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CONSEQUENCE OF COMPUTER SIMULATION FOR VERIFICATION OF CLOSED DIE CAVITY SHAPE

Mária Kapustová MSc. Eng.,PhD., Miroslava Košťálová MSc. Eng.
Faculty of Materials Science and Technology, Institute of Production Technologies, Department of Forming

Abstract: *In present day the successful development and competitiveness of forges relates with feeding of simulation software into forgeds technical prepare of production. The staple offers to users for solving simulation of technological processes production relatively qualitative simulation software. The aim of the paper is focus on the importance of simulation software for material flow following in the cavity of die. The simulation proves to detect the possible mistakes of material flow, whose are reason of leads creation on forged. It is possible by adjusting of tool geometry to eliminate mistakes in preliminary phase of forged production, what presents production costs savings. Using of simulation software has big importance by successful development of new unconventional technologies in production praxis, because essentially reduces economical severity of proving processes in prepare phase of production.*
Key words: *closed die forging, simulation, impression of die, wad shape*

1. INTRODUCTION

Computer technique in forming area allows to apply in all stages of production processes designing in forming, such also at production of forged pieces. The present market offers relative high quality simulation programs, what have wide application in verification of technological method accuracy. They become quickly integral member of design and all development process, because they provide in relatively short time to obtain optimal alternative of production and so to eliminate economically and time demanding experiments. The advantage of technological process simulation is realization of experiments out of real object, without real incidence to the production operations.

2. MERIT SIMULATION PROGRAMMS FOR DEVELOPMENT OF DIE FORGING WITHOUT FLASH

In loading of precision die forging method into production praxis has big consequence computer simulation of technological process, which enables to understand forging process and plastic flow of material in die impression during its filling. So that are very quickly

diagnostic mistakes of bad flow, or not filling places in die impression, whether big flash, what signalizes abnormal consumption of material. Simulation software allows to optimization dimensions of billet, shape of forging blank, whether final shape of tool impression and so eliminate mistakes in prepare phase of production.

The merit of computer simulation for another development of precision die forging it is possible to summarize

- ♣ detection of defects reason in forged parts,
- ♣ obtaining important information about forging process,
- ♣ optimization of technological flow production of forged parts,
- ♣ reduction of expensive experiments and reduction of prepare production time.

For process simulation of die forging were developed different simulation programs such DEFORM, FORM2D, QFORM3D, FORGE3, MSC.SuperForge, MSC.SuperForm and others, they use final element method (FEM), what is based on dividing of forming volume for finite final of simple geometrical shapes, eventually programs use finite volume method (FVM), where is calculated material flow by help of constant volume elements and there is not needed remeshing. The process of forging is highly non-linear, for forging process is typically big material transfer and therefore has FVM method application in 3D simulation of forging.

3. SHAPE AND PRODUCTION OF FORGED PIECE

Required forged shape Wheel is obtained by closed die forging. Closed die forging appertains into advanced technology of forging, which make possible to produce forged parts with high precision of dimensions and surface quality[1], [3]. For round shape of die forged Wheel was suggested redundant material compensation method into internal flash. It is necessary to order bars with higher precision, eventually sizing them on own devices. At forging in closed die is required precision dividing of material. For dividing of material is suitable saw of type Individual 510.330 GA, what make possible higher quality of cutting shape. Round shape bars Ø 65 is needed to cut for stock with weight batch 2,68 ± 0,03kg, informative length of stock is 103 mm.

For production of round shape forged was suggested forging press type LZK2500 and forging process consists of three stages:

- to heat billet on upper forging temperature 1150°C ÷ 1200 °C,
- upset billet into height 40mm,

- to block the shape in blocking die impression,
- to finish forged shape in impression of closed die.

