

## **Laminated safety glazing as side windows on buses**

### **1. History**

Since the beginning of discussing the rollover problems of buses the danger of passenger ejection is known and discussed. First UK reported about this problem in the '70-s and it was followed by many others during the years. Several main sources of danger (risk of injury) can be concluded from these accident analyses:

- The passengers were ejected through the broken windows and were compressed by the rolling bus.
- In a rollover situation, when the bus turns on its side and slips away, the passengers – while the side windows were broken – were wiped out by the road surface or by the ground. This may be called as partial ejection.
- Intrusion into the bus of dangerous objects, such as big rocks.
- Passengers were injured by crushed glass.

### **2. Precedents**

To prevent the ejection: the use of laminated safety glazing as side windows is a returning proposal – as a possible solution – since many years. On the last GRSG meeting, during the discussion of the rollover subject, Sweden and UK raised this option again as a possible effective way to reduce the risk of ejection in rollover. Hungary supported to analyse this possibility. This paper tries to collect all the belonging questions helping GRSG to make a decision.

### **3. Possible tools against ejection.**

Four ways are known to reduce the risk of ejection and partial ejection:

- Horizontal rail (hand strap) at the side windows, at the shoulder height of the seating passengers. Less effective method against ejection, instructions and crushed glass, could help against partial ejection.
- Safety belt on every seat. Effective against ejection if it is used, less effective against partial ejection instructions and crushed glass. Three-point seat belts are more effective than two-point belts.
- Laminated glassing as side windows. Most effective all in both cases.
- Smaller windows. The height of side windows could be reduced. Could reduce the injury risk in all cases, but its measure is a question.

May be the best solution is to use the four tools together.

### **4. Technology of laminated safety glazing.**

The laminated safety glazing is widely used in the automotive industry, as well as in the bus industry as the windscreen of the vehicle. To have an effective tool against ejection, the laminated safety side windows shall be glued into the sidewall (rubber profile is not appropriate). This gluing technology is widely used for the moment in the bus industry.

There is no need for further development or test to introduce the laminated safety side windows in buses.

### **5. Emergency windows**

Nowadays the emergency windows are mostly made from heat-treated breakable safety glass. The laminated safety glass is not breakable, so it is not a simply process to change the material of an emergency side window, the construction of this window has to be also changed. The

construction of the hinged emergency windows are known and used in the practice. The bus regulations also refer to this solution, so it is not a technical novelty to be developed.

## **6. Regulatory background.**

- 6.1. The glazing materials – including the laminated safety glazing, too – their requirements and test methods are covered by ECE-Reg.43 and also a new GTR is being in process. It should be checked whether these regulations are appropriate for this purpose as well and whether the section on installation of safety glazing should be amended.
- 6.2. The requirement for using laminated safety side windows – if it is decided – should be put into the bus regulations: ECE-R.36; R.52; R.107 and R.107/Rev.1. The requirements for emergency exits must be changed accordingly.
- 6.3. It should be also a question: in which categories would be obligatory the use of laminated side windows (May be for city buses – class I. – this would not be a requirement)
- 6.4. To put this requirements into the bus regulations, the following modifications are needed (as an example, Annex3. in R.107/Rev.1 is used):
  - A new paragraph is needed requiring the glued laminated safety glazing where seats are next to the window (other windows could be made from normal safety glazing)
  - The best place for this paragraph could be in para.7.3. (changing its title from “Strength of the superstructure” to “Rollover safety”) as para. 7.3.2.
  - Certain modifications are needed in para. 7.6.8 (“Technical requirements for emergency windows”) according to the new situation. Easy to do it.

## **7. Summary**

- The ejection and partial ejection of bus passengers, intrusions into the bus and the crushed glass in rollover accident are well-known severe risk of fatality and serious injury.
- To reduce this risk the use of laminated safety glazing as side windows could be an effective tool.
- Neither in the technology (gluing the side windows) nor in the construction of emergency windows (hinged solution) further developments, tests are needed.
- The regulatory work to put into force the requirements for laminated safety side windows on buses is a simple process. It needs only a positive decision.
- The only – and not negligible – question is the cost consequence of this decision. A detailed, clear cost/benefit analysis is needed to this decision.

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