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APPLICATION OF RAPID PROTOTYPING IN PROCESS OF MAKING TOOLS FOR METAL CASTING

Nermina Zaimović-Uzunović Ph. D.[1], Damir Ćurić Bsc, Msc[2], Jasmin Mulabdić Bsc[3], Amina Hadžiahmetović Bsc[4], Samir Lemeš Bsc, Msc[5]

[1] Mechanical faculty, Zenica, Bosnia and Herzegovina, nzaimovic@yahoo.com
[2] Foundry "Novi život", Zenica, Bosnia and Herzegovina, nzivot@miz.ba
[3] Foundry "Novi život", Zenica, Bosnia and Herzegovina, nzivot@miz.ba
[4] Foundry "Novi život", Zenica, Bosnia and Herzegovina, nzivot@miz.ba
[5] Mechanical faculty, Zenica, Bosnia and Herzegovina, slemes@mf-ze.unsa.ba

Summary: This paper deals with stages of tool manufacturing for metal sand casting process. All stages are practicaly presented with the real working model. 3D design is the first step in manufacturing tools for metal sand casting. Next step concerns master patern for sand casting. RP (rapid prototyping) model, which is treated in this paper, is made by virtual model for commercial part. According to the virtual model from Z-Corp, RP model is ordered. Master patern is used in the following stage for producing negative. The procedure ends with positive of the model. Material for master patern used in this case is produced by Z-Corp company. RP technologies for production of tools for casting simplify the whole process and significantly decrease costs and save a time for the market.
Keywords: RP, 3D model, 3D printer, foundry tool

1. INTRODUCTION

The problem of manufacturing and utilizing new tools is present not only in casting, but also in other branches of engineering. Basic stages in the manufacturing of casting tools are:

- defining the casting piece,
- designing the piece with increased dimensions for shrinking, core and angled sides (model),
- defining the gating system,
- designing the casting pattern tool,
- manufacturing the casting pattern tool,
- tool testing and correcting.

Concerning the market requirements, the need for smaller series of castings of different shapes, thus greater foundry flexibility, the time for the beginning of production should be as short as possible, meaning that the casting model should be produced and mounted on the casting tool as soon as possible. Tools and castings mentioned in this paper are manufactured in the producer's foundry [1].

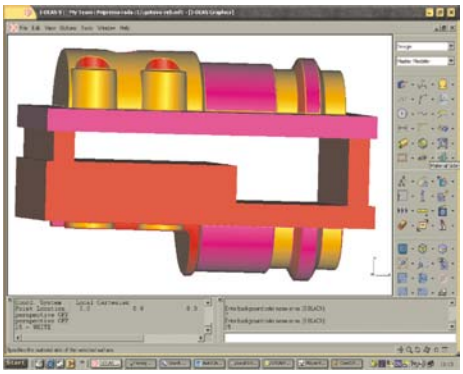

Figure 1: 3D model – CAD

2. MASTER PATTERN 3D PRINTING

Modern CAD software enables fast and precise design of 3D models. Next figure shows one such 3D model. It is a model of product marked as T0 0791, made of ductile iron (GGG 50), being a part of railway overhead equipment, made for buyer [2]. After casting, the casting piece is then machined and hot dip galvanized. Because of complicated geometry of the casting piece and the estimate that it would take a lot of time to make a casting model the conventional way, 3D model has been designed using I-Deas Master Series v. 9, property of [3].

Two halfs of the model for the mentioned casting tool are shown on Figure 1. Those halfs are joined for simplier and cheaper model manufacturing.

3D model could be used then as input for CAM software on which the software defines the paths for CNC machine tool path, as well as the tool type. This paper does not describe that procedure – the 3D model was used as input for the software of company [4] in order to make the model with 3D printer. Thanks to the company [5], which was the representative firm of company [4] for the SE Europe, it was possible to make the model free of charge, based on the model's 3D drawing, which was sent in .STL format over the Internet. It is important to emphasize that 3D printer works in a completely different way than CNC machine, because the object is built using layer-by-layer system, rather than chipping the material off, as the CNC machines do. On the next figure, there is a photograph of a model (master pattern) made on 3D printer.

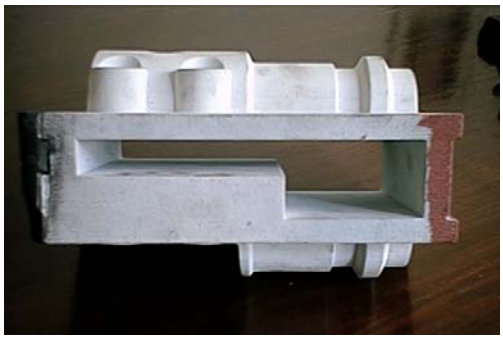

Figure 2: 3D model – 3D printer

The 3D model (master pattern) was made on Z™310 printer, produced by company [4]. Dimensions are: 151 x 237 x 135 mm, surface area: 2059,55 cm^2, volume: 2071,6 cm^3. The model was built in 6 hours, not including the machine setting (human work) for 1 hour. The material used for this model was monochrome ZCast 500, with the commercial price of 3D model manufacturing totaling at 420,00 EUR. It is a very light and fragile material, obviously powder based. The level of form detail complies with the requirements for a casting tool.

Figure 3: The casting model's negative – 2 halfs

After getting the 3D model (master pattern), the casting model's negative was made. It was made using liquid plastics. The model's negative halfs are shown on Figure 3. A couple of tests showed that plastics firmly sticks to the master pattern's material, so it was necessary to cover the master pattern with basic nitro dye first, to make sure it won't stick to the plastics. After the plastic hardened firmly around 3D model, it was still not possible to separate the model from the negative without damaging the 3D model (master pattern), so the 3D model was ruined. The negative, however, remained intact.

Filling the negative with liquid plastic, it is possible to make more plastic casting models (positives) for mounting on the casting tool. The next figure shows the two halfs of the model's positive.

Figure 4: Two halfs of the model's positive

These two halfs were mounted on pattern plates, as shown on the next figure.

Figure 5: The model on pattern plate

In order to speed up the making of test pieces, the model's positive was monted on an improvised pattern plate, made for manual mould forming, and gate system was cut into the mould sand. After forming the mould and casting, a product's test sample was made, which was then machined and hot dip galvanized. The product's appearance is shown on Figure 6.

Figure 6: Final cast product

3. CONCLUSION

This paper shows all the stages in manufacturing the tools for metal sand casting. 3D design is the first stage of the tool making process. RP procedure using 3D printers proved to be faster and cheaper than using CNC machines. The precision of model manufacturing on 3D printers complies with the requirements of casting tool standards. The 3D printer was chosen to create the 3D model (master pattern's positive), because of the fragile material used to make the 3D model. Liquid plastic showed to have an abrasive effect on the mentioned material, so it is not possible to fill it with plastic more than once. This way of producing cast models represents significant progress in RP process of manufacturing, decreasing costs of production and increasing productivity.

[1] Foundry "Novi život", Zenica, Bosnia and Herzegovina
[2] Company "Rebosio", Lecco, Italy
[3] University in Sarajevo, Mechanical faculty in Zenica
[4] Company "Z-Corp", Burlington, Australia
[5] Company "MSM Trading AG", Zurich, Swiss