Members

2.3.1. Members - B1

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Rectangle (10; 25)	Material	0.600	N1	N2	beam (80)

2.3.1.1. Arbitrary members

AP			
Member	B1		
Coor	Rela		
length 1, Css1(1), Css2(1)	0.167	CS1 - Rectangle (10; 30)	CS2 - Rectangle (10; 25)
length 2, Css1(2), Css2(2)	0.167	CS2 - Rectangle (10; 25)	CS3 - Rectangle (10; 20)
length 3, Css1(3), Css2(3)	0.167	CS3 - Rectangle (10; 20)	CS4 - Rectangle (10; 16)
length 4, Css1(4), Css2(4)	0.167	CS4 - Rectangle (10; 16)	CS5 - Rectangle (10; 13)
length 5, Css1(5), Css2(5)	0.166	CS5 - Rectangle (10; 13)	CS6 - Rectangle (10; 11)
length 6, Css1(6), Css2(6)	0.166	CS6 - Rectangle (10; 11)	CS7 - Rectangle (10; 9)

2.4. Nodal supports

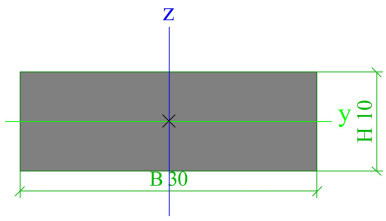
Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid
Sn2	N2	GCS	Standard	Rigid	Rigid	Rigid

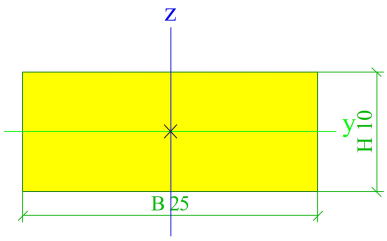
2.5. Materials

Steel EC3

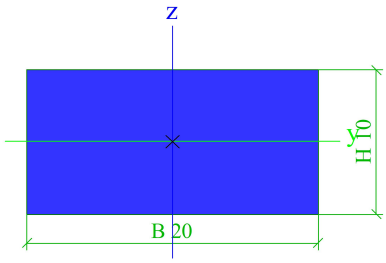
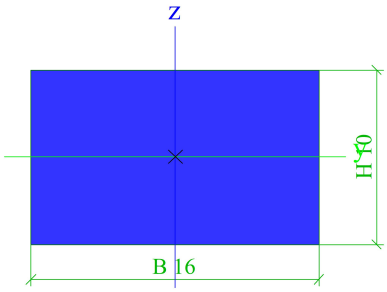
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7800.00	2.0000e+05	0.3	0	40	235.0	360.0	
		7.6923e+04	0.01e-003	40	80	215.0	360.0	

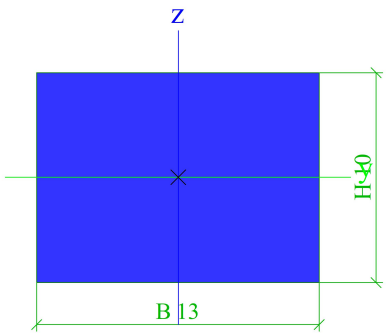
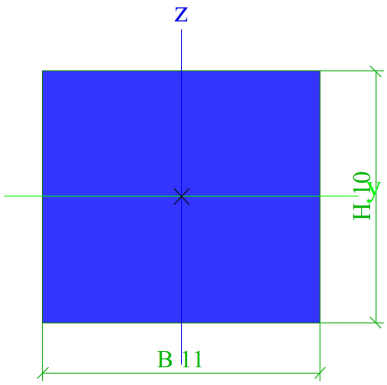
2.6. Cross-sections

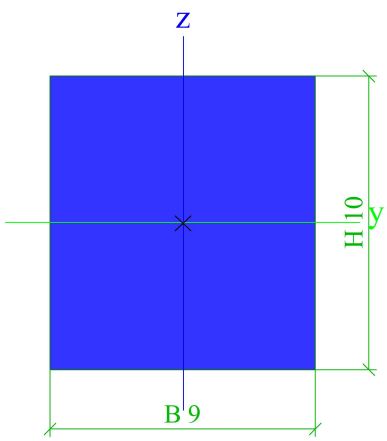
CS1		
Type	Rectangle	
Detailed	10; 30	
Item material	Material	
A [m²]	3.0000e-04	
A_y [m²], A_z [m²]	2.5000e-04	2.5000e-04
A_L [m²/m], A_D [m²/m]	8.0000e-02	8.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	15	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.5000e-09	2.2500e-08
i_y [mm], i_z [mm]	3	9
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	5.0000e-07	1.5000e-06
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	7.5000e-07	2.2500e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	176.25	176.25
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	528.75	528.75
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	7.9003e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

CS2		
Type	Rectangle	
Detailed	10; 25	
Item material	Material	
A [m²]	2.4562e-04	
A_y [m²], A_z [m²]	2.0468e-04	2.0468e-04
A_L [m²/m], A_D [m²/m]	6.9124e-02	6.9124e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	12	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.0468e-09	1.2348e-08
i_y [mm], i_z [mm]	3	7
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	4.0937e-07	1.0055e-06
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	6.1405e-07	1.5082e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	144.30	144.30
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	354.43	354.43
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	6.0892e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		

CS3		
Type	Rectangle	
Detailed	10; 20	
Item material	Material	
A [m²]	2.0110e-04	
A_y [m²], A_z [m²]	1.6758e-04	1.6758e-04
A_L [m²/m], A_D [m²/m]	6.0219e-02	6.0219e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.6758e-09	6.7769e-09
i_y [mm], i_z [mm]	3	6

$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	3.3516e-07	6.7399e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	5.0274e-07	1.0110e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	118.14	118.14
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	237.58	237.58
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	4.6108e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		
CS4		
Type	Rectangle	
Detailed	10; 16	
Item material	Material	
A [m^2]	1.6464e-04	
A_y [m^2], A_z [m^2]	1.3720e-04	1.3720e-04
A_L [m^2/m], A_D [m^2/m]	5.2929e-02	5.2929e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	8	5
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.3720e-09	3.7192e-09
i_y [mm], i_z [mm]	3	5
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	2.7441e-07	4.5179e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	4.1161e-07	6.7768e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	96.73	96.73
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	159.26	159.26
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	3.4118e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		
CS5		
Type	Rectangle	
Detailed	10; 13	
Item material	Material	
A [m^2]	1.3480e-04	
A_y [m^2], A_z [m^2]	1.1233e-04	1.1233e-04
A_L [m^2/m], A_D [m^2/m]	4.6960e-02	4.6960e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	7	5
α [deg]	0.00	
I_y [m^4], I_z [m^4]	1.1233e-09	2.0412e-09
i_y [mm], i_z [mm]	3	4
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	2.2467e-07	3.0285e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	3.3700e-07	4.5427e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	79.19	79.19
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	106.75	106.75
d_y [mm], d_z [mm]	0	0
I_t [m^4], I_w [m^6]	2.4533e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0

Picture		
CS6		
Type	Rectangle	
Detailed	10; 11	
Item material	Material	
A [m²]	1.1036e-04	
A_y [m²], A_z [m²]	9.1970e-05	9.1970e-05
A_L [m²/m], A_D [m²/m]	4.2073e-02	4.2073e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	6	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	9.1970e-10	1.1202e-09
i_y [mm], i_z [mm]	3	3
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.8394e-07	2.0300e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.7591e-07	3.0451e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	64.84	64.84
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	71.56	71.56
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.7059e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0
Picture		
CS7		
Type	Rectangle	
Detailed	10; 9	
Item material	Material	
A [m²]	9.0358e-05	
A_y [m²], A_z [m²]	7.5298e-05	7.5298e-05
A_L [m²/m], A_D [m²/m]	3.8072e-02	3.8072e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	5	5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	7.5298e-10	6.1478e-10
i_y [mm], i_z [mm]	3	3
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.5060e-07	1.3608e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.2589e-07	2.0411e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	53.09	53.09
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	47.97	47.97
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	1.1432e-09	0.0000e+00
β_y [mm], β_z [mm]	0	0

Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Self weight

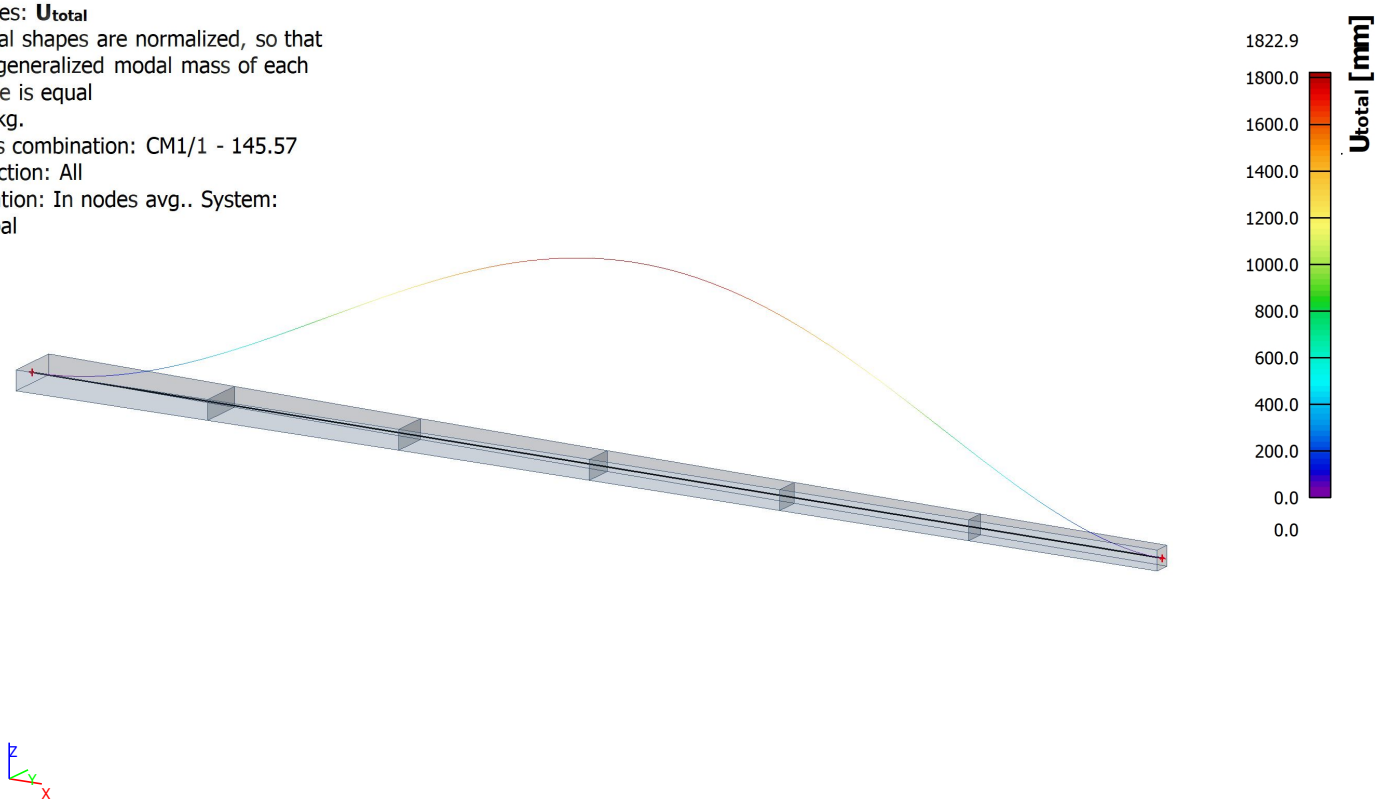
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [$1/s^2$]	T [s]
Mass combination : CM1				
1	145.57	914.61	836511.58	0.01
2	398.64	2504.64	6273211.74	0.00
3	777.84	4887.18	23884511.42	0.00
4	1280.20	8043.48	64697575.00	0.00

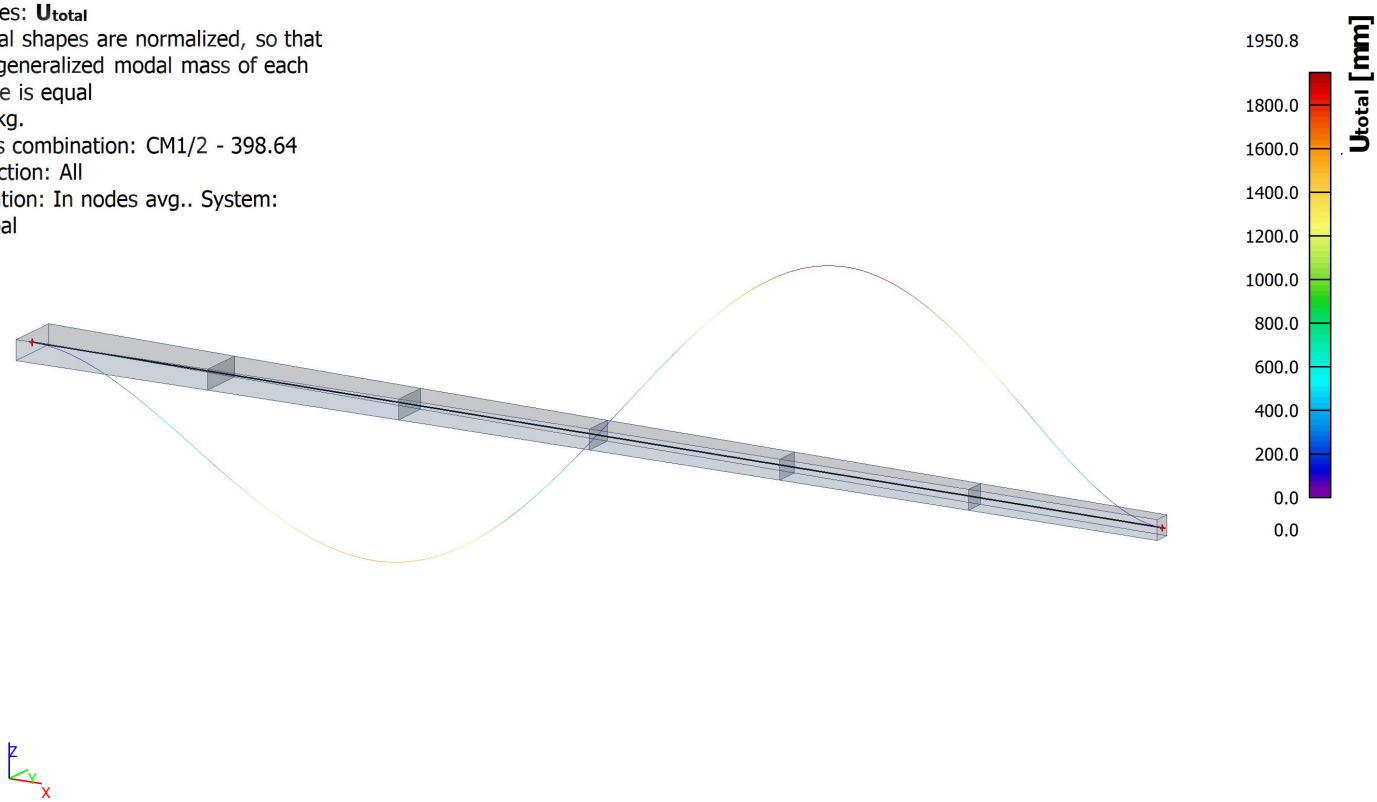
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 145.57
Selection: All
Location: In nodes avg.. System: Global



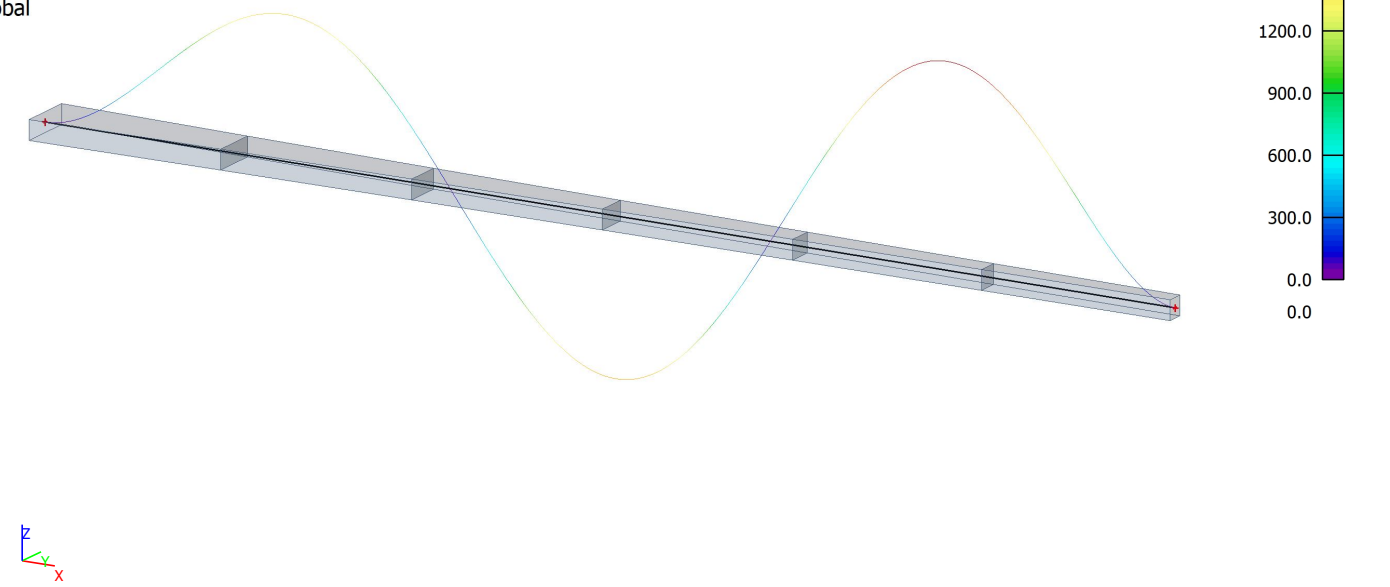
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 398.64
Selection: All
Location: In nodes avg.. System: Global



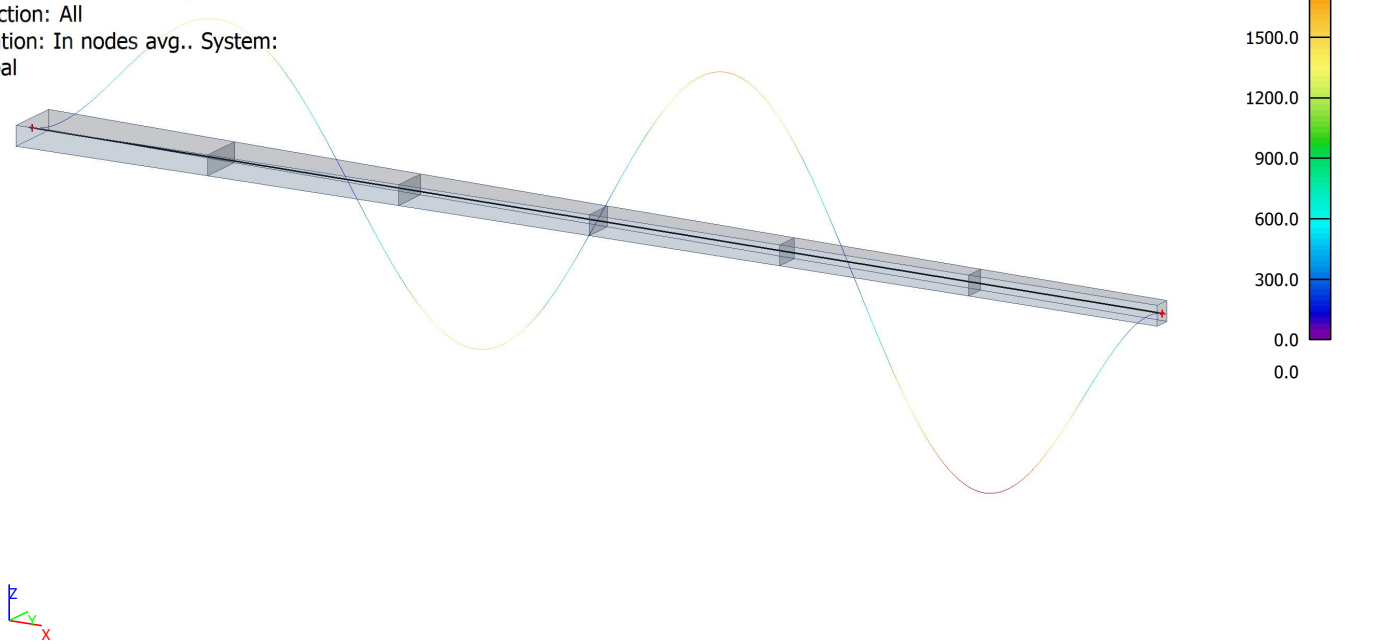
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/3 - 777.84
Selection: All
Location: In nodes avg.. System: Global



4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 1280.20
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 143.3 Hz
f2 = 396.8 Hz
f3= 779.4 Hz
f4 = 1289.6 Hz

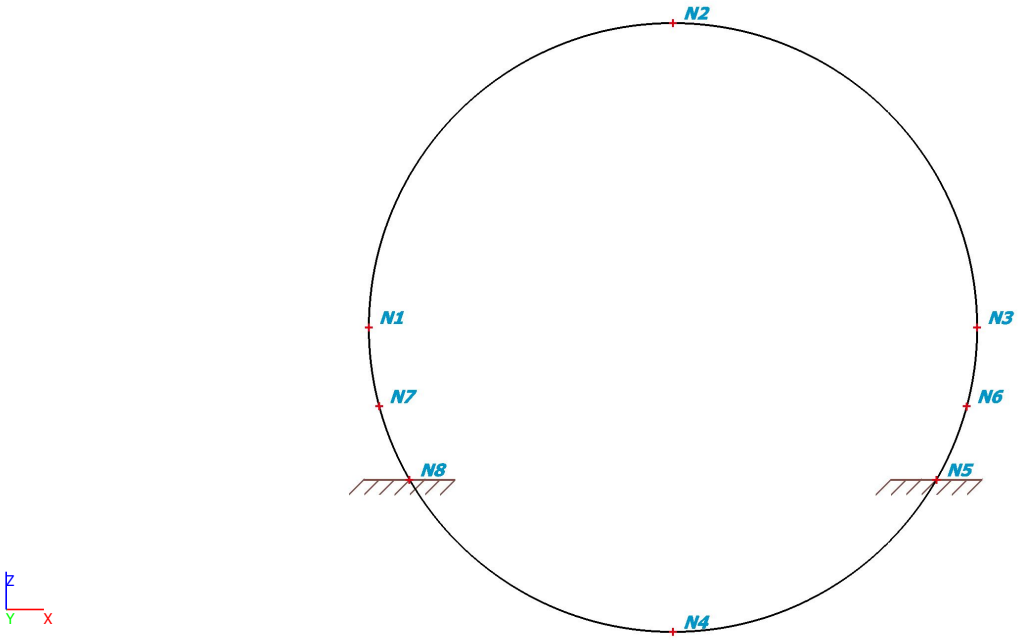
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a circular ring fixed in two points

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	
N2	0.100	0.100	B1	
N3	0.200	0.000	B1	
N4	0.100	-0.100	B4	

Name	Coord X [m]	Coord Z [m]	Member	Data
N5	0.187	-0.050	B1	Sn1
			B4	
N6	0.197	-0.026	B1	
N7	0.003	-0.026	B1	
N8	0.013	-0.050	B1	Sn2
			B4	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Rectangle (5.0; 10.0)	Material	0.419	N8	N5	general (0)
B4	CS2 - Rectangle (5.0; 10.0)	Material	0.209	N8	N5	general (0)

2.4. Nodal supports

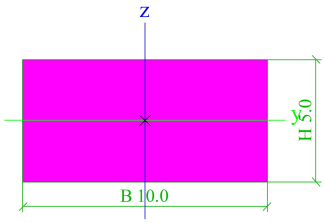
Name	Node	System	Type	X	Z	Ry
Sn1	N5	GCS	Standard	Rigid	Rigid	Rigid
Sn2	N8	GCS	Standard	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [mm]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	2700.00	7.2000e+04	0.3	0.0	40.0	235.0	360.0	
		2.7692e+04	0.01e-003	40.0	80.0	215.0	360.0	

2.6. Cross-sections

CS2		
Type	Rectangle	
Detailed	5.0; 10.0	
Item material	Material	
A [m²]	5.0000e-05	
A_y [m²], A_z [m²]	4.1667e-05	4.1667e-05
A_L [m²/m], A_D [m²/m]	3.0000e-02	3.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	5.0	2.5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.0417e-10	4.1667e-10
i_y [mm], i_z [mm]	1.4	2.9
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	4.1667e-08	8.3333e-08
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	6.2500e-08	1.2500e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	14.69	14.69
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	29.37	29.37
d_y [mm], d_z [mm]	0.0	0.0
I_t [m⁴], I_w [m⁶]	2.8591e-10	0.0000e+00
β_y [mm], β_z [mm]	0.0	0.0
Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

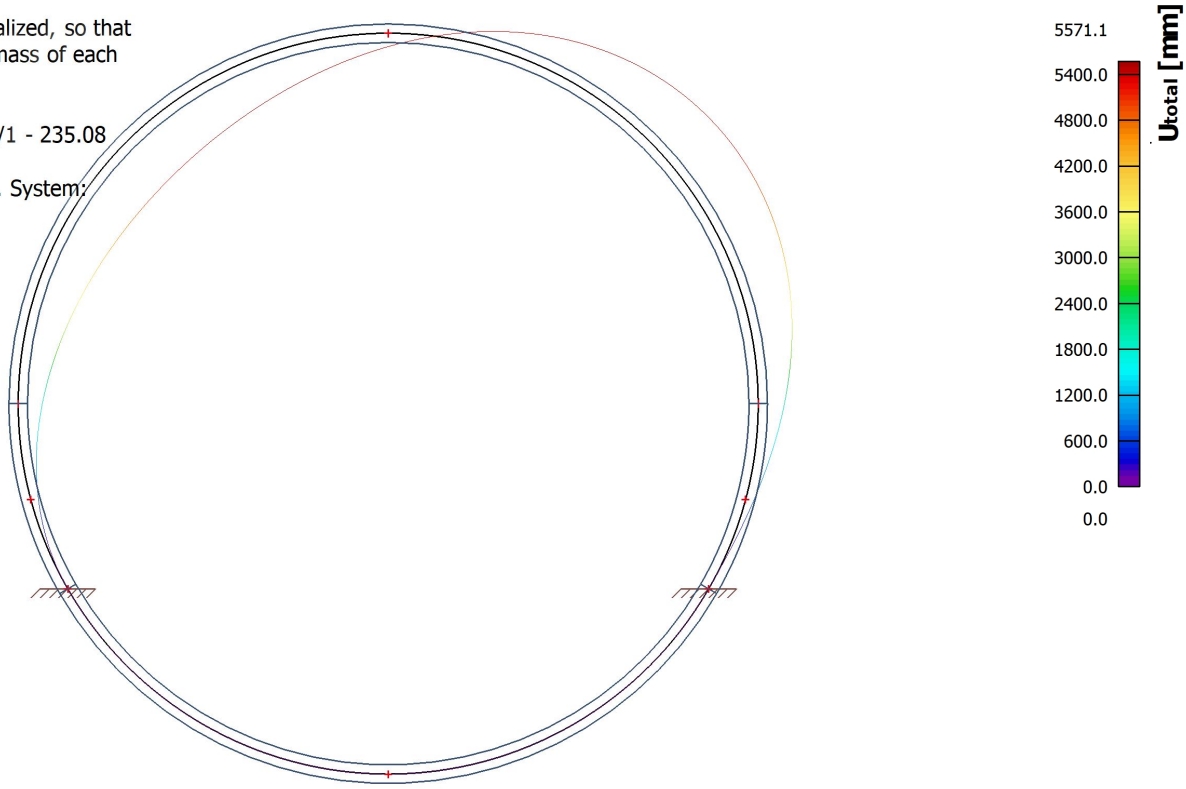
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [$1/s^2$]	T [s]
Mass combination : CM1				
1	235.08	1476.98	2181477.29	0.00
2	574.44	3609.23	13026522.85	0.00
3	1103.78	6935.07	48095253.54	0.00
4	1403.35	8817.25	77743973.46	0.00
5	1745.56	10967.36	120283075.20	0.00
6	2548.65	16013.16	256421365.74	0.00
7	2750.68	17282.51	298685303.01	0.00

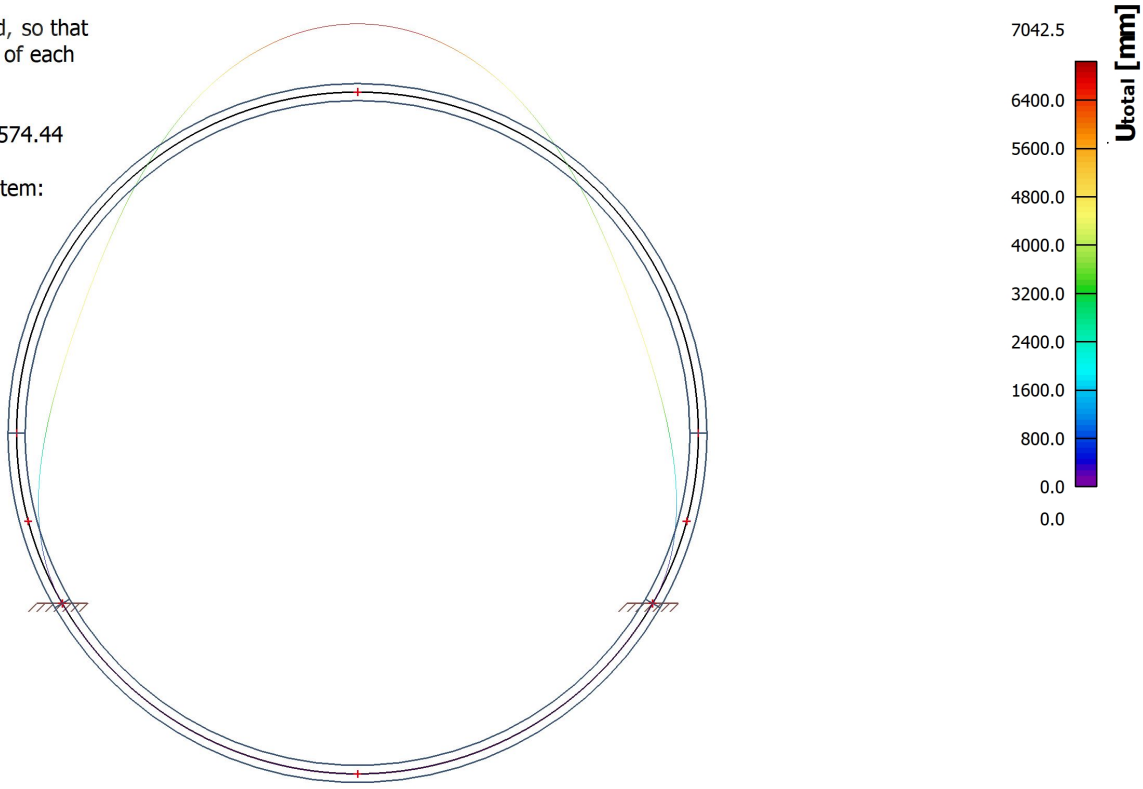
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/1 - 235.08
Selection: All
Location: In nodes avg.. System: Global



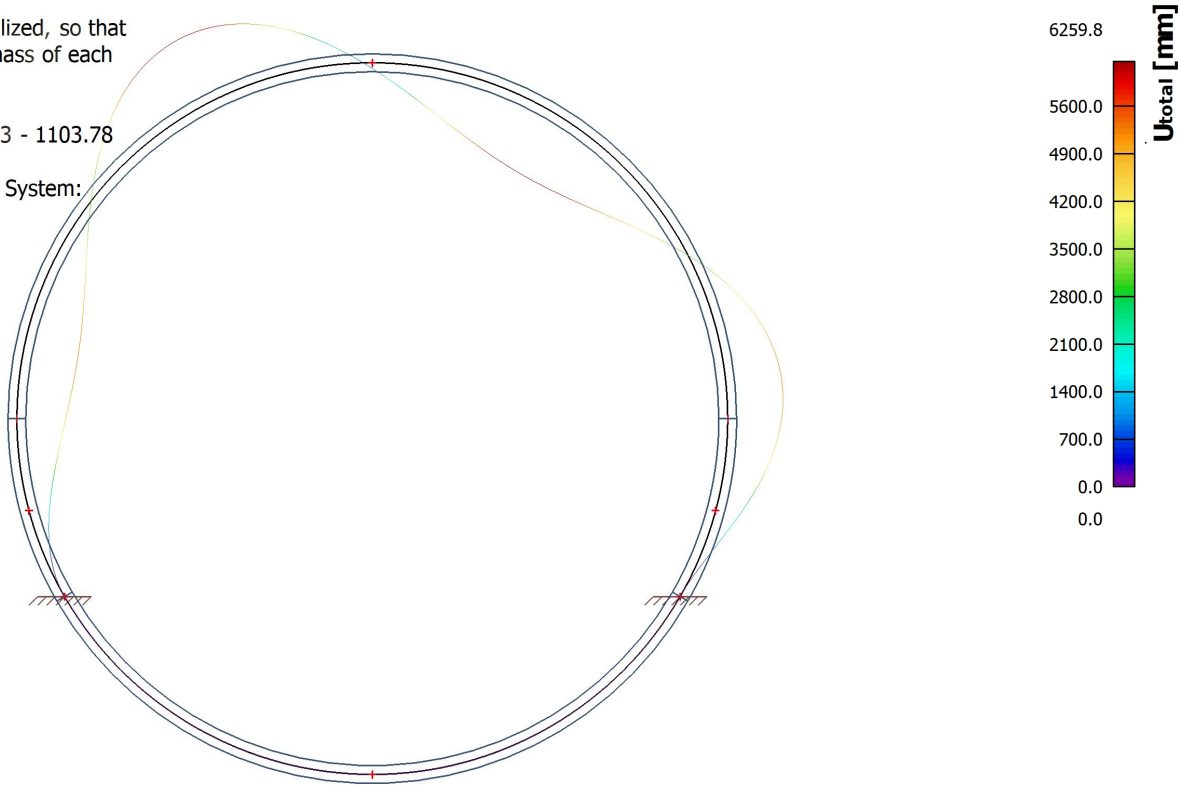
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/2 - 574.44
Selection: All
Location: In nodes avg.. System: Global



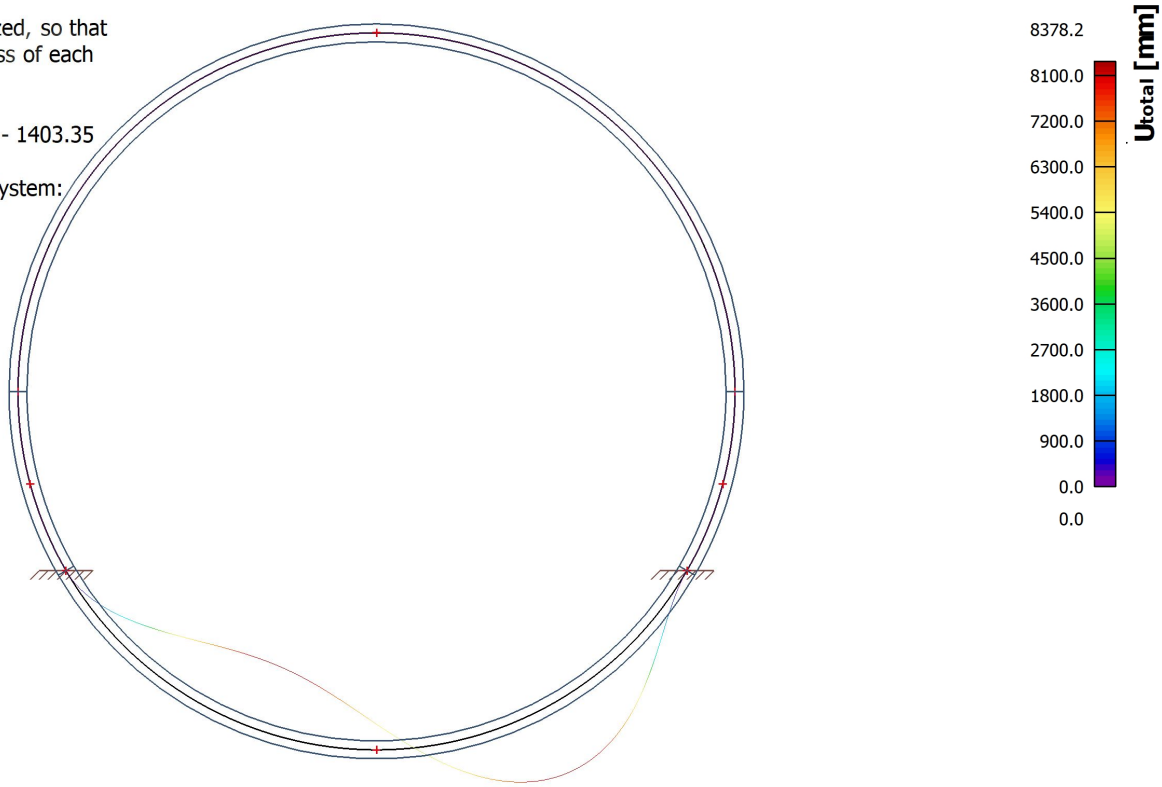
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/3 - 1103.78
Selection: All
Location: In nodes avg.. System: Global



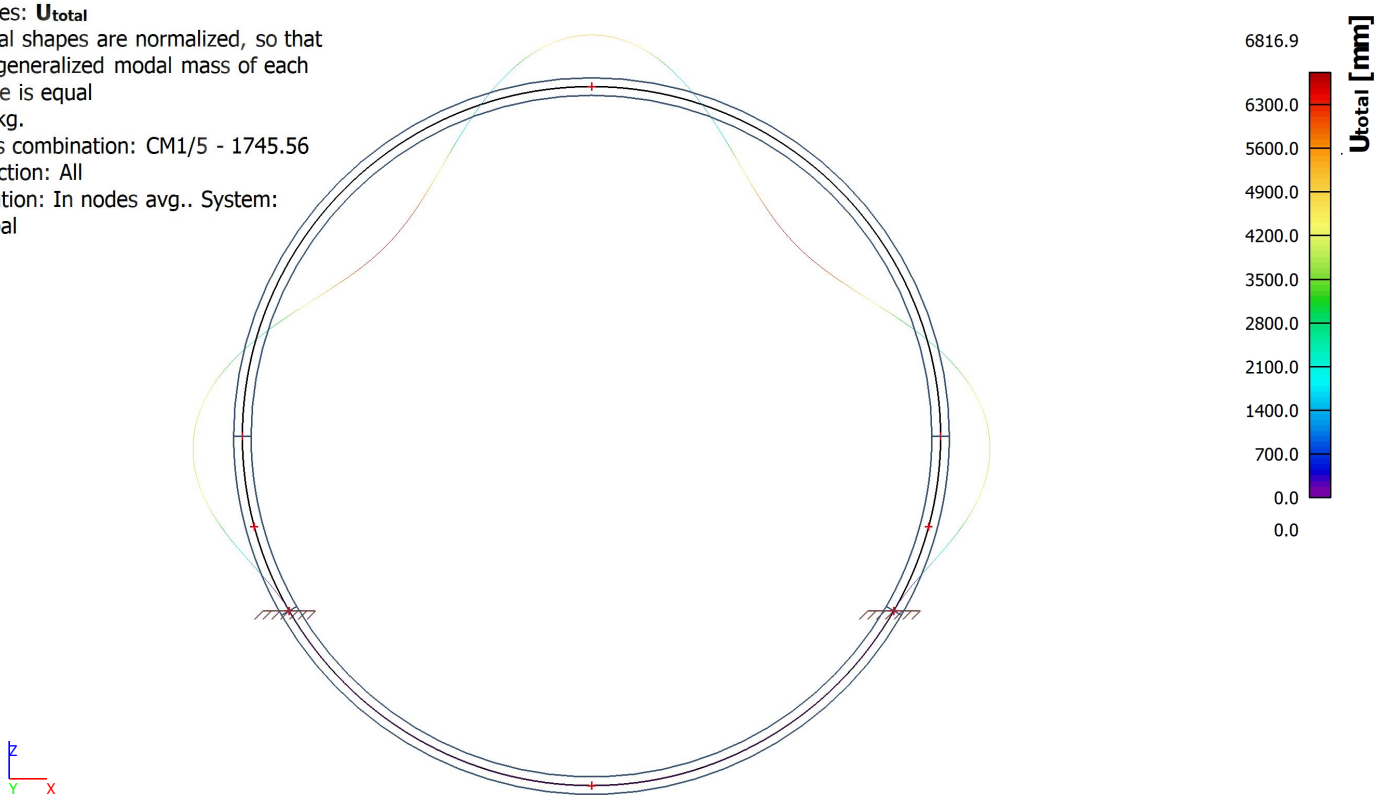
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 1403.35
Selection: All
Location: In nodes avg.. System: Global



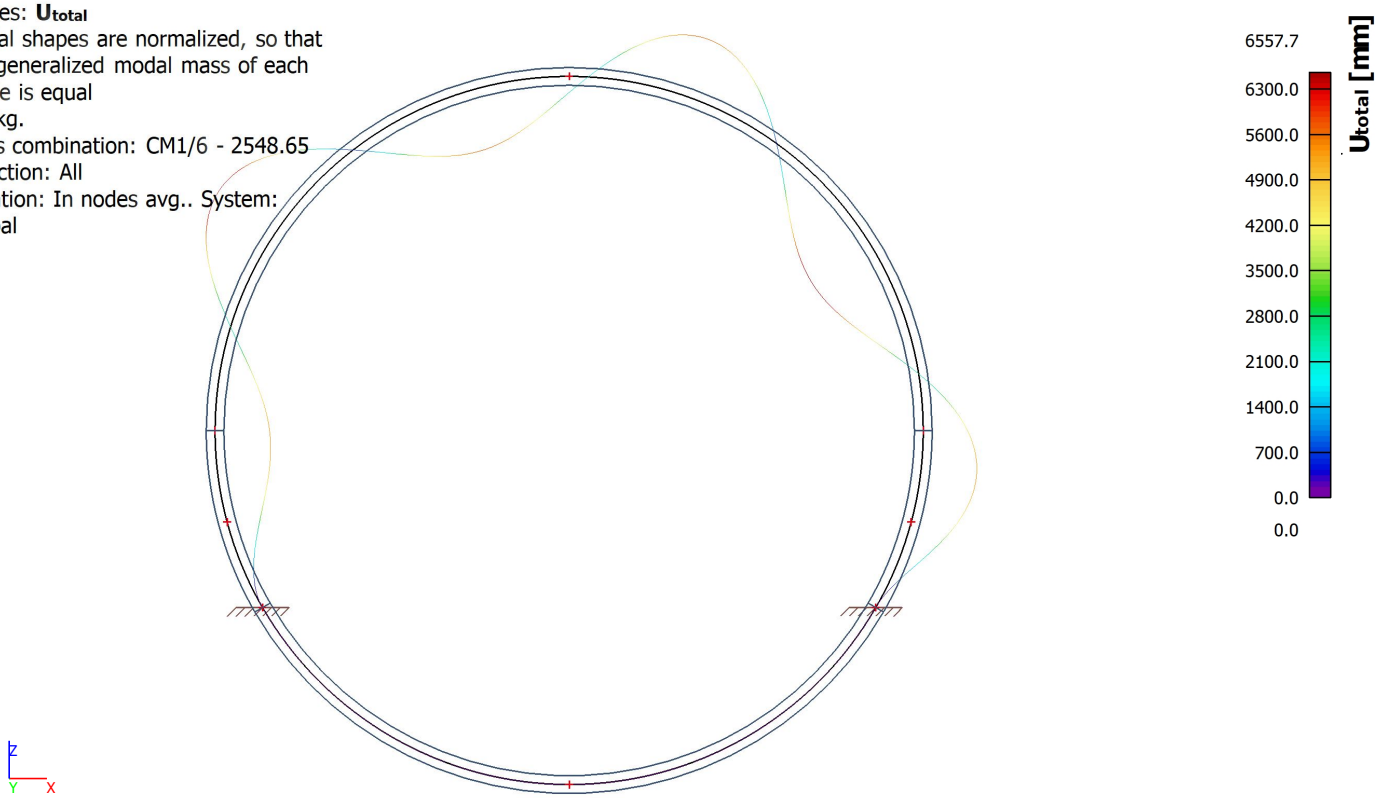
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/5 - 1745.56
Selection: All
Location: In nodes avg.. System: Global



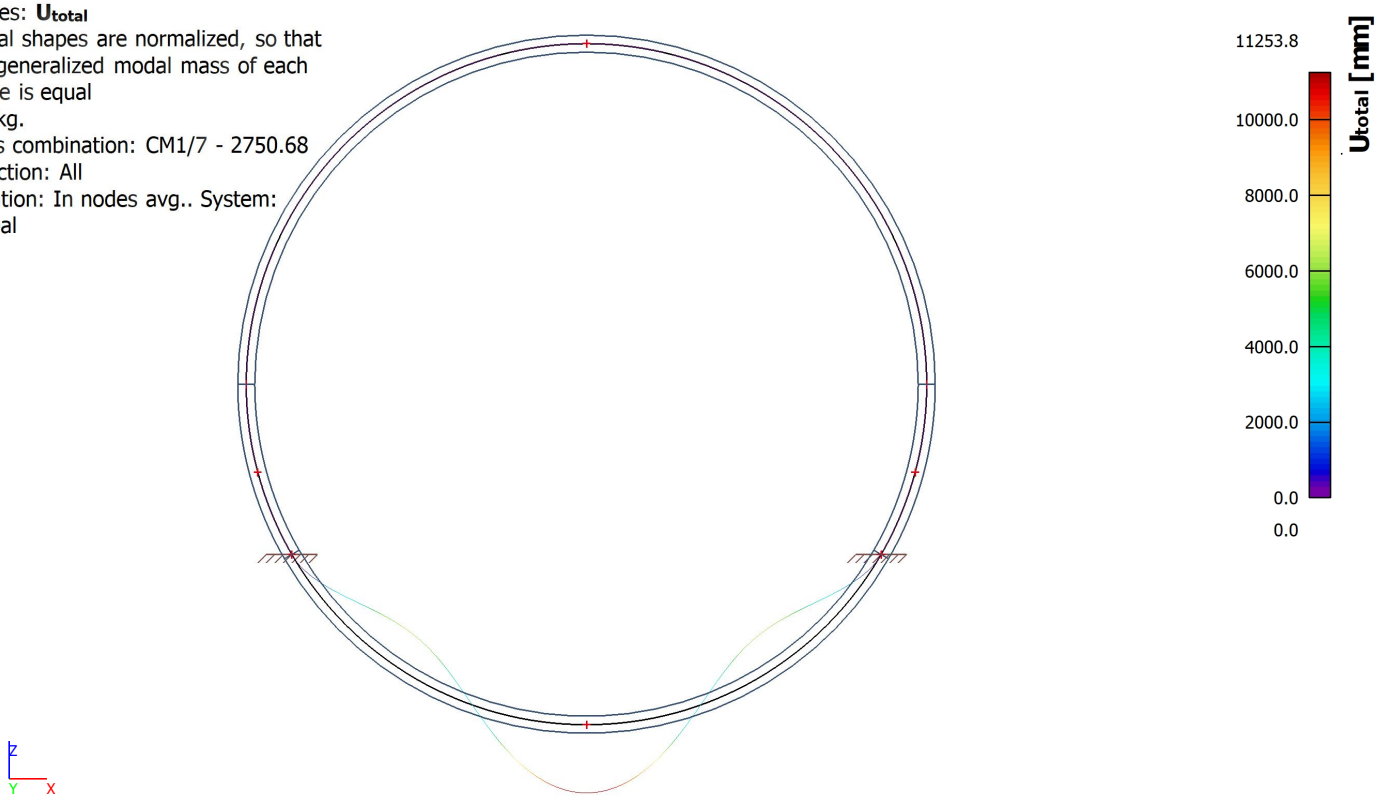
4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/6 - 2548.65
Selection: All
Location: In nodes avg.. System: Global



4.8. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/7 - 2750.68
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 235.3 Hz
f2 = 575.3 Hz
f3 = 1105.7 Hz
f4 = 1405.6 Hz
f5 = 1751.1 Hz
f6 = 2557.0 Hz
f7 = 2801.5 Hz

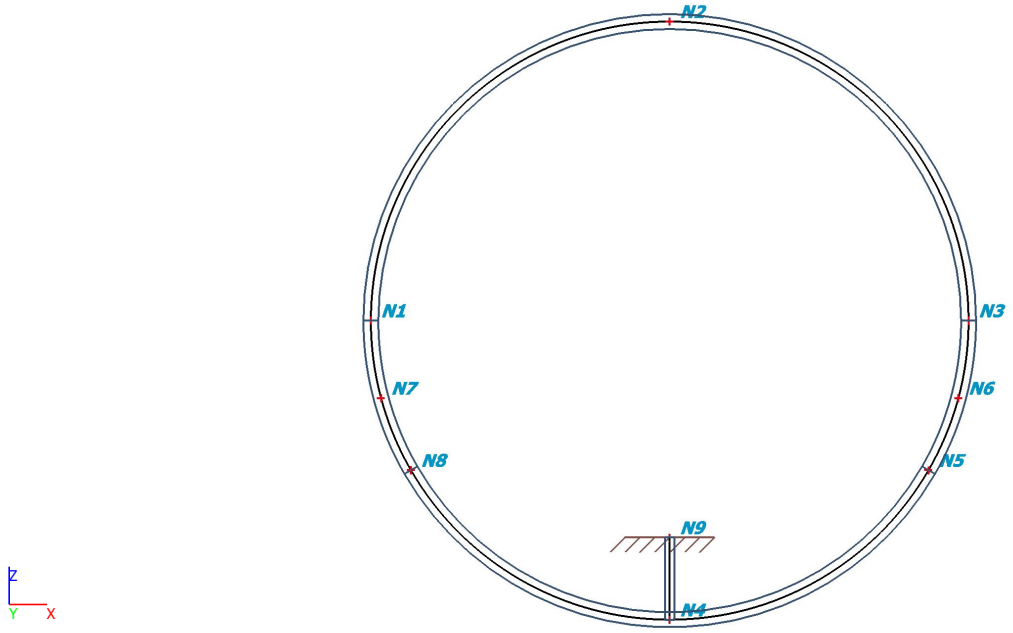
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a suspended circular ring

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	B1	
N2	0.100	0.100	B1	
N3	0.200	0.000	B1	
N4	0.100	-0.100	B4	
			B5	
N5	0.187	-0.050	B1	
			B4	

Name	Coord X [m]	Coord Z [m]	Member	Data
N6	0.197	-0.026	B1	
N7	0.003	-0.026	B1	
N8	0.013	-0.050	B1	
			B4	
N9	0.100	-0.072	B5	Sn1

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - Rectangle (5.0; 10.0)	Material	0.419	N8	N5	general (0)
B4	CS2 - Rectangle (5.0; 10.0)	Material	0.209	N8	N5	general (0)
B5	CS3 - Rectangle (3.0; 10.0)	Material	0.028	N4	N9	column (100)

2.4. Nodal supports

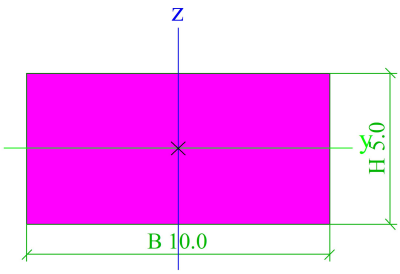
Name	Node	System	Type	X	Z	Ry
Sn1	N9	GCS	Standard	Rigid	Rigid	Rigid

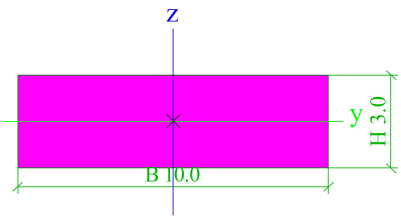
2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	2700.00	7.2000e+04	0.3	0.0	40.0	235.0	360.0	
		2.7692e+04	0.01e-003	40.0	80.0	215.0	360.0	

2.6. Cross-sections

CS2		
Type	Rectangle	
Detailed	5.0; 10.0	
Item material	Material	
A [m²]	5.0000e-05	
A_y [m²], A_z [m²]	4.1667e-05	4.1667e-05
A_L [m²/m], A_D [m²/m]	3.0000e-02	3.0000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	5.0	2.5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.0417e-10	4.1667e-10
i_y [mm], i_z [mm]	1.4	2.9
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	4.1667e-08	8.3333e-08
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	6.2500e-08	1.2500e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	14.69	14.69
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	29.37	29.37
d_y [mm], d_z [mm]	0.0	0.0
I_t [m⁴], I_w [m⁶]	2.8591e-10	0.0000e+00
β_y [mm], β_z [mm]	0.0	0.0
Picture		

CS3		
Type	Rectangle	
Detailed	3.0; 10.0	
Item material	Material	
A [m²]	3.0000e-05	
A_y [m²], A_z [m²]	2.5000e-05	2.5000e-05
A_L [m²/m], A_D [m²/m]	2.6000e-02	2.6000e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	5.0	1.5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.2500e-11	2.5000e-10
i_y [mm], i_z [mm]	0.9	2.9
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.5000e-08	5.0000e-08
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	2.2500e-08	7.5000e-08
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	5.29	5.29
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	17.63	17.63
d_y [mm], d_z [mm]	0.0	0.0
I_t [m⁴], I_w [m⁶]	7.2991e-11	0.0000e+00
β_y [mm], β_z [mm]	0.0	0.0
Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

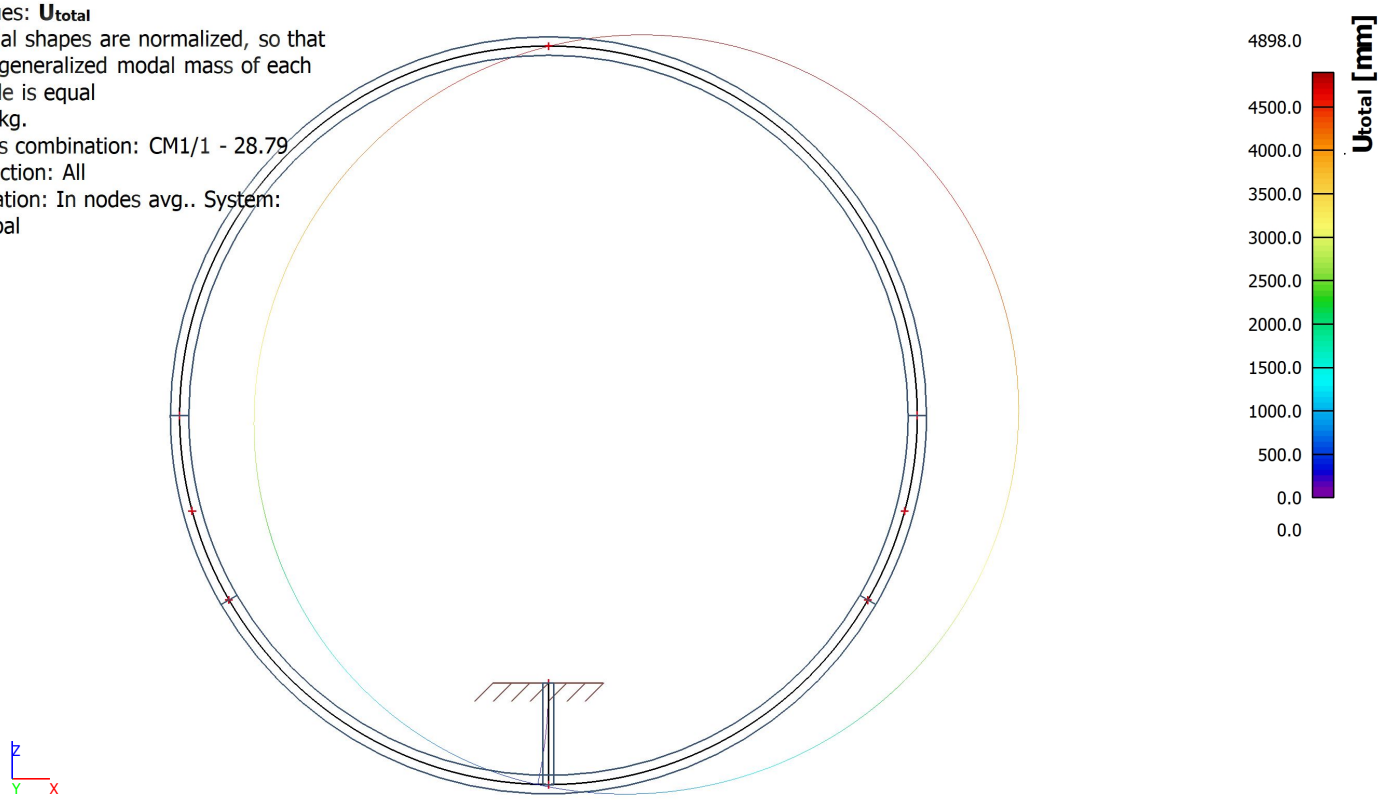
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [$1/s^2$]	T [s]
Mass combination : CM1				
1	28.79	180.89	32720.84	0.03
2	189.06	1187.89	1411071.76	0.01
3	267.95	1683.53	2834278.93	0.00
4	637.78	4007.14	16057207.00	0.00
5	681.01	4278.81	18308240.60	0.00
6	1061.28	6668.04	44462754.19	0.00

