Ansys

Ansys + UNL

“Sign support, luminaire support, and work zone traffic control devices are installed in an extensive array of configurations. Some recent full-scale crash tests involving sign supports resulted in windshield tearing and roof deformation of the test vehicles, which could be potential safety risks. Researchers evaluated design options for improving the crashworthiness of breakaway devices and developing new surrogate testing vehicles to accurately replicate breakaway device behavior with lower-cost components in partnership with Florida Department of Transportation and the National Cooperative Highway Research Program. LS-DYNA from Ansys, Inc. allowed us to arrive at a cost-effective solution and to have confidence that the solution will work for a wide range of systems.”

— **Dr. Joshua Steelman**
Associate Professor in Civil Engineering / UNL

CASE STUDY

Crashworthy Sign Supports Used Near Coastal Environments

Engineers in the Midwest Roadside Safety Facility (MwRSF) at the University of Nebraska-Lincoln (UNL) develop life-saving devices for use on the sides of the road to protect the occupants of impacting vehicles. Although full-scale crash testing of all roadside hardware is required to demonstrate that occupants will be safe during impacts, simulation enables the faster and less expensive evaluation of unique features of roadside devices and maximizes the probability of occupant survival and successful test performance. Simulation also enables researchers to explore impact conditions that could increase occupant risk but are difficult to test for, such as side impacts and airborne vehicles.

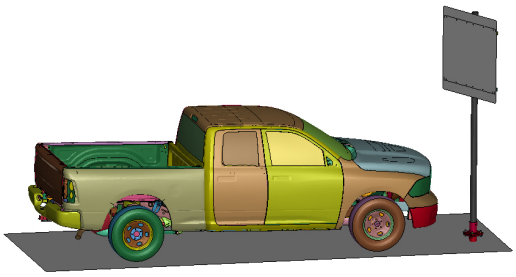

Figure 1. Computer models for slip base sign support

Challenges

Full-scale crash testing is expensive and time-consuming. Often, determination of the most critical impact conditions requires evaluation of many different combinations of parameters such as impact location, speed, and vehicle attitude. Computer simulations are a useful tool for predicting system performance during impact and making improvements before performing a crash test. Simulation software must be capable of reproducing vehicle reactions and occupant risk through nonlinear dynamics, predict fracture and plastic damage to components with multiple types of materials such as timber, steel, and aluminum, and enable researchers to perform parametric studies with different impact conditions. Visualizing simulation results and calibrating simulation data with empirical test results ensures that the best roadside safety products are evaluated in the most critical ways.

Ansys Products Used

- Ansys LS-DYNA

Engineering Solution

One example of a simulation-driven research effort includes the evaluation of safe, breakaway sign supports in combination with the Flordia Department of Transportation (DOT) to generate efficient, low-cost, and safe sign supports. Due to the corrosive sea air environment throughout Florida, aluminum sign supports are favored over steel when practical. The research team developed and calibrated sign support models that mimicked sign supports used in full-scale crash tests. Next, the research team investigated breakaway post sizes and heights, sign panel clusters comprised of various individual sign panel shapes and sizes, and cost-effective modifications such as adding masses of various sizes and at various locations to alter post-impact dynamic behavior. Each of these features affected how sign supports reacted after impact, such as the potential for the sign support to impact windshields or roofs and potentially spear into the occupant compartment. Designs were optimized to maximize safety for all road users and finalized recommendations were developed for crash testing.

