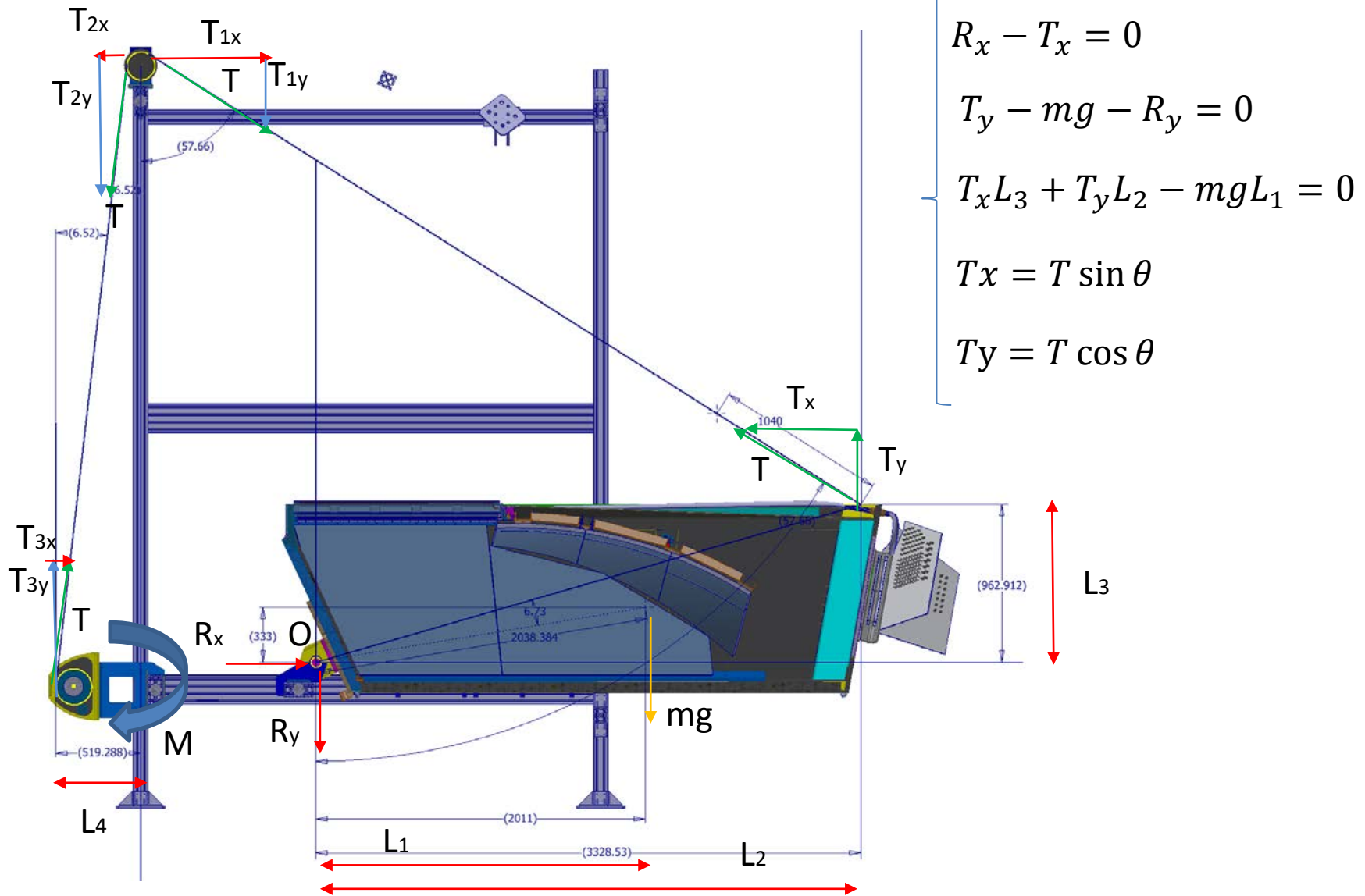


RICH ROTATION

Without equipments installed in the case

GEOMETRY: horizontal



$$R_x - T_x = 0$$

$$T_y - mg - R_y = 0$$

$$T_x L_3 + T_y L_2 - mg L_1 = 0$$

$$T_x = T \sin \theta$$

$$T_y = T \cos \theta$$

Force and Moment Balance: RICH frame only

$$R_x - T_x = 0$$

$$T_y - mg - R_y = 0$$

$$T_x L_3 + T_y L_2 - mg L_1 = 0$$

$$T_x = T \sin \theta$$

$$T_y = T \cos \theta$$

$$R_x = T_x$$

$$R_y = T_y - mg$$

$$T \sin \theta L_3 + T \cos \theta L_2 - mg L_1 = 0$$

$$R_x = T_x$$

$$R_y = T_y - mg$$

$$T = \frac{mg L_1}{L_3 \sin \theta + L_2 \cos \theta}$$

$$T_x = T \sin \theta$$

$$T_y = T \cos \theta$$

$$R_x = 3928 \text{ N}$$

$$R_y = 2487 - 6000 = -3513 \text{ N}$$

$$T = \frac{600 \cdot 10 \cdot 2011}{963 \sin 57.66 + 3329 \cos 57.66} = 4650 \text{ N}$$

$$T_x = 4650 \sin 57.66 = 3928 \text{ N}$$

$$T_y = 4650 \cos 57.66 = 2487 \text{ N}$$

Case 01: Loads acting on the AI Frame

Case 01: rotation of the RICH without any device installed inside (Assembly at Tecnavan or first assembly in the clean room EEL124)

$$T1x = 4650 \sin 57.66 = 3928 \text{ N}$$

$$R_x = -3928 \text{ N}$$

$$T1y = 4650 \cos 57.66 = 2487 \text{ N}$$

$$R_y = 3513 \text{ N}$$

$$T2x = 4650 \sin 6.52 = 528 \text{ N}$$

$$T2y = 4650 \cos 6.52 = 4620 \text{ N}$$

$$T3x = 4650 \sin 6.52 = 528 \text{ N}$$

$$T3y = 4650 \cos 6.52 = 4620 \text{ N}$$

$$M = T3y * L4 = 4620 \text{ N} * 0.520 \text{ m} = 2403 \text{ Nm}$$

Load on Pulley for **load case 01**

$$Tr_x = T_{1x} - T_{2x} = 3928 - 528 = 3400N$$

$$Tr_y = T_{2y} + T_{1y} = 4620 + 2487 = 7107N$$


















$$Tr = \sqrt{(Tr_x)^2 + (Tr_y)^2} = \mathbf{7878N} < 31750 \text{ N Pulley Rate} \quad \mathbf{VERIFIED}$$

Load on Pivot for **load case 01**

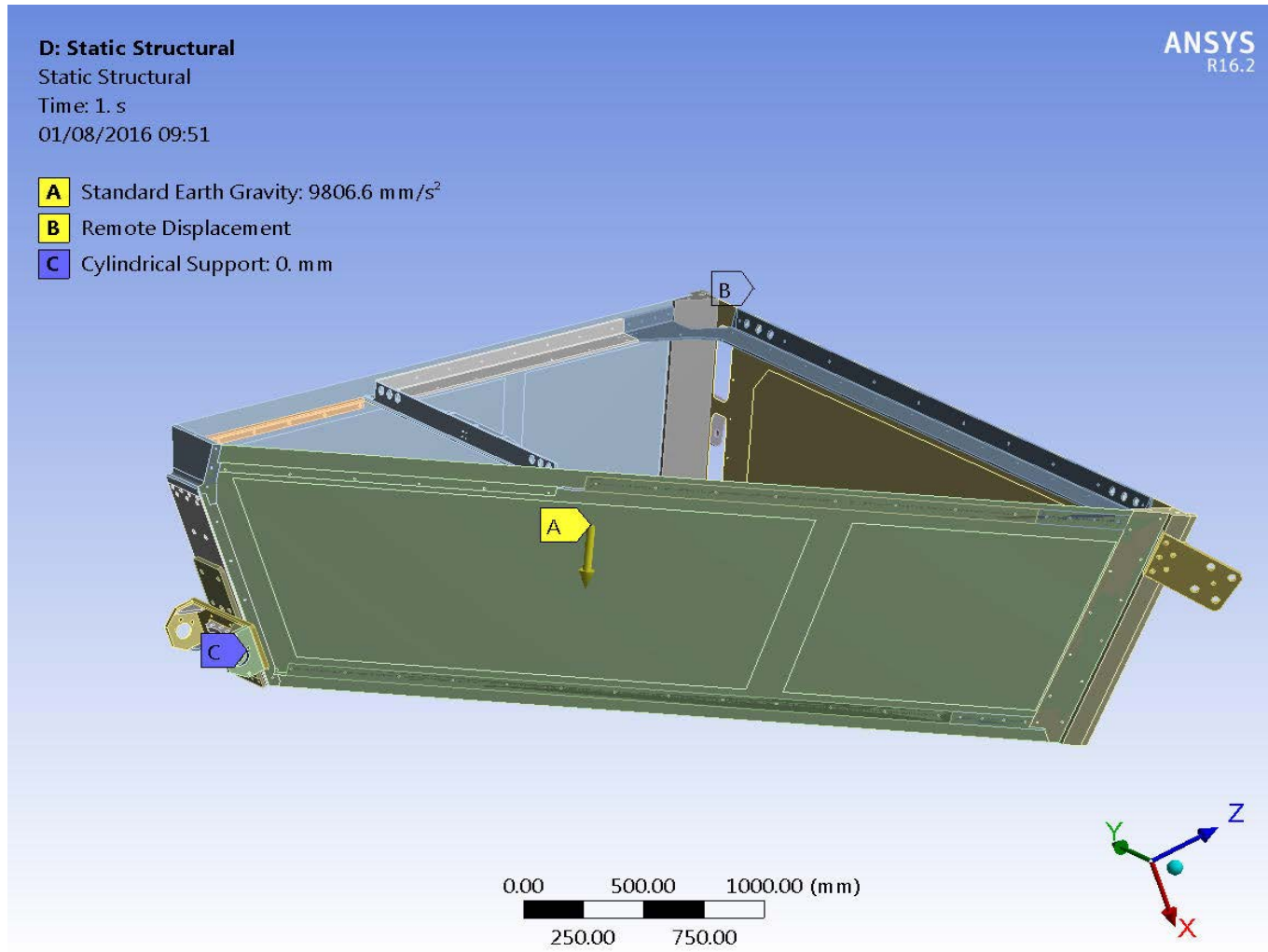
$$R_x = -3928 \text{ N}$$

$$R_y = 3513 \text{ N}$$

FEM file location

Files						
	A	B	C	D	E	
1	Name	Ce...	Size	Type	Date Modified	
2	 Assy_metal envelope.iam	A2,B3	311 KB	Geometry File	19/06/2015 17:54:05	C:\Lavori\Lavori_INFN\CLAS12\CLAS12-2013-10-18\Workspaces\Area di lavoro\envelope_FEM
3	 material.engd	B2,D2	90 KB	Engineering Data File	27/07/2016 14:11:40	dp0\SYS\ENGD
4	 SYS.engd	B4	90 KB	Engineering Data File	27/07/2016 14:11:40	dp0\global\MECH
5	 SYS.mechdb	B4	17 MB	Mechanical Database File	03/08/2016 13:53:40	dp0\global\MECH
6	 2016-07-27-rich-case-fem.wbpj		435 KB	Workbench Project File	03/08/2016 13:52:19	C:\Lavori\Lavori_INFN\CLAS12\Envelope\FEM\2016-07-27-RICH CASE
7	 EngineeringData.xml	B2,D2		Engineering Data File		dp0\SYS\ENGD
8	 2016-07-27-ASSEMBLY Rich External Box	C2,D3	733 KB	Geometry File	29/07/2016 12:15:27	C:\Lavori\Lavori_INFN\CLAS12\Envelope\FEM\2016-07-27-RICH CASE\2016-07-27-Geometry
9	 SYS-1.engd	D4	90 KB	Engineering Data File	27/07/2016 14:11:40	dp0\global\MECH
10	 SYS-1.mechdb	D4	36 MB	Mechanical Database File	01/08/2016 09:30:44	dp0\global\MECH
11	 Assembly_Fixed Parts.iam	E2,F3	125 KB	Geometry File	01/08/2016 17:08:19	C:\Lavori\Lavori_INFN\CLAS12\Envelope\FEM\2016-07-27-RICH CASE\2016-07-27-Geometry\Rotating base
12	 material.engd	F2	18 KB	Engineering Data File	01/08/2016 10:06:42	dp0\SYS-2\ENGD
13	 SYS-2.engd	F4	18 KB	Engineering Data File	01/08/2016 10:06:42	dp0\global\MECH
14	 SYS-2.mechdb	F4	7 MB	Mechanical Database File	01/08/2016 13:39:29	dp0\global\MECH
15	 Profilo 90x180 Tecnavan Type Horizontal	G2,H3	2 MB	Geometry File	01/08/2016 13:43:15	C:\Lavori\Lavori_INFN\CLAS12\Struttura assemblaggio RICH\Geometry
16	 material.engd	H2	29 KB	Engineering Data File	01/08/2016 13:41:18	dp0\SYS-3\ENGD
17	 SYS-3.engd	H4	29 KB	Engineering Data File	01/08/2016 13:41:18	dp0\global\MECH
18	 SYS-3.mechdb	H4	6 MB	Mechanical Database File	01/08/2016 13:42:00	dp0\global\MECH

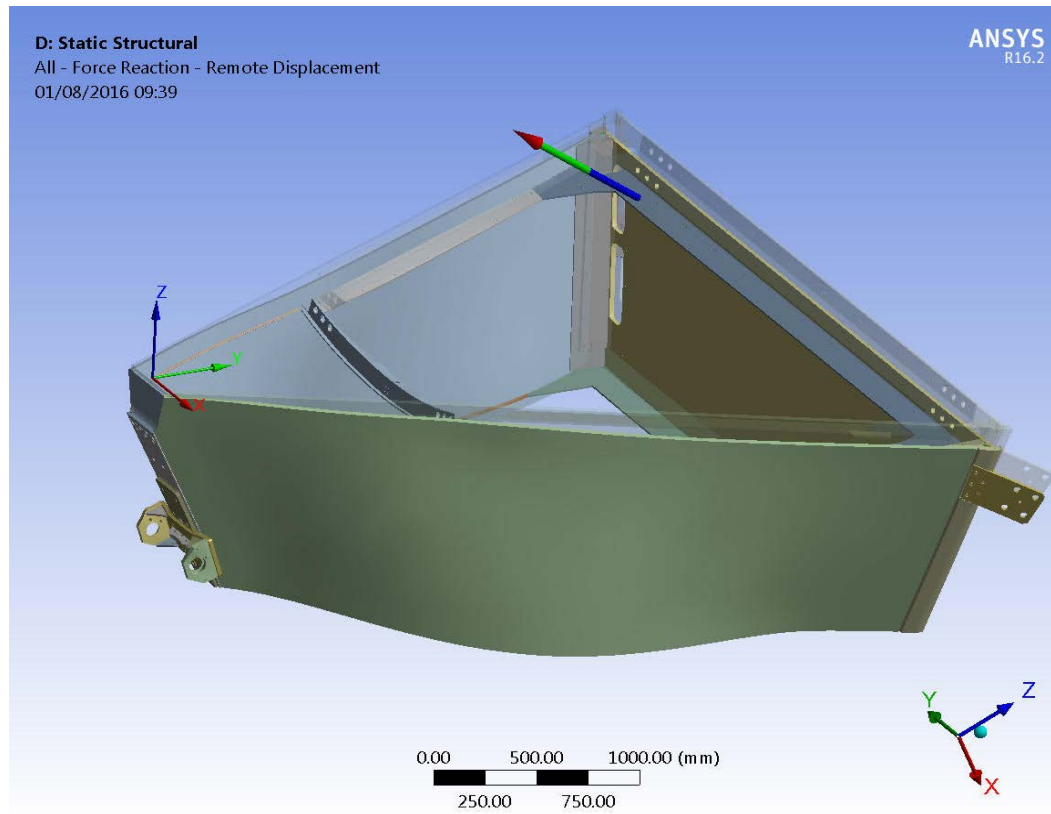
FEM ANALYSIS ANSYS: Supports and loads



FEM Results: LIFT Force

Note: the lift force and the reaction force at the cylindrical support were evaluated by means of the **FEM Ansys code** and it was a cross check of what was evaluated analytically and reported in the two previous slides.

Conclusions: **the FEM results agree with the analytical solution.**



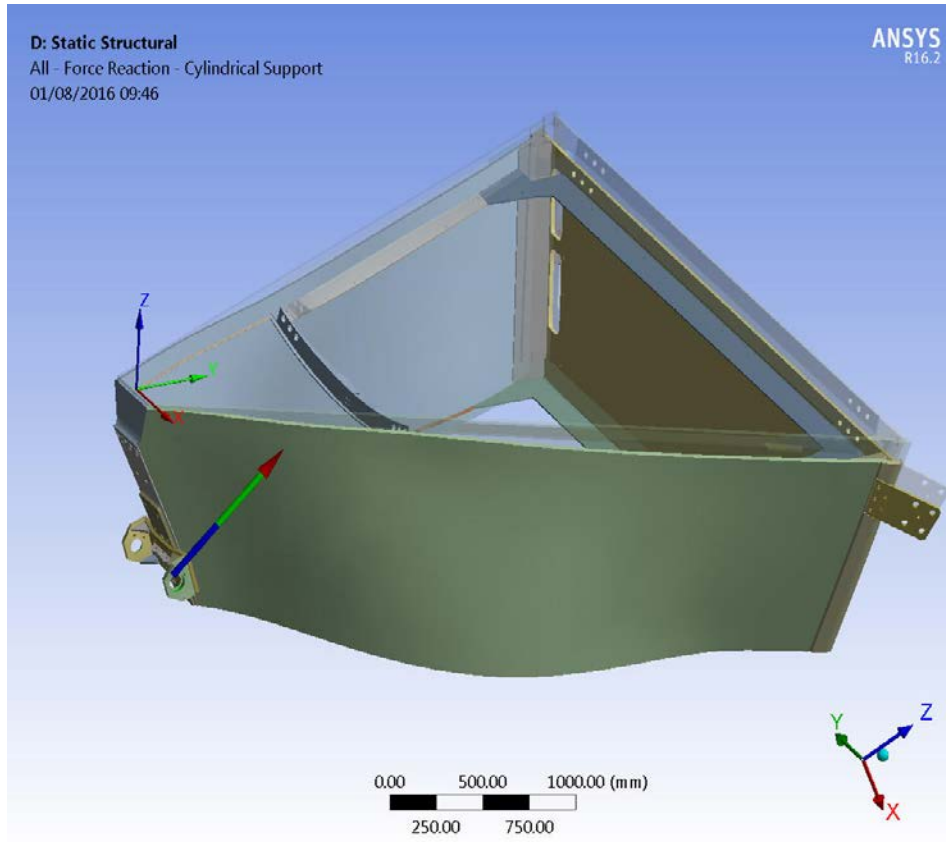
Details of "All - Force Reaction - Remote Displacement"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Remote Displacement
Orientation	Coordinate System for remote point
Suppressed	No

Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	-7.4596 N
<input type="checkbox"/> Y Axis	-3986.1 N
<input type="checkbox"/> Z Axis	2782.3 N
<input type="checkbox"/> Total	4861.1 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	-7.4596 N
<input type="checkbox"/> Y Axis	-3986.1 N
<input type="checkbox"/> Z Axis	2782.3 N
<input type="checkbox"/> Total	4861.1 N

