Motorcycle Safety and Roadside Barriers

Why are road and traffic engineers installing wire-rope barriers?

Raphael Grzebieta

Dr. Mike Bambach

Transport and Road Safety (TARS) Research, UNSW
Reducing tree impacts – chopping down trees to provide large clear zones? Little or no support from environmentalists.

Safe System Approach – Safer Roads
Protection against tree impacts & hazards, drains, culverts, median cross over.

Wire-rope in combination with tactile line marking (rumble strips) – very effective in reducing fatal and serious injury fatigue crashes.
Wire-rope median barrier

Elephant in the room!

Large controversy with motorcyclists concerning installation of road safety barrier but in particular wire rope barriers.
All sorts of myths and claims being made concerning roadside barriers.

Project was started to look at the crash data and carry out in-depth analysis of barrier involved crashes in a scientific manner.
New Zealand Fatalities


Percentage of motorcycle death relative to all road deaths
Percentage of motorcycle death relative to all road deaths

Motorcyclist killed as a percentage of the total road toll in Australia, NZ and USA

Source:
Road Safety Branch, Infrastructure and Surface Transport Policy, Department of Infrastructure, Transport, Regional Development and Local Government, NZ Transport Agency and FARS website and NZ Transport Agency data
### Australian Motorcycle Registrations
\[ \approx 3.2\% \]
Fatalities \( \approx 16\% \) of all road fatalities

### New Zealand Motorcycle Registrations
\[ \approx 1.5\% \]
Fatalities \( \approx 10\% \) of all road fatalities

<table>
<thead>
<tr>
<th>State</th>
<th>Total Vehicle Population</th>
<th>Motorcycle Population</th>
<th>Proportion of motorcycles (%) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Capital Territory</td>
<td>224 076</td>
<td>8 022</td>
<td>3.58%</td>
</tr>
<tr>
<td>New South Wales</td>
<td>4 268 631</td>
<td>122 211</td>
<td>2.86%</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>114 015</td>
<td>3 950</td>
<td>3.46%</td>
</tr>
<tr>
<td>Queensland</td>
<td>2 897 867</td>
<td>110 501</td>
<td>3.81%</td>
</tr>
<tr>
<td>South Australia</td>
<td>1 137 957</td>
<td>33 772</td>
<td>2.97%</td>
</tr>
<tr>
<td>Tasmania</td>
<td>374 846</td>
<td>10 488</td>
<td>2.80%</td>
</tr>
<tr>
<td>Victoria</td>
<td>3 740 726</td>
<td>114 438</td>
<td>3.06%</td>
</tr>
<tr>
<td>Western Australia</td>
<td>1 600 566</td>
<td>59 675</td>
<td>3.73%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>3,308,142</td>
<td>49,283</td>
<td>1.49%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14 358 684</strong></td>
<td><strong>512,340</strong></td>
<td><strong>2.90%</strong></td>
</tr>
</tbody>
</table>

*Motorcycles as a proportion of the population of registered motor vehicles 2006 data
Motorcycle impacts into roadside barriers
TARS research project

Partners
WA Office of Road Safety, WA Main Roads
Australian Automobile Association
NSW Centre for Road Safety (formerly RTA – Tf NSW)
NSW Motor Accidents Authority
New Zealand Transport Agency

Research Investigators
Raphael Grzebieta (Team leader)
Mike Bambach (injury mechanisms & statistics)
Hussein Jama (statistics)
Andrew McIntosh (biomechanics)
Rena Friswell (causation & epidemiology)
Rob Smith (motorcycle expert)
Motorcycle impacts into roadside barriers  
TARS research project

**Scientific Advisory Committee (includes researchers)**
- Soames Job – NSW Roads and Traffic Authority
- Michael de Roos – (formerly) NSW Roads and Traffic Authority
- Wal Smart – NSW Roads and Traffic Authority
- David Pratt – NSW Roads and Traffic Authority
- Iain Cameron – West Australian Office of Road Safety
- Brian Kidd – West Australian Main Roads
- Jan Karpinski - West Australian Main Roads
- Fergus Tate – New Zealand Transport Agency  
  (formerly Fabian Marsh: New Zealand Land Transport Agency)
- Craig Newland – Australian Automobile Association
- Dimitra Vlahoporitros – (formerly) NSW Motor Accidents Authority
- Clay Gabler – Virginia Tech, USA

