

Transmitted by the expert from Hungary

Informal document No. GRSG-99-26  
(99th GRSG, 19-22 October 2010  
agenda item 2)

# BEHAVIOUR OF THE LOWER LEVEL (DECK) OF DOUBLE-DECK VEHICLES IN ROLLOVER

99<sup>th</sup> GRSG session  
2010, October

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delegate of Hungary

# THE PROPOSAL AND ITS ADVANTAGES

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The Hungarian proposal to R.66: insert a new paragraph as follows ((ECE/TRANS/WP.29/GRSG/2010/2)

## 5.6. Testing of double deck vehicles

In the case of a double deck vehicle only the upper level (UL) of the vehicle shall comply with the general requirement specified in paragraph 5.1. The whole lower level (LL) shall be considered as a rigid part, therefore no test is required on it.

# THE PROPOSAL AND ITS ADVANTAGES

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Among the definitions of R.66, the rigid part is specified:

2.28. „Rigid part” means a structural part or element which does not have significant deformation and energy absorption during the rollover test

„Rigid part” could be the underfloor structure, the roof structure, certain parts of door and window columns between plastic hinges, etc.

# THE PROPOSAL AND ITS ADVANTAGES

Annex 4 in R.66 gives examples for rigid parts

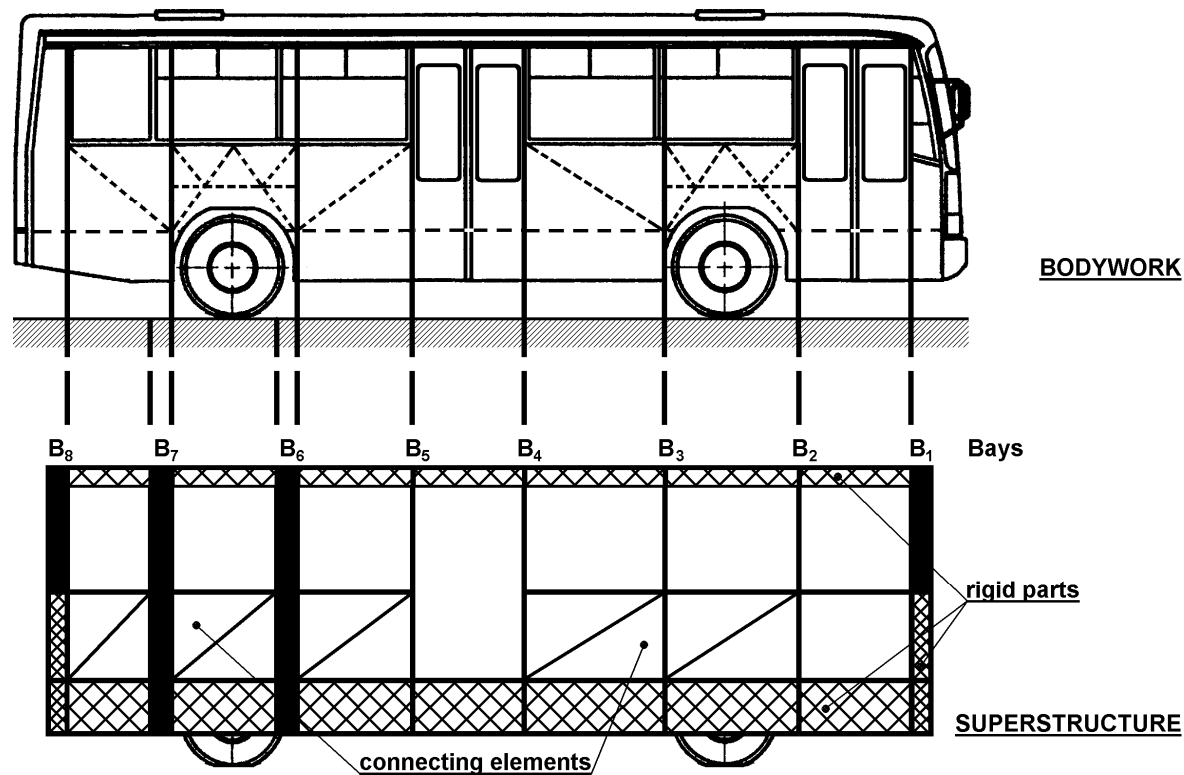


Figure A4. 1 - Derivation of the superstructure from the bodywork

# THE PROPOSAL AND ITS ADVANTAGES

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The advantages of this proposal:

- Much simpler approval test (no observation and measurement on the LL)
- Significant cost reduction in the approval test
- Clearer and unified calculation approval methods (in quasi-static calculation and dynamic computer simulation)

# CONSTRUCTIONAL ARGUMENTS

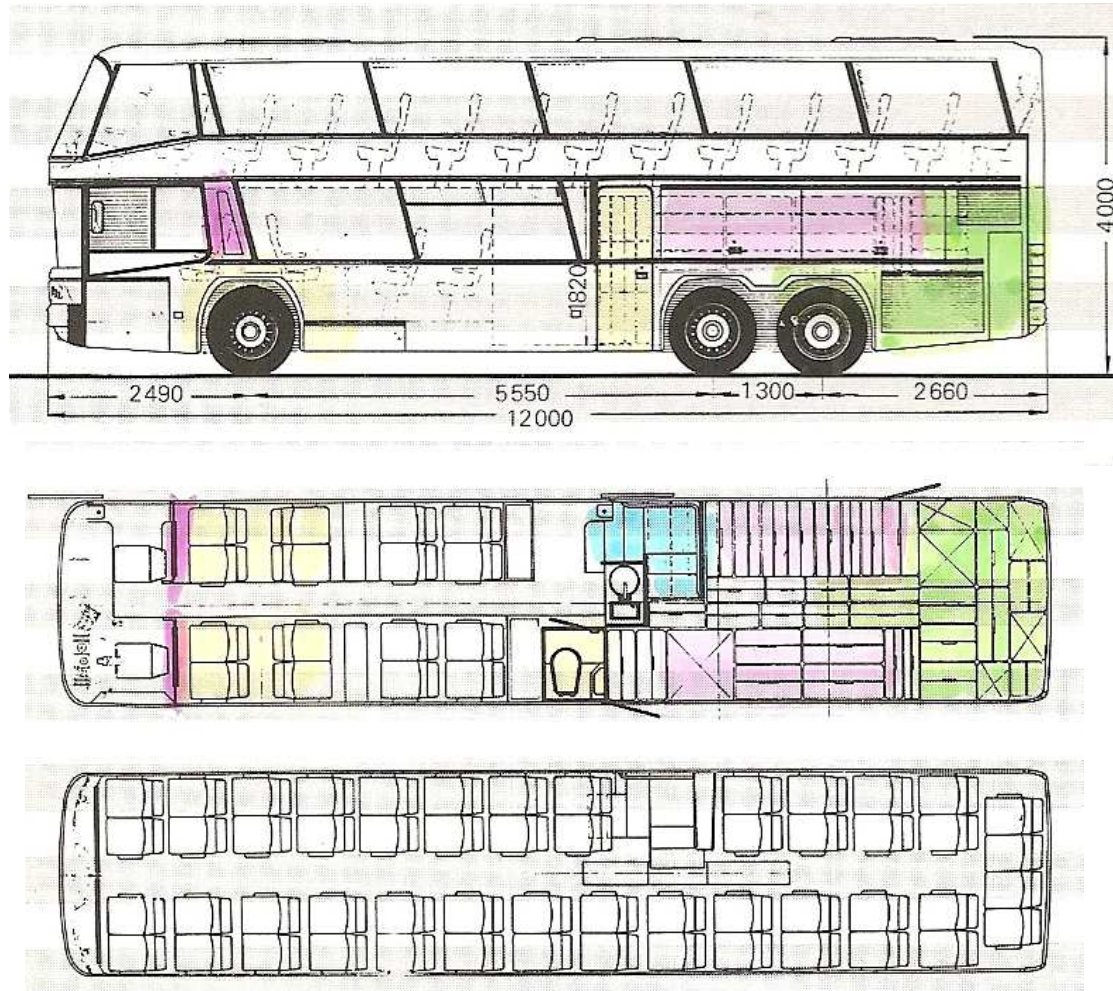
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The LL of a DD vehicle is reinforced by strong structural elements, coming from the design and arrangement of this kind of vehicles:

- Engine compartment in the rear part
- Driver compartment in the front part
- Wheel arches in the front part
- Staircase(s) in the mid of the vehicle
- Toilet
- Baggage compartment(s)

