

CRASHWORTHINESS AND ROADSIDE SAFETY AT WORCESTER POLYTECHNIC INSTITUTE

ROADSIDE SAFETY RESEARCH GROUP

<http://www.wpi.edu/~roadsafe>

18 October 2001

Key Research Interests

- Impact performance of vehicles and traffic barriers,
- Occupant tolerance to the impact environment,
- Methods for comparing and validating finite element simulations and full-scale crash test experiments,
- Side impact collisions and crash tests,
- Real-world collision data
- Roadside safety audits and
- Design of traffic barriers and vehicles for improved crashworthiness.

Roadside Safety and Crashworthiness Courses

CE 3050 Introduction to Transportation
(undergraduate).

CE 355X Impact Mechanics (undergraduate)

CE 527 Impact Analysis and Structural
Crashworthiness
(graduate)

CE 543 Highway Safety Audits (graduate)

CE 544 Highway Safety (graduate)

Staff and Students

Faculty: Malcolm H. Ray, Assoc. Professor

Staff: Chuck A. Plaxico, Research Engineer

Jennifer A. Weir, Research Engineer

Students:

We have been recruiting graduate students from select European programs during the past several years. The 1999-2000 group came from the University of Linkoping, Sweden and the 2000-2001 group came from Politecnico Milano, Italy.



2000-2001 Team of Faculty, Staff and Students.



1999-2000 Team of Faculty, Staff and Students.

On-Going Sponsored Research Projects

The Roadside Safety Research Group has generated \$1.3 million in externally sponsored research funding in the past three years. The following list show the projects and sponsors of our recent projects.

Title: Simulation and Analysis of a Guardrail System Impacted by a 3/4 Ton Pickup Truck

Sponsor: Battelle Memorial Laboratories

Amount: \$22,693

Title: Guardrail Installation Training Course

Sponsor: American Traffic Safety Services Association

Amount: \$17,867

Title: Recommended Guidelines for Curb and Curb-Barrier Combinations

Sponsor: National Cooperative Highway Research Program

Amount: \$300,000

Title: Centers of Excellence in LS-DYNA Analysis

Sponsor: Federal Highway Administration

Amount: \$125,000

Title: Development of an Improved Roadside Barrier System

Sponsor: National Cooperative Highway Research Program

Amount: \$60,792.

Title: Acquisition of Structural Mechanics Tester,"

Sponsor: National Science Foundation, Major Research Instrumentation

Amount: \$143,093.

Title: In-Service Evaluation of Traffic Barriers

Sponsor: National Cooperative Highway Research Program

Amount: \$280,000

Recently Completed Sponsored Research Projects

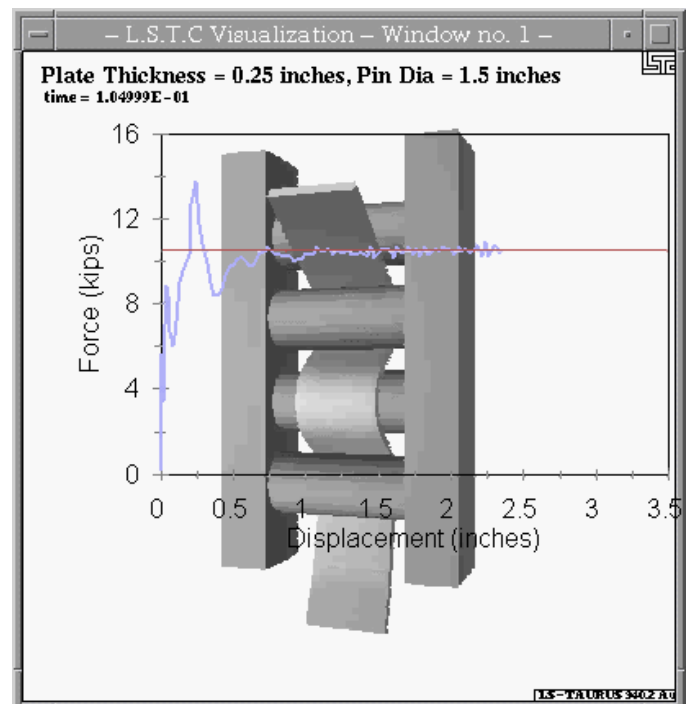
Title: Side Impact: Finalizing the Test Procedures