**Methodology**

- ✓ Statistics (fatalities & serious injury)
- ✓ Determine causal factors (other vehicle, speed, alcohol, fatigue, bad cornering, inexperience, human error?, etc)
- ✓ Determine biomechanical injury causal mechanism/s
Motorcycle impacts into roadside barriers

TARS research project

Methodology

- Determine survivable and non-survivable impact envelopes
- Reconstruct crashes & computer simulation
- Develop / investigate injury mitigation strategies and assess their effectiveness
- Carry out crash tests

Motorcycle into Barrier Fatalities

2001 - 2006 National Coroners Information System data

2001 – 2006 Crash Analysis System (CAS) of the New Zealand Transport Agency

In-depth investigation of fatal crashes where information is available

Motorcycle into Barrier Fatalities

Infrastructure only addressing at best only 6% of fatalities in Australia and 2% in NZ

Motorbike Crashes 2001-2006

<table>
<thead>
<tr>
<th>State</th>
<th>Total MC fatalities</th>
<th>Barrier related MC fatalities</th>
<th>Non-barrier MC fatalities</th>
<th>Not known</th>
<th>Barrier/Known (%)</th>
<th>CT 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Capital Territory</td>
<td>21</td>
<td>4</td>
<td>17</td>
<td>0</td>
<td>19.0%</td>
<td>7.7 – 40.0</td>
</tr>
<tr>
<td>New South Wales</td>
<td>335</td>
<td>23</td>
<td>277</td>
<td>35</td>
<td>7.7%</td>
<td>5.2 – 11.2</td>
</tr>
<tr>
<td>North Territory</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>......</td>
</tr>
<tr>
<td>Queensland</td>
<td>266</td>
<td>13</td>
<td>251</td>
<td>2</td>
<td>4.9%</td>
<td>2.9 – 8.2</td>
</tr>
<tr>
<td>South Australia</td>
<td>121</td>
<td>13</td>
<td>108</td>
<td>0</td>
<td>10.7%</td>
<td>6.4 – 17.5</td>
</tr>
<tr>
<td>Tasmania</td>
<td>48</td>
<td>8</td>
<td>40</td>
<td>0</td>
<td>16.7%</td>
<td>8.7 – 29.6</td>
</tr>
<tr>
<td>Victoria</td>
<td>299</td>
<td>10</td>
<td>299</td>
<td>0</td>
<td>3.2%</td>
<td>2.0 – 6.3</td>
</tr>
<tr>
<td>Western Australia</td>
<td>142</td>
<td>2</td>
<td>140</td>
<td>0</td>
<td>1.4%</td>
<td>0.3 – 4.9</td>
</tr>
<tr>
<td>Total Australia</td>
<td>1261</td>
<td>73</td>
<td>1149</td>
<td>35</td>
<td>6.0%</td>
<td>5.2 – 8.0</td>
</tr>
<tr>
<td>New Zealand</td>
<td>201</td>
<td>4</td>
<td>196</td>
<td>0</td>
<td>2.0%</td>
<td>0.8 – 5.0</td>
</tr>
<tr>
<td>Total</td>
<td>1462</td>
<td>77</td>
<td>834</td>
<td>38</td>
<td>5.4%</td>
<td>4.4 – 6.8</td>
</tr>
</tbody>
</table>

National Coroners Information System - findings

Motorbike Crashes 2001-2006

![Graph showing Motorbike Crashes 2001-2006](chart)

**Motorcycle into Barrier Fatalities**

**TIME of Day (Afternoons)**

<table>
<thead>
<tr>
<th>Time (0-2)</th>
<th>Frequency</th>
<th>New Zealand</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2-4</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4-6</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6-8</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8-10</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>10-12</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>12-14</td>
<td>14</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>14-16</td>
<td>16</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>16-18</td>
<td>18</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>18-20</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>20-22</td>
<td>22</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>22-24</td>
<td>24</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

**Weather Conditions – dry weather**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency</th>
<th>New Zealand</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear, dry</td>
<td>40</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Dark, dry</td>
<td>35</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Raining</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Overcast, dry</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Clear, moist</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Wet, overcast</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Unknown</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Motorcycle into Barrier Fatalities

DAY of Crash (mostly weekends & recreational for Australia. Weekdays for New Zealand)

- Male 71
- Females 6 (of which 4 were female pillions)

Worth noting: ABS data shows between 2001 and 2006, only 5.0% of all riders (including pillion passengers) killed in a motorcycle crash were female.
Motorcycle into Barrier Fatalities


Installed Lengths - Australia

W beam comprises 71.5% of the barriers and results in 72.7% of the fatalities; Concrete comprises 8.6% of the barriers and results in 10.4% of the fatalities; and Wire rope comprises 15.9% of the barriers and results in 7.8% of the fatalities.

