Heavy vehicle crashes in rural and remote Australia and New Zealand

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A substantial proportion of crashes in rural and remote areas involve heavy vehicles (rigid trucks, articulated vehicles and buses). The freight task is expected to continue to grow steadily over the next 20 years, and an associated increase in crashes can be expected unless effective safety measures are implemented.

This paper presents the results of the crash data analysis for Austroads Project ST1193 (Heavy Vehicle Safety in Rural and Remote Areas). The project involved (1) a literature review identifying existing road design safety measures and intelligent transport systems (2) analysis of mass crash data for Australia and New Zealand (3) site investigations and (4) a review of the predicted growth in the freight task.

There were an annual average 1,761 heavy vehicle casualty crashes in rural Australia between 2001 and 2005, and 10% of these were fatal crashes. In rural New Zealand the average annual number of heavy vehicle casualty crashes during the same period was 518, and 12% of these were fatal crashes. Detailed results on crash characteristics, environmental conditions and location features are presented, with consideration given to probable exposure.

The crash data analysis identified patterns in crash characteristics, environmental conditions and location features. Targeted safety measures were identified based on the crash data analysis and site investigations.

Keywords

Heavy vehicles, crashes, rural

Introduction

Road safety in rural and remote areas of Australia and New Zealand is a key area of concern for road authorities (Austroads 2005). More than half of all road fatalities across Australia (approximately 60%) and New Zealand (approximately 70%) occur on roads in rural and remote areas. The substantial crash reductions achieved in urban areas over recent years have not been matched in rural and remote areas.

Austroads (2005) found that a large proportion of crashes in rural and remote areas involve heavy vehicles (rigid truck, articulated vehicles and buses). Trucks (rigid and articulated) have a fatality rate (per 100 million vehicle kilometres travelled) about three times that of all other vehicle types combined. The freight task is expected to continue to grow substantially over the next 20 years, and an associated growth in heavy vehicle crashes can be expected unless effective safety countermeasures are put in place. There is a clear need to address heavy vehicle safety in rural and remote areas.

A crash data analysis was undertaken to identify the key factors associated with heavy vehicle casualty crashes in Australia and New Zealand, and to identify predominating factors surrounding these crashes. This paper presents the results of the crash data analysis for Austroads Project ST1193 (Heavy Vehicle Safety in Rural and Remote Areas) (Austroads 2009). The project also included (1) a literature review identifying existing road design safety measures and intelligent transport systems (2) site investigations and (3) a review of the predicted growth in the freight task.

Method

The crash data analysis was conducted using SPSS (Statistical Package for the Social Sciences) Version 13.0 and MS Excel 2003. To be included in the analysis of rural casualty crashes involving a heavy vehicle, crashes must have:

- occurred in a rural area (Appendix A)
- occurred within an area with a speed limit greater than or equal to 80 km/h
- resulted in at least one fatality or injury
- involved at least one heavy vehicle (bus, rigid truck or articulated truck; Appendix A).

Property-damage-only crashes were not included because (1) not all jurisdictions record such crashes, and (2) the under-reporting of property-damage-only crashes is likely to be more problematic in rural and remote areas compared with urban areas due to reduced access to police services.

ACT crash data was excluded because the Department of Territory and Municipal Services ACT indicated that, due to the limited geographical area of the Territory, they did not have a significant rural road network.[1]

The crash data covered the period 2001 to 2005 for most jurisdictions. At the time of the analysis, ARRB only had access to an older Tasmanian crash database (2000–2004) with which it was possible to complete the crash data analysis. More details on the method of selecting and screening data can be found in the project report.

Australian Bureau of Statistics (ABS) data from the Survey of Motor Vehicle Use (SMVU) was accessed from the ABS website to estimate probable exposure levels. This was not part of the original analysis for Austroads project ST1193. The rural and interstate categories in the SMVU do not match the rural and remote categories in the crash data analysis, so they provide an approximate guide to exposure only.

Results

Travel patterns

Overall, 52% of Australian vehicle kilometres travelled (VKT) by heavy vehicles is interstate and/or in rural areas, and heavy vehicles account for 13% of all VKT in interstate and/or rural areas (Table 1). Articulated vehicles spend a much higher percentage of VKT interstate and/or in rural areas.

- 38% of Australian VKT by rigid trucks is interstate and/or in rural areas and rigid trucks account for 5% of all interstate and rural travel in Australia.

[1] Initial examination of the number of heavy vehicle crashes in rural areas in the ACT revealed only seven injury crashes involving a heavy vehicle and zero fatal crashes involving a heavy vehicle over the five year period (2001 – 2005).

- 75% of Australian VKT by articulated vehicles is interstate and/or in rural areas and articulated trucks account for 7% of all interstate and rural travel in Australia.
- 34% of Australian VKT by buses is interstate and/or in rural areas and buses account for 1% of all rural and interstate travel in Australia.

