Overview of Motorcycle Crash Fatalities Involving Road Safety Barriers

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Abstract

There were 238 motorcycle-related fatalities in Australia during 2006, the highest number recorded in over 15 years. Similar increases are being noted in New Zealand where 38 motorcyclists were killed in 2006. Previous research indicates around 8% of NSW motorcycle fatalities involve a roadside barrier. No studies have been done for all of Australia.

Many myths still pervade concerning how injuries occur when a motorcycle strikes a roadside barrier. The main reason is that there have been relatively few recent real world studies of such crashes where "in depth" detailed analysis of the factors leading up to the crash and the injury mechanisms have been thoroughly investigated. Physics dictates that a rider/pillion passenger travelling at speeds at around 60 km/h or more impacting a crash barrier is at a very high risk of a fatal injury, regardless of whether the barrier is concrete, steel or wire rope. Obviously the human body is not designed for such high severity impacts, in the absence of any additional safe system components.

This paper presents some preliminary findings from a major research project currently underway at UNSW's Injury Risk Management Research Centre and funded by a consortium comprised of road authorities, insurers and a consumer group. Statistical characteristics from an investigation of motorcycle fatal crashes for the years 2001 to 2006 extracted from the National Coroners Information System (NCIS), are presented. The issues of survivability and motorcycle rider injury reduction strategies are also discussed and observations concerning typical crash scenarios are provided.

Keywords

Motorcycle Crashes, Roadside Barriers, Wire Rope, W-beam

Introduction

Motorcycle fatalities in Australia have been rising over the past decade as shown in Figure 1. They are increasing at an average of 5.7% per annum [1]. Of particular alarm is the rise of single vehicle motorcycle crashes. They have almost doubled between 2003 and 2008, rising from 61 to 110 deaths [2]. Single vehicle motorcycle crashes include impacts into roadside barriers.

The increased numbers of motorcycle crashes are likely in part to be the result of an increase in motorcycle registrations. Australian Bureau of Statistics (ABS) data of motorcycle registrations shown in Figure 2, indicate the number of motorcycle numbers over the past decade has almost doubled, a trend which can be expected to continue with increases in fuel costs, parking costs, and traffic density.

Motorcycles, and more recently scooters, are perceived as a viable alternate mode of transport to cars. Thus, motorcycle safety is likely to become an increasingly important focus for road safety researchers and practitioners, particularly because motorcycle crashes are typically severe. Hence, it is important to understand the factors leading to these crashes and how riders are being injured during the crash in order to mitigate the rise in deaths.

This paper presents preliminary results of a research project investigating motorcycle crashes into roadside safety barriers. The work is being carried out at the Injury Risk Management Research Centre at the University of New South Wales.

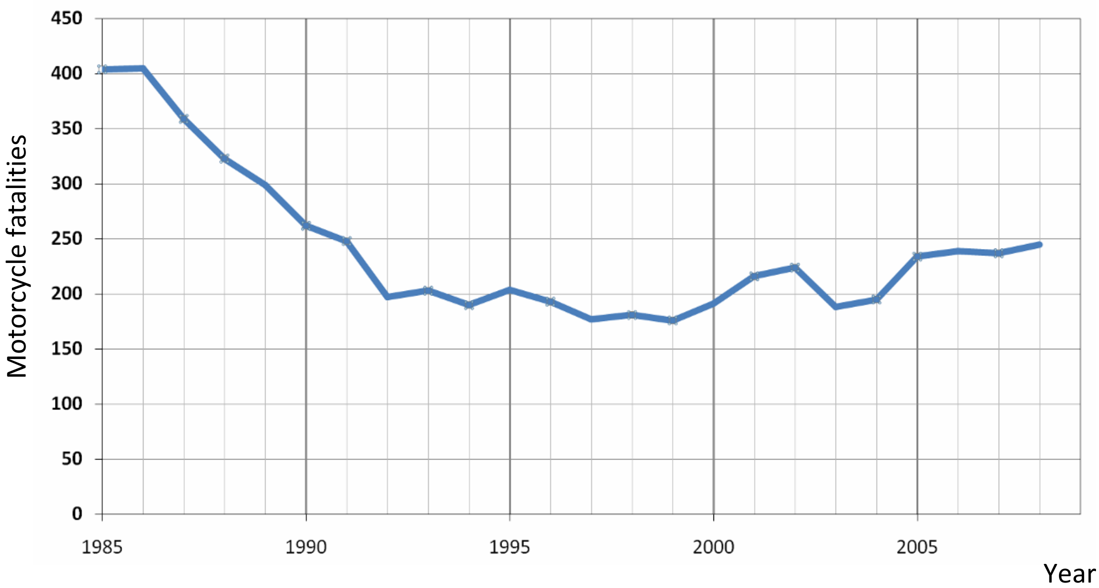

Figure 1: Motorcycle fatalities [2]

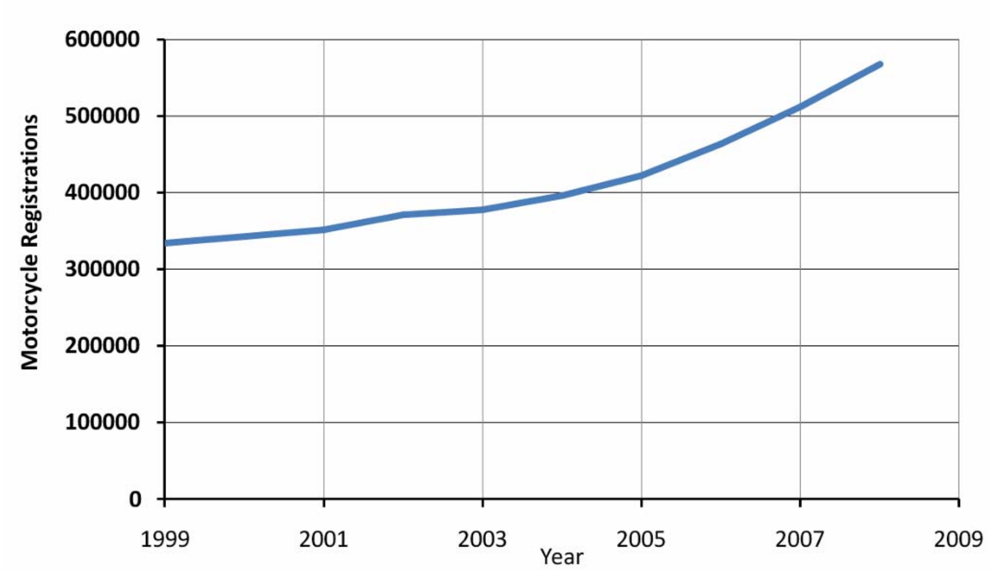

Figure 1: Motorcycle registrations (ABS)

Roadside barriers are typically concrete, W-beam, Thrie beam, bridge railings and/or wire-rope. There has been significant concern raised by motorcycle organisations in Australia and overseas regarding the use of wire rope barriers. One of the main objectives of the research described here is to inform such public debate in regards to the safety or otherwise of motorcycle riders and pillions impacting all forms of roadside barriers.

