A study of heavy vehicle crashes in Australia

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A detailed study of fatal heavy vehicle crashes occurring on major New South Wales highways in the period 1988-1989 was carried out on behalf of the NSW Roads and Traffic Authority and the Federal Office of Road Safety. This involved inspection of each crash site and use of reports by police, coroners, and vehicle inspectors. The circumstances surrounding these crashes and the likely contributing factors were identified; these factors relate to drivers, vehicles, the road and the environment. In addition, a wide range of possible countermeasures to truck crashes were evaluated; these related to vehicles, heavy vehicle drivers, speeds, roads and traffic, other road users, management and regulation of the industry and enforcement. The results of the study are described and the major factors found to be contributing to such crashes are discussed, including: road standard, road alignment, poor lighting conditions, roadside objects, excessive truck speed, variance between car and truck speeds, truck instability, driver inattention, fatigue and alcohol. Consideration is also given to the potential role a range of possible countermeasures.

1. INTRODUCTION

Heavy vehicle safety became an important issue in Australia in the late 1980s. Changes in the heavy vehicle speed limit, media treatment and several serious crashes involving heavy vehicles combined to raise community awareness. There was also increasing evidence that the road transport industry was operating under high pressure, leading to reported abuse of such regulations as speed limits and driving hours.

During late 1988 and early 1989, the Road Safety Bureau of the Roads and Traffic Authority became aware of a growing problem with fatal heavy vehicle crashes in NSW. Fatal crashes involving articulated trucks increased from 59 in 1987 to 120 in 1988. This represented an increase from 30% of Australia-wide fatal crashes to 48%. By comparison NSW represents 31% of Australia's vehicle ownership, 34% of Australia's truck km of travel and 35% of the road freight (tonne km).

The doubling of fatal crashes in NSW, and a corresponding 25% increase nationally, prompted the Road Safety Bureau and the Federal Office of Road Safety to launch a detailed analysis of fatal and serious injury crashes involving heavy vehicles.

The study was carried out during the period September 1989 to August 1990 and aimed to (i) ascertain the circumstances of, the factors contributing to, fatal and serious crashes involving heavy vehicles and occurring in 1988 and 1989 and (ii) provide a basis for developing countermeasures to improve heavy vehicle safety.

2. STUDY APPROACH

While mass accident data, provides access to overall trends plus some level of detail concerning crash circumstances, it was realized that additional data, particularly related to road and vehicle factors, would be needed to fully address reasons for crashes. This is largely because the mass data is based on Police reports which are primarily oriented towards culpability, and the actions of drivers considered to be at fault.

Crash investigations by the study team utilized all available sources of information, including the Police forms. Not only fatal crashes, but also serious injury crashes, are of great concern to the community. However, the level of local information (for example, Accident Investigation Squad, Police and RTA Staff first-hand knowledge) concerning the fatal crashes is an order of magnitude better than that for the injury crashes. The study therefore concentrated on fatal crashes.

While many heavy vehicle crashes occur in urban areas, the regions of greatest concern in relation to a possibly deteriorating crash problem were in the long-distance environments of the Hume Highway carrying freight between Sydney and Melbourne and the Pacific Highway carrying freight between Sydney and Brisbane. The study therefore concentrated on these highways.

In order to consider trends in truck crash problems, it is essential to consider not only crash numbers, and numbers of people killed, but also the increasing level of exposure to such crashes. Exposure is indicated by traffic volumes and changes in traffic composition, especially the percentage of trucks in the traffic stream. These traffic factors tend to follow an increasing trend related to growth of the nation's economy.

2.1 Study Overview

The study consisted of three strands:

(i) Detailed examination of all available data on fatal and serious crashes involving heavy rigid trucks, articulated trucks and long distance coaches in NSW, concentrating on the Hume and Pacific Highways, and covering 1988 and 1989. This included visits to all fatal crash sites.

(ii) Analysis of the NSW mass crash data, covering 1982 through 1988, and determining how 1988 heavy vehicle crashes may have differed from previous years.

(iii) Analysis of exposure and economic data, covering travel, tonne-km and weather data for the period 1982 through 1988.

The multi-level approach was structured to gain a specific understanding of the NSW truck crash problem and to provide the basis for the development of countermeasures which could be implemented via NSW Government policy or Federal Government policy.