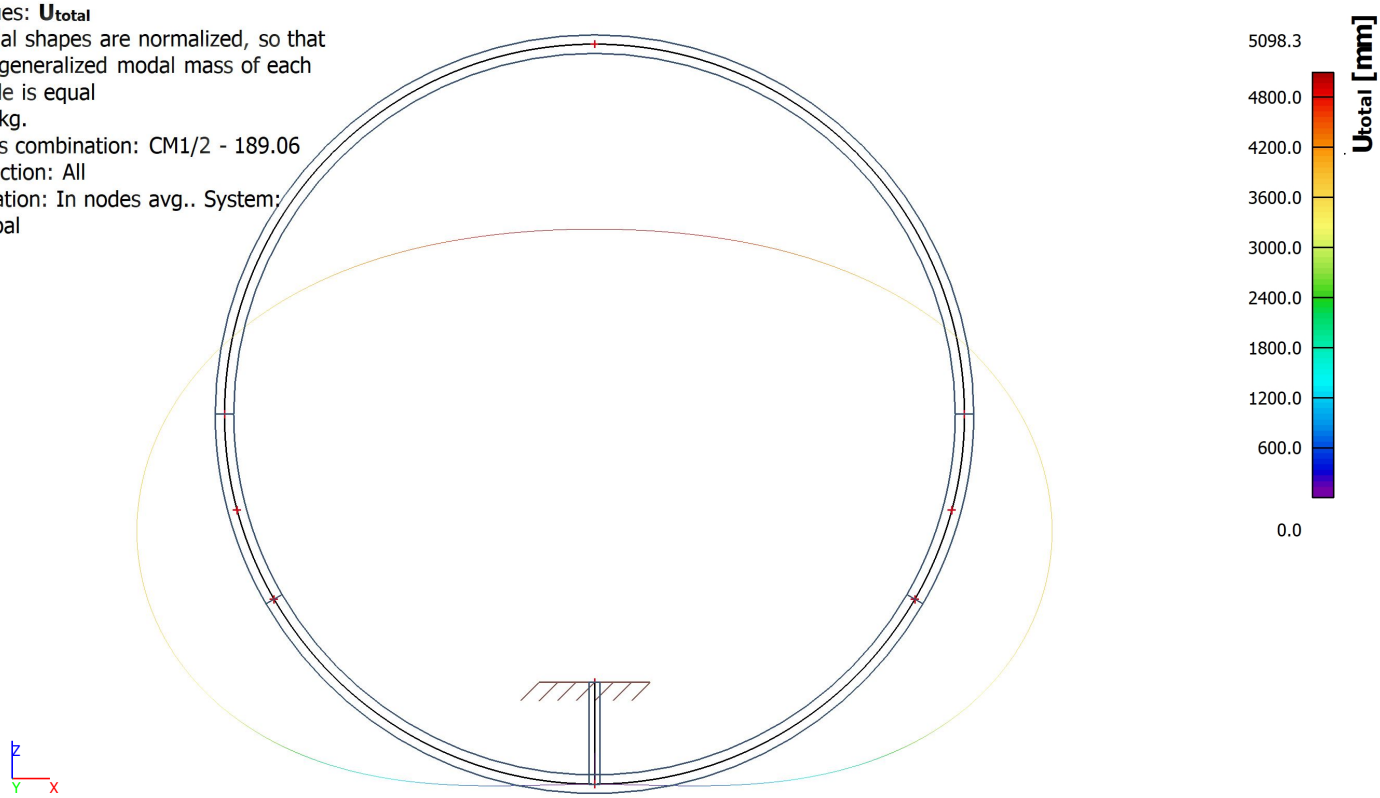
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 28.79
Selection: All
Location: In nodes avg.. System: Global



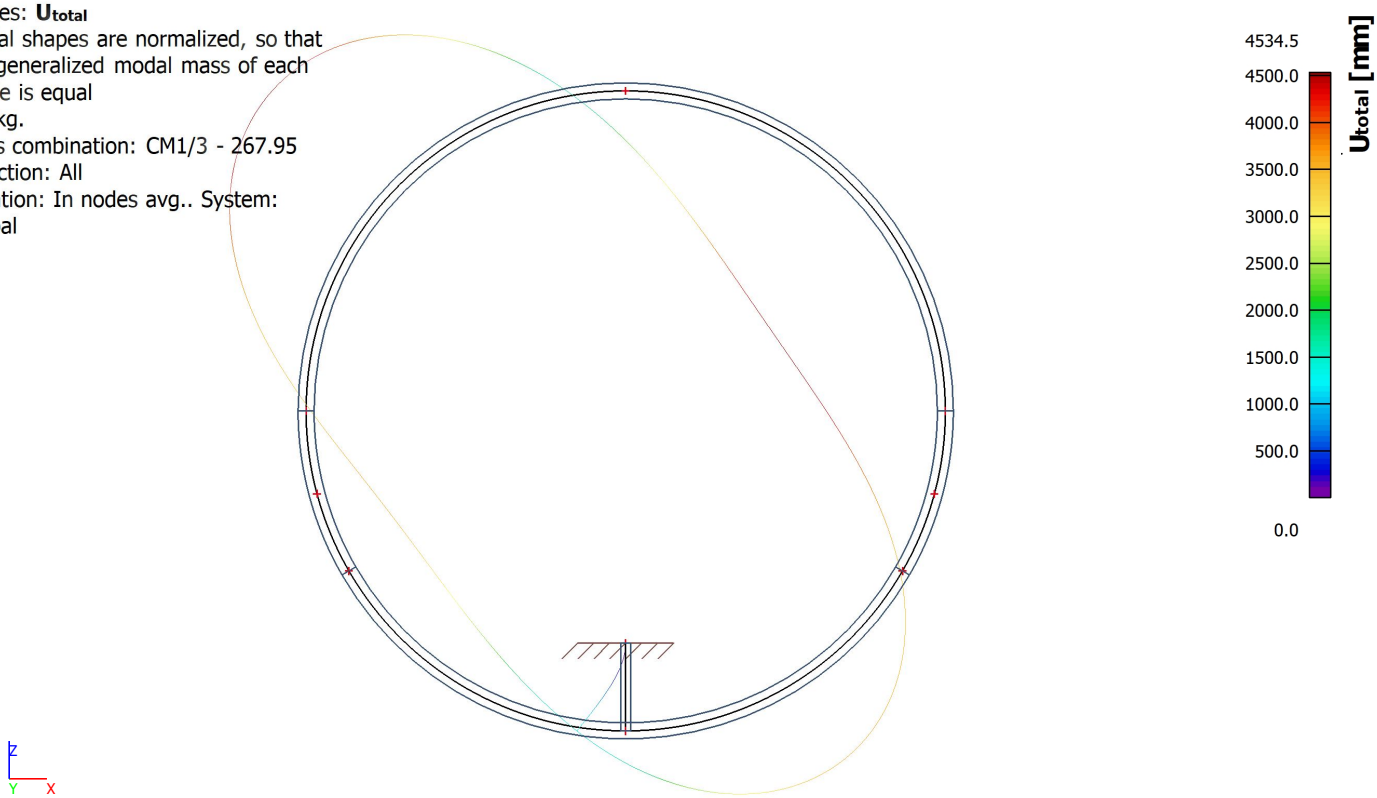
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 189.06
Selection: All
Location: In nodes avg.. System: Global



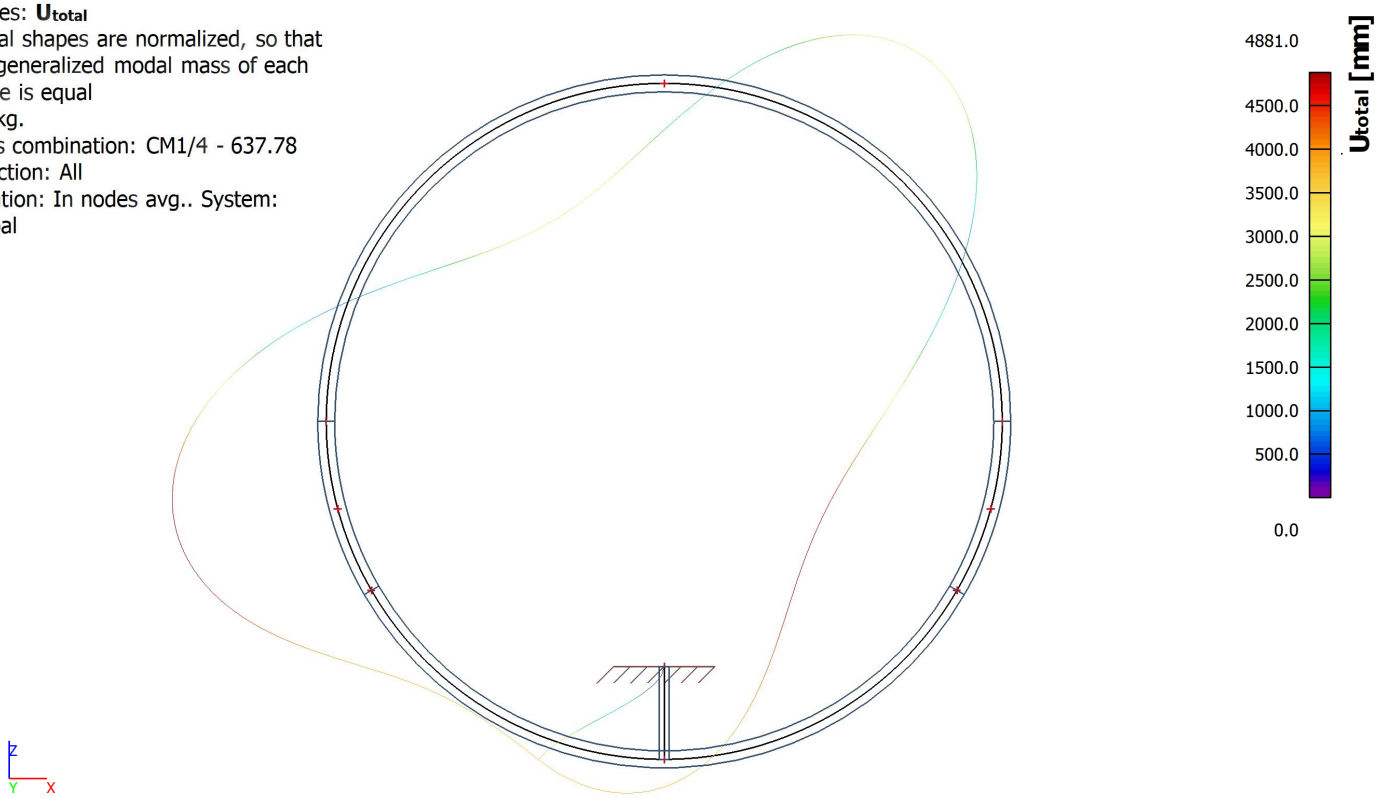
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/3 - 267.95
Selection: All
Location: In nodes avg.. System: Global



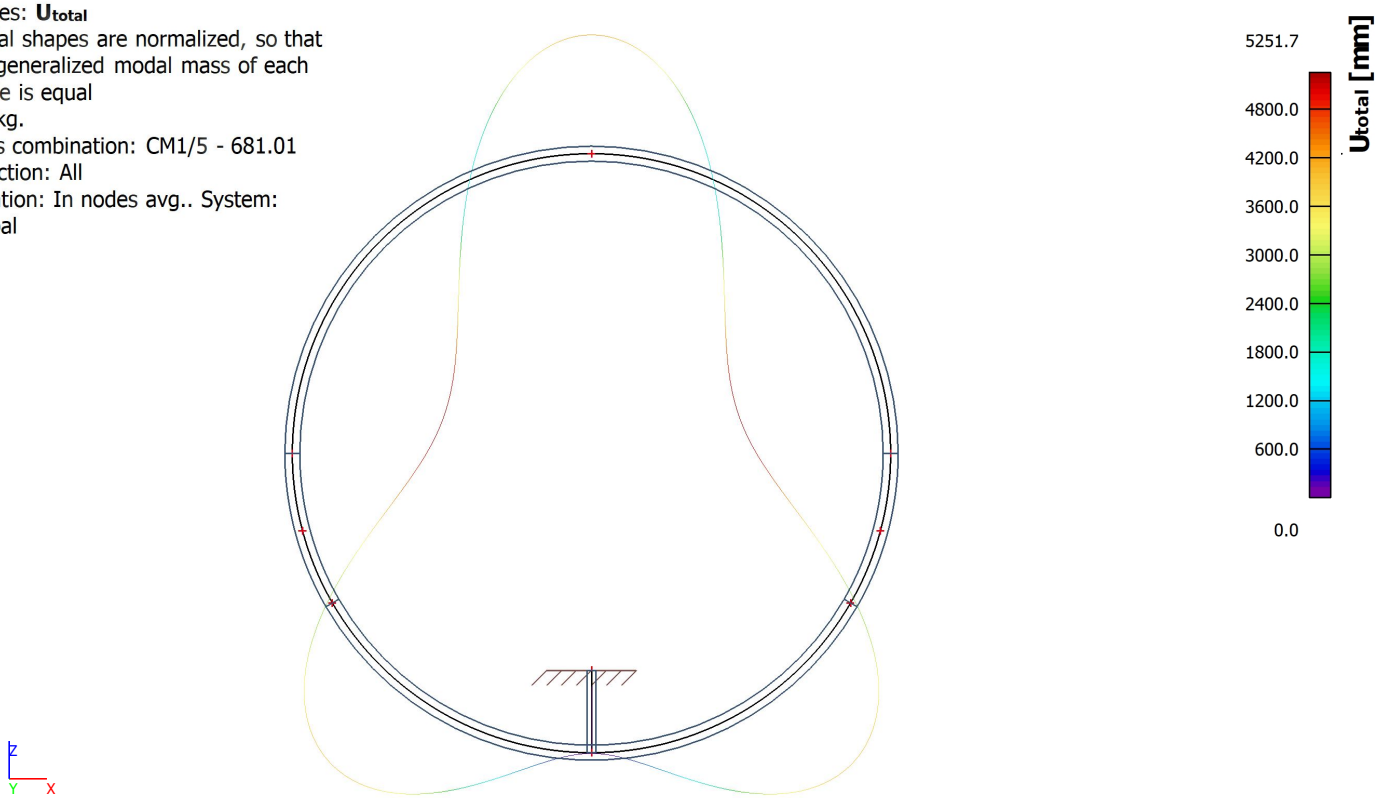
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/4 - 637.78
Selection: All
Location: In nodes avg.. System: Global



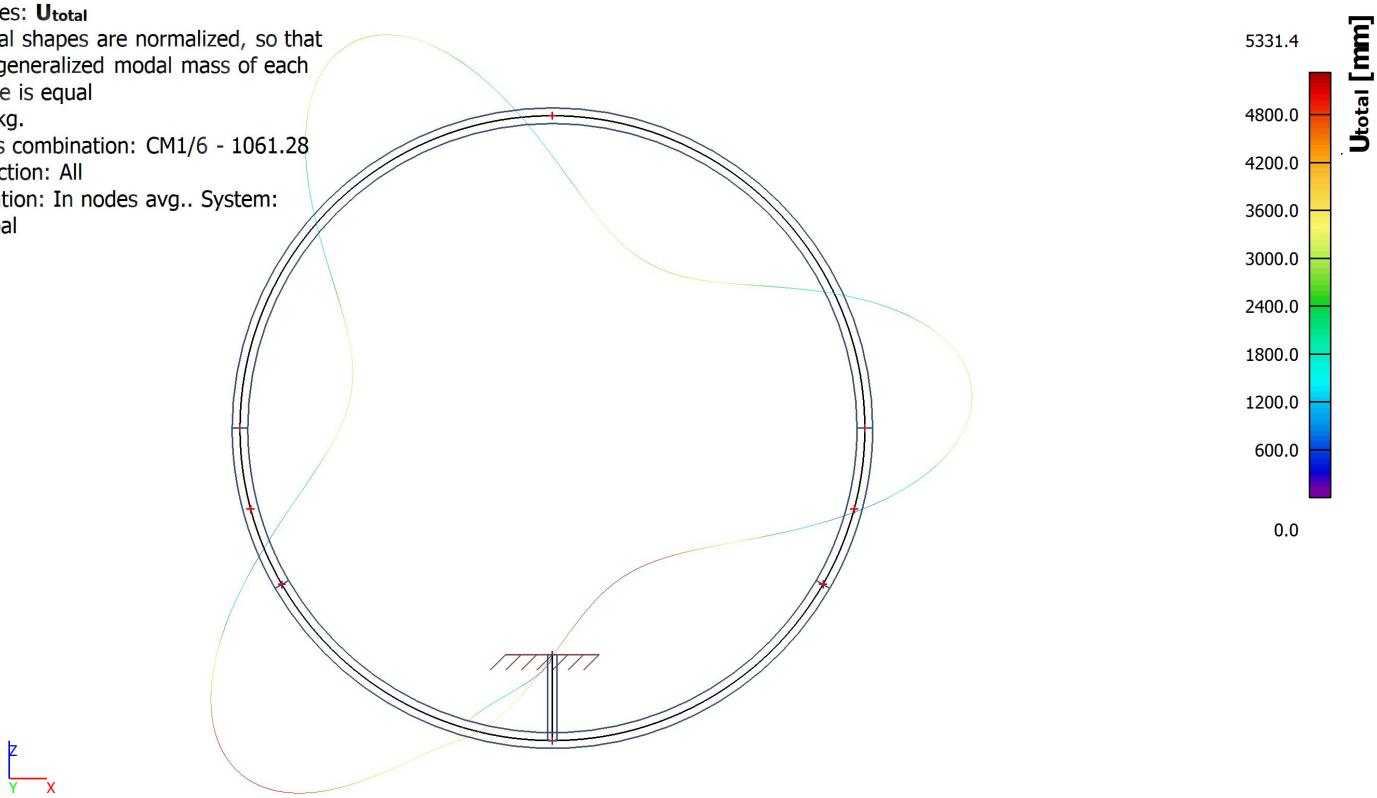
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/5 - 681.01
Selection: All
Location: In nodes avg.. System: Global



4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/6 - 1061.28
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 28.8 Hz
f2 = 189.3 Hz
f3 = 268.8 Hz
f4 = 641.0 Hz
f5 = 682.0 Hz
f6 = 1063.0 Hz

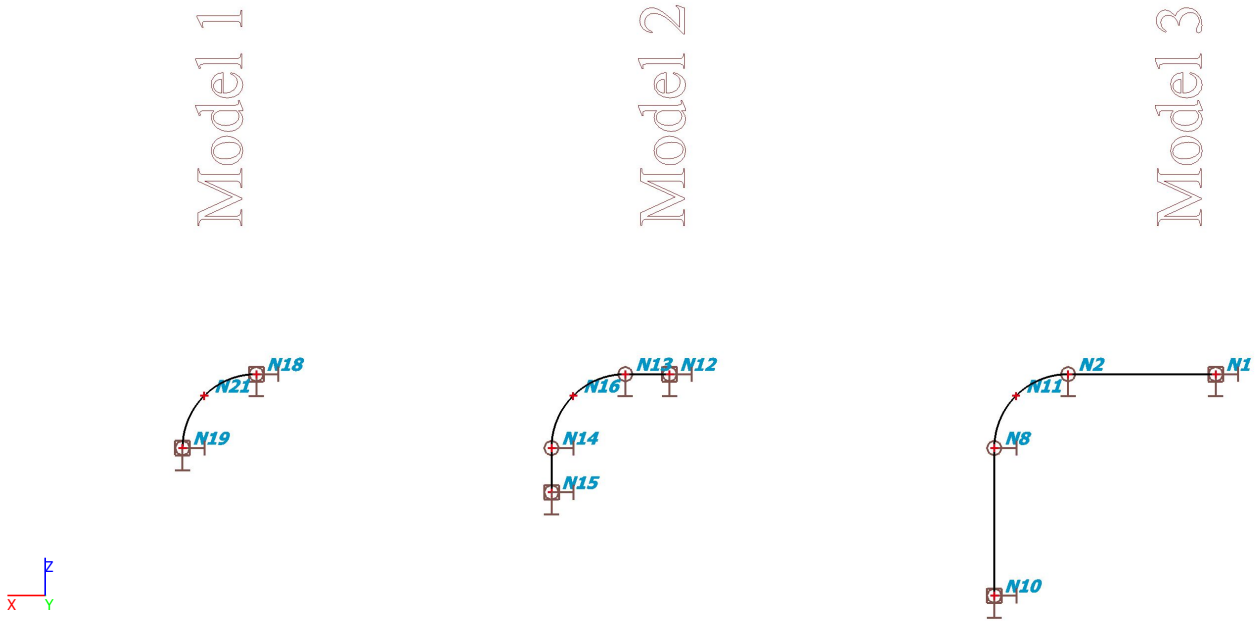
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of pipes

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.000	0.000	0.000	B1	Sn1
N2	2.000	0.000	0.000	B1	Sn3
				B5	
N8	3.000	0.000	-1.000	B5	Sn4
				B4	
N10	3.000	0.000	-3.000	B4	Sn2
N11	2.707	0.000	-0.293	B5	
N12	7.400	0.000	0.000	B6	Sn5
N13	8.000	0.000	0.000	B6	Sn6
				B7	

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N14	9.000	0.000	-1.000	B7	Sn7
				B8	
N15	9.000	0.000	-1.600	B8	Sn8
N16	8.707	0.000	-0.293	B7	
N18	13.000	0.000	0.000	B10	Sn10
N19	14.000	0.000	-1.000	B10	Sn11
N21	13.707	0.000	-0.293	B10	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - CHS (20.0; 2.0)	S 235	2.000	N1	N2	general (0)
B5	CS1 - CHS (20.0; 2.0)	S 235	1.571	N2	N8	general (0)
B4	CS1 - CHS (20.0; 2.0)	S 235	2.000	N8	N10	general (0)
B6	CS1 - CHS (20.0; 2.0)	S 235	0.600	N12	N13	general (0)
B7	CS1 - CHS (20.0; 2.0)	S 235	1.571	N13	N14	general (0)
B8	CS1 - CHS (20.0; 2.0)	S 235	0.600	N14	N15	general (0)
B10	CS1 - CHS (20.0; 2.0)	S 235	1.571	N18	N19	general (0)

2.4. Nodal supports

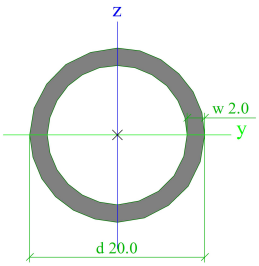
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn2	N10	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn3	N2	GCS	Standard	Free	Rigid	Rigid	Free	Free	Free
Sn4	N8	GCS	Standard	Rigid	Rigid	Free	Free	Free	Free
Sn5	N12	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn6	N13	GCS	Standard	Free	Rigid	Rigid	Free	Free	Free
Sn7	N14	GCS	Standard	Rigid	Rigid	Free	Free	Free	Free
Sn8	N15	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn10	N18	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn11	N19	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0.0	40.0	235.0	360.0	
		8.0769e+04	0.01e-003	40.0	80.0	215.0	360.0	

2.6. Cross-sections

CS1		
Type	CHS	
Detailed	20.0; 2.0	
Formcode	3 - Circular hollow section	
Item material	S 235	
A [m^2]	1.1310e-04	
A_y [m^2], A_z [m^2]	7.2000e-05	7.2000e-05
A_L [m^2/m], A_D [m^2/m]	6.2829e-02	1.1309e-01
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	10.0	10.0
α [deg]	0.00	
I_y [m^4], I_z [m^4]	4.6370e-09	4.6370e-09
i_y [mm], i_z [mm]	6.4	6.4
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	4.6370e-07	4.6370e-07
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	6.5067e-07	6.5067e-07
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	152.86	152.86
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	152.86	152.86
d_y [mm], d_z [mm]	0.0	0.0
I_t [m^4], I_w [m^6]	9.1609e-09	1.0996e-45
β_y [mm], β_z [mm]	0.0	0.0
Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

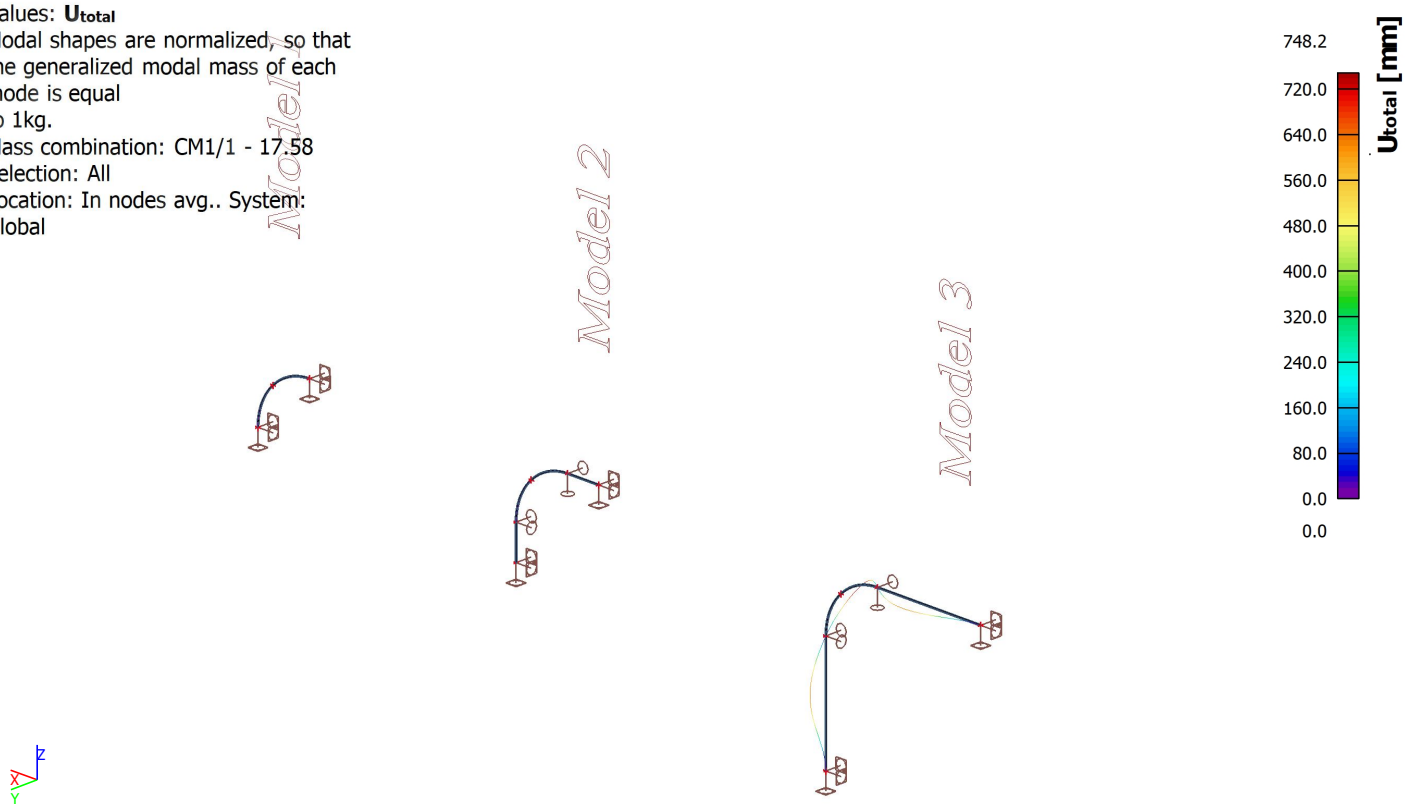
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	17.58	110.47	12203.52	0.06
2	24.33	152.87	23368.02	0.04
3	24.85	156.14	24380.00	0.04
4	26.61	167.18	27949.84	0.04
5	33.04	207.56	43081.59	0.03
6	34.71	218.09	47561.81	0.03
7	43.92	275.96	76152.06	0.02
8	67.00	420.97	177219.63	0.01
9	67.40	423.46	179318.51	0.01
10	74.10	465.54	216729.43	0.01
11	74.33	467.00	218086.90	0.01
12	93.77	589.14	347084.95	0.01
13	98.04	615.98	379435.01	0.01
14	98.24	617.27	381019.53	0.01
15	101.43	637.27	406112.17	0.01
16	118.96	747.42	558640.66	0.01
17	125.07	785.80	617475.59	0.01
18	142.48	895.18	801347.29	0.01
19	143.54	901.88	813393.30	0.01
20	151.92	954.49	911044.18	0.01
21	152.20	956.30	914514.87	0.01
22	182.37	1145.81	1312877.15	0.01
23	191.13	1200.87	1442097.36	0.01
24	192.92	1212.12	1469243.38	0.01
25	206.01	1294.34	1675324.48	0.00
26	224.55	1410.85	1990490.99	0.00

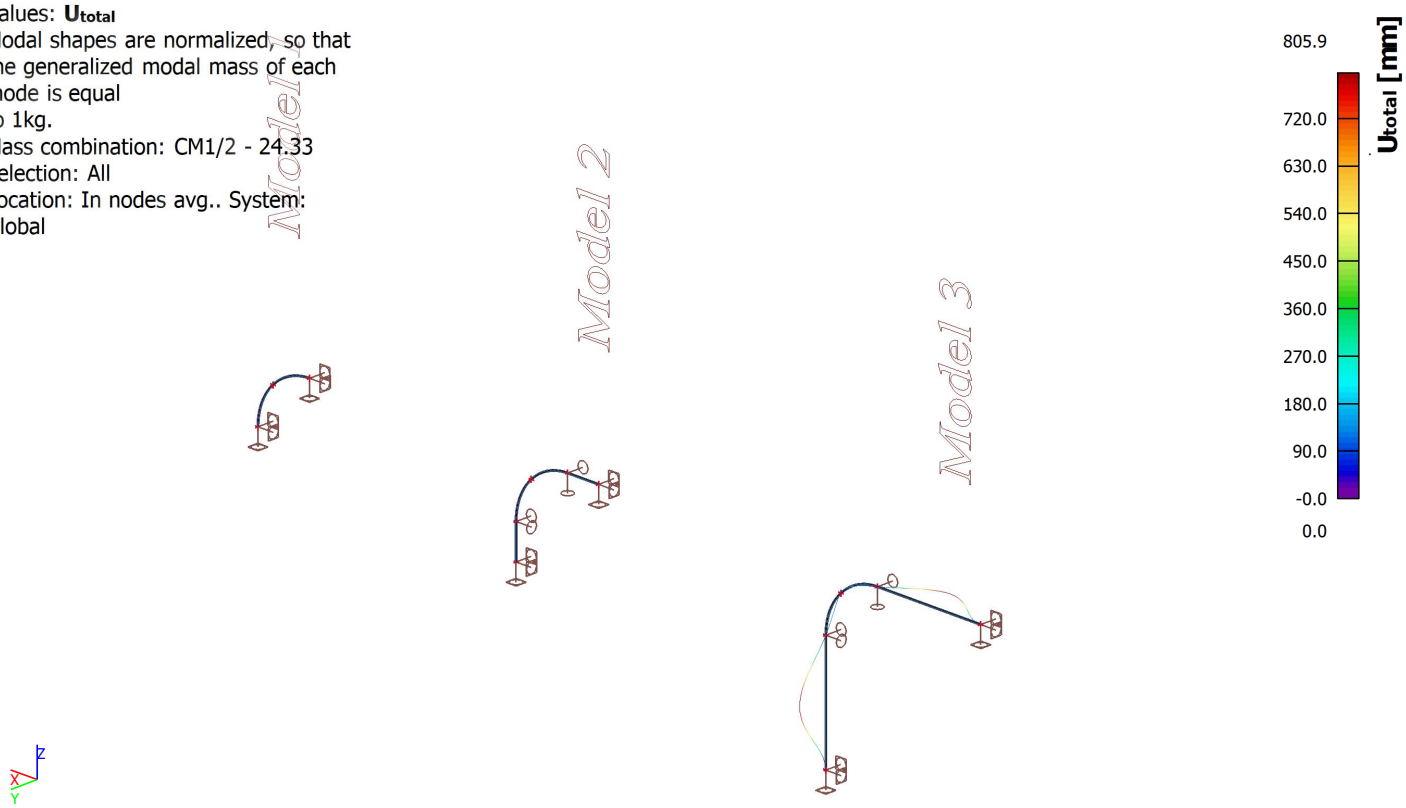
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 17.58
Selection: All
Location: In nodes avg.. System: Global



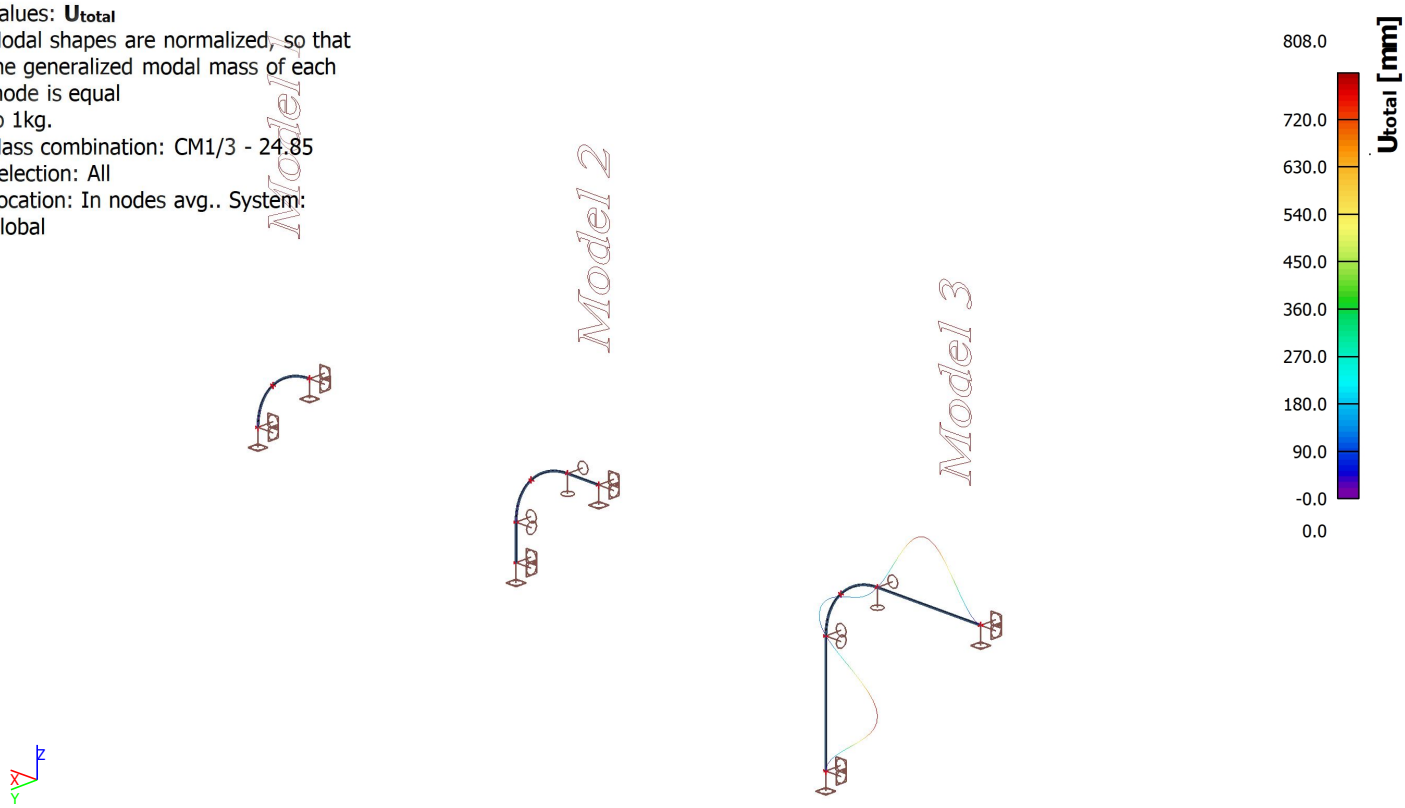
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 24.33
Selection: All
Location: In nodes avg.. System: Global



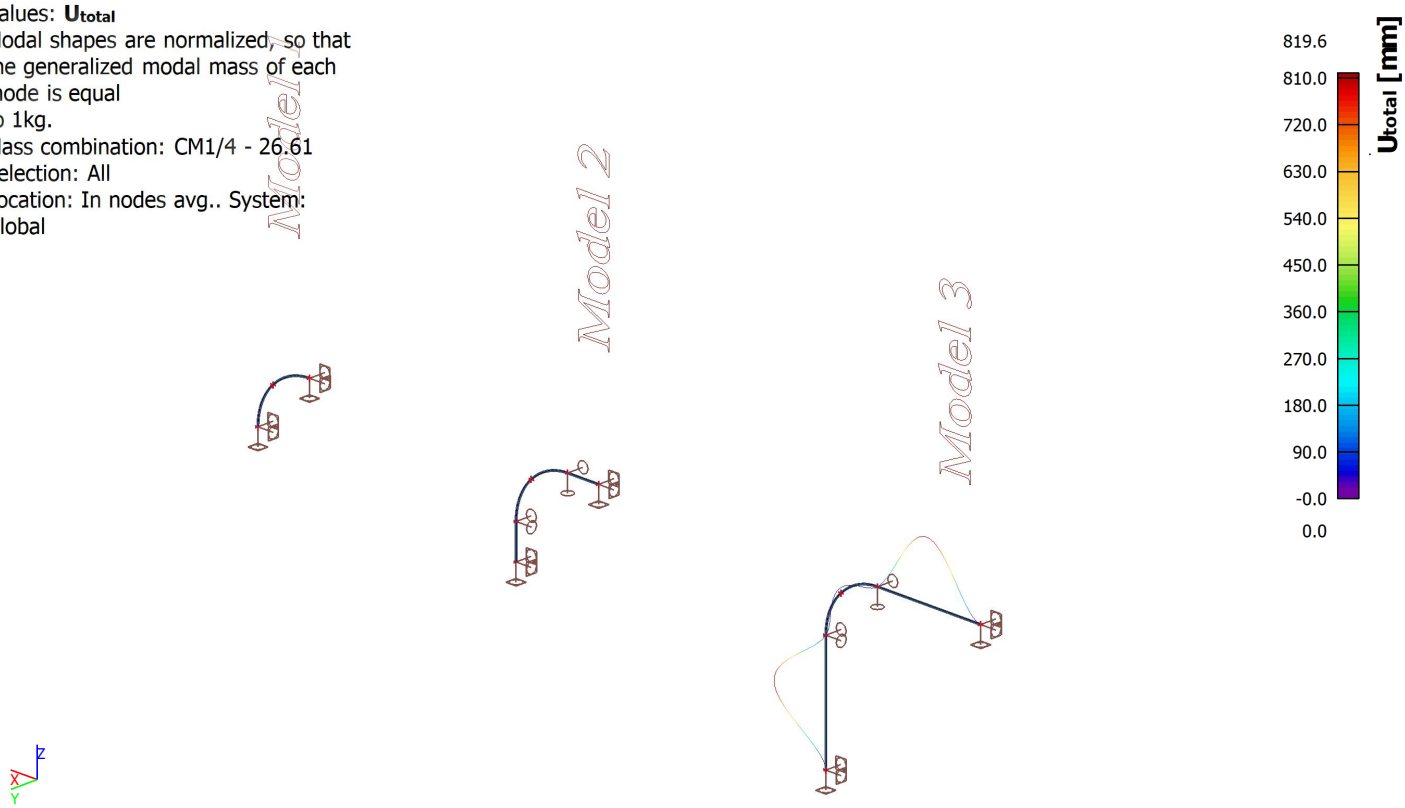
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/3 - 24.85
Selection: All
Location: In nodes avg.. System: Global



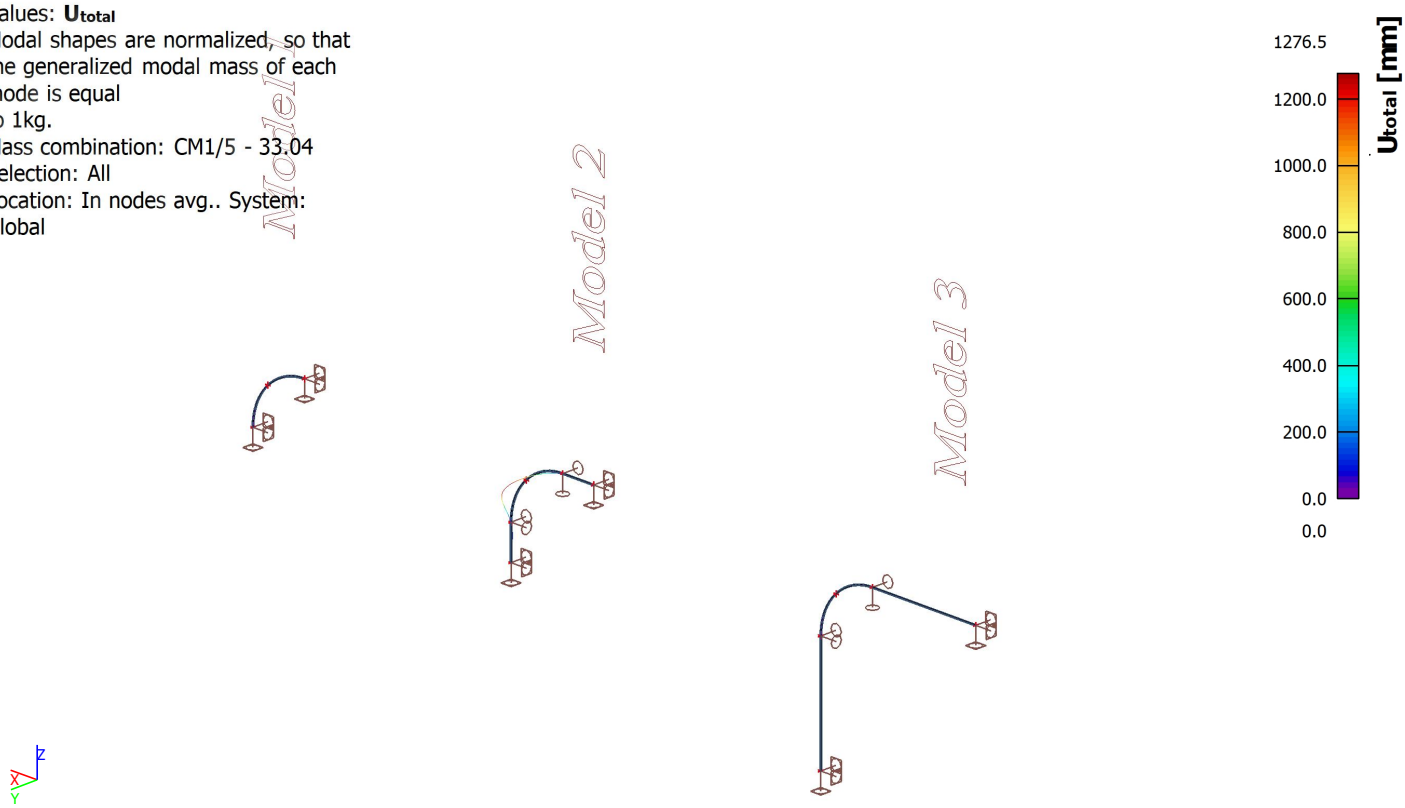
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 26.61
Selection: All
Location: In nodes avg.. System: Global



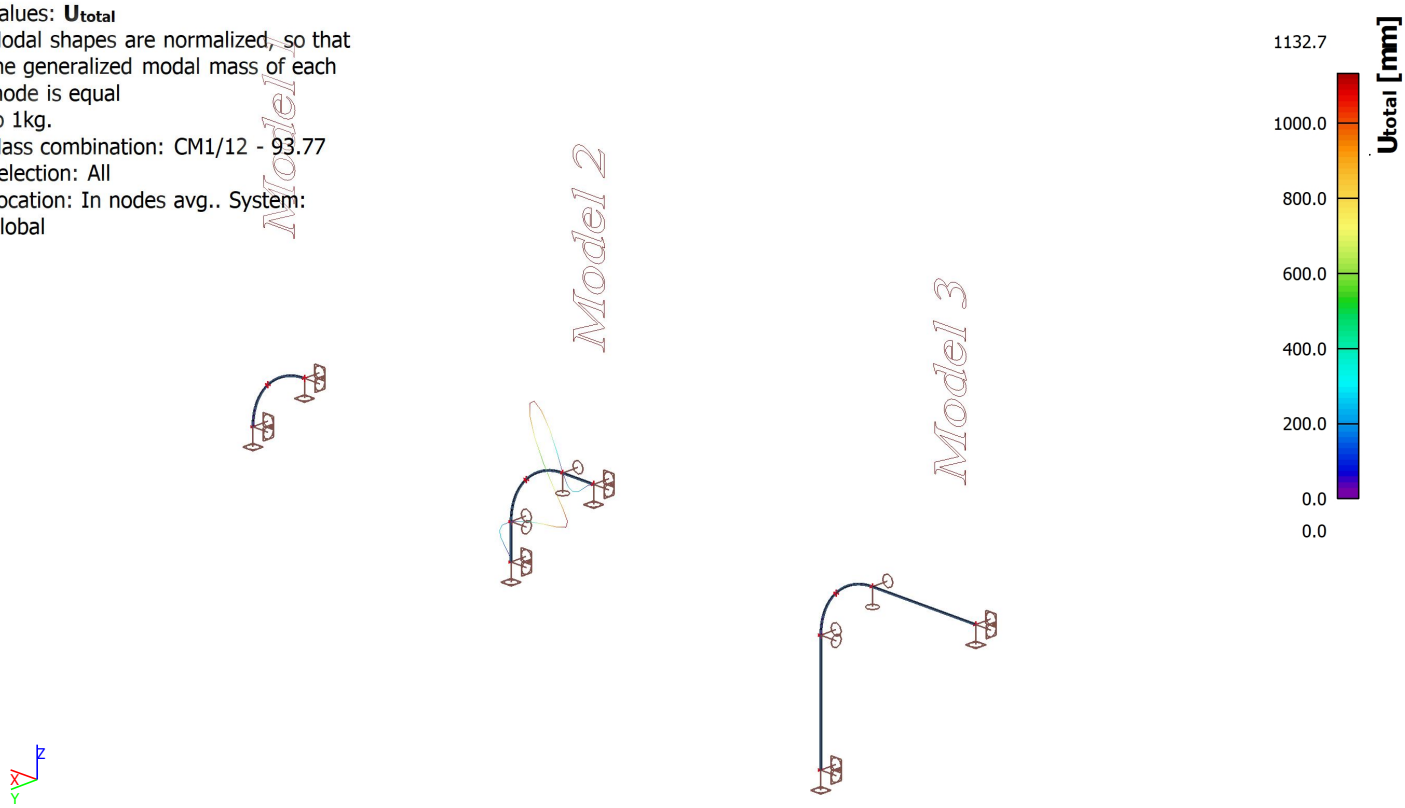
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/5 - 33.04
Selection: All
Location: In nodes avg.. System: Global



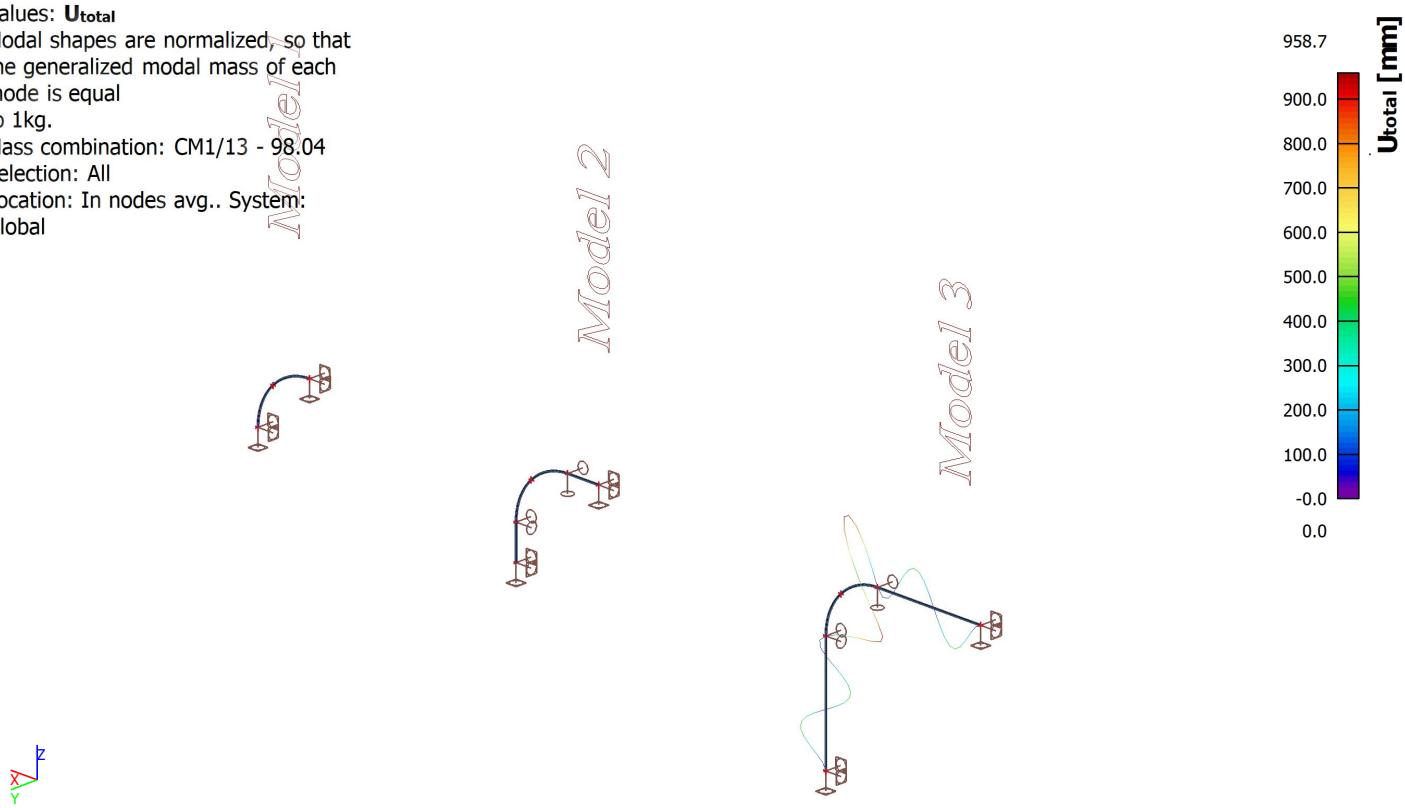
4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/12 - 93.77
Selection: All
Location: In nodes avg.. System: Global



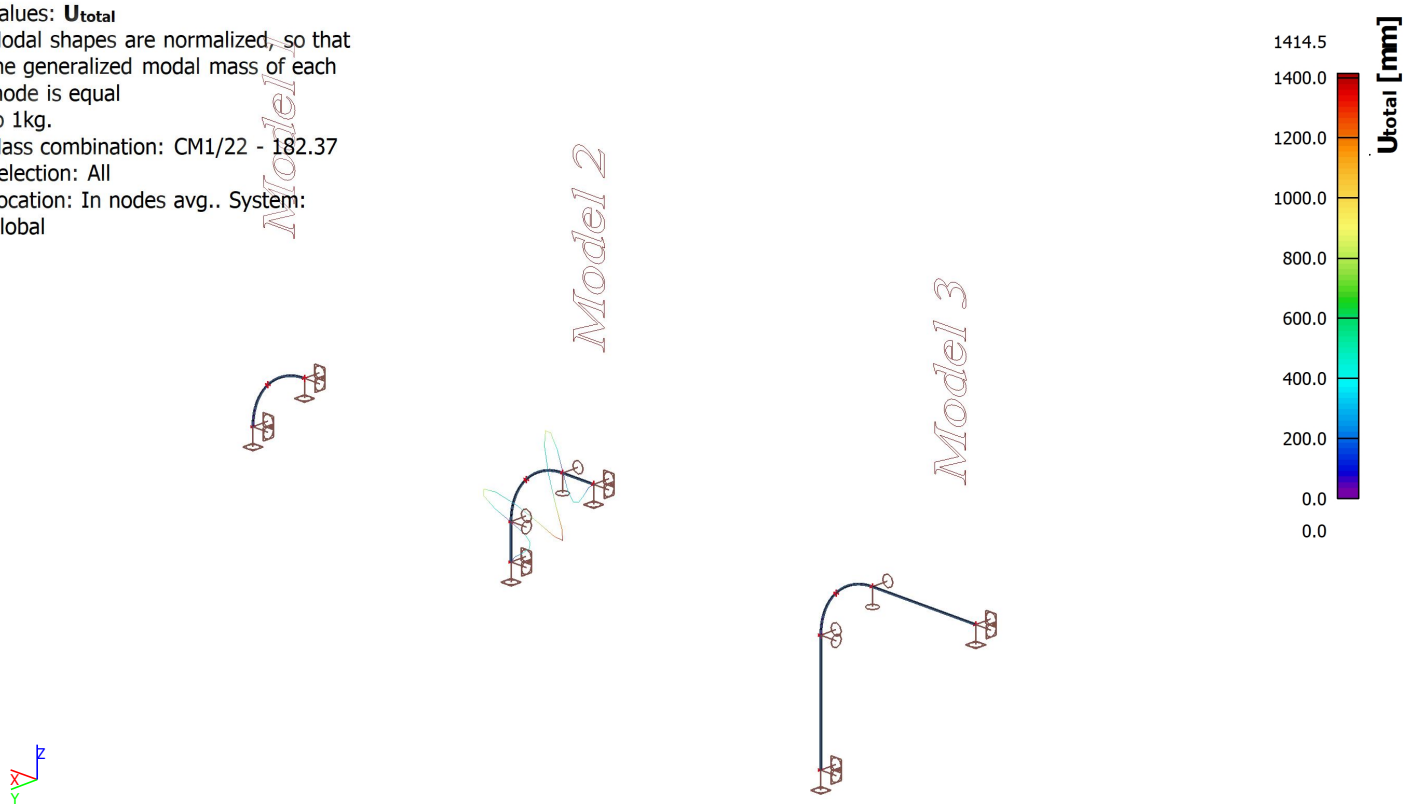
4.8. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/13 - 98.04
Selection: All
Location: In nodes avg.. System: Global



