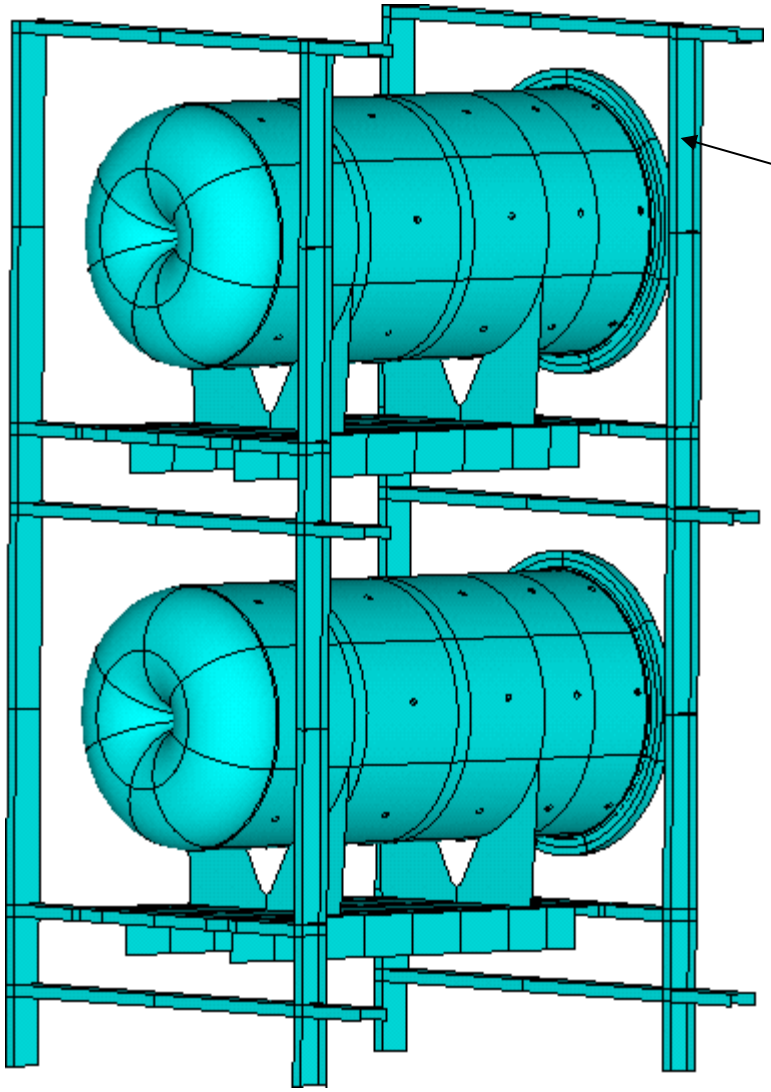
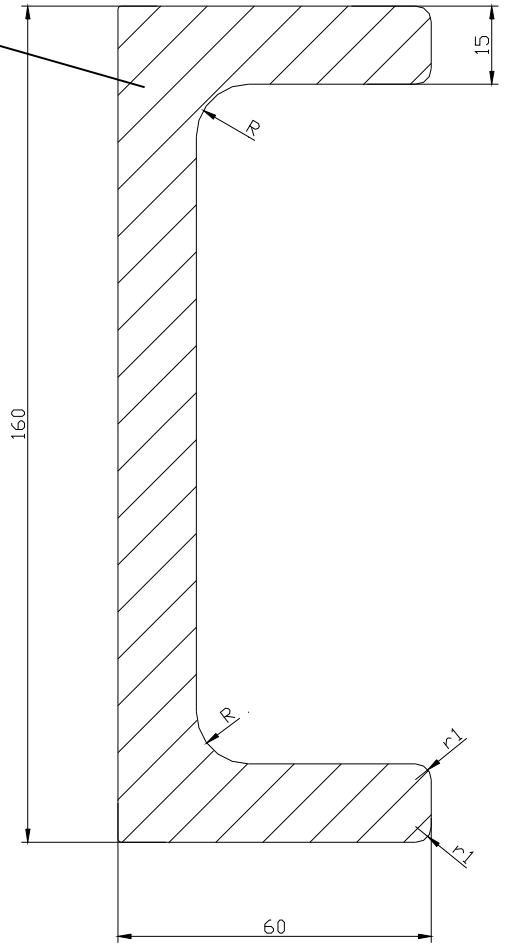
Four horns support system – update (06 June 2012)

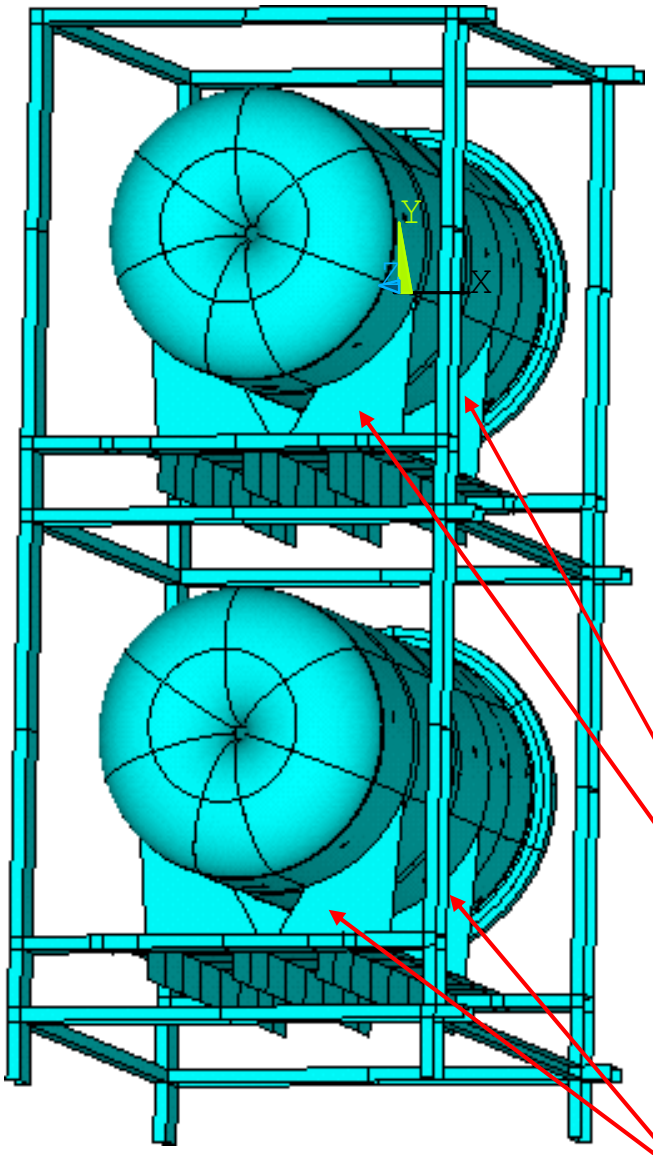
B.Szybiński, Cracow University of Technology

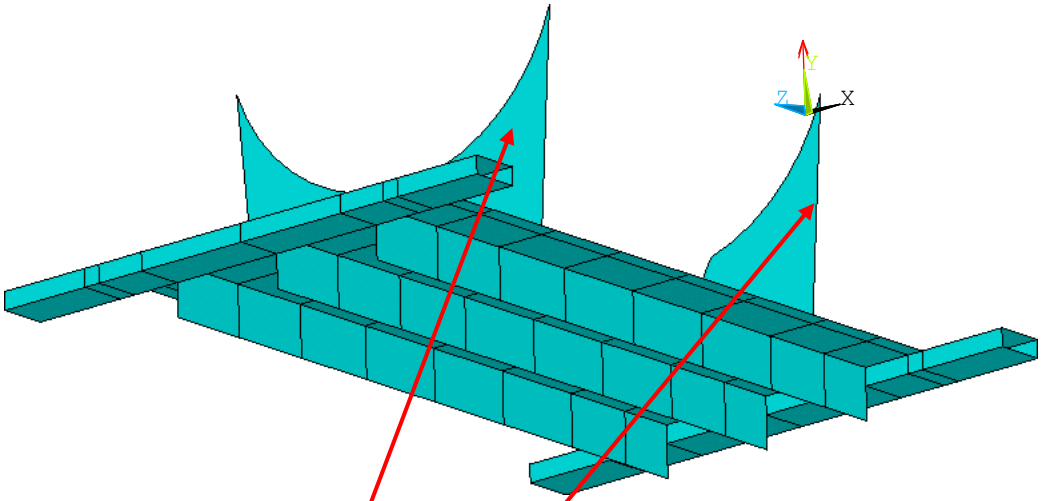
Standard aluminium channel section for frame structure with thickness t_c