FEM Results: Reaction Force @ Cylindrical Support



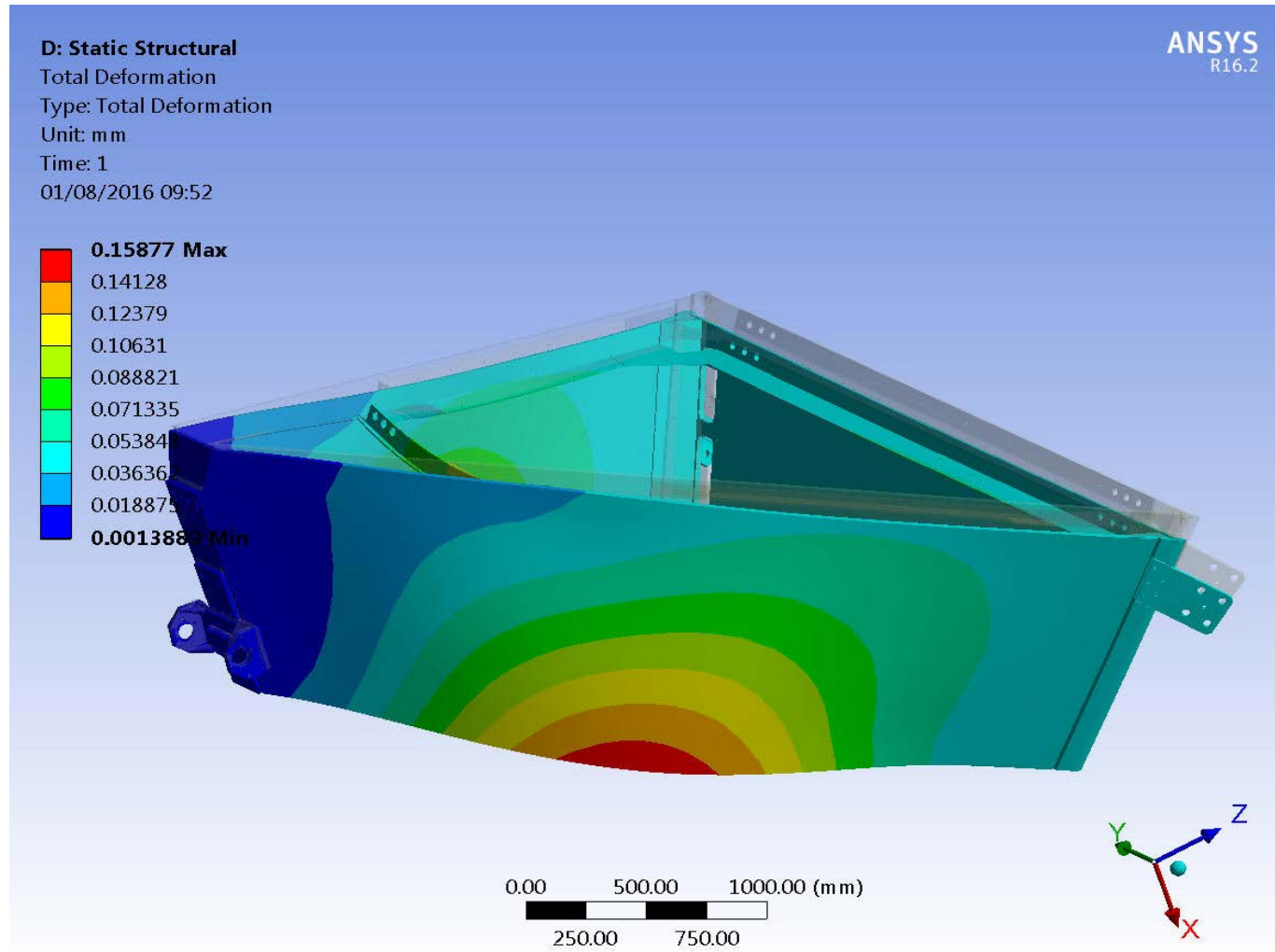
Details of "All - Force Reaction - Cylindrical Support"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Cylindrical Support
Orientation	Coordinate System for remote point
Suppressed	No

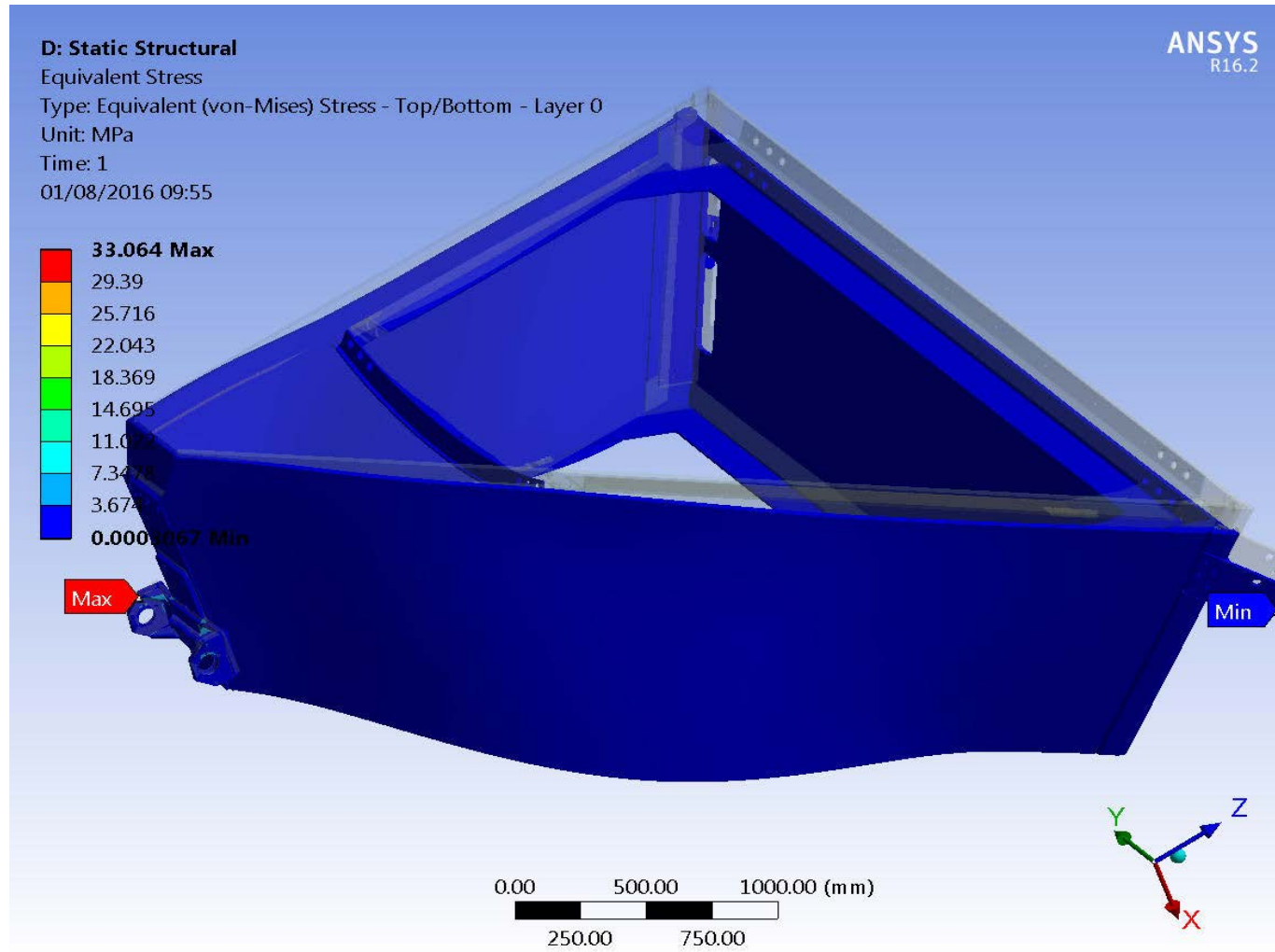
Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	7.4594 N
<input type="checkbox"/> Y Axis	3986.1 N
<input type="checkbox"/> Z Axis	3535.1 N
<input type="checkbox"/> Total	5327.8 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	7.4594 N
<input type="checkbox"/> Y Axis	3986.1 N
<input type="checkbox"/> Z Axis	3535.1 N
<input type="checkbox"/> Total	5327.8 N