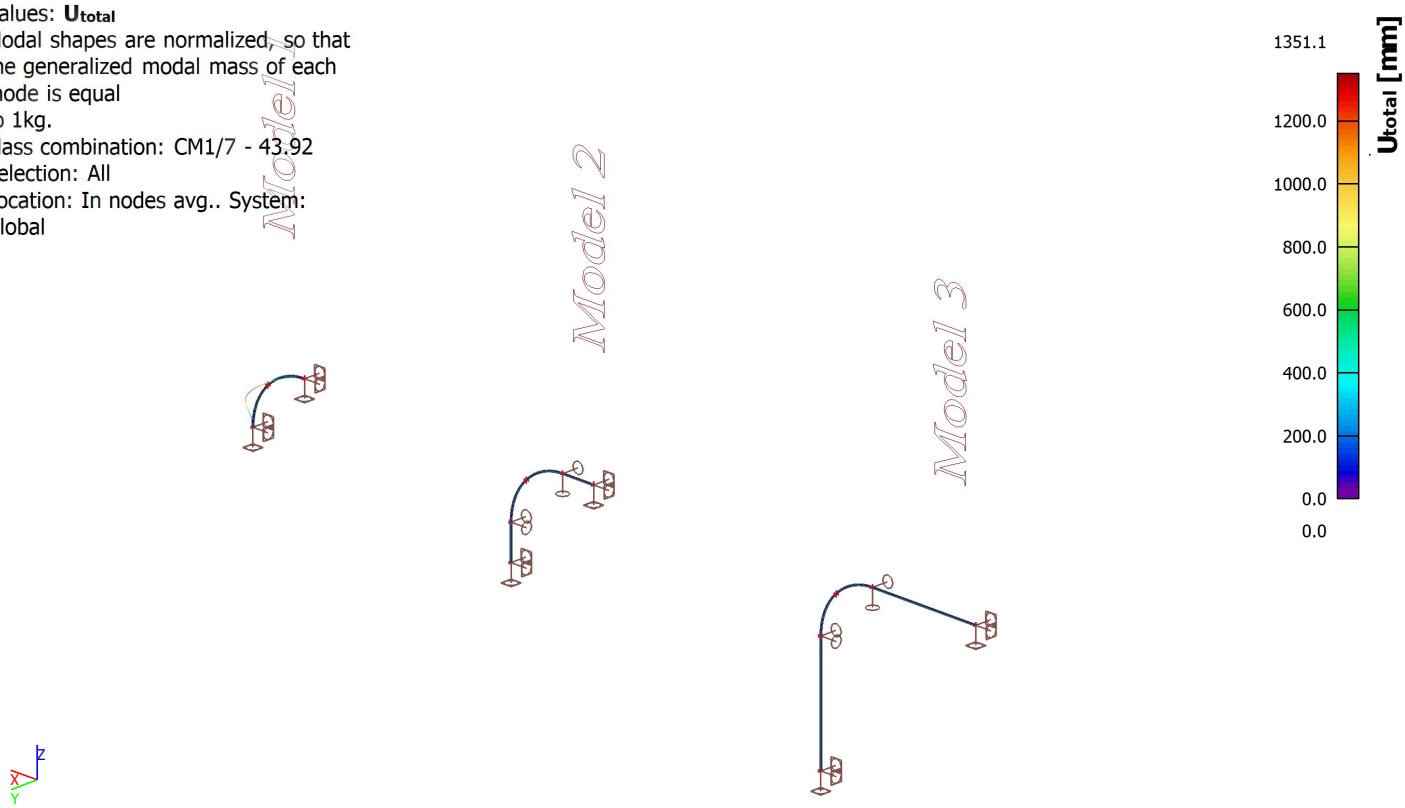
4.9. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/22 - 182.37
Selection: All
Location: In nodes avg.. System: Global



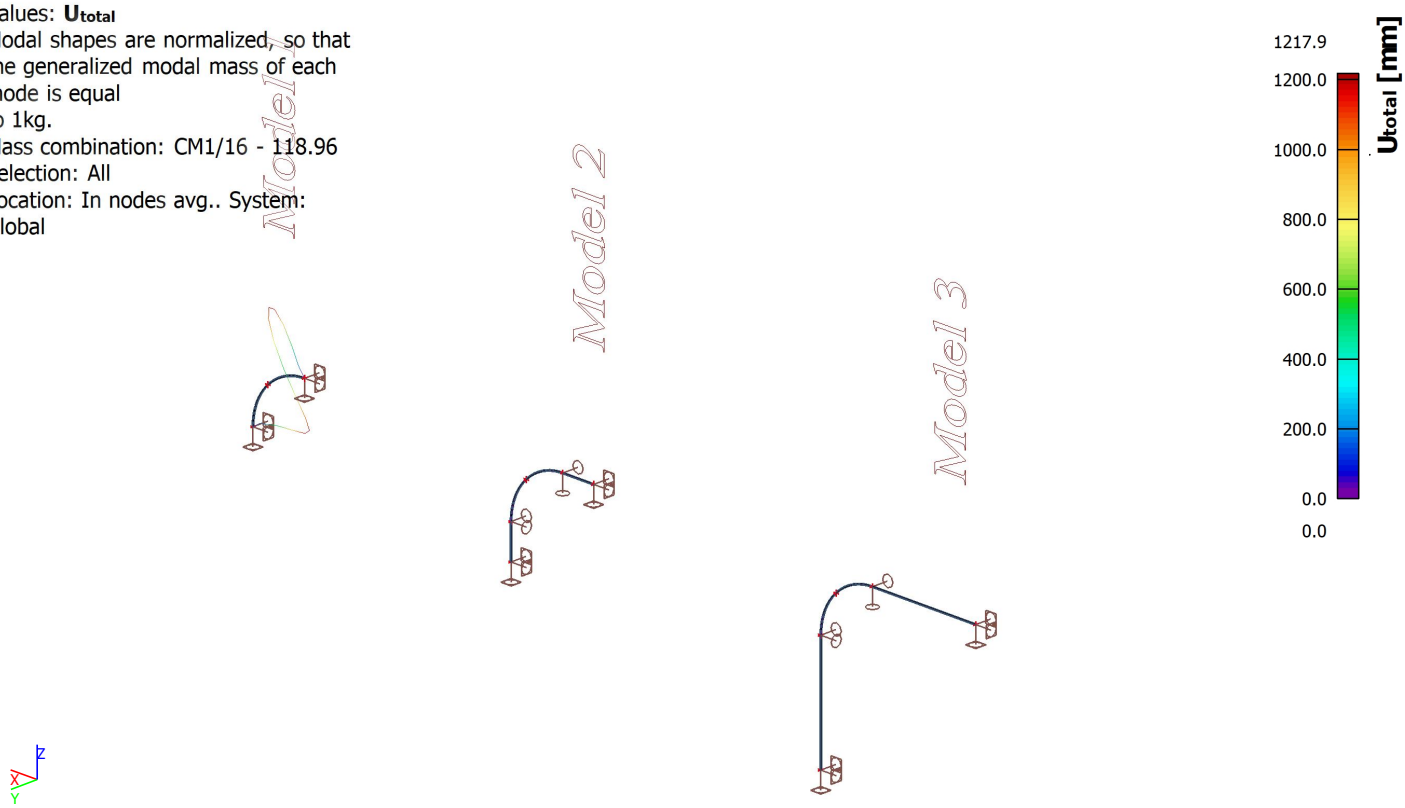
4.10. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/7 - 43.92
Selection: All
Location: In nodes avg.. System: Global



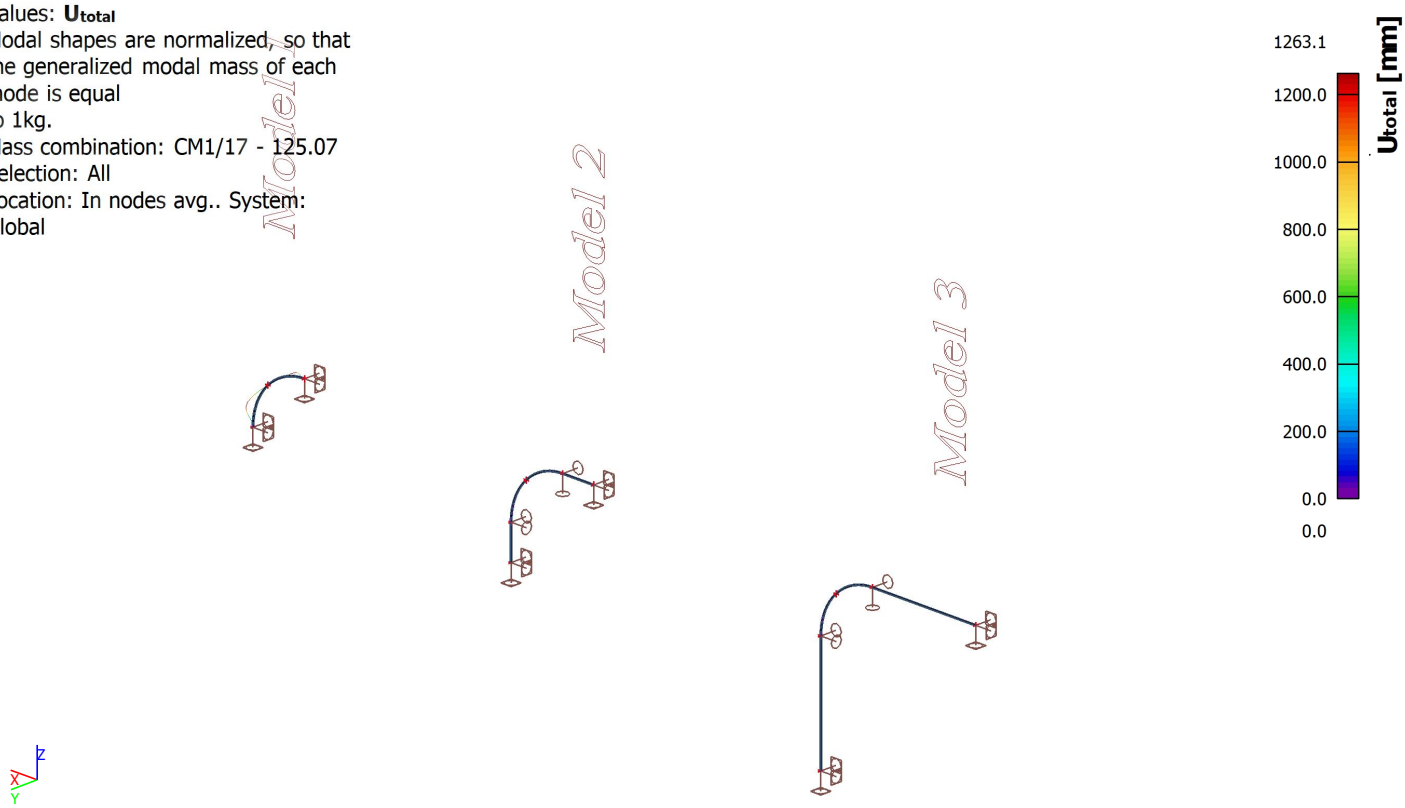
4.11. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/16 - 118.96
Selection: All
Location: In nodes avg.. System: Global



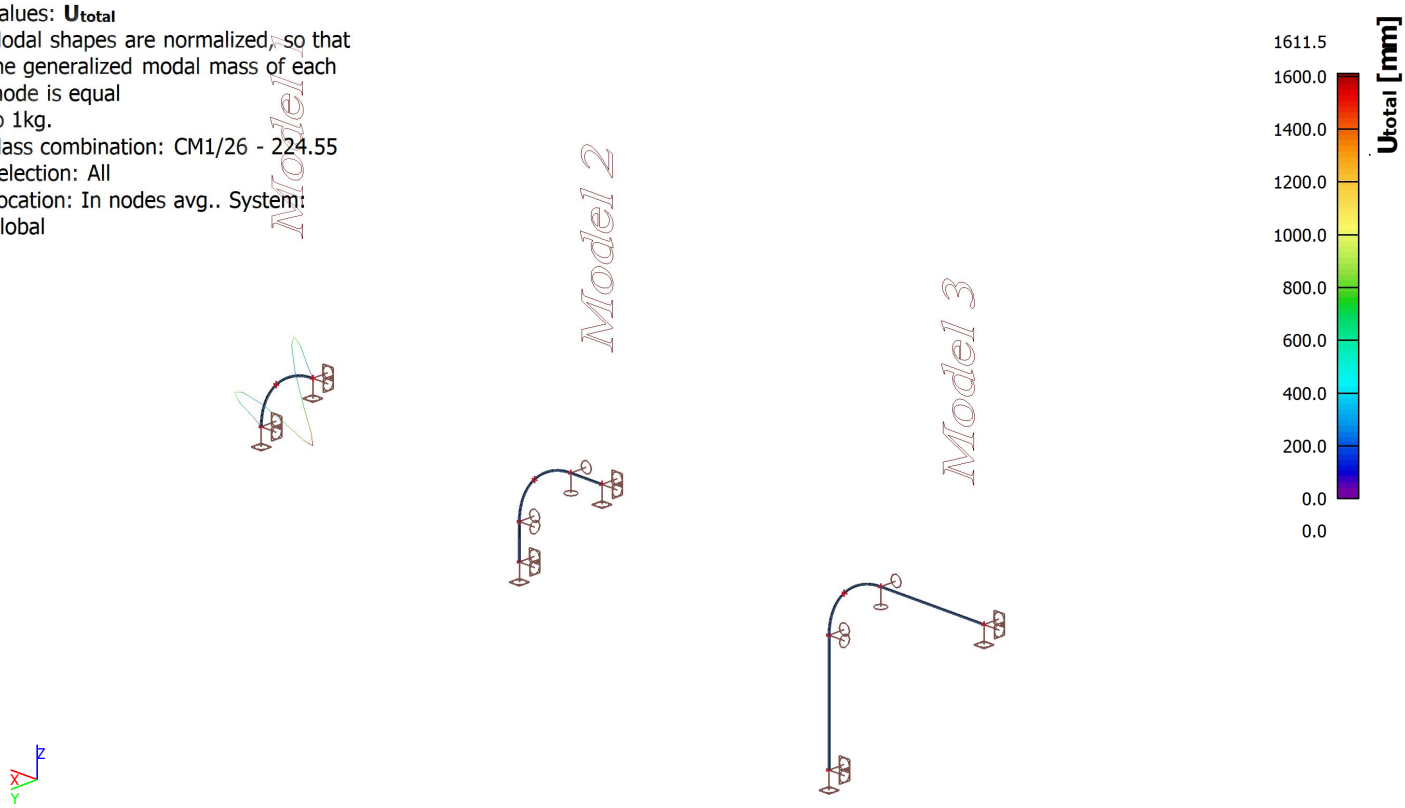
4.12. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/17 - 125.07
Selection: All
Location: In nodes avg.. System: Global



4.13. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/26 - 224.55
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Model 1:

Transversal mode 1 = 44.23 Hz
In-plane mode 1 = 119.0 Hz
Transversal mode 2 = 125.0 Hz
In-plane mode 2 = 227.0 Hz

Model 2:

Transversal mode 1 = 33.4 Hz
In-plane mode 1 = 94.0 Hz
Transversal mode 2 = 100.0Hz
In-plane mode 2 = 180.0 Hz

Model 3:

Transversal mode 1 = 17.9 Hz
Transversal mode 2 = 24.8 Hz
In-plane mode 1 = 25.3 Hz
In-plane mode 2 = 27.0 Hz

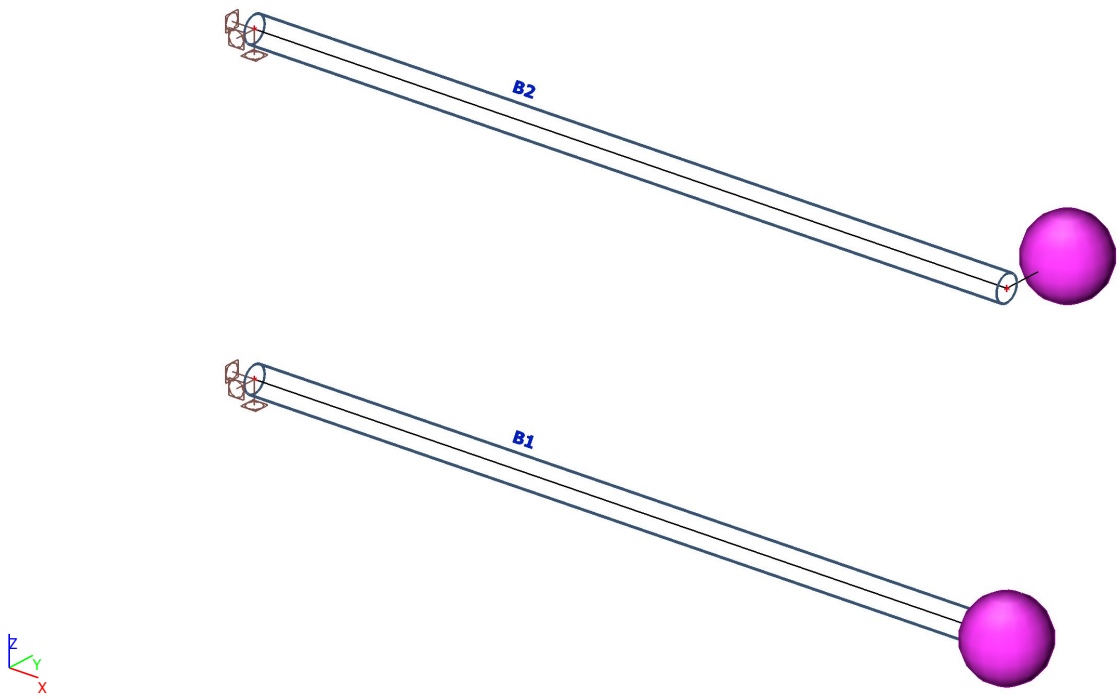
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a cantilever beam with mass at the extremity (with and withoud eccentricity) - Bending-torsion coupling

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	0.048	0.000	0.000	B1	Sn1
N2	10.048	0.000	0.000	B1	MN1
N3	0.048	0.000	4.000	B2	Sn2

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N4	10.048	0.000	4.000	B2	
				B3	
N5	10.048	1.000	4.000	B3	MN3

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - CHS (350; 15)	S 355	10.000	N1	N2	general (0)
B2	CS1 - CHS (350; 15)	S 355	10.000	N3	N4	general (0)
B3	CS2 - Rond plein (Numerical)	RIGID	1.000	N4	N5	general (0)

2.4. Nodal supports

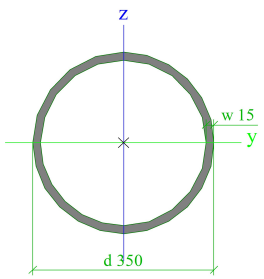
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn2	N3	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 355	7800.00	2.1000e+05	0.3	0	40	355.0	490.0	
		8.0769e+04	0.01e-003	40	80	335.0	470.0	
RIGID	0.00	3.0000e+10	0.25	0	40	235.0	360.0	
		1.2000e+10	0.01e-003	40	80	215.0	360.0	

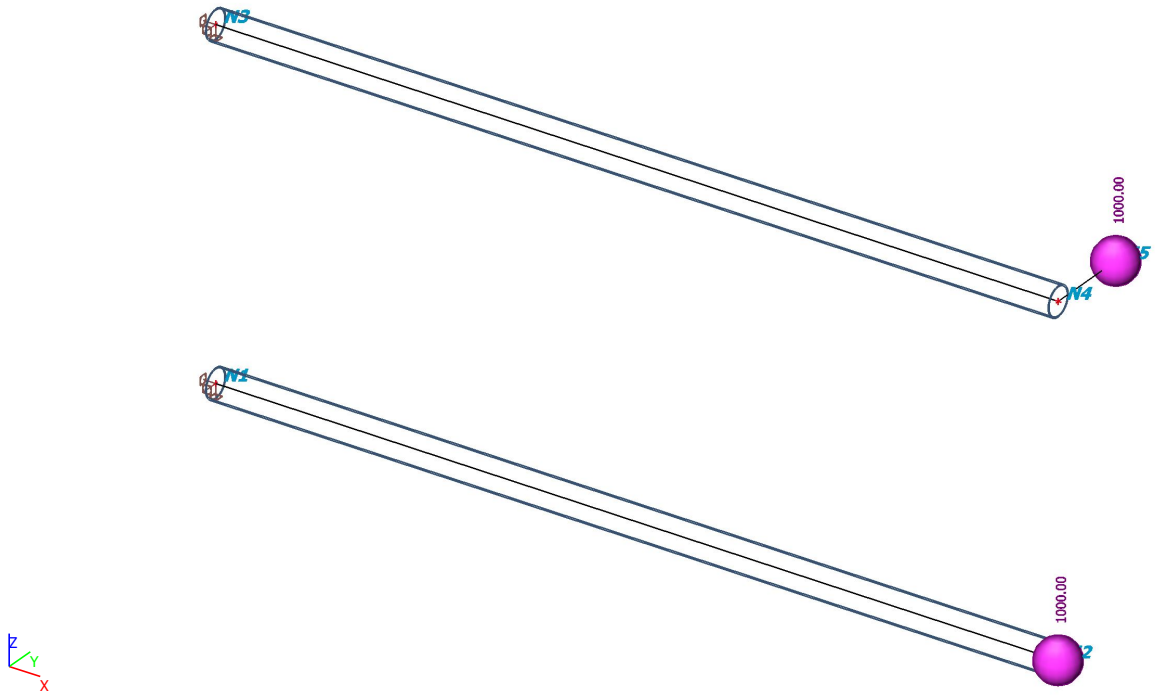
2.6. Cross-sections

CS1		
Type	CHS	
Detailed	350; 15	
Formcode	3 - Circular hollow section	
Item material	S 355	
A [m²]	1.5787e-02	
A_y [m²], A_z [m²]	1.0050e-02	1.0050e-02
A_L [m²/m], A_D [m²/m]	1.0995e+00	2.1048e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	175	175
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.2190e-04	2.2190e-04
i_y [mm], i_z [mm]	119	119
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.2680e-03	1.2680e-03
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.6845e-03	1.6845e-03
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	597815.36	597815.36
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	597815.36	597815.36
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	4.4291e-04	6.6891e-39
β_y [mm], β_z [mm]	0	0
Picture		

CS2		
Type	Rond plein	
Detailed	Numerical	
A [m²]	7.8540e-01	
A_y [m²], A_z [m²]	6.7325e-01	6.7325e-01
A_L [m²/m], A_D [m²/m]	3.1414e+00	3.1414e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	500	500
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	4.9087e-02	4.9087e-02
i_y [mm], i_z [mm]	250	250
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	9.8175e-02	9.8175e-02
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.6667e-01	1.6667e-01
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	39154737.03	39154737.03
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	39154737.03	39154737.03
d_y [mm], d_z [mm]	0	0
I_t [m⁴], I_w [m⁶]	9.8109e-02	2.2156e-13
β_y [mm], β_z [mm]	0	0

3. LOAD and MASS

3.1. LC1 / Tot. value



3.2. Nodal mass

Name	Mass group	M [kg]	Imx [kgm²]	Koeff mx	Imy [kgm²]	Koeff my	Imz [kgm²]	Koeff mz	Node
MN1	MG1	1000.00	0.00	1	0.00	1	0.00	1	N2
MN3	MG1	1000.00	0.00	1	0.00	1	0.00	1	N5

Explanations of symbols	
Node	(10.048;0.000;0.000)

