Transmitted by the expert from Spain

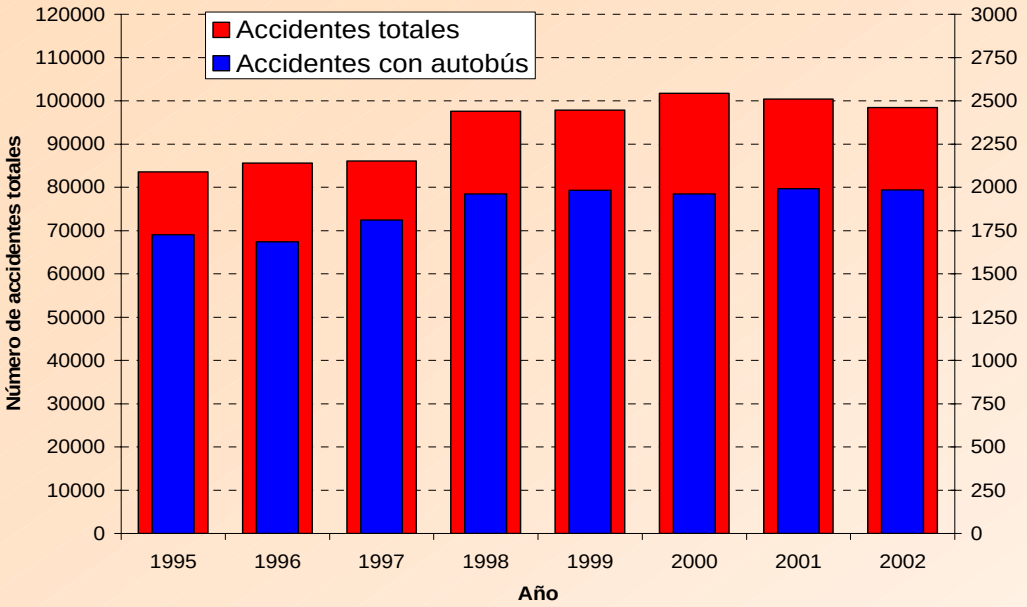
Informal document No. **GRSG-90-30**
(90th GRSG, 24-28 April 2006
agenda item 1.4.7.)

FRONTAL COLLISION BUSES AND COACHES. RESEARCH AND PROBLEMS

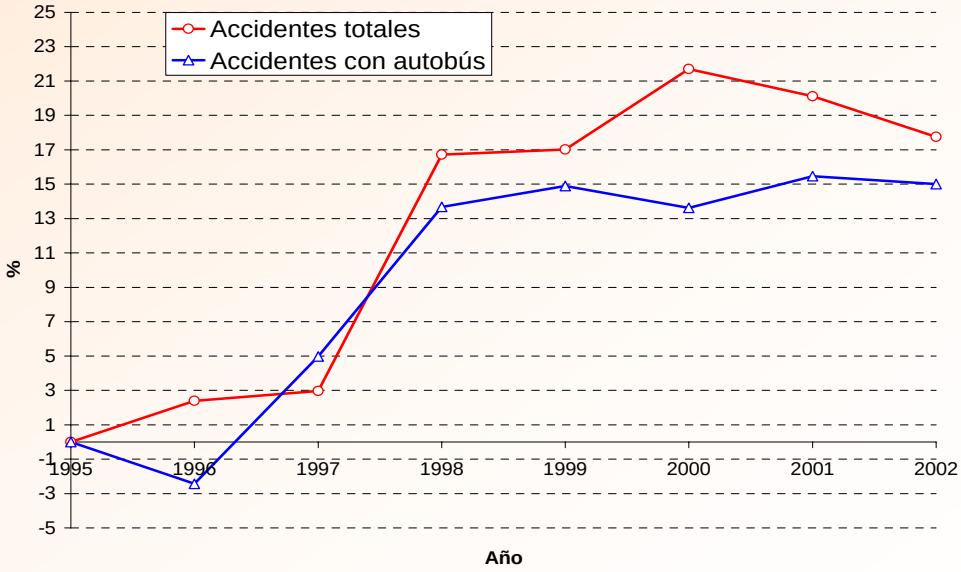
APSN Workshop on Bus and Truck Passive Safety

INSIA
UNIVERSITY INSTITUTE FOR AUTOMOTIVE RESEARCH

TRAFIC ACCIDENTS (SPAIN 1995-2002)

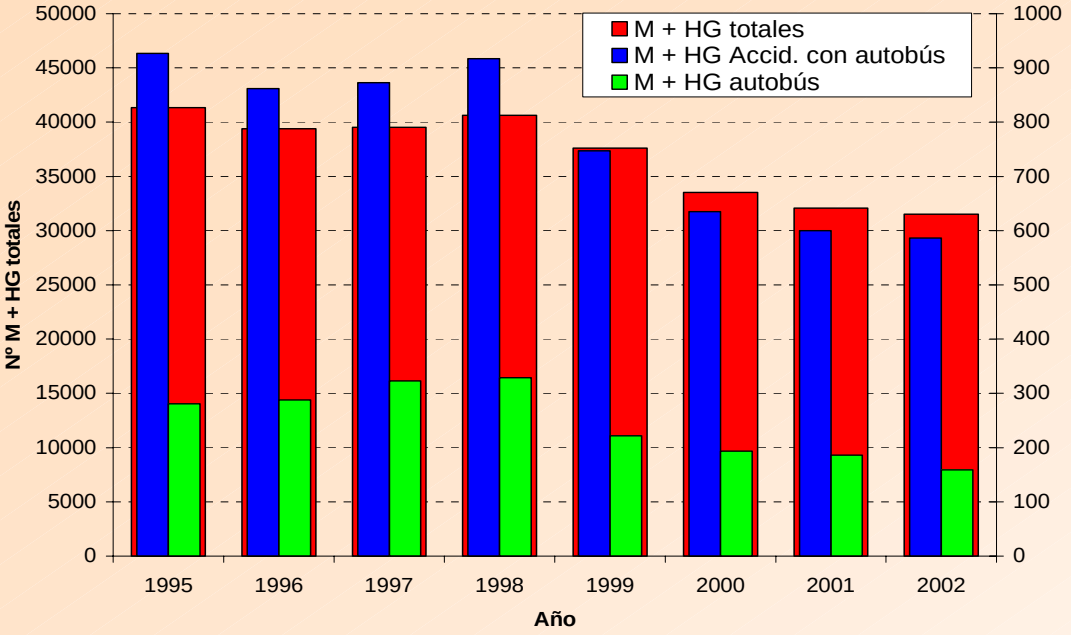


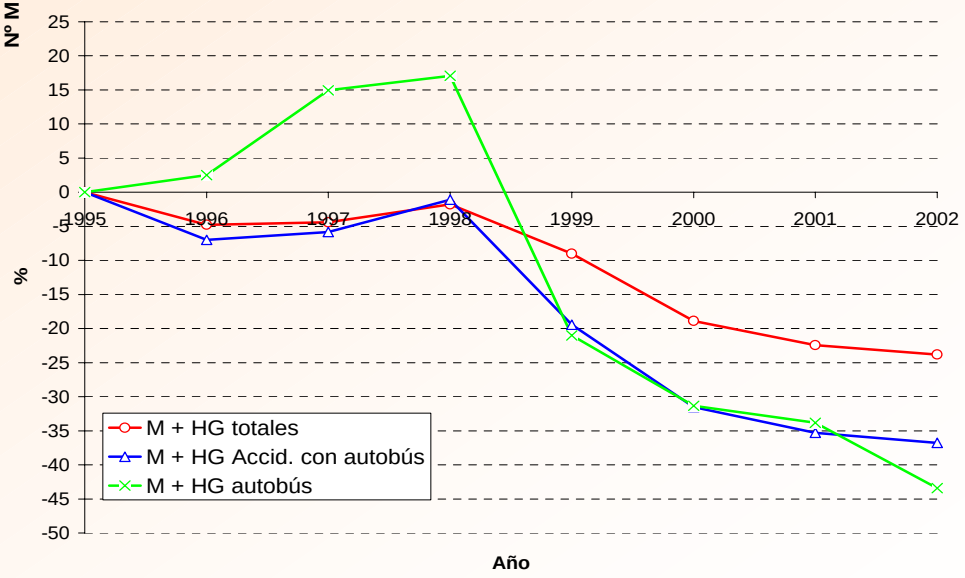
APROX. 15000 ACC.