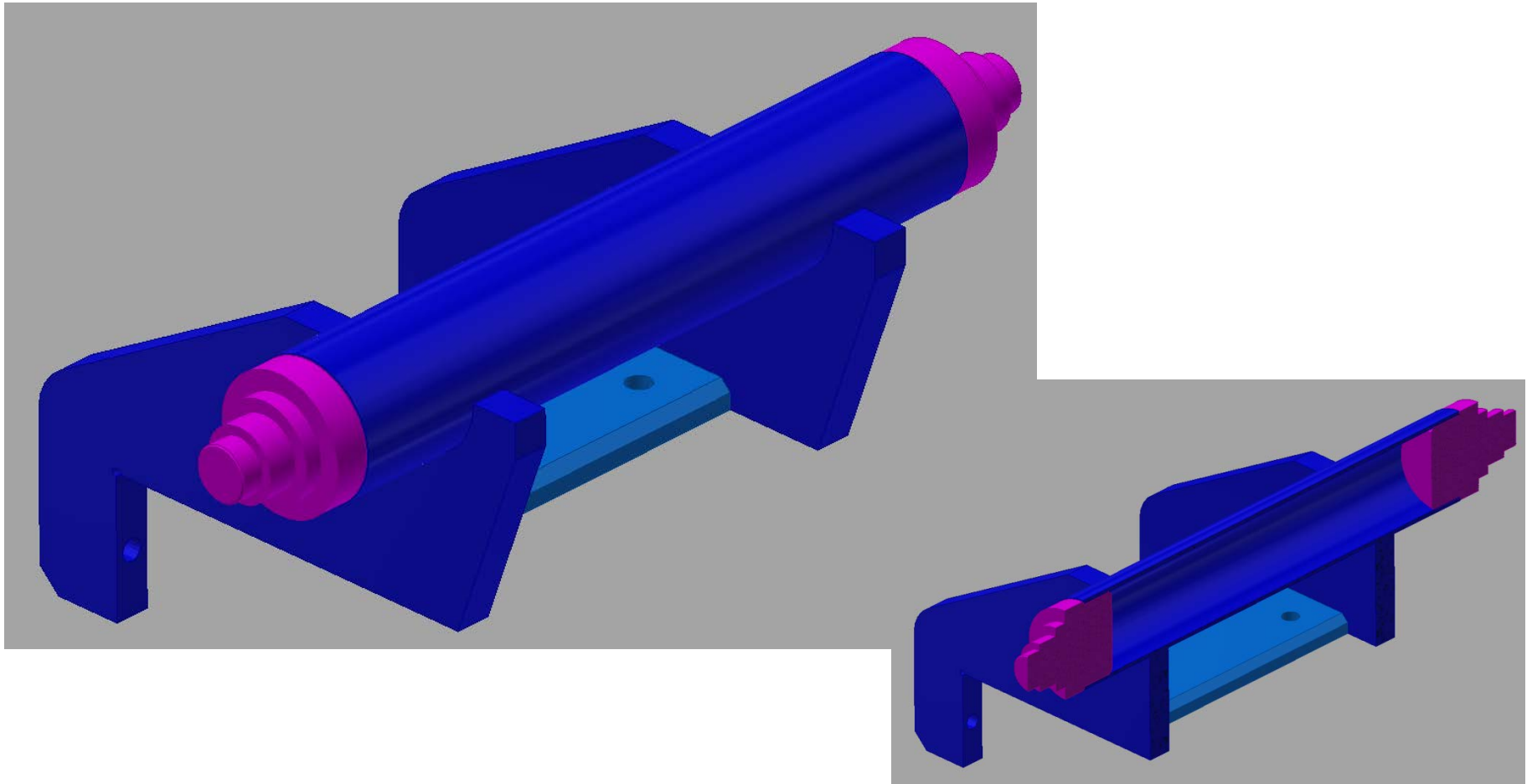
FEM Results: Total Deformation



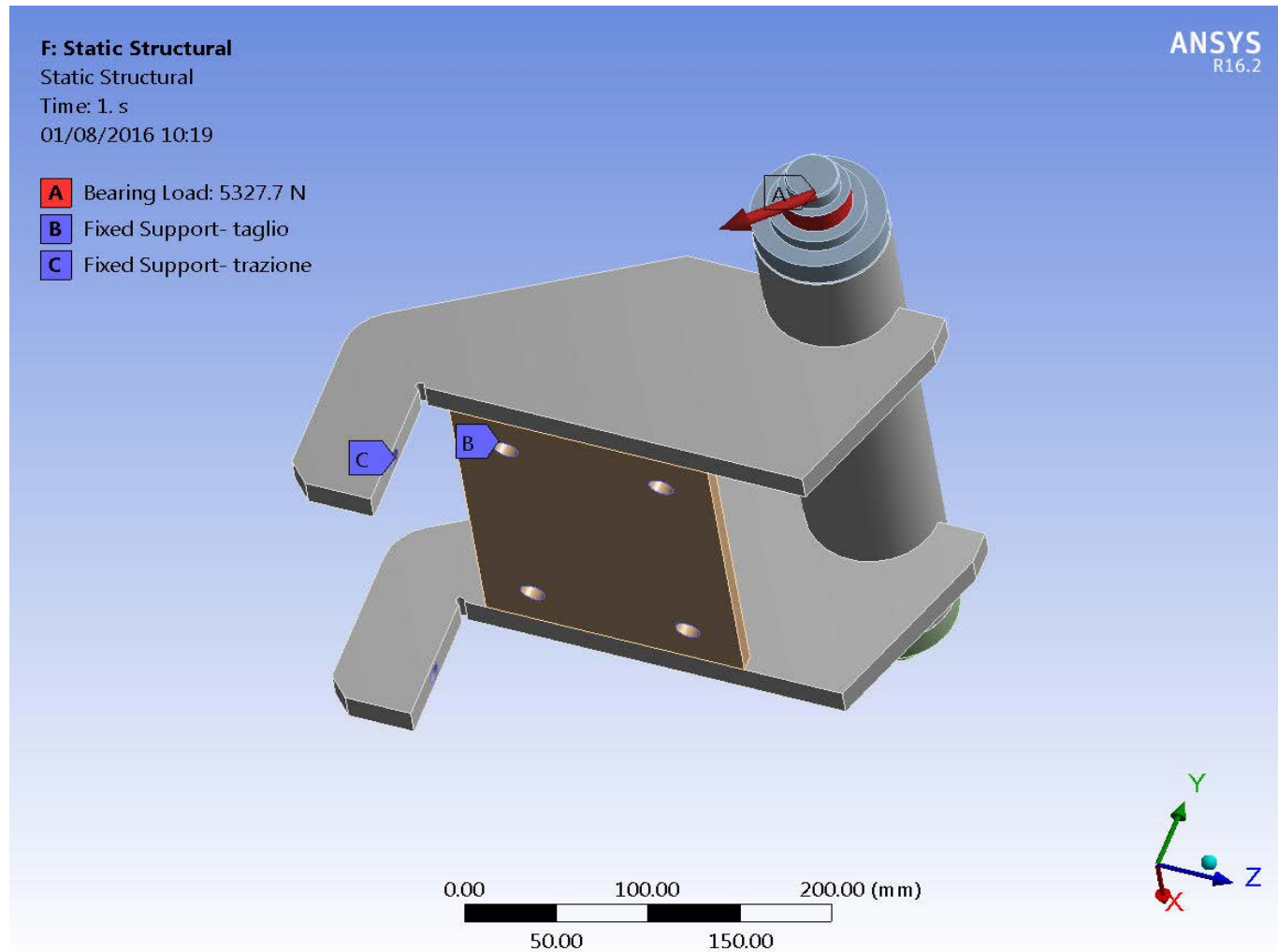
FEM Results: Stress Equivalent



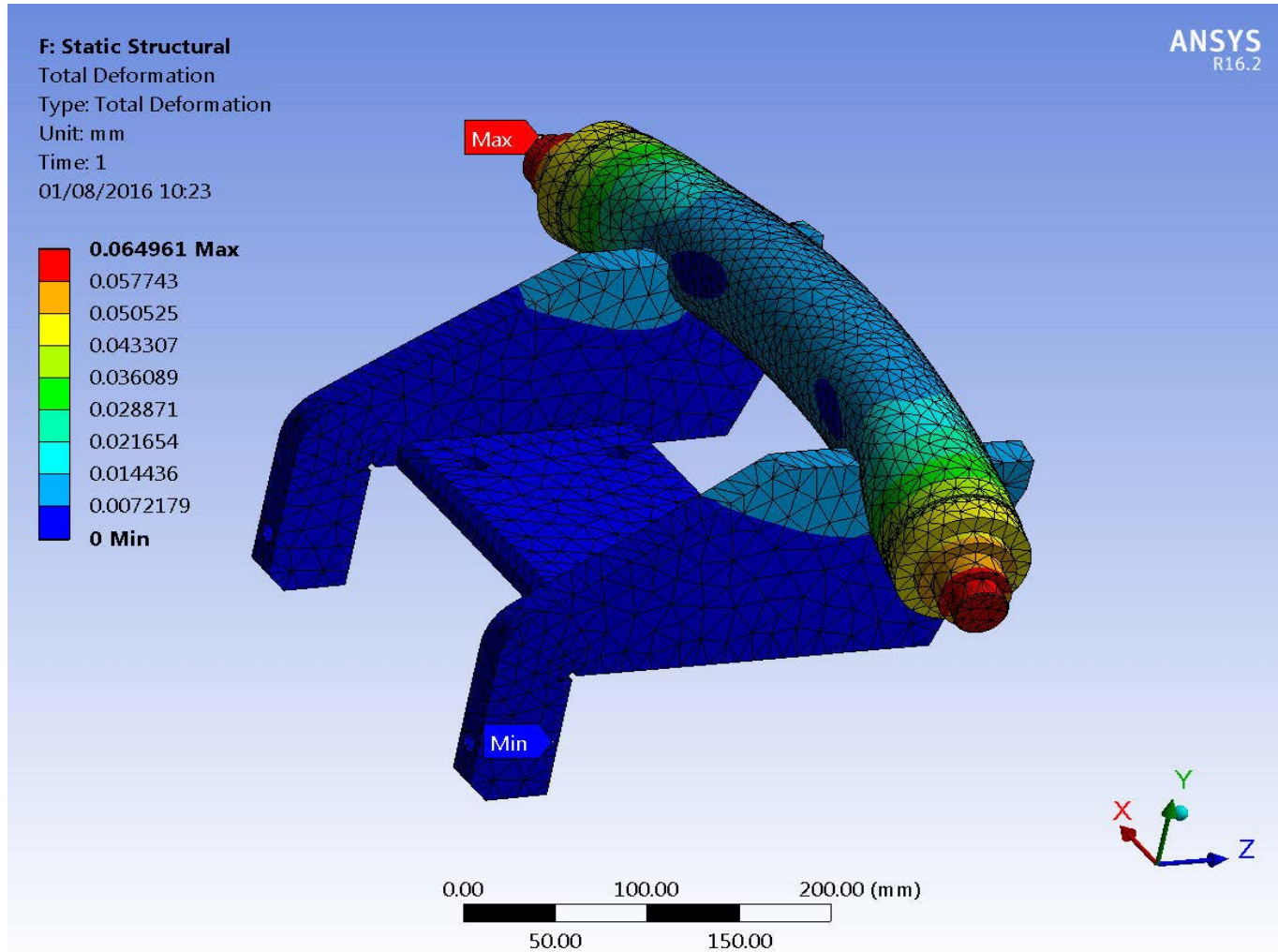
Rotating Base: geometry



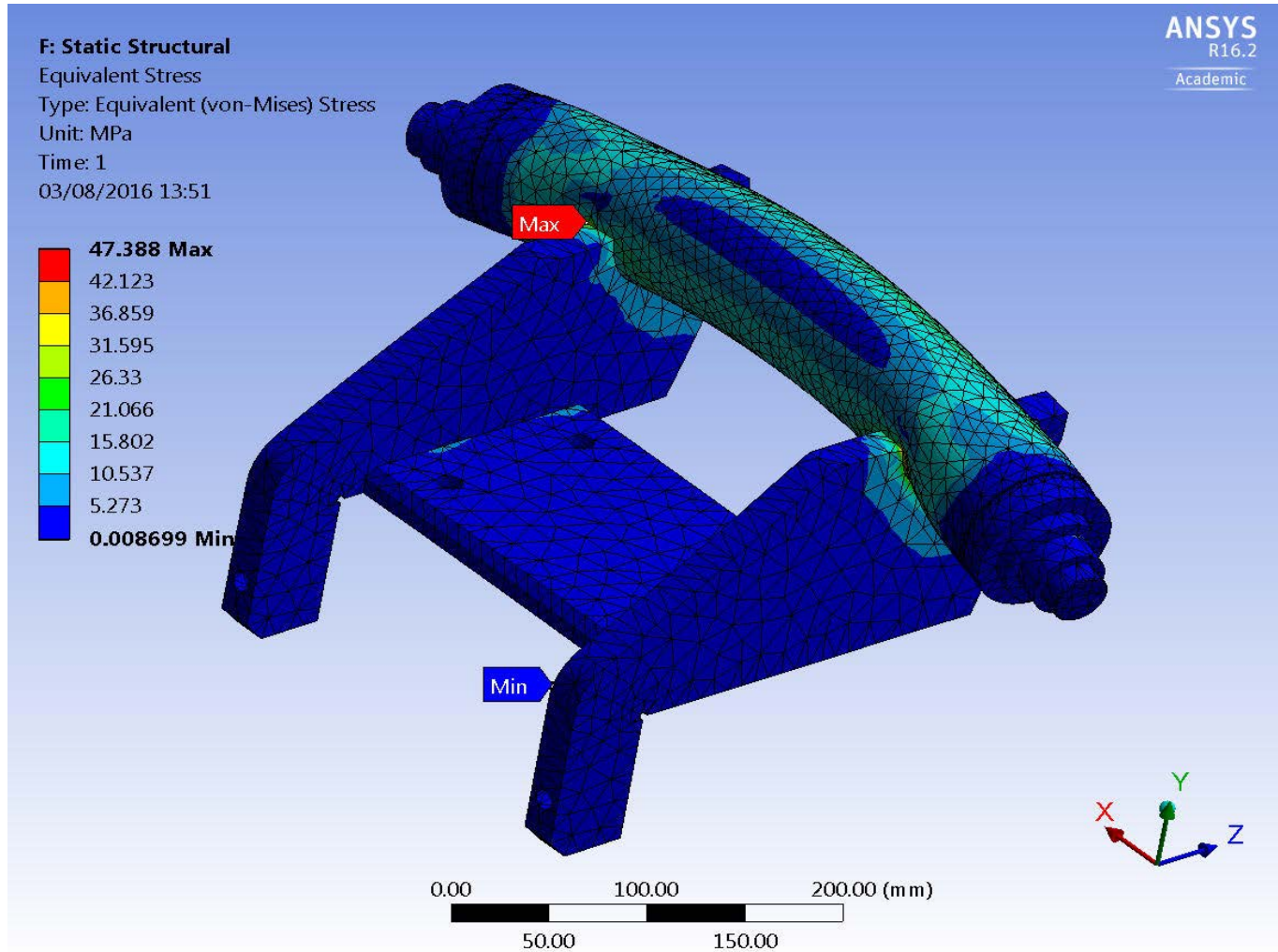
Loads and Constrains



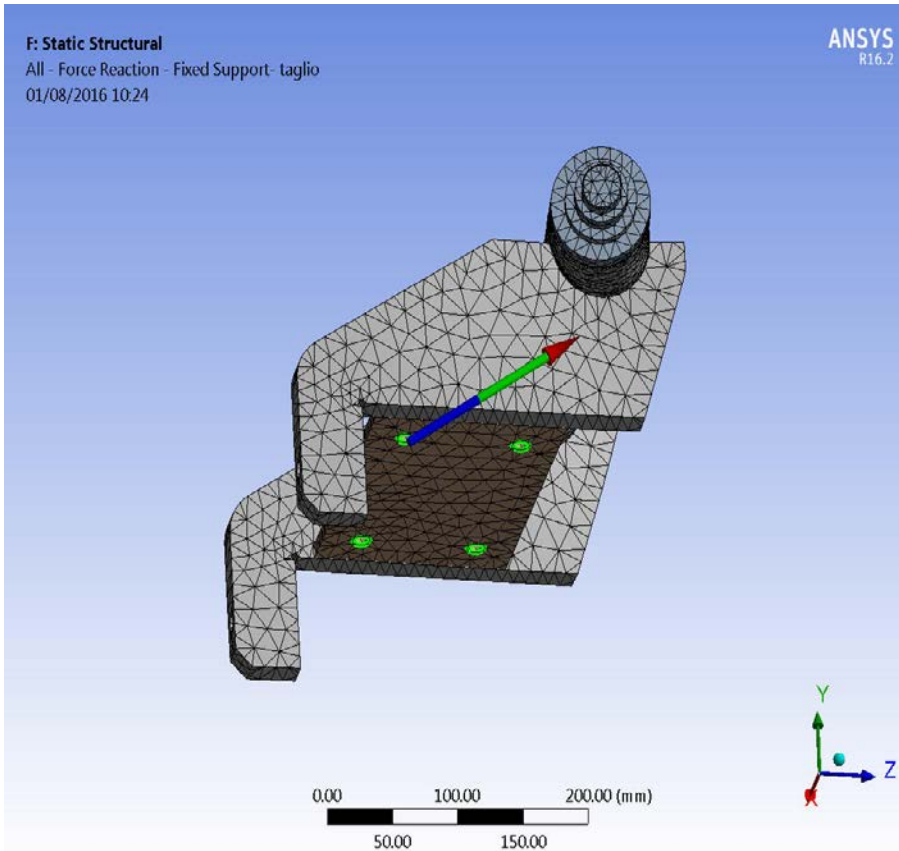
Total Deformations



Stress equivalent: Von Mises



Reaction Force 01



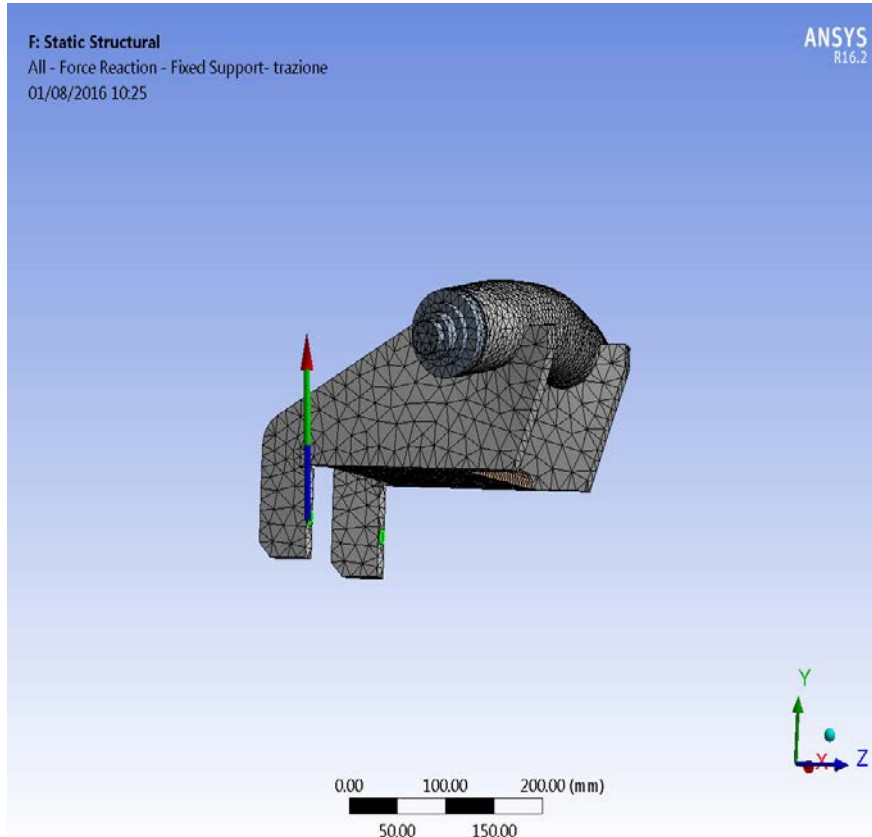
Details of "All - Force Reaction - Fixed Support- taglio"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Fixed Support- taglio
Orientation	Global Coordinate System
Suppressed	No

Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	-5.7574 N
<input type="checkbox"/> Y Axis	2528.6 N
<input type="checkbox"/> Z Axis	4149.6 N
<input type="checkbox"/> Total	4859.3 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	-5.7574 N
<input type="checkbox"/> Y Axis	2528.6 N
<input type="checkbox"/> Z Axis	4149.6 N
<input type="checkbox"/> Total	4859.3 N

Reaction Force 02



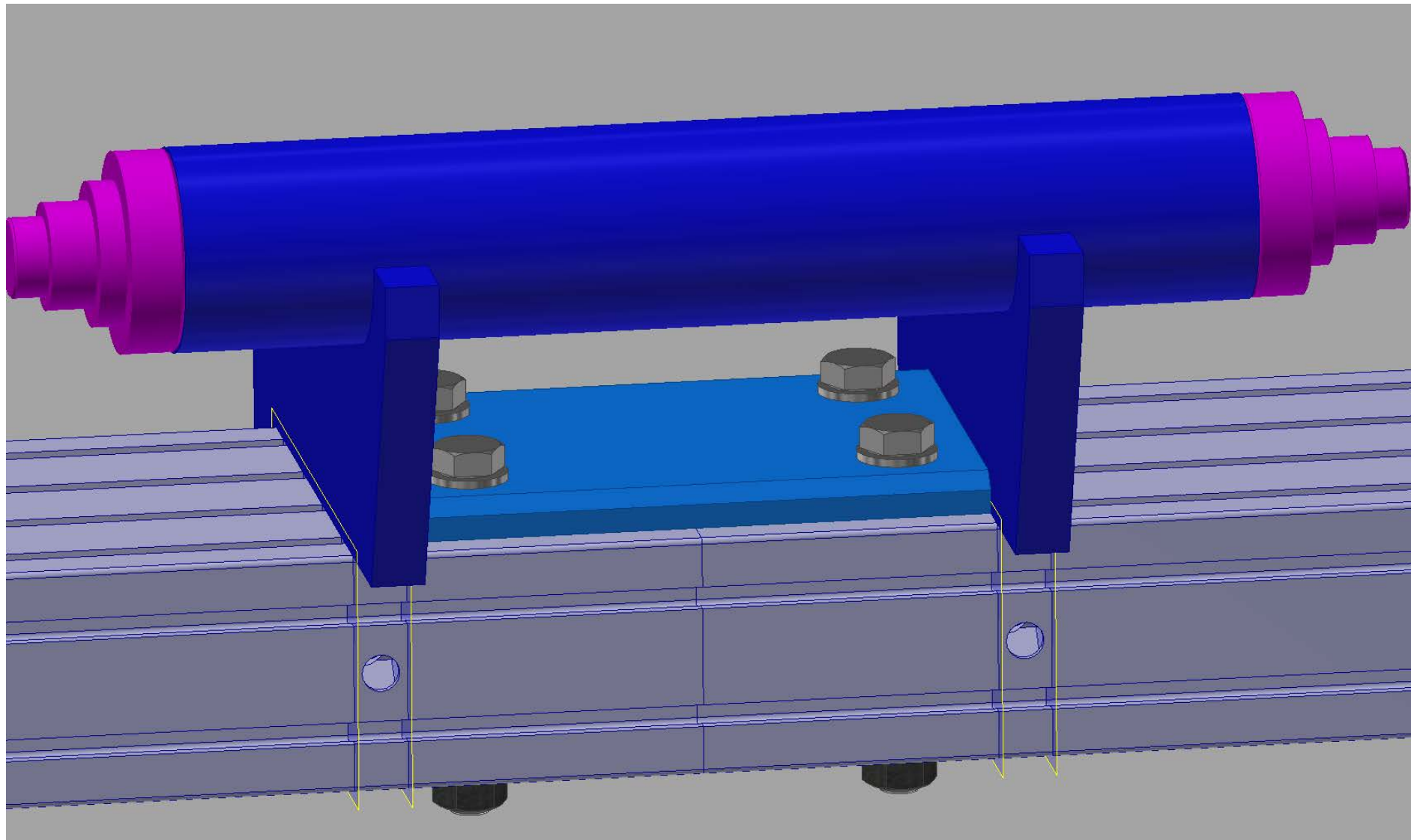
Details of "All - Force Reaction - Fixed Support- trazione"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Fixed Support- trazione
Orientation	Global Coordinate System
Suppressed	No

Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	5.7574 N
<input type="checkbox"/> Y Axis	1092.2 N
<input type="checkbox"/> Z Axis	-66.841 N
<input type="checkbox"/> Total	1094.3 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	5.7574 N
<input type="checkbox"/> Y Axis	1092.2 N
<input type="checkbox"/> Z Axis	-66.841 N
<input type="checkbox"/> Total	1094.3 N

Bolted connection: geometry



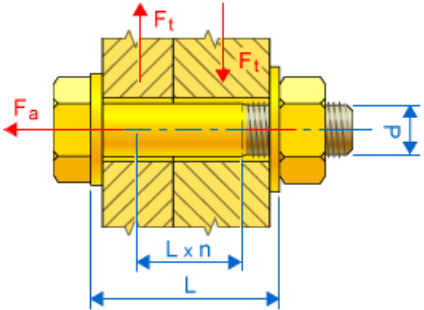
Bolted connection check

Bolted Connection Component Generator

Design Calculation Fatigue Calculation

Type of Strength Calculation
Check calculation

Loads



Maximal Axial Force F_a 2528 N
 Maximal Tangent Force F_t 4149 N
 Tightness Factor k 1.50 ul
 Force Input Factor n 0.50 ul
 Joint Friction Factor f 0.40 ul
 Required Safety Factor k_s 3.00 ul

Plates Material
 User material
 Modulus of Elasticity E_2 206700 MPa

Joint Properties
 Functional Width L 128.900 mm

Bolt
 Number of bolts z 4 ul
 Thread Diameter d 16.000 mm
 Pitch p 1.500 mm
 Mean Bolt Diameter d_s 15.026 mm
 Minimal Bolt Diameter d_{min} 14.160 mm

Bolt Material
 User material
 Yield Strength S_y 324 MPa
 Modulus of Elasticity E_1 207000 MPa
 Allowable Thread Pressure p_a 40 MPa
 Thread Friction Factor f_1 0.20 ul
 Head Friction Factor f_2 0.25 ul

Results

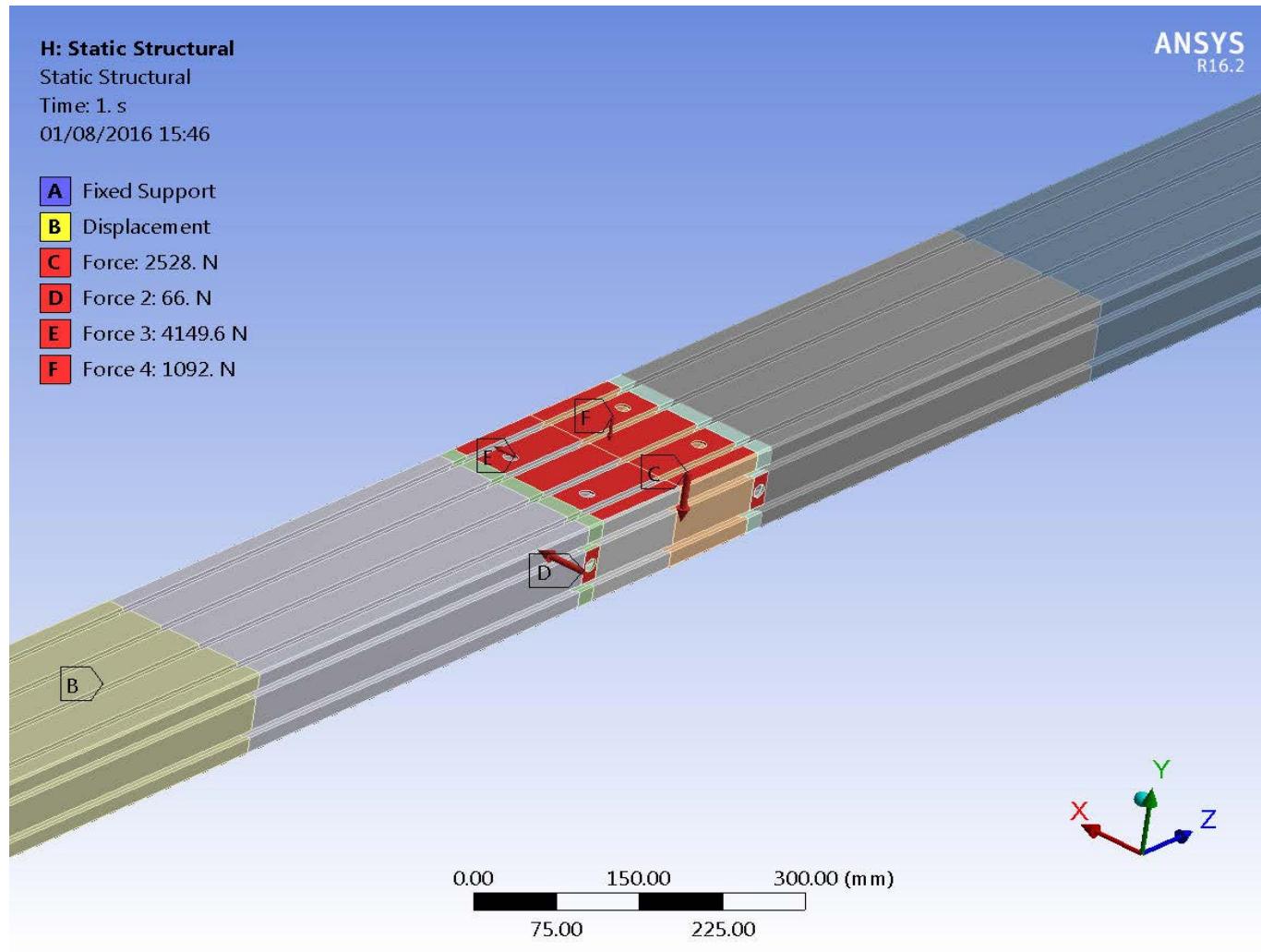
F_v	4787.606 N
F_{max}	4837.688 N
M_u	23.078 N m
σ_t	30.403 MPa
τ_k	41.401 MPa
σ_{red}	77.888 MPa
σ_{max}	30.721 MPa
p_c	14.634 MPa
k_{sc}	4.15981 ul

13:45:22 Calculation: Calculation indicates design compliance!

