

HEAVY VEHICLE ACCIDENT FACTORS

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Abstract

A general study on accidents involving Heavy Goods Vehicles (HGV) was carried out in France in 2001, which was followed by a more local analysis, focusing on accidents in the Rhône-Alpes region between 1996 and 2000. These two studies enabled statistic features of HGV accidents to be identified. The analysis of several influent factors in crashes involving at least one HGV, enabled the following elements to be examined:

- their seriousness (or accident severity)

HGVs above 3.5 t, which represent 2% of vehicles on the roads and account for 6.3% of the kilometres travelled, are involved in 5.2% of accidents with physical injuries and 12.9% of road fatalities which cause 13% of deaths. They represent 3.2% of the vehicles involved in road fatalities.

- the road network where they appear the most (road type)

There are more accidents involving physical injuries on secondary roads and main roads, than on country roads and motorways.

- the manoeuvres that lead to most of the accidents (pre-crash motion)

52.7% did not change their lane. Side collisions are the most important (29.24%). Accidents with a head-on crash (14.75%) are caused by swerving, overtaking by the left, and left turns. Accidents without collision (5.14%) involve vehicles running off the road.

- parameters related to infrastructure (road layout)

37% of accidents involving only one HGV occur in a curve. The road geometry therefore seems to be faulty in these cases. Road surface characteristics are highly important factors in an accident and there is a relation between road skid-resistance and the percentage of HGV accidents on wet pavements.

Keywords: Heavy Vehicle – accident – infrastructure

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1. INTRODUCTION

A general study on HGV accident characteristics in France was carried out in 2001 (Calma,T. 2002), which was followed by an analysis focusing more specifically on accidents in the Rhône-Alpes region between 1996 and 2000 (Briet, F. 2003).

These two studies identify the characteristics of HGV accidents by statistical analysis. They indicate accident-prone situations that are representative for this type of vehicle. The analysis of several factors present in accidents involving at least one HGV, enabled the following aspects to be examined:

- their seriousness,
- the road type on which they most often occur,
- the most accident-prone manoeuvres,
- road type and road surface related parameters.

2. THE SERIOUSNESS OF ACCIDENTS INVOLVING A HGV

In 2001, out of the 116,745 accidents in France with casualties, which led to 7,720 fatalities, 6,039 of these accidents involved a HGV. These HGV accidents caused the death of 1,005 road users, giving a rate of 16.64 fatalities for 100 accidents, which is more than 2.5 times higher than observed from all accidents (6.61) (refer to figure 1). This is an average fatality rate, as it varies from 9.44 in urban environments to 21.01 in the open country and from 6.01 on toll-free motorways to 27.16 on secondary roads in the open country. However, the fatality rate remains significantly higher than that for all accidents total number of users, regardless of the location.

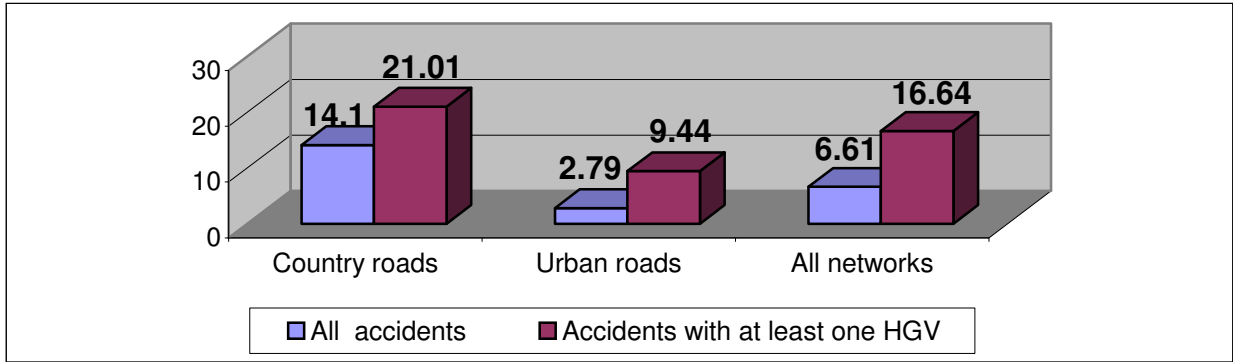


Figure 1. Fatality rate for 100 accidents involving injuries

HGVs weighing over 3.5 tons, which represent 2% of the number of vehicles on the road and account for 6.3 % of the kilometres travelled, are involved in 5.2 % of injury accidents and 12.9 % of fatal accidents which lead to 13.0 % of road deaths (refer to figure 2). They represent 3.2 % of the vehicles involved in injury accidents and 8.4 % of vehicles involved in fatal accidents.

