THE FINITE ELEMENT ANALYSIS OF HYDRAULIC MOTOR CASING FROM HORIZONTAL HYDRAULIC PRESS – 2 MN

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Abstract: This paper analyse through the finite elements method (FEM) the hydraulic motor casing from horizontal Hydraulic Press – 2 MN. The analysis of hydraulic motor casing of horizontal Hydraulic Press – 2 MN was made for determination of displacements, deformations and the factors of safety distribution. A three-dimensional model of the hydraulic motor casing with a complex geometry was generated based on the designed data. Finite elements analysis was performed using COSMOSWorks software. Results predicted by the finite element method show that the presented method is efficient and accurate and in good agreement with the theoretical and experimental values.

Keywords: horizontal Hydraulic Press, hydraulic motor casing, finite elements method, displacements, deformations, factors of safety

1. INTRODUCTION

Today manufacturing processes must be fast, flexible, and adapt quickly to the market change. Achieving this objective requires integrated solutions. Minimization of response times and costs and maximization of the efficiency and quality in producing a product are imperative in the competitive manufacturing industry.

Finite element analysis (FEA) is a powerful computer-based tool widely used by engineers, analysts and designers for understanding the mechanics of physical systems, to perform engineering simulations, calculations and optimizations from different engineering fields. This method of product design and testing is far superior to the manufacturing costs which would accrue if each sample was actually built and tested [1, 2].

Hydraulic presses are characterized in that it provides material deformation at relatively constant speeds so even if it forces large variation and are extensively use in metalworking by cold and hot plastic deformation.

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2. MATERIALS AND METHODS

2.1. The hydraulic element force from horizontal Hydraulic Press – 2 MN

The hydraulic element force from horizontal Hydraulic Press – 2 MN, which is a non-standard assembly, includes: a linear hydraulic motor, the clamping and restraint elements and the element to transmission force to piece. A three-dimensional modelling of this subsystem and a longitudinal section in it is shown in Figure 1.

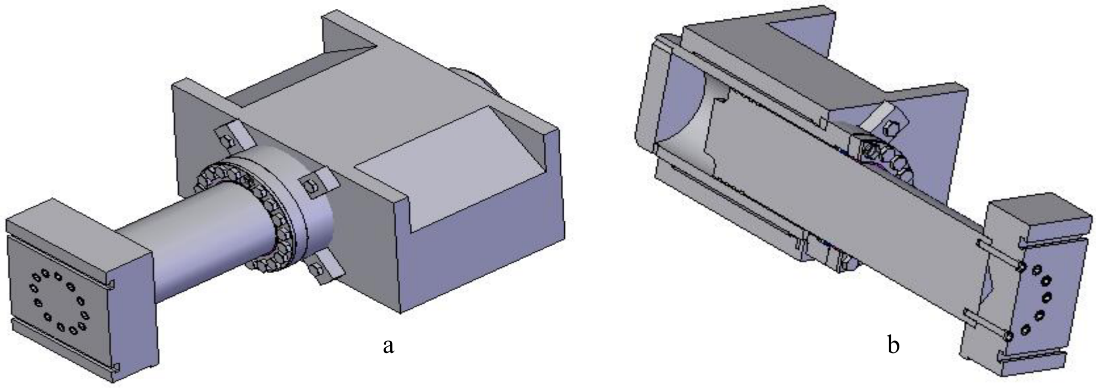

Fig.1. A 3D modelling of the hydraulic element force from horizontal Hydraulic Press – 2 MN (a) and a longitudinal section in it (b).

2.2. Meshing of the hydraulic motor casing

A three-dimensional model of the hydraulic motor casing with a complex geometry was generated based on the designed data (Fig. 2). Finite elements analysis was performed using COSMOSWorks software.

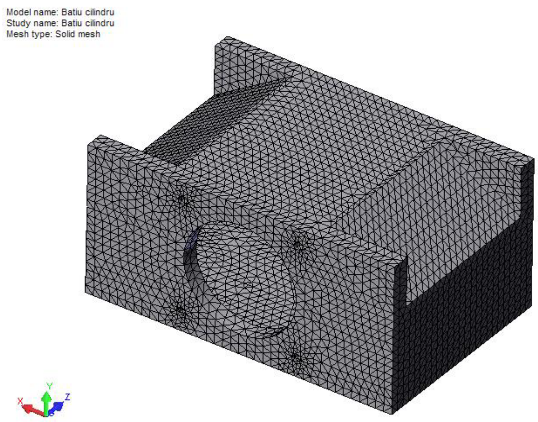

Fig.2. A 3D meshing of the hydraulic motor casing.