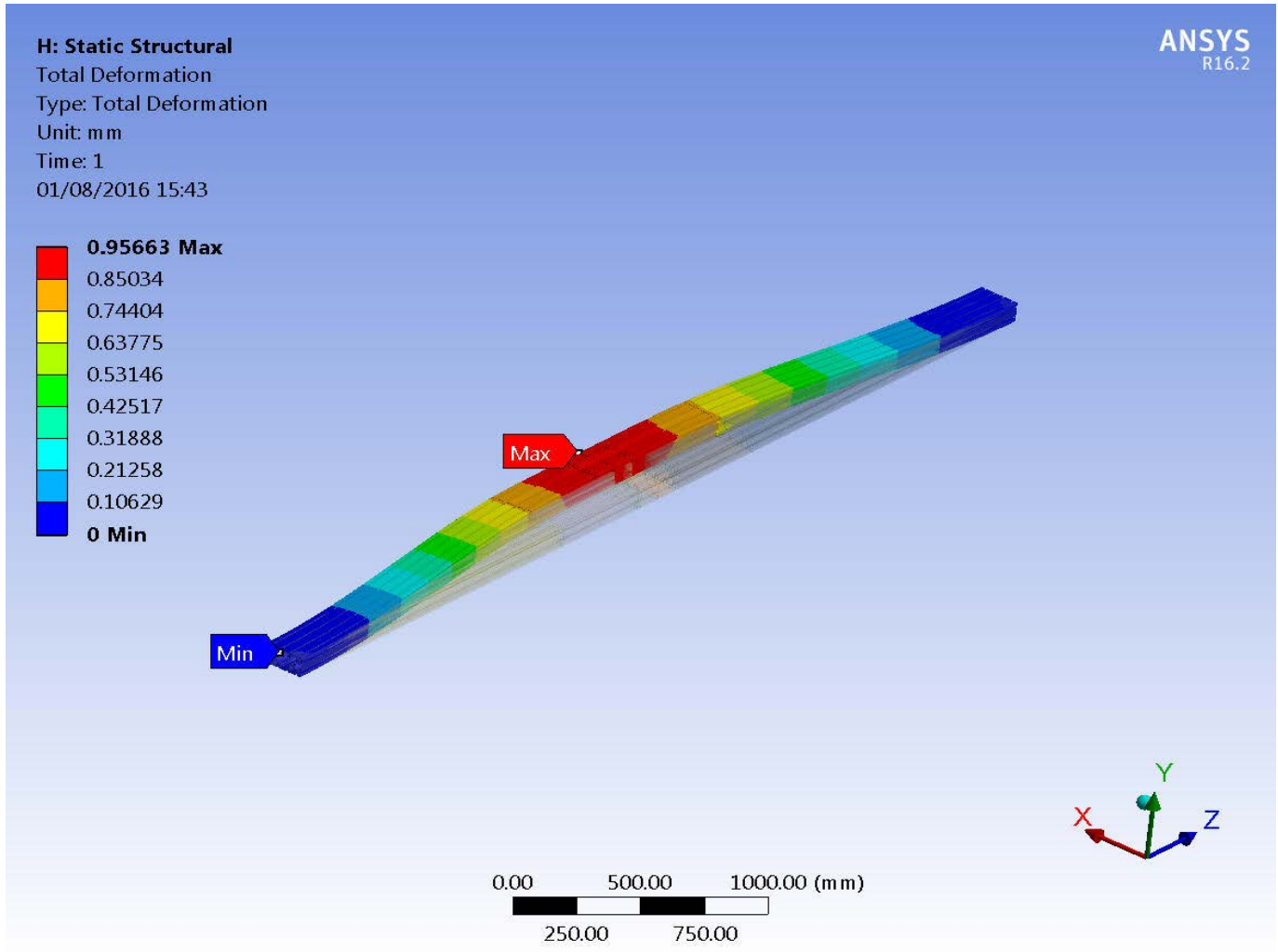
Calculate OK Cancel <<

Diameters settings
 Mean Bolt Diameter d_s is equal to Thread Pitch Diameter d_2
 Minimal Bolt Diameter d_{min} is equal to Thread Minor Diameter d_1 or d_3 (metric thread)

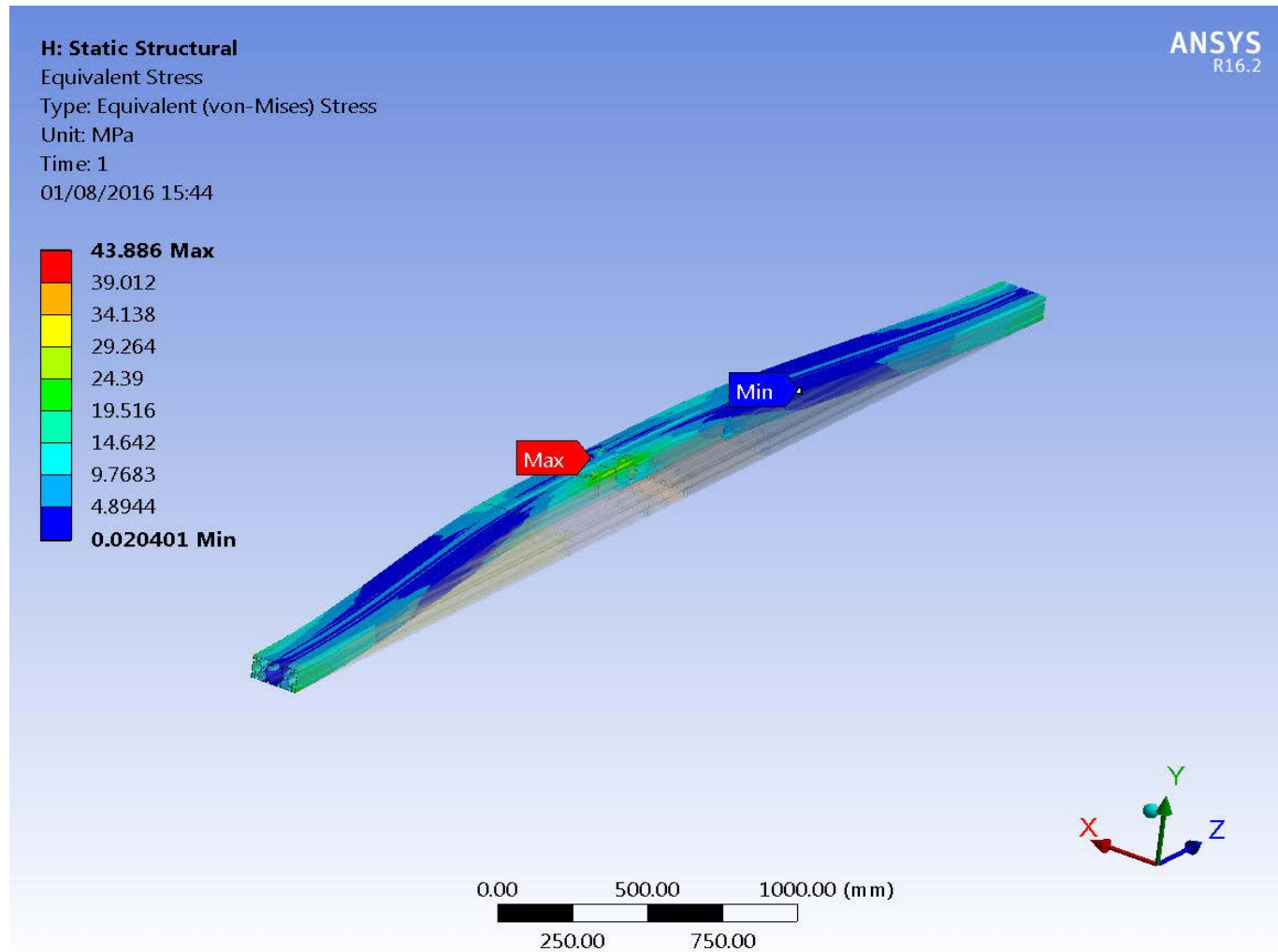
Al beam check: loads



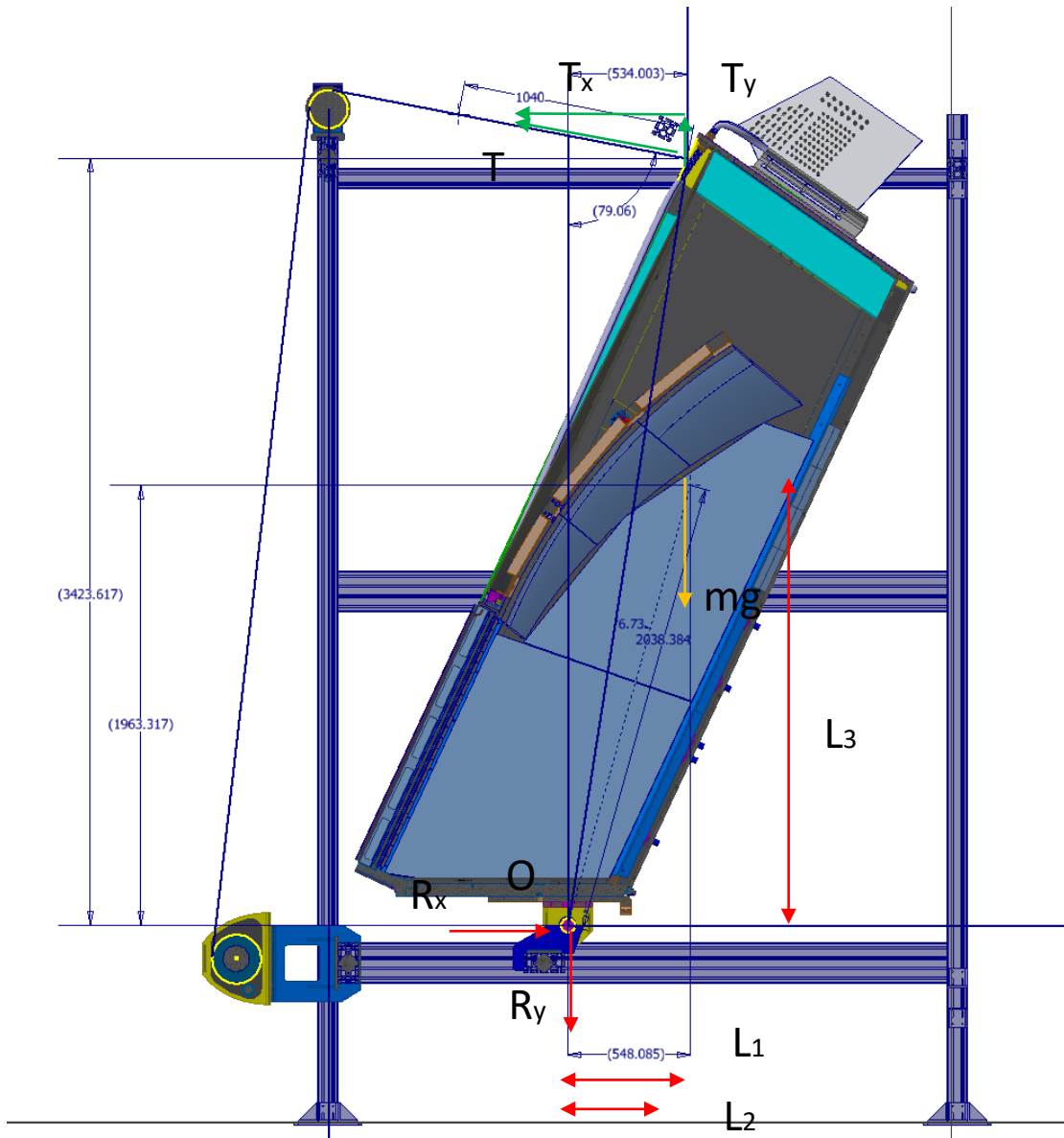
AI beam check: total deformation



Al beam check: equivalent stress



GEOMETRY: vertical



$$R_x - T_x = 0$$

$$T_y - mg - R_y = 0$$

$$T_x L_3 + T_y L_2 - mg L_1 = 0$$

$$T_x = T \sin \theta$$

$$T_y = T \cos \theta$$

$$L_1 = 548 \text{ mm}$$

$$L_2 = 534 \text{ mm}$$

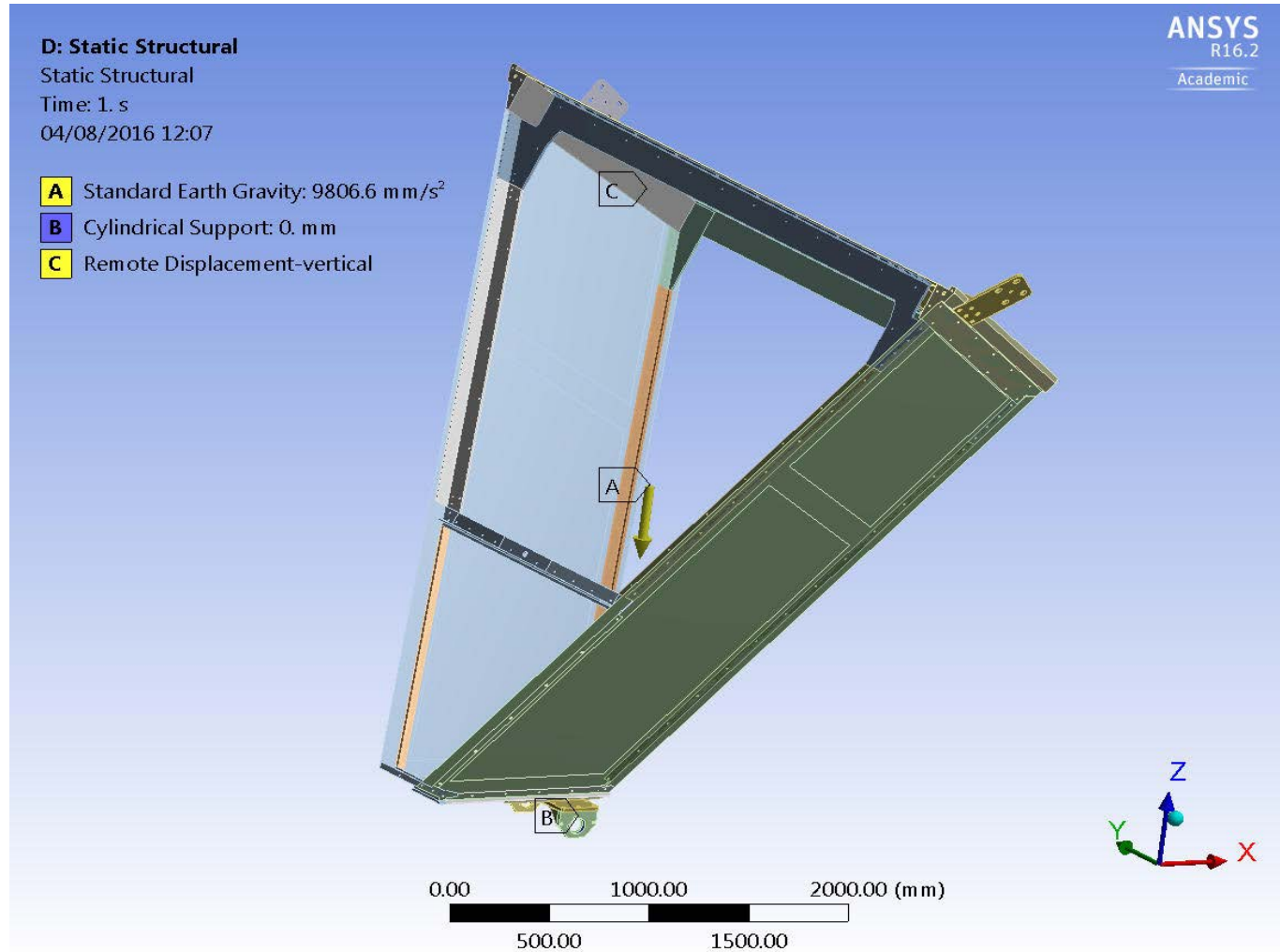
$$L_3 = 1963 \text{ mm}$$

Force and Torque Equilibrium: RICH frame only

$$\left[\begin{array}{l} R_x - T_x = 0 \\ T_y - mg - R_y = 0 \\ T_x L_3 + T_y L_2 - mg L_1 = 0 \\ T_x = T \sin \theta \\ T_y = T \cos \theta \end{array} \right. \quad \left[\begin{array}{l} R_x = T_x \\ R_y = T_y - mg \\ T \sin \theta L_3 + T \cos \theta L_2 - mg L_1 = 0 \end{array} \right.$$

$$\left[\begin{array}{l} R_x = T_x \\ R_y = T_y - mg \\ T = \frac{mg L_1}{L_3 \sin \theta + L_2 \cos \theta} \\ T_x = T \sin \theta \\ T_y = T \cos \theta \end{array} \right. \quad \left[\begin{array}{l} R_x = 1590 \text{ N} \\ R_y = 309 - 6000 = -5691 \text{ N} \\ T = \frac{600 \cdot 10 \cdot 548}{1963 \sin 79 + 534 \cos 79} = \mathbf{1620 \text{ N}} \\ T_x = 1620 \sin 79 = 1590 \text{ N} \\ T_y = 1620 \cos 79 = 309 \text{ N} \end{array} \right.$$

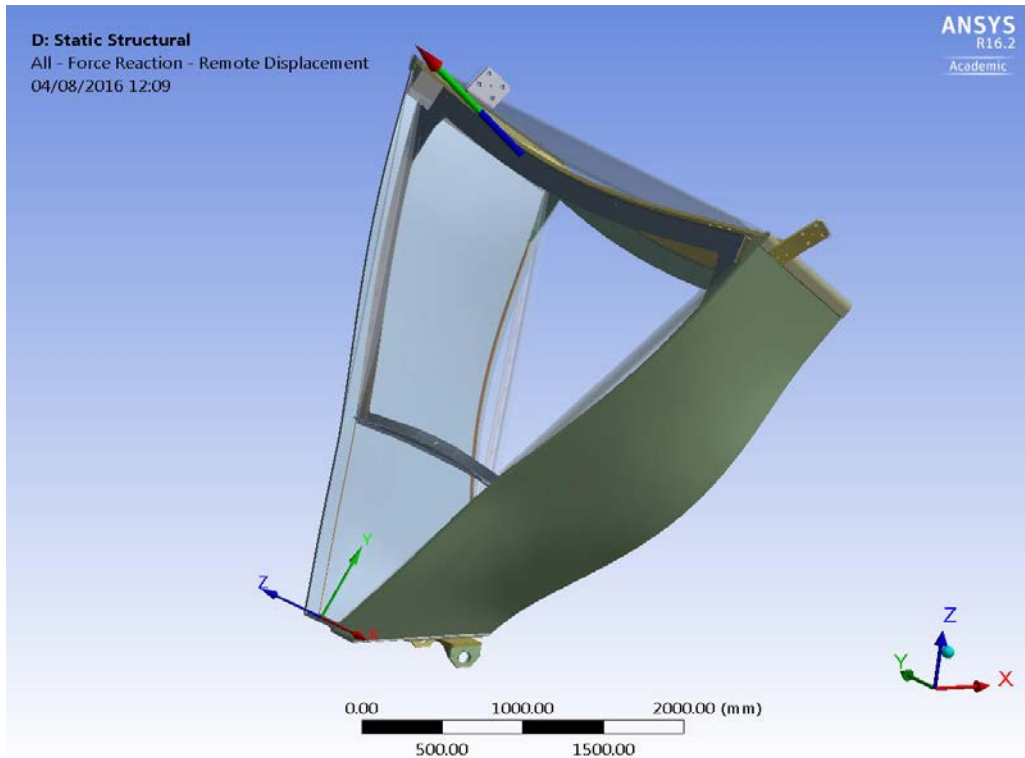
FEM ANALYSIS ANSYS: Supports and loads



FEM Results: LIFT Force

Note: the lift force and the reaction force at the cylindrical support were evaluated by means of the **FEM Ansys code** and it was a cross check of what was evaluated analytically and reported in the two previous slides.

