22nd International Technical Conference on the Enhanced Safety of Vehicles
June 13 - 16, 2011
Washington, DC

Final Abstract Booklet | Countdown until Opening Day: 13 Day, 02 Hour, 57 Min, 58 Sec | Student Competition | 26 Day, 09 Hour, 34 Min, 46 Sec | Award Announcement

Final Abstract Booklet

22nd Enhanced Safety of Vehicles Conference: Final Abstract Booklet

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Oral Presentations

Biomechanics #1: Crash Injury Analysis: Test and Computer Methods

Tuesday, June 14, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Stephen Ridella, United States | Co-Chair: Philippe Vezin,
TRACK A Room: Annapolis 1&2

Side Impact and Rollover Crashes: Prevention and Occupant Protection

Tuesday, June 14, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Bernd Lorenz, Germany | Co-Chair: Riley Garrott, United States
TRACK B Room: Woodrow Wilson A

Assessment of Strategies for Integrated Improvements in Fuel Economy and Safety, Including Use of Alternate Fuels and Batteries

Tuesday, June 14, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Jac Wismans, The Netherlands | Co-Chair: Antonio Erario, Italy
TRACK C | Room: Annapolis 3&4

Biomechanics #2: Development of Crash Test Dummies Related Instrumentation and Analysis Techniques

Tuesday, June 14, 2011 | 2:00 p.m.-5:30 p.m.
Chairperson: Koshiro Ono, Japan | Co-Chair: Bruce Donnelly, United States
TRACK A | Room: Annapolis 1&2

Assessment of Performance of Occupant Protection Systems for Children, Older Adults, and Other Vulnerable Occupants

Tuesday, June 14, 2011 | 2:00 p.m.-5:30 p.m.
Chairperson: Bernie Frost, United Kingdom| Co-Chair: David Adams, United Kingdom
TRACK B | Room: Annapolis 3&4

Advanced Technology #1: Safety Performance and Effectiveness of Driver Assistance

Technologies, Test & Evaluation Procedures, and Benefits Assessment

Tuesday, June 14, 2011 | 2:00 p.m.-5:30 p.m.
Chairperson:Ray Resendes, United States| Co-Chair: Anders Lie, Sweden
TRACK C | Woodrow Wilson A

Panel Discussion Vehicle Safety: Regulatory Compliance & Enforcement and Defects Investigation

Wednesday, June 15th, 2011 | 9:00a.m-10:30 a.m.
Chairperson: Claude Harris, United States
Track B | Room Annapolis 2-3-4

Advanced Technology #2: Human Performance and Driver Behavior

Wednesday, June 15, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Tim Johnson, United States | Co-Chair: Andre Seeck, Germany
TRACK C | Room: Woodrow Wilson A

Restraint System Design and Performance Challenges: Effects of Future Fleet Changes

Wednesday, June 15, 2011 | 2:00 p.m.-5:30 p.m.
Chairperson: Stephen Summers, United States | Co-Chair: Lex Van Rooij, The Netherlands
TRACK A | Room: Annapolis 1&2

Advancements in Pedestrian and Other Vulnerable Non-Occupant Road User-Safety

Wednesday, June 15, 2011 | 2:00 p.m.-5:30 p.m.
Chairperson: Rikard Fredriksson, Sweden | Co-Chair: Robert Anderson, Australia
TRACK B | Room: Annapolis 3&4

NCAP and Other Non-Regulatory Strategies for Improving Safety

Wednesday, June 15, 2011 | 2:00 p.m.-5:30 p.m.
Chairperson: Mark Terrell, Australia | Co-Chair: Jenny Dang, United States
TRACK C | Room: Woodrow Wilson A

Vehicle Structural Design Changes: Implications for Frontal Impact Protection and Compatibility

Thursday, June 16, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Bernie Frost, United Kingdom| Co-Chair: Suzanne Tylko, Canada
TRACK A | Room: Woodrow Wilson A

