



Application of layer deposition manufacturing in the manufacture of centrifugal water pump blade master molds for aluminum casting process

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ABSTRACT

The mold master is a product that is used as a reference for making mold models. The mold master can also be said to be an original sample of a product to be developed. The goal to be achieved from this research is to apply the Layer Deposition Manufacturing (LDM) method for the development of small and medium industries in order to be able to make mold masters that are more complex in shape, especially for making centrifugal water pump mold master molds for the aluminum casting process. print master by utilizing CAD, then cutting the master per layer according to the product area boundaries, after being cut the data for each layer is saved to a file to be printed, the print results are pasted on the Win layer, then the pattern is cut using a pattern cutting machine, after the layer pattern is formed then the pouring of the material in the form of solid, liquid, powder is carried out in a controlled manner layer by layer until it is as high as the desired product. The application of the LDM method for the manufacture of mold masters in the aluminum casting industry is an alternative method which is easy and fast to manufacture. The advantages of LDM are that it can create hollow products, can experiment with physical objects with a high level of complexity, can optimize product design to meet customer demands. Meanwhile, the disadvantages of LDM are that the size produced is less precise, it requires a lot of material support, it cannot make thin products. The LDM method can be used to make mold masters, especially for centrifugal water pump blade mold masters, both simple and complex shapes.

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1. INTRODUCTION

The mold master is a product that is used as a reference for making mold models. In the aluminum casting industry for small and medium scale molds are made using materials from wood. The manufacturing process is done manually, that is, the wood material is carved little by little and then finished to form the product as desired. This wood carving method still has drawbacks including

requiring quite a long time, unable to make complex product models, and unable to make precise product sizes.

After conducting research and studying reference studies, this woodcarving method was felt to be less effective and efficient, because the master mold could only be made by a carver. The research was carried out by reference studies with the aim of finding alternative methods in making master molds. Several methods that are well known in Rapid Prototyping technology are Stereo Lithography (SLA), Laminated Object Manufacture (LOM), Selective Laser Sintering (SLS), Fused Deption Modeling (FDM), Solid Ground Curing (SGC), 3dInk Jet Printing. In this research on Rapid Prototypes, a new method was found that can be used for making prototypes, namely the Layer Deposition Manufacturing (LDM) method. Layer Deposition Manufacturing (LDM) is a method that can be used to make products with multiple layers. Where the manufacture of a product is divided into several layers which are then printed layer by layer so that it becomes a product. In previous research the Layer method.

Deposition Manufacturing is used to make simple layer products. Based on the reasons above, a new alternative is obtained to use the Layer Deposition Manufacturing method as an alternative step in making centrifugal water pump blade master molds. a tool to pump water from below so that it rises upwards with the help of a diesel engine. The application of the Layer Deposition Manufacturing (LDM) method to the aluminum casting industry is felt to be the most practical, economical and efficient method compared to using the wood carving method.

2. RESEARCH METHOD

The steps involved in making a centrifugal water pump blade mold master can be seen in Figure 3.1.

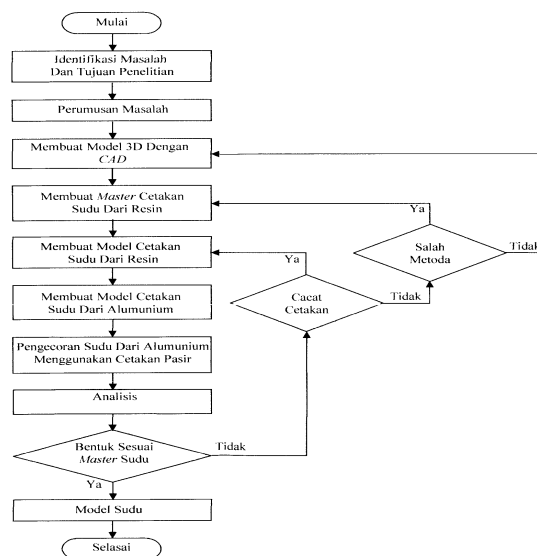


Image 1.Research flow chart

In conducting this research there are steps that must be carried out starting from making the design, the process of cutting each layer, making the mold master, making product molds to making the finished product. The manufacturing process is carried out using the Layer Deposition Manufacturing (LDM) method.

2.1 Design Using CAD

The first design is to make a master mold for centrifugal water pump blades using CAD. CAD is a special tool that is able to make it easy for users to design a product, both from simple shapes to complex shapes. The prototype design that will be carried out is to make a master mold for

centrifugal air pump blades with a height of 75 mm and a diameter of 200 mm. The master mold for centrifugal water pump blades was made using CAD in 3-dimensional solid form.

3. RESULTS AND DISCUSSIONS

To be able to find out the factors that influence the master model, mold model, and product results of centrifugal water pump blades. So it is necessary to analyze the process of making master molds, master cutting for molds in sand, and aluminum casting process strategies.