While there is currently a reasonable amount of knowledge in regards to what is a survivable crash for occupants in cars, trucks and buses that crash into different barrier systems for speeds up to 100 km/h and impact angles up to 25 degrees, there is little credible information concerning survivability of crashes involving motorcyclists. Similarly, statistical information concerning the incidence of rider impacts into roadside barriers may now be dated. Data compiled by Gibson & Benetatos of crashes in 1998-99 [3] showed that 8% of motorcycle fatalities in NSW involve a roadside barrier (excluding roadside hazards such as trees, poles, etc). This data is around ten years old now. No work has been done since then for Australian or New Zealand (NZ) crashes despite the nearly doubling of motorcycle registrations over the past decade.

There have been a number of studies carried out to date to determine factors associated with how Australian motorcyclists are being killed and injured [3, 4, 5, 6, 7, 8]. Two of these studies have focussed on roadside barrier impacts. However, over the past decade a large number of wire-rope barriers have been installed. Hence, further work needs to be carried out to assess if there have been any changes to the type and nature of injuries occurring with the existing mix of roadside barriers. Moreover, little information concerning causal factors leading to the crash with the barrier has been provided by these previous researchers. While the nature of how the injuries are occurring to riders when impacting a roadside barrier are important, just as important are the casual factors leading up to the crash.

A research team was consequently formed to investigate the causal factors and the injury mechanisms that motorcycle riders and pillions are subjected to when they impact a roadside barrier. The team is also determining the survivability envelope for motorcyclists crashing into each of the different barrier system types. This survivability envelope will be compared to the survivability envelope for occupants in other vehicles that impact the barriers in later phases of the project.

In summary, the different phases of the project are:

- to gather information and statistics (fatalities & serious injury) for all available motorcycle impacts into any roadside barrier;
- determine the causal factors the led to the crash such as other vehicle involvement, speed, alcohol, fatigue, bad cornering, inexperience, human error, etc;
- determine the biomechanical injury causal mechanism during impact;
- determine survivable and non-survivable impact envelopes for all barrier types;
- reconstruct crashes using currently accepted practices & computer simulation;
- develop and investigate injury mitigation strategies and assess their effectiveness. This may include proposed redesign of some barrier types;
- carry out crash tests demonstrating injury reducing design modifications that can be made to existing barriers

As presented above, the initial phase of this work has focused on accessing detailed information from the Australian National Coroners Information System (NCIS). Ethics approval for the research was obtained from the University of New South Wales and from the Victorian Department of Justice, to access the National Coronial Information (NCIS) system. Physical case files held by the Coroner's courts were accessed and coded in terms of the details of the crashes that were available. It is also planned to access New Zealand serious injury and fatality data in later phases of the project.

The results presented in this paper focus on this first phase of the project, i.e. background information and some preliminary statistical results.

Background information from other studies

A number of studies have been carried out around the world concerning motorcycle impacts into roadside barriers. Gibson and Benetatos [3] present a good précis of the earlier work by others. The reader is referred to their report for references and summary information concerning those studies. Gibson and Benetatos concluded from their study of 102 (out of 113) motorcycle fatalities in NSW that occurred in 1998 and 1999, that impacts with trees and telegraph poles were more likely to be identified as responsible for the fatal injuries incurred in motorcycle crashes than kerbs/culverts and roadside barriers. They mention little about the main factors that led to the loss of control in the first place, i.e. speeding, fatigue, alcohol, inexperience, other vehicles, etc. These circumstances must also be explored. While they point out a number of issues concerning motorcycle impacts with wire-rope barriers, they did not find any crashes (of the 8 barrier crashes they investigated) that occurred with any wire-rope barrier at that time.

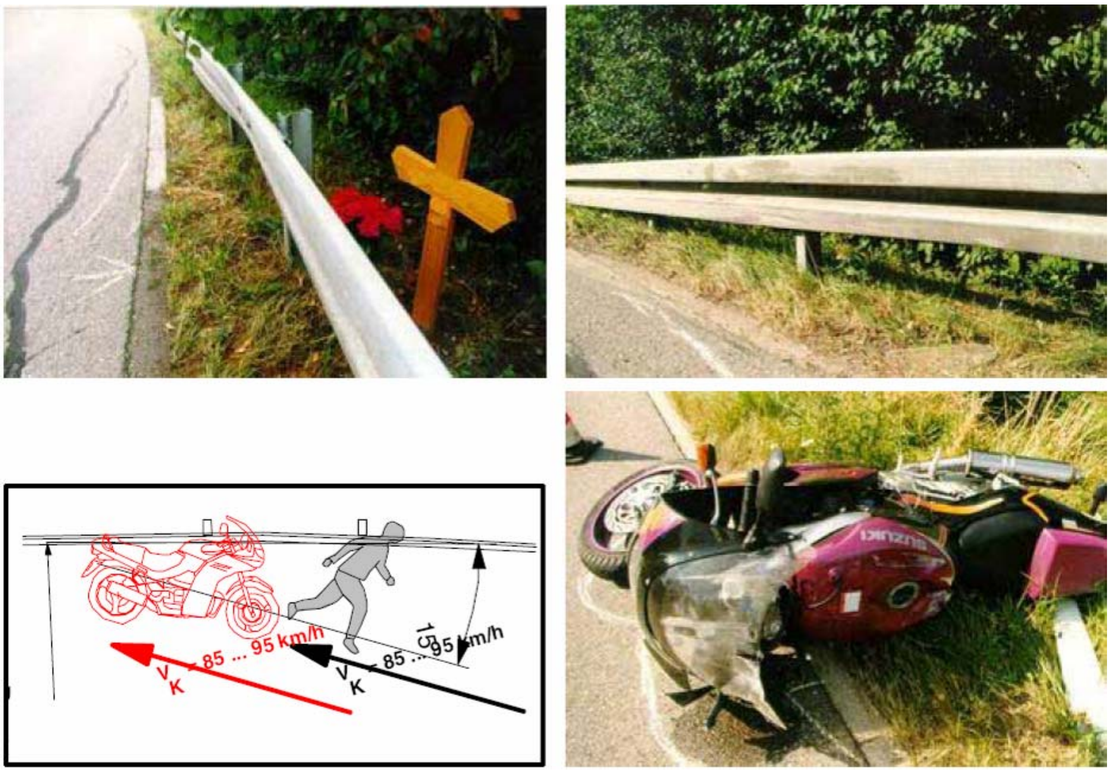

Figure 3: German study of barrier impacts after Berg et al [10].