Table 1: Interstate and rural VKT by vehicle type (including percentage of total VKT in interstate and/or rural areas)

		Interstate and/or rural			All Australia
Vehicle category	**Vehicle type**	**Million VKT**	**% of VKT by vehicle type**	**% of all Australian VKT**	**VKT (million)**
Heavy vehicles	Rigid trucks	2,986	4.7	38.4	7,768
	Articulated trucks	4,385	6.8	75.1	5,841
	Buses	642	1.0	33.9	1,893
	Non-freight carrying trucks	70	0.1	34.5	203
	All HV	**8,083**	12.6	**51.5**	**15,705**
Other vehicles	Passenger vehicles	42,411	66.1	27.9	151,743
	Motor cycles	566	0.9	41.1	1,376
	Light commercial vehicles	13,067	20.4	40.0	32,671
	All other	**56,044**	87.4	**30.2**	**185,790**
	Total	**64,128**	100.0	**31.8**	**201,497**

Crashes by jurisdiction

There were an annual average 1,761 heavy vehicle casualty crashes in rural Australia over the five year period 2001–2005 (Table 2). Of these, 10% were fatal. The number of crashes in each Australian jurisdiction generally reflects the cumulative length of the state road network and density of population. More than half of all Australian rural heavy vehicle casualty crashes occurred in New South Wales (51%). Victoria and Queensland experienced the next highest proportions of heavy vehicle casualty crashes (19% and 17% respectively). Although the proportion of crashes in the Northern Territory was small, the proportion of these that were fatal was relatively high (16% compared with a national average of 10%). These figures should be seen only as a general guide due to the differences in categorising crash severities and vehicles types between the jurisdictions. In rural New Zealand the average annual number of casualty crashes during the same period was 518, and 12% of these were fatal.

Table 2: Annual average heavy vehicle casualty crashes in rural areas by jurisdiction (2001–2005)

Jurisdiction	Rural casualty crashes	% of all crashes in country	% of casualty crashes that were fatal
New South Wales	898.0	51.0	9.7
Victoria	339.4	19.3	12.0
Queensland	291.8	16.6	8.5
Western Australia	78.4	4.5	13.8
South Australia	89.4	5.1	10.7
Tasmania	42.2	2.4	6.6
Northern Territory	21.4	1.2	15.9
Australia	**1760.6**	100.0	**10.2**
New Zealand	**517.8**	**100.0**	**11.8**

Rural bus crashes were infrequent compared with rural truck crashes (Table 3). They accounted for approximately 4% of rural heavy vehicle casualty crashes in Australia and 6% in New Zealand.

Overall, there were more casualty crashes involving rigid vehicles than articulated. However, rigid vehicles recorded a lower percentage of fatal crashes. This probably reflects the different types of road environments (particularly speed environments) that the vehicle types are primarily exposed to.

Table 3: Heavy vehicle casualty crashes in rural areas by vehicle type and country (2001–2005)

Country	Vehicle type	Fatal crashes		Injury crashes		Casualty crashes		
		No.	%	No.	%	No.	%	% within country
Australia	Bus	41	11.2	324	88.8	365	100.0	4.2
	Rigid	389	8.0	4494	92.0	4883	100.0	55.4
	Articulated	467	13.1	3095	86.9	3562	100.0	40.4
Total Australia		**897**	**10.2**	**7913**	**89.8**	**8810**	**100.0**	**100.0**
New Zealand	Bus	15	9.9	136	90.1	151	100.0	5.8
	Truck	291	11.9	2,147	88.1	2,438	100.0	94.2
Total New Zealand		**306**	**11.8**	**2,283**	**88.2**	**2,589**	**100.0**	**100.0**

Speed zone

Figure 1 confirms that articulated vehicles were more likely to have crashes on roads with a higher speed limit. The figure also shows that most heavy vehicle casualty crashes occurred on roads with a 100 km/h speed limit. This would reflect the fact that more of the 'rural' roads operate with this speed limit. A substantial proportion of heavy vehicle casualty crashes occur on roads with 80 or 90 km/h speed limits (i.e. about 20%). This is most pronounced for buses where the proportion is about 30%. Roads with these speed limits are generally reflective of some level of roadside development (i.e. small townships or hamlets). In some jurisdictions lower limits may have been applied on road sections with a poor safety record. In New Zealand the proportion of heavy vehicle casualty crashes occurring along such roads is markedly lower at about 5%.