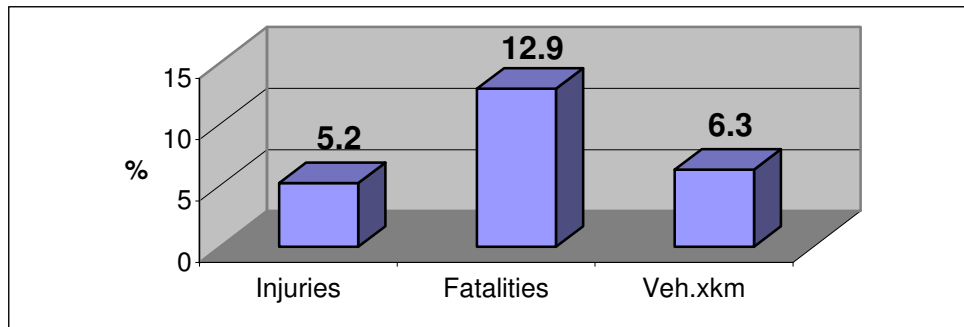


Figure 2. Involvement of HGVs in accidents

In 45% of the number of injury accidents involving at least one HGV, the main crash partner is a car and in 11 % of the cases a motor-driven two-wheeled vehicle. Consequently, the victims of accidents involving HGVs are primarily drivers or passengers of light vehicles (60%). It should be noted that in almost 12% of the accident cases, HGVs are not in collision with another vehicle (single vehicle accident).

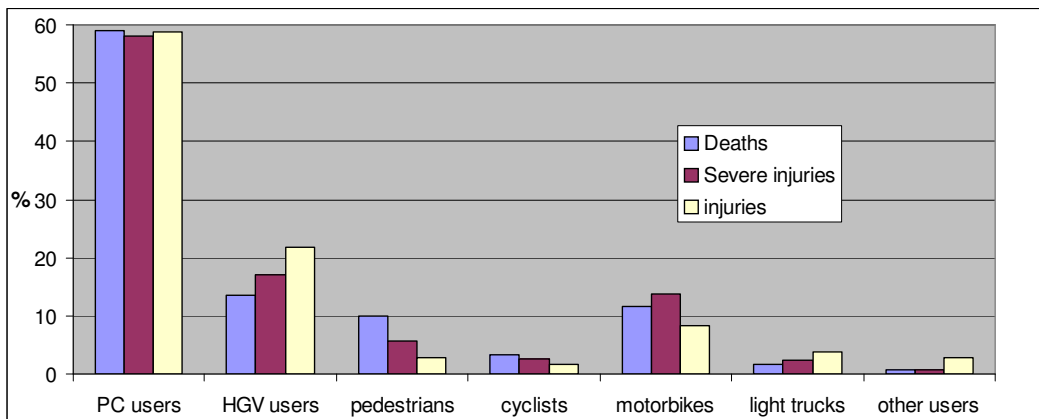


Figure 3. Share of user categories in accidents involving at least one HGV

3. ROAD TYPE AND TIME PERIOD HGV ACCIDENTS MAINLY OCCURS

The majority of HGV accidents causing injuries occur on major secondary roads (“routes nationales” and “routes départementales”), followed by smaller local roads and motorways. However, if this portion is compared to all injuries accidents, it can be noted that there are three times as many accidents involving HGVs on motorways, almost twice as many on major secondary roads (routes nationales), twice as few on smaller local roads and almost equal on other secondary roads (routes départementales). The majority of accidents involving HGVs do not occur at junctions and occur on country roads (refer to figures 4 and 5).

Whereas the peak period for all injury accidents is between 3pm and 9pm, accidents involving HGVs are more evenly distributed, between 6am and 6pm. In HGV accidents, 65% of fatalities occur in the daytime and 35% at night. For all road accidents, with or without HGVs, the figures are 54% and 46% respectively.

