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Structural Evaluation of a Hydraulic Loader Crane Using Structural Mechanical (Comsol Multiphysics®)

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1. Introduction

Loader cranes

- Machine with a complex structural design;
- Use of different materials (HSLA, Copolyamide, cast parts).
- Failure in the structure causes material damage and risks to life;
- The objective is to evaluate the stress in the structure and compare it with results from structural calculation according to DIN EN 12999.

1. Introduction

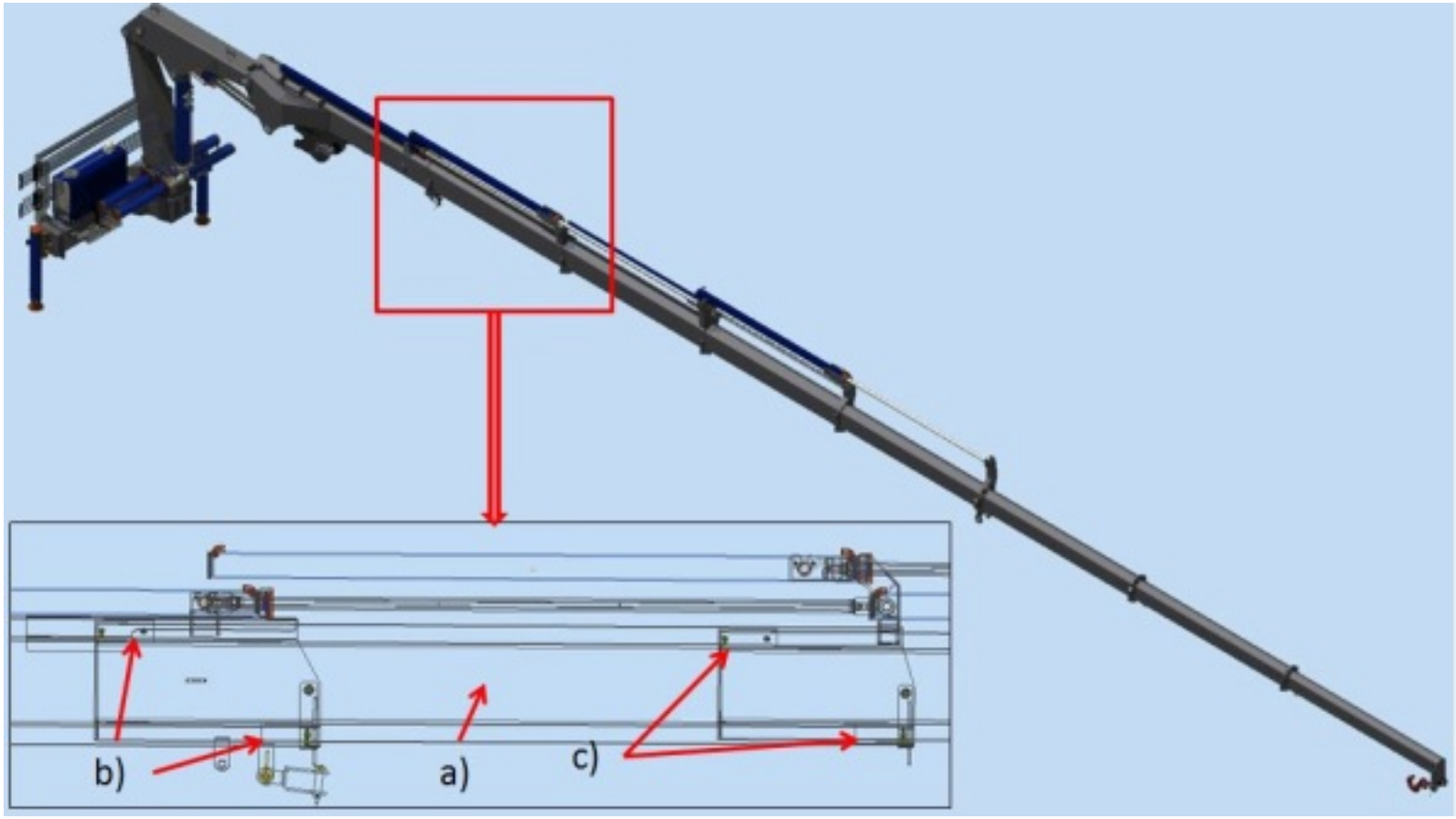

Figure 1. Crane`s 3D model, boom steel profile (a), rear sliders (b) and front sliders (c).