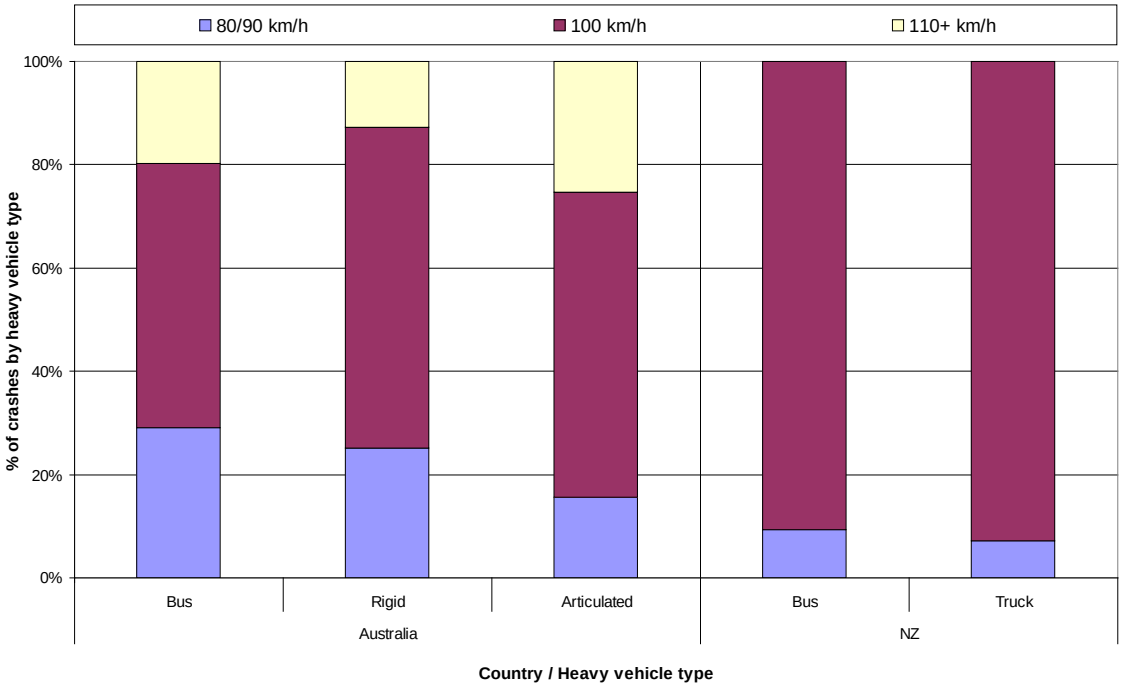

Figure 1: Rural heavy vehicle crashes by speed limit (Australia and New Zealand, 2001 – 2005)

Crash types

In Australia, the most common types of heavy vehicle casualty crashes were run-off-road ('off path – straight' and 'off path – curve'), head-on ('opposite') and vehicles travelling in the same direction striking one and other, including rear-end and side-swipe ('same') (Figure 2). Buses, however, were less prone to run-off road crashes than rigid trucks and articulated vehicles. In New Zealand, the most common types of casualty crash were head-one (i.e. 'opposite'), vehicles travelling in the same direction striking one and other ('same') and out-of-control on curves ('cornering'). Trucks were more likely to be involved in lost control on straight crashes or cornering than buses (Figure 3). In view of the relatively low frequency of intersections in a rural road environment, the proportion of adjacent crashes in Australia and New Zealand is noteworthy.

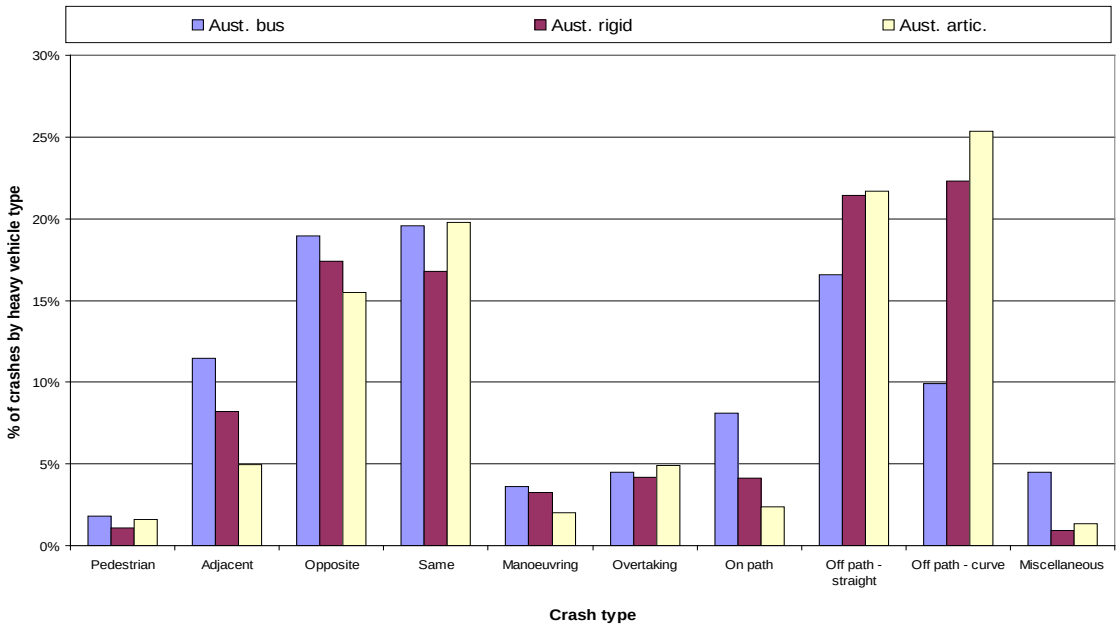

Figure 2: Rural heavy vehicle casualty crashes by crash type (Australia, 2001–2005)

