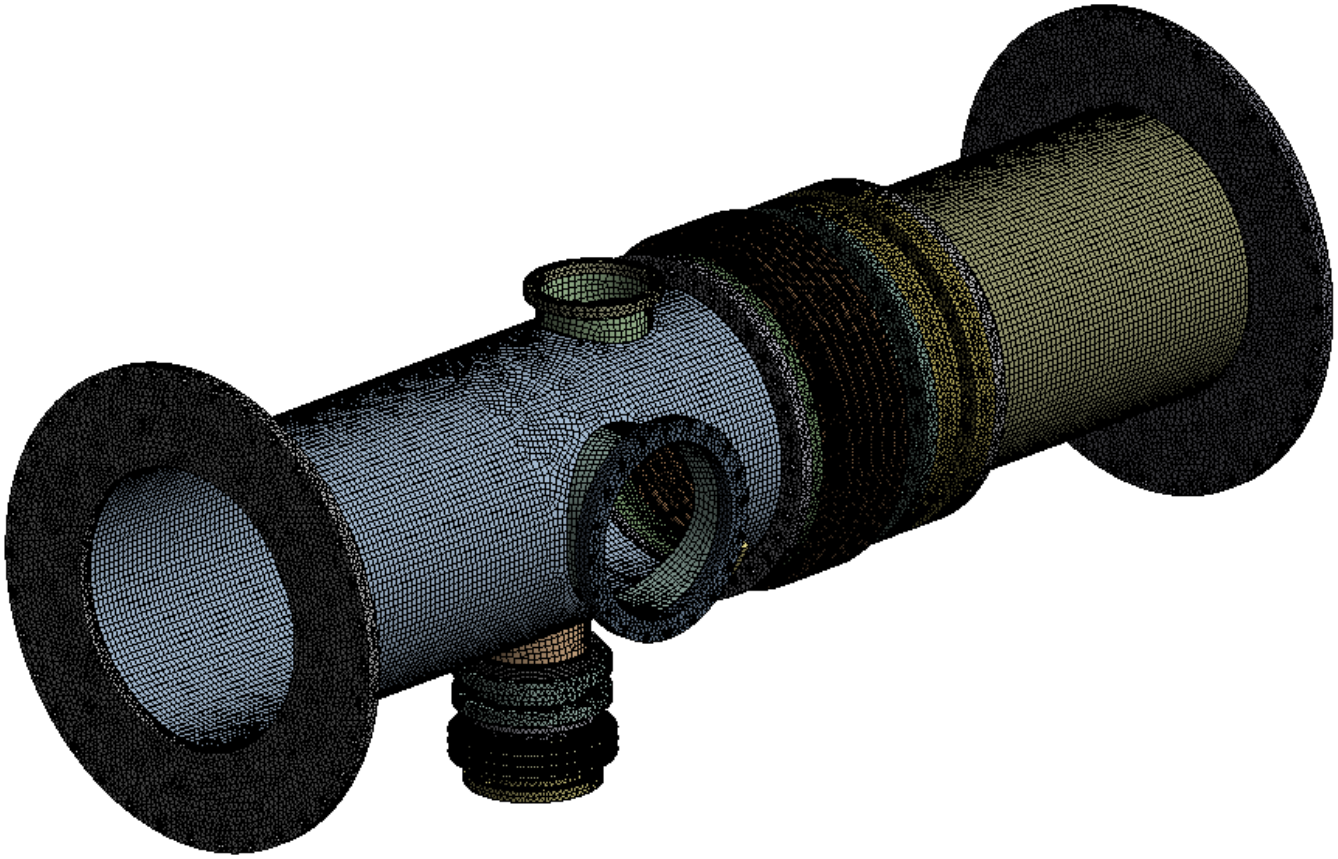
BS-SR SYSTEM PIPING CONNECTING ASSEMBLY

TECHNICAL REPORT



REV.	DATE	DESCRIPTION	ORIGINATOR	CHECK	APPROVAL
2	31/01/2013	*MODIFIED AFTER CUSTOMER REMARKS*	*F. Lamperti*	*A. Barbini*	*M. Ciolli*
2	31/01/2013	*MODIFIED AFTER CUSTOMER REMARKS*	*A. Barbini*	*F. Lamperti*	*M. Ciolli*
1	25/01/2013	*FIRST ISSUE*	*A. Barbini*	*F. Lamperti*	*M. Ciolli*

1 Summary

Scope of the work is to design the connection pipes for BS – SR system. In this report stresses are calculated using FEA software. These stresses are checked for compliance with UNI EN 13445-3 (external pressure).

Operating conditions:

- $P_{operating}$ = -1 barg (Full Vacuum)
- $T_{operating}$ = 20°C

Design limits operating:

- $P_{operating}$ = -1 barg (Full Vacuum)
- $T_{operating}$ = 20°C

Weight of components:

- Weight of piping connection (1150 kg)

No nozzle loads are defined.

The computed stresses are compared with the maximum allowable stresses according to EN 13445-3

2 Conclusion

The piping connection complies with the requirements of:

UNI EN 13445-3 – Unfired pressure vessel – Part 3: Design

3 Reference documents

The reference documents are the following:

- UNI EN 13445-3 – Unfired pressure vessel – Part 3: Design
- 3D model in "step" format given by EGO

4 Units

All dimensions are in mm

5 Material

Material of the shell, flanges and bellows is AISI304 with the following properties:

- Elastic modulus: 193000 MPa
- Yield stress: 190 MPa
- Tensile stress: 500 MPa
- Poisson coefficient: 0,3

6 Piping connection system

6.1 Components

The material of the components is AISI304. The components are identified (with their dimensions) in the below layout.

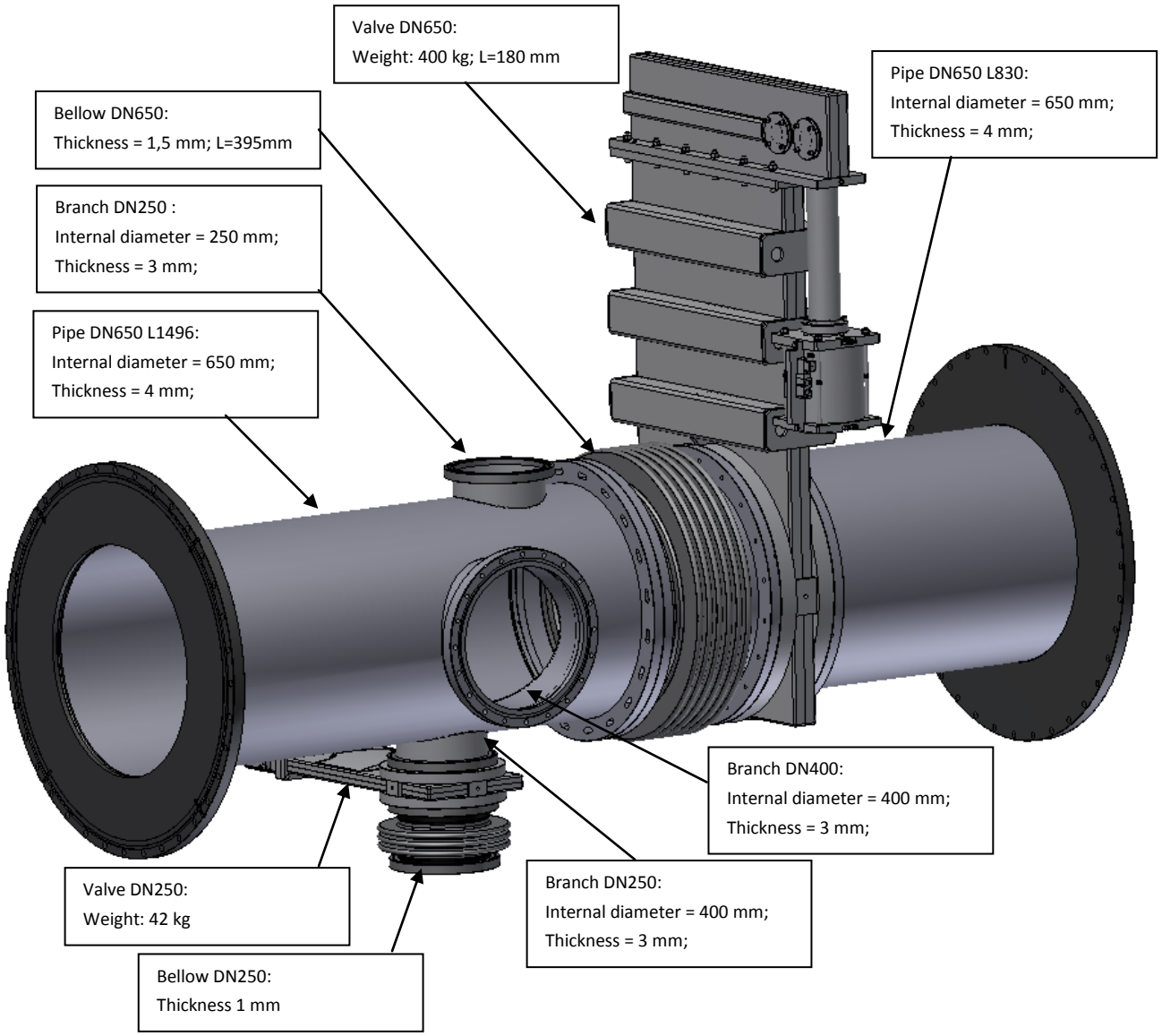


Figure 1 - 3D model

The thickness of bellows is supposed to be 1,5 mm for DN650 and 1 mm for DN250.

6.2 Corrosion allowances

Corrosion allowance is 0 mm.

6.3 FEA check

With Ansys, stresses and displacement are computed. The stresses in the various figures is the Von Mises stress.

6.3.1 Load case 1 (Design)

Primary load:

- P_{design} = -1 barg (Full vacuum)
- T_{design} =+20°C
- Weight of components

According to UNI EN 13445-3, the admissible stress is checked:

- $\sigma_{adm} \leq$ yield stress/S = 190/1.5 = 127 MPa with S=1,5 (safety factor) according to UNI EN 13445-3

6.4 Buckling check

According to UNI EN 13445-3, the buckling of the system due to external pressure is checked

6.5 Modal analysis

A modal analysis is carried out to find the natural frequencies of the system.

7 FEA analysis

The FEA analyses are performed using the software package ANSYS. The analyses are linear elastic, no plastic material behavior is incorporated. Both solid and shell elements are used.

7.1 Load case 1 – Design – Loads and boundary conditions

The applied load are

- the self weight;
- the load due to the vacuum pump

The load due to the vacuum pump is:

$$0{,}1\ MPa\ \cdot \frac{\pi \cdot 250\ mm^2}{4} = 4909\ N$$

- the load on the plug of the upper branch due to the atmospheric pressure acting on the plug. The load is:

$$0{,}1\ MPa\ \cdot \frac{\pi \cdot 256\ mm^2}{4} = 5150\ N$$

- the load on the plug of the lateral branch due to the atmospheric pressure acting on the plug. The load is:

$$0{,}1\ MPa\ \cdot \frac{\pi \cdot 406\ mm^2}{4} = 12950\ N$$

The boundary condition are zero displacements on the other flanges and no vertical displacements on the supports below the pipe.
The images below show this loads and boundary condition.