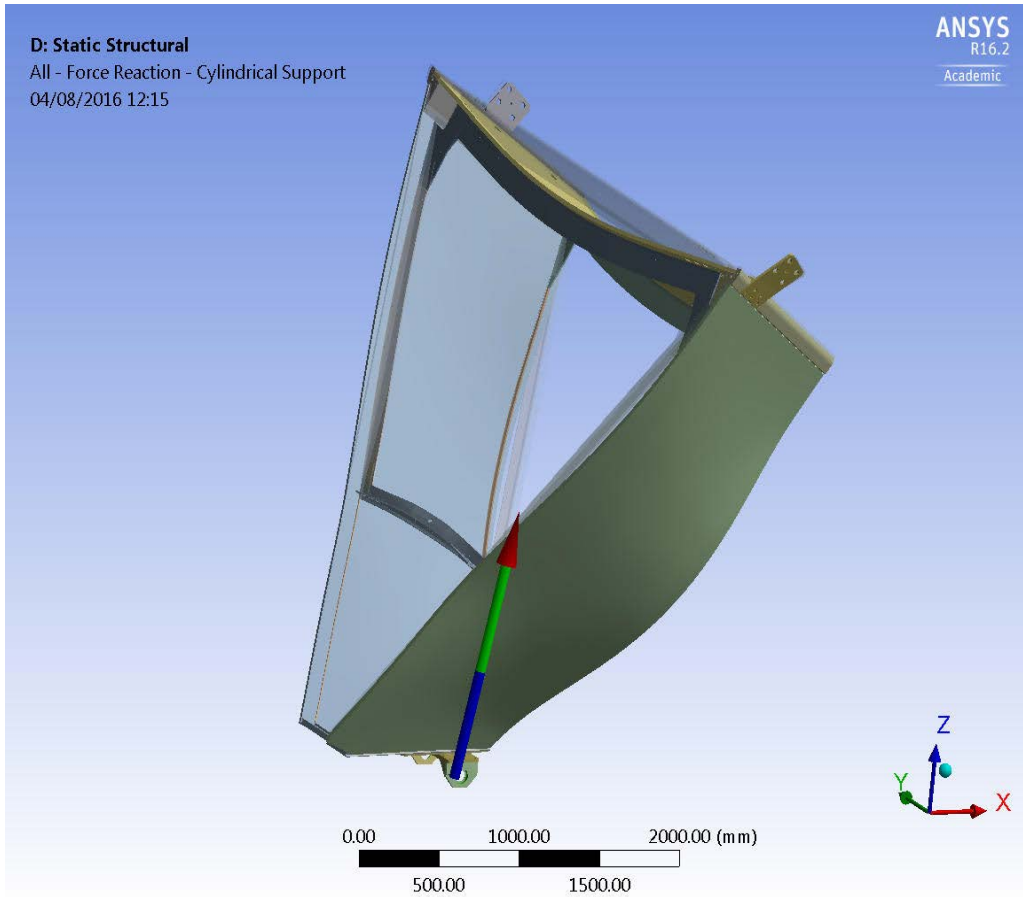
Conclusions: **the FEM results agree with the analytical solution.**



Details of "All - Force Reaction - Remote Displacement"

<input type="checkbox"/> Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Remote Displacement-vertical
Orientation	Global Coordinate System
Suppressed	No
<input type="checkbox"/> Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time
<input checked="" type="checkbox"/> Results	
<input type="checkbox"/> Maximum Value Over Time	
<input type="checkbox"/> X Axis	-913.18 N
<input type="checkbox"/> Y Axis	41.255 N
<input type="checkbox"/> Z Axis	833.98 N
<input type="checkbox"/> Total	1237.4 N
<input type="checkbox"/> Minimum Value Over Time	
<input type="checkbox"/> X Axis	-913.18 N
<input type="checkbox"/> Y Axis	41.255 N
<input type="checkbox"/> Z Axis	833.98 N
<input type="checkbox"/> Total	1237.4 N
<input checked="" type="checkbox"/> Information	

FEM Results: Reaction Force @ Cylindrical Support



Details of "All - Force Reaction - Cylindrical Support"

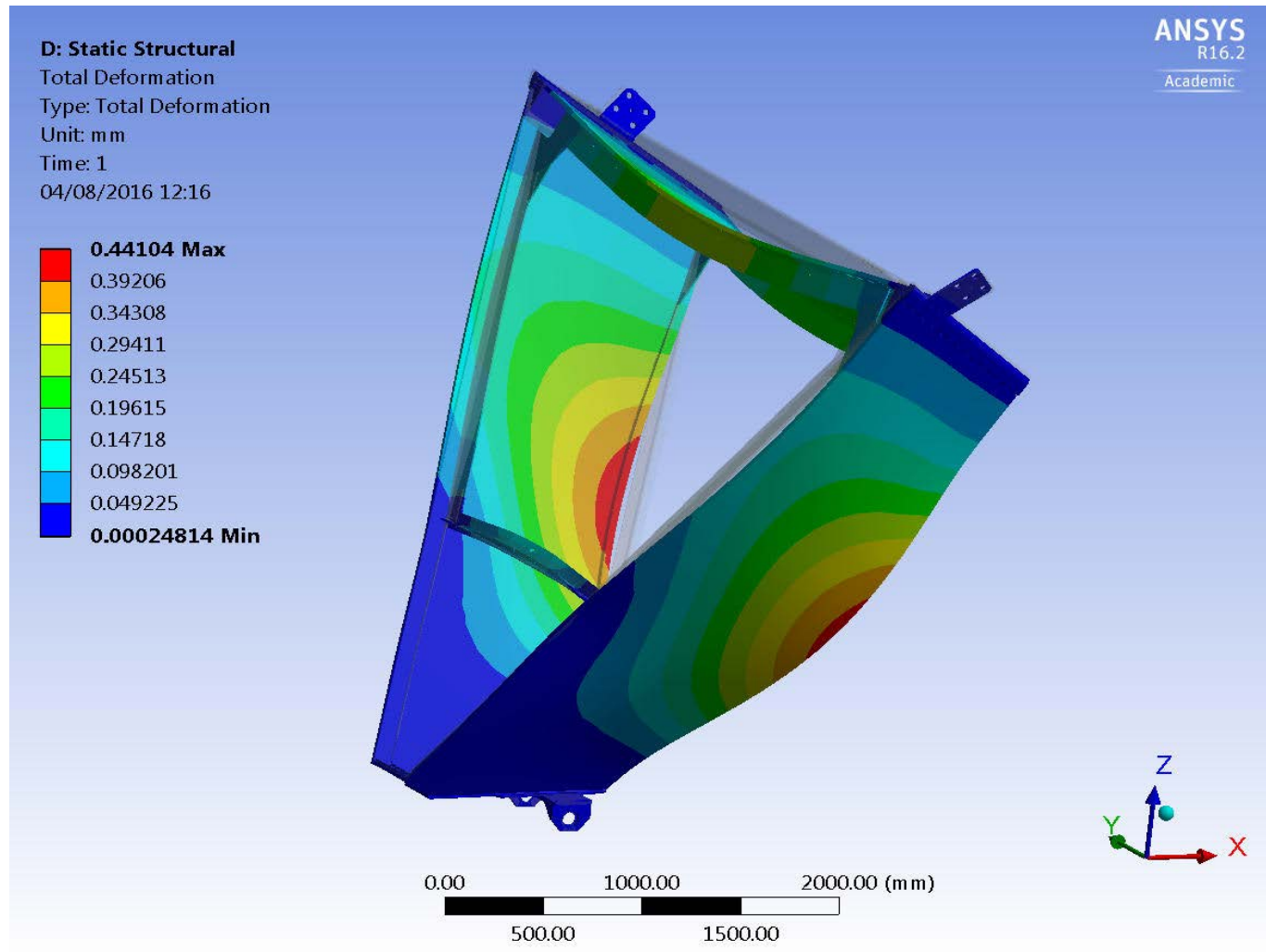
Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Cylindrical Support
Orientation	Global Coordinate System
Suppressed	No

Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

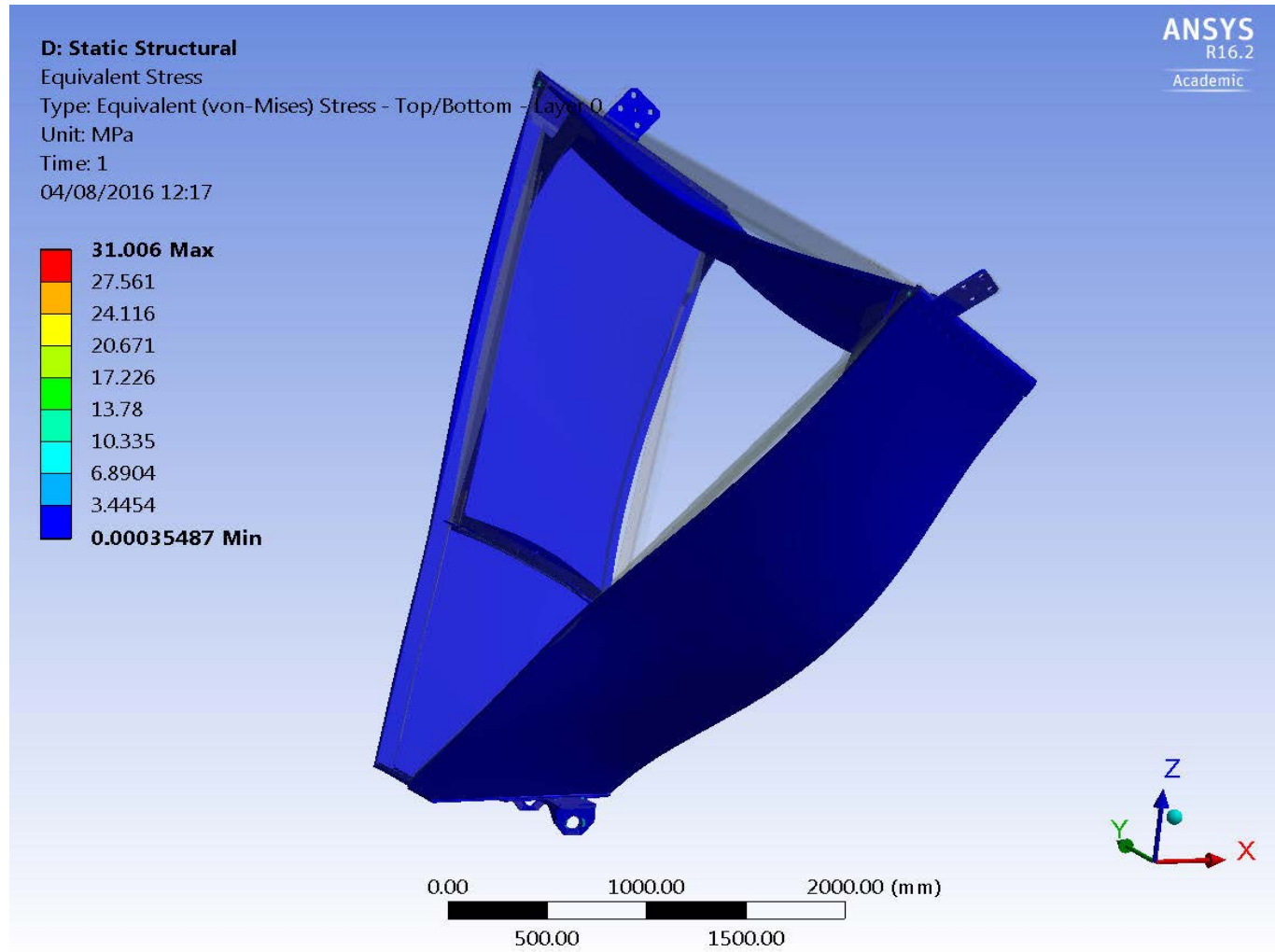
Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	913.18 N
<input type="checkbox"/> Y Axis	-41.255 N
<input type="checkbox"/> Z Axis	5483.5 N
<input type="checkbox"/> Total	5559.2 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	913.18 N
<input type="checkbox"/> Y Axis	-41.255 N
<input type="checkbox"/> Z Axis	5483.5 N
<input type="checkbox"/> Total	5559.2 N