# CONSTRUCTIONAL ARGUMENTS

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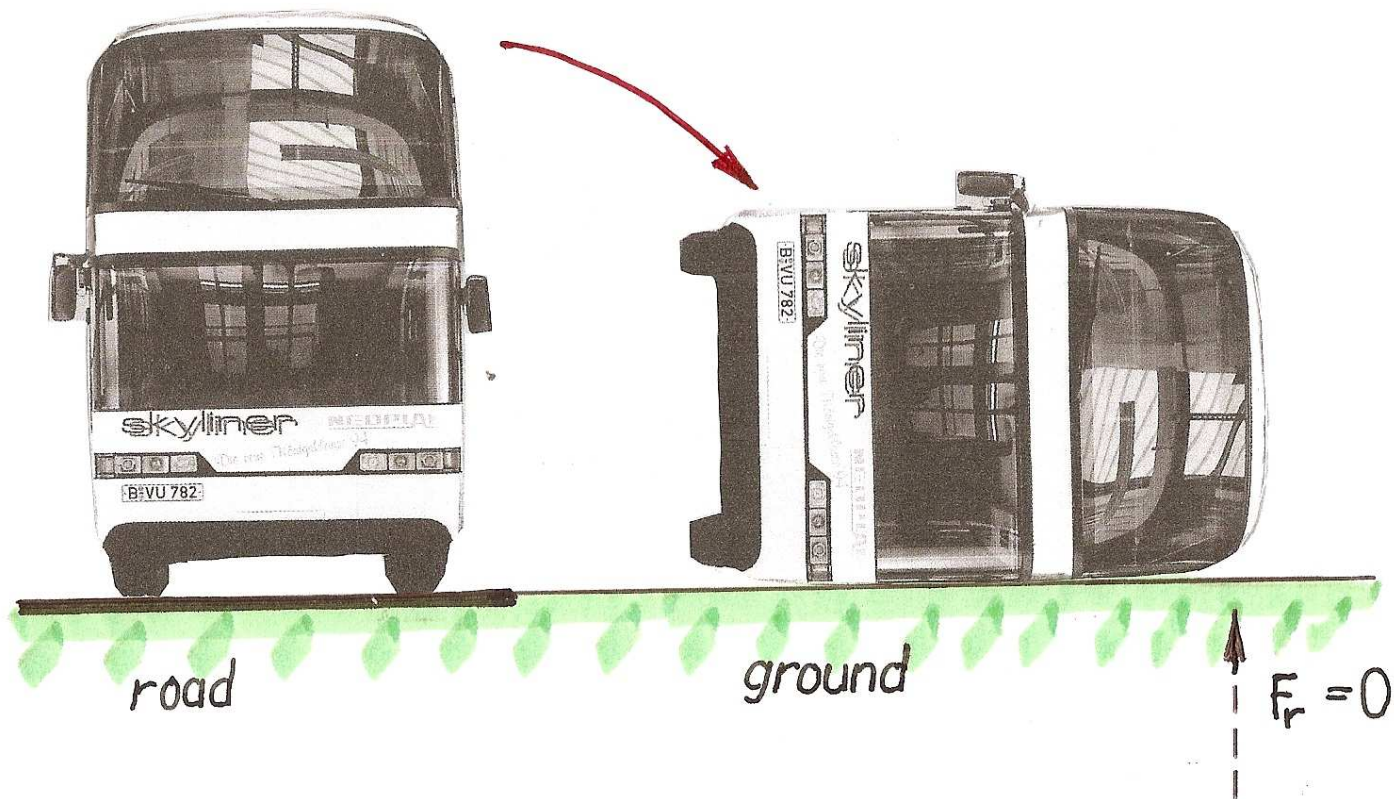
The structural reinforcements of LL



# CONSIDERED TYPES OF ROLLOVER

Tip over (turn on side)