1. Introduction

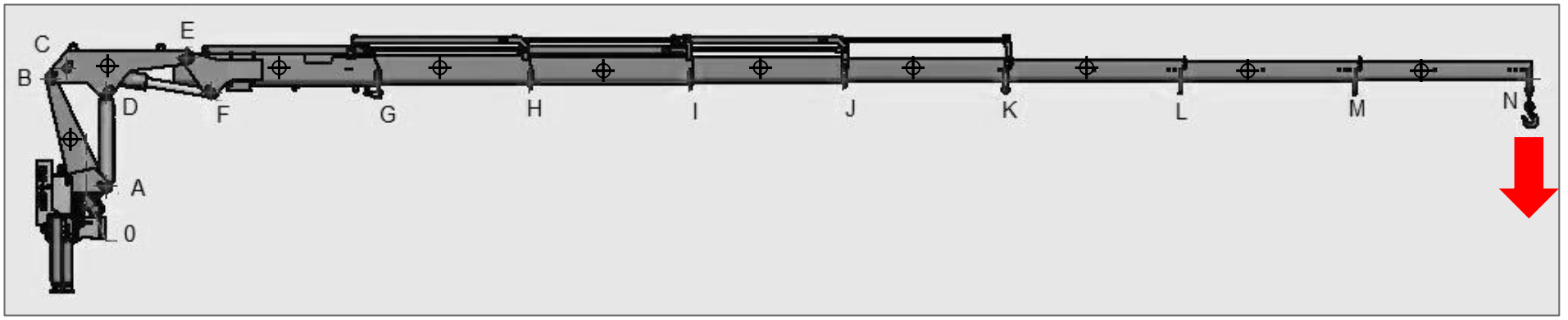

Figure 1. Crane's geometric points.

Point	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Total Reation (Kgf)	36097	33601	65526	36097	65926	65526	18798	18656	12982	10578	10403	5897	3082	2421

Table 1. Reactions in the Geometric Points.

2. Computational Methods

- Solid Mechanical's module
- Linear Elastic Material
- Stationary.

The equations solved in the model are:

$$-\nabla . \sigma = Fv, \qquad \sigma = s$$ Tension - Deformation

$$\varepsilon = \frac{1}{2}(\nabla \mathrm{u} + \nabla \mathrm{u}^{\mathrm{T}})$$ Total strain tensor

$$s = \mathrm{s}_0 + \mathrm{C}\colon(\varepsilon - \varepsilon_0 - \alpha\theta)$$ The Duhamel-Hooke's law