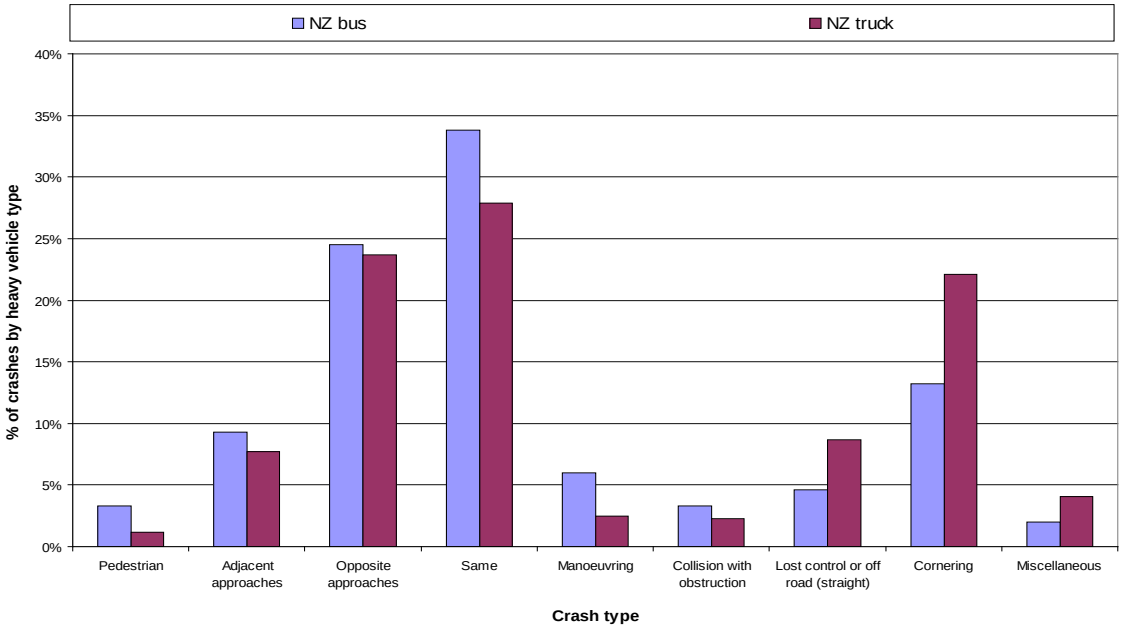

Figure 3: Rural heavy vehicle casualty crashes by crash type (New Zealand, 2001–2005)

Light conditions

While most casualty crashes in both Australia and New Zealand occurred during daylight conditions (Figure 4 and Figure 5), a substantial number occurred during 'poor' light condition periods (i.e. Australia – dark, dusk or dawn periods; New Zealand – overcast, twilight or dark periods).

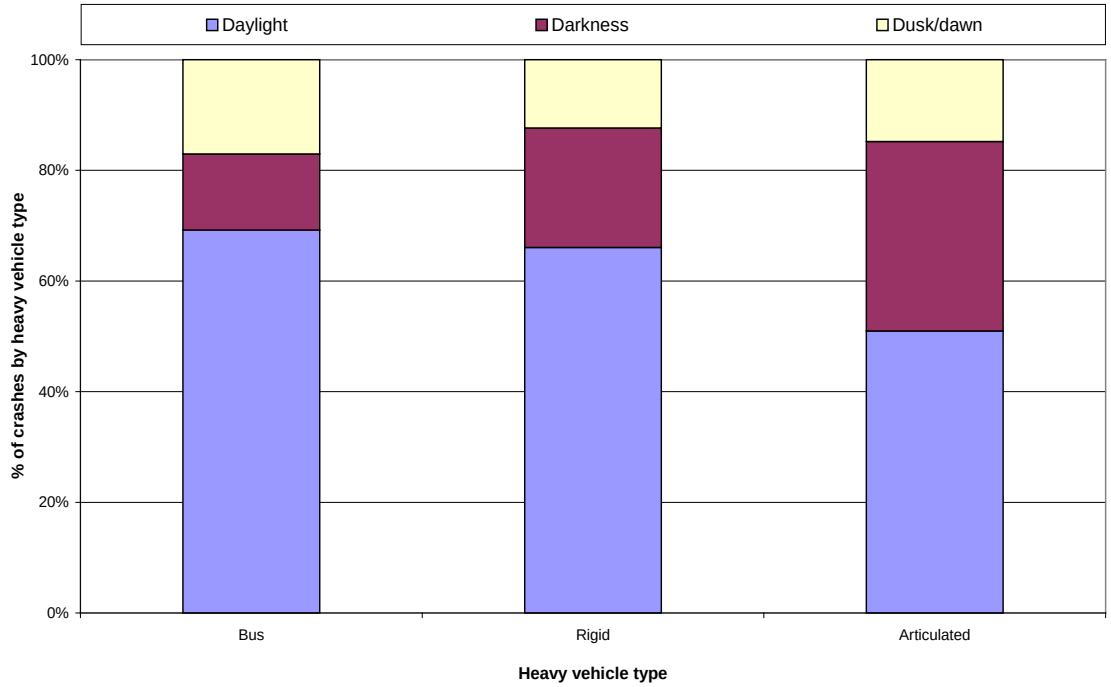

Figure 4: Rural heavy vehicle casualty crashes by natural light conditions (Australia, 2001 – 2005)