Figure 4: Stong post W-beam barriers with steel posts and blockouts.

Similarly, Gibson and Benetatos [3] did not provide information with respect to the hazards being protected by the barriers and whether they were equivalent or worse in terms of crash severity and potential injury outcomes than resulted from the barrier. Detailed investigations of the sites where motorcycle barrier crashes occur need to be included into any “in-depth” study. Also little was explored by them in terms of varying the different factors and degrees of these factors leading to the crash, e.g. speed, sobriety, etc, and how they may produce different injury outcomes. For example, García et al [9] indicated in their ‘in-depth’ crash reconstruction study of 16 run-off-road motorcycle crashes that included 19 injuries and 2 fatalities, that in 90% of the 16 crashes studied, high speed was clearly present. Data related to motorcycles, showed, for instance, that in a 50 km/h speed limit bend, 85% of the motorcycles were travelling at over 100 km/h.

Previous work by Berg et al [10], involving the lead author in collaboration with DEKRA Germany, investigated German fatalities. It was found that 82% of fatalities involved a steel barrier. In 51% of 57 cases analysed the motorcycle impacted the barrier while riding in an upright position. However, 45% occurred where the motorcycle slid on its side on the road surface and then struck the barrier as shown in Figure 3. Berg et al [10] carried out a number of upright impact tests and demonstrated that the rider is either ejected over the barrier or slides along it. Berg et al [10] also demonstrated how certain features of existing German steel barriers can snag a rider. The new system developed by them had a smooth surface along the top of the barrier causing the rider to be thrown over the barrier.

The German barriers are different to Australian, New Zealand and US roadside W-beam type barriers. The longitudinal part of the most common steel barrier in Australia is made from a W-beam profile, similar to US guardrail barriers. In Australia, the traditional wooden posts and block outs commonly used in the US, have been replaced with steel C-section posts and block outs as shown in Figure 4. The flanges of the C-section post are turned away from the oncoming traffic. Nevertheless, if a rider were to fall onto or slide along the top of the barrier, the post and block out would likely cause serious injury.

Work on 2005 fatality data carried out in the United States (US) by Gabler [11] from Virginia Tech, indicated that for the first time, US motorcycle riders suffered more fatalities (224) than the passengers of cars (171) or any other single vehicle type involved in a guardrail collision. The total number of US motorcycle fatalities for 2005 is 4553 which means US motorcycle fatalities involving a guardrail barrier represents around 5% of all motorcycle fatalities. In terms of fatalities per registered vehicle, motorcycle riders are dramatically overrepresented in the number of fatalities resulting from guardrail impacts. US motorcycles comprise only 2% of the vehicle fleet impacting guardrail, but account for 42% of all fatalities resulting from guardrail collisions.

The German and US studies show that steel roadside barriers appear to be a concern both in the US and Europe. The research question that has arisen as a result of recent motorcyclists' concerns regarding installation of wire-rope barriers is, what barrier type is particularly hazardous and associated with the majority of Australian and New Zealand fatalities. Gibson and Benetatos [3] only identified one concrete barrier impact resulting in a fatality from the 8 barrier impacts they analysed. They identified the W-beam barrier as hazardous and essentially speculated what may occur with wire-rope barriers. In summary, their study had too few barrier impacts to be able to reach any firm conclusions concerning other barrier types such as concrete and wire-rope barriers. Similarly, no Australian study has identified what proportion of barrier impacts are riders striking the barrier sliding or in an upright manner, nor identified at what speed and angle the impact occurs at with reasonable certainty. The issue of whether a motorcyclist strikes the barrier upright or slides into it is particularly relevant. If the motorcyclist is being thrown over the barrier protecting the hazard, then it possibly becomes irrelevant what barrier the motorcycle strikes depending on the nature of hazard being protected.

Some recent work concerning the effectiveness of wire-rope barriers has also been carried out in Sweden. Around 1,800 km of wire-rope safety barrier systems have been installed in Sweden. A study by the Swedish National Road and Transport Research Institute (VTI) to evaluate the in-service performance of this road safety barrier type was published in January 2009. It showed that this barrier system significantly reduces road trauma [12]. The evaluation covered 470 km of what the Swedish researchers called "collision-free" expressways of which 336 km have a speed limit of 110 km/h. These are also sometimes referred to as 2+1 roads.

Sweden's 2+1 roads are a category of three-lane road, consisting of two lanes in one direction and one lane in the other, alternating every few kilometres, and separated with a steel wire-rope barrier. Traditional roads of at least 13 metres width can be converted to 2+1 roads. Figure 5 shows a picture of a Swedish 2+1 road.

The evaluation also examined data from 1,275 km of 2+2 roads of which 400 km had a posted speed limit of 100 km/h. A 2+2 road is a specific type of dual-carriageway built in Sweden, consisting of two lanes in each direction separated by a steel wire rope barrier. These roads do not have hard shoulders.

Figure 5: Swedish 2+1 road [source: reproduced with kind permission from Torsten Bergh of a VTI Powerpoint presentation to US AFB 20 Roadside Safety Barrier committee in San Antonio, June 2009]

The Swedish report [12] found that compared to normal 13 metre wide roads and expressways, 2+1 and 2+2 roads with a speed limit set at 110 km/h showed an overall reduction in fatalities and serious injuries of about 57% and 39% respectively. For the roads with a posted speed limit of 90 km/h, the fatalities and serious injuries were reduced by 62% and 63% on the 2+1 and 2+2 road types, respectively.

The Swedish study also looked into the road safety outcome of the 2+1 roads for motorcyclists. This was in response to complaints registered by motorcyclists concerning the safety of 2+1 roads. Fatal and seriously injured (FSI) motorcyclists were found to constitute 7.8% of the total FSI's for this road type being slightly lower than the Swedish nationwide proportion of 9.3%. However, 9 motorcycle fatalities were reported out of 56 (16.1%) which according to Carlson [12] is slightly higher than the national Swedish average of 11.5%. Nevertheless, when compared to standard 13 metre wide roads (without a wire-rope median barrier) and accounting for the mileage covered by motorcyclists, the 2+1 road type showed a reduced number of killed or seriously injured motorcyclists (65-70%). Carlson points out that even when the mileage travelled by motorcyclists was reduced significantly, the 2+1 road type showed a reduction of 32% to 35% in the number of killed or serious injured motorcyclists.

