

BRIEF DESCRIPTION ABOUT A SERIOUS BUS ROLLOVER ACCIDENT
(Presented by Hungary)

Date: 1. July, 2002 early morning hours, gloom

The scene of the accident: close to Balatonszentgyörgy, Hungary, main road No.7. a roundabout

The coach: 3 years old HD coach. License number: LB 02930. Berkhof "Excellence 3000" body on DAF chassis, type DE 33WS. Max total mass 18600 kg

Persons on board: 49 passengers (pilgrims from Poland to Bosnia-Herzegovina) and 2 drivers

Casualty list: 20 fatalities, 17 serious injuries, 14 light injuries.

Brief description of the accident (See Fig.1.): The coach speed was 84 km/h when closing the roundabout (1) The driver did not realise the situation, his reaction and the braking was too late. In the approaching section of the roundabout (2) the bus was drifting and was not able to perform the right hand curve. The front left wheel hit (speed around 70 km/h) the 10 cm high central curbstone of the roundabout (3) which produced an unexpected sudden steering on the right for the driver. The driver made a sudden left hand correction, the bus turned on its right side (service door side) (4) The speed of the coach in this moment was 40-50 km/h. On its side the coach slipped away (20-25 m) until a ditch on the outer side of the roundabout (5) The cantrail of the bus was hit by the other side of the ditch, the superstructure collapsed and finally the bus stopped on its roof. See Fig.2. The speed values are given by the police.

Reaction of the public opinion: There were many discussions, reports about this accident in the press (TV, radio, newspapers) and the people were talking about it. The main conclusions:

- the result of this accident is a disaster
- the accident itself was not so serious compared to the result
- the roof must not collapse in this kind of accident.
- what about the regulations and standards?
- who is responsible for this catastrophe? (Not only for the accident but for its tragic result)

Some further technical details about the accident are given in the Annex.

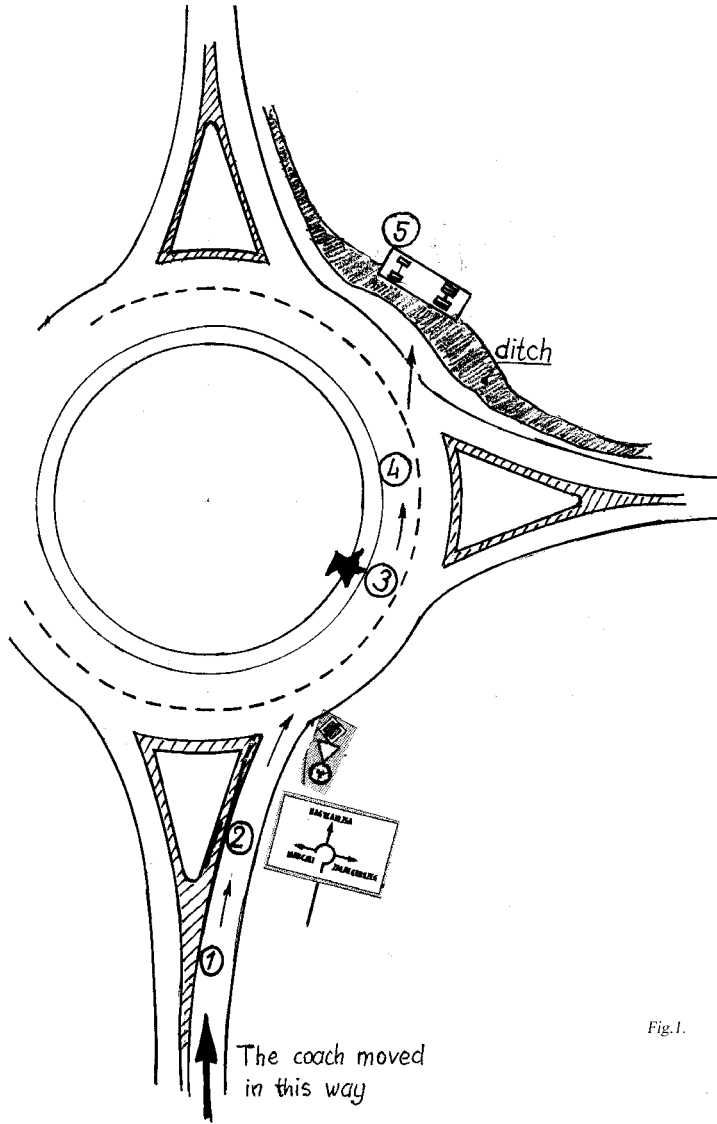


Fig.1.



