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HEAVY PLANT DESIGN AND STATIC BEHAVIOUR SIMULAION. CASE OF STUDY

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ABSTRACT
In this paper it is presented the finite element analyse of a milling machine used in mining industry. The 3D model was made using technical possibilities of I-DEAS and ALGOR and the analyse was done with ABAQUS. At the end there are presented the obtained results.
Keywords: finite element method, milling machine analyse, modeling.

1. SOLID MODEL
The main aim of the design is to obtain the best system for an assembly that has imposed functional conditions. In machine building industry a machine or a simple part are mainly calculated to have a proper strength and the stress level is imposed to do not exceed some values.
In case of an assembly the designer is obliged to consider different aspects strong connected with the functionality as: the force flow and the level of the forces that are acting on each part, to realise a right position of the parts according with the real components of the machine, the relative motions between different parts, to realise a static and dynamic stability, etc.
The above mentioned methodology was applied to a milling machine used in mining industry. The assembly consists of 20 different parts (Figure 1) that are connected by screws, cotters, and pegs.

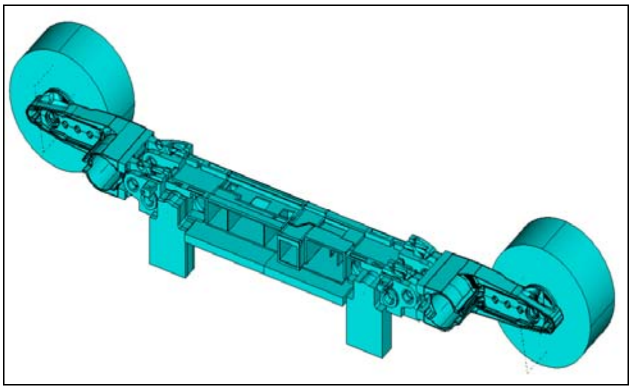


Figure 1. Milling machine. Assembly view.

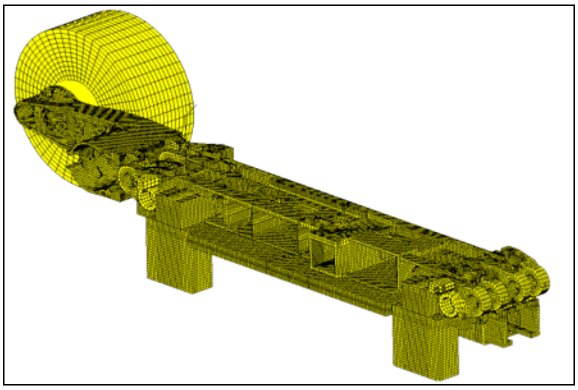


Figure 2. FEM model

After all parts were designed in I-DEAS and meshed with solid or surface mesh they were exported in ALGOR. In the next step, in ALGOR all parts were arranged on their position in the assembly. As reference system of the milling machine was considered the rotation axe of the arm.

Then, all components that were meshed only with surface elements were re-meshed with solid element of the first order. This was realised using the facilities offered by ALGOR. At the end the assembly consists of approximately 260,000 elements (Figure 2).
Considering the complexity of the milling machine parts, the diversity of the connecting elements and the large number of contact surfaces the assembly was analysed using as finite element program ABAQUS. The input file used in ABAQUS can be divided in some distinguish parts: in the first one there are defined the nodes and the elements with materials characteristics.

2. ASSEMBLY FINITE ELEMENT ANALYSIS

The main boundary conditions are presented in Figure 3: the gap elements that are used to model the link of the machine with the base support and the hydraulic cylinder that push the arm.

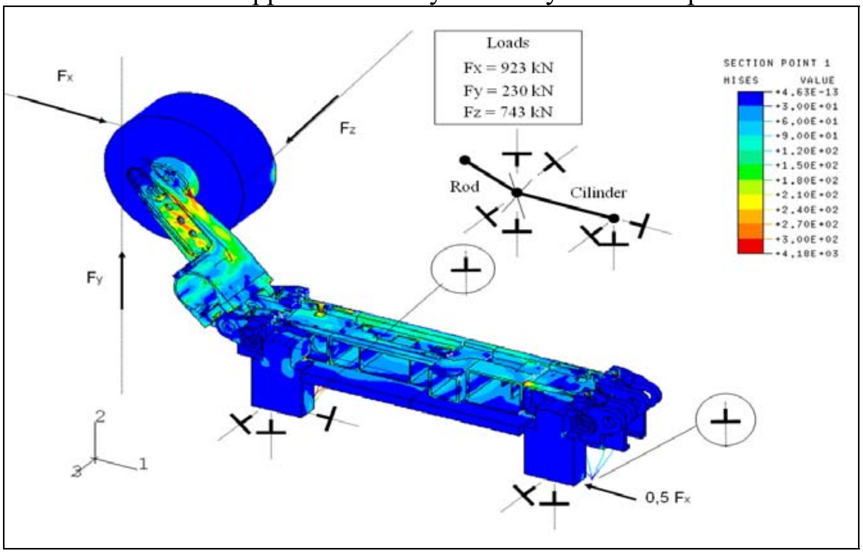


Figure 3. The milling machine with boundary conditions and von Mises stresses.

