FINITE ELEMENT ANALYSIS STUDY ON DEEP DRAWING SPEED PUNCH

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ABSTRACT: Analysis drawing process can sometimes be quite expensive and time consuming. Finite Element analysis manages to solve some of these shortcomings. It is very important that the results obtained by finite element simulation to be close to those obtained experimentally. This happens only when the drawing process parameters are correctly set. In some cases it is necessary to change artificial these parameters but without having an effect on the results. Increasing speed punch in the deep drawing process, can be applied only when it can be proven that the process is quasi-static.
KEY WORDS: finite element analysis, abaqus, punch speed, kinetic energy.

1. INTRODUCTION

The variety of factors that influence the process of deep drawing led to a series of studies in the literature.[1][2][3] It was study how the variation of each factor influences by hem self and in combination with other factors.

The experimental study of the deep drawing process parameters is quite expensive which makes the variety of parameters studied is not very high and the results of the research are not complete.[4][5] The parameters studies that require modification of geometric shape are those that make the costs to be quite large requiring different versions of active elements.[6][7][8]

This has led to research in this field that are made using finite element analysis . The modelling of geometric elements variation and the motion parameters of deep drawing process can be done very easy .

2. FINITE ELEMENT ANALYSIS

Using Abaqus / Explicit is recommended for simulation experiments in which inertial forces plays an important role . It also can be use for quasi-static process. Because a quasi-static process simulation at normal speed can be a time consumer, it is necessary to increase the speed of work in a way the we will not affect the result.

2.1 Geometric model

Geometric model consists of the following components, which interact with each other :

- the punch has a diameter of 100 mm and execute a vertical translational motion , the other moves being blocked . In the simulation study are proposed multi-speed punch.
- the die has an interior diameter of 101.8 mm and all freedom degrees are blocked
- the blank holder plate executes a vertical motion transfer, other movements being blocked.
- The blank has a diameter of 0.8 mm . This is the only element which is assigned a mesh

All the four components that make up the geometric model are defined rigid and only the blank will be defined as deformable.

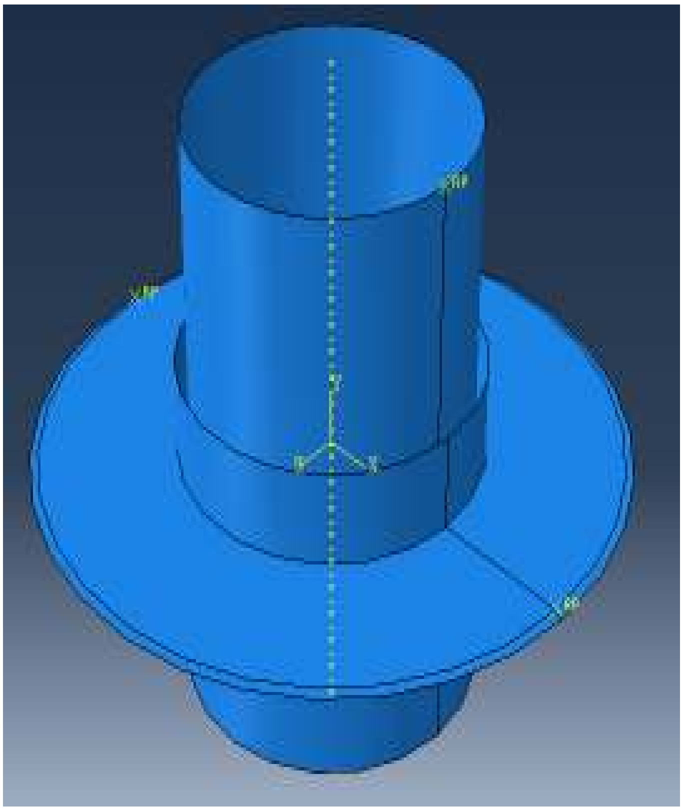

Figure 1. Deep drawing geometric model

Calculation time depends on the mesh size and the speed of movement of the punch. It is desirable to make the simulation to artificial speed high than physical. If the speed is too high the simulation results obtained are not the same as in the case of lower speeds due to inertia forces which are dominant. In a typical process of forming by stamping punch speed is 1 m/s or less. In this analysis the mass scaling technique was used to adjust the speed without changing the material properties punch.

