MACHINE DESIGN, VOL.7(2015) NO.1, ISSN 1821-1259 PP. 31-34

Research paper

ANALYSIS OF PRE-STRESSES CAUSED BY WIRE TENSION OF STONE CUTTING MACHINE

Dragan ČUKANOVIĆ [1,*] - Milan BLAGOJEVIĆ [2] - Snežana VULOVIĆ [2] - Miroslav ŽIVKOVIĆ [2]
[1] University of Kosovska Mitrovica, Faculty of Technical Sciences, Kosovska Mitrovica , Serbia
[2] University of Kragujevac, Faculty of Engineering, Kragujevac, Serbia

Received (02.12.2014); ***Revised*** (24.02.2015); ***Accepted*** (27.02.2015)

Abstract: *In this paper finite element model of machine for stone cutting is created. In accordance with the real working environment appropriate boundary conditions are applied. Pre-stress static analysis is performed. Results of analysis and field of von Misses equivalent pre-stress are shown. Based on the results of analysis appropriate conclusions are presented.*

Key words: *Pre-stress, Static analysis, Stone cutting machine, FEM*

1. INTRODUCTION

In the modern age of technology, sophisticated devices and structures, software for the calculation and simulation behavior are widely used. Based on different theoretical methods these programs are effectively used in different areas of industry. The main task is to create 2D or 3D models as well as to do static and dynamic linear and nonlinear analysis in order to predict the behavior of structures in a real working environment. Today, software based on finite element method (FEM) has become one of the most frequently used method for solving such problems.

Pre-stress static analysis provides an opportunity to simulate how a prestiffened or prestressed structure affects your model's deformations, stresses and strains. This type of analysis determines the strengthening or weakening of the part due to the applied loads. Results of a previously run pre-stress static analysis can be the starting point for some other type of analysis. Pre-stress static analysis can be run for the different problem and situations. For example, if the specified loads in the static analysis are close in magnitude to a corresponding buckling load. In this case, the prestiffening effects are negligible from a static analysis. Also, if applied loads affect the stiffness of the model. For example, if there is a model with an existing load that projects an existing force. Beside above mentioned, pre-stress static analysis can be run in order to get more specific information about the model.

In this paper the analysis goal is the pre-stresses analysis of the machine for stone cutting. The analysis is performed using finite elements model generated by software Femap. Calculations are performed by software NX Nastran [1].

2. MODEL

Machine is modeled using software Femap with NX Nastran solver. According to the construction type, shell elements of the appropriate thickness, 3D elements (for modeling some part of rollers), beam element and rod

