STATIC ANALYSIS OF A PRESS RAM-LINEAR HYDRAULIC MOTOR PISTON ASSEMBLY FROM HORIZONTAL HYDRAULIC PRESS – 2 MN

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Abstract. *The aim of this paper is to analyse through the finite elements method (FEM) the press ram-linear hydraulic motor piston assembly from horizontal Hydraulic Press – 2 MN. The analysis of ram-piston assembly was made for determination of stresses, displacements, deformations and the factor of safety distribution. A three-dimensional model of the ram-piston assembly with a complex geometry was generated based on the designed data. The Finite Elements Analysis was performed using SolidWorks 3D CAD Design and COSMOSWorks software. The simulation results were evaluated and compared to the experimental data. Results show that the established FEM model provides useful information for the ram-piston assembly optimal design.*
Keywords: *high pressure pump, finite elements analysis, stresses, displacements, deformations*

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 [1, 2].
Presses can be placed into two categories according to the source of power: mechanical presses and hydraulic presses. Mechanical presses are restricted in stroke and are known to show great variation in load and slide velocity during the stroke. They are inferior to hydraulic presses for noise, vibration and overload problems near boltom dead centre. In spite of these disadvantages, mechanical presses are widely used in the metal forming industry owing to the low cost of maintenance and high production rate. Hydraulic presses are able to maintain constant pressing capacity throughout the stroke, and they have an adjustable stroke and velocity and variable pressure throughout the stroke. Because of these load and velocity characteristics, hydraulic presses are generally used for cold forging and deep drawing processes and offer good performance and reliability. New fast acting valves, electrical components, and more efficient hydraulic circuits have enhanced the performance capability of hydraulic presses.
Mathematical modelling and numerical simulation of hydraulic components are a powerful tool in analysis and synthesis of the hydraulic systems.
Finite element analysis is universally recognised as the most important technological breakthrough in the field of engineering analysis of structures. The development of computer has caused the finite element method to become one of the most popular techniques for solving engineering problems [3-10].
A major advantage of the finite element method is the efficiency of verified numerical procedures and standardized information describing the engineering structures, which may be transferred and communicated with other computer aided design or monitoring systems.
The general scheme of the horizontal Hydraulic Press – MN is shown in Fig. 1 and includes the following components: FR, return filter; RZ, oil tank; M, manometer; R, tap; DSS, valve unlock effect; SSP, safety valve; DH, hydraulic distributor; SSU, one-way valve; SD-coupling valve; PIP, high pressure hydraulic pump; PJP, low pressure hydraulic pump; ME, electric motor; EC, flexible coupling; MHL, linear hydraulic motor.

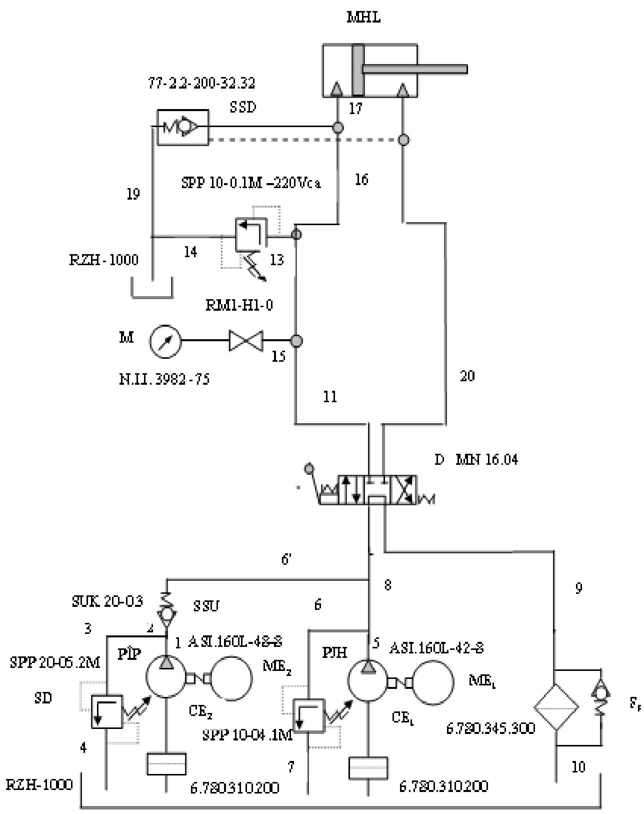

Figure 1. The schedule of the horizontal Hydraulic Press – 2MN.