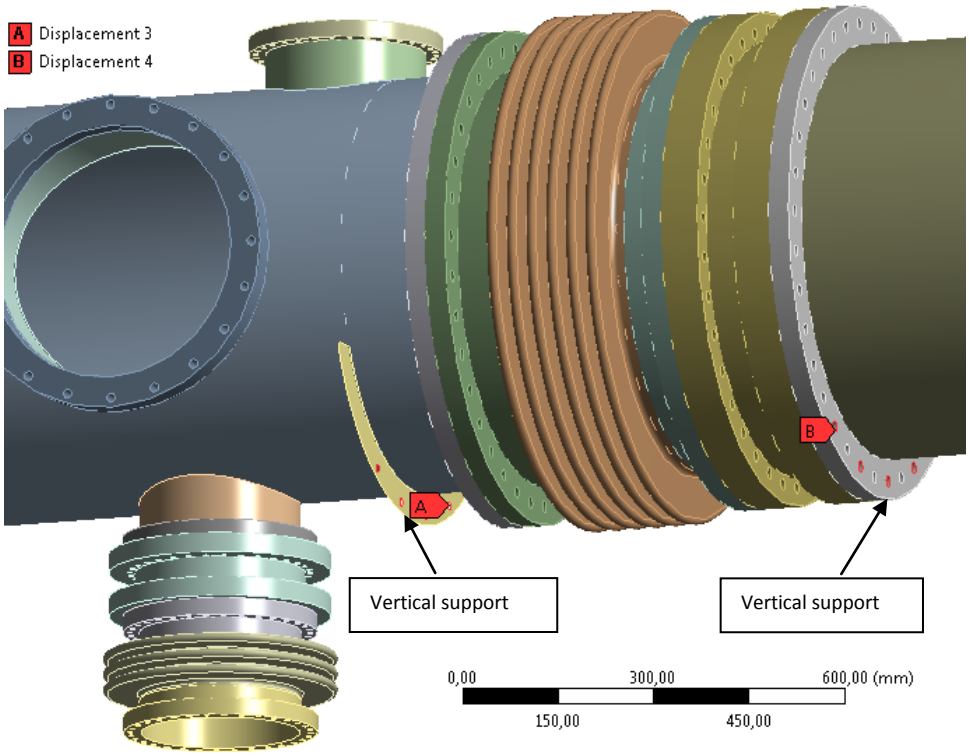


Figure 2 - Vertical support

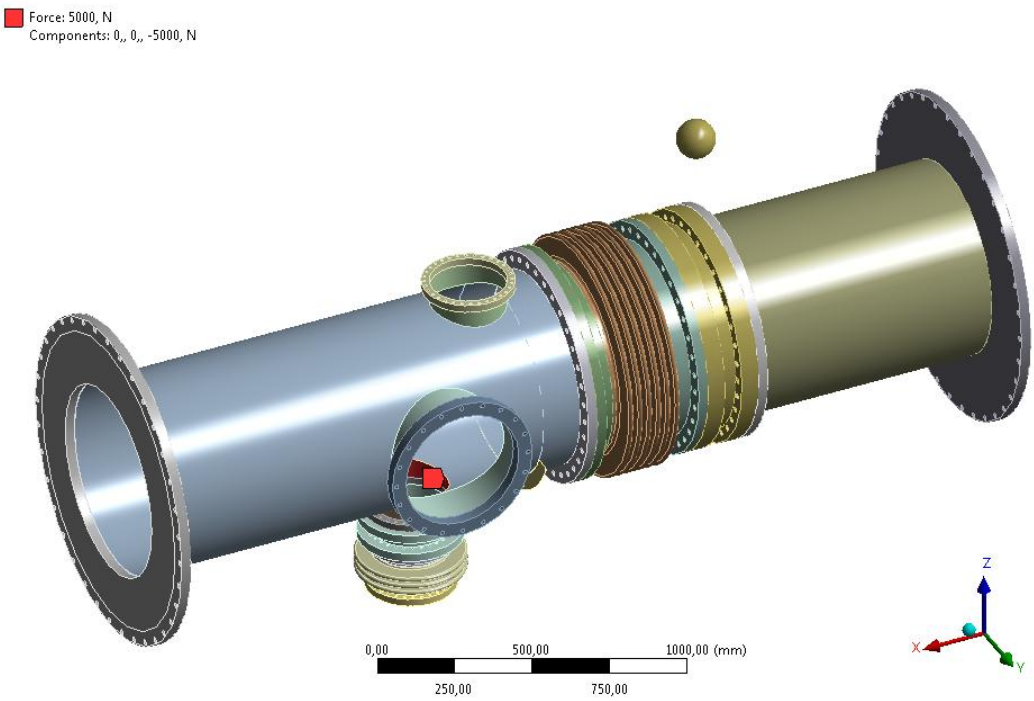


Figure 3 – Force due to vacuum pump

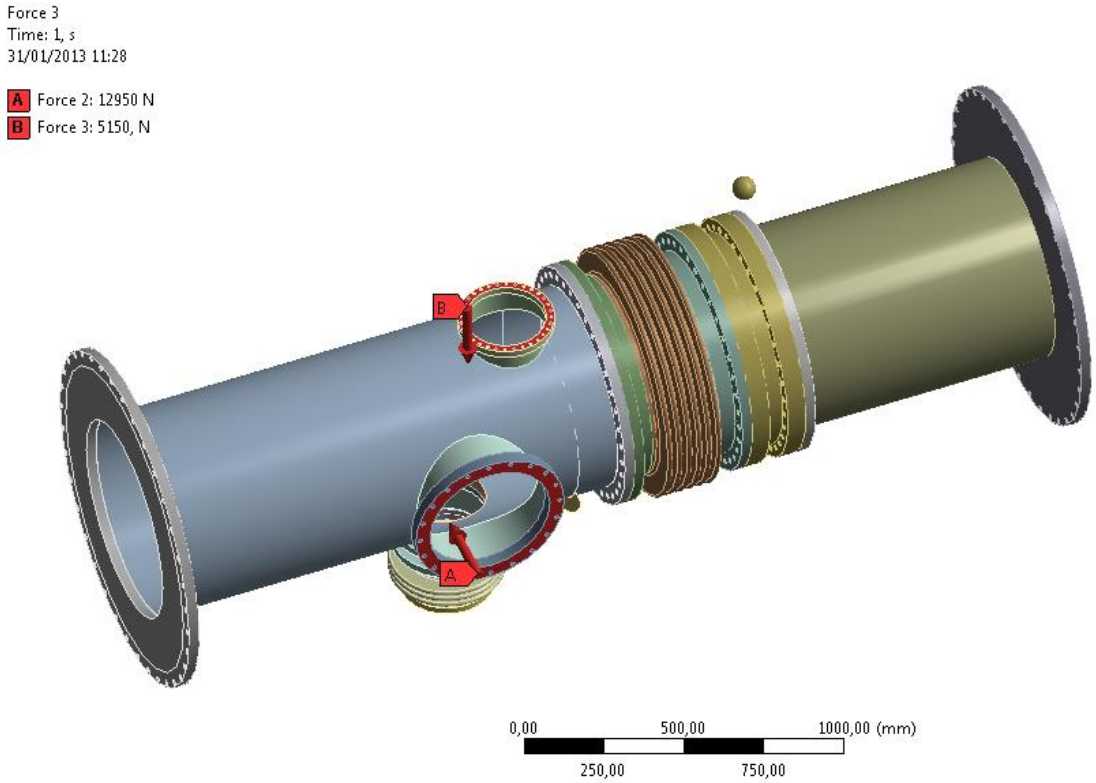


Figure 4 – Force due to atmospheric pressure on plugs of lateral and upper branch

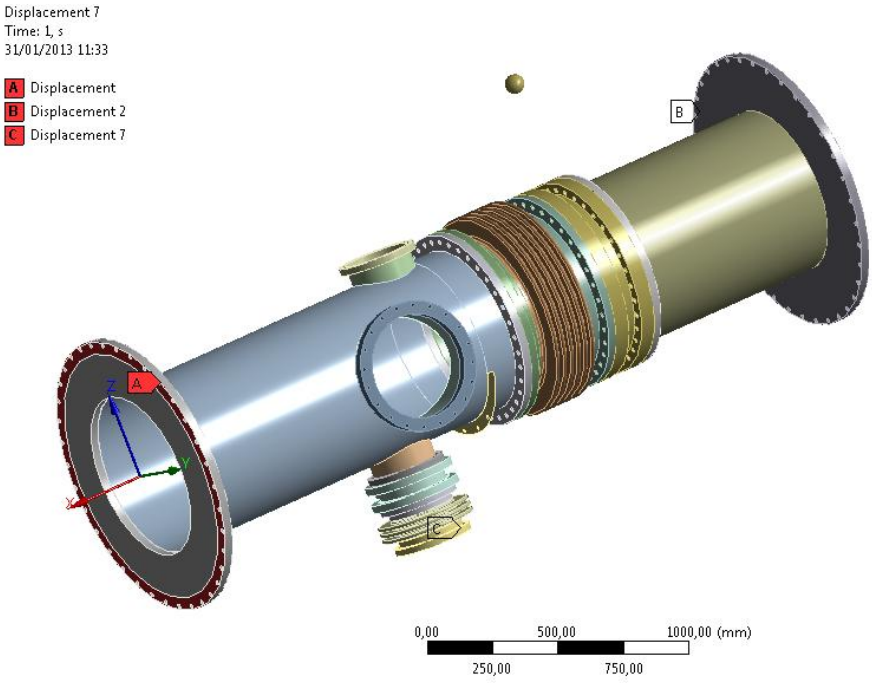


Figure 5 – Constraints on flanges (zero displacements on all directions)

7.2 Load case 1 – Design - Stress results

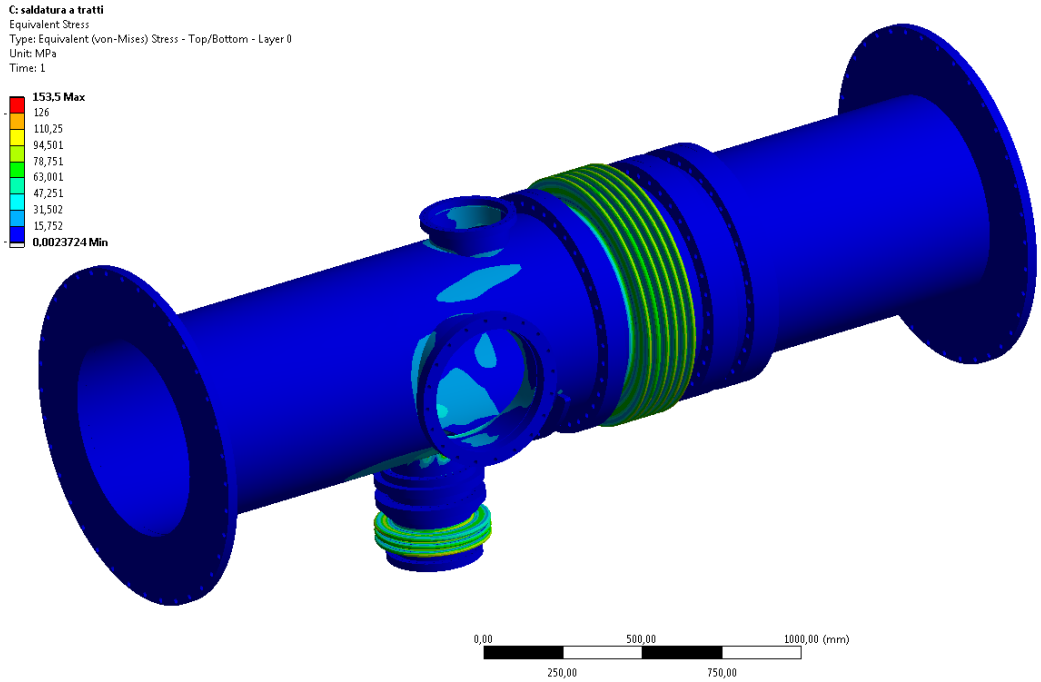


Figure 6 - Von Mises stress

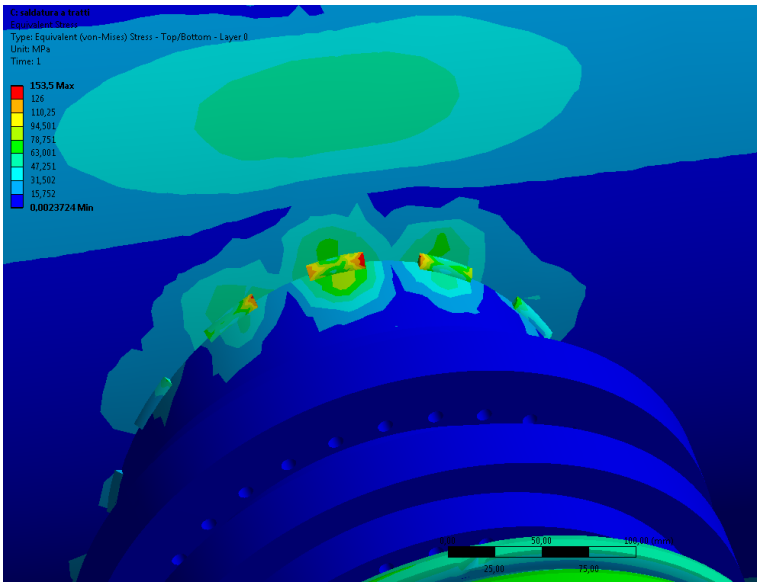


Figure 7 - Von Mises stress - detail

There is a small zone where the stress is slightly above the admissible (147 MPa instead 190/1,5 = 126 MPa). Since the nature of the effect is very local and the zone is very small the effect can be neglected. The stress level of the system is acceptable respect to the admissible stress calculated as stated in EN 13445-3.

7.3 Load case 1 – Design - Displacements results

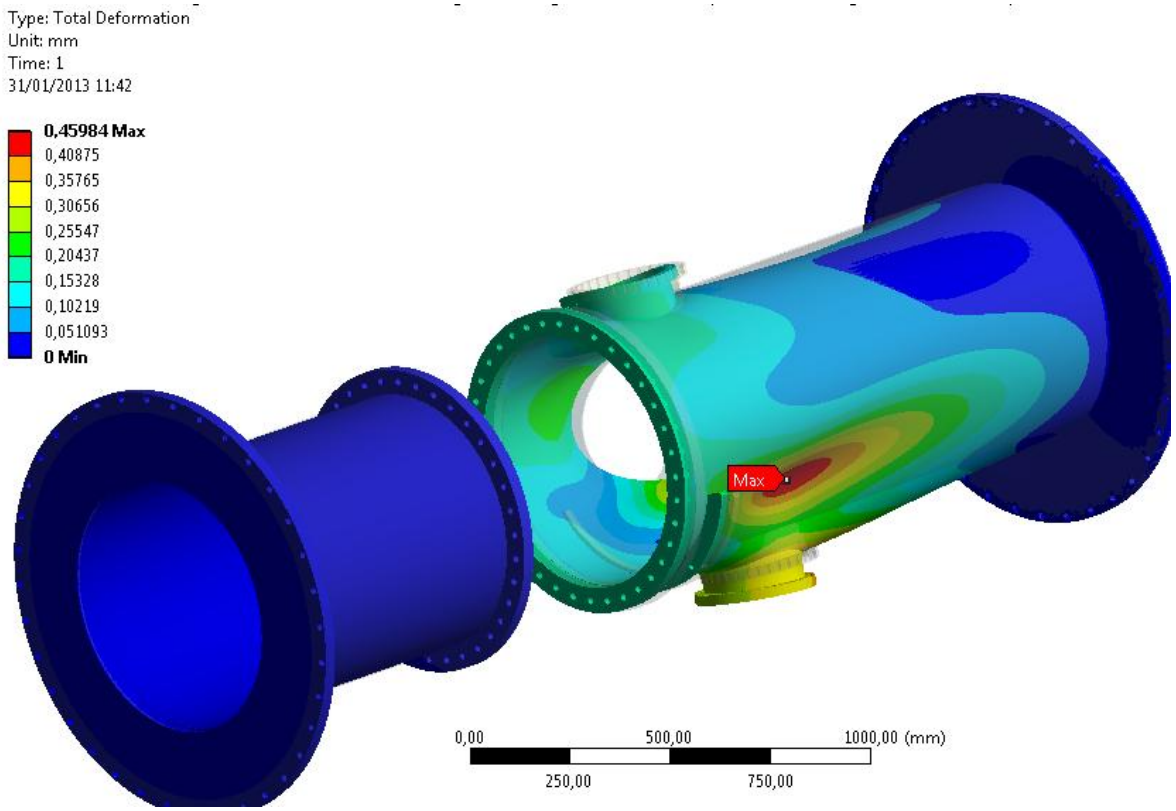


Figure 8 - Displacements

The displacements are very small and can be accepted from a point of view of the functionality of the system.

7.4 Load case 1 – Design - Reaction results

The reactions shown in the below images are in the global coordinate system (depicted in each image).