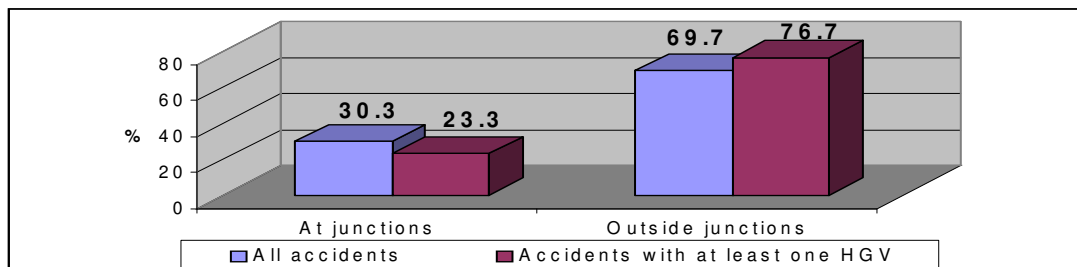


Figure 4 : Spatial share of injury accidents at junctions and outside junctions

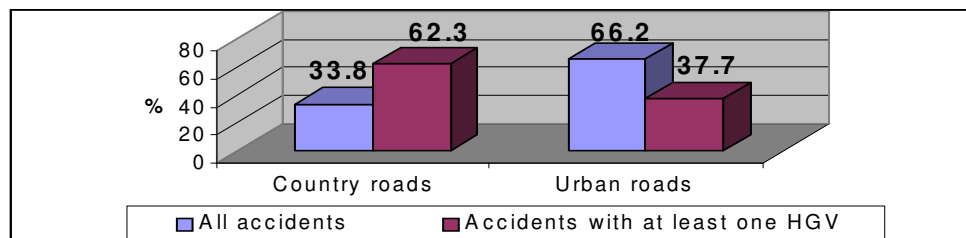


Figure 5 : Share of injury accidents in the open country and in urban areas

The frequency of injury accidents, fatal accidents and deaths from Monday to Friday is greater for accidents involving at least one HGV than for all accidents. The frequency of accidents is much less on Saturdays, Sundays and Bank Holidays due to the HGV traffic restrictions that are in force in France at weekends and on Bank Holidays.

It is also important to report that between 1997 and 2001, the number of injury accidents in which HGVs were involved diminished more rapidly (-11 %) than for the total number of injury accidents (-6.8 %). This reduction is much more apparent in urban areas than in the open country. However, one should not be too optimistic. Although the average speeds of HGVs in 2001 remained practically the same as for the year 2000, regardless of the road type and trailer, over this five-year period they have nevertheless generally risen by 1 to 7 km/h.

Accidents involving at least one HGV are therefore more severe. In part, this can be explained by the fact that when driving at the same speed as a car, their kinetic energy is much greater due to their higher mass. This justifies the interest in HGV accidentology at a European level. Although

this type of vehicle is involved in only 5.9% of injury accidents, and although certain accidentology indicators are decreasing, they nevertheless account for 13% of road deaths!

4. THE MOST ACCIDENT-PRONE MANOUVRES (Rhône-Alpes analysis)

All the figures given in this chapter concern accidents involving at least one HGV. A study undertaken between 1996 and 2000 (Calma, T. 2002) enabled an analysis of HGV accidents in the Rhône Alpes region over this period. Between 1996 and 2000, 53,939 injury accidents were recorded in the Rhône-Alpes region, of which 4,279 involved a HGV (7.93%). Infrastructure-related criteria, useful for HGV accidentology (vehicles involved, manoeuvre preceding the accident, seriousness of the accident, type of collision, state of the road surface, horizontal alignment, longitudinal profile, road category) were selected in order to carry out a more detailed analysis in comparison to national accident data.

The proportion of accidents involving a single HGV is more than 20% in the Rhône Alpes region, compared to 12% for the whole of France. This situation may be due to the presence of numerous mountainous roads in this region, which are rarely adapted to HGV traffic.

