Paula - Task Force

TECHNICAL SUMMARY

U.S. Department
of Transportation

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FHWA Vehicle Crash Analysis Conference Proceedings

Publication No. FHWA-RD-96-212
April 1997

Safety

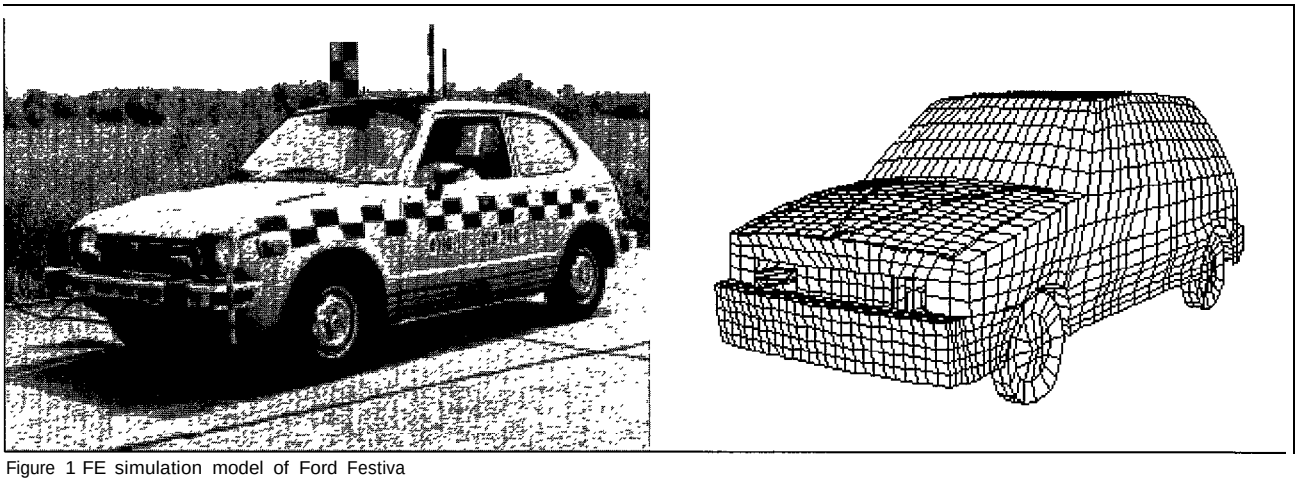

Figure 1 FE simulation model of Ford Festiva

This technical summary announces the publication of conference proceedings as a Federal Highway Administration (FHWA) report (FHWA-RD-96-212) of the same title. The report represents a compilation of seven research papers presented at "The FHWA Vehicle Crash Analysis Conference" on July 8-9, 1996, at the Turner-Fairbank Highway Research Center (TFHRC). (See report-ordering information on the last page of this summary.)

Introduction

In an ongoing effort to improve highway safety, TFHRC's Office of Research and Development (R&D), Safety Design Division, sponsored a series of studies on the use of DYNA3D finite element (FE) code for analyzing vehicle collisions with roadside safety hardware and other roadside features.

DYNA3D, the code of choice for modeling vehicle collisions, is a nonlinear FE code developed by the Lawrence Livermore National Laboratory. For this research, each of seven universities used the code to perform FE modeling of vehicle collisions with a different type of roadside safety structure.

Why Finite Element Modeling?

The use of FE modeling for crash analysis has several positive attributes. Visually, FE modeling allows a better view of what transpires during a crash, e.g., fenders can be removed from view when a vehicle wraps around a pole. Stop-action capabilities allow millisecond-by-millisecond crash coverage, and once the model is created, it can be used to conduct unlimited crash simulations. Computer simulations also allow for parametric studies (i.e., the ability to vary experimental parameters and measure performance effects) not done with traditional crash testing. Furthermore, analytical tools can evaluate the crash performance of all vehicle types, not just the limited few that crash tests can evaluate.