2. MODELLING OF HYDRAULIC ELEMENT FORCE ASSEMBLY FROM HORIZONTAL HYDRAULIC PRESS – 2 MN

2.1 The 3D modelling of hydraulic element force assembly

The hydraulic element force assembly 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.

The assembly of linear hydraulic motor is set up by a hydraulic cylinder and a piston.

A 3D modelling of hydraulic element force assembly was generated based on the designed data and performed using SolidWorks 3D CAD Design.

The axonometric representation and a longitudinal section in it are shown in Fig. 2 and Fig. 3.

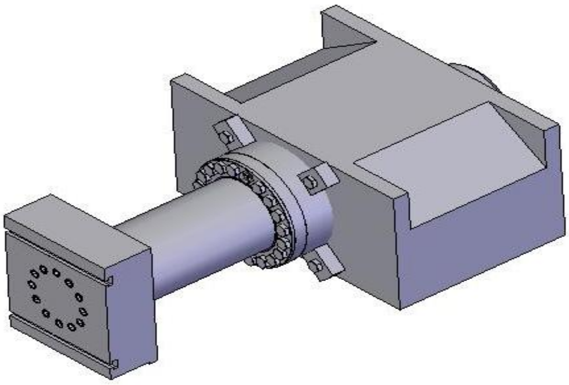

Figure 2. The hydraulic element force.

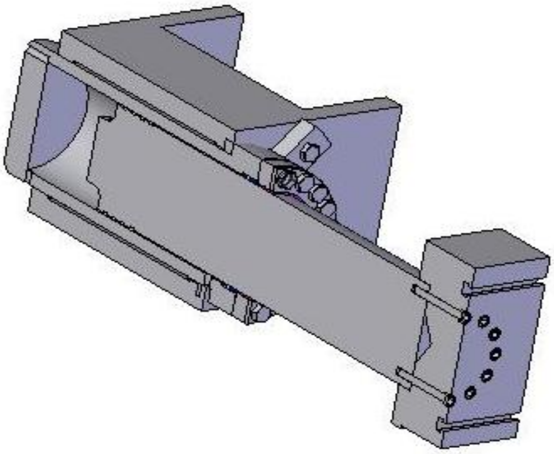

Figure 3. The hydraulic element force in longitudinal section.

A three-dimensional exploded representation of this assembly and a longitudinal section in it are shown in Fig. 4 and Fig. 5.

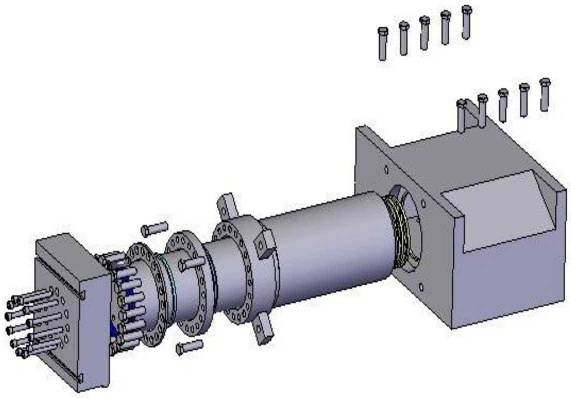

Figure 4. 3D exploded representation of the hydraulic element force.

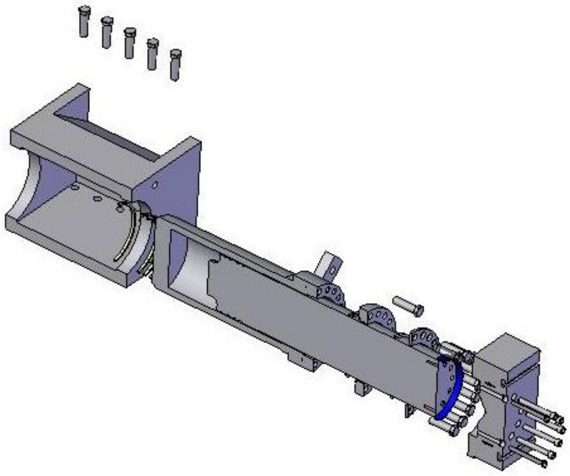

Figure 5. 3D exploded representation of the hydraulic element force in longitudinal section.