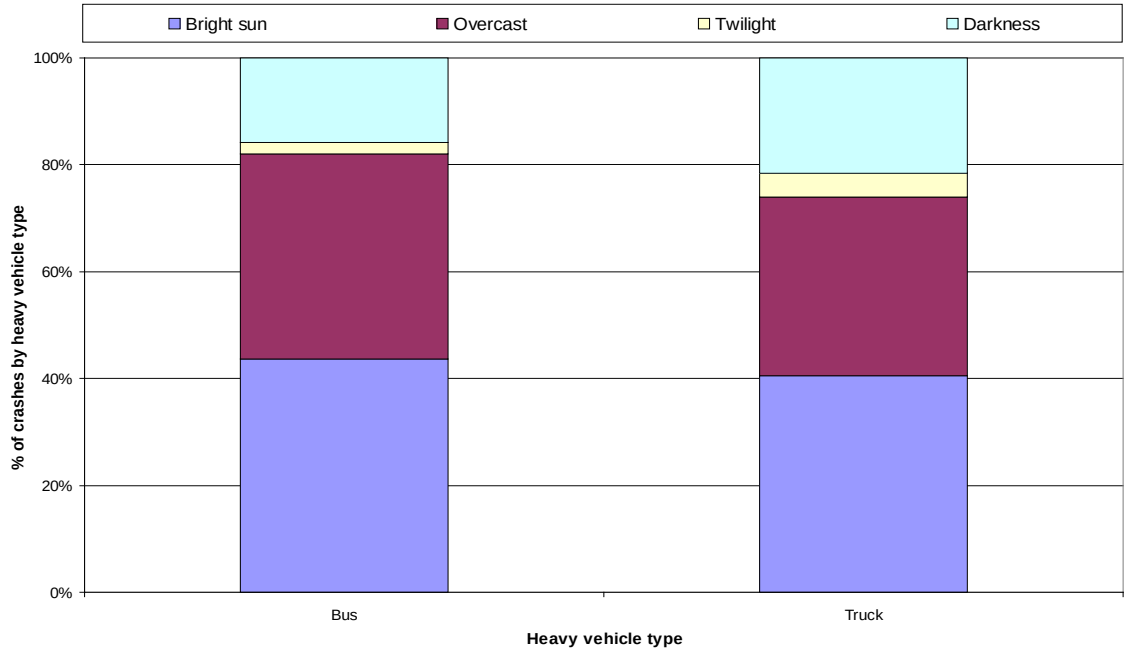

Figure 5: Rural heavy vehicle casualty crashes by natural light conditions (New Zealand, 2001 – 2005)

Vertical and horizontal road alignment

Most heavy vehicle casualty crashes occurred on a level grade roads (Figure 6), but a substantial proportion of casualty crashes in Australia occurred on roads which were at-grade or on a crest (i.e. about 20% for articulated and rigid trucks and 15% for buses). This figure does not include Victoria or New Zealand as vertical alignment data was not available.

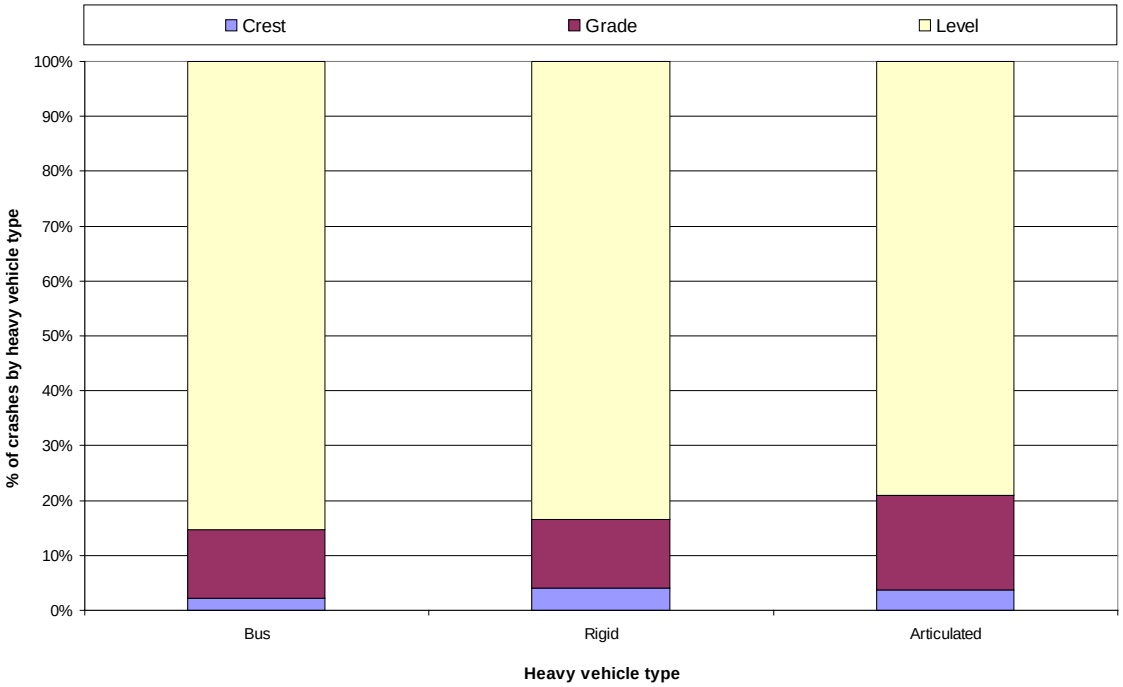

Figure 6: Rural heavy vehicle casualty crashes by vertical alignment (Australia, 2001 – 2005)

About 40% of rural heavy vehicle casualty crashes occurred on curves in Australia and New Zealand (Figure 7 and Figure 8). In both countries, buses had slightly fewer crashes on curves than trucks.

