Quebec Chapter

The Materials Information Society

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Presentation:

Extruded Aluminum Front Rails with Enhanced Crush Response for Automotive Application

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Abstract: Vehicle manufacturers are under intense environmental regulatory pressure to lightweight their vehicle fleets by adopting new, lighter weight, high-strength materials in an effort to achieve critical efficiency gains while reducing vehicle weight. Lightweighting of the structural members, such as the front rail, crush tubes, B-pillars, etc., designed to absorb impact energy in the event of a crash, have to also confirm to regulatory crash requirements without compromising the performance of the vehicle desired by the consumer.

In this study, a technology platform is developed to design an optimized front rail that maximizes crash energy absorption characteristics. The new design is coupled with material and process development to provide a component with superior energy absorption and strength characteristics that is also sustainable commercially. An extrudable front rail geometry and an aluminum alloy are optimized for maximum crash performance while providing weight reduction and ease of fabrication using a novel non-linear optimization scheme. Finite element analysis and crystal plasticity are employed in the numerical analyses. A new extrusion profile using an easily extrudable 6xxx aluminum alloy modified to meet the strength and energy absorption characteristics predicted by design optimization program is fabricated at a commercial scale to validate the numerical predictions. Mechanical tests, microstructural analysis and dynamic sled tests of the extruded material confirm that in the T6 temper condition, the new extruded tubes are able to match the energy absorption characteristics predicted by numerical models. Furthermore, it also meets all the requirements for implementation in vehicles.

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Biography:

Kaan Inal is an Associate Professor in the Department of Mechanical and Mechatronics Engineering at the University of Waterloo, Waterloo, ON, Canada. He received his undergraduate degree in 1996 and his Ph.D. in 2001. After working as a post-doctoral fellow and research associate, Dr. Inal joined the Department of Mechanical and Mechatronics Engineering at the University of Waterloo (2006). His primary research focuses on multi-scale modeling and development of mechanism driven advanced material models. Dr. Inal has applied multiscale frameworks for several new and emerging materials to enable their applications for automotive lightweighting. He also leads a research group focusing on high performance computing (parallel computing) for "industrial scale" simulations with mechanism based constitutive models. These models are coupled with computational intelligence methods such as neural networks and genetic algorithms for simulations in the field of solid mechanics. He has co-authored more than 50 research articles and book chapters. Dr. Inal has held visiting professorship at University of Pennsylvania and Georgia Institute of Technology. He was also a visiting scientist with General Motors Canadian Regional Engineering Center (2014) where he participated in various projects on lightweighting.

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