

Lightweight Tie Rod for Heavy Trucks

Background

With the assistance and direction of the U.S. Department of Energy's Office of FreedomCAR and Vehicle Technologies, Oak Ridge National Laboratory (ORNL) is conducting research and development into lightweight materials for transportation. In Class 8 trucks, higher payloads and corresponding increases in fuel economy, on a ton-mile per gallon basis, can be achieved by replacing dense materials such as steel with strong, lightweight materials. Carbon fiber-reinforced composites are excellent candidates for this application. Carbon fibers, as the load-bearing components in these composites, offer significant weight-saving potential because of their remarkably high strength, high modulus, and low density. Higher payloads mean higher revenue, affording a modest cost premium that allows the use of somewhat more expensive materials to achieve weight reduction.

The Technology

Delphi Corporation and the National Composite Center, under subcontract with ORNL, are developing structural chassis components for Class 8 trucks using carbon fiber-reinforced composites. One of the

components under development is a tie rod for passively steerable lift axles.

The carbon fiber-reinforced tie rod tube is targeted to weigh 60% less than the conventional steel tie rod tube, while exceeding its performance at a modest cost premium. Challenges include developing a cost-effective manufacturing process and transmitting the load between

the composite tube and metal ends. A large number of subscale specimens were fabricated to test various designs and manufacturing processes. Design variables included fiber architecture and hybrid materials selection (carbon plus glass and/or metal). The specimens underwent ultimate and fatigue testing at ORNL's composite materials mechanical testing laboratory, including durability tests after exposure



to simulated chemical and thermal insults. After a design was developed that satisfied all requirements in subscale testing, full-scale specimens were fabricated and tested in buckling.

To meet the challenging cost target, an optimization model was developed that included cost as an objective function. Design studies are continuing to further reduce cost by minimizing material requirements and using less costly manufacturing techniques.

The production released tie rod tube assembly reduces vehicle mass by 11

to 13 pounds per lift axle, of which there may be up to 3 to 4 per vehicle (for example, on dump trucks and garbage trucks).

Commercialization

The composite tie rod has been commercialized on a limited basis. The first tie rods were delivered in early 2002, and to date approximately 7,000 units have been delivered for fleet testing. The first field failure occurred recently and the failed tie rod has been returned for failure analysis.



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