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INVESTIGATION THE COMPACTING PROCESS OF EXTERNAL FLANGED POWDER PARTS

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ABSTRACT
The external flanged parts are used on a large scale in automotive industry. In the paper are presented the main methods of compaction external flanged parts and then the common cracks that appear in pressing cycle. Using the (FE) simulation it was modelled the axial pressing of an external flanged part, point out the density, the axial force and the spring back variations. The results are useful in optimal design of pressing equipments, in the process and specifics parameters control, lead to important benefits.
Key words: *powder compaction, FEM, process design*

1. METHODS OF COMPACTING EXTERNAL FLANGED COMPONENTS

According to their complexity and difficulty of manufacture, the two level parts belong to class 3 after [1], and are usually termed external and internal flanged components, which could be obtained by axial pressing.

There are two possibilities to compact external flanged components.

Two level geometries are often pressed in stepped dies (figure 1).

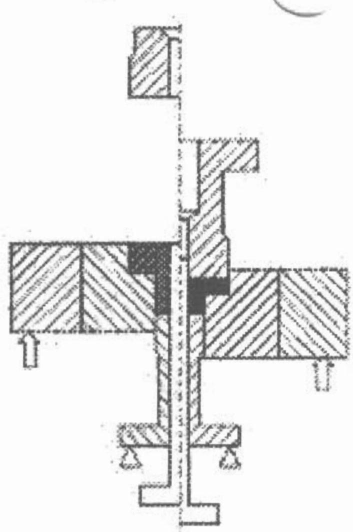

Fig. 1

The component in this case could be obtained either by using the double motion pressing or using the upper punch pressing with floating die (figure 1).

To obtain the same distribution of density, the upper punch must compact the powder column in die step and the powder column on the lower punch by the same percentage. This implies precisely adjustment of the die elements movements.

Die step should have a release taper of at least 1 μm per mm step height and a corner radius of not less than R=1 mm, from manufacturing reasons. A drawback of stepped die is the necessity to use the same powder reproducible apparent density.

The steps can also be formed by two independent lower punches (figure 2), using the upper punch pressing with floating die.

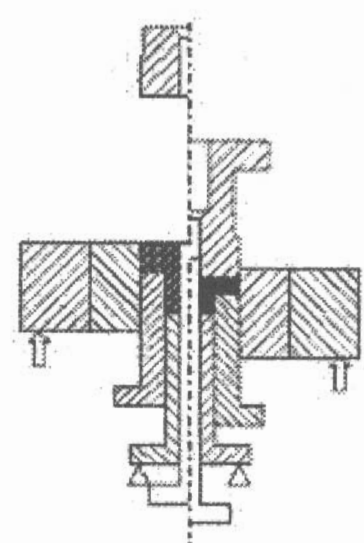

Fig. 2

The inner lower punch supporting the highest powder column is the longest and is backed by a base plate that is fixed in the press frame. The outer lower punch is lifted to its filling position by an intermediate plate controlled using mechanical springs, hydraulic cylinders or servo-hydraulic CNC systems. In compaction position all lower punches rest on the base plate that is the reference plane for the whole tool assembly.

For part ejection the die is withdrawn and the lower punches are stripped beginning with the outer lower punch consecutively to the inner lower punch until the parts rest free only on the inner lower punch from where it can be picked off after core rod retraction.

The filling heights for the two levels are determined using the relation (1):

$$k = \frac{h_1}{H_{u1}} = \frac{h_2}{H_{u2}} \qquad (1)$$

where: k is the compacting ratio; h_1, h_2 are the component heights; H_{u1}, H_{u2} are the filling heights (see figure 3).

The distance of outer lower punch moving is equal according with [2] with:

$$\Delta h = k\,(h_2 - h_1) - h_1 \qquad (2)$$

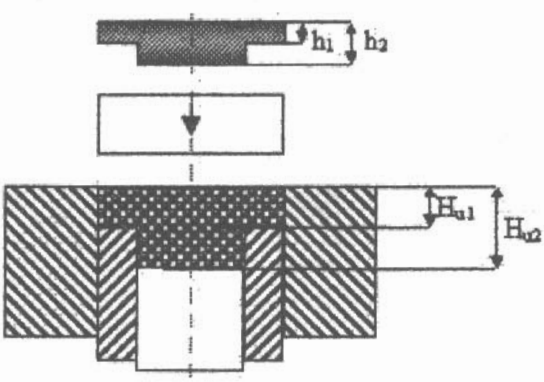

Fig. 3

2. TYPES OF CRACKS IN EXTERNAL FLANGED GREEN PARTS

In general, it is not possible to achieve a homogeneous green density distribution by die compaction. The density is more or less inhomogeneous depending on the part geometry, the tool design and the friction between the powder and die wall. As a result the part could undergoes shape distortions or cracks may develop during pressing.