2.3. The calculation of the stresses distribution, displacements and total strain energy

The study was conducted considering that the maximum force of the hydraulic cylinder was applied to the hydraulic motor casing. Results obtained are presented below:

D I S P L A C E M E N T S

NODE	X-DISPL.	Y-DISPL.	Z-DISPL.	XX-ROT.	YY-ROT.	ZZ-ROT.
			MINIMUM/MAXIMUM DISPLACEMENTS			
NODE	6392	4839	76596	0	0	0
MIN.	-4.89089E-06	-8.60879E-06	-1.94191E-06	0.0000	0.0000	0.0000
NODE	45479	6125	58227	0	0	0
MAX.	4.88836E-06	1.11421E-05	3.53414E-05	0.0000	0.0000	0.0000
			MAXIMUM RESULTANT DISPLACEMENT			
NODE	58228					
MAX.	3.62307E-05					

FOR REQUESTED (Global Cartesian Coord. System)

NODES	FX	FY	FZ	MX	MY	MZ
Total React.	0.1466E+00	0.5574E+00	-.2500E+05	0.0000E+00	0.0000E+00	0.0000E+00

TOTAL STRAIN ENERGY. . . . . = 0.225715E+00

MAXIMUM NODAL VON MISES STRESS

NODE 151

MAX. 0.48918E+09

The stresses distribution of the hydraulic motor casing determined according the theory of Von Mises is shown in Figure 3 and stresses distribution in a longitudinal section is shown in Figure 4.

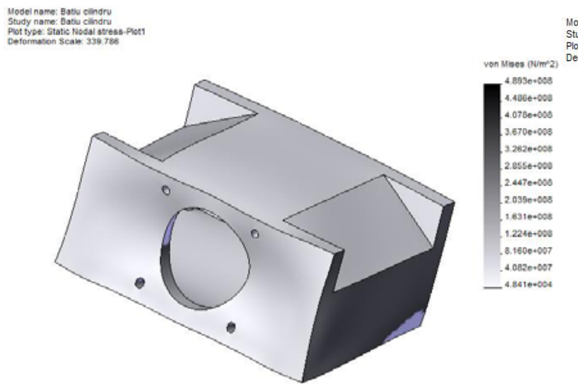

Fig. 3. The stresses distribution.

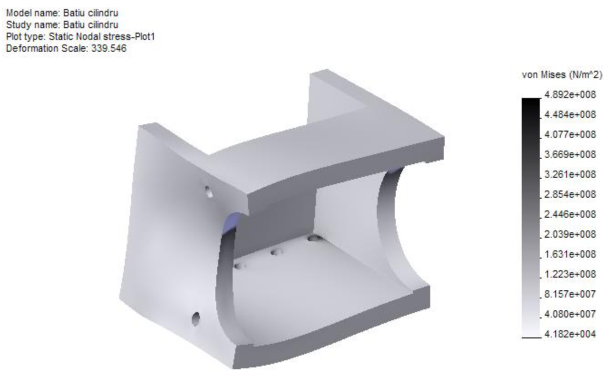

Fig. 4. The stresses distribution in longitudinal section.

The resulting 3D deformation distribution is shown in Figure 5 and the slipping result is shown in Figure 6.

Fig. 5. The deformations distribution.

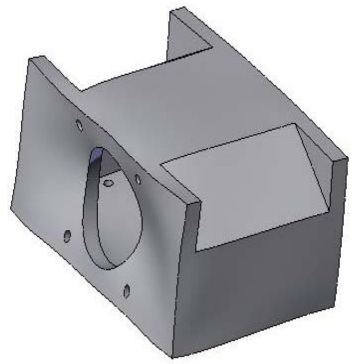

Fig. 6. The slipping result distribution.

2.4. The vibrational analysis

The first 4 modes of natural vibration of casing were studied. The program shows the following results:

F R E Q U E N C Y A N A L Y S I S by L A N C Z O S A L G O R I T H M

FREQUENCY NUMBER	FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SECONDS)
1	0.2325800E+05	0.3701626E+04	0.2701515E-03
2	0.2651214E+05	0.4219539E+04	0.2369927E-03
3	0.3651351E+05	0.5811306E+04	0.1720784E-03
4	0.3809972E+05	0.6063758E+04	0.1649142E-03
5	0.4321081E+05	0.6877214E+04	0.1454077E-03

Mode 1 is shown in Figure 7a, natural frequency of vibration is ν = 3701.6 Hz, scale deformation is Kd = 103.62.
Mode 2 is shown in Figure 7b, natural frequency of vibration is ν = 4219.5 Hz, scale deformation is Kd = 107.31.
Mode 3 is shown in Figure 7c, natural frequency of vibration is ν = 5811.3 Hz, scale deformation is Kd = 107.31.
Mode 4 is shown in Figure 7d, natural frequency of vibration is ν = 6063.8 Hz, scale deformation is Kd = 107.31.