Sponsor: Federal Highway Administration\

Amount: \$228,291

Title: In-Service Evaluation of Traffic Barriers in Iowa

Sponsor: Iowa Department of Transportation



Amount: \$94,255

Title: Improvements to Weak Post W-Beam Guardrails

Sponsor: Pennsylvania Department of Transportation

Amount: \$43,929

Recent Student Theses and Dissertations Completed
The roadside safety research group has sponsored seven MS students and two Ph.D. students during the past three years.

Brittany Noga, "Use of an Impact Monitoring System to Determine Unreported Collisions," " M.S. Thesis, Worcester Polytechnic Institute, Worcester, MA, 2001.

Paolo Tiso, "Improvements to the Suspension of the NCAC C2500 Pickup Truck Finite Element Model," " M.S. Thesis, Worcester Polytechnic Institute, Worcester, MA, 2001.

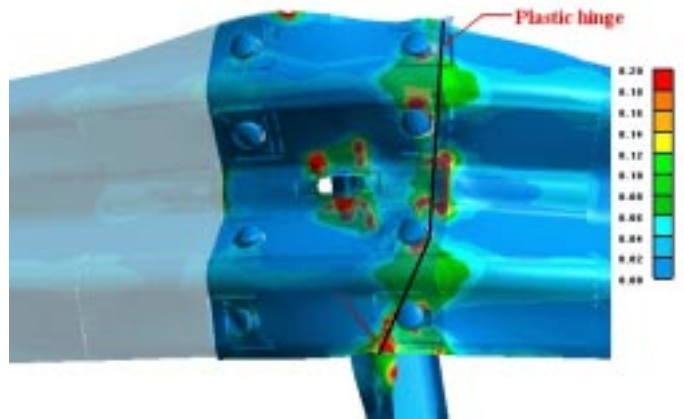
Andrea Giola, "Performance of a High-Density Polyethylene Pull-Through Energy Dissipater," " M.S. Thesis, Worcester Polytechnic Institute, Worcester, MA, 2001.

Fausto Mozzarelli, "Conceptual Design for a New Guardrail System," M.S. Thesis, Worcester Polytechnic Institute, Worcester, MA, 2001.

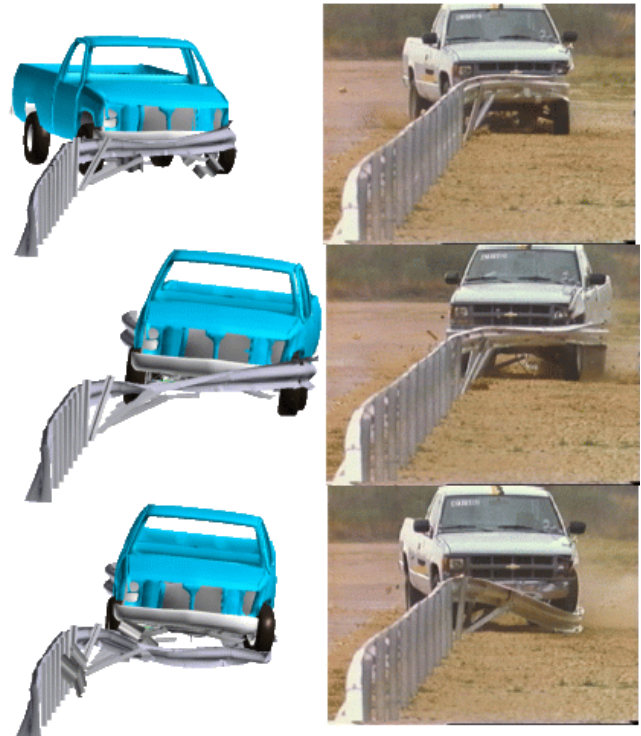
Klas Engstrand, "Performance of Bolted Guardrail Connections," M.S. Thesis, Worcester Polytechnic Institute, Worcester, MA, 2000.

