DEVELOPMENT OF AN AUTOMATIC PROCEDURE FOR SAFETY ANALYSIS OF ELEVATOR FRAMES FOLLOWING THE EN-81 REGULATION

[1,2]Dr. Ioannis Zyganitidis*
[1]BLAU EI, Greece, [2]Laboratory of Mechanics and Materials Aristotle Univesity of Thessaloniki, Greece

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elevator car frame, overspeed protection means, ANSA task manager, EN-81

ABSTRACT
According to EN 81-1 and EN 81-2 standards for the safety of construction and installation of lifts, all hydraulic and specially high speed traction lift must be equipped with overspeed protection means. These means, comprising speed monitoring and speed reducing elements, shall detect uncontrolled movement of an ascending or descending passenger car and shall stop or at least reduce the speed of the car to an acceptable level. To assess the mechanical behaviour of a full loaded elevator car frame subject to intense deceleration BLAU EI engineers created detailed finite element models of the complete construction. ANSA was crucial for this purpose due to its ability to build detailed models of complicated assemblies mixing bolt and weld connections but most importantly due to its scripting functionality. In this work we present a new automatic process build up to perform a number of simulations of a complete passenger elevator. The process allowed the engineers to optimize the design through a number of iterative runs and analysis by taking into account a large number of independent design, safety and cost factors. Most importantly the approach allowed the estimation of the load performance curve of the elevator frame. The whole simulation approach resulted in a remarkable reduction of time, a high quality and very accurate model and finally in a process less prone to human errors.

TECHNICAL PAPER

1. INTRODUCTION

Information about the load performance of a hydraulic or traction elevator car frame when the overspeed protection means are engaged is critical not only for the engineers of the design department but also for the sales department, the general manager e.t.c. One of the methods to spread this information to people with different technical background is to create 2D curves which correlate various parameters of the mechanical components. In the case of elevator frames one of the most common graph is the load performance diagram which depicts the suspended load versus the width of the passenger cabin.
BLAU EI developed an automated procedure in both preprocessing and postprocessing analysis stage in order to create load performance curves for elevator car frames. We analysed the performance of car frames using FEA techniques for a variety of rated load and subject to intense deceleration or acceleration due to the engagement of the overspeed protection means. The whole simulation approach resulted in a remarkable reduction of time, a high quality and very accurate model and finally in a process less prone to human errors.

