THE FINITE ELEMENT ANALYSIS OF A TURBINE SHAFT – MAIN SHAFT SUBASSEMBLY FROM A AVERAGE POWER HYDRODYNAMIC CLUTCH INCLUDED IN A DRIVELINE AGRICULTURAL MACHINERY

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Abstract. *This paper analyze through the finite elements method (FEM) a turbine shaft – main shaft subassembly from a average power hydrodynamic clutch included in a driveline agricultural machinery. The static and dynamic analysis of turbine shaft – main shaft subassembly was made. A three-dimensional model of the turbine shaft – main shaft subassembly 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. Results predicted by the finite element method show the method presented is efficient and accurate and in good agreement with the theoretical and experimental values. Results from the current analysis can be used for further studies in designing of the turbine shaft – main shaft subassembly.*
Keywords: *agricultural machinery, driveline, hydrodynamic clutch, turbine shaft – main shaft assembly, finite elements analysis*

1. INTRODUCTION

The requirements for the manufacturers of agricultural machinery are nowadays to make the machinery work quickly, efficiently, precisely and easily.
The modern condition of design, construction and manufacture of agricultural machinery must be in accordance with the international quality and standardizations.
Agricultural machinery manufacturers, in the trend towards the competitiveness and more economical agricultural production, need to cope with two different market demands for the specifications and features; one is characterized by need for high-grade products that have cost-effective performance, the other is characterized by the need for simple specification products featuring mainly low price.
In such present conditions, in order to meet the demands of high-grade products featuring high performance, high durability and low price, manufacturers need to strive, not only to reduce manufacturing costs but also to reduce developing and marketing costs.
Optimal design and manufacture of the agricultural machinery components, that are result of a complex chain of actions, starting with a design to match the functional demands, is important for safety and reliability [1].
CAD and finite element analysis (FEA) play a key role in the design of the agricultural machinery components.
Finite element analysis allows designs to be analyzed, optimized, and revised quickly and accurately. Virtual testing and optimization is conducted early in the design cycle, thereby saving both time and money and assuring a consistent product each production run [2 - 7].

2. MODELLING OF THE TURBINE SHAFT-MAIN SHAFT SUBASSEMBLY

2.1 The 3D modelling of hydrodynamic clutch

A three-dimensional model of the hydrodynamic clutch assembly with all components, with a complex geometry, was generated based on the designed data and performed using SolidWorks 3D CAD Design.
The hydrodynamic clutch in a longitudinal section is shown in Fig. 1.

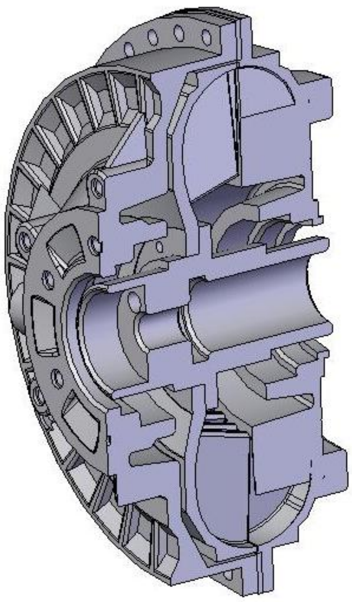

Figure 1. The hydrodynamic clutch.

The analyzed subassembly receives the rotation through the turbine wheel. The axonometric representation and a longitudinal section in it are shown in Fig. 2 and Fig. 3.

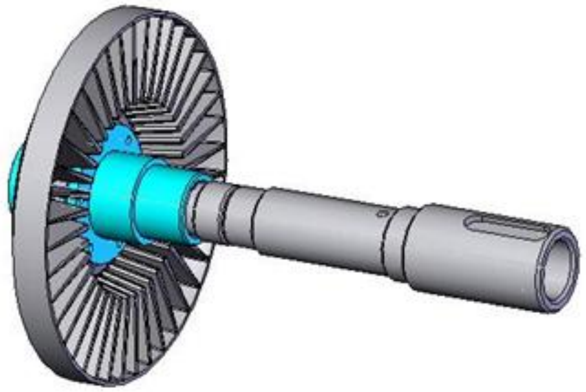

Figure 2. The turbine shaft – main shaft subassembly with the turbine wheel.