3.3. Mass groups

Name
MG1

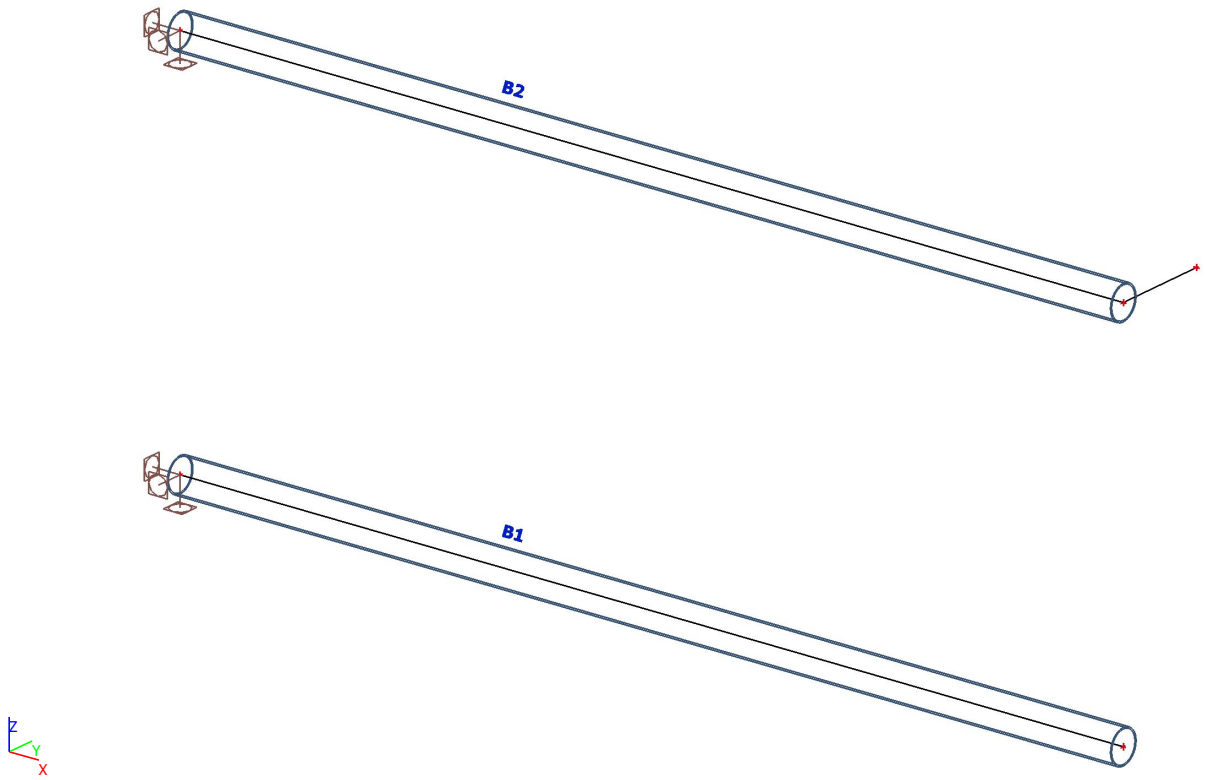
4. RESULTS

4.1. Eigen frequencies

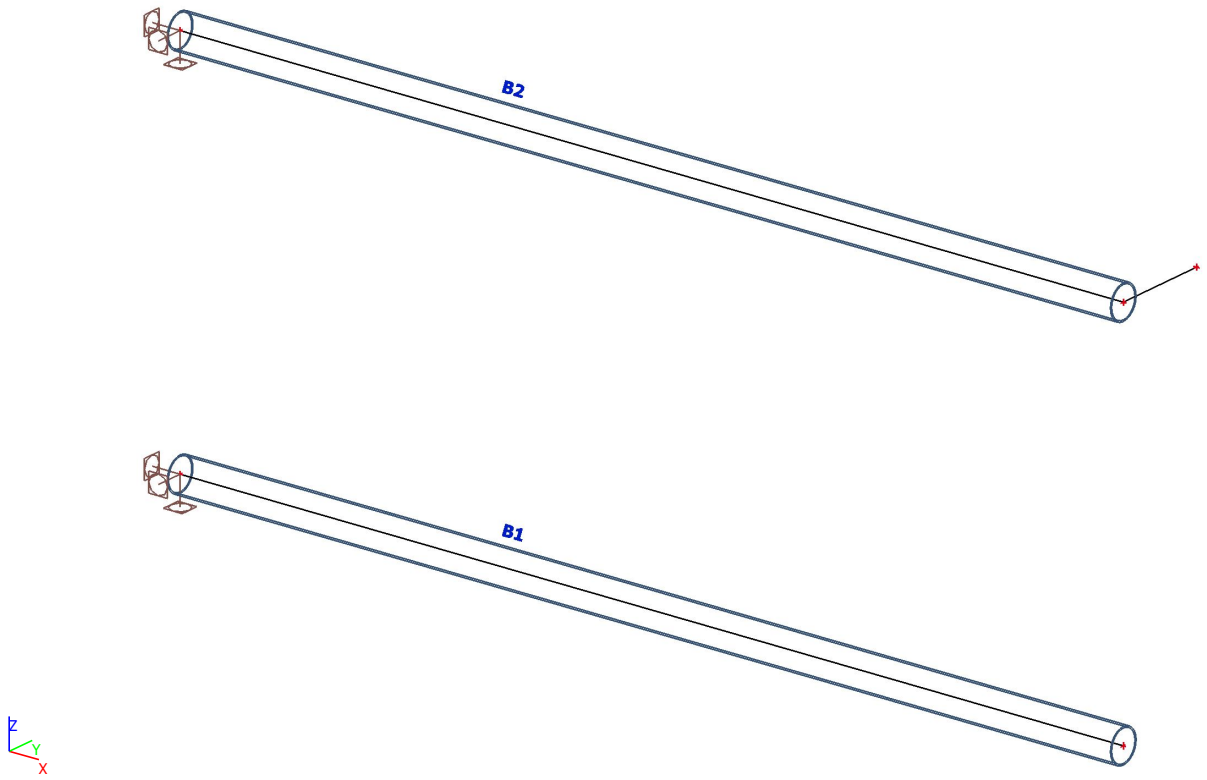
Eigen frequencies

Calculation protocol

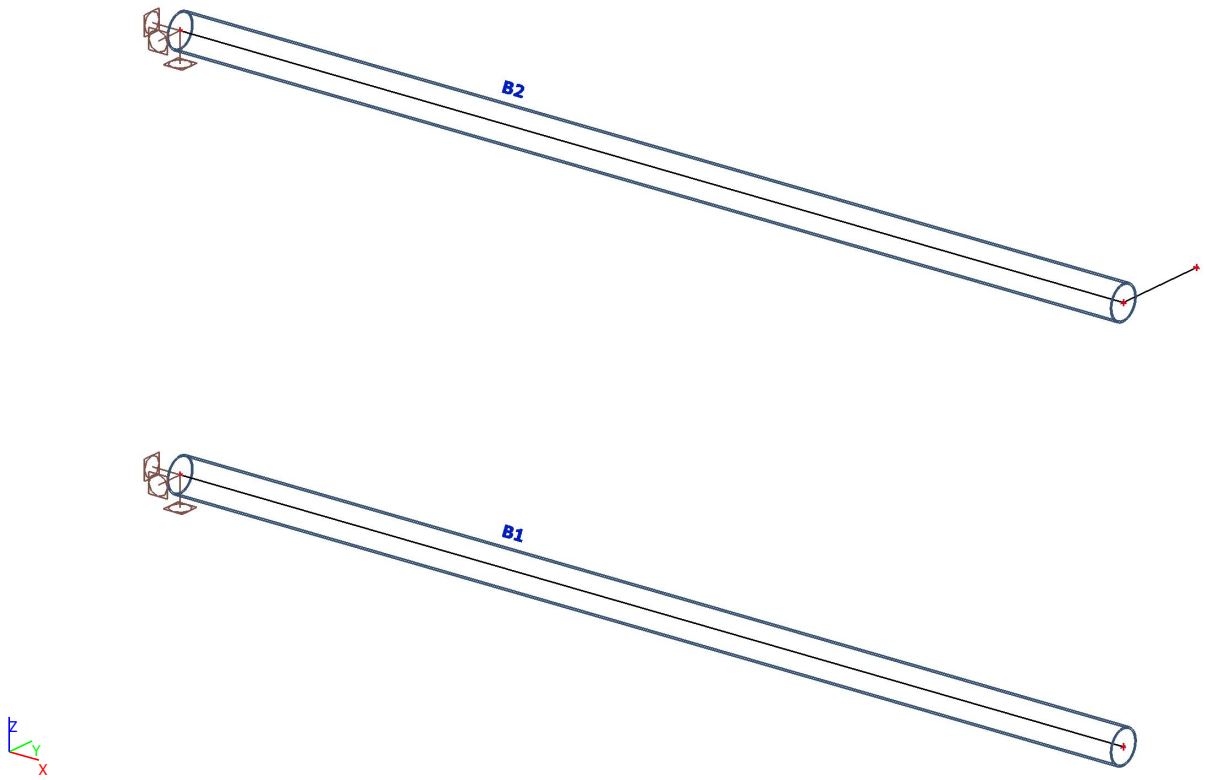
4.2. 3D displacement; Beam B1



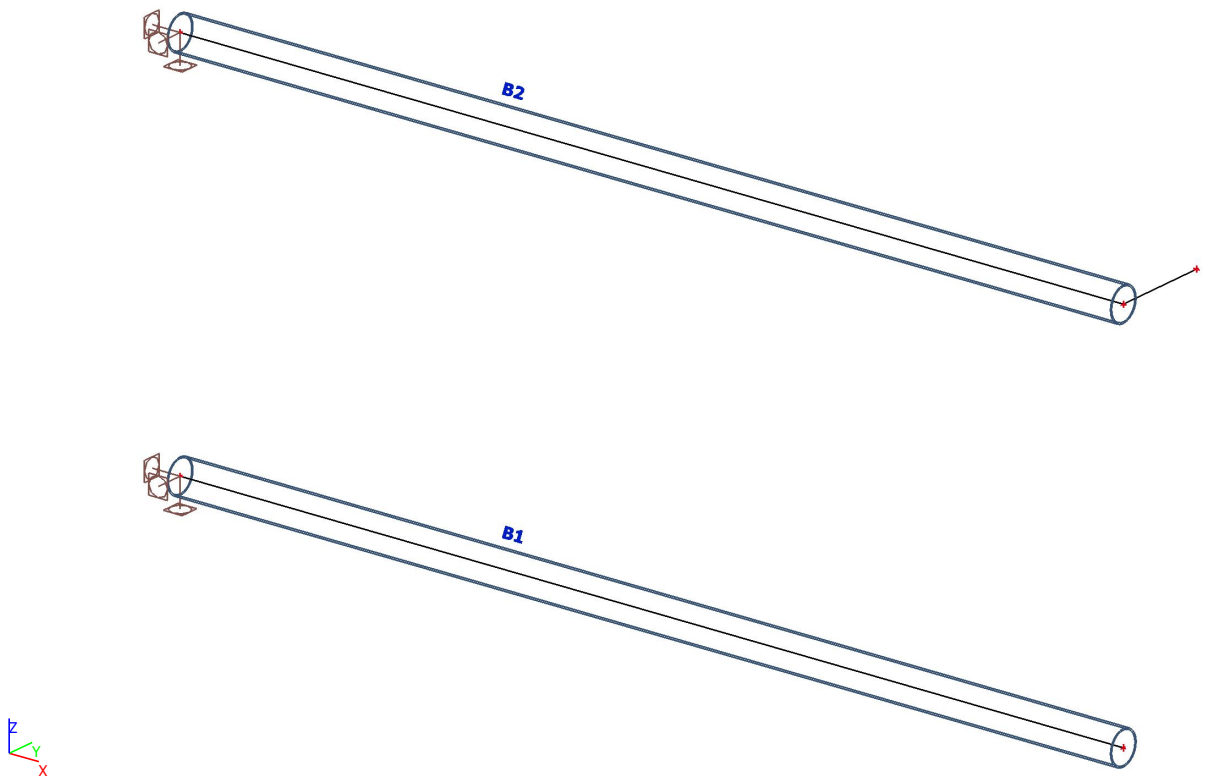
4.3. 3D displacement; Beam B1



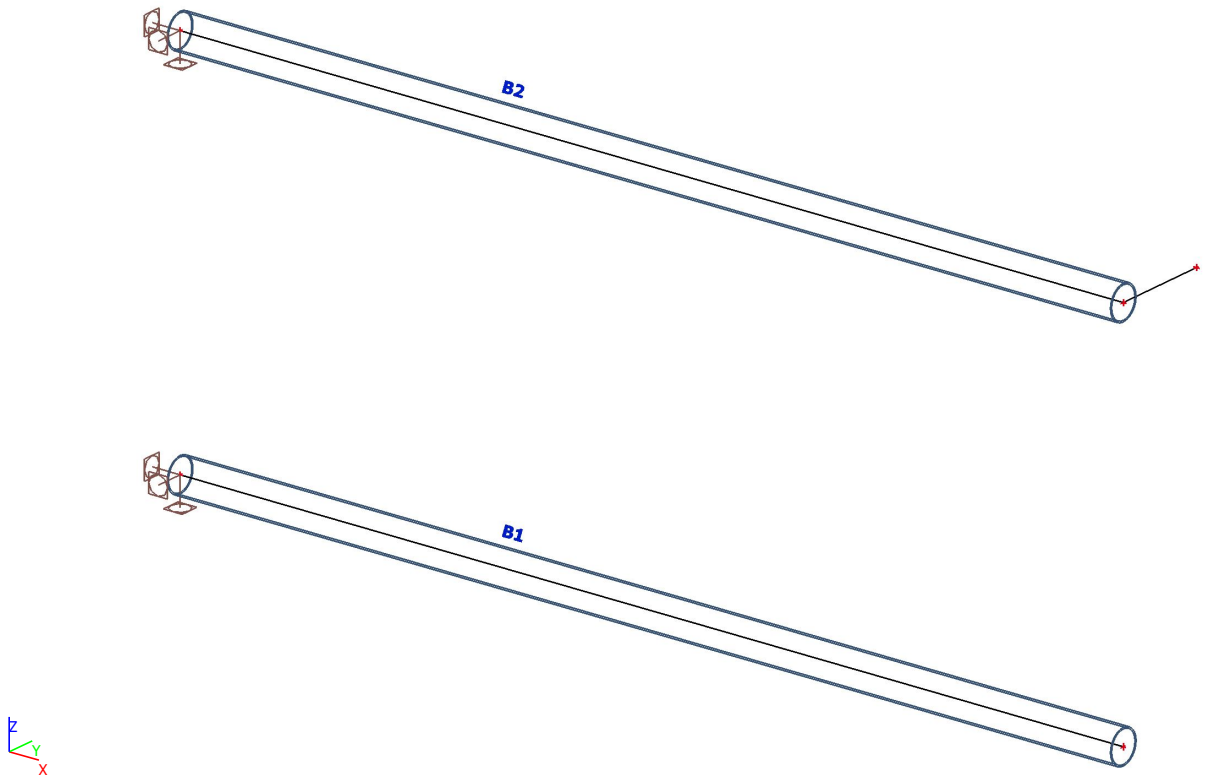
4.4. 3D displacement; Beam B1



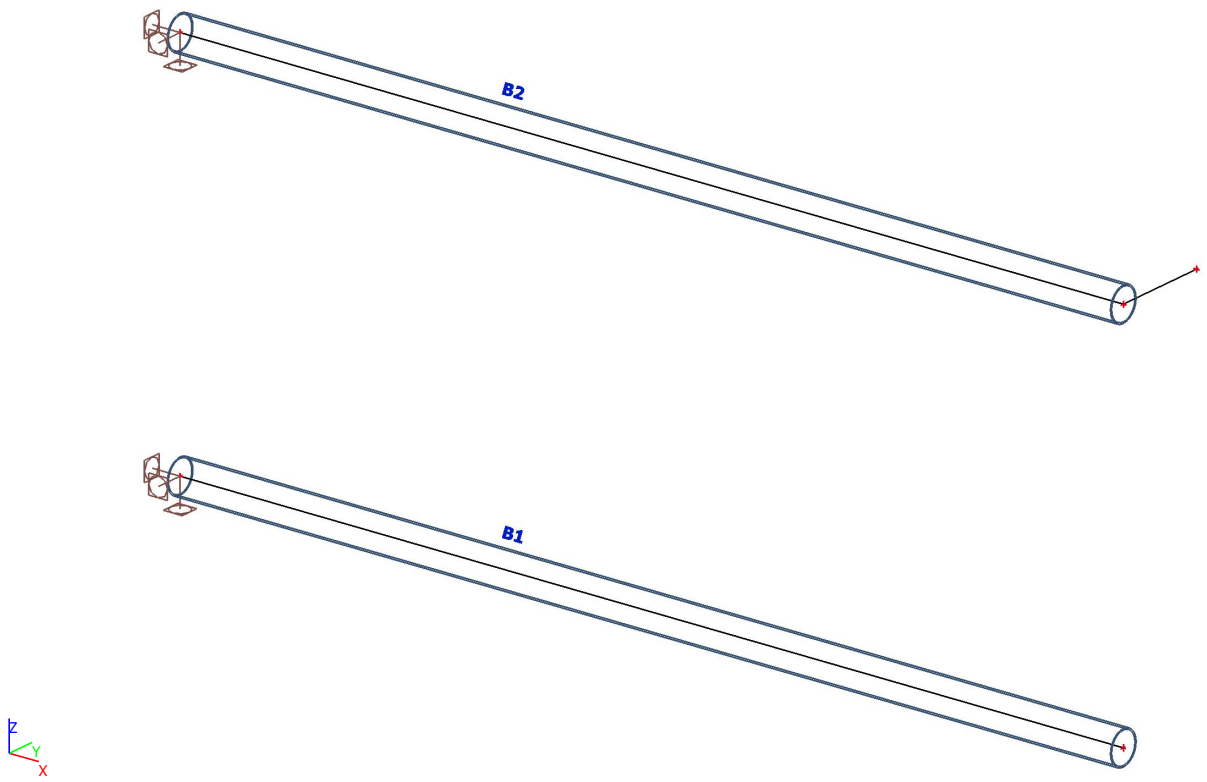
4.5. 3D displacement; Beam B1



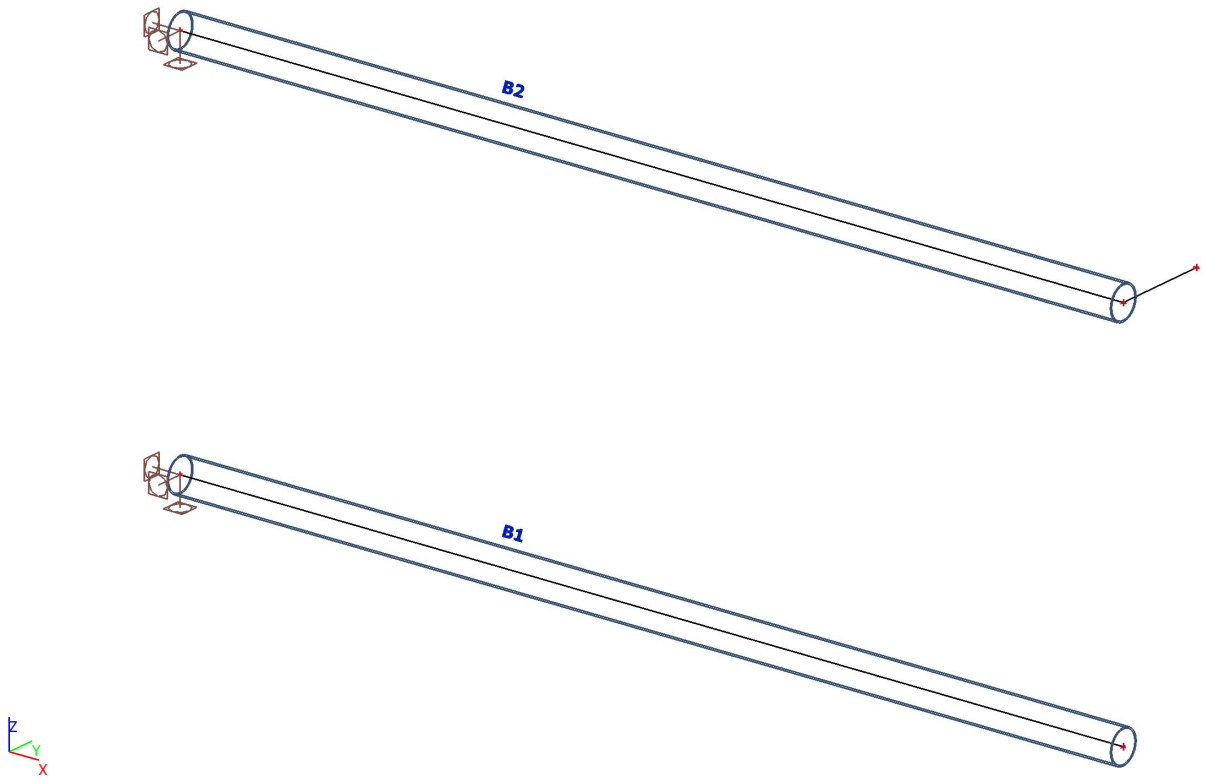
4.6. 3D displacement; Beam B1



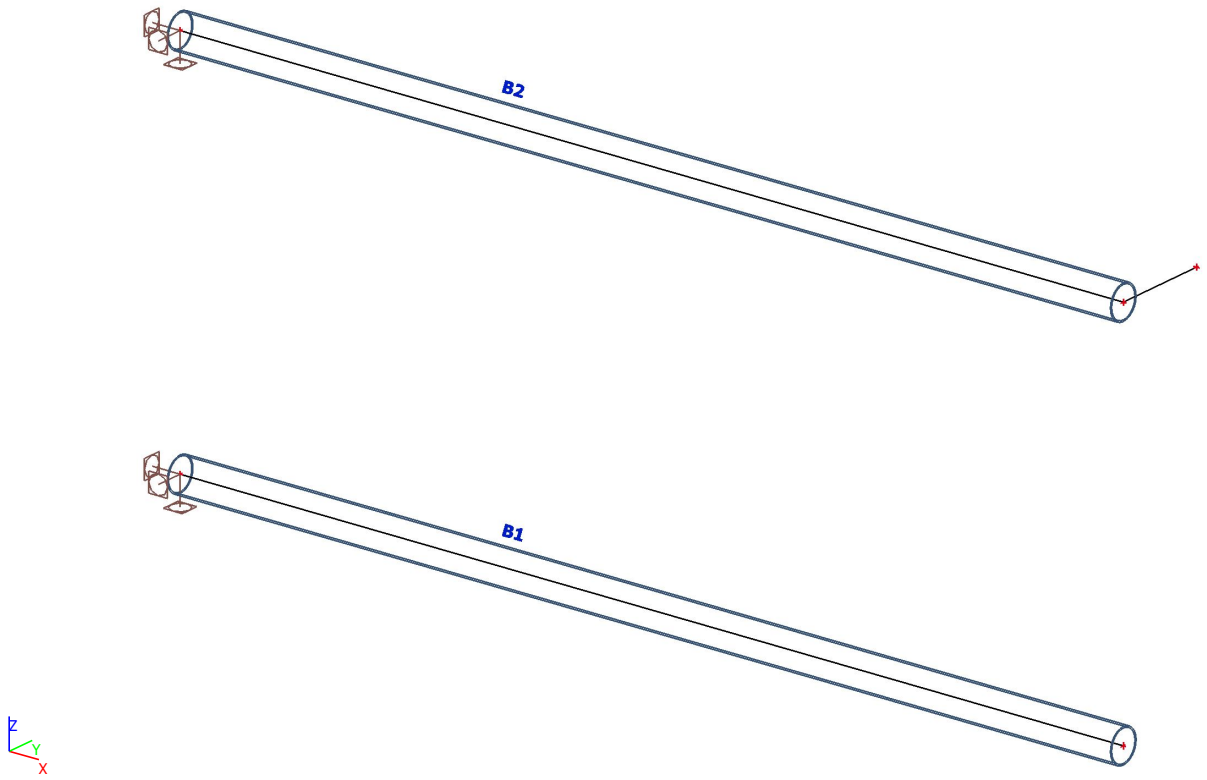
4.7. 3D displacement; Beam B1



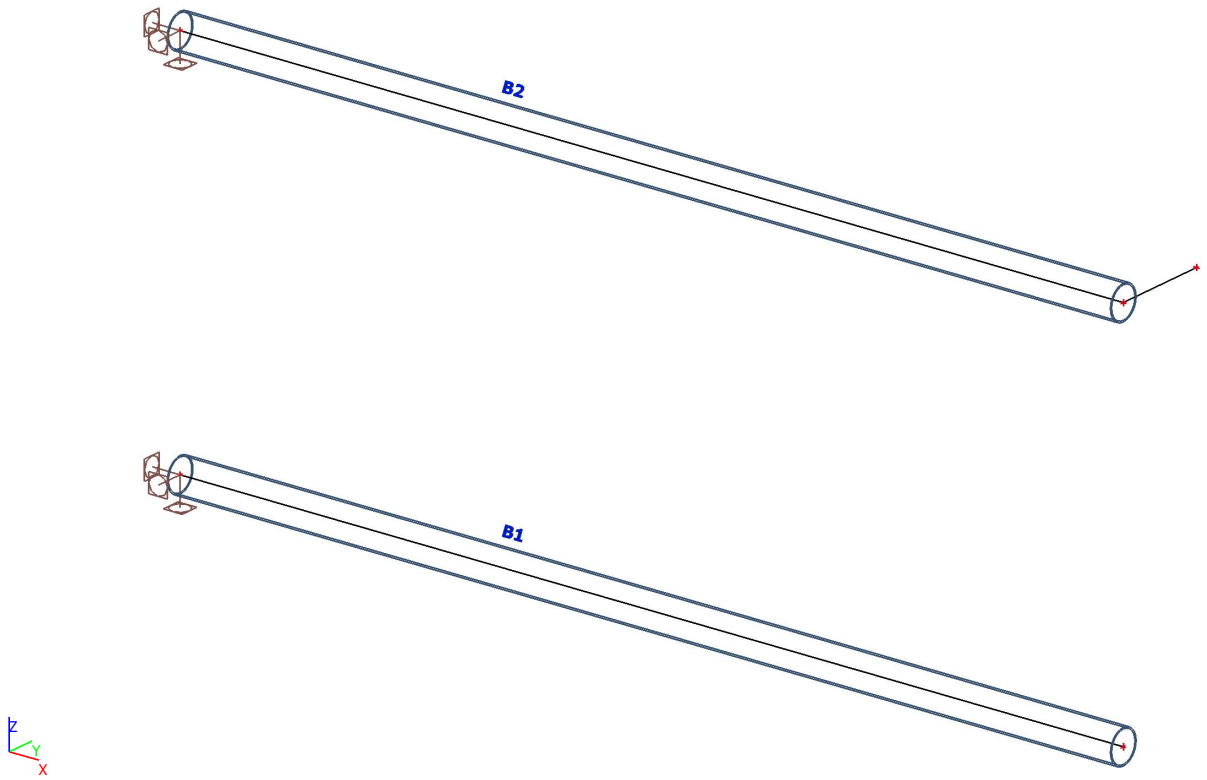
4.8. 3D displacement; Beam B1



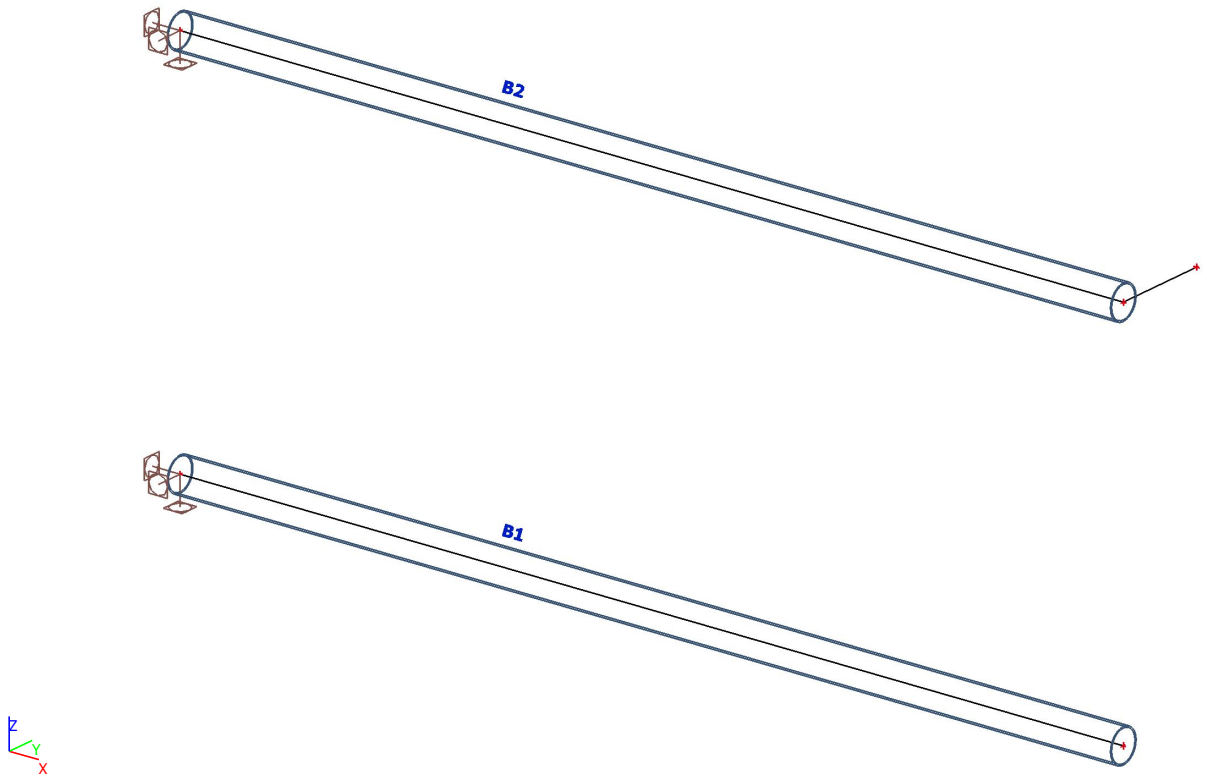
4.9. 3D displacement; Beam B1



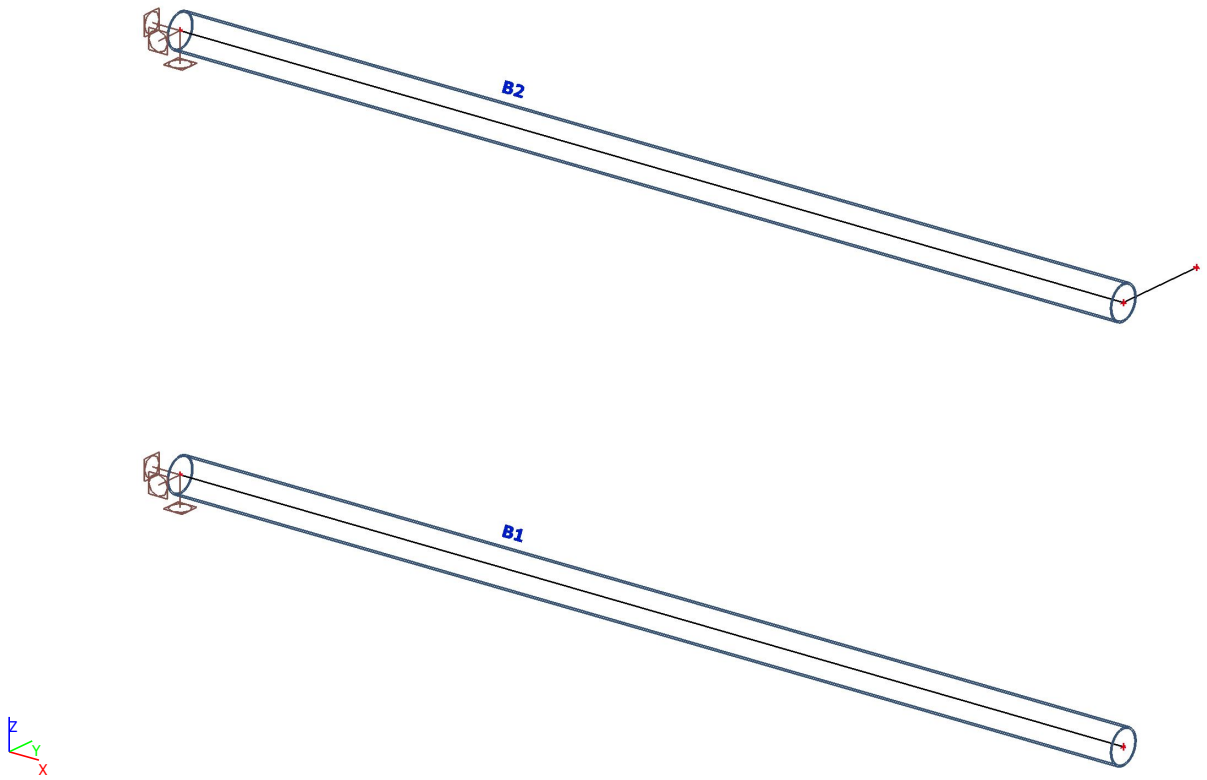
4.10. 3D displacement; Beam B1



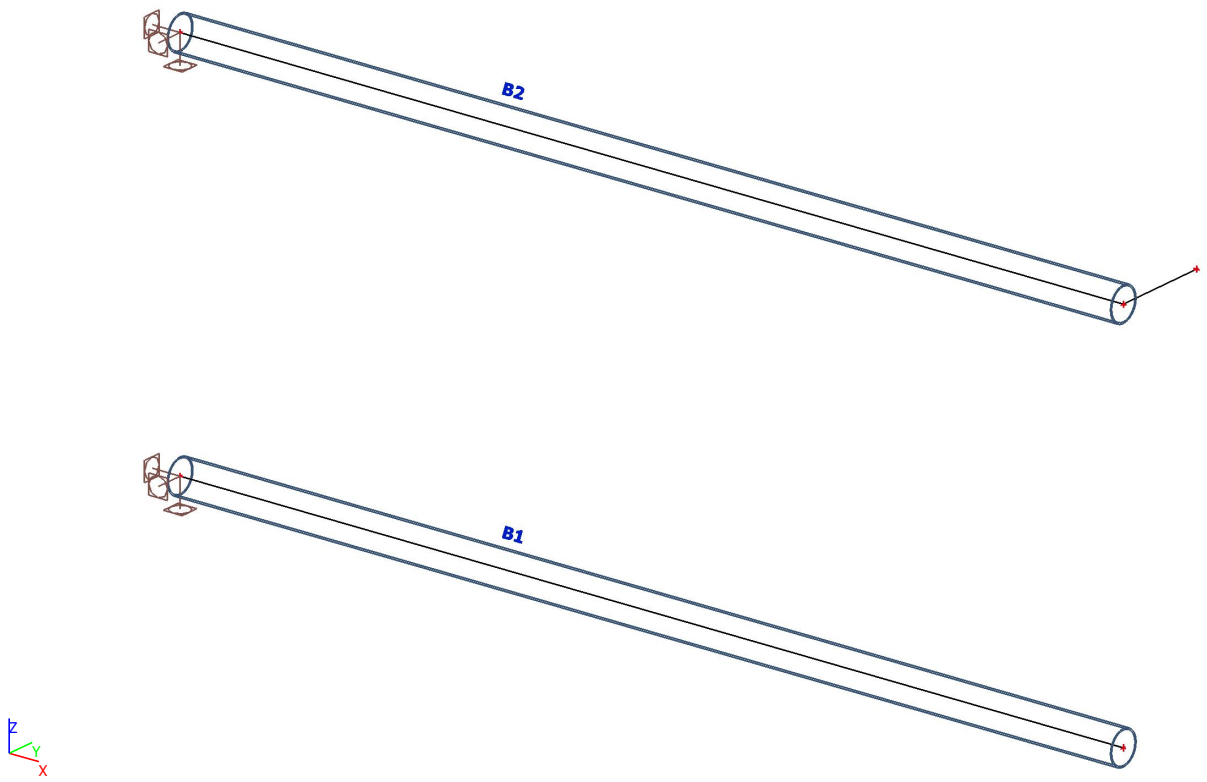
4.11. 3D displacement; Beam B1



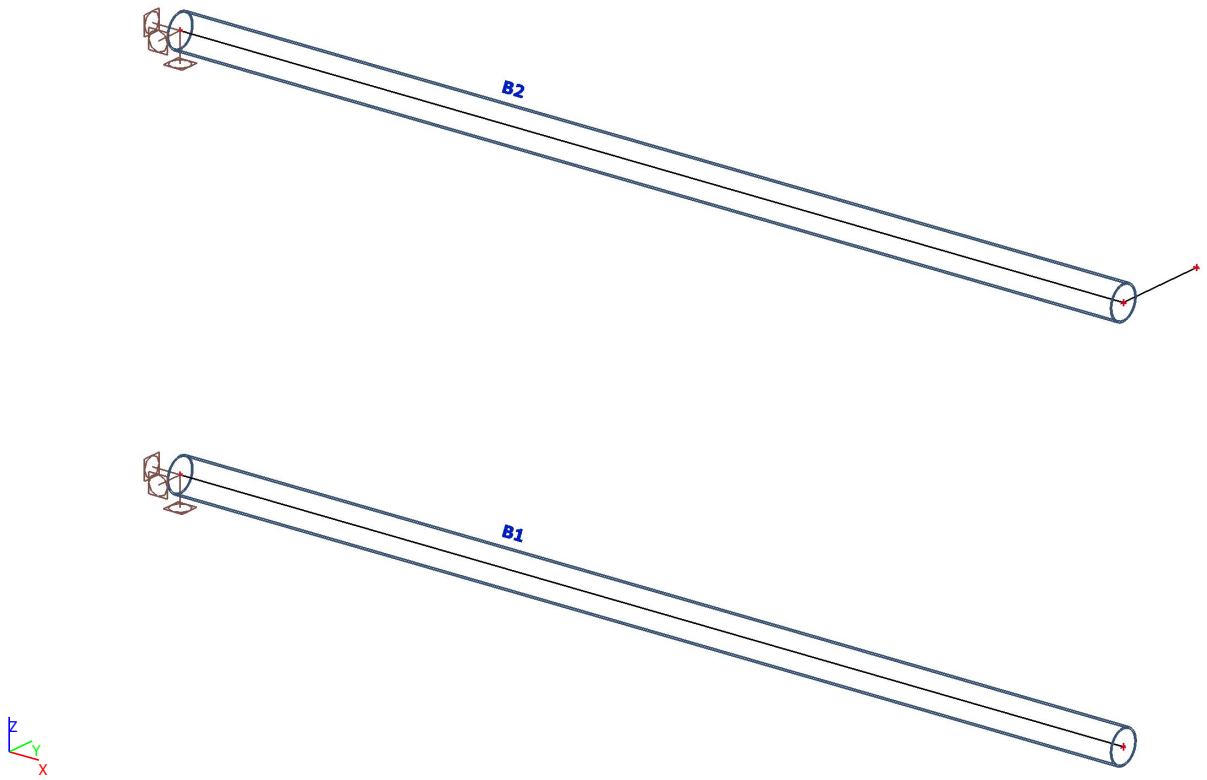
4.12. 3D displacement; Beam B2



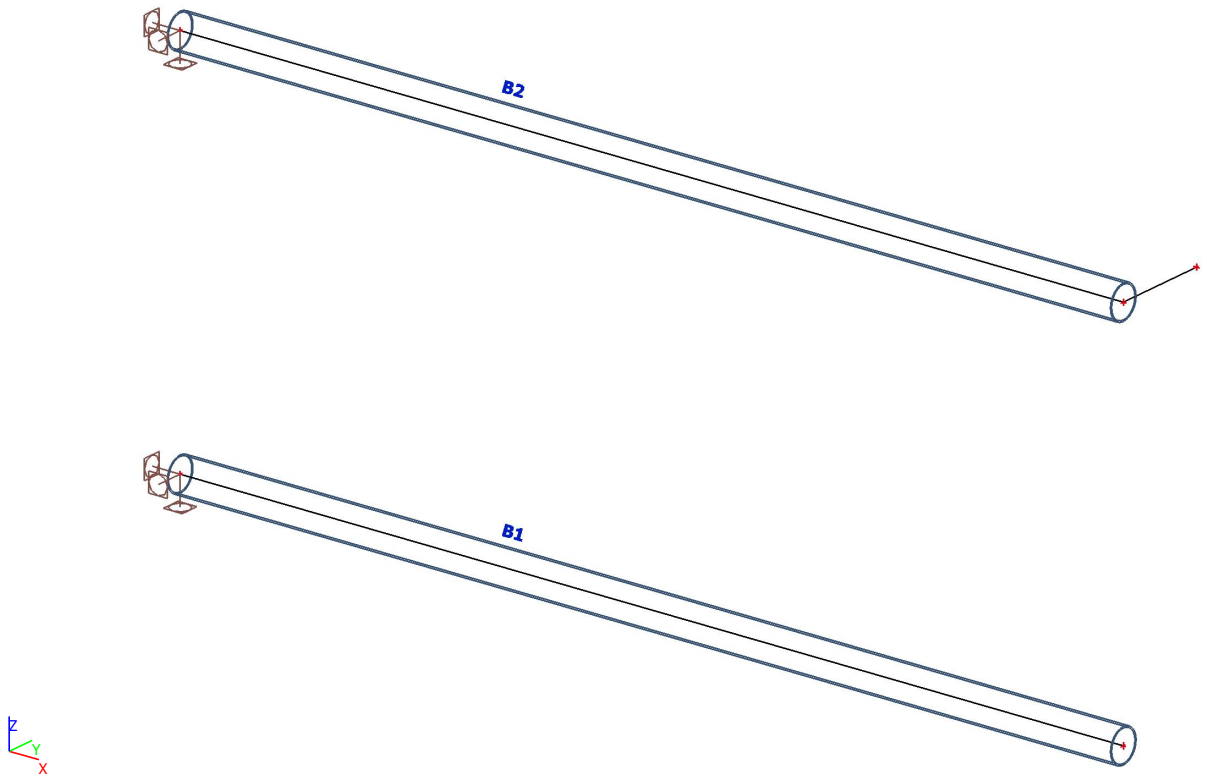
4.13. 3D displacement; Beam B2



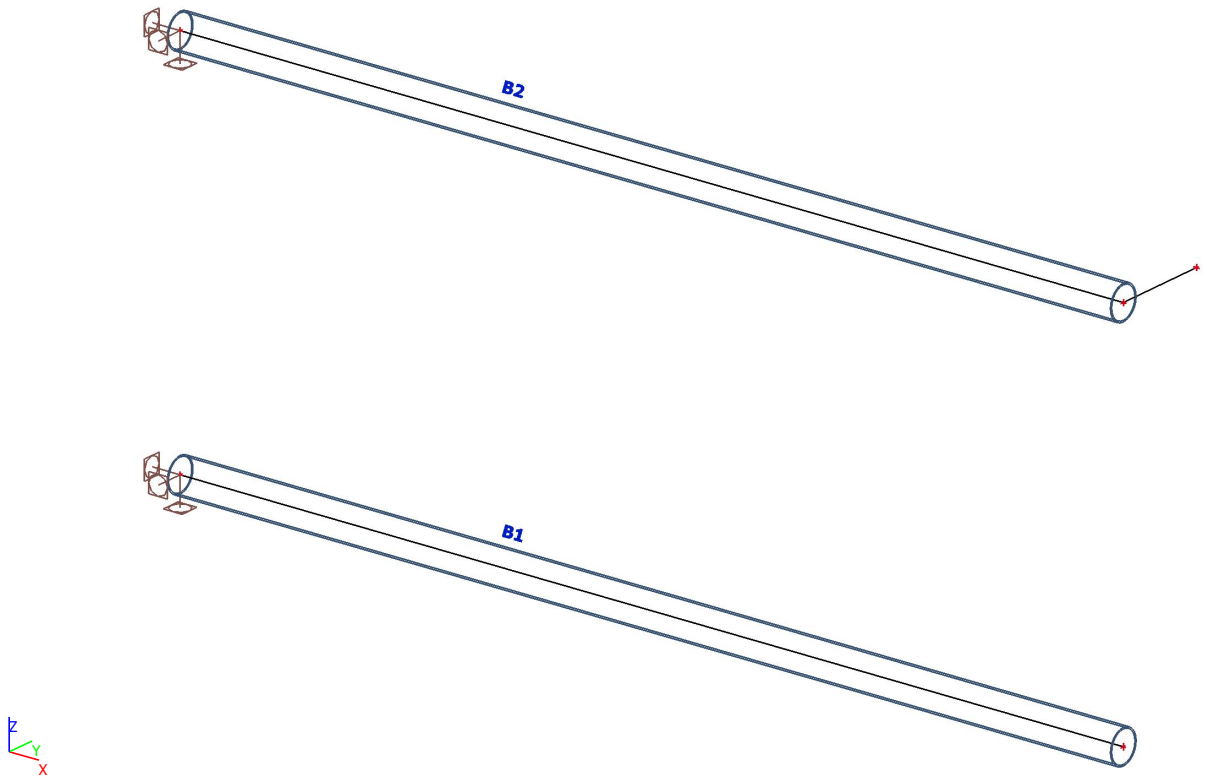
4.14. 3D displacement; Beam B2



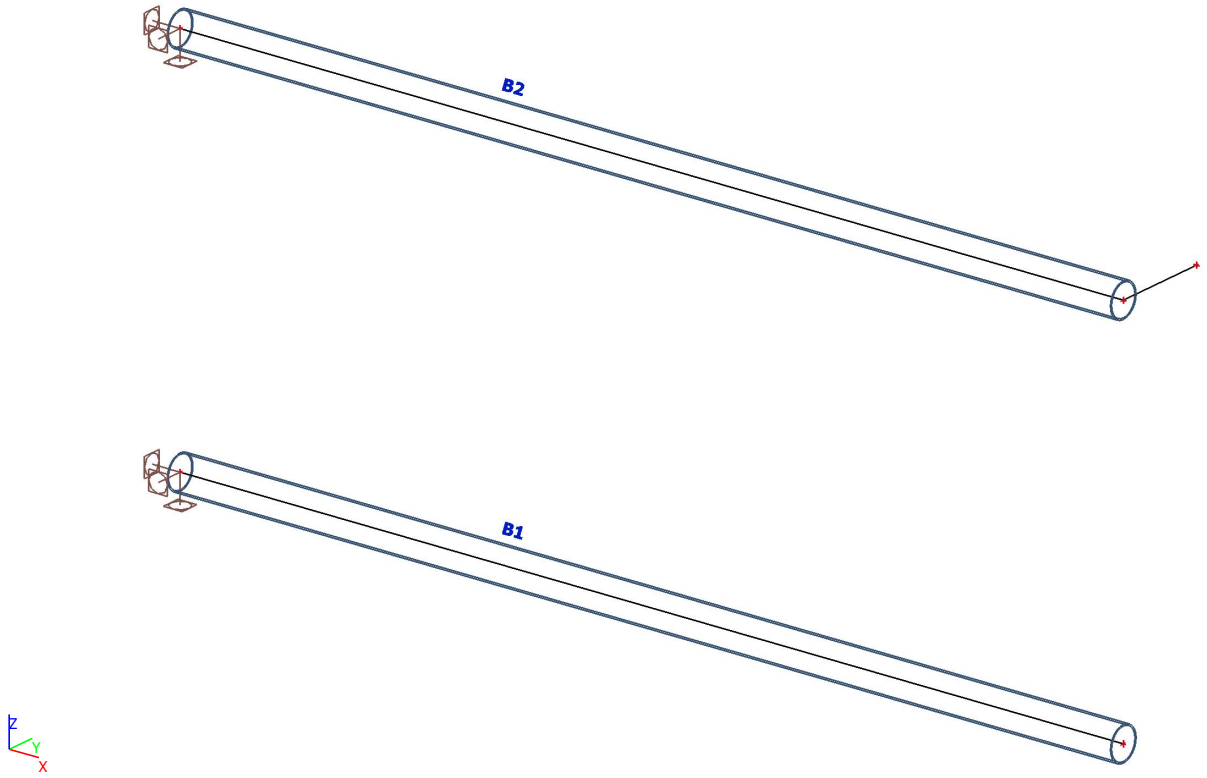
4.15. 3D displacement; Beam B2



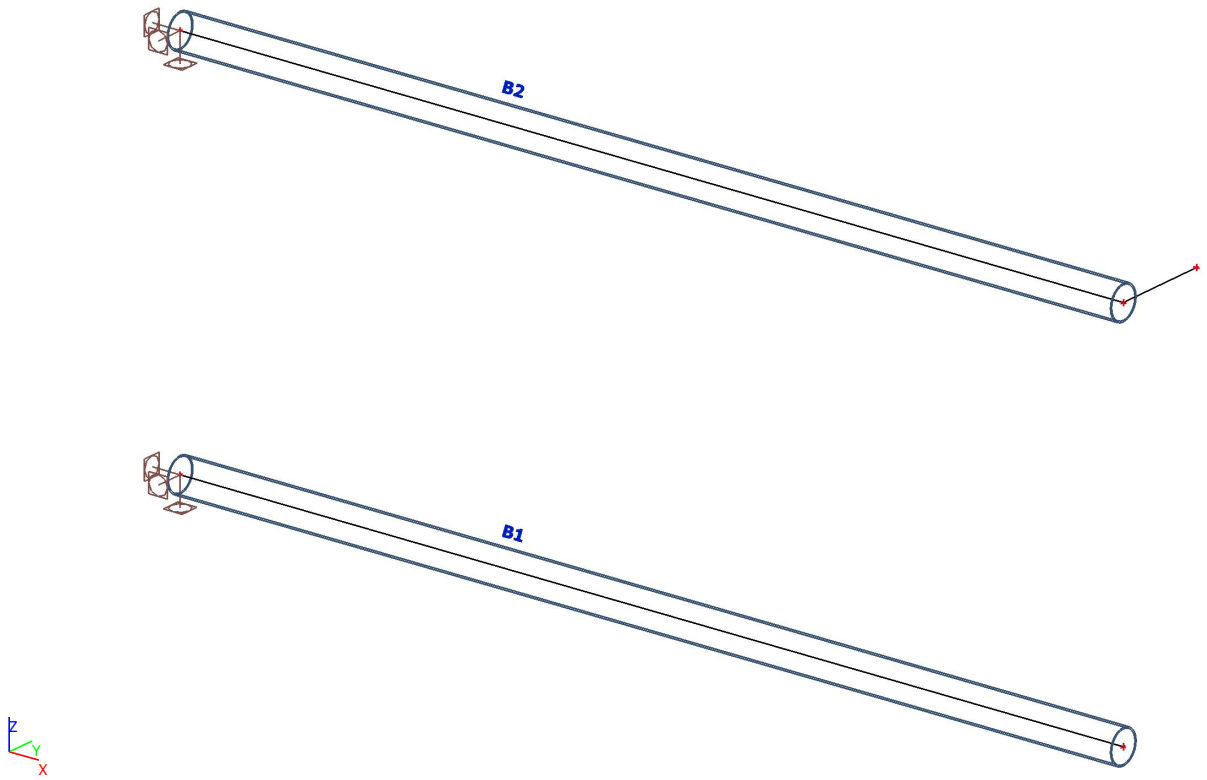
4.16. 3D displacement; Beam B2



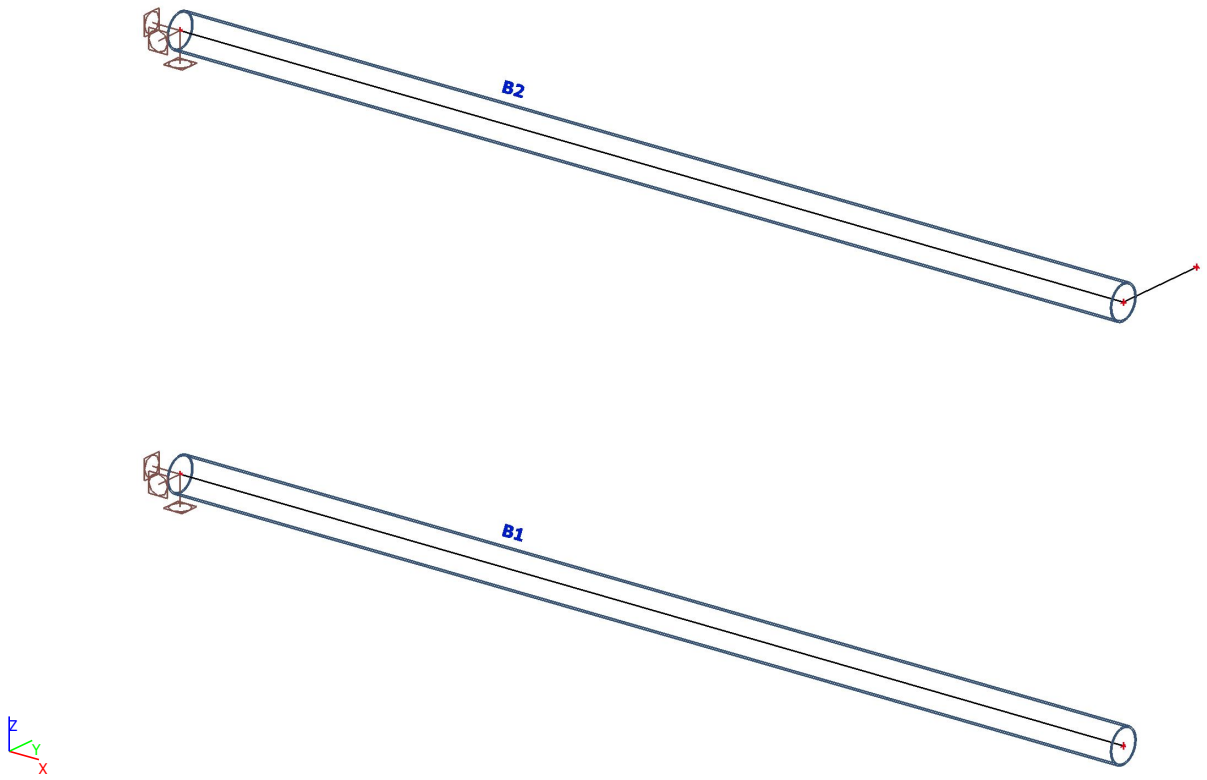
4.17. 3D displacement; Beam B2



4.18. 3D displacement; Beam B2



4.19. 3D displacement; Beam B2



5. EXPECTED AFNOR RESULTS

Beam B1 (no eccentric mass):

Bendings 1 & 2 = 1.65 Hz
Bendings 3 & 4 = 16.07 Hz
Bendings 5 & 6 = 50.02 Hz
Tension 1 = 76.47 Hz
Torsion 1 = 80.47 Hz
Bendings 7 & 8 = 103.20

Beam B2 (with eccentric mass):

Bending + Torsion = 1.636 Hz
Bending + Tension = 1.642 Hz
Bending + Tension = 13.46 Hz
Bending + Torsion = 13.59 Hz
Bending + Torsion = 28.90 Hz
Bending + Tension = 31.96 Hz
Bending + Torsion = 61.61 Hz
Bending + Tension = 63.93 Hz

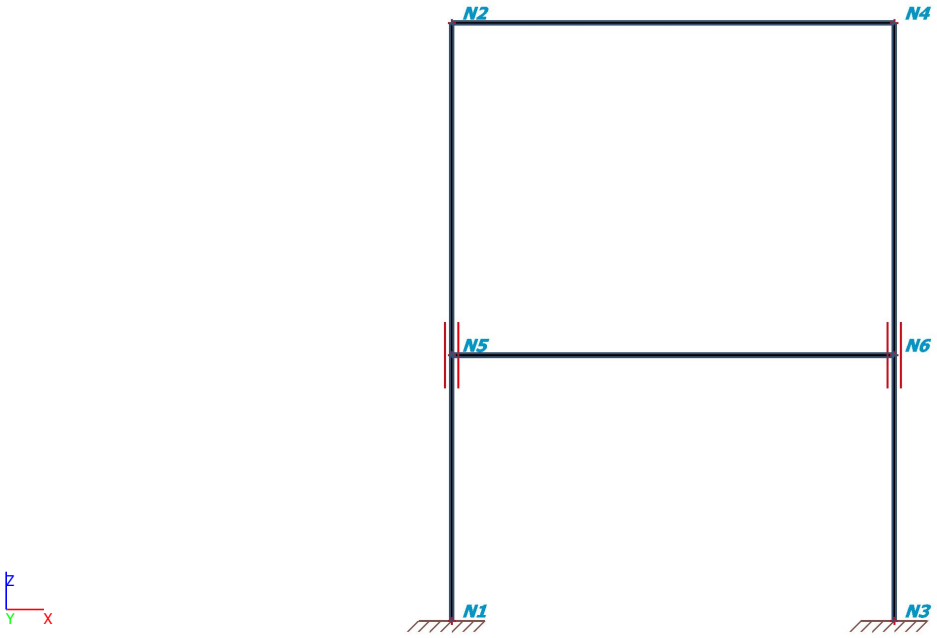
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a symmetric portal frame

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]	Member	Data
N1	-0.300	0.000	B1	Sn1
N2	-0.300	0.810	B1	
			B3	
N3	0.300	0.000	B2	Sn2

Name	Coord X [m]	Coord Z [m]	Member	Data
N4	0.300	0.810	B2	
			B3	
N5	-0.300	0.360	B1	
			B4	
N6	0.300	0.360	B2	
			B4	

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Full rectangular (4.8; 29.0)	S 235	0.810	N1	N2	column (100)
B2	CS1 - Full rectangular (4.8; 29.0)	S 235	0.810	N3	N4	column (100)
B3	CS1 - Full rectangular (4.8; 29.0)	S 235	0.600	N2	N4	beam (80)
B4	CS1 - Full rectangular (4.8; 29.0)	S 235	0.600	N5	N6	beam (80)

2.4. Nodal supports

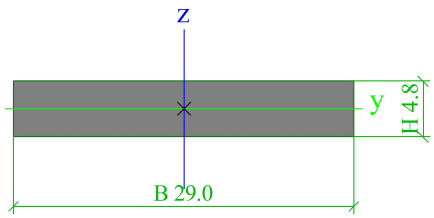
Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Rigid
Sn2	N3	GCS	Standard	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0.0	40.0	235.0	360.0	
		8.0769e+04	0.01e-003	40.0	80.0	215.0	360.0	

2.6. Cross-sections

CS1		
Type	Full rectangular	
Detailed	4.8; 29.0	
Formcode	7 - Full rectangular section	
Item material	S 235	
A [m²]	1.3920e-04	
A_y [m²], A_z [m²]	1.1600e-04	1.1600e-04
A_L [m²/m], A_D [m²/m]	6.7600e-02	6.7600e-02
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	14.5	2.4
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	2.6726e-10	9.7556e-09
i_y [mm], i_z [mm]	1.4	8.4
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.1136e-07	6.7280e-07
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.6704e-07	1.0092e-06
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	39.25	39.25
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	237.16	237.16
d_y [mm], d_z [mm]	0.0	0.0
I_t [m⁴], I_w [m⁶]	9.5758e-10	0.0000e+00
β_y [mm], β_z [mm]	0.0	0.0
Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Self weight

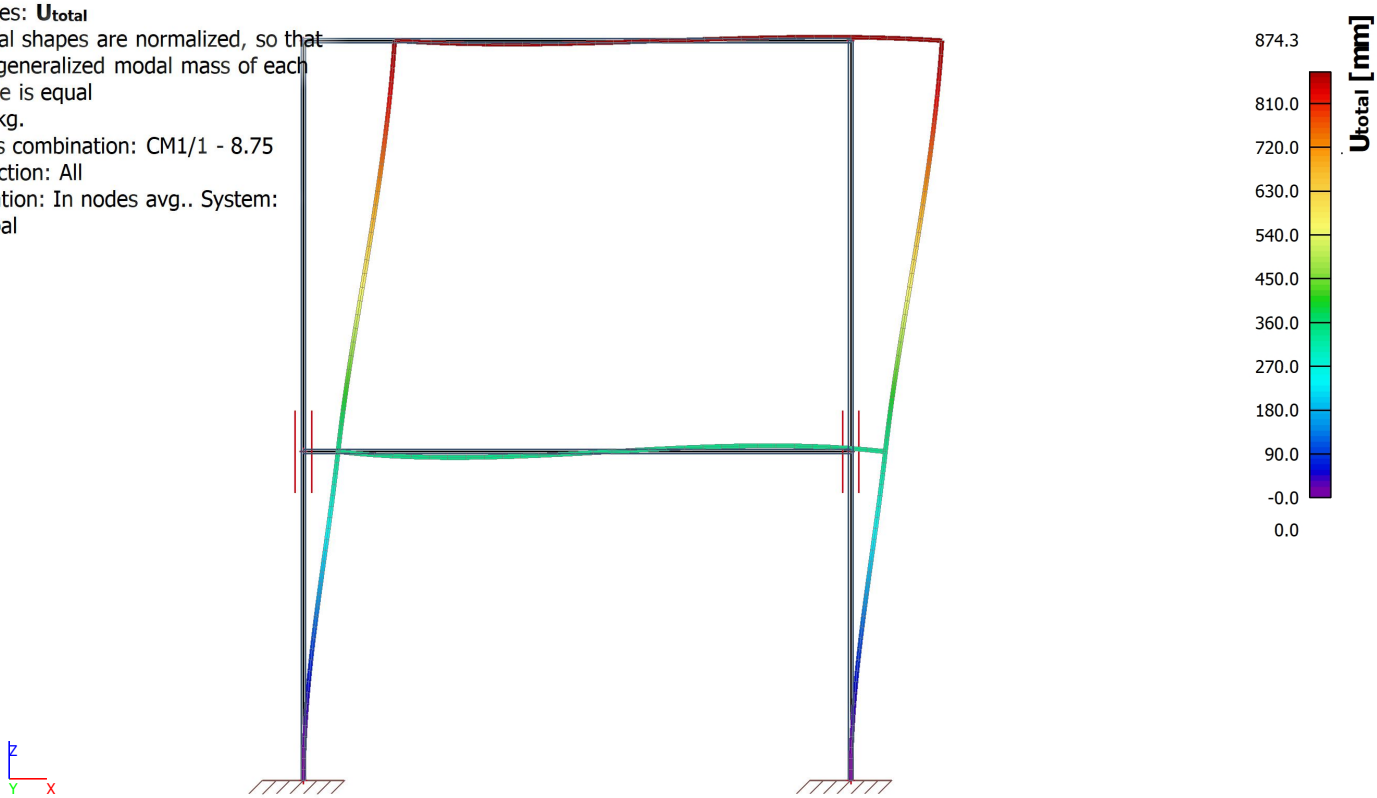
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	8.75	55.00	3024.66	0.11
2	29.34	184.37	33993.26	0.03
3	43.71	274.61	75412.58	0.02
4	56.12	352.61	124331.60	0.02
5	95.86	602.30	362770.46	0.01
6	102.37	643.18	413685.92	0.01
7	146.64	921.34	848863.44	0.01
8	174.39	1095.67	1200500.42	0.01
9	178.36	1120.61	1255760.55	0.01
10	205.58	1291.65	1668361.32	0.00
11	265.81	1670.09	2789205.97	0.00
12	319.35	2006.47	4025929.16	0.00
13	334.36	2100.79	4413307.87	0.00

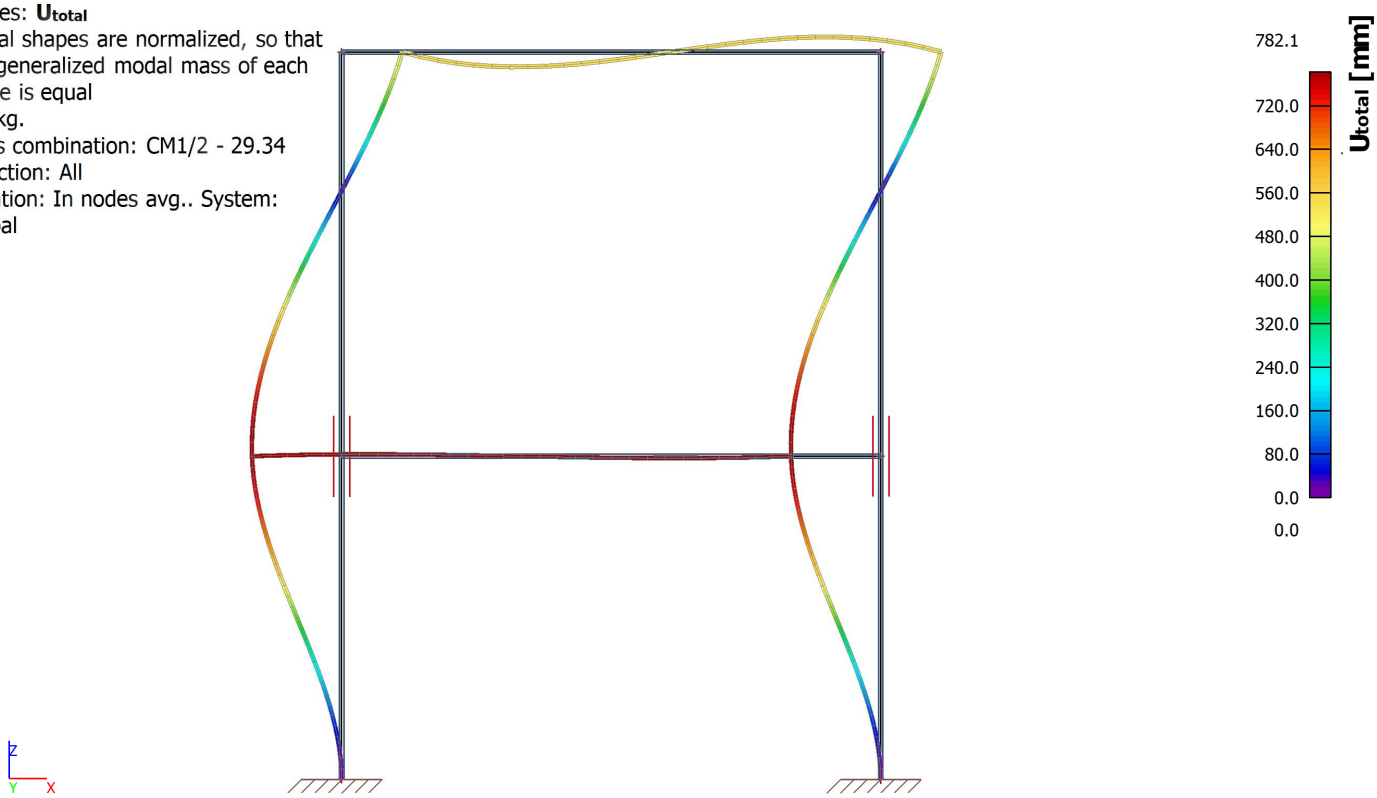
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 8.75
Selection: All
Location: In nodes avg.. System: Global



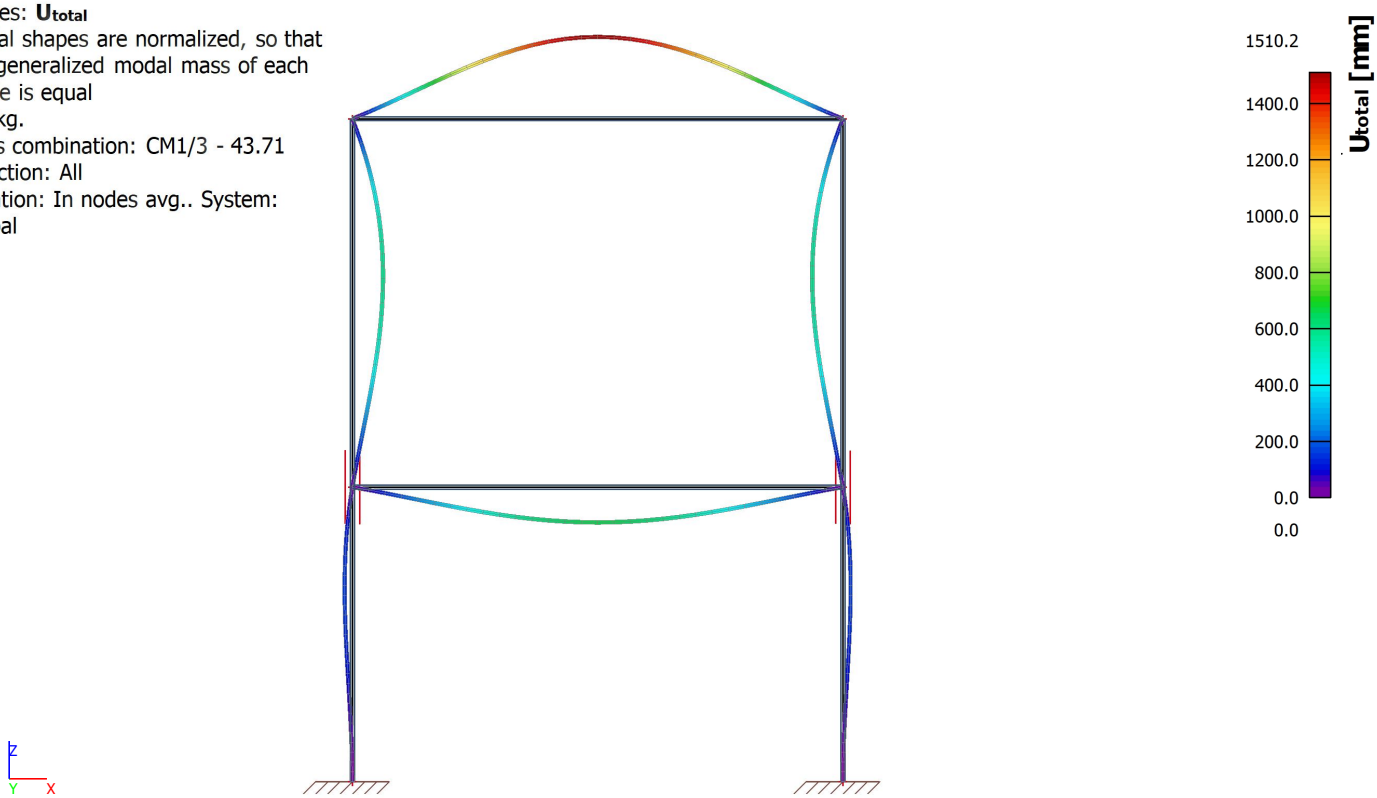
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 29.34
Selection: All
Location: In nodes avg.. System: Global



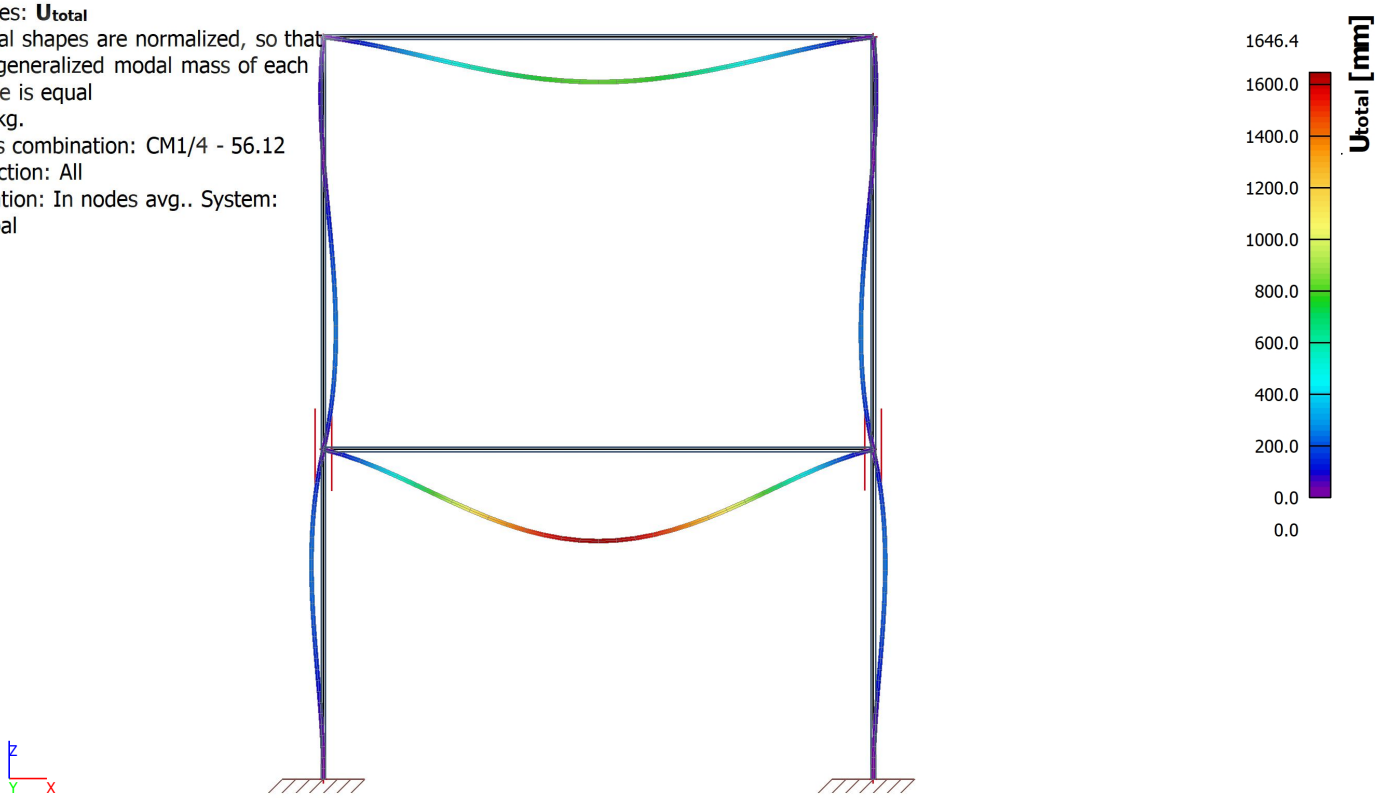
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/3 - 43.71
Selection: All
Location: In nodes avg.. System: Global



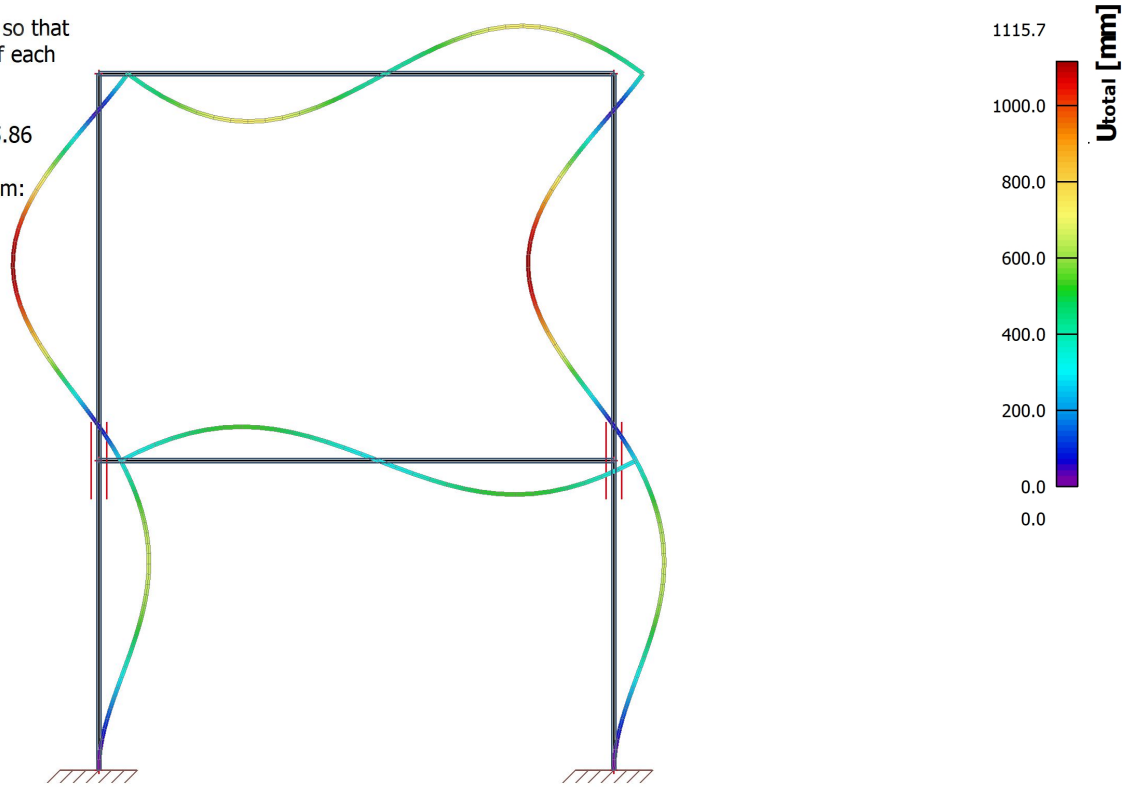
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 56.12
Selection: All
Location: In nodes avg.. System: Global



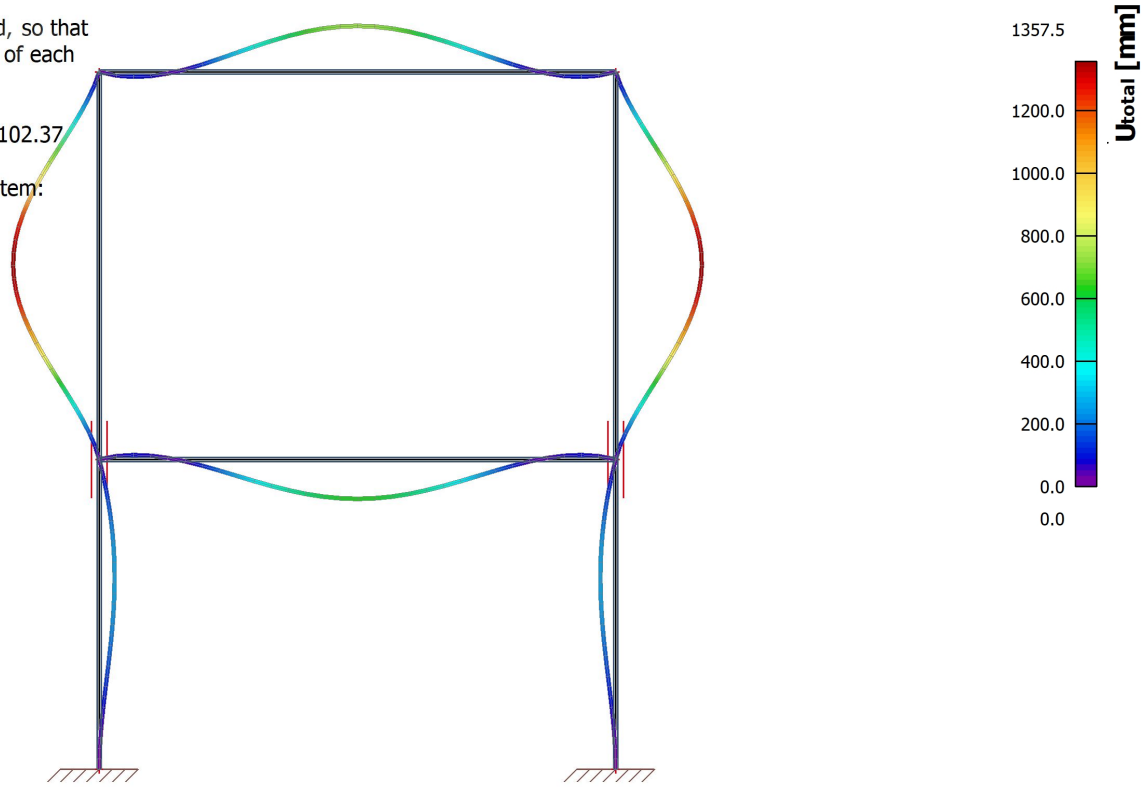
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/5 - 95.86
Selection: All
Location: In nodes avg.. System: Global



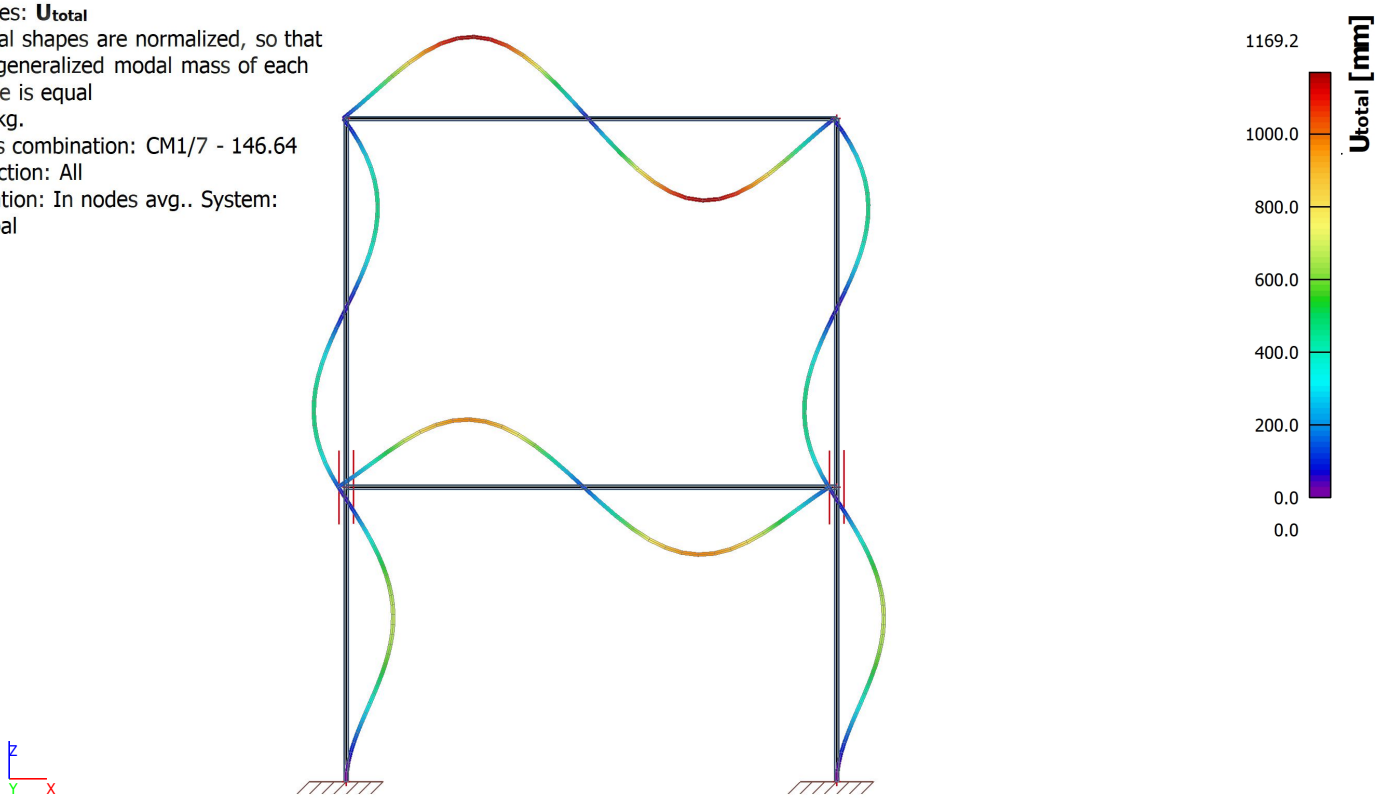
4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/6 - 102.37
Selection: All
Location: In nodes avg.. System: Global



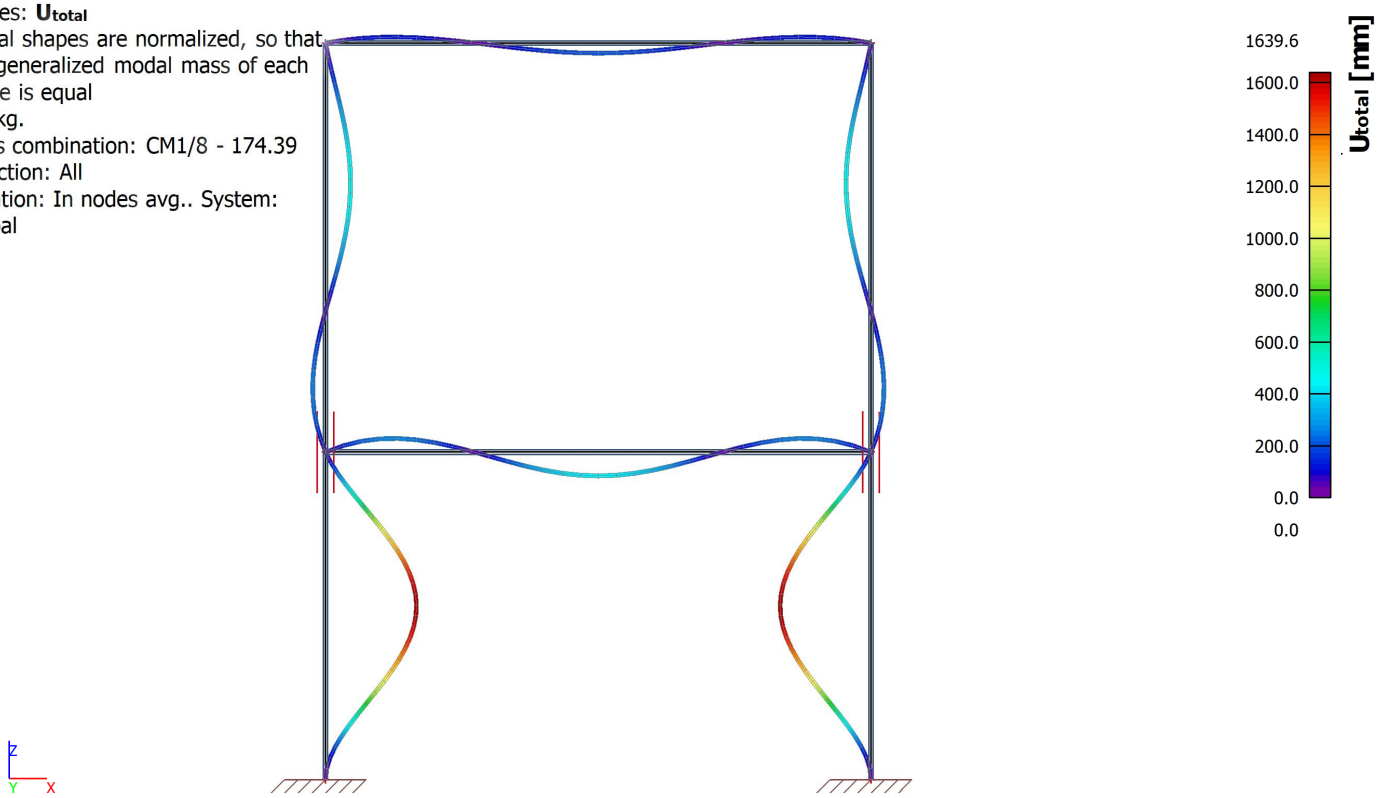
4.8. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/7 - 146.64
Selection: All
Location: In nodes avg.. System: Global