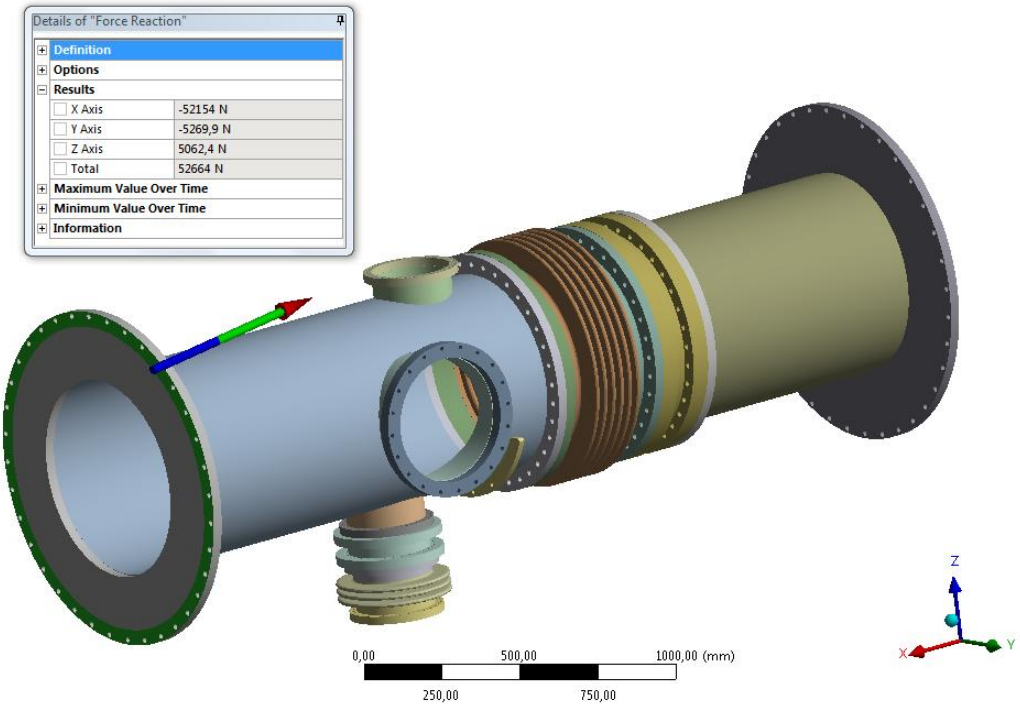


Figure 9 - Flange force reaction

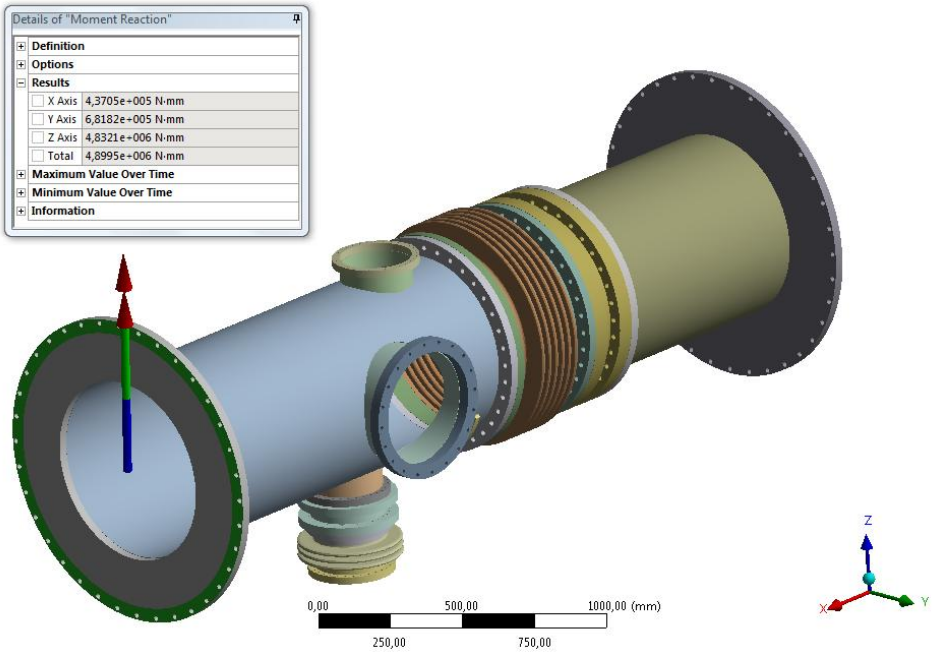


Figure 10 - Flange moment reaction

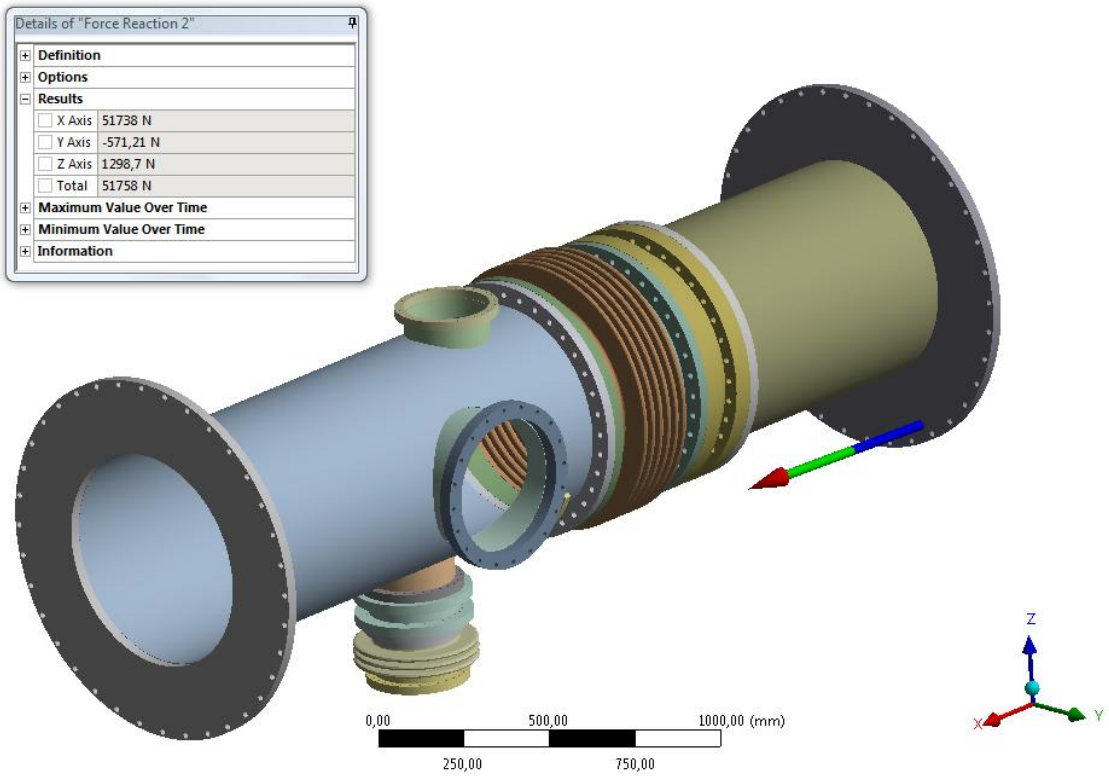


Figure 11 - Flange force reaction

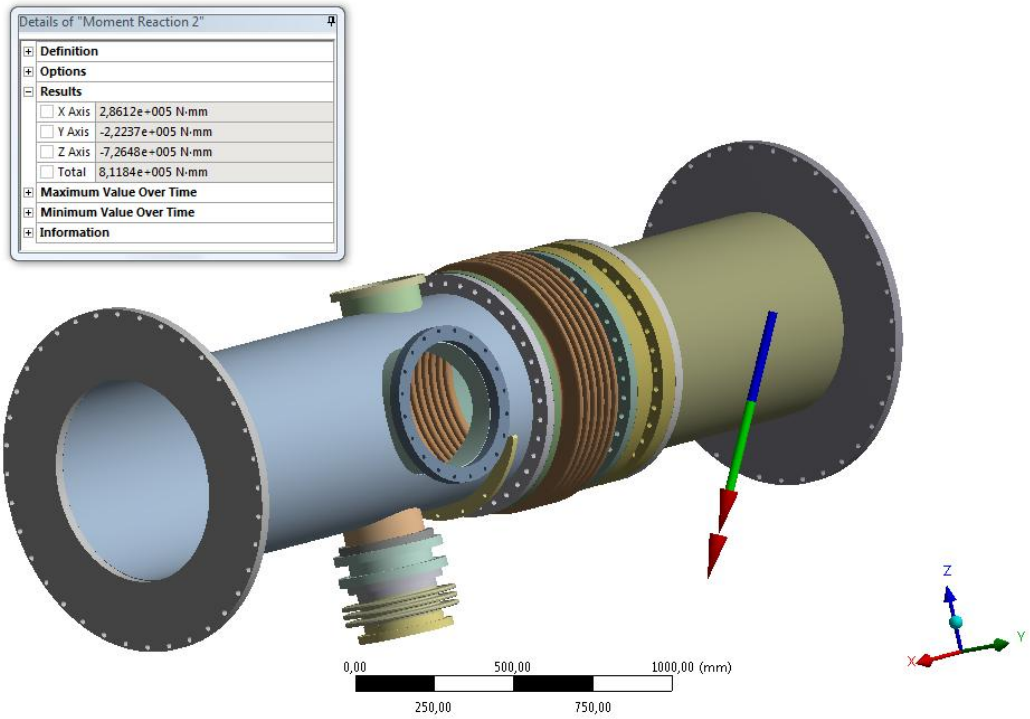


Figure 12 - Flange moment reaction

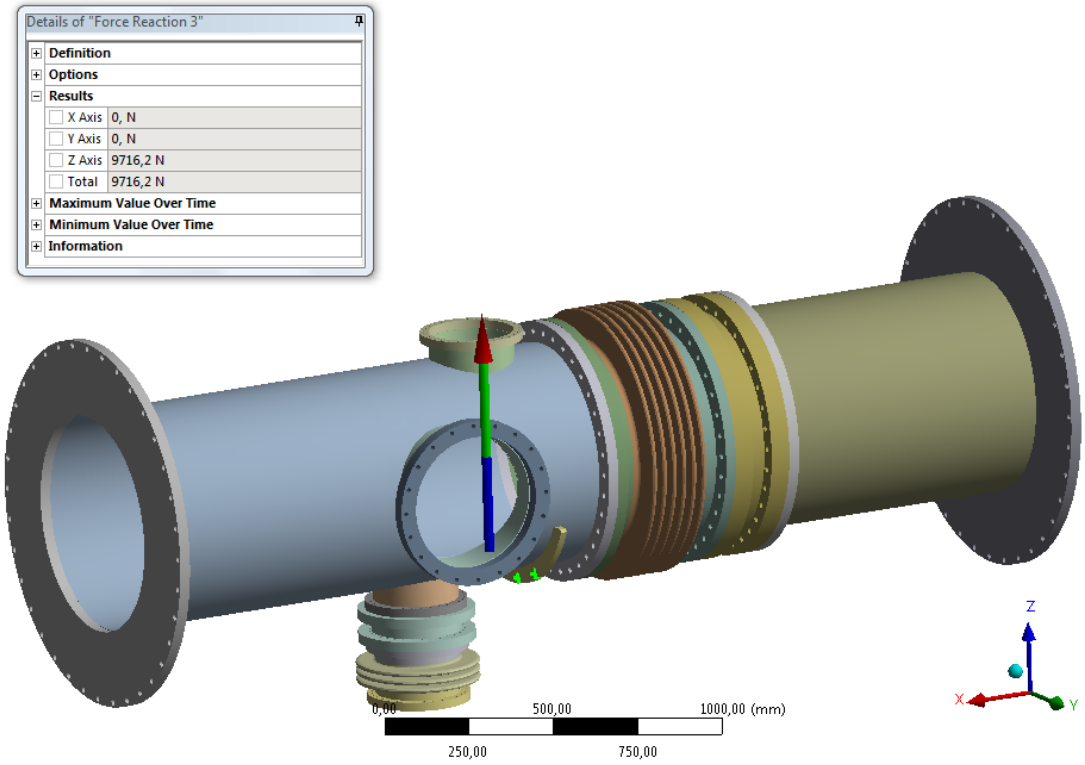


Figure 13 - Vertical support reaction

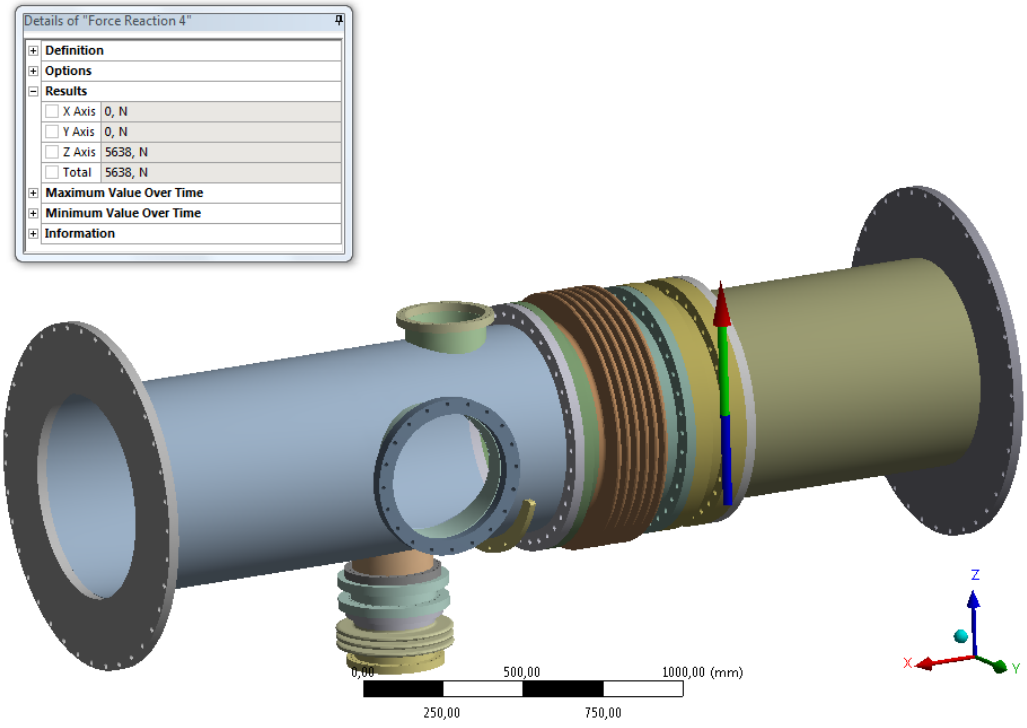


Figure 14 – Vertical support reaction

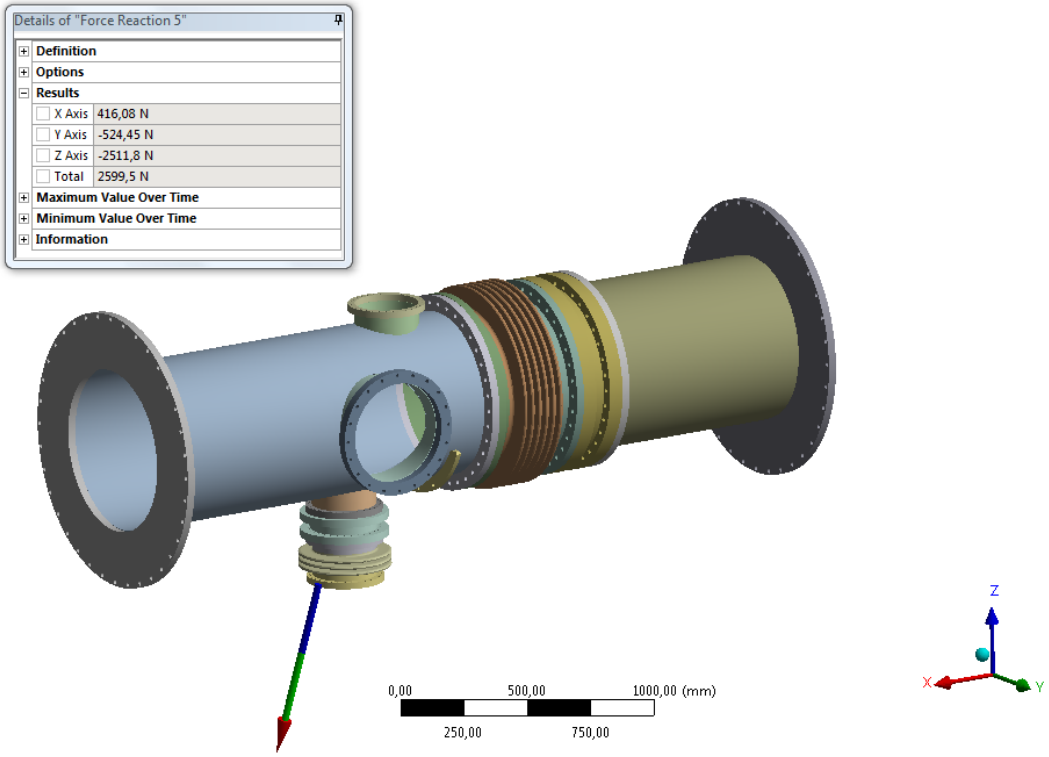


Figure 15 – Pump flange force reaction

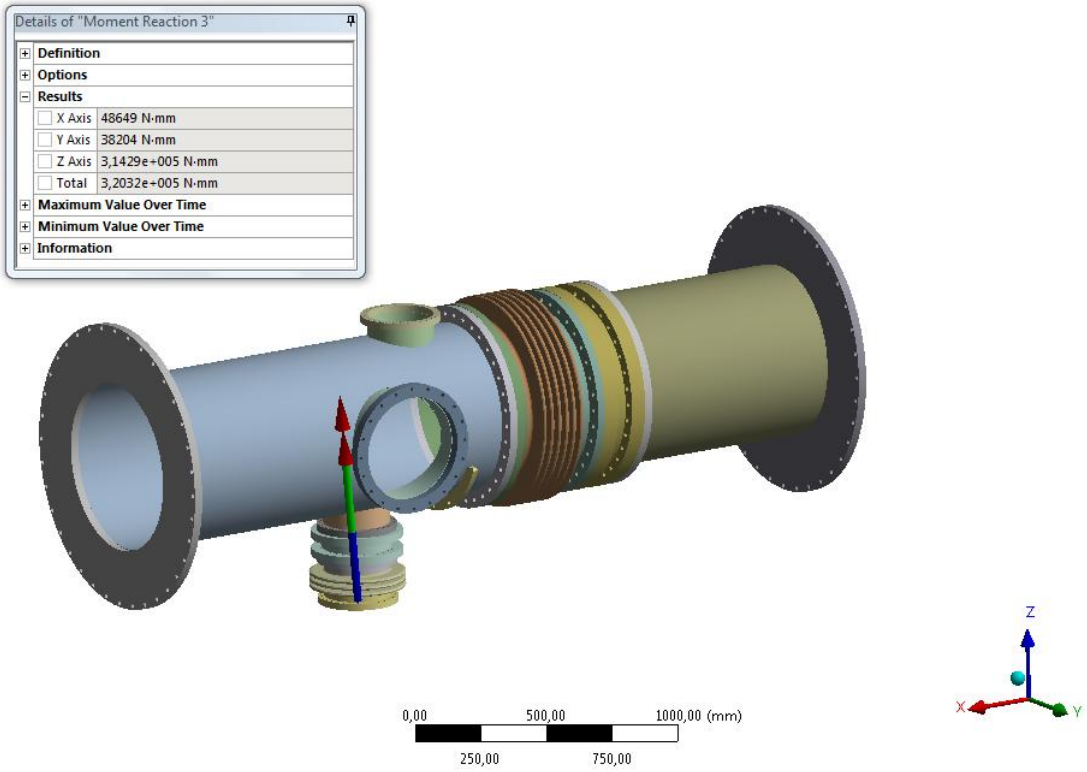


Figure 16 – Pump flange moment reaction

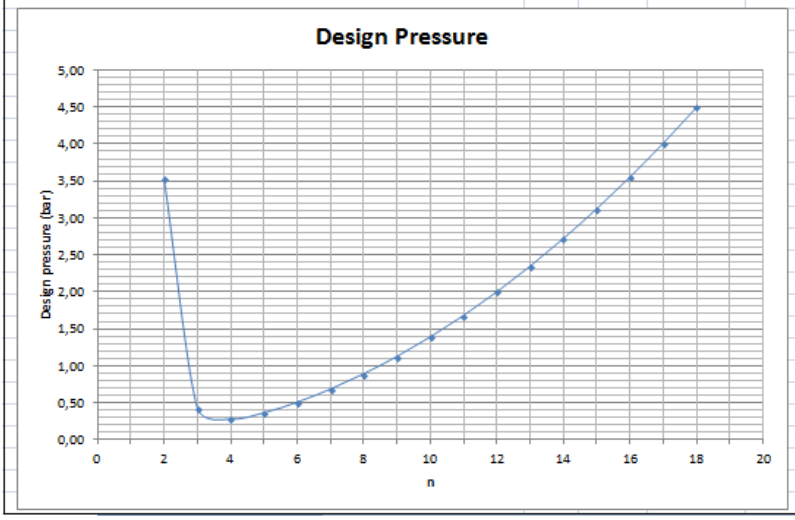
8 Buckling analysis

The buckling analysis is made following the EN13445-part 3. The free length of pipe considered is 1496 mm (anyway, the presence of the branches reduce this free length).

The results is shown in the below spreadsheet.

EN13445 - Check external pressure

				Mode of instability	Theoretical elastic instability pressure for collapse of a perfect cylindrical shell	Ratio between critical pressure and yield pressure
Material		-	AISI 304	n	P_m	P_m/P_y
Elastic Modulus	E	*MPa*	193000	-	*Mpa*	*Mpa*
Yield stress	$R_{p0,2}$	*MPa*	190	2	8,23	3,54