2.2 Highways Studied

The area of interest on the Hume Highway ran from the fringe of the Sydney metropolitan area to the Victorian state border, a distance of 536 km. This route is being progressively upgraded, and in late 1989 some 49% of the highway in NSW was divided. Traffic volumes vary considerably along the Hume Highway, from an AADT of 20,000 vehicles per day (20% heavy vehicles) to 5,600 vehicles per day (35% heavy vehicles). The area of interest on the Pacific Highway ran from a point immediately north of the Sydney metropolitan area to the Queensland border, a distance of 685 km. The Pacific Highway is not part of the National Highway system, but its topography is preferred by heavy vehicle operators. It is of a generally low geometric standard and virtually none of it is divided. Traffic volumes are typically 6,000 - 8,000 vehicles per day AADT, with approximately 15% heavy vehicles.

2.3 Crash Causation and Severity

It has been long established that road crashes are complex events contributed to by a chain of factors. Any one "break" in this chain may lead to avoidance of the crash, or to a reduction in its severity. In this study, some emphasis was placed on considering all factors which may have contributed to the occurrence or consequences of the crash. Such factors related to the driver (or unprotected road user), vehicle, road and road system environment.

Despite the often large number of factors involved in crashes, it is usually possible to assign responsibility to one participant. For example, in the case of a head-on collision on an undivided road, where one vehicle is on the wrong side of the road, the driver of that vehicle would be considered responsible.

2.4 Exposure

Exposure to road hazard is often assessed globally in terms of total vehicle travel (vehicle km). At the disaggregated level of particular regions or highways, it is possible to consider traffic levels, traffic composition (% trucks) or freight movements (tonne km). At a more micro level, exposure varies according to the type of crash being considered. For example, exposure to head-on crashes varies with the product of the traffic flows (vehicles per day) in each direction.

Patterns in vehicle travel fluctuate daily, weekly and seasonally, respond to economic and recreational cycles and are influenced by random events, such as the closure of an alternative route.

Truck travel is influenced by trends in the economies of regions, states and the nation, by the size and weight limits applying in different states, by diversions of freight to other modes and by freight customers' inventorying habits. For example, so-called Just In Time freight affects the number of scheduling of truck trips.

This study concentrated on global economic indicators and disaggregated traffic and freight data. Micro level exposure data is simply not available.

2.5 Countermeasures

Over the years, a number of initiatives have been taken to improve truck safety. Such measures may be applied to the truck or car driver, truck, car, road, or road system environment. While not always the case, these measures are usually required by law. They may address the exposure of heavy vehicles to traffic situations, the risk of crashes occurring in these traffic situations, and the consequences of such crashes. In some cases, a measure could affect both the risk of a crash and its consequences. Measures to curb excessive speeds are examples of this double benefit.

Intensive debate on the heavy vehicle safety issue in Australia and overseas (for example, refs. 1,2) in recent years has produced an extensive list of countermeasures. In this study, this list was scrutinized in the light of the actual circumstances and contributing factors found to be associated with NSW truck crashes. In some cases, it is possible to conclude that a particular countermeasure probably would or would not have contributed to a lessening of the crash severity (for example, truck cabin rollover protection). In other cases, it is only possible to say that it was or was not relevant. Driver training and roadside rest areas are two examples in the latter category.

The study did not consider the cost of countermeasures. The implementation of the study's findings will need to estimate the likely effectiveness of countermeasures (i.e. the number of crashes, deaths and injuries likely to be saved over the life of the countermeasure). Future benefits need to be valued and discounted to present day values in order to arrive at cost/benefit ratios. It may well be that countermeasures which were found to be relevant less often are more cost effective than some which were relevant to a large number of crashes. Furthermore, some countermeasures are well known and proven, while others require further development.

3. ANALYSIS OF MASS CRASH DATA

In 1988, 62% of fatal articulated vehicle crashes occurring on major NSW highways occurred on the Hume Highway or the Pacific Highway. Individual figures for these highways were 28% and 34% respectively.

Analysis of the mass crash data provided the following findings.

3.1 Speed Zones

Compared with state-wide figures, a high proportion of severe crashes on the Hume and Pacific Highways occur in the zones of higher speed limits (80 km/h or more).

3.2 Road Type

Very few severe crashes occurred at intersections, and the vast majority occurred on sections of undivided road. Crashes on undivided sections of these two highways dominated severe crashes on major NSW highways throughout the period of analysis (1982-88).

3.3 Heavy Vehicle Type

Over all of NSW, and considering the period 1982-88, articulated vehicles were involved in 59% of fatal heavy vehicle crashes, rigid trucks 39% and coaches 2%.

3.4 Time Of Day

Articulated vehicle crashes on the Hume and Pacific Highways tend to occur more during hours of darkness, although this is not the case on other major NSW highways. Over the period 1982-88, 61% of Pacific Highway crashes occurred during hours of darkness, and 70% of Hume Highway crashes occurred during hours of darkness.

