

# Report1\_Smooth Comum

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**Subject:** Analysis Report  
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**Software Used:** Autodesk Nastran Version 18.2.0.35

# Tables of Contents

[1. Summary](#)

[2. Assumptions](#)

[3. Model Definition](#)

[3.1 Group Definition](#)

[Table 3.1.1 Group Definition](#)

[Table 3.1.2 Part Mass Properties](#)

[3.2 Contact Definition](#)

[3.3 Material Properties](#)

[Table 3.3.1 Isotropic Material Definition](#)

[Table 3.3.2 Anisotropic Shell Element Material Definition](#)

[Table 3.3.3 Anisotropic Solid Element Material Definition](#)

[Table 3.3.4 Orthotropic Shell Element Material Definition](#)

[Table 3.3.5 Orthotropic Solid Element Material Definition](#)

[Table 3.3.6 Hyperelastic Element Material Definition](#)

[3.4 Mesh](#)

[Table 3.4.1 Element Initial Distortion Summary](#)

[4. Environment](#)

[4.1 Structural Loading](#)

[Table 4.1.1 Applied Load Vector Resultant](#)

[4.2 Structural Support](#)

[Table 4.2.1 Reaction Load Vector Resultant](#)

[5. Solution](#)

[Table 5.1.1 Displacement Summary](#)

[Table 5.1.2 Peak Displacement Component Summary](#)

[Table 5.1.3 Stress Results Summary](#)

[Table 5.1.4 Solution Error Measure and the Relative Stress Error Summary](#)

[6. Conclusion](#)

[7. Glossary](#)

# 1. Summary

The report documents design and analysis using Autodesk Nastran engineering simulation software. A linear static analysis was performed using the finite element model shown in the figure below. The model is divided into 1 property group(s). The units system is m-N-s. The model consists of a total of 137396 nodes and 81630 elements.

