Greater understanding of rear-end crashes in a Safe System

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Abstract

Rear-end crashes contribute a significant proportion of the total fatal and serious injury (FSI) crashes occurring on Australian roads. Despite accounting for less than 2% of fatal crashes on Australian and New Zealand roads, this crash type accounts for an estimated 16% of serious injury crashes on urban roads and approximately 8% on rural roads. As such, road safety professionals seeking to drive down FSI crashes need to consider methods of addressing this crash type.

As rear-end crashes are generally less severe than other crash types, it may be tempting to assume that these crashes do not warrant attention when addressing crashes resulting in fatal or serious injuries. Further, since it is not possible to physically separate or shield the striking vehicle from the struck vehicle, developing options to treat the rear-end crash problem may be considered to consume too many resources for too little benefit.

This extended abstract describes the findings of an Austroads' study to identify factors contributing to the incidence and severity of rear-end crashes and treatments to reduce their occurrence or mitigate their severity. The study involved a literature review, detailed analysis of 5 years of crash data from Australia and New Zealand, and a comparison of common factors at crash sites in several states. The extended abstract discusses options within the four Safe System pillars for addressing rear-end crashes in order to answer the question: Is it worthwhile investing our resources in treating this crash type?

Background

Rear-end crashes feature significantly in jurisdictions' road crash statistics, accounting for about 40% of CTP insurance claims. Whilst most rear-end crashes are not fatal, a large proportion result in serious injuries, with about one-quarter being classed as fatal or serious injury crashes, warranting attention under the Safe System approach. As a result, almost 50 FSI rear-end crashes occur on average on Australian and New Zealand Roads each week.

Austroads commissioned a research project (Austroads 2015) exploring the contributory factors for rear-end crashes, especially those leading to fatal and serious injuries, in urban and rural locations. The project sought to identify appropriate solutions, with a particular focus on engineering treatments – both currently used and new potential treatments.

This extended abstract summarised key findings from this project. Further information may be found in the published report (Austroads 2015).

Method

To meet the research goals, a review of national and international literature was undertaken. The review identified previous investigations into factors associated with rear-end crashes in urban and rural environments, measures that may be used to prevent such crashes, and the effectiveness of these measures. Crash data over a five year study period (2006–10) was analysed, with a series of site investigations also conducted at 'high' crash sites in New South Wales, Victoria and Queensland. The purpose of these site investigations was to identify factors that may have contributed to the occurrence or severity of rear-end crashes.

Throughout the project, road environment, vehicle and driver characteristics were considered as potential crash contributory factors.

Findings

Crash contributory factors

Analysis of the crash data, together with the site investigations and literature review found the following environmental factors related to the rear-end crashes

- Crash rate is higher at intersections than midblock locations, due to a greater presence of slow-moving or stationary traffic.

- The crash rate is further elevated at signalised intersections compared to other intersections. Rear-end crashes at signalised intersections were greatly affected by driver decisions during the yellow phase. Drivers of lead vehicles may decide to stop, whilst the driver of the trailing vehicle may have intended to pass through. This issue is exacerbated when red light cameras are present, which may lead to drivers of lead vehicles braking more harshly during the yellow phase to avoid the risk of running a red light.