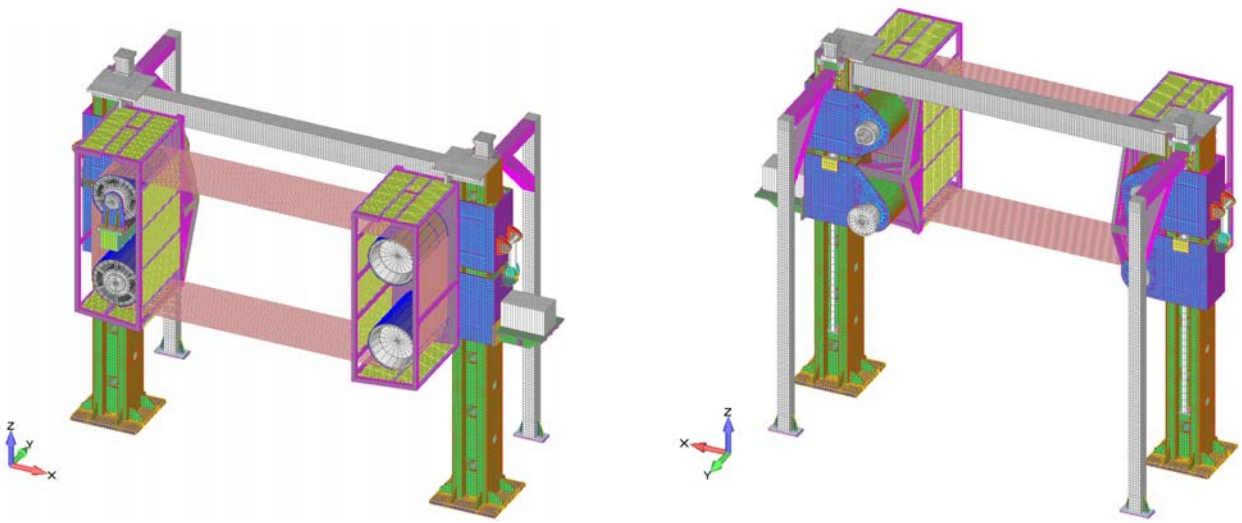


Fig.1. Finite element model

*Correspondence Author's Address: University of Kosovska Mitrovica, Faculty of Technical Sciences, Kneza Milosa 7, 38220 Kosovska Mitrovica, Serbia, dragan.cukanovic@pr.ac.rs

elements (for modeling wires) are used for creating the finite element mesh. Structure is modeled in details with 151527 elements and 167273 nodes. Figure 1 shows the FE model of the machine with 40 wires

2.1. Material characteristics

Structural components are made of steel except small rollers, that are made of aluminum. Over the rollers there is a polyurethane strip with 90 Sh [2]. Table 1 shows physical characteristics of materials.

Table 1. Material properties

Materials	E [N/mm^2]	ρ [kg/mm^3]	ν
Steel	$2.1 \cdot 10^5$	$7.8 \cdot 10^{-6}$	0.3
Aluminum	$70 \cdot 10^5$	$2.7 \cdot 10^{-6}$	0.34
Polyurethane	$0.025 \cdot 10^5$	$1.2 \cdot 10^{-6}$	0.49

2.2. Loads

The goal of this analysis is to determine the pre-stresses caused by wire tension before cutting. The tension force in the wire before cutting process is F_w=2500 N. Wire tension is simulated by thermo-mechanical analysis. On the nodes that belong to elements that represent wire, force of tension corresponding to the given temperature is applied. On the driving roller friction force is acting during the cutting. Friction force in the wire is $F_f=M/R_\omega$=370N, where M=150Nm is the drive torque, and R_ω=0.406 m is diameter of drive roller. Friction forces are given as a concentrated force on the drive roller, see figure 2.

