Ablation Casting Evaluation for High Volume Structural Castings

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USAMP
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Project ID #
LM055

Overview

Timeline

- Start: Dec 2010
- End: June 2012
- Completed

Budget

- Total project funding
  - DOE = $551K
  - Contractor share = $551K
- Funding received in FY11
  - $437K
- Funding for FY12
  - $27K

VT Program Barriers Addressed

- Manufacturing - Demonstrate the ability to produce a quantity of parts in a stable process
- Performance – Demonstrate ability to cast high strength alloys.
- Cost – Identify cost differences compared with precision sand casting.

Partners

- Project lead: USAMP
- Participants: Ford, GM, Chrysler, Alotech and Mercury Marine

History

- The Ablation Casting Process is basically a sand casting process that utilizes a water soluble binder system that allows the mold to be washed away by water sprays as the part solidifies. This produces very high temperature gradients and short solidification times which are highly desirable.

Figure 1: Ablation of Mold in Progress

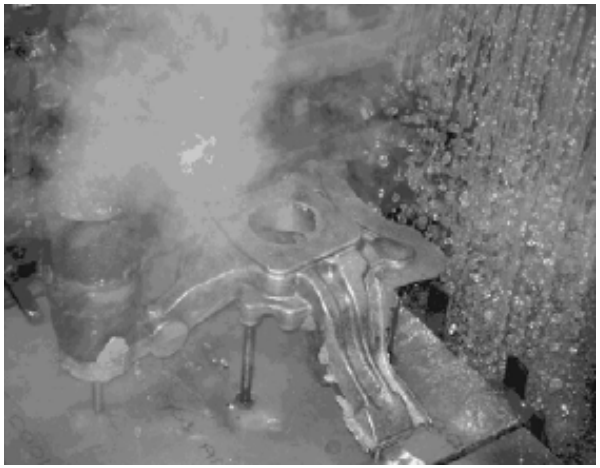


Figure 2: Ablation Complete

- The Ablation process has demonstrated the capability to cast complex shapes with higher integrity and significantly better mechanical properties than conventional casting processes during low volume experimental runs in both AMD 405 (B206 aluminum alloy development for suspension components) and AMD 601 (High Integrity Magnesium Automotive Component Project.

Relevance

Objectives of this Study

Demonstrate the ability to produce a quantity of parts in a stable process with consistent high quality.
(VT Barriers = Manufacturing and Performance)

Define all the unique process steps for this process and their associated costs (or savings) compared to a conventional sand casting.
(VT Barriers = Cost and Manufacturing)

Approach

Leverage ongoing work by Alotech and Mercury Marine on the development of a structural casting (transom bracket).

Develop and implement a process to recycle aggregate and water used in the Ablation Casting Process.

Develop and implement a “fast” binder cure process to match current high volume mold making production rates.

Conduct casting trials to define and generate process data to develop cost models. Process data included cycle times for all steps, energy usages, media loss, etc.

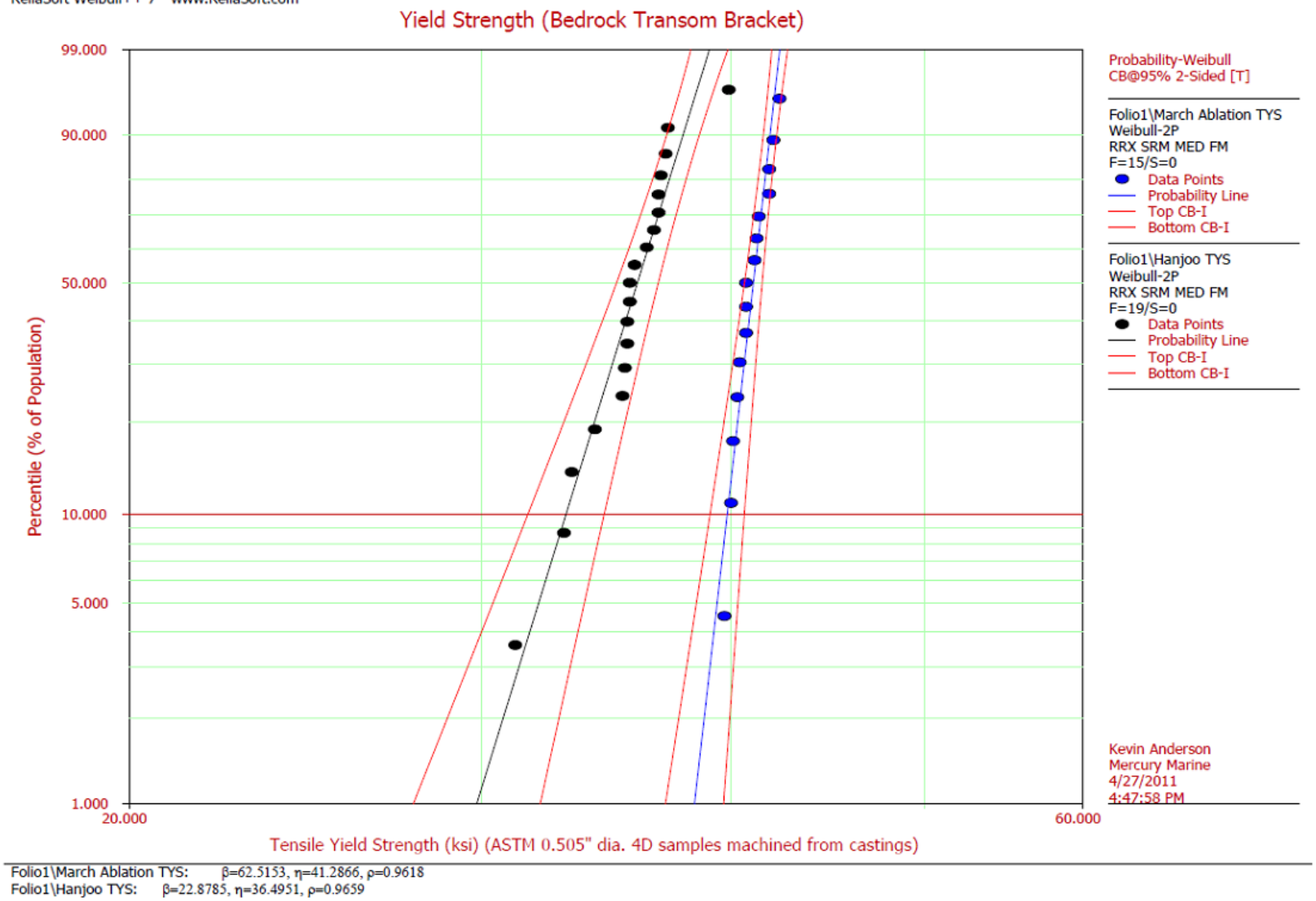
Evaluate castings by NDE and destructive testing.