2. Computational Methods

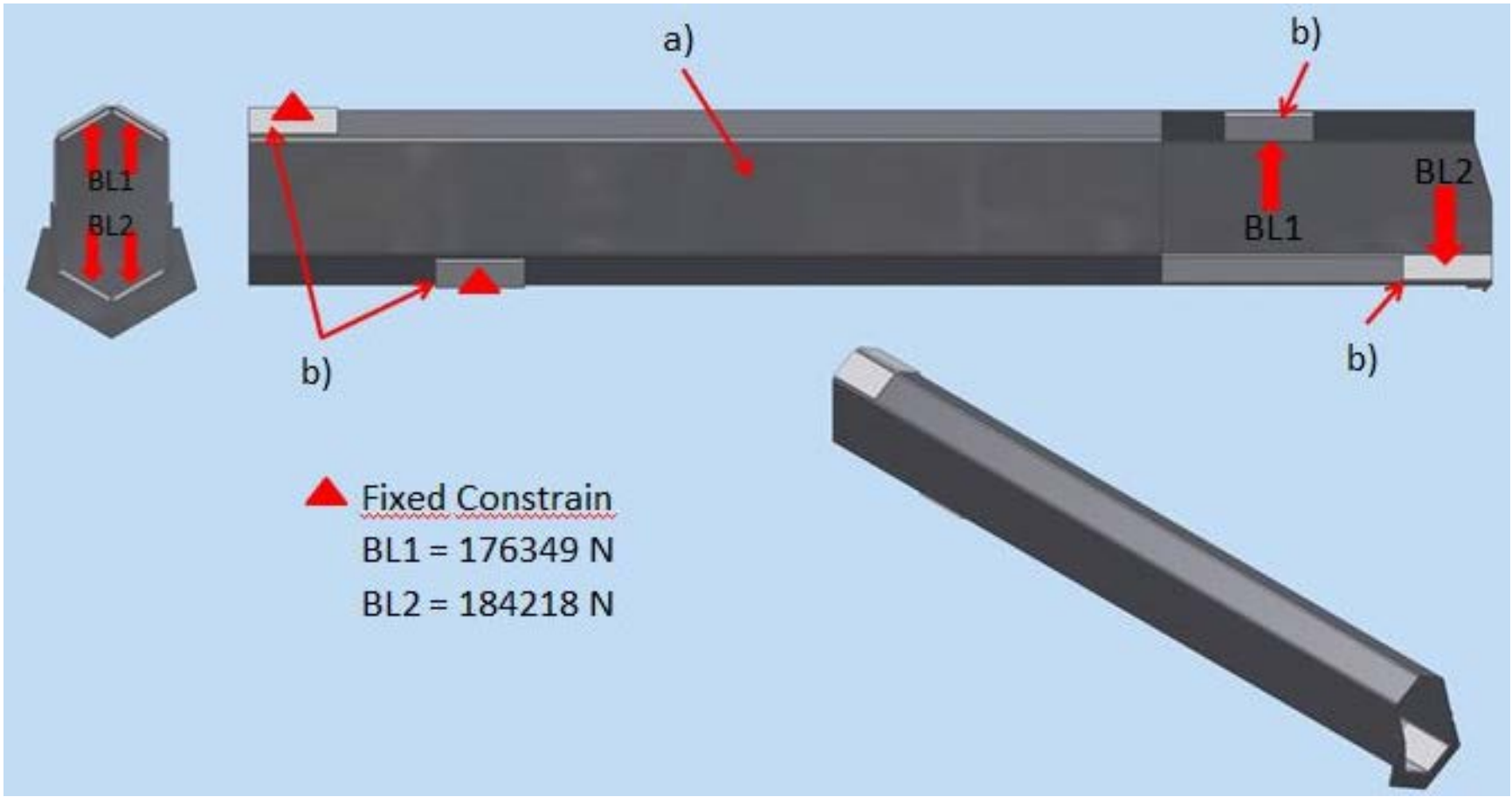

Figure 2. Crane first boom: hexagonal profile (a), sliders (b) and applied boundary conditions.