Wire rope barriers have around half the fatality rate of W beam barriers and around 0.4 of concrete barriers – concrete most dangerous.

<table>
<thead>
<tr>
<th>State</th>
<th>Total road length (kms)*</th>
<th>Total length of roadside barriers (kms)</th>
<th>Steel Barrier length (kms)</th>
<th>Concrete barrier length (kms)</th>
<th>Wire rope barrier length (kms)</th>
<th>Other (kms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>17,818</td>
<td>2,272.0</td>
<td>1,825.0</td>
<td>152.0</td>
<td>295.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Queensland</td>
<td>35,000</td>
<td>1,511.0</td>
<td>1,118.0</td>
<td>264.0</td>
<td>121.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Tasmania</td>
<td>3,900</td>
<td>521.5</td>
<td>245.2</td>
<td>8.5</td>
<td>88.4</td>
<td>213.9</td>
</tr>
<tr>
<td>Victoria</td>
<td>23,300</td>
<td>1,726.0</td>
<td>1,263.0</td>
<td>*</td>
<td>463.0</td>
<td>*</td>
</tr>
<tr>
<td>Western Australia</td>
<td>18,024</td>
<td>370.0</td>
<td>212.2</td>
<td>60.4</td>
<td>97.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Australian</td>
<td>98,042</td>
<td>6,400.5</td>
<td>4,633.4</td>
<td>484.9</td>
<td>1,064.6</td>
<td>221.9</td>
</tr>
<tr>
<td>Total New Zealand</td>
<td>10,800</td>
<td>1,383.0</td>
<td>902.0</td>
<td>188.0</td>
<td>170.0</td>
<td>123</td>
</tr>
</tbody>
</table>

* These figures refer to the roadways managed by the state authorities and excludes roads managed by the local government authorities such as councils and shires.

* not available

Installed lengths of roadside barriers along roads in Australia and New Zealand
Motorcycle into Barrier Fatalities

Road type – predominantly bends (N=77)

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>LH Bend</td>
<td>35</td>
</tr>
<tr>
<td>RH Bend</td>
<td>25</td>
</tr>
<tr>
<td>Bend</td>
<td>10</td>
</tr>
<tr>
<td>Straight</td>
<td>5</td>
</tr>
<tr>
<td>Intersection</td>
<td>5</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
</tr>
</tbody>
</table>

Hazard type protected – mostly trees

<table>
<thead>
<tr>
<th>Hazard Type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td>30</td>
</tr>
<tr>
<td>Median</td>
<td>25</td>
</tr>
<tr>
<td>Enbankment</td>
<td>20</td>
</tr>
<tr>
<td>Rocks</td>
<td>15</td>
</tr>
<tr>
<td>Culvert</td>
<td>10</td>
</tr>
<tr>
<td>Poles</td>
<td>5</td>
</tr>
<tr>
<td>Guardrail</td>
<td>5</td>
</tr>
<tr>
<td>Road Workers</td>
<td>5</td>
</tr>
<tr>
<td>Bridge</td>
<td>2</td>
</tr>
<tr>
<td>Cliff</td>
<td>2</td>
</tr>
<tr>
<td>Property wall</td>
<td>1</td>
</tr>
<tr>
<td>Utility Pole</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
</tr>
</tbody>
</table>
Motorcycle into Barrier Fatalities

Speed a major factor

43 cases – speeding

Average posted maximum speed limit for these cases was 85.6km/h

Average riding speed was 99.1km/h

Instances of rider estimated to be travelling at twice the speed limit, i.e. 200km/h in a 100km/h zone and 150km/h on a 70km/h speed zone

Motorcycle into Barrier Fatalities

Speed, alcohol, drugs or a combination of the three were a factor in 2 in every 3 crashes