PaperNo.11-0209-O

Self-Protection and Partner-Protection for New Vehicles – UNECE R94 Amendment

Cyril Chauvel, Gerard Faverjon, Nicolas Bertholon
Laboratory of Accidentology, Biomechanics and Human Behavior, Peugeot Citroën Renault, France
Sophie Cuny
European Center of Safety Studies and Risk Analysis, CEESAR, France
Pascal Delannoy
Safran Engineering, SAFRAN Group – UTAC Passive Safety Department, France

Abstract:
This work aims at bringing evidence for incompatibility in frontal impact for cars built according to the UNECE R94 regulation. The heterogeneity of frontal self-protection among cars of different masses is investigated, as well as the partner protection parameter offered by these cars. The analysis deals with the estimation of the benefit, in terms of fatal and severe injuries avoided, if crashworthiness was harmonized for the whole fleet of vehicle. This calculation is done for France and is extended

to all Europe. Furthermore, potential benefits of UENECE R94 amendment introduction is also investigated.

Self-protection is analyzed through the percentage of fatal and serious injuries among car occupants and comparisons are made between cars of different mass/size. Partner protection is defined as the severity rate in the car impacted by the focus vehicle; this parameter is calculated in relation with the crashworthiness characteristic of the car. The benefit of having a homogenous fleet in term of frontal protection is estimated by calculating the reduction number of fatal and severe injuries expected if all cars come up with the severity rate of the most crashworthy vehicle in frontal impact.

French national injury accidents database census for years 2005 to 2008 were used for the analysis. This is an disaggregated database which records only accidents with at least one injuries involved into the accident. It describes the circumstances of each accident through a series of descriptive variables. We selected only front belted occupants involved in a frontal impact. Only occupants of cars designed according to UNECE R94 regulation were taken into account. The final sample consists in 2800 cars occupants. Injury outcome for the car occupants and for the opposite vehicle were available. Car masses had been also entered into the data base. This paper is also based on document and work generated by GRSP FI Group activities.

Data demonstrate that frontal self protection depends on vehicle mass: in cars weighting less than 950kg, 27% of occupants are killed or severely injured whereas the severity rate in cars weighting more than 1700 kg decreases to 11%. Cars coming up to the UNECE R94 regulation are also characterized by their heterogeneity regarding partner protection: in case of head on collision with another UNECE R94 vehicle, aggressivity ranges from 12 to 42% of fatal or serious injuries observed in the opposite vehicle.

According to this study, it is yet required to limit vehicle front unit's aggressiveness. It is necessary to assess the possibility to check and improve partner protection with regards to self-protection. To achieve this new requirement, the amendment of UNECE R94 test procedure, is proposed in order to check both parts of compatibility (structural interactions - partner - and compartment strength - self) If all cars had the same frontal crashworthiness characteristic, 7% of fatal and severe injuries sustained by passenger cars would be avoided. This work is to support the UNECE R94 amendment. Most of this analyzis was presented to the informal Frontal Impact group in Geneva .

PaperNo.11-0295-O

Priorities for the Assessment of Frontal Impact Compatibility

Sean O'Brien
Volkswagen AG, Germany

Abstract:
Compatibility has been a subject of research for 40 years, and a multitude of design factors have been identified that influence the compatibility of a vehicle, a collision, or the fleet as a whole. The purpose of this study was to identify priorities and opportunities for improvement.

The goal of compatibility is undisputed: to reduce the number of injuries and fatalities that occur in the accident environment. However, this definition is difficult to apply to individual collisions or vehicles because they only represent a small part of an extremely complex system. Hence, multiple definitions of a "compatible collision" and "compatible vehicle" have arisen. The first part of this study was to compare these definitions and propose a single definition for a compatible collision.