Porcentajes referidos al año 1995

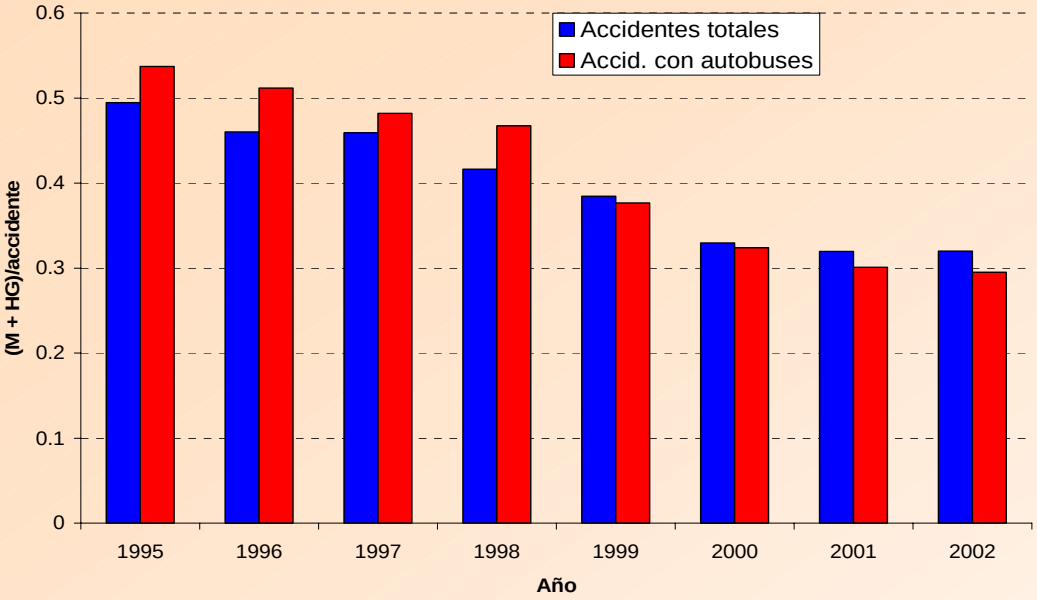
VICTIMS (SPAIN-1995-2002)

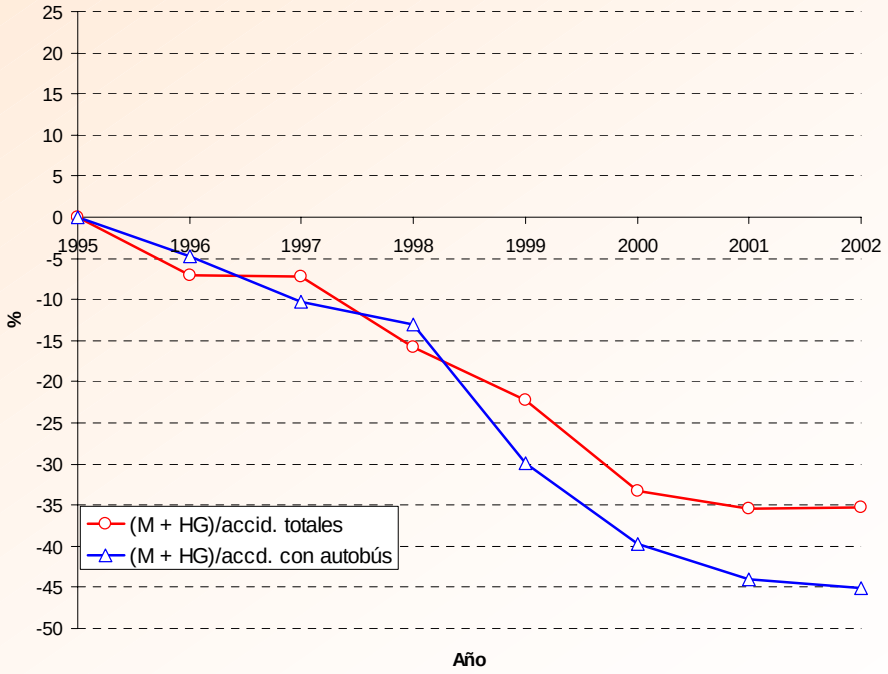




Porcentajes referidos al año 1995

VICTIMS/ACCIDENT (SPAIN-1995-2002)

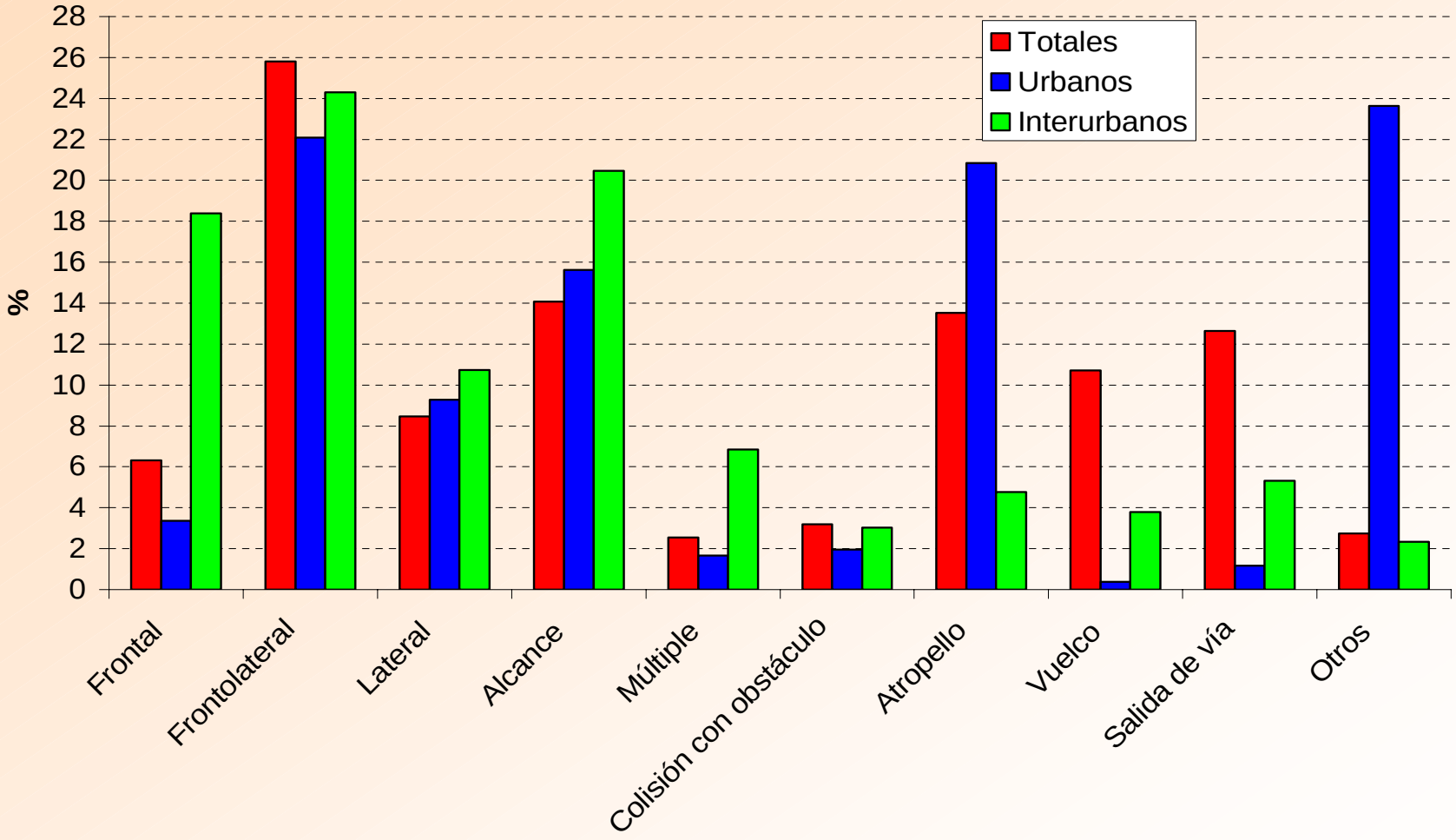




Porcentajes referidos al año 1995

TYPE OF COLISION (SPAIN-1995-2002)

Accidentes con autobuses

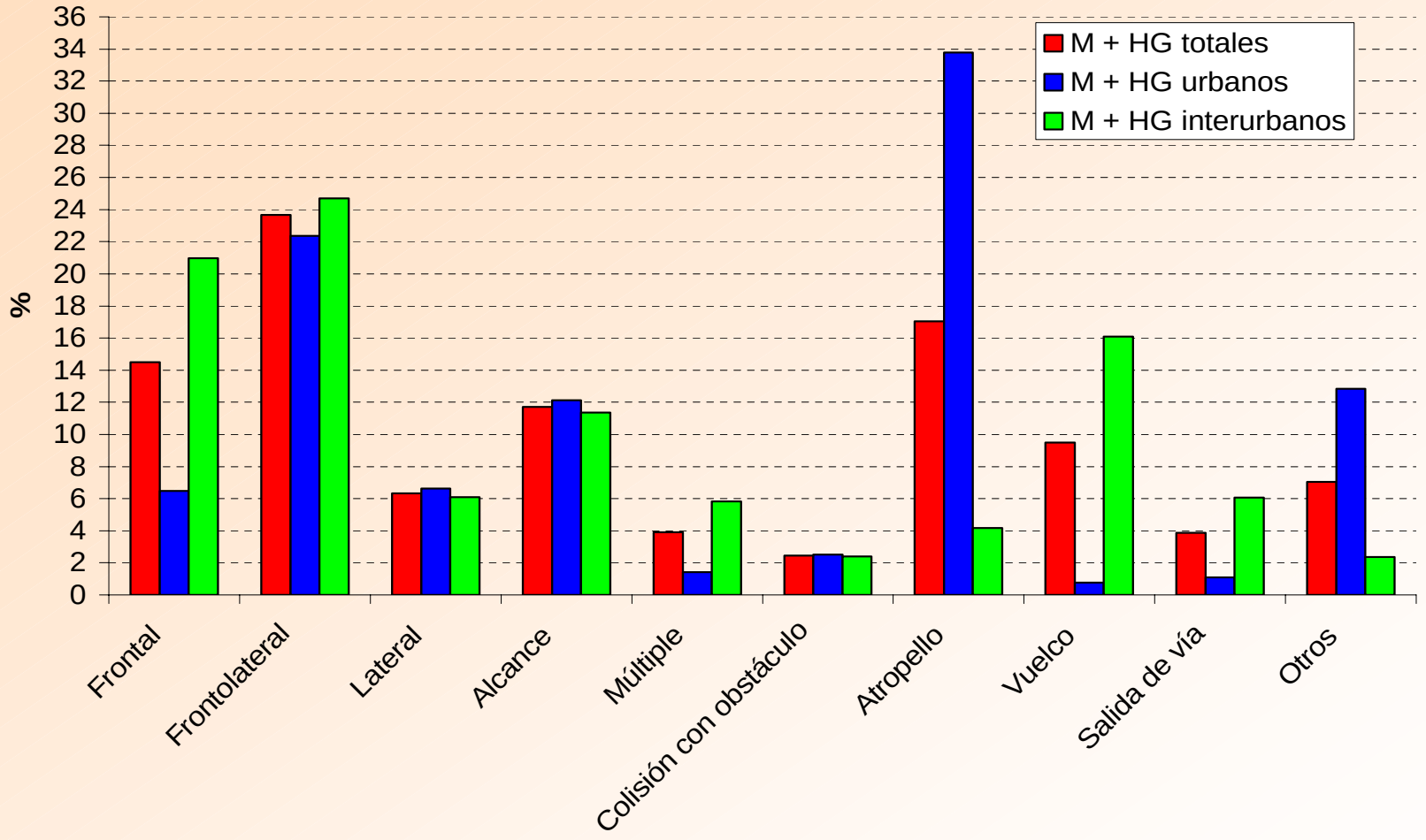


Tipo de colisión

Datos promedio 1995-2002

TYPE OF COLISION (SPAIN 1995-2002)