3.1. Layer Printing Machine Analysis

The layer printing machine is made of glass with A4 paper size, namely, length 297 mm, width 210 mm, then the thickness of the glass is 10 mm. The thickness of the glass is made thick so that during the process of pouring hot wax the glass does not break easily. To unite the glass series using the bolts between the left and right sides.

3.2. Pattern Forming Machine Analysis

The pattern forming machine is used to cut the wax layer that has already been drawn with a pattern. The machine is installed at the bottom of a table then the center of the table is given a hole for the drill bit. The working system is, the wax layer that has been drawn with a pattern is placed on the table, then the layer is moved directly by hand so that the drill bit will cut the layer according to the pattern image made. Pattern forming machine, can be seen in the picture.

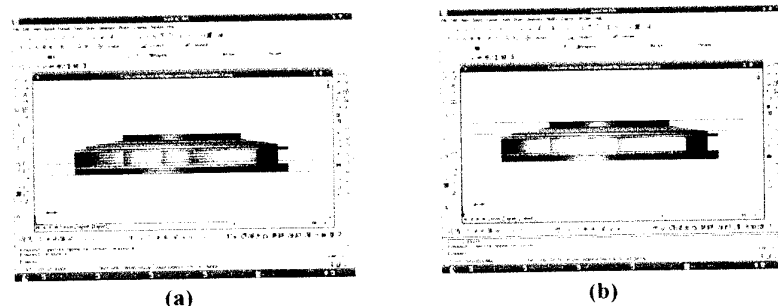


Figure 2. Pattern forming machine

Figure (a) shows a table frame made of wood which is used to seat the pattern forming machine so that the machine does not move. Figure (b) shows a drill bit model that has been installed on a table so that the drill bit can rotate in the center.

3.3 Master Per Layer Cutting

In the Layer Deposition Manufacturing method, the process of dividing patterns per layer only uses cutting areas that are multiplied according to the length of the 3D model to be made and the spacing is set as desired, for example: 5 mm, 10 mm, 15 mm. Layer cutting can be done with the same thickness, for example 5 mm all. This cutting process will show the connection between one layer and another, so the finishing stage is still needed. To simplify the manufacturing process and get good results, the cuts are adjusted to the boundaries of the product area. Thus the boundaries between one layer and another layer are not visible so that the resulting product will be neat. Master perlayer cutting, can be seen in the following figure:

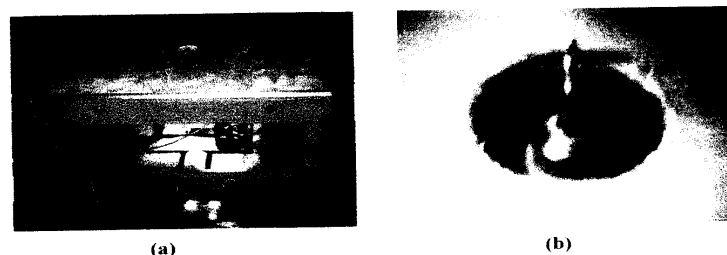


Figure (a) shows the cutting of the model with the same spacing of 5 mm. Figure (b) shows a cut with a distance according to the product area boundary. The Layer Deposition Manufacturing method in model cutting can be done vertically or horizontally according to the level of complexity of the product model to be made.

3.4 Pattern Making Process Analysis

To be able to find out the results of layer prints made by machining using either a pattern machine or a cutting knife, it is necessary to analyze the data obtained during the test. The data obtained is in the form of results from the machining process. The results of machining will be compared with the results of the design to find out whether there are similarities between the data during design in CAD and the results obtained during machining.

a. Using the Pattern Machine

The purpose of cutting layers with this machine is to get perpendicular cuts so that when the material is poured the resulting product will be straight. Cutting using this machine results are not immediately smooth, so it needs to be finished using a cutter. This machine is capable of cutting both thin and thick layers, all you have to do is change the drill bit according to the thickness of the layer to be cut.

b. Using a Cutting Knife (Cutter)

The purpose of cutting layers with this cutting knife is to get slanted cuts so that when the material is poured the resulting product will be slanted. Cutting using this cutting knife results can be immediately smooth so there is no need for finishing. Cutting with a cutting knife is capable of making slopes for both thin and thick layers, because in essence this manual method is very easy in practice, it only requires tenacity and skill in making products, especially each layer.

3.5 Analysis of Making Master Mold Blades From Resin

The mold master is created first before the manufacture of the product mold model. The basic material for the master mold for centrifugal water pump blades uses resin. In this way, the resin which was originally in liquid form was then mixed with catalytics as a hardener, after being mixed it was put into the layer that had been formed in the previous pattern. In making the layer pattern, the shape must resemble the original centrifugal water pump blade. Because the manufacturing process is manual, the size of the layer pattern is enlarged from the actual centrifugal water pump blade. This is so that when reducing the material in the finishing stage, the resulting product can be the size you want.