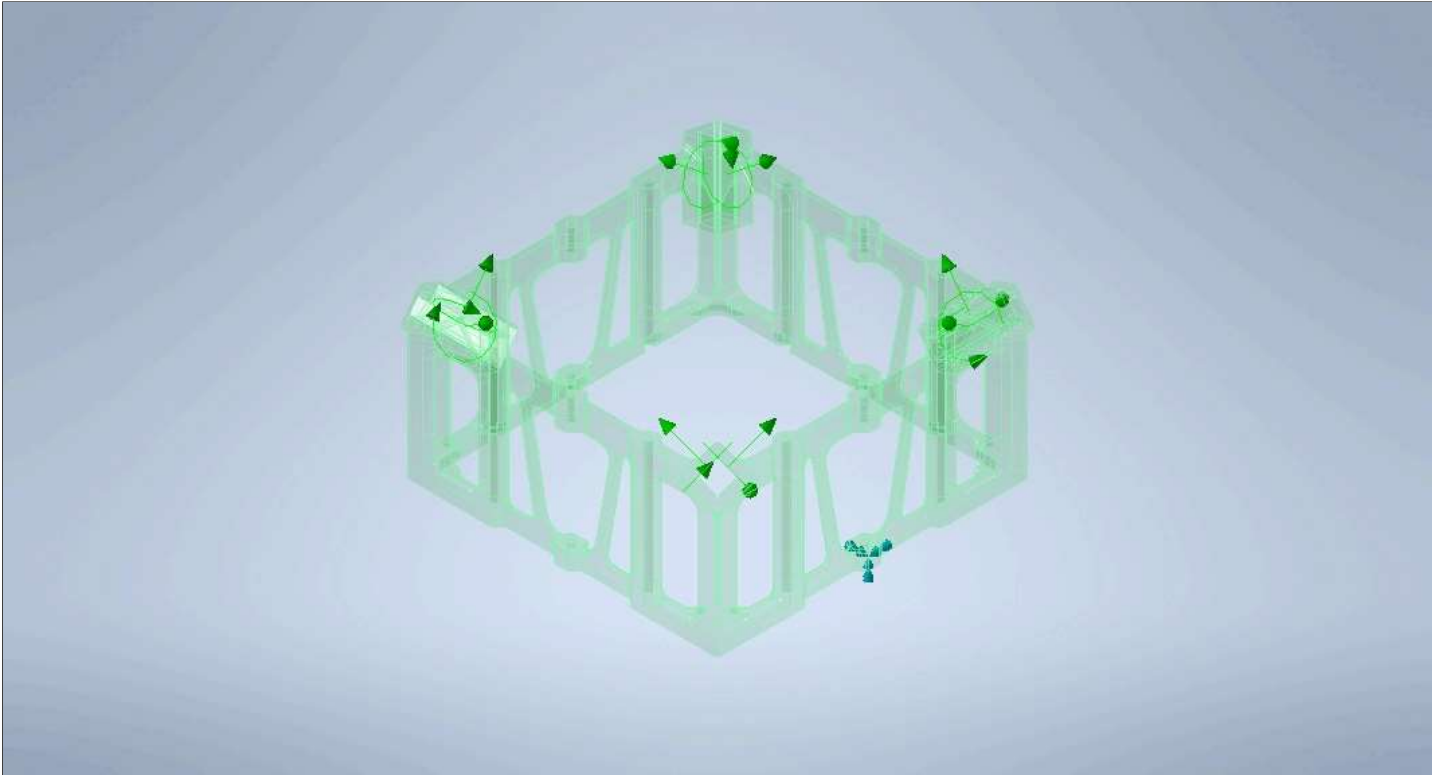


Figure 1 - Finite Element Model

## 2. Assumptions

1. Displacements are small.
2. [Follower forces](#) are ignored.

### 3. Model Definition

#### 3.1 Group Definition

The model is divided into 1 property group(s). Details for each group are given in Table 3.1.1.

1. The [bounding box](#) for all positioned bodies in the model measures 0,1711 by 8,631E-02 by 0,1711m along the basic coordinate system x, y and z axes, respectively.
2. The total mass of the model is 0,4154 kg.
3. The model center of mass is located at (2,073E-02, 1,993E-02, -2,39E-02) m.

Table 3.1.1 Group Definition

Property Group	Material	<a href="#">Bounding Box</a> (m)	Mass (kg)	Volume (m <sup>3</sup> )	Nodes	Elements
SOLID 16	MAT 3	0,1711, 8,631E-02, 0,1711	0,4154	1,69E-04	137396	81630

Table 3.1.2 Part Mass Properties

Property Group	Material	Mass (kg)	Center of Mass (m)	Moments of Inertia (m)
SOLID 16	MAT 3	0,4154	2,073E-02, 1,993E-02, -2,39E-02	2,009E-03, 3,492E-03, 2,009E-03

#### 3.2 Contact Definition

The model contains 0 contact region(s).

- Adaptive stiffness scaling is enabled.

#### 3.3 Material Properties

##### 3.3.1 Isotropic Material Definition

Material ID	E	G	NU	RHO	ALPHA	T-REF
3	1,188E+09	4,042E+08	0,47	2458,0	0,0	0,0

##### 3.3.2 Anisotropic Shell Element Material Definition

No Data

##### 3.3.3 Anisotropic Solid Element Material Definition

No Data

##### 3.3.4 Orthotropic Shell Element Material Definition

No Data

##### 3.3.5 Orthotropic Solid Element Material Definition

No Data

##### 3.3.6 Hyperelastic Element Material Definition

No Data

#### 3.4 Mesh

The finite element mesh is shown in the figure below. The model consists of a total of 137396 nodes and 81630 elements.

Table 3.4.1 Element Initial Distortion Summary

Property Group	Property Type	<a href="#">Aspect Ratio</a>	Recommended Limit	<a href="#">Taper Ratio</a>	Recommended Limit	<a href="#">Skew Angle</a>	Recommended Limit	<a href="#">Warping Angle</a>	Recommended Limit
SOLID 16	TET	10,8	100,0	0,0	0,0	173,2	80,0	0,0	0,0