Fig.2.

TECHNICAL DETAILS ABOUT THE ROLLOVER ACCIDENT

The scene of the accident.

Figure A1.gives some details of the roundabout. A bus is just entering in a normal way into the roundabout. Figure A2. shows the curb stones with the traces of the bus. The ditch can be seen on Figure A3.

Deformation of the superstructure

Fig.2. (in the main text) and Figure A4. show the deformation of the superstructure, the location of the plastic hinges (PH) Figure A5. shows the difference between the deformation of the front and rear part of the coach. The difference is due to the different height of the rigid part in the front and rear wall. (Their side wall supporting effect is different) The front rings collapsed with a 4 PH-s mechanism, but the rear rings had the same result with 6 PH-s.

Rigid parts and elements: the whole underfloor structure, the whole roof structure, the front and rear walls under the glazing, window and door pillars between the PH-s.

Plastic hinge locations on both sides:

in the front part: at the floor level and at the roof (4 PH-s deformation model)

in the rear part: at the floor level, at the waistrail and at the roof (6 PH-s deformation model)

Plastic zone locations: on the side walls at the floor level

The superstructure

On both side there are 6 window pillars (the frame of the windscreen is not included) which are side wall pillars, too. No special reinforced pillars (rings) in the front or rear. The cross sections of the pillars are shown on Figure A7. (the values were measured on the structure) The waistrail is a quadratic profile 40x40 mm, the grids have a profile of 40x20 mm. The seats are connected to the side walls (height 250 mm) but they could not provide considerable support, the seat frames, legs were broken almost everywhere.

The accident compared to the standard rollover test

At the first glance this accident is a rather different one, but analysing it, the similarity to the standard rollover test is obvious. Figure A6. shows the direction of the dynamic impact forces. The energy input in both cases may be estimated, but it shall be emphasised that these estimations are very rough, first approximations only, because a lot of data are missing, they were estimated (e.g. height of the coach's CG, the friction coefficient between the road and the bus, the energy absorbed by the soil at the impact, etc.)

The kinetic energy in the standard rollover test:

$$E_{kin}^{st} = Mg(h + \Delta h) = 14000 * 9,81 * 1,3 = 151kJ$$

The kinetic (impact) energy in the accident:

$$E_{kin}^a = M \left(\frac{v_3^2}{2} - \mu * g * s \right) = 14000 \left(\frac{11^2}{2} - 0,25 * 9,81 * 20 \right) = 154kJ$$

where: $\mu = 0,25$ the friction coefficient between the slipping bus and the road
 $s \approx 20$ m the length of the slipping way
 $v_3 = 11$ m/s slipping speed when the bus turned on its side (40km/h)

This calculation is nothing else, just showing the possibility: the two energy inputs could be in the same order. (If the slipping speed was 45 km/h, the kinetic energy is 400 kJ)

The legal situation

Poland joined to ECE Reg.66, the date of its application in Poland is 1.12.2001. This coach was three years old. There is no information yet, whether:

- it has been approved or not
- if so who made the approval test
- which test method was used for approval

The answers on these questions would be very useful for AHEG in its work.



Figure A2.

- a) the curb stone of the approaching way with the trace of the bus wheel , when the bus was drifting.
- b) the curb stone of the central circle of the roundabout with the trace of the left front wheel when getting the sudden, unexpected steering force.