Motorcycle into Barrier Fatalities

Update NZ motorcycle-barrier crash data (funder: NZ Accident Compensation Corporation ACC)

- Non-fatal cases – CAS (non-injury, minor injury, serious injury)
- Fatal cases – identified on CAS then Coronial files collected
- Study period: January 2001 to July 2013
  - Non-injury = 17
  - Minor injury = 102
  - Serious injury = 89
  - Fatal = 20

Total vehicle fatalities over this period is around 4384, i.e. around 0.5% of all road fatalities

Total motorcycle fatalities over this period is around 425, i.e. around 5% of all motorcycle fatalities
Updating NZ motorcycle-barrier crash data

(funder: NZ Accident Compensation Corporation ACC)

- Non-fatal cases – CAS does not provide barrier type
- Fatal cases - barrier types determined from Coronial files:
  - W-beam = 13
  - Wire rope = 3
  - Other = 2 (wood rail and bridge barrier)
  - Open file = 2

- Comparison with other single-vehicle fixed-object collisions:
  - Post/pole = 97
  - Traffic sign = 70
  - Tree = 93

- Rate of Serious injury or Fatality (FSI ratio):
  - Guardrail = 0.47
  - Post/pole = 0.61
  - Traffic sign = 0.55
  - Tree = 0.51

- Roadside barriers provide a reduction in injury risk to motorcyclists, compared with trees, posts, signs and utility poles
**Survivability Analysis**

No Australian or New Zealand data:
- used US NASS data which is on-line
- weighted sample of 30,000 single-vehicle fixed object collisions – 2000 to 2009
- 50,000 police incident reports sampled from 5.8 million annual police-reported crashes that include a fatality, injury and property damage only crashes.

Odds ratios for the probability of fatality conditional upon a motorcyclist being involved in a collision with a fixed object assuming all other variables remain the same ($n_{weighted} = 29,305$)

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>pole vs barrier</td>
<td>1.888</td>
<td>0.918, 3.882</td>
</tr>
<tr>
<td>tree vs barrier</td>
<td>3.587</td>
<td>1.841, 6.990</td>
</tr>
<tr>
<td>other vs barrier</td>
<td>0.853</td>
<td>0.484, 1.504</td>
</tr>
</tbody>
</table>

What is a survivable impact?

Hitting an object at 30 km/h is equivalent to jumping off the roof of a house.

At 60 km/h, driving off a 3 story building.

At 80 km/h, driving off a 6 story building.

At 100 km/h, driving off a 10 storey building.
**Motorcyclist - What is a survivable impact?**

Motorcyclist fatality risk profiles, rural roadway departure into a tree or utility pole, for road safety measures; a) None, b) Install a barrier, c) Speed not exceeding the speed limit, d) Helmet use, e) All measures (b, c and d).

**Methods**

- **Design** – retrospective analysis of linked police-reported crash data and hospitalisation data in NSW, 2001 – 2009 (inclusive)
- **Data sources** – Admitted Patient Data Collection (APDC – NSW Health) and CrashLink (Centre for Road Safety, Transport for NSW)
- **Data linkage** – probabilistic data linkage performed by the Centre for Health Record Linkage (CHeReL)
- **Inclusions** – motorcyclists in CrashLink that were injured or killed as a result of a single-vehicle collision with a fixed object (W-beam/guardrail, concrete barrier, culvert, embankment, post, tree and utility pole)
- **Statistical analysis** – SI values determined from three methods; FSI ratios, major injury rates and logistic regression
Methods

- **FSI ratios** – fatally or seriously injured persons as a ratio of all persons:
  \[
  FSI = \frac{\sum FSI_i}{\sum \text{Persons}_i}
  \]
  ‘seriously injured’ is defined as admitted to hospital (linked APDC record)

- **Major injury rates** – number of individual major injuries sustained per 100 motorcyclist collisions:
  \[
  MI \text{ rate} = \frac{\sum \text{major injuries} \times 100}{\sum \text{collisions}}
  \]
  ‘major injury’ is defined as an ICD-10 injury code with a mortality ≥ 3.5%

- **Logistic regression** – odds ratios of fixed objects compared with barriers, controlling for confounding using crash variables in CrashLink

