A FINITE ELEMENT ANALYSIS OF HYDRAULIC CYLINDER OF LINEAR HYDRAULIC MOTOR FROM HORIZONTAL HYDRAULIC PRESS – 2 MN

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Abstract**:** This paper analyse through the finite element method (FEM) the hydraulic cylinder of linear hydraulic motor from horizontal Hydraulic Press – 2 MN. The analysis of the hydraulic cylinder of linear hydraulic motor from horizontal Hydraulic Press – 2 MN was made for determination of displacements and deformations. A three-dimensional model of the hydraulic cylinder with a complex geometry was generated based on the designed data. Finite element analysis was performed using COSMOSWorks software. Good agreement between predicted and measured results was obtained for hydraulic cylinder establishing the finite element method as an accurate analysis tool.

Keywords**:** horizontal Hydraulic Press, linear hydraulic motor, hydraulic cylinder, finite element method, displacement, deformation.

1. INTRODUCTION

Finite Element Analysis (FEA) is particularly well suited to dealing with complex problems, which in reality are normally a composite of continuous fields of displacements, strains, stresses, temperatures, state variables etc. Finite element modelling and analysis can greatly reduce testing and time to market by allowing the designer to computer test his product in advance of any prototypes [1, 2].

Mathematical modelling and numerical simulation of hydraulic components are powerful tool in analysis and synthesis of the hydraulic systems. The results from experimental research and numerical simulation can become a database with direct implications over the cost and duration of product manufacturing.

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 includes: a linear hydraulic motor, the clamping and restraint elements and the element to transmission force to piece. A three-dimensional exploded representation of this assembly and a longitudinal section in it are shown in Figure 1.

The assembly of the linear hydraulic motor is set up by a hydraulic cylinder and a plunger (Fig. 2).

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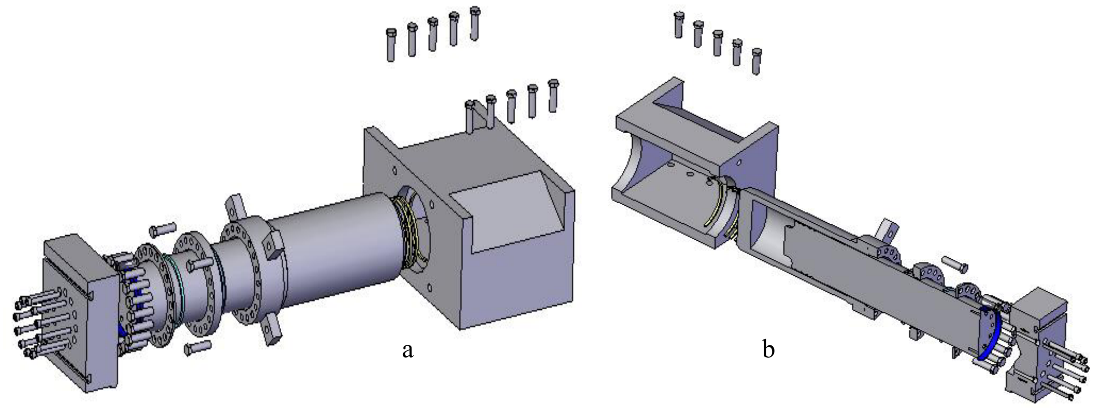
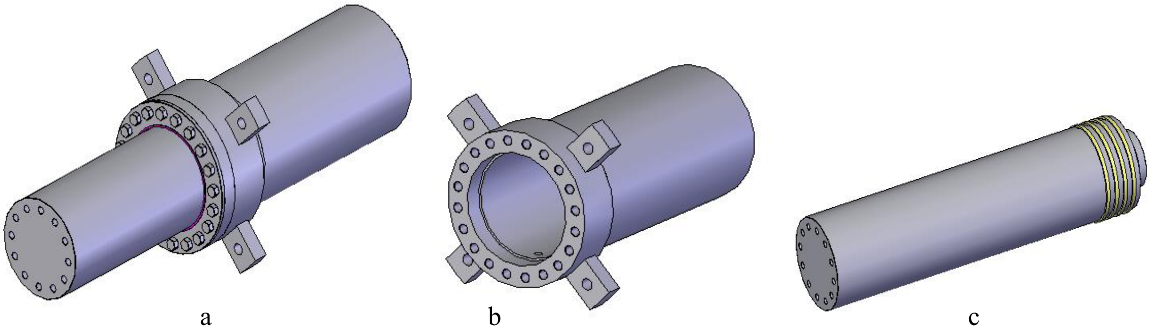


Fig. 1. 3D exploded representation of: a) the hydraulic element force from horizontal Hydraulic Press – 2 MN; b) a longitudinal section in the hydraulic element force from horizontal Hydraulic Press – 2 MN.



a b c

Fig. 2. 3D representation of: a) the assembly of linear hydraulic motor; b) hydraulic cylinder; c) plunger.