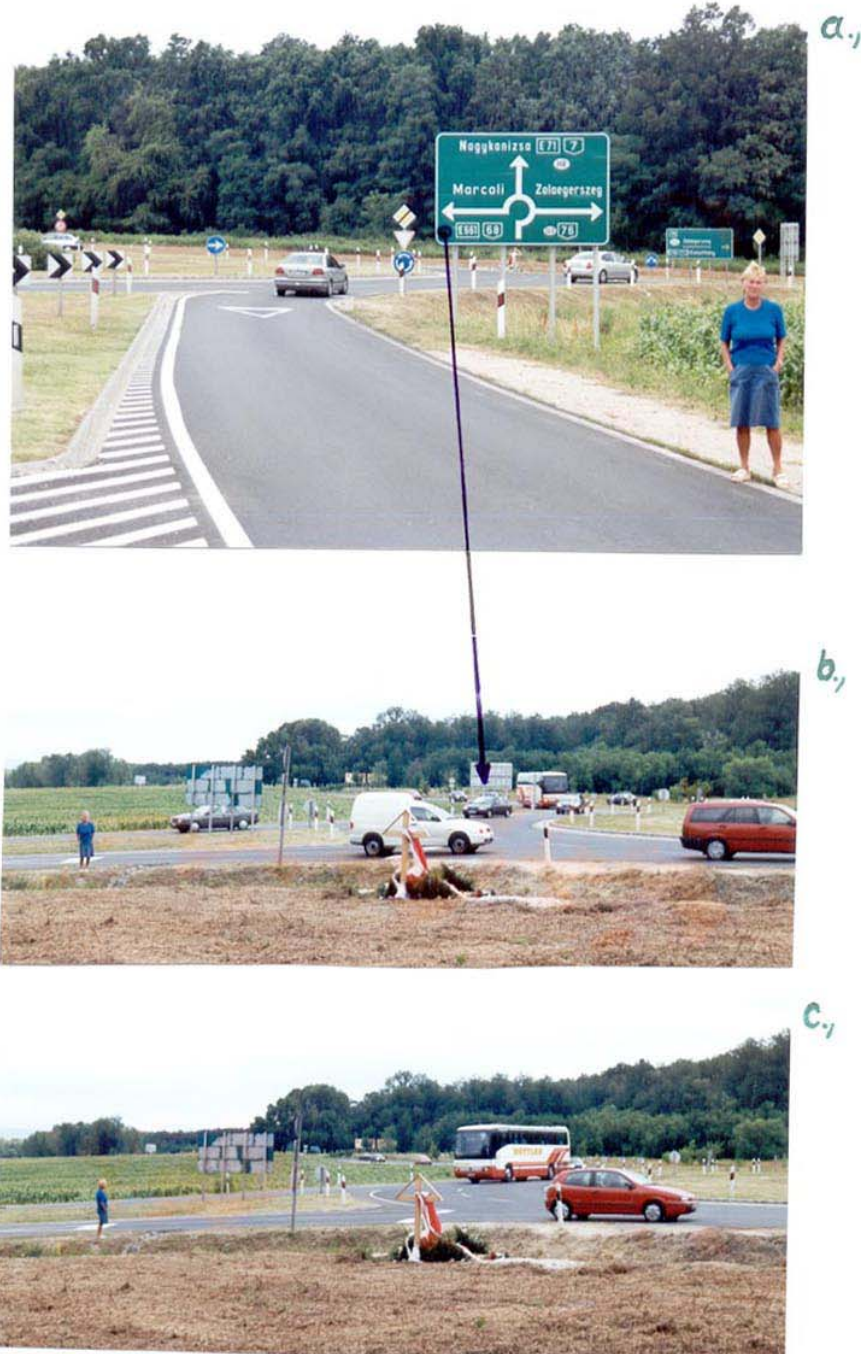
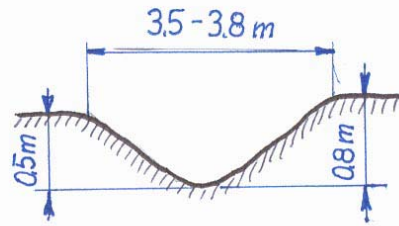


Figure A1.

- the approaching of the roundabout with the traffic signs
- the other side of the roundabout with the ditch, where Polish bus stopped on its roof. A bus is in the approaching way, entering into the roundabout.
- the bus is in the roundabout.