Nominal elastic limit	σ_c	*MPa*	190	3	0,99	0,43
Tensile stress (min)	R_t	*MPa*	500	**4**	**0,64**	**0,27**
Poisson coefficient	ν	-	0,3	5	0,83	0,36
External diameter	D_e	*mm*	658	6	1,17	0,50
Wall thickness	e_s	*mm*	4	7	1,58	0,68
Internal diameter	D_i	*mm*	650	8	2,06	0,89
Mean radius	R	*mm*	327	9	2,61	1,12
Length	L	*mm*	1496	10	3,23	1,39
Coefficient"Z"	Z	-	0,69	11	3,91	1,68
Yield pressure	Py	*MPa*	2,3	12	4,65	2,00
Ratio Pr/Py (calculated from below graph)	Pr/Py	*MPa*	0,125	13	5,46	2,35
Pressure Pr (calculated lower bound collapse pressure)	Pr	*MPa*	0,29	14	6,33	2,72
Safety factor	S	-	1,5	15	7,27	3,13
Design pressure	P	*MPa*	0,19	16	8,27	3,56
				17	9,34	4,02
				18	10,47	4,51



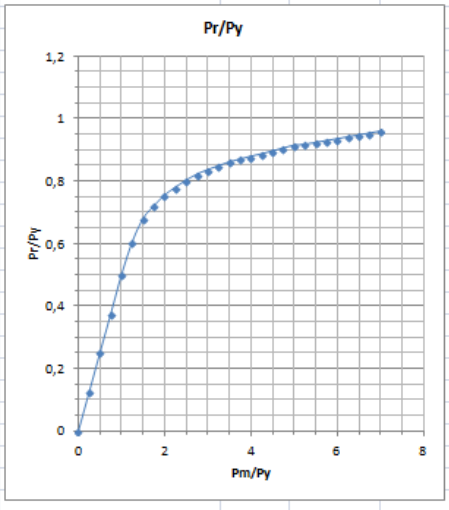


Table 1 - Buckling check

Design pressure (1,9 bar) is greater than design limit (1 bar).

9 Modal analysis

The number of natural frequencies calculated is 50. The min frequency is 42 Hz, the max is 267 Hz.

9.1 Main modes

The natural frequencies are determined mainly by the bellows that are the components with the lowest stiffness. In the next images showing the main modes, in order to highlight the deformed shape of the most important components (i.e. the pipes), the bellows are hided.

