Manufacturing a Vertically Mounted Sandcast Plaque for The Greenbush Cemetery

This senior design project through the Purdue EPICS Program is dedicated to remembering Colonel William B. Carroll, a Union soldier who died at the Battle of Chickamauga. By manufacturing a plaque that details his contributions to the Civil War and to the City of Lafayette, the EPICS team backed by Purdue’s School of Materials Engineering can honor his legacy and his impact on Lafayette’s community.

Project Background

Greenbush Cemetery is one of the oldest garden cemeteries in Tippecanoe County and is the final resting place of terms of Lafayette’s finest citizens as well as U.S. senators, abolitionists, and Civil War soldiers, including Colonel William B. Carroll.

There are two community partners involved with this project. Monica Casarino, who is the Fairview Township Trustee, is the lead man’s point of contact for details involving approving design decisions. John Collier, who is the Assistant Director of the City of Lafayette’s Economic Development Department, acted as a representative for the project during the transition between the previous Fairfield Township Trustees and Monica Casarino’s election.

Past Work

Some EPICS teams have gotten the historical content to be displayed on the plaque approved by the Historical Preservation Committee. A past team laser engraved a sheet of acrylic in Spring 2022 to be used as the pattern for the sandcasting mold.

Materials

The materials for casting this plaque are cutout pieces of 3104-aluminum donated by Logan Aluminum. The plaque is 3050 aluminum alloy.

The 3104-aluminum alloy is not meant for sand casting, as it is a wrought alloy. Although sand casting is normally done with aluminum alloys of the 300 series due to silicon being one of the primary alloying elements and increasing their castability, it is not possible to produce a plaque of the intended quality using the 3104-aluminum alloy.

Results

Sanding Casting

The process for sand casting was not properly followed. A draft angle was not included in the original pattern for the sand casting mold. No draft angle was used for the final casting, and the mold was not properly cleaned before casting. This caused the quality of the plaque to be lacking the quality of a deliverable product.

Heating and Preparation in Casting

The sand casting was performed with the help of Purdue EPICS. The sand was heated in a 500°F furnace, the plaque was then heated up to 1000°F, and it was placed on a heat proof table. The plaque was then casted in aluminum. The casting was then allowed to cool before being removed from the mold.

Press Fit studs

Press fit studs were installed in coupons cut from failed castings. The press fit studs were used to assemble the plaque. The plaque was assembled with the press fit studs using JB Weld reinforcement. The JB Weld reinforcement was used to ensure that the press fit studs were secure.

Finite Element Analysis

One version of the model was designed using a 1.5 in 80/20 aluminum post for the post and a 1.5 in 3104-aluminum post for the plaque. This version was designed using Finite Element Analysis (FEA) to determine the deflection of the plaque.

The second finite element analysis was designed using 3104-aluminum post for the post and 80/20 aluminum plaque. This version was designed using Finite Element Analysis (FEA) to determine the deflection of the plaque.

Note: Both finite element analyses were performed with a 10 mph wind blowing perpendicular to the plaque.

Assembly and Installation

After the plaque was manufactured, it was attached to the back plate using JB Weld reinforcement. The plaque was attached to the back plate with neoprene inserts. The plaque was then attached to the back plate using JB Weld reinforcement.

Discussion

Notes on Iterations During the Sandcasting Process

First Casting

The first casting was the first attempt at casting the plaque. The first attempt at casting the plaque failed due to the lack of draft angle and the lack of cleaning the mold before casting.

Second Casting

The second casting was improved by adding a draft angle to the mold and cleaning the mold before casting.

Third Casting

The third casting was improved by adding a draft angle to the mold and cleaning the mold before casting.

Fourth Casting

The fourth casting was improved by adding a draft angle to the mold and cleaning the mold before casting.

Fifth and Final Casting

The fifth and final casting was improved by adding a draft angle to the mold and cleaning the mold before casting.

Final Element Analysis

Based on the information received from the finite element analysis, the 1.5 in 80/20 aluminum post was well suited for use as the post holding up the vertically mounted plaque. The plaque casted in 80/20 aluminum performed well under this stress test. However, the 80/20 plaque did not perform as well as the 3104-aluminum plaque.

Conclusion

The EPICS Program has plans to work with other community partners to design and manufacture similar plaques, and this senior design project and EPICS Team obtained necessary information for future teams to apply and obtain similar quality results from the casting process.

Recommendations for Future Senior Design Students Working on Manufacturing Sandcast Plaques Through EPICS on Future EPICS Teams

It is unknown how much more difficult the production of the plaque was. However, the production of the plaque was challenging due to the high coefficient of thermal expansion of the aluminum, which caused the quality of the plaque to be lacking the quality of a deliverable product.

This project was a learning experience for the EPICS teams involved in the casting process. The project provided an opportunity for students to learn about the challenges and limitations of working with aluminum and to develop solutions to overcome those challenges.

MSE Senior Design

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This work is partnered with Fairfield Township through the help of Purdue EPICS.