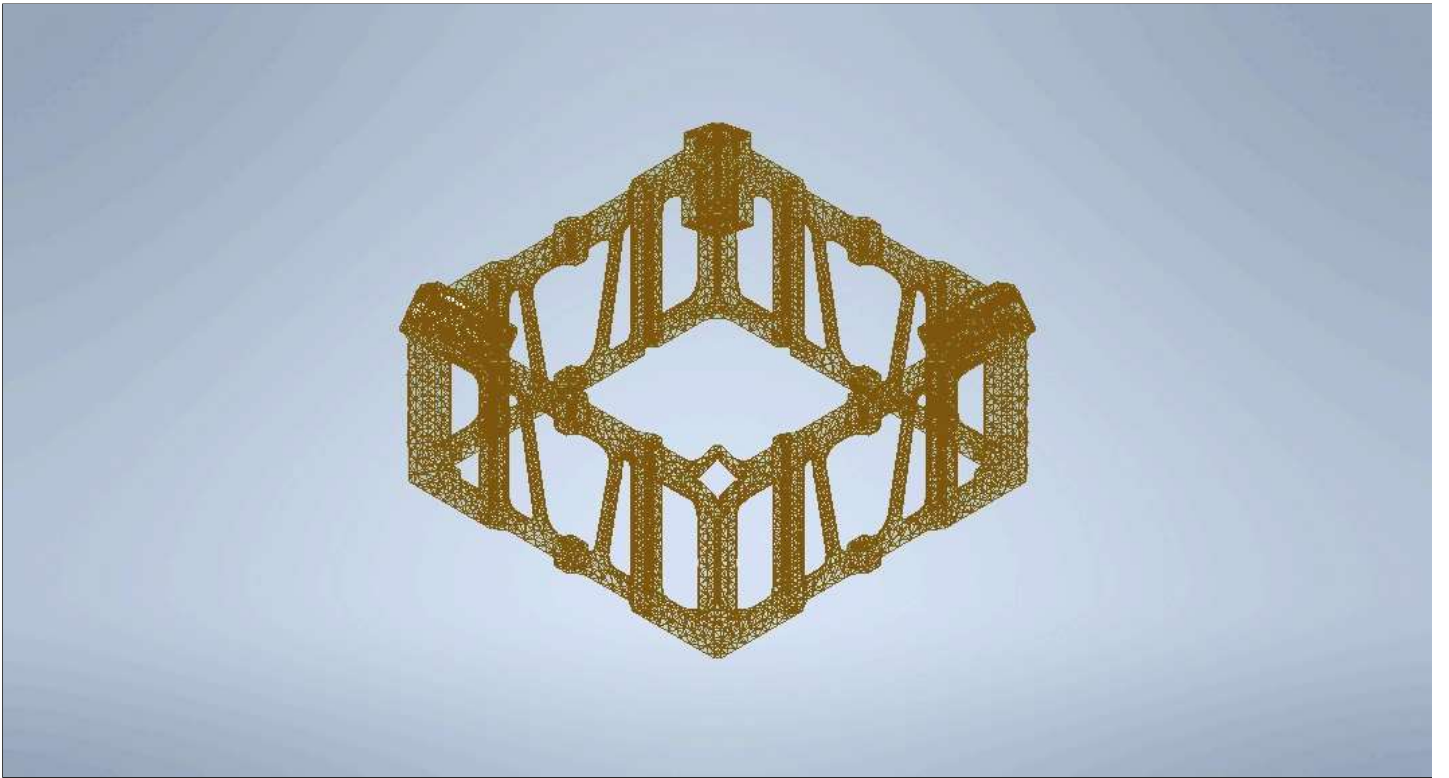


Figure 2 - Finite Element Mesh

# 4. Environment

## 4.1 Structural Loading

The finite element environments are shown in the figures below. Applied structural loading is summarized in Table 4.1.1. Applied load vector resultants are defined in the basic coordinate system. Moments are summed about location (0,0,0,0,0,0).

Table 4.1.1 Applied Load Vector Resultant

Subcase	Resultant Force(N)			Resultant Moment(N m)		
	XT	YT	ZT	XR	YR	ZR
SUBCASE 1	0,1164	49,07	9,603E-02	1,177	3,707	1,013

## 4.2 Structural Support

Reaction loads are summarized in Table 4.2.1. Reaction load vector resultants are defined in the basic coordinate system. Moments are summed about location (0,0,0,0,0,0).

Table 4.2.1 Reaction Load Vector Resultant

Subcase	Resultant Force (N)			Resultant Moment(N m)		
	XT	YT	ZT	XR	YR	ZR
SUBCASE 1	-0,1164	-49,07	-9,597E-02	-1,177	-3,707	-1,013