Results – descriptive

- 1,364 – motorcyclists in single-vehicle collisions with fixed objects
  - 352 – tree (26%)
  - 291 – guardrail (21%)
  - 247 – embankment (18%)
  - 226 – post (17%)
  - 111 – culvert (8%)
  - 95 – utility pole (7%)
  - 42 – concrete barrier (3%)
Results – descriptive

1,364 – motorcyclists in single-vehicle collisions with fixed objects

| Speed related | 67   | 79
| Average      | 16   | 114
| Location     | 176  | 79
| Number       | 123  | 95
| Angle        | 116  | 77
| Speed        | 1271 | 932
| Time         | 123  | 95
| Intersection | 17   | 115
| Location     | 61   | 75
| Time         | 26   | 1
| Speed        | 126  | 921
| Location     | 1    | 763
| Time         | 1    | 14
| Time related | 21   | 213
| Severity     | 756  | 55.4
| Fatally injured | 130 | 9.5
| FSI          | 886  | 65.0

Results – descriptive

Major injuries* per 100 collisions

- Concrete barrier
- Guardrail
- Tree
- Post
- Utility pole

*ICD-10 injuries with mortality ≥ 3.5%
### Results – Severity Indices

<table>
<thead>
<tr>
<th>Location</th>
<th>FSI 95</th>
<th>FSI 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier</td>
<td>0.63</td>
<td>0.72</td>
</tr>
<tr>
<td>Post</td>
<td>0.67</td>
<td>0.78</td>
</tr>
<tr>
<td>Tree</td>
<td>0.71</td>
<td>0.7</td>
</tr>
<tr>
<td>Utility pole</td>
<td>0.74</td>
<td>0.1</td>
</tr>
</tbody>
</table>

The table above shows the FSI ratio for different locations. The FSI ratio is calculated as the ratio of the frequency of major injuries to the frequency of all injuries. The FSI ratio is lower for barrier and post locations, indicating a lower severity index.

### Major Injury Rate

<table>
<thead>
<tr>
<th>Location</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier</td>
<td>74</td>
</tr>
<tr>
<td>Post</td>
<td>138</td>
</tr>
<tr>
<td>Tree</td>
<td>135</td>
</tr>
<tr>
<td>Utility pole</td>
<td>167</td>
</tr>
</tbody>
</table>

The Major Injury Rate table shows the number of major injuries sustained at each location. Barrier and post locations have the lowest rate of major injuries, indicating better safety.

### Relative to Barriers

<table>
<thead>
<tr>
<th>Location</th>
<th>Relative to Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier</td>
<td>1</td>
</tr>
<tr>
<td>Post</td>
<td>1.06</td>
</tr>
<tr>
<td>Tree</td>
<td>1.11</td>
</tr>
<tr>
<td>Utility pole</td>
<td>1.16</td>
</tr>
</tbody>
</table>

The Relative to Barriers table shows the relative severity of injuries at each location compared to barriers. The utility pole shows the highest relative severity, indicating the need for improved safety measures.

*Outcome: sustain at least one major injury or died.*
### Results – Severity Indices

<table>
<thead>
<tr>
<th>Barriers</th>
<th>FSI for Motorcycle</th>
<th>FSI for Passenger Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>0.63</td>
<td>0.71</td>
</tr>
<tr>
<td>Utility pole</td>
<td>0.55</td>
<td>0.57</td>
</tr>
<tr>
<td>Post</td>
<td>0.36</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Relative to barriers, magnitudes for motorcyclists are smaller (barriers are less effective in reducing injury risks for motorcyclists than for passenger vehicle occupants).

Relative to barriers, magnitudes for passenger vehicle occupants (motorcyclists are unprotected by a structure).

Relative to barriers, there is scope to prove roadside barriers or motorcyclist collisions.
Motorcycle into barrier Fatalities

Other studies

D.R. Germany

involved a steel barrier

51 out of 5 cases analysed
- motorcycle impacted the barrier while driving in an upright position

45 occurred where the motorcycle slid on its side on the road surface before first contacting the barrier.