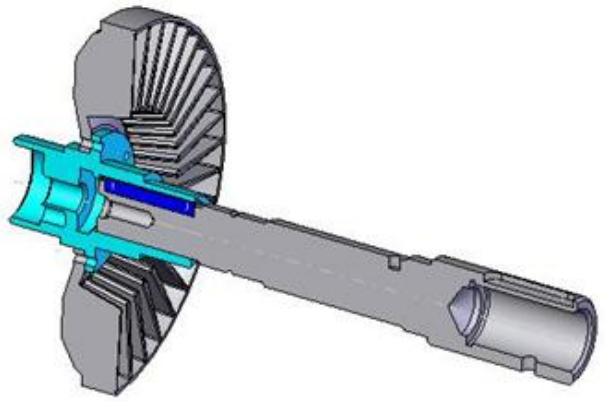

Figure 3. The turbine shaft – main shaft subassembly with the turbine wheel in longitudinal section.

The axonometric representation and a longitudinal section in turbine shaft – main shaft subassembly are shown in Fig. 4 and Fig. 5.

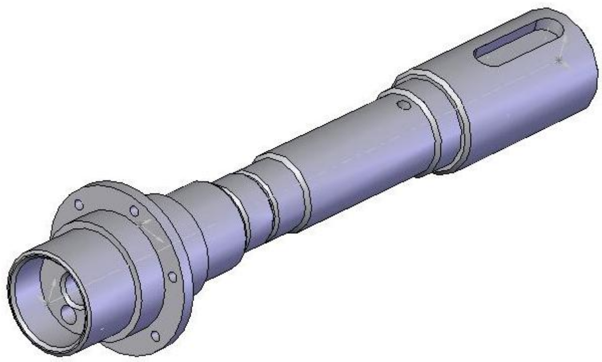

Figure 4. The turbine shaft – main shaft subassembly.

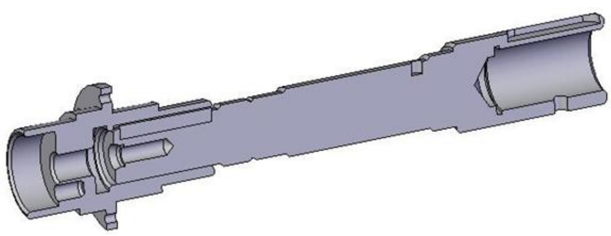

Figure 5. The turbine shaft – main shaft subassembly in longitudinal section.

3. THE FEM ANALYSIS OF THE TURBINE SHAFT-MAIN SHAFT ASSEMBLY

3.1 Meshing the turbine shaft – main shaft subassembly

Finite elements analysis was performed using COSMOSWorks software.

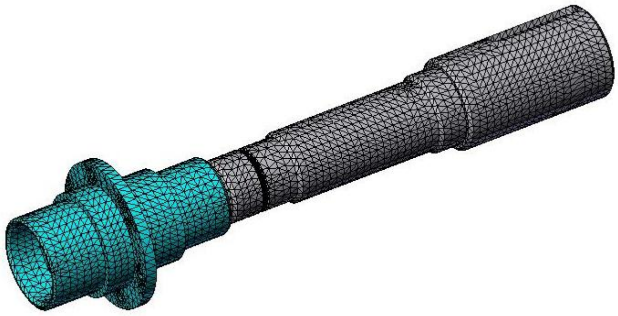

Figure 6. A 3D meshing of turbine shaft – main shaft subassembly.

3.2 The calculation of stresses distribution and displacements

The obtained results are presented with a deformation scale to emphasize the distortions of turbine shaft – main shaft subassembly.