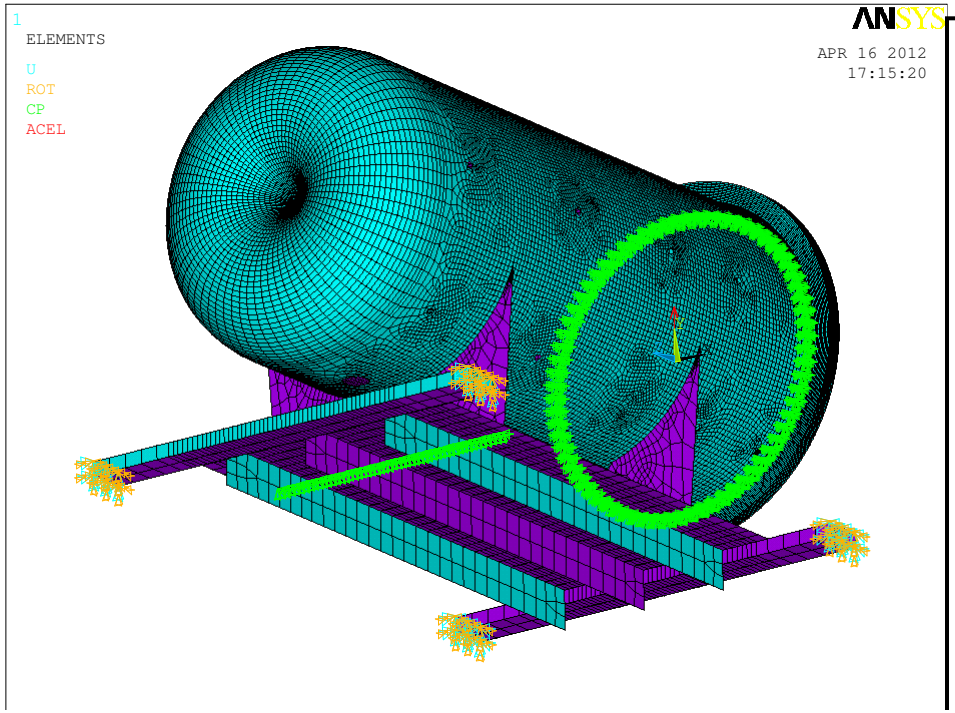


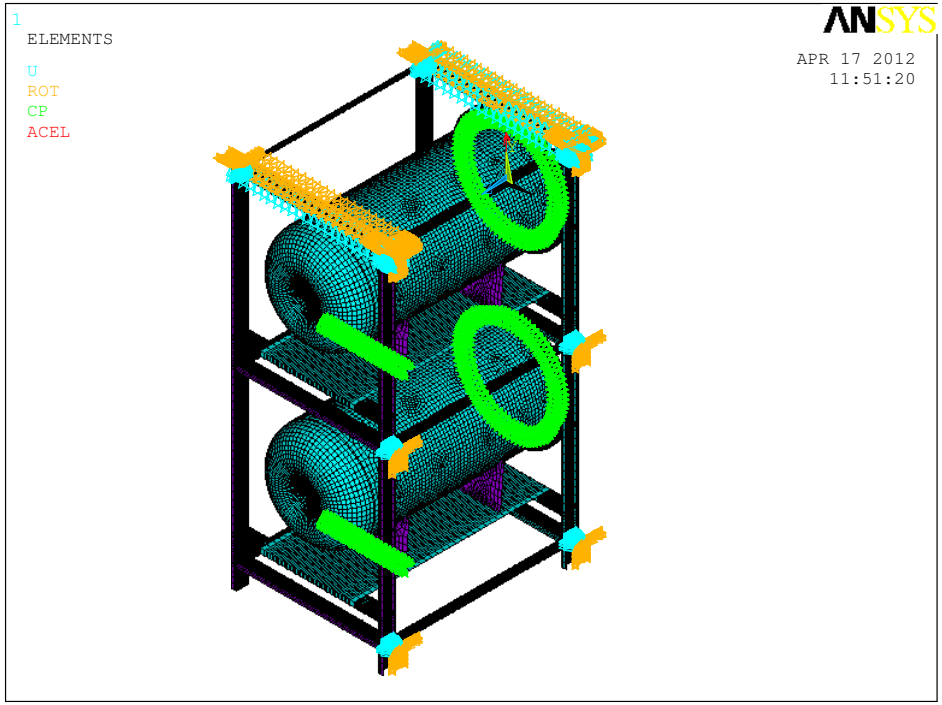
System of plates for single horn support





Vetical plate for saddle supports with thicknes t_h





Optimization is divided into two stages:

1. **Search of the set of optimal thickness and height of important design variables with minimum absolute difference of vertical deflections in supporting point A and B for 1 horn**
2. **Search of the set of optimal thickness of important design variables supporting lower horn while thickness of important design parameters for upper horn is set in the 1st stage of the process**

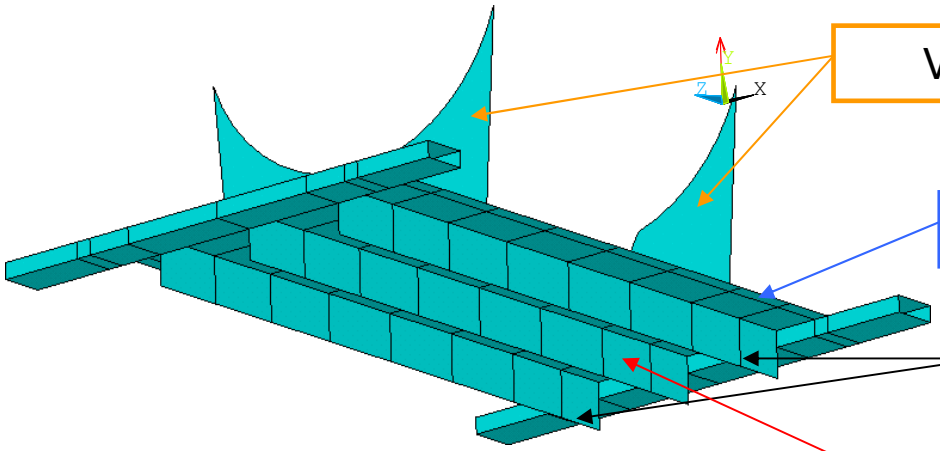
Objective function: minimization of absolute value of difference of vertical deflection in point A and B

$$\left| u_{y\_p1} - u_{y\_p2} \right|$$

State variables:

1. **Maximum absolute value of vertical deflection;**
2. **Equivalent stress in horns**
3. **Equivalent stress in the whole structure**

Upper horn supporting plates:



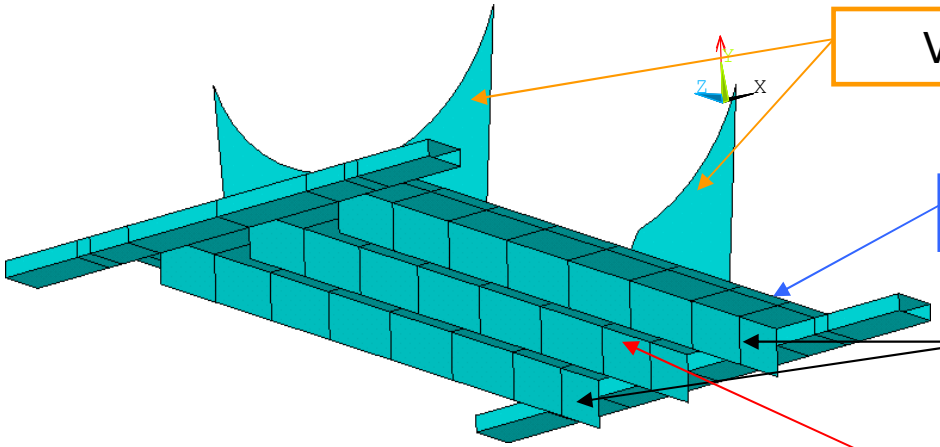
Vertical supp.plates, thickness t_h = 12[*mm*]

Horiz.supp.plate, thickness t_p = 48 [*mm*]

Outer ribs, thicknes t_{rout} = 12 [*mm*]

Inner rib, thicknes t_{rinn} = 17 [*mm*]

Lower horn supporting plates:



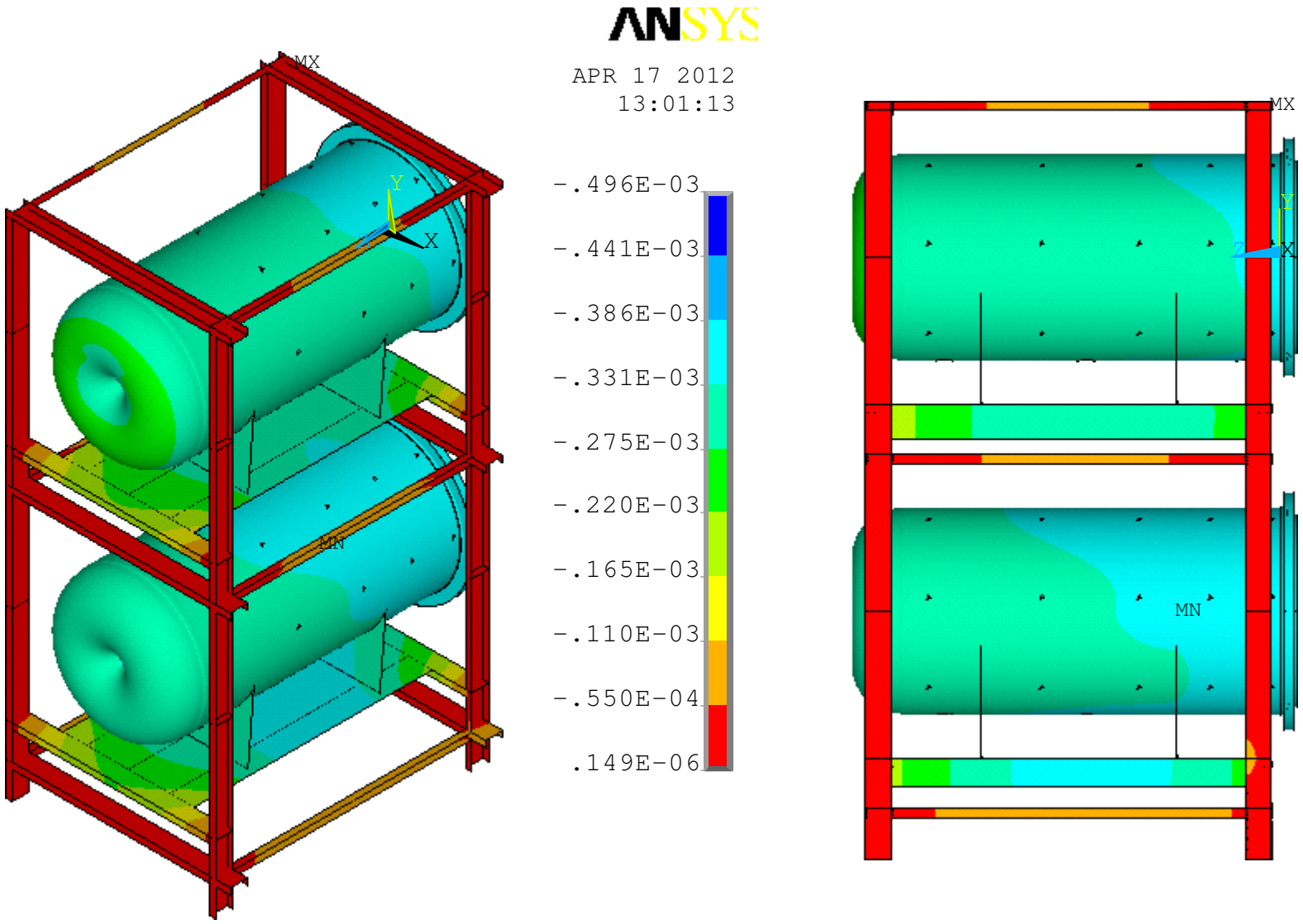
Vertical supp.plates, thickness t_h = 12[*mm*]