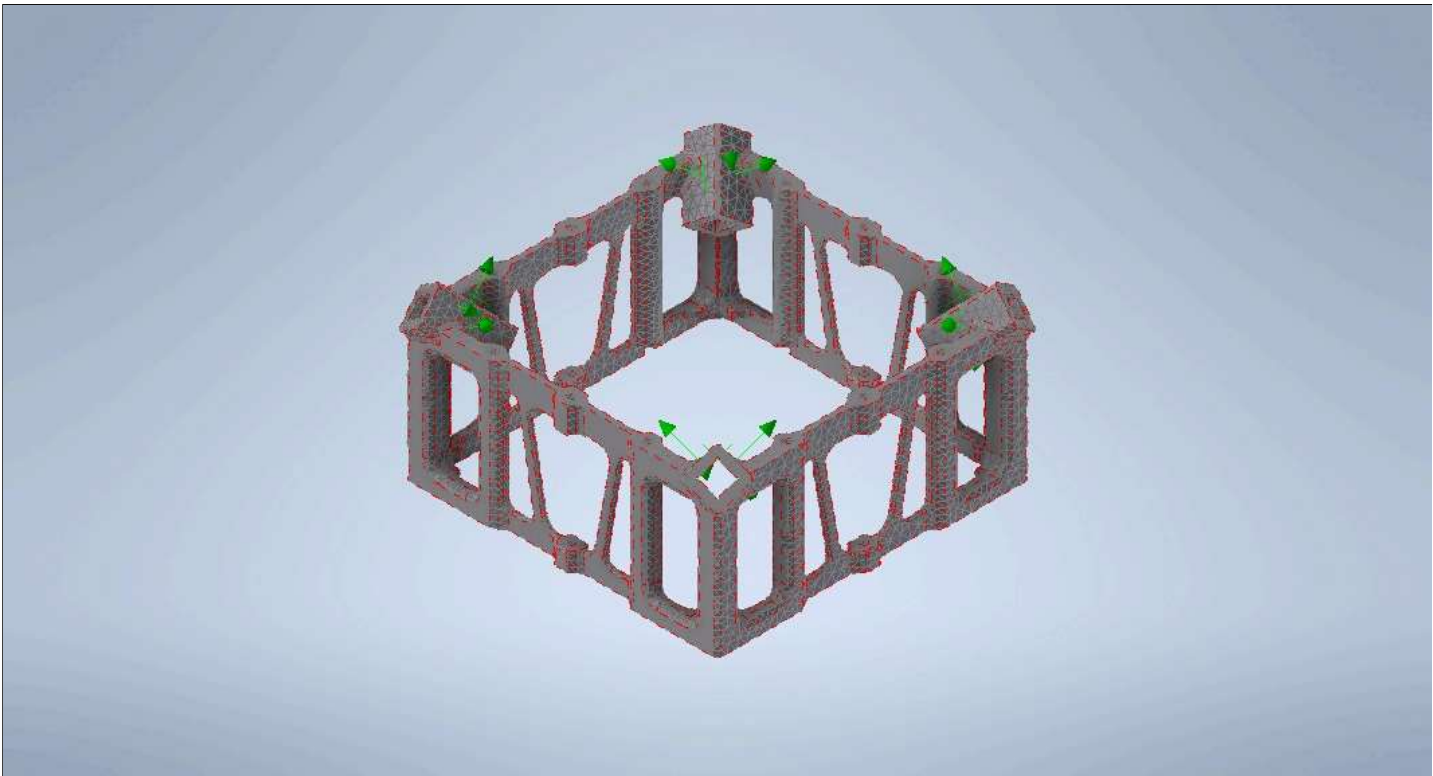


Figure 3 - Applied Load

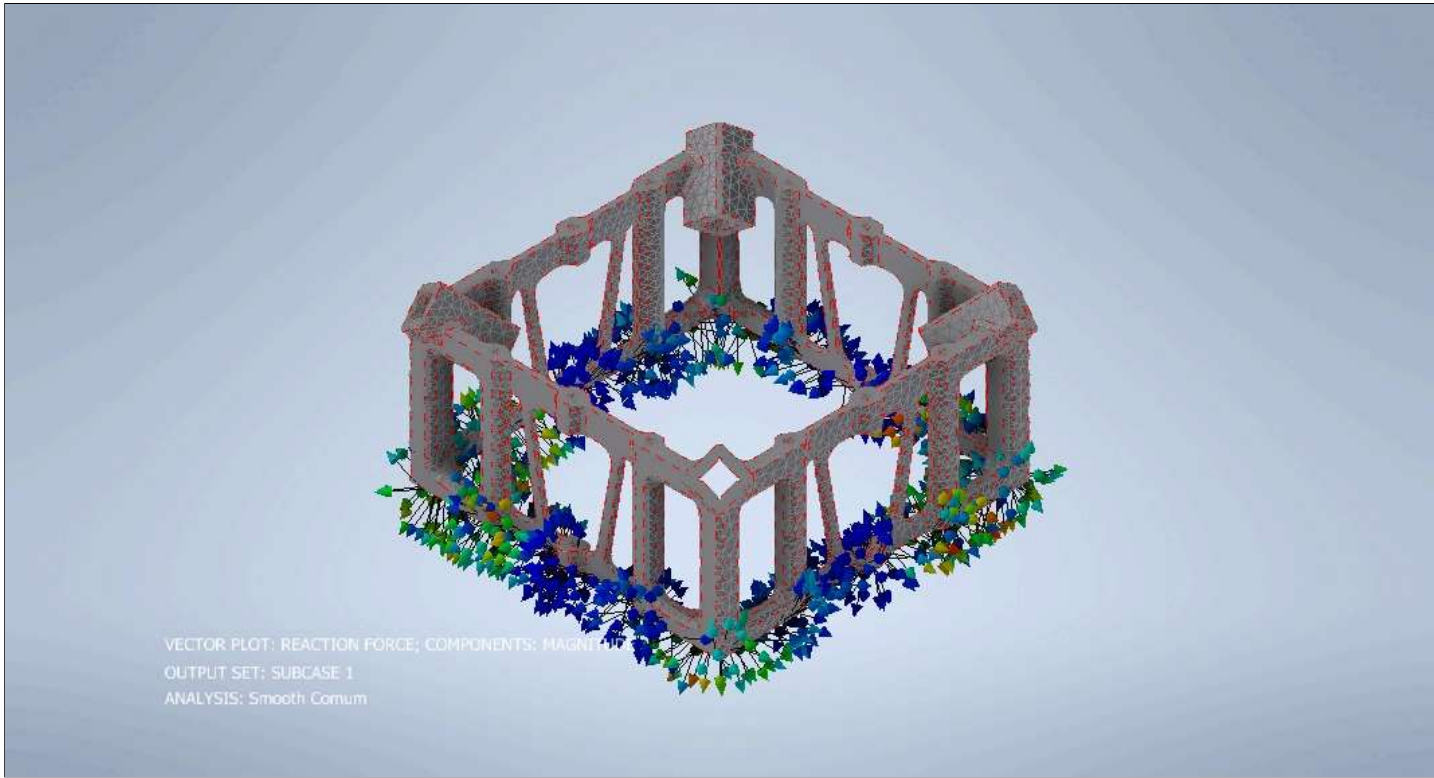


Figure 4 - Reaction Load



# 5. Solution

The solution to the Environment defined in Section 4 applied to the Model defined in Section 3 is given below. The program selected the PCGLSS linear solver. Total solution time was 37.43 seconds. The largest [solution error measure](#) was 1,194E-09 for SUBCASE 1. The largest solid element [relative stress error](#) was 0,112 for SUBCASE 1. The results are summarized in the table(s) and figure(s) below.

Table 5.1.1 Displacement Summary

Subcase	Minimum Displacement (m)	Property Group	Maxmium Displacement (m)	Property Group
Subcase 1	0,0	Part 1	1,172E-03	Part 1

Table 5.1.2 Peak Displacement Component Summary

Subcase	Displacement Components (m)			Rotation Components (m)		
	XT	YT	ZT	XR	YR	ZR
SUBCASE 1	9,942E-04	6,935E-04	1,168E-03	0,0	0,0	0,0

Table 5.1.3 Stress Results Summary

Subcase	Minimum Principal Stress (Pa)	Property Group	Maximum Principal Stress (Pa)	Property Group	Maximum Von Mises Stress (Pa)	Property Group
Subcase 1	-3,986E+07	Part 1	3,214E+07	Part 1	3,239E+07	Part 1

Table 5.1.4 [Solution Error Measure](#) and the [Relative Stress Error](#) Summary

Subcase	<a href="#">Solution Error Measure</a>	Shell Element <a href="#">Relative Stress Error</a>	Solid Element <a href="#">Relative Stress Error</a>
SUBCASE 1	1,194E-09	n/a	0,112

