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

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## Abstract

Introduction
The hydraulic loader crane (HLC) stands out among the machines used for cargo handling. The machine's structural project is complex because several considerations are required. The main design issue is that the failure in the structure causes material damage and risks to life. Validation with numerical simulation is advantageous because it allows the analysis of details like points of stresses and different design options, leading to a safer product. Figure 1 shows the 3D model of the crane with the hydraulic boom outstretched, where the red rectangle shows the first boom, selected for analysis, with front and rear sliders. In this position the first boom has a portion of its length inside the previous boom and the subsequent boom with a portion of its length inside it.

The objective is to evaluate the stresses in the sliders and in the first boom of HLC and compare it with results from structural calculation according to DIN EN 12999 (BRAUN, 2014 ).

COMSOL Multiphysics® software use
The COMSOL Multiphysics® Solid Mechanics physics interface was used to model a Linear Elastic Material in a stationary study to analyze the crane's first boom (Figure 2). This was built with a hexagonal shape and 4 sliders, made of high strength low alloy steel according to BS EN 10149-2 and modified copolyamide 6.6, respectively. In the simulation, it was used the boundary conditions: fixed constraint on the rear sliders and boundary load in the front sliders (BL1 and BL2), as shown in Figure 2. The input data were obtained from the structural calculation (BRAUN, 2014).

The mesh was generated, with a total of 199.855 elements, predominantly tetrahedral. From this study the stresses in the assembly was obtained (Figure 3).

Results
Figure 3 shows the stresses on the first boom (a) and sliders (b), with maximum values for the steel shape of 420 MPa (upper) and 320 MPa (bottom). The maximum stress is in the contact region of the sliders with the boom, as expected. For the sliders, the maximum stress of 17 MPa was found in the upper and 14 MPa in the lower ones, also as expected.

The loads determined in structural calculation and numerical simulation results are: calculated maximum stress of 370 MPa in the boom, in the numerical simulation the stress was 420 MPa

(11,9% difference); the calculated maximum stress and simulated stress in the upper slider was 14 MPa and 17 MPa, respectively (17.6% difference); the maximum stress in the lower slider is 14 MPa in the calculation and simulation.

Conclusion
With the results, it is possible to conclude that the values of the static simulation are close to the results of the structural calculation. Through simulation we can achieve the maximum stresses location, which can be used for optimizing the design. The objective was achieved, as were evaluated and compared the stresses in sliders and hexagonal boom profile, obtained from the COMSOL Multiphysics software with the results of structural calculations (DIN EN 12999). For further analysis it can be performed simulations of the other booms of the machine.

## Reference

Anderson Braun. Evaluation of a hydraulic loader crane' structure subject to low temperatures. Master's degree. Feevale University. Brazil. 2014.

British Standart. BS EN 10149-2:2013. Hot rolled flat products made of high yield strength steels for cold formingTechnical delivery conditions for thermomechanically rolled steels. England. 2013.

DIN. DIN EN 12999:2013. Cranes - Loader cranes. German version EM 12999:2011+A1:2012. Germany. 2013.

## Figures used in the abstract

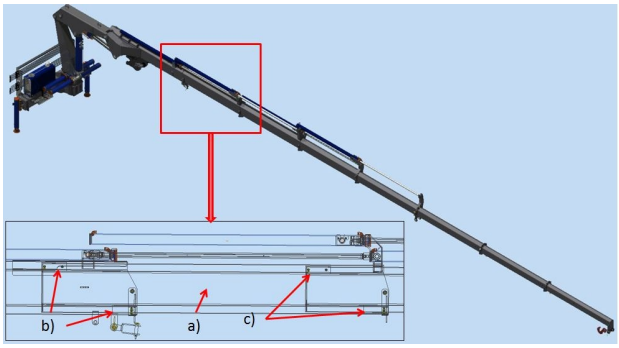


**Figure 1**: Machine`s 3D model, boom steel profile (a), rear sliders (b) and front sliders (c).

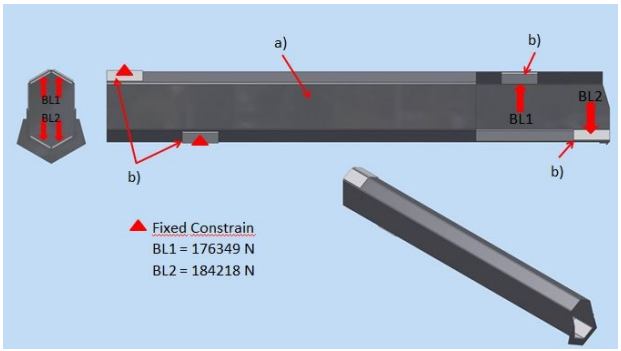


**Figure 2**: HLC first boom: hexagonal shape (a), sliders (b) and applied boundary conditions.

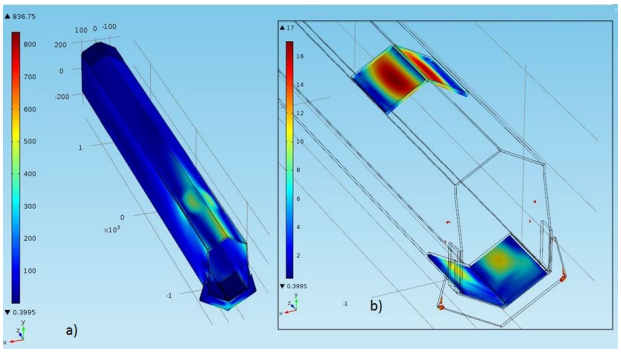


**Figure 3**: Stress obtained in the first boom structure (a) and sliders (b) [MPa].