Contacts parameter definition between deformable surfaces (blank) is performed using surface -to-surface model, which involves choosing an area of master type and one slave type.

The master type surface was attach to the rigid elements and the slave type was associated to the blank.

For all those element it was defined the friction coefficient and the type of interaction between the elements.

The interaction between the die and the blank, between blank holder and the blank, is defined starting with first step in the finite element analysis, where the blank holder force is apply to the blank. The interaction between the punch and the blank it's setup starting with the deformation of the blank.[9]

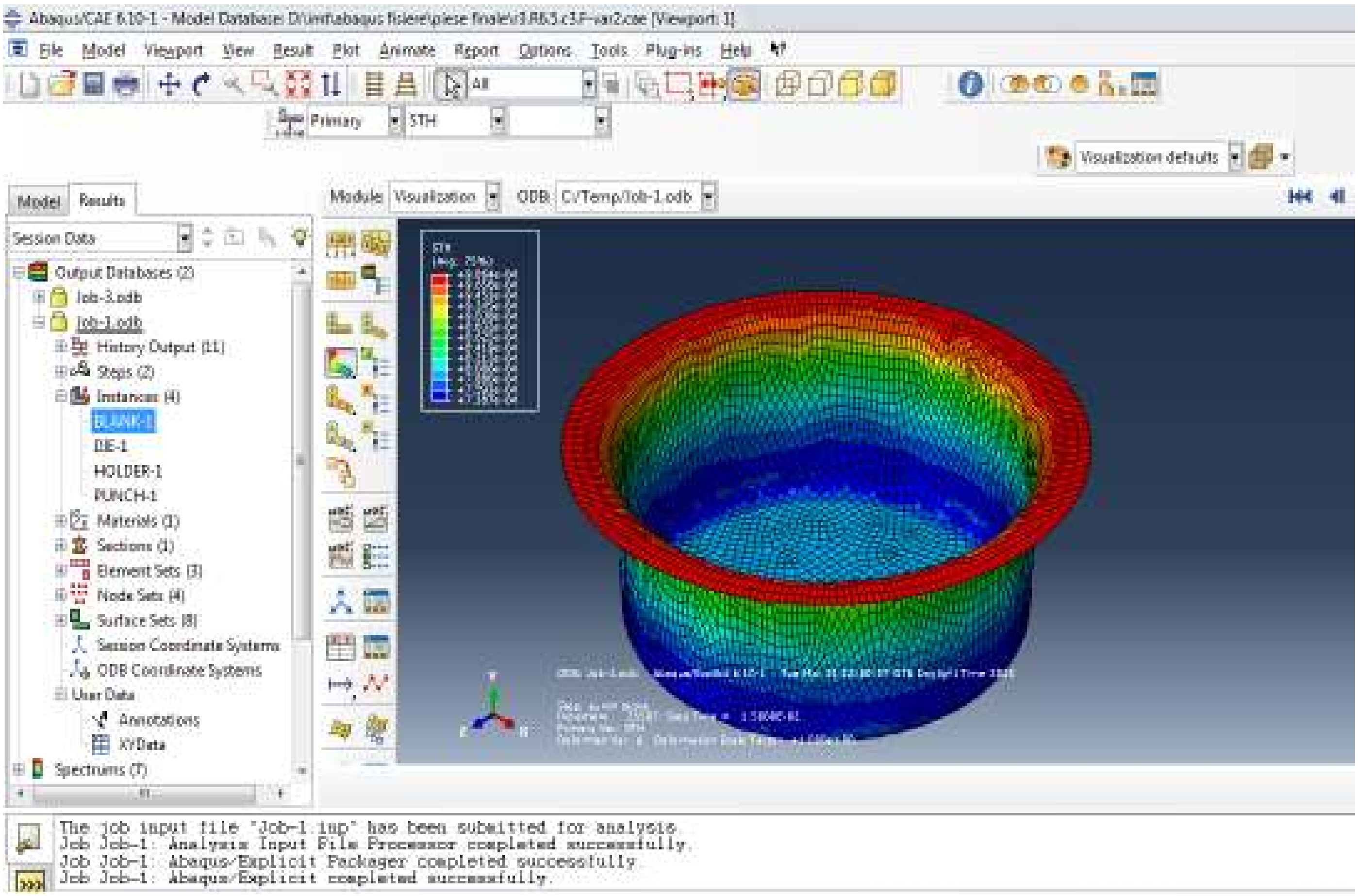

Figure 2. Finite element analysis of the deep drawing process

3. THE STUDY OF ENERY BALANCE

In the evaluation process of the simulation accuracy of a quasi-static problem, it is necessary to make an analysis of the energies. The sum of all energies is constant. It is established that the inertial forces in quasi-static process are very close to zero, because of the speed low level. It be can conclude that kinetic energy appear in the deed drawing process can't exceed 10% from the internal energy. When it's compare the energies ,it must consider that in the reports of the program Abaqus / Explicit , total energy include kinetic energy of all elements that have associated rigid mass . What interests us is the only the blank component, we ignore the other components.