3. Results

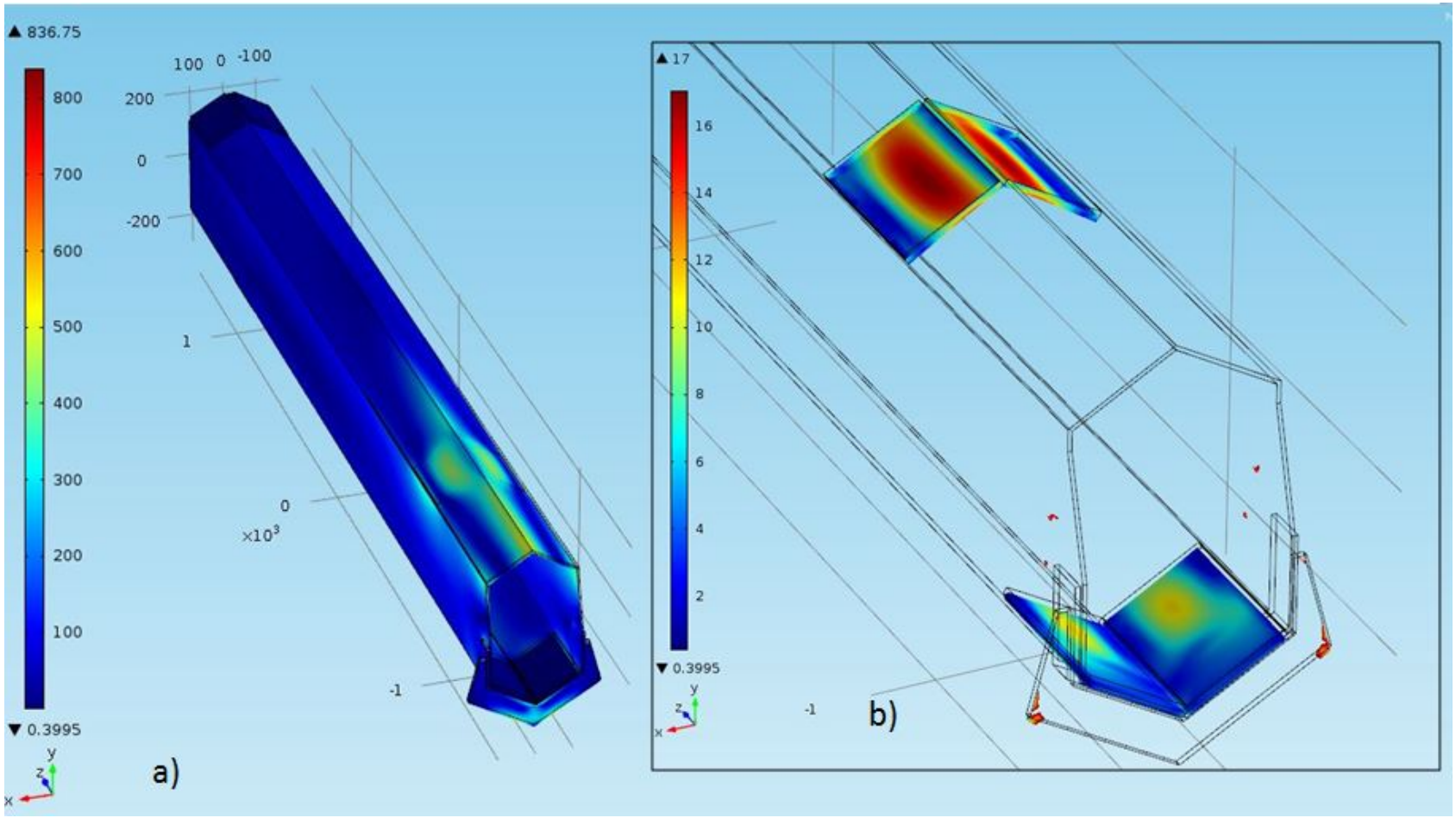

Figure 3. Stress obtained in the first boom structure (a) and sliders (b) [MPa].

