

Durability of Carbon-Fiber Composites

Lightweight Materials

Transportation

FOR THE 21ST CENTURY

U.S. DEPARTMENT OF ENERGY

ENERGY EFFICIENCY AND
RENEWABLE ENERGY PROGRAM

OAK RIDGE NATIONAL LABORATORY



Background

Widespread application of carbon-fiber composites in automotive body structures requires an understanding of the performance and durability characteristics of composites. A project at the Oak Ridge National Laboratory has developed experimentally based design criteria to assure the long-term (15-year) durability of polymeric composite automotive structures. Issues being addressed include the effects of cyclic and sustained loadings, temperature extremes, and automotive fluids on strength, stiffness, and dimensional stability. The project is coordinated with the Automotive Composites Consortium, an R&D partnership between Ford, General Motors, and DaimlerChrysler.

The Technology

A durability-based design criteria document has been published for a crossply continuous-fiber composite, which serves as a baseline reference. In addition to basic properties and short-time allowable stresses, the document includes design limits developed for long-term loadings and cyclic loadings. The document also contains guidance for assessing damage tolerance, which is defined as a measure of a structure's ability to sustain a level of damage, such as low-level impact damage or a flaw, and still safely perform its function.

More than 2300 specimens were tested to establish the design guidance for the composite. A variety of specimen designs and test types were employed. In most cases, tests were performed not only in ambient air, but in various automotive fluids and at temperatures ranging from -40°C to 120°C.

A reduced durability test program was completed for a quasi-isotropic continuous-fiber composite. A similar program is under way for 1.5-mm-thick chopped-fiber composite.

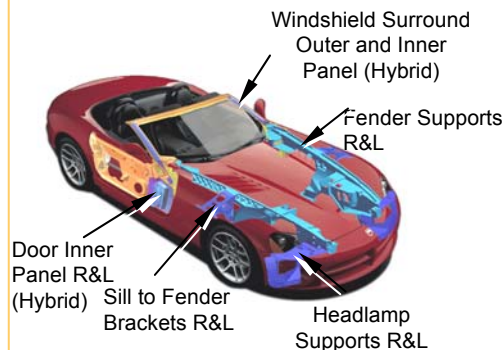
Commercialization

The durability-based design criteria document has been published and made available to DaimlerChrysler, Ford, and General Motors for their use and the use of their Tier 1 suppliers.

The research results were applied in Chrysler Group's use of carbon-fiber sheet molding compound in nine components of the 2003 Dodge Viper (shown in the illustration) to enhance structural performance and reduce vehicle weight. The left and right fender support systems are formed from six carbon-fiber molded components. Carbon fiber is also used to stiffen the Viper's windshield surround and door inner structures. According to Chrysler Group engineers, ORNL's durability research, plus its efforts to reduce the cost of producing carbon fibers, is increasing the feasibility of using carbon-fiber composites in the automotive industry.

Benefits

- Leads to increased acceptance of composites for commercial manufacturing
- Provides durability test protocol for use by companies and suppliers for characterizing and evaluating new composites
- Reduces fuel consumption because of lower vehicle mass



- Carbon Fiber SMC
- Glass SMC areas of Hybrid Panels

For more information on how DOE is helping America remain competitive in the 21st century, please contact:

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Success Story

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