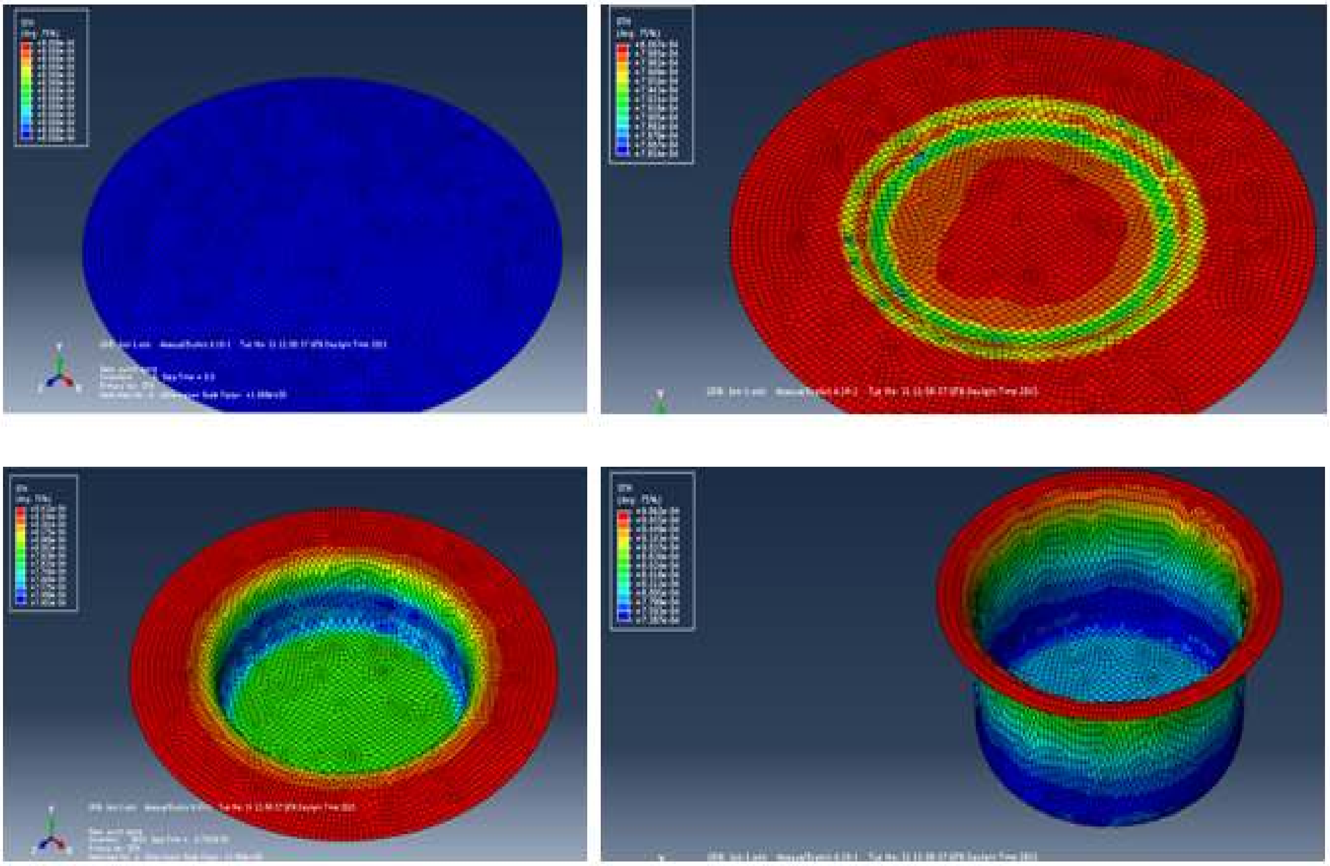

Figure 3. Deep drawing punch travel steps

Before checking the results, such tension and deformation we need to ensure that the solution is quasi-static.

In most cases, to check if a simulation is quasi-static it important to see the energy variation model. The energy model in Abaqus / Explicit is given by the following equation [10] :

$$E_I + E_V + E_K + E_{FD} - E_W = E_{total} \quad [1]$$

Where: E_I - internal energy, E_V - dissipated energy E_K- kinetic energy -E_{FD}-dissipating energy absorbed by friction, E_W external forces, E_{total}- total energy in the system

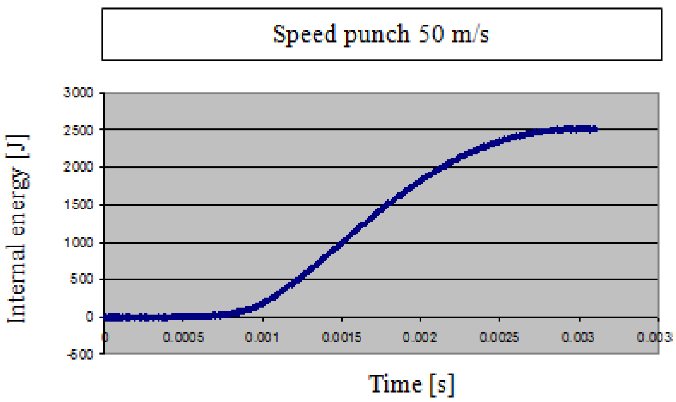