Horiz.supp.plate, thickness t_p = 50 [*mm*]

Outer ribs, thicknes t_{rout} = 22 [*mm*]

Inner rib, thicknes t_{rinn} = 12 [*mm*]

Results after two stage optimization process

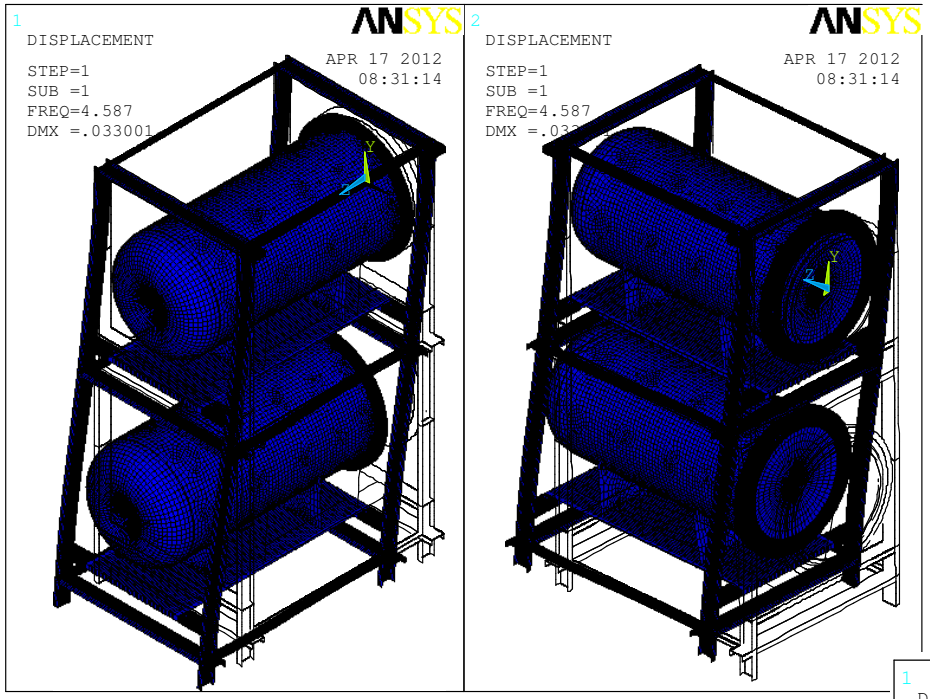


Uy displacement in [*m*]

Analysis of natural frequencies – results for symmetric half of 4 horns structure with dimensions chosen on the base of static optimization results

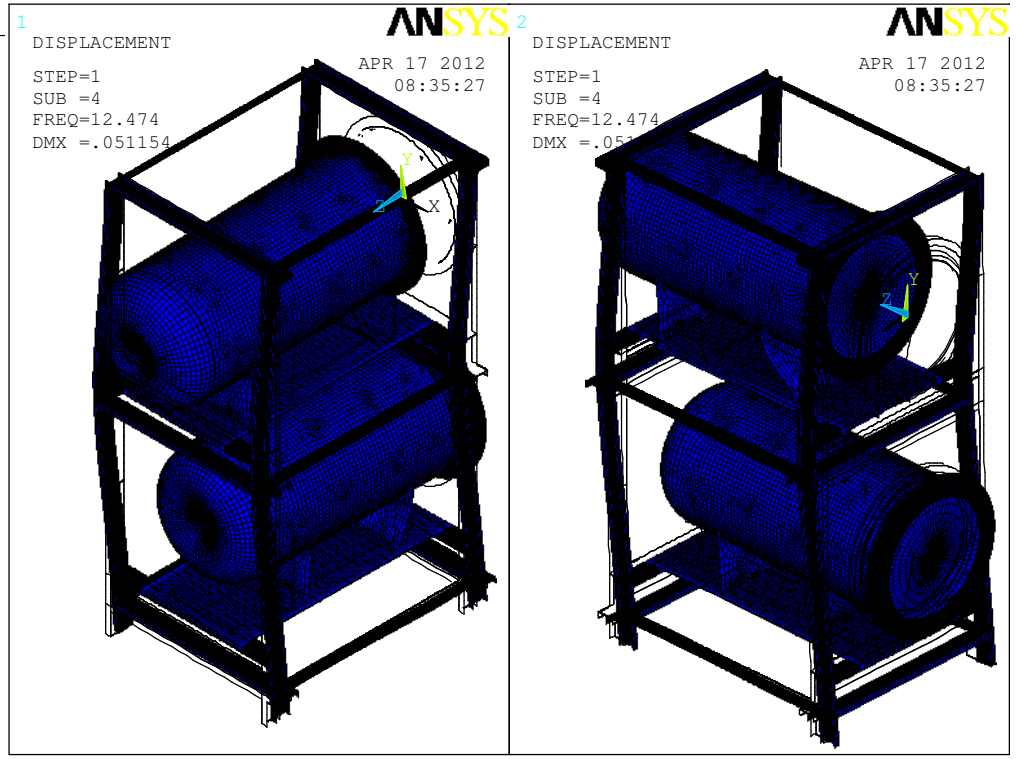
Mode	Freq.[Hz]
1	4.59
2	6.07
3	6.20
4	12.47
5	18.60
6	25.82
7	26.45
8	27.62

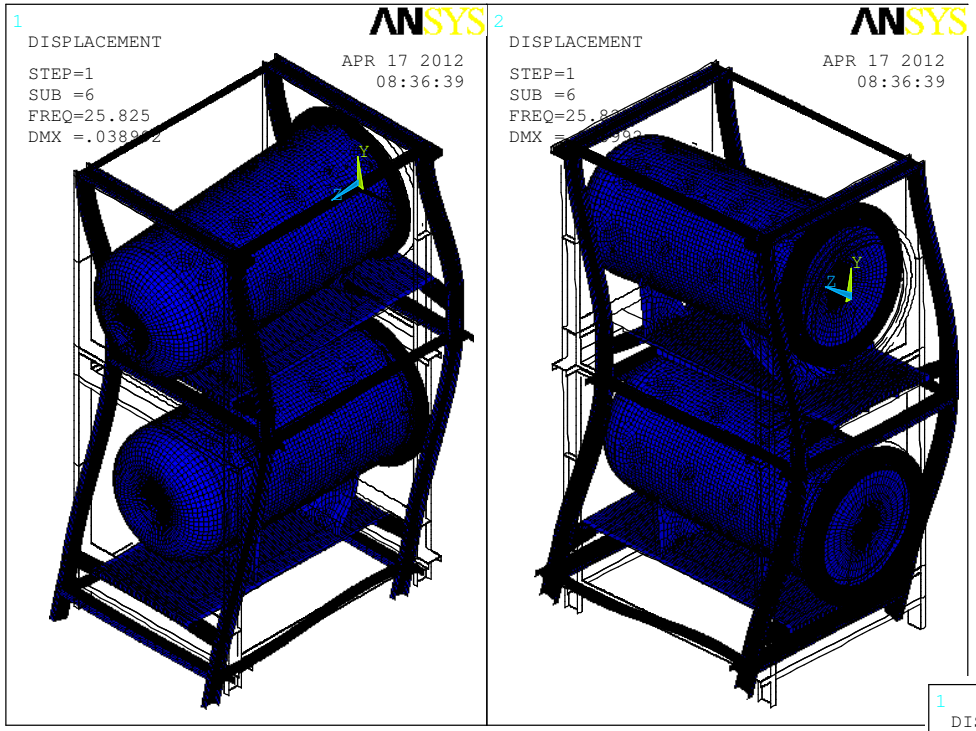
Mode	Freq.[Hz]
9	28.08
10	29.69
11	41.74
12	43.72
13	44.15
14	48.26
15	48.43