Motorcycle into arrier Fatalities

(a) Number of motorcyclists who received 1 or more AIS 3+ injuries in each body region;
b) Number of motorcyclists who received the most severe injury (MAIS) in each body region (and % of total of 70)

Motorcycle into arrier Fatalities

(a) Number of motorcyclists that received AIS3+ injuries to multiple body regions, b) Severity distribution of injuries to motorcyclist body regions

Impact inematics

<table>
<thead>
<tr>
<th>Injured body region</th>
<th>Odds ratio</th>
<th>95% CI lower</th>
<th>95% CI upper</th>
<th>Chi-squared p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>0.97</td>
<td>0.33</td>
<td>2.84</td>
<td>0.960</td>
</tr>
<tr>
<td>Neck</td>
<td>0.23</td>
<td>0.02</td>
<td>2.40</td>
<td>0.186</td>
</tr>
<tr>
<td>Torax</td>
<td>4.67</td>
<td>1.08</td>
<td>20.14</td>
<td>0.029</td>
</tr>
<tr>
<td>Abdomen</td>
<td>2.04</td>
<td>0.47</td>
<td>8.91</td>
<td>0.329</td>
</tr>
<tr>
<td>Spine</td>
<td>1.46</td>
<td>0.37</td>
<td>5.71</td>
<td>0.584</td>
</tr>
<tr>
<td>Upper ext.</td>
<td>0.37</td>
<td>0.03</td>
<td>4.30</td>
<td>0.409</td>
</tr>
<tr>
<td>Lower ext.</td>
<td>1.75</td>
<td>0.56</td>
<td>5.45</td>
<td>0.326</td>
</tr>
<tr>
<td>Pelvis</td>
<td>9.41</td>
<td>1.10</td>
<td>80.54</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Odds ratios and 95% confidence intervals for injuries occurring to those that crashed sliding into a W beam, compared to those impacting a W beam in the upright posture.
**ECE Standard – Only head injury criterion**

- Measurement: 60 km/h

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Biomechanical limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resultant head acceleration</td>
<td>220 g</td>
</tr>
<tr>
<td>HIC</td>
<td>1000</td>
</tr>
<tr>
<td>Neck flexional moment</td>
<td>190 Nm</td>
</tr>
<tr>
<td>Neck extension</td>
<td>57 Nm</td>
</tr>
</tbody>
</table>

**ECE Standard – No thorax Injury**


Motorcycle Into Arrier Atalities

ire-rope barrier installation

• NZ Centenial Highway

– 1996 to 2000: 8 fatalities, 2 serious injury and 7 minor

– 2001 to 2004 removed passing lanes & wide yellow double tactile lines & reflectors & signs: 4 fatalities 2 serious injuries 2 minor injuries

– 2005 to 2009 installed wire-rope median barriers and dropped speed limit to 80 km/h: No atalitie No eriou injurie, 3 minor injuries.

Source: Marsh, and Pilgrim M., 2000 Performance of arrow Median ire Rope barrier Installation on Centennial hghwa, ew ealand, accepted for publication Journal of the Australasian College of Road Safety, Ma.
In every atalitie in old eed alcohol drug or a combination of any one of the e decided to loo at all motorcycle atalitie or the a e eriod.

<table>
<thead>
<tr>
<th>Year</th>
<th>ACT</th>
<th>NSW</th>
<th>NT</th>
<th>QLD</th>
<th>SA</th>
<th>TAS</th>
<th>VIC</th>
<th>WA</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>2</td>
<td>66</td>
<td>5</td>
<td>36</td>
<td>17</td>
<td>7</td>
<td>69</td>
<td>33</td>
<td>235</td>
</tr>
<tr>
<td>2002</td>
<td>2</td>
<td>51</td>
<td>4</td>
<td>54</td>
<td>23</td>
<td>10</td>
<td>61</td>
<td>24</td>
<td>229</td>
</tr>
<tr>
<td>2003</td>
<td>1</td>
<td>59</td>
<td>1</td>
<td>43</td>
<td>15</td>
<td>11</td>
<td>41</td>
<td>25</td>
<td>196</td>
</tr>
<tr>
<td>2004</td>
<td>4</td>
<td>38</td>
<td>0</td>
<td>50</td>
<td>21</td>
<td>7</td>
<td>40</td>
<td>25</td>
<td>185</td>
</tr>
<tr>
<td>2005</td>
<td>9</td>
<td>55</td>
<td>3</td>
<td>72</td>
<td>21</td>
<td>7</td>
<td>52</td>
<td>26</td>
<td>245</td>
</tr>
<tr>
<td>2006</td>
<td>3</td>
<td>49</td>
<td>6</td>
<td>61</td>
<td>28</td>
<td>7</td>
<td>49</td>
<td>30</td>
<td>233</td>
</tr>
</tbody>
</table>

Total atalitie

The number increased since the carrier study completed in the recent study carried out in Set...
II atalitie – eather

II atalitie – road alignment
Of 323 fatalities, 261 were male and 62 of riders and pillion passengers were female.