Figure 5. Internal energy corresponding to 50 m/s punch travel speed

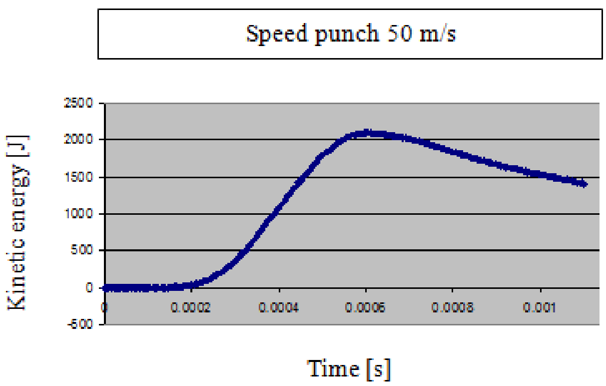

Figure 4. The kinetic energy corresponding to 50 m/s punch travel speed

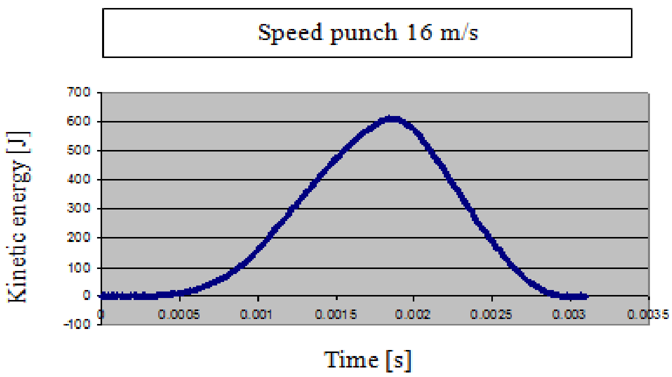

Figure 6. The kinetic energy corresponding to 16 m/s punch travel speed

The maximum value of the kinetic energy is in the middle of the distance of travel punch. At a speed of 50 m/s the kinetic energy is 95% of the internal energy. In our model the blank is the main source of generation of kinetic energy (the movement of the blank holder are not take into account) and the punch and the die don't have attack mass[11][12].