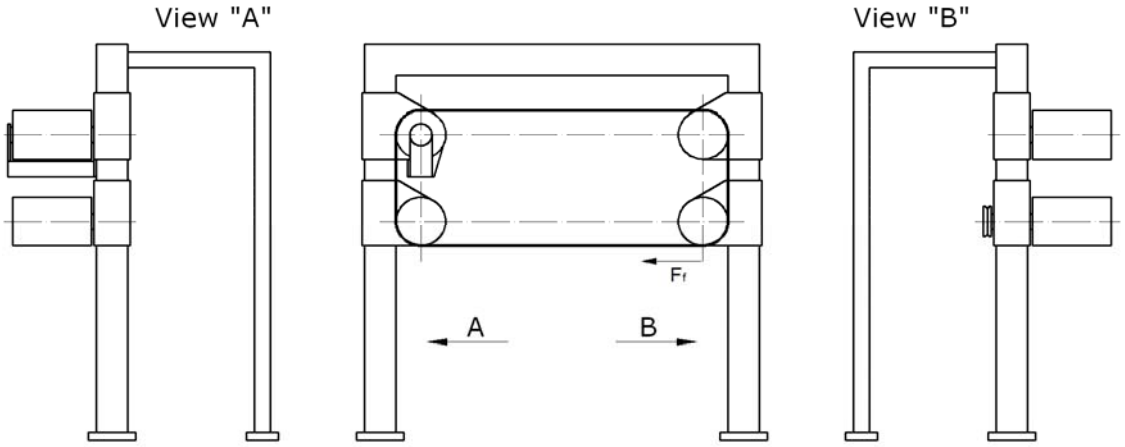
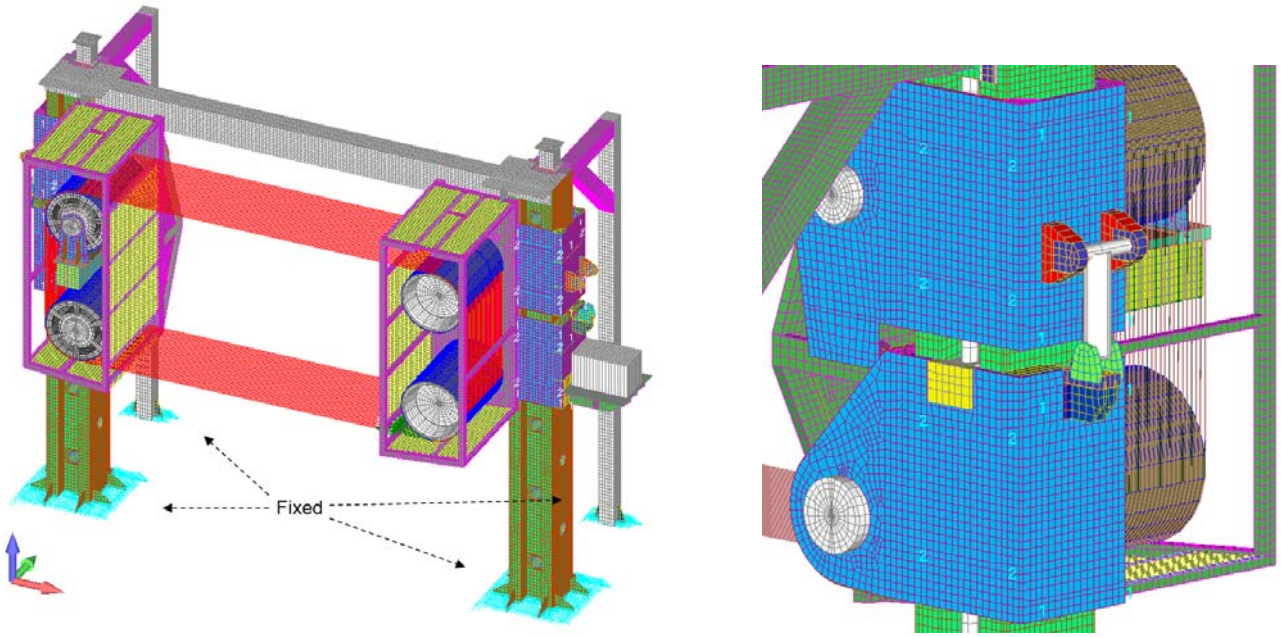


Fig.2. Friction force

2.3. Boundary conditions

Boundary conditions are given in accordance with the requirements of the real construction of machine. All nodes at the contact surface between machine and base are fixed, figure 3. Colors in figure 3. match the various thickness of shell elements. At the locations of small wheels, which provide vertical guidance of moving parts, constraint equations are given, see figure 3.



(a) *(b)*

Fig.3. Boundary conditions

3. RESULTS

Figure 4 shows field of von Mises equivalent pre-stress in structure before the cutting process. Maximal value of the equivalent stress is 85.8 MPa [3].

