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THE 3D ASSISTED DESIGN AND STATIC ANALYSIS OF A NEW TYPE OF EXCAVATOR ARM

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ABSTRACT

The paper presents a new constructive solution of excavator arm that allows using the bucket with an increased degree of freedom The assisted design 3D permitted the optimization of execution model, checking the assembly of components.
The 3D model allowed for the static analysis of each component of the arm so verifying the correctness of the design.

KEYWORDS**:** Excavator arm, CAD, static analysis

1. Introduction

The 3D modeling of a navy equipment reduces the manufacturing cycle and minimizes the costs of releasing into production designing and execution of the prototype.

The development of a new concept involves increasing the degrees of freedom of the excavator arm for using the cup in narrow areas and difficult to reach.

The paper presents a new constructive solution of the excavator arm (fig.1) in order to obtain new degrees of freedom for bucket, designed with Solid Edge ST.4 software [1]. In fact, it allows to rotate the arm (as the indicated arrow) keeping the other degrees of freedom related to bucket movements.

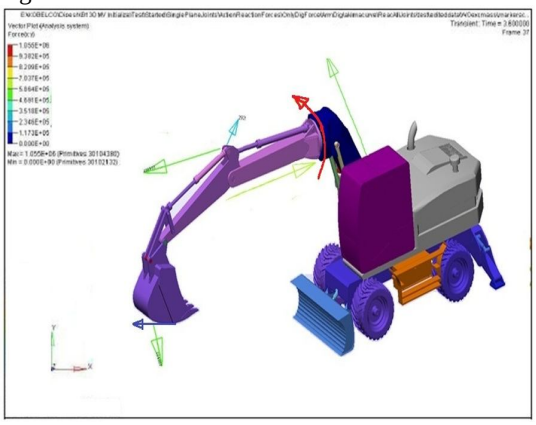

Fig. 1 Kinematic scheme with a new type of rotary excavator arm

2. Rotary arm of the excavator

In fig.2 it is shown a new constructive solution of the excavator arm that allows new degrees of freedom of the bucket.

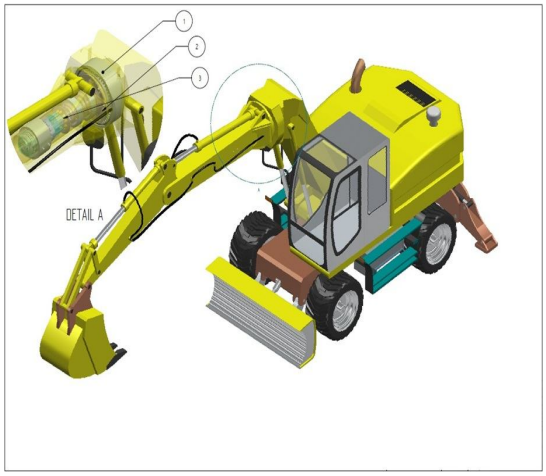

Fig. 2 The 3D Model of the excavator rotating arm

The rotating equipment arm is performed using 2 subassemblies:
- hydro motor subassembly
- rotary special mechanism

The hydro motor subassembly (fig. 3) of the rotating arm excavator has the following components:
- double planetary gearbox
- rotary hydraulic motor with pistons
- hydraulic break