A three-dimensional representation of the press ram with the linear hydraulic motor piston assembly is shown in Fig. 6.

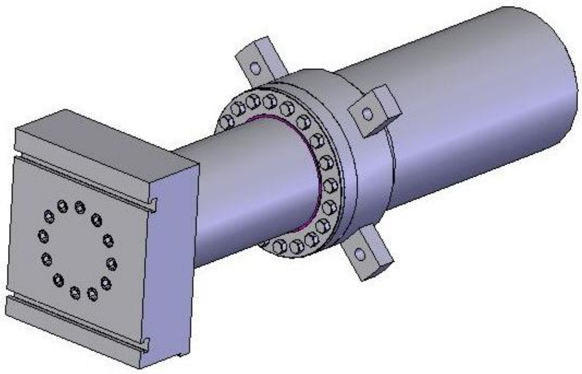

Figure 6. 3D representation of the the press ram with the linear hydraulic motor piston assembly.

3. THE STATIC ANALYSIS OF RAM-PISTON ASSEMBLY

3.1 Meshing of ram-piston assembly

A three-dimensional representation of 3D meshing ram-piston assembly, generated based on the designed data, is shown in Fig. 7. Finite elements analysis was performed using COSMOSWorks software.

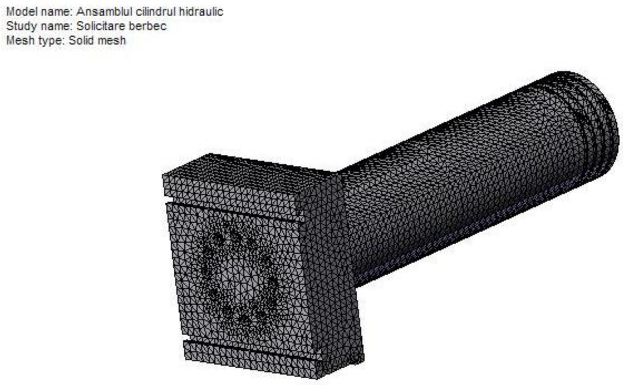

Figure 7. A 3D meshing of ram-piston assembly.

3.2 The calculation of the stresses distribution, displacements and deformations

The obtained results are presented with a deformation scale 1: 419 to emphasize the distortions of ram-piston assembly.
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 2193 2210 1983 0 0 0
MIN. -2.03195E-06 -1.98989E-06 -3.90623E-05 0.0000 0.0000 0.0000
NODE 1966 1983 270712 0 0 0
MAX. 2.08574E-06 2.09408E-06 0.0000 0.0000 0.0000 0.0000

MAXIMUM RESULTANT DISPLACEMENT
NODE 1983
MAX. 3.91222E-05

FOR REQUESTED (Global Cartesian Coord. System)
NODES FX FY FZ MX MY MZ
Total React. -.4825E-01 0.1232E+01 0.3798E+05 0.0000E+00 0.0000E+00 0.0000E+00

MAXIMUM NODAL VON MISES STRESS
NODE 270679
MAX. 0.25795E+09

The stresses distribution of ram-piston assembly determined according the theory of Von Mises is shown in Fig. 8 (deformation scale is k = 419).

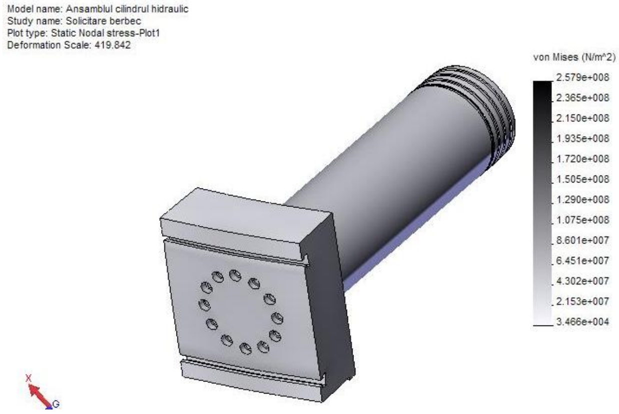

Figure 8. The stresses distribution

The resulting deformation distribution is shown in Fig. 9.

