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(85th GRSG, 21-24 October 2003,Agenda item 11.9)

REPORT

about the meeting held in Madrid
(15-16 September 2003)
dealing with the frontal collision of buses

1. On the 84th meeting of GRSG the Spanish delegate raised the problem of the frontal collision of buses and pointed out the severity of this type of accident (high mortality and injury rate) He asked for certain regulatory work on this field. Hungary supported this action. Spain promised to organise a small meeting about this subject and present an informal document to GRSG on its October meeting. GRSG welcomed and supported this action.

2. The meeting was held at INSIA in Madrid with the following participants:
   Prof. F. Aparicio (INSIA, Spain)
   Prof. F. Páez (INSIA, Spain)
   Dr. A. Garcia (INSIA, Spain)
   Prof. K. Langwieder (GNV, Germany)*
   Mr. W. Niewöhner (DEKRA, Germany)
   Dr. M. Matolcsy (GTE, Hungary)
   Dr. A. Martin (INSIA, Spain)
   Ms. T. Vicente (INSIA, Spain)

   * Prof. Langwieder was to come to the meeting, but finally he could not. He sent his presentation to Prof. Aparicio and some more relevant documents about the European ECBOS projects. These documents were distributed to the participants and they were considered in the discussion.

   Mr. P. de Coo (TNO, Holland) also joint to this action, but he had another obligation in this time so he could not attend this meeting. He offered to organise a meeting for the bus manufacturers to discuss this topic. Both of them asked for getting the Report of this meeting and expressed their interest in the future work.

3. During the meeting the following subjects have been discussed:
   - statistical data about bus frontal collisions (partners, objects, fatalities and injuries, bus categories, etc.)
   - types and specifications of bus frontal collisions
   - ECE regulations for other vehicle categories in case of frontal collisions. Who are protected in these regulations? (Driver, crew, passengers, partners, etc.)
   - what kind of ECE regulations and EU directives should be considered for buses in frontal collisions? (New regulation or extension of existing regulations)
   - what kind of tests could be considered as approval test, is the industry (including research institutes and technical services) ready to use and apply these tests?

   All the participants had a presentation concentrating on the subjects mentioned above and this was followed by a common discussion. It was mentioned that the final report of the

ECBOS project is due to the end of September and even the frontal collision of buses was not a central subject in this research, its results could be worth wile in the future work.

4. The survey of the existing ECE regulations and EU directives related to the frontal collisions of all kind of vehicle categories show (see Annex 1):
   - There are altogether 13 ECE regulations and one EU directive, but only 2,5 cover bus subjects
   - The main goals of these regulations are:
     - driver protection
     - occupant (passenger) protection
     - structural integrity (behaviour)
     - partners protection
     - reducing agressivity and increasing compatibility

   Two regulations relates to the bus seats and their anchorages (Reg.17. and Reg.80.) which should be harmonised, and one to the safety belt anchorages (Reg.14.)

5. It is very difficult to collect and evaluate technically valuable and comparable accident statistics for bus head on impact. The difficulties are shown in Annex 2. Spanish, German, Hungarian, Japanese and English data (collected and published earlier) were shown and discussed during the meeting. The analysis of the accident statistics showed some considerable evidences:
   - the frontal collisions with heavy vehicles, big rigid objects or pole like objects give very similar high casualty rate (casualty/accident) in some countries for the bus occupants as the rollover (see Annex 3)
   - all the bus categories (class I., class II., and class III., small bus, special buses) are involved in this type of accidents
   - the driver has an extra high casualty rate in frontal collisions compared to the average passenger casualty rate (10 times higher or more) and also the passengers sitting behind a partition.
   - in the frontal collisions many other vulnerable road users (partners) are endangered (pedestrians, mopeds, bicycles, motorcycles, cars, etc.)

6. Analysing real bus frontal impacts different accident types may be separated, like
   - collision with vulnerable partners (run over)
   - total head on impact with big, rigid objects (heavy vehicles, walls, pole like objects) in which every bus occupant is endangered. Special attention should be given to the collision with the rear part of plato of heavy trucks
   - impact on the driver compartment, in which the driver has unacceptable casualty risk
   - impact on the service door side of the front wall, in which the crew and passengers are endangered
   - underrun type accidents, in which the bus driver, the main controlling systems of the bus (steering, braking, electric systems) could be endangered as well as the occupants of the underrunning car.

7. Different kind of passive safety ECE regulations (with different goals) may be considered for frontal collision of buses. The following type of approval tests may be considered, which are know, widely used, well instrumented for testing other vehicle categories:
   - complete vehicle impact test against fixed barrier
   - pendulum impact test

- dynamic impact test by moving impactor
- static loading test

There is no need to specify new type of test for regulating the problems of buses, only the specification of these tests listed above will be required for bus requirements.

8. The experts started to collect the available technical publications related to the question of bus frontal collisions. (see Annex 4.) This can help to get an overview about the present day international knowledge of this subject.

9. Conclusion of the meeting
   - the frontal collision of buses is a rather severe accident category endangering both the bus occupants and the other road user partners
   - there are 13 ECE regulations and one EU directive related to frontal collision of other vehicle categories covering the subject of driver protection, passenger protection, underrun protection, structural integrity, partners protection, etc. These regulations could serve as good examples and basis for regulating buses, too.
   - the following step in this subject could be: the informal expert group could prepare a proposal to GRSG:
     – which subjects, problems should be regulated in respect of bus frontal collisions
     – which case could be solved by an extension of existing ECE regulation and where is a need for new regulation
     – priority order of succession among the subjects to be regulated
   - A short presentation should be given to GRSG on its next October meeting to show the main questions of the bus frontal collisions.

dr. Matolcsy Mátyás Prof. Francisco Aparicio

Annex 1

ECE REGULATIONS RELATED TO FRONTAL COLLISIONS OF VEHICLES

No. of the Reg.	Subject of the Regulation	Scope of the Reg.	Remarks
Reg.12.	Protection of the drivers against the steering mechanism in the event of impact	M_1 and N_1 below 1500 kg	Dynamic impact test (48 km/h and 24 km/h)) without dummy against rigid barrier. Requirements for the motion of steering wheel and force limitation
Reg.14.	Safety belt anchorages	M and N	Static and/or dynamic tests
Reg.17.	Seats and their anchorages and head restraints	M_2, M_3 N	Geometrical and functional requirements, also strength requirements against static load
Reg.26	External projections of vehicle	M_1	Surface requirements (geometrical and hardness) to reduce the agressivity of cars
Reg.29	Protection of the occupants of commercial vehicle cab	Trucks (N_3)	Dynamic tests for front wall and roof of the cab. Survival space is required for the driver
Reg.33.	Structural behaviour of impacted vehicle in a head-on collision	M_1	Dynamic impact test (48 km/h) without dummy. Geometrical requirements and certain limitation of the deformations, door opening requirements
Reg.42.	Front and rear protective devices (bumpers, etc.)	M_1	Dynamic low speed test with a rigid impactor, longitudinal (4 km/h) and corner impacts (2,5 km/h) No damage in lighting and signalling devices, fuel system, exhaust system, etc.
Reg.44	Restraining device for children occupants	M_1 (?)	Dynamic impact test
Reg.61	External projection of commercial vehicles	N	General and geometrical requirements
Reg.80.	Strength of bus seats and their anchorages	M_3	Bus passenger seat as a unit may be tested independently and also its anchorages to the body. Static and dynamic test methods may be used for approval
Reg.93.	Front underrun protection	N_2 and N_3	The goal of this regulation is reduce the agressivity of the vehicles against pedestrians and weaker partners in frontal collision
Reg.94	Occupant protection in case of frontal collision	M_1	Dynamic impact test with biomechanical limit values
Reg.114.	Replacement of airbag modules	M_1, N_1	Requirements for after market equipments when replacing the used module

EU DIRECTIVES

Most of the ECE regulations have a parallel EU directive. There is one EU directive, which does not have equivalent ECE regulation: Directive 2000/4/CE for cars (M_1)

Annex 2.

DIFFICULTIES WHEN COMPARING DIFFERENT ACCIDENT STATISTICS

Different authorities in different countries, different expert groups, different road and police organizations, insurance companies, transport companies, etc. Are collecting road accident statistics. They have different interests, different considerations, different goals.
Therefore the data collection has different basis, for example those accidents are considered only where:

- bus occupants were killed (at least one)
- bus occupants were injured (and killed)
- anyone were killed in the accident (partners, too)
- anyone were injured in the accident
- the damage of the bus exceeded a certain value (no need for injury)
- only a certain bus category is considered (e.g. class I. or class III. etc.)
- bus accidents on certain road types (e.g. only on highways, or rural roads, on city streets, etc.)
- collisions only with category of certain objects (heavy vehicles and fixed objects)
- the multiple accidents are involved or excluded

STATISTICS

Comparing the casualty rate in rollover and frontal collision

casualty rate = casualty/accident

Accident situation		Fatality rate	Injury rate	All casualty rate
All rollover accident	(157)	11,0	13,3	24,3
"Protected" rollover	(86)	5,8	13,4	19,2
Rollover in which survival space unharmed	(32)	1,0	11,0	12,0
Rollover in which survival space damaged	(30)	12,8	20,2	33,0
Frontal collision with car, light truck	(12)	0,2	1,5	1,7
Frontal collision with heavy vehicles, stable objects and pole like objects	(40)	8,3	14,7	23,0
Australian data*		7,0	27,0	34,0

*Presented in the journal: Australian Bus and Coach 16. January 1998. Only coaches were considered 1987-94. Including head on ompact side impact rollover.

Annex 4.

TECHNICAL PAPERS, PUBLICATIONS
About bus frontal collisions

Those publications are listed below which were published after 1993 and which are available for everyone (in journals, conference proceedings including CD-s too, books, etc.)

Matolcsy M. Crashworthiness of bus structures and rollover protection. Crashworthiness of Transportation Systems: Structural Impact and Occupant Protection. Kulwer Academic Press. (ed. J.A. Ambrosio) 1997. p.321-360

Matolcsy M. Frontal collision of buses. – Problems, questions regulations. 33rd Meeting of Bus and Coach Experts. Keszthely (Hungary) 2002. GTE p.14

Matolcsy M. Protection of bus drivers in frontal collisions. 18th ESV Conference, Nagoya (Japan) 2003. Paper No. 359. p.11

Matolcsy M. Frontal collision of buses – Lessons learned from real accidents. 9th EAEC Congress, Paris 2003. Paper No. C216 p.10

Sukegawa, Y. Matsukawa, F. Okano, S. Results and experience of bus full-scale head-on collision tests. 30th Meeting of Bus and Coach Experts. Győr (hungary) 1999. GTE Vol.2. p.187-193

Sukegawa, Y. Matsukawa, F. Kuboika, T. Study of large bus crash test. JARI Research Journal, 20-11

Langwieder, K. Coaches and buses in accident scene. Result of a study regarding passenger protection. 33rd Meeting of Bus and Coach Experts. Keszthely (Hungary) September 2002. GTE p.27

Gewehenberger, J. Langwieder, K. Bende, J. Der Kraftomnibus im aktuellen Umfallgeschehen. Risikopotential für Reise und Linienbuspassegiere. 43rd München Arbeitskreis für Strassenfahrzeuge. München October 2001. p. 29.

Aparicio F., Garcia A. Coaches in traffic accidents. A study of the Spanish situation during the years 1984-1988. Proc. of the XXI Meeting of Bus and Coach Experts, Budapest, GTE. 1990 p.3-11

Liurow, M. Erprobe der Gasbuse auf die passive sicherheit. Proc. of the XXI Meeting of Bus and Coach Experts, Budapest, GTE. 1990 9. 22-29.

Aparicio, F. Garcia, A., Fazio, E. Longitudinal strength of coaches in high speed frontal and rollover accident Proc. of the XXVII. Meeting of Bus and Coach Experts Budapest, GTE 1996 p. 349-356

Berg, A. Niewöhner, W. Bus safety analysis results and assessments by DEKA accident research. Proc. of XXX Meeting of Bus and Coach Experts Győr, Hungary GT+E 1999 Vol.2. p.121-147

Berg, A. Niewöhner, W. Pointers toward the improvement of safety in buses, derived from an analysis from 371 accidents involving buses in Germany 16th ESV Conference Paper No 98-94-0-03, Windsor, Canada 1998

Perea, A. – Aparicio, F. – Garcia, A. Passive safety improvements of buses and coaches. Proc. of XXIV. Meeting of Bus and Coach Experts (1993) Budapest, GTE Vol.2. p.314-323

Grandel, J; Niewöhner, W: Untersuchungen zur inneren Sicherheit von Kraftomnibussen, Berichte der Forschungsvereinigung Automobiltechnik (FAT) (1995), Heft Nr. 122, Frankfurt (Main), 93 pages

Niewöhner, W; Berg, A; Mann, T; Egelhaaf, M: Accident Occurrence of School Buses - Results of a pilot study, 33rd Meeting of Bus and Coach Experts. Keszthely (Hungary) 2002. GTE, 22 pages

Neumann, L; Hofmann, P; Schaaf, B; Berg, A; Niewöhner, W: Unfall- und Unfallkostenanalyse im Reisebusverkehr, Berichte der Bundesanstalt für Straßenwesen, Reihe Mensch und Sicherheit, Heft M110, 1999, 64 pages