

Ceramic Shell Molds for Sculptural Castings

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ABSTRACT

The research for the process of ceramic shell mold making was done by first studying the ceramic shell method and then comparing and contrasting it with other methods I have used: resin-bonded-sand and traditional investment. The results showed both the advantages and disadvantages of the shell method as compared with the other mold making techniques. Differences in size and weight, time of creation, and the outcome of the final casting were all factors that were considered when figuring the results for this research project.

INTRODUCTION

Metal casting has been used for centuries to produce many items that can be useful and aesthetically pleasing and interesting. There are many different ways to create a casting, but they all involve the same basic principles. First, an original pattern is created. This is the form that will later be cast in metal. It is usually created in wax or some other moldable material. Next, a mold is made around this pattern. This mold is made of materials that will not only be able to capture the detail of the original pattern, but will also be able to withstand the heat and pressure of the molten metal. Once the mold is completed, the original pattern is removed and a negative impression is left. Molten metal is then poured in, filling the impression left by the original pattern. Once the metal has cooled, the mold can be opened, and the final casting can be removed.

Different techniques are used to create metal castings. I researched the ceramic shell mold making method in order to compare it with the other methods I have used (resin-bonded-sand and traditional investment). Each method has the ability to capture a different amount of detail in the final casting. Also the time and work in making the mold and cleaning the casting after it has been poured vary between the different mold types. I researched the method of ceramic shell mold making to determine if it was a superior method than the others I have used.

METHODS

The first method I learned was resin-bonded-sand. In this method, a pattern is taken and a mold is created out of silica sand and sodium silicate, a resin that hardens the sand and allows it to retain a shape. Sand molds are often done in two or more parts so that the mold can be opened in order to remove the pattern. Once the pattern is removed, channels for pouring metal and venting gasses, called sprues, are carved into the hardened sand. The sand mold is then bound back together, and the metal is poured in. The sand mold took about two days to make and weighed approximately 55 lbs.

The next mold method I learned was traditional investment. This method involves a wax pattern with the sprues for pouring and venting created in wax and attached to the pattern. A

one piece, cylindrical mold is made around the pattern out of plaster and silica sand. Since it is a one piece mold and cannot be taken apart, the wax pattern must be burnt out of the mold. This is done by placing the mold in a special kiln upside down. This gets rid of both the wax and any moisture that may be left in the mold. Once the mold is cleaned out, it must then be removed from the kiln and immediately poured into. If the mold is not hot when the molten metal is poured into it, thermal shock will occur, causing miscasting and a potential for danger towards the people pouring, due to metal being spit back. Because of thermal shock, metals that have a high melting point, such as iron, cannot be poured into investment molds. The investment mold, used on the same pattern as was used for the sand mold took about a half hour to make. However, the burnout took three days. The final mold weighed approximately 120 lbs.

The ceramic shell method is similar to the traditional investment method. A wax pattern is created with a sprue system attached to it. A one-piece mold is created around the pattern, which must then be melted out of the mold. However, there are several differences. One is the makeup of the mold. Ceramic shell molds are made from slurry and stucco. The slurry is a liquid binder, which is silicon dioxide (SiO_2) particles suspended in water. These materials allow the mold to withstand great amounts of heat and pressure, so thermal shock is not as big of a concern as in traditional investment. Also, this type of mold allows gasses to vent through its sides, so the sprue system is less intricate than the one used in investment molds. The shell also takes longer to make. The pattern is dipped in the slurry, and then the stucco sand is applied. Now the piece has to dry, which takes 12 to 24 hours. Once it has completely dried, another layer is applied. This is done until approximately eight layers have been built up. This takes about eight days to complete. Once the mold is completely built up. The wax pattern is burnt out. This takes less than an hour, a significantly less amount of time than the three days to burn out the investment mold. Another difference is the size and weight of the mold. The shell mold of the same pattern used for both the sand and investment molds only weighed 2.5 lbs., considerably less than either of the others.

RESULTS

I made eleven castings during my research. Since I had worked with resin-bonded-sand and traditional investment in the past, I only made one of each for this project. I had varied results with the nine shell molds I had made.

One of the first things I learned was that the slurry had to be maintained. It had to constantly be mixed and the amount of moisture had to be constant. I hadn't properly maintained the slurry and evaporation took place. This caused the interiors of one of the shell molds to weaken and the final casting's surface had a chipped or broken texture. Another problem I faced was proper venting. Even though the shell mold allows gasses to vent out through its sides, it still needs an adequate amount of venting with the sprues. About three of my molds had gasses trapped in them, and the metal didn't fill the patterns completely. These are problems that cannot usually be detected prior to pouring, so they are discovered after the piece has been cast.

The successes I had with the shell method were great. The sprue systems were less intricate, and therefore they required less time and effort to remove and clean up than the investment mold. Also there was less flashing in the shell than in the sand and investment molds. Flashing is when molten metal fills into tiny cracks along the surface of the mold's interior pattern. The flashing has to be chiseled off of the casting and is slightly detectable in

the final piece. On the shell casting, there was almost no flashing at all. There was also a greater amount of detail in the final castings. The surface texture of the metal is as smooth or textured as it was in the original wax pattern. Because of the placement of the complex sprue system in the investment mold, some details and surface textures were lost. The sand mold captured less detail due to the sand grains that make up the mold. The final casting has a slightly sand like texture to it. But the shell mold's liquid slurry allows it to fill in and capture the tiny details that other methods can't.

CONCLUSIONS

I feel that this research has allowed me to broaden my knowledge base in the technical field of sculpture. I am now able to easily choose the method of mold making that better fits my purposes. The ceramic shell method of mold making, once understood, is a highly effective way to create metal castings. Still, like resin-bonded-sand and traditional investment, problems can and will occur. But in terms of weight of the mold, resistance to heat and pressure, and detail in the final casting, I see the ceramic shell as a slightly superior method than the other two I have used. But matters of time and available materials make the other methods necessary and useful as well. My research has also introduced the ceramic shell method to the advanced sculpture class here on the UW-La Crosse campus. It has returned mostly successful results and will most likely be used by both the advanced class and me in the future.

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