3.6 Discussion

a. Discussion of Master Blade Molds From Resin

After the manufacture of the master blade mold from resin is complete, a measurement is carried out which aims to determine the size of the mold master before pouring the material. Measurements were made using a caliper with an accuracy of 0.05 mm.

b. Discussion of Product Mold Model Design

The purpose of mold design is to produce a large number of products and the shape and size can be uniform. The mold model is the same as the mold master model, only separated into three parts, namely, lid, blade, and base as can be seen in the picture:

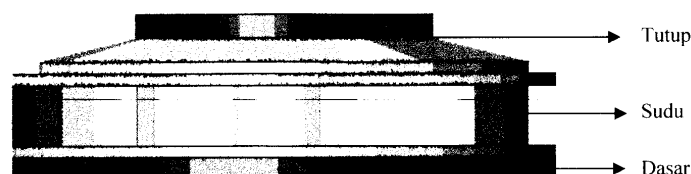


Figure 4. Mold cut

Separation of the mold into three parts is to make it easier to form mold patterns in the sand. Sand is a high heat resistant material so it is very good for aluminum casting moulds. The mold size is made larger than the mold master. This is intended to anticipate material shrinkage when casting aluminum. Product mold model design,

c. Discussion of Making a Close Mold Model

The purpose of making a centrifugal water pump blade cover is to facilitate the process of making mold patterns in sand for aluminum casting. The process for working on this cover is the same as for making a mold master using the Layer Deposition Manufacturing (LDM) method. The material used is resin mixed with catalytic as a hardener, then inserted into the layer that has been formed by the previous mold pattern. Schematic of the steps for making product molds, can be seen in the following figure:

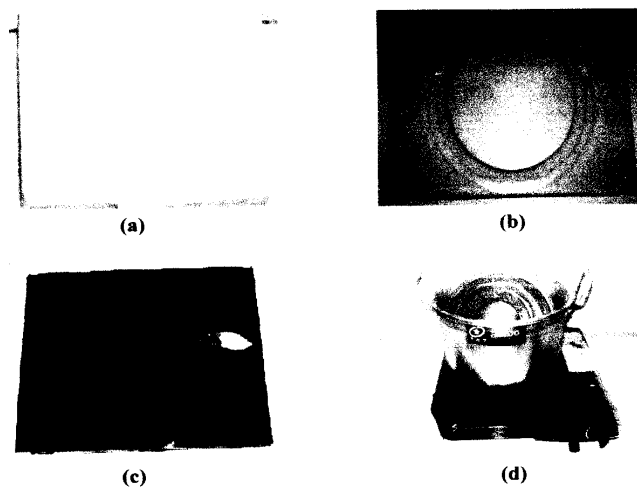


Figure 6. Lid mold manufacturing process

Figure (a) shows that the base is given a plain/glass layer so that the resulting product on the bottom is flat. Figure (b) shows the composing of the next layer that has been formed by the previous pattern until the last layer. Figure (c) shows the process of pouring the resin material through the top which has prepared a hole for pouring the material. Figure (d) shows the lid mold being boiled in hot water which serves to dissolve the wax that is still attached to the lid mold.

4. CONCLUSION

In LDM technology, the process of forming products or forms is carried out by adding material little by little in a controlled manner until it is as high as the product or forms to be made. The LDM method can be used to make master molds for centrifugal water pump blades for the aluminum casting process. It is proven that centrifugal water pump blade masters, both simple and complex shapes, can be made using this method. The application of the LDM method to the aluminum casting industry for small and medium scale is a practical alternative because the time required to manufacture the product is relatively short. In practice, the process of making products or various things is done manually, it only takes skill and tenacity of ordinary hands. So that,

REFERENCES

- Griffith. M. 1998. Rapid Prototyping Technologies. Rapid Prototyping. liUI[^]vv[^]wjiiie[^]su[^]
 Johnson. 2003. AutoCAD 2002 application for Mechanical Engineering. Jakarta, PT Elex Media Komputindo.

- Prinz. FB 1994. Novel Applications and Implementations of Shape Deposition Manufacturing. Mechanical Engineering, Carnegie Mellon University
<http://www.cmu.edu/~engr/shape/shape.htm>
- Surdia and Shinroku. 1999. Engineering Materials Knowledge. Jakarta, Pradnya Paramita.
- Tontowi. 2004. Lecture Layer Manufacturing. Majoring in mechanical engineering. Faculty of Engineering. Gadjah Mada University.
- Weiss. LE 1997. Panel Report on Rapid Prototyping in Europe and Japan. JTEC/WTEC SFF Processes