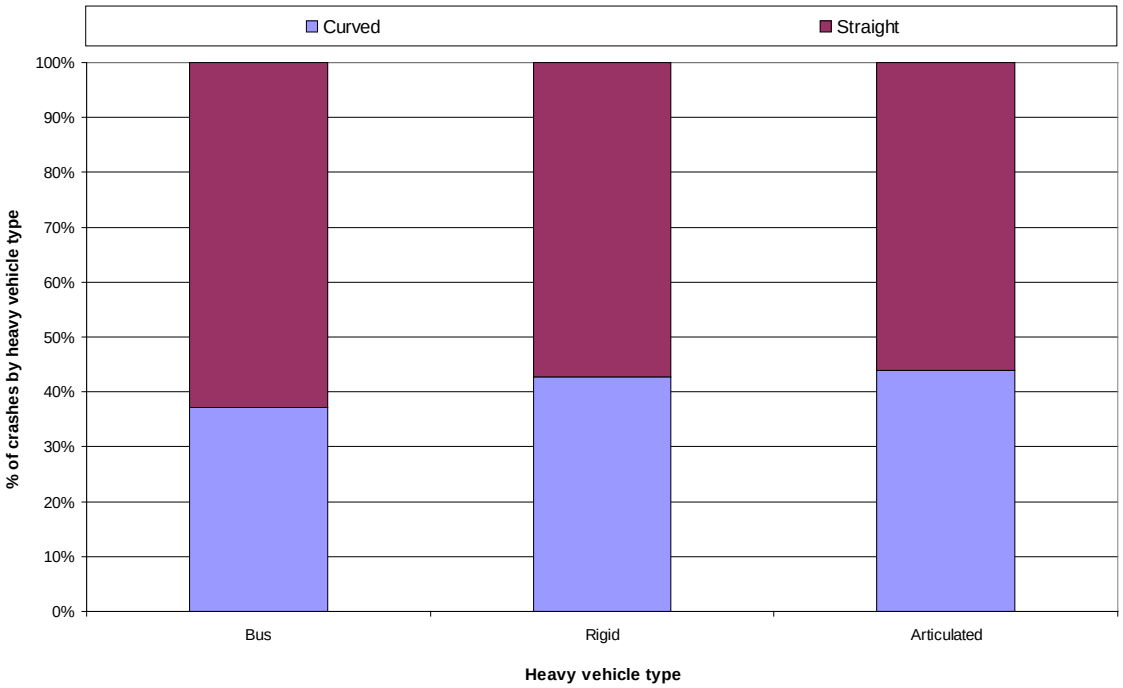

Figure 7: Rural heavy vehicle casualty crashes by horizontal alignment (Australia, 2001 – 2005)

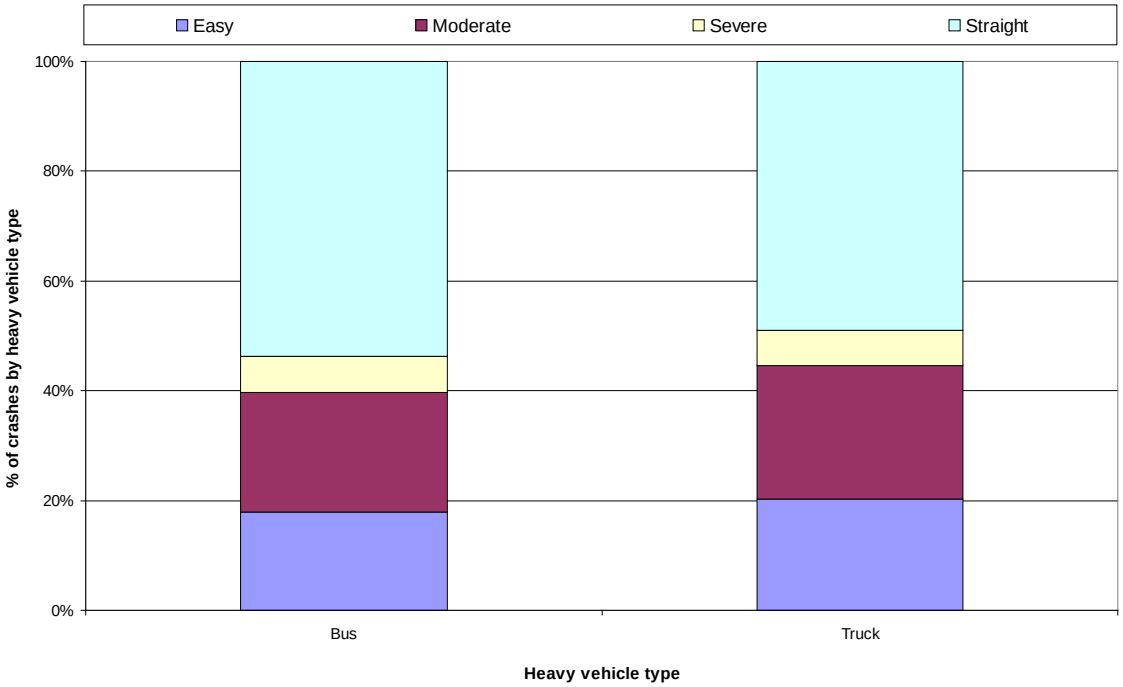

Figure 8: Rural heavy vehicle casualty crashes by horizontal alignment (New Zealand, 2001 – 2005)

Intersections and mid-block road segments

Approximately 80% of rural heavy vehicle casualty crashes occurred in mid-blocks (Figure 9). This likely reflects the prevalence of intersections within a 'rural road' environment.