Similarly, several regions of the United States of America have more recently installed wire-rope safety barrier systems. A report published by the state of North Carolina by Lynch [13] shows that between 1994 and 1997, 97 people were killed on North Carolina freeways in cross median crashes. This study showed that cross median crashes constituted only 5% of all freeway crashes but they accounted for 20% of the fatalities and 13% of severe injuries on freeways. Further, this report showed that cross median crashes on North Carolina freeways were difficult to characterise as they did not occur on any particular day, season, or time of day. A case study was undertaken to gauge the effectiveness of median wire rope barriers on a section of freeway in North Carolina. After 30 months, it was reported that average daily traffic had increased from 90,000 vehicles per day to 120,000 vehicles per day. Prior to the installation of the wire-rope safety barrier, the section of highway being monitored was experiencing an average of one fatality and ten (10) cross median serious injuries per year. During the trial period, of the 118 crashes recorded by the police where vehicles hit the wire-rope safety barrier, only 2 involved serious injuries. It was also reported that one of the injured drivers was travelling at 85 miles per hour (approximately 136 km/h) while the posted speed limit was 65/70 miles per hour (approximately 104/113 km/h). Overall, the trial was deemed a success as no fatality was recorded and as a result median wire-rope safety barriers were progressively installed on more freeways.

Further data published recently by South Carolina Department of Transport (SCDOT) [14] has shown that road fatalities have reduced on highways fitted with wire-rope median safety barrier when compared to the number of fatalities on the same road prior to barrier installation. Figure 6 shows that fatal crashes were rising before South Carolina Department of Transport (SCDOT) instituted the safety improvement program which encompassed installing wire-rope median barriers from October 2000. The data in Figure 6 only refers to fatalities occurring on South Carolina highways involving an errant vehicle crossing the median strip and colliding with another vehicle. It appears that following the installation of the wire rope barrier system, the number of fatal crashes dropped dramatically.

Other regions of the USA such as the Washington State, have reported favourable performance of wire-rope safety barrier systems. Data collected in Washington State between 1997 and 2003 (the installation dates varied between 1.75 years to 5 years) showed that the installation of wire-rope safety barrier systems was cost effective. A 2004 report by McClanahan [15] stated that "*While the accident data shows that the number of accidents increased noticeably, the number of severe accidents (fatal and disabling) decreased significantly*". Furthermore, only one (1) fatality where the driver was ejected from the vehicle after it rolled was reported.

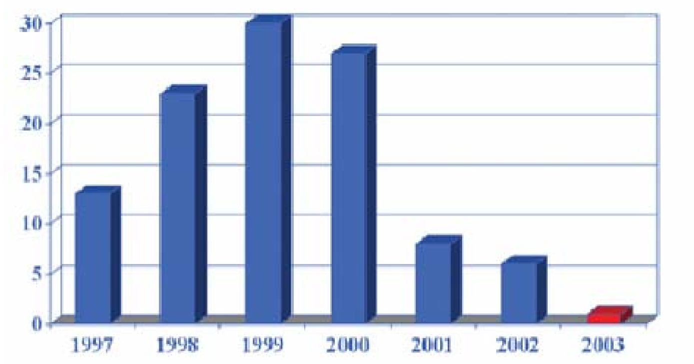

Figure 6: Fatalities on South Carolina Highways
Source: http://www.tfhrc.gov/pubrds/03nov/11.htm [accessed March 3, 2009]

The Washington state report [15] concluded that the wire-rope safety barrier system has a net benefit to society of US$420,000 per installed mile (equivalent to approximately US$261,000 per km). This figure was arrived at after taking into consideration the installation and maintenance costs as well the damage to property as a result of impact with the barrier. These costs were then compared to the benefit accrued to the society based on the fatalities and injuries prevented.

Further information from Washington State indicates that wire-rope safety barrier systems continue to be effective in preventing fatalities and serious injuries wherever they are installed [16]. This report suggests that in 2000, there were eighteen fatal and disabling crashes involving unprotected medians and about 10 miles of cable median barrier installed. By 2006, 135 miles of cable median barrier had been installed and the number of fatal and disabling collisions had been reduced to five. The report concludes that by installing cable median barriers, fatal and disabling crash rates had reduced by 75%. The barriers were also found to be effective in containing 95% of errant vehicles in the median.

The findings of a study conducted in 2001 on the efficacy of three strand median barriers by the Missouri Department of Transport (MsDOT) was also reported by Donnell and Hughes [17]. This study suggests that three strand wire rope median barriers are effective in preventing cross median fatalities and serious injuries. A 55 km section of Interstate 44 was used to gather data of which 21 km had a three strand wire rope barrier installed and 34 km had a concrete median barrier or no median barrier. Data was gathered over four years (1997 to 2000) with two years used as "before installation" and two years as "after installation". At locations where the wire rope barrier system was installed, the following was recorded;

Cross-median crashes were reduced by 33% (33 before, 12 after).

Fatal cross-median crashes were reduced by 33% (3 before, 1 after).

Injury cross-median crashes were reduced by 50% (13 before, 6 after).

Property damage only crashes were reduced by 70% (17 before, 5 after).

Enter median only crashes were reduced by 45%.

Enter median and struck wire rope crashes increased by 300%.

Enter median and struck wire rope injury crashes increased by 150% and

Enter median and struck wire rope property damage only crashes increased by 400%.

For comparative purposes, sections where wire rope barrier was not installed were analysed. In the "after installation" period, cross-median crashes declined (33 before, 25 after), but the fatal crash frequency increased (2 before, 4 after). In combining injury and property damage only crashes, the frequency was reduced in the after period (21 before, 16 after). The Donnell and Hughes [17] report concluded that after installing a wire rope median barrier, cross median crash severity will decrease, however, the crash frequency will increase. This is similar to the previously reported findings.

A more recent 2007 report by Chandler [18] on the performance of wire rope barriers in the State of Missouri also suggests that wire rope barrier system is effective in preventing cross median crashes and fatalities. On a particular stretch of a highway (Interstate 70) 24 motorists were killed in 2002 as a result of a crash after crossing the median. After installation of a wire rope median barrier, 2 fatalities were registered on the same road. Figure 7 shows the effect of progressively installing more wire rope median barriers on a stretch of Interstate 70. It is clear from Figure 7 that as the length of the highway with wire rope barriers installed increased, there was a corresponding decrease in cross median fatalities.