Information	
-------------	--

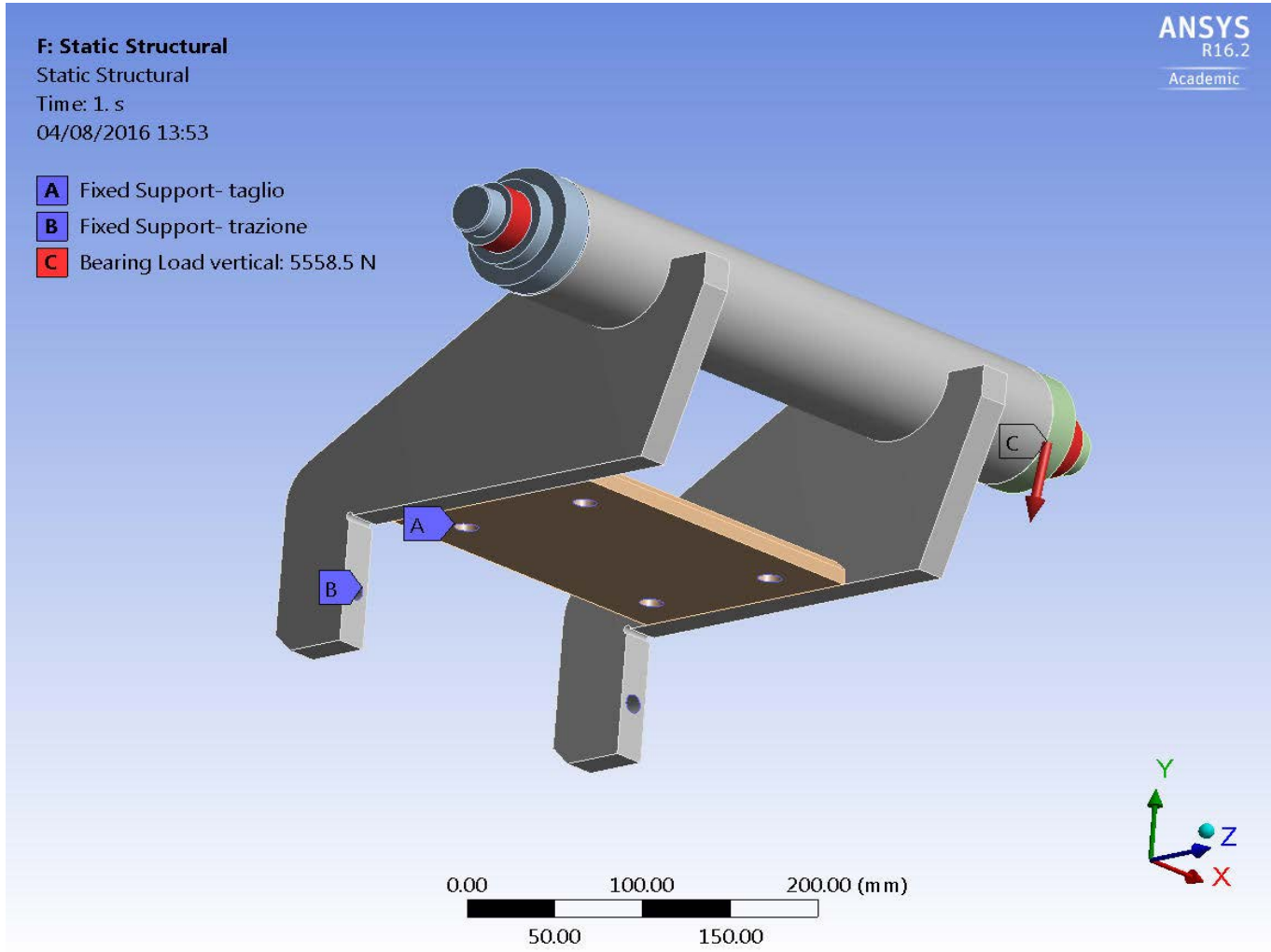
FEM Results: Total Deformation



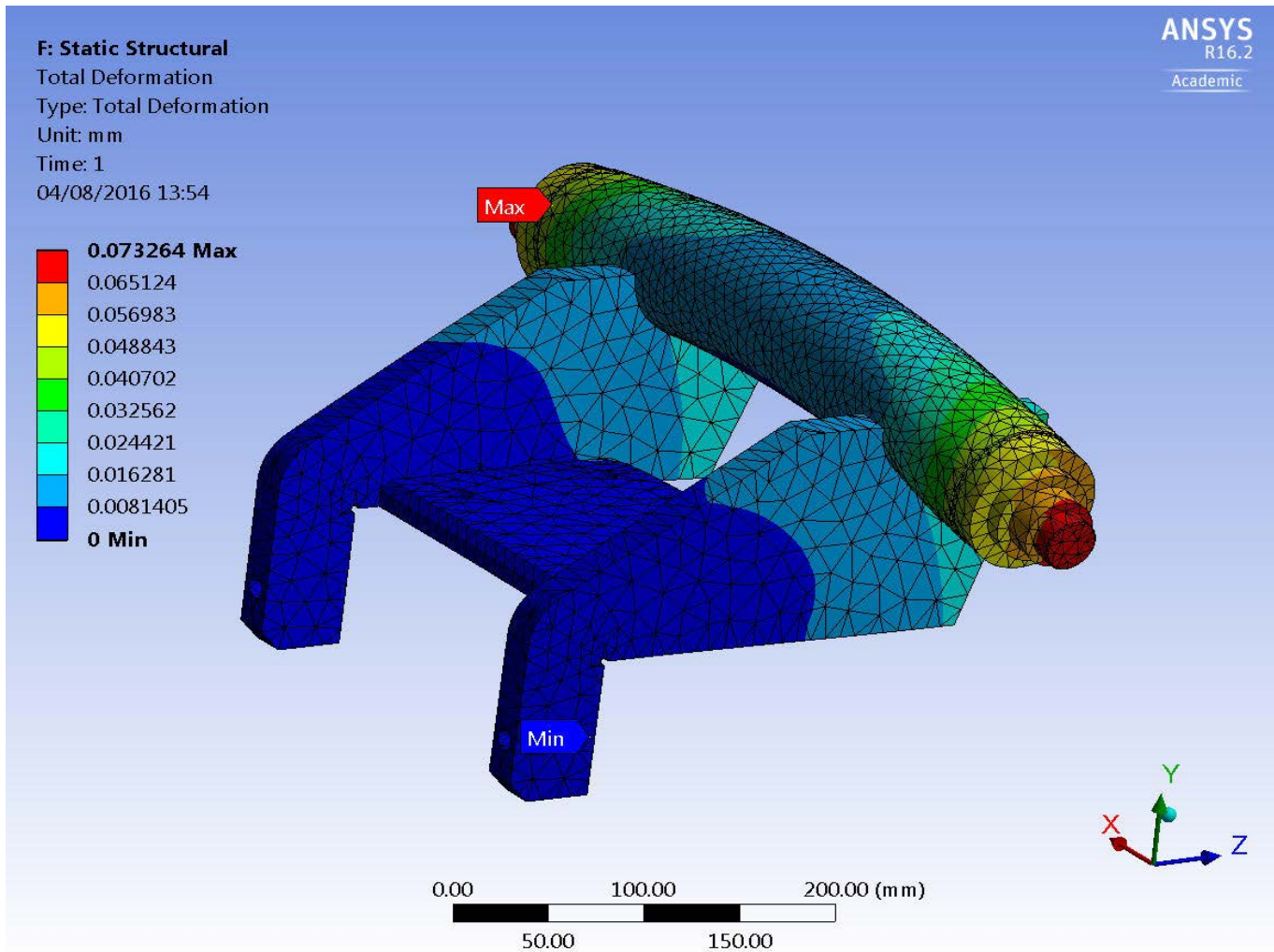
FEM Results: Stress Equivalent



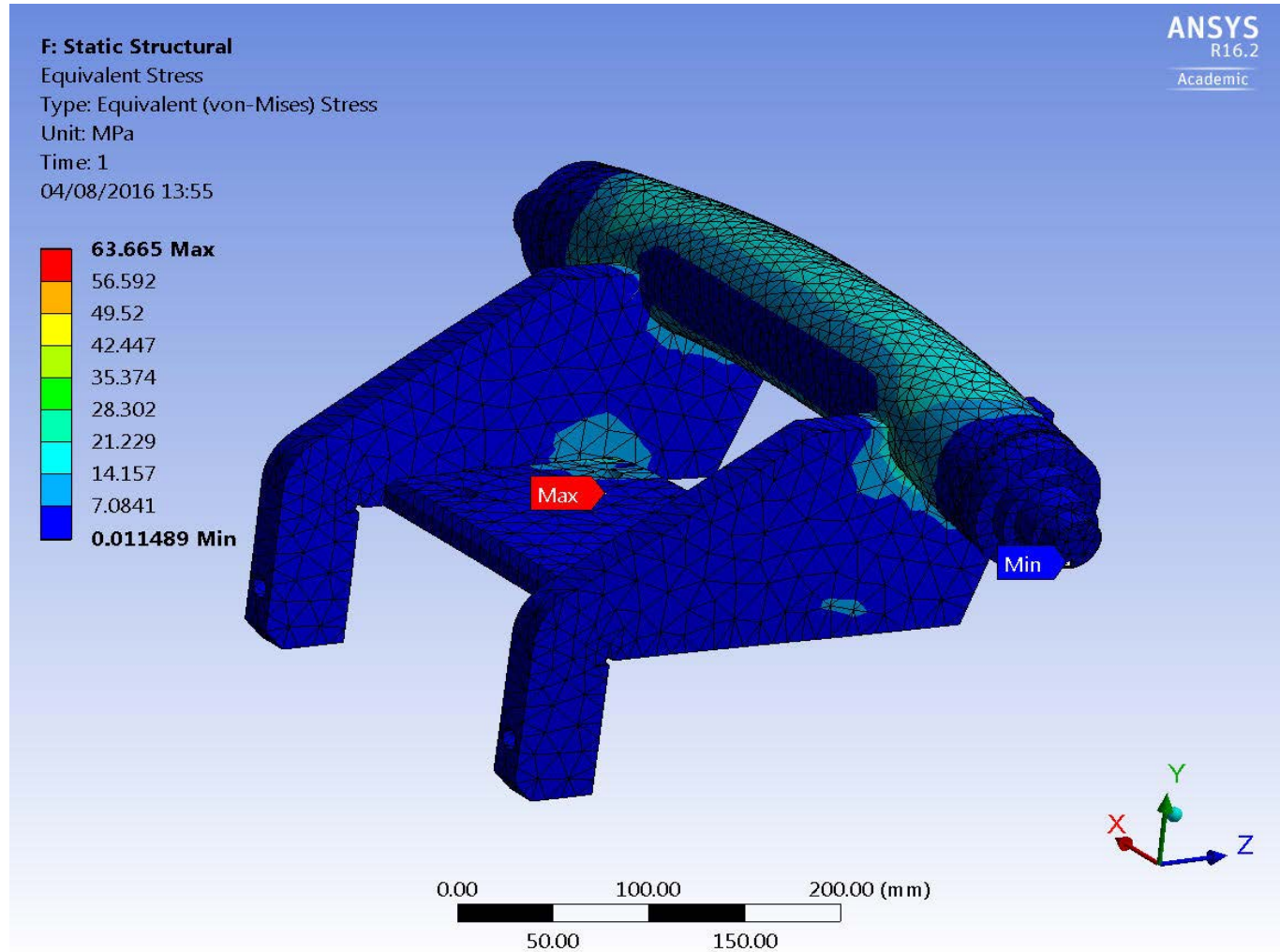
Loads and Constrains



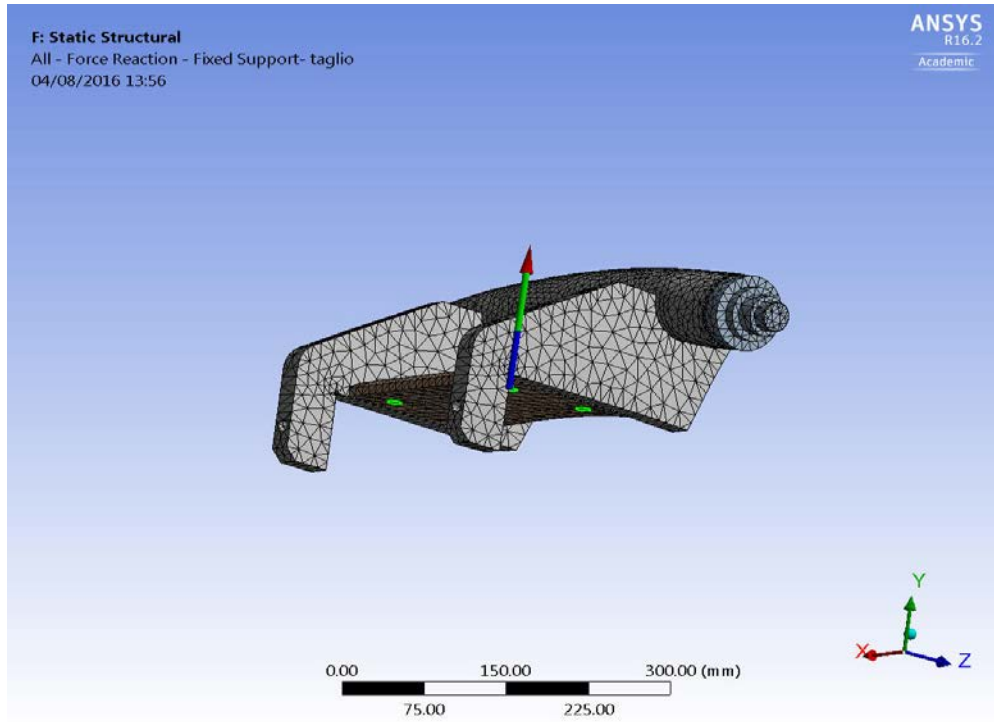
Total Deformations



Stress equivalent: Von Mises



Reaction Force 01



Details of "All - Force Reaction - Fixed Support- taglio"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Fixed Support- taglio
Orientation	Global Coordinate System
Suppressed	No
Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time
Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	-1.553 N
<input type="checkbox"/> Y Axis	6708.5 N
<input type="checkbox"/> Z Axis	149.79 N
<input type="checkbox"/> Total	6710.1 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	-1.553 N
<input type="checkbox"/> Y Axis	6708.5 N
<input type="checkbox"/> Z Axis	149.79 N
<input type="checkbox"/> Total	6710.1 N

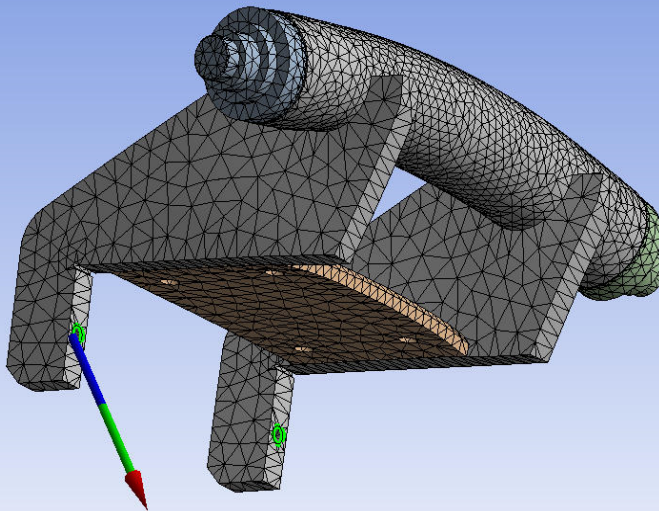
Reaction Force 02

F: Static Structural

All - Force Reaction - Fixed Support- trazione

04/08/2016 13:59

ANSYS
R16.2
Academic



0.00 100.00 200.00 (mm)
50.00 150.00



Details of "All - Force Reaction - Fixed Support- trazione"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Fixed Support- trazione
Orientation	Global Coordinate System
Suppressed	No

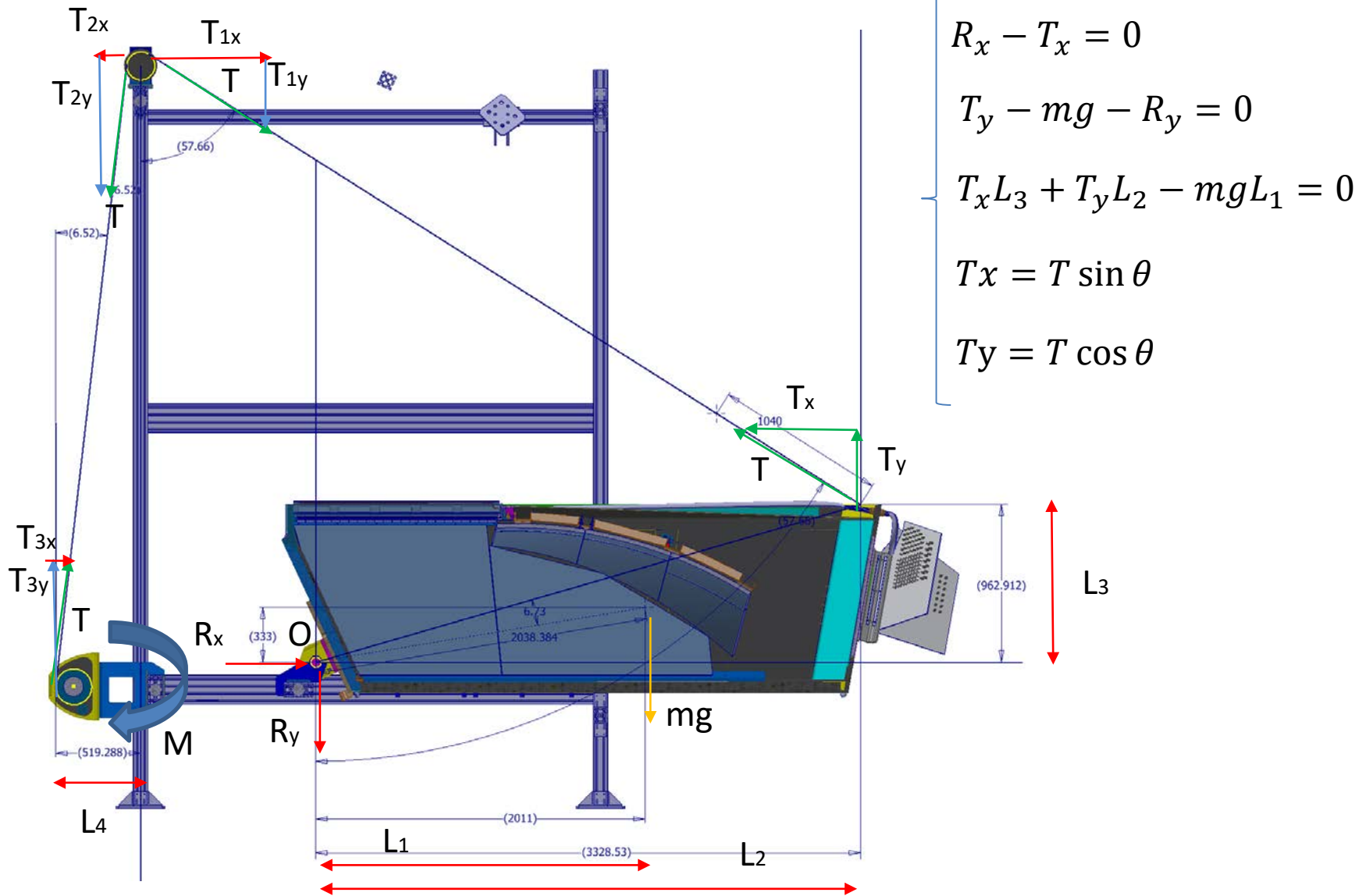
Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	1.553 N
<input type="checkbox"/> Y Axis	-1186.4 N
<input type="checkbox"/> Z Axis	769.72 N
<input type="checkbox"/> Total	1414.2 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	1.553 N
<input type="checkbox"/> Y Axis	-1186.4 N
<input type="checkbox"/> Z Axis	769.72 N
<input type="checkbox"/> Total	1414.2 N

RICH ROTATION

With equipments installed in the case

GEOMETRY: horizontal



$$R_x - T_x = 0$$

$$T_y - mg - R_y = 0$$

$$T_x L_3 + T_y L_2 - mg L_1 = 0$$

$$T_x = T \sin \theta$$

$$T_y = T \cos \theta$$

Force and Torque Equilibrium: RICH assembly completed + stiffening frame

$$\left\{ \begin{array}{l} R_x - T_x = 0 \\ T_y - mg - R_y = 0 \\ T_x L_3 + T_y L_2 - mg L_1 = 0 \\ T_x = T \sin \theta \\ T_y = T \cos \theta \end{array} \right. \quad \left\{ \begin{array}{l} R_x = T_x \\ R_y = T_y - mg \\ T \sin \theta L_3 + T \cos \theta L_2 - mg L_1 = 0 \end{array} \right.$$

$$\left\{ \begin{array}{l} R_x = T_x \\ R_y = T_y - mg \\ T = \frac{mg L_1}{L_3 \sin \theta + L_2 \cos \theta} \\ T_x = T \sin \theta \\ T_y = T \cos \theta \end{array} \right. \quad \left\{ \begin{array}{l} R_x = 6549 \text{ N} \\ R_y = 4146 - 10000 = -5854 \text{ N} \\ T = \frac{1000 \cdot 10 \cdot 2011}{963 \sin 57.66 + 3329 \cos 57.66} = 7751 \text{ N} \\ T_x = 7751 \sin 57.66 = 6549 \text{ N} \\ T_y = 7751 \cos 57.66 = 4146 \text{ N} \end{array} \right.$$

Case 02: Loads acting on the Al Frame

Case 02: rotation of the RICH in the EEL124 clean room after **RICH assembly is completed**

In order to take into account the fact that at the end of the assembly the module weight is 1000 kg instead of 600 kg, then all the loads acting on the Al frame have been updated:

$$T1x = 7751 \sin 57.66 = 6549 \text{ N}$$

$$R_x = -6549 \text{ N}$$

$$T1y = 7751 \cos 57.66 = 4146 \text{ N}$$

$$R_y = 5854 \text{ N}$$

$$T2x = 7751 \sin 6.52 = 880 \text{ N}$$

$$T2y = 7751 \cos 6.52 = 7700 \text{ N}$$

$$T3x = 7751 \sin 6.52 = 880 \text{ N}$$

$$T3y = 7751 \cos 6.52 = 7700 \text{ N}$$

$$M = T3y * L4 = 7700 \text{ N} * 0.520 \text{ m} = 4004 \text{ Nm}$$

In this case it is necessary to use two additional stiffening elements between the winch and the pulley. Moreover a link at half height of the two columns is necessary.

Load on Pulley for **load case 02**

$$Tr_x = T_{1x} - T_{2x} = 6549 - 880 = 5669N$$

$$Tr_y = T_{2y} + T_{1y} = 7700 + 4146 = 11846N$$

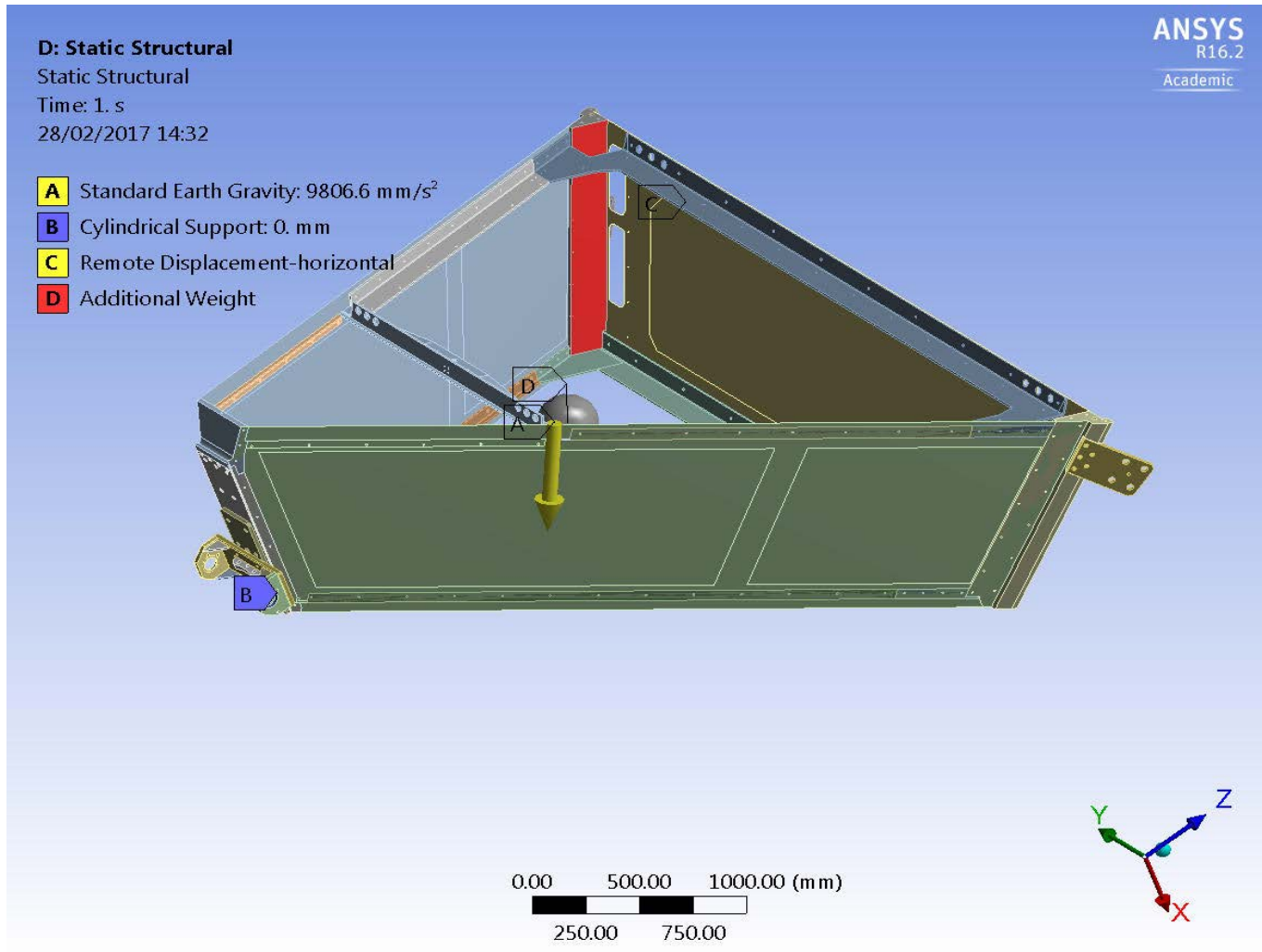
$$Tr = \sqrt{(Tr_x^2 + Tr_y^2)} = \mathbf{13132N} < 31750 \text{ N pulley rate} \quad \underline{\text{VERIFIED}}$$

