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RESEARCH ON THE OPTIMIZATION OF TECHNOLOGIES APPLIED IN THE CONSTRUCTION OF AGRICULTURAL MACHINES

[1-4.]INMA Bucharest, ROMANIA

Abstract: In this paper we present the static and modal analysis of the main shaft, the static analysis of the hydraulic universal and of the clamping system. Also, the 3D model of the turning center and of the main kinematic chain was realized, the operation of an automatic system for fixing the parts, the construction of a hydraulic universal in detail and the static analysis by means of the finite element method.
Keywords: numerical control, machining center, turning, static analysis with finite element

INTRODUCTION

Lately, the objective need to produce as quickly as possible, with the highest productivity, has led to an amazing evolution of the current conception of agricultural machinery, which depends largely on the technological specificity of the various parts that are mechanically processed, as well as the volume of their production. Especially for the unique parts or for those that are produced in small series specific to these types of equipment, the last 15-20 years have marked the replacement of the classic universal machine tools with numerically controlled machine tools. These allow for high processing precision, which remain constant over long periods of time, without the intervention of the human operator to make some corrections.

According to several specialized works C. Mohora, Cr. Pupază, Cr., Zapciu, M., Popoviciu, G., Rusu-Casandra, A., (1997) machining centers are numerically controlled machine tools capable of processing revolution parts by combining the main rotational movement of the semifabricated with the movement advance of the cutting tool. The numerical control is a set of instructions in the form of letters, numbers and symbols that control the same kinematic chains and based on which the machine tool performs various processing operations. Dr. Eng. Vlad Diciuc (2015)

The machining operation that underlies such a center is turning. This represents the cutting process, with the most frequent use, being the basic method for obtaining revolution bodies, with profiles of the shape: curvilinear, cylindrical and conical. In the construction of agricultural machines, the parts containing such surfaces have a significant weight, which justifies the intense use of this type of processing. In general, the types of parts that can be processed on these centers are: hub type, disc type or shaft type.

MATERIAL AND METHOD

In this paper, the ANSYS program was used for a better post-processing of the results. ANSYS is a finite element analysis program widely used in research and industry with the aim of simulating the response of a physically required mechanical, thermal or electromagnetic system. Each launch of the program starts with specifying the problem. The final solution is obtained by launching the program, specifying the element type of the constants, specifying the material properties, discretizing the model, specifying the boundary conditions, post-processing the results and validating the results.

A modal analysis of the main shaft of the machining center was carried out to determine its own frequencies and modes, in order to simulate the requests to which it is subjected during operation.

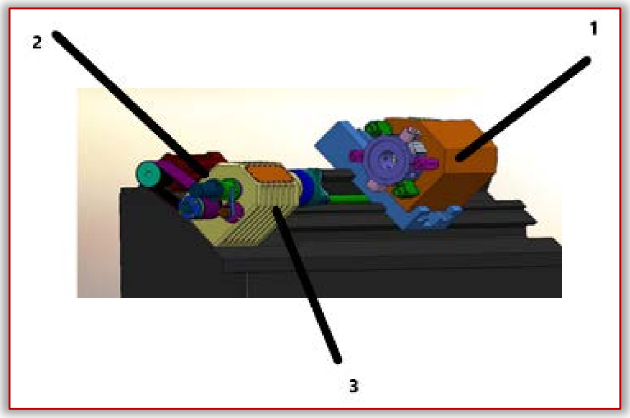


Figure 1. Turning center
Legend: 1- Main kinematic chain, 2-Advance kinematic chain, 3-Gearbox

The Turning Center (Figure 1) consists of: the *main kinematic chain*, the *kinematic feed chain* and the *gearbox*, placed on a work stand. The main kinematic chain consists of the 18.5 kW *power electric motor*, the *Poly-V belt wheels* and the *Poly-V belt*, the *gearbox* that is in the housing and the *universal* that is actuated for fixing the parts by means of the bays by a linear hydraulic motor. The kinematic chain of advance has in its composition the revolver head.

The main drive is carried out with an 18.5 kW AC Siemens 200 AC motor with a maximum speed of 8000rot / min. The main shaft is mounted on 3 axial radial ball bearings (front) and 2 axial radial ball bearings (rear). The lubrication is done with oil under pressure. The movement from the main drive is received by means of a belt wheel (Poli V), using a solution that does not require the main shaft to bend.