The ditch



Figure A3.
The ditch where the bus landed.
Considerable soil deformation can
be observed.



Figure A4

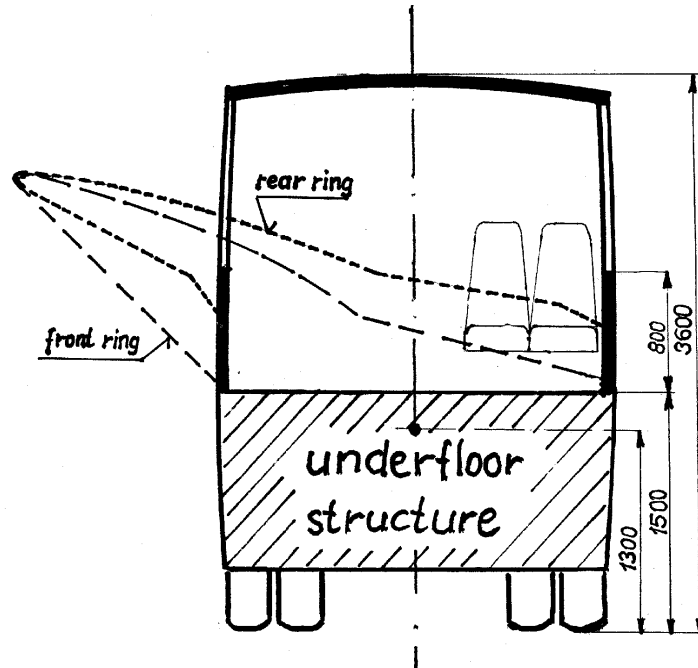
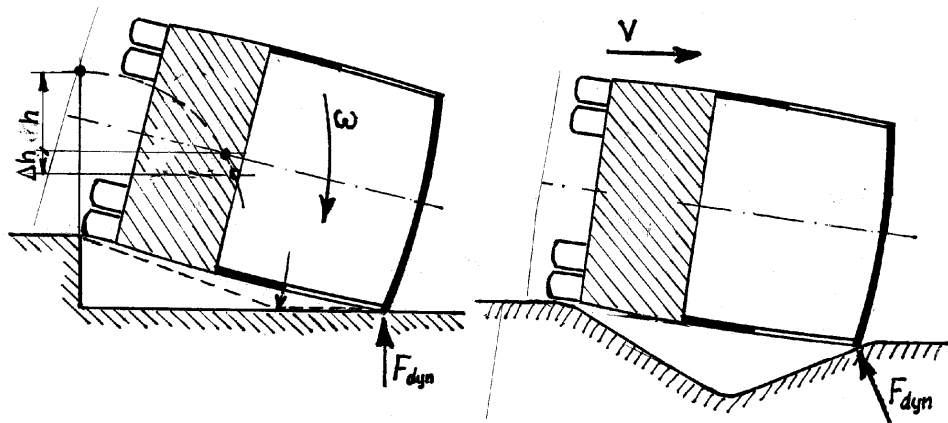


Figure A5



Standard rollover test

Polish bus accident

Figure A6

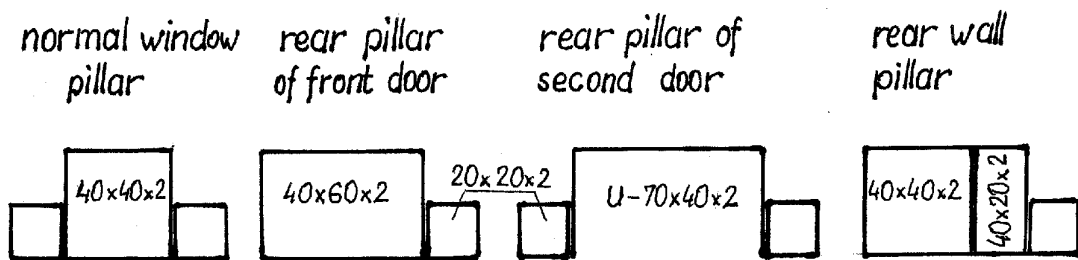


Figure A7