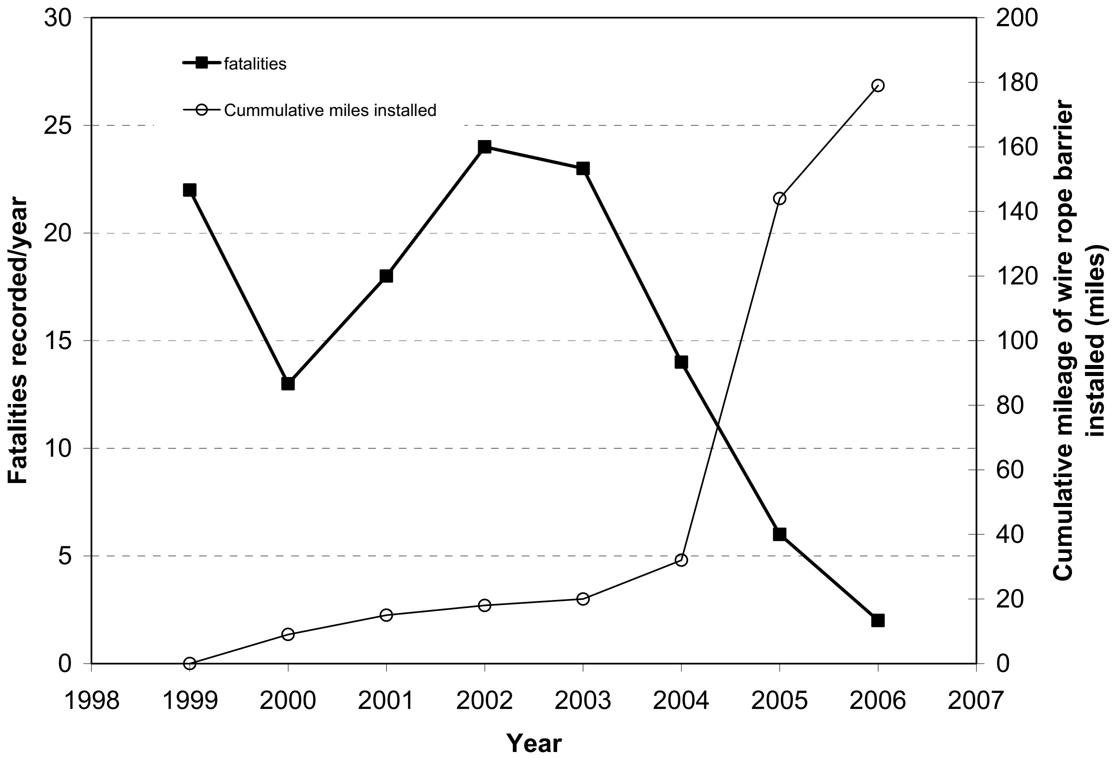

Figure 7: Cross median fatalities on Interstate 70 in Missouri and the cumulative miles of wire rope median barrier installed (source: after Chandler, 2007 [18]).

A relatively old working party report was published by the Australian Transport Safety Bureau (ATSB) in 2000 [19]. The working party consisted of officials from the ATSB and motorcyclist representative groups and was formed after the then Australian federal minister of Transport and Regional Development had directed ATSB to examine motorcyclist concerns about wire rope safety barriers. This report [19] indicated no known report of a fatality as a result of motorcyclist impacting a wire rope barrier in Australia. Similarly, no fatality was reported on Australian roads involving a wire rope barrier system.

The ATSB working party report [19] could not reach a consensus on the wire rope safety barriers. However the stated views of the ATSB were published which indicated that;

- *If wire rope barriers were banned, the substitution with more rigid barrier types could result in a net increase in casualties among car occupants.*

- *If wire rope barriers were banned, the cost of installing alternative treatments would be greater in many cases. This could require an increase in overall road funding levels or a reduction in the number of treated sites. The latter would result in a net increase in road user casualties.*

In regards to crash testing of roadside barriers, Peldschus et al [20] proposed in 2007 a new test for the European Community (ECE) simulating an upright and sliding rider. Considerable research work still needs to be carried out in regards to the viability of the test procedures. For example the sliding test requires a rider wearing a helmet to slide into a barrier head first at 30 degrees at 60 km/h. This is an equivalent "diving" speed of around 30 km/h, i.e. dropping a person upside down on their head into the ground. This may indeed be an overly ambitious requirement when one considers what is required to fracture the neck. The load at which injuries begin to occur is around 6000 N or an impact "equivalent diving speed" of around 2.2 m/s (8 km/h). Catastrophic loading to the neck is around 11 kN or 4.5 m/sec (16 km/h) [21]. This demanding "diving mode" procedure may be an unrealistic requirement that rarely occurs in "real world" motorcycle into roadside barrier crashes. This has yet to be established from "in-depth real world" crash data.

Another issue in regards to the ECE tests is that the procedure requires only upper neck loads be measured in the test dummy. It is well known that subluxation neck fractures may well occur as a result of a diving type of impact similar to what is being proposed in the new standard. Hence lower neck loads should also be measured.

A variety of products have been developed to protect motorcyclists who impact longitudinal barriers. Most of these products, many of which come from Europe, are designed to shield the posts of the steel barrier systems. Padding around posts, whilst useful at low speeds, become quickly ineffective at higher impact speeds (30 km/h or more), analogous to the ineffectiveness of motorcycle helmets to protect against brain trauma and neck fractures at higher impact speeds. Shield fascias, considered useful in terms of reducing the snagging characteristics of some barriers for riders, may result in changing the crash characteristics of the barrier for the other vehicle crashes for which they were certified. Hence, the overall road safety benefit could drop significantly with only a small gain in motorcycle safety. Similarly, proposals to increase the frangibility of posts by drilling holes at the base of the posts may not necessarily increase post frangibility because the inertial mass of the post has not been reduced. Thus, further work needs to be carried out in regards to suitable test procedures and protective systems to ensure that the safety of all road users is considered.