Final shape of forged is possible to obtain after punching of wad, what represent technologically needed scrap. Neat weight of forged is 2,54 kg. Technological forging process of forged Wheel is in Fig.1.

a b c

Fig.1 Model of die forging WHEEL a –shape of forged piece with wad and conical compensator, b –forged piece after punching of wad, c –shape of final forged piece

4. OPTIMIZATION OF IMPRESSION SHAPE OF DIE BY HELP OF SIMULATION SOFTWARE SUPERFORGE

Optimization of impression shape was made by simulation software MSC.SuperForge, what in preliminary stage the simulation requires to define process of die forging, to insert model of tool, to choose material from database and forming machine, choice friction and temperature conditions for billet and tool. Output effect of this program is tracing all behavior of plastic material flow in die impression, deformation mesh in forming, color display of flow velocity of material, values of strains, values of stresses in forming material and contact presses of tool surface on the end of simulation and backward during all behavior of forging too [2]. This software was used in forging simulation of die forged Wheel.

After simulation upsetting of billet (Fig. 2), was follow

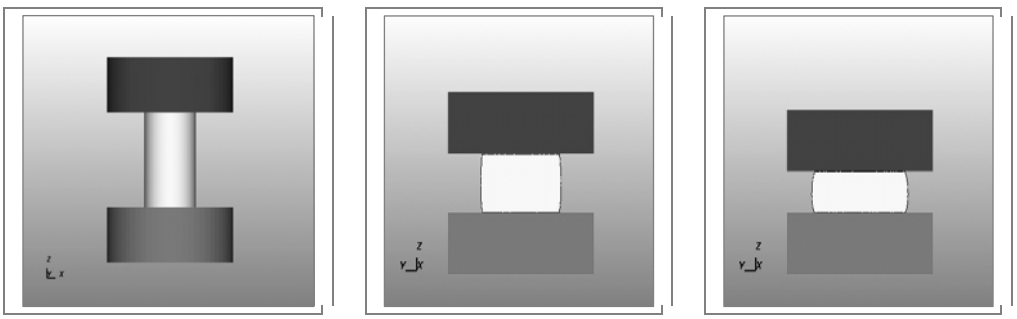

Fig.2 Billet upsetting

mainly setting of forged production simulation process:

- hot forging in closed die , choice of FVM method, insert 3D model,
- choice of machine: mechanical press LZK 2500,
- material of billet: DIN 1.7131, material of die: steel H13,
- billet temperature: 1150°C, die temperature: 250°C,
- friction coefficient: 0.25,

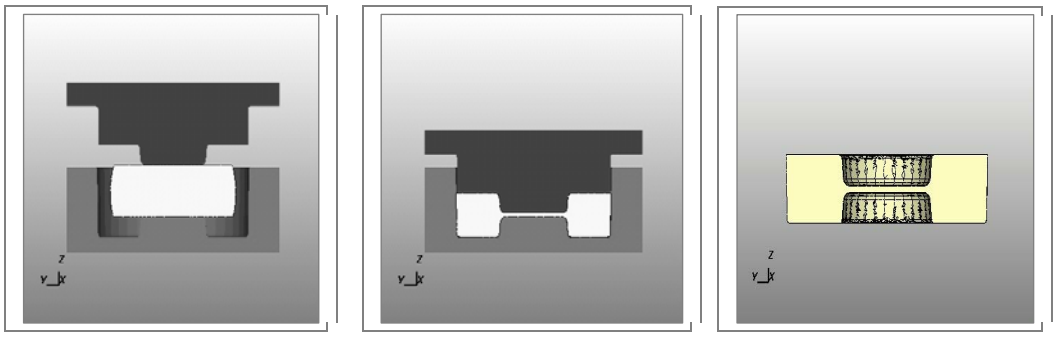

Fig.3 Plastic flow in impression of blocking die and correct shape of forging blank

Simulation of blocking of the shape in blocking die impression is in Fig.3., finished forged shape in impression of finishing closed die is in Fig. 4.

Computer simulation provides to try different variants of finishing die impression modification and tracking of flow material in die impression. It is interesting to detect during bulk forming stressed – deformation states in forged part. For production praxis it is important select of the most suitable shape of finishing impress in term of plastic flow but also in term of energetic severity of final forged part production. In term of wad shape for forging part Wheel it is better to use lens shape of the wad with batter.