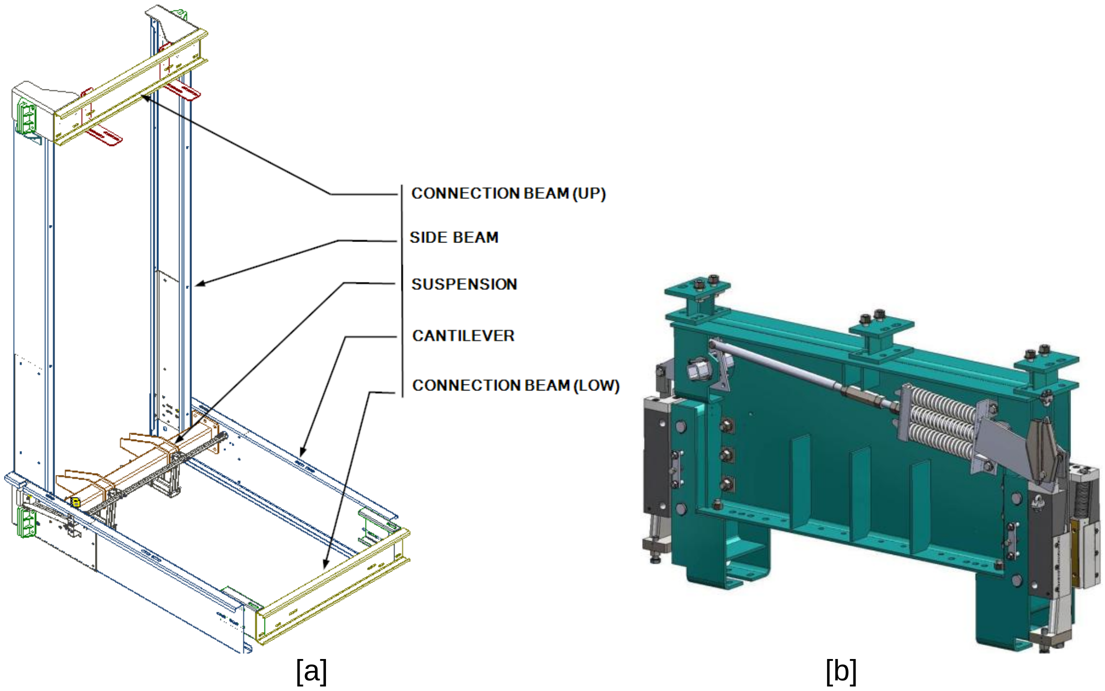

Figure 1 – [a] Elevator cabin frame and its main parts (courtesy of TELCO, complete elevators) [b] One direction safety gear mechanism (courtesy of Wittur, complete elevators and elevator parts)

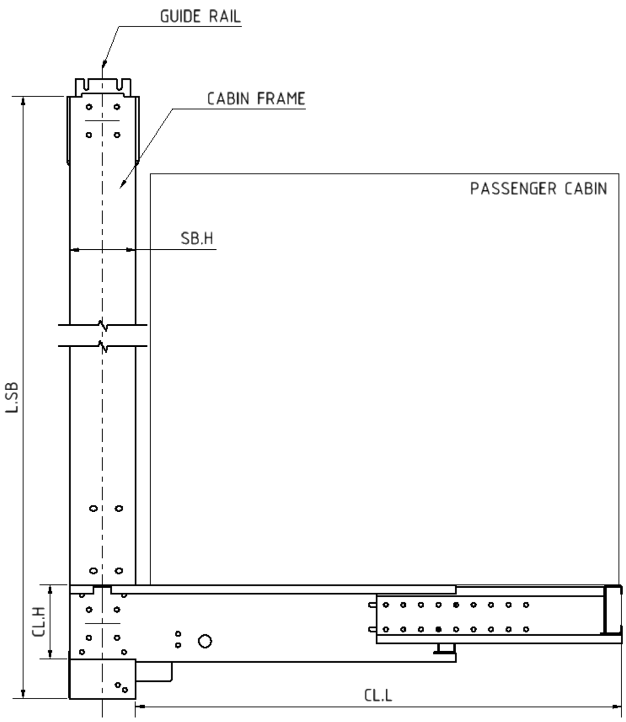

Figure 2 – Simplified assembly of car frame and a passenger cabin. The free length of the cantilever CL.L is the main design parameter used to asses the mechanical behaviour of a car frame.

2. PREPROCESSING - ANSA

A number of scripts were developed with Python Programming Language by using the ANSA Scripting Interface as an Application Programming Interface (API). This allows us to obtain access to ANSA core functionality and data. The work flow of our method is illustrated bellow.