Víctimas en accidentes con autobuses

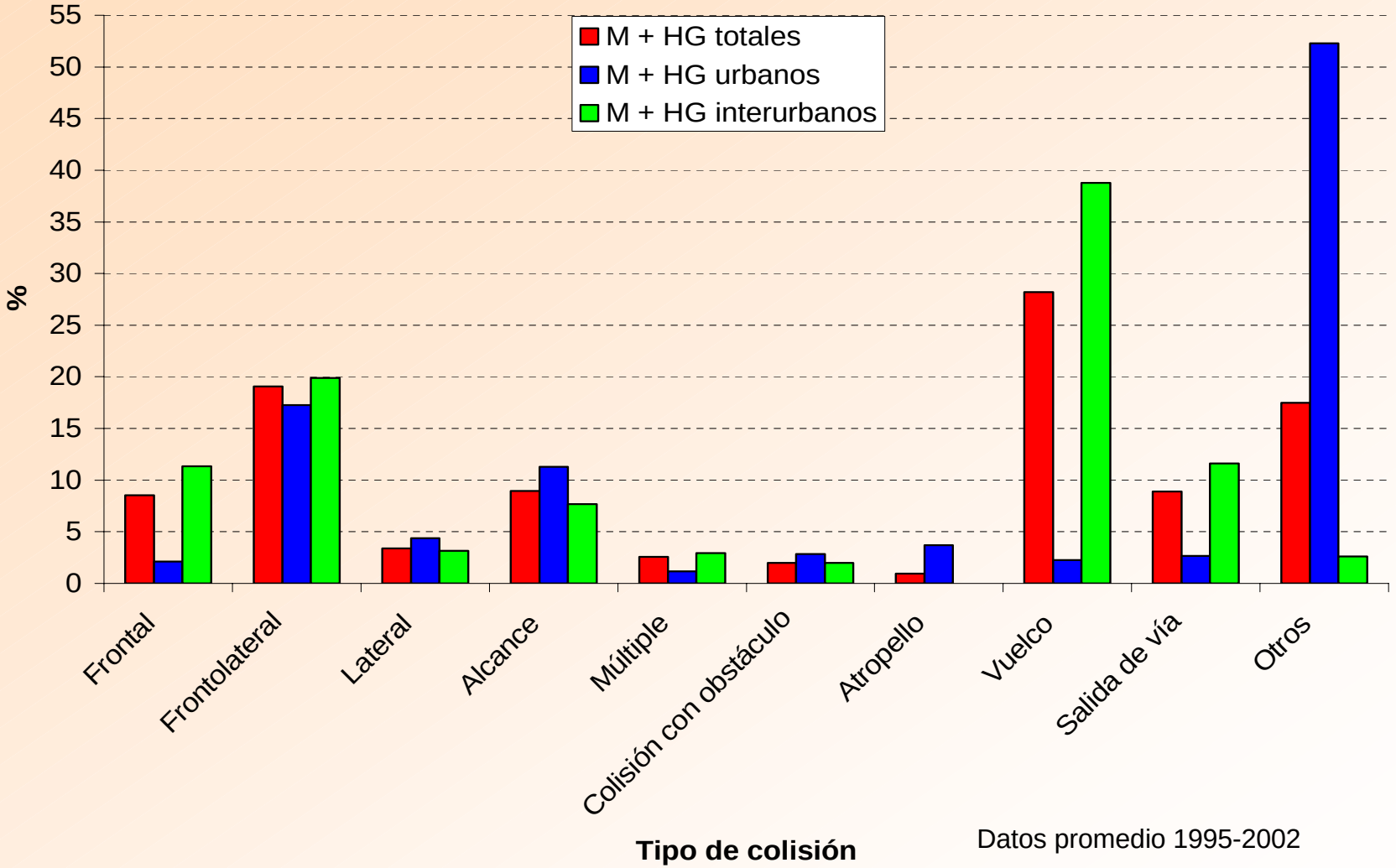


Tipo de colisión

Datos promedio 1995-2002

TYPE OF COLISION (SPAIN-1995-2002)

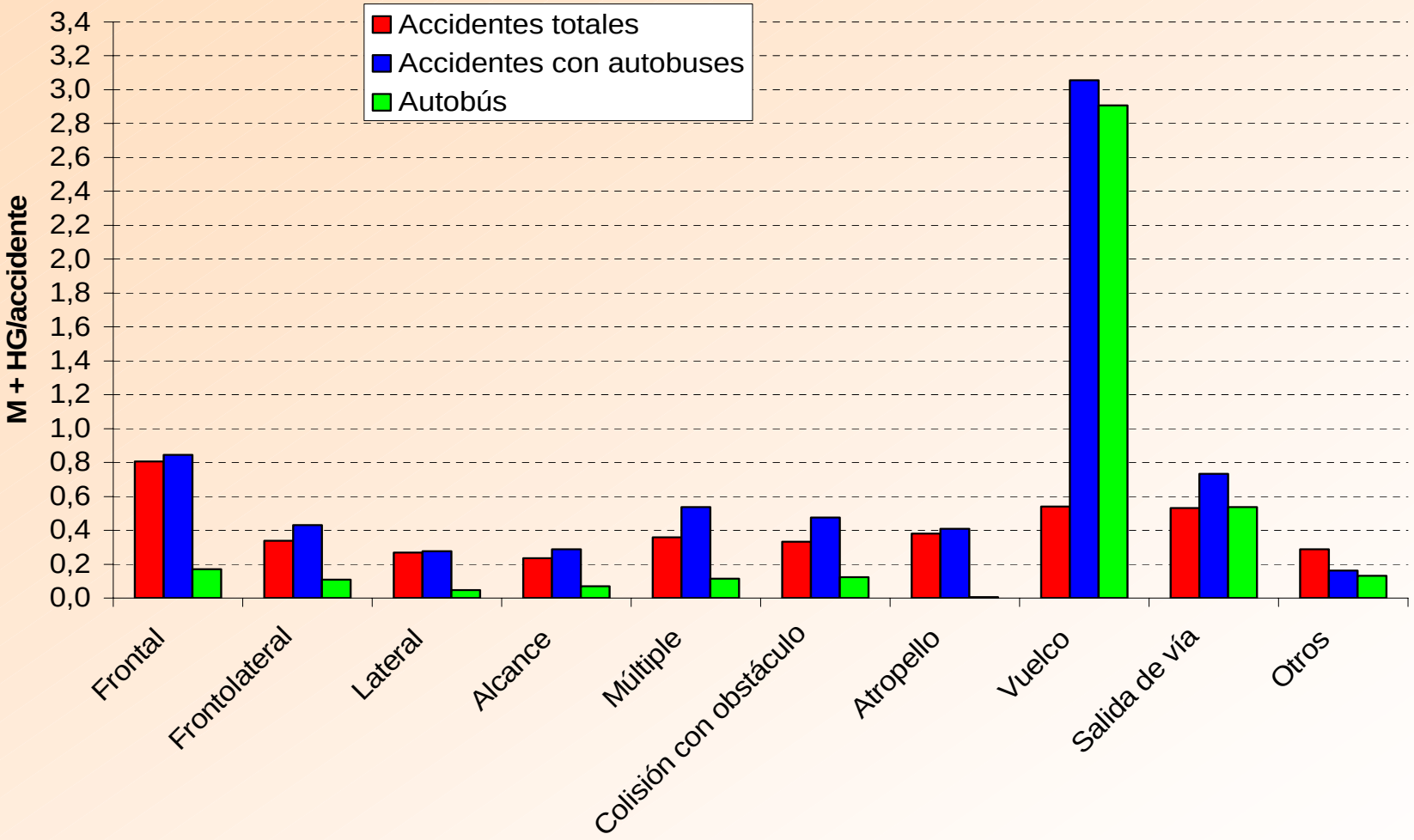
Víctimas en autobuses



Datos promedio 1995-2002

TYPE OF COLISION (SPAIN 1995-2002)

