THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XV MECHANICHAL ENGINEERING, ISSN 1224-5615
2013

# 3D MODELING AND STATIC ANALYSIS OF A BUCKET CRUSHER EQUIPMENT ATTACHED TO THE EXCAVATOR ARM

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## ABSTRACT

*This paper aims to show the 3D modeling of a bucket crusher equipment attachable to the excavator arm. The static analysis of this type of crusher jaws allowed a correct designing for a better reliability. This analysis allowed the correct 3D sizing of the equipment.*

KEYWORDS**:** bucket crusher equipment, CAD, CAE

### 1. Description, composition, functioning(CAD)

In figures 1a and 2 there is a 3D drawing of a set of crushing equipment attachable to the excavator arm type S 1203. The production capacity is between 25 and 32 $m^3$/h depending on the size of the required grain (fig.1b). The types of materials that can be crushed are contained in a detailed range: stone, brick, concrete, reinforced concrete, aggregates, tiles, clay tiles, asphalt.

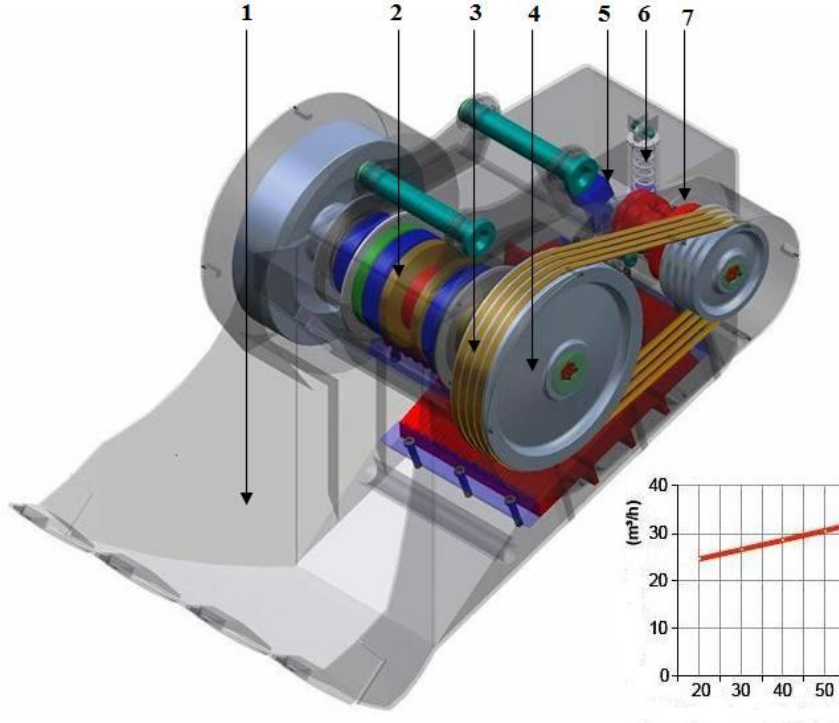


Fig.1a The 3D model presentation of the equipment type cup crushed $m^3$/h




Fig.1b Productivity diagram of the equipment

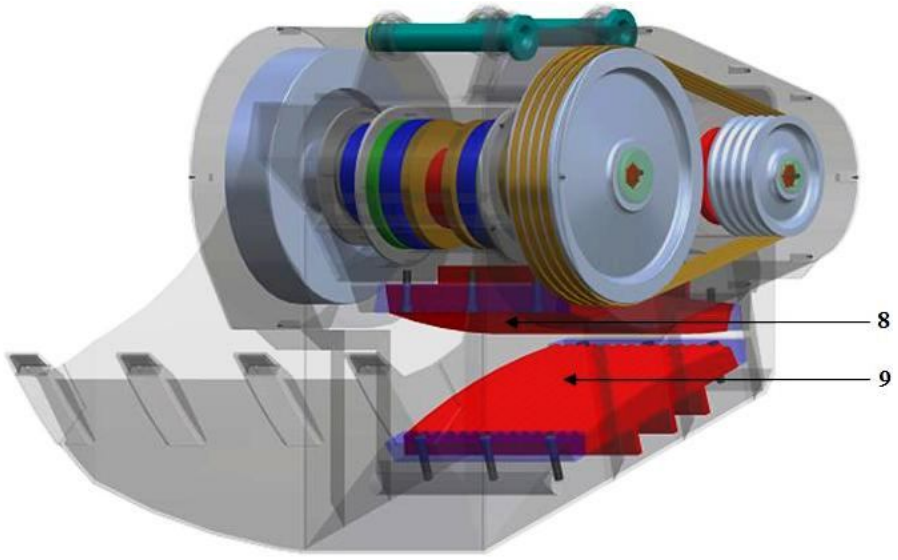


Fig. 2 The 3D model presentation of the equipment type cup crushed

The „3D" modeling was done using Solid Edge software, the CAD ultimate technology complex software produced by Siemens PLM.

Inside a cup (item 1) is assembled a crusher with simple joint, powered by a V-belt drive (item 3 and 4), these in turn are driven by a rotating hydraulic motor (item 7).

The engine hydrostatic pressure required is taken from a hydraulic excavator.

It is remarkable the control system crushing size (item 5 and 6) which will produce different sorts of sizes between 20 and 60 mm.

Movable jaw movement (item 8) from fixed jaw (item 9) is given by rotating eccentric shaft mounted in the assembled box (item 2).

## 2. A static analysis jaw crusher armor(CAE)

After the 3D modeling of the armor crusher, it is necessary to perform static analysis to validate the form and construction dimensioning. This analysis should easily visualize 3D design deficiencies, but they should also be on hand to design engineers.

All this information combined in virtual prototype fabrication allows market launch within a shortest time and with minimum cost.

Modeling of crusher wear armor was made with Solid Edge 3D software. In the proposed analysis method, ALGOR software was used.

In fig. 3 is shown the result of modeling the following components: fixed jaw (item 9) and mobile jaw (item 8).

