Structural Evaluation of a Hydraulic Loader Crane Using COMSOL Multiphysics® Software

A. Braun[1], A. Moura[1]
1. Feevale University, Novo Hamburgo, RS, Brazil.

Introduction: Loader cranes are machines with a complex structural design. The main design issue is that the 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 calculus from DIN EN 12999 [1,2].

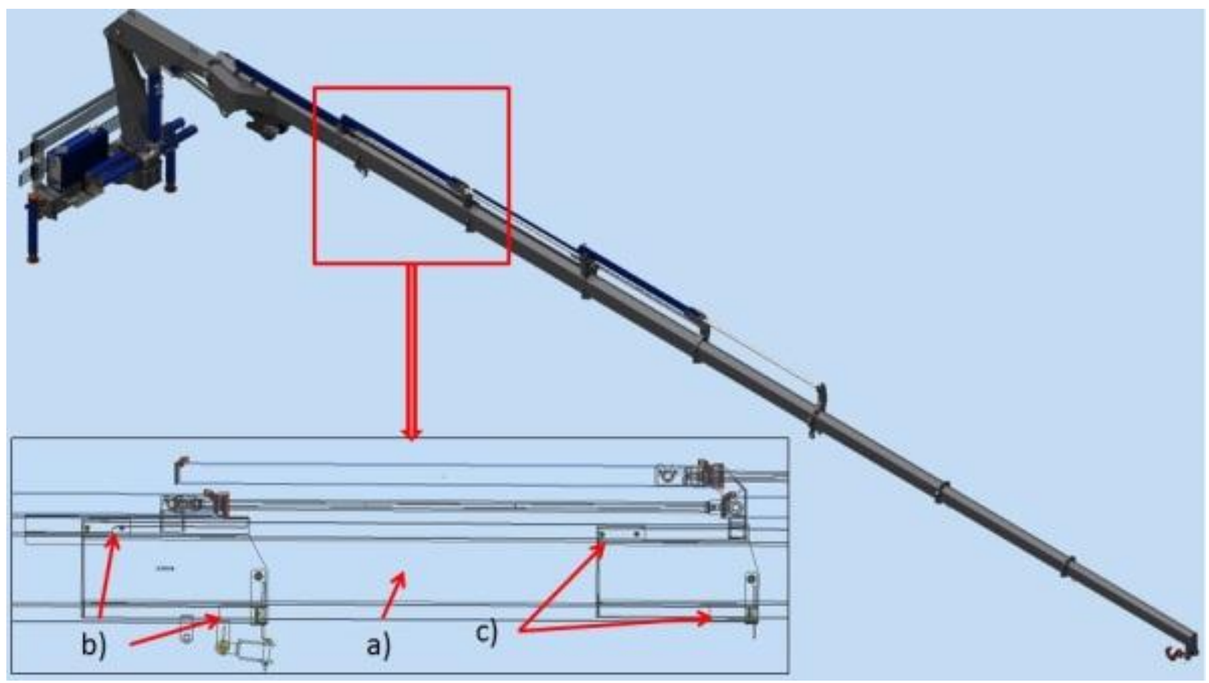

Figure 1. Crane's 3D model, boom steel beam(a), rear sliders (b) and front sliders (c).

Computational Methods: COMSOL Multiphysics' Solid Mechanics physics interface was used to model a Linear Elastic Material in a stationary study. The equations solved in the model were:

$$-\nabla . \sigma = Fv$$

$$s = s_0 + C : (\varepsilon - \varepsilon_0 - \alpha\theta)$$

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

The models' geometry has one structural steel profile (a) and copolyamide 6.6 sliders (b). The fixed constrains and boundary loads shown in Fifure 2 were used in the model.