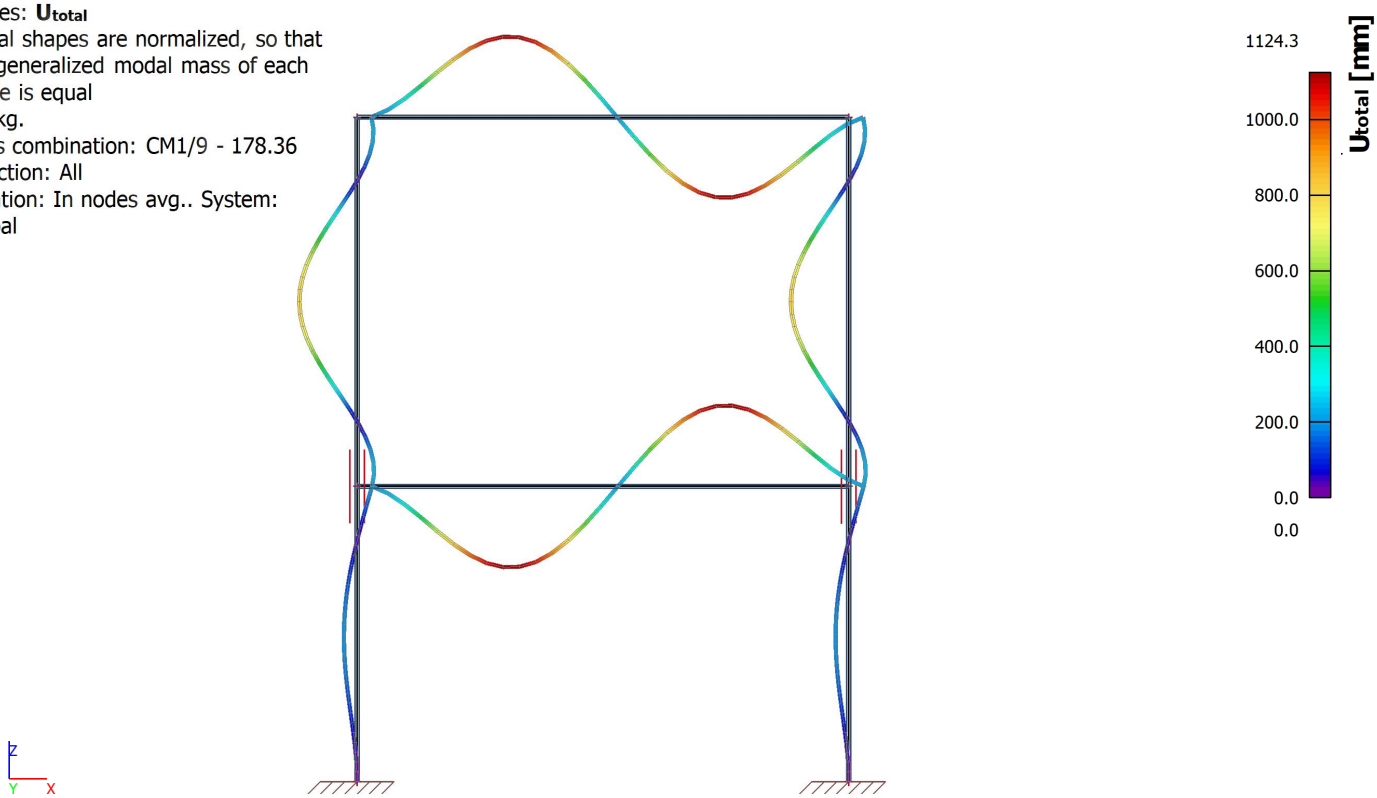
4.9. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/8 - 174.39
Selection: All
Location: In nodes avg.. System: Global



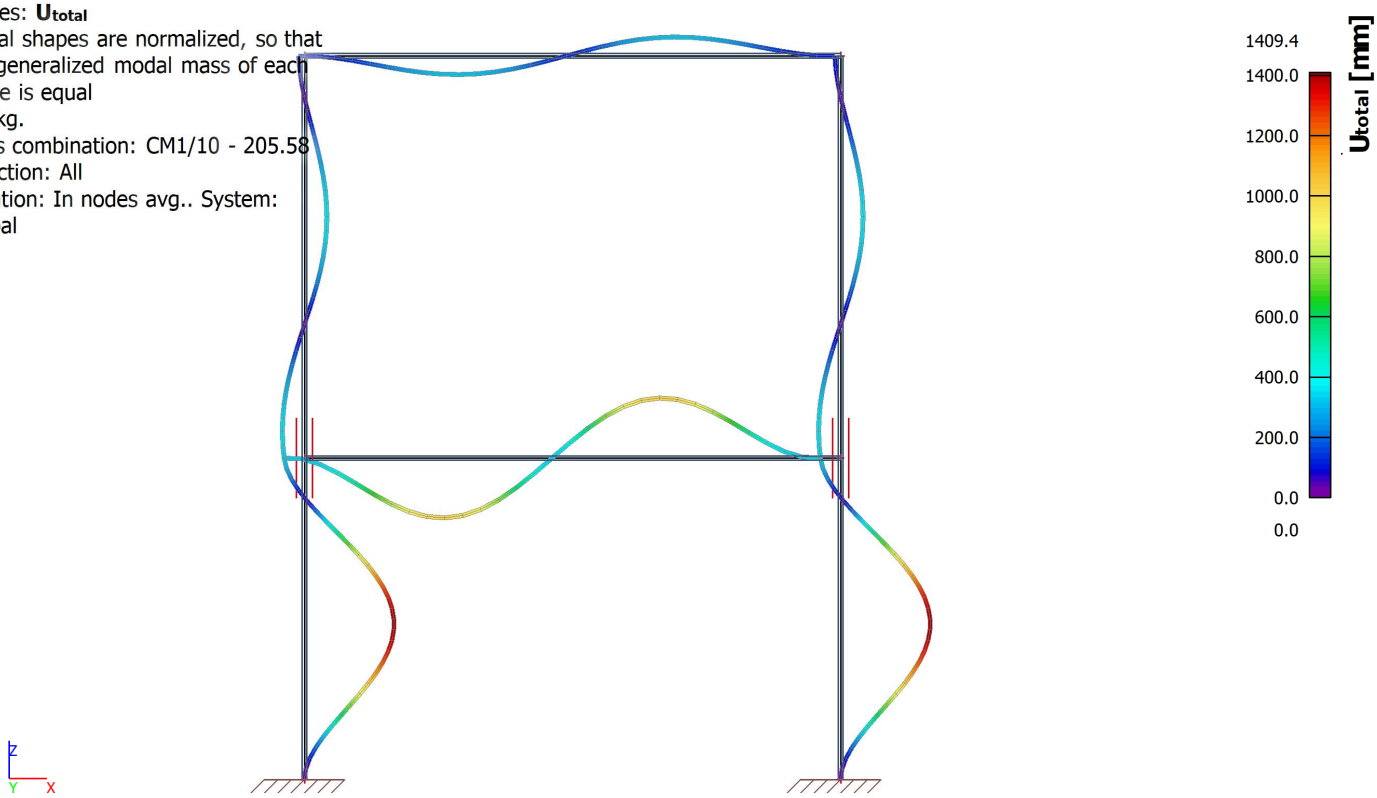
4.10. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/9 - 178.36
Selection: All
Location: In nodes avg.. System: Global



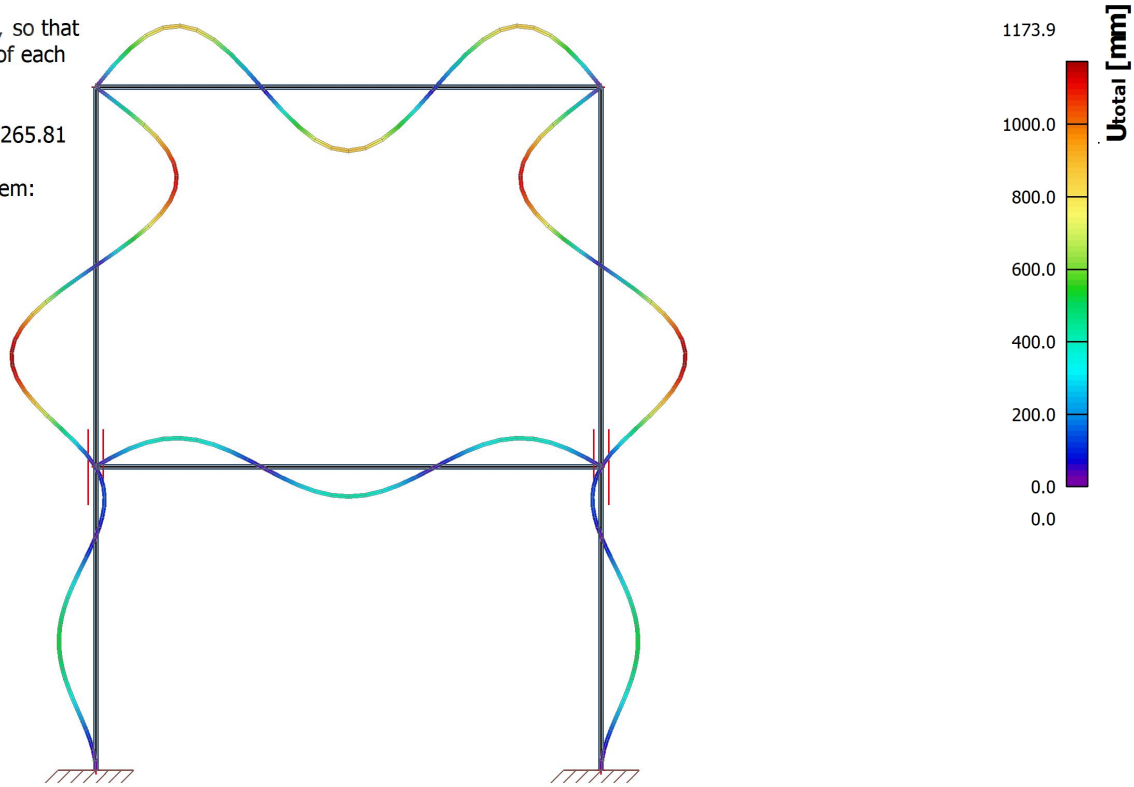
4.11. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/10 - 205.58
Selection: All
Location: In nodes avg.. System: Global



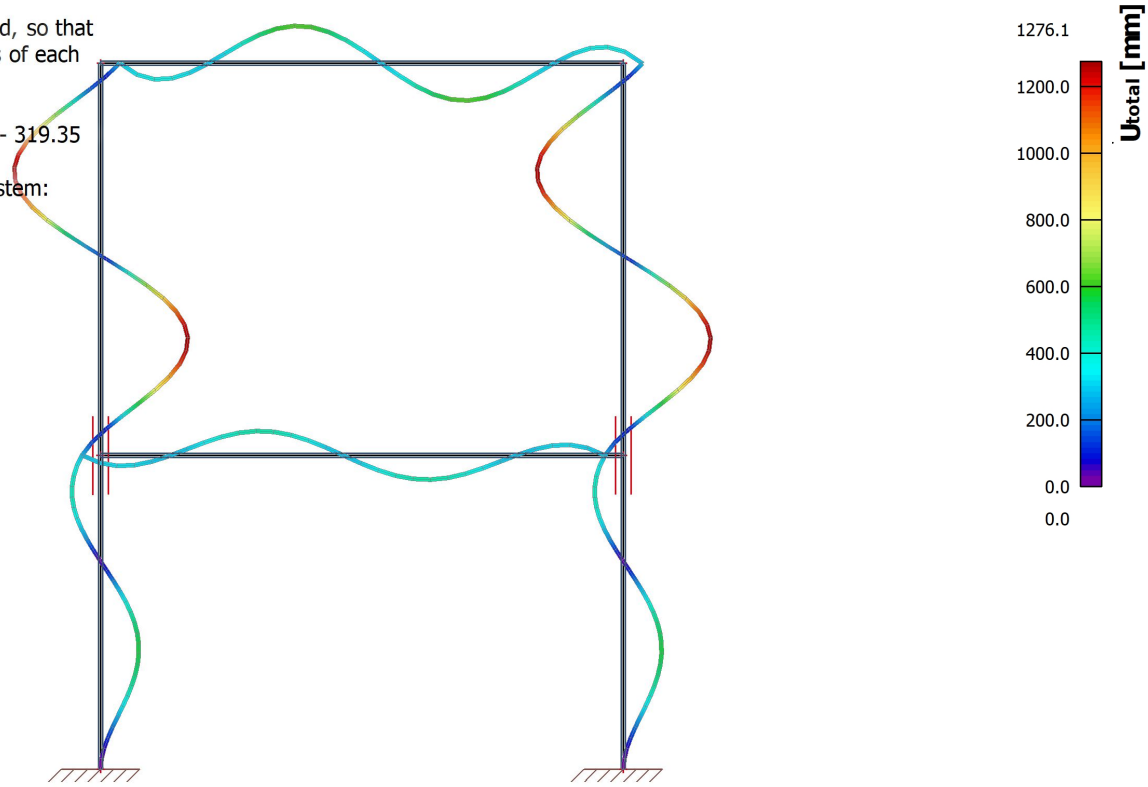
4.12. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/11 - 265.81
Selection: All
Location: In nodes avg.. System: Global



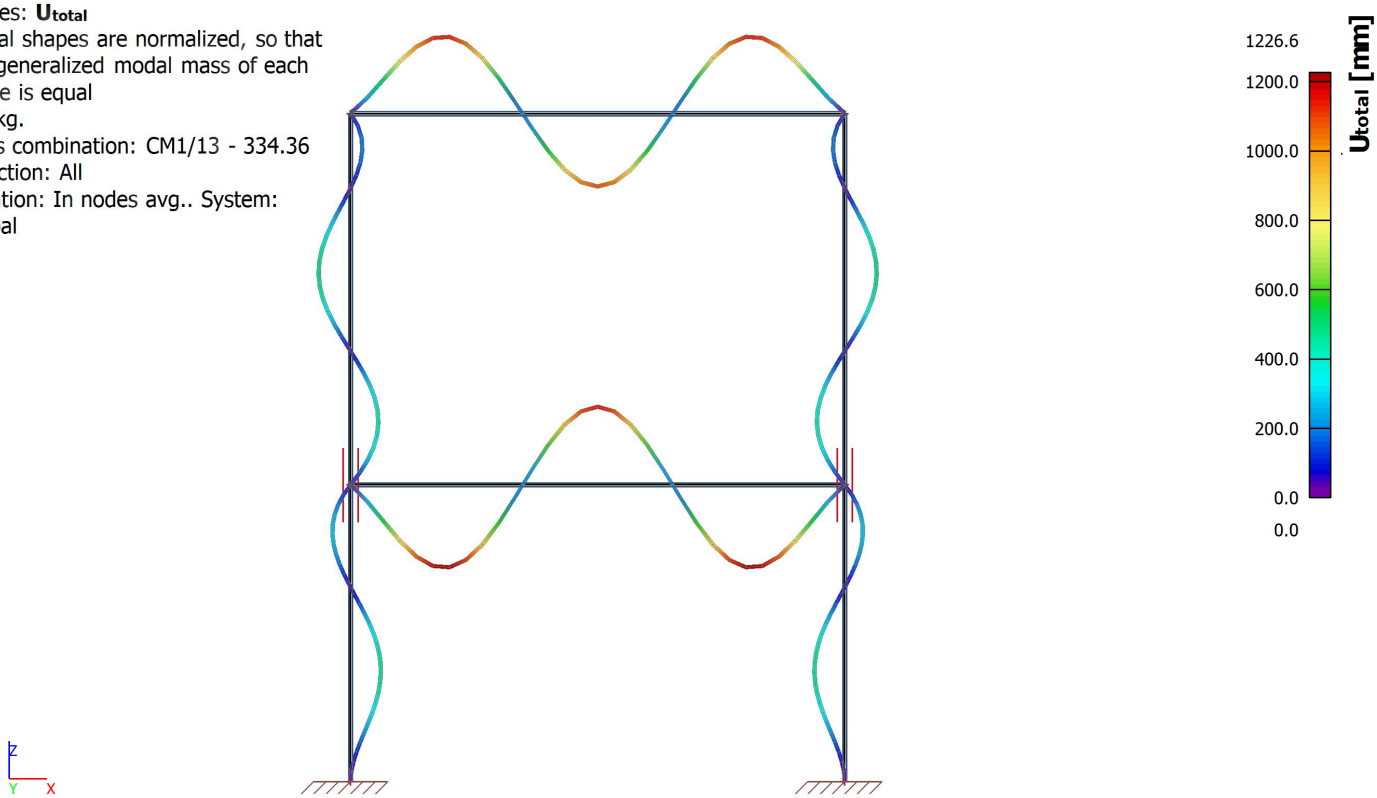
4.13. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/12 - 319.35
Selection: All
Location: In nodes avg.. System: Global



4.14. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/13 - 334.36
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 8.8 Hz
f2 = 29.4 Hz
f3 = 43.8 Hz
f4 = 56.3 Hz
f5 = 96.2 Hz
f6 = 102.6 Hz
f7 = 147.1 Hz
f8 = 174.8 Hz
f9 = 178.8 Hz
f10 = 206.0 Hz
f11 = 266.4 Hz
f12 = 320.0 Hz
f13 = 335.0 Hz

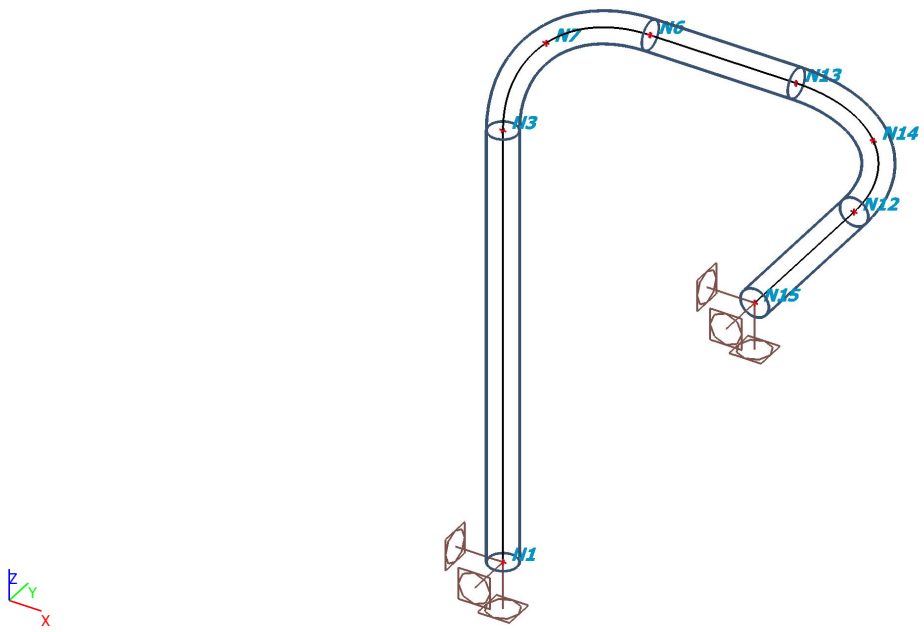
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Hovgaard problem - Modal analysis of a pipe

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N1	-2.750	0.000	-3.690	B1	Sn2
N3	-2.750	0.000	-0.922	B1	
				B5	
N6	-1.828	0.000	0.000	B3	
				B5	
N7	-2.480	0.000	-0.270	B5	

Name	Coord X [m]	Coord Y [m]	Coord Z [m]	Member	Data
N12	0.000	-0.922	0.000	B7	
				B9	
N13	-0.914	0.000	0.000	B3	
				B9	
N14	-0.267	-0.273	0.000	B9	
N15	0.000	-1.960	0.000	B7	Sn1

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Tube (185.0; 6.1)	Material	2.768	N1	N3	column (100)
B3	CS1 - Tube (185.0; 6.1)	Material	0.914	N6	N13	beam (80)
B5	CS1 - Tube (185.0; 6.1)	Material	1.448	N6	N3	beam (80)
B7	CS1 - Tube (185.0; 6.1)	Material	1.038	N12	N15	beam (80)
B9	CS1 - Tube (185.0; 6.1)	Material	1.440	N12	N13	beam (80)

2.4. Nodal supports

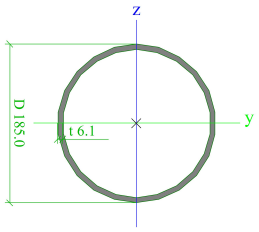
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn1	N15	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn2	N1	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [mm]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	13404.11	1.6580e+05	0.3	0.0	40.0	235.0	360.0	
		6.3769e+04	0.01e-003	40.0	80.0	215.0	360.0	

2.6. Cross-sections

CS1		
Type	Tube	
Detailed	185.0; 6.1	
Item material	Material	
A [m²]	3.4392e-03	
A_y [m²], A_z [m²]	2.1895e-03	2.1895e-03
A_L [m²/m], A_D [m²/m]	5.8117e-01	1.1239e+00
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	92.5	92.5
α [deg]	0.00	
I_y [m⁴], I_z [m⁴]	1.3772e-05	1.3772e-05
i_y [mm], i_z [mm]	63.3	63.3
$W_{el.y}$ [m³], $W_{el.z}$ [m³]	1.4889e-04	1.4889e-04
$W_{pl.y}$ [m³], $W_{pl.z}$ [m³]	1.9590e-04	1.9590e-04
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	46023.54	46023.54
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	46023.54	46023.54
d_y [mm], d_z [mm]	0.0	0.0
I_t [m⁴], I_w [m⁶]	2.7512e-05	0.0000e+00
β_y [mm], β_z [mm]	0.0	0.0
Picture		

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

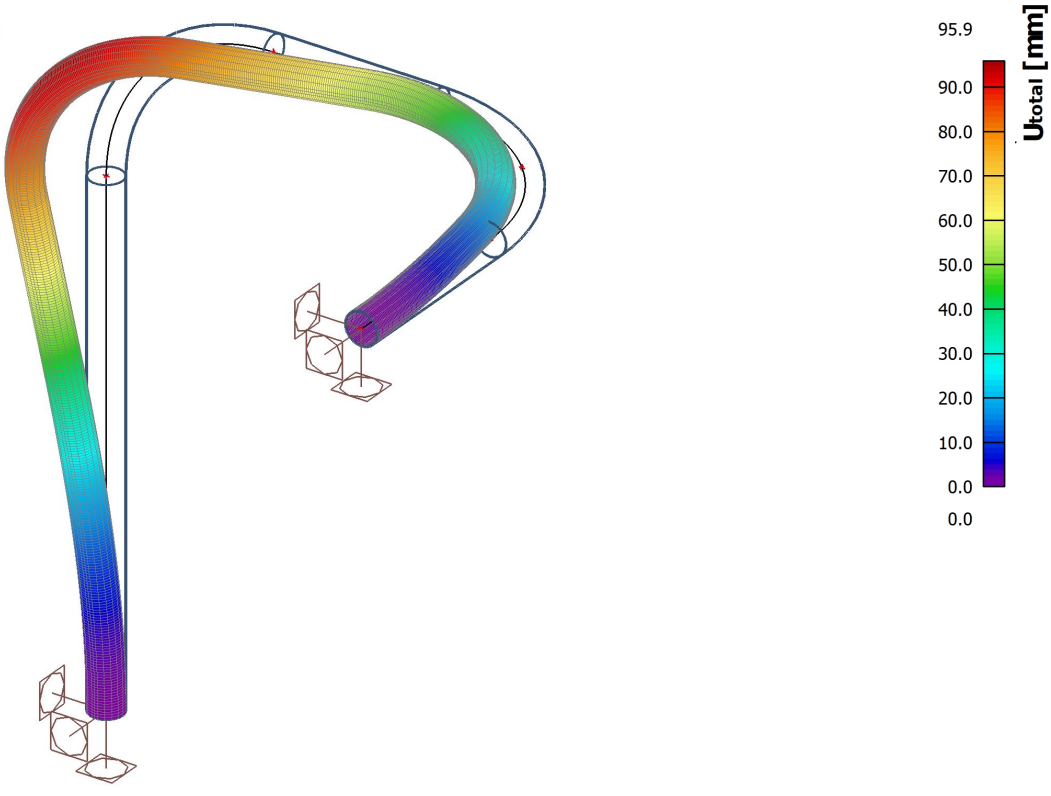
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	11.20	70.40	4955.54	0.09
2	23.04	144.77	20957.05	0.04
3	28.03	176.10	31009.62	0.04
4	52.89	332.32	110436.28	0.02
5	57.99	364.33	132739.20	0.02
6	93.95	590.30	348457.15	0.01
7	97.55	612.91	375656.55	0.01
8	151.37	951.04	904472.88	0.01
9	153.67	965.53	932251.99	0.01

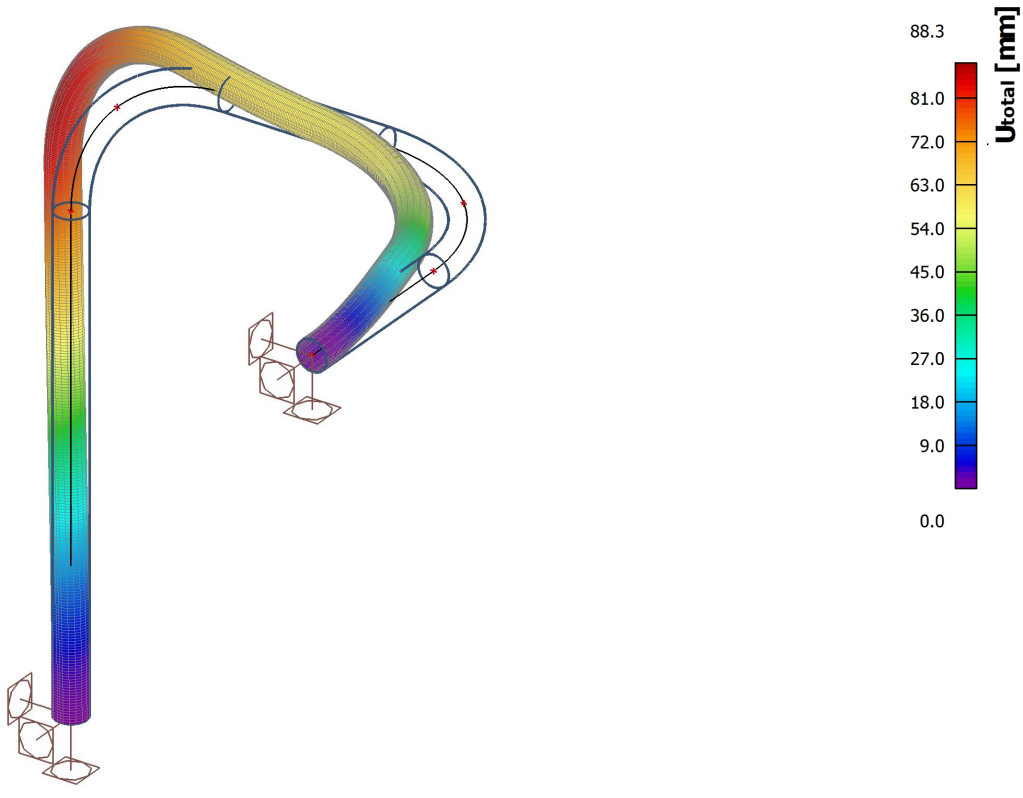
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/1 - 11.20
Selection: All
Location: In nodes avg.. System: Global



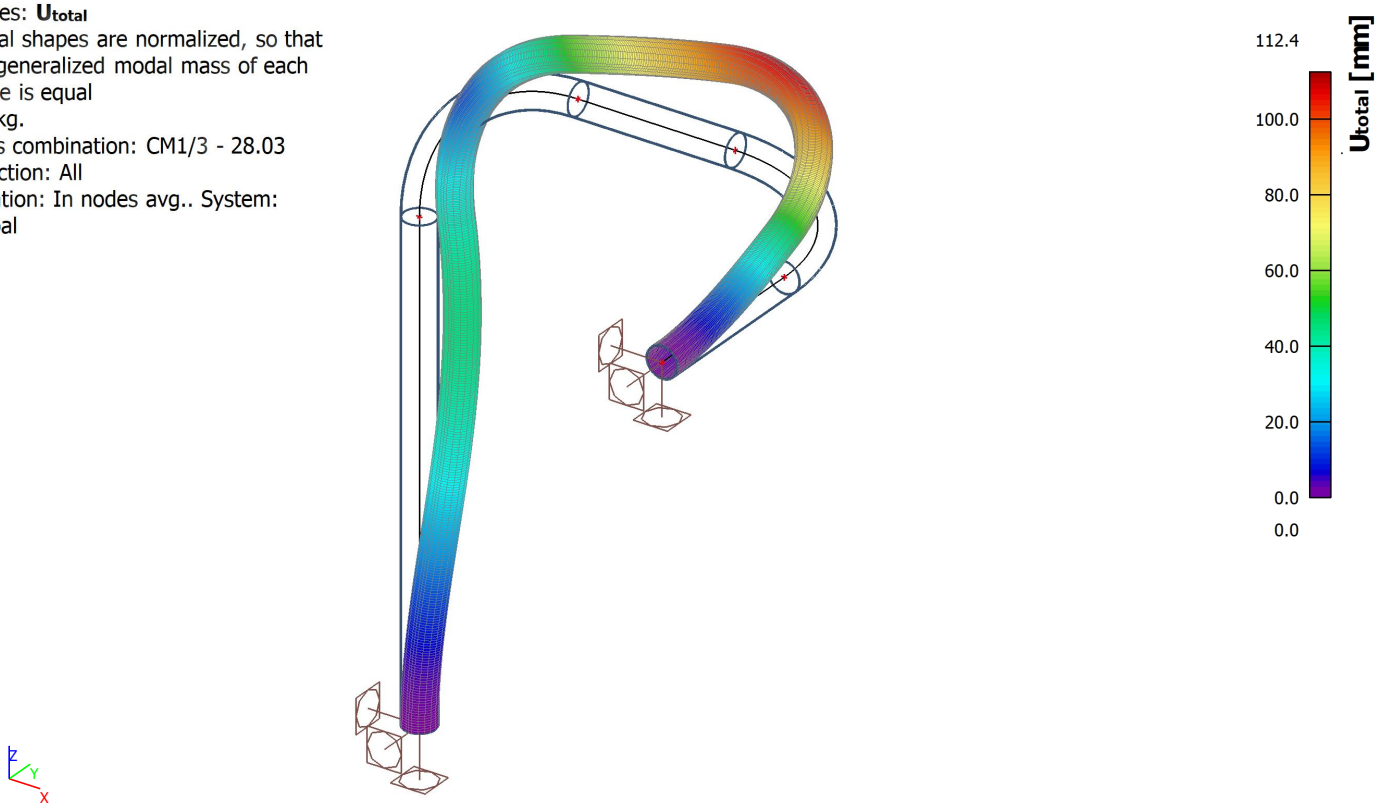
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/2 - 23.04
Selection: All
Location: In nodes avg.. System: Global



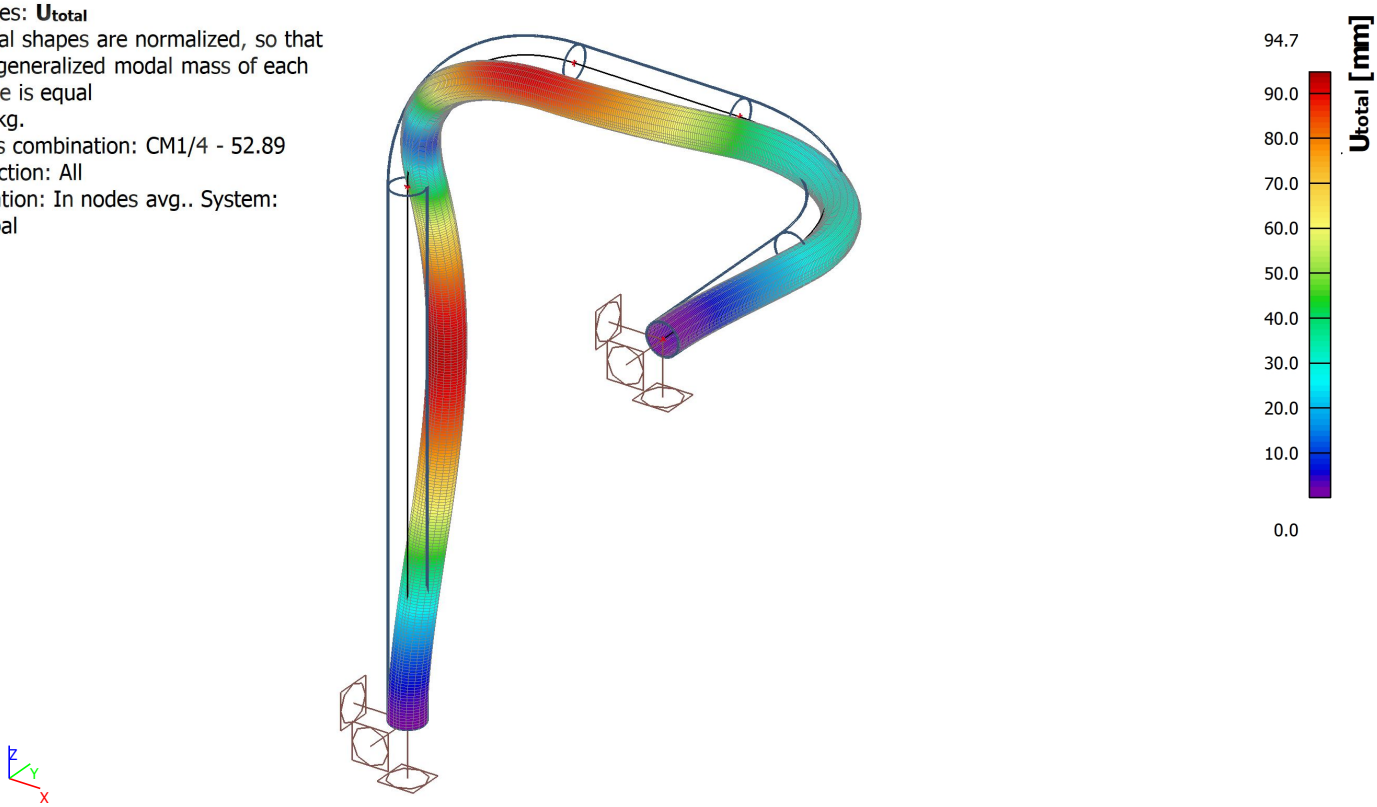
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/3 - 28.03
Selection: All
Location: In nodes avg.. System: Global



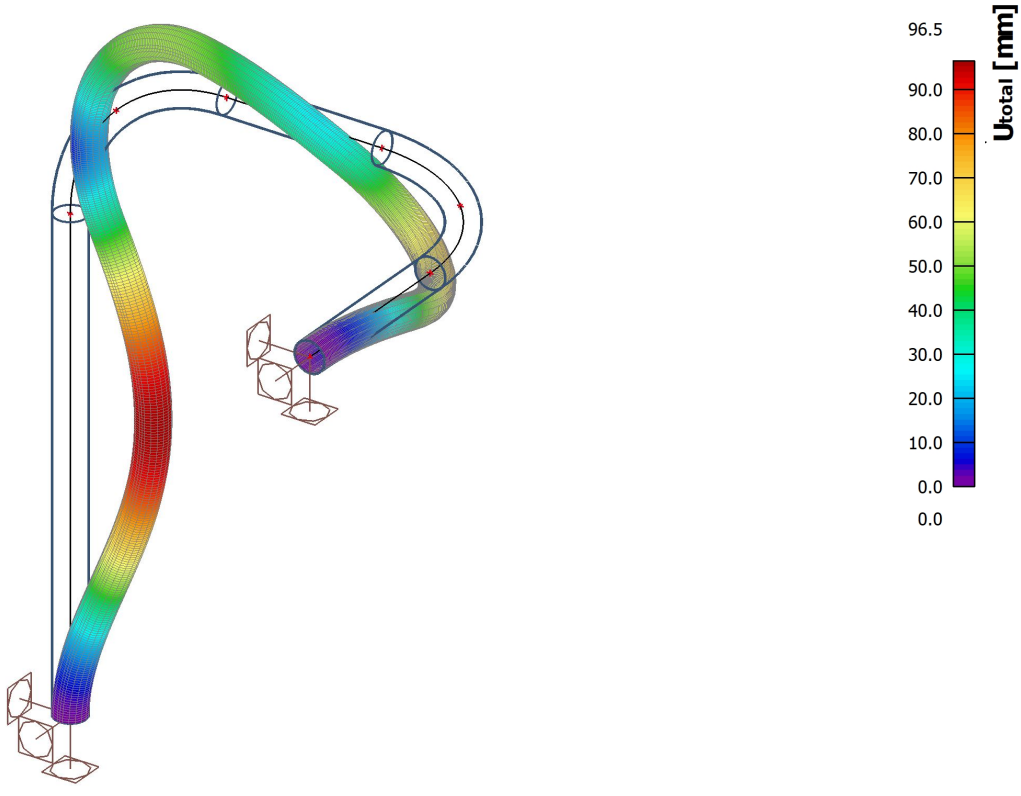
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/4 - 52.89
Selection: All
Location: In nodes avg.. System: Global



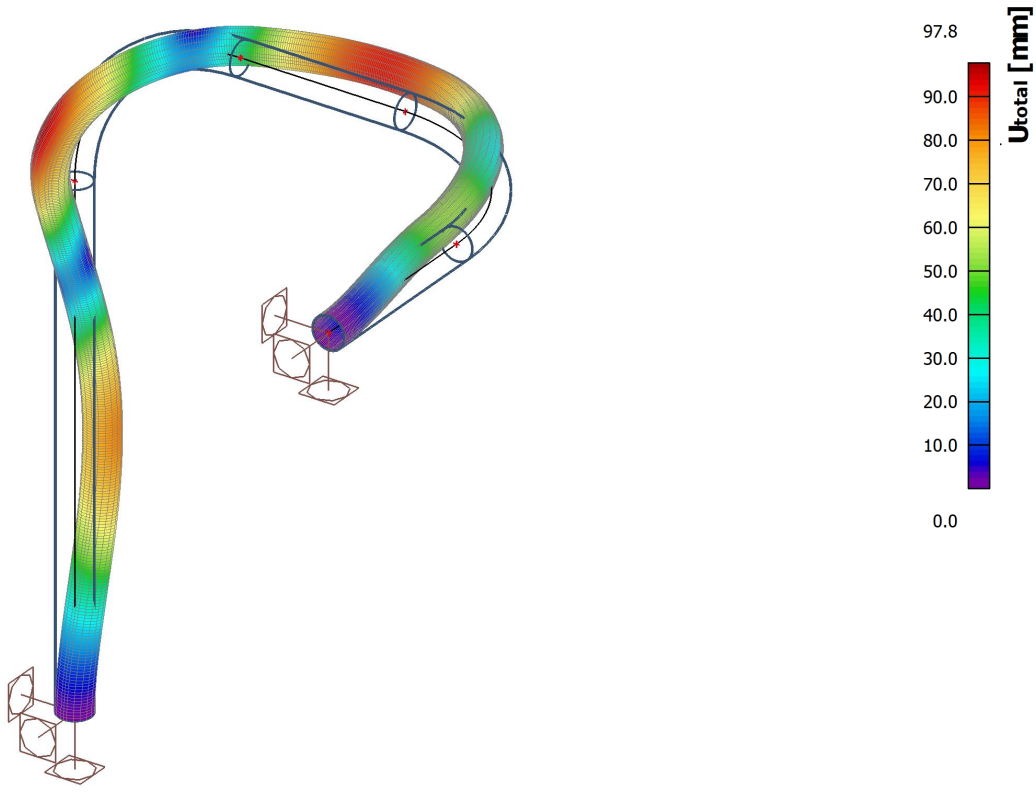
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/5 - 57.99
Selection: All
Location: In nodes avg.. System: Global



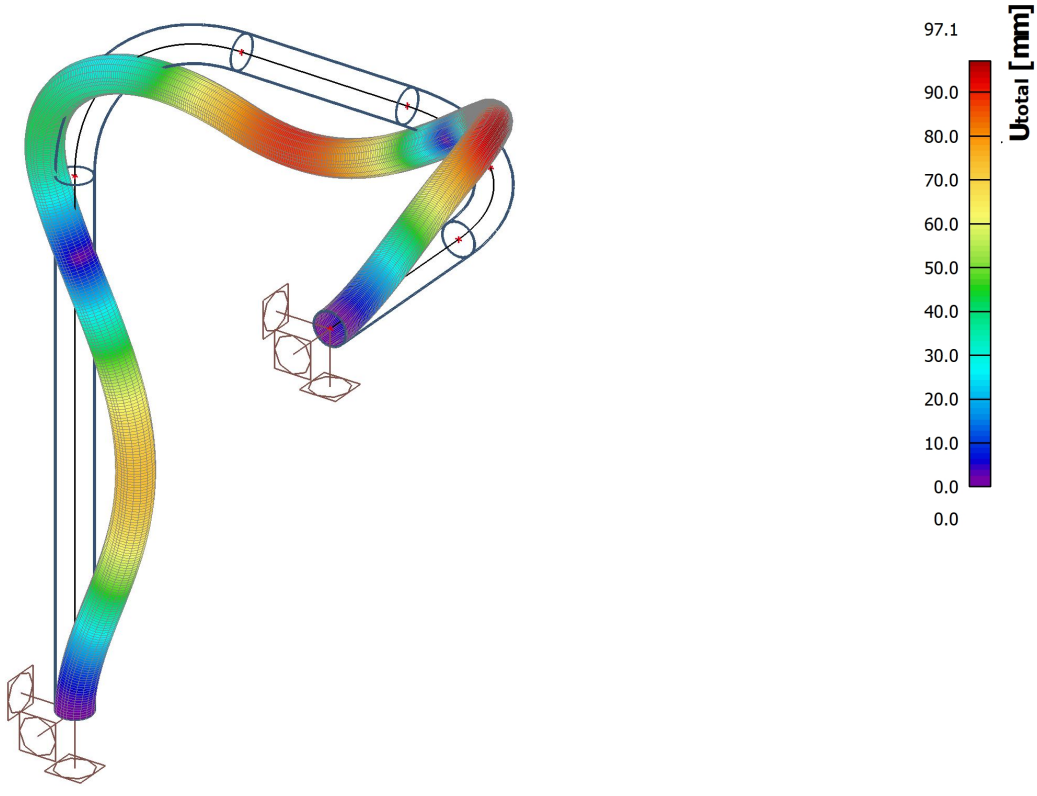
4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/6 - 93.95
Selection: All
Location: In nodes avg.. System: Global



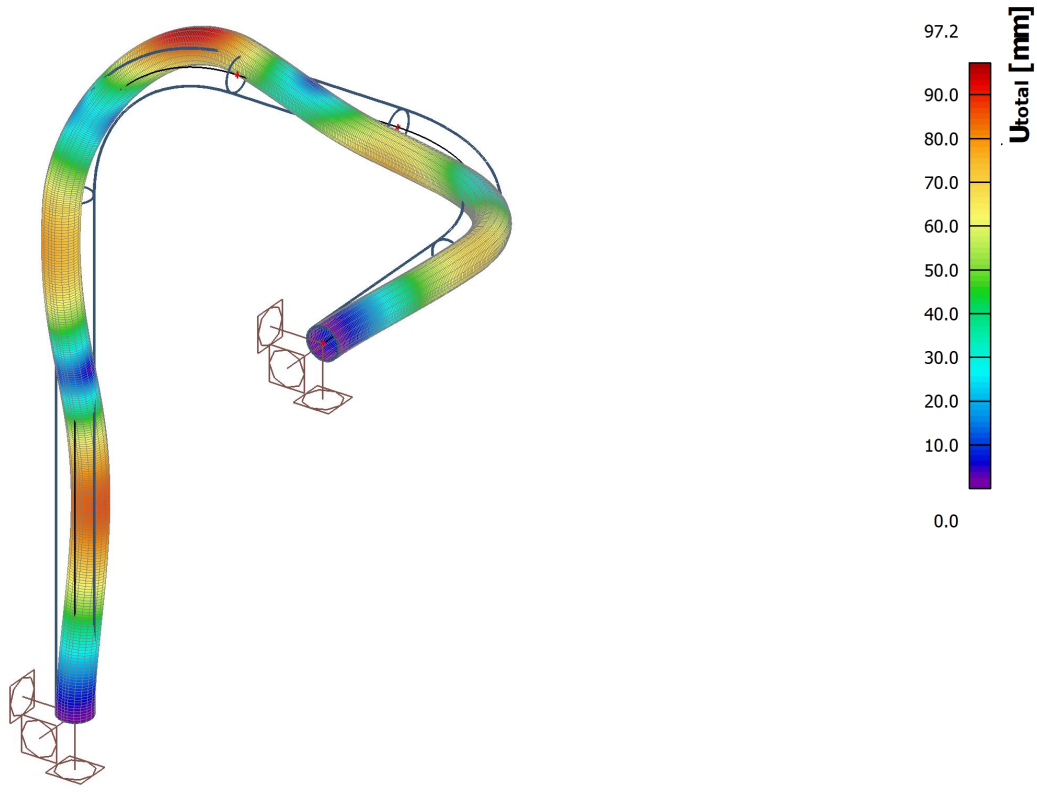
4.8. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/7 - 97.55
Selection: All
Location: In nodes avg.. System: Global



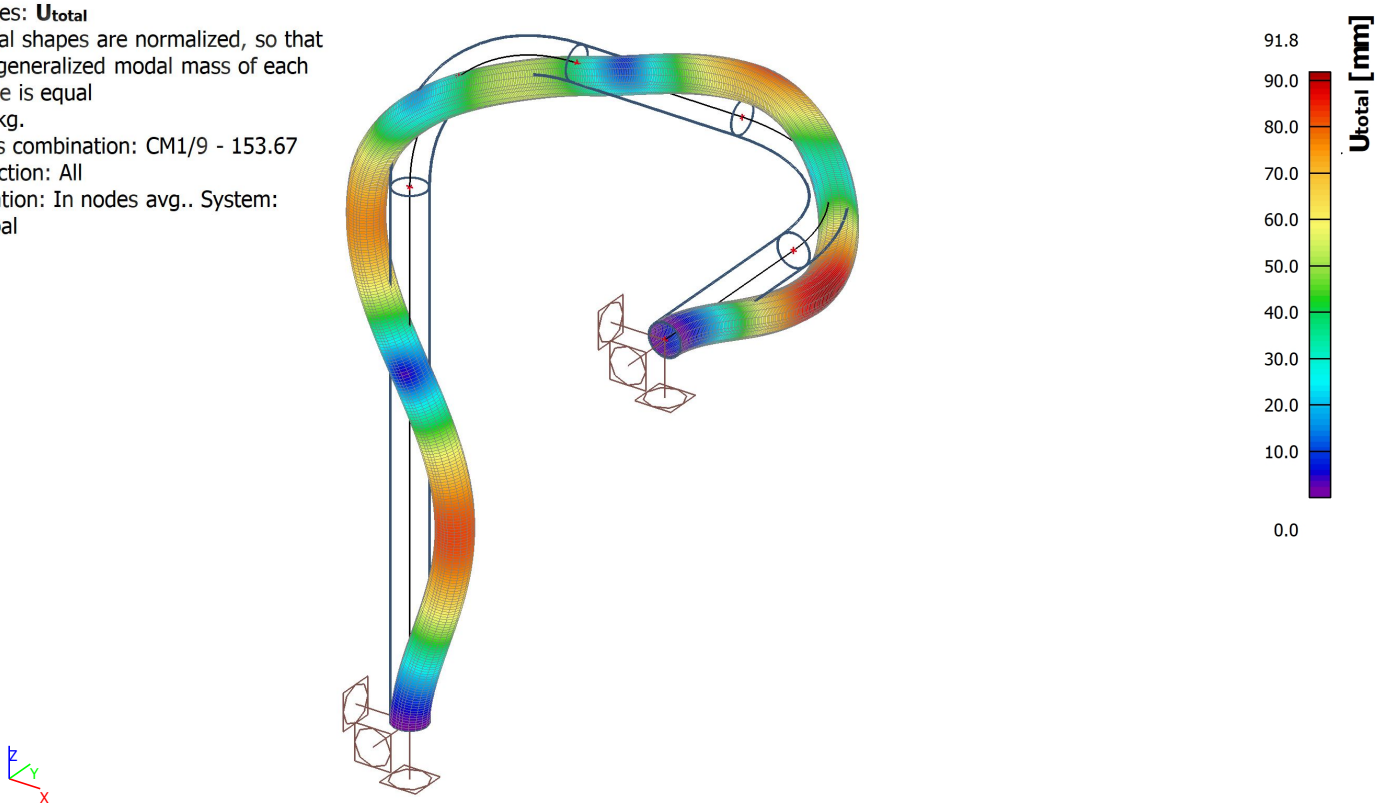
4.9. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/8 - 151.37
Selection: All
Location: In nodes avg.. System: Global



4.10. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/9 - 153.67
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 10.18 Hz
f2 = 19.54 Hz
f3 = 25.47 Hz
f4 = 48.09 Hz
f5 = 52.96 Hz
f6 = 75.94 Hz
f7 = 80.11 Hz
f8 = 122.34 Hz
f9 = 123.15Hz

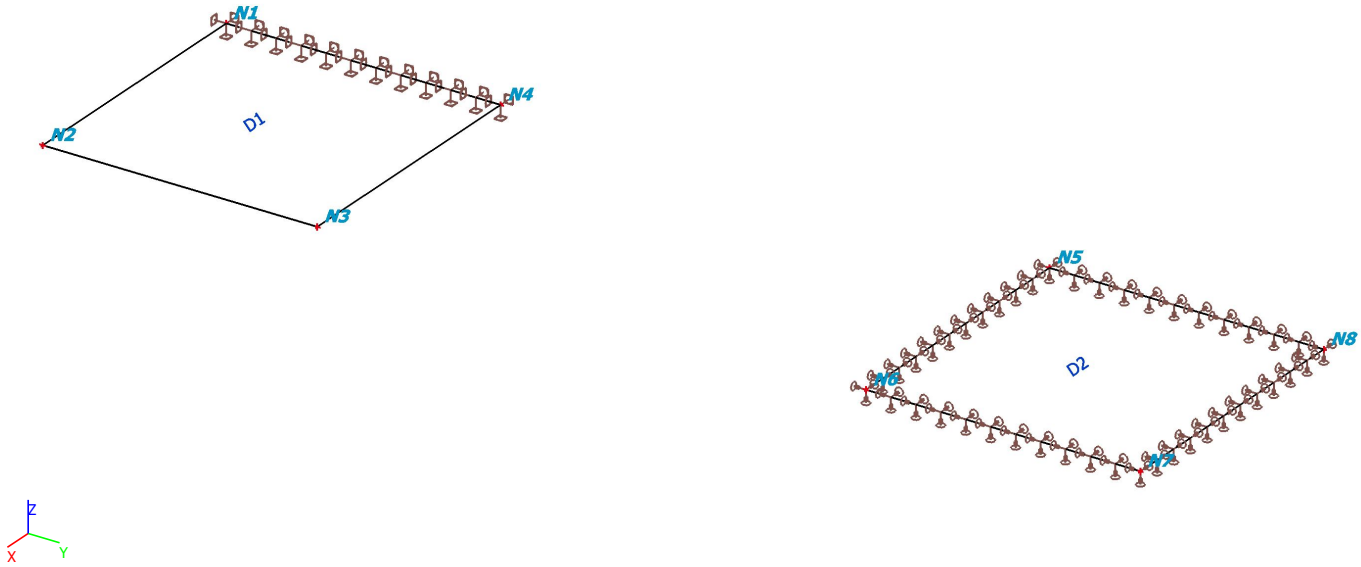
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a cantilever and a free plate

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.000	0.000	0.000
N2	1.000	0.000	0.000
N3	1.000	1.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N4	0.000	1.000	0.000
N5	0.000	3.000	0.000
N6	1.000	3.000	0.000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N7	1.000	4.000	0.000
N8	0.000	4.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	10.0
D2	Calque1	plate (90)	Standard	S 235	constant	10.0

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz	Stiffness X [MN/m²]
	Edge	Coor	Pos x_2							Stiffness Y [MN/m²]
										Stiffness Z [MN/m²]
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid	
	4	Rela	1.000							
Sle2	D2	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free	1.0000e-06
	4	Rela	1.000							1.0000e-06
										1.0000e-06
Sle3	D2	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free	1.0000e-06
	1	Rela	1.000							1.0000e-06
										1.0000e-06
Sle4	D2	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free	1.0000e-06
	2	Rela	1.000							1.0000e-06
										1.0000e-06
Sle5	D2	From start	0.000	Flexible	Flexible	Flexible	Free	Free	Free	1.0000e-06
	3	Rela	1.000							1.0000e-06
										1.0000e-06

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0.0	40.0	235.0	360.0	
		8.0769e+04	0.01e-003	40.0	80.0	215.0	360.0	