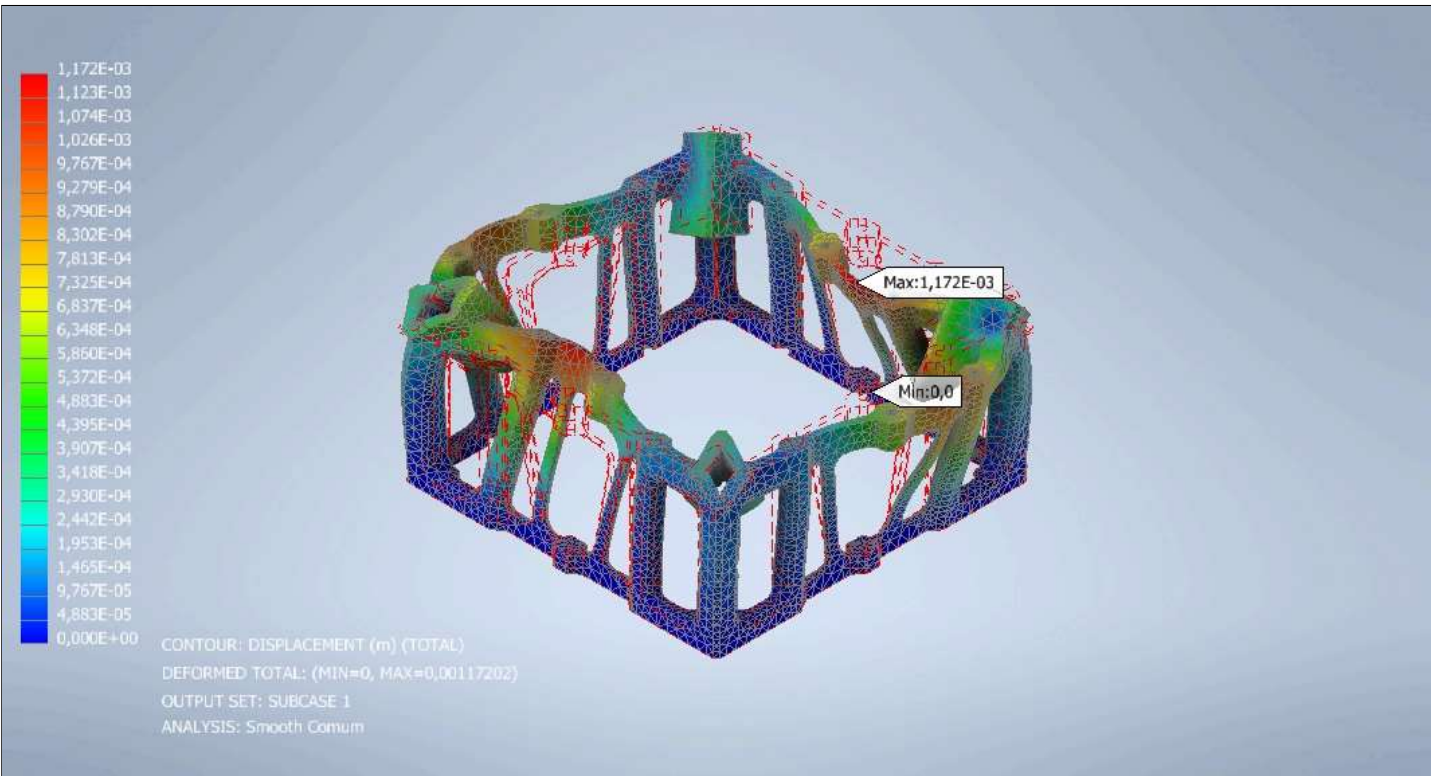


Figure 5 - OUTPUT SET: SUBCASE 1 -- DEFORMED TOTAL: (MIN=0, MAX=0,00117202) -- CONTOUR: DISPLACEMENT (m) (TOTAL)

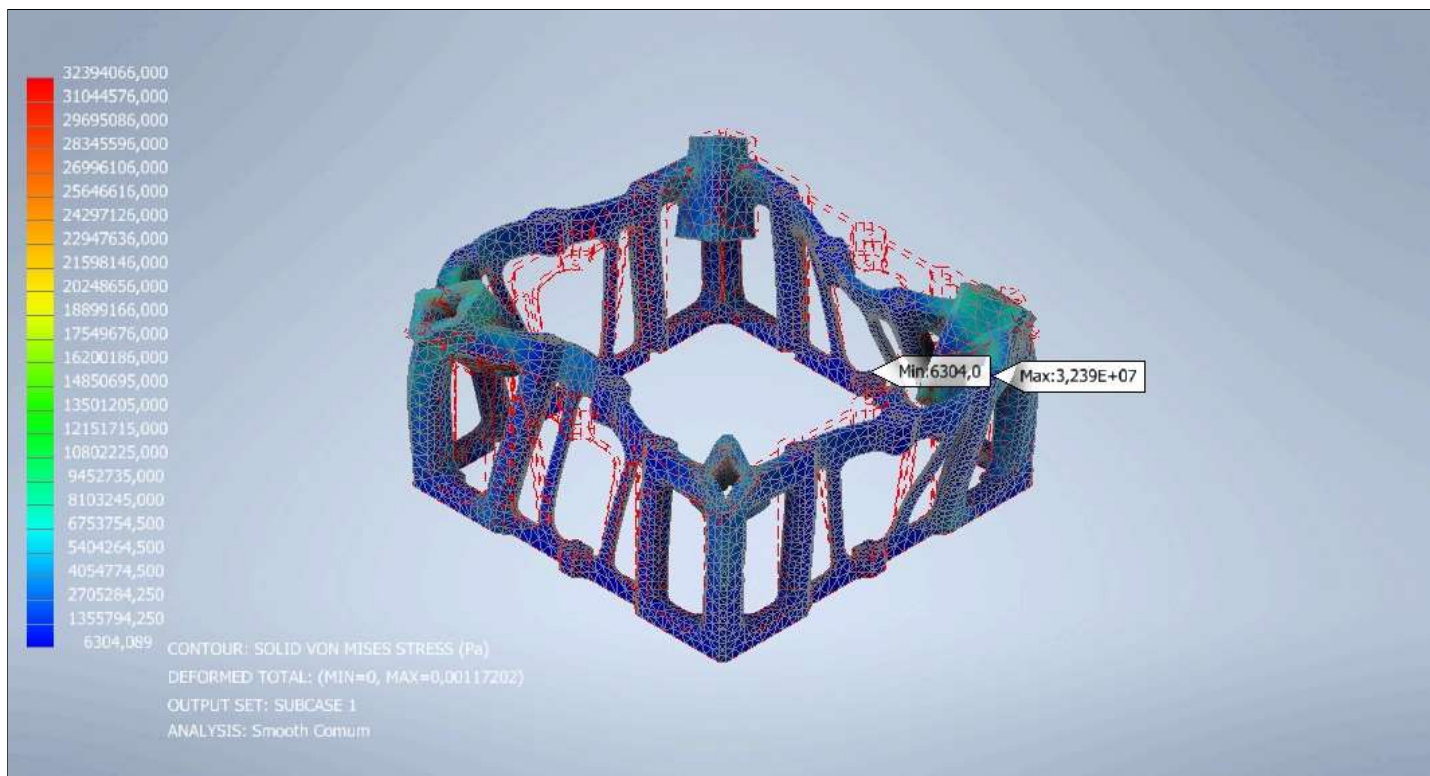


Figure 6 - OUTPUT SET: SUBCASE 1 -- DEFORMED TOTAL: (MIN=0, MAX=0,00117202) -- CONTOUR: SOLID VON MISES STRESS (Pa)