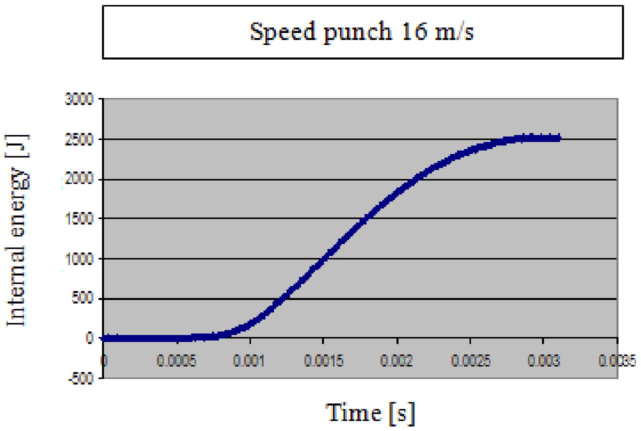

Figure 7. Internal energy corresponding to 16 m/s punch travel speed

The punch speed of 16 m/s the kinetic energy is 33% of internal energy.

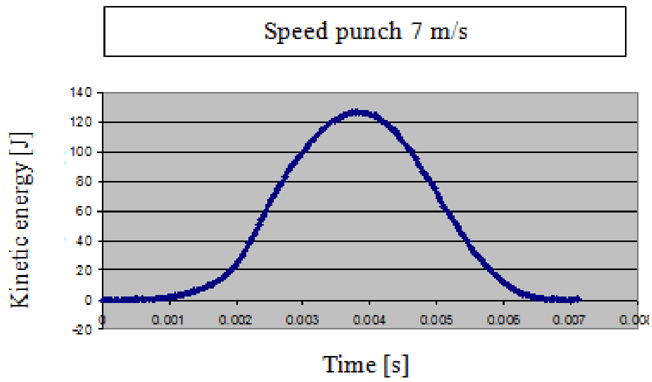

Figure 8. The kinetic energy corresponding to 7 m/s punch travel speed

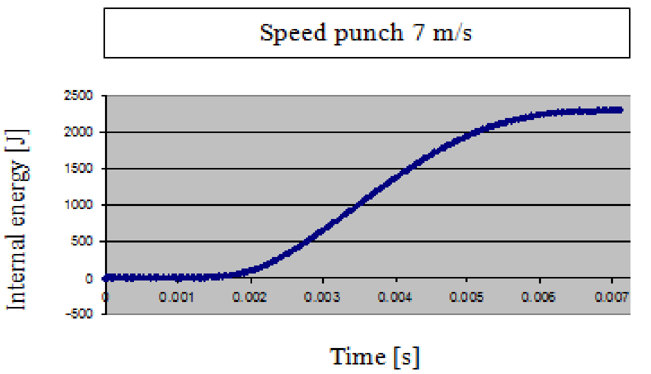

Figure 9. Internal energy corresponding to 7 m/s punch travel speed

To the punch speed level of 7 m/s the kinetic energy has a maxim value of 120 J, that is more than 8% form the internal energy.