Víctimas por accidente

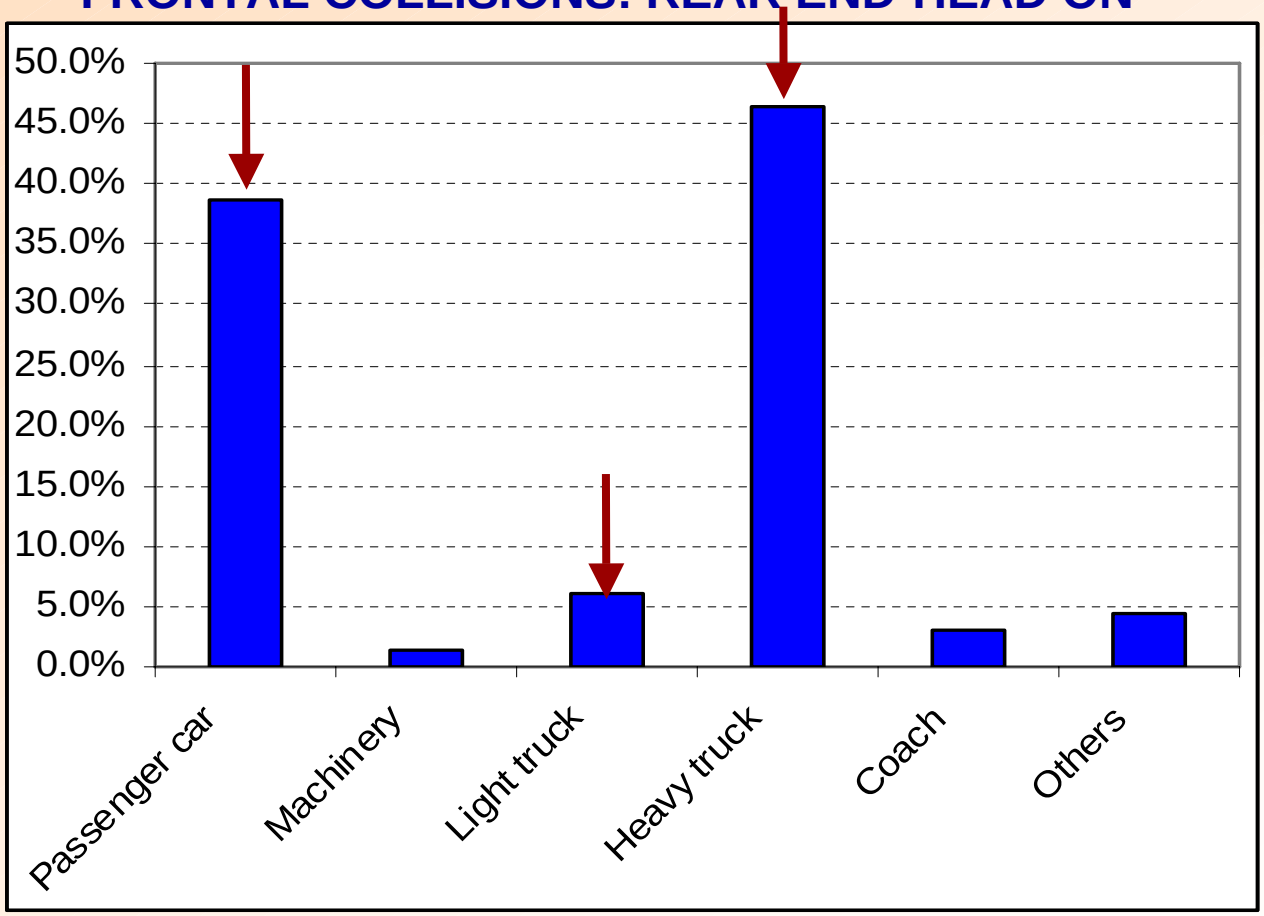


Tipo de colisión

Datos promedio 1995-2002

INTRODUCTION

FREQUENCY DEPENDING ON THE OPPOSITE VEHICLE IN FRONTAL COLLISIONS: REAR END-HEAD ON



FRONTAL PROBLEMS: INCOMPATIBILITY

Collision with passengers car, vans and light trucks

Frontal – Rollover

Description:

A car crashes semi-frontally with the bus while finishing a wrong overtake. Finally the coach left the road and rolled over 90 degrees, standing on its right side.

Bus Deformations:

The right side of the bus damaged because of the rollover. The left front corner was badly damaged because of the impact with the car.

FRONTAL PROBLEMS: INCOMPATIBILITY

Collision with passengers car, vans and light trucks

Frontal (Bus) and Frontal (Car)

Description:

The coach was driving by a dual carriage way, in a left curve. A car crashes frontally (40% offset) into the bus, at 130kph, and reaches coach fuel tank. Coach starts burning.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FRONTAL PROBLEMS: INCOMPATIBILITY

Collision with heavy vehicles

Collision – Frontal (Bus) and Rear (Opponent)

Description:
The coach was driving by a motorway, when crashed (60% offset) against the rear part of a truck, which was driving at 40kph.

Bus Deformations:
The right front corner of the coach structure was badly damaged, because of the crash against the truck.

FRONTAL PROBLEMS: INCOMPATIBILITY

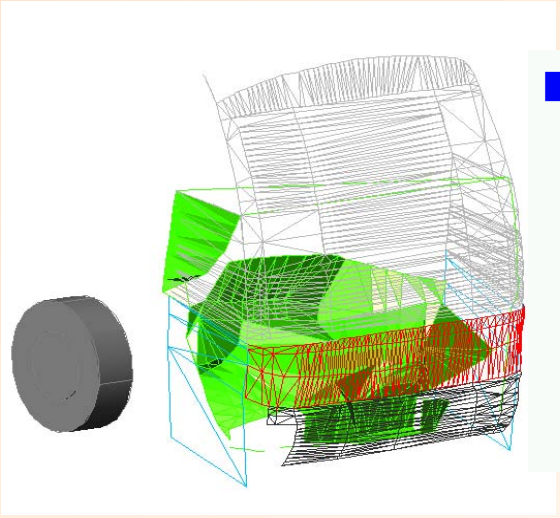
Collision with heavy vehicles

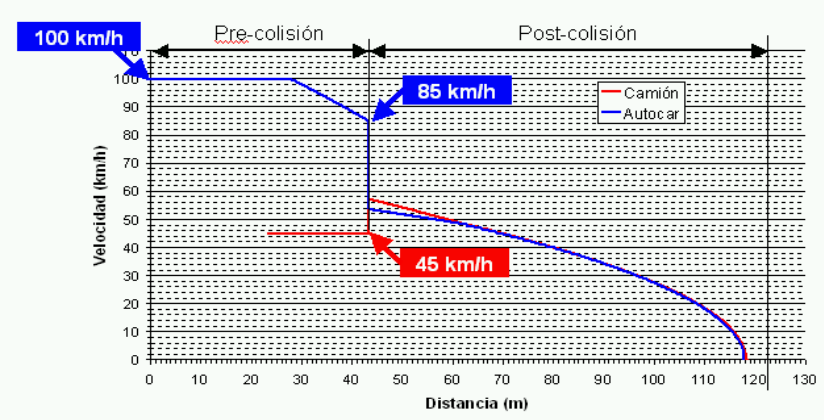
Collision – Frontal (Bus) and Rear (Opponent)

Description:

The coach was driving by a motorway, when crashed (65% offset) against the rear part of a truck,

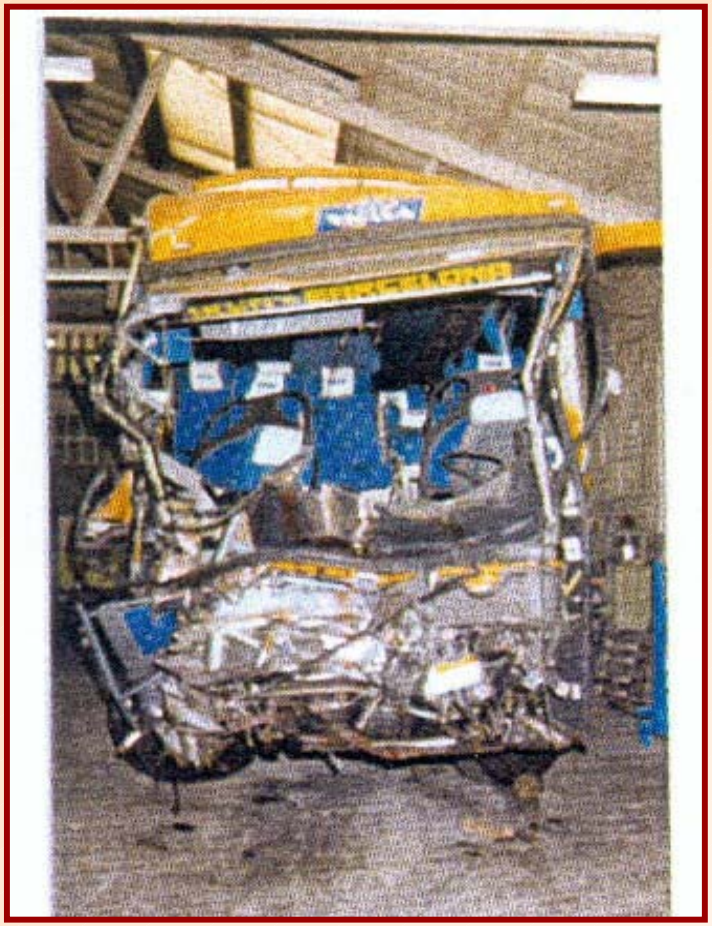
Bus Deformations:





Height(m)	Intrusión (mm)
0.4	0
0.6	553
0.8	661
1	899
1.2	1164
1.4	1148
1.6	1089
1.8	872

FRONTAL PROBLEMS: DRIVER AND CREW



Driver's safety is not adequately contemplated in current regulations:

The risk can be higher than the passenger's in many kind of accidents.

If the driver remained conscious and not seriously injured, he would keep the control of the vehicle and make easy the evacuation.

