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Injury of a Passenger in a Public Transport Bus and a Possibility to Determine the Occurrence and Course of the Accident

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Abstract: ***The article deals with the fall and injuries of passengers on a bus which were caused by intensive braking of the bus. It includes a demonstration of a procedure by a technical expert using the PC Crash simulation program, as well as the FORTIS forensic system and the PC FORTIS forensic program. It was necessary to handle the aforementioned case with a passenger´s fall mainly based on the detected injuries, as the car did not stop at the scene of the accident and the location was neither documented nor closely identified. The article presents the procedures and results, as well as the method of injury parametrisation and localisation using the FORTIS system. It also includes the result of the whole investigation, which is the accurate determination of all relevant values and, consequently, a possibility to assess the entire case from a legal point of view.***

Keywords: Intensive braking, bus, passenger, injuries, car, PC Crash, PC FORTIS

1. Introduction

A bus as a means of transport is used to transfer passengers. Therefore, it is necessary to maintain the maximum safety of the persons being transported. Nevertheless, there are circumstances within the road traffic leading to a situation where a bus driver is forced to brake intensively or change direction abruptly in order to avoid a collision with another vehicle. Such situations might result an uncontrolled movement of passengers associated with falls and even injuries. For that reason, some of the seats on a bus are equipped with safety belts. If a passenger does not use the safety belts on the seats equipped with them, he/she puts himself/herself in risk. Moreover, there is a risk that his/her uncontrolled fall might cause an injury to other passengers as well. There are situations in which the aim of a traffic expert is to prove whether the other passenger were injured due to the fall of the passenger who had not used the safety belt, or whether they would have been injured due to their own fall, disregarding the fall of the passenger who had not used the safety belt, or whether such a fall would have occurred at all. The assessment of such cases is a challenging task and the presented cases might help professionals expand their knowledge in the field. In the presented cases it was necessary to assess the occurrence and course of the accident. The procedures followed by the technical expert using the results of the forensic evaluation and the FORTIS system are demonstrated as well.

2. Submitted details

Given the nature of the accident, the situation was not documented at the point where the accident happened, but at the point where the bus stopped. Therefore, the calculation in the PC Crash simulation program and the substantiation using the Fortis system and the FORTIS program may be considered the most reliable method, since it uses the detected injuries of the passengers, which are the only material data available to be used for the calculation [2]. The dimensions of the bus and position of the seats are shown in Fig.1:

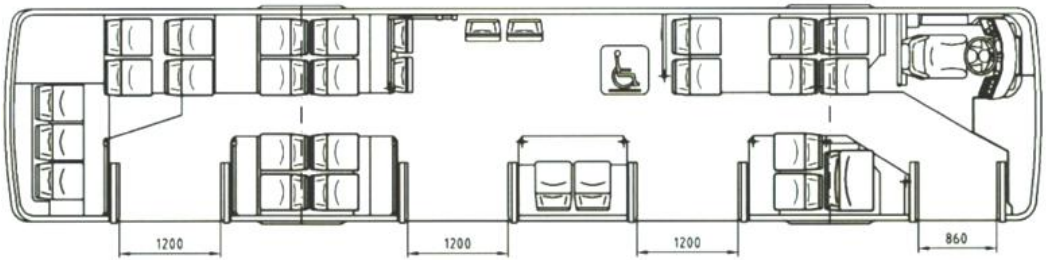


Figure 1: Drawing of the bus and position of the seats

Fig.3 shows the positions of the passengers on the bus, whereas

- passenger A was sitting on the seat not equipped with a safety belt
- passenger B was sitting on the seat equipped with a safety belt
- passenger C was sitting on the seat not equipped with a safety belt

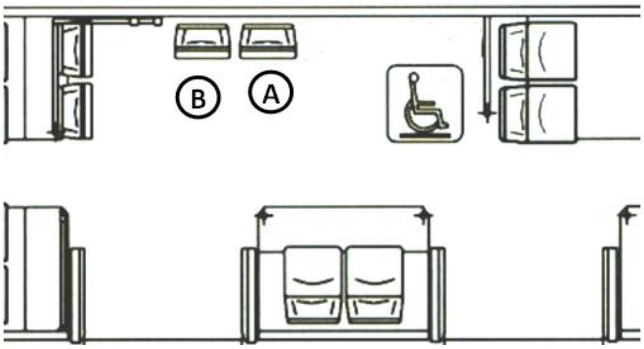


Figure 2: Positions of passengers A,B on the bus at the time the accident happened

Injuries suffered by passenger A:
Passenger A:

- A fracture of the right external ankle with a minimum movement of the fragments
- A contusion of soft tissues on the right forehead with a blood suffusion
- A contusion of the left arm
- A contusion of the left knee and shin

Fig.3 shows a possible mechanism of the external ankle fracture. Set your page as A4, width 210, height 297 and margins as follows [3]:

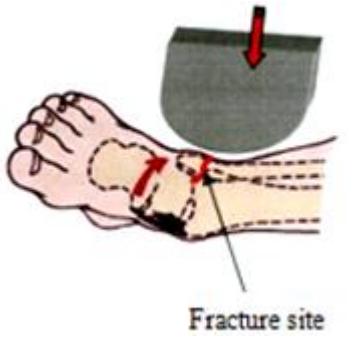
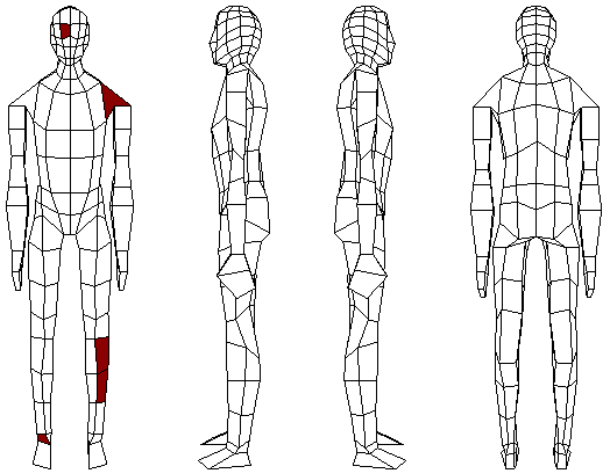


Figure 3: Possible mechanism of the external ankle fracture

The assessment and quantification of the passenger A´s injury were performed by means of the FORTIS scoring system *(Forensic Traumatology Injury Scale).* It is graphical representation of the localisation on a human body template in 128 topographic and anatomic areas. The injury quantification in the aforementioned case reflects the severity of the injuries incurred due to traffic accidents, depending on the mechanical energy causing the injuries. The localization designated on the human body template indicates the contact point where the mechanical energy was applied to the body surface of the injured person. The FORTIS system is a modification of the internationally accepted injury parameter standardization AIS/ISS (*Abbreviated Injury Scale/Injury Severity Score*) represents a method of parametrising under the influence of mechanical force. The aforementioned method is compatible with the calculation model of the PC Crash simulation program [3].
A view of the injury parametrization results of passenger A using PC FORTIS ©



Meno: A
Žena, 52 kg, 164 cm,
FORTIS

	Celkom	ZPZ	Ko1	Ko2
Trup	0	0	0	0
Panva	0	0	0	0
Pravé stehno	0	0	0	0
Pravé lýtko	2,6	2,6	0	0
Pravé chodidlo	0	0	0	0
Ľavé stehno	0	0	0	0
Ľavé lýtko	0,4	0,4	0	0
Ľavé chodidlo	0	0	0	0
Ľavé nadlaktie	0,4	0,4	0	0
Ľavé predlaktie	0	0	0	0
Pravé nadlaktie	0	0	0	0
Pravé predlaktie	0	0	0	0
Krk	0	0	0	0
Hlava	0,3	0,3	0	0
Ľavé koleno	0	0	0	0
Pravé koleno	0	0	0	0

Celkom: FORTIS ZPZ	3,7
Celkom: FORTIS Ko1	0
Celkom: FORTIS Ko2	0
FORTIS celkom	3,7

3. Bus and Car Movement

Based on the calculation of the bus movement in the PC Crash program, it was found out that at the bus speed of 42,0 kph a car at the speed of 22,0 kph entered the traffic lane of the bus and started to brake intensively and as a result the bus driver was made to brake the bus intensively too until it stopped behind the unknown car – Fig.4. Due to the intensive braking of the bus, passengers A,B fell down.

Fig.4 shows the movement of the bus along the main road and the car coming from the side road. The calculation of the positions is performed in the PC Crash simulation program [2] .

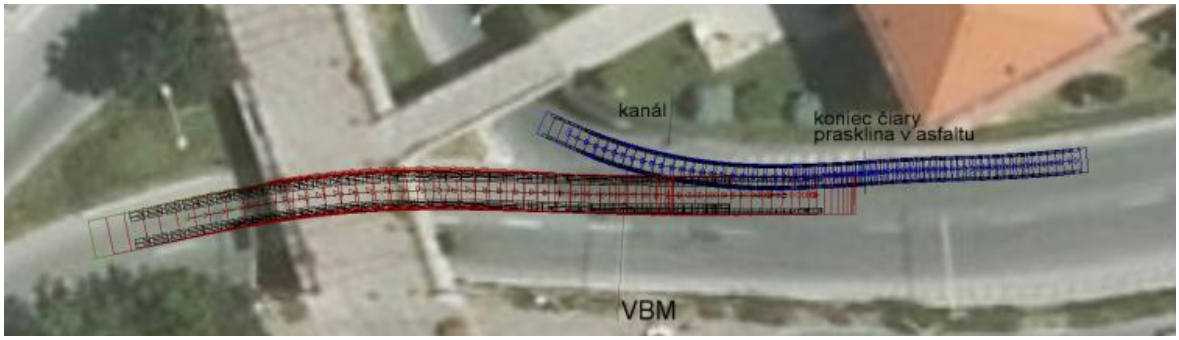


Figure 4: View of the bus movement along the main road and the car coming from the side road

Figure 5: shows the bus and car movement with a trajectory – speed diagram.

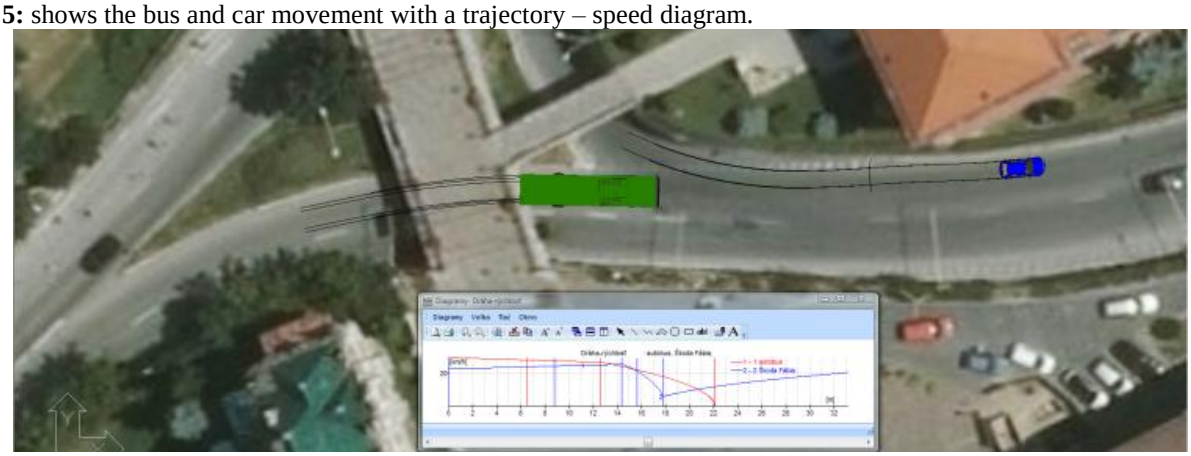


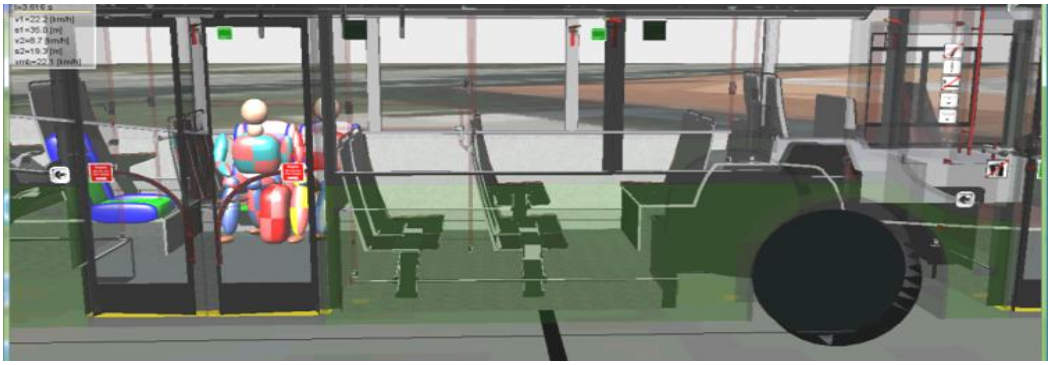
Figure 5: View of the bus and car movement with a trajectory – speed diagram

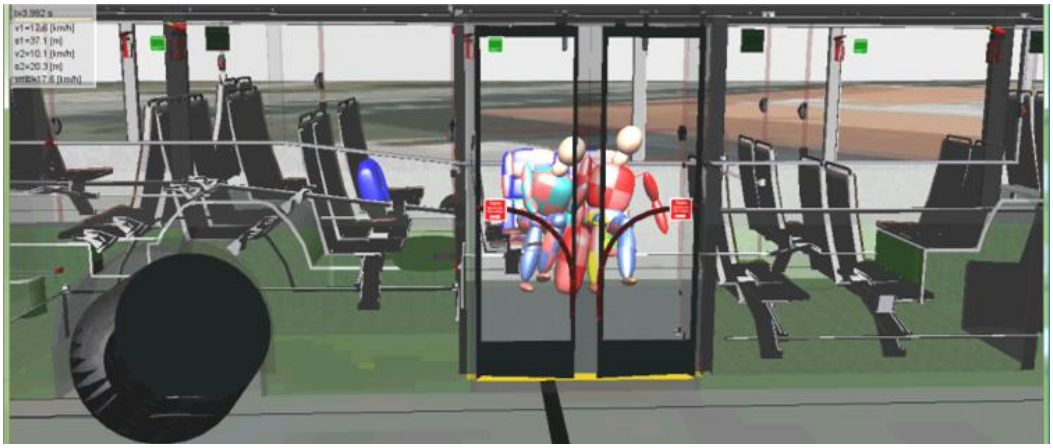
Figure 6: shows the position where the bus driver prevented a collision with the car by intensive braking.

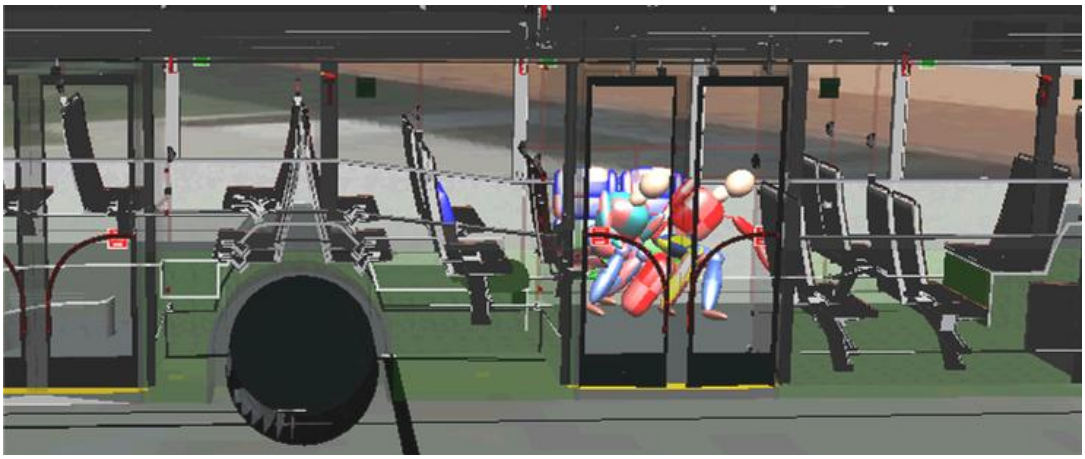
Figure 6: View of the position where the bus driver prevented a collision with the car by intensive braking

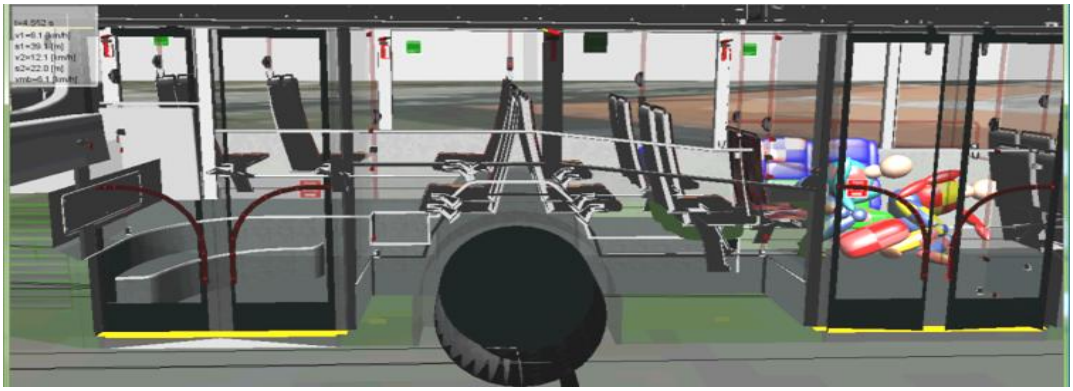
4. Calculation of movement of passengers during accident and injuries incurred to passenger A

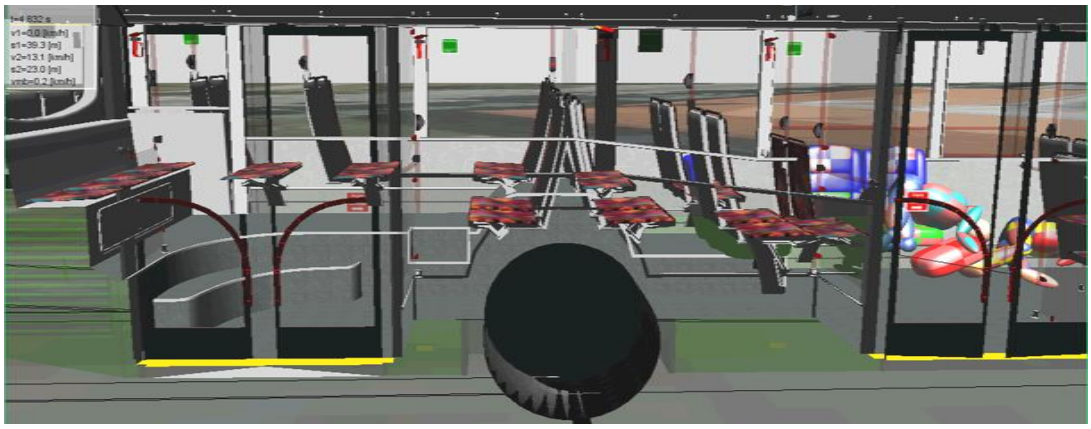
Using the calculation of the bus and car movement a calculation of the movement of the passengers sitting on seats A, B (between which there was the suitcase) was made with a result shown in the following Fig.7:

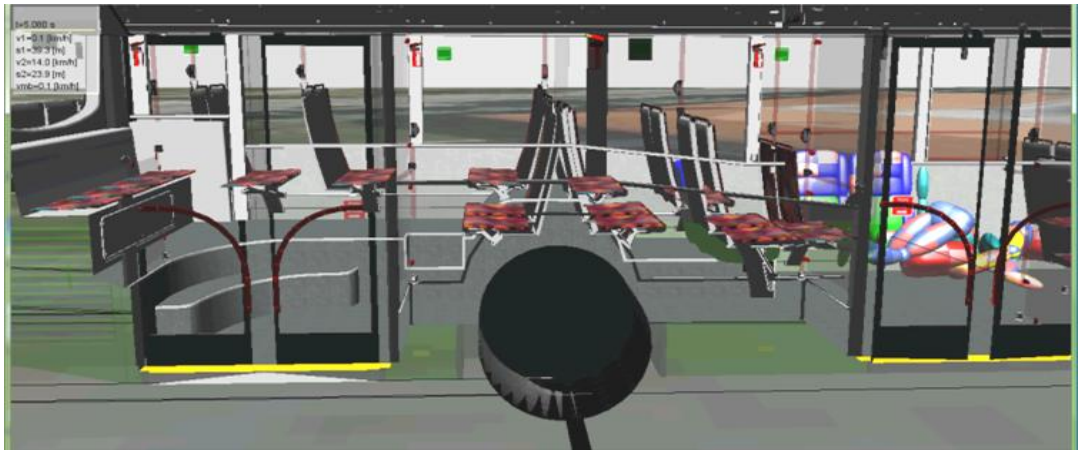


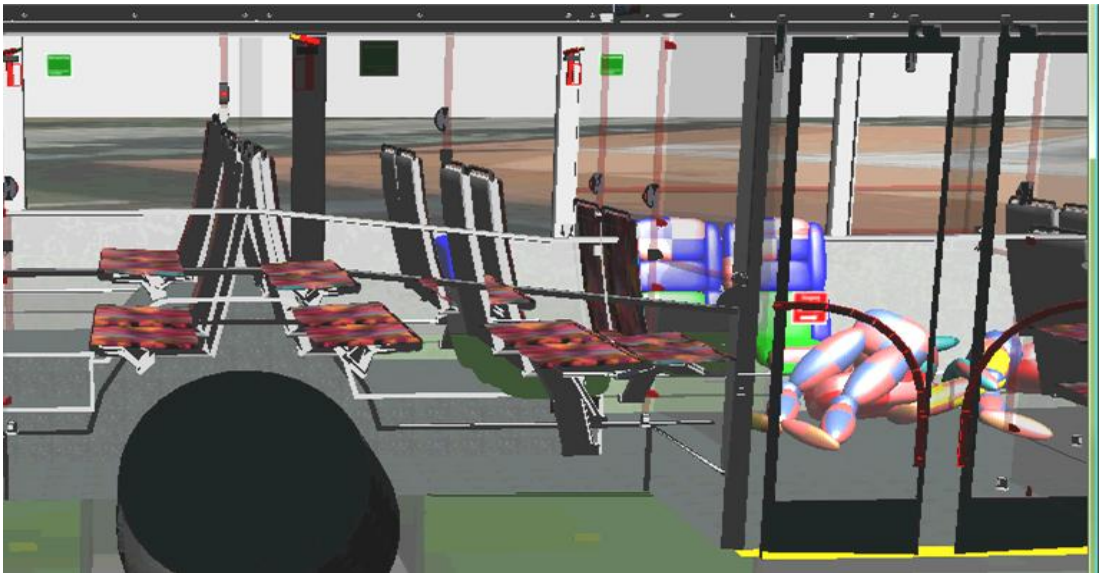












5. Conclusion

In a demonstrated way, i.e. by means of a calculation in the PC Crash simulation program and consequently by a comparison of the injuries by the FORTIS system, it was found out that:

- Passenger A suffered injuries as a result of her falling on her left side and squeezing her right ankle with the suitcase at the time she was lying on the bus floor. The calculation confirmed the original hypothesis of the accident course.

The outputs of the FORTIS system in form of the forensic classification and individual injury signatures are useful to verify the correctness of the performed technical analysis and to check the accuracy of the traffic accident simulation using the PC-CRASH program [4].

Therefore, it is the driver of the car who is responsible for the incurred injuries as he made the bus driver brake intensively by moving into the traffic lane in which the bus was driving.

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[5] PC FORTIS program ©