Angle of rotation  $\alpha \approx 90^\circ$



No reaction force on the cantrail  $F_r = 0$

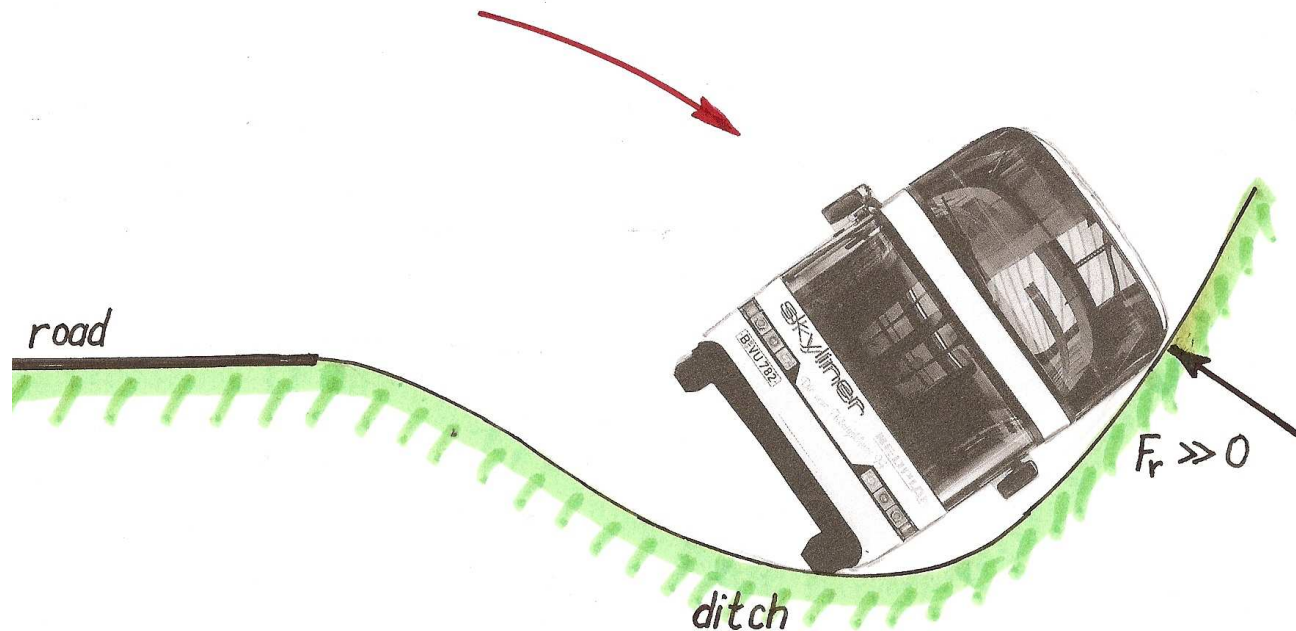
Less dangerous rollover



# CONSIDERED TYPES OF ROLLOVER

Turn on side, but the other side of a ditch or the inclining ground hits the cantrail.

Angle of rotation  $\alpha \approx 45^\circ - 60^\circ$



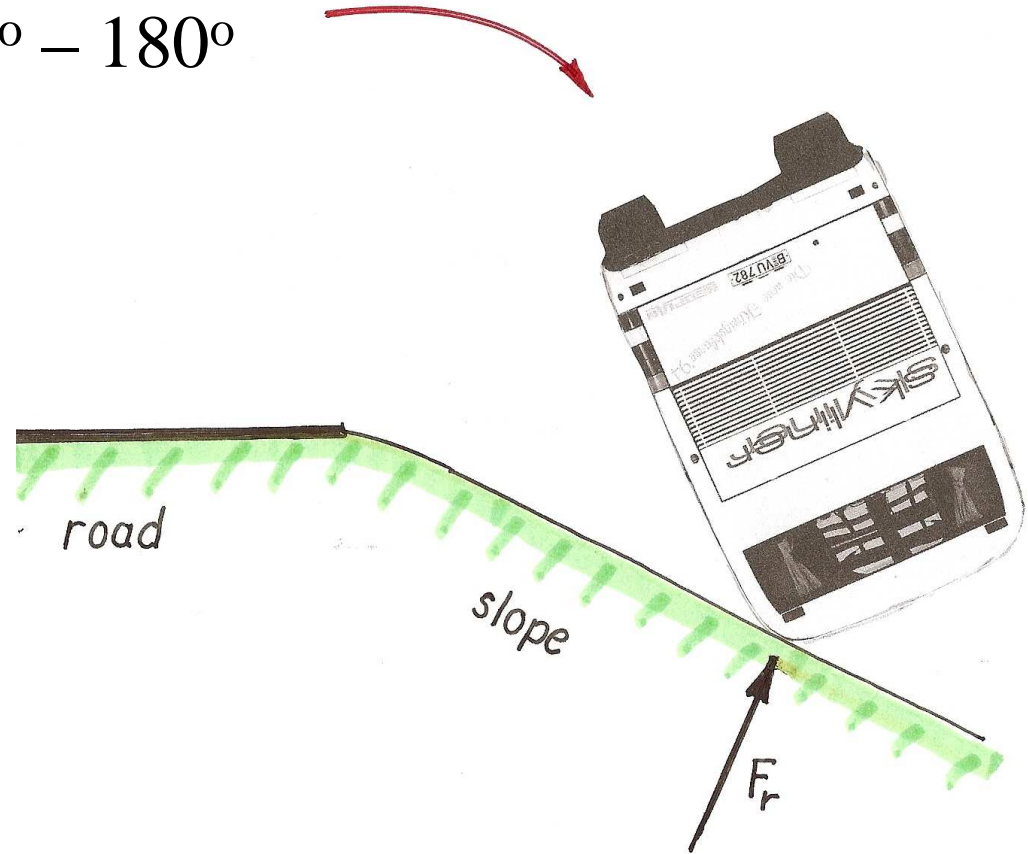
Considerable reaction force on the cantrail  $F_r > 0$