Petter Hedstrom, "Design and Testing of a Side Impact Attenuation Device," MS Thesis, Worcester Polytechnic Institute, Worcester, MA, 2000.

Jessica Karlsson, "Design of a Non-Snagging Guardrail Post," MS Thesis, Worcester Polytechnic Institute, Worcester, MA, 2000.



Potential Rupture Location in a W-Beam Guardrail Splice Identified using F.E. Simulation



-Weak-Post Guardrail Impact Event-
Full-Scale Test and F.E. Simulation

Recent Publications

Students, staff and faculty have published eight peer-reviewed journal articles and two sponsor-published final reports in the past three years. The roadside safety research group is very active in publishing the results of its research.

Journal Articles

C. A. Plaxico, F. Mozzarelli and M. H. Ray, "Test and Simulation of a W-Beam Rail-to-Post Connection," Transportation Research Record No. (in review), Transportation Research Board, Washington, D.C., 2002.

P. Tiso, C. A. Plaxico and M. H. Ray, "An Improved Truck Model for Roadside Safety Simulations: Part II -- Suspension Modelling," Transportation Research Record No. (in review), Transportation Research Board, Washington, D.C., 2002.

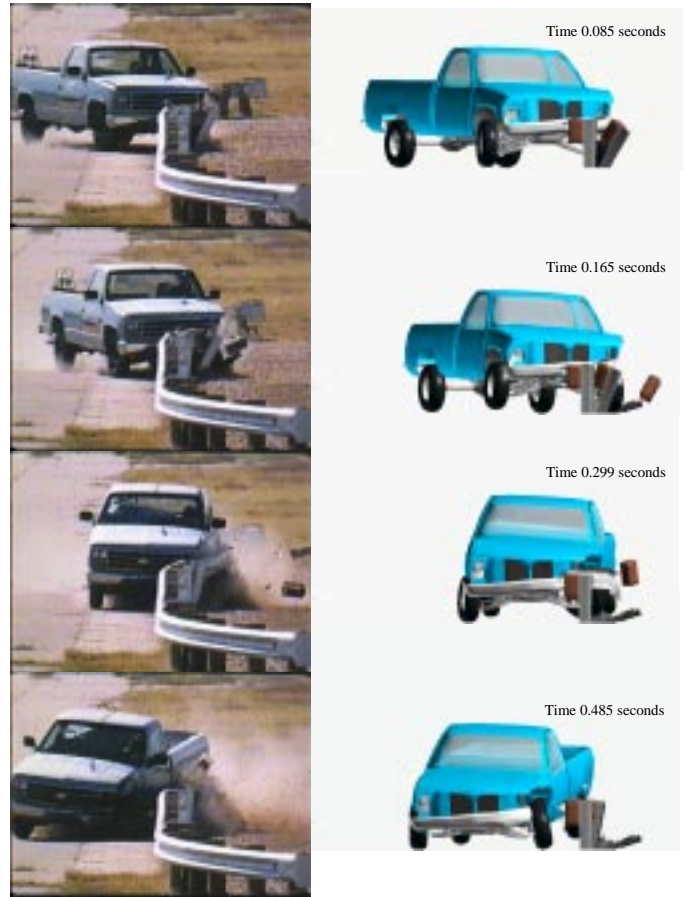
M. H. Ray and J. A. Weir, "Unreported Collisions with Post-and-Beam Guardrails in Connecticut, Iowa and North Carolina," In *Roadside Safety Features*, Transportation Research Record No.1743, Transportation Research Board, Washington, D.C., 2001.

M. H. Ray and J. A. Weir, "In-Service Performance Evaluation of the Bullnose Median Barrier in the State of Iowa," In *Roadside Safety Features*, Transportation Research Record No.1743, Transportation Research Board, Washington, D.C., 2001.

