

Submitted by the expert from Finland

Informal document GRSP-70-06
70th GRSP, 6-10 December 2021
Agenda item 6



Three-point safety- belts in buses and coaches

Background

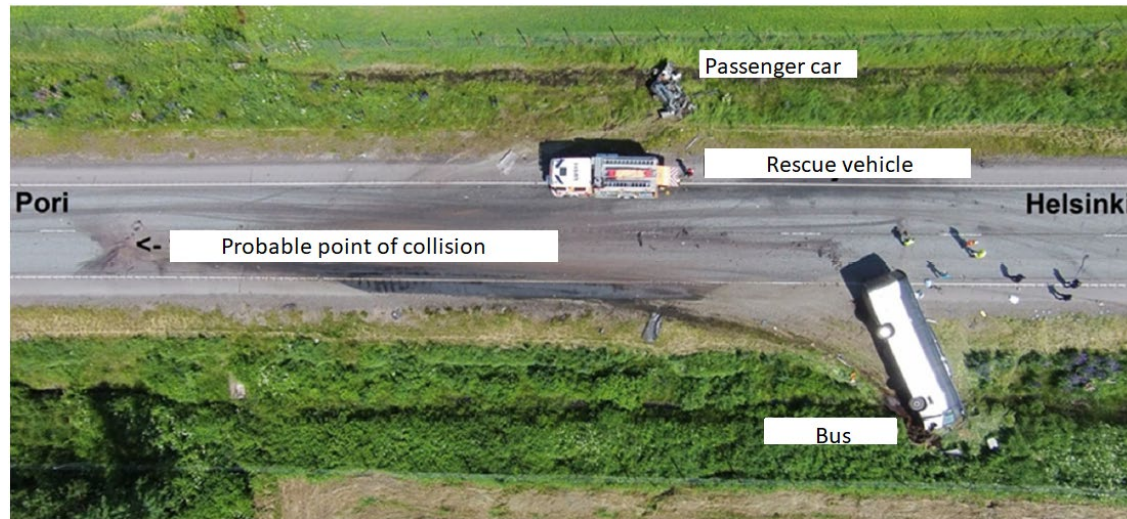
- ▶ Finland has raised a concern about the safety of passengers in buses and coaches due to requirements of the seat back and lack of three-point safety-belts. (GRSP-66-07 and GRSP-66-08)
- ▶ Concerns were based on investigations and safety recommendations of the Finnish Safety Investigation Authority
- ▶ On 68th meeting, GRSP agreed to resume consideration (on the basis of accident data) of a proposal from the expert from Finland on the possibility to require three-point safety-belts in M2 and M3 categories of vehicles
- ▶ Need of accident data, benefits of three-point safety-belts in frontal collisions and portion of frontal collisions were discussed in earlier sessions of GRSP

Current requirements for safety-belts in R16

<i>Minimum requirements for safety-belts and Retractors</i>						
<i>Vehicle category</i>	<i>Forward facing seating positions</i>				<i>Rearward-facing seating positions</i>	<i>Side-facing seating position</i>
	<i>Outboard seating positions</i>		<i>Centre seating position</i>			
	<i>Front</i>	<i>Other than front</i>	<i>Front</i>	<i>Other than front</i>		
$M_2 > 3.5\text{ t}$	Br3, Br4m, Br4Nm, or Ar4m or Ar4Nm ●	Br3, Br4m, Br4Nm, or Ar4m or Ar4Nm ●	Br3, Br4m, Br4Nm or Ar4m or Ar4Nm ●	Br3, Br4m, Br4Nm or Ar4m or Ar4Nm ●	Br3, Br4m, Br4Nm	-
M_3	Br3, Br4m, Br4Nm, or Ar4m or Ar4Nm ● See para. 8.1.7. for conditions when a lap belt is permitted	Br3, Br4m, Br4Nm, or Ar4m or Ar4Nm ● See para. 8.1.7. for conditions when a lap belt is permitted	Br3, Br4m, Br4Nm or Ar4m or Ar4Nm ● See para. 8.1.7. for conditions when a lap belt is permitted	Br3, Br4m, Br4Nm or Ar4m or Ar4Nm ● See para. 8.1.7. for conditions when a lap belt is permitted	Br3, Br4m, Br4Nm	B, Br3, Br4m, Br4Nm