2.2. Meshing of the hydraulic cylinder

A three-dimensional model of the hydraulic cylinder with a complex geometry was generated based on the designed data. (Fig. 3). Finite element analysis was performed using COSMOSWorks software.

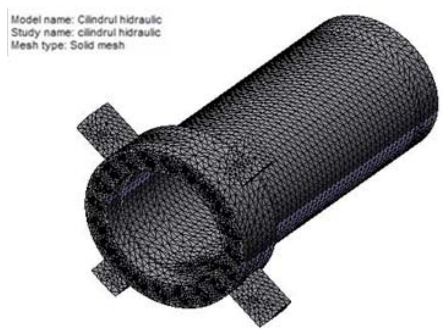


Fig. 3. 3D meshing of the hydraulic cylinder.

2.3. The calculation of the stresses distribution and displacements

The hydraulic cylinder is loaded at the designed nominal pressure p = 250 bar. Obtained results are presented below (with Cosmos/FFE Static Solver 2.8):

Load Case 1

Maximum Nodal Von Mises Stress

Node: 1609

Max.: 4.3157e+007

Minimum/Maximum Displacements

	X-displ.	Y-displ.	Z-displ.
Node:	7058	1832	10

Min.: -5.7181e-007 -5.6264e-007 0.00000
Node: 1780 7069 7301
Max.: 5.6507e-007 5.6697e-007 1.2777e-005

Maximum Magnitude of Displacement
Node: 7301
Max.: 1.2777e-005

The stress distribution of the hydraulic cylinder determined according the theory of Von Mises is shown in Figure 4 and 3D deformation distribution is shown in Figure 5.

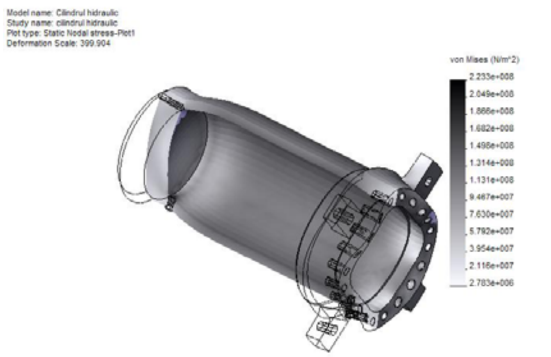


Fig. 4. The stress distribution.

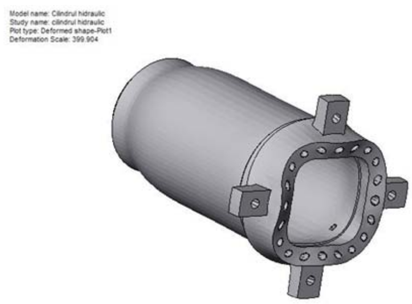


Fig. 5. The deformations distribution.

The resulting 3D displacement distribution is shown in Figure 6 and the slipping result is shown in Figure 7.

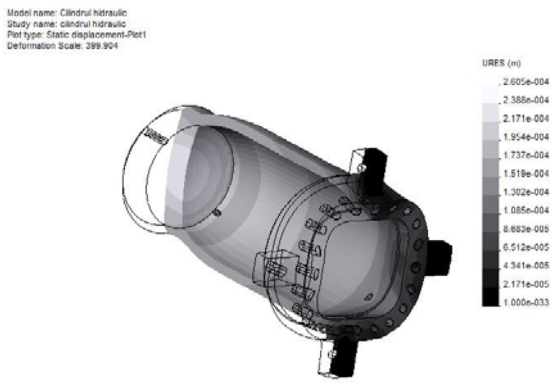


Fig. 6. The displacement distribution.