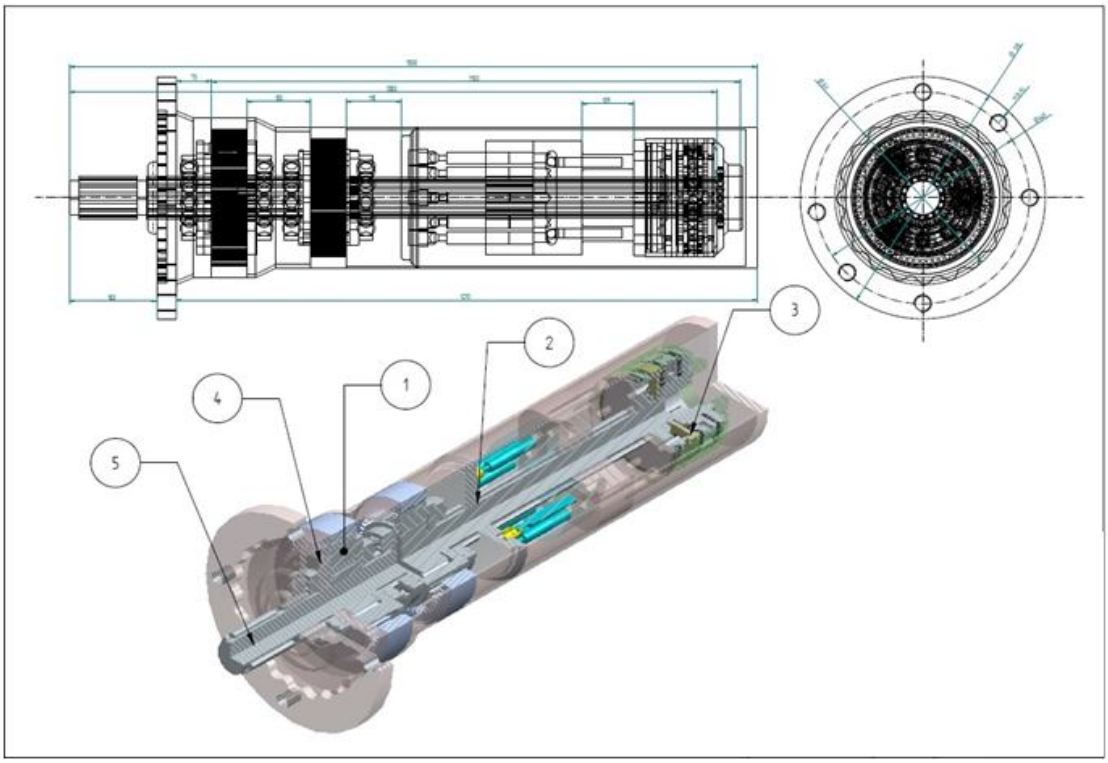

Fig.3 The 3D modeling of the hydro motor subassembly

In fact, the hydro motor subassembly mounted inside the arm allows rotation due to the rotary hydraulic motor with pistons (item 2). The rotating is amplified as a power through a double planetary gearbox (item 1), the rotation speed is down-converted to about 3 revolutions / minute.

There is a hydraulic brake component (item 3) that allows an indexing of the rotation depending on the imposed load. Separately there is a rotary joint that allow for an oil supply system without any problems related to the torsion of the hydraulic hoses.

In the forearm, it is mounted a special rotary mechanism (item 4). This mechanism is composed of a special radial axial bearing (fig. 4) and a planetary gearbox in one stage (fig. 5).

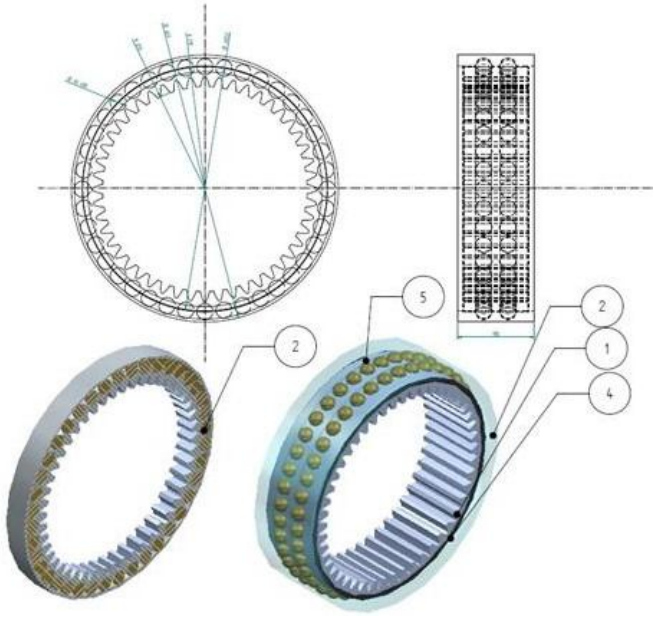

Fig.4. Subassembly of special radial-axial bearing

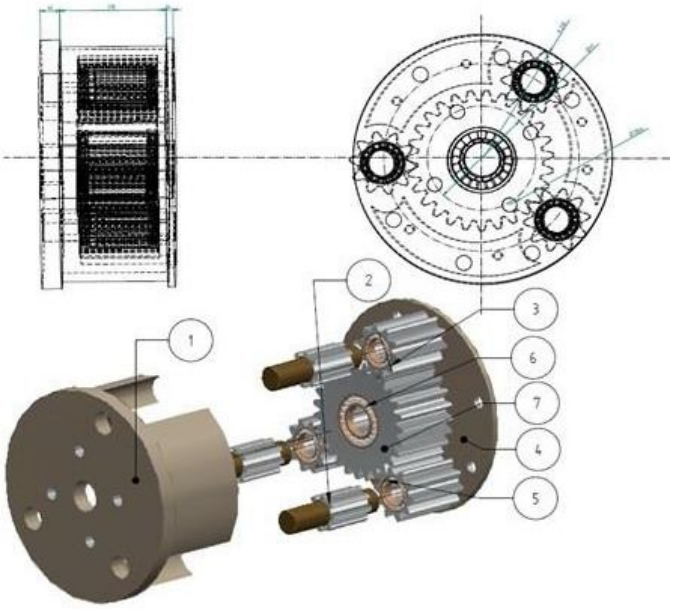

Fig.5. Subassembly of planetary gear

It allows a smooth rotation of the excavator arm taking over the loads during operation.

3. Static analysis of a new type of rotary arm excavator

Static analysis was performed using various simulations of the equipment two-dimensionally and three-dimensionally designed using the Algor software v23.1 [2].

The 3D virtual model of the equipment is used in all subsequent analyses of all the components and mechanisms.

In fig.6 is shown the modified joining of the arm which will be statically analyzed in terms of the influence of the excavator arm and forearm.

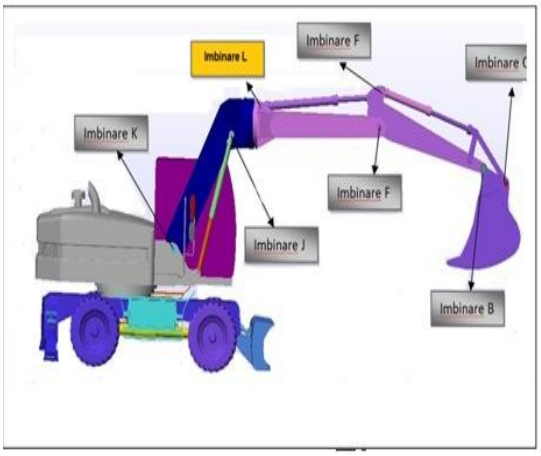

Fig.6 The modified joining of the excavator arm

3.1. Movement and force vectors

After applying external forces and torques, the resistance structure loses shape. Deformable structure is described by the mesh node displacements. If these movements are represented in the global coordinate system, the position of the deformed structure is given by the vector:

$$\{D\}^T = [D_1\ D_2\ D_3 \ldots\ D_n]; \quad (1)$$

For a bucket of 1,2 m^3 and a moment of rotation M = 50000 daN*m, the 3D model of the arm after meshing is deformed and this deformation values are between 0,05÷0,15 mm for every section of the excavator arm.

In figures 7÷9 are presented the models after the meshing for each component of the excavator arm.