The working support is provided with a longitudinal and a transverse sled for the movement on the Z (longitudinal) and X (transverse) axes, which represents the advances. Advance operation is done with two DC motors type SMUC-C 1A-102, by means of ball screws, with pre-tensioned nuts for eliminating the games. Each motor is controlled by a converter. The feed engines have a minimum speed of 0.2 rpm and for fast feeds (5000mm / min on the X axis and 1000 mm / min on the Z axis), and a maximum speed of 1000 rpm on the X axis and 2000 rpm. min on the Z axis.

The feed speeds are controlled through a closed loop system, via an analog transducer type RD. The advance systems are equipped with electromagnetic brakes that provide braking when the power is interrupted. For the limitation of the movements on axes, blocks with micro-switches are used for each axis.

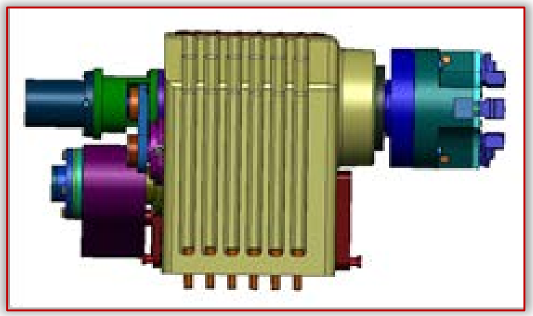


Figure 2. The gearbox

The gearbox (Figure 2) consists of the input shaft, main shaft, thread transducer, housing.

The input shaft is grooved and ends with a Poly V belt wheel, the movement transmitted from the electric motor via the belt wheels and the Poly V belt first reaches the input shaft which is well extended to the end where the wheel is located. Poly V belt, to withstand twisting, and high speeds. The strap wheel is placed on a body that has 2 radial ball bearings and a spacer between the two bearings, and a safety ring. Thus, the input shaft does not take all the forces, because the belt wheel is placed on this well-widened body, and the input shaft enters the body and is less demanded.

On this shaft there is still a group of radial ball bearings and the balador group, it has the role of changing the rpm, being only 2 rpm.

In the figure 3 you can see how the system for tightening the trays on the universal works. The universal consists of a universal body, the actuating bushing, the tray holder, the lever, the bolt, the guide tray and the tray.

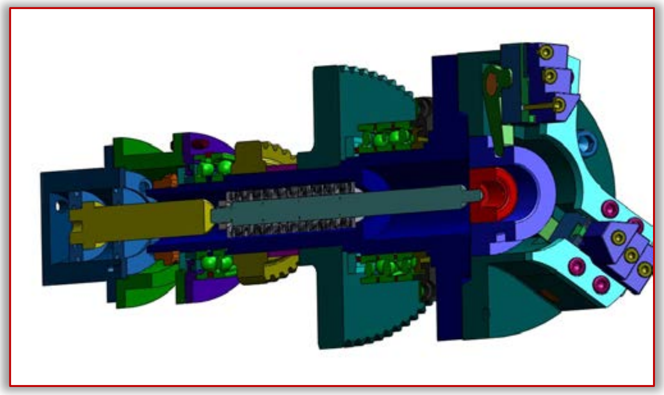


Figure 3. The system for tightening the bins

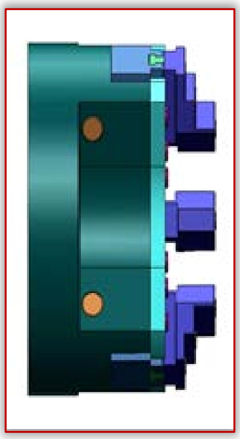


Figure 4. Universal

Thus, the rods are held in position to tighten the piece with a rod that has a cage at the end and is screwed into the universal drive bush, on this rod there is a package of 40 talar springs that rest on one shoulder from the inside of the main shaft and is tightened with a nut. This spring pack is meant to keep the pods in this position.