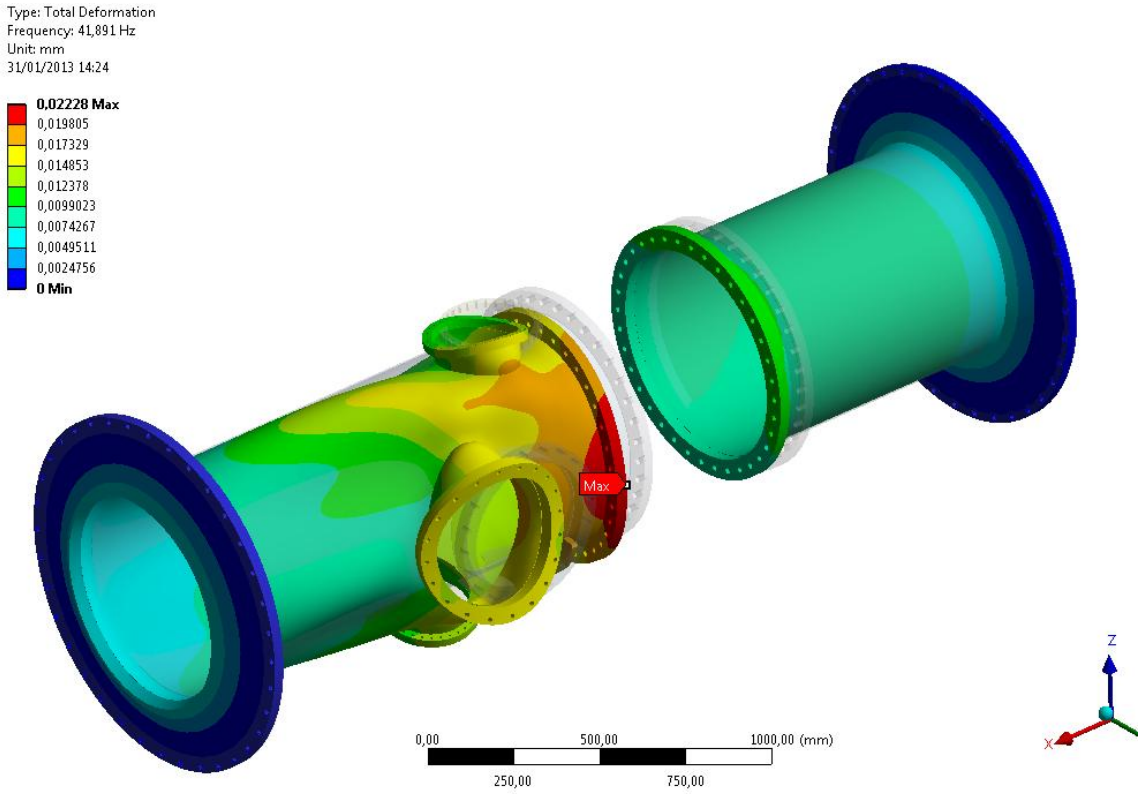


Figure 17 – Mode 1

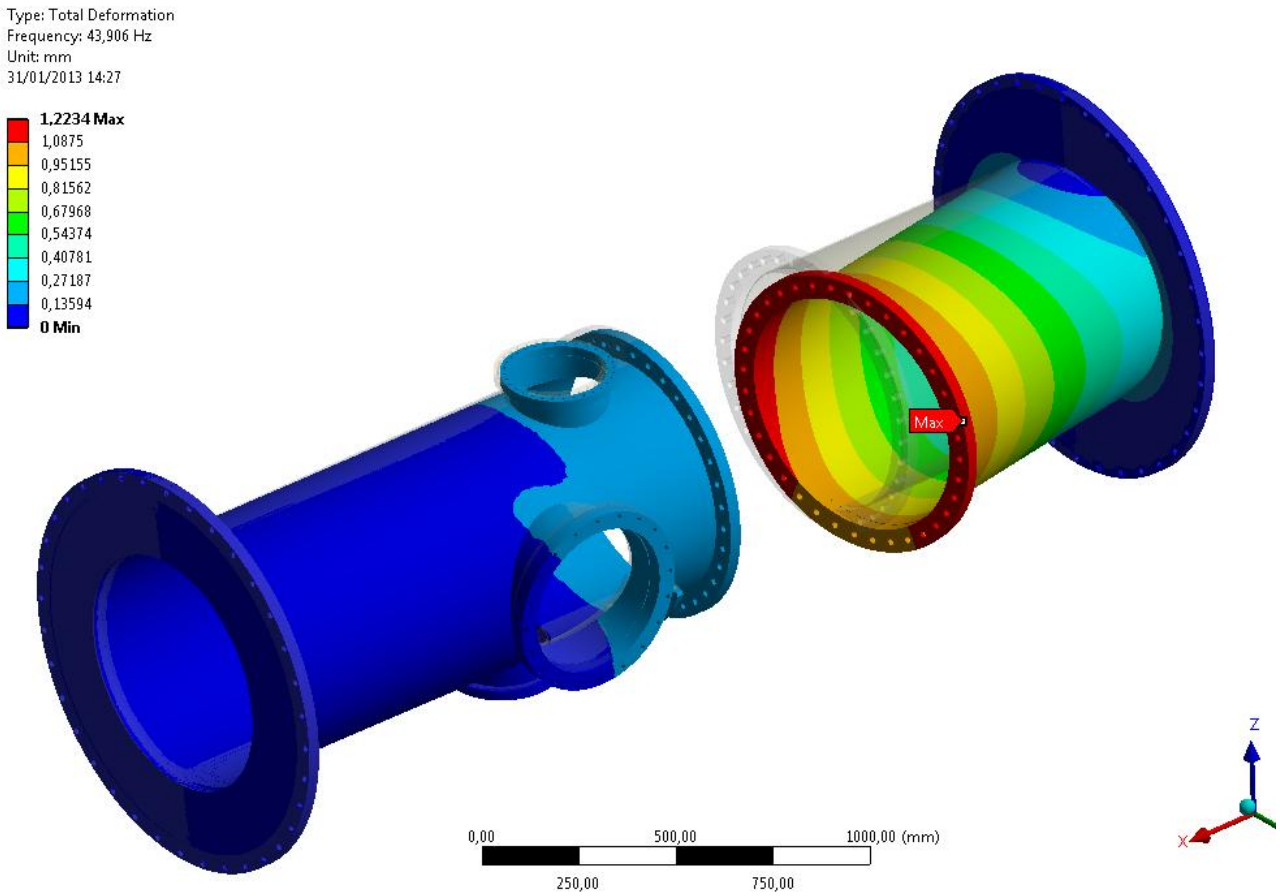


Figure 18 – Mode 2

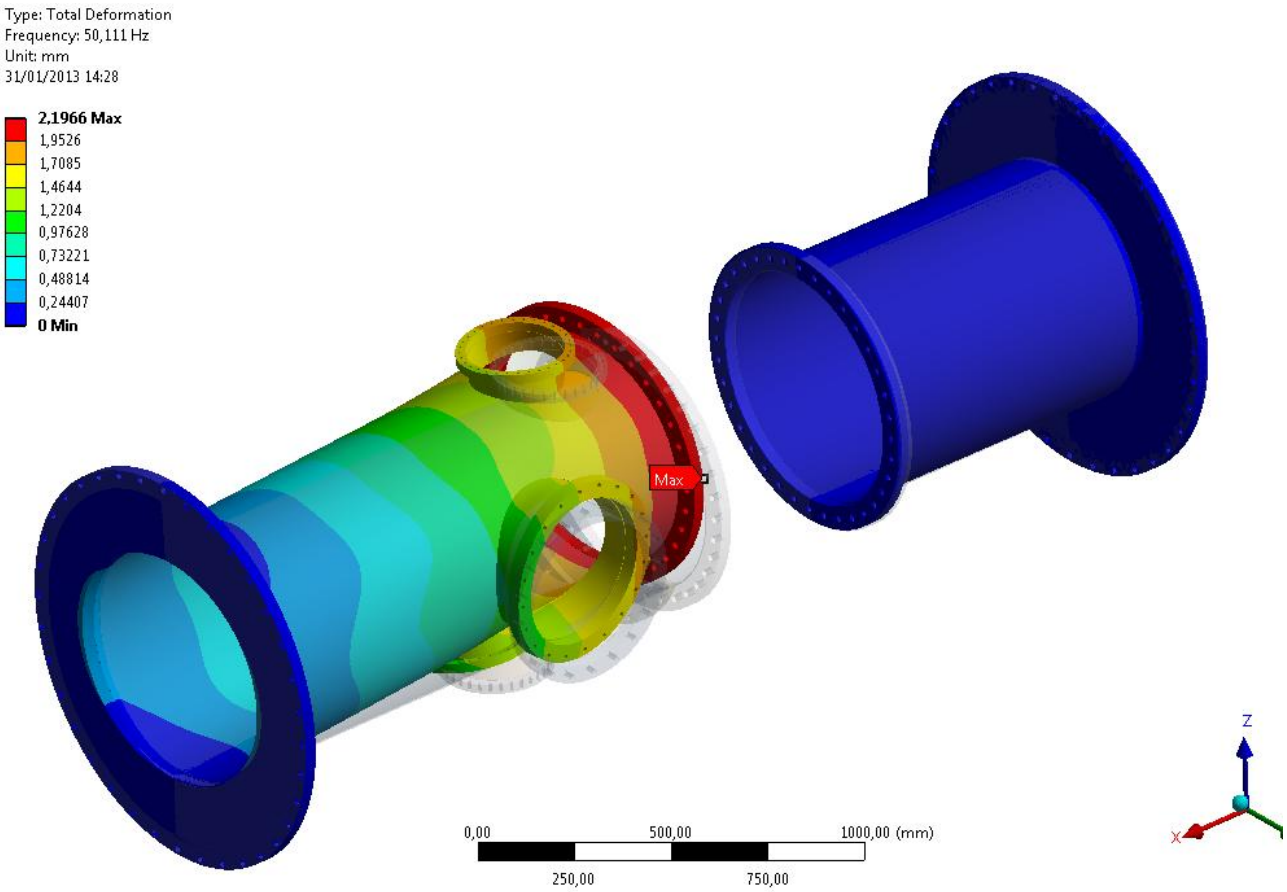


Figure 19 – Mode 3

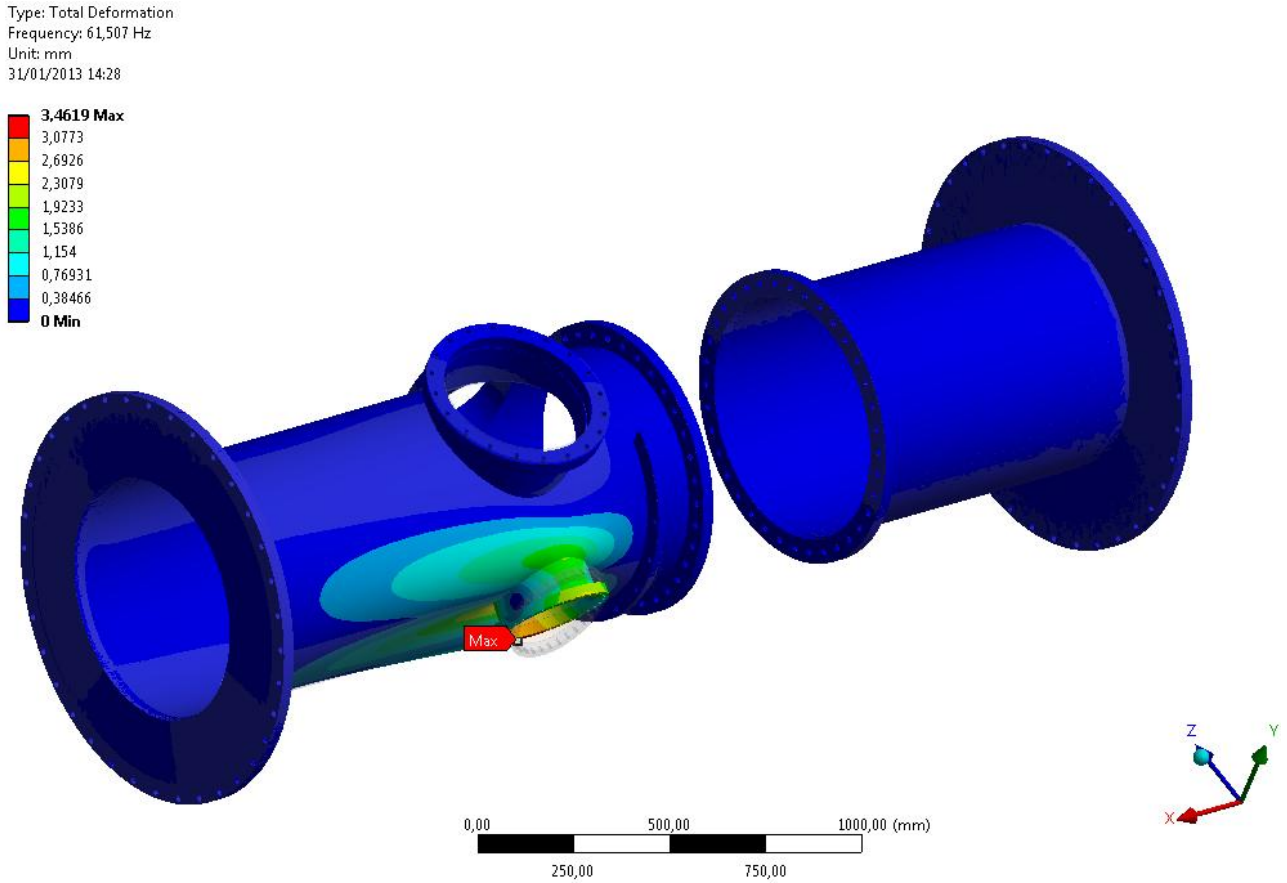


Figure 20 – Mode 4

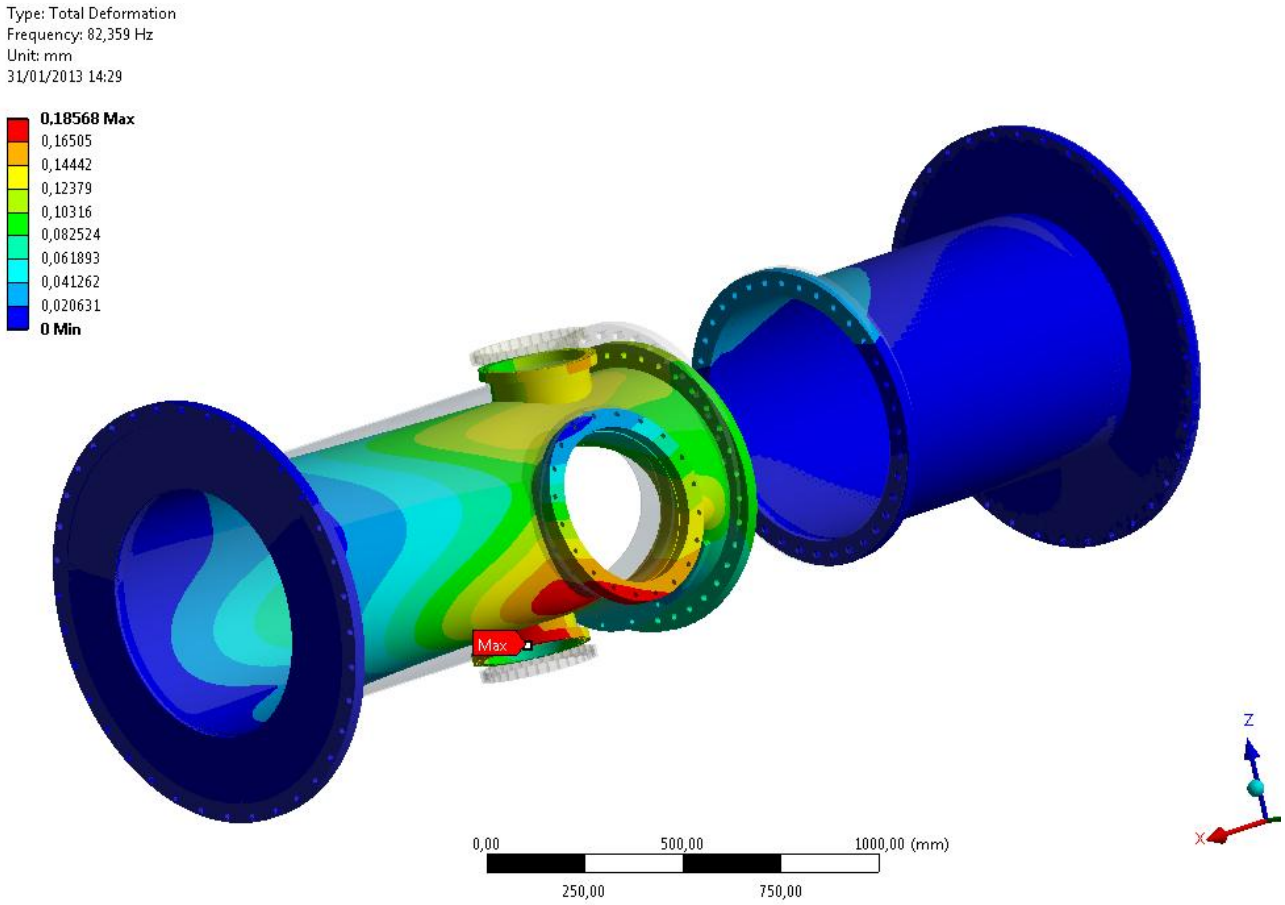


Figure 21 – Mode 5

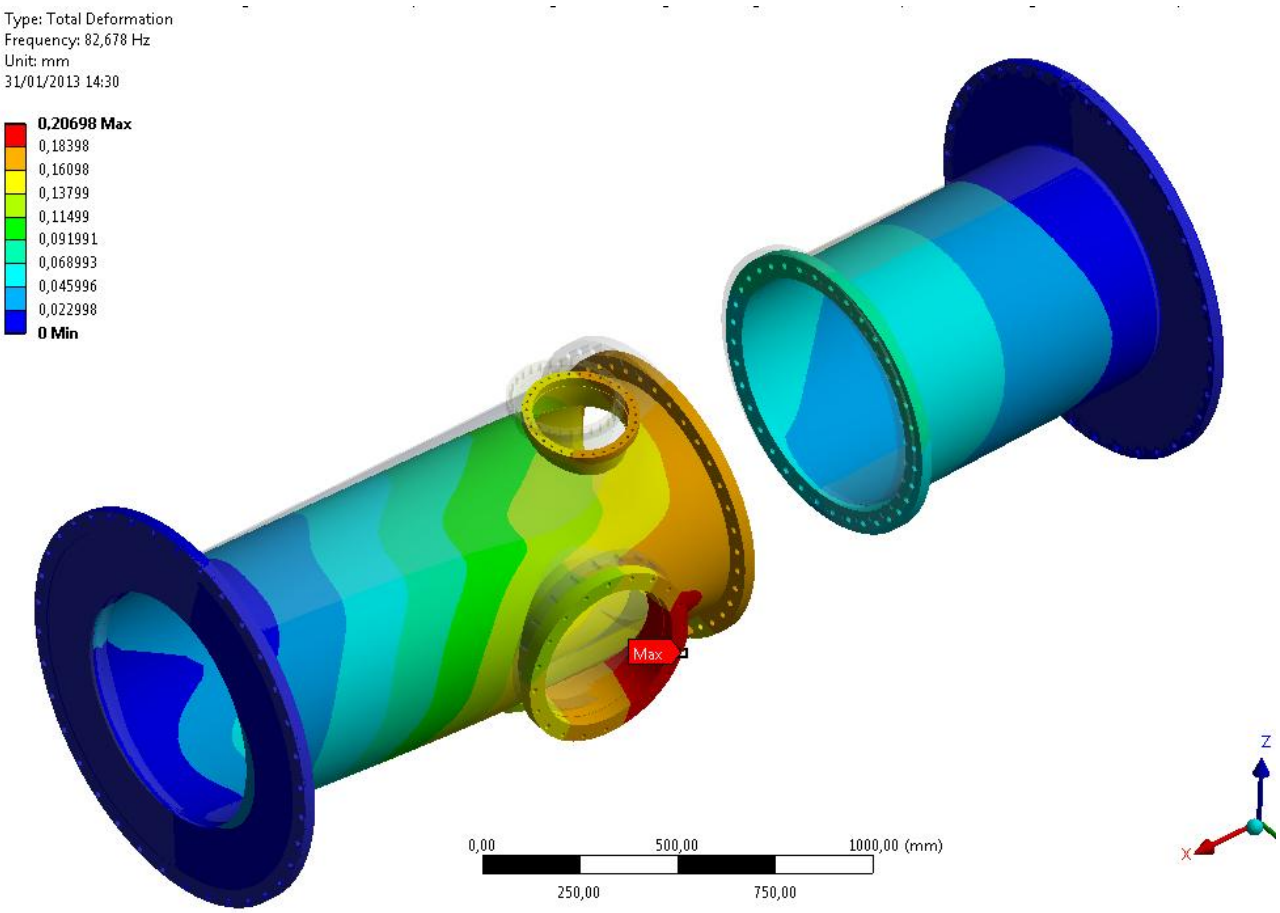


Figure 22 – Mode 6

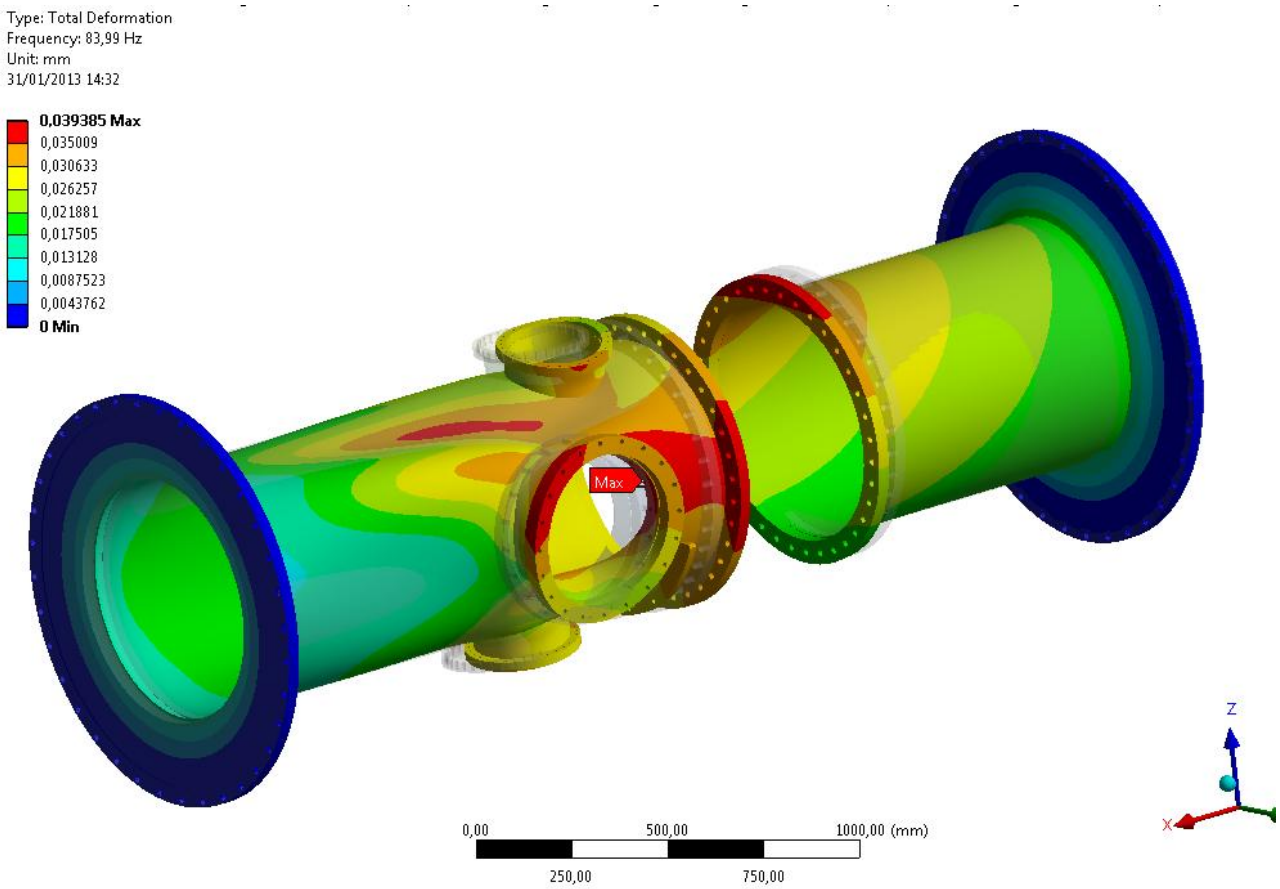


Figure 23 – Mode 7

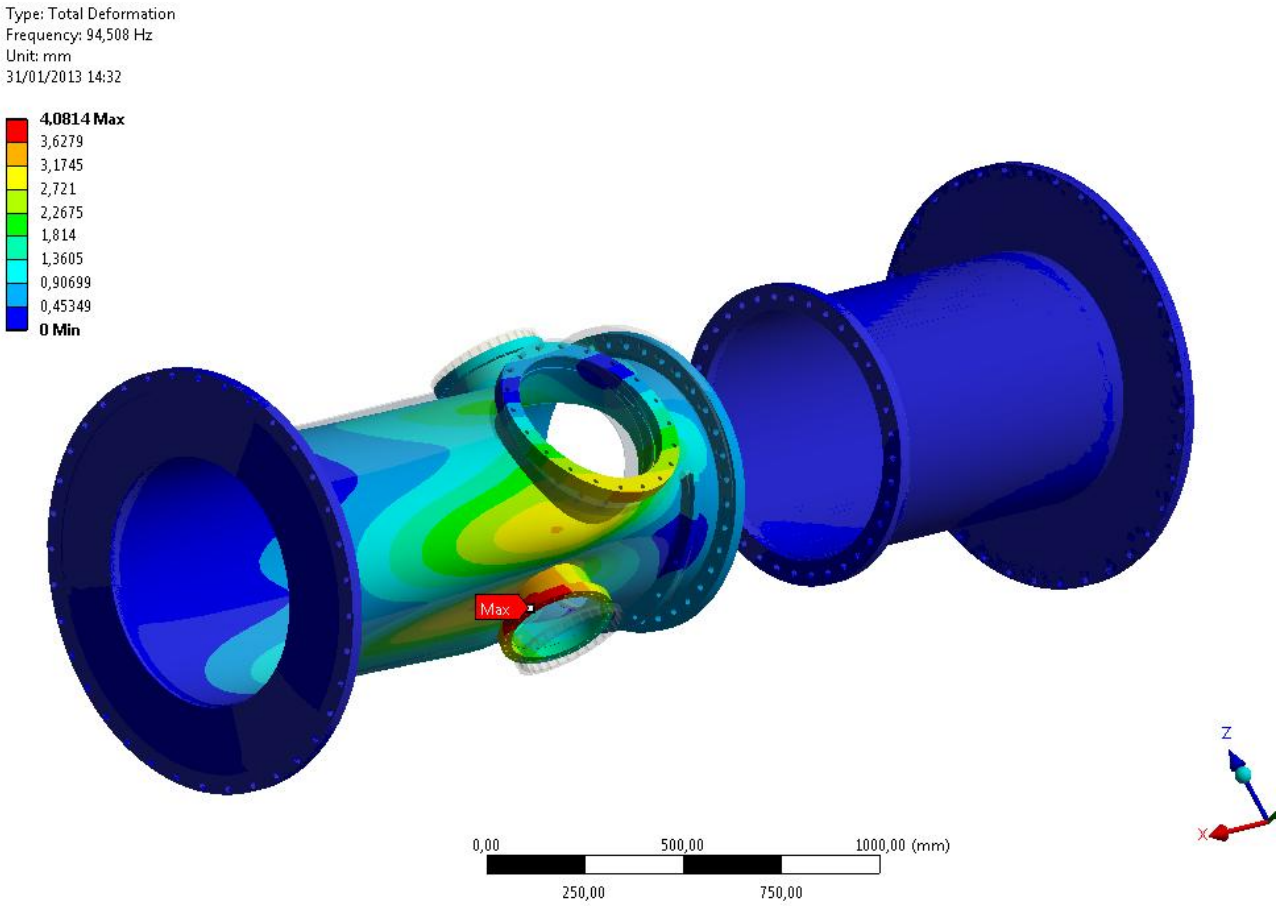


Figure 24 – Mode 8

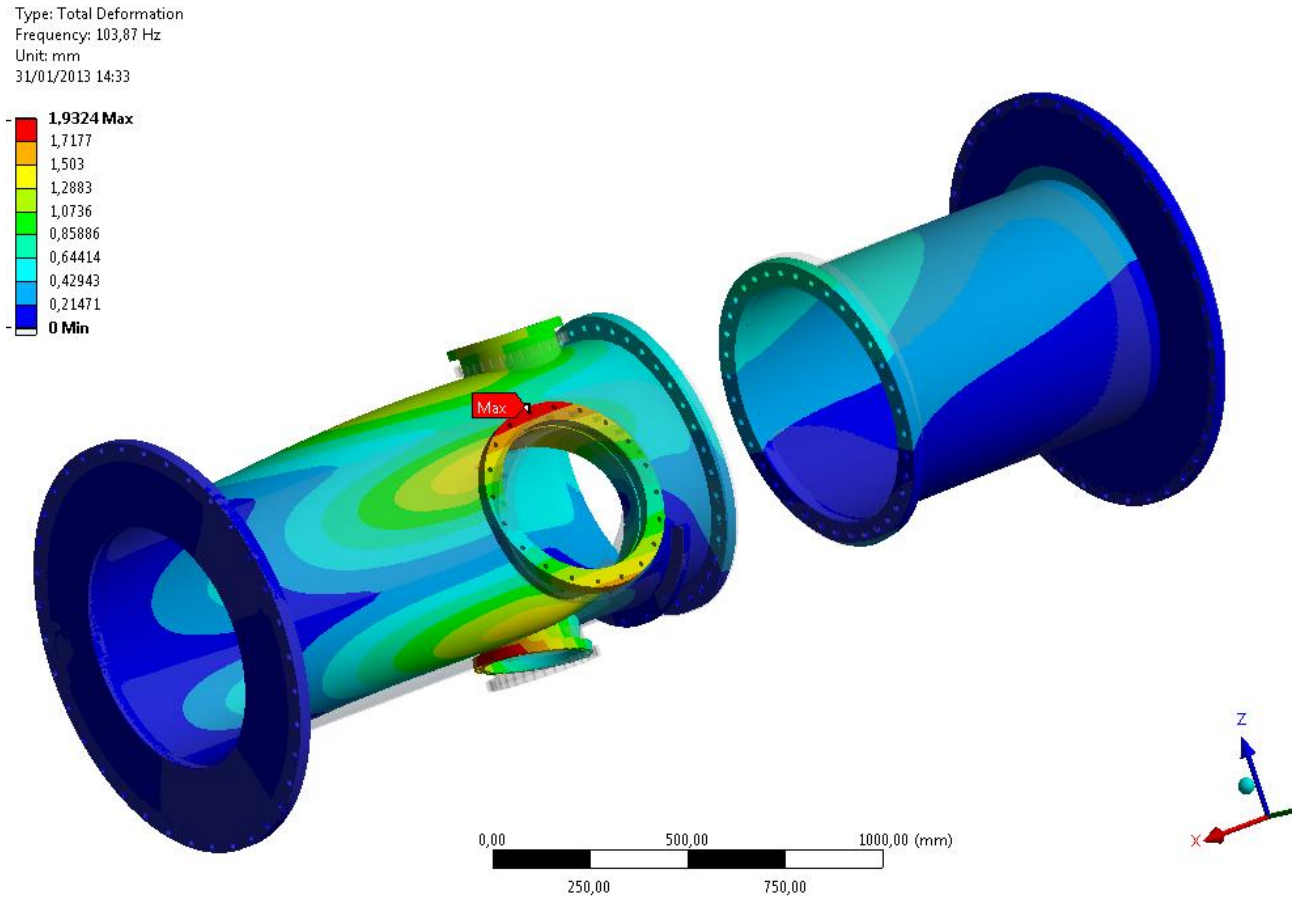


Figure 25 – Mode 9

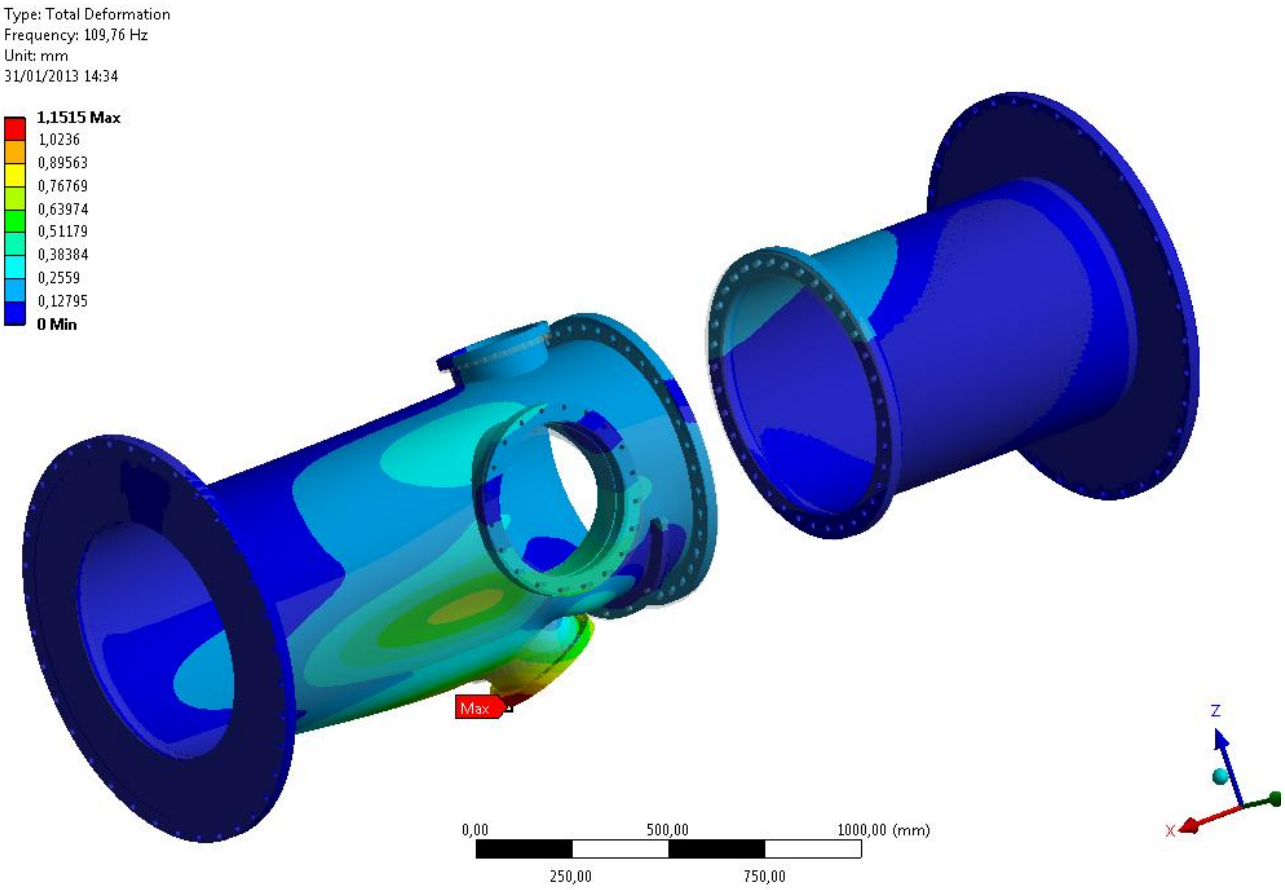


Figure 26 – Mode 10

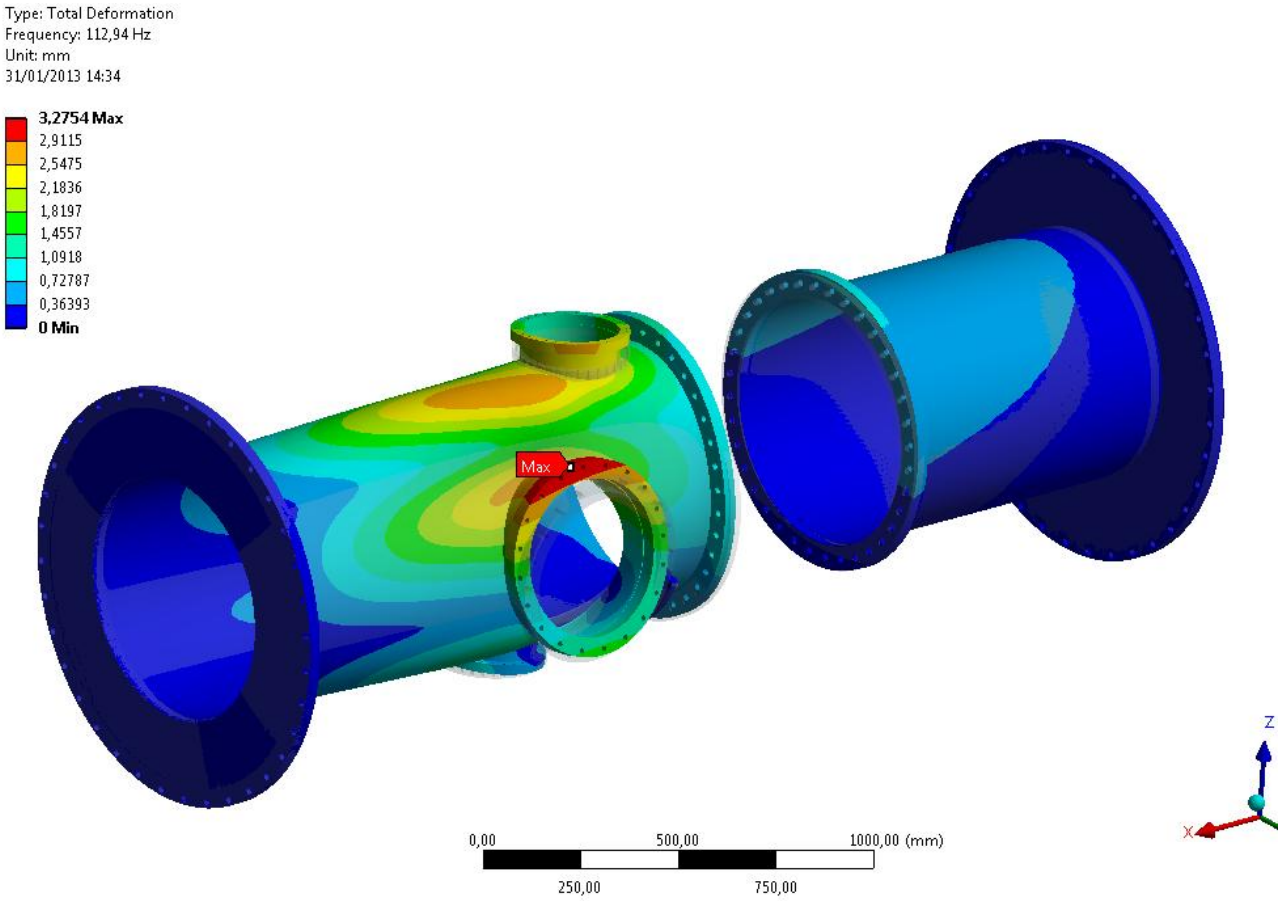


Figure 27 – Mode 11

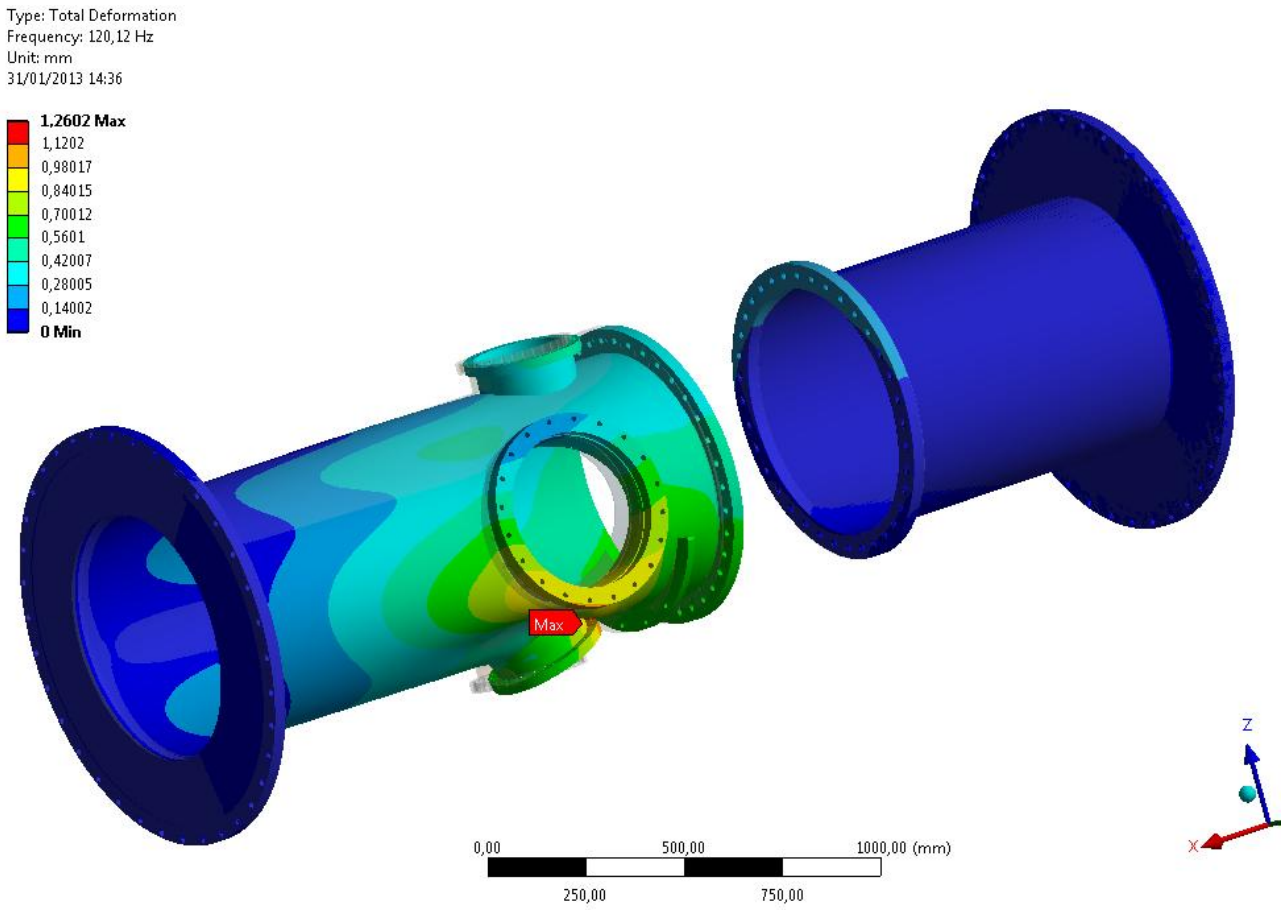


Figure 28 – Mode 12

9.2 Partecipation tables

***** PARTICIPATION FACTOR CALCULATION ***** X DIRECTION

MODE	FREQUENCY	PERIOD	EFFECTIVE MASS	CUMULATIVE MASS FRACTION
1	41,8915	2,39E-02	2,65E-02	3,12E-02