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

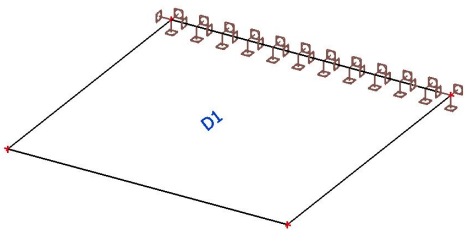
4. RESULTS

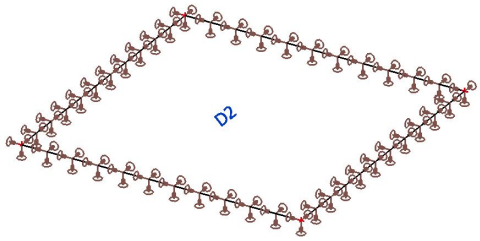
4.1. Eigen frequencies

Eigen frequencies

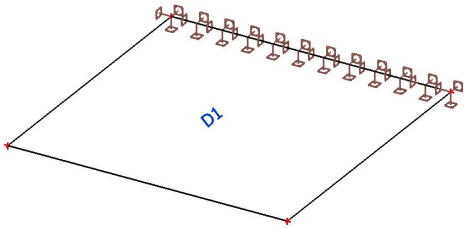
Calculation protocol

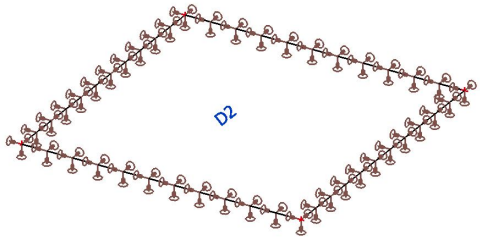
4.2. 3D displacement; Cantilever plate



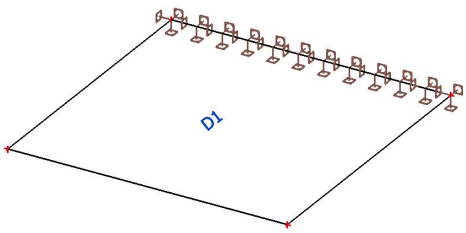


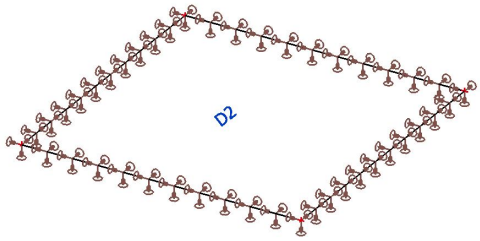
4.3. 3D displacement; Cantilever plate



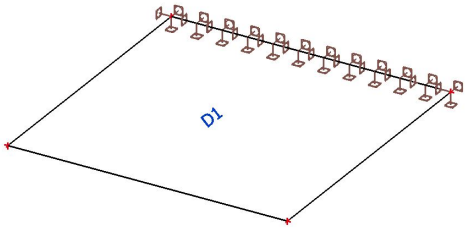


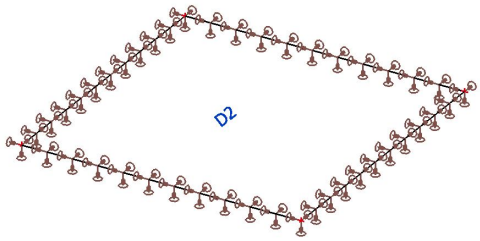
4.4. 3D displacement; Cantilever plate



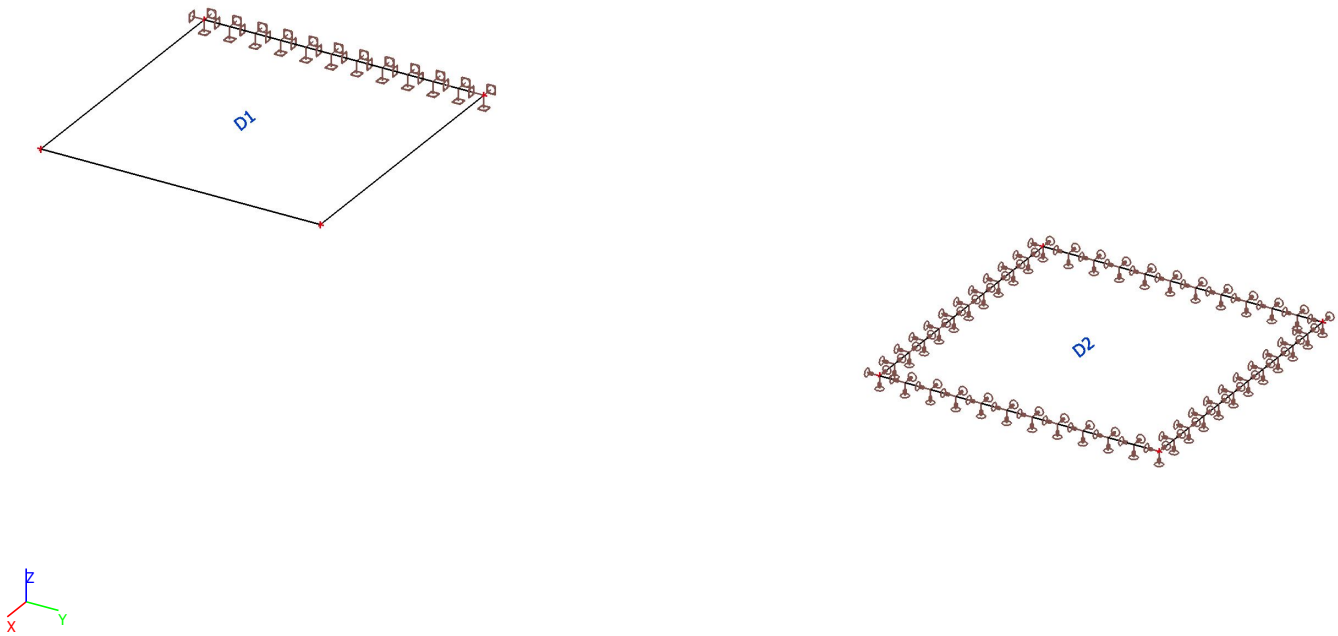


4.5. 3D displacement; Cantilever plate

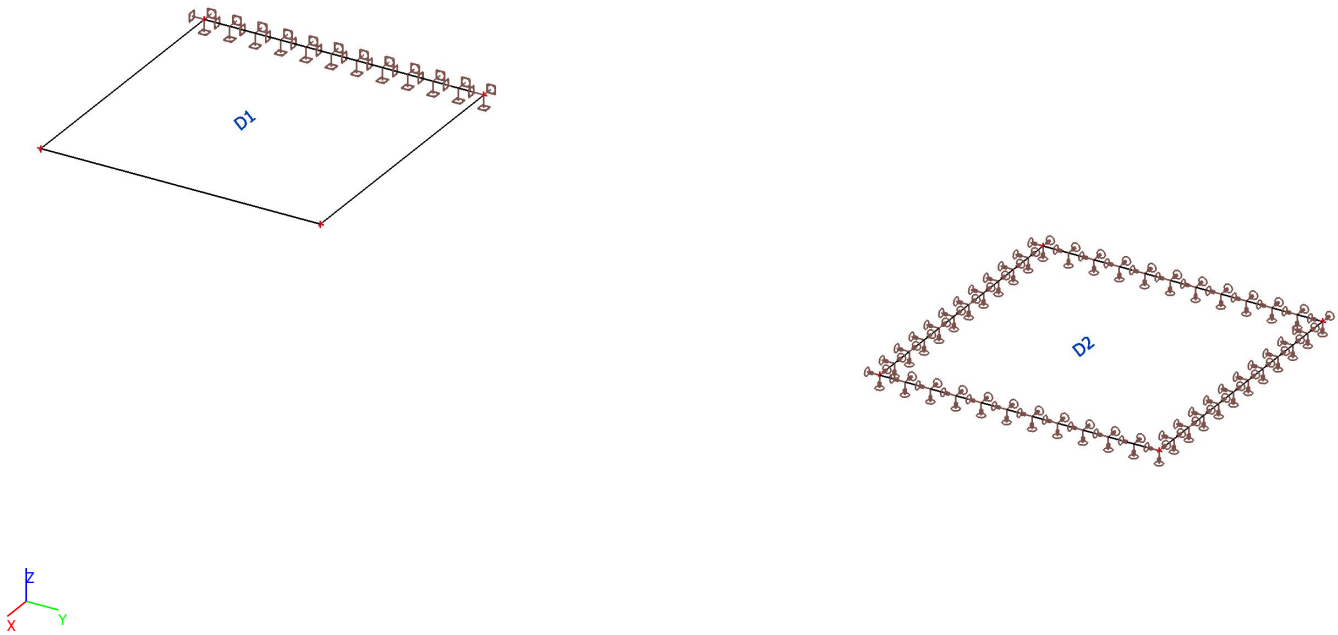




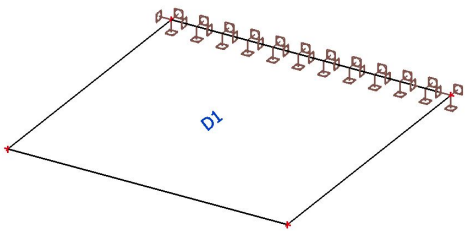
4.6. 3D displacement; Cantilever plate

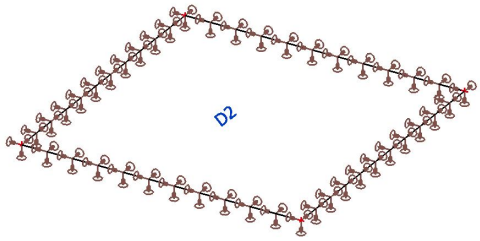


4.7. 3D displacement; Cantilever plate

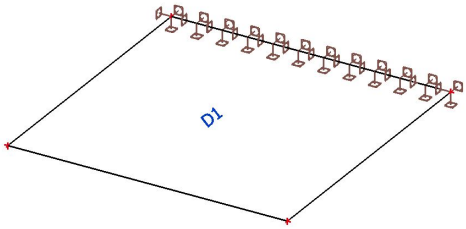


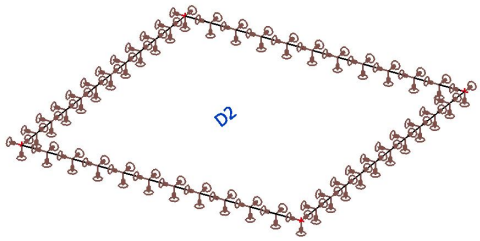
4.8. 3D displacement; Free plate



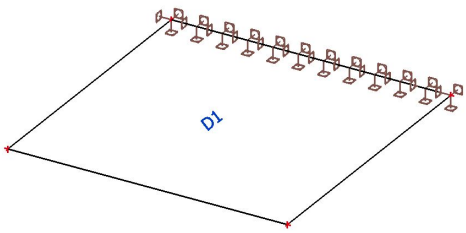


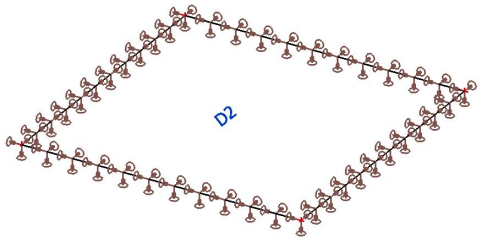
4.9. 3D displacement; Free plate



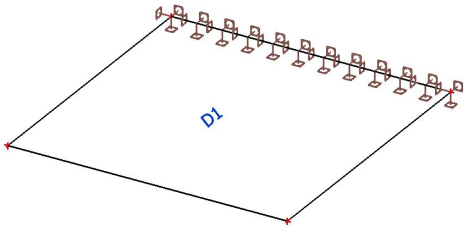


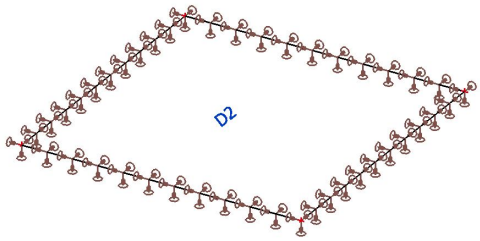
4.10. 3D displacement; Free plate



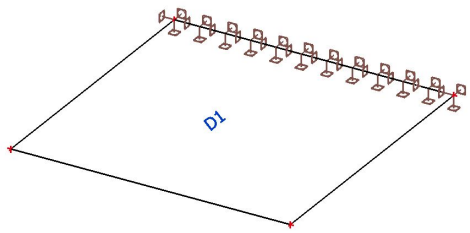


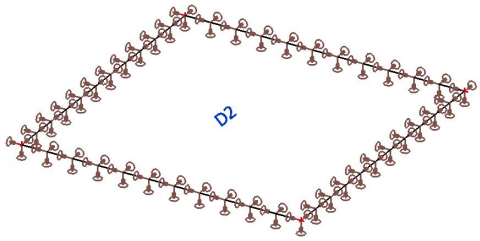
4.11. 3D displacement; Free plate





4.12. 3D displacement; Free plate





5. EXPECTED AFNOR RESULTS

Cantilever plate (D1) eigenfrequencies:

f1 = 8.7266 Hz
f2 = 21.3042 Hz
f3 = 53.5542 Hz
f4 = 68.2984 Hz
f5 = 77.7448 Hz
f5 = 136.0471 Hz

Free plate (D2) eigenfrequencies:

f1 = 33.7119 Hz
f2 = 49.4558 Hz
f3 = 61.0513 Hz
f4 = 87.5160 Hz
f5 = 87.5160 Hz

NOTE : First six eigenfrequencies are nul and correspond to rigid body motion.

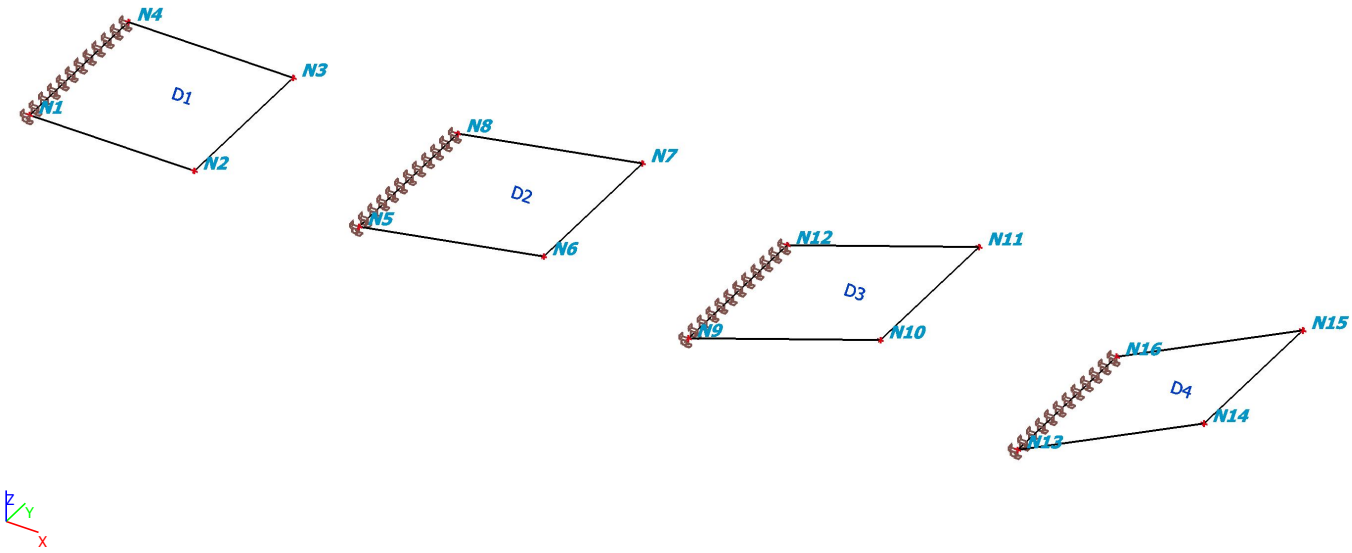
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a diamond plate with different angles

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X	Coord Y	Coord Z
N1	0.000	0.000	0.000
N2	1.000	0.000	0.000
N3	1.000	1.000	0.000
N4	0.000	1.000	0.000
N5	2.000	0.000	0.000
N6	2.966	0.259	0.000

Name	Coord X	Coord Y	Coord Z
N7	2.966	1.259	0.000
N8	2.000	1.000	0.000
N9	4.000	0.000	0.000
N10	4.866	0.500	0.000
N11	4.866	1.500	0.000
N12	4.000	1.000	0.000

Name	Coord X	Coord Y	Coord Z
N13	6.000	0.000	0.000
N14	6.707	0.707	0.000
N15	6.707	1.707	0.000
N16	6.000	1.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	10.0
D2	Calque1	plate (90)	Standard	S 235	constant	10.0
D3	Calque1	plate (90)	Standard	S 235	constant	10.0
D4	Calque1	plate (90)	Standard	S 235	constant	10.0

2.4. Supports on 2D member edge

Name	2D member Edge	Orig Coor	Pos x_1 Pos x_2	X	Y	Z	Rx	Ry	Rz
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						
Sle2	D2	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						
Sle3	D3	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						
Sle4	D4	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	4	Rela	1.000						

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0.0	40.0	235.0	360.0	
		8.0769e+04	0.01e-003	40.0	80.0	215.0	360.0	

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

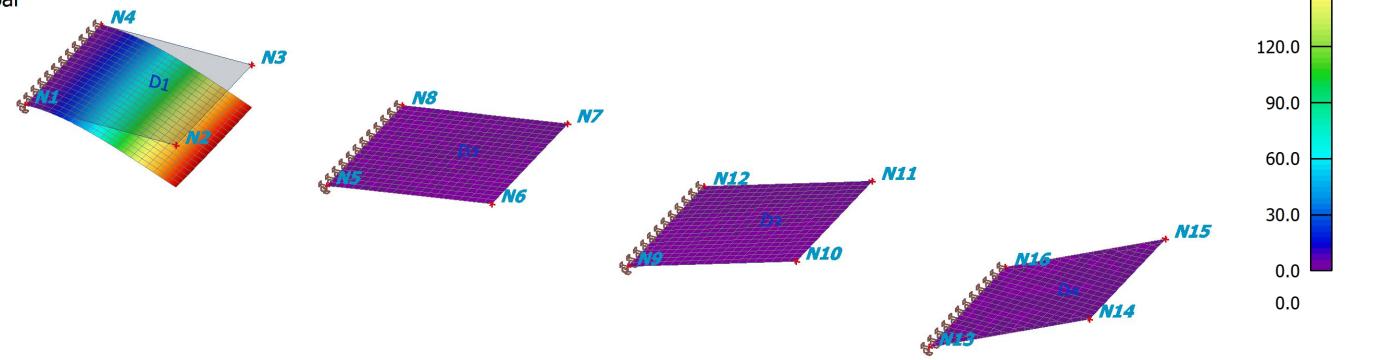
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	8.64	54.29	2947.60	0.12
2	8.92	56.04	3140.87	0.11
3	9.78	61.44	3775.33	0.10
4	11.27	70.81	5013.91	0.09
5	21.13	132.74	17620.75	0.05
6	21.60	135.73	18423.69	0.05
7	23.39	146.98	21602.45	0.04
8	27.89	175.21	30698.34	0.04

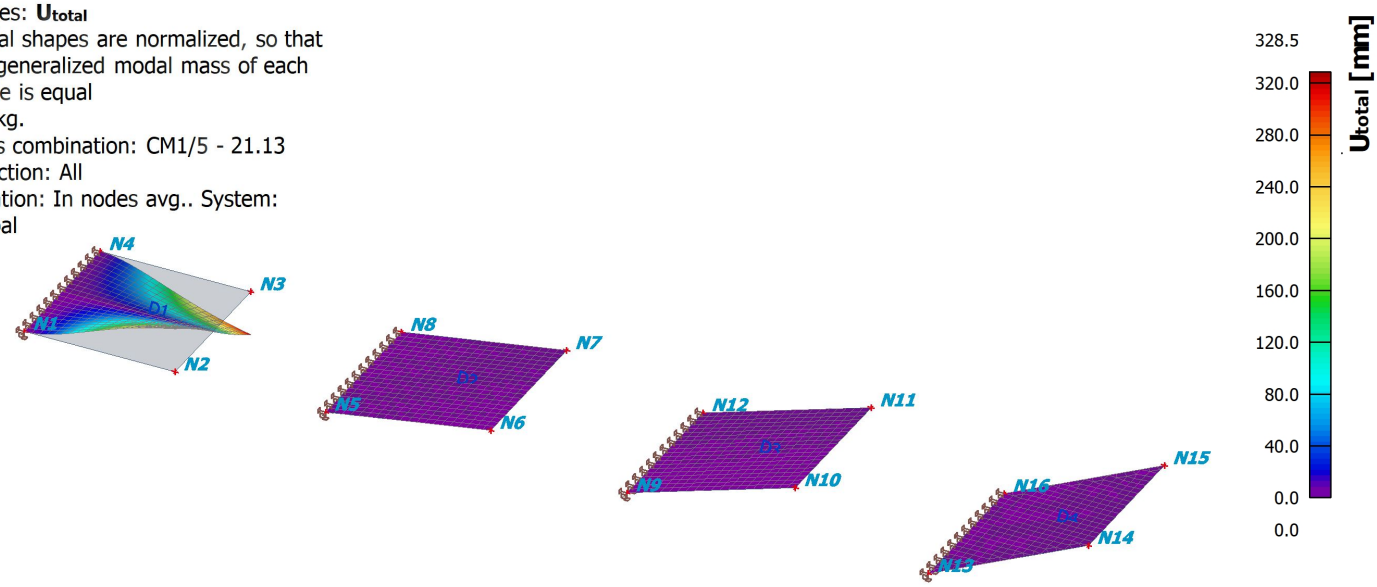
4.2. 3D displacement; Plate D1

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 8.64
Selection: All
Location: In nodes avg.. System: Global



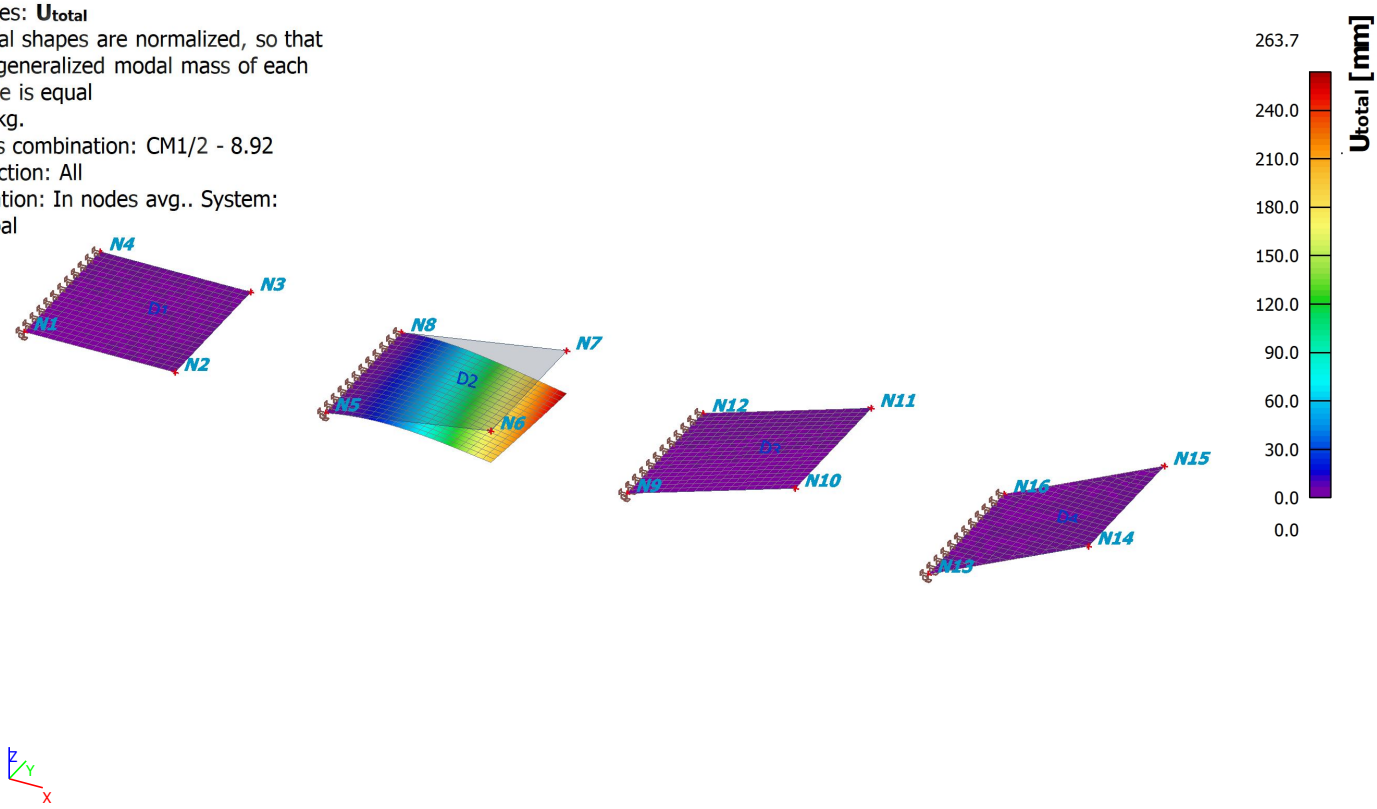
4.3. 3D displacement; Plate D1

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/5 - 21.13
Selection: All
Location: In nodes avg.. System: Global



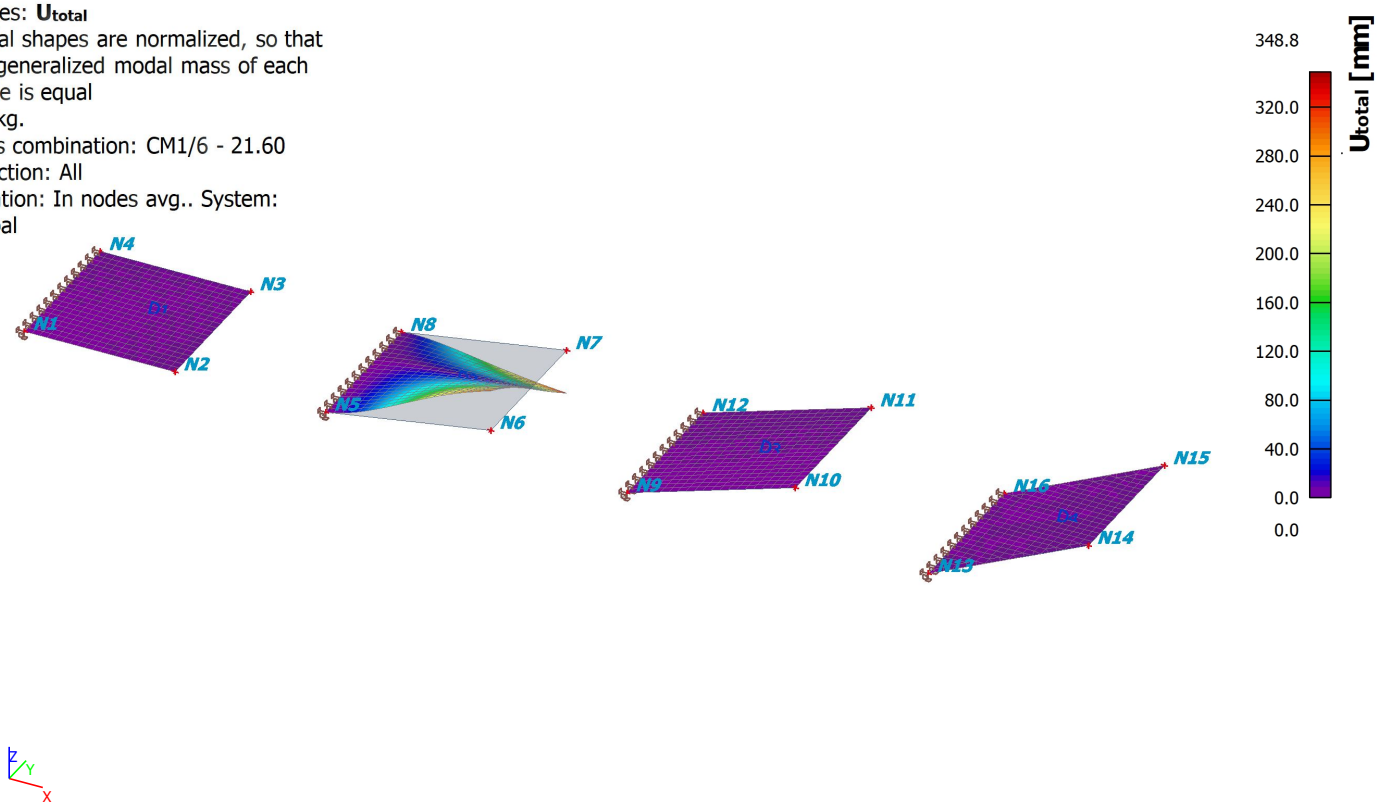
4.4. 3D displacement; Plate D2

Values: **Utotal**
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 8.92
Selection: All
Location: In nodes avg.. System: Global



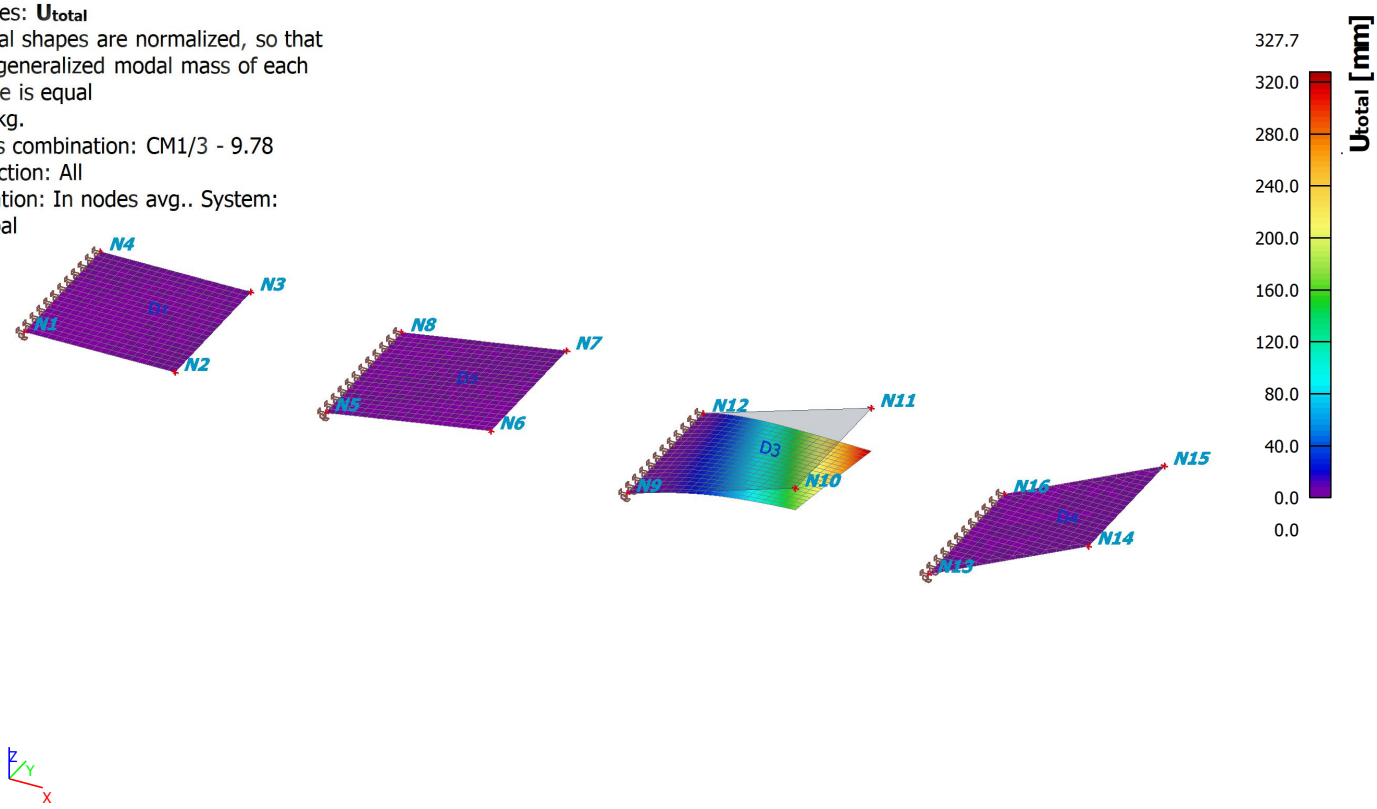
4.5. 3D displacement; Plate D2

Values: **Utotal**
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/6 - 21.60
Selection: All
Location: In nodes avg.. System: Global



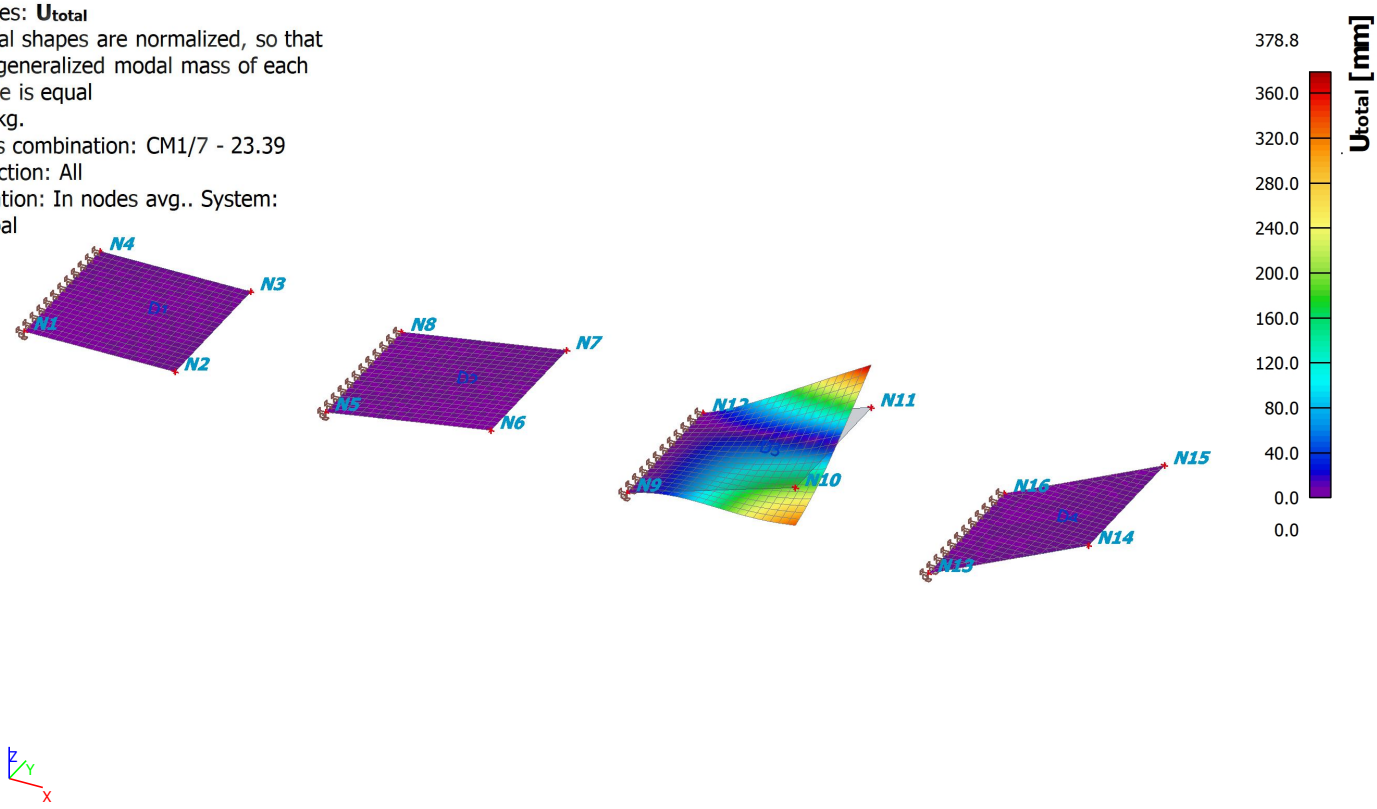
4.6. 3D displacement; Plate D3

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/3 - 9.78
Selection: All
Location: In nodes avg.. System: Global



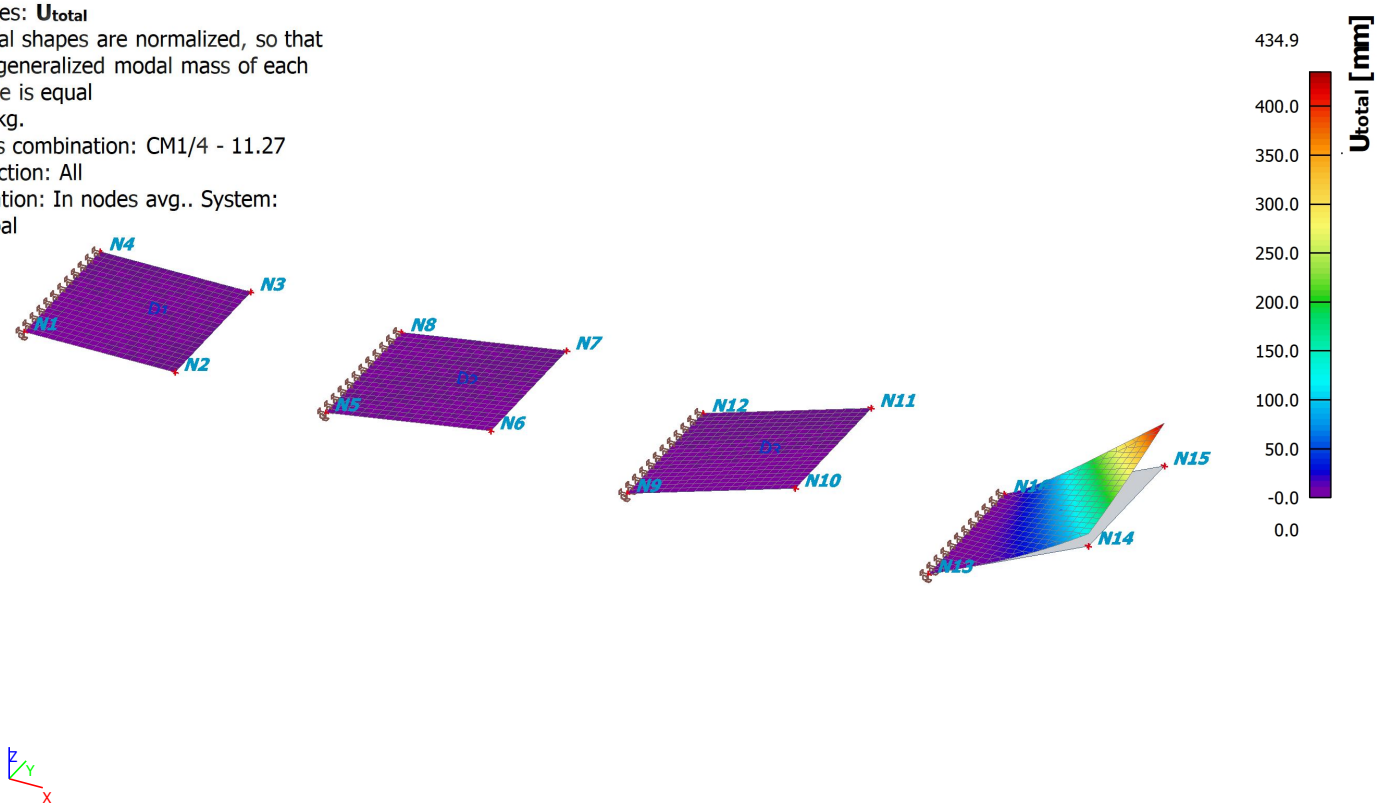
4.7. 3D displacement; Plate D3

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/7 - 23.39
Selection: All
Location: In nodes avg.. System: Global



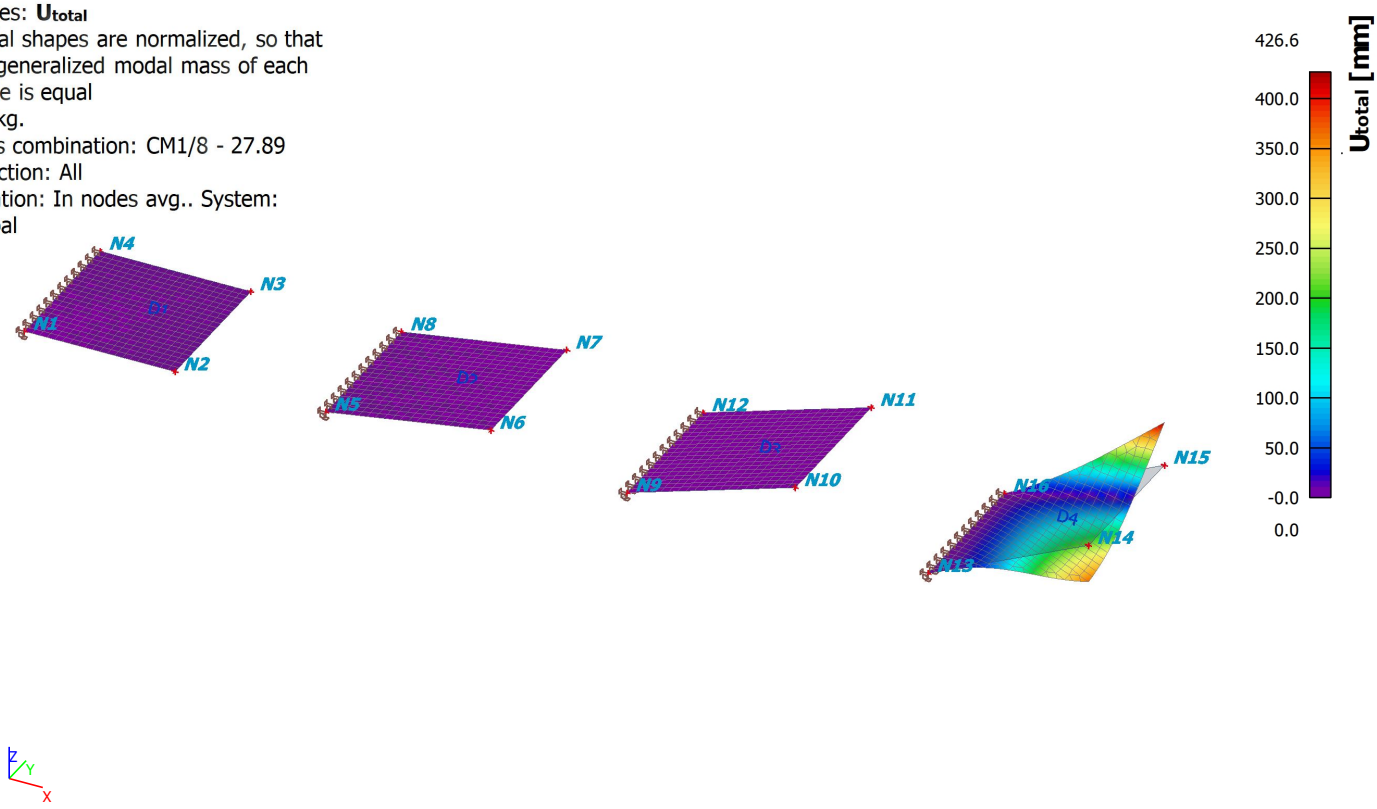
4.8. 3D displacement; Plate D4

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/4 - 11.27
Selection: All
Location: In nodes avg.. System: Global



4.9. 3D displacement; Plate D4

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/8 - 27.89
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

PLATE D1 (0 degrees):

f1 = 8.7266 Hz
f2 = 21.3042 Hz

PLATE D2 (15 degrees):

f1 = 8.9990 Hz
f2 = 22.1714 Hz

PLATE D3 (30 degrees):

f1 = 9.8987 Hz
f2 = 25.4651 Hz

PLATE D4 (45 degrees):

f1 = 11.15 Hz
f2 = 27.0 Hz

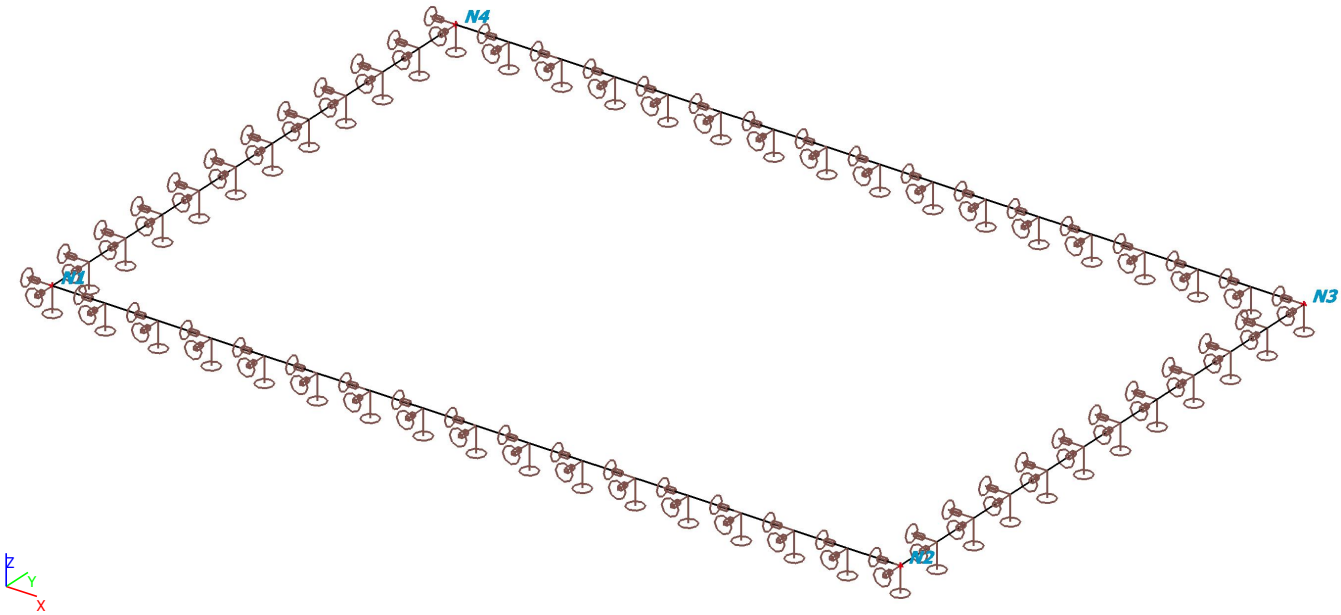
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a thin plate simply supported on the edges.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X	Coord Y	Coord Z
N1	0.000	0.000	0.000
N2	1.500	0.000	0.000
N3	1.500	1.000	0.000
N4	0.000	1.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	10.0

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	1	Rela	1.000						
Sle2	D1	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	2	Rela	1.000						
Sle3	D1	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	3	Rela	1.000						
Sle4	D1	From start	0.000	Flexible	Flexible	Rigid	Free	Free	Free
	4	Rela	1.000						

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0.0	40.0	235.0	360.0	
		8.0769e+04	0.01e-003	40.0	80.0	215.0	360.0	

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

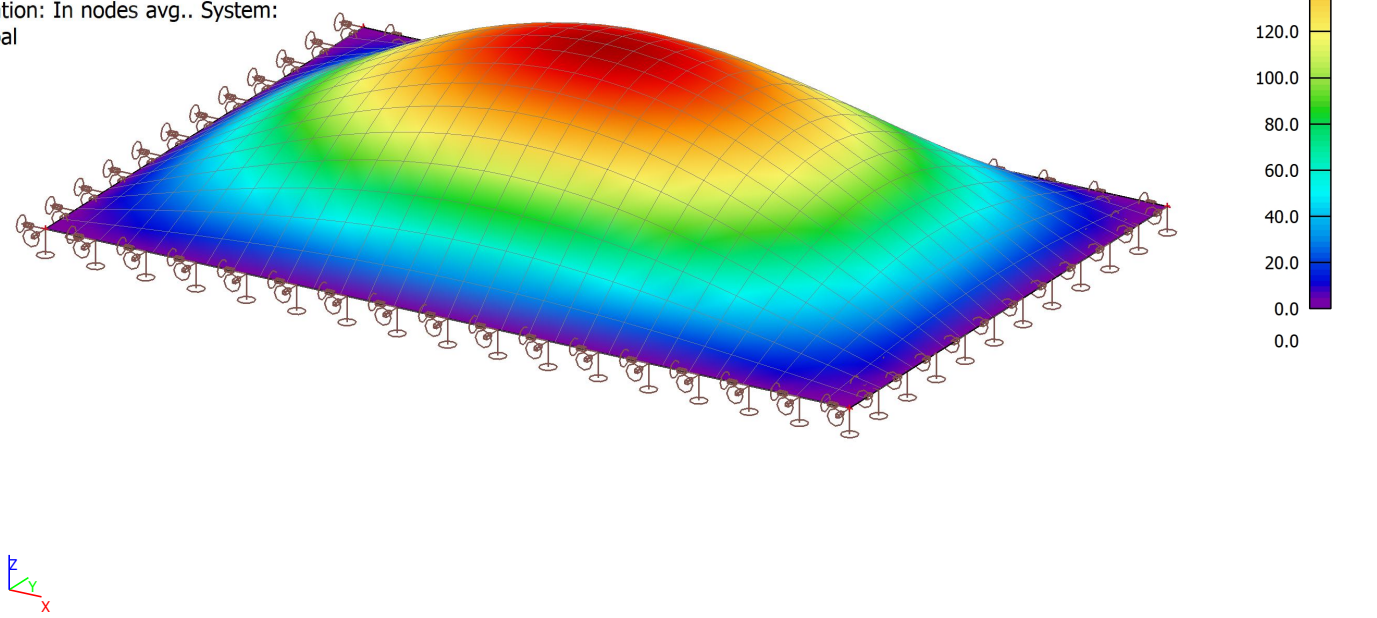
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	0.34	2.15	4.62	2.92
2	0.34	2.15	4.62	2.92
3	0.49	3.10	9.64	2.02
4	35.46	222.79	49635.98	0.03
5	68.11	427.95	183145.09	0.01
6	109.38	687.21	472256.16	0.01
7	122.74	771.19	594737.56	0.01
8	141.49	888.98	790293.41	0.01
9	195.24	1226.70	1504790.18	0.01

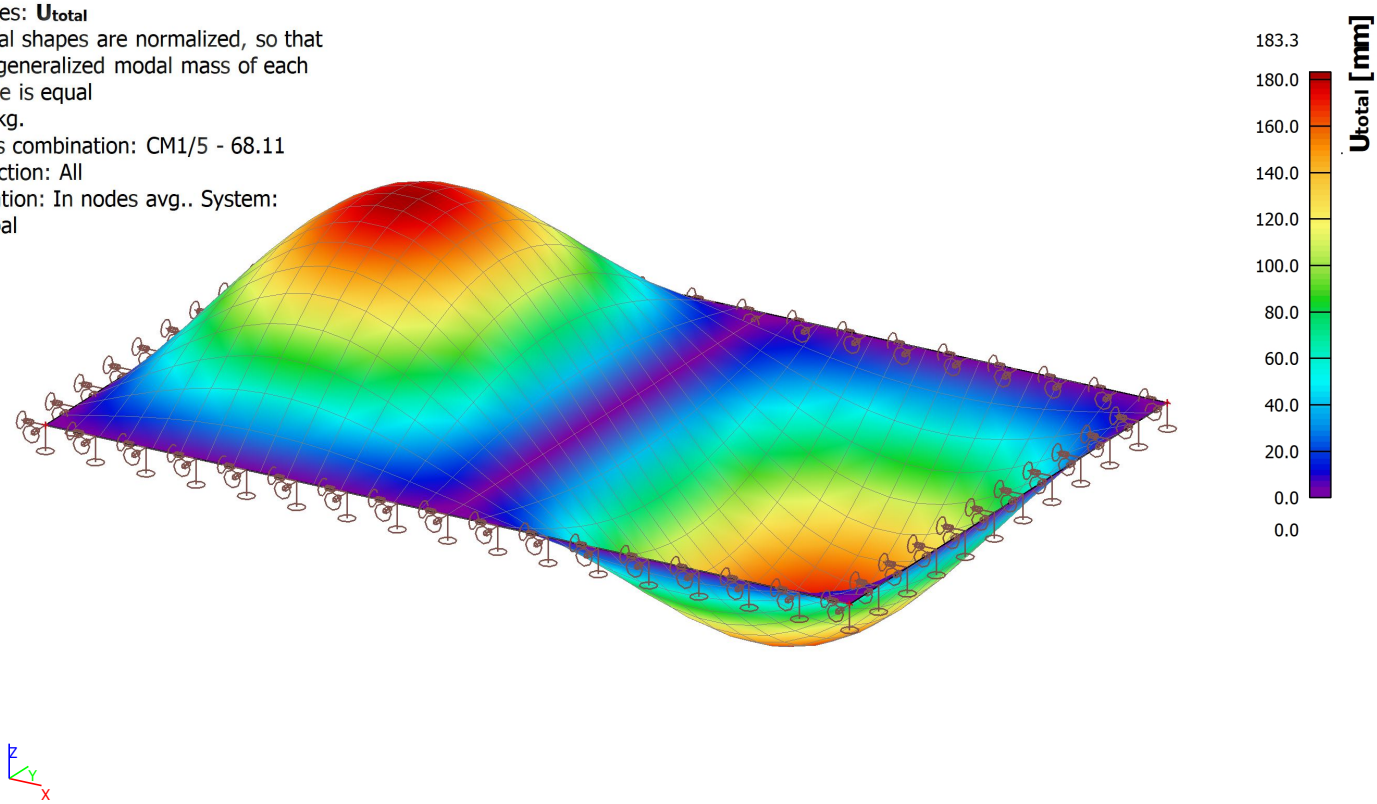
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/4 - 35.46
Selection: All
Location: In nodes avg.. System: Global



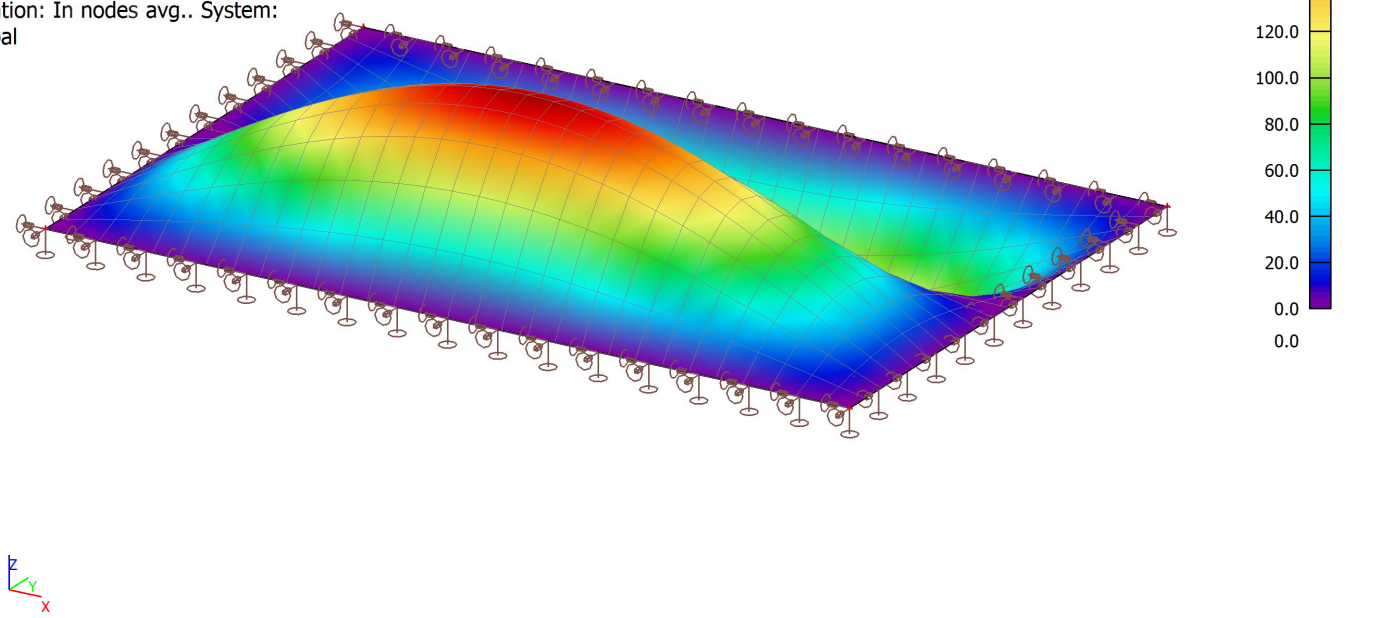
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/5 - 68.11
Selection: All
Location: In nodes avg.. System: Global



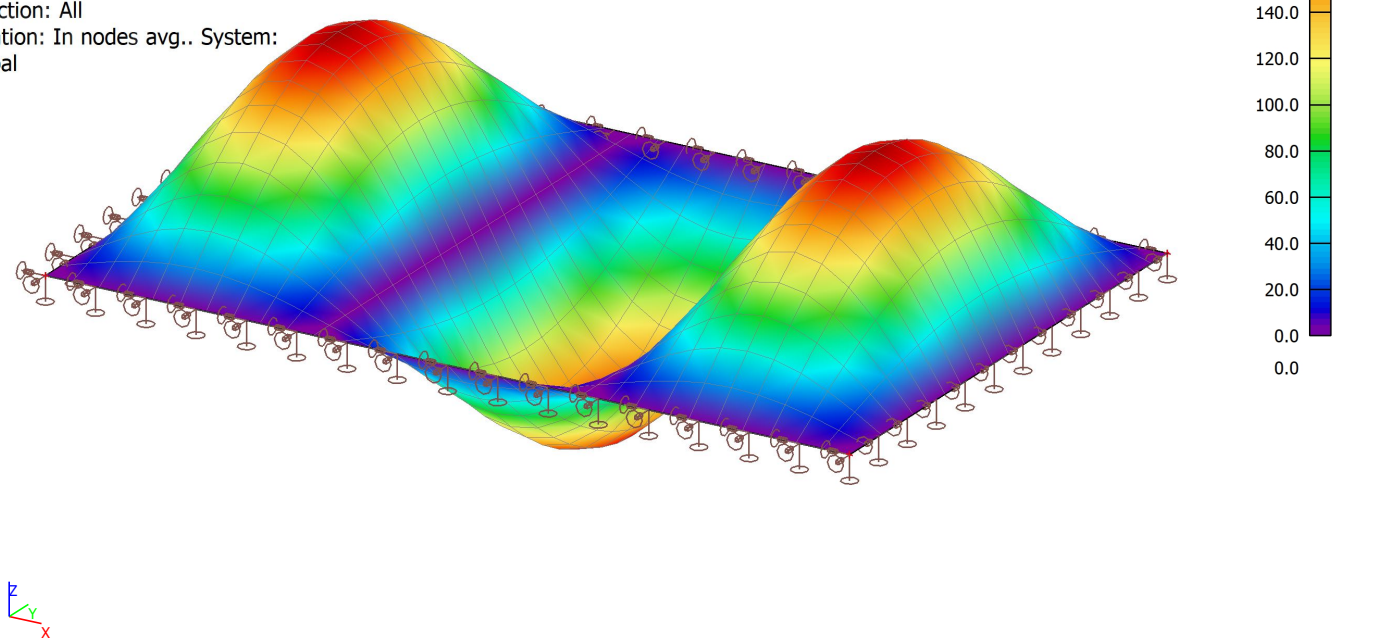
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/6 - 109.38
Selection: All
Location: In nodes avg.. System: Global



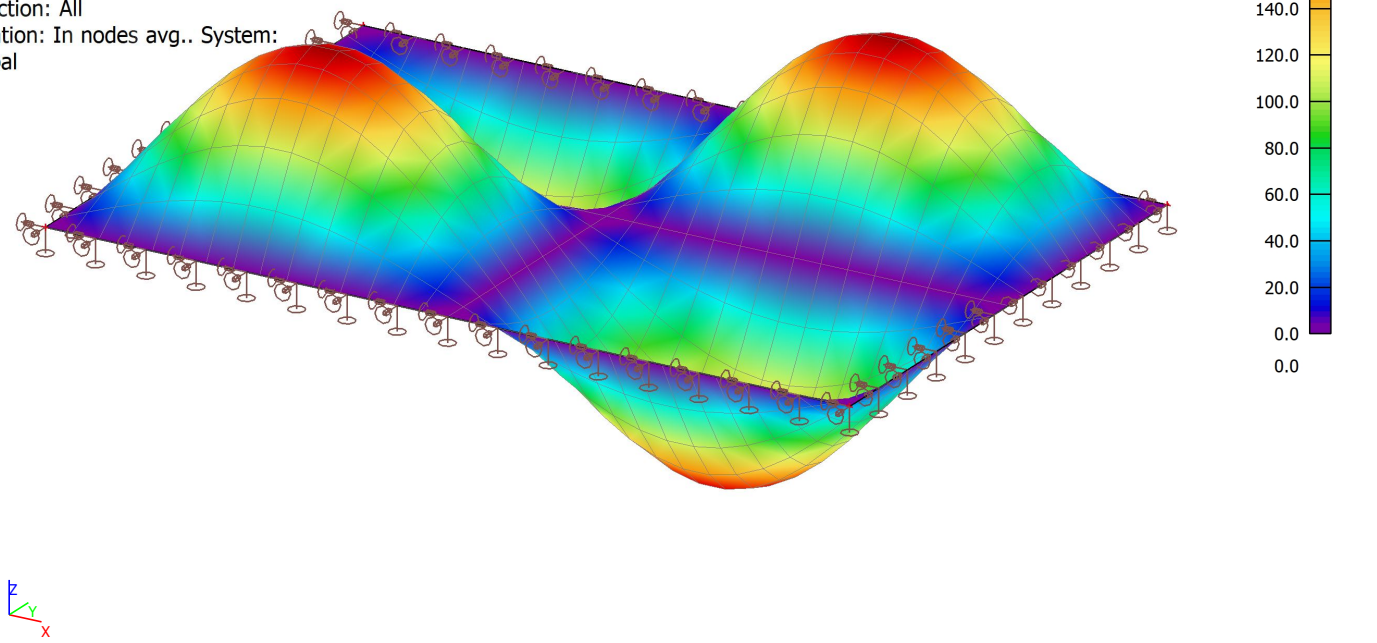
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/7 - 122.74
Selection: All
Location: In nodes avg.. System: Global



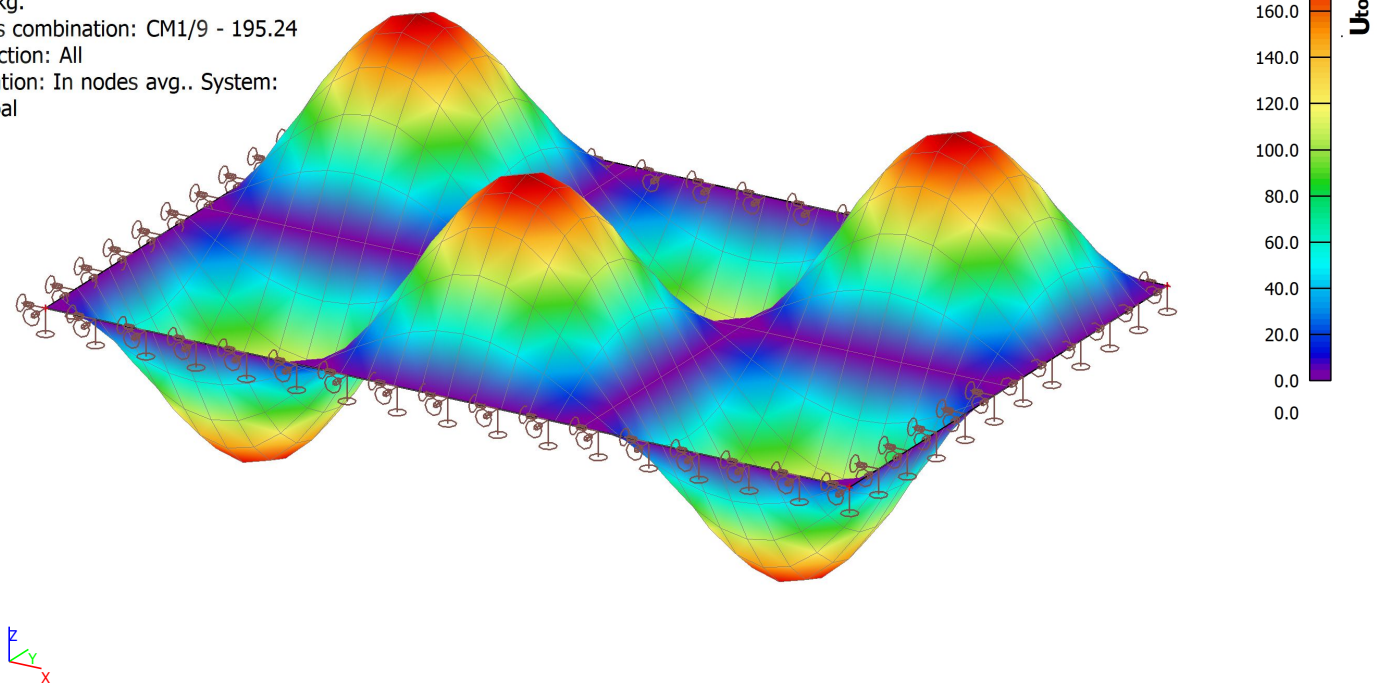
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/8 - 141.49
Selection: All
Location: In nodes avg.. System: Global



4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/9 - 195.24
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 35.63 Hz
f2 = 68.51 Hz
f3 = 109.62 Hz
f4 = 123.32 Hz
f5 = 142.51 Hz
f6 = 197.32 Hz

NOTE: The first three Eigenfrequencies are nul and correspond to rigid body motion.