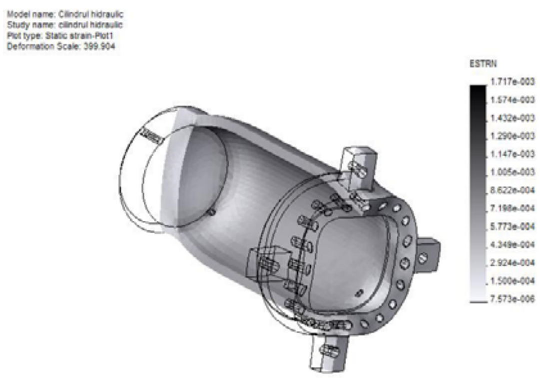


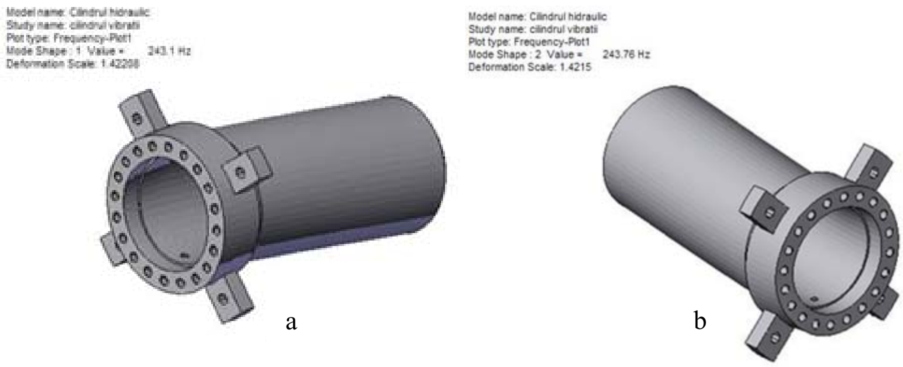
Fig. 7. The slipping result distribution.

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

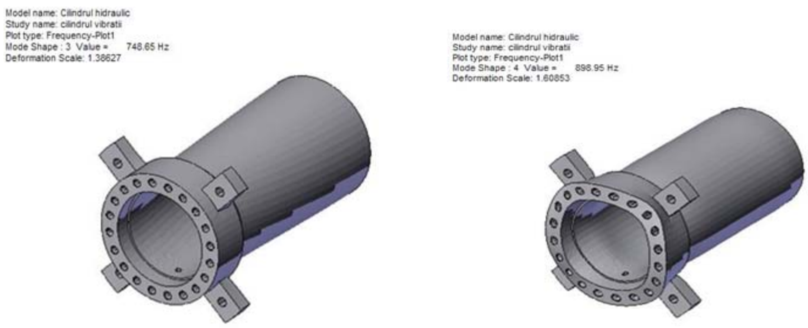
FREQUENCY NUMBER	FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SECONDS)
1	0.1527419E+04	0.2430963E+03	0.4113595E-02
2	0.1531608E+04	0.2437629E+03	0.4102347E-02
3	0.4703921E+04	0.7486523E+03	0.1335734E-02
4	0.5648253E+04	0.8989473E+03	0.1112412E-02

Mode 1 is shown in Figure 8a, natural frequency of vibration is ν = 243.1 Hz, scale deformation is Kd = 1.422.
Mode 2 is shown in Figure 8b, natural frequency of vibration is ν = 243.76 Hz, scale deformation is Kd = 1.4215.
Mode 3 is shown in Figure 8c, natural frequency of vibration is ν = 748.65 Hz, scale deformation is Kd = 1.386.
Mode 4 is shown in Figure 8d, natural frequency of vibration is ν = 898.95 Hz, scale deformation is Kd = 1.608.



a b

Fig. 8. The vibrational analyses: a - Mode 1; b - Mode 2.



c d

Fig. 8. The vibrational analyses: c - Mode 3; d - Mode 4.

3. CONCLUSIONS

The Finite Element Analysis using COSMOSWorks software for the hydraulic cylinder of linear hydraulic motor from horizontal Hydraulic Press – 2 MN was made for determination of displacements and deformations. Good agreement between predicted and measured results was obtained for hydraulic cylinder establishing the finite element method as an accurate analysis tool.

4. ACKNOWLEDGEMENTS

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