The milling machine analyse was made using ABAQUS program. The level of von Mises stresses in all parts is presented in Figures 4 ÷ 8.

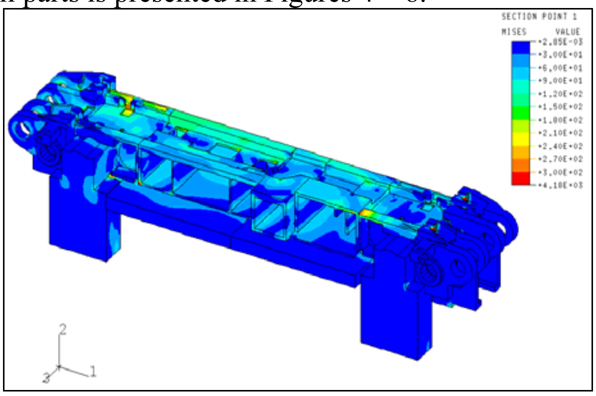


Figure 4 The middle parts of the machine

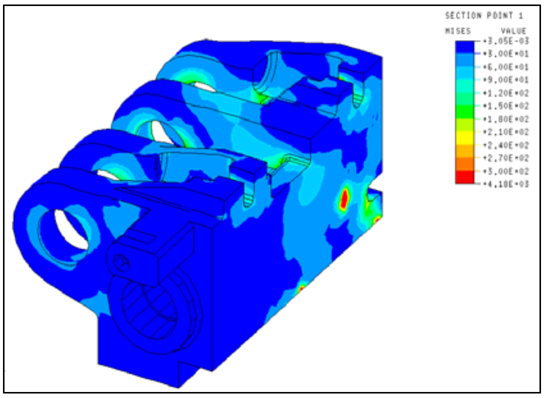


Figure 5. Rotating system base.

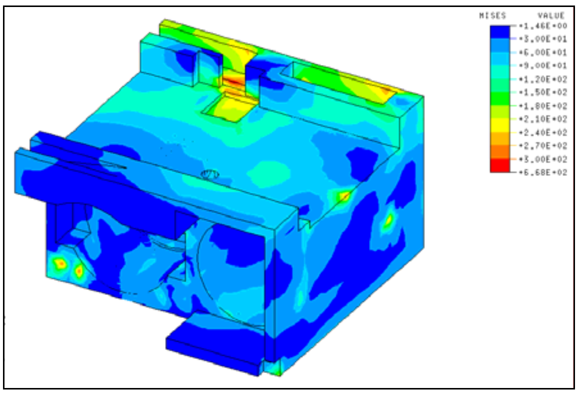


Figure 6. Gearbox.

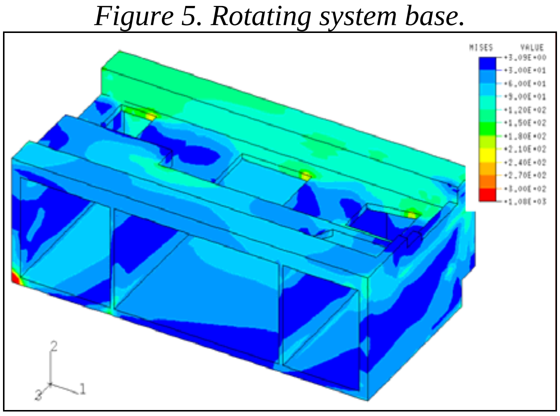


Figure 7. Electric equipment box.

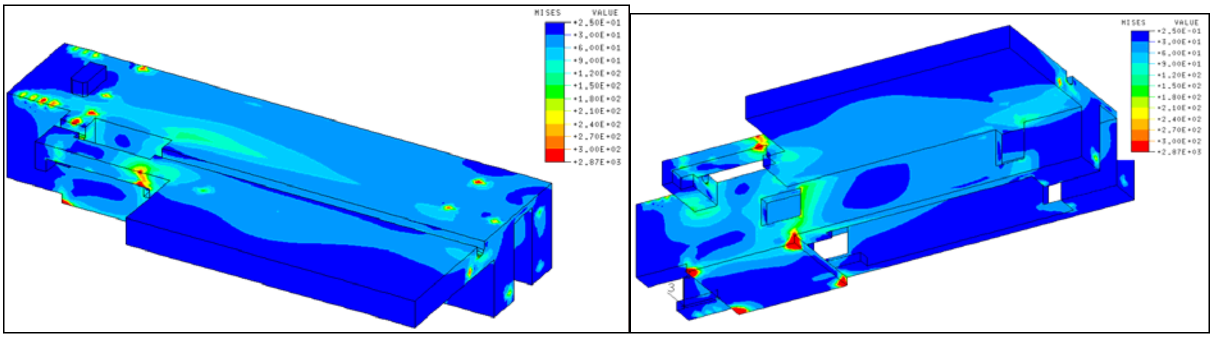
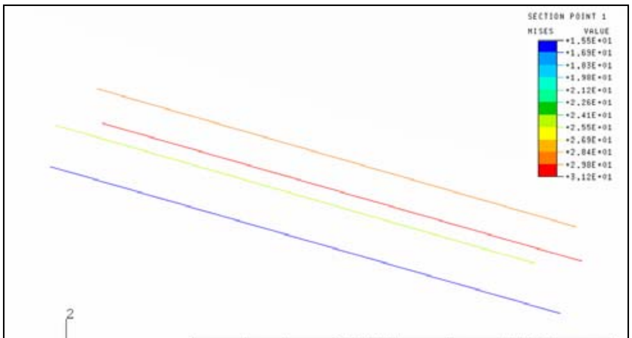