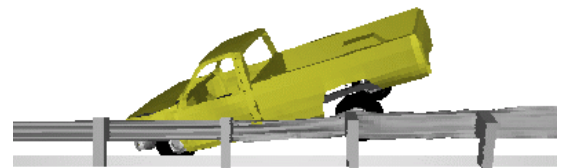
M. H. Ray, C. A. Plaxico and K. E. Engstrand, "Performance of W-Beam Splices," In *Roadside Safety Features*, Transportation Research Record No.1743, Transportation Research Board, Washington, D.C., 2001.

M. H. Ray, C. A. Plaxico, K. E. Engstrand and R. G. McGinnis "Improvements to the Weak-Post W-Beam Guardrail," In *Roadside Safety Features*, Transportation Research Record No.1743, Transportation Research Board, Washington, D.C., 2001.

C. A. Plaxico and M. H. Ray, " Impact Performance of the G4(1W) and G4(2W) Guardrail Systems: Comparison Under NCHRP Report 350 Test 3-11 Conditions," In *Roadside Safety Features*, Transportation Research Record No. 1720, Transportation Research Board, Washington, D.C., 2000.



-Strong-Post Guardrail Impact Event- Full-Scale Test and F.E. Simulation



-Strong-Post Guardrail with 150-mm Curb- F.E. Simulation of a 2000P

M. H. Ray and K. Hiranmayee, "Evaluating Human Risk in Side Impact Collisions with Roadside Objects," In *Roadside Safety Features*, Transportation Research Record No. 1720, Transportation Research Board, Washington, D.C., 2000.

Reports

M. H. Ray, "Recommendations for Performing Side-Impact Crash Tests of Roadside Safety Features," Report No. (in review), Federal Highway Administration, Washington, D.C., August 2001.

M. H. Ray, J. C. Weir, C. A. Plaxico and K. Hiranmayee, "Evaluating the Results of Side Impact Crash Tests of Roadside Features," Report No. (in review), Federal Highway Administration, Washington, D.C., August 2001.



Computational Facilities

Most projects rely on the use of nonlinear dynamic finite element analysis of impact events. Most analysis is performed in the Department of Civil and Environmental Engineering's Graduate Research Computing Laboratory:

Software

- LS-DYNA and DYNA3D for analysis,
- TrueGrid, LS-Ingrid and FEMB for pre-processing,
- LS-Taurus and FEMB for post-processing,
- A variety of special-purpose programs for filtering, processing and displaying crash test data, and
- A variety of general purpose software programs.

Hardware:

- Three dual-processor 1.8 GHz Dell Precision Workstations with Linux OS,
- Five dual-processor Z and M Pro 450 to 550 MHz computers,
- Four Pentium PCs,
- Access to a 12 cpu IBM SP-1 parallel processor,
- A Pentium computer with a Digitizer pad,
- A Power PC with a scanner,
- An HP LaserJet printer,
- A large sheet pen plotter and
- A variety of other peripheral devices.

For further information see

<http://www.WPI.EDU/Academics/Depts/CEE/Facilities/GRCL.html>.

Experimental Facilities

The Structural Mechanics Impact Laboratory is used to perform dynamic impact tests to characterize the dynamic properties of materials, determine the failure mechanisms in structural components and provide validation experiments for finite element simulation results. The laboratory features an Instron 8250 droptower impact tester with a RedLake Motionscope high speed video system and a Dynatup force sensing data acquisition system. Quasi-static experiments are performed in the Civil and



Environmental Engineering Department's Structures Laboratory using a 400,000-lb load tester. For further information see <http://www.WPI.EDU/Academics/Depts/CEE/Facilities/SMIL.html> .

Further Information

For further information about roadside safety and crashworthiness research at WPI, please contact:

Malcolm H. Ray, P.E., Ph.D.
Ralph H. White Family Distinguished Professor
Department of Civil and Environmental Engineering
Worcester Polytechnic Institute
100 Institute Road
Worcester MA 01609-2280
508-831-5340 (voice)
508-831-5808 (fax)
mhray@wpi.edu
<http://www.wpi.edu/~mhray>
<http://www.wpi.edu/~roadsafe>