3.5 Responsibility for Crashes

In multi-vehicle crashes, the other road user was more frequently considered responsible than the heavy vehicle driver during the period 1987-89. In 1988, articulated vehicles were responsible for 31% of multi-vehicle fatal rashes. For articulated vehicles responsible for fatal crashes, most (55%) were "proceeding along lane" and a significant number (36%) were "on incorrect side of road".

3.6 Driver Errors and Indictments

The most common driver errors for articulated vehicles responsible for fatal crashes are "loss of control" and "unusual manoeuvre". The most common indictment against drivers of articulated vehicles responsible for crashes is culpable driving, with some 19% being so charged.

4. ANALYSIS OF ECONOMIC AND ENVIRONMENTAL TRENDS

4.1 Economic Activity

Increases in the national and New South Wales Gross Domestic Product were fairly steady over the period 1982-88. National GDP showed yearly increases of in the range 9-12% during the period studied (1982-88). The transport component of the National Accounts showed yearly increases in the range 7-12% during the period studied.

4.2 Freight and Passenger Activity

Interstate movements on the Hume Highway are estimated to represent 50% of national interstate freight, and those on the Pacific represent 18% of the national total.

On a yearly basis, Sydney-Brisbane freight increased by 16% in 1988, and Sydney-Melbourne freight increased by 10%.

It is believed that an increase in Sydney-Brisbane freight activity, well above the GDP and particularly strong in the December quarter of 1988, was associated with the 1988 Brisbane EXPO.

Coach passenger trips showed a strong increase of 22% Australia-wide in 1988, and Sydney-Melbourne passenger trips again associated with EXPO.

4.3 Vehicle Travel Activity

4.3.1 Annual Travel Data

Over the period 1982-88, total annual vehicle km of travel increased by 20% for cars and station wagons, and by 20% for articulated vehicles. Over the same period, total annual tonne km of articulated vehicle travel increased by 47%.

4.3.2 Traffic Volume and Composition

Traffic volume, expressed as Average Annual Daily Traffic (AADT), showed steady increases on all major NSW highways over the period 1982-88. The Pacific and New England Highways both showed uncharacteristically large increases in 1988.

4.3.3 Vehicle Speed

In the period 1987-88, there was little difference between the speeds of cars and trucks in NSW. Articulated vehicles travel slightly slower than cars, but 22% of articulated trucks exceeded 110km/h in 1988, compared to 14% for the previous year.

Analysis showed that increases in articulated vehicle speeds between 1986 and 1989, while small, were statistically significant for most conditions.

4.4 Weather Conditions

It was found that a higher proportion of articulated vehicle crashes (approximately 30%) occur in the wet than rigid truck crashes (approximately 20%). Wet-road crashes tend to occur more at night, emphasizing the importance of visibility as well as the slipperiness of the road surface.

5. FACTORS CONTRIBUTING TO CRASHES

A database consisting of all fatal heavy vehicle crashes occurring on the Hume and Pacific Highways in 1988 and 1989 was established. The database covered 83 crashes. Analysis of the database provided specific insights into the circumstances of these crashes and the factors contributing to the crashes. Full details of the data collection and analysis are given in ref. 3.

5.1 Crash Circumstances

87% of the database fatal crashes occurred on undivided roads. Individual figures for the Hume and Pacific Highways were 81% and 92% respectively.

57% of the data base fatal crashes were heavy vehicle/car, 19% were heavy vehicle/heavy vehicle, 11% were single heavy vehicle and 10% were heavy vehicle unprotected road user.

The truck was considered responsible in 49% of the database fatal crashes. By definition in the database, truck responsibility in single vehicle crashes is 100%. In multi-vehicle crashes, trucks were considered responsible in 43% of crashes. In truck-car crashes, the truck was considered responsible in 32% of cases; in truck crashes with unprotected road users, the truck was not considered responsible in any case.

24% of the database fatal crashes were car (on the wrong side of the road) head-on into truck. A further 12% of the database fatal crashes were truck ran off road. 60% of truck ran off road crashes occurred at night. A further 7% of the database fatal crashes were pedestrian into path of truck.

In all 26% were car-on-wrong-side-of-road-head-on, 11% were truck-on-wrong-side-of-road-head-on, and 5% were head-on-while-overtaking

11% of the database fatal crashes were single vehicle.

29% of the database fatal crashes occurred in the wet. Half of these occurred at night.

51% of the database fatal crashes occurred at night.