2	43,9056	2,28E-02	2,00E-03	3,36E-02
3	50,111	2,00E-02	1,39E-05	3,36E-02
4	61,5065	1,63E-02	2,08E-04	3,39E-02
5	82,3589	1,21E-02	4,51E-04	3,44E-02
6	82,6778	1,21E-02	5,02E-06	3,44E-02
7	83,9904	1,19E-02	1,57E-04	3,46E-02
8	94,5077	1,06E-02	3,83E-04	3,50E-02
9	103,872	9,63E-03	0,200745	0,271766
10	109,759	9,11E-03	2,99E-02	0,306993
11	112,938	8,85E-03	0,13019	0,460526
12	120,115	8,33E-03	3,44E-03	0,464583
13	122,992	8,13E-03	1,60E-04	0,464773
14	126,409	7,91E-03	1,83E-02	0,486402
15	127,261	7,86E-03	1,16E-02	0,500139
16	144,838	6,90E-03	1,84E-02	0,521827
17	157,507	6,35E-03	1,57E-04	0,522012
18	157,652	6,34E-03	1,91E-04	0,522238
19	158,084	6,33E-03	4,20E-05	0,522287
20	158,125	6,32E-03	7,99E-06	0,522297
21	159,437	6,27E-03	2,81E-03	0,525612
22	167,149	5,98E-03	1,17E-04	0,52575
23	167,472	5,97E-03	6,00E-04	0,526458
24	168,095	5,95E-03	5,67E-03	0,533148
25	170,37	5,87E-03	9,92E-05	0,533265
26	171,563	5,83E-03	1,05E-06	0,533266