# CONSIDERED TYPES OF ROLLOVER

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Roll down on a slope

Angle of rotation  $\alpha \approx 90^\circ - 180^\circ$



Strong reaction force on the cantrail  $F_r \gg 0$

Most dangerous rollover

# TIP OVER

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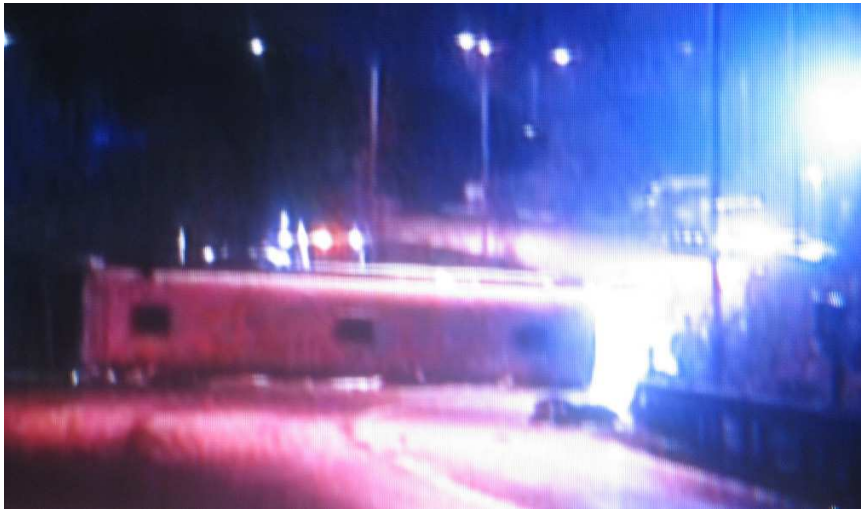
Tip over at an exit of a tunnel  
(The left wheels run up a rising  
concrete barrier)

- No significant, but slight deformation on the UL
- Residual space (RS) remained intact
- Rigid LL





# TIP OVER



Tip over on a flat road

- No significant deformation on the UL
- RS remained intact
- Rigid LL



# TIP OVER

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Flat road, flat snowy ground