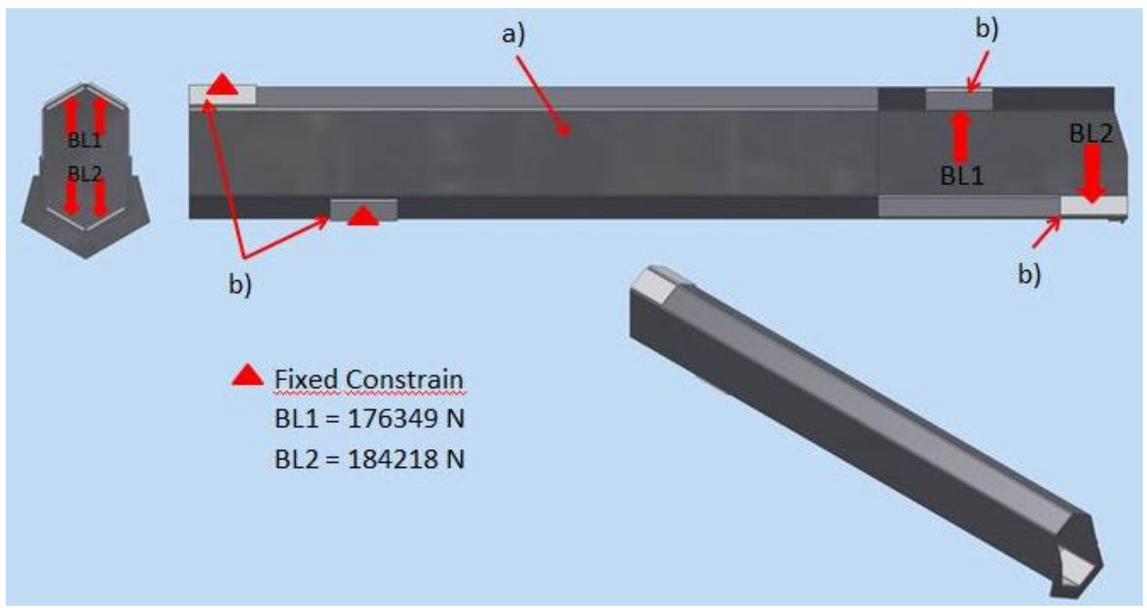

Figure 2. Crane first boom: hexagonal profile (a), sliders (b) and applied boundary conditions.

Results: In the steel beam the tension is 420 MPa (upper) and 320 MPa (bottom). For the sliders, the maximum stress of 17 MPa was found in the upper and 14 MPa in the lower ones

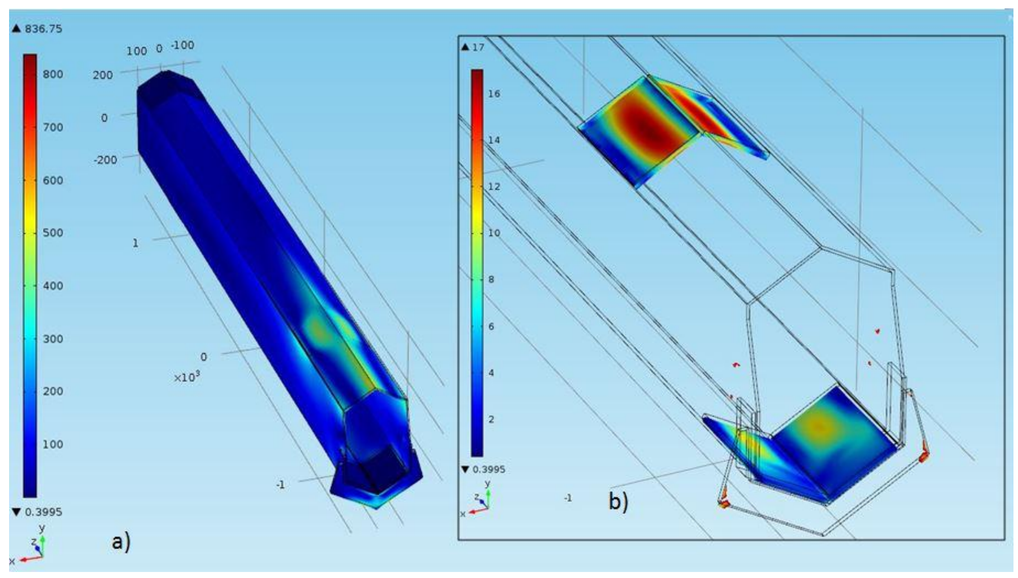

Figure 3. Von Mises Stress obtained in the first boom structure (a) and sliders (b) [MPa].

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

Table 1. Calculus and Numerical Simulation results

Conclusions: The 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. In further analysis it can be performed simulations of the others booms of the crane.

References:

1. Anderson Braun. Evaluation of a hydraulic loader crane' structure subject to low temperatures. Feevale University. Brazil. (2014)
2. DIN. DIN EN 12999:2013. Cranes - Loader cranes. EN 12999:2011+A1:2012. Germany. (2013)

Acknowledgements:

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