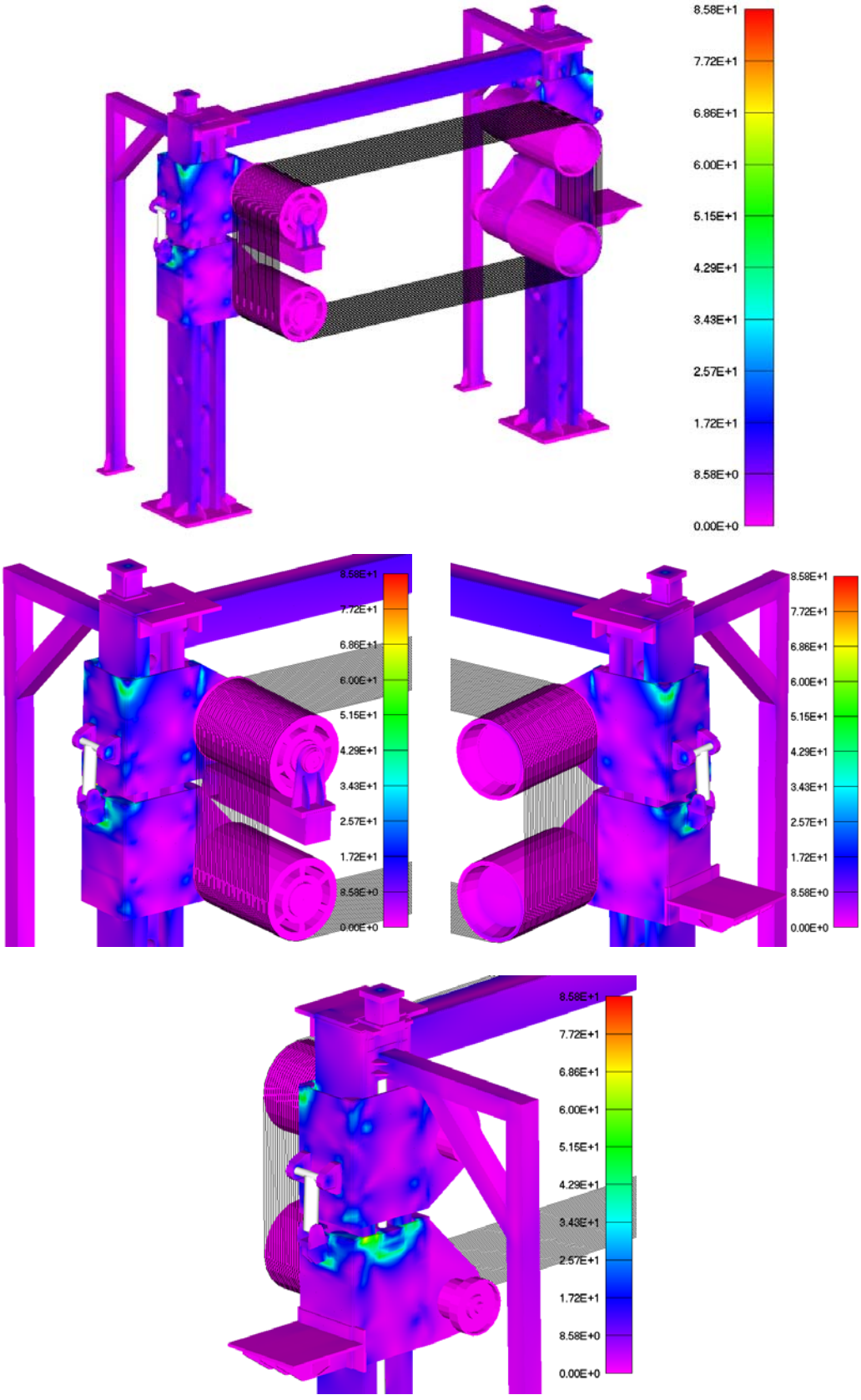


Fig.4. Field of von Misses stress

4. CONCLUSION

The finite element model of the machine for stone cutting is presented. Loads and constraints are modeled very realistically.

Stresses occurring in the structure due to the wire tension is relatively low. They are far below the yield stress for the material of which the machine is made.

In the future work, this model will be used for modal and dynamic analysis. Particularly it is interesting effect of prestressing on own frequencies of machine.

ACKNOWLEDGMENT

The part of this research is supported by Ministry of Education, Science and Tehnological Development, Republic of Serbia, Grant TR32036.

REFERENCES

[1] Femap with NX Nastran V.10
[2] EN 10025 - European structural steel standard – Grade designations, properties and nearest equivalents.
[3] Eurocode 3: Design of Steel Structures 1.