[a] PREPROCESSING [b] POSTPROCESSING

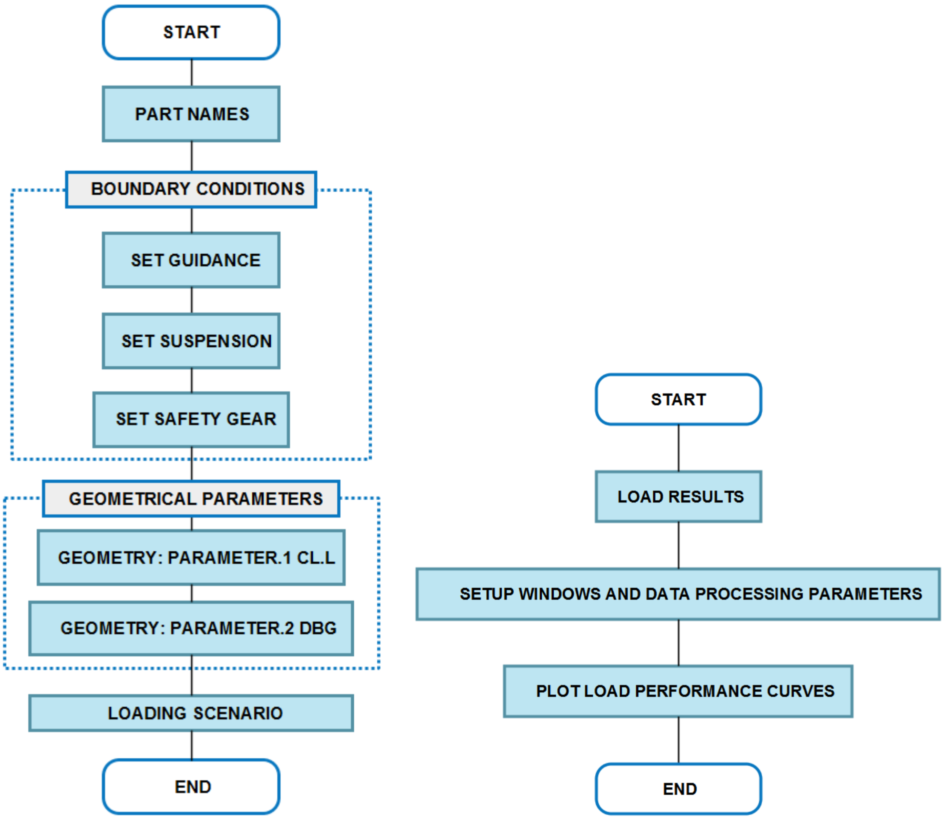

Figure 3 – Workflow chart for both preprocessing [a] and postprocessing [b]

For the boundary conditions (e.g. guidance, suspension and safety gear) a library of simplified FEA models was created based on RBE2 elements. The whole procedure is very effective and the only input of the user is the exact type and the selection of CONS or the POINTS where the created models will be applied.

[a] CAD MODEL [b] ANSA MODEL

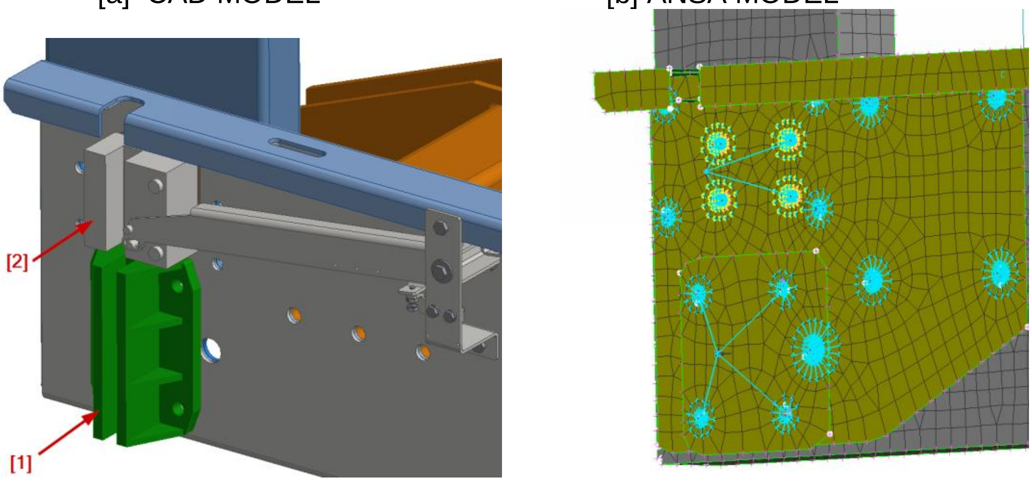

Figure 4 – Example of FEA models developed to simulate [1] guidance shoe and [2] safety gear. Left their 3D CAD geometries, right the equivalent automated created RBE2 models in ANSA.

One of the most challenging tasks was the parametrization of the cabin frame for the two main dimensions: the distance between guides (DBG) and the free length of the clantilever (CL.L)

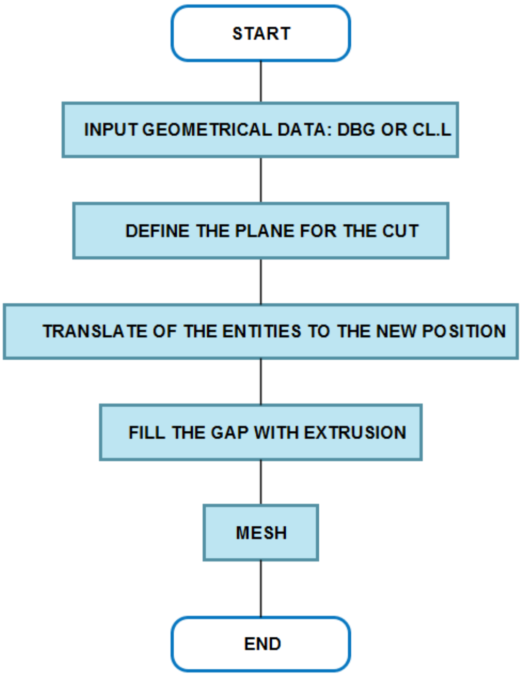

Figure 5 – Workflow chart for parametrization of the geometry.