An analysis of the data files on the main manoeuvres of vehicles before an accident involving a HGV is revealing: out of the 6,488 manoeuvres recorded for all the vehicles involved in the accidents, 3,419 vehicles did not change direction prior to the accident, which represents 52.70% of the cases listed in the study. This figure is then followed by vehicles turning left (7.85%), vehicles swerving to the left (7.68%) and vehicles driving in the same direction and in the same lane (6.78%). This shows that the majority of vehicles involved in an accident with a HGV do not change lanes, which implies that the drivers of these vehicles do not try to avoid the accident. One can suppose that this is due to the element of surprise (due to the manoeuvre of another vehicle, the reaction of their own vehicle in relation to the road layout or a lack of visibility...).

For vehicles driving in the same direction and in the same lane, the accidents mainly involve rear collisions that may be due to poor vehicle braking, driver inattention, tyre wear, an insufficient safety distance between vehicles, or road surface problems such as skid resistance.

Finally, accidents involving a HGV, whose main manoeuvre preceding the accident was to turn left, can largely be explained. A lack of visibility encountered by the vehicle arriving opposite that which is turning is highly likely as this type of accident often occurs at junctions in curves or at the top of a hill when visibility is poor.

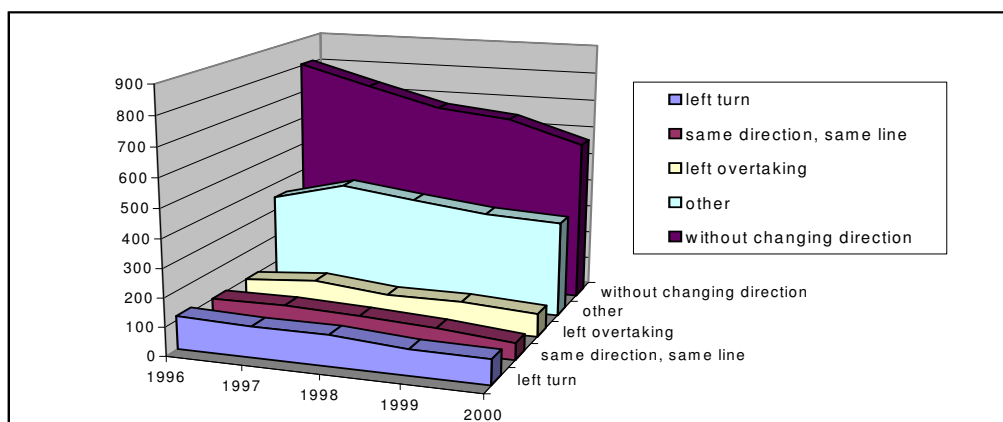


Figure 7. Main manoeuvres preceding an accident involving a HGV

This lack of visibility when turning left calls for specific modifications to be made to junctions. Side collisions are the most frequent (29.24% of cases). They occur following left turns, swerving while overtaking or when trying to enter the traffic flow.

Head on collisions (14.75%) are due to swerving, overtaking by the left, and left turns. The state of the road surface (wet, icy, snowy) can be an aggravating factor in these situations.

Rear collisions can also be due to road surface skid resistance characteristics: on wet roads, poor skid resistance increases risks during emergency braking. The vehicle risks hitting the preceding vehicle and possibly causing a multiple collision (12.50% of recorded cases).

Accidents without collision (5.14%) include accidents where a vehicle is not in contact with another vehicle and runs off the road. These are due to a driver's inattention, risky behaviour or intrinsic negative road surface characteristics. (problems relating to skid resistance, road geometry etc...)

Table 1 Types of collision in accidents involving a HGV

Type of collision	Injury accidents	
	Total	%
Frontal	631	14.75
Rear	589	13.76
Side	1251	29.24
Multiple	535	12,50
Other collisions	1053	24.61
No collision	220	5.14
Total	4279	

“Other” collisions includes collisions with an obstacle on the road or the roadside (which can be occupied by a stationary vehicle) and represent 24.61% of recorded cases. This rather high figure leads to questions relating to the road environment, and more specifically to road design, maintenance and road works.

5. Road-related parameters (Rhône-Alpes analysis)

5.1 Type of road

Accidents involving at least one HGV are most common on secondary roads (routes départementales) (29.9%) as they are not adapted to heavy HGV traffic. Major secondary roads (routes nationales) are also concerned (25.9%) as along with motorways, they are the type of roads mostly used by HGVs.