The conclusion of this first analysis was that compatibility should be assessed using the mean risk of injury for all occupants involved in a collision. Data from the (German) GIDAS relational database have been analyzed (404 pairs of belted passenger vehicle drivers involved in front-to-front collisions), and it has been shown that the distribution of MAIS2+ and MAIS3+ injuries is independent of the mass ratios of the vehicles. Although many previous studies have shown that mass ratios affect the injury outcomes in individual vehicles, this result indicates that the mass ratio is irrelevant at the collision level, and hence it is irrelevant for the accident environment as a whole. Further analysis is planned using national accident data, which should allow conclusions to be drawn based on the distribution of fatalities.

If mass ratios are irrelevant for the analysis of compatibility, mass dependent issues such as stiffness matching must be given a lower priority. Therefore, the third phase of this study focused on the analysis of structural interaction, which has been shown to improve the partner protection of LTVs in collisions with cars (IIHS, 2008). Using models of a mid-sized passenger car and a large SUV, perfect horizontal homogeneity and perfect vertical homogeneity have been analyzed independently in front-to-front (50% and 100% overlap) and front-to-side collisions. These are the first known results that specifically analyze vertical homogeneity independently from horizontal homogeneity. The results indicate that improvements can be achieved with a vertically homogeneous region between the main rails and a horizontally homogeneous region outside the main rails. The conclusions from this part of the study are limited by their reliance on simulations, the use of theoretical structures to achieve the homogeneity, and the use of compartment deformations as the only assessment criteria.

The final part of the paper considers current proposals for the assessment of compatibility from the USA, Europe, and Japan and discusses their ability to achieve the priorities identified in the preceding analysis.

PaperNo.11-0286-O

FIMCAR – Frontal Impact And Compatibility Assessment Research: Strategy and First Results for Future Frontal Impact Assessment

Heiko Johannsen

Automotive Engineering, Technische Universität Berlin, Germany
Thorsten Adolph
Passive Vehicle Safety and Biomechanics, Bundesanstalt für Straßenwesen, Germany
Robert Thomson
VTI, Sweden
Mervyn Edwards
TRL, United Kingdom
Ignacio Lázaro
APPLUS IDIADA, Spain
Ton Versmissen
TNO, The Netherlands

Abstract:
For the assessment of vehicle safety in frontal collisions, the crash compatibility between the colliding vehicles is crucial. Compatibility compromises both the self protection and the partner protection properties of vehicles. Although compatibility has received worldwide attention for many years, no final assessment approach has been defined. FIMCAR (Frontal Impact and Compatibility Assessment Research) is a research project started in October 2009 to address compatibility test procedures and is co-funded by the European Commission within the 7th Framework Programme. The aim of the project is to answer the remaining open questions identified in earlier projects (such as understanding of the advantages and disadvantages of force based metrics and barrier deformation based metrics, confirmation of specific compatibility issues like structural interaction, investigation of force matching) and to finalise the test procedures required to assess compatibility. Within the project the research activities focus on car-to-car frontal impact accidents. However, other configurations such as lateral impact, car-to-HGV accidents etc. will be considered to ensure that changes made to cars to improve their compatibility in frontal impacts are not detrimental for other impact types. The FIMCAR project is harmonising its activities with the GRSP informal group on frontal impact and cooperating with EUCAR to address relevant stakeholders.

The proposed paper will focus on the results of the accident research identifying the compatibility issues of recent cars, the overall strategy for selecting the best assessment approach as well as the preliminary metrics for full-overlap and off-set tests.

For the accident data analysis the following in depth data bases were used: CCIS, GIDAS, PENDANT. Selection criteria were frontal car accidents with car in compliance with ECE R94. For this study belted adult occupants in the front seats sustaining MAIS 2+ injuries were studied. Following this analysis FIMCAR concluded that the following compatibility issues are relevant:
- Poor structural interaction (especially low overlap and over/underriding)
- Frontal force mismatch with lower priority than poor structural interaction
- Compartment strength especially in accidents with HGV and objects

In addition acceleration loading to the occupant is present in significant portion of frontal crashes.

Based on the findings of the accident analysis the aims that shall be addressed by the proposed assessment approach was defined and priorities were allocated to them. The aims and priorities shall help to decide on suitable test procedures and appropriate metrics. In general it is anticipated that a combination of full overlap and off-set test procedure would fit best to assess frontal impact crashworthiness and occupant protection level; one of these test procedures could be an MDB test. For the analysis of the test procedures and metrics mainly existing crash test data were used in order to focus a limited number of new tests to open questions, which cannot be answered from existing data.

PaperNo.11-0335-O

Accuracy of AHOF400 with Moment-Measuring Load Cell Barrier

Sanjay Patel, Stephen Summers, Aloke Prasad
National Highway Traffic Safety Administration, United States
Pradeep Mohan
The George Washington University, United States
John Brewer
U.S. Department of Transportation, Volpe National Transportation Systems Center, United States

Abstract:
Research Question: Several performance measures derived from rigid barrier crash testing have been proposed to assess vehicle-to-vehicle crash compatibility. One such measure, the Average Height of Force 400 (AHOF400), has been proposed to estimate the height of the vehicle's primary energy absorbing structures. Previous studies have concluded that single axis load cell measurements do not have sufficient accuracy to evaluate vehicle crash geometry. This paper will evaluate the results using a rigid barrier that measures vertical and lateral moments in addition to longitudinal force. The results will be evaluated against vehicle geometry measurements.

Research Methods: A test series was conducted using a load cell barrier with vertical and lateral moment capability. The test results will be compared with vehicle measurements and the significance of moment measuring load cells will be evaluated.

Data Sources: NHTSA Vehicle Crash Test Database

Expected Results: The author's hypothesis is that the barrier instrumented with moment measuring load cells should yield improved AHOF400 measurements. The accuracy of the AHOF400 measure will be compared against static vehicle structural measurements.

Conclusions: The feasibility of using AHOF400 will be evaluated.
Discussion: Previous studies have shown that the difference in AHOF measures is a significant predictor of crash partner fatality in vehicle to vehicle crashes. However the 250 mm size of the load cells limited the accuracy of these performance measure. NHTSA recently purchased a load cell barrier using 125 mm load cells that measure compressive force and moment. Computer simulation studies predicted this should significantly improve the AHOF accuracy. This test program will evaluate these previous conclusions

Limitation of Study: The initial test metric consisted of only 6 vehicles.

What does this paper offer that is new in the field: Evaluation of a methodology to evaluate vehicle geometric compatibility.

PaperNo.11-0283-O

Use of Secondary Energy Absorbing Structures for Improved Self Protection Performance – Experiences During the Development of a Chassis Based Vehicle

Ganesh Gadekar, Anil Kumar Chigullapalli, Ashok G. Joshi, Makarand Takle
Tata Technologies Ltd.

Abstract:
Secondary Energy Absorbing Structures (SEAS) have been discussed in literature in the context of improving geometric compatibility between larger vehicles like SUVs and cars. While compatibility related work is still in a research phase, development of the vehicles for self protection remains a priority. Vehicles also have to be designed to meet set targets against consumer group tests like EuroNCAP.

A Secondary Energy Absorbing Structure on a Crossover kind of vehicle was evaluated to see the effect on self protection. Through the evaluation it was realized the SEAS can actually be optimized for improving the self protection and lead to reduced weight of the chassis frame. This concept was optimized to achieve weight savings in EuroNCAP load case.

This paper presents the results of evaluations, analysis of the reasons why SEAS is expected to lead to weight savings in a typical offset frontal crash along with the optimization work carried out for achieving weight savings.

PaperNo.11-0073-O

Front and Side Car-to-Car CAE Based Crash Analysis of Different Class Vehicles

Jangho Shin
Advanced Safety CAE Team, Hyundai Motor Company, Korea
Haeng Kyeom Kim, Yun Chang Kim
Platform Development Team, Hyundai Motor Company, Korea

Abstract:
In recent years, rapid-increasing market share of compact cars and SUVs has brought for both consumer and automaker to pay more attention on crash compatibility between the compact passenger vehicles and the light trucks (i.e., Pickups and SUVs). Vehicle compatibility regarding both self and partner protection in frontal crash of different class vehicles is one of hot issues in vehicle safety. Furthermore, it is expected that the amendment of UNECE-Regulation 94 to implement compatibility issues in couple of coming years. This paper presents front and side car-to-car CAE based crash of different class vehicles which describes a car accident in real field. Structural engagement and energy balance of different class vehicles in front and side car-to-car crash are identified and compared with those of barrier test for current regulations and New Car Assessment Program (NCAP). In this study, conceptual design of compatibility compliant frontal vehicle structure which improves the distribution of frontal crash loading and structural engagement between vehicles is introduced and its effect on car-to-car crash is also investigated.

PaperNo.11-0430-O

Progressive Deformable Barrier (PDB) – Evaluation of Its Impact on Small Car Designs Through CAE Analysis

Pratap Daphal, Anil Kumar Chigullapalli
Tata Technologies Ltd.

Abstract:
Progressive Deformable Barrier (PDB) based offset test method was recently proposed as an alternative to the existing regulatory test using Offset Deformable Barrier (ODB) as per ECE R94. Implications of this change on structural design of cars were studied through CAE simulations.

Comparative simulations were run with the two barriers for vehicles with different mass and effect of the barrier change was studied against the mass of the vehicle. Stiffness improvements required in car structures for similar intrusions when PDB was

Comparative simulations were run with the two barriers for vehicles with different mass and effect of the barrier change was studied against the mass of the vehicle. Stiffness improvements required in car structures for similar intrusions when PDB was used were then studied. The study showed that PDB was able to absorb a lot more energy compared to ODB and this could essentially mean the car structures can be engineered with reduced energy absorbing capability while still meeting the requirements with PDB.

PaperNo.11-0435-O

Frontal Impact Improvements - Enhanced Modeling of the Impact Barrier

Loïc Grall, Richard Zeitouni, Céline Adalian
PSA Peugeot Citroën, France

Abstract:
The honeycomb barrier behavior has a major influence on the vehicle structures designed to absorb a frontal crash, for ECE 94 or Euro NCAP and other NCAP frontal tests.
The increased use of modeling and the improvements made on numerical capacities forced us to be able to represent in a better and an in-depth manner the numerical behavior of the honeycomb barrier in order to improve our prediction of the vehicle behavior in a frontal crash test, especially on the load distribution in the car front-end.
PSA Peugeot Citroën launched a huge physical and numerical program on the behavior of the regulatory honeycomb barrier in order to improve its numerical model available of the major crash software. This program focused on the instabilities generated by the industrial barrier that can lead to very different load distribution profiles.

Physical tests were performed from simple tests (honeycomb static compression) to more complex dynamic tests such as puncture tests, up to sub systems tests where a rigid car front end was propelled on a full ECE 94 barrier. This program highlighted new phenomenon that were not represented up to now in the numerical barrier such as densification and effect of air pressure in the cells when high volume reduction and high velocities occurred. Other important scatterings due to bonding and cell wall thickness were also seen as major parameters to take into account.

All these mechanical characteristics as well as the aluminium mechanical behavior are now included in the enhanced modeling developed in the crash software in order to represent all the simple tests performed up to the more complex ones. This led us to better predictive modeling of the honeycomb barrier.

The paper will conclude with a direct comparison between the standard barrier model and our enhanced model and their consequences on the prediction of the full car crash behavior.
This brand new model is now used for the design of the new vehicle programs at PSA Peugeot Citroën.

PaperNo.11-0384-O

Injury Analysis of Real-World Small Overlap and Oblique Frontal Crashes

Rodney W. Rudd, Mark Scarboro, James Saunders
National Highway Traffic Safety Administration, United States

Abstract:
Recent research has indicated poor injury outcomes for front row occupants of passenger vehicles equipped with frontal air bags when the longitudinal frame rail(s) are missed by the struck object. The objective of this research was to establish key factors for injury causation from a uniform manual analysis of real world crashes where very limited or no engagement of the longitudinal structures occurred. A multidisciplinary team of experts at the National Highway Traffic Safety Administration was assembled to review the available real-world cases matching this crash profile. The NHTSA team utilized a uniform process to review all cases to ensure the same data points were evaluated by each team member. Regular meetings were held by the team to discuss cases and to keep the reviews uniform. More than 180 cases were extracted from the National Automotive Sampling System-Crashworthiness Data System (NASS-CDS) and the Crash Injury Research and Engineering Network (CIREN).

The findings from the case reviews mimic those in other recent studies that indicate head and thoracic injuries are prevalent in the narrow overlap crashes, with longitudinal and lateral component intrusion being key factors. Injuries to the head, thorax and pelvis were the most prevalent, and longitudinal intrusion and occupant kinematics were key factors in their causation. The cases reviewed demonstrated possible issues with air bag coverage of contact points, intrusion contributing to injury, and occupant lower extremity kinematics influencing pelvic fractures. The final result of the reviews was to initiate a vehicle crash research plan to test the feasibility of recreating the real-world crash and kinematic responses seen during the case reviews. The results of these case reviews indicate opportunities for improved anthropomorphic test device response to duplicate the crash outcomes seen in this research.

PaperNo.11-0372-O

Frontal Crashes Between the Longitudinal Rails

Paul Scullion, Richard Morgan, Kennerly Digges, Cing-Dao (Steve) Kan
George Washington University - National Crash Analysis Center, United States

Abstract:

The objective of this study is to further investigate the injuries and injury mechanisms associated with belted front-row occupants in between-rail narrow object frontal crashes, whereby the damage profile is akin to a center-pole impact. This study examines real-world crash data from the NASS-CDS between the years 2003-2009 with a focus on frontal crashes involving 1999 and later model year vehicles. This study expands upon a methodology developed by Ford Motor Co. for classifying frontal impacts based upon the Collision Deformation Classification (CDC) [SAE J224] and the location of direct damage relative to the estimated location of the underlying vehicle frame-rail structure. This Frontal Impact Taxonomy will be used to identify those crashes with damage localized between the vehicle frame-rails. In a recent study, it was identified that between-rail impacts had a higher risk of front row occupants sustaining either an MAIS 2+, or MAIS 3+ injury, compared to all other frontal impact damage classifications (Full engagement, Offset, Moderate offset, Small Overlap, and so on). The extent of damage, delta V, and magnitude of interior intrusion to the occupant seating position will be used as a measure of impact severity. This study will investigate the crash conditions required to induce interior intrusion in between-rail impacts, as well as compare the injuries and the corresponding involved physical components associated with this type of impact damage. The results and conclusions are expected to follow that in between-rail impacts the most commonly intruding components are the toe-pan, floor-pan, and instrument panel, which often result in MAIS 2+ lower extremity injuries. In both the presence and absence of intrusion, the between-rail impact may cause the head, chest, and upper extremities of the front seat occupant to move forward and laterally toward the vehicle centerline. This may result in the occupant slipping from the belt restraint and/or glancing off of the side of the airbag, increasing their potential for contact with the windshield or center console. This study will discuss the structural countermeasures and occupant restraint systems designed to accommodate for existing regulatory and consumer testing and how they may or may not adequately address the injuries and impact conditions associated with the between-rail crash. Additional considerations with respect to vehicle structural design and occupant restraint systems may be necessary for protecting belted front row occupants in these collisions. A limitation of the study is that the occupant injury mechanisms are determined using the documented involved physical component for each occupant injury, based on the NASS crash investigation report. This study offers an in-depth perspective to centralized between-rail impacts through consideration for intrusion, occupant injuries, and the engagement of the underlying vehicle structure.

PaperNo.11-0239-O

Improving the Crash Compatibility of Cars and Roadside Poles

Michael Griffiths
Road Safety Solutions, Australia
John Jarvie
Accountable Safe Innovations, Australia

Abstract:
Car to pole impacts account for a large proportion of car occupant casualties in many motorized countries. Each year in Australia about 2000 vehicles crash into timber power poles resulting in approximately 100 fatalities and 1000 serious injuries at a community cost of about A$500 million. The estimates for North America are over 1000 fatalities and over 100,000 serious injuries each year, with an estimated 10-fold increase in costs. Historically the primary countermeasure used by road safety authorities has been to move utility/power poles away from the roadside. While this may reduce the risk of an impact, moving the position of the timber pole has little effect on the outcome if an impact occurs. To reduce the risk of injury there is a need to change the properties of the pole, so that the pole acts to stop the car while retaining integrity ensuring that neither becomes an unrestrained hazard.

This paper presents the results of a program aimed at developing a utility pole that absorbs energy and yields sufficiently to stop the vehicle in several metres at survivable decelerations with no intrusion into the occupant space. This has been achieved by using composite materials supplemented with built in energy management systems. To test the impact properties of the prototype, we conducted ten full-scale frontal crash tests using a variety of car sizes at impact speeds of 50,80 and 100 km/hr. The performance of the poles during the tests was monitored using multiple high-speed cameras, and accelerometers were fitted to the vehicles on later tests.

The results demonstrate the superior impact performance of the composite poles and the ability of these poles to safely stop impacting vehicles even at high impact speeds, while retaining enough integrity to ensure cables carried by the poles remain intact and supported above the ground.

This superior impact performance carries substantial potential safety benefits. Furthermore, the projected whole of life costs of the composite pole are less than existing timber poles. The lighter weight and lower cost of the poles also assists the primary countermeasure of relocation away from the road. Limitations of the preliminary test program are the lack of instrumented test dummies that means that these results cannot be communicated directly in terms injury criteria. However the reduced decelerations measured in the vehicle, and the retention of the occupant compartment even in the highest test speeds strongly indicates likely reduction in injury risk.

This is the first energy absorbing utility pole that prevents unrestrained hazards and can keep the power/communication cables supported. Widespread use of these composite poles could prevent considerable serious injury, death and associated community cost.

PaperNo.11-0074-O

Crash Test Performance of Large Truck Rear Underride Guards

Matthew Brumbelow
Insurance Institute for Highway Safety, United States

Abstract:
Recent studies have shown that large truck crashes account for a substantial portion of the fatalities and serious injuries occurring in modern passenger vehicles designed for good frontal crash protection. Incompatibilities in mass, stiffness, and ground clearance present challenges in improving crash outcomes for passenger vehicle occupants. A recent Insurance Institute for Highway Safety study of cases from the Large Truck Crash Causation Study (LTCCS) found that rear underride guards meeting US federal requirements still can allow severe passenger vehicle underride, often resulting in serious or fatal injury. Although the study identified patterns of real-world guard failure, the impact speeds necessary to produce these failures could not be determined. Also, due to the LTCCS case selection requirement that each crash produce an injury, differences among the large number of guard designs and resulting crash performance and injury risk could not be compared. The current study used a series of crash tests to investigate these issues.

Crash tests were conducted in which the front of a midsize sedan impacted the rear of a semi-trailer equipped with an underride guard. Three guard designs were evaluated; two were tested in 56 km/h full-width tests and one in 50 percent overlap tests at 40 and 56 km/h. Each guard design was certified to the US Federal Motor Vehicle Safety Standard (FMVSS) 223 requirements, but two also met the more stringent Canadian (CMVSS 223) regulation. Quasi-static tests were conducted to verify compliance.

In a full-width test at 56 km/h, the guard design built only to the US requirements failed catastrophically at the points of attachment to the trailer, allowing severe underride and trailer contact with the dummy's head. The CMVSS-compliant guard tested under these conditions prevented underride. The second CMVSS-compliant guard failed in 50 percent overlap tests at 56 and 40 km/h, producing underride to the dummy's head in the first test and to the base of the sedan's windshield in the second.

The minimum force requirements of FMVSS 223 are too low to prevent guard failure in full-width crashes. While producing improved full-width performance, CMVSS 223 requirements also need to be strengthened since underride still can occur in offset crashes. Both standards should require quasi-static tests to be conducted with guards attached to a trailer. The current standards allow tests using a rigid fixture, so even well-designed guards could be attached to a trailer such that they fail to prevent underride due to weakness of the trailer chassis or attachment mechanism.

The current study was limited by the selected test conditions. Changes in the mass and geometry of striking passenger vehicles could produce different results, as could changes in impact speed, overlap, or angle. Many other guard and trailer designs are on the road, and each could perform somewhat differently. This research represents the first series of crash tests conducted to evaluate production trailers with underride guards certified to current US or Canadian regulations and demonstrates the need for additional improvements to these standards.

PaperNo.11-0288-O

Analysis of Compatibility and Occupant Injury Mechanisms in Frontal Collisions Involving Buses in Spain

Francisco Javier Páez Ayuso, Arturo Furones Crespo, Alexandro Badea Romero, Enrique Alcalá Fazio, Francisco Aparicio Izquierdo
University Institute for Automobile Research (INSIA) - Technical University of Madrid (UPM), Spain

Abstract
The European Regulations introduced over the last years on the enhancement of secondary safety of buses are proving to be efficient, reducing accident seriousness and their consequences, as real accident data can show. However these measures seem to be insufficient, especially in certain impact configurations such as frontal collisions in which not only the driver and the crew are the most prone to casualty but also the rest of the occupants who often suffer severe or fatal injuries.
The aim of the study presented in this paper is to identify the main characteristics of bus frontal collisions that have occurred in Spain over the last years, and to analyse the compatibility of these vehicles with their collision partners or obstacles in frontal impacts.
The study has two main parts: a statistical analysis based on the Spanish Accident Database that includes bus accidents occurred in Spain between 1993 and 2008 investigated by the Police Forces with at least one injured person as consequence of the accident; and an in-depth study using a bus accident database including highly detailed information, retrospective investigation, reconstruction, police reports, and medical records with injury description and mechanisms. A total of 28 real-world accidents were considered, in depth-analysed by the Accident Research Unit of INSIA and investigated in collaboration with the Police Forces, Paramedics and Hospitals.
It is expected that the results obtained in this research will help to gauge the extent of the problem in the Spanish roads and to understand the influence of compatibility on the injury severity of the occupants of both vehicles and their mechanisms.
The statistical analysis revealed that interurban frontal bus accidents represent around 50% of the total Spanish interurban bus accidents with killed or severe injuries. The in-depth analysis based on the injury mechanisms most commonly found suggests that new structural solutions in the frontal design of the bus should be considered to enhance occupant protection and to improve the compatibility between the vehicles involved.
There are not many research works about bus frontal collisions up to day, so the potential enhancement of secondary safety is still high. This study is based on Spanish data and its conclusions reflect the situation in the Spanish roads, however it should be extended and considered as guidelines for future research works.

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Advances in Driver Assistance Systems for Heavy Trucks and Buses & All Aspects of Motorcycle Safety [–]

Thursday, June 16, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Devin Elsasser, United States | Co-Chair: Younghan Youn, Korea
TRACK B | Room: Annapolis 1&2

Assessments of New and Improved Field Data Collection & Analysis Methods [–]

Thursday, June 16, 2011 | 9:00 a.m.-12:30 p.m.
Chairperson: Andre Seeck, Germany | Co-Chair: Augustus (Chip) Chidester, United States
TRACK C | Room: Annapolis 3&4

Written Papers

Biomechanics #1: Crash Injury Analysis: Test and Computer Methods [–]

Side Impact and Rollover Crashes: Prevention and Occupant Protection [–]

Assessment of Strategies for Integrated Improvements in Fuel Economy and Safety, Including Use of Alternate Fuels and Batteries [–]

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