Value of Research Results

The results of this research help to further FHWA's goal of using FE analysis as an additional analytical tool that can reduce reliance on full-scale crash tests of roadside hardware. The analyses presented will eventually lead to improved structural design procedures and development of new high-performance materials with which to construct roadside safety

(Issued May 1997)

structures. Therefore, this report contains groundbreaking information of interest to researchers in the roadside safety community and any other researchers using DYNA3D.

How It Was Done

The results of each commissioned university study applying the DYNA3D code to model impacts with different roadside structures were compared with the results of actual crash tests to validate model behavior. The modeling efforts included :

- Development of both detailed and reduced FE models of a 1994 Chevrolet C-1500 pickup truck for evaluation in two tests-a frontal impact with a full rigid wall and a corner impact into a 1.07-m vertical concrete median.
- Development of a nonlinear FE model of the modified eccentric loader terminal (MELT) to test its performance against a full-scale crash test involving a small passenger car.
- Use of an FE model of a frangible, transformer-base luminaire support for collision analysis with a Ford Festiva.
- Conduct of a simulation study to model a compact automobile impacting a modified thrie-beam guardrail.
- Applications of LS-DYNA3D in simulations involving the Nebraska turned-down end terminal, a dual-leg breakaway sign, a truck-guardrail redirection, and new concepts for mailbox designs.
- Development of an FE model of the Arizona Department of Transportation's slip-base luminaire support for impact testing at high and low speeds.
- Development of the American Association of State Highway and Transportation Officials G2 guardrail FE model, with procedures for INGRID, DYNA3D, and TAURUS, conducting impact simulations with guardrail and vehicle models.

Results

In general, this application of FE garnered a positive reaction, with several researchers recognizing the value of FE modeling to crash analysis, noting close conformity of the simulations to actual test results.

For instance, while the high- and low-speed simulations of the slip-base luminaire support showed disparity between the model and the crash test data, a longitudinal impact with the G2 guardrail was successfully simulated. Similarly, FE modeling of the MELT successfully replicated its basic behavior in an end-on impact with a small car, and the detailed model simulation for the pickup truck impacting a rigid wall showed good correlation between the simulation and the full-scale test into a rigid wall (see figure 2).

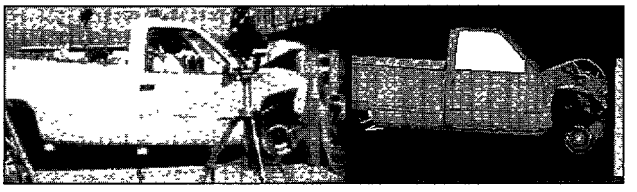

Figure 2 Deformation profiles of pickup truck's hood, fender, and bumper show good correlation between simulation and crash test

In all cases, researchers felt that applications of DYNA3D in FE modeling had an important role in improving the roadside safety design process. They recognized the value of continued efforts to improve and expand the use of nonlinear FE analysis as an alternative to physical crash testing, as efforts continue to design better; safer, and more cost-effective roadway systems.

Researcher-The FE study was performed by researchers from the following universities: NCAC, George Washington University (Washington, D.C.); Center for Computer-Aided Design, University of Iowa; University of Colorado; Department of Civil Engineering, University of Mississippi; University of Nebraska-Lincoln; TTI, The Texas A&M University System; and FAMU-FSU College of Engineering. Contract no. DTFH61-96-P-00392.

Distribution-This technical summary is being distributed according to a standard distribution. Direct distribution is being made to the Regions and Divisions. The conference proceedings document is being distributed according to a standard distribution. Direct distribution is being made to conference participants and attendees.

Availability-The publication will be available in April 1997. Copies will be available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, A limited number of copies will be available from the R&T Report Center, HRD-11, FHWA, 9701 Philadelphia Court, Unit Q, Lanham, MD 20706, Telephone: (301) 577-0818, Fax: (301) 577-1421.

Key Words-Finite element modeling, 820C vehicle, luminaire support, DYNA3D, three-beam guardrail, C-1500 pickup truck.

Publication No FHWA-RD-97-050