- No significant deformation on the UL,
- intact RS
- Rigid LL



# TIP OVER

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Flat, soft grassy ground

- No significant deformation on the UL
- Rigid LL

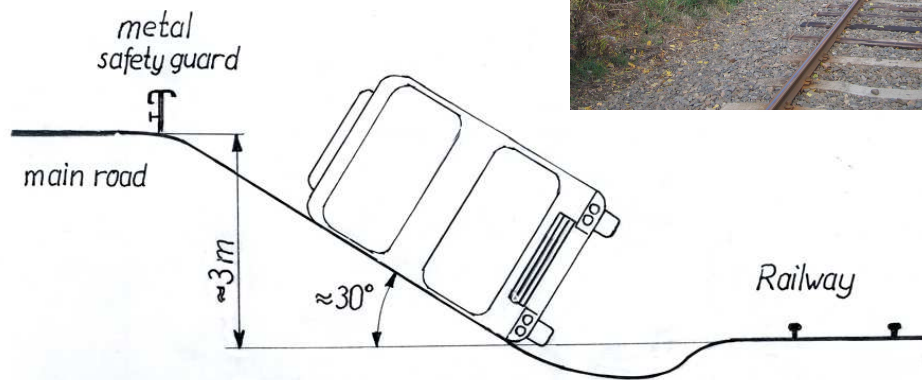


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# TURN ON SIDE WITH INCLUDING NEXT TO THE ROAD

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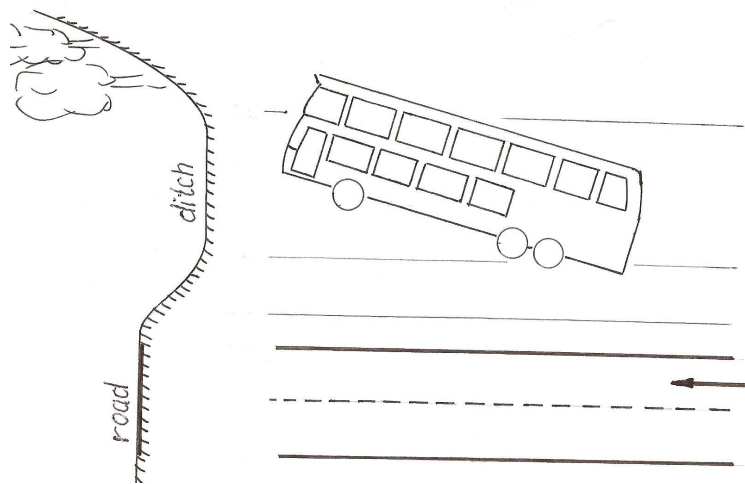
After a severe frontal collision (on the driver's cab) the bus run down on the slope and a railway embankment turned it back onto the slope.

- Slight deformation on the UL
- RS remained intact
- Rigid LL (deformation only as the result of the frontal impact)



# TURN ON SIDE WITH INCLUDING NEXT TO THE ROAD

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The bus turned into a ditch having an inclining elevated other side

- Considerable deformation on the front half of the UL
- Possible intrusions into the RS on the UL
- Rigid LL

# ROLL DOWN ON A SLOPE

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- The UL collapsed
- RS disappeared on the UL
- Rigid LL

# ROLL DOWN ON A SLOPE

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After a frontal collision on the driver's cab side, the bus rolled down on a slope

- Asymmetrically collapsed UL
- RS strongly damaged
- No structural deformation on LL except due to the frontal collision





# ROLL DOWN ON A SLOPE

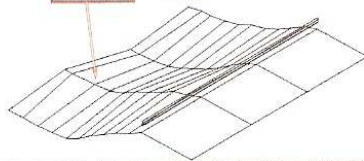
## CAUSE OF THE DAMAGE:

- 1.- **FIRST COLLISION:** Fronto-lateral impact against the coach
- 2.- **SECOND IMPACT:** Against the safety barrier
- 3.- **FINAL COLLISION:** Off-Road rollover

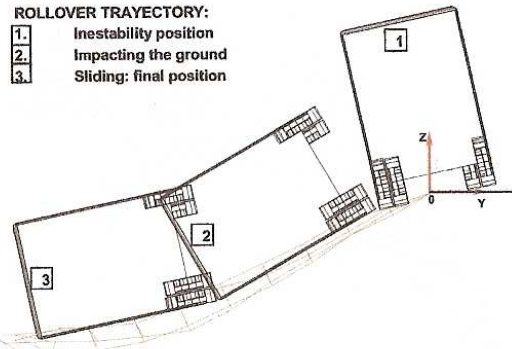


pot-holes of the land

SLOPE



- ### ROLLOVER TRAYECTORY:
1. Instability position
  2. Impacting the ground
  3. Sliding: final position



Deformation by impacting the ground

After a frontal collision on the driver's cab the bus rolled down... on a slope

- Considerable deformation on the UL
- Possible intrusion into the RS on the UL
- Rigid LL

# ROLL DOWN ON A SLOPE

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After a severe frontal collision on the driver's cab, the bus rolled down on a slope.

- The UL collapsed
- RS disappeared on the UL
- Rigid LL (deformation only due to the frontal collision)



# ROLL DOWN ON A SLOPE

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- Severe, locally concentrated deformation on the UL
- Harmed RS on the UL
- Rigid LL



# ROLL DOWN ON A SLOPE

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- The UL collapsed (Firemen cut it down to rescue the passengers)
- RS disappeared on the UL
- Rigid LL



# SUMMARY

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Type of rollover	$\Sigma$	No deformation		No significant (only slight) deformation		Significant deformation		Severe deformation	
		UL	LL	UL	LL	UL	LL	UL	LL
$\alpha = 90^\circ$	4	0	4	4	0	0	0	0	0
$\alpha = 45^\circ-60^\circ$	2	0	2	1	0	1	0	0	0
$\alpha = 90^\circ-180^\circ$	6	0	6	0	0	1	0	5	0
total	12	0	12	5	0	2	0	5	0

If somebody can show a DD rollover accident, in which the LL put up significant structural deformation, due to the rollover, Hungary will withdraw the proposal