5. CONCLUSION

The aim of the paper is mention on actual trends and perspectives for further technology development of precision die forging technology, what present lower production cost and they raise competitiveness of our forges. Important role in loading of precision forging method in praxis have qualitative simulation programs, because they are available to obtain a lot of valuable information about forming process in a short time. The article states example of using program MSC.SuperForge for optimisation and specification impression shape of closed die, what is important for correct final shape of forged part.

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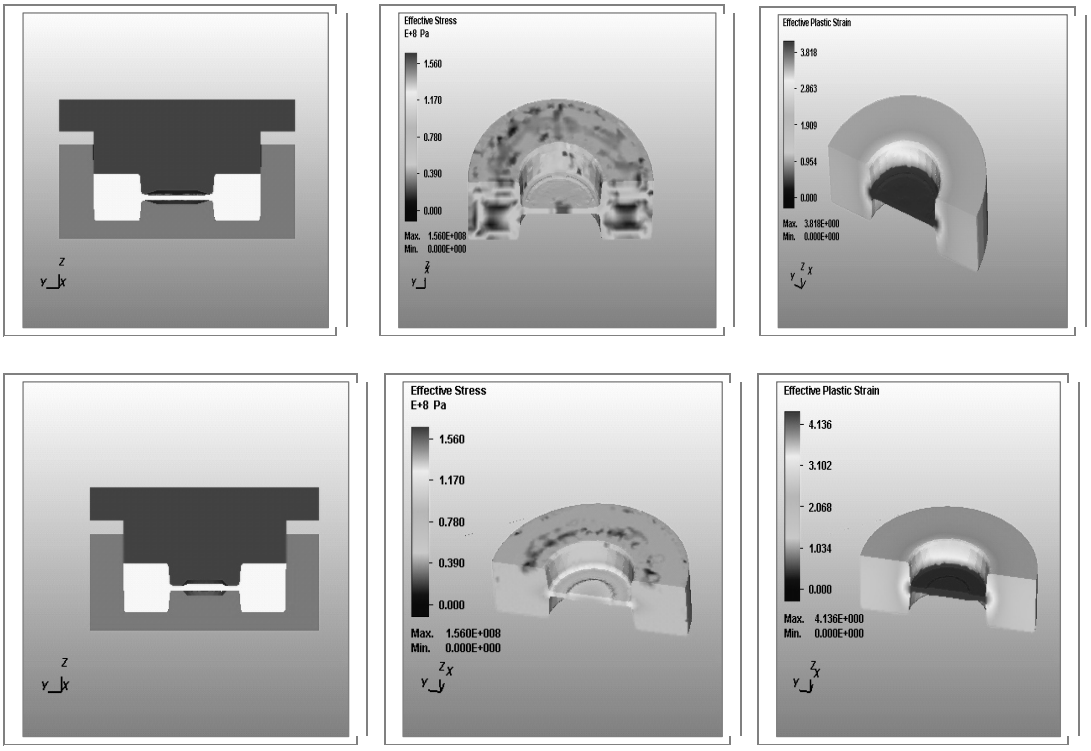

Fig.4 Comparison of stresses and straines behavior in forging at optimization of wad shape

6. REFERENCES

[1] Bača, J. Objemové tvárnenie. Zápustkové kovanie. Bratislava: MtF STU, 2005, s. 157. ISBN 80-227-2176-X

[2] Ulík, A. Simulácia kovania výkovku ozubeného kolesa. In FORM 2000. Brno: 2000,s. 175-180. ISBN 80-214-1661-0

[3] Bílik, J. Životnosť zápustiek. In KOVÁRENSTVÍ. č.27, 2006, s. 6-10. ISSN 1213-9829

[4] BAČA, J., BÍLIK J., TITTEL V., SOBOTA R. Dynamické a statické ubíjanie ocelí s malou deformačnou schopnosťou v objímkach. In *KOVÁRENSTVÍ č.29*, 2007, s. 9-12. ISSN 1213-9829

RETURN ADDRESS

Maria KAPUSTOVA, MSc. Eng., PhD.

Faculty of Materials Science and

Technolgy STU

J. Bottu 24

917 24 Trnava

Slovak Republic

e-mail: maria.kapustova@stuba.sk