Mode 1, $f = 4.59$ *Hz*

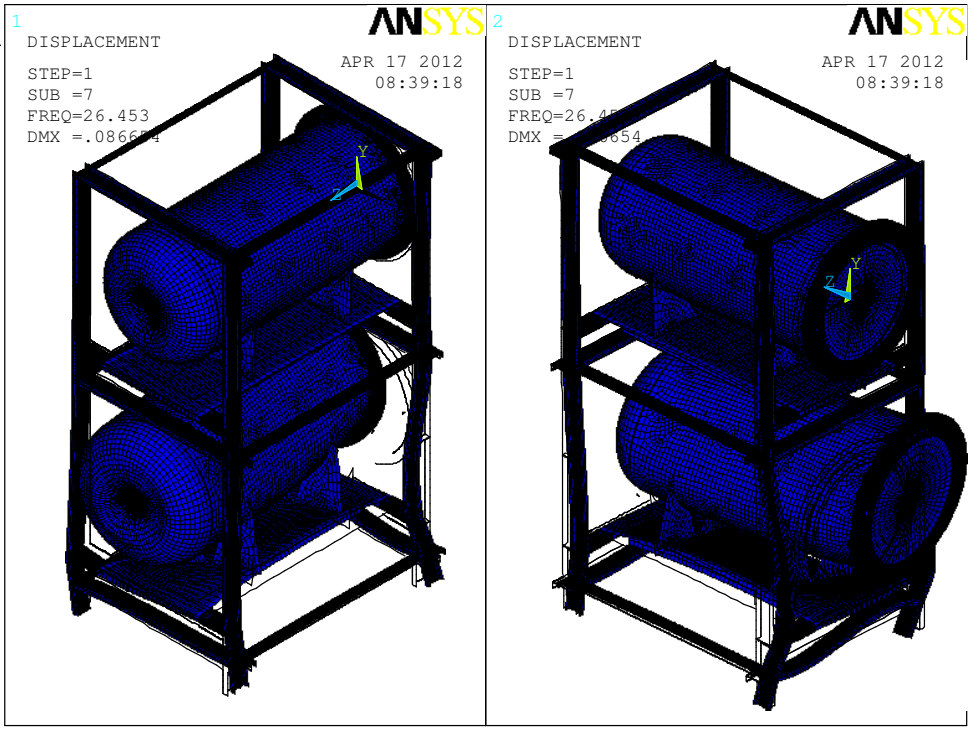
Mode 4, $f = 12.47$ *Hz*



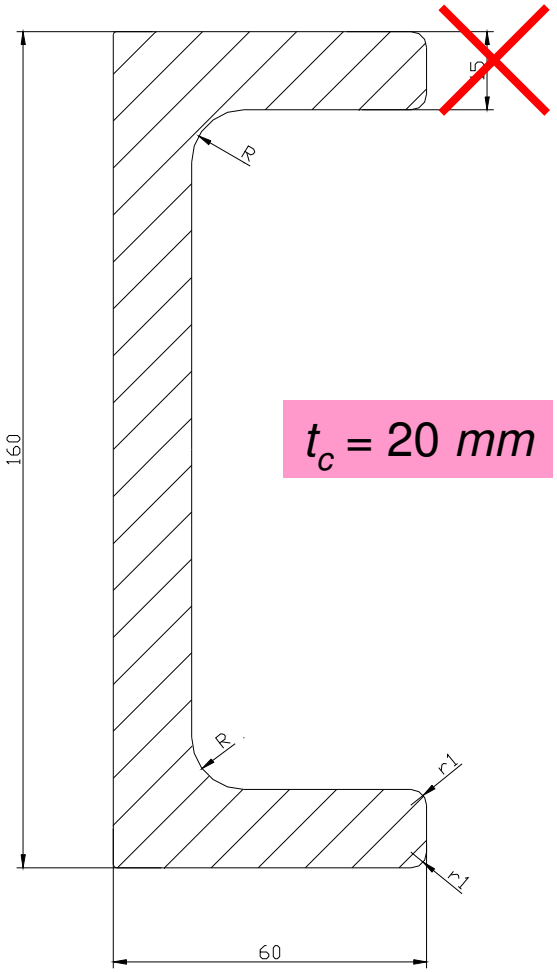


Mode 6, $f = 25.82$ *Hz*

Mode 7, $f = 26.45$ *Hz*



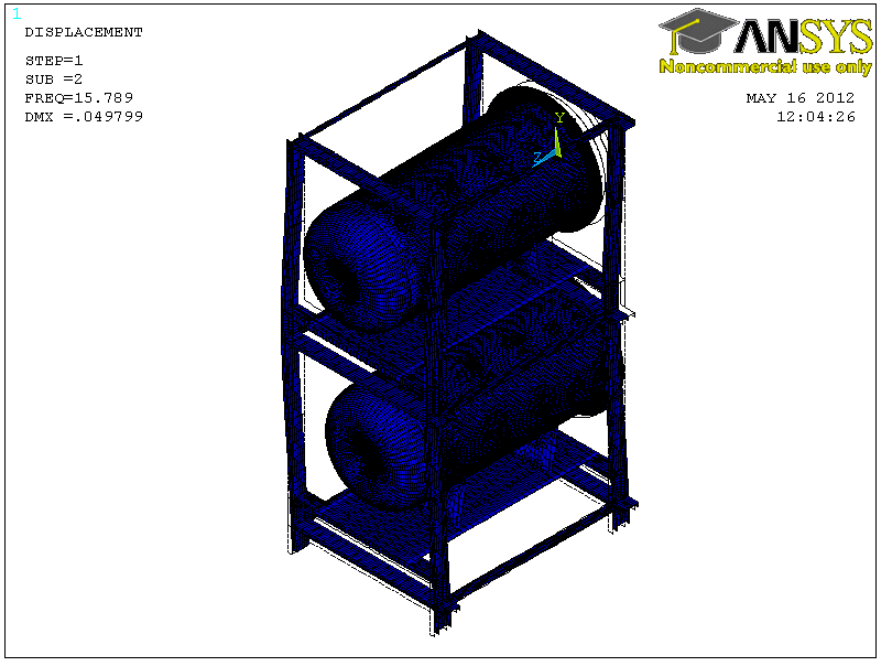
Natural frequencies – results for symmetric half of 4 horns structure with dimensions chosen on the base of static optimization results and with increased thickness of the channel section (modification 1)

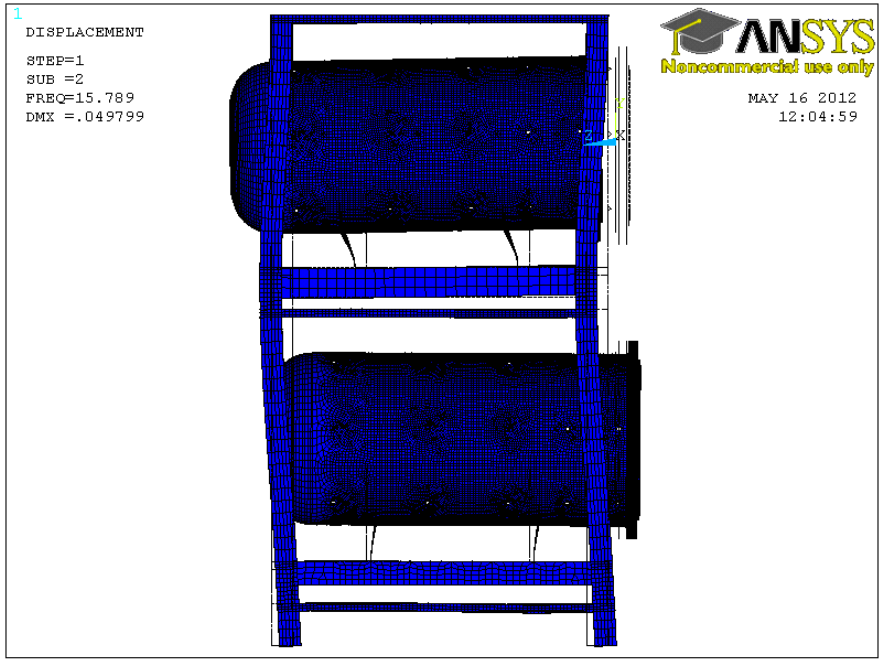


$t_c = 20\ mm$

Modif.1

Mode	Freq.[Hz]
1	5.08
2	15.79
3	24.68
4	27.35
5	28.39
6	30.26
7	30.51
8	32.26
9	46.27
10	47.29
11	47.76
12	48.09
13	48.91
14	49.07
15	50.06