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 91911 105055 104865
0 0 0
MIN. -9.61571E-07 -1.79219E-06 -2.09792E-07
0.0000 0.0000 0.0000
NODE 111077 111092 2563
0 0 0
MAX. 9.08880E-07 9.17108E-07 5.63300E-07
0.0000 0.0000 0.0000

MAXIMUM RESULTANT DISPLACEMENT
NODE 89602
MAX. 1.96829E-06

FOR REQUESTED (Global Cartesian Coord. System)
NODES FX FY FZ MX MY
MZ
Total React. 0.1839E-01 0.8000E+03 0.1383E+00
0.0000E+00 0.0000E+00 0.0000E+00
TOTAL STRAIN ENERGY. . . . . = 0.205975E-03

MAXIMUM NODAL VON MISES STRESS
NODE 2204 MAX. 0.61836E+07

Graphical distribution of stresses by axes Ox, Oy, Oz and resultant are shown in Fig. 7, Fig. 8, Fig. 9 and Fig. 10 (deformation scale k = 1500).

Figure 7. The stresses distribution by Ox axis.

Figure 8. The stresses distribution by Oy axis.

Figure 9. The stresses distribution by Oz axis.

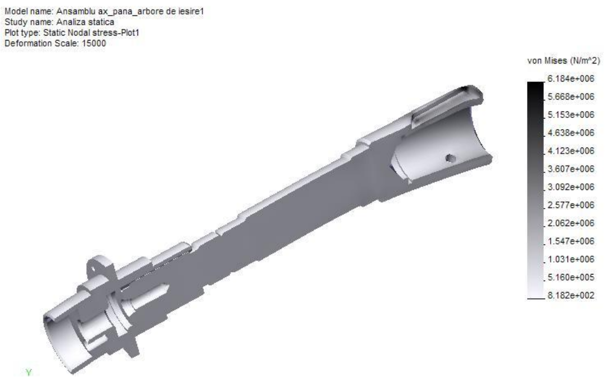

Figure 10. The resultant stresses distribution.

Graphical distribution of displacements by axes Ox, Oy, Oz and resultant are shown in Fig. 11, Fig. 12, Fig. 13 and Fig. 14 (deformation scale k = 20000).

Figure 11. The displacements distribution by Ox axis.

Figure 12. The displacements distribution by Oy axis.

Figure 13. The displacements distribution by Oz axis.

Figure 14. The resultant displacements distribution.

3.3 The vibrational analysis

The first four modes of natural vibration of subassembly were studied and represented with state of deformations in Fig. 15 - Fig. 18. The program shows next results:

Frequency No.	Frequency (Rad/Sec)	Frequency (Cycles/Sec)	Period (Seconds)
1.	0.6003106E+04	0.9554239E+03	0.1046656E-02
2.	0.1197075E+05	0.1905204E+04	0.5248783E-03
3.	0.1450314E+05	0.2308246E+04	0.4332294E-03
4.	0.2618092E+05	0.4166822E+04	0.2399911E-03

Figure 15. The vibrational analysis: Mode 1.

Figure 16. The vibrational analysis: Mode 2.

Figure 17. The vibrational analysis: Mode 3.

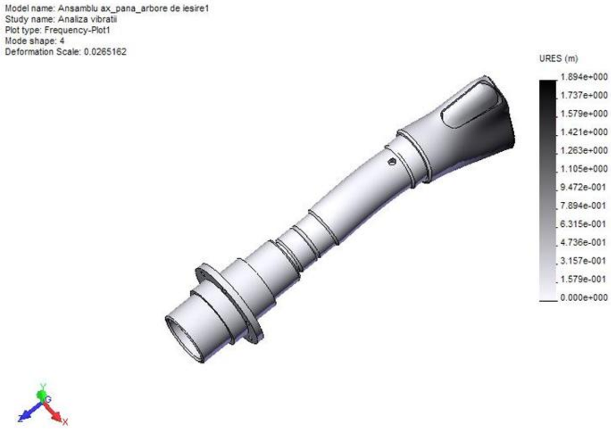

Figure 18. The vibrational analysis: Mode 4.

4. CONCLUSIONS

The Finite Elements Analysis using COSMOSWorks software for turbine shaft – main shaft subassembly from a average power hydrodynamic clutch included in a driveline agricultural machinery was made.

Results predicted by the finite element method show the method presented is efficient and accurate and in good agreement with the theoretical and experimental values.

Results from the current analysis can be used for further studies in designing of the turbine shaft – main shaft subassembly.

5. ACKNOWLEDGMENTS

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