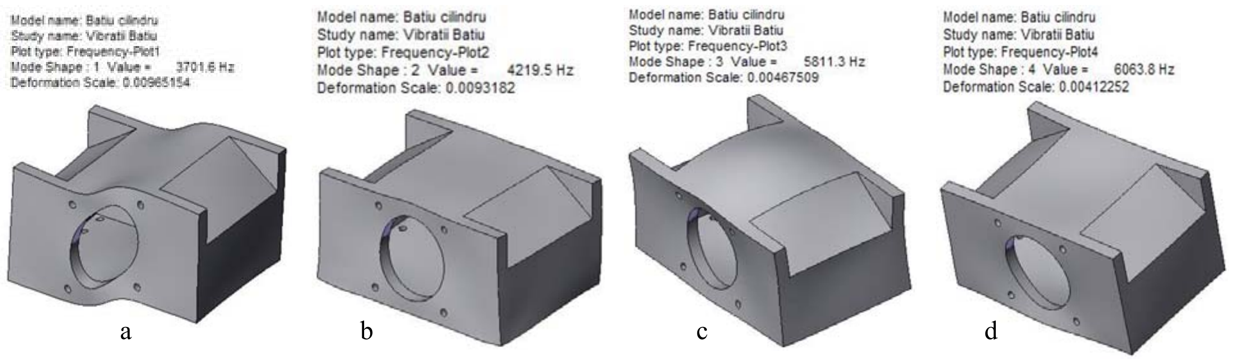

Fig. 7. The vibrational analysis: a - Mode 1; b - Mode 2; c - Mode 3; d - Mode 4.

2.5. The factors of safety distribution

Graphical distributions for factors of safety distribution are shown according:
- criterion: Max von Mises Stress; factor of safety distribution: Min FOS = 0.42 (Fig. 8a);
- criterion: Mohr-Coulomb Stress; factor of safety distribution: Min FOS = 0.27 (Fig. 8b);

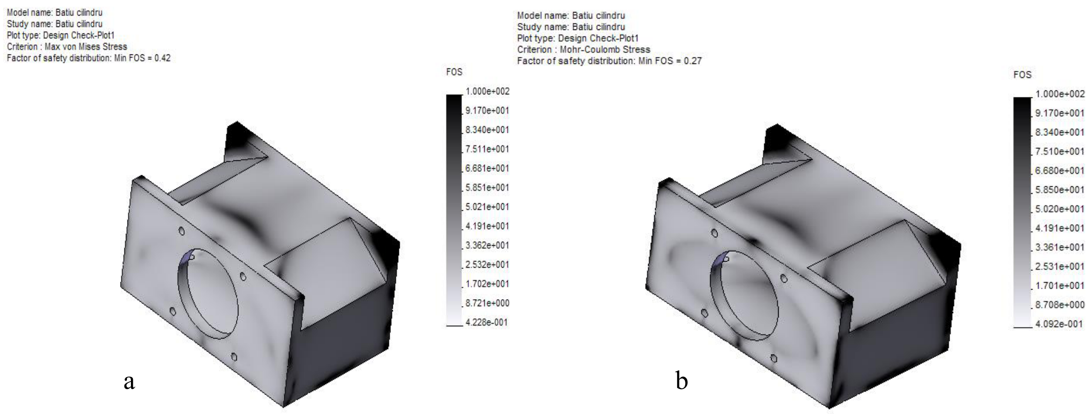

Fig. 8. The factors of safety distribution: a - criterion: Max von Mises Stress; b - criterion: Mohr-Coulomb Stress.

3. CONCLUSIONS

The Finite Elements Analysis using COSMOSWorks software for hydraulic motor casing of horizontal Hydraulic Press – 2 MN was made for determination of displacements, deformations and the factors of safety distribution. Results predicted by the finite element method are in good agreement with the theoretical and experimental values and can be used for further studies in designing of the horizontal Hydraulic Press – 2 MN.

ACKNOWLEDGEMENTS

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