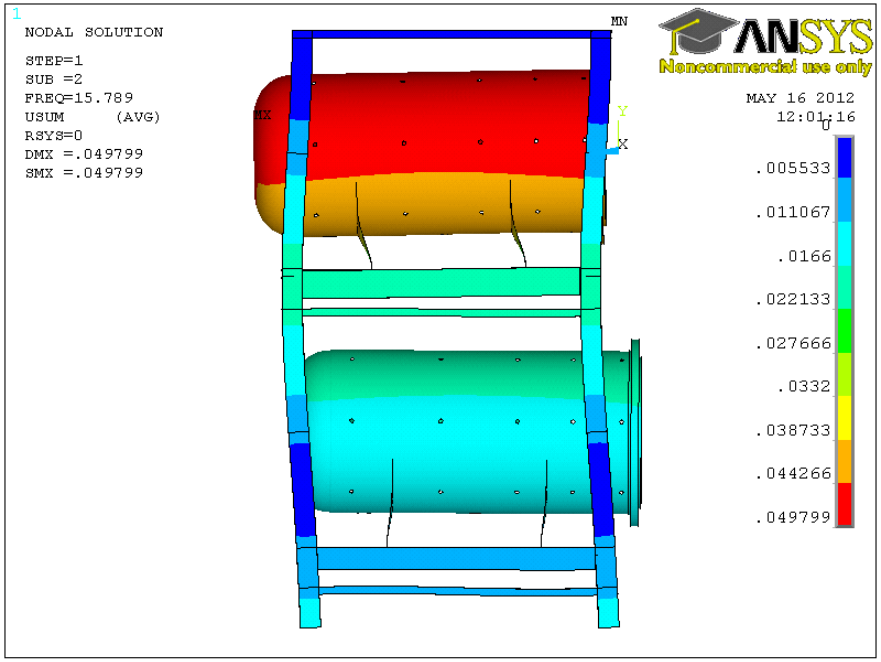




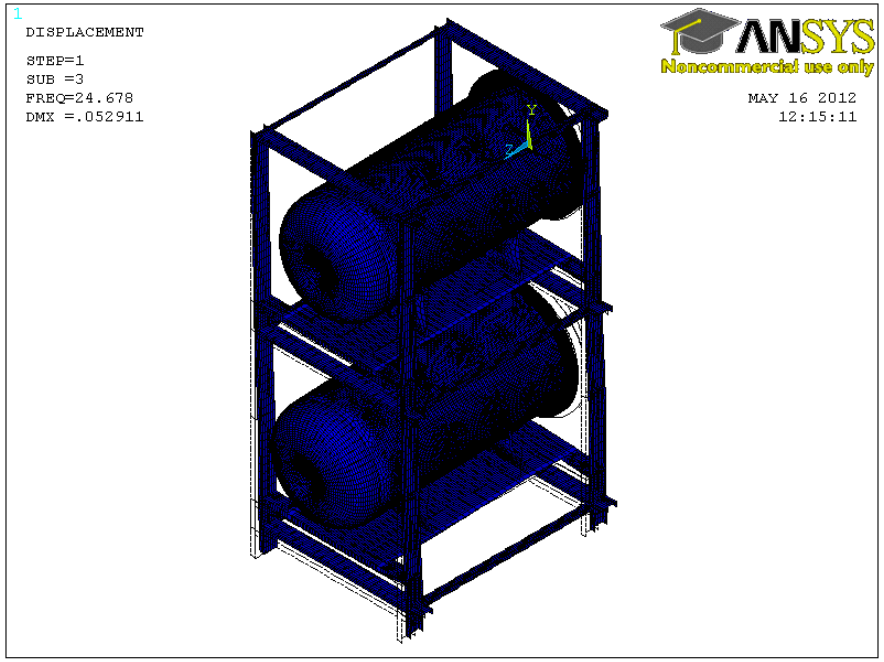
Mode 2, $f = 15.79\ Hz$

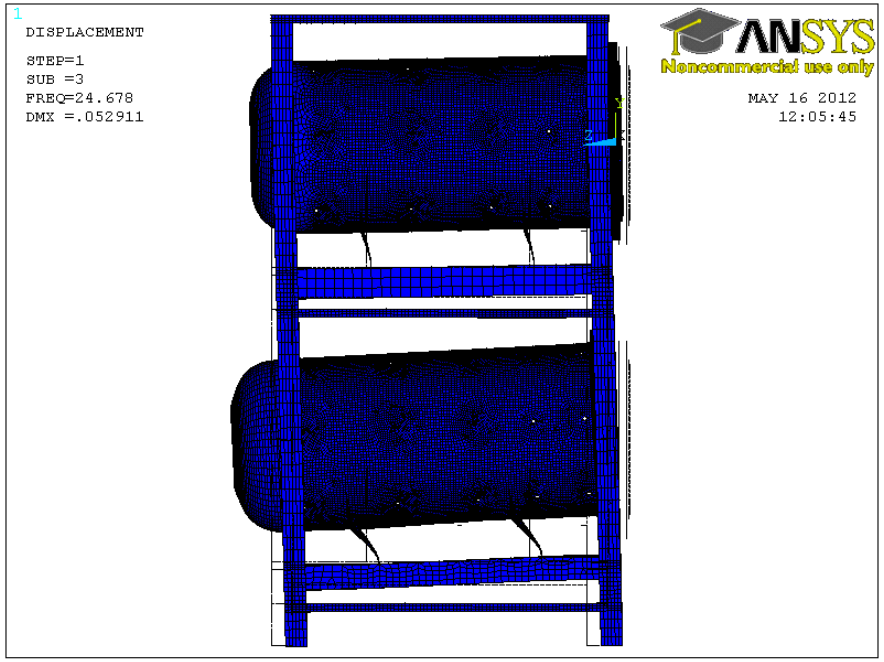
Instead of:

$f_{old} = 12.47\ Hz$

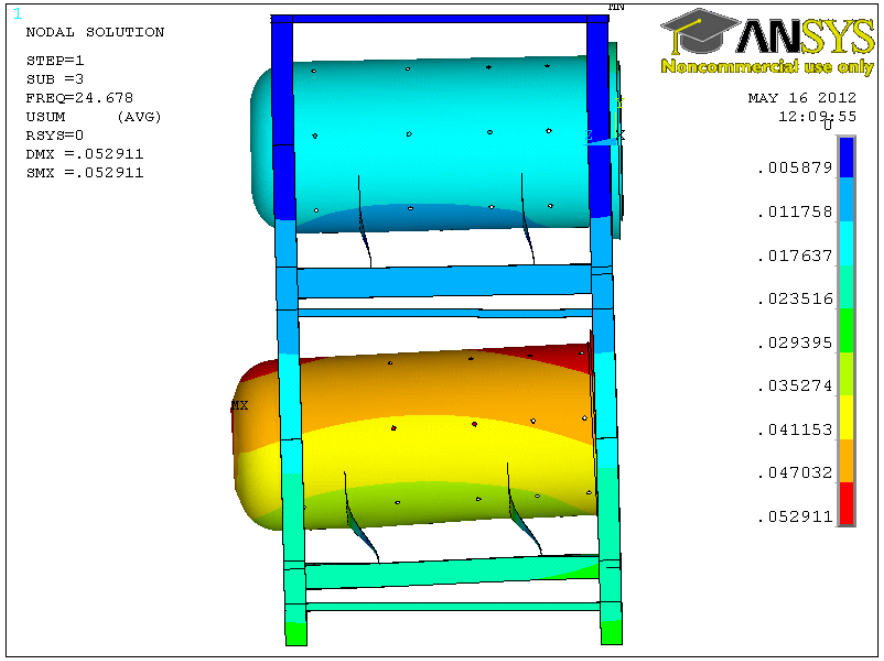


Modif.1

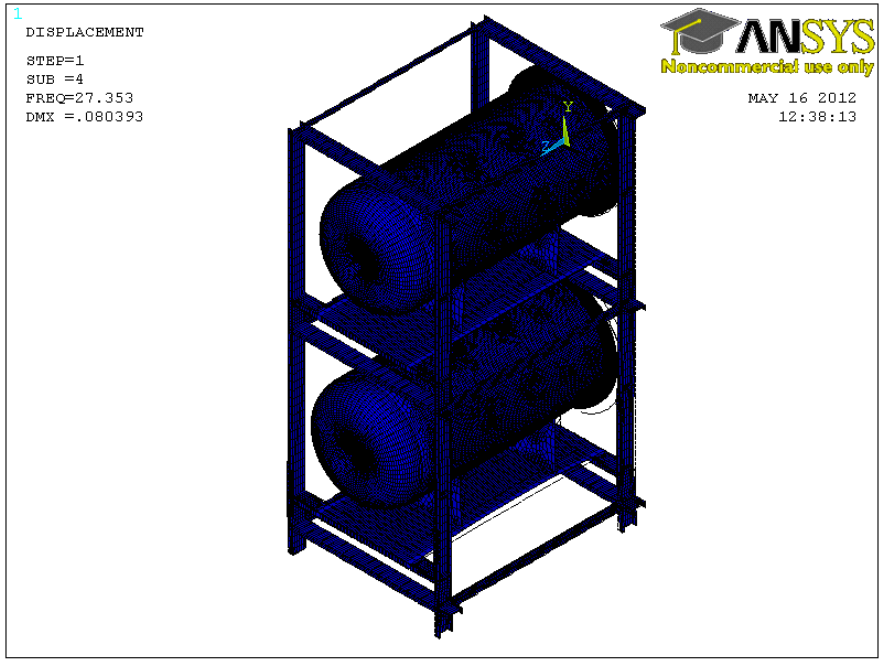


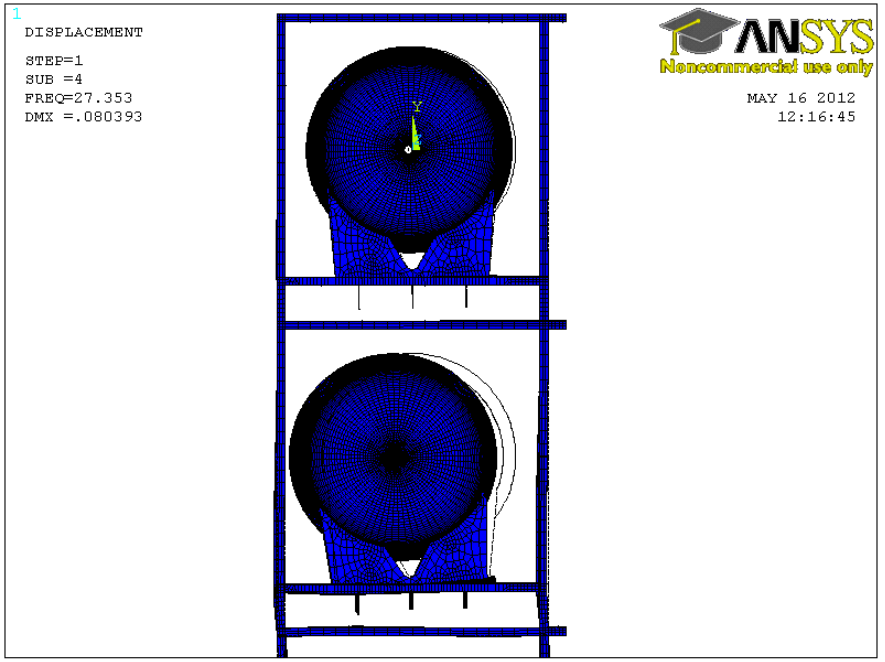


Mode 3, $f = 24.68$ *Hz*

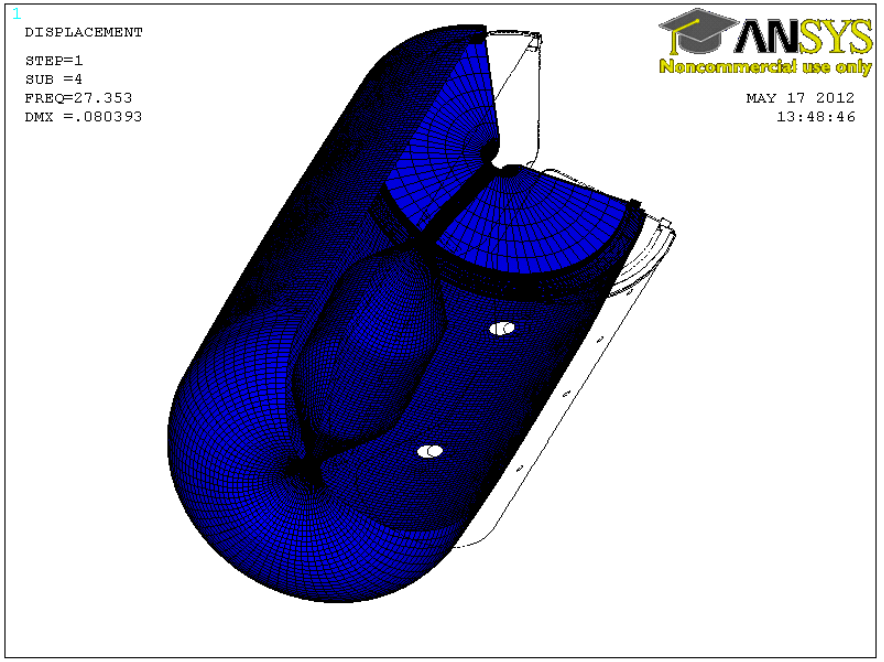


Modif.1

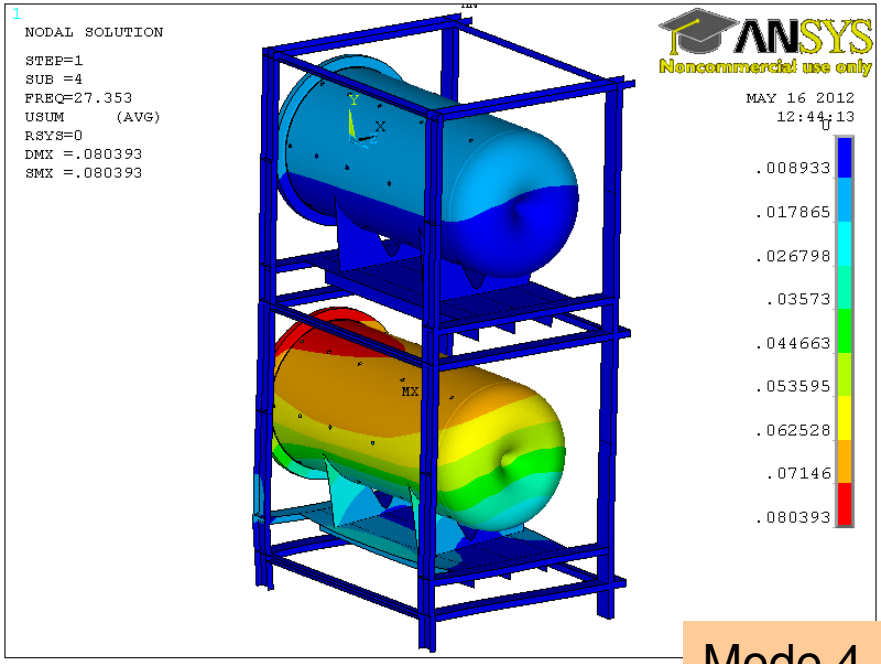


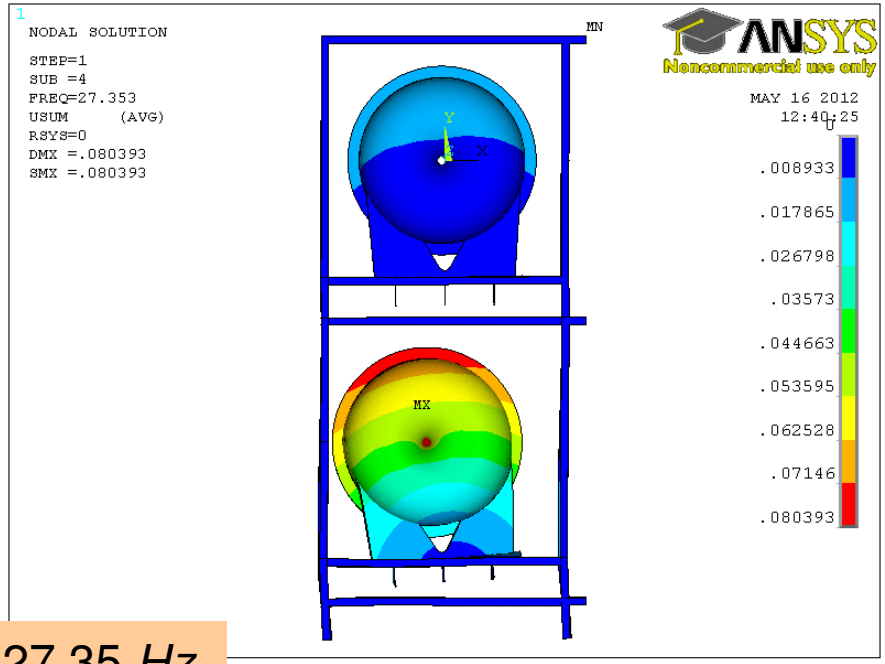


Mode 4, $f = 27.35$ *Hz*



Modif.1

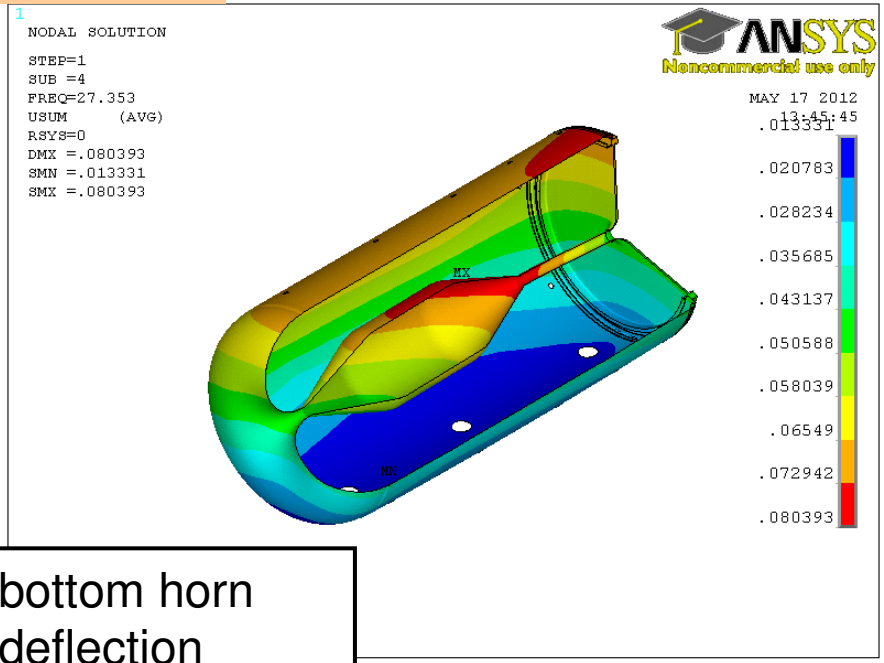




Mode 4, *f* = 27.35 *Hz*

Mode	Freq.[Hz]
3	24.68
4	27.35
5	28.39
6	30.26
7	30.51
8	32.26
9	46.27
10	47.29
11	47.76
12	48.09