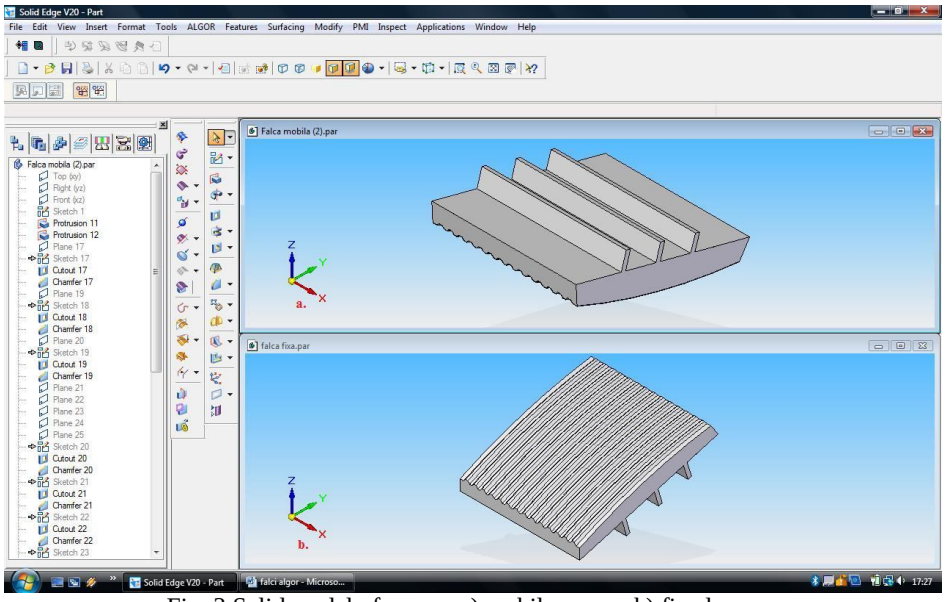


Fig. 3 Solid model of armor: a) mobile armor, b) fixed armor

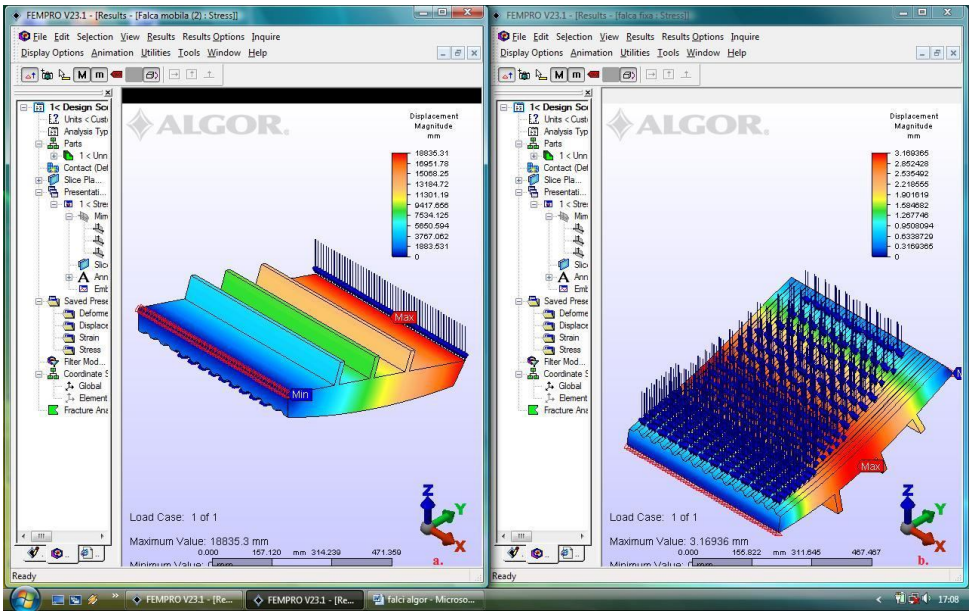


Fig. 4 The result of the analysis of movement: a) mobile armor, b) fixed armor

## 2.1. Computer aided analysis

Elements of this equipment, fixed jaw, movable jaw, must resist the good functioning of the requests in the context of extreme conditions (heat, weather, and so on). Mathematical modeling and application of forces further analysis are correct premises.

Certain assumptions and approximations are required to simulate the behavior of wear plates. The analysis was done with the assumption that the arrangement of forces acting on the crusher, loaded with particles of different sizes and irregular shapes, act perpendicular to the wear plates.

Developed pressure equipment items due to external forces must be obtained and compared to the maximum voltage that the equipment can safely withstand.

## 2.2. The properties of ware plates material

Austenitic manganese steel has the manganese content of about 8% and this steel can be classified as alloy steel. When manganese content exceeds about 10%, the steel will become austenitic steel after slow cooling. A special type of steel, manganese steel known as "Hadfield" typically contains 12% manganese.

Crusher wear plates are made of cast steel that is resistant to wear, generally referred to as manganese steel "Hadfield". Properly, the heat control of the austenitic treated steel is made by cooling with cold water or air .