If we want to release the part, then the linear hydraulic motor, which is made of piston, rod comes into operation. The pressure is formed inside the MHL with the help of a hydraulic system. Thus, the pressure pushes the piston, the rod changes its position and pushes the rod on which the talar springs are, the rod has a cage that is screwed into the actuator bush, and on this bush there are 3 levers fixed by it, and of the tray support. Through the movement of the MHL rod, the rod will also move where the talar springs will compress, so with the help of the levers, the rods are detached from the piece, which can be taken. After removing the part, the pressure in the MHL returns to normal and thus the MHL rod stops pushing the rod from the shaft, the springs return to normal, and thus the rods return to their original position. This cycle will resume whenever it is necessary to process a piece or to remove the part from the universal (Figure 4).

RESULTS

Static analysis provides information on the deformations of the structure as well as the voltage state.

The analysis aimed to study the behavior of the hydraulic universal during rotation with a maximum speed of 4000 rpm and an angular speed of 420 rad/s (mechanical or hydraulic pull force is 1500 N).

During the rotation of the universal the rods tend to weaken the part and may cause accidents, therefore the hydraulic universal is analyzed so that the displacements are not too high because the piece can be detached from the rods at a maximum speed.

In (Figure 5) the maximum voltage of 981 MPa appears in the coupling between the tray and the tray support, in conclusion they must be made from a high-quality steel σa> 1000 MPa.

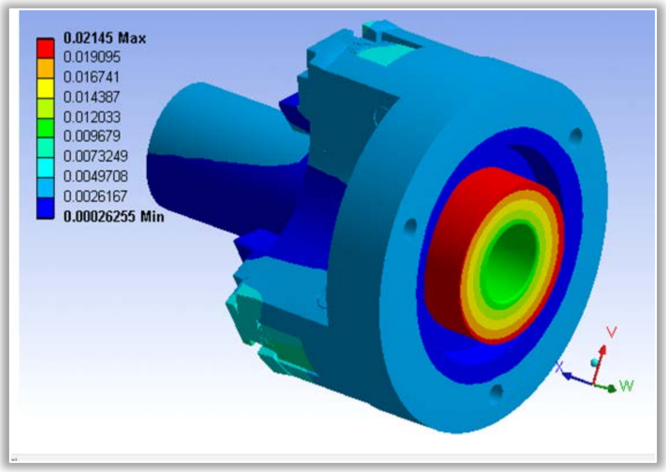


Figure 5. Maximum voltage

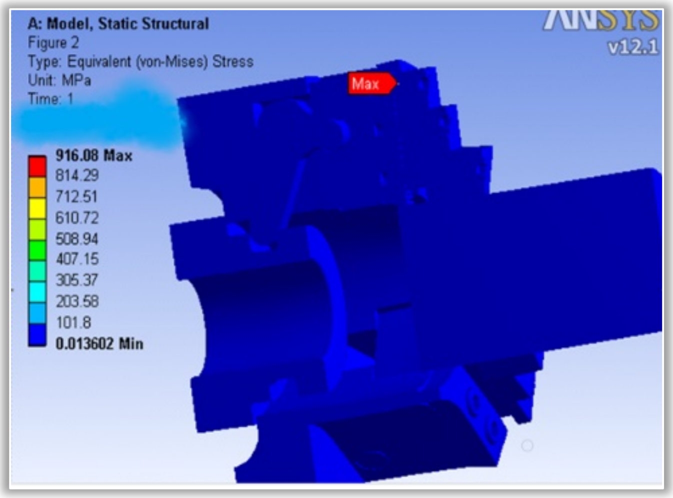


Figure 6. Von Mises

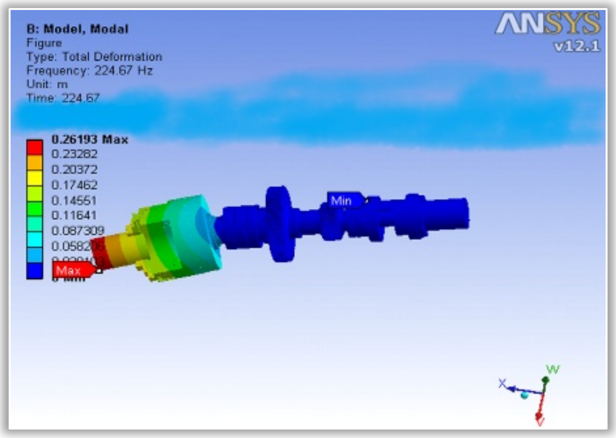
It is observed in (Figure 6) that the maximum displacements of the structure are 21 microns and do not negatively influence the universal displacement and in terms of stresses their maximum value calculated according to the Von Mises criterion (resulting from the stresses).