Load on Pivot for **load case 02**

$$R_x = -6549 \text{ N}$$

$$R_y = 5854 \text{ N}$$

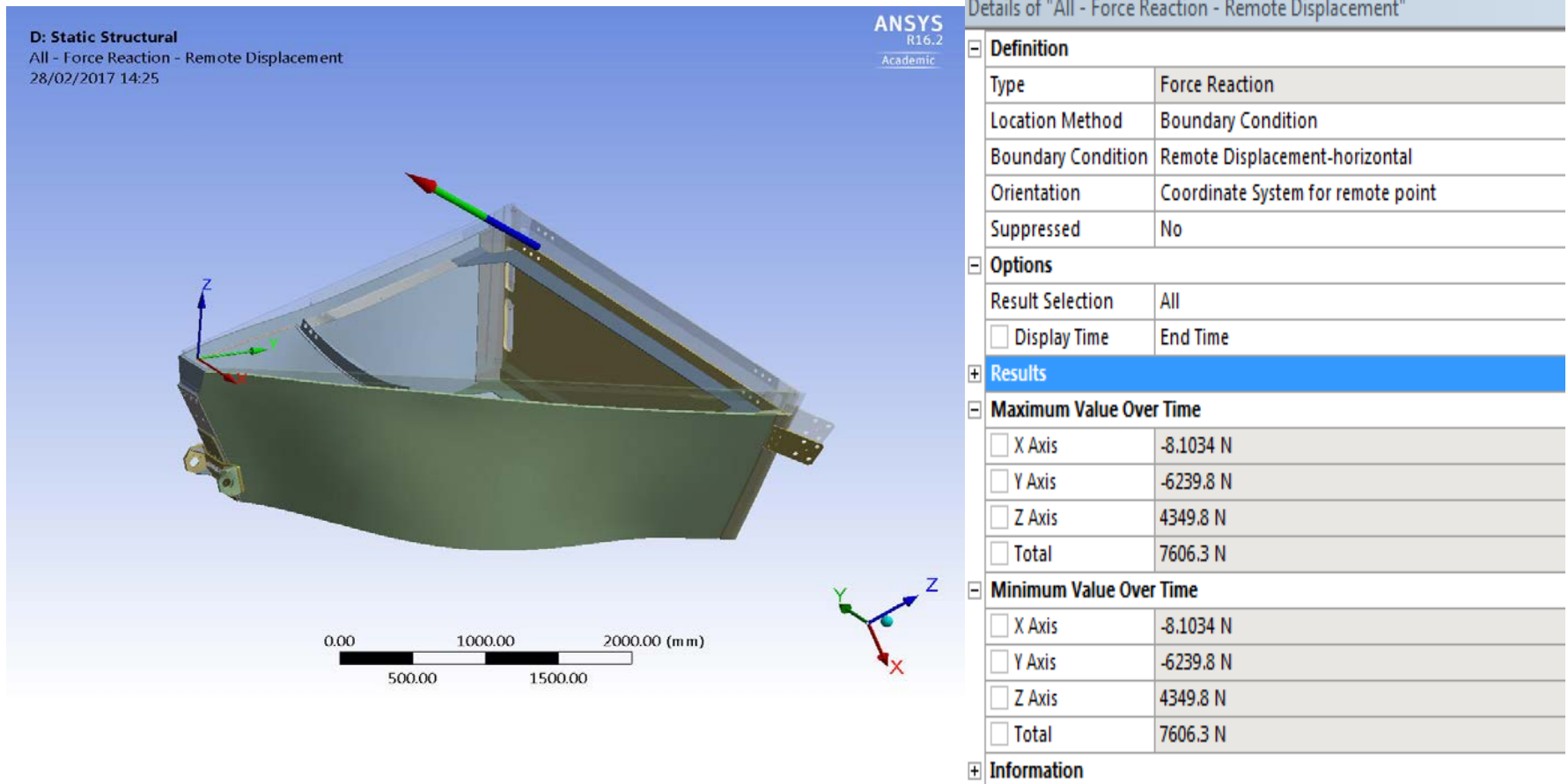
FEM ANALYSIS ANSYS: Supports and loads



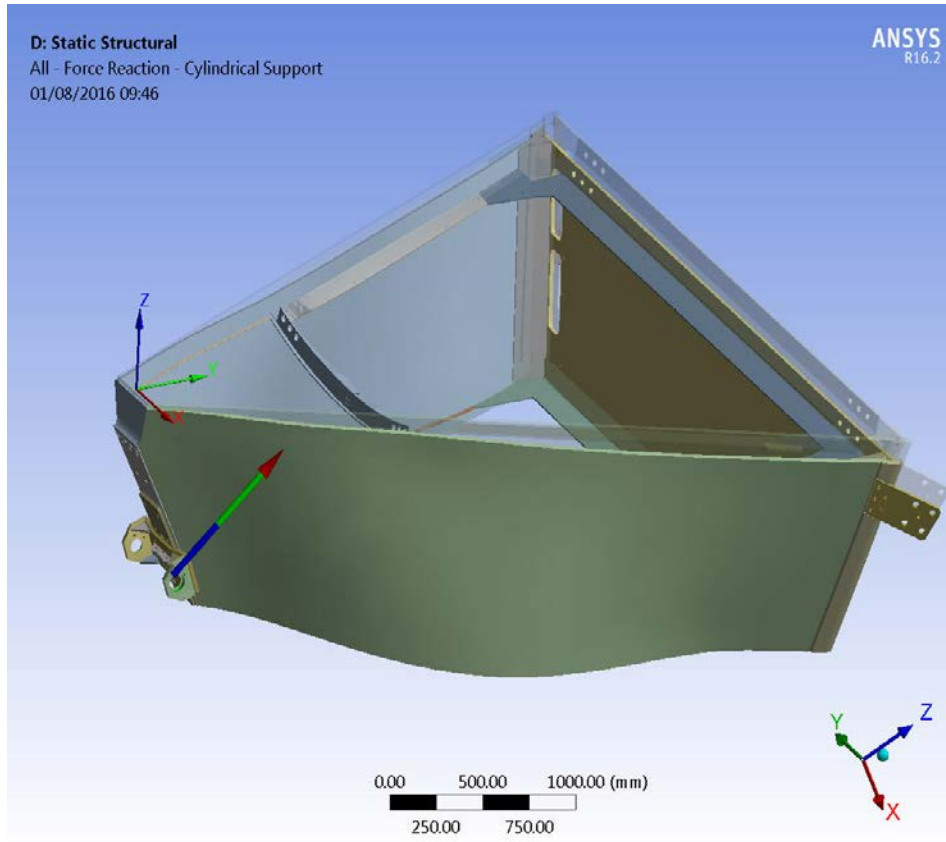
FEM Results: LIFT Force

Note: the lift force and the reaction force at the cylindrical support were evaluated by means of the **FEM Ansys code** and it was a cross check of what was evaluated analytically and reported in the two previous slides.

Conclusions: **the FEM results agree with the analytical solution.**



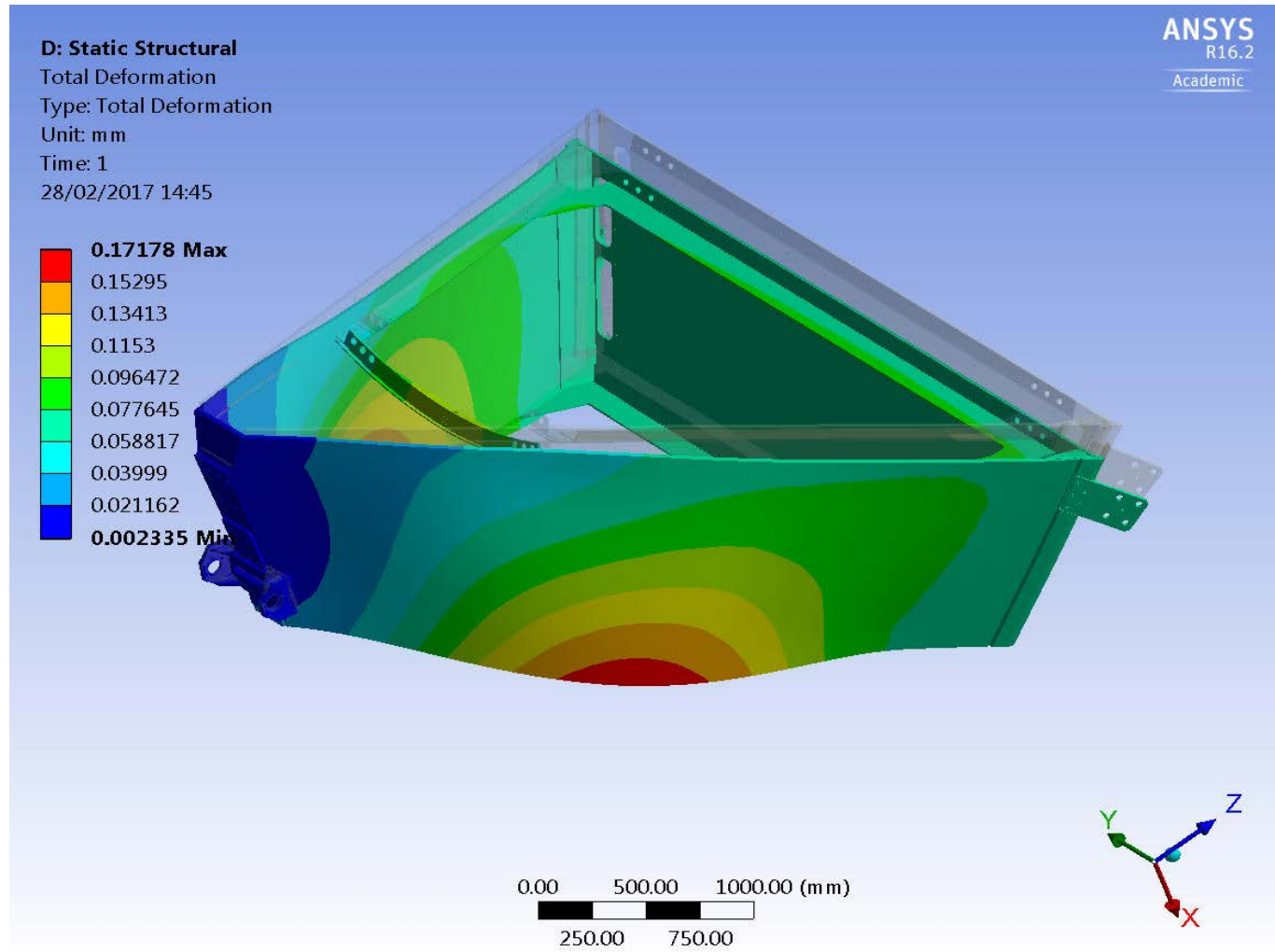
FEM Results: Reaction Force @ Cylindrical Support



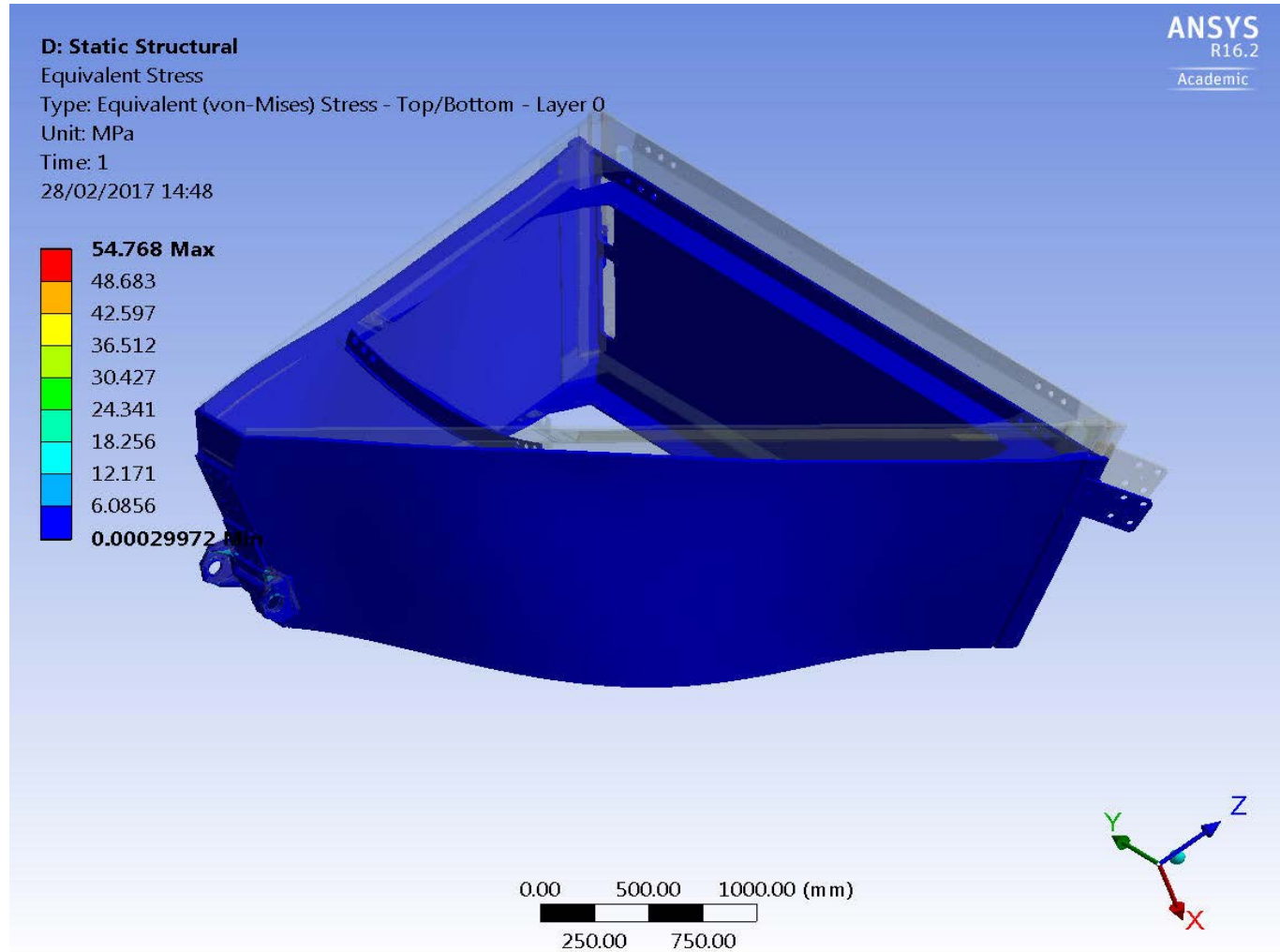
Details of "All - Force Reaction - Cylindrical Support"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Cylindrical Support
Orientation	Coordinate System for remote point
Suppressed	No
Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time
Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	8.0973 N
<input type="checkbox"/> Y Axis	6239.8 N
<input type="checkbox"/> Z Axis	5890.3 N
<input type="checkbox"/> Total	8580.8 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	8.0973 N
<input type="checkbox"/> Y Axis	6239.8 N
<input type="checkbox"/> Z Axis	5890.3 N
<input type="checkbox"/> Total	8580.8 N
Information	