Modif.1

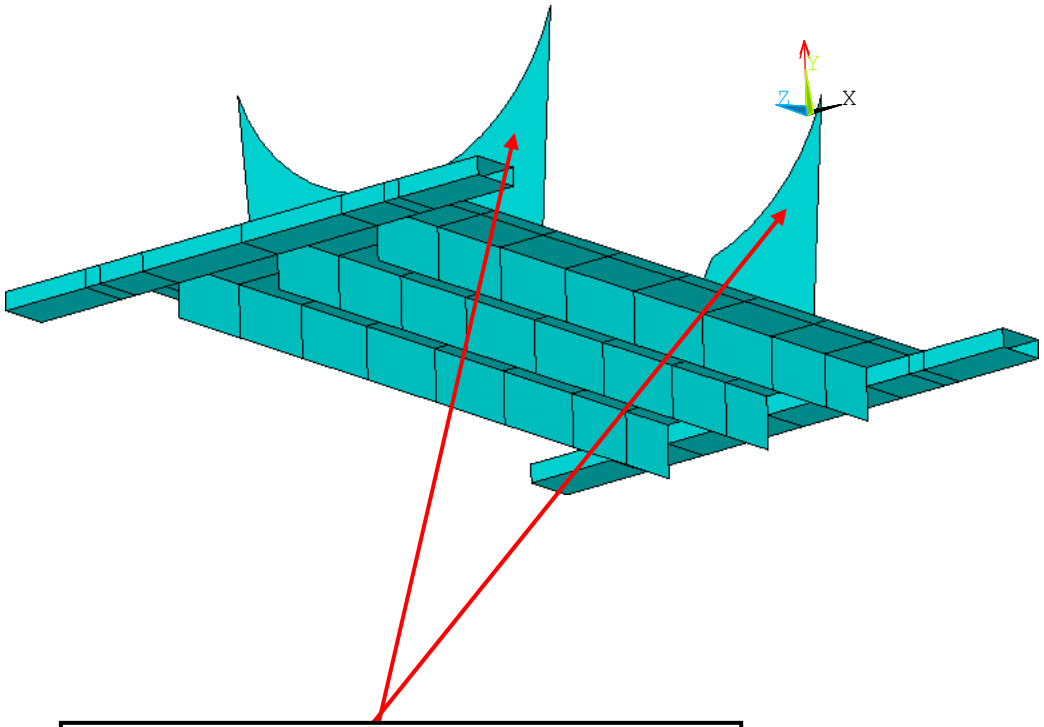


bottom horn deflection

Natural frequencies – results for symmetric half of 4 horns structure:

thickness of the channel section t_c = 20 *mm*, modif.1

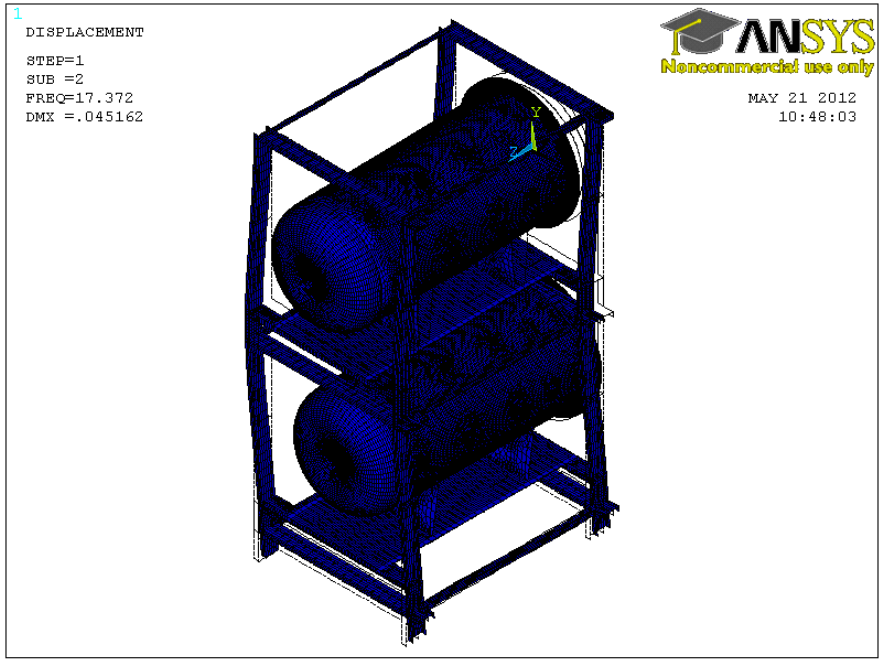
thickness of vertical plates t_h =16 mm, modif.2

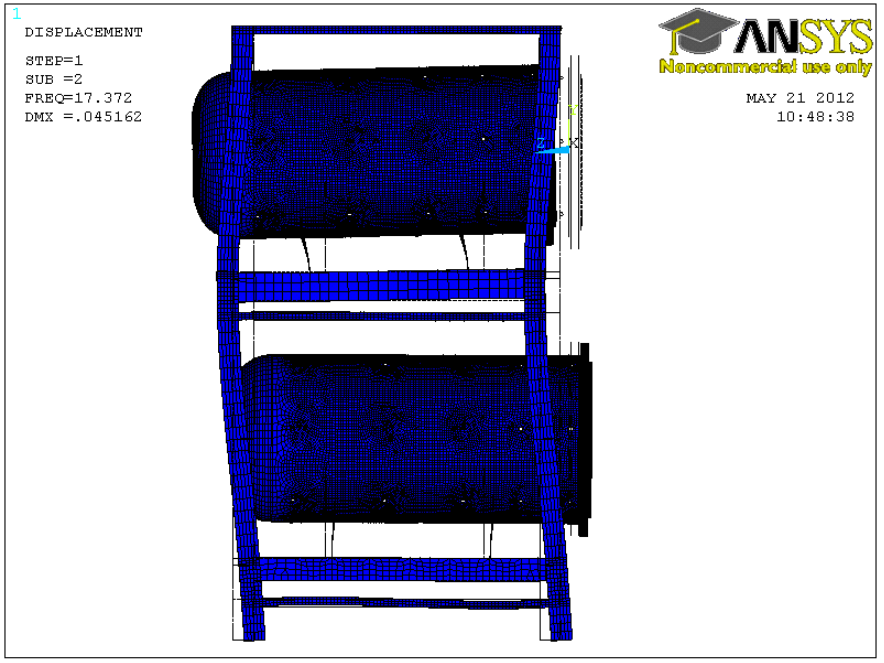


Vetical plates used for saddle supports thickness increased from: t_h =12 *mm* to t_h =16 *mm*

Modif.2

Mode	Freq.[Hz]
1	5.08
2	17.37
3	27.52
4	28.56
5	29.64
6	31.46
7	31.77
8	34.83
9	47.74
10	47.86
11	48.01
12	48.11
13	48.96
14	50.28
15	50.86

