Steel Processing Properties and Their Effect on Impact Deformation of Lightweight Steel Structures

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Executive Summary

The Partnership for New Generation Vehicles (PNGV) goal of 40% vehicle weight reduction has resulted in numerous research projects aimed at replacing steel as the main vehicle structural material. Viewed solely from a weight-to-strength perspective, steel, as employed in current vehicle designs, is clearly inferior to alternative materials. However, as soon as other important issues are brought into consideration (cost, structural performance, uniformity in properties, manufacturability, ease of application, to name just a few), there are substantial obstacles which will have to be overcome in order for other materials to became a viable alternative to steel. An alternative weight reduction methodology, demonstrated in the studies of the Ultra Light Steel Auto Body (ULSAB) Consortium, has shown that significant weight reduction is possible by holistic design improvements.

The objective of this research is to further pursue the ULSAB approach and to investigate and document the effects of advanced material processing, forming and joining techniques on ULSAB structural performance in high strain rate deformation conditions. By using computational modeling and optimization coupled with state-of-the-art equipment, we will be able to consider the variety of effects resulting from material processing and manufacturing of ULSAB structure. The final goal of the project is to accelerate the development and introduction of lightweight steel autobodies through the use of advanced computational simulations for the assessment of advanced materials processing techniques on design and performance. This project takes advantage of ongoing automotive related projects at the Oak Ridge National Laboratory (ORNL) aimed at developing vehicle models that are representative of the U.S. car and truck fleet.

The main project activities are:

- computational analysis of various ULSAB dynamic loading situations including impacts with rigid and deformable barriers and the current U.S. fleet vehicles
- development of structural finite element computer models that integrate advanced material processing into existing ULSAB designs