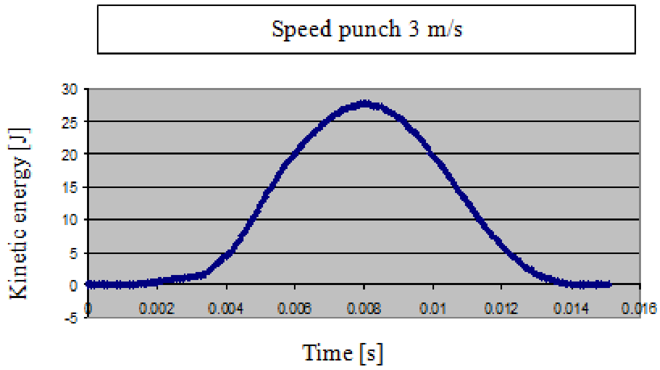

Figure 10. The kinetic energy corresponding to 3 m/s punch travel speed

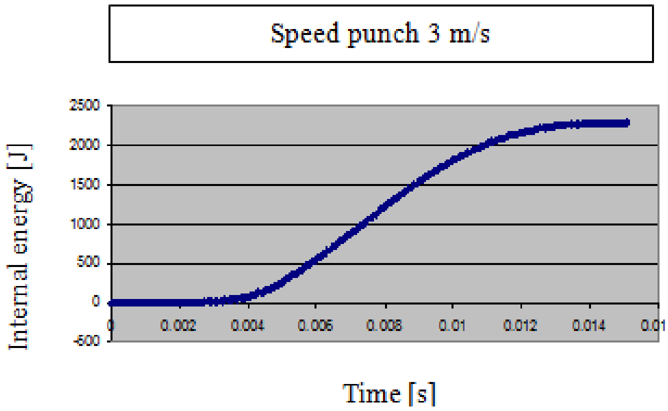

Figure 11. Internal energy corresponding to 3 m/s punch travel speed

To a punch travel speed of 3 m/s the maximum kinetic energy value is about 4% of internal energy value.

It can be notice how the percentage of kinetic energy in the total energy decreases with speed.

Comparing the kinetic energies for all punch speeds considered, it is observed that for low speeds punch travel the kinetic energy is approaching zero.

Seeing the percentage values of the kinetic energy in the internal energy values it can be concluded that under 3 m/s the speed of the punch, the process can be regarded as quasi-static.

Table 1. Maxim kinetic energy level

Speed [m/s]	Kinetic Energy [J]	Internal Energy [J]
50	2100	2500
16	650	2500
7	120	2300
3	27	2200

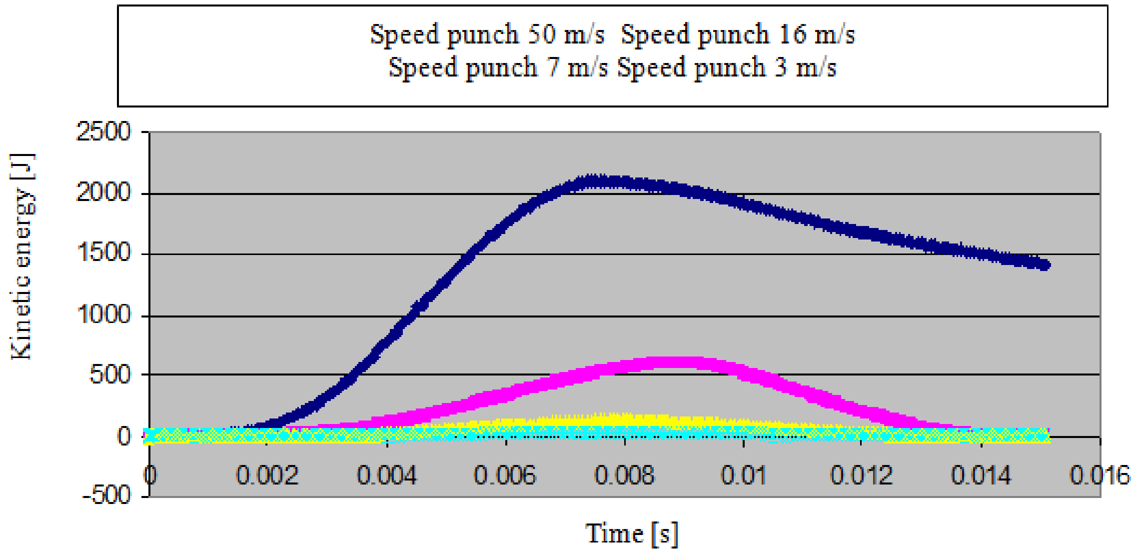

Figure 12. Kinetic energies

4. CONCLUSION

Regarding the study of drawing process is very clear that finite element analysis is the best method to use. It is very important that all process parameters are correctly set for the results to be close to the simulation results obtained through experimental tests.

A small punch speed of deep drawing process makes the simulation to be a lengthy process, time and resource consuming, requiring thus an artificial increase of speed without the effects of inertial forces to take effect.

Kinetics energy appeared in a stamping process steps can not 10% of domestic energy. Simulations conducted show that only at speeds below 3 m / s, kinetic energy falls below this percentage.

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