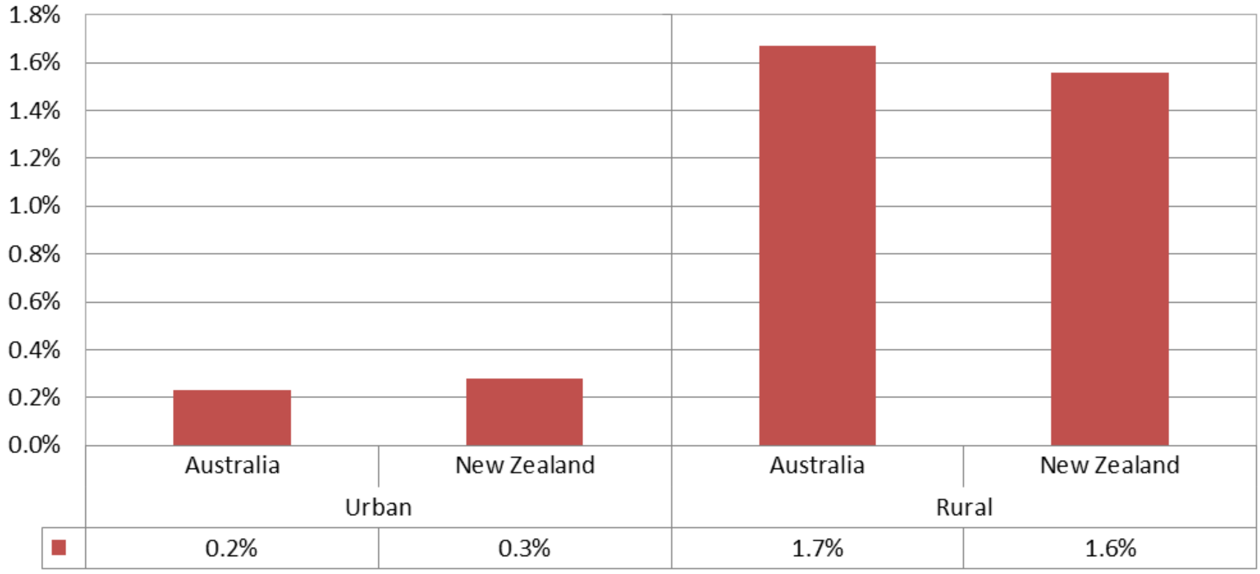
- Crash rate increases with increasing traffic density. As such, rear-end crashes tend to be related to times of peak hour traffic and on arterial roads, conditions where higher traffic volumes are expected.

- Rear-end crashes are more common in road work zones. This may be due to a higher traffic density, changes in traffic flow, and a higher incidence of heavy vehicles.

- Rear-end crashes are generally an urban crash type, with a 4.6 times as many FSI rear-end crashes occurring on urban roads than rural. The higher rate in urban environments can be understood when considering that most of the above environmental factors associated with rear-end crashes are more common in urban conditions.

  However, rear-end crashes in rural environments are generally more severe (Figure 1), most likely due to higher travel speeds resulting in a greater likelihood of higher impact speeds.

Figure 1. Proportion of rear-end casualty crashes (2006-10) resulting in a fatality by road environment



Driver-related factors for rear-end crashes include:

- Drivers that maintain a poor headway time gap with the vehicle ahead are at greater risk of rear-end crashes. There is no clear consensus of what is considered a safe headway amongst road agencies, so confusion amongst drivers is understandable. Drivers may also struggle to maintain a safe headway when traffic volumes are high as other vehicles may move into the space.

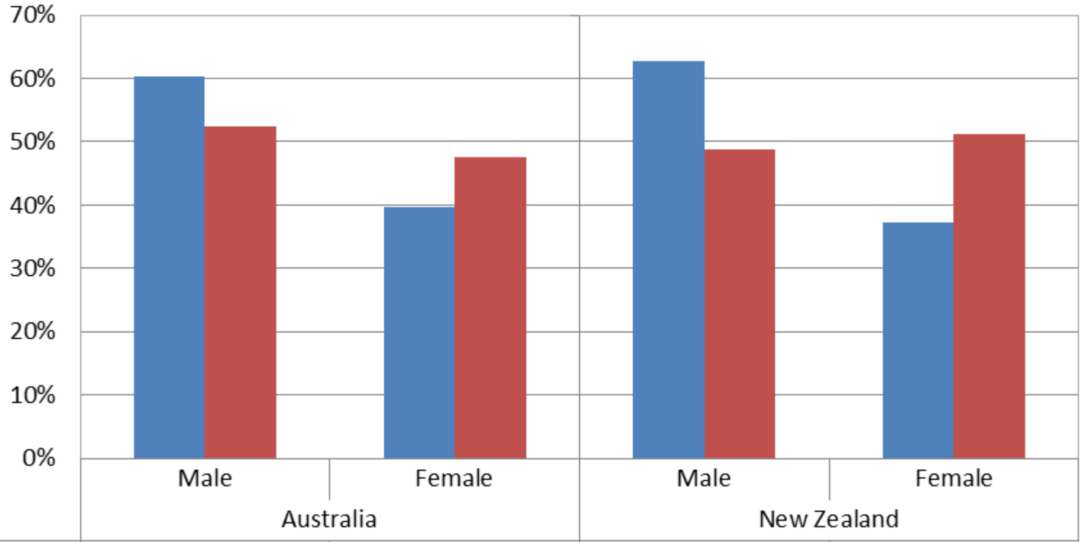
- Driver distraction and inattention is a common factor in rear-end crashes. This is most commonly due to an in-vehicle distraction, such as mobile phones, other passengers or radio. Another common type of driver distraction associated with this crash type is cognitive inattention, described as a driver having 'looked but failed to see'.