FRONTAL PROBLEMS: RESTRAIN SYSTEMS

SEATS AND SAFETY BELTS ANCHORAGES

PARTITIONS

RETENCIÓN DE PASAJEROS

PROPOSALS: SEATS-SAFETY BELTS ANCHORAGES

Combined Test (worst situation)

OR PARTITIONS

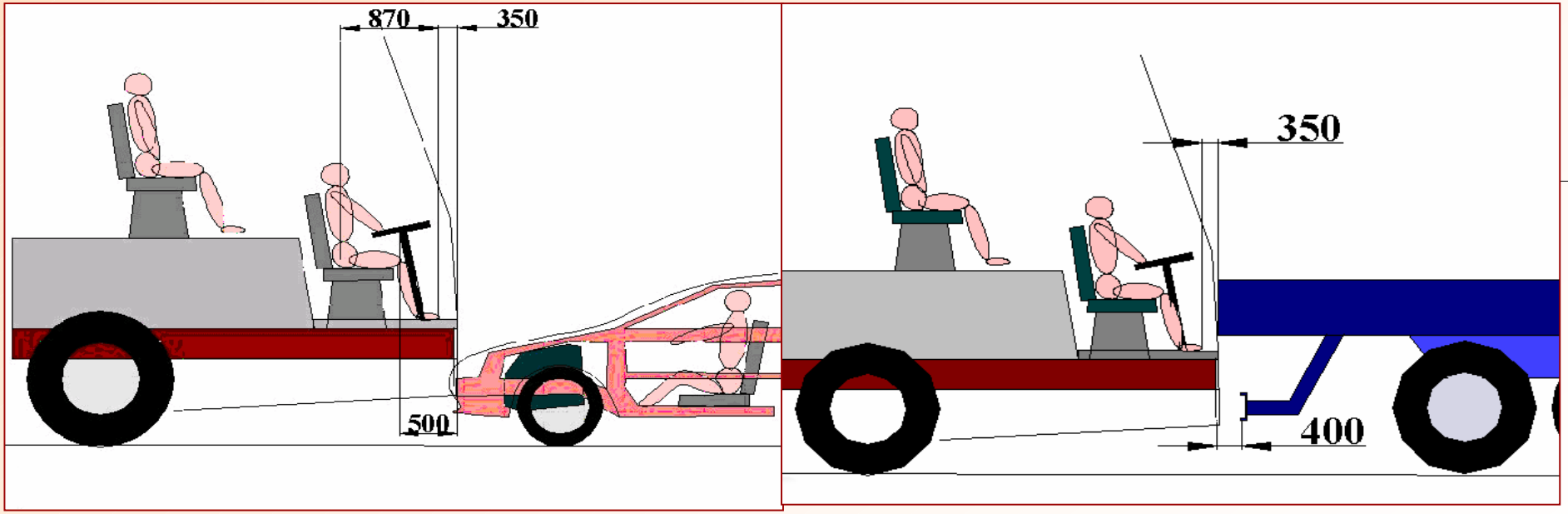
The seats and their anchorages should tolerate the more typical efforts which appear in real accidents. The use of seat belts combined with an adequate behaviour of the seats and their anchorages, would reduce drastically the severity of the injuries, especially in the case of occupants projected or ejected.

MAIN PARAMETERS AFFECTING THE DRIVER'S SAFETY (INSIA research)

★ **Height of the driver's floor. (Geometric Compatibility)**

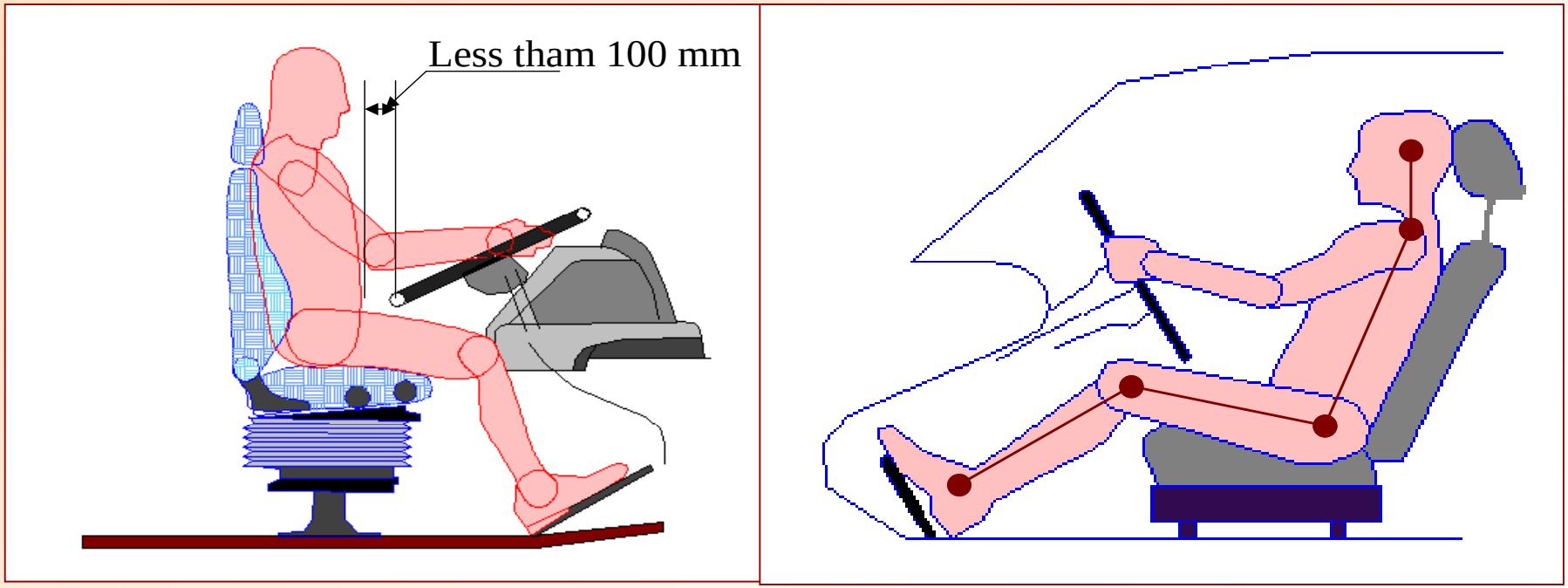
- Low driver's floor (around 800 mm)
- Normal driver's floor (around 975 mm)
- High driver's floor (around 1060 mm)

★ **Distance to the front of the vehicle**



MAIN PARAMETERS AFFECTING THE DRIVER'S SAFETY

Free space around the driver



Different posture between coach and cars drivers

DEFINITION OF A SURVIVAL SPACE FOR THE DRIVER

e. From comfort and displacement allowed by safety belt

Test:

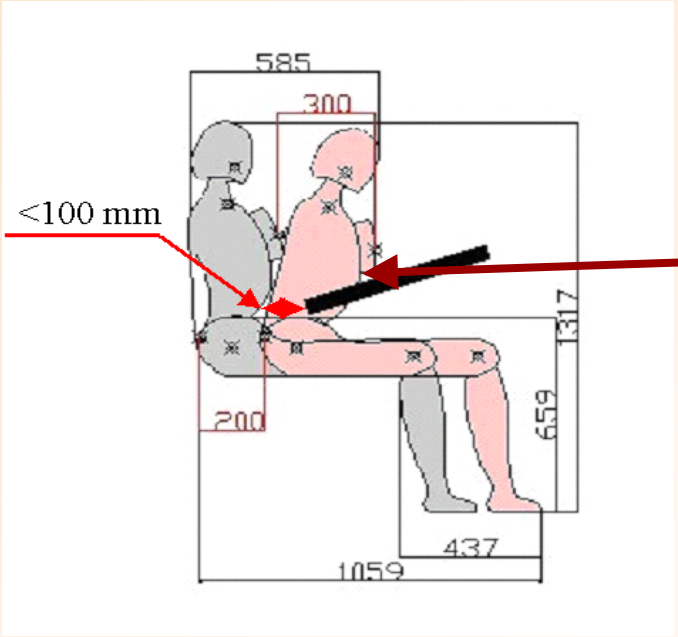
- **According Regulation 80**
- **50% percentile dummy**
- **Coach's driver's seat**

DEFINITION OF A SURVIVAL SPACE FOR THE DRIVER

Minimum space around driver, to remain free of any intrusion in an accident

Four options could be considered:

a. The driver restrained with 3-point belt never cross it (R16 or Directive 2000/3)



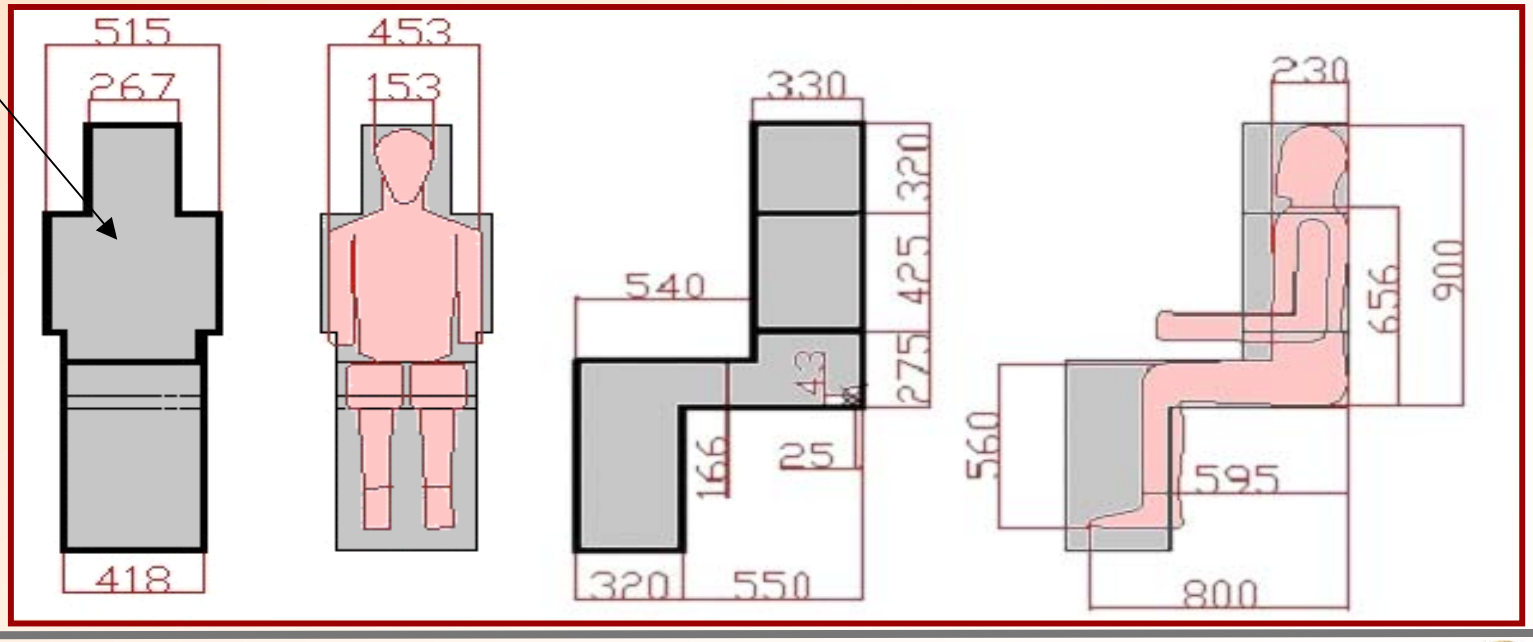
INTRUSSION: So, It should not be use to define survival space

