

TRUCK ACCIDENT INVESTIGATION : ANALYSIS OF OCCUPANT INJURIES

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Abstract :

This study involves trucks accidents investigation where occupants are injured. It has been made from the analysis of 51 accidents in which we found 59 occupants.

These crashes are on an average very serious and usually the occupants are polytrauma injured ; the main lesion being in the cephalic segment.

We found main lesions either in case of frontal impact and rollover, or in case of the cab is very collapsed.

We concluded that the increase of occupants' safety during a crash involved either a better stiffness or a higher protection of the cab.

INTRODUCTION :

The aim of this study is to analyse the commercial vehicles accidents with the intention of bettering the safety of their occupants.

On the road, safety scope of heavy trucks occupants is apart from the other road-users. Up to now, a few studies have been conducted for their safety.

This lacuna is probably due to the fact of this type of accidents small statistical rate. So, in 1979 in France, 202 heavy trucks occupants died and 3529 have been injured, that is to say 3 and 2 per cent of the totality of cars and trucks occupants.

It is also important to notice that these victims of accidents are professionnals and on this point, professionnall risk is more important than in other professions ; so studies are justified to better safety conditions.

METHOD :

To answer the question of the Transportation Ministry, we use the methodology of bidisciplinary accidental investigation which exists from 10 years in our laboratory.

In order to have an enough representative number, we extended the investigation area.

Since 1980, our investigations concern all the accidents in which one at least heavy truck occupant is wounded ; this takes place :

- On the A7 highway between Vienne and Salon de Provence (Société des Autoroutes du Sud de la France, the alarm has been given by the "exploitation service" of the Company).
- On the other roads in departments of AIN and ISERE (the alarm has been given by the "Direction Départementale de la Gendarmerie").

Today, this study is composed of 51 accidents in which we find 59 victims with 11 deaths.

In these 51 accidents, 32 take place on highway and 19 on the other roads (mainly on national roads).

ACCIDENTS CONDITIONS :

As we wrote, heavy trucks accidents are works accidents, so they occure during the week and we can notice that the accidents are more frequent at the end of the week (on Friday).

Besides, if we consider accidents occurence during the day, we notice a bigger number of accidents in the night ; 16 accidents on 51 (which means 30%) happen between midnight and four o'clock in the morning. (Fig 2).

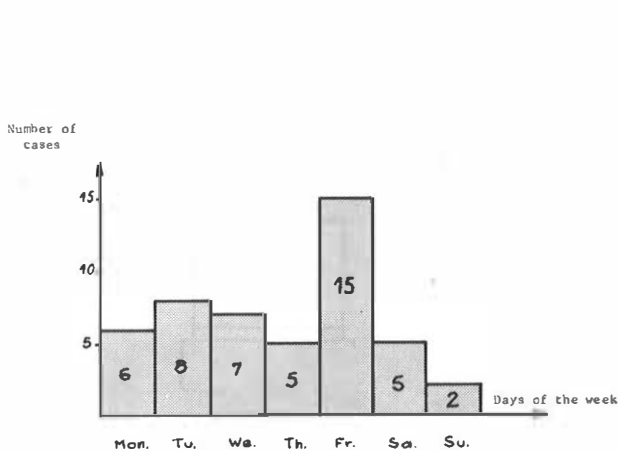


FIG 1 - REPARTITION BY DAYS OF THE WEEK

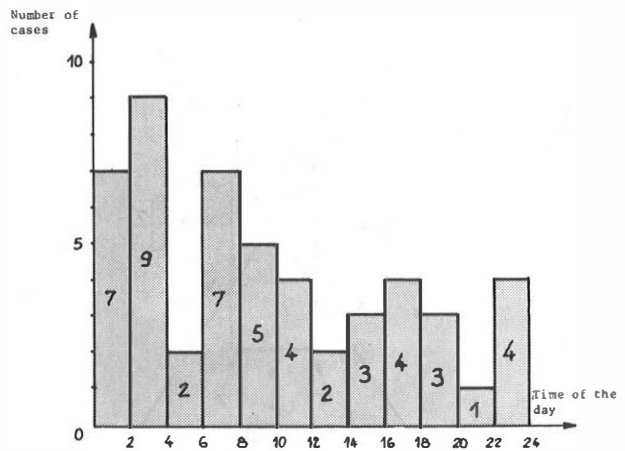


FIG 2 - REPARTITION BY TIME OF THE DAY

The major portion of accidents during the night results of sleepiness. In our sample, 16 accidents on highway are such accidents (accident with running out the road with small angle, without braking).

This point has been analysed in a study of ONSER : conditions of trucks circulation on highway (4).

We noticed that straight trucks and essentially tractor trailers are the most involved.

TYPES OF COLLISIONS :

Concerning different types of collision we find some characteristic crashes (Fig 3).

- Frontal impacts : 24 cases, so approximatively 50% of impacts.