22 out of 3 crashes in ever 3 involving a female fatalities were pillion passengers.

Motorcycle fatalities predominantly occur as a result of a collision with another vehicle or a single-vehicle collision with a fixed roadside object.

Most common crash modes were a motorcycle collision impacting the side of a car at an intersection, or a tree, utility pole, post or roadside barrier on a bend.
Illicit drugs detected for 207 motorcyclists 27 02 motorcyclists 3 used more than one type of illicit drug and 02 motorcyclists used illicit drugs and alcohol. ma orit was cannabis.
3. Motorclists exceeded speed was identified as excessive speed as a proportion of all 3,323 cases was 27.

Motorclists disobeyed a traffic control
3 motorcyclists of all 323 fatalities, riding behaviour was identified as a contributing causal factor in the crash speed, alcohol, drugs, disobeying a traffic control, or a combination in every 2 crashes.
47% upright posture, 44% sliding posture
30-50% of serious injuries (AIS3+) are thoracic
We need a motorcyclist-barrier crash test protocol that includes thoracic injury measures and upright collision postures

- Crash test are expensive – test protocols can be assessed first with computer simulations
- Total Human Model for Safety (THUMS) 50th percentile adult male
- High-resolution CT scans, around 2 million elements
- NCAC steel W-beam barrier model, around 125,000 elements
o ile che t injury echani

- Post impact – lateral
- Post impact - frontal
- W-beam impact
ead nec injury echani
Future work

Reconstruct crashes & computer simulation
Currently underway

develop / investigate injury mitigation strategies and assess their effectiveness
Post padding, rub rails, post caps and covers, pole and sign protection – what are their limitations – at what speeds can one survive and at what injury level
Future work

- Arrive out crash tests – measure impact loads and confirm simulations.
- Develop the current standard to also include the hoop injury measures and an upright test. Incorporate this into A/NZ Australian standard for Road Safety Barriers. Can be used for any system that is used to protect other hazards.

Summary

- Motorcycle fatalities resulting from roadside barriers crashes are low at around 5 to 6% - around 1.5 per year nation wide of around 35 fatalities
- Seed alcohol drug combination or any three in out of every fatality (this compares to 1 in every 2 for all motorcycle fatalities)
Summary

• About a 50/50 split between sliding and impacting upright.

• Guardrail impacts are the most dangerous and often struck – mostly exposure an issue.

• Concrete barrier impacts can also be dangerous but low numbers – all upright – no sliding fatalities.

• Wire-rope fatal impacts are also low.

  – reduction in road fatalities wherever installed which is why they are being installed.

Summary

• Cheese cutter effect is a Myth that needs to be strongly rebutted.

• Cutting a tensioned cable will cut you in half is a Myth (myth busters ‘pig test’).

• Solutions exist to reduce motorcycle fatalities – but credible science must be used so as not to effect all road users and gains to date – rub rails and skirting should not cause a vehicle to launch.
**Summary**

- Predominantly chest injuries - European motorcycle barrier standard - no chest injury measurement or criterion - only HIC

- Trees and poles greater fatality risk than roadside barriers – indicates deployment of a barrier to protect road users from trees and poles reduces motorcyclists risk

- 95% killed in motorcycle crashes are male - large proportion of females killed are pillions. Training/education needs to target males

**Conclusion**

- Retrofitting roadside barriers and infrastructure furniture with padding, rub rails, etc. and installing more expensive motorcycle ‘friendly’ barriers will have minimal effect on reducing motorcycle fatalities and injuries. Such crashes only constitute around 6% of motorcycle fatalities and serious injuries and only around 0.5% of all road users fatalities.

- Installing roadside and median barriers – particularly wire-rope barriers - has a beneficial effect of around 50 to 60% in terms of reducing motorcycle casualties.
• Installