REMADE INSTITUTE

LOW-HEAT REPAIR OF CAST IRON

A new approach creates a robust weld without the high temperatures that commonly lead to warping.

Relatively low-cost and easy to manufacture, gray cast iron is often the material of choice for sizable products such as engine blocks, wheel hubs, and other components for a variety of industries. However, gray cast iron is not very weldable, partly because of the graphite flake microstructure that lends the material its color and name. Weld processes exist, but they lack robustness, require long processing times, incur high capital investments, and demand specialized welding skills.

That means repair options for gray cast iron are limited. A team from Rochester Institute of Technology (RIT), working with industry partner John Deere, set out to develop a robust weld repair process for gray cast iron that requires lower preheat temperatures and shortens cool down periods to less than an hour. To be commercially viable, the process also needed to consistently create a weld interface with minimal regions of high hardness and no cracks in or around the weld.

The resulting technological repair process, validated on full size John Deere components, has significant potential to make salvaging components more technically and economically feasible.

PROJECT DESCRIPTION

This project set out to develop an enhanced repair process based on a welding technique called cold metal transfer (CMT). The process involved lower preheating temperatures and post weld heat treatment steps to reduce microcracks within the weld joint, thus creating durable, leak-tight repairs. CMT does not impart high temperatures and, accordingly, shortens the cool down periods compared to typical repairs.

To confirm that the weld properties met industry requirements, the researchers used heat-affected zone mapping to evaluate fabricated weld coupons, also conducting automated hardness indentation measurements, tensile strength testing, and fatigue life analyses. The final material properties met or exceeded the target values specified by John Deere for their engine head application.

After satisfactory results were achieved on coupons, the repair process was transferred to worn-out, cracked diesel engine heads that John Deere supplied. After several iterations of weld process development, final performance verification of the weld-repaired heads was demonstrated through on-engine testing at John Deere's dynamometer lab in their remanufacturing facility.

PROJECT IMPACT

This technology application could increase the reuse of an estimated 23,000 metric tons of discarded metal components nationally that would otherwise go to scrap, saving 0.5 petajoules of energy annually. With further development, the process could be transferable to other gray cast iron components, such as engine blocks, planet carriers, pump housings, and wheel hubs in agricultural, mining, power generation, and rail applications.

PROJECT NUMBER: 19-01-RM-04

NEXT STEPS

The repair method, materials documentation, quality evaluation procedures, and research findings have been consolidated into a technology documentation package. Given the initial results, John Deere is interested in fully vetting this technology through extending testing that would include a longer full-load power profile and thermal shock events, which would be similar to worst-case engine conditions in on-vehicle applications. RIT and John Deere have been awarded a follow-on project through REMADE to perform this durability testing and transition the CMT repair method to the shop floor at John Deere's remanufacturing facility.

PROJECT PARTNERS

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PUBLICATIONS

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FOR MORE INFORMATION

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