The common cracks, which appear in powder compacting of flanged parts, are the results of the next principal factors, considering that the initial density is uniformly distributed:

1. the travels of the active elements don't respect relation (1). The neutral zone in most cases is situated at the lower cross section or at the step of stepped die. This should be no problem with computer controlled hydraulic presses. With mechanical presses appear problems because in general, it not possible to control the movement of punches and die independently. In this case there is the danger of large shear motions in the powder that lead to cracks.

2. the pressure applied on the upper and lower punches when it is using the method of double motion pressing, is not uniform. In the case presented in figure 1, if the pressure applied by the lower punch is low, then at the face of this punch will appear a cross flow which will cause a crack.

The two typical cracks are: cracks due to normal tension stress with a dull looking surface, case 1 and cracks caused by shear stresses which look glossy, case 2.

3. NUMERICAL SIMULATION OF AXIAL PRESSING OF EXTERNAL FLANGED PARTS

For many practical applications numerical simulation of die compaction is a useful tool to reduce the time and cost for the development of a complicated part or to optimise the production cycle. The (FE) simulation can be used to optimise the tool geometry, the punch movements and the prediction of crack formation during pressing, unloading or ejection of the part from the die.

It is considered an external flanged part having: the flange diameter of 25.4.mm; the body diameter of 10.15 mm; the height h_1 of 7 mm and h_2 of 19 mm.

The part is made from Ancorsteel 1000, Water atomized powder withh 0.75 weight percent Acrawax C lubricant with a theoretical density of 7.85 g/cm3 and a apparent density of 3.22g/cm3.

The method of pressing is the upper punch pressing with floating die (figure 4).

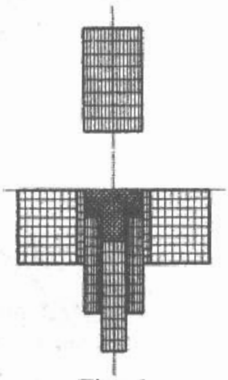

Fig. 4

The punches and die travels are presented in figure 5.

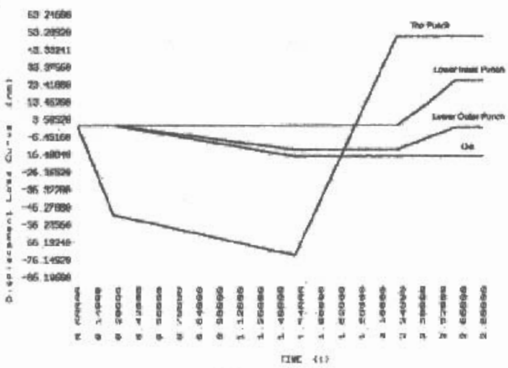

Fig. 5

First the upper punch is moving down till he come in contact with the powder. From this point both the die and the outer lower punch is moving till the pressing position (figure 6). When the pressing is ready, the die remain fixed, and the inner and outer lower punches are moving up to eject the part from the die (figure 7).

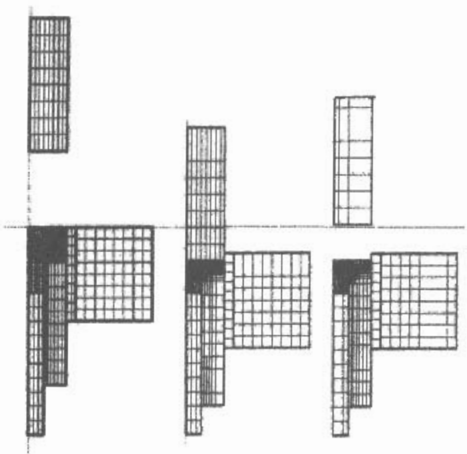

Fig. 6

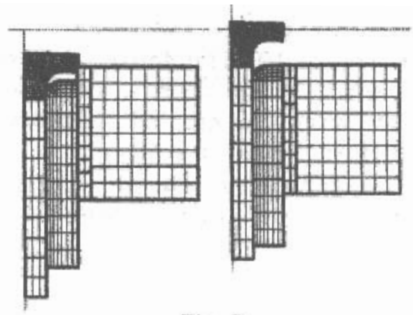

Fig. 7

4. SIMULATION RESULTS FOR AN EXTERNAL FLANGED PART

As a result of the pressing method the distribution of density appear like in figure 8. At the corners the level of density is higher then in the rest of the part. The smallest density is in the radius zone. A risk of crack could be considered.

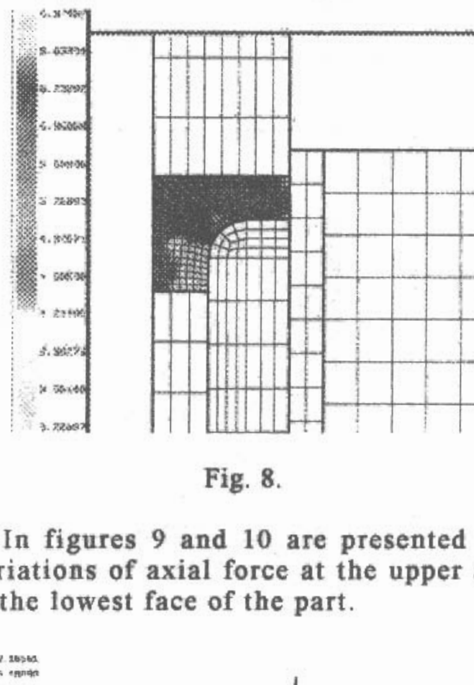

Fig. 8.