DEFINITION OF A SURVIVAL SPACE FOR THE DRIVER

b. The procedure in Regulation UN-ECE 29 (for trucks)

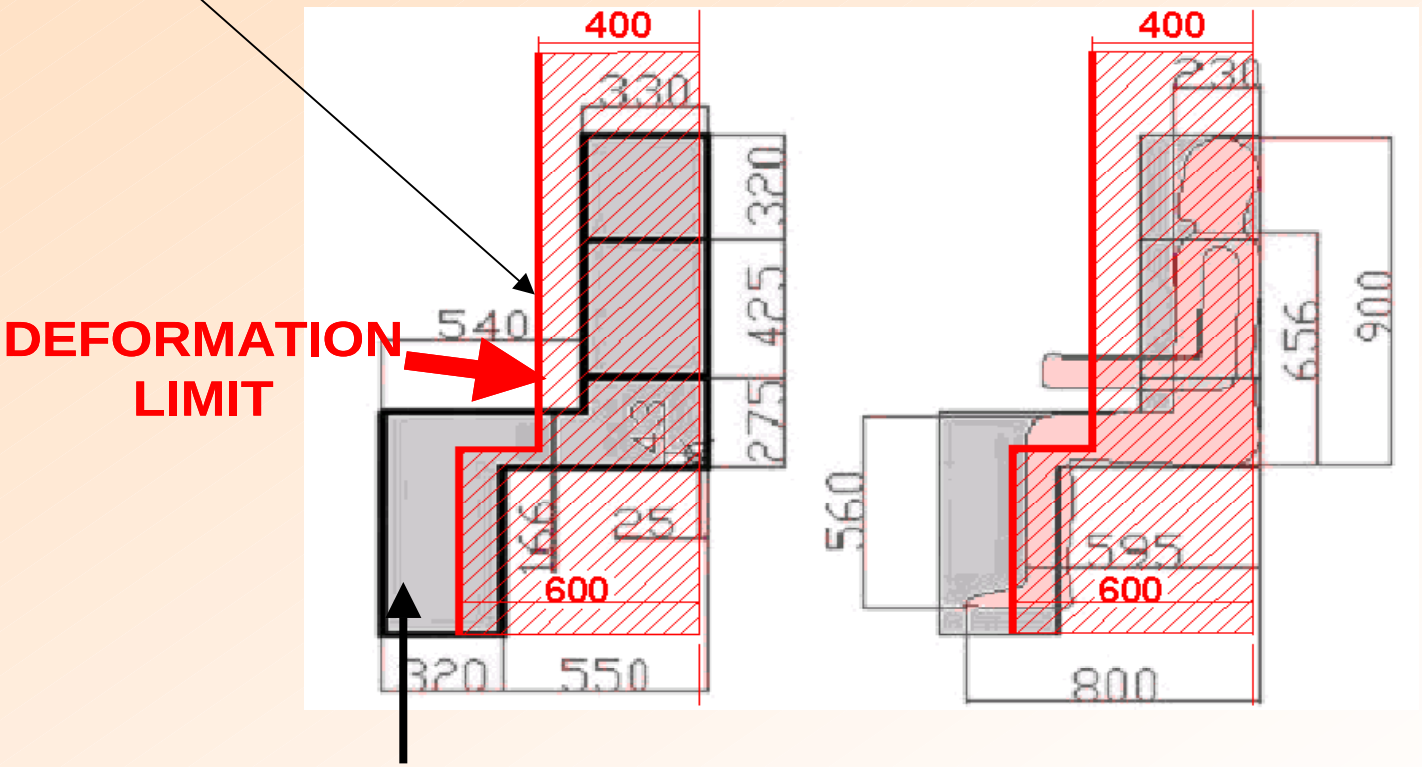
A dummy of the 50Th percentile cannot be in contact with any rigid part or the cabin after the tests.

c. The Spanish's standar UNE 115-204-87 which deals with rollover strength in utility vehicles. Volume free of intrusion



DEFINITION OF A SURVIVAL SPACE FOR THE DRIVER

d. ECBOS Work Document: Task 3.3.2 (TNO) propound a survival space after Swing-bod test (1500 kg) conform ECE/ R29 .



UNE survival space seems the better

PROPOSALS: Collision with passengers car, vans and light trucks

THE PROBLEM: Incompatibility (mass, stiffness and geometries)

THE PROPOSAL:

Use a “FUP” (UN-ECE R93)

or better “eaFUP”

MAIN PARAMETERS AFFECTING THE DRIVER'S SAFETY

★ **Structural stiffness**

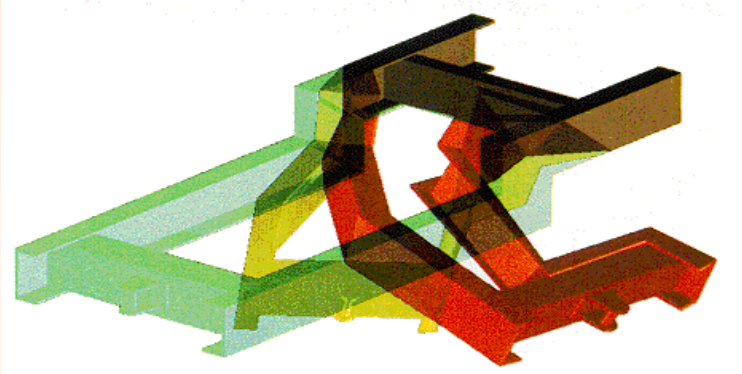
The frontal frame is thought to support frontal impact but in case of low overlap

