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THE COMPUTER MODELING OF THE TECHNOLOGICAL PROCESS OF COMPRESSOR BLADE BLANKS EXTRUSION

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Abstract

It was shown in this work the computer modeling of the technological process of compressor blade blanks extrusion with using the QForm2D/3D software package. 3D models of stamp equipment and extruded blade blanks, which correspond to the prototype were developed. The qualitative comparison of modeling results with actual extrusion process results was carried out. It was shown the correspondence of processes in the region of metal flow hindered zones.

Introduction

In the modern aviation engines construction the issue of competitive products production is particularly relevant. In this case, it is necessary to take into account the quality of products, short production times and the cost of products. Aviation engines blades are the most massive and loaded parts. They are subject to special requirements according to the structure of the material, its chemical composition, mechanical properties, geometric dimensions, and especially with out defects in the manufacture, which can fall into the body of the blade and reduce the strength characteristics in the future [1].

The defect's emergence is influenced by the technological parameters of blade's blanks manufacturing: the deformation rate, temperature, friction on the contact surface and the geometric dimensions of the part [2].

Modern modeling systems can significantly reduce the cost and new equipment developing time due to virtual modeling of the stamping process, without the equipment manufacture and using forge-pressing equipment.

Purpose

The purpose of this work is numerical modeling of the extrusion process of the aviation engines compressor blades blanks with solving the plastic deformation problems, comparing the modeling results with the actual results of extrusion.

It was used the QForm 2D/3D software package as a process modeling system, which allows to vary the parameters of the deformation process [3, 4].

Entering modeling parameters

The extrusion process of the compressor blade blanks was modeled according to the actual size of the blade and stamp equipment. The scheme of the flat extrusion process research is presented in fig. 1. It shows the matrix, punch and stamped metal.

In the first stage of the modeling, it was created a 3D model of stamp equipment and extrusion workpieces. For the possibility of further modeling it was applied the finite elements grid on the tool and the workpiece in the QShape application of Qform. (fig. 2)

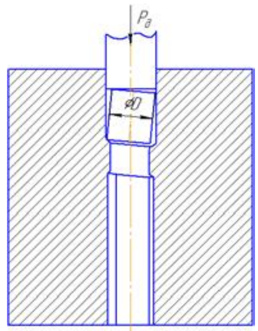
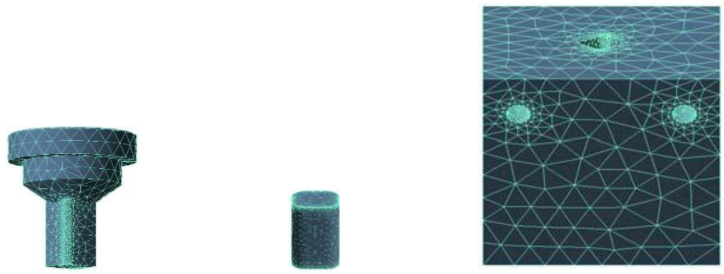


Fig. 1. The scheme of the compressor blade workpiece extrusion process



a *b* *c*

Fig. 2. Grid drawing by the finite elements method: a – punch,
b – workpiece for extruding, c – matrix

It was considered a volume task, when the workpiece extrusion process is modeling. As the equipment it was chosen the model of mechanical press for the efforts of 6.3 MN. The deforming tool was considered absolutely rigid.

The computer modeling results of the compression blade blanks extrusion process of a characteristic size 27 mm

A titanium alloy VT6 was chosen for the model of the workpiece material. The calculation was made using a graphite lubricant with a friction coefficient μ=0.3. The heating temperature of the workpiece is equal to 900°C.

As a result of the calculations, data were obtained on filling the stamp engraving and the areas of the difficult metal flow with the defects presence. In fig. 3 shows the distribution of the deformation resistance, and in fig. 4 – the distribution of the metal flow velocities.

Based on the analysis of the obtained results, the extruding blade can be divided into four zones (fig. 5).

The zones 1 and 3 of the template are the zones of the difficult metal flow. There is a metal contacts of the workpiece with a punch in zone 1. There is a metal stagnation due to the structural features of the compressor blade blank and matrix corners in zone 3. Intense metal flow is observed in zone 2. Metal flows into the cavity of the matrix, where the formation of the blade nib is observed. In the 4th is zone there is stable metal flow here.

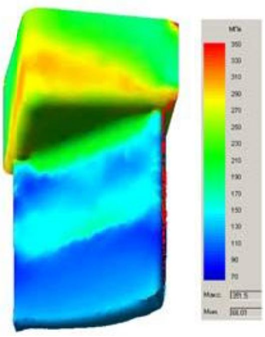


Fig. 3. Distribution of the deformation resistance on the compressor blade blank surface

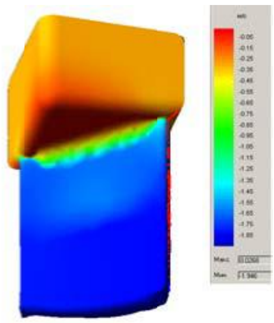


Fig. 4. Distribution of the metal flow velocities on the compressor blade blank surface

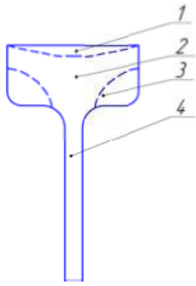


Fig. 5. Characteristic zones of the metal flow

Experimental study of compression blade blanks extrusion

To verify the results of computer simulation of compression blade blanks extrusion process using the QForm software package, an experimental study was conducted on the serial production installation. Before extrusion on the lateral surface of the workpiece, horizontal lines were drawn in order to assess the nature of the metal flow.

The resulting compressor blade blanks indicate the complete filling of the stamp engraving and the absence of clogs and cracks on the blank body, with the blank contour corresponding to the modeling (fig. 6).

The characteristic zones of metal stagnation are clearly visible on the obtained workpieces, the same as in computer modeling.

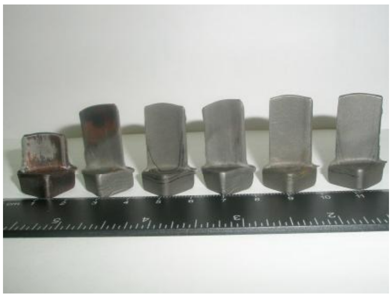


Fig. 6. The series of extruded compressor blade blanks, obtained with the nib length gradual increase

Conclusions

A qualitative comparison of the obtained extruded compressor blade blanks with the results of computer simulation of the extrusion process was performed.

Computer modeling of the compressor blade blanks extrusion process showed a good correspondence between the shape of the extruded workpiece, which was obtained by calculation, the external shape of the actual workpiece, filling the matrix cavity, as well as defects places. The use of applied technologies for deformation process modeling and the stamp equipment manufacture was shown.

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