27	171,594	5,83E-03	1,07E-06	0,533267
28	174,363	5,74E-03	4,77E-03	0,538893
29	180,167	5,55E-03	2,70E-05	0,538925
30	180,395	5,54E-03	1,85E-03	0,541103
31	188,82	5,30E-03	1,63E-02	0,560354
32	203,694	4,91E-03	4,40E-03	0,565537
33	204,52	4,89E-03	5,60E-07	0,565538
34	209,199	4,78E-03	6,44E-05	0,565614
35	214,868	4,65E-03	2,73E-02	0,597823
36	215,49	4,64E-03	8,98E-04	0,598882
37	215,653	4,64E-03	1,81E-03	0,601021
38	219,901	4,55E-03	2,59E-02	0,631509
39	221,022	4,52E-03	1,21E-03	0,63294
40	224,298	4,46E-03	2,39E-02	0,661083
41	226,276	4,42E-03	1,97E-02	0,684306
42	231,134	4,33E-03	6,70E-04	0,685096
43	231,418	4,32E-03	1,23E-03	0,686549
44	234,078	4,27E-03	2,18E-02	0,71221
45	238,189	4,20E-03	0,183729	0,928882
46	247,257	4,04E-03	5,32E-03	0,935155
47	253,353	3,95E-03	2,03E-02	0,959126
48	255,59	3,91E-03	4,12E-04	0,959611
49	258,129	3,87E-03	2,66E-02	0,990962
50	267,1	3,74E-03	7,66E-03	1
sum			0,847959	