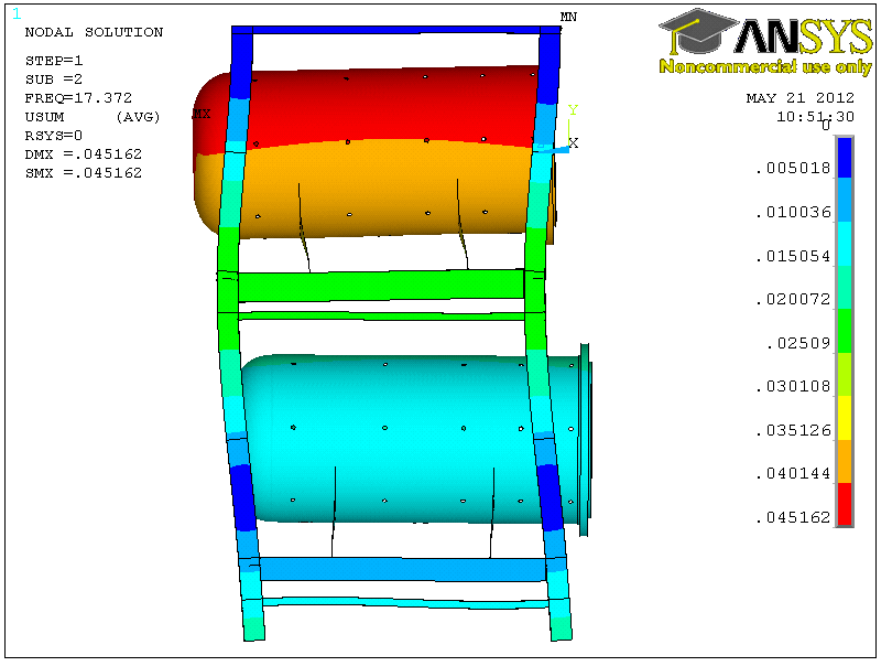




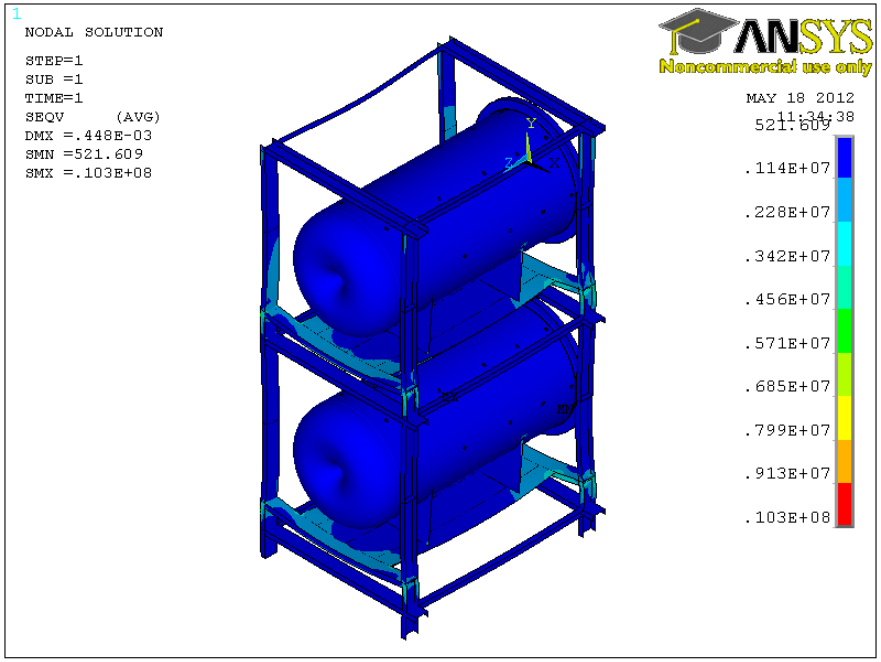
Mode 2, *f* = 17.37 *Hz*

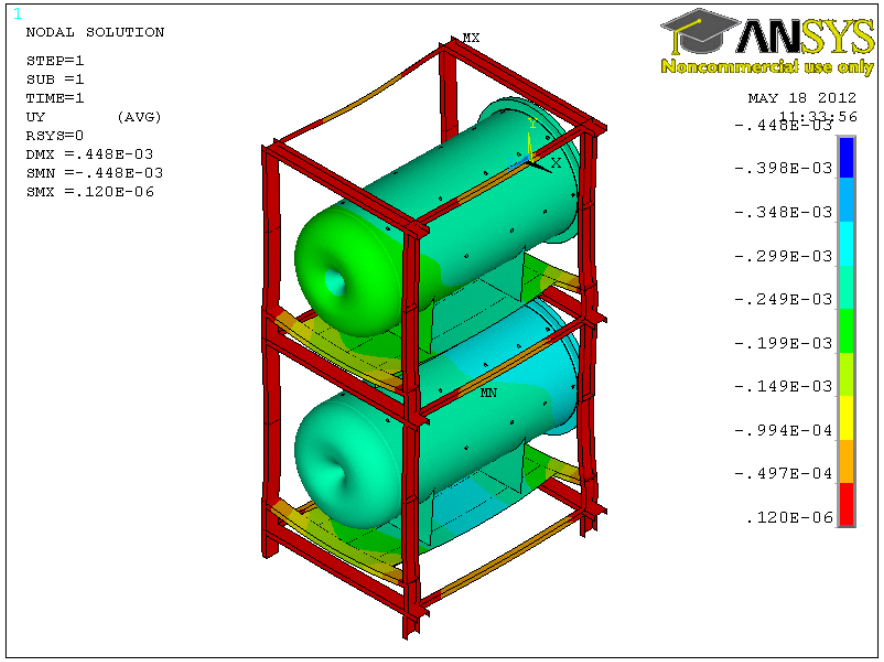
Originally:
f = 12.47 *Hz,*

After 1st modification:
f = 15.79 *Hz,*



Modif.2





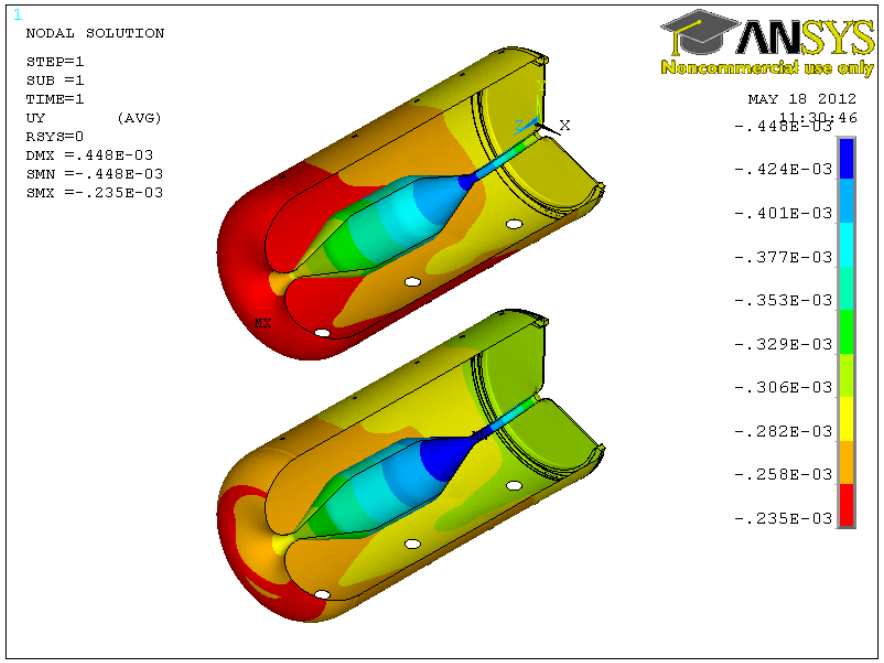
Results of static analysis

- Max. for abs. value of vertical deflection:

$$\left|u_y\right|_{\max} = 0.45[mm]$$

- Max. value for equivalent stress:

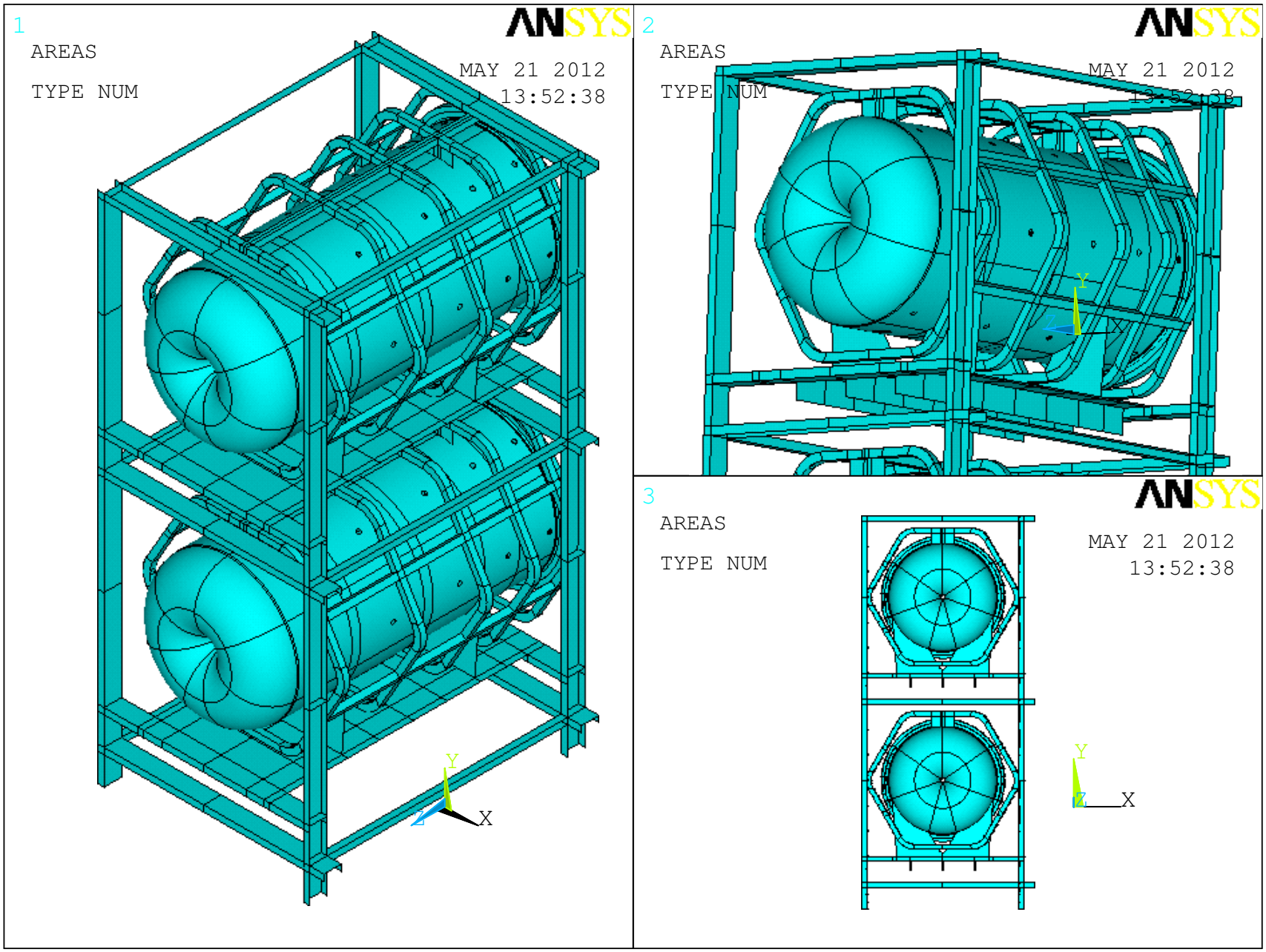
$$\sigma_{eqv}^{\max} = 10.3[MPa]$$



Modif.2

Comparison of natural frequency values for structure with statically optimized support system and with modifications of thickness in certain members

No of freq.	Statically optim. str.	1st modif.	2nd modif.
1	4.59	5.075	5.084
2	12.47	15.79	17.37
3	18.60	24.68	27.52
4	25.82	27.35	28.56
5	26.45	28.39	29.64
6	27.62	30.26	31.46
7	28.08	30.51	31.77
8	29.69	32.26	34.83
9	41.74	46.27	47.74
10	43.73	47.29	47.86


1
ANSYS
AREAS
TYPE NUM
MAY 21 2012
13:52:38
Y
Z
X
2
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AREAS
TYPE NUM
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3
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AREAS
TYPE NUM
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Z
X

Thank you for your attention