Among them, we can find some impacts against road side rigid obstacles and one collision with head on impact.

Though the majority of cases (14 cases on 24) shows a frontal impact against the back of another truck, Figure 4 shows that in the majority of cases, the deformation involves the totality of the cab frontal structure.

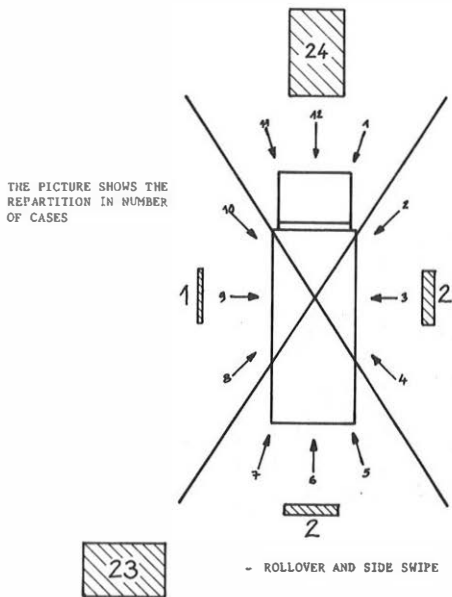


FIG 3 - DIRECTION OF IMPACTS

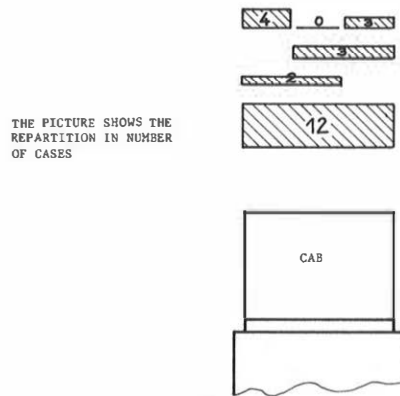


FIG 4 - FRONTAL IMPACT - DEFORMATION OF THE CAB

Concerning vehicles damages, the accidents are characterized by important deformations on the front of the cab.

It is right for collisions either with high speed variations (frontal impacts against roadside rigid obstacles and head on impacts), or with low speed variations (frontal impacts against back of another truck).

It results of the fact that the frame of the back part of impacted truck is higher than the front part of the concerned truck. So during the crash, loads are directly applied on cabs which present more deformations.

- Side swipes and Rollovers :

An other very frequent case involves side swipes and rollovers (23 cases on 51). The frequencies of these types of accidents are sensibly equal.

In the case of simple side swipes, it can be either on the curve or on the straight line, because of a bad stability of vehicle or a running out the road on the verge at the same level. So damages of the cab are slight if the cab on its side does not meet obstacles during its movement.

Usually, the case of side swipes is a running out on embanked road. This type of accident is frequent on highways ; the vehicle falls down below the road level.

It results important deformations on the cab which in general is completely collapsed up to the belt line.

The driver stays incarcerated in the below of the belt line of the cab.

- The other types of impacts : They are impacts on lateral structures or on the back of the truck, which are rare.

TYOLOGY OF INJURIES :

General evaluation : Fig 5.

If we consider the global severity (OAIS) (5) occurring on the 59 injured occupants, we can notice an important number of deaths and serious injuries (OAIS = 5,6), as it says 13 cases ; besides, there is a small proportion of medium lesions (OAIS = 3,4); the minor lesions being very represented.

We find these expended characteristics in some types of accidents, mainly in frontal impacts and in rollovers in which serious injuries and deaths represent 30%.

The gravity of frontal impacts, in particular against roadside rigid obstacles or other trucks has been noticed by GRATTAN and HOBBS (2).

LESIONS REPARTITION :

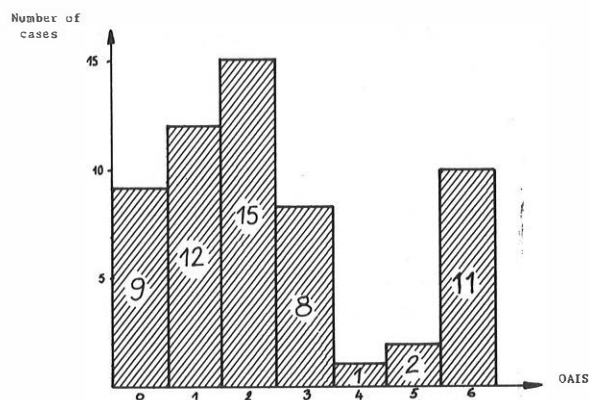


FIG 5 - DISTRIBUTION OF GLOBAL AIS

TOTAL NUMBER OF LESIONS : 97

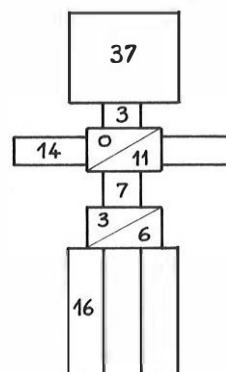


FIG 6 - DISTRIBUTION OF LESIONS

These 59 injured people present 97 lesions (Fig 6), which means an average of 1,7 lesion.