Finally a set o load scenarios was created by inserting text in NASTRAN header with the corresponding function.

SCENARIO CODE	DESCTIPTION
S01	NORMAL, CAR FRAME IS MOVED UP AND DOWN
S02	EMERGENCY, MOTOR BRAKE
S03	EMERGENCY, SAFETY GARE BRAKE
S04	EMERGENCY, IMPACT ON BUFFER.

2. POST PROCESSING

The most important graph for an elevator is the change of total suspended load as a function of cantilever length. In beta cae mETA we developed a procedure to plot the load performance curve for an elevator frame. First the stress field of each component in the maximum load together with 2D graph of various parameters (Fig.6 and Fig.6) was ploted. The next step is to create a diagram combining the maximum allowable load for each component as a function of cantilever free length is created (Figure.8). Using the minimum value of the curves for each length the performance curve is created.

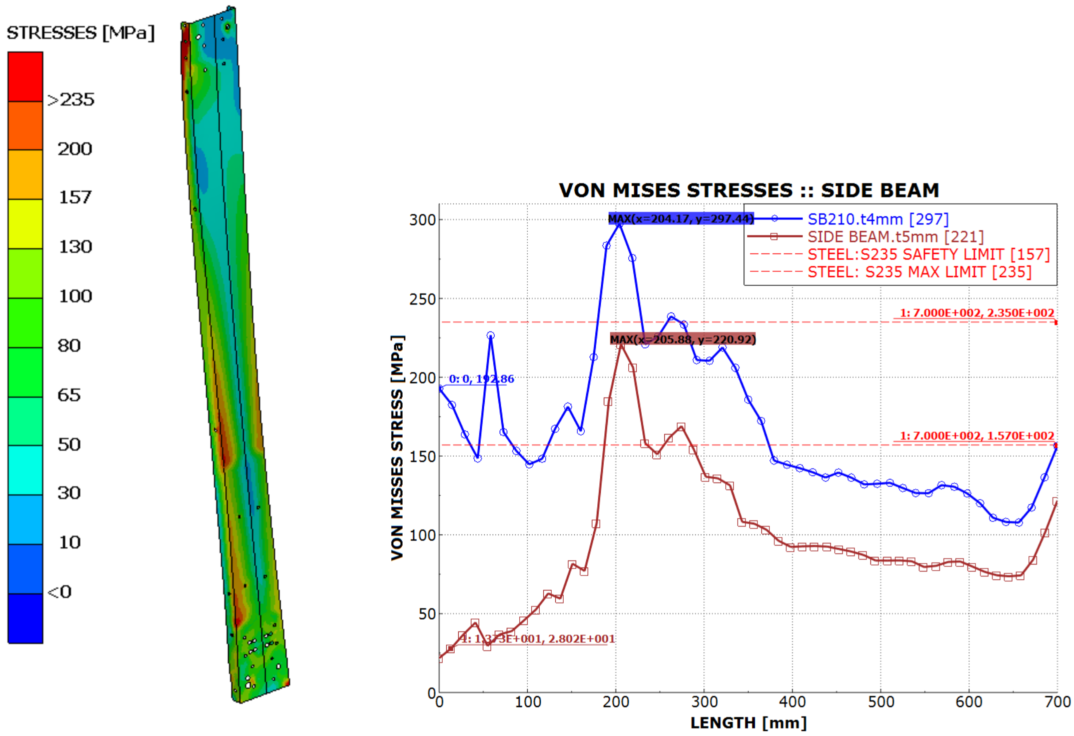

Figure 6 – Stress field diagram of the side beam (left) and changes of Von Mises stresses as a function of side beam length, using the beam thickness as a parameter.