Accidents on smaller local roads and other roads, represent 23.7% of the cases recorded. This relatively high rate, compared to the HGV traffic supported by this type of roads, can be explained by the fact that these roads are not at all designed for HGV traffic. The road geometry and visibility may also be unsuitable for HGVs.

On motorways, HGV accidents represent 20.5% of injury accidents, which is a relatively low figure when considering the number of vehicles that use this type of road. This is certainly due to the safety and comfort of driving on motorways.

Table 2. Frequency distribution of accidents involving a HGV according to type of road

Road category	Injury accidents	
	Total	%
Motorways	876	20.47
Major secondary roads	1106	25.85
Secondary roads	1278	29.87
Local roads	896	20.94
Others	123	2.87
Total	4279	

5.2 Type of profile

5.2.1 Horizontal alignment

In terms of horizontal alignment, accidents are the most common on straight sections (70.53%, refer to table 3).

Table 3. Injury accidents according to horizontal alignment

Horizontal alignment	Injury accidents	
	Total	%
Straight section	3018	70.53
Left bend	490	11.45
Right bend	657	15.35
S bend	114	2.66
Total	4279	

Accidents are less frequent in curves than on straight sections but are still considerable in number. In these cases, the accident provoking manoeuvres are mainly swerves to the left or right, which may be due to the road geometry (radius of curvature, length of the curve, superelevation, slope).

37% of accidents involving a HGV and no other vehicle, occur in a curve. This is higher than the percentage for all accidents involving a HGV (29.46%). Swerving to the left or right or turning can make HGVs leave their initial trajectory and run off the road.

56% of accidents involving a swerve to the right occur in curves, whereas in the entire study, accidents in curves represent only 30% of injury accidents. For this type of HGV accident, a head-on collision occurs in 46% of reported cases, compared to 14.7% overall in the study.

On the other hand, the proportion of accidents concerning a vehicle that is not in contact with another is low (6.8% compared to 20.6% of accidents overall in the study). This is because the swerving vehicle has more room to perform an evasive manoeuvre.

It can also be observed that the number of accidents involving a HGV swerving to the left is much higher on slippery surfaces (on wet roads: 28% compared to 22% for the overall study, on snowy roads: 2.8% compared to 1.6%). This parameter therefore constitutes an aggravating factor: if the vehicle that begins to swerve brakes on a slippery road surface, it will not be able to regain its trajectory and the collision with a vehicle approaching in the opposite direction will be

inevitable. Accidents involving a HGV swerving to the left are by far the most severe. For this type of accident there are 30.52 fatalities per 100 injury accidents and 72.59 fatalities + seriously injured for 100 injury accidents. These figures are significantly higher than those for the overall study (14.77 fatalities for 100 injury accidents and 44.94 fatalities + seriously injured for 100 injury accidents). The higher severity can be explained by the force of the collisions that for the most part occur head-on and at full speed.

5.2.2 Longitudinal profile

For longitudinal profiles (table 4), it can be observed that almost three quarters of injury accidents involving a HGV (73.91%), occur on a flat section of road.

Accidents on slopes are primarily due to inefficient braking at relatively low speeds. According to a study carried out by SETRA (Brenac, T. 1992), for gradients on motorways of 3 to 4%, HGVs are over-represented in accidents if the length of the slope exceeds six kilometres.

Table 4. Injury accidents according to longitudinal profile

Longitudinal profile	Injury accidents	
	Total	%
Flat	3257	73.91
Slope	918	20.83
Hill-top	116	2.63
Bottom of hill	116	2.63
Total	4407	

5.3 Road conditions

The state of the road surface is a highly important factor in road accidents as it determines the road's skid resistance. If a road is wet, snowy, icy or oily, its skid resistance will be reduced and an accident is more likely to occur. Accidents involving HGVs on wet roads account for almost 22% of injury accidents. On wet roads, the braking capacity of tyres is reduced, and this reduction may be further increased if the tyres are worn.