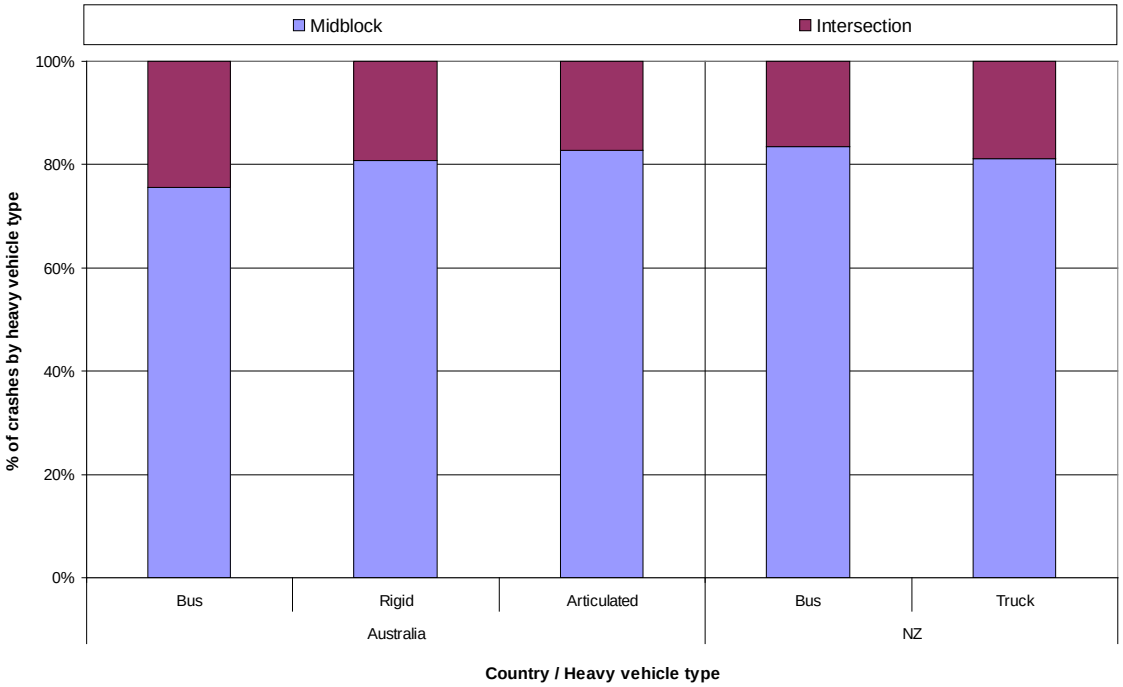

Figure 9: Rural heavy vehicle casualty crashes by crash location (Australia & New Zealand, 2001 – 2005)

Divided and undivided roads

About 10% of bus and rigid truck casualty crashes occurred on undivided roads, whereas approximately 20% of articulated truck casualty crashes occurred on undivided roads (Figure 10). Carriageway type was only available for Northern Territory, New South Wales and South Australia.

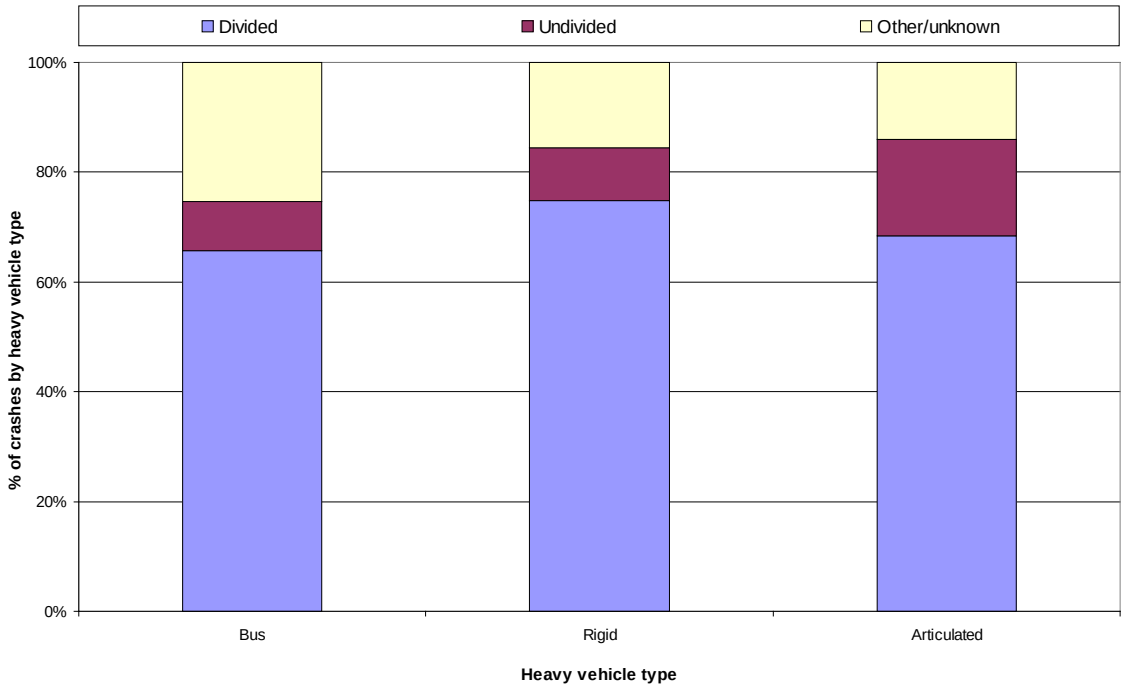

Figure 10: Rural heavy vehicle casualty crashes by carriageway type (NT, NSW & SA, 2001 – 2005)

Discussion

Crash characteristics

While heavy vehicles account for a small percentage of total VKT in Australia, more than 50% of travel by heavy vehicles occurs interstate or in rural areas. Thus, rural road safety is an important issue for the transport industry.