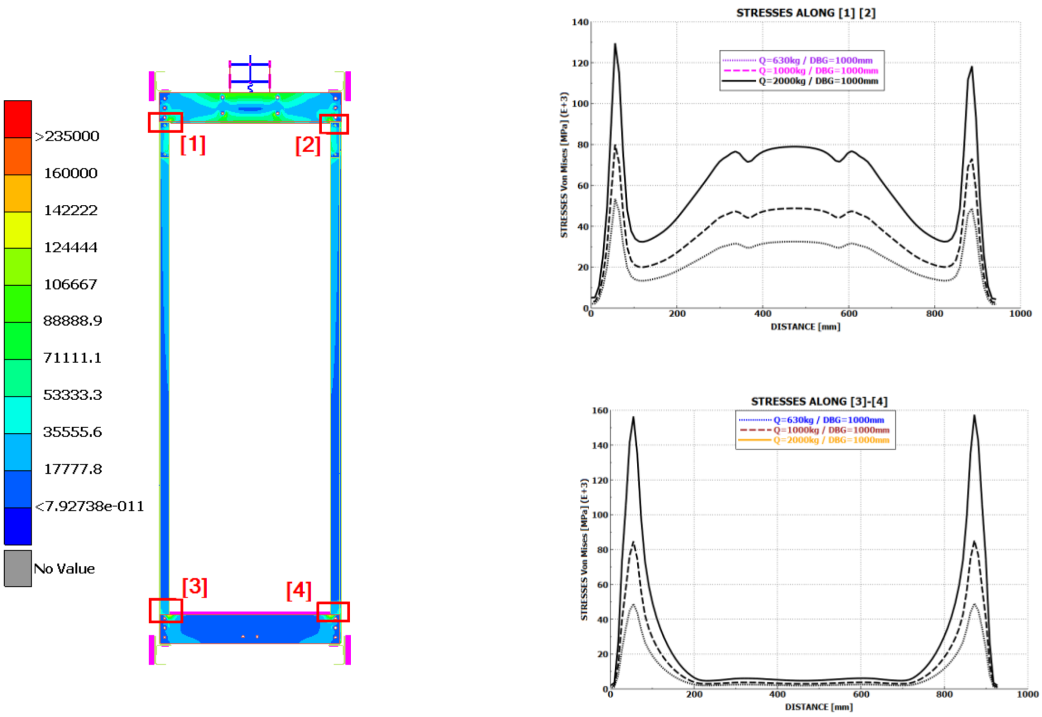

Figure 7 – Stress field diagram of the complete counter weight frame of a traction elevator (left) and the changes of stresses along DBG as a function of passenger cabin rated load (right)

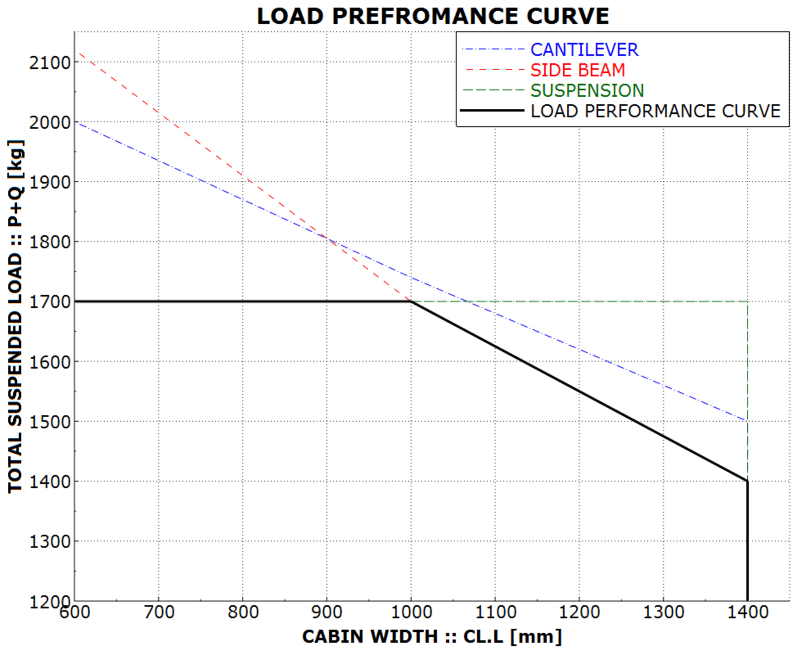

Figure 8 – Load performance of each component of the elevator

4. CONCLUSIONS

The process allowed the engineers to optimize the design through a number of iterative runs and analysis by taking into account a large number of independent design, safety and cost factors, by significantly reducing the simulation time

REFERENCES

(1) ANSA version 15. User's Guide, BETA CAE Systems S.A., 2015
(2) μETA PostProcessor version 15. User's Guide, BETA CAE Systems S.A., 2015
(3) EN 81-1 Safety rules for the construction and installation of lifts - Part 1: Electric lifts
(4) EN 81-2 Safety rules for the construction and installation of lifts - Part 2: Hydraulic lifts