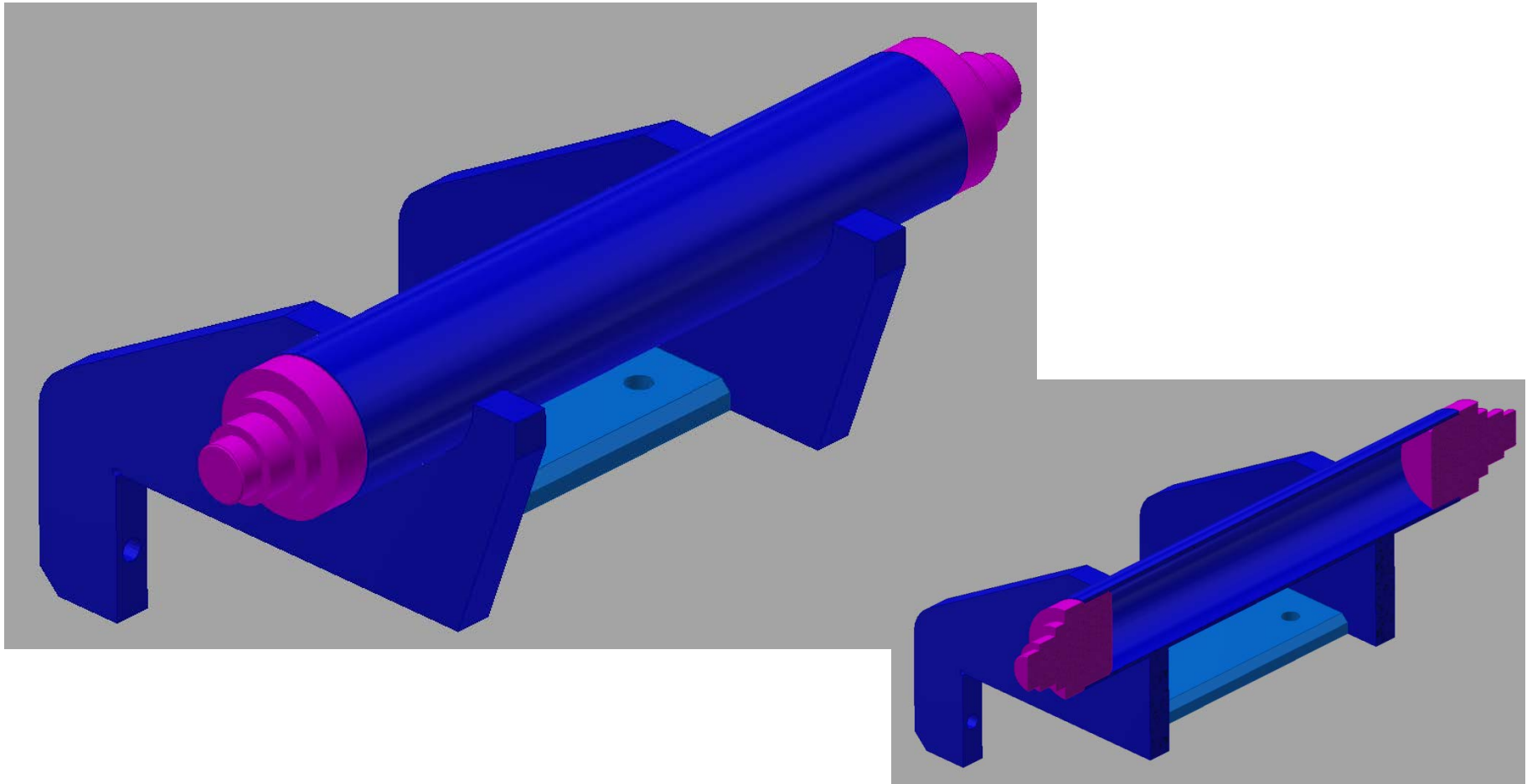
FEM Results: Total Deformation



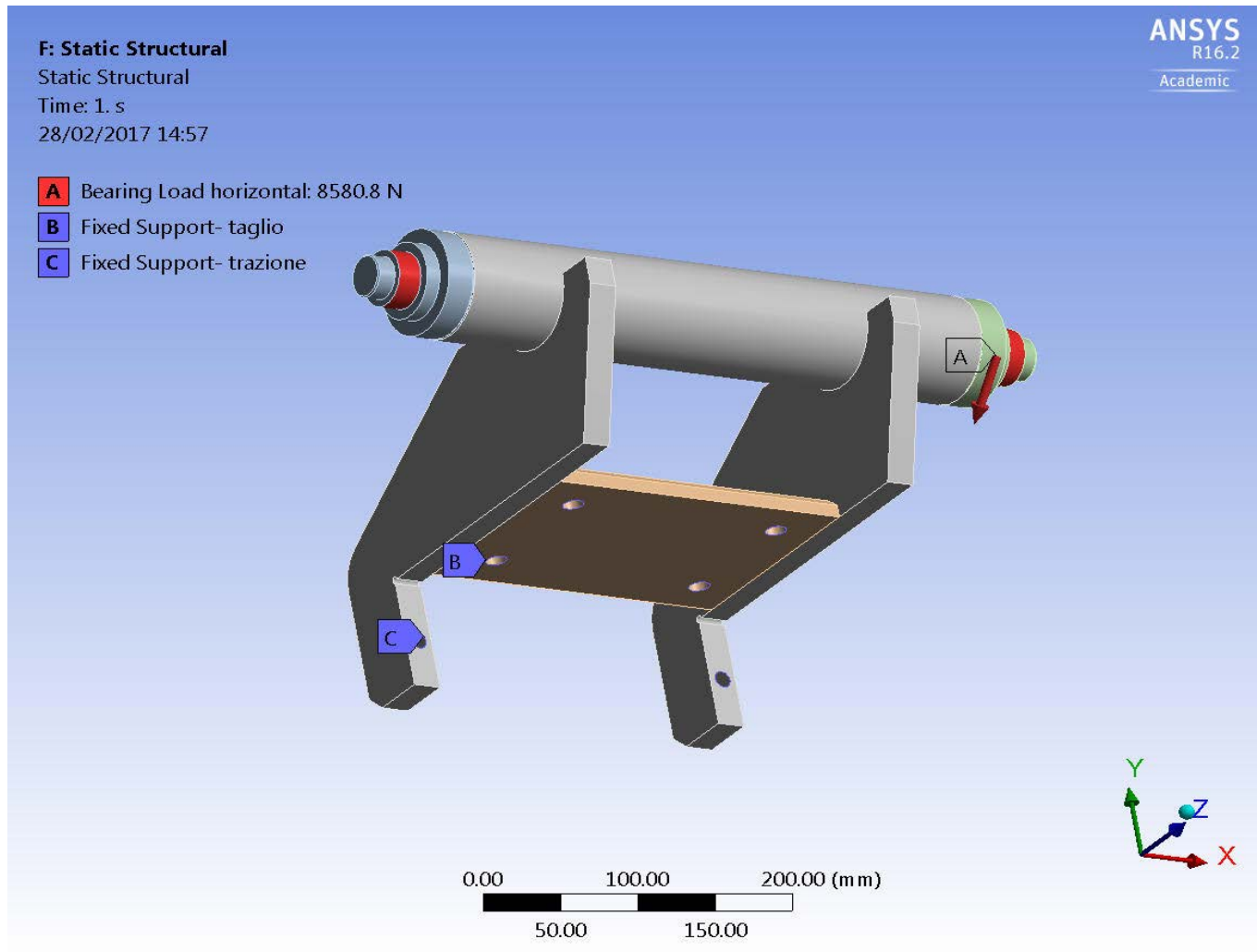
FEM Results: Stress Equivalent



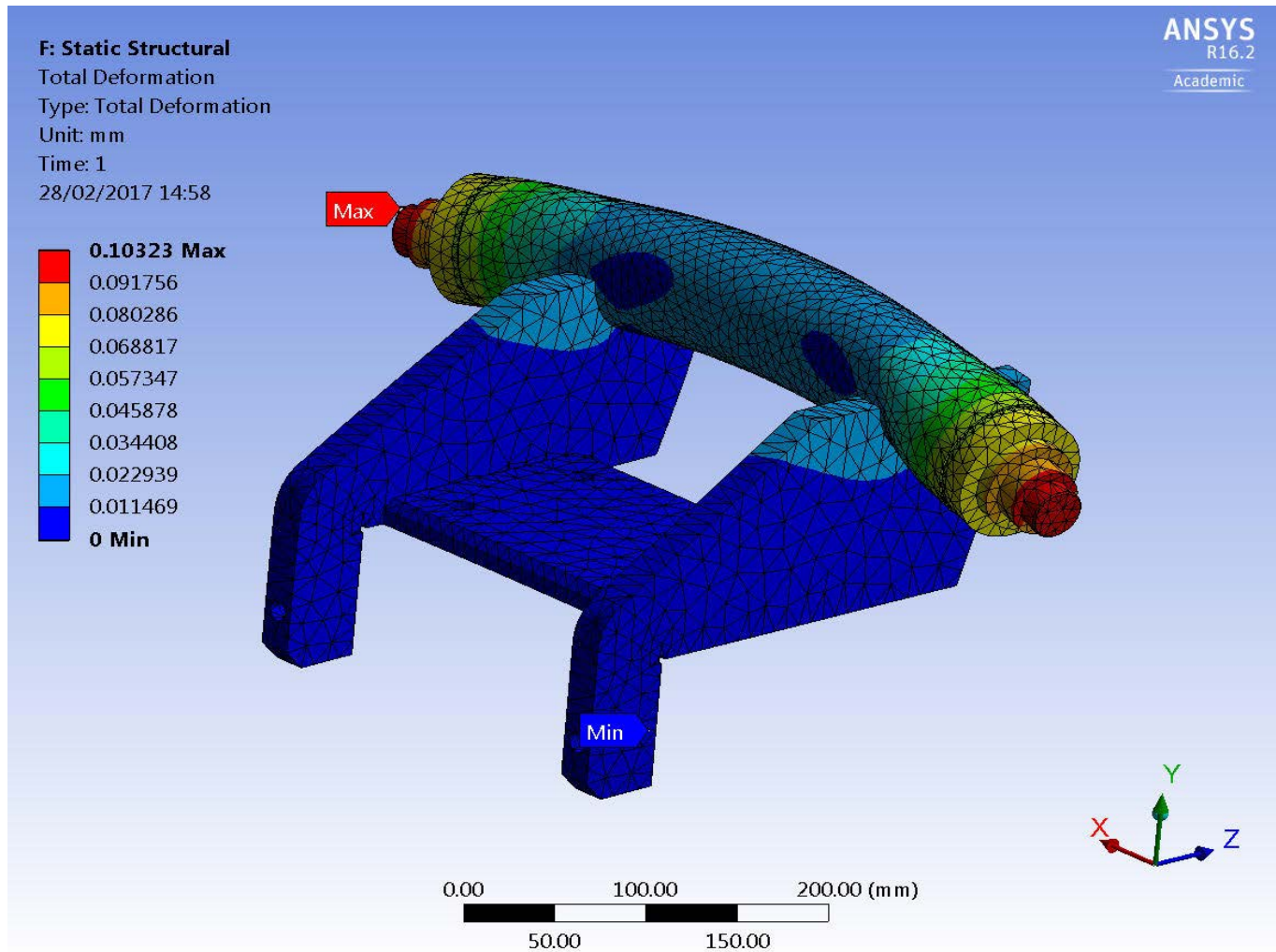
Rotating Base: geometry



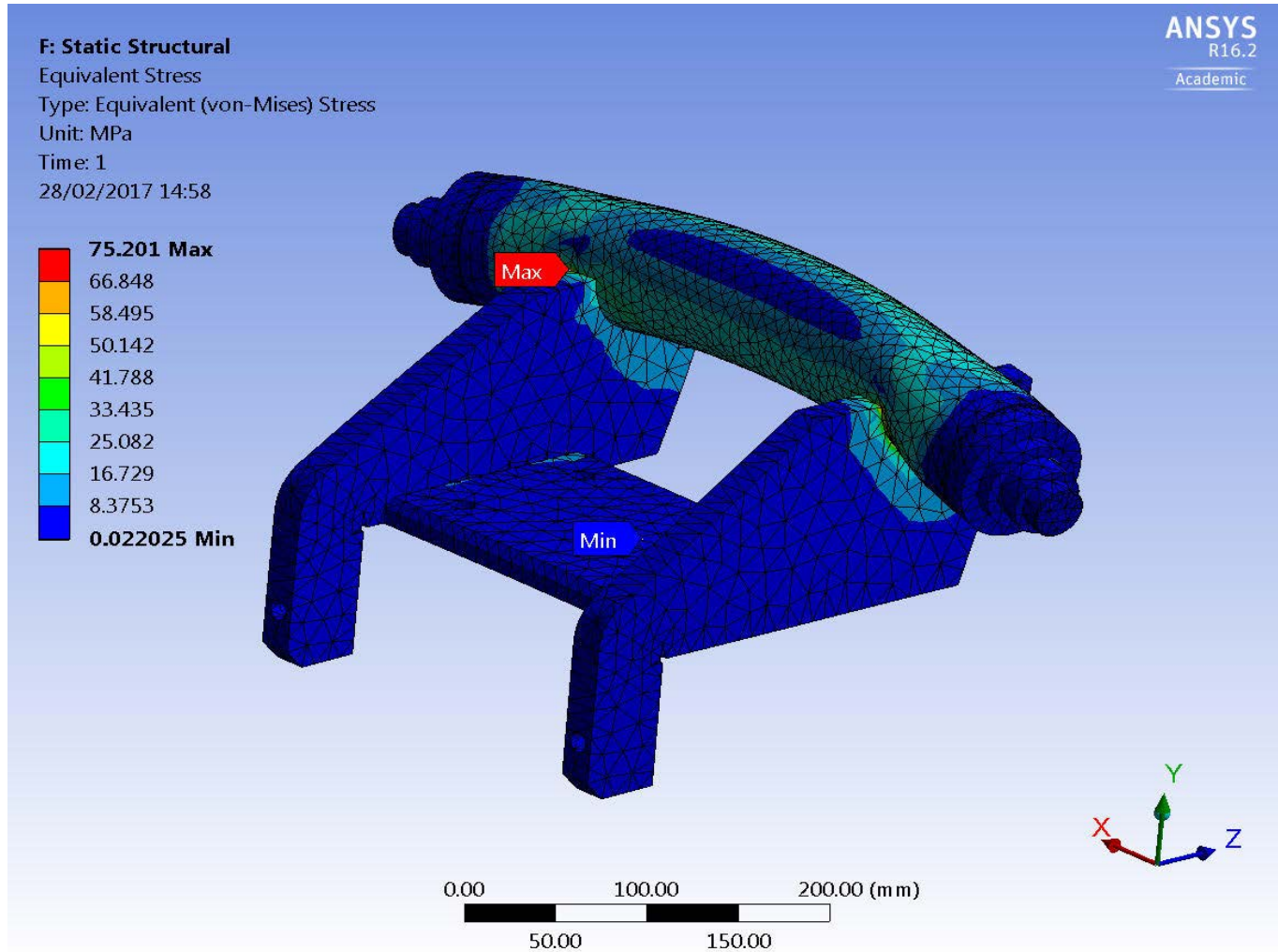
Loads and Constrains



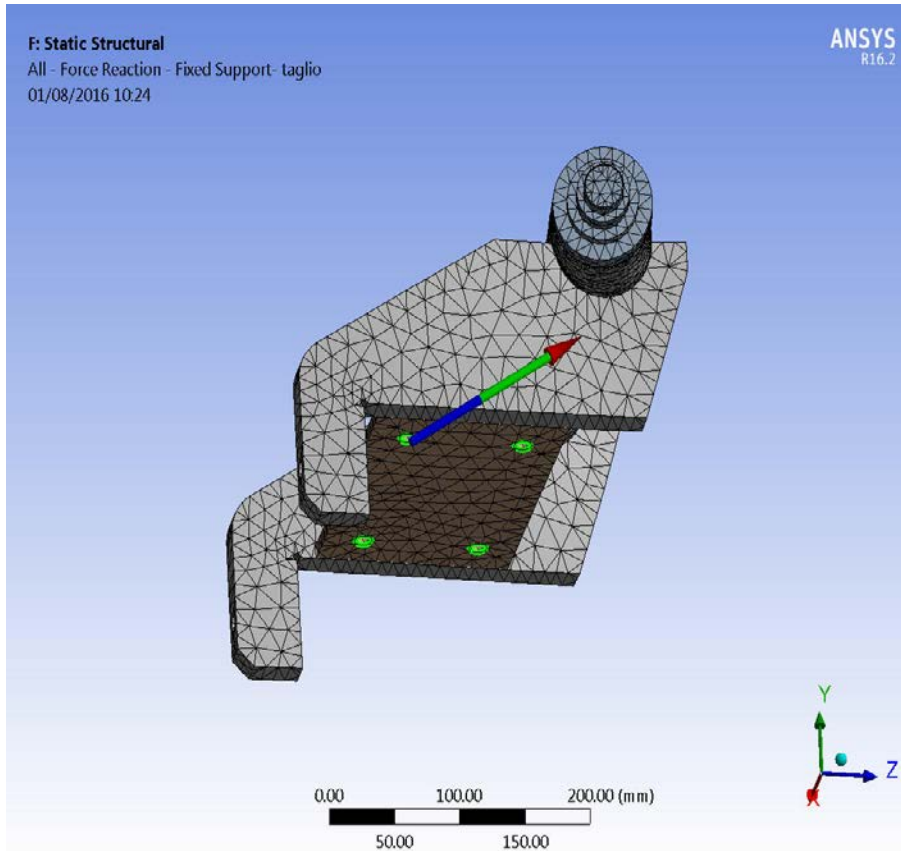
Total Deformations



Stress equivalent: Von Mises



Reaction Force 01



Details of "All - Force Reaction - Fixed Support- taglio"

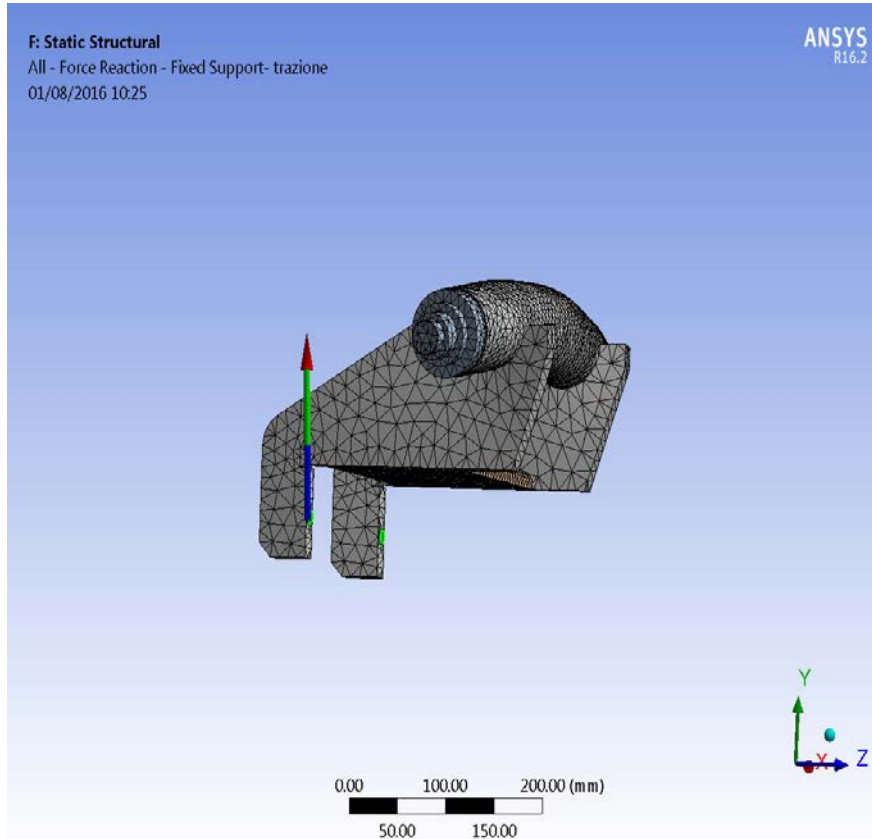
Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Fixed Support- taglio
Orientation	Global Coordinate System
Suppressed	No

Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	-9.6127 N
<input type="checkbox"/> Y Axis	4432.1 N
<input type="checkbox"/> Z Axis	6426.6 N
<input type="checkbox"/> Total	7806.7 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	-9.6127 N
<input type="checkbox"/> Y Axis	4432.1 N
<input type="checkbox"/> Z Axis	6426.6 N
<input type="checkbox"/> Total	7806.7 N

Information	
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Reaction Force 02



Details of "All - Force Reaction - Fixed Support- trazione"

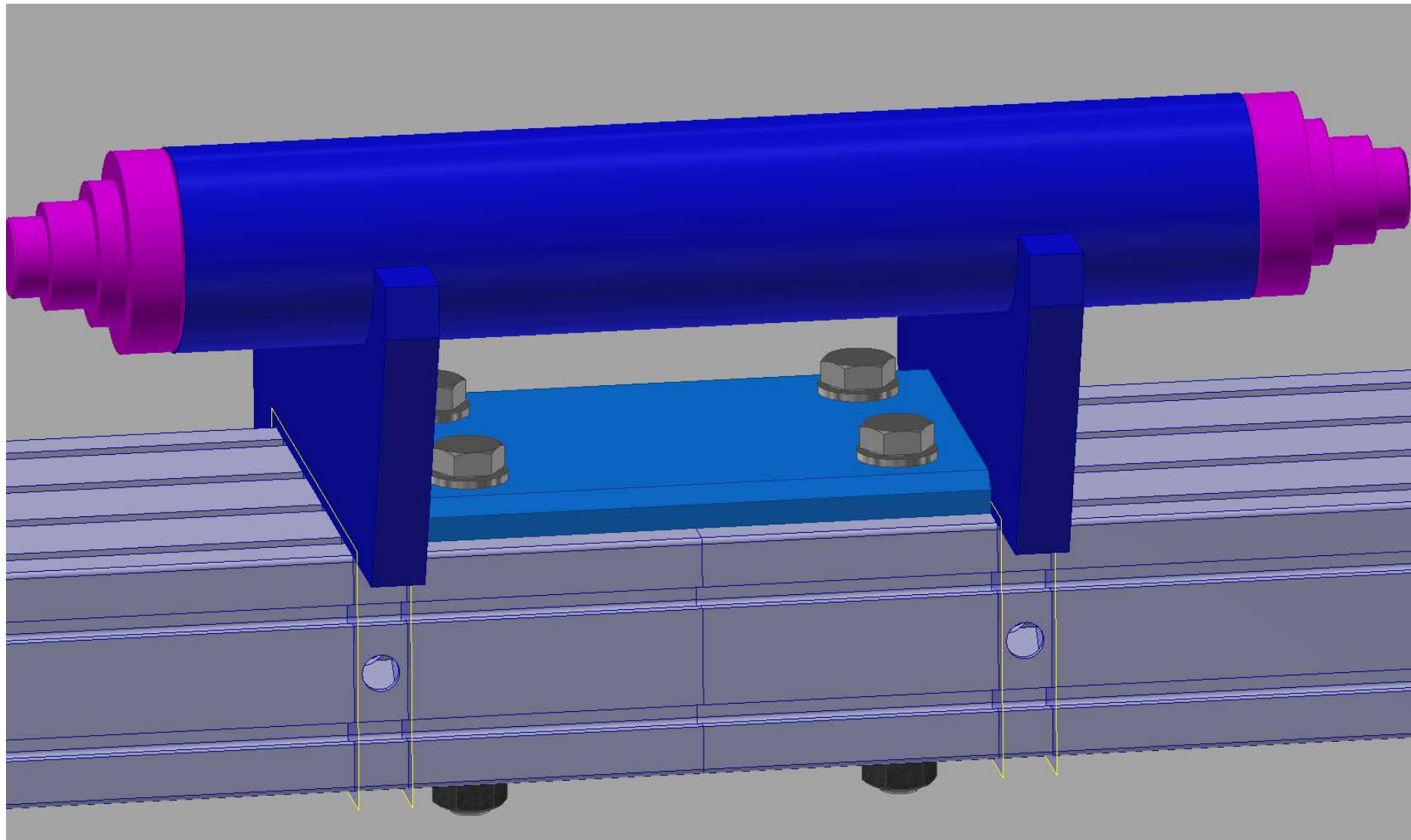
Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Fixed Support- trazione
Orientation	Global Coordinate System
Suppressed	No

Options	
Result Selection	All
<input type="checkbox"/> Display Time	End Time

Results	
Maximum Value Over Time	
<input type="checkbox"/> X Axis	9.6127 N
<input type="checkbox"/> Y Axis	1593.7 N
<input type="checkbox"/> Z Axis	-42.796 N
<input type="checkbox"/> Total	1594.3 N
Minimum Value Over Time	
<input type="checkbox"/> X Axis	9.6127 N
<input type="checkbox"/> Y Axis	1593.7 N
<input type="checkbox"/> Z Axis	-42.796 N
<input type="checkbox"/> Total	1594.3 N

Information	
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Bolted connection: geometry



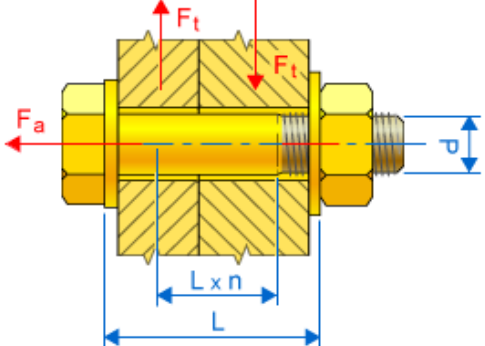
Bolted connection check

Bolted Connection Component Generator

Design Calculation Fatigue Calculation

Type of Strength Calculation
Check calculation

Limits



Maximal Axial Force F_a 4432 N

Maximal Tangent Force F_t 6426 N

Tightness Factor k 1.50 ul

Force Input Factor n 0.50 ul

Joint Friction Factor f 0.40 ul

Required Safety Factor k_s 3.00 ul

Plates Material
 CSN 423115

Modulus of Elasticity E_2 105000 MPa

Joint Properties
Functional Width L 128.900 mm

Bolt
Number of bolts z 4 ul

Thread Diameter d 16.000 mm

Pitch p 1.500 mm

Mean Bolt Diameter d_s 15.026 mm

Minimal Bolt Diameter d_{min} 14.160 mm

Bolt Material
 JIS SCR440

Yield Strength S_y 640 MPa

Modulus of Elasticity E_1 206000 MPa

Allowable Thread Pressure p_a 40 MPa

Thread Friction Factor f_1 0.20 ul

Head Friction Factor f_2 0.25 ul

Results

F_v	7537.062 N
F_{max}	7686.375 N
M_u	36.332 N m
σ_t	47.863 MPa
τ_k	65.178 MPa
σ_{red}	122.618 MPa
σ_{max}	48.812 MPa
p_c	23.251 MPa
k_{sc}	5.21945 ul

15:34:09 Calculation: Calculation indicates design compliance!

Calculate OK Cancel >>

Calculation of the AI Frame (Prosap)