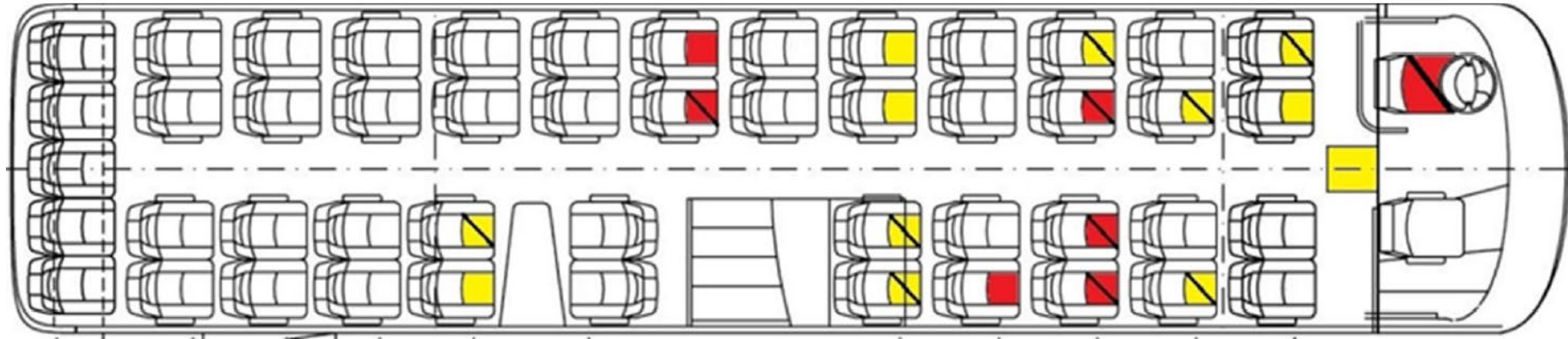
- ▶ 8.1.7. Every seating position in Annex 16 marked with the symbol ●, three-point belts of a type specified in Annex 16 shall be provided unless one of the following conditions is fulfilled, in which case two-point belts of a type specified in Annex 16 may be provided.
 - ▶ 8.1.7.1. There is a seat or other vehicle parts conforming to paragraph 3.5. of Appendix 1 to UN Regulation No. 80 directly in front; or
 - ▶ 8.1.7.2. No part of the vehicle is in or, when the vehicle is in motion, capable of being in the reference zone; or
 - ▶ 8.1.7.3. Parts of the vehicle within the said reference zone comply with the energy absorbing requirements set out in Appendix 6 of UN Regulation No. 80.

Accident in Karkkila, Finland, 2015



- ▶ In July 2015, a collision occurred between a passenger car and a bus.
- ▶ The passenger car suddenly moved to the oncoming lane right before the collision and hit the left front part of the bus.
- ▶ The bus had a total of 19 people in it, of which the driver and six passengers were seriously injured. The rest of the passengers suffered minor injuries, though these injuries did have a clear impact on their ability to function.
- ▶ More information on accident: [link](#)

Seating positions and injuries (Karkkila, 2015)



Picture: Probable seating positions of the passengers.

Red = serious injuries, yellow = minor injuries, black line = seat-belt fastened during accident

- ▶ Serious injuries included a basilar skull fracture and complex facial fractures
- ▶ The less serious injuries included for example concussion
- ▶ Any correlation between the seriousness of the injuries and usage of the 2-point belt cannot be seen.

Accident data: Brief introduction to statistical study of bus accidents (GRSG-109-03)

- ▶ The document from the expert of Hungary (GRSG-109-03) introduced statistical accident data about accidents and injuries in buses. Data is based on media reports.
- ▶ About one-third of the collisions are frontal collisions (FC in table)

Type of accident	Rollover	Frontal collision	Rear and side collision	Direct fire	Combined accident	Collision with train	Special accidents	Total
	R	FC	RSC	F	CA	CT	S	
Hungary	176	335	28	65	11	6	19	645
Europe	168	96	7	13	28	12	5	324
World	201	124	2	20	146	15	17	525
Σ	545	555	37	98	185	33	41	1494

Bus category	R	FC	RSC	F	CA	CT	S	Total
Class I City	9	81	5	41	4	-	11	151
Class II Interurban	84	139	14	21	30	8	11	307
Class III Tourist	205	99	6	19	43	4	4	380
Double decker (DD)	29	12	-	3	3	1	5	53
Small bus (SB)	88	150	10	2	18	8	4	280
Other	23	18	1	4	16	4	1	67
Not known	107	56	1	8	71	8	5	256
Σ	545	555	37	98	185	33	41	1494

- ▶ Frontal collisions do have relatively high Accident Casualty Rates (number of casualties in one accident.)

Table XII.