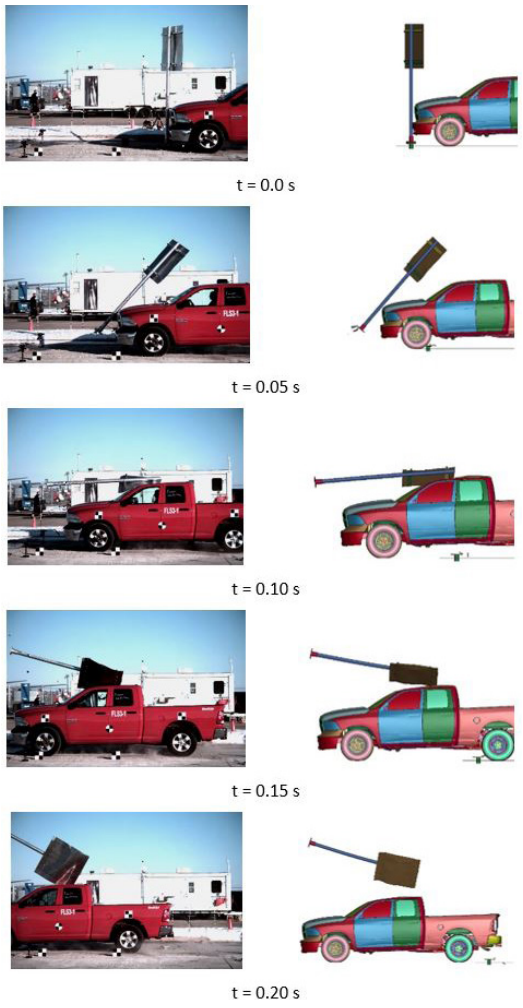

Figure 2. Comparison of baseline simulation and crash test

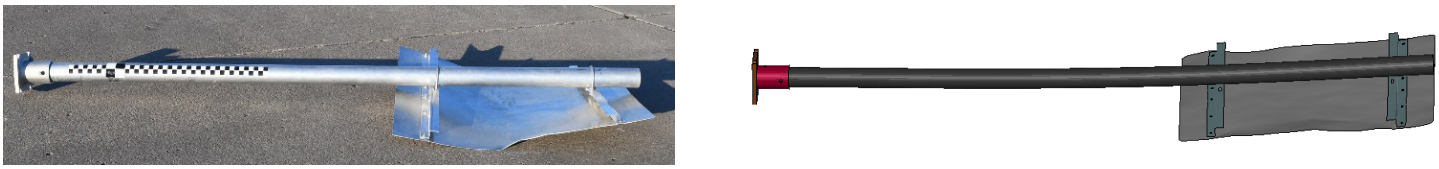

Figure 3. Comparison of tested and simulated post damage

Benefits

Computer simulation enabled the research team to evaluate many combinations of sign supports and identify which combinations would maximize occupant safety while meeting the DOT needs for information exchange, resistance to wind and weather conditions, and using low-cost, efficient construction techniques. This enabled the rapid evaluation of a large number of potential parameters and minimized the number of full-scale crash tests required to confirm the safety of the sign support design.

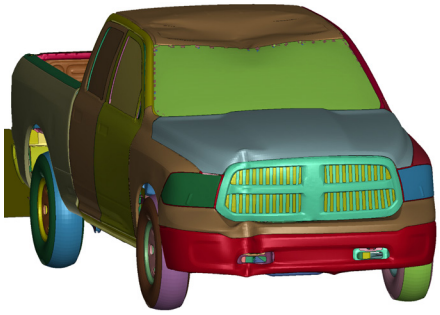

Figure 4. Comparison of tested and simulated vehicle damage for new breakaway concept

Company Description

Researchers at the UNL's MwRSF have developed crashworthy roadside hardware for 37 years. Every state in the U.S. utilizes systems developed and tested at UNL. Researchers design roadside systems, evaluate their assembly and energy absorption, perform component testing, simulate hardware reactions to predict occupant safety, and evaluate systems using full-scale crash testing. MwRSF works with state DOTs and private manufacturers to seek federal approval for these crashworthy devices that emphasize sustainable, efficient construction, minimize waste with renewable and low-cost components, and maximize safety for all road users. The research team has a combined experience of more than 100 years as experts in roadside safety and occupant protection, and perform research ranging from hardware design and testing, military facility protection, connected and autonomous vehicle safety, and high-speed motorsports safety.

The team for this project includes Joshua Steelman, Associate Professor in Civil Engineering at UNL, Chen Fang, Postdoctoral Research Associate at MwRSF, and Cody Stolle, MwRSF Assistant Director and research assistant professor at UNL.

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