  As driver distraction extends driver response times, and shorter headways require shorter response times, distracted drivers maintaining shorter headways would exacerbate both issues.

- Younger and older drivers are both more likely to be operating the striking vehicle in a rear-end crash. Younger driver risk is believed to be higher due to more risk-taking behaviour and poorer spatial awareness, resulting in poor maintenance of headway. Older drivers are believed to be at greater risk due to physical and cognitive impairments that delay their responses.

- Males are more likely to be operating the striking vehicle (Figure 2).

Figure 2. Proportion of urban rear-end casualty crashes (2006-10) in Australia and New Zealand by striking and struck driver gender

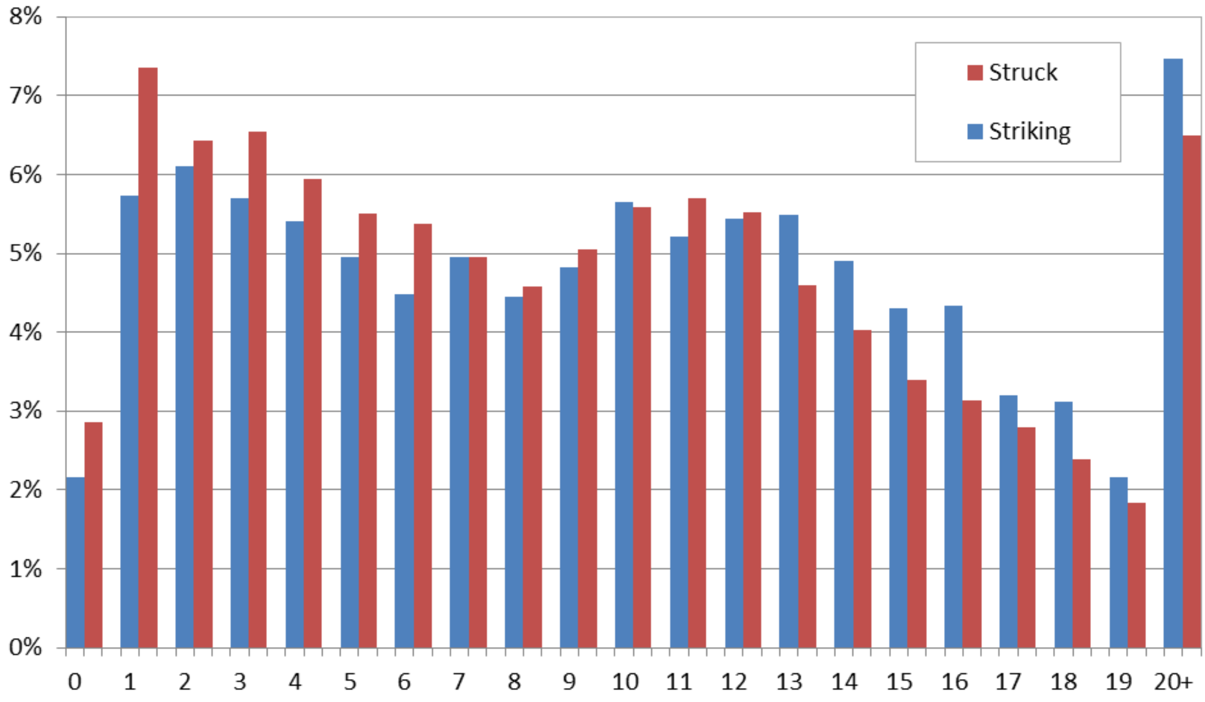


	Australia Male	Australia Female	New Zealand Male	New Zealand Female
Striking	60.3%	39.7%	62.7%	37.3%
Struck	52.4%	47.6%	48.8%	51.2%