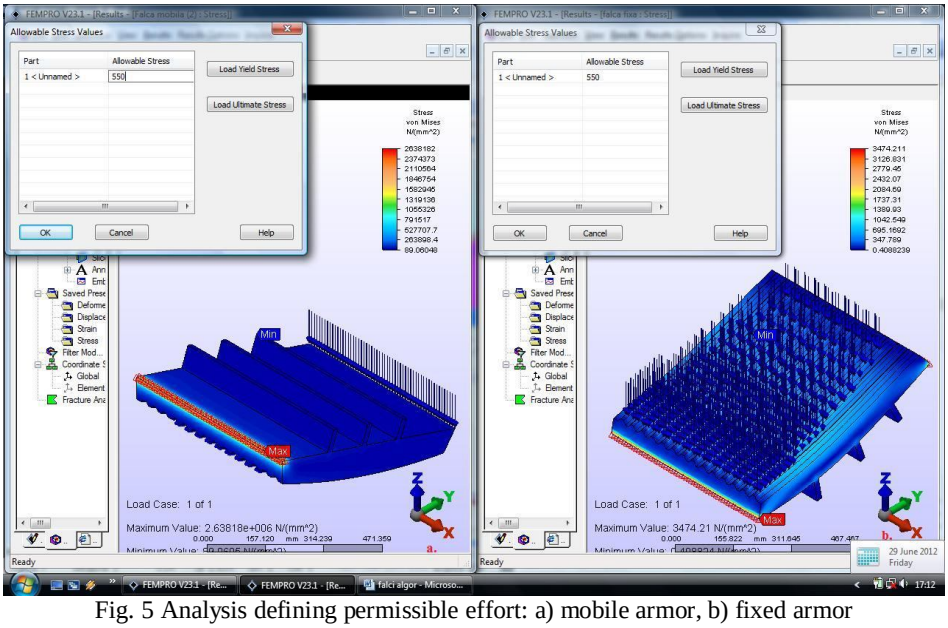


Fig. 5 Analysis defining permissible effort: a) mobile armor, b) fixed armor

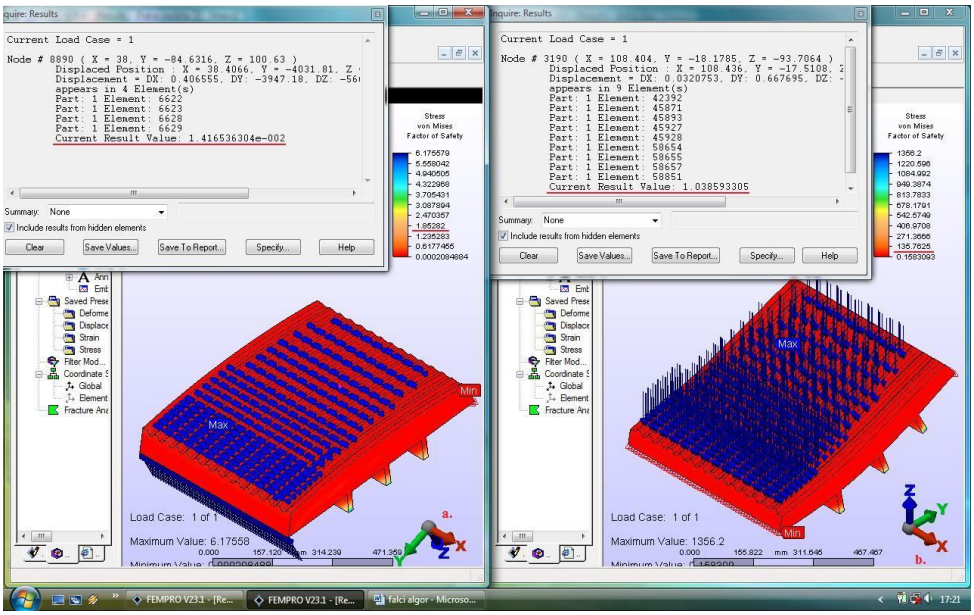

Fig. 6 Results of the analysis of permissible effort: a) mobile armor, b) fixed armor

Another very important property of the Hadfield steel is its ability to strengthen the initial hardness of 240 HB to 500 HRC. The resulting material is austenitic manganese steel, the isotropic material.

Resulted: modulus of elasticity (E) = 210 GPa, density (ρ)= 7838 kg/m$^3$, Poisson's ratio (ν) = 0.3, shear modulus (Φ) = 80.76 GPa and strength capacity (YS)= 550Mpa.

Figure 4 shows the analysis results. It is presented graphically the displacement of stretching developed inside the crusher wear armor. The results for the mobile armor have values between the minimum value of 0 [mm] and the maximum of 18835.3 [mm]. The analysis for the fixed armor shows values between, the minimum value of 0 [mm] and the maximum value of 3.169365 [mm]. These results are identified in the color grid.

It was also made the analysis of the static effort. The results for the movable jaw are values between the minimum of 89.06048 [N/mm$^2$] and the maximum value of 2638182 [N/mm$^2$]. For the fixed jaw the analysis shows values between the minimum of 0.4088239[N/mm$^2$] and the maximum value of 3474.211[N/mm$^2$]. These values are identified in the color grid.

After analyzing the static effort it was done the analysis of the admissible strength of the wear armor. The input value of strength is 550 MPa (fig. 5).

Figure 6 presents the results of the analysis. The values of the admissible strength for the fixed jaw are between the minimum value of 0.0002084884 and the maximum value of 6.175579. The values of the admissible strength for the movable jaw are between the minimum value of 0.1583093 and the maximum value of 1356.2. These values can be identified in the color grid of the fig. 6.

## 3. Conclusions

The "3D" modeling of this type of crusher attachable to the excavator arm allows for the designers a grater facility in typification these equipments.

Finite element analysis to optimize jaw crusher armor for their size increased reliability.

New constructive solution of the crushing equipment which can be attached to the excavator arm allows getting different grains within small and medium sites.

## References

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