3. Results

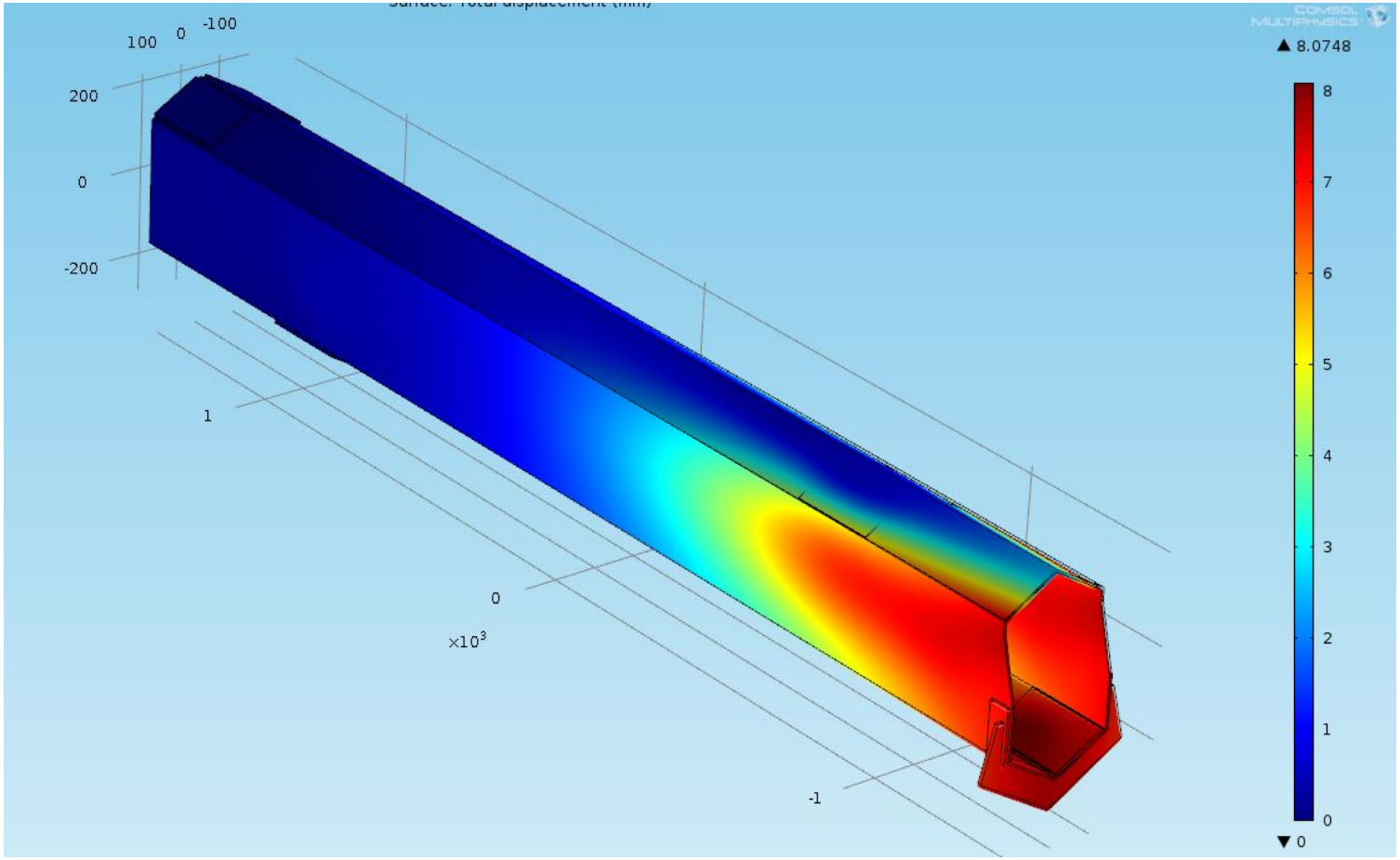

Figure 4. Deformation in the first boom structure [mm].

3. Results

Component	DIN EN 12999	FEA results	Difference
Upper Steel Profile	370 MPa	320 MPa	-15,63%
Lower Steel Profile	370 MPa	420 MPa	11,90%
Upper Slider	14 MPa	17 MPa	17,64%
Lower Slider	14 MPa	14 MPa	0,00%

Table 2. Calculation and Numerical Simulation results.

4. Conclusions

- Values of the static simulation are close to the results of the structural calculation;
- Through simulation we can achieve the maximum stresses location, optimizing the design;
- For future studies, it is possible to conduct non-linear analysis and verify the influence of the clearance between the sliders and the steel profile.

Thank You!

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Questions?