The crash data analysis identified these key characteristics:

- a high proportion of run-off-road crashes (particularly in Australia), adjacent and same-direction crashes (particularly in New Zealand)
- a relatively high proportion of crashes in poor light conditions (dark or low sun)
- over-representation of crashes on curves and at intersections (relative to the likely presence of these features in the road network).

Examination of site crash data, together with site attribute data, provided the basis upon which crash factors were identified in the project report. Major crash factors identified included:

Intersections:

- poor sight distance
- delineation either not provided or inadequate (i.e. linemarkings, raised reflective pavement markers - RRPMs, edgelines and guide posts)

- unsealed or only partially sealed shoulders
- insufficient or poorly positioned signing
- roadside hazards located within the clear zone (e.g. poles, culverts and steep embankments)
- safety barriers either not provided or inadequate (NZ)
- insufficient advisory / warning signs (e.g. of curves, intersection ahead, advisory speed.

Road segments:

- poor road pavement (i.e. poorly maintained, poor drainage or too narrow)
- unsealed or only partially sealed shoulders
- unexpected transition between roads of varying standard (NZ)
- poor sight distance for overtaking
- insufficient or poorly positioned signing
- roadside hazards located within the clear zone (e.g. trees, poles, culverts).

Limitations

Buses, rigid trucks and articulated trucks are likely to have different travel patterns due to their different functions. So, it is difficult to say whether differences in crash patterns between vehicle types are due to their travel patterns, the road environment, or some intrinsic quality of the vehicle. For example, it may be that articulated vehicles travel more on undivided roads, and/or it may be that their larger size makes overtaking or passing more hazardous on undivided roads.

There are inherent limitations in the method of defining 'rural' crashes. For example, some crashes that occurred within 80 km/h zones in rural towns would have been included in the analyses. However, the bulk of crashes that occurred in built-up areas should have been successfully filtered.

It is now possible to access road inventory data for some Australian jurisdictions that quantifies characteristics of the road network (e.g. length of the network that is curved, divided and undivided, subject to different speed limits etc.) Traffic volume data distinguishing the proportion of heavy vehicles in the traffic mix is also more available. Re-analysis of the data presented in the current paper in light of this new information would resolve some of these limitations. Integration of crash data with road inventory and traffic volume data would provide greater insight into what aspects of the road network are particularly hazardous for heavy vehicles, maximising efficient targeting of hazards.

Recommendations

The project report lists evidence-based safety improvements for heavy vehicles that can be prioritised as part of (1) regular maintenance and (2) capital works programs. Regular maintenance that is likely to improve heavy vehicle safety includes improvements to road delineation and signage, shoulders, road surface and sight distance at intersections. Capital works projects likely to improve heavy vehicle safety include: passing lanes, safety barriers where heavy vehicle run-off-road crashes are a particular problem. Where these recommendations have been taken up, the safety outcomes should be analysed and the programs revised where necessary.

References

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Appendix A: Definitions of rural areas and heavy vehicles

Definitions of rural areas

Jurisdiction	Variable	Values allowed	Values excluded
NSW	Urbanisation	Country urban areas, Country non-urban areas, Country unknown	Sydney metro, Newcastle metro, Wollongong metro
Victoria	Degree of urbanisation	Rural, Hamlets, Large Provincial Cities, Other Cities/Towns, Other Urban Areas in MSD, Small Provincial Cities, Small Towns	Melbourne CAD, Urban Melbourne excluding CAD
Queensland	LGA	All LGAs not within the Brisbane or Moreton Statistical Divisions	LGAs located within the Brisbane or Moreton Statistical Divisions
Western Australia	Region	Gasgoyne, Goldfields, Great Southern, Kimberly, Mid West, Pilbara, South West, Wheat belt North, Wheat belt South	Metropolitan
South Australia	Statistical area code	Country	Adelaide, Metropolitan
Tasmania	Land use	Rural	Metropolitan – Industrial, Residential and Commercial
Northern Territory	Urban / Rural	Rural	Urban
ACT	Urban / Rural	Rural	Urban
New Zealand	Urban / Rural	Rural – open roads	Urban

Definitions of heavy vehicles

State	Bus	Rigid	Articulated
NSW	STA bus Coach Other bus	Light truck Mobile vending Large rigid Rigid tanker	Road train B-double Articulated tanker Semi-trailer
Victoria	Bus / coach	Truck (not semi-trailer)	Semi-trailer
Queensland	Omnibus	Truck Low truck	Articulated Road train
Western Australia	Bus	Truck Prime mover	Truck & 1 trailer Prime mover & 1 trailer Road train
South Australia	Omnibus	Truck	Semi-trailer
Tasmania	Bus School bus	Rigid truck	Semi-trailer Log truck B-double
Northern Territory	Coach (tourist) Other bus Passenger bus	Rigid truck >4.5 t GVM Rigid truck <4.5 t GVM	Articulated vehicle
ACT	Bus	Truck (excl. semi)	Articulated vehicle (semi)
New Zealand	Bus	Truck	