The maximum voltage of 981 MPa appears in the connection between the tank and the support of the tank in conclusion they must be made of a high-quality steel σa> 1000 MPa.

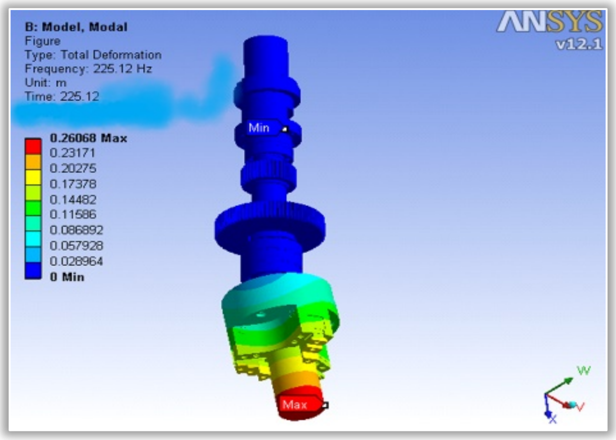
The modal analysis of the main shaft and the part fixing system was performed to highlight the dynamic behavior, especially by determining the frequencies and modes.

With this analysis, the frequency at which the machine tool resonates is determined. At resonance, deformations with a large amplitude appear, which have a direct influence on the machining accuracy of machine tools and negatively influence the strength of their structure.

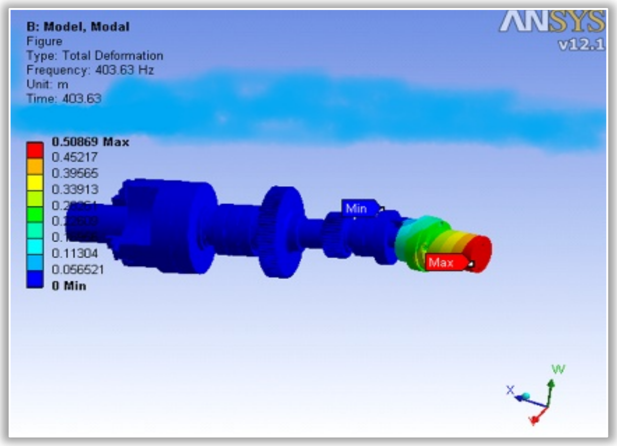
The first own modes are the most dangerous being characterized by large amplitudes, so it is recommended that the own frequency be greater than the working frequency (> 66 Hz).



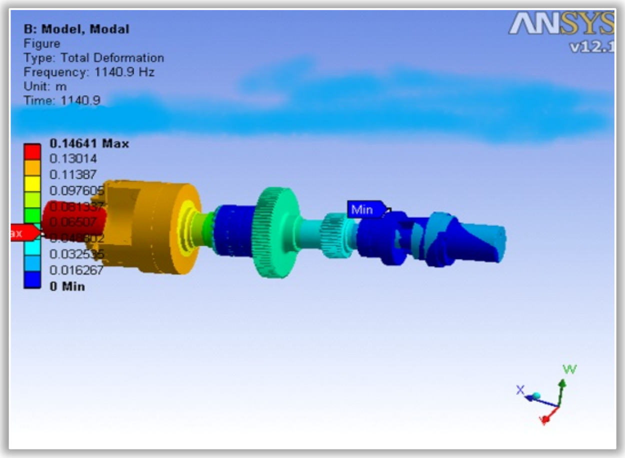
Mode 1 - Vertical bending mode = 224 Hz



Mode 2 – Horizontal bending mode = 225 Hz



Mode 3 – Horizontal bending mode = 403 Hz



Mode 4 – Axial deformation mode – 1141 Hz

CONCLUSIONS

Both CNC processing and 3D simulation allow manufacturers to move from design to manufacturing quickly. Simply put the design on a CAD file (computer-aided design) and upload it to the machine. Thus, conventional cutting processes can be analyzed and optimized using the Finite Element Method (MEF).

The simulations represent a solution for shortening the process duration, reducing costs and ensuring ecological conditions in the production systems.

Acknowledgement

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Note:

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