The chassis could not come in

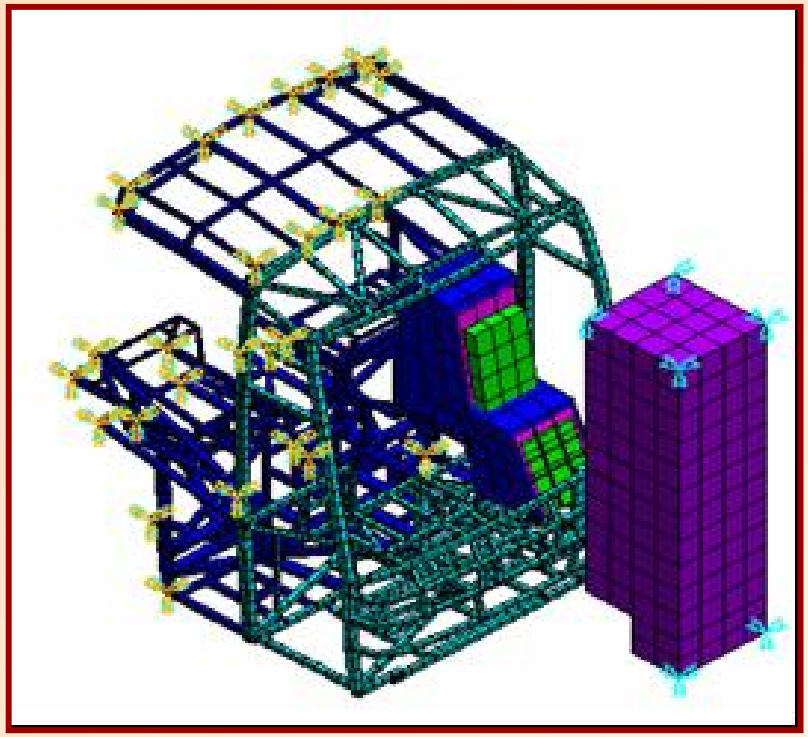
contact with the impacting vehicle

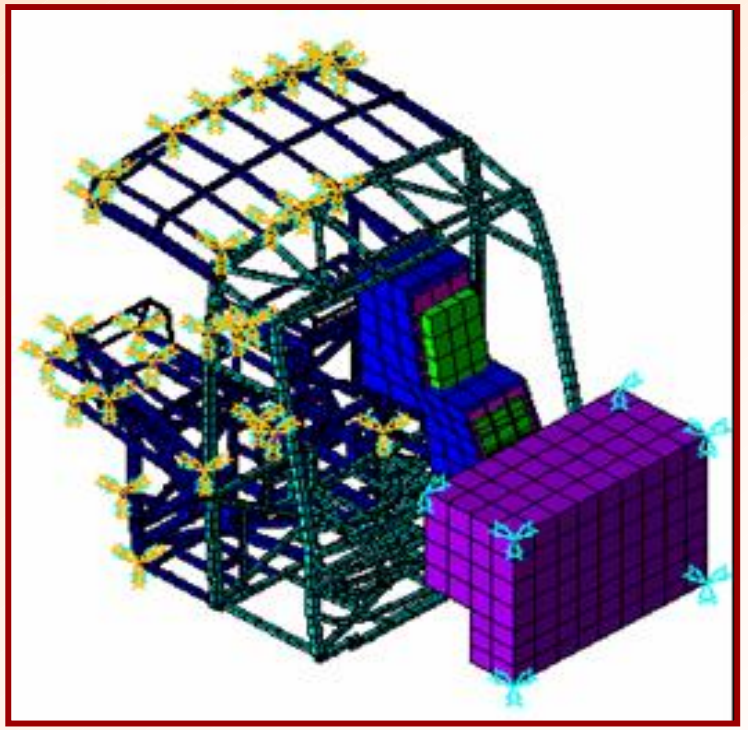
or

bend as a result of the impact



PROPOSALS: Collision with heavy vehicles





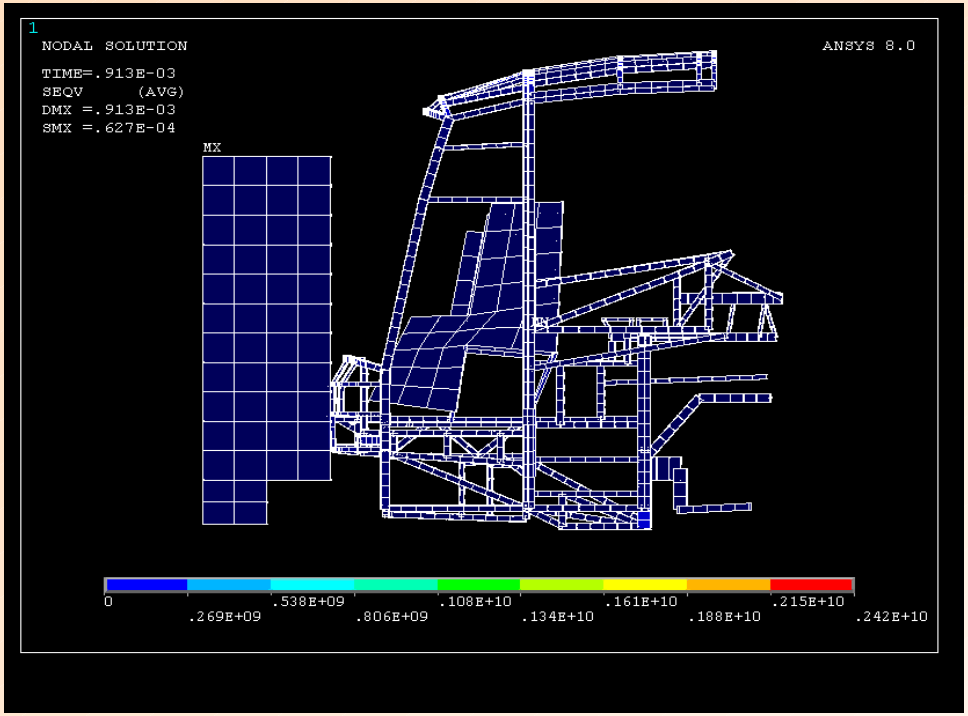
SIM 1: FRONTAL LOW OVERLAP

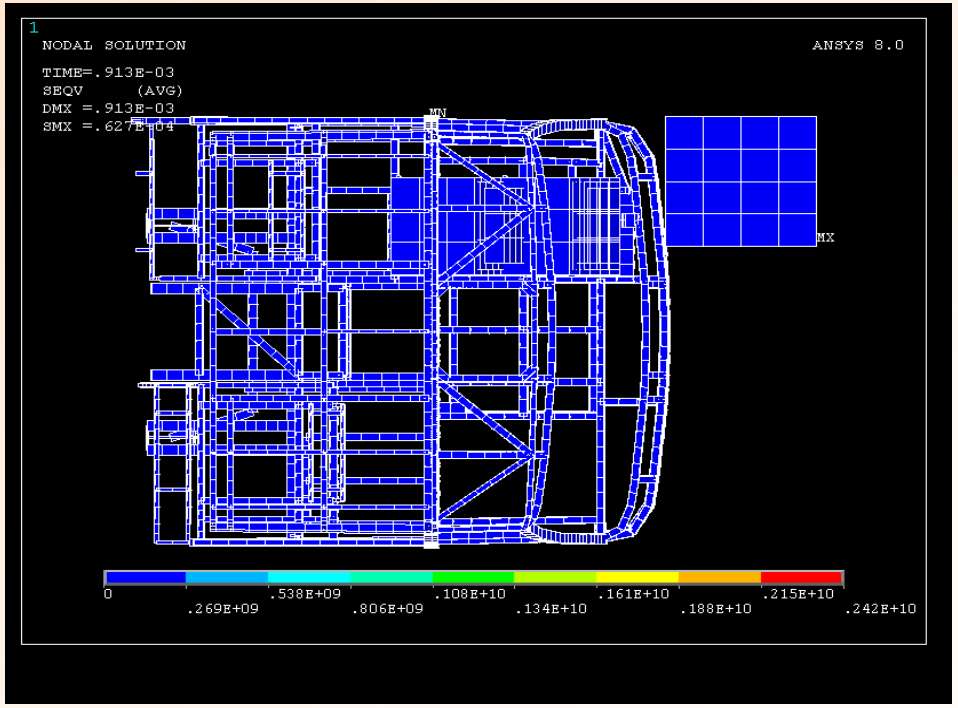
- Speed 30 km/h
- Overlap 30%

SIM 2: REAR ON HIGH OVERLAP

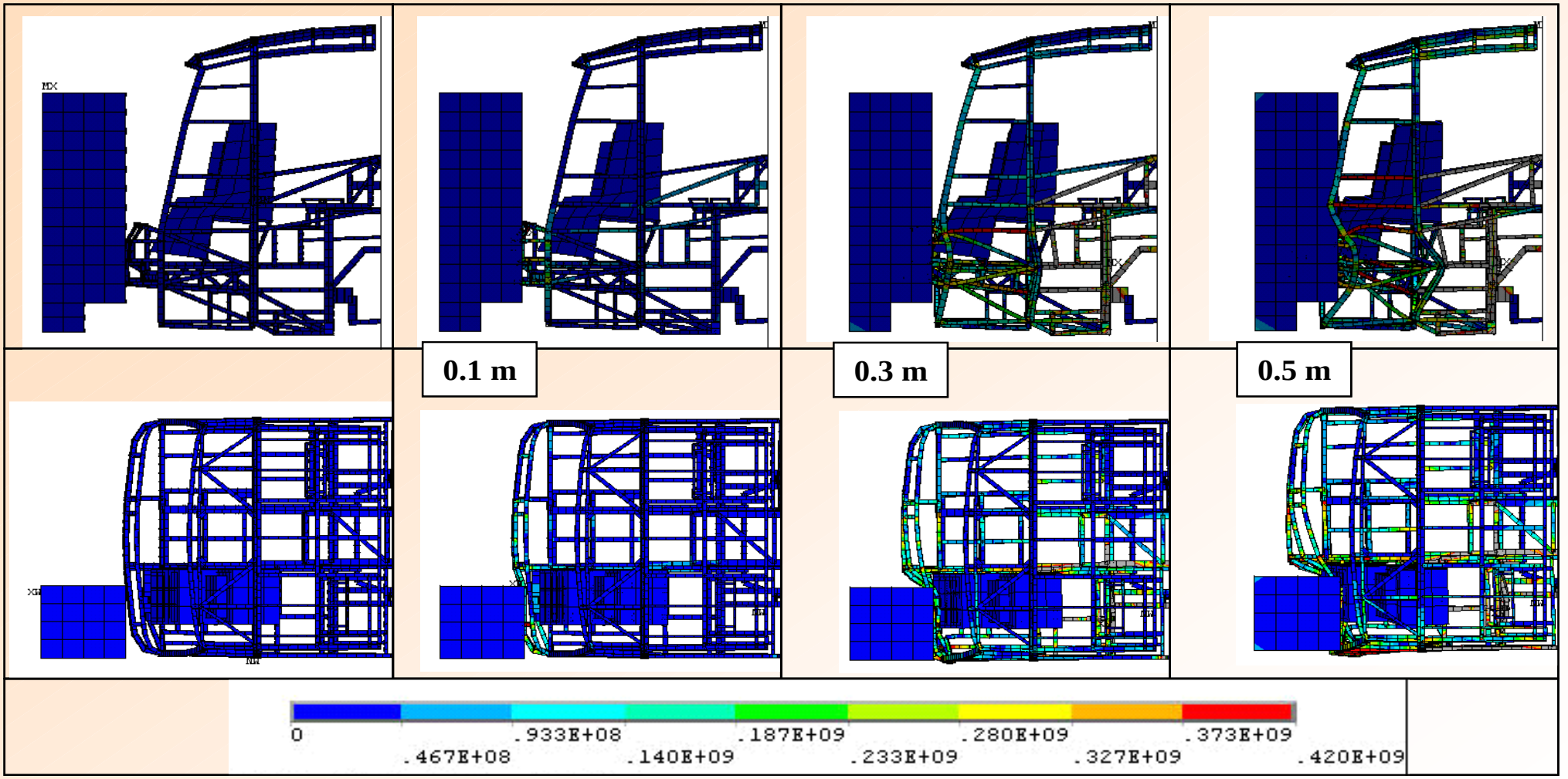
- Speed 30 km/h
- Overlap 70%

PROPOSALS: Test frontal Collision with heavy vehicles

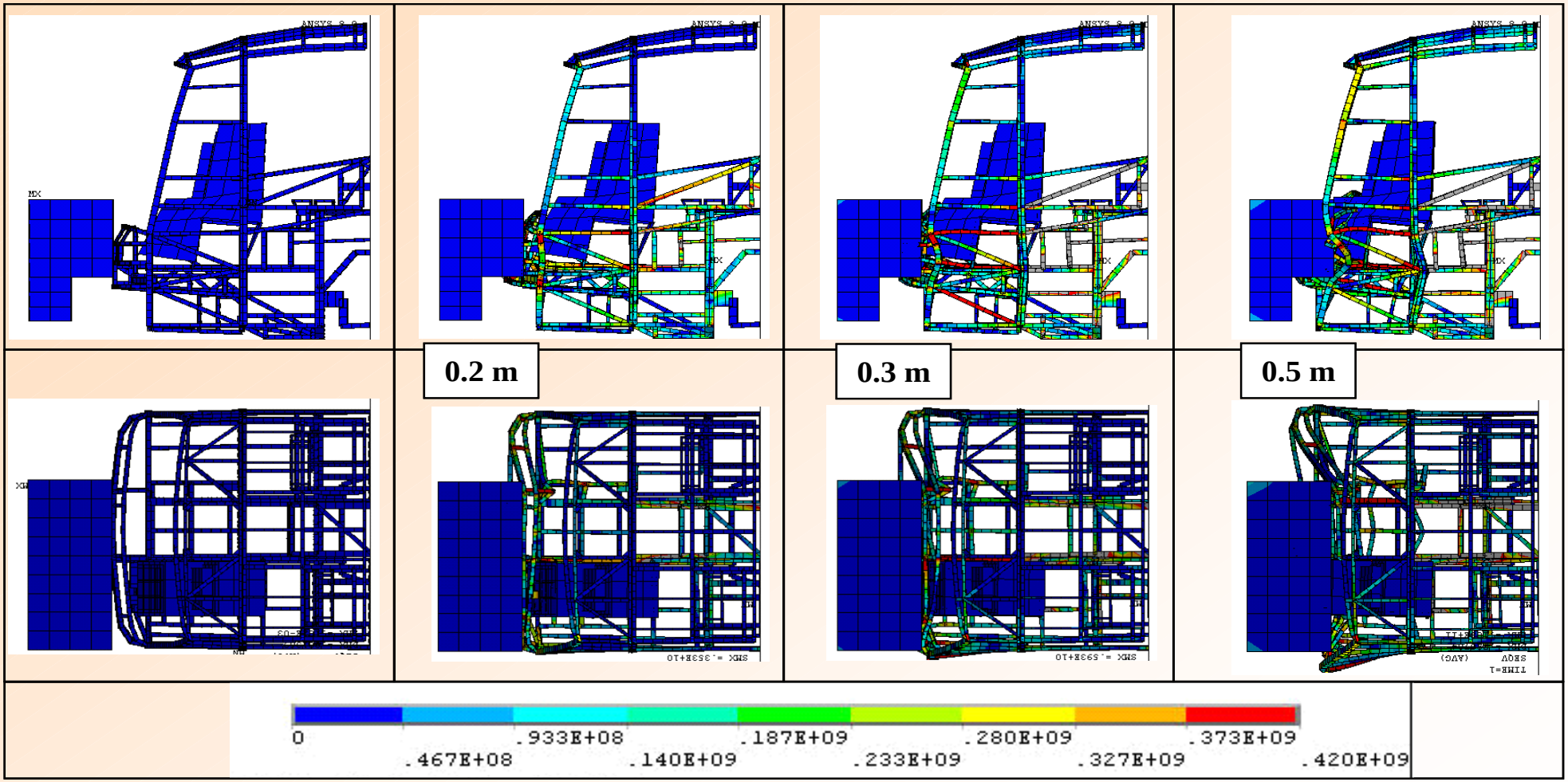




PROPOSALS: Test Frontal Collision with heavy vehicles

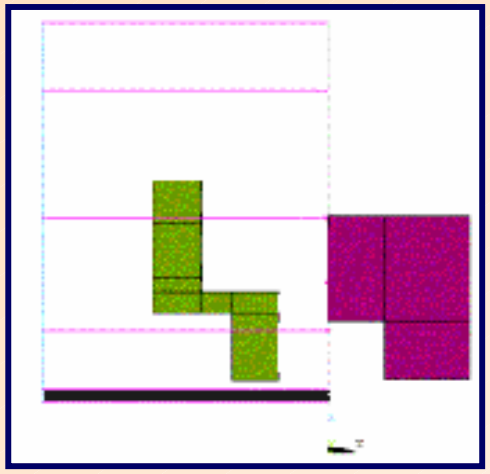


PROPOSALS: Test Rear-on Collision with heavy vehicles

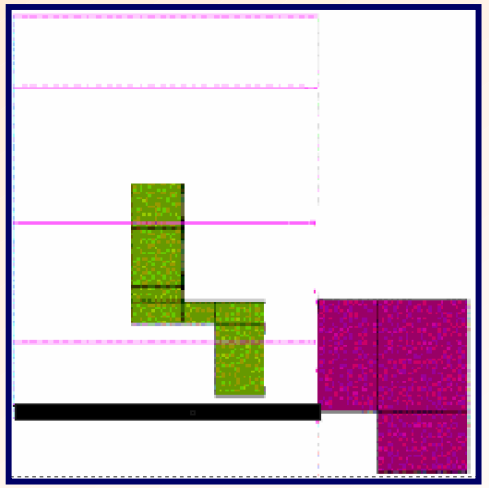


PROPOSALS: Collision with heavy vehicles

A higher floor with FUP's enhances passive safety



height < 1100 mm

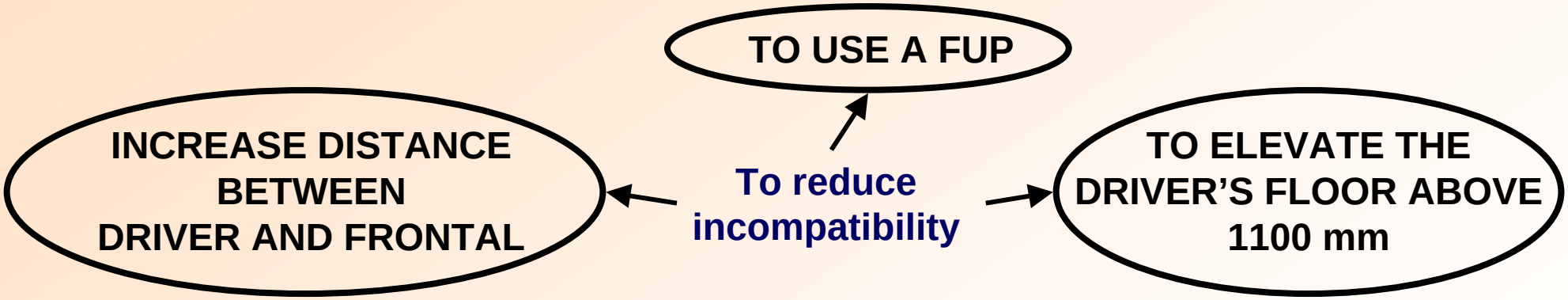


height > 1100 mm

Current designs are not strong enough to maintain the defined survival volume for driver/crew in the two simulations

CONCLUSIONS AND FURTHER DEVELOPMENT ABOUT FRONTAL

- **A survival space for the driver, free of intrusions in an accident, has been defined.**
- **Two crash test have been defined (against front and rear of a truck) to specify some requirements to the frontal structure of buses and coaches.**



When the geometrical incompatibility cannot be avoided:

increase the resistance of the floor, front structure, side pillars and doors to contribute to the survival space preservations

REPERCUSSIONS

R & D needed:

- **Statistical data**
- **Definition of possible tests/simulations**
- **Biomechanical analysis**
- **…**

Ad Hoc Expert Groups/ EEVC/European Projects / …

MANUFACTURES:

- **FUP:** ***Not difficult to adopt (little structural changes)***
- **Seats-safety belts anchorages:** ***Not much more difficult than nowadays***
- **Partitions: New requirements**
- **Structural strength: New designs and/or new vehicle concept**

INTRODUCTION

Accidents data collected by Spanish Traffic Authorities, since 1995 to 1999.

Only accidents with two vehicles with implication of almost one bus.

	SUCCESS	PERCENT
FRONTAL IMPACT	415	22.29%
FRONT-LATERAL	508	27.28%
SIDE IMPACT	189	10.15%
REAR-END	344	18.47%
FIXED OBJECT	121	6.50%
PEDESTRIAN IMP.	200	10.74%
ROLLOVER	85	4.56%
TOTAL	**1862**	**100%**

1º Head on

3º Side impacts

2º Rear end collisions

INTRODUCTION

Consequences to the driver.

- Head on causes the 50% of the deaths
- Rear end impact the 15% of the deaths

	INJURES IN DRIVERS				
TYPE OF	DIED	SERIOUS INJURES	SLIGHT INJURY	NO INJURY	NOT KNOWN
FRONTAL	1.67%	2.39%	8.13%	87.32%	0.48%
FRONTAL-SIDE	0.59%	2.94%	8.22%	86.89%	1.37%
SIDE		1.57%	5.76%	92.67%	
REAR END	0.86%	3.15%	7.45%	88.25%	0.29%
FIXED OBJECT	1.64%		14.75%	80.33%	3.28%
PEDESTRIAN IMP.			1.71%	98.29%	
ROLLOVER			27.27%	72.73%	
RUNNING OUT	3.31%	12.71%	27.62%	55.25%	1.10%
OTHERS			13.33%	86.67%	
TOTAL	**1.07%**	**3.32%**	**9.68%**	**85.19%**	**0.75%**

DEFINITION OF A SURVIVAL SPACE FOR THE DRIVER

From comfort and displacement allowed by safety belt: extrapolation to other percentiles