Categories of frontal collision	Casualty rates Number of events	Accident casualty rates (ACR _x)		
		Fatality rate (R _F)	Injury rate (R _I)	All casualty rate (R _A)
All small buses (SB)	150	10,2*	11,4*	21,6*
All large buses (LB)	405	6,2	10,3	16,5
LB with small objects	147	0,6	3,3	3,9
LB with large, stable objects	258	6,7	12,6	19,3
All LB city buses	81	0,1	4,2	4,3
LB with high energy input	48	12,9	19,4	32,3
LB with low energy input	78	0,2	5,4	5,5

*comperative casualty rate (see equ.4)

Simulation data: ECBOS: Enhanced Coach and Bus Occupant Safety

- ▶ ECBOS study (Enhanced coach and bus occupant safety) was made during years 2000-2003. ECBOS project was funded by the European Commission under the competitive and sustainable growth program of the 5th framework.
- ▶ As a part of the study, simulations of roll-over, frontal and rear collisions were performed.
- ▶ In the report, using a 3-point belt system was recommended:
“It is recommended to prevent the contact between passenger head and seat back in front in most cases. The validated models for frontal impact showed that, even for crash pulses higher than the 80 regulation one, which should be prevented when using a 3-point belt. The use of a 2-point belt produces a higher neck extension moment for a frontal impact than a 3-point belt. Attention must be paid to the correct restraining of children.”

ECBOS. Enhanced Coach and Bus Occupant Safety. Final report. Project N°: 1999-RD.11130. [Link](#) [12.8.2021]

Accident data: 128 injured in roll over coach crashes in Sweden – injury outcome, mechanisms and possible effects of seat belts

- ▶ The article is part of a medical dissertation of the Umeå University.
- ▶ Results of the studies are presented also in GRSG (GRSG-89-24)
- ▶ According to the study, a 3-point belt may provide an injury reduction of about 80% of the severe injuries
 - ▶ The study mentions also the upper anchorage point of the 3-point belt shall be mounted towards the window side
- ▶ These results were based on three coach crashes, involving 128 injury cases, occurring over three years in Sweden.

Albertsson P, Falkmer T, Kirk A, et al. (2006). Case study: 128 injured in roll over coach crashes in Sweden – injury outcome, mechanisms and possible effects of seat belts. Journal of Safety Science 2006; 44:87-109

Rollover situation for coaches – a serious risk for injuries. Informal document No. GRSG-89-24 (89th GRSG, 11-14 October 2005, agenda item 1.3.) [Link](#) [12.8.2021]

Simulation data: Effectiveness of seat belt usage on the rollover crashworthiness of an intercity coach

- ▶ Gueler & al (2009) studied the effectiveness of seat belts on rollover crashes with simulations.
- ▶ Results of the simulations were HICs and neck forces of the passengers without seatbelts, with 2p-belts and with 3p-belts.
- ▶ According to the results, two-point and three-point belts resulted in approximately the same level of safety. Three-point belts decreased the risk of head injuries but increased the risk of neck injuries in rollover accidents.

Gueler, M., Atahan, A., & Bayram, B. (2009). Effectiveness of passenger seat belt usage on the rollover crashworthiness of an intercity coach. Proceedings of the 21st (ESV) International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, Germany. [Link](#) [6.8.2021]

Summary of the cost and impact analysis (Based on Finnish data of M₃, Class III vehicles)

- ▶ An average of 73 buses are first registered each year in category M3 class III in Finland.
- ▶ Equipping these new buses with three-point seat belts instead of two-point seat belts would incur an additional cost of €104 000–174 000 per year. (Based on an estimation of 30–50 € additional cost per seat)
- ▶ Three-point seat belts would prevent approximately 3–20 bus passenger injuries per year based on in-depth accident studies.
- ▶ Savings in accident costs (€0.5 - 3.4 million) exceed the additional seat belt costs
- ▶ Even if we consider only real economic accident costs like medical and rescue costs, the minimum monetary safety benefit is approximately the same as seat belt costs.

Conclusions according to presented data

- ▶ According to data gathered from the Karkkila accident, serious head and face injuries have occurred although the requirements in 8.1.7 allowing the use of lap belt has been fulfilled during type approval.
- ▶ The same conclusion was found in the ECBOS report based on the simulation of frontal collisions. In addition, the issue of restraining children was raised.
- ▶ The benefits of three-point belts in roll-over accidents are not as evident as in frontal collisions.
- ▶ According to GRSG-109-03, approximately one-third of the accidents are frontal collisions. In addition, frontal collisions have relatively high Accident Casualty Rates (number of casualties in one accident.)
- ▶ According to Finnish data, cost and impact analysis show the benefits of the three-point belts.

Proposal for the way forward

- ▶ We would like to hear the opinions of the delegations on removing the lap belt derogations laid down in Annex 16 and point 8.1.7. of the UN Regulations 16 and the corresponding points on Regulation 14.
- ▶ Based on the discussions, Finland will consider drafting a working document for the 71st session of GRSP to remove the lap belt derogations from the UN Regulations 16 and 14 by adding new series of amendments with transitional provisions.

Thank you