If we compare this repartition with injured cars occupants, it results that the cephalic segment is not frequently affected. Nevertheless, these head injuries involve the overall severity

We also notice the low lesions number of the limbs. On 97 lesions, we have 20 lesions of the chest and pelvis, with three very serious or fatal lesions.

Table 7 : Repartition of AIS

	1	2	3	4	5	6 and +
Head	8	14			4	4
Face	6	1				
Neck	1		1	1		
Spin	4	1	1	1		
Upper limbs	8	6				
Chest	5	2	2	1		1
Thoracic viscera						
Pelvis	3	1	1		1	
Abdomen	1		1		1	
Lower limbs	8	6	2			

ASSOCIATED LESIONS :

Among these 59 injuries, there are 5 unknown cause of death.

We have 23 injured people with head AIS ≥ 2 . We can notice among them : 8 polytrauma with head AIS ≥ 5 , and associated lesions being serious lesions, to chest, pelvis or abdomen. (AIS ≥ 3).

We can find these injured people in two types of impacts, either in frontal impacts against an other truck, or against a roadside rigid obstacle.

The cab shows important deformations in frontal structures or in rollover impacts (the occupant is encarcerated under the collapsed top).

We have to notice that only one single case presents an only hurt on the head which has been mortal.

We notice too, head lesions (AIS = 2) associated to chest lesions (AIS =2 or 3) in two cases and two spine lesions (AIS = 3 or 4) in four cases.

Serious lesions of pelvis are always associated to other serious hurts (head - thorax - abdomen).

We can not find injury mechanisms coming from the intrusion of the front under belt line of the cab of backward movement of the steering wheel.

These mechanisms must certainly exist (frontal impacts) but they are dissimulated by important deformations of the cab and very serious or fatal hurts that they involve (head) - (Table 8)

Table 8 : Associated lesions for O AIS 3

Unknown cause of deaths Polytrauma	Polytrauma O AIS head > 5 O AIS thorax pelvis 3	Head AIS=6 one lesion	Head AIS = 2 thorax spine AIS = 2 or 3 AIS = 3 or 4	
5	8	1	2	4
20				

We can not show simple mechanism for occupants who have principal lesions such as thoracic or spine hurts (6 cases).

It looks like if these lesions were, in some cases consequences of complex kinematic of occupants in the cab during rollover crashes.

So in any case it happens during pure frontal impacts which are the only one involving simple and known movements.

We also find some cases in which occupants are ejected (5 cases). In these cases, severity is very important but the problem is not so different as in ejections cars crashes.

CONCLUSION :

This analysis made from an investigation which started in 1980, is constituted by an insufficient number of cases and does not allow us to give a definitive conclusion.

Nevertheless, we can make some remarks :

- heavy trucks crashes are different from cars crashes.

In term of deceleration, we notice that heavy trucks accident is on average, less important than in cars accident .

There is a certain difference between the types of impacts, and we could show the importance and gravity of frontal impacts and rollovers when the cabs show very important deformations.

In consequence, the occupant suffers very often polytrauma with severe head lesions.

The safety improvement of heavy trucks users might consist in a better protection of cabs during impacts ; which means for cabs behaviour during the rollover and a better protection during frontal impacts.

It is particularly important to study the impacts compatibility between front and back areas of heavy trucks.

We can not yet really appreciate the advantage of the inside safety device.

REFERENCES :

- 1 - T.A. KARLSON, S.P. BAKER, B.F. MORTON :
"FATALLY INJURED TRUCK DRIVERS". Proceedings of the 21st Conference of the American Association for Automotive Medicine; September 77 .
- 2 - E. GRATTAN, J.A. HOBBS :
"INJURIES TO OCCUPANTS OF HEAVY GOODS VEHICLES". TRRL Reports 1978. Ref LR 854.
- 3 - K.HÖGSTRÖM, L. SVENSSON, B. THÖRNQVIST :
"ACCIDENT INVESTIGATION - FATAL ACCIDENTS, HEAVY TRUCKS AND CARS". AB VOLVO, Truck division Traffic Safety Department - Götteborg -
- 4 - B.DUVERGE, B. CHRETIEN, R. QUINCY :
"ACCIDENTOLOGIE POIDS-LOURDS SUR AUTOROUTES ET ROUTES NATIONALES". ONSER N° 311-81-01 1980.
- 5 - ABBREVIATED INJURY SCALE (AIS), 1976 -
AMERICAN ASSOCIATION OF AUTOMOTIVE MEDICINE-
- 6 - J.O'DAY, R.E. SCOTT :
"AN ANALYSIS OF TRUCK ACCIDENT INVOLVEMENT".
Report of HSRI (Michigan) - April 1974 - Vol 4, N°8 -