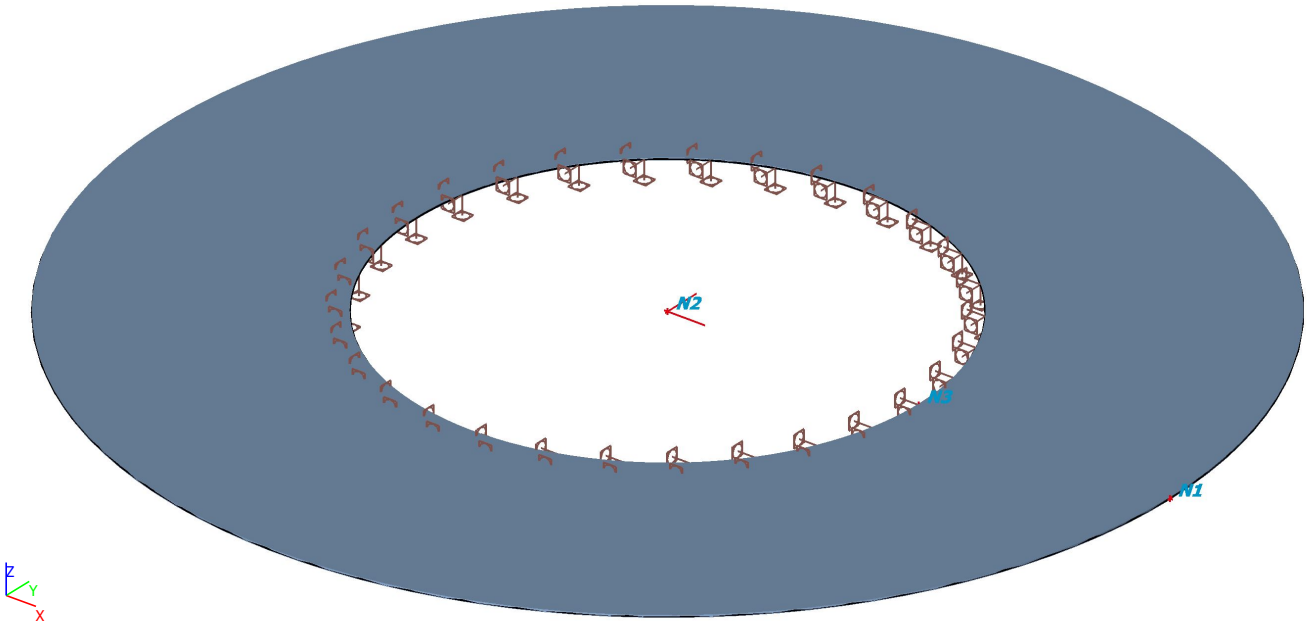
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a circular ring plate fixed on the internal circumference.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X	Coord Y	Coord Z
N1	0.200	0.000	0.000
N2	0.000	0.000	0.000
N3	0.100	0.000	0.000

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	S 235	constant	1.0

2.4. 2D member openings

Name	2D member
O1	D1

2.5. Supports on 2D member edge

Name	Edge	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
		Coor	Pos x_2						
Sle1	1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
		Rela	1.000						

2.6. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850.00	2.1000e+05	0.3	0.0	40.0	235.0	360.0	
		8.0769e+04	0.01e-003	40.0	80.0	215.0	360.0	

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

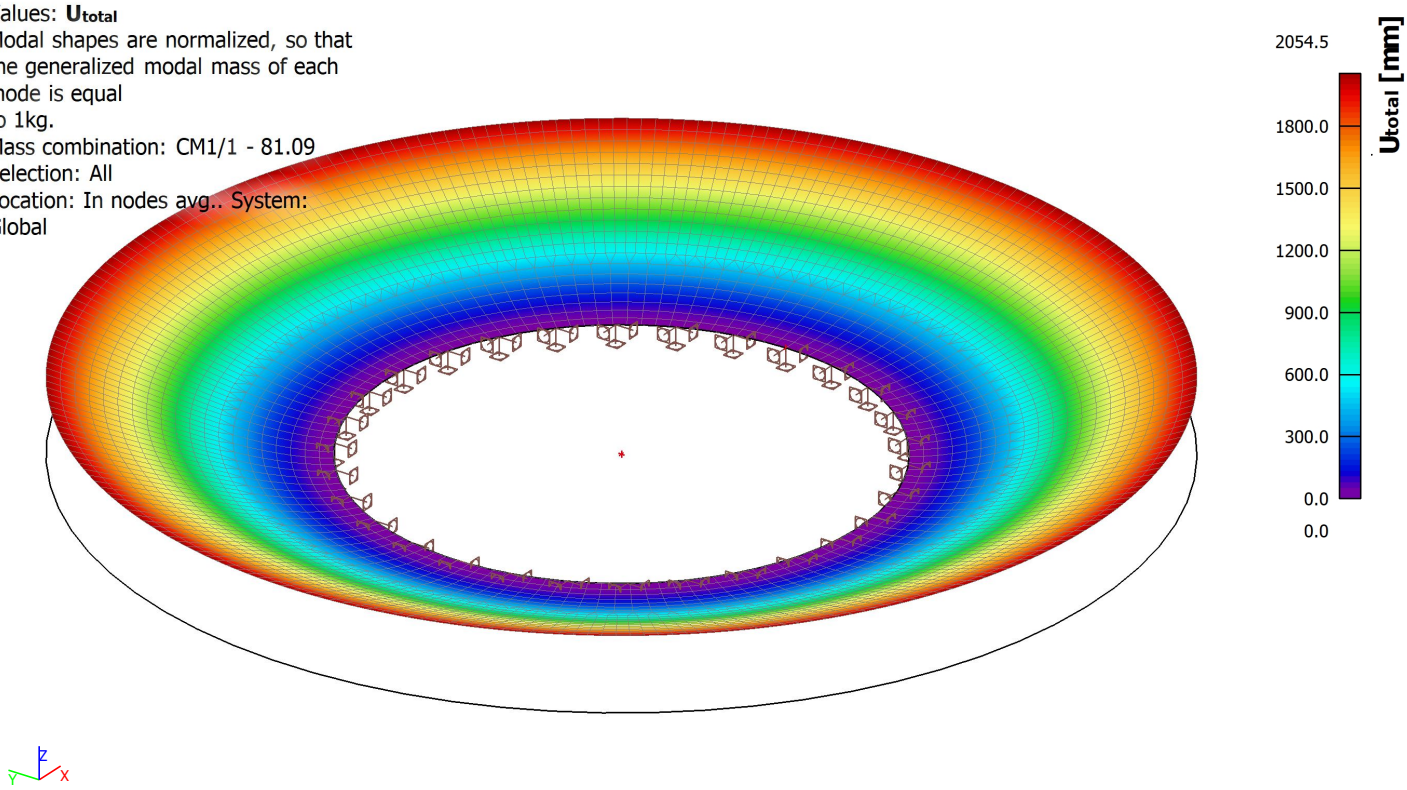
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	81.09	509.50	259593.39	0.01
2	82.73	519.82	270212.61	0.01
3	82.73	519.82	270212.61	0.01
4	91.49	574.85	330455.21	0.01
5	91.49	574.85	330457.35	0.01
6	115.43	725.24	525970.02	0.01
7	115.43	725.24	525970.02	0.01
8	159.11	999.72	999430.68	0.01
9	159.11	999.72	999434.13	0.01
10	222.10	1395.48	1947354.45	0.00
11	222.10	1395.48	1947354.45	0.00
12	302.58	1901.13	3614291.34	0.00
13	302.59	1901.15	3614372.30	0.00
14	399.08	2507.41	6287129.70	0.00
15	399.08	2507.41	6287129.70	0.00
16	510.57	3207.91	10290667.03	0.00
17	510.57	3207.93	10290802.62	0.00
18	529.08	3324.18	11050178.80	0.00
19	539.34	3388.67	11483054.83	0.00
20	539.34	3388.67	11483054.83	0.00
21	570.21	3582.61	12835083.28	0.00
22	570.23	3582.73	12835924.02	0.00
23	621.96	3907.75	15270480.10	0.00
24	621.96	3907.75	15270480.10	0.00

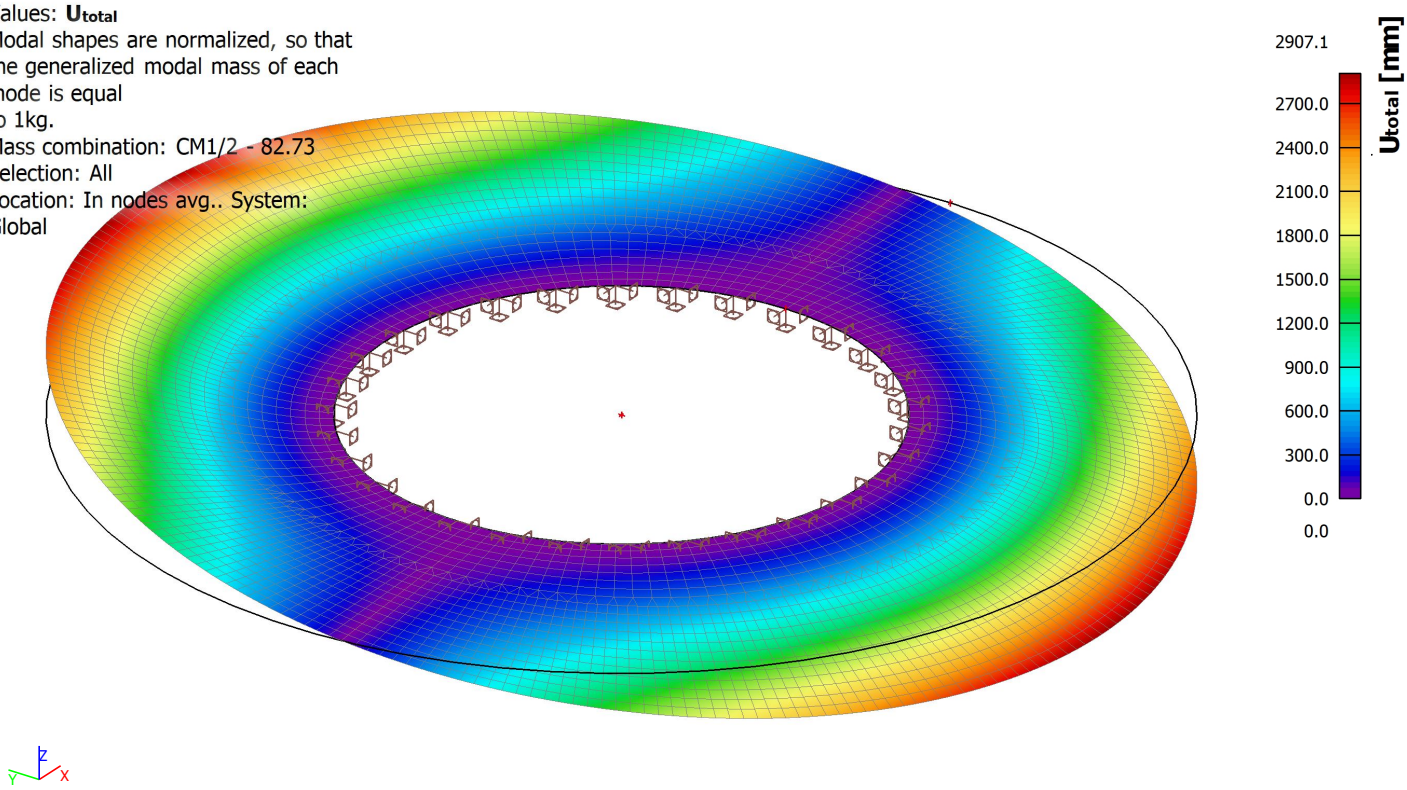
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 81.09
Selection: All
Location: In nodes avg.. System: Global



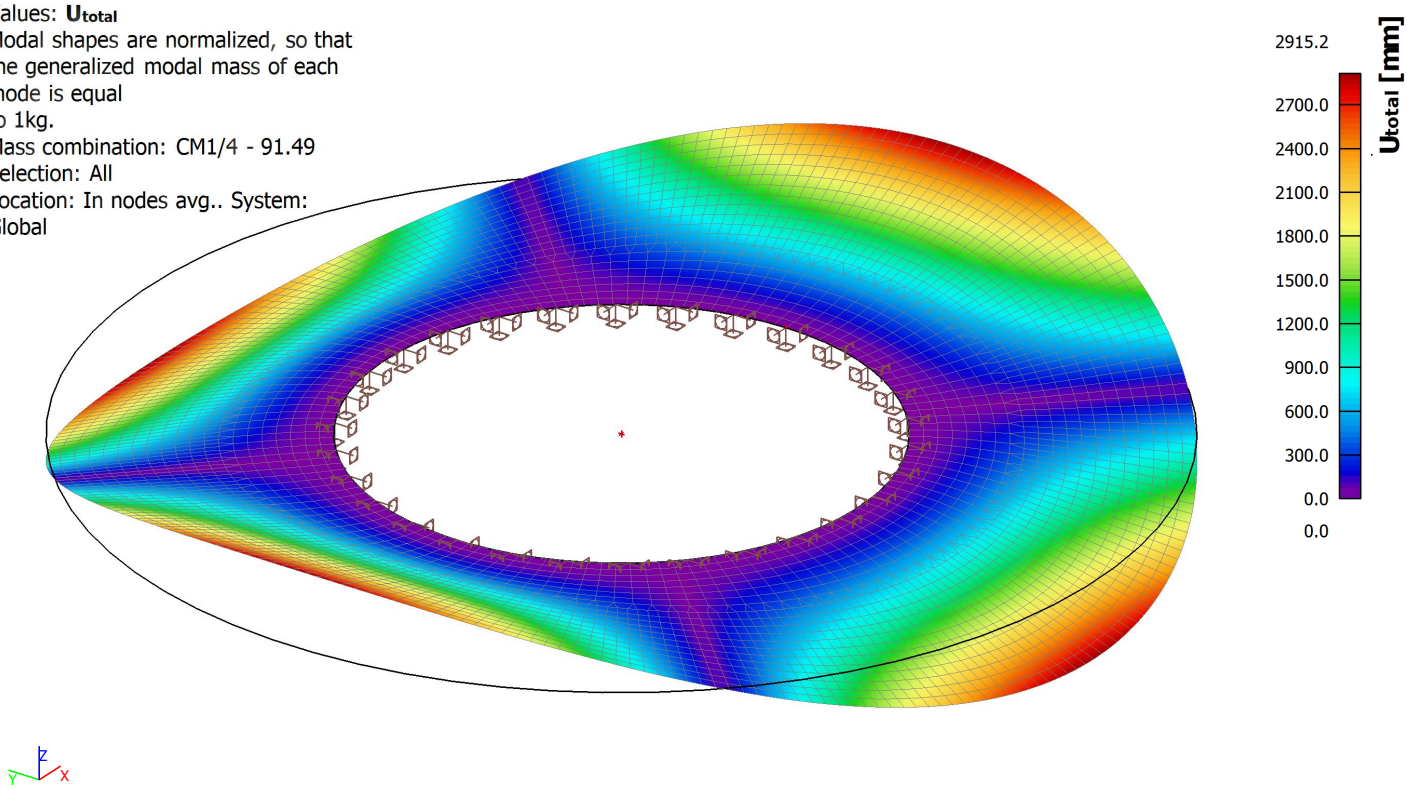
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 82.73
Selection: All
Location: In nodes avg.. System: Global



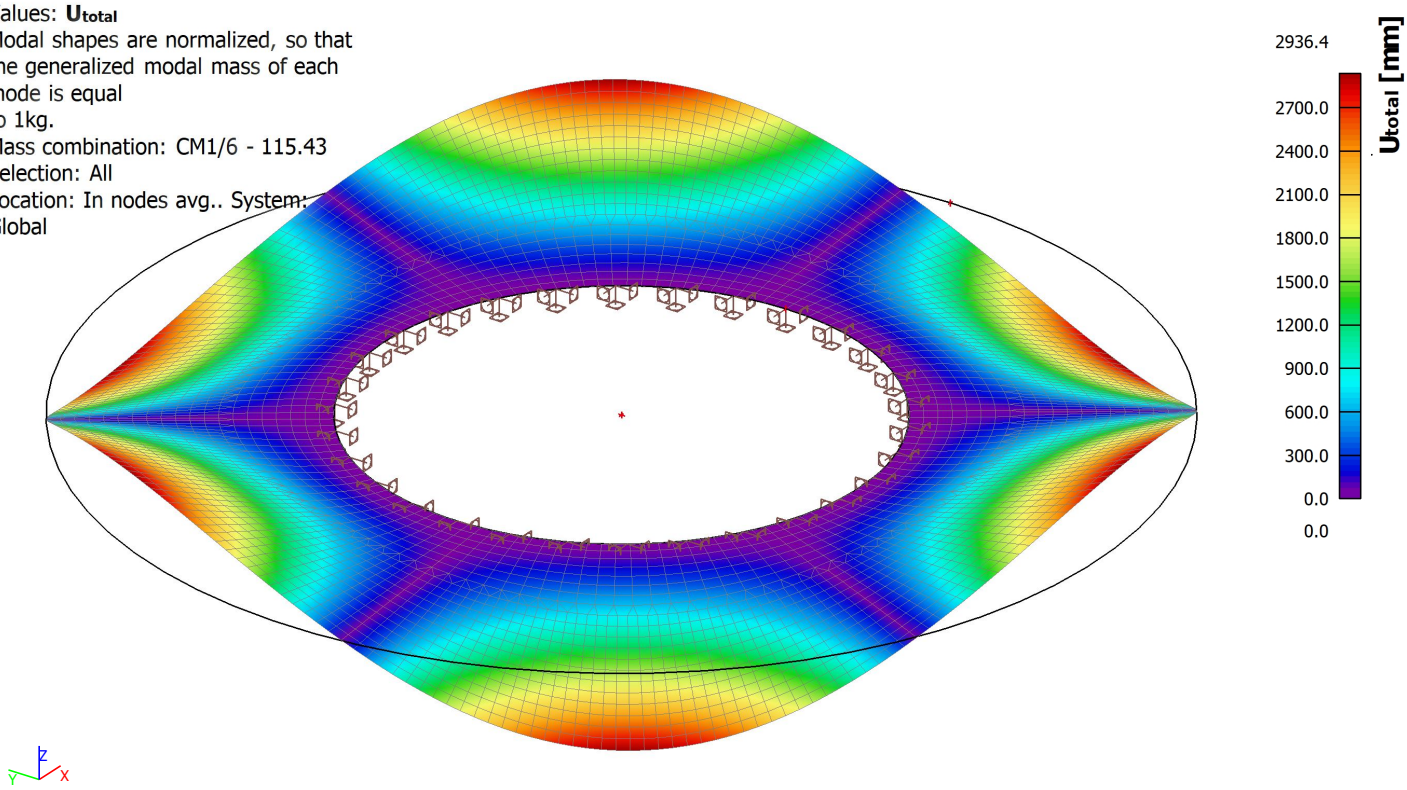
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/4 - 91.49
Selection: All
Location: In nodes avg.. System: Global



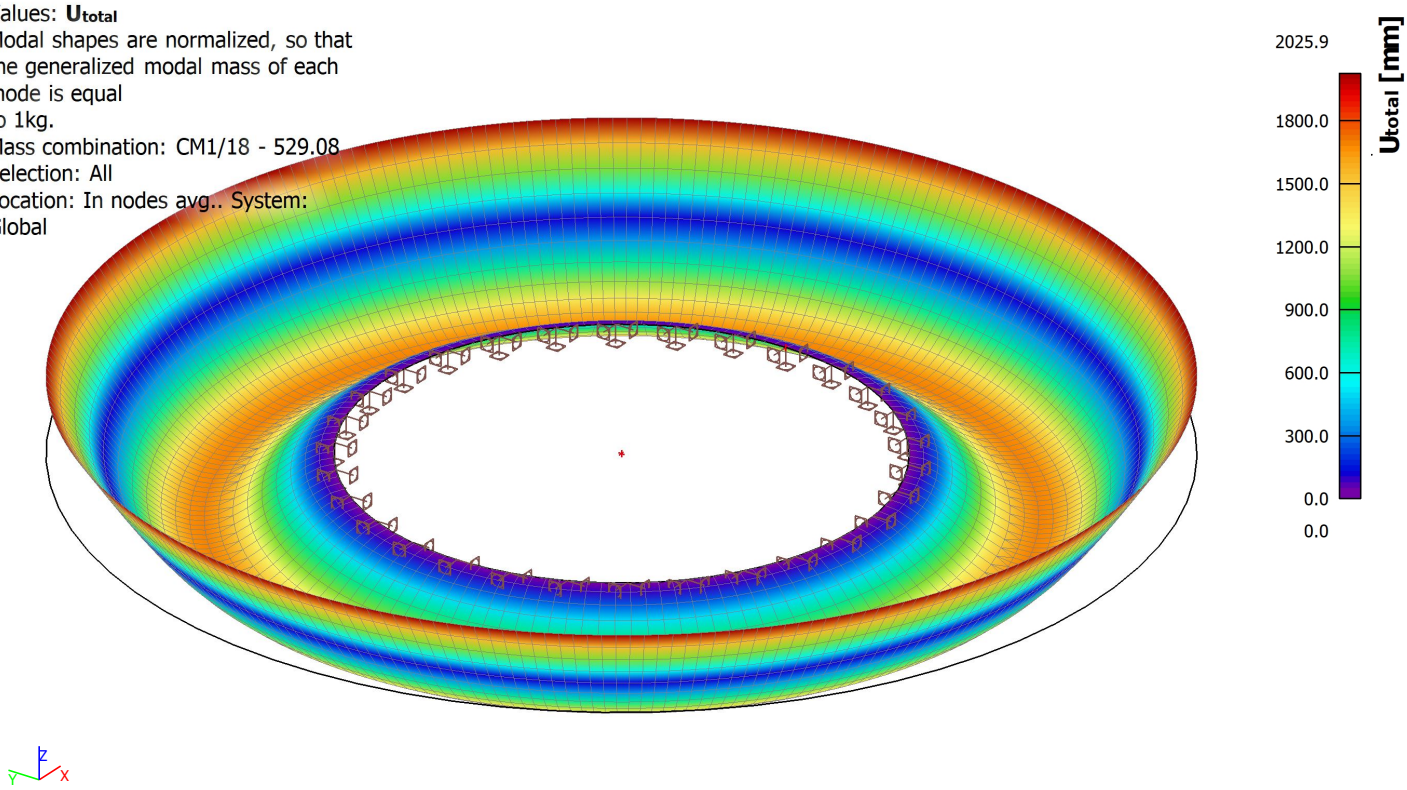
4.5. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/6 - 115.43
Selection: All
Location: In nodes avg.. System: Global



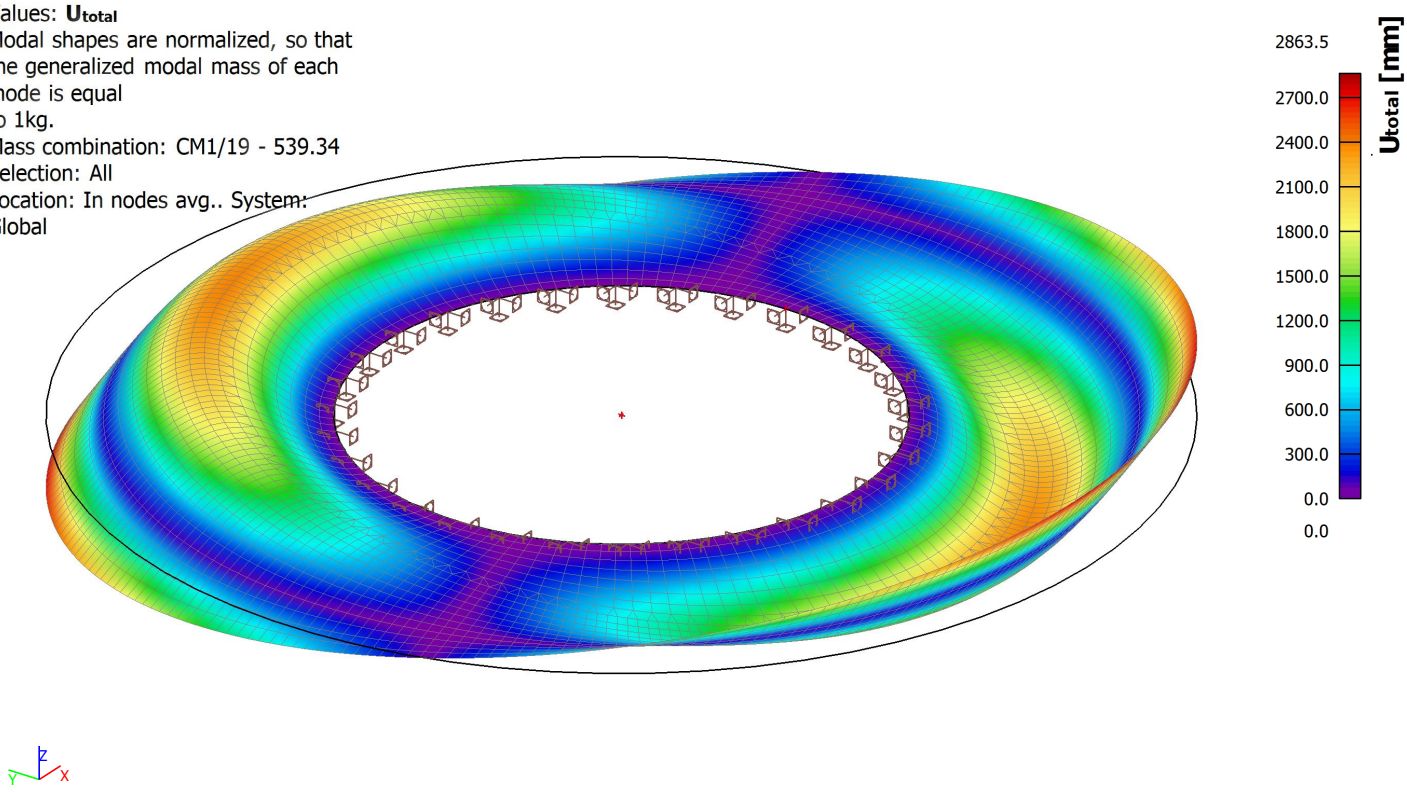
4.6. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/18 - 529.08
Selection: All
Location: In nodes avg.. System: Global



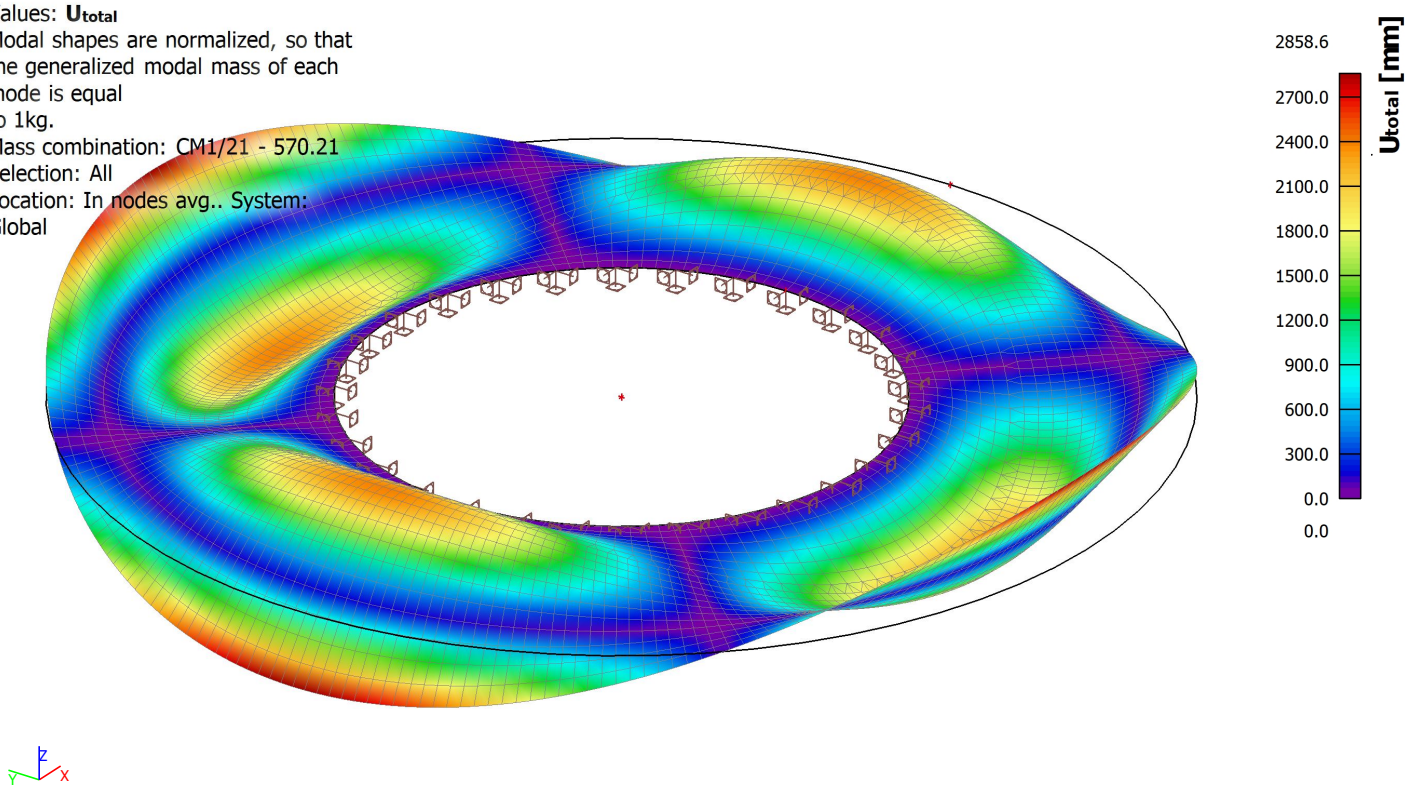
4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/19 - 539.34
Selection: All
Location: In nodes avg.. System: Global



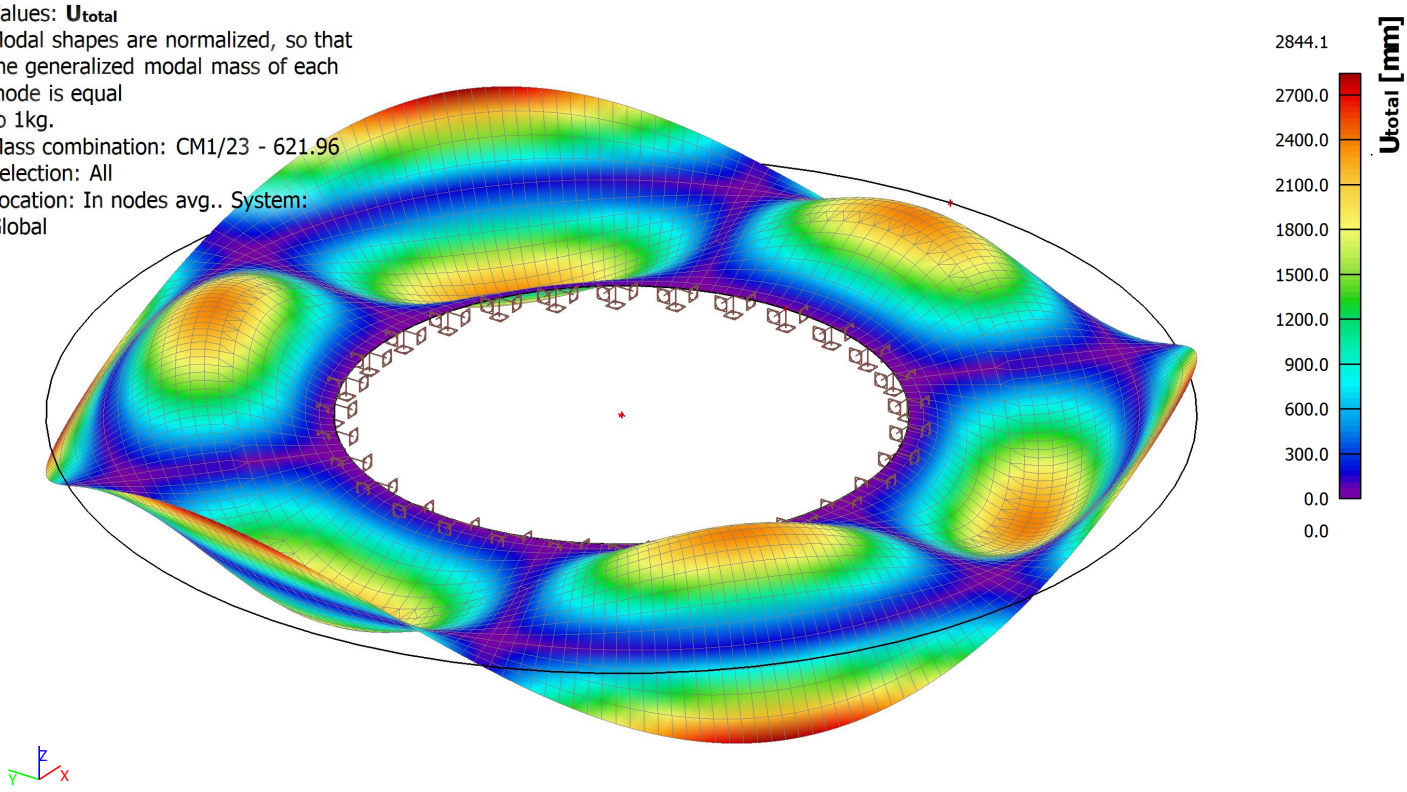
4.8. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/21 - 570.21
Selection: All
Location: In nodes avg.. System: Global



4.9. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/23 - 621.96
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 79.26 Hz
f2 = 81.09 Hz
f4 = 89.63 Hz
f6 =112.79 Hz
f18 = 518.85 Hz
f19 = 528.61 Hz
f21 = 559.09 Hz
f23 = 609.70 Hz

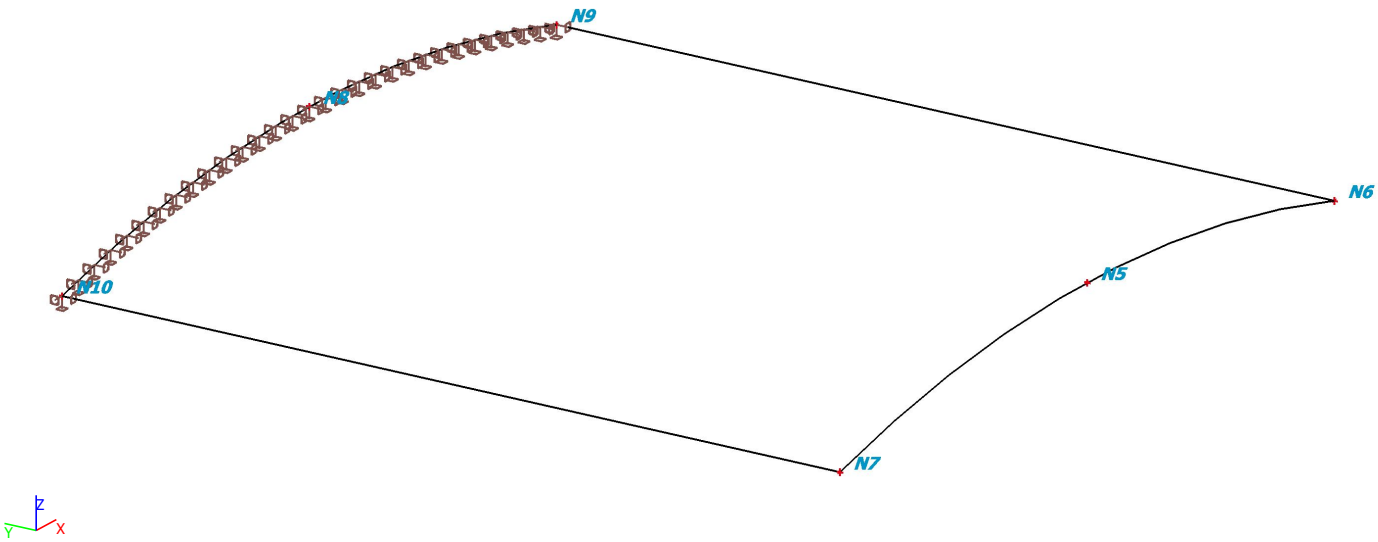
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a cantilever curve shell.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X	Coord Y	Coord Z
N5	0.000	0.000	0.610
N6	0.151	0.000	0.591

Name	Coord X	Coord Y	Coord Z
N7	-0.151	0.000	0.591
N8	0.000	0.305	0.610

Name	Coord X	Coord Y	Coord Z
N9	0.151	0.305	0.591
N10	-0.151	0.305	0.591

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D3	Calque1	shell (98)	Standard	Material	constant	3.0

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D3	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	2	Rela	1.000						

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7857.20	2.0685e+05	0.3	0.0	40.0	235.0	360.0	
		7.9558e+04	0.01e-003	40.0	80.0	215.0	360.0	

3. LOAD and MASS

3.1. Mass groups

Name	Load case
MG1	LC1 - Poids propre

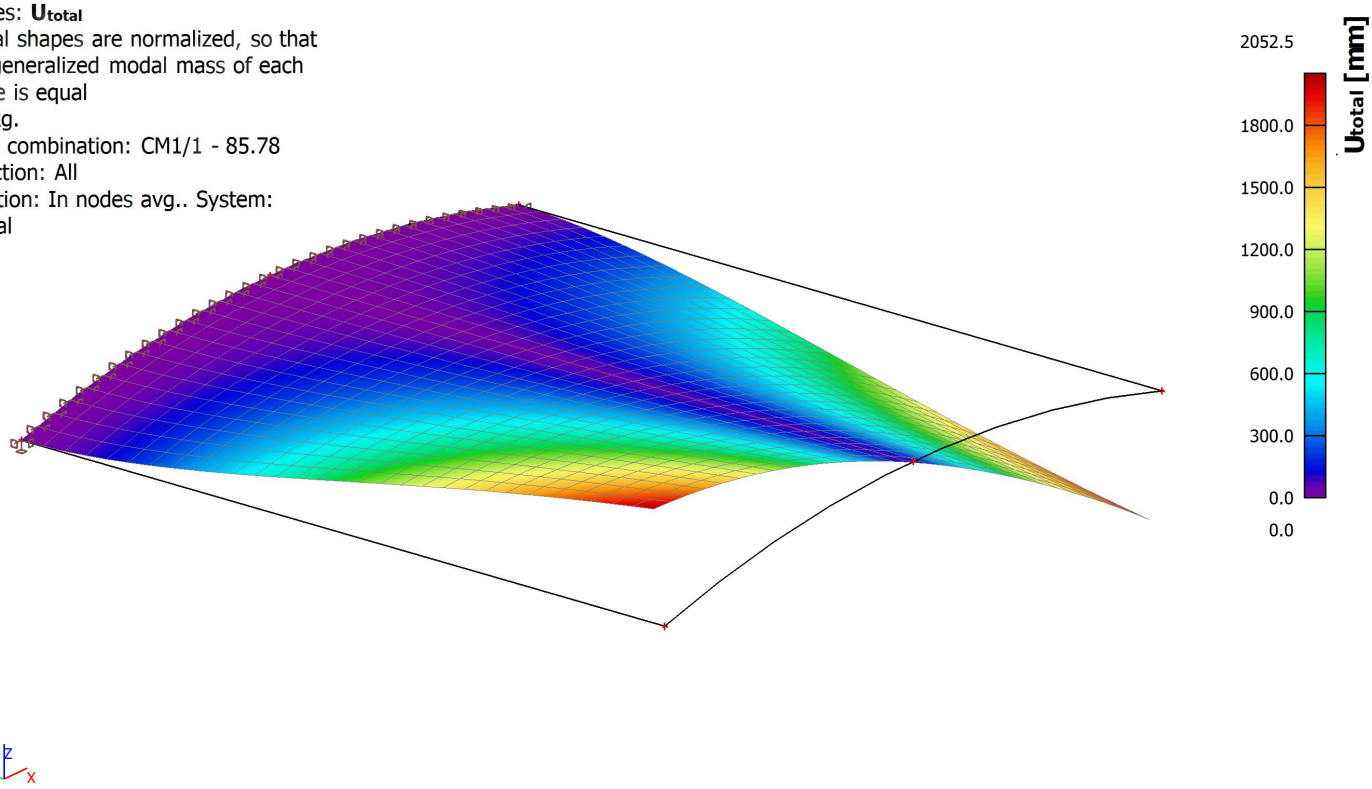
4. RESULTS

4.1. Eigen frequencies

N	f [Hz]	ω [1/s]	ω^2 [1/s^2]	T [s]
Mass combination : CM1				
1	85.78	538.96	290473.04	0.01
2	138.32	869.07	755290.44	0.01
3	246.33	1547.71	2395393.73	0.00
4	341.59	2146.22	4606279.85	0.00
5	384.96	2418.71	5850163.98	0.00
6	526.42	3307.52	10939663.66	0.00

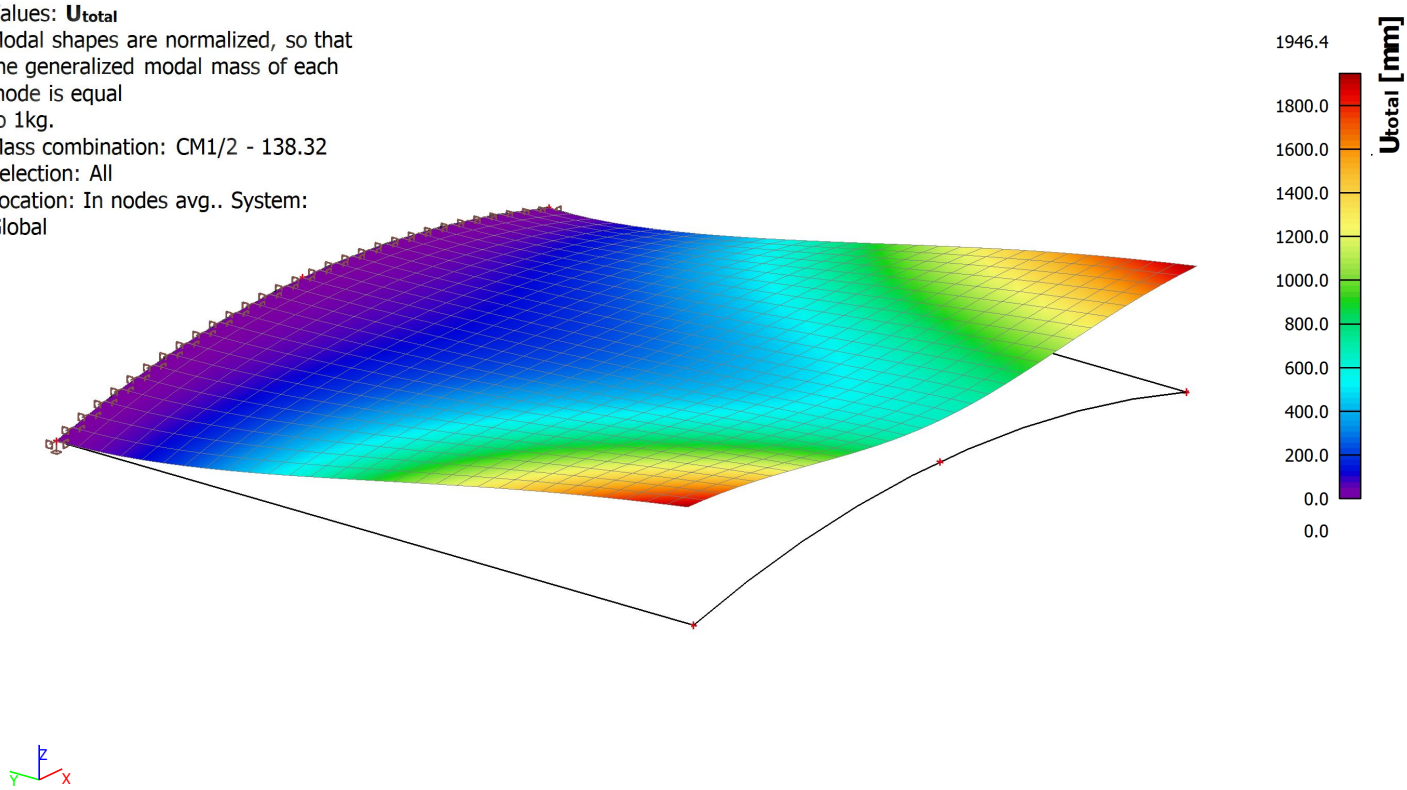
4.2. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/1 - 85.78
Selection: All
Location: In nodes avg.. System: Global



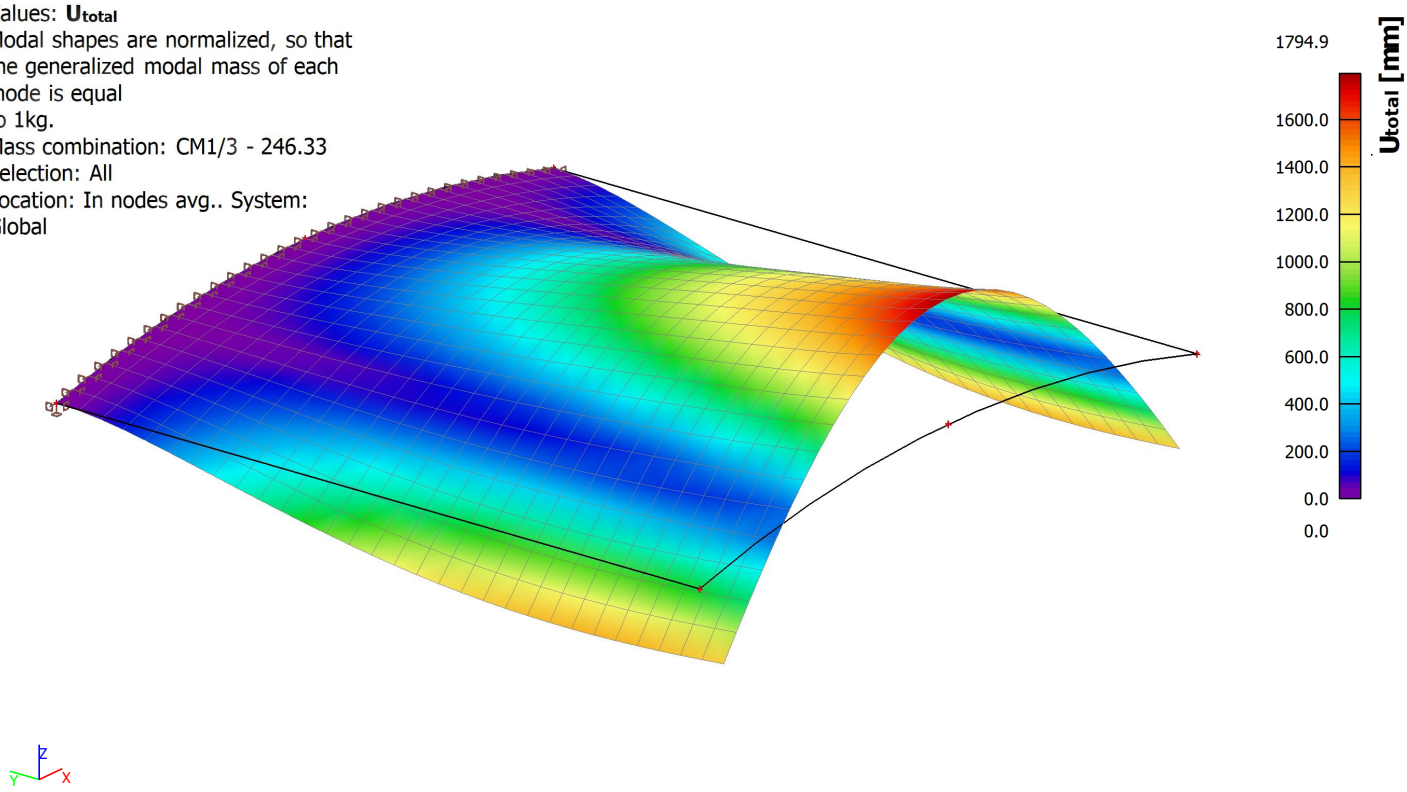
4.3. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/2 - 138.32
Selection: All
Location: In nodes avg.. System: Global