Figure 8. The milling machine platform

Along the assembly there were mounted four rods that were pre-tensioned. The level of normal stresses is presented in Figure 9. In Figure 10 there are presented the contact pressure between the different parts of the assembly.



		Pretentioned			Under loads		
Rod	l [mm]	von Mises	ε	Δl [mm]	von Mises	ε	Δl [mm]
1	6250	298,4	1,4210E-03	8,881	282,4	1,3450E-03	8,406
2	6250	298,4	1,4210E-03	8,881	272,1	1,2959E-03	8,099
3	6250	238,7	1,1368E-03	7,105	234,6	1,1170E-03	6,981
4	6650	238,7	1,1368E-03	7,560	233,4	1,1116E-03	7,392

Figure 9. Normal stresses in rods.

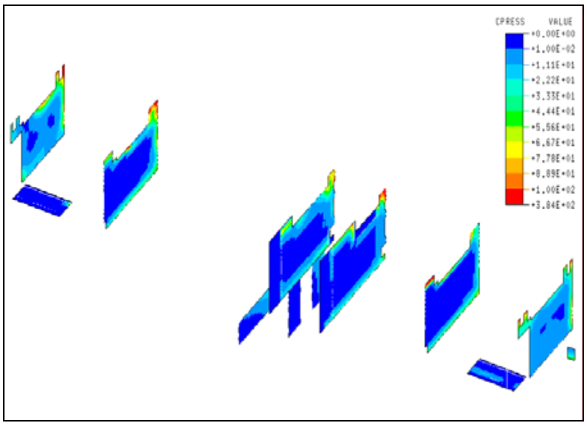


Figure 10. Contact pressure.

Another analyse that is necessary to be done consists of deformation study of the milling machine. The construction with long beams and many screws, cotters, and pegs generate a very flexible structure that can have a large deformation during the milling process. The deformations of the assembly and of different parts there are presented in Figures 11.

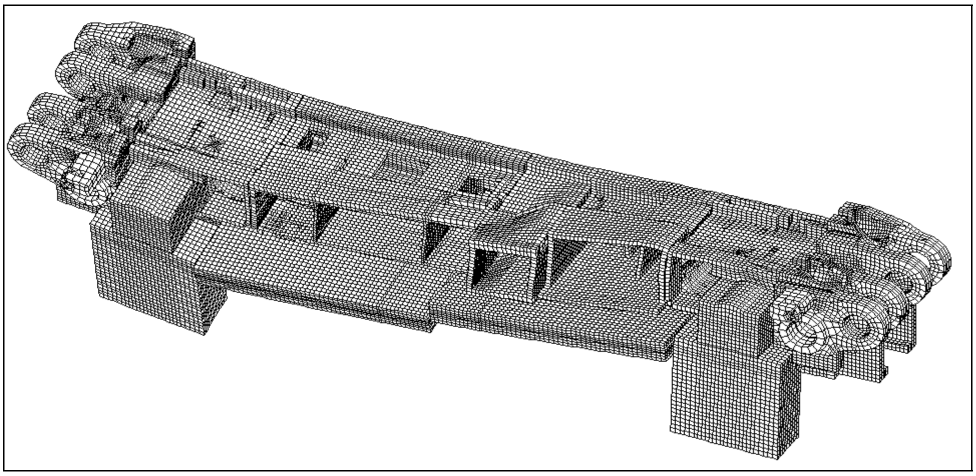


Figure 11: Deformation of the middle body of the machine (magnification coefficient 50).

3. CONCLUSIONS

Based on the obtained results presented above one can conclude that:

a) The level of the von Mises stresses is situated in the limits of the material strength and from this point of view the analysis confirm that there are no problem;
b) The contact pressure is in some corners a little bit greater that the admitted value and is necessary to be done some technical changes (new shapes, new material in that area, etc.);
c) The deformation pictures show that some parts have a large modification of the shape during the loads and the structure is very flexible. These deformations represent an important problem for the designer and, as solution, it is necessary to introduce more screws in those regions where the contact between parts is lost and the deformations are large.

The finite element method can offer to engineer designer an image about the level of stresses and deformations and so, from the stage of designing, can take the proper decisions to solve all possible damages.

The present work is part of the activity done in the frame of the research project "Teilautomatisierte Generierung von 3D-CAD-Modellen", developed at the Institut für Bergwerks –und Hüttenmaschinenkunde, Rheinisch-Westfälische Technische Hochschule, Aachen, Germany.

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