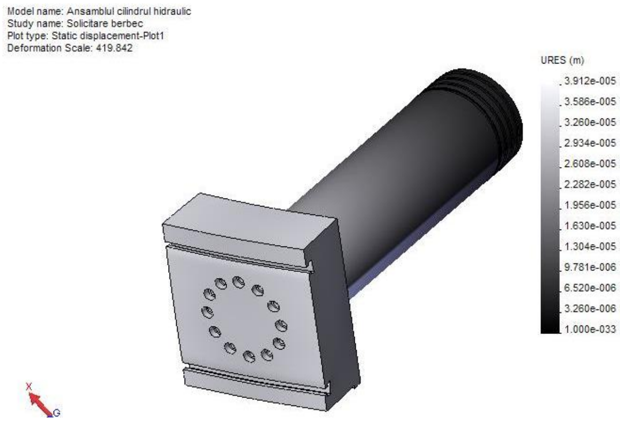

Figure 9. The 3D deformations distribution.

The 3D slipping result is shown in Fig. 10.

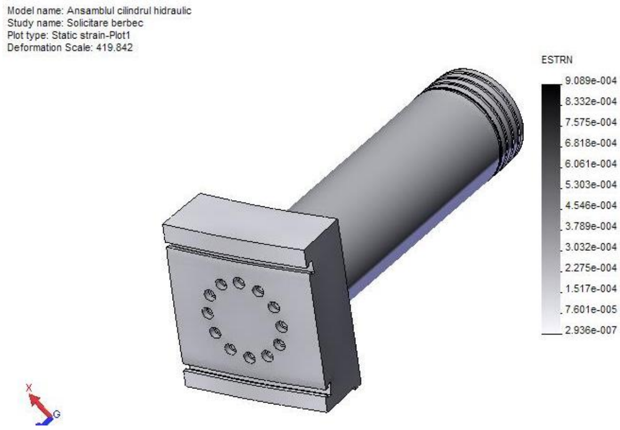

Figure 10. The3D slipping result distribution.

3.1 The factor of safety distribution

Graphical distributions for factor of safety distribution according criterion: Max Normal Stress; factor of safety distribution: Min FOS = 1.4 is shown in Fig. 11.

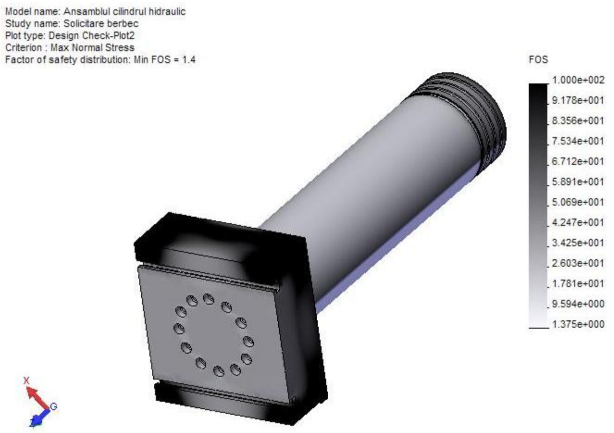

Figure 11. The factor of safety distribution.

4. CONCLUSIONS

The Finite Elements Analysis using COSMOSWorks software for press ram-linear hydraulic motor piston assembly from horizontal Hydraulic Press – 2 MN was made for determination of stresses, displacements, deformations and the factor of safety distribution.

A three-dimensional model of the ram-piston assembly with a complex geometry was generated based on the designed data. The simulation results were evaluated and compared to the experimental data. Results show that the established FEM model provides useful information for the ram-piston assembly optimal design.

5. ACKNOWLEDGMENTS

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