5.2 Contributing Factors

Based on a literature review and a small pilot study, a list of potential contributing factors to crashes was developed. There were six categories of factor, as follows:

- heavy vehicle driver factors
- car driver factors
- heavy vehicle factors
- car factors
- road factors
- environment factors.

These factors were considered for each crash, based on the information which was available. In each case, the criterion was that the absence of a particular factor might have meant that the crash would not have occurred, or its severity reduced. Table 1 summarises the results of the analysis of major contributing factors, showing the percentage of database crashes to which each factor was considered to contribute.

The fact that a heavy vehicle is less stable in steering and braking than a car was considered to be a factor in 18% of the database fatal crashes. Of the 18% of all crashes considered to involve truck instability, 87% also involved poor road alignment, 87% also involved truck excess speed and 73% also involved inappropriate evasive action.

Table 1. Incidence of factors contributing to fatal heavy vehicle crashes

Factor	% Incidence of Involvement
HEAVY VEHICLE DRIVER	
excess speed	28
inattention	17
fatigue	15
alcohol, drugs	13
inappropriate evasive action	11
attitude problem	10
inexperience	2
CAR DRIVER	
slow speed	20
inattention	18
alcohol, drugs	14
fatigue	11
excess speed	11
inexperience	8
attitude problem	6
ill health	6
HEAVY VEHICLE	
instability	18
ROAD	
standard (divided/two-way)	80
alignment	48
roadside objects	33
shoulder	24
delineation	20
ENVIRONMENT	
hours of darkness	41
wet road	28

6. COUNTERMEASURES

Following the analysis of contributory factors, a list of potential countermeasures was compiled and assessed for its possible effect under the circumstances of each crash. The results of this analysis, expressed as the percentage of crashes to which each countermeasure was considered to be relevant, are given in Table 2.

Table 2. Relevance of countermeasures to heavy vehicle crashes

Countermeasure	Relevance (%)
VEHICLES	
increased payload	42
reduced frontal aggressivity	40
improved cabin crashworthiness	20
car crashworthiness	15
improved truck braking	11
improved front bumpers on heavy vehicles	9
improved truck stability	9
heavy vehicle conspicuity	5
load security	5
heavy vehicle inspection	4
heavy vehicle field of view	2
under-run protection	2
ROADS	
divided road	61
traffic engineering black spot treatment	27
improved delineation	25
improved road shoulders	22
rumble strips	18
road engineer education	7
improved sight distance	7
roadside guard fencing	5
roadwork practices	5
pavement skid resistance	5
road culvert protection	4
overtaking lanes	3
rest areas	3
pavement quality	2
ROAD USERS	
education and training	33
driver licensing, demerits	21
fatigue detectors	11
driving skills	8
HEAVY VEHICLE DRIVERS	
seat belt wearing	19
defensive driving training	18
fatigue detectors	16
attitude improvement	14
control of driving hours	10
TRANSPORT POLICY	
modal diversion (to rail)	42
operator licensing	23
crash research	11
ENFORCEMENT	
electronic enforcement of speed, alcohol	24
enforcement at black spots	19
speed limiters, tachographs	18

7. CONCLUSIONS

(i) Major factors contributing to severe truck crashes in NSW were found to be: undivided roads, poor road alignment, light conditions (night-time), roadside objects, excess truck speed, poor road shoulders, slow car speed, truck instability, car driver alcohol use, truck driver alcohol use, car drivers falling asleep and excess car speed. Up to 60% of crashes could involve some element of driver fatigue, and up to 40% could involve excessive speed by truck or car drivers.

(ii) Trucks were found to be responsible in about 45% of multi-vehicle fatal crashes involving trucks and in about 32% of truck-car crashes.

(iii) Road alignment was found to be a particular problem on the Hume and Pacific Highways. Tight radius curves, especially in combination with abrupt grade changes, and compound or extended curves were found to threaten the controllability of both trucks and cars, contributing to severe crashes.

(iv) Countermeasures having a high level of relevance plus specific mechanisms for reducing the fatal consequences of truck crashes were identified and relate to roads, vehicles, heavy vehicle drivers, car drivers and the road system environment. These are summarised in Table 2.
(v) The provision of divided highways is an outstanding countermeasure to truck crash hazard. Priorities for reconstruction should take into account the current incidence of poor alignment (involving tight radius curves combined with abrupt grade changes, and compound and extended curves).
(vi) It is important that truck crash issues continue to be monitored, evaluated and researched. It is recommended new initiatives relating to crash analysis and data sources, are taken into account in evaluating the effectiveness of countermeasures and finding new countermeasures.

8. REFERENCES

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