Vehicle-related factors for rear-end crashes include:

- Larger vehicles, such as 4WDs and light trucks, restrict the sight distance of drivers following, reducing their ability to anticipate changes in traffic ahead. As such, these vehicles are at greater risk of being struck.
- Heavy vehicles are not able to decelerate as rapidly as smaller vehicles. As such, heavy vehicles are less likely to be struck, but more likely to strike a vehicle in a rear-end crash.
- Striking vehicles are more likely to be older than the struck vehicle in a rear-end crash, likely reflecting recent improvements in vehicle technology (Figure 3).

Figure 3. Proportion of rural rear-end casualty crashes (2006-10) in Australia and New Zealand by striking and struck vehicle age



Factors affecting injury outcomes in a rear-end crash include:

- Occupants in struck vehicles are more likely to sustain injuries than those in the striking vehicle.
- Older vehicles generally allow for a greater separation between an occupant's head and the head restraint. As the occupant's head has a greater range of motion the risk of whiplash injury increases.
- Females are more susceptible to injuries in rear-end crashes than males.

Potential countermeasures

Safety measures that could be effective were identified as either short-term measures that could be undertaken as part of a road maintenance program, or more substantial improvements to be undertaken as part of a capital works or road safety program.

Short term measures to treat rear-end crash sites include:

- Raise awareness of intersections, such as through improved or supplementary signage and delineation.
- Banning of turn movements through signage.
- Speed management, for example through lower speed limits and enforcement. This measure is particularly effective to improve vehicle headways in work zones.

More substantial treatment options include:

- Treatments to alert drivers of intersections, including rumble strips on approach and improvements to visibility of traffic signals and intersection lighting.
- Installation of exclusive turn lanes or median turn lanes to separate slow-moving or queued vehicles preparing for a turn from the general traffic flow. Turn lanes at capacity may need to be extended or a supplementary lane added.
- Co-ordination of traffic signals to encourage platooning of vehicles and reduce speed differentials along the route.
- Signalisation of turn movements to remove conflict between turning and through traffic.
- Replacement of red-light cameras with red-light speed cameras. These cameras counteract the rear-end crash increase associated with red-light cameras by encouraging more controlled speeds at the intersection.
- Installation of congestion advisory signs. These signs may be activated when traffic queuing is significant to alert approaching drivers to anticipate the need to decelerate.
- Tailgating measures, such as:
    - Vehicle-activated signs when a low headway time is detected.
    - Headway distance marking with accompanying signposting to inform drivers of the appropriate distance to maintain.
    - Hand-held headway enforcement cameras that may be used to detect and fine drivers maintaining a low headway. This system will be difficult to implement without headway times being mandated in state road rules.
- Variable speed signs to reduce congestion.

As well as road-engineering based countermeasures, there are a number of in-vehicle technologies being developed that could help reduce the rate of rear-end crashes. Forward collision avoidance technologies and brake assist will help a driver bring a vehicle to a halt before colliding with a vehicle ahead. Headway monitoring devices will warn drivers if they are maintaining too small a headway.

Future research

The study identified a number of opportunities for future research. These include studying the rear-end crash risk associated with disruptions to traffic flow (such as caused by bus stops and driveways), and with short yellow phase times at traffic signals. Also, it is recommended that measures aimed at reducing tailgating be investigated.

Conclusion

This research project highlighted the high number of injury crashes resulting from rear-end crashes. Whilst these crashes are generally less severe, the sheer number of rear-end crashes results in a large number of road users sustaining serious injuries, justifying the need to consider options to reduce the incidence and severity of this crash type.

References

Austroads 2015, *Investigation of key crash types: rear-end crashes in urban and rural environments*, by D Beck, AP-R480-15, Austroads, Sydney, NSW.