Table 2 – Partecipation factor – X direction

***** PARTICIPATION FACTOR CALCULATION ***** Y DIRECTION

MODE	FREQUENCY	PERIOD	EFFECTIVE MASS	CUMULATIVE MASS FRACTION
1	41,8915	2,39E-02	9,40E-07	1,28E-06
2	43,9056	2,28E-02	0,50285	0,684733
3	50,111	2,00E-02	0,209194	0,969592
4	61,5065	1,63E-02	6,06E-03	0,977838
5	82,3589	1,21E-02	4,59E-05	0,977901
6	82,6778	1,21E-02	2,18E-03	0,980869
7	83,9904	1,19E-02	9,24E-06	0,980882
8	94,5077	1,06E-02	8,01E-04	0,981972
9	103,872	9,63E-03	2,28E-03	0,985071
10	109,759	9,11E-03	2,90E-04	0,985465
11	112,938	8,85E-03	2,33E-03	0,98864
12	120,115	8,33E-03	4,26E-04	0,989219
13	122,992	8,13E-03	8,89E-05	0,989341
14	126,409	7,91E-03	1,70E-04	0,989572
15	127,261	7,86E-03	1,51E-04	0,989778
16	144,838	6,90E-03	8,33E-05	0,989891
17	157,507	6,35E-03	5,03E-05	0,98996
18	157,652	6,34E-03	2,50E-05	0,989994
19	158,084	6,33E-03	1,23E-05	0,99001
20	158,125	6,32E-03	7,76E-08	0,990011
21	159,437	6,27E-03	2,07E-03	0,992826
22	167,149	5,98E-03	1,74E-04	0,993063
23	167,472	5,97E-03	2,89E-04	0,993456
24	168,095	5,95E-03	5,98E-05	0,993538
25	170,37	5,87E-03	1,96E-06	0,99354
26	171,563	5,83E-03	3,44E-06	0,993545
27	171,594	5,83E-03	5,51E-07	0,993546
28	174,363	5,74E-03	2,44E-04	0,993878
29	180,167	5,55E-03	7,99E-06	0,993889
30	180,395	5,54E-03	9,97E-07	0,99389
31	188,82	5,30E-03	1,55E-04	0,994101
32	203,694	4,91E-03	6,43E-04	0,994976
33	204,52	4,89E-03	4,43E-06	0,994982
34	209,199	4,78E-03	1,10E-05	0,994997
35	214,868	4,65E-03	2,82E-05	0,995036
36	215,49	4,64E-03	9,15E-06	0,995048
37	215,653	4,64E-03	3,92E-06	0,995053
38	219,901	4,55E-03	1,05E-04	0,995196
39	221,022	4,52E-03	3,49E-05	0,995244
40	224,298	4,46E-03	2,02E-05	0,995271
41	226,276	4,42E-03	8,71E-05	0,99539
42	231,134	4,33E-03	1,79E-04	0,995633
43	231,418	4,32E-03	2,04E-05	0,995661
44	234,078	4,27E-03	1,34E-03	0,997483
45	238,189	4,20E-03	5,12E-04	0,998181
46	247,257	4,04E-03	5,58E-06	0,998188
47	253,353	3,95E-03	1,73E-05	0,998212
48	255,59	3,91E-03	3,09E-04	0,998632
49	258,129	3,87E-03	2,00E-04	0,998904
50	267,1	3,74E-03	8,05E-04	1
sum			0,734376	

Table 3 – Partecipation factor – Y direction

***** PARTICIPATION FACTOR CALCULATION ***** Z DIRECTION

MODE	FREQUENCY	PERIOD	EFFECTIVE MASS	CUMULATIVE MASS FRACTION
1	41,8915	2,39E-02	1,12E-08	2,96E-08
2	43,9056	2,28E-02	3,83E-06	1,01E-05
3	50,111	2,00E-02	1,55E-04	4,17E-04
4	61,5065	1,63E-02	1,30E-02	3,46E-02
5	82,3589	1,21E-02	1,92E-03	3,96E-02
6	82,6778	1,21E-02	7,65E-06	3,97E-02
7	83,9904	1,19E-02	2,85E-06	3,97E-02
8	94,5077	1,06E-02	1,81E-03	4,44E-02
9	103,872	9,63E-03	1,10E-03	4,73E-02
10	109,759	9,11E-03	8,31E-03	6,92E-02
11	112,938	8,85E-03	5,40E-02	0,211312
12	120,115	8,33E-03	7,32E-04	0,213238
13	122,992	8,13E-03	1,17E-02	0,243963
14	126,409	7,91E-03	7,22E-05	0,244153
15	127,261	7,86E-03	2,29E-05	0,244213
16	144,838	6,90E-03	2,77E-02	0,317182
17	157,507	6,35E-03	3,10E-05	0,317264
18	157,652	6,34E-03	7,17E-06	0,317283
19	158,084	6,33E-03	9,03E-06	0,317307
20	158,125	6,32E-03	7,84E-06	0,317327
21	159,437	6,27E-03	4,67E-03	0,329611
22	167,149	5,98E-03	2,36E-03	0,335819
23	167,472	5,97E-03	1,67E-05	0,335863
24	168,095	5,95E-03	1,74E-03	0,340445
25	170,37	5,87E-03	3,77E-04	0,341438
26	171,563	5,83E-03	6,93E-07	0,34144
27	171,594	5,83E-03	3,82E-06	0,34145
28	174,363	5,74E-03	1,12E-03	0,344402
29	180,167	5,55E-03	5,98E-05	0,34456
30	180,395	5,54E-03	1,97E-04	0,345079
31	188,82	5,30E-03	2,96E-02	0,422949
32	203,694	4,91E-03	4,08E-02	0,530228
33	204,52	4,89E-03	1,99E-04	0,530753
34	209,199	4,78E-03	6,86E-04	0,532558
35	214,868	4,65E-03	6,03E-03	0,548431
36	215,49	4,64E-03	4,93E-04	0,549728
37	215,653	4,64E-03	1,34E-03	0,553246
38	219,901	4,55E-03	3,67E-02	0,649927
39	221,022	4,52E-03	9,06E-04	0,652311
40	224,298	4,46E-03	2,69E-02	0,723184
41	226,276	4,42E-03	6,48E-02	0,893643
42	231,134	4,33E-03	5,63E-07	0,893645
43	231,418	4,32E-03	5,12E-03	0,907127
44	234,078	4,27E-03	3,22E-03	0,915607
45	238,189	4,20E-03	2,83E-02	0,990047
46	247,257	4,04E-03	8,85E-04	0,992376
47	253,353	3,95E-03	2,12E-04	0,992933
48	255,59	3,91E-03	1,72E-03	0,997456
49	258,129	3,87E-03	8,99E-04	0,999822
50	267,1	3,74E-03	6,75E-05	1
sum			0,380063	

Table 4 – Partecipation factor – Z direction

***** PARTICIPATION FACTOR CALCULATION ***** ROT X DIRECTION

MODE	FREQUENCY	PERIOD	EFFECTIVE MASS	CUMULATIVE MASS FRACTION
1	41,8915	2,39E-02	4,01E-02	1,72E-07
2	43,9056	2,28E-02	81526,4	0,350928
3	50,111	2,00E-02	74,192	0,351247
4	61,5065	1,63E-02	6663,31	0,379929
5	82,3589	1,21E-02	5,74E-04	0,379929
6	82,6778	1,21E-02	425,22	0,381759
7	83,9904	1,19E-02	1,44541	0,381765
8	94,5077	1,06E-02	2427,78	0,392216
9	103,872	9,63E-03	273,974	0,393395
10	109,759	9,11E-03	13,1467	0,393452
11	112,938	8,85E-03	4004,57	0,410689
12	120,115	8,33E-03	7917,93	0,444772
13	122,992	8,13E-03	2465,02	0,455382
14	126,409	7,91E-03	10,5279	0,455428
15	127,261	7,86E-03	171,932	0,456168
16	144,838	6,90E-03	1802,41	0,463926
17	157,507	6,35E-03	2838,85	0,476146
18	157,652	6,34E-03	706,998	0,479189
19	158,084	6,33E-03	557,979	0,481591
20	158,125	6,32E-03	0,620913	0,481593
21	159,437	6,27E-03	102140	0,921251
22	167,149	5,98E-03	53,5729	0,921482
23	167,472	5,97E-03	709,85	0,924538
24	168,095	5,95E-03	1045,35	0,929037
25	170,37	5,87E-03	44,1563	0,929227
26	171,563	5,83E-03	20,0604	0,929314
27	171,594	5,83E-03	1,57216	0,92932
28	174,363	5,74E-03	586,855	0,931847
29	180,167	5,55E-03	262,258	0,932975
30	180,395	5,54E-03	78,0827	0,933312
31	188,82	5,30E-03	5910,51	0,958753
32	203,694	4,91E-03	193,997	0,959588
33	204,52	4,89E-03	4747	0,980021
34	209,199	4,78E-03	1052,38	0,984551
35	214,868	4,65E-03	56,5209	0,984795
36	215,49	4,64E-03	8,45527	0,984831
37	215,653	4,64E-03	33,72	0,984976
38	219,901	4,55E-03	170,222	0,985709
39	221,022	4,52E-03	17,2027	0,985783
40	224,298	4,46E-03	195,313	0,986624
41	226,276	4,42E-03	333,665	0,98806
42	231,134	4,33E-03	30,1195	0,98819
43	231,418	4,32E-03	76,4987	0,988519
44	234,078	4,27E-03	142,304	0,989131
45	238,189	4,20E-03	35,5654	0,989284
46	247,257	4,04E-03	128,096	0,989836
47	253,353	3,95E-03	585,01	0,992354
48	255,59	3,91E-03	1077,94	0,996994
49	258,129	3,87E-03	156,124	0,997666
50	267,1	3,74E-03	542,228	1
sum			232317	

Table 5 – Partecipation factor – rot X direction

***** PARTICIPATION FACTOR CALCULATION ***** ROT Y DIRECTION

MODE	FREQUENCY	PERIOD	EFFECTIVE MASS	CUMULATIVE MASS FRACTION
1	41,8915	2,39E-02	4,62151	4,76E-06
2	43,9056	2,28E-02	1599,36	1,65E-03
3	50,111	2,00E-02	144,158	1,80E-03
4	61,5065	1,63E-02	13042,9	1,52E-02
5	82,3589	1,21E-02	4562,05	1,99E-02
6	82,6778	1,21E-02	1,30194	1,99E-02
7	83,9904	1,19E-02	46,4632	2,00E-02
8	94,5077	1,06E-02	2779,78	2,28E-02
9	103,872	9,63E-03	6376,6	2,94E-02
10	109,759	9,11E-03	8055,55	3,77E-02
11	112,938	8,85E-03	11528,1	4,96E-02
12	120,115	8,33E-03	2922,36	5,26E-02
13	122,992	8,13E-03	40288,1	9,41E-02
14	126,409	7,91E-03	53,2988	9,41E-02
15	127,261	7,86E-03	389,172	9,45E-02
16	144,838	6,90E-03	28332,5	0,123692
17	157,507	6,35E-03	438,472	0,124144
18	157,652	6,34E-03	37,628	0,124182
19	158,084	6,33E-03	104,287	0,12429
20	158,125	6,32E-03	4,58136	0,124295
21	159,437	6,27E-03	25648,8	0,150705
22	167,149	5,98E-03	3026,09	0,153821
23	167,472	5,97E-03	110,28	0,153934
24	168,095	5,95E-03	56,2634	0,153992
25	170,37	5,87E-03	731,462	0,154745
26	171,563	5,83E-03	0,907846	0,154746
27	171,594	5,83E-03	4,43916	0,154751
28	174,363	5,74E-03	8,69295	0,15476
29	180,167	5,55E-03	257,733	0,155025
30	180,395	5,54E-03	2607,81	0,15771
31	188,82	5,30E-03	98959,9	0,259608
32	203,694	4,91E-03	119734	0,382897
33	204,52	4,89E-03	13,0683	0,38291
34	209,199	4,78E-03	62,273	0,382974
35	214,868	4,65E-03	18887,4	0,402422
36	215,49	4,64E-03	1509,78	0,403977
37	215,653	4,64E-03	4315,22	0,40842
38	219,901	4,55E-03	150673	0,563566
39	221,022	4,52E-03	2632,95	0,566277
40	224,298	4,46E-03	93520,1	0,662574
41	226,276	4,42E-03	205480	0,874153
42	231,134	4,33E-03	0,528617	0,874154
43	231,418	4,32E-03	14483,3	0,889067
44	234,078	4,27E-03	10653,8	0,900037
45	238,189	4,20E-03	66931,6	0,968956
46	247,257	4,04E-03	3068,12	0,972115
47	253,353	3,95E-03	2467,21	0,974655
48	255,59	3,91E-03	9786,89	0,984733
49	258,129	3,87E-03	14425,5	0,999586
50	267,1	3,74E-03	401,781	1
sum			971171	

Table 6 – Partecipation factor – rot Y direction

***** PARTICIPATION FACTOR CALCULATION ***** ROT Z DIRECTION

MODE	FREQUENCY	PERIOD	EFFECTIVE MASS	CUMULATIVE MASS FRACTION
1	41,8915	2,39E-02	2,41108	9,59E-07
2	43,9056	2,28E-02	2,02E+06	0,801872
3	50,111	2,00E-02	442842	0,978038
4	61,5065	1,63E-02	4898,12	0,979986
5	82,3589	1,21E-02	104,99	0,980028
6	82,6778	1,21E-02	6260,71	0,982518
7	83,9904	1,19E-02	40,4962	0,982535
8	94,5077	1,06E-02	530,217	0,982746
9	103,872	9,63E-03	14686,9	0,988588
10	109,759	9,11E-03	1069,59	0,989014
11	112,938	8,85E-03	15004,8	0,994983
12	120,115	8,33E-03	1480,03	0,995571
13	122,992	8,13E-03	327,489	0,995702
14	126,409	7,91E-03	133,033	0,995754
15	127,261	7,86E-03	0,468252	0,995755
16	144,838	6,90E-03	409,626	0,995918
17	157,507	6,35E-03	7,67092	0,995921
18	157,652	6,34E-03	12,4638	0,995926
19	158,084	6,33E-03	2,08949	0,995926
20	158,125	6,32E-03	0,261731	0,995927
21	159,437	6,27E-03	114,743	0,995972
22	167,149	5,98E-03	100,499	0,996012
23	167,472	5,97E-03	285,503	0,996126
24	168,095	5,95E-03	450,175	0,996305
25	170,37	5,87E-03	3,94348	0,996306
26	171,563	5,83E-03	3,61E-02	0,996306
27	171,594	5,83E-03	0,150009	0,996306
28	174,363	5,74E-03	137,566	0,996361
29	180,167	5,55E-03	1,72E-02	0,996361
30	180,395	5,54E-03	58,5956	0,996385
31	188,82	5,30E-03	289,99	0,9965
32	203,694	4,91E-03	939,836	0,996874
33	204,52	4,89E-03	1956,91	0,997652
34	209,199	4,78E-03	99,9776	0,997692
35	214,868	4,65E-03	18,9791	0,9977
36	215,49	4,64E-03	38,9132	0,997715
37	215,653	4,64E-03	0,998688	0,997715
38	219,901	4,55E-03	179,288	0,997787
39	221,022	4,52E-03	3,63316	0,997788
40	224,298	4,46E-03	1,64E-02	0,997788
41	226,276	4,42E-03	5,92799	0,997791
42	231,134	4,33E-03	347,73	0,997929
43	231,418	4,32E-03	54,9733	0,997951
44	234,078	4,27E-03	380,951	0,998102
45	238,189	4,20E-03	74,5467	0,998132
46	247,257	4,04E-03	99,4832	0,998172
47	253,353	3,95E-03	938,504	0,998545
48	255,59	3,91E-03	1087,87	0,998978
49	258,129	3,87E-03	818,491	0,999303
50	267,1	3,74E-03	1751,53	1
sum			2,51E+06	

Table 7 – Partecipation factor – rot Z direction