Another concern is the issue of human body vulnerability. Rumar [22] proposed an injury risk curve for pedestrians being struck by an automobile. One could theoretically draw the analogy that a motorcycle rider's body is equivalent in terms of vulnerability to that of pedestrian's body. Both road users are unprotected during a crash. Figure 8 shows the Rumar graph. At impact speeds in excess of around 60 km/h, the crash has a very low chance of survivability if the rider strikes an immovable object. Indeed the impact can be presented as being equivalent to jumping off a building hoping one will survive. For example, the well known equation from physics $v = \sqrt{2gh}$ where v is the velocity, g is the earth's gravitational constant 9.81 m/sec^2 and h the height above the ground, it can be readily shown that: striking a solid object at 30 km/h is equivalent to jumping off the roof of a house, 40 km/h is equivalent to jumping off a 3 story building, 50 km/h is equivalent to jumping off a 5 storey building, and 60 km/h is equivalent to jumping off a 7 story building and hoping you will survive.

All of these issues demonstrate the need for further research in terms of understanding the underpinning physics of the human into structure interaction, basic energy management principles, and overall assessment of injury countermeasure strategies from a broader road safety perspective for all road users. It is evident from all of the above cited publications that a rigorous analysis of Australia motorcycle impacts into roadside safety barriers is still much needed.

Preliminary statistical results

The National Coroners Information System (NCIS) was interrogated for motorcycle crashes involving a roadside safety barrier. NCIS contains information about every reportable death in Australian states and territories. NCIS was created in 2000 by all state and territory governments except Queensland. The

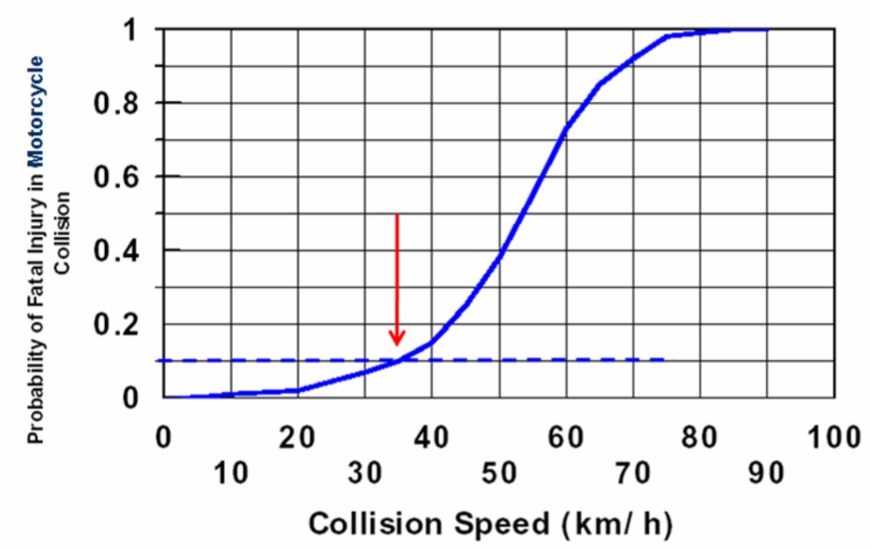

Figure 8: Probability of a motorcycle fatal crash by collision speed (motorcyclist striking a hard object).

system became operational in July 2000. Queensland joined NCIS at the beginning of 2001. The NCIS database is hosted by the Victorian Institute of Forensic Medicine. NCIS is funded by state and territory governments as well as the federal government of Australia. Any results from searching NCIS data needs to bear this history in mind.

The NCIS database query for this study was designed as follows:

1) All jurisdictions were searched
2) Employment field was left blank
3) Time field was left blank
4) Query object was chosen as a mechanism
5) The mechanism that caused the death was defined as blunt force
6) Level 2 of the mechanism was defined as a transport injury event
7) Level 3 of the mechanism was defined as motorcyclist/motorcycle rider
8) The vehicle details were defined as two wheeled motor vehicle
9) The vehicle was further defined as a motorcycle

The database was searched for particulars of the deceased such as the sex, age, date of birth, date of death, location, the counterpart crash vehicle, and any associated police, toxicology and autopsy reports. The automated data search produced a total of 1532 identified fatalities involving a motorcyclist or a pillion passenger for the years 2000 to 2007. These results were transferred to a Microsoft excel spreadsheet and manually categorised. Each death record should have attached to it an initial police, autopsy and toxicology report. Each case also usually has the finding of the cause of death as recorded by the investigating coroner. Further detailed information is usually available where an inquest was held to establish the cause of death.

To gauge the reliability of the data obtained, the number of motorcycle deaths identified per annum from NCIS was compared in Figure 9, to the number of motorcycle deaths recorded by the Australian Department of Infrastructure, Transport, Regional development and Local government (DITRL)[1] and the Australian Bureau of Statistics (ABS). Data from the ABS was available only up to 2006. Figure 9 shows that the data extracted from NCIS, DITRL and ABS were generally in agreement. However, the data from the ABS consistently reports a slightly higher number of deaths than that from NCIS or DITRL.

[1] These data was formerly collated by the Australian Transport Safety Bureau, ATSB

There are a number of possible reasons why motorcycle fatality numbers differ between data sources. This includes issues such as coding errors, missing data and variations in the definition of a road fatality. For example, ABS data refers to underlying cause of death which may include a long period of complicating illnesses as a result of injury sustained in a motorcycle crash. The data from all sources is in reasonably close agreement for the years 2001 to 2005. Hence the statistical analyses were restricted to this period.

Once all motorcycle fatality cases from all jurisdictions in Australia were identified for 2001 to 2006, each case was screened manually using the coroner's findings, the initial police, autopsy and toxicology reports, in order to determine whether a roadside barrier was involved in the incident. All motorcycle fatality cases were then categorised into: (a) involving a barrier; (b) not involving a barrier; and (c) undefined cases with insufficient information. The results are shown in Figure 10.

In total 1261 cases of a roadside fatality involving a motorcycle were identified to have occurred in Australia for the period under review. A further 67 cases were positively identified as involving a roadside safety barrier. Unfortunately 147 cases could not be categorised, the majority of which (134 out of 147) occurred in NSW. The NSW NCIS data lacked sufficient information to identify how the crash occurred. For example, thirty four cases or nearly 10% of the total motorcycle fatality cases in NSW (34 out of 335) did not provide any details other than the gender and age of the deceased. Queensland also had a number of cases which could not be categorised because of insufficient information in the database.

Figure 11 shows that around 5.3% of all motorcycle fatalities are known to involve a roadside barrier. This value is somewhat less than that found by Gibson and Benatatos for NSW data. The 67 motorcycle fatalities identified in Figure 10 involving roadside barriers identified occurred over a 5 year period, translates to an average of around 13 to 14 fatal crashes involving a roadside barrier nationally per year. For NSW, SA and Qld the average was around 3 per year, for Vic around 2 per year and around 1 per year for ACT, Tas and WA. The numbers are quite low in comparison to other modes of injury for motorcyclists such as fixed object impacts (trees, poles, etc) and collisions involving other motor vehicles.

