Informal document GRSG-103-21
(103rd GRSG, 2-5 October 2012
Agenda item 2(a))

THE SAFETY BELT PROBLEM IN BUS ROLLOVER ACCIDENT

How to prevent the ejection of passengers?

(Explanation to informal document GRSG-103-04)

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103rd GRSG meeting
Geneva, October, 2012

SAFETY BELT

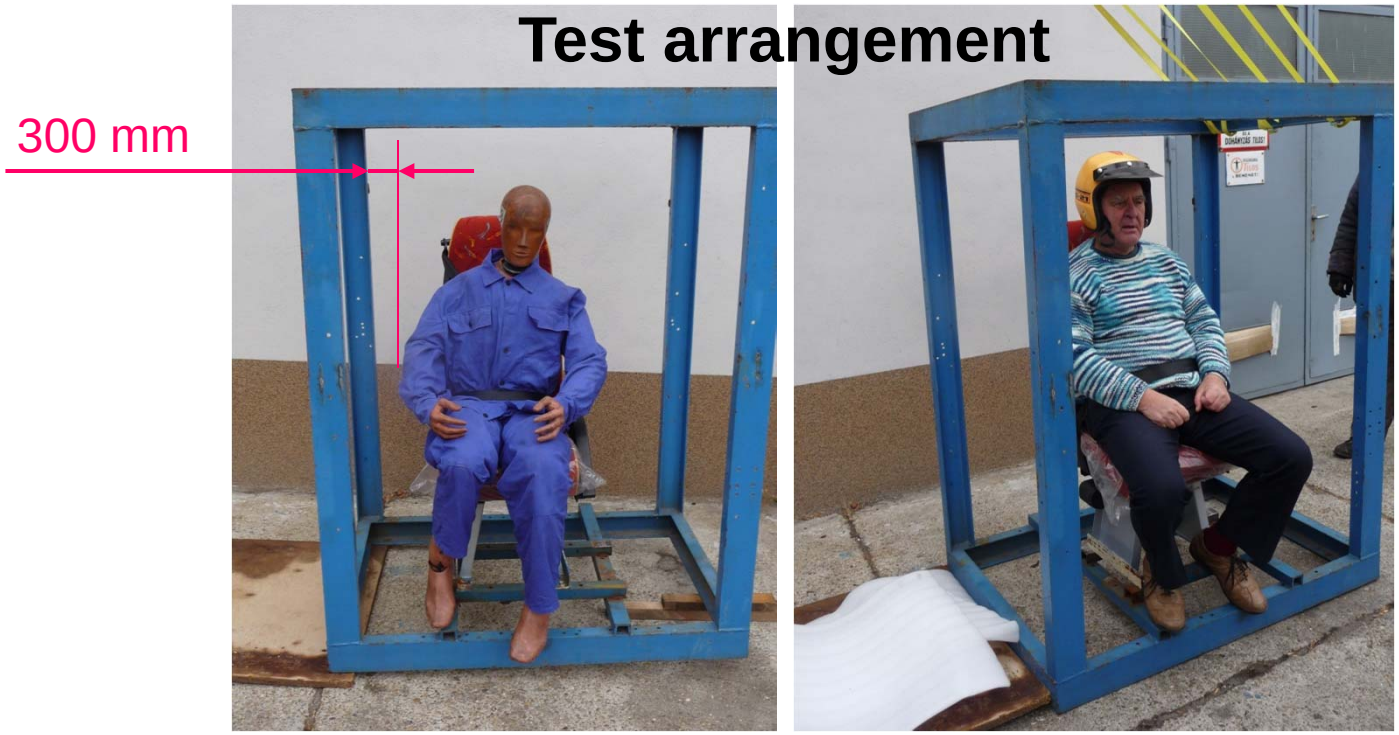
- Safety belt was developed to prevent projection in frontal collision
- The coach seats have to be equipped with safety belts
- It was thought that in rollover the safety belt also prevents:
  - both projection and ejection
  - both partial and total ejection
- 2 pts belt (airplane) and 3 pts belt was proposed and discussed
- Questions:
  - what about the standing passengers? (Class II)
  - how to make sure the obligatory use of the safety belt during a long journey?
  - is the safety belt really effective in rollover?
  - does safety belt have disadvantages?

SAFETY BELT

Quasi static and dynamic tilting tests were carried out in Hungary (AUTOKUT):

- to study the effectiveness of safety belt in rollover
- to compare the 2 pts and 3 pts belts
- to compare the behaviour of 50% male Hybrid III dummy and real passenger (human body), approximately with the same size
- to study (measure) the releasing force of safety belt after the tilting test, when the belt is loaded
- to study the possible disadvantage of the safety belt in rollover

SAFETY BELT



- strong, steel tilting frame
- real coach seat with 2 pts and 3 pts safety belt installation
- for safety reason the seat was shifted ~ 300 mm away from the „theoretical side wall”
- first the tilting frame was slowly rotated (**quasi static motion**) and reaching the equilibrium position it rotates quickly (**dynamic motion**) until reaching the ground

SAFETY BELT

Three tilting positions

Dummy with 3 pts belt

$\alpha = 20^{o}$

$\alpha = 25^{o}$

$\alpha = 30^{o}$

SAFETY BELT

Three tilting positions

Dummy with 2 pts belt

$\alpha = 20^{o}$

$\alpha = 25^{o}$

$\alpha = 30^{o}$

SAFETY BELT

Three tilting positions

Human body with 2 pts belt

$\alpha = 20^o$

$\alpha = 25^o$

$\alpha = 30^o$

It is impossible to be sitting on the seat without strong grasping, even at $\alpha = 20^o$

SAFETY BELT

Human body, 2 pts belt

Dummy, 2 pts belt

Dummy, 3 pts belt

Comparing the 3 tests

The dummy can not simulate the real passenger motion and behaviour

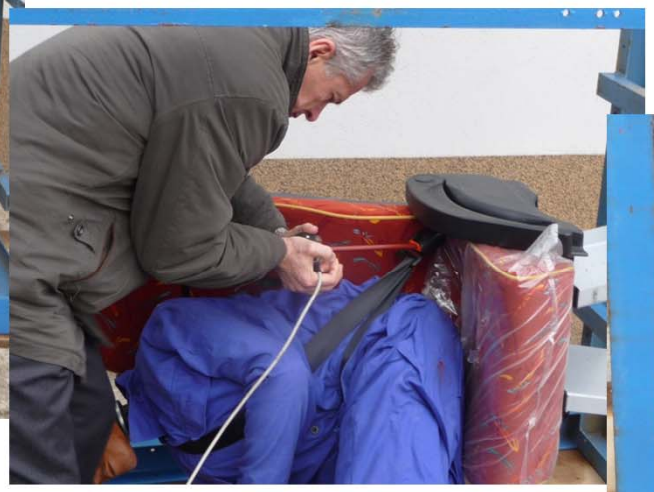
The dummy is too rigid in crosswise direction

SAFETY BELT

How to release the safety belt

Dummy with 3 pts

a) The dummy is hanging on the seat belt, only its feet are touching the ground



b) Trying to release the safety belt trough a force transducer (380 N)

c) The dummy fell out from the seat after releasing the belt

SAFETY BELT

Comparing 3 pts and 2 pts belts with dummy, in final position

3 pts belt, dummy is hanging on the belt

(Belt releasing force: 380 N)

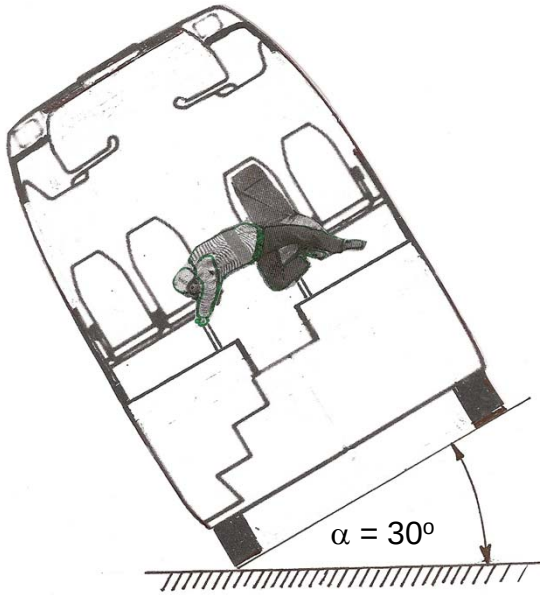
2 pts belt, dummy is hanging on the belt, but its head and arms are supported by the ground.

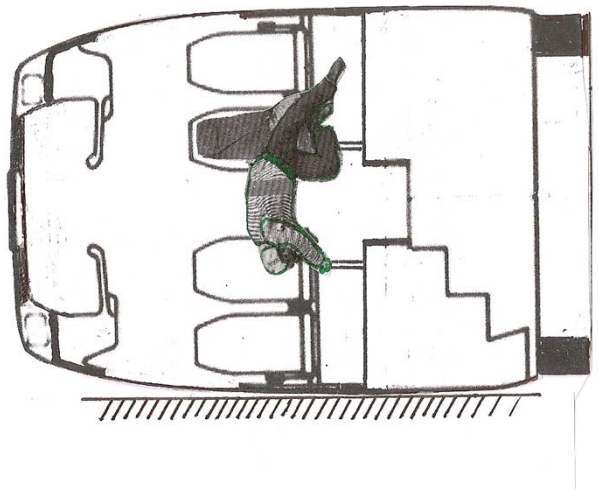
(Belt releasing force: 310 N)

Empty seat in normal position, belt releasing force: 29 N

SAFETY BELT

Just a notion, an estimation about the passenger's position



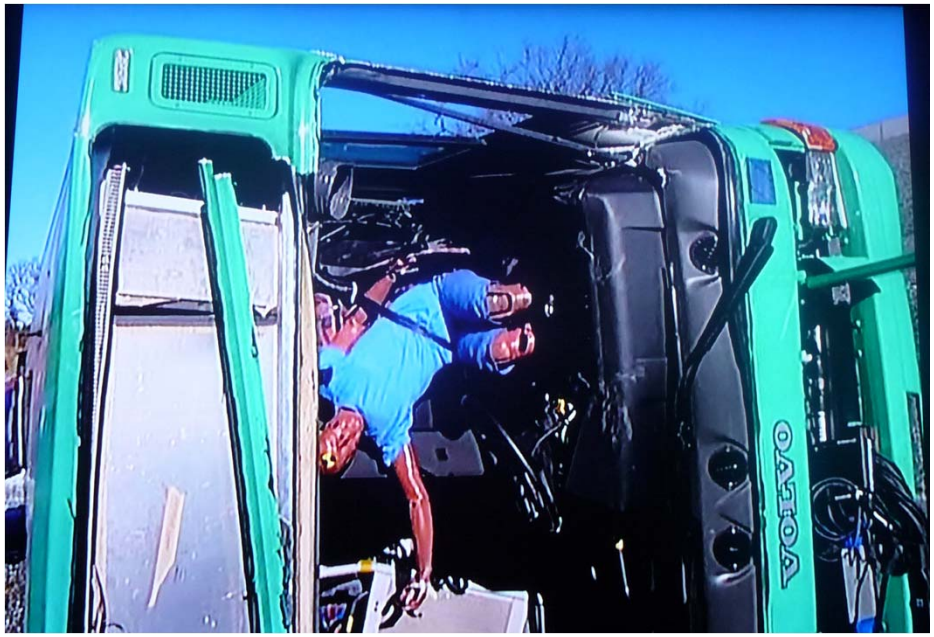


- think about 4 passengers in one row of seats
- consider panic after a rollover
- in case of a fire, there are only 3-5 minutes to evacuate the bus
- are the safety belts really „safe" in rollover?

SAFETY BELT

VOLVO rollover test

Starting (original) position



Final position after 3¼ rotations

MAIN CONCLUSIONS

- Safety belt can not solve the partial ejection (neither 3 pts nor 2 pts belt)
- If the bus is lying on its side or standing on its roof, the belted passengers are hanging on the belt and it is impossible to release the safety belt.
- The Hybrid III. dummies are not appropriate to simulate the human body’s behaviour in rollover (neither in test, nor in computer simulation), They are very rigid in cross-wise direction.