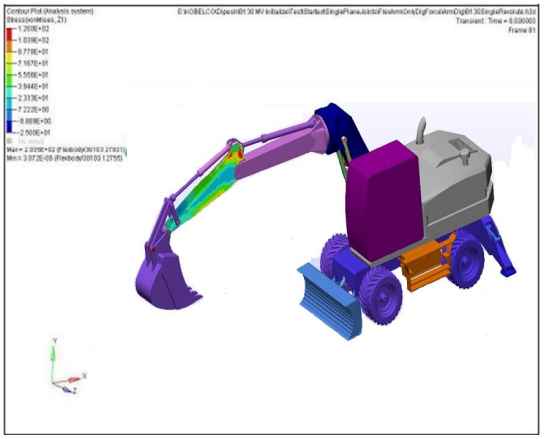

Fig. 7. Modeling arm no.1 after meshing

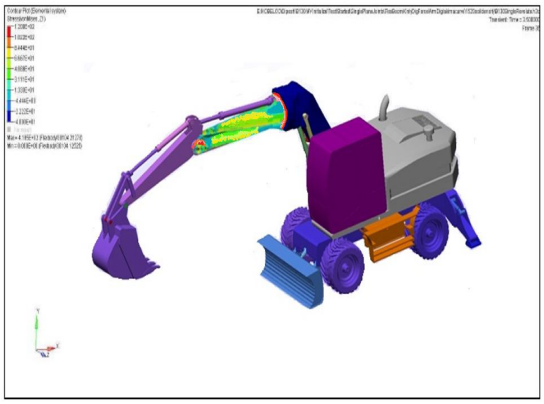

Fig. 8. Modeling arm no.2 after meshing

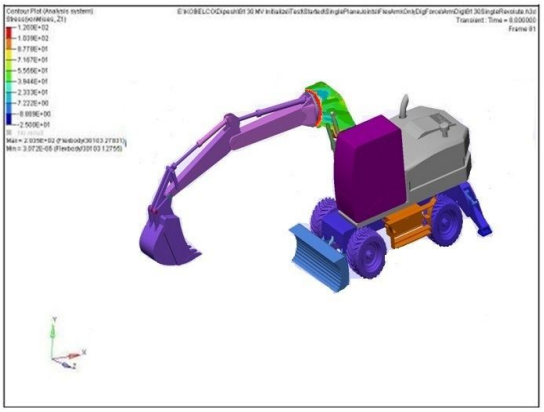

Fig. 9. Modeling arm no.3 after meshing

Figures 7÷9 indicate how the effect of reaction forces is transmitted even at the bottom of the excavator arm by torques applied (these effects were amplified).

In fig. 10 is represented in red the new access area of the excavator bucket due to the inclusion of the new joint into the arm. The old entrance area, without including the joint, is marked in gray and has a much smaller area.

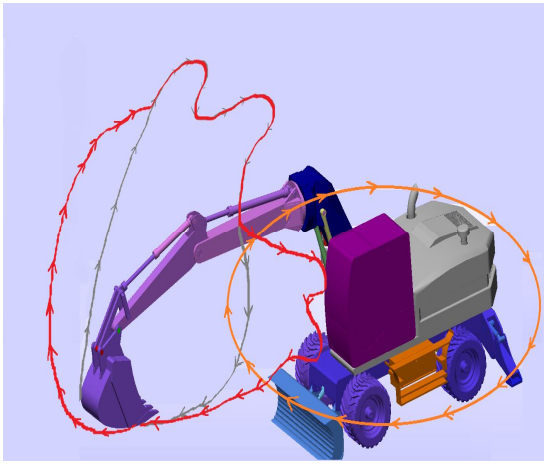

Fig. 10. Access areas of the excavator bucket

4. Conclusions

The 3D assisted design allows for the virtual modeling of a new type of the excavator arm. It also allows checking the correct sizing using the static analyses with specialized software.

Using this software allows reducing the manufacturing cycle but also reducing the costs in launching production of the prototype.

Design optimization of the new type of excavator arm is greatly facilitated by using static analysis on each component.

References

[1]http://www.plm.automation.siemens.com/en_us/products/velocity/solidedge/

[2]http://business.highbeam.com/436102/article-1G1-165639955/autodesk-certifies-algor-fea-software