Integrated Physical and Virtual Test Machine for Automotive Crashworthiness

Lightweight Materials

U.S. Department of Energy

Energy Efficiency and Renewable Energy Program

Oak Ridge National Laboratory

UT-BATTELLE

Transportation

FOR THE 21ST CENTURY

Background

Automotive manufacturers are increasingly using computer models to simulate automotive crashworthiness testing earlier in the conceptualization and design stages than is possible or practical using the traditional test methods. Computer modeling of automotive crashworthiness testing has the potential to save time and money for automobile manufacturers and suppliers. Consumers benefit from accurate modeling of crashworthiness testing because new materials and automobile models will be available to them more quickly. Physical tests of structural materials provide data needed for designers and engineers to build safer cars without expensive and time-consuming iterations of the design-build-crash test process.

The Technology

ORNL and the Automotive Composites Consortium, part of the United States Council for Automotive Materials, have successfully demonstrated the world's first integrated virtual and physical test system for high-force, high-rate crashworthiness experiments for automotive materials and structures. The Integrated Physical and Virtual Test Machine for Automotive Crashworthiness (TMAC) was installed during 2002 at the National Transportation Research Center, a DOE National User Facility. The TMAC was custom designed, engineered, and manufactured by MTS Systems Corporation of Eden Prairie, Minnesota.

The unique features of the TMAC permit controlled, progressive crush experiments, at high force levels, according to programmable velocity profiles. The TMAC provides data never before available to the scientific and automotive communities. Because it is located at a DOE National User Facility, this new capability will be available for use by automotive safety stakeholders, including automotive manufacturers, suppliers, universities, and government laboratories. Any type of structural material -- for example, metals, polymers, glazings, composites, and so forth -- can be tested in the TMAC.

The TMAC is capable of test velocities from quasi-static to greater than 8 meters per second (18 miles per hour) for coupon testing. For structures, the machine is capable of up to greater than 6 meters per second (13 miles per hour) at a mean crush force of 133 kN (30,000 pounds), and greater than 4 meters per second (9 miles per hour) at a mean crush force of 267 kN (60,000 pounds). The maximum crush distance is 250 millimeters, or 10 inches.

The TMAC incorporates a large mass (450 kilograms or 1,000 pounds) to mitigate experimental issues related to force spikes and crush force variations. It can maintain controlled velocity profiles at intermediate rates from 1 to 5 meters per second and at high force levels. It also provides an integrated virtual and physical capability that permits the system to learn and tune itself prior to a physical test, minimizing the consumption of expensive test articles.

Commercialization

The TMAC is a custom designed and engineered experimental apparatus. There are no plans to patent or commercialize the TMAC. It is available for industry, university, and government use under a DOE National User Facility Agreement.

Benefits

- Integrates virtual and physical testing of automotive structural materials
- Provides data heretofore unavailable to the scientific and automotive design and manufacturing communities
- Provides data needed for accurate crashworthiness testing and test modeling

Aluminum honeycomb specimen before and after crush. The specimen exhibited a sustained crush force of 133 kN (30,000 lbs) at a velocity of 6 meters per second.

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

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Success Story

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