In figures 9 and 10 are presented the variations of axial force at the upper and at the lowest face of the part.

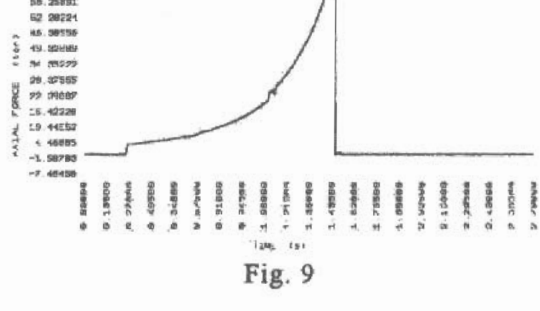

Fig. 9

Result of the deformation media, the axial force induced in material in not uniform. At the upper face of the part this force is about 80 tones (figure 9) and at the lowest face the force is about 16 tones (figure 10. The density variation is clear. Also at the inner lowest punch, when the part is ejected, appears a supplementary force of compaction when the part is pushing on the die. This leads to a supplementary densification of the part.

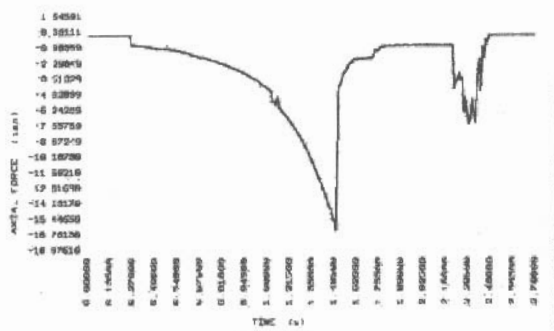

Fig. 10.

Finally in figure 11 is presented the spring back of the part, in the transversal direction, during the process of ejection.

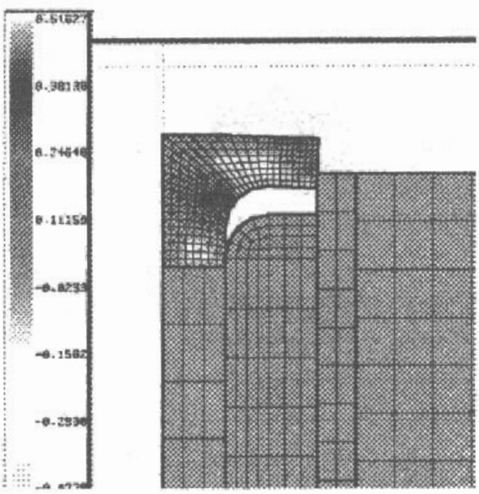

Fig. 11

In the part there are zones of positive and negative displacements. These correspond to theirs positions in connections with the active elements. In the radius zone exists the largest positive displacement, which could conduct to crack.

5. CONCLUSIONS

In the pressing cycle of an external flanged part appears a series of problems, like uncontrolled powder flow, density and spring back variations which could lead to cracks. The results are useful in optimal design of pressing equipments, in the process and specifics parameters control, lead to important benefits.

6. Acknowledgements

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INVESTIGAREA PROCESULUI DE PRESARE AL PULBERILOR DESTINATE REALIZĂRII PIESELOR CU FLANŞĂ

Rezumat

Piesele din pulberi cu flanşă sunt utilizate pe scară largă în industria automobilului. În lucrare sunt prezentate principalele metode de presare a acestor tipuri de piese şi principalele defecte care pot să apară în procesele analizate. Utilizând apoi metoda elementului finit, s-a modelat procesul de presare a unei piese cu flanşă, evidenţiindu-se variaţia densităţii, a forţei axiale şi a revenirii elastice pe direcţie radială a materialului. Rezultatele permit proiectarea optimă a echipamentului, controlul procesului şi nu în ultimul rând a parametrilor specifici rezultând beneficii importante.

UNTERSUCHUNG DER VERBINDENE PROZESS DER EXTERNEN ANGEFLANSCHTEN PUDER-TEILE

Zusammenfassung

Die externen angeflanschten Teile werden auf einer großen Skala in der Automobilindustrie benutzt. Im Papier werden die Hauptmethoden der Verdichtung extern flanschte Teile und dann die Common-Sprünge dargestellt, die erscheinen, wenn sie Zyklus betätigen. Mit der Simulation (F.E.), die sie das axiale Betätigen eines externen angeflanschten Teils modelliert wurde, unterstreichen Sie die Dichte, die axiale Kraft und die Frühling zurück Veränderungen. Die Resultate sind im optimalen Design des Betätigens der Ausrüstungen, im Prozeß nützlich und Besondereparameter Steuerung, führen zu wichtigen Nutzen.