Accidents on snowy, icy or oily roads account for only a low percentage of accidents involving a HGV (3.4%), which can be explained by the fact that such conditions are generally seasonal and not very frequent

Table 5. HGV injury accidents according to road conditions

Road surface conditions	Injury accidents	
	Total	%
Normal	3172	74.09
Wet (or very wet)	929	21.70
Snowy	72	1.68
Icy	50	1.17
Oily (or covered in another substance)	26	0.61
Other conditions	32	0.75
Total	4281	

Out of the 816 accidents are caused by the road and/or its environment conditions, only 343 occurred on wet pavements, which represents about 42%. Out of these 343 accidents, many occurred on secondary roads for which no information is available. It was therefore possible to analyse only 139 HGV accidents on a wet road.

Out of these 139 located accidents for which SFC measurements were obtained, there are:

- 60 accidents with a SFC lower than 0.50, (41% of the study)
- 52 accidents with a SFC between 0.50 and 0.60, (36% of the study).
- 28 accidents with a SFC between 0.60 and 0.70, (19% of the study).
- Only 5 accidents with a SFC higher than 0.70, (3% of the study). (refer to figure 7)

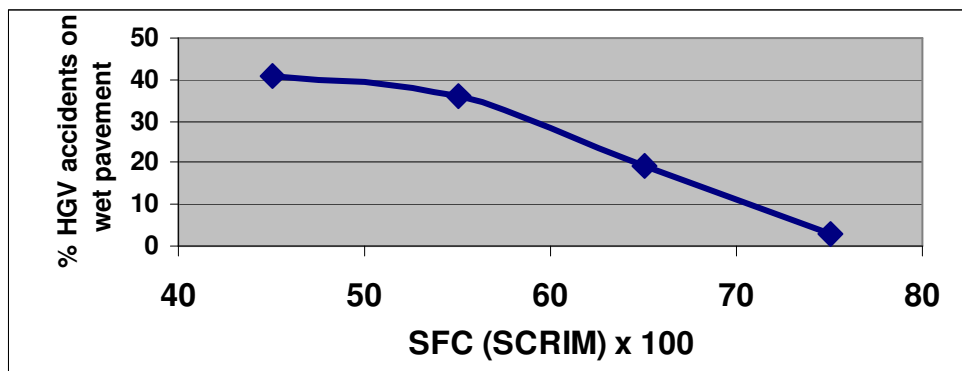


Figure 7. Skid resistance and % of HGV accidents on wet pavements (139 ac.)

This figure shows that for HGV accidents on wet pavements, the lack of skid resistance can be considered an accident-provoking factor. Although one might be tempted to think that due to the weight of their trailers and the structure of their tyres, HGVs are less affected by skid resistance than light vehicles, the study carried out shows that the opposite is in fact true.

6. CONCLUSIONS

This essentially statistical study highlights the variety of HGV accidents. It reveals the main tendencies and shows that generally speaking, HGV accidents are not accountable to HGVs alone.

In terms of the road infrastructure itself, it would appear that curves are a subject for further investigations. Due to their nature, road conditions in curves undoubtedly become critical much more rapidly for HGVs than for light vehicles. It can therefore be stated that swerves in curves contribute to accident-prone situations and that the characteristics inherent to HGVs are aggravating factors.

It is important to remember that HGVs are not always the cause of accident situations! A HGV driver may suddenly be faced with another road user who cuts in front of him (or hits the HGV from behind):

- Road user approaching from the opposite direction on a straight section of road and on a wide infrastructure without a central reservation;
- Road user approaching from the opposite direction, in a curve of a narrow road;

- Road user without right of way who cuts in front of a HGV at a junction or suddenly turns left in front of the HGV;
- Rear collision–stationary HGV, waiting to turn left.

The specificity of HGVs has little impact on this type of accident, other than in terms of passive safety, since their mass explains the severity of injuries.

The three main situations involving road infrastructure which can lead to HGV accidents are:

- Intentional and risky driver behaviour on a road or a stretch of road that is poorly adapted to HGV traffic,
- Steep downward slopes over a distance greater than 6 km (Brenac,T 1992),
- The (often unexpected) presence of an isolated danger zone.

This isolated danger zone may be a tight bend after a long straight stretch of road, a curve with a tight radius, a slippery area (due to meteorological conditions or poor skid resistance). When associated with geometry-related constraints and the dynamics of a HGV, a curve can therefore rapidly provoke a critical situation for the latter, even if statistics tend to draw more attention to other situations.

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