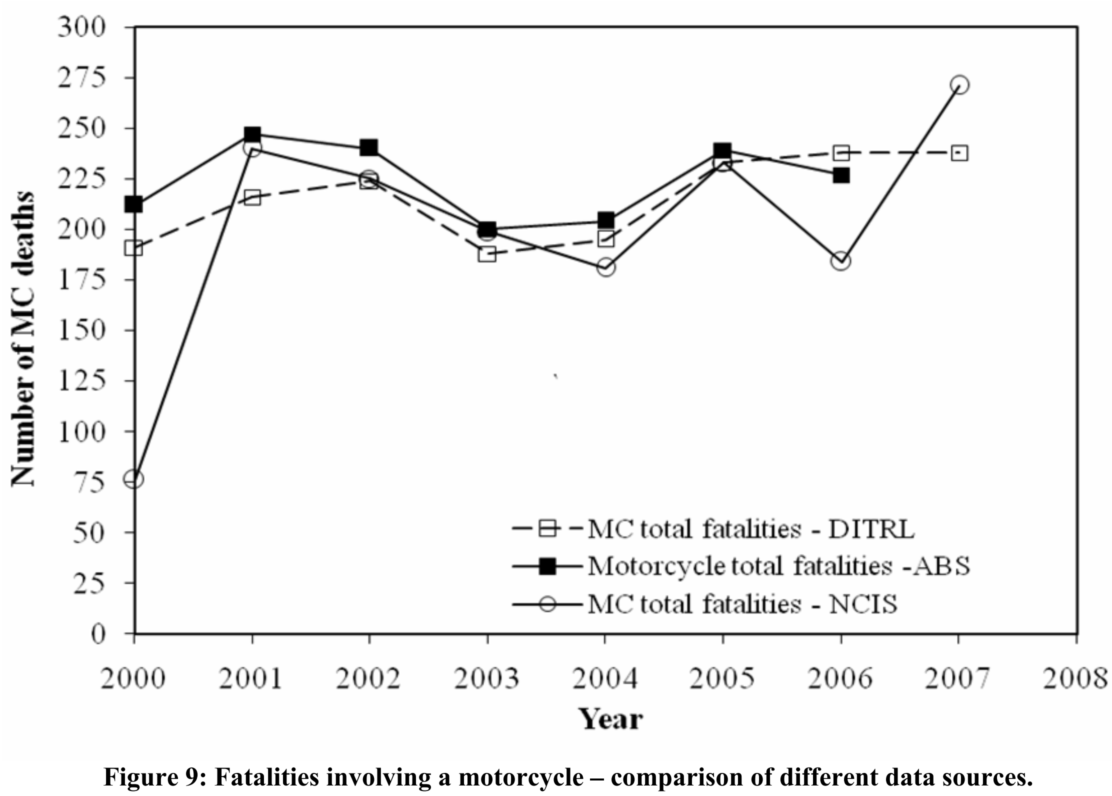

Figure 9: Fatalities involving a motorcycle – comparison of different data sources.

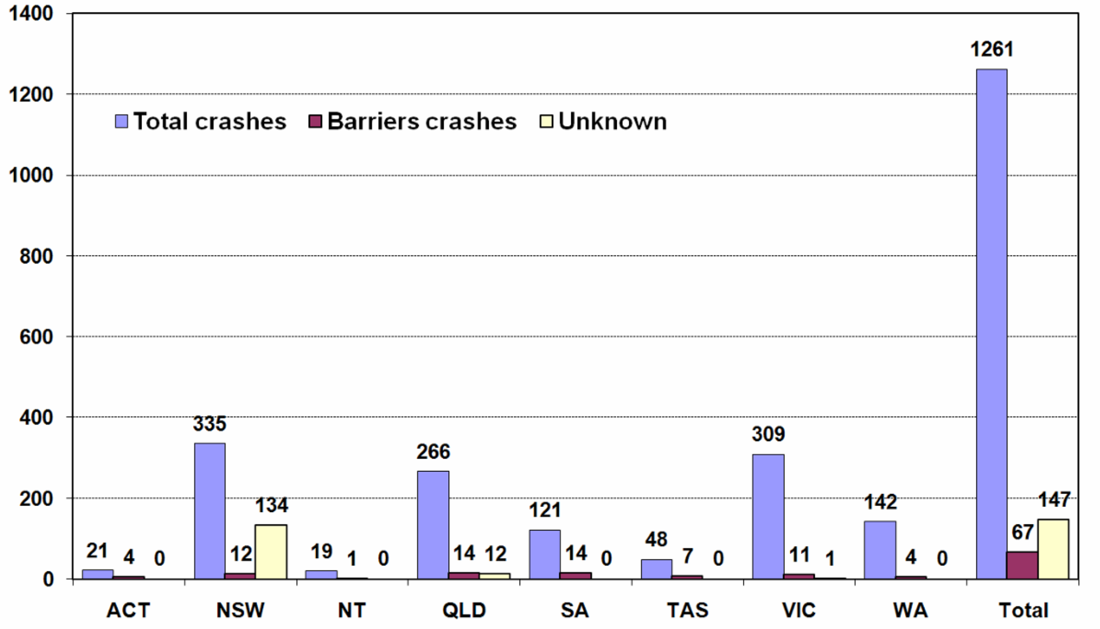

Figure 10: Motorcycle fatalities in Australia (2001 to 2006) based on NCIS data

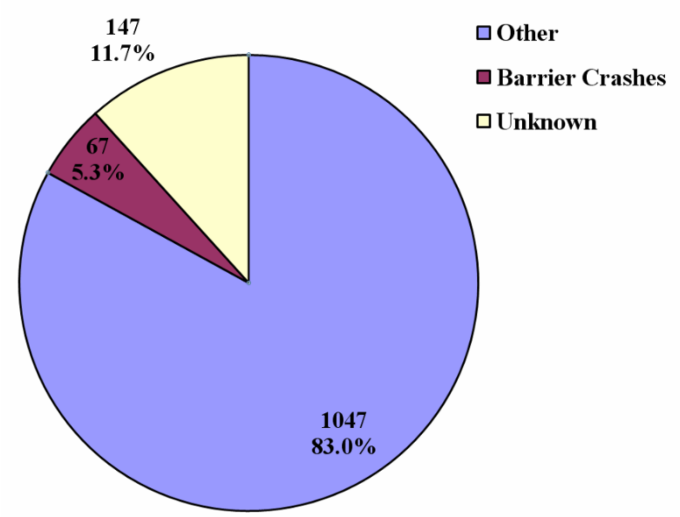

Figure 11: Breakdown of motorcycle fatalities in Australia (2001 to 2006) based on NCIS data.