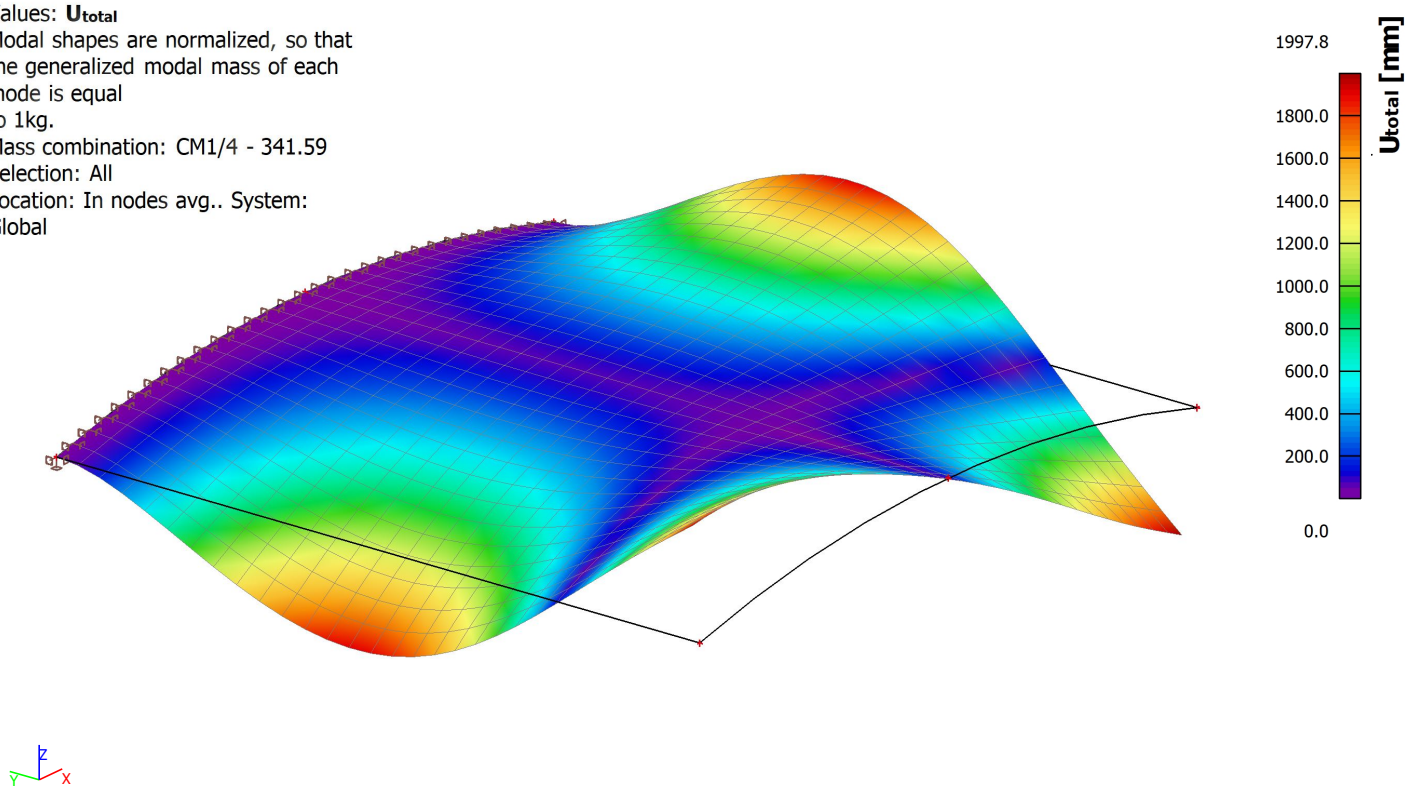
4.4. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/3 - 246.33
Selection: All
Location: In nodes avg.. System: Global



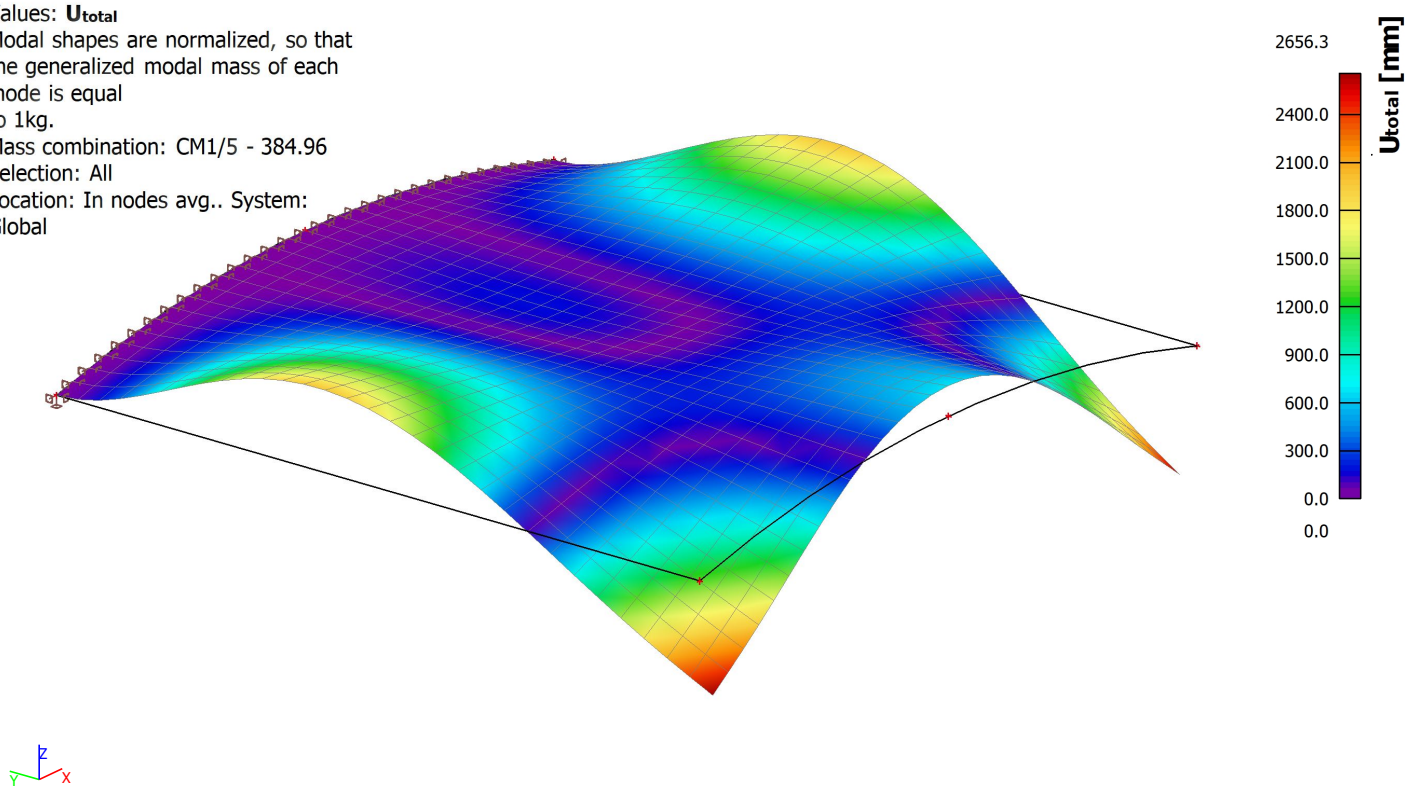
4.5. 3D displacement; U_total

Values: **U_{total}**
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/4 - 341.59
Selection: All
Location: In nodes avg.. System: Global



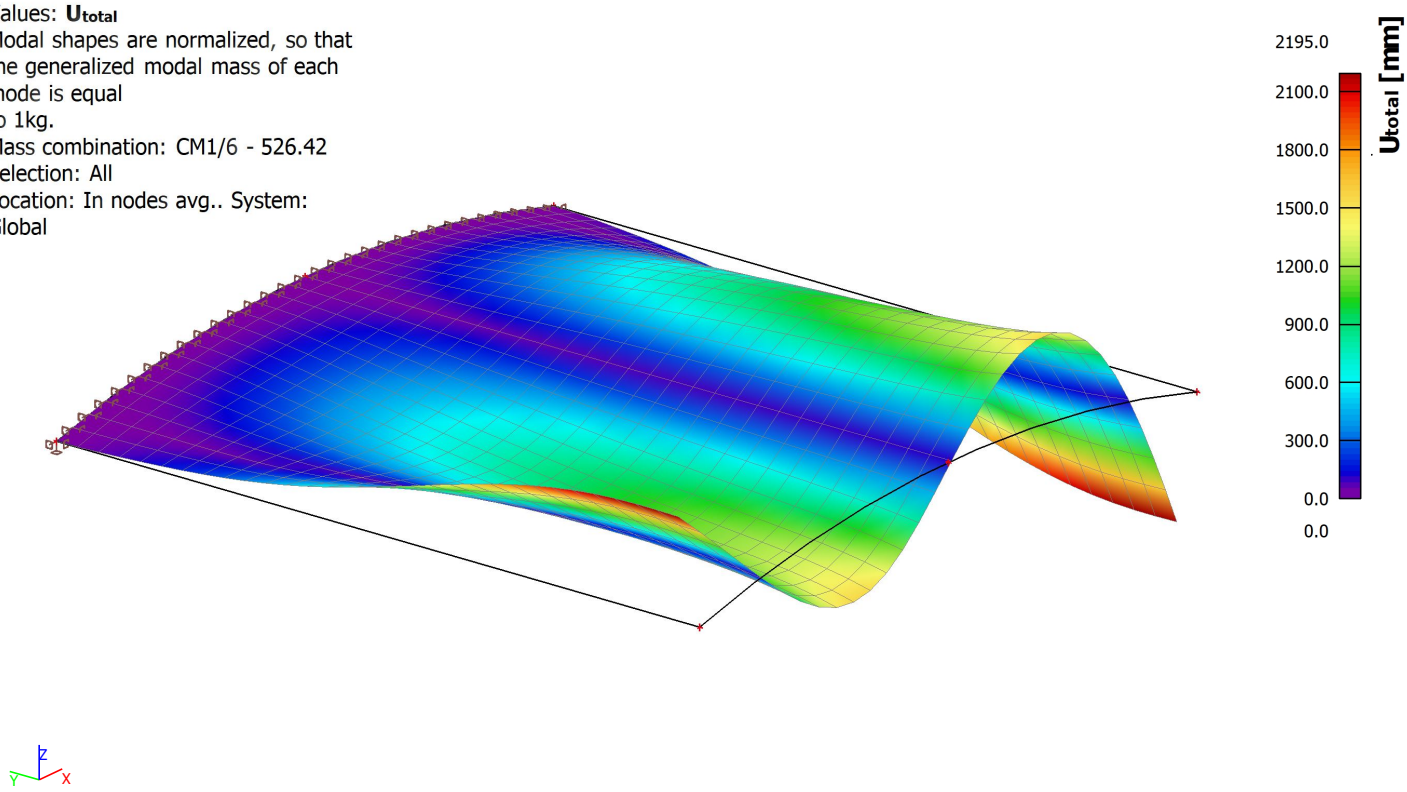
4.6. 3D displacement; U_total

Values: **U_{total}**
Modal shapes are normalized, so that the generalized modal mass of each mode is equal to 1kg.
Mass combination: CM1/5 - 384.96
Selection: All
Location: In nodes avg.. System: Global



4.7. 3D displacement; U_total

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/6 - 526.42
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies:

f1 = 85.6 Hz
f2 = 134.5 Hz
f3 = 259.0 Hz
f4 = 351.0 Hz
f5 = 395.0 Hz
f6 = 531.0 Hz

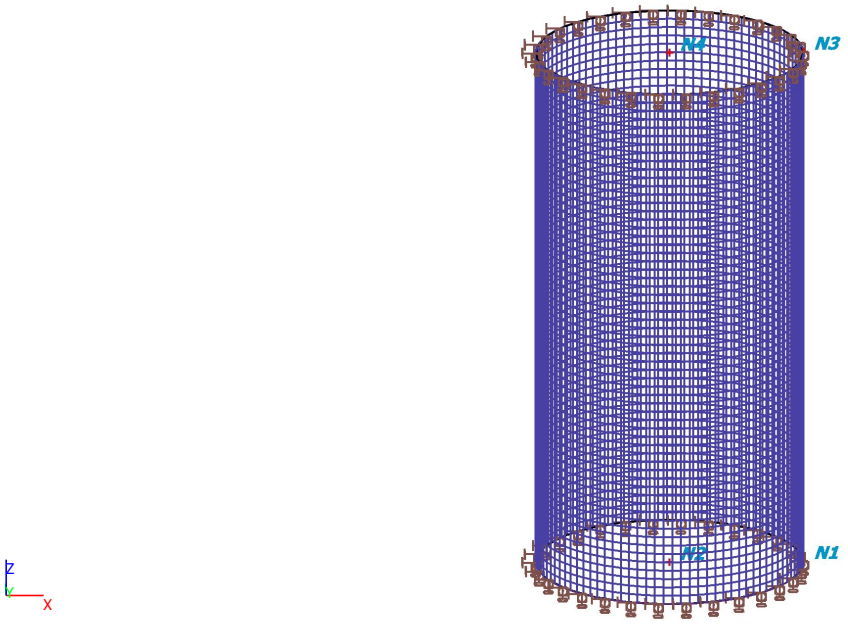
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Modal analysis of a thin cylinder fixed at both ends.

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0.076	0.000	0.000
N2	0.000	0.000	0.000
N3	0.076	0.000	0.305
N4	0.000	0.000	0.305

2.3. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
S1	Layer1	wall (80)	Standard	Material	constant	0

2.4. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	S1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	3	Rela	1.000						
Sle2	S1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
	1	Rela	1.000						

2.5. Materials

Steel EC3

Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7850.00	2.0600e+05	0.3	0	40	235.0	360.0	
		7.9231e+04	0.01e-003	40	80	215.0	360.0	

3. LOAD and MASS

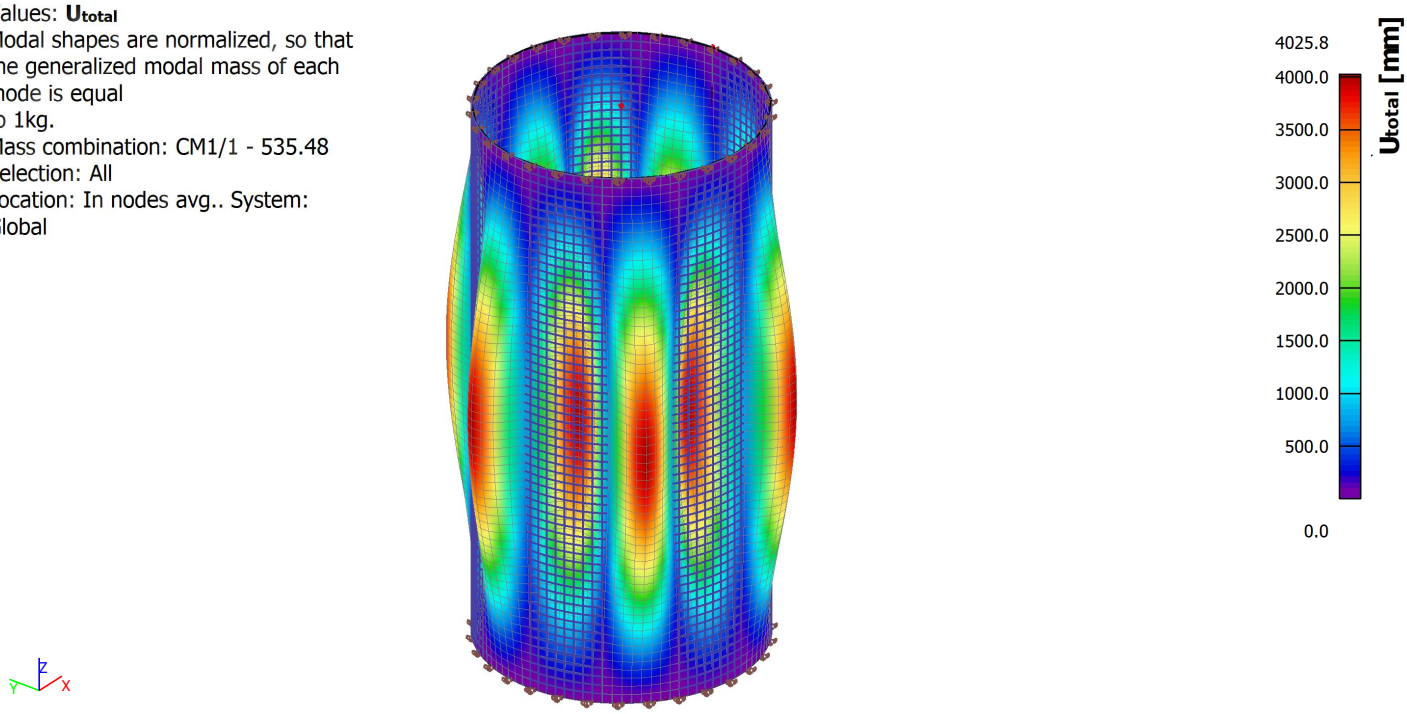
3.1. Mass groups

Name	Load case
MG1	LC1 - Self weight

4. RESULTS

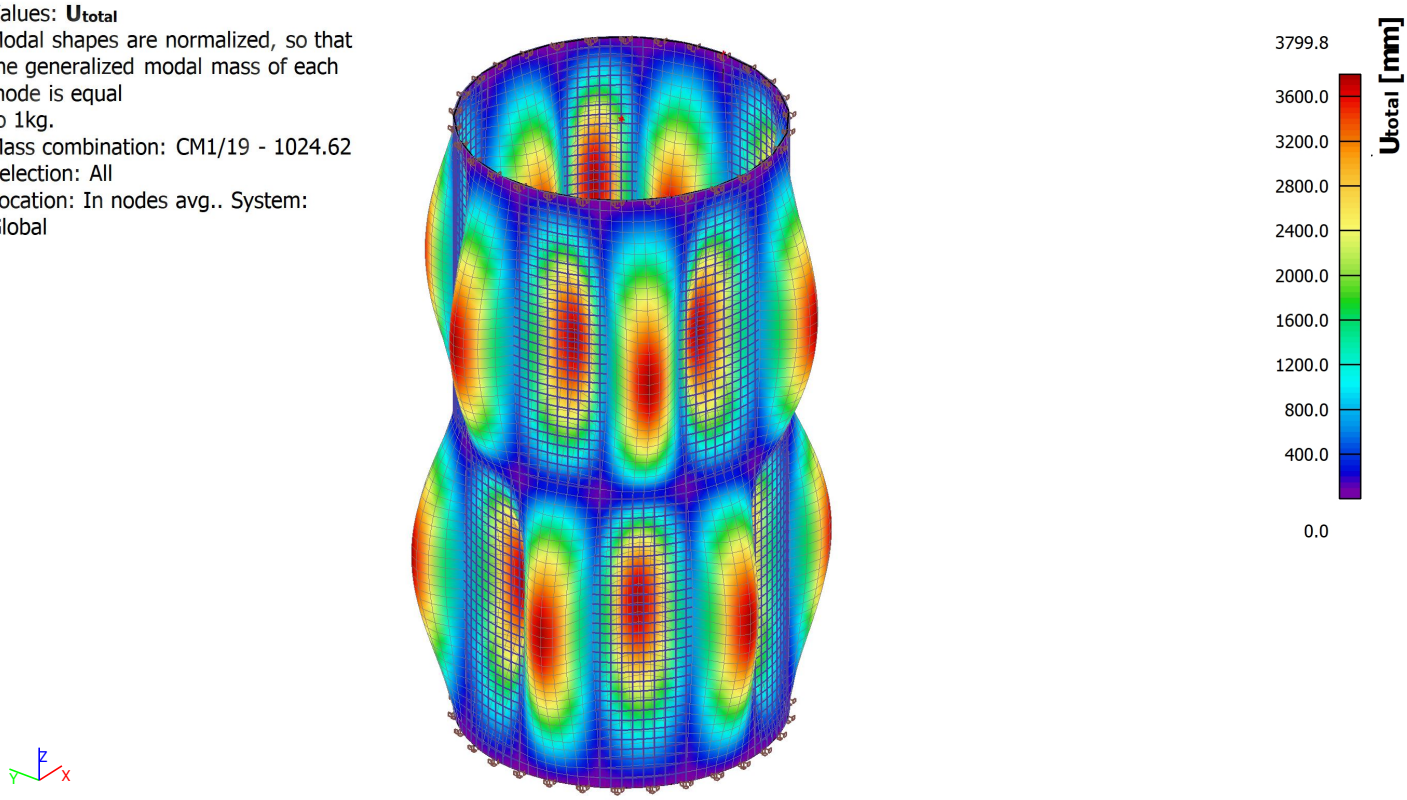
4.1. 3D displacement; m=1, n=6

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/1 - 535.48
Selection: All
Location: In nodes avg.. System: Global



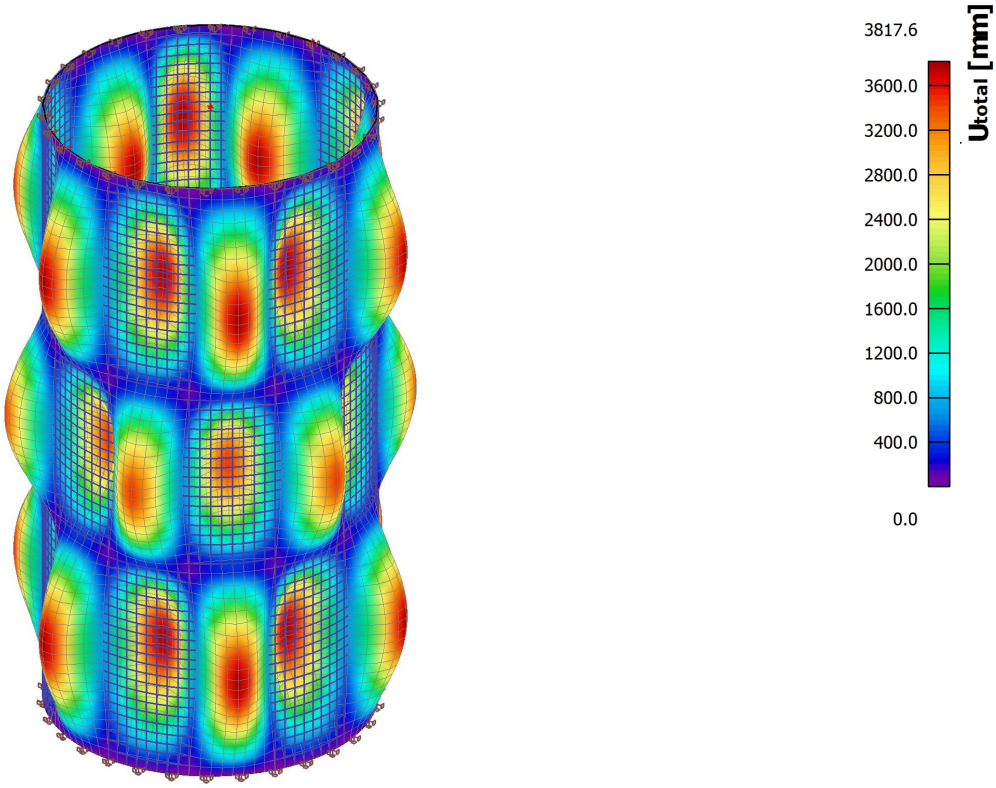
4.2. 3D displacement; m=2, n=6

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/19 - 1024.62
Selection: All
Location: In nodes avg.. System: Global



4.3. 3D displacement; m=3, n=6

Values: U_{total}
Modal shapes are normalized, so that the generalized modal mass of each mode is equal
to 1kg.
Mass combination: CM1/55 - 1727.51
Selection: All
Location: In nodes avg.. System: Global



5. EXPECTED AFNOR RESULTS

Eigenfrequencies (m=1, n=6)

f = 538.5 Hz

Eigenfrequencies (m=2, n=6)

f = 1041.5 Hz

Eigenfrequencies (m=3, n=6)

f = 1764.9 Hz

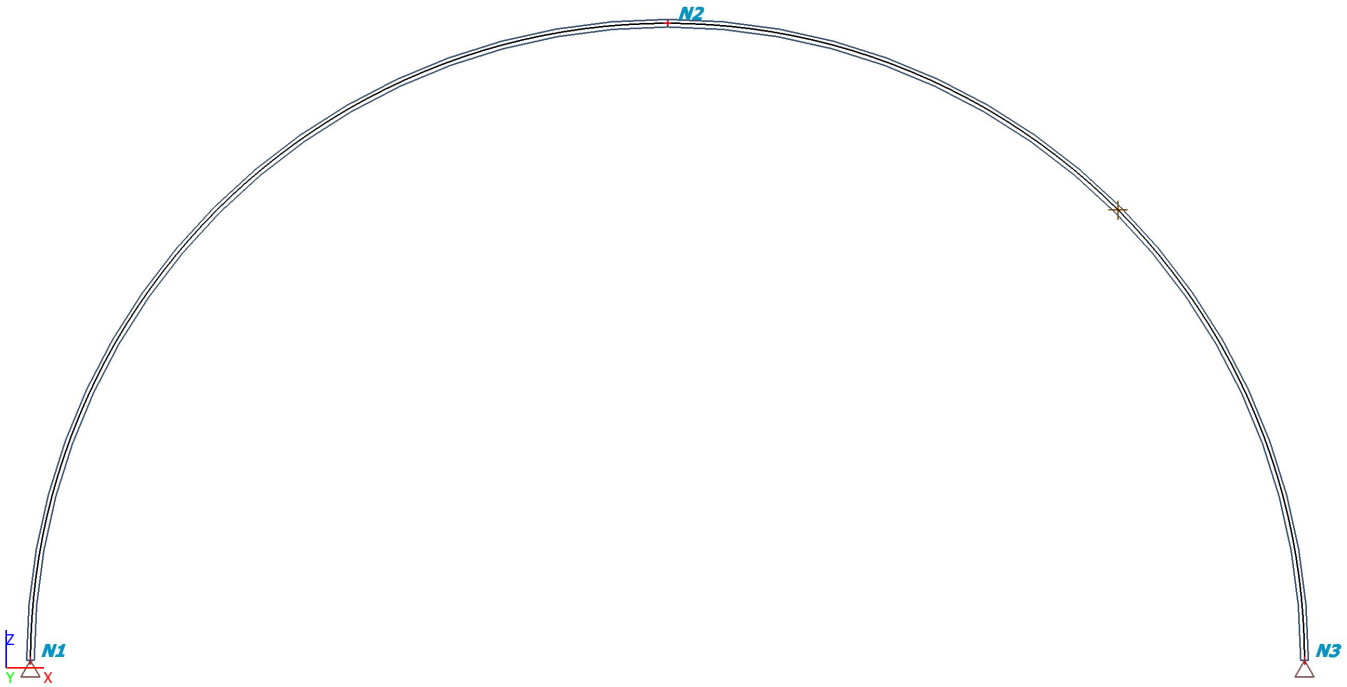
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Arch with 2 pinned supports
Specification: Thin-walled arch - Thermal gradient - Pinned supports

2. MODEL

2.1. Analysis model



2.2. Nodes

Name	Coord X [m]	Coord Z [m]
N1	0.000	0.000
N2	10.000	10.000
N3	20.000	0.000

2.3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS1 - Full rectangular (120.0; 120.0)	S 355	31.416	N1	N3	general (0)

2.4. Nodal supports

Name	Node	System	Type	X	Z	Ry
Sn1	N1	GCS	Standard	Rigid	Rigid	Free
Sn2	N3	GCS	Standard	Rigid	Rigid	Free

2.5. Materials

Steel EC3

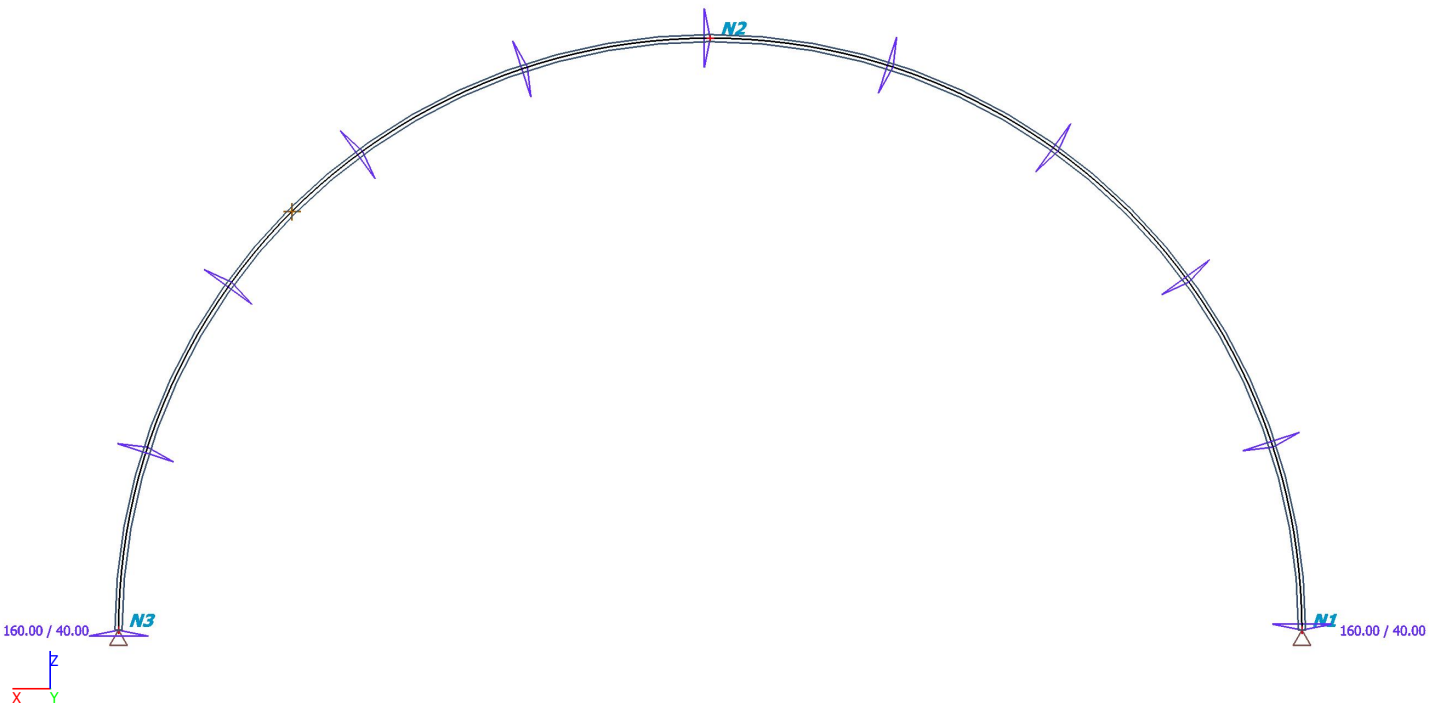
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 355	7850.00	2.0000e+05	0.3	0.0	40.0	355.0	490.0	
		7.6923e+04	0.01e-003	40.0	80.0	335.0	470.0	

3. LOAD

4. Thermal load

Name	Member	Load case	Pos x_1	Coor	Orig	Distribution	+z - Top delta [K]
			Pos x_2				-z - Bottom delta [K]
LT1	B1	LC2	0.000	Rela	From start	Linear	160.00
			1.000				40.00

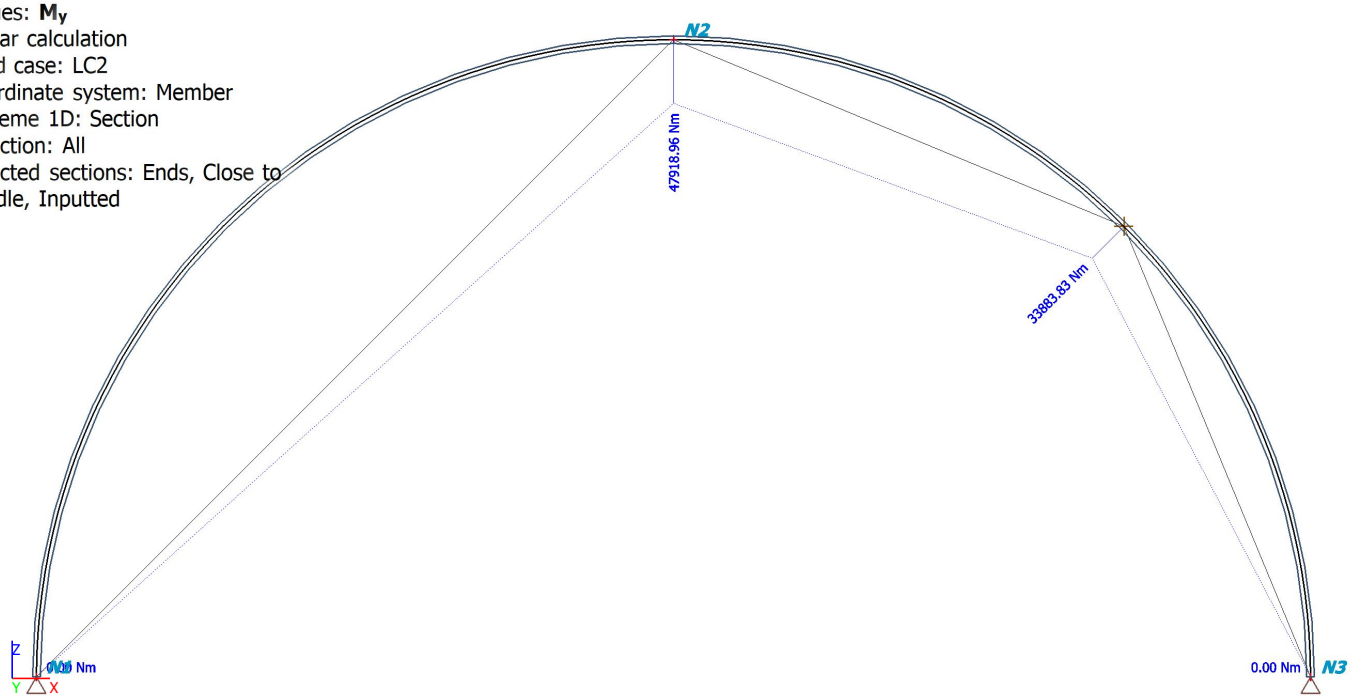
5. LC2



6. RESULTS

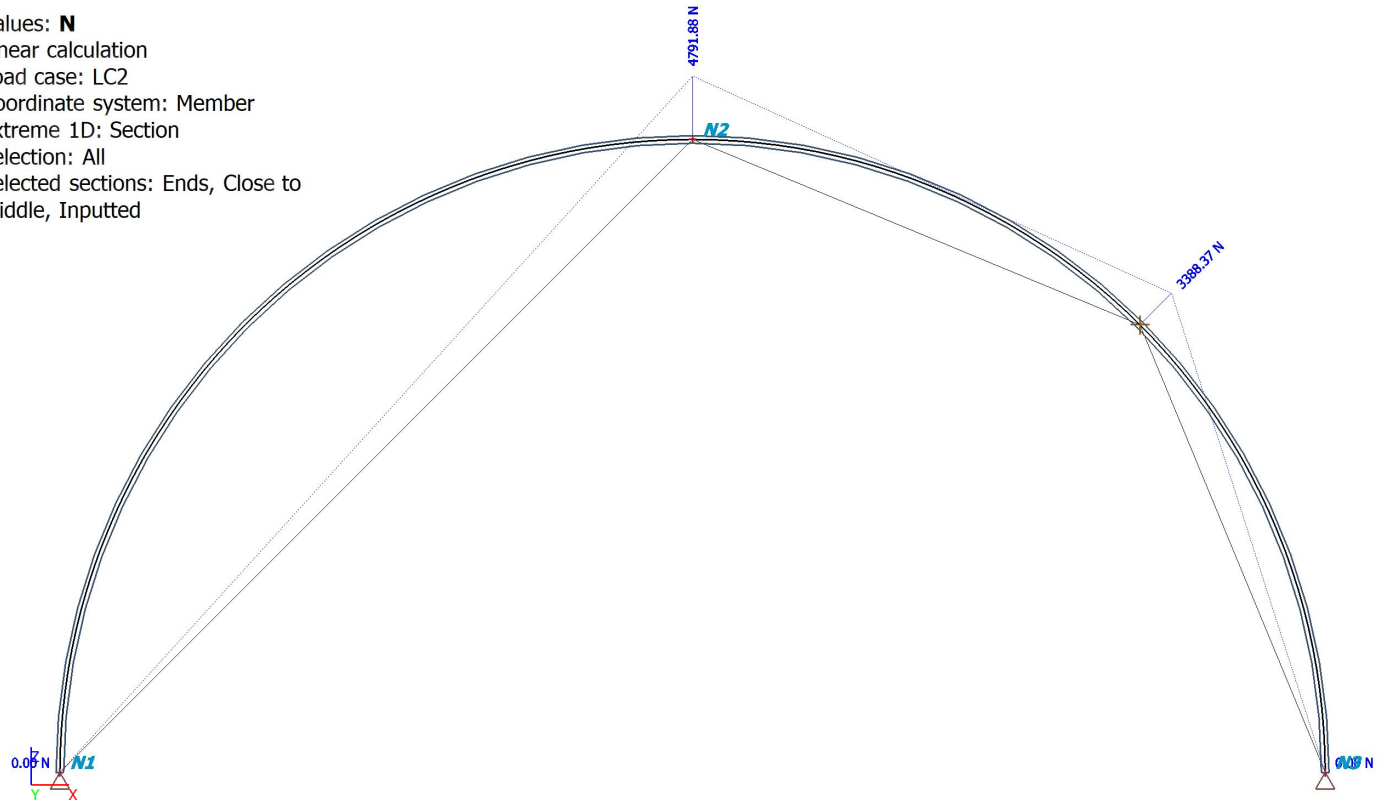
7. 1D internal forces; M_y

Values: M_y
Linear calculation
Load case: LC2
Coordinate system: Member
Extreme 1D: Section
Selection: All
Selected sections: Ends, Close to middle, Inputted



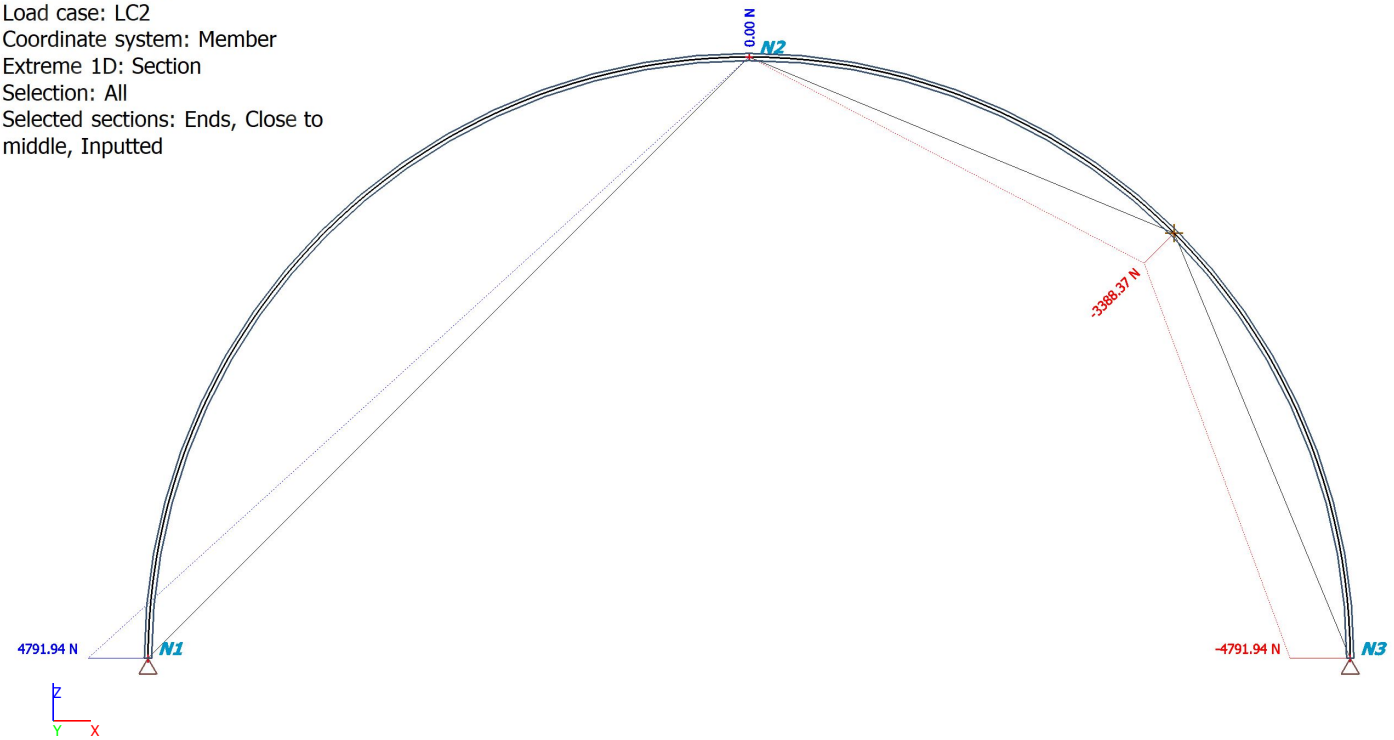
8. 1D internal forces; N

Values: **N**
Linear calculation
Load case: LC2
Coordinate system: Member
Extreme 1D: Section
Selection: All
Selected sections: Ends, Close to middle, Inputted



9. 1D internal forces; V_z

Values: V_z
Linear calculation
Load case: LC2
Coordinate system: Member
Extreme 1D: Section
Selection: All
Selected sections: Ends, Close to middle, Inputted



10. 1D internal forces

Linear calculation
Load case: LC2
Coordinate system: Member
Extreme 1D: No
Selection: All
Selected sections: Ends, Close to middle, Inputted

Name	dx [m]	Case	N [N]	V_z [N]	M_y [Nm]
B1	0.000	LC2	0.00	4791.94	0.00
B1	15.708-	LC2	4791.88	0.00	47918.96
B1	15.708+	LC2	4791.88	0.00	47918.96
B1	23.562-	LC2	3388.37	-3388.37	33883.83
B1	23.562+	LC2	3388.37	-3388.37	33883.83
B1	31.416	LC2	0.00	-4791.94	0.00

11. EXPECTED AFNOR RESULTS

For THETA= PI/2 (dx=31,416) :
M = 0 Nm
N = 0 N
V = -4792 N

For THETA= PI/4 (dx=23,562) :
M = 33883 Nm
N = -3388 N
V = -3388 N

For THETA= 0 (dx=15,708):
M = 47918 Nm
N = -4792 N
V = 0N

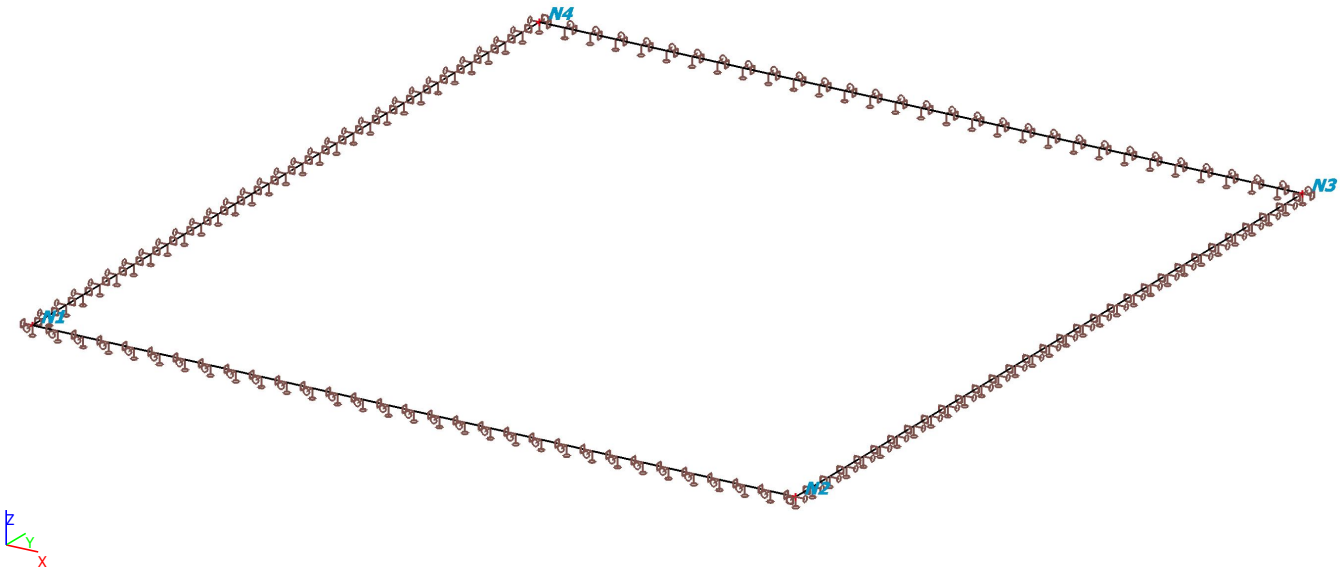
REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990

1. TESTCASE DESCRIPTION

Thin plate deformed according to spherical curve under thermal gradient

2. MODEL

2.1. Analysis model



2.2. 2D members

Name	Layer	Type	Element type	Material	Thickness type	Th. [mm]
D1	Calque1	plate (90)	Standard	Material	constant	10.0

2.3. Supports on 2D member edge

Name	2D member	Orig	Pos x_1	X	Y	Z	Rx	Ry	Rz
	Edge	Coor	Pos x_2						
Sle1	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Free	Free
	1	Rela	1.000						
Sle2	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Free	Free
	2	Rela	1.000						
Sle3	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Free	Free
	3	Rela	1.000						
Sle4	D1	From start	0.000	Rigid	Rigid	Rigid	Rigid	Free	Free
	4	Rela	1.000						

2.4. Materials

Steel EC3

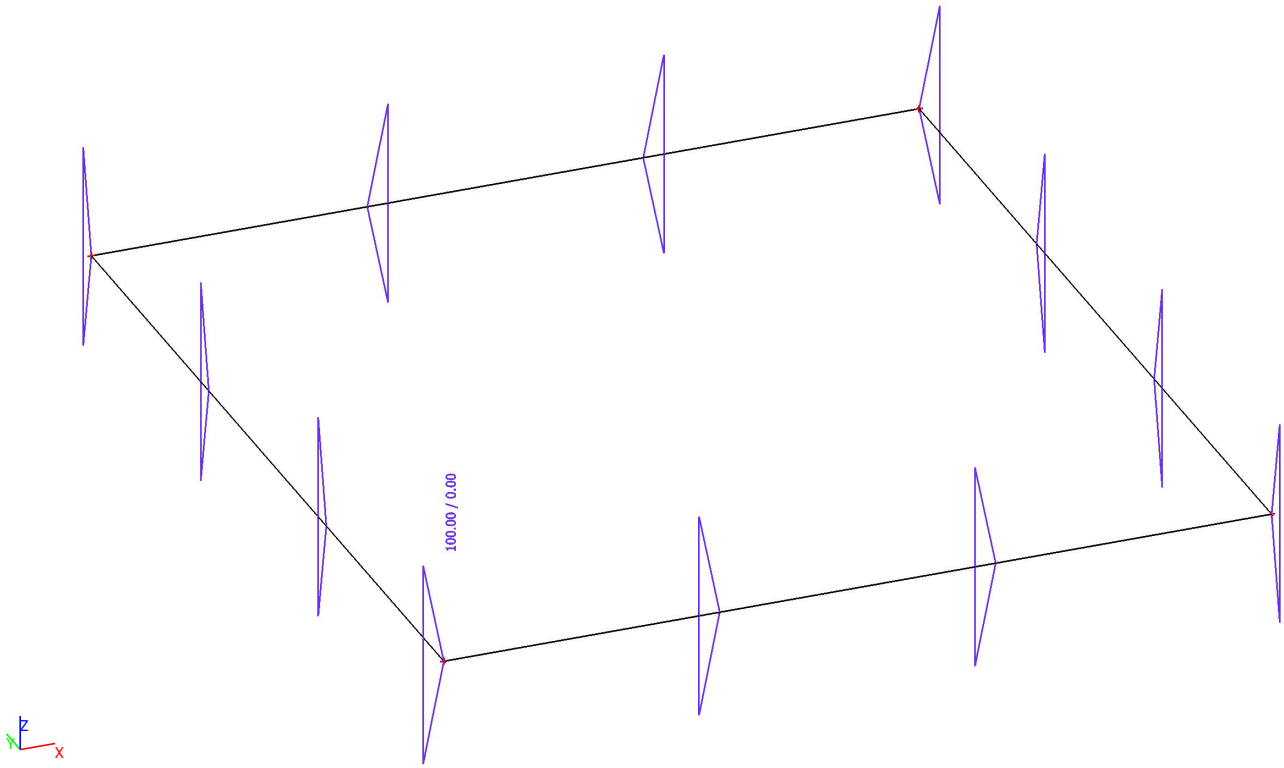
Name	ρ [kg/m³]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
Material	7850.00	2.0000e+05	0.3	0.0	40.0	235.00	360.00	
		7.6923e+04	0.01e-003	40.0	80.0	215.00	360.00	

3. LOAD

3.1. Thermal load on 2D member

Name	2D member	Load case	Distribution	+z - Top delta [K]	-z - Bottom delta [K]
ST1	D1	LC2	Linear	100.00	0.00

3.2. LC2



4. RESULTS

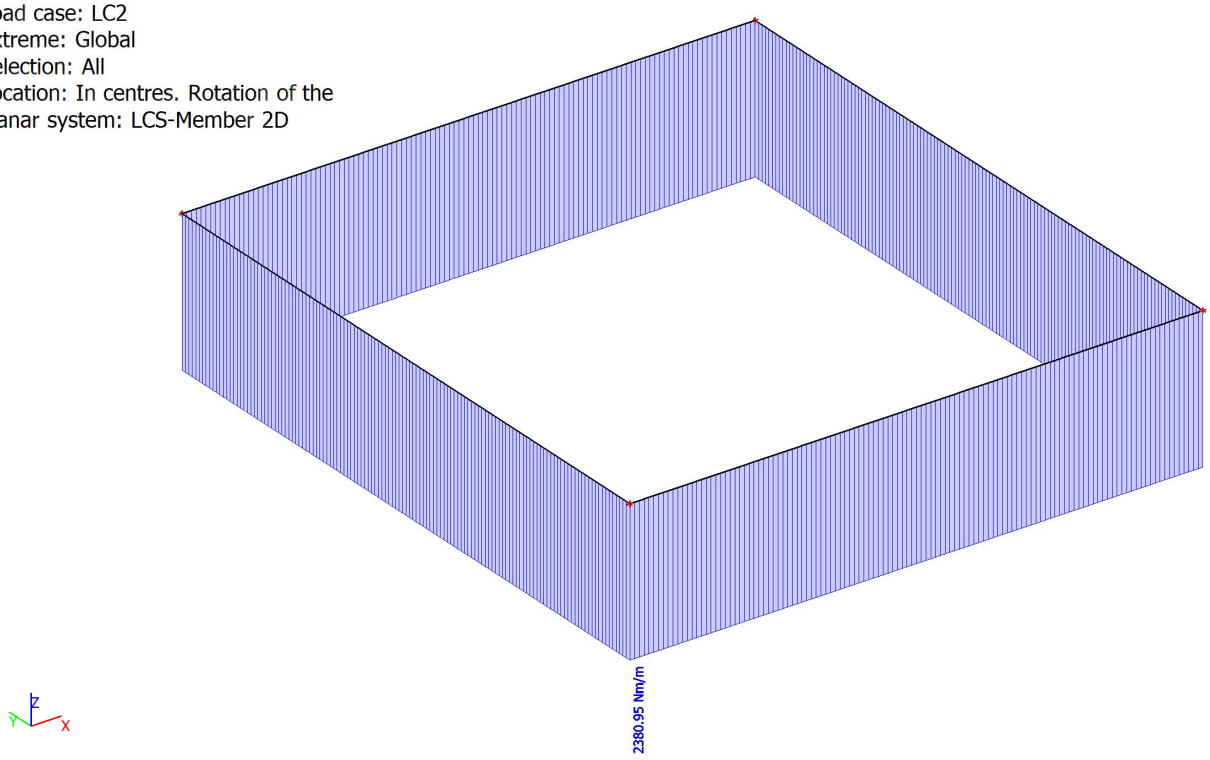
4.1. 2D internal forces

Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Basic magnitudes

Name	Mesh	Position [m]	Case	m_x [Nm/m]
D1	Element: 1 Node: 1	0.000 0.000 0.000	LC2	**2380.95**

4.2. 2D internal forces; m_y

Values: m_y
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In centres. Rotation of the planar system: LCS-Member 2D



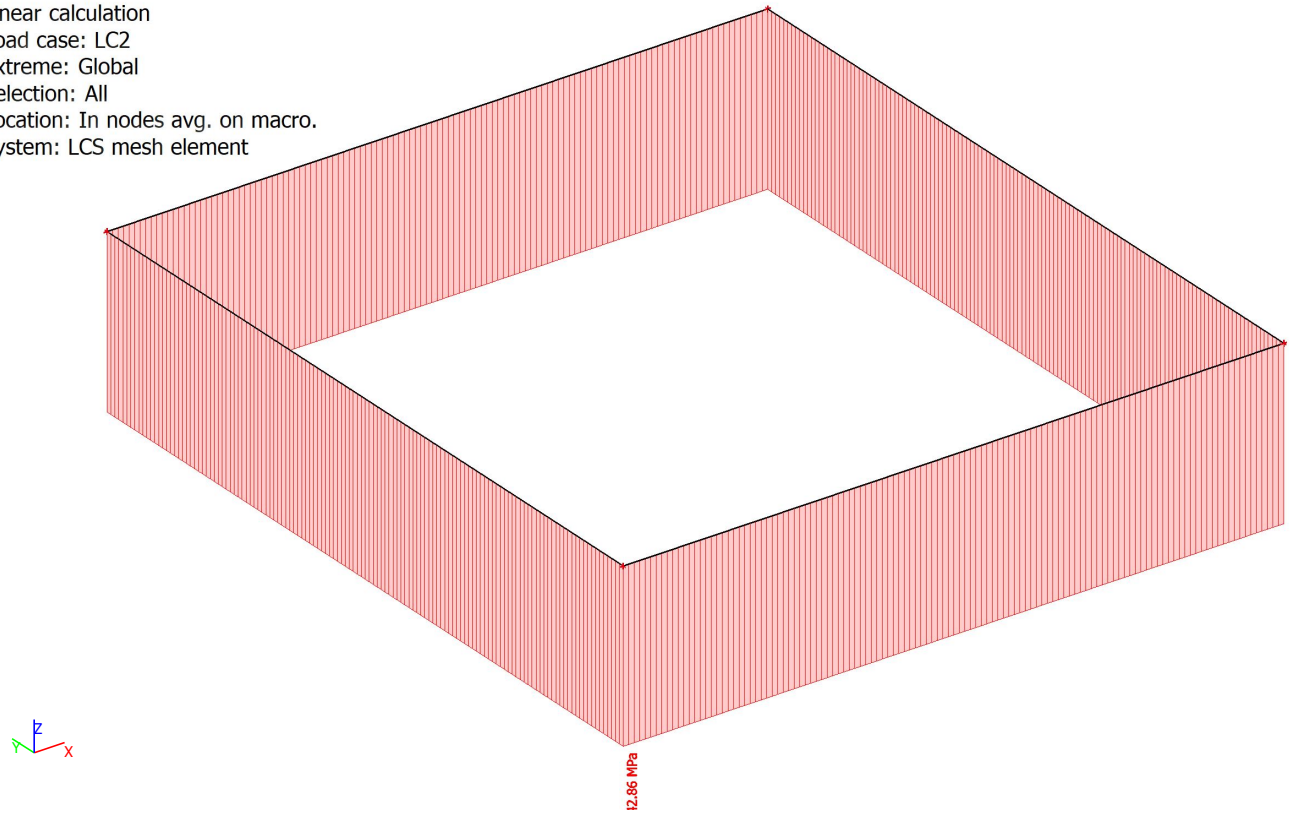
4.3. 2D stress/strain

Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro. System: LCS mesh element
Membrane stress

Name	Mesh	Position [m]	Case	σ_{mE} [MPa]	σ_{m1} [MPa]	σ_{m2} [MPa]
D1	Element: 1 Node: 1	0.000 0.000 0.000	LC2	**142.86**	**-142.86**	**-142.86**

4.4. 2D stress/strain; σ_m1

Values: σ_{m1}
Linear calculation
Load case: LC2
Extreme: Global
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element



5. EXPECTED AFNOR RESULTS

Bending moment =2380,95Nm/m
Maximum stress= 142,857 MPa

REFERENCE : "Guide de validation des progiciels de calcul de structures" AFNOR, 1990