Transom Bracket

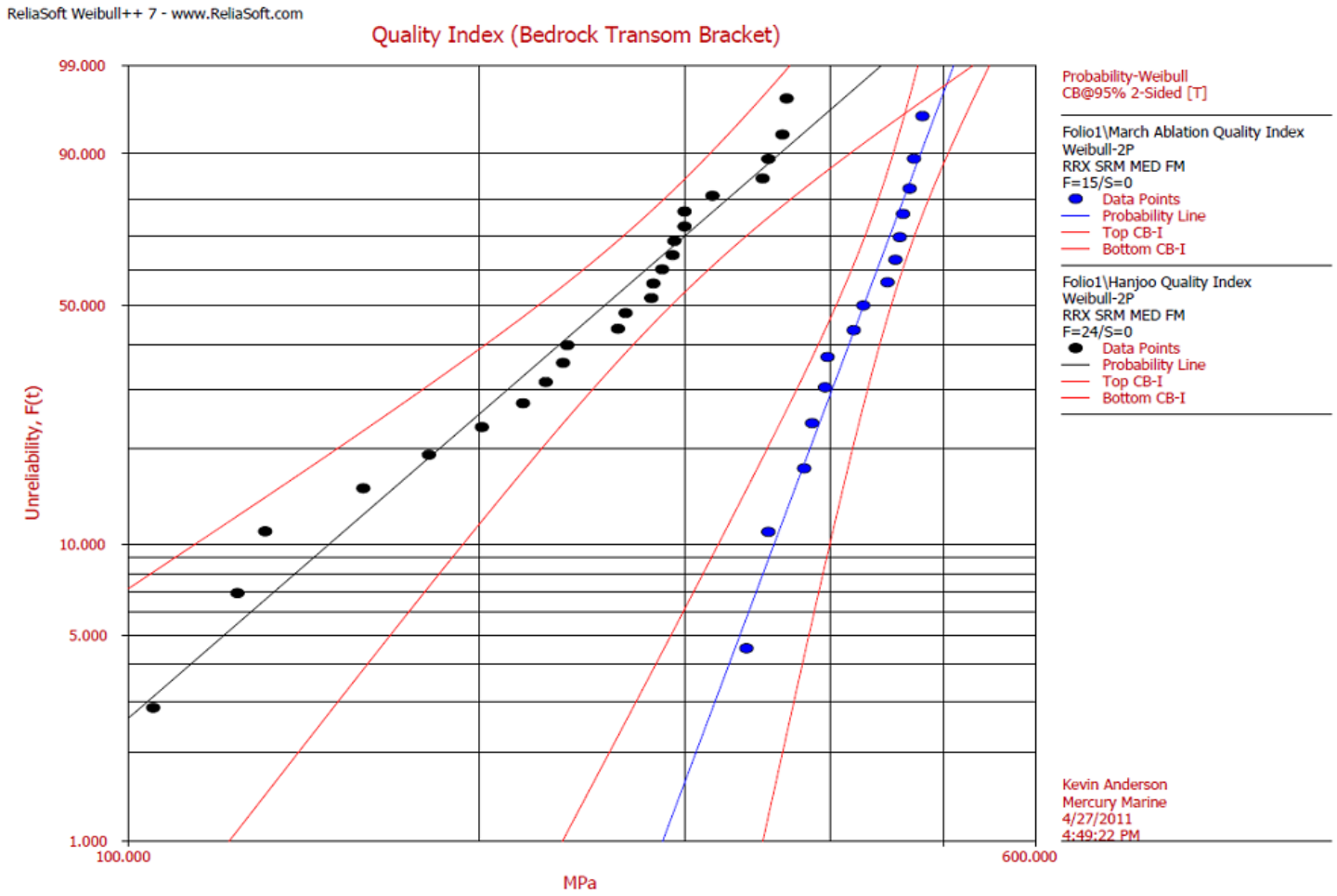
Technical Accomplishments

- **Sand Reclamation:** A system was designed where the artificial aggregate is reclaimed and the water is reused. This system is a totally "*green system*" by the environmental standards.
- **Mold Making (Core Blowing):** A process was developed to produce a core in 35 seconds using a conventional core blower.
- **Production Rate Validation:** Production runs were completed to the satisfaction of Mercury Marine and the OEMS. Ablation cycle times are controlled the by part thickness. The Transom bracket is very thick---and requires about 180 seconds to ablate.
- **Development of Cost Model:** The preliminary cost model has been reviewed by the OEMs and the project participants. The final version of the cost model will be included in the project's Final Report.
- **Final Report**: The Final Report preparation is in progress.

Comparison of 6061-T6 Ablation to A356.2-T6 Permanent Mold – Yield Strength



Comparison of 6061-T6 Ablation to A356.2-T6 Permanent Mold – Quality Index



This slide illustrates the advantages of the Ablative Casting Process over permanent mold: better consistency and higher properties due to lower porosity and the ability to cast “difficult” alloy compositions.

Collaboration and Coordination with Other Institutions

Alotech Ltd. LLC - Owners of the Ablative Casting IP
Mercury Marine – Design and Evaluation of Process and Parts.
American Foundry Society – Technology transfer and consulting.
Bright Automotive Industries – Material testing
Casting Technologies Company – Non-destructive evaluation
Chrysler Group LLC
Eck Industries – Heat treatment and destructive testing.
EKK Inc. – Casting process computer simulations
Ford Motor Company
General Aluminum Manufacturing Company – Foundry interested in technology
General Motors LLC
Georg Fisher Automotive – Casting characterization and interested in technology
Manufacturing Services & Development Inc – Project Administration
Finn Pattern - Tooling
Rio Tinto Alcan – Material supplier and material characterization

APPLICATION OF TECHNOLOGY

Mercury Marine Transom Bracket Cast by the Ablation Process

Application
This bracket is the structural attachment between the engine and boat.

Critical Safety Application applies to the use of this engine bracket for All Watercraft—especially High Power Off Shore Watercraft.

Proposed Future Work

This project has essentially ended. Only Final Report Preparation and invoicing for Supplier In-Kind are still in progress

There is no plan to propose further work. The state of the technology is such that the next level of effort will probably be directly related to component development, which may not be pre-competitive.

Summary

The project determined that there are no technical barriers to the implementation of Ablative Casting for high volume production.

Since this process uses inorganic molding media binders and reuses the molding media, it is also very environmentally friendly, an extra benefit.

The cost model developed in this project will allow potential automotive OEMs and suppliers to make informed decisions, based on their individual business situation, regarding adopting this process for their manufacturing needs.