Figure 12 shows motorcyclist fatalities involving a roadside safety barrier segregated according to the type of barrier impacted. Fatalities involving a steel barrier (not wire-rope) appear to be the most dominant. W-beam steel barriers were involved in a large majority of the 54 out of the 67 (80.6%) cases. This was followed by 7 deaths involving a concrete roadside safety barrier (10.4%). 5 out of the 7 deaths involving a concrete barrier occurred on a raceway. Therefore on public roads only 3.0% of motorcycle fatalities involved a concrete barrier. Wire rope safety barriers were involved in 3 cases (4.5%). Two of the wire-rope cases involved high speed whereas one of the cases could not be properly analysed based on the information so far available.

It should also be pointed out that attempts to identify the 147 unknown motorcycle crash modes are being made. Similarly, the steel barrier type cases will be assessed and further segregated into for example W-beam, Thrie-beam, or steel bridge rails, etc. Hence, the crash distributions shown in Figures 10 to 12 will change as more information is revealed. Suffice to say that W-beam barriers appear to be over represented in the injury data. This is consistent with overseas findings.

An important consideration concerning the information provided in Figure 12 is the exposure of motorcyclists to the different roadside safety barriers. Further information concerning the installed lengths (kms) of each safety barrier type in each state will be considered in order to try to establish fatality rates for each barrier type. However, it should be noted that W-beam roadside safety barriers are used predominantly on curved hilly road sections in areas regularly frequented by motorcycling enthusiasts. Hence, utilising actual installed lengths as a denominator for exposure rates may not reflect the problems concerning roadside barrier type involvement in motorcycle injuries and fatalities. In contrast wire rope barriers are often installed on straight roads and hence may be why they are not struck as often. These issues need to be further investigated.

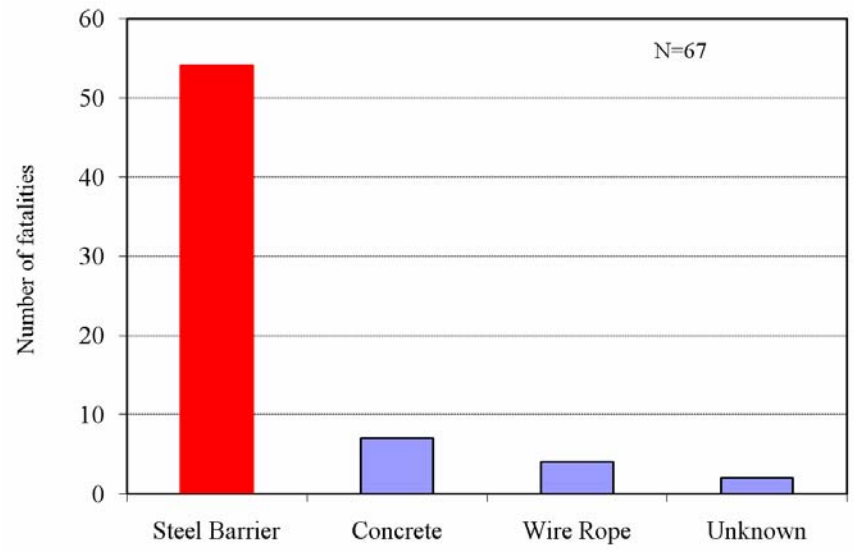

Figure 12: Australian motorcycle fatalities involving a roadside safety barrier segregated according to barrier type impacted (2001 to 2006) - NCIS data

Detailed data is still being collected and processed at this point in time. Similarly, little work has been completed concerning the impact mechanisms. The results from this work will be presented in future papers as more information and results become available.

Conclusions

A number of conclusions can be reached in regards to the information and results presented in this paper. They are:

1. Motorcycle fatality data from National Coroners Information System (NCIS) appears to be reliable for the years 2001 to 2006. However a substantial amount of information is missing from NSW and Queensland data making detailed analysis of crash circumstances difficult. Case file follow-up is being conducted.

2. The number of known motorcycle impacts into roadside barriers is low at around 5.3% of all motorcycle fatalities over the five year period 2001 to 2006 for the whole of Australia. This is notably less than the 8% value presented by Gibson and Benetatos for 1998-1999 for NSW data. More recent data obtained after this paper was written, indicates that motorcycle impacts into roadside barriers appears to be still at around 8% for NSW and that motorcycle into barrier crashes may be over represented for this state compared to other states.
3. W-beam steel barriers are over represented in fatal motorcycle crashes into roadside barriers. They appear to be particularly hazardous to motorcycle riders which is consistent with other international research findings.

4. Wire-rope barriers have to date provided a significant benefit to reducing vehicle related crash fatalities in Europe and the USA. It also appears that installation of wire-rope barriers in Sweden

has reduced motorcycle fatalities. However it is still unclear what effect these barriers are having on motorcycle fatalities in Australia.

5. Assuming that when a motorcycle rider crashes and impacts an object that is solid relative to the human body, and that the risk of a fatal injury is similar to that for a struck pedestrian, it would appear that survivability of a rider would likely rapidly reduce above body impact speeds of around 40 km/h.

Acknowledgements

The authors would like to thank the following project funding partners:

- NSW Road and Transport Authority
- New Zealand Land Transport Agency (Formerly known as Transit New Zealand)
- Office of Road Safety, Main Roads Western Australia
- NSW Motor Accident Authority
- Australian Automobile Association

for their generosity and support for such an important project on which many lives depend.

The following members of the Scientific Advisory Committee are also thanked for their valuable contribution:

Dr. Soames Job – NSW Roads and Traffic Authority
Mr. Iain Cameron –Office of Road Safety, Main Roads Western Australia
Mr. Fabian Marsh – New Zealand Land Transport Agency
Mr. John Metcalfe – Australian Automobile Association
Mr. Jan Karpinski –Main Roads Western Australia
Ms Dimitra Vlahoporitros – NSW Motor Accidents Authority
Ms Nadine King – NSW Motor Accidents Authority
Mrs Pam Albany – Formerly from the NSW Motor Accidents Authority

The authors would also like to thank the Victorian Institute of Forensic Medicine as the source organisation of the National Coroners Information System from which the motorcycle crash data was extracted for the statistical analysis presented in this paper.

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