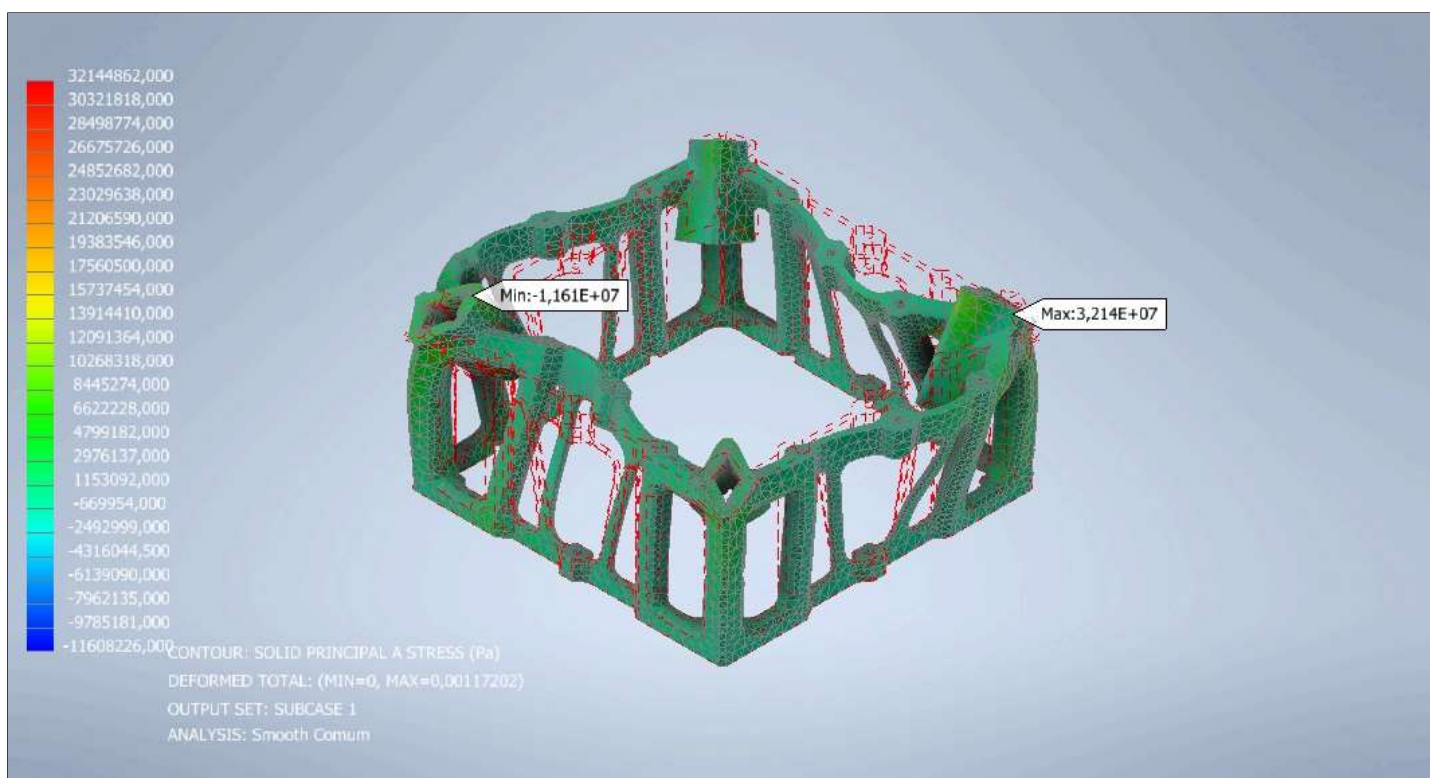


Figure 7 - OUTPUT SET: SUBCASE 1 -- DEFORMED TOTAL: (MIN=0, MAX=0,00117202) -- CONTOUR: SOLID PRINCIPAL A STRESS (Pa)

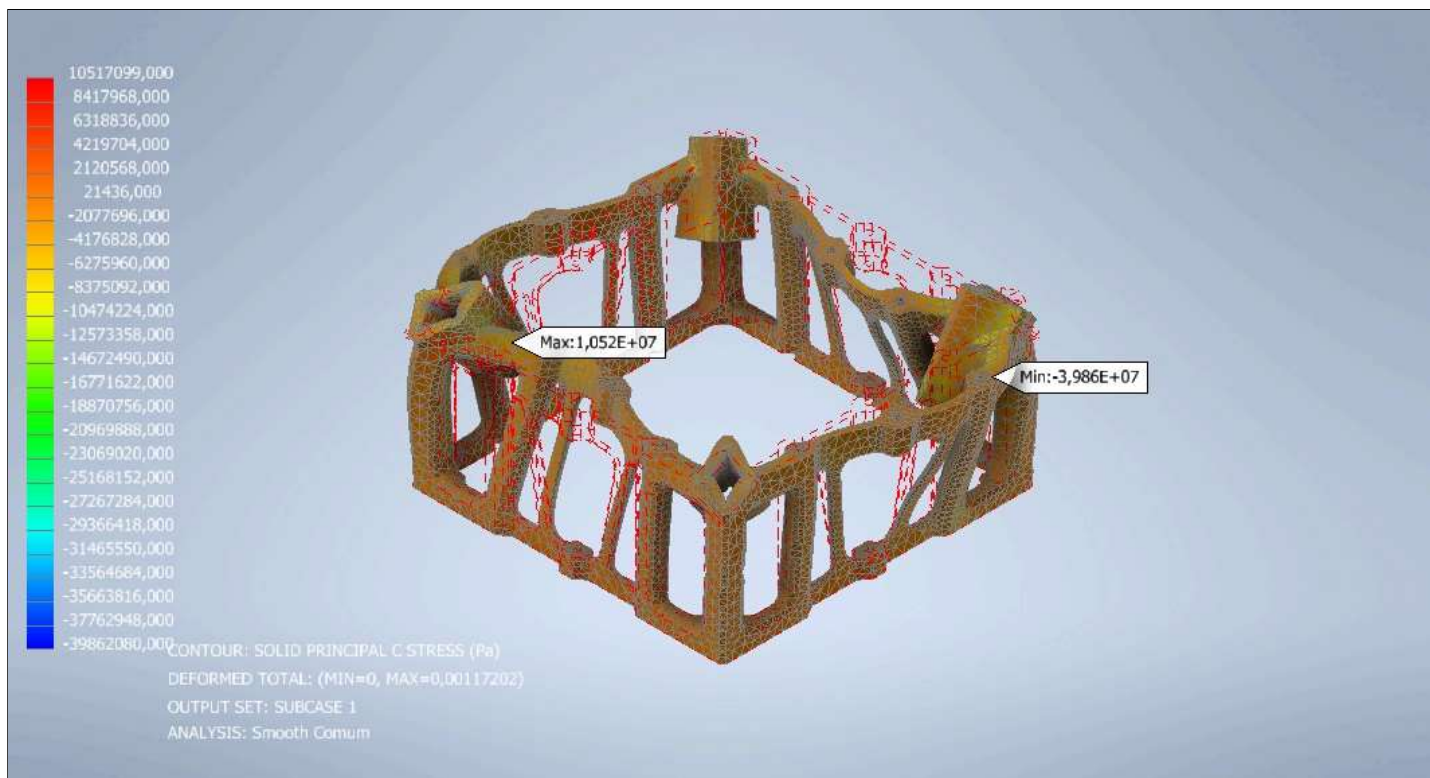


Figure 8 - OUTPUT SET: SUBCASE 1 -- DEFORMED TOTAL: (MIN=0, MAX=0,00117202) -- CONTOUR: SOLID PRINCIPAL C STRESS (Pa)

## 6. Conclusion:

A linear static analysis was performed using the Autodesk Nastran Version 18.2.0.35 finite element solver on the akovagckx structure. The finite element model contained mainly Part 1 elements and consisted of 412188 degrees of freedom. 1 loading condition was analyzed. The maximum displacement was 1,172E-03 m (load case Subcase 1). The maximum von Mises stress was 3,239E+07 (load case Subcase 1).

## 7. Glossary:

### **Aspect Ratio**

Ratio of an element's longest side to its adjacent side.

### **Bi-Directional Slide**

Prevents contacting regions from separating or closing but permits sliding (zero coefficient of friction)

### **Bounding Box**

A three-dimensional cube aligned to the global x,y and z axes that exactly contains a body or assembly.

### **Follower Forces**

Loads that follow the motion of the structure as it deforms.

### **General Contact**

Models standard nonlinear surface contact with friction if specified.

### **Relative Stress Error**

A measure of mesh convergence (values greater than 0.01 may indicate that further mesh refinement is required in areas with large stress gradients over a few elements).

### **Rough Contact**

Nonlinear contact that allows separation and closure but does not permit sliding (infinite friction).

### **Skew Angle**

The angle between the lines that join opposite midsides of a quadrilateral face.

### **Solution Error Measure**

A measure of solution quality (values less than 1.0E-07 are generally considered acceptable).

### **Taper Ratio**

The ratio of the areas on the two sides of a diagonal of a quadrilateral face.

### **Warping Angle**

The extent to which a quadrilateral face deviates from being planar.

### **Welded Contact**

Prevents contacting regions from sliding, separating, or closing.