High Strength Weight Reduction Materials

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 lightweight material. 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.

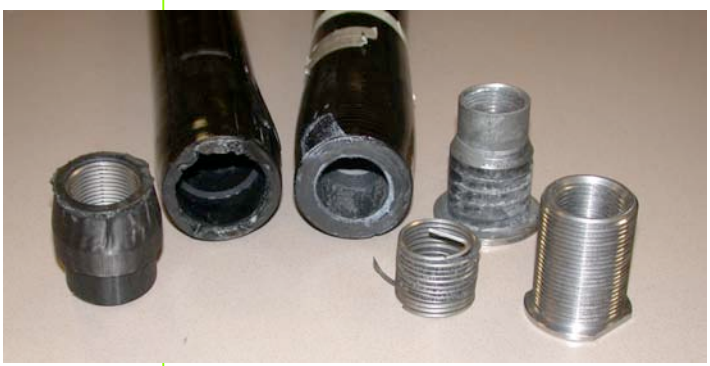
The Technology

Delphi Corporation, under contract with ORNL, is 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

Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle



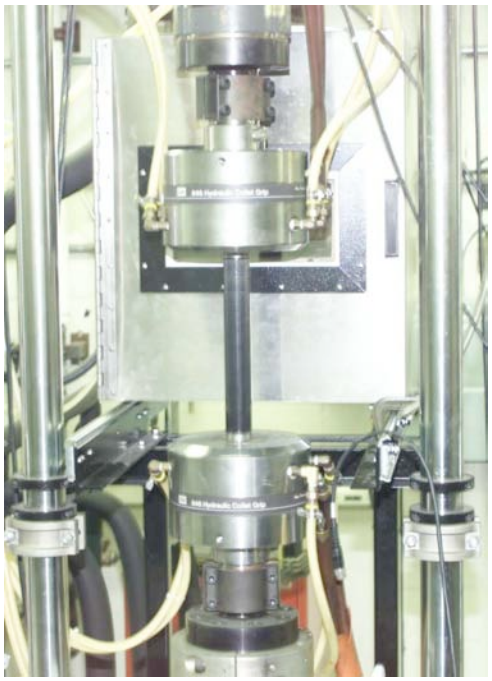
laboratory, including durability tests after exposure to simulated chemical and thermal insults. After a design was developed that satisfied all requirements in subscale testing, full-scale specimens were fabricated and tested in buckling.

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. Delphi's initial customer has accepted delivery of over 1,100 production pieces as part of its low-mass lift axle product line. Fleet test vehicle samples have been in the field for over 20 months with no problems reported.



Composite materials undergo mechanical and durability tests in ORNL's composite materials mechanical test laboratory.

Benefits

- Over 60% mass savings
- Ability to carry higher buckling loads than current steel design
- Increased natural frequency (decreased vibration)
- Improved durability
- Inherent resistance to corrosion

Where Can I Find More Information?

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