

Frontal collision of buses

1. On the 84th session of GRSG the Spanish delegate raised the problem of the frontal collision of buses and pointed out the severity of this type of accident. He proposed certain regulatory work on this field. Hungary supported this action. Spain organised two voluntary expert meetings (12 participants) in Madrid. Certain working documents of these meetings, a report including proposals were presented to GRSG the list of which may be found in Annex 1 together with other GRSG informal documents belonging to this subject.

2. Table 1. in Annex 2 summarizes the opinion of the expert group about the possible and needed activities on the field of safety in bus frontal collisions. The proposed priorities and the responsible GR-s are also listed.

3. Structural integrity of the front part of the bus in frontal collision covers more safety issues:

- protect the driver sitting in the direct deformation zone
- protect the crew (if any) sitting in a similar (symmetrical) position as the driver
- protect the passengers, if they are sitting in line with the driver (in the direct deformation zone)
- protect the vital control systems (steering, braking, electric and electronic, etc.)

4. The Summary Report of the ECBOS project in paragraph 20.2 “Suggestions for new regulations and written standards”, in the chapter “Recommendations about new regulations” proposes “research for driver/co-driver frontal impact safety”. Later (on page 174) the text says: “The analysis of real world accidents indicated that the occupants in the first row (driver, guide) can be ejected through the front window, or affected by the intrusion of coach elements. Assuming that both the driver and co-driver are belted, the major problem is the energy absorption of the frontal area and the intrusions... if the drivers were correctly protected... they remained conscious and were not seriously injured, they would keep the control of vehicles in manoeuvres after the accidents and would make easy the evacuation... the driver’s safety is not adequately considered in current regulations.”

5. In the Report of European Vehicle Passive Safety Network 2: Prospective Study on Bus and Coach Safety (January 2004) the problems belonging to the frontal collision, among others the protection of driver and passengers got high “importance index.”

6. Many bus accident statistics (more thousands bus accidents) have been collected and analysed during the work of the informal Madrid meetings from different countries, different sources, from which only three summary tables are presented in Annex 2 to prove that there are information enough to start thinking and working on solutions.

Table 2. in Annex 2. collects some accident statistics in which buses are involved and injury happened either among the bus occupants or among the traffic partners.

Table 3. (see Annex2.) concentrates only those accidents in which bus occupants were injured and gives the rate of the frontal collisions.

Table 4. shows the driver/passenger (D/P) casualty rates in all types of bus accidents and in frontal collisions.

Comparing the injury probability (IP) of the driver and an average passenger in different accident situations it may be said:

- in side impact the driver has lower IP
- in rear impact the driver has lower IP
- in rollover the IP is equal for driver and passenger
- in fire the IP is equal for driver and passenger
- in frontal collision the driver has higher IP

This means that the high D/P casualty rates considering all types of bus accidents are due to the frontal collisions. Table 2. shows that the ratio of frontal collisions is in the range of 50-60% among all bus accidents. So the D/P casualty rate for frontal collisions is at least twice higher than that for all accidents.

Similar D/P casualty rates may be derived from the ECBOS data for all kind of bus accidents as it is shown in Table 5 (Annex 2.)

7. Having limited capacity in GRSG, a decision should be made about the priorities among the subjects proposed by the ad-hoc expert group. If GRSG could accept the driver's protection as 1st priority subject, as it was proposed by the group and supported by the ECBOS conclusions and EVPS. Having this decision, two ways of work could be used:

- establishing an informal expert group by GRSG
- keeping the work on GRSG level and using a step by step approach

8. Step by step approach means that a voluntary delegate (expert) prepares for GRSG documents for decision in the most important, essential questions of regulating the driver's protection. These documents should contain the possible, reasonable alternatives but only on general level (not on paragraph level) and GRSG may choose the most appropriate solution in the given question and go on the next one. Hungary undertake this voluntary work of document preparation.

9. The possible main issues, questions could be:

- The scope and the frame of the future regulation
- Definitions, especially vehicle type, family of vehicle types and worst case
- The main requirements
- The possible approval test(s)
- Modification and extension of approval of a vehicle type

Of course, if it seems to be necessary during the work, further main issues may be pointed out and discussed.

10. Having a clear picture and acceptable answers on the main questions GRSG will be in the position to make the final decision about the necessity and the frame and form of a future regulation on the basis of which the paragraph by paragraph elaboration of the regulation can be started.

GRSG informal documents dealing with the frontal collision of buses

The following documents contain useful, usable, interesting information, statistics, etc. about frontal collision of buses:

Inform. Doc. No.6. 65 th GRSG, Oct. 1993	Driver and passenger casualties, all buses and coaches 1971-1992 (Presented by UK)
Inform. Doc. No.3. 75 th GRSG, Oct. 1998	Measures for safety of buses concerning the improvement of collision safety of drivers and passengers in Japan. (Presented by Japan)
Inform. Doc. No.5. 85 th GRSG, Oct. 2003	Report about the meeting held in Madrid, September 2003 (Frontal collision of buses)
GRSG-86- 4	Summary Report of ECBOS project
GRSG-86- 11	Accident statistics – frontal collision of buses. WD from the informal Madrid meeting.
GRSG-86- 12	The role of full-scale frontal impact test of buses WD from the informal Madrid meeting
GRSG-86- 13	Drawn report about the two meetings, held in Madrid
GRSG-86- 24	Persons and systems to be protected (Frontal collision of buses) WD from the informal Madrid meeting
GRSG-86- 23	Typical bus frontal collisions. WD from the informal Madrid meeting
GRSG-87- 31	Proposal for possible and necessary regulatory work in relation to bus frontal collisions. (Presented by Spain and Hungary)
GRSG-90- 31	Frontal collision of buses – Information learned from the ECBOS Summary Report (Presented by Hungary)

Some accident statistics supporting the importance of driver's protection in frontal collision of buses

Table 1. Proposals of the expert group to GRSG about the possible and needed safety activities in bus frontal collision

	Object of regulatory work	Related ECE Regulation	Related EU Directive	Responsible GR	Proposed priority	Estimation of needed work
1.	Strength of bus seats and their anchorages	R.80/01 R.17/04	91/676-03/20EC	GRSP	A	M
2.	General safety of buses (all kind)	R.107/Rev.1.	2001/85/EC	GRSG	B	M
3.	External projection	R.61/00		GRSG	B	S
4.	Safety belt anchorage	R.14/05 R.16/04	76/115-96/38EC 77/541-00/3EC	GRSP	B	S
5.	Structural integrity	R.107/Rev.1*	2001/85/EC	GRSG	A	M
6.	Underrun protection	R.93/00	92/114/EC	GRSG	B	M
7.	Limit of deceleration	-	-	GRSG	B	L
8.	Compatibility and aggressivity	-	-	GRSP	B	M

Symbols:

A = first priority

B = second step priority

* = it could be an independent new regulation, too

S = short work, less than 2 years, it does not need further study and analysis

M = medium size work, 2-4 years, it needs certain study

L = Long term work, more then 4 years, further study, analysis, international discussion is needed

The first six objects in the table have certain basis, background among the existing regulations, but the last two ones do not have this.

Table 2. Bus accident statistics from different sources

Bus accidents with injuries (or fatalities)	Hungarian [1]	German [3]	German [4]		Spanish [6]	Spanish [2]
			official data	special collected data		
time period	1978-82	1998	1996	1985-97	1984-88	1995-99
Number of accident	1803	579	930	288	546	1682
Studied bus categories	large buses and coaches	large buses and coaches		large buses and coaches	large coaches	large coaches
Pedestrian overrun	27,7%	15,5%	27,9%	4,1%	16,6%	10,7%
Collision with bicycle, motorcycle	27,3%	16,1%	24,2%	5,2%	7,4%	-
Collision with car and van	27,7%	56,1%	44,0%	53,7%	} 57,5%	34,2%
Collision with heavy vehicle	12,1%	8,4%	3,7%	22,0%		38,6%
Impacting rigid object	1,7%	1,3%	-	} 8,2%	0,6%	6,5%
Rollover	1,2%	1,7%	-		6,0%	4,6%
Others	2,3%	0,9%	-	6,8	12,9%	5,4%
	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Table.3. The ratio of frontal collisions among all kind of accidents in which bus occupants were injured

Type of collision	Hungarian [1]	Japanese [5]	Spanish [2]	Spanish [6]	German ⁽³⁾ [11]
Time period	1978-82	1992-94	1995-99	1984-88	1978-84
Number of accidents	770	106	1662	420	100
Frontal collision	57,2 %	61,5 %	55,5 %	59,5 %	61,7 %
Side impact	17,8 %	6,1 %	11,4 %	16,1%	17,4 %
Rear impact	22,1 %	8,4 %	20,7 %		9,6 %
Other	-	24,0 % ⁽¹⁾	7,3 %	16,6 % ⁽²⁾	4,1 %
Rollover	2,9	-	5,1 %	7,8 %	7,2 %
	100,0 %	100,0 %	100,0 %	100,0 %	100,0 %

Remark: (1) this figure involves the rollover, too
(2) including the multiple accidents, too
(3) specially collected, deeply analysed accidents

Table 4. Driver/passenger casualty rates in all types of bus accidents and in frontal collisions.

D/P injury rate	All type of bus accidents					Frontal impact only
	Japanese [3]	Spanish [2]	German [4]	U.K. [5]	Hungarian	
Fatality	83:1	6:1	8:1	5:1	5:1	125:1
Serious injury	13:1	3:1	10:1	4:1	3:1	18:1
Light injury	7:1	2:1	6:1	3:1	3:1	4:1
Total number of casualties	4800	2400	4500	234,616	4300	3200
Time of observation	1992-94	1984-88	1979	1971-92	1987-92	1992-94

Table.5. D/P casualty rates derived from the ECBOS data for all kind of bus accidents

Among the 8 participating countries	D/P fatality rate	D/P injury rate
Minimum value	3:1	4:1
Average value	9:1	8:1
Maximum value	20:1	20:1

References in which further information may be got to the better understanding of Table 2, Table 3 and Table 4.

- GRSG-86-11 Accident statistics –frontal collision of buses. WD of the informal Madrid meeting (2004)
- Matolcsy M. Constructional aspects of bus driver’s compartment in relation to frontal collision. Proc. of Conference on Vehicle Safety, London, December, 2004 IMechE, p.10
- Matolcsy M. Lessons learned from the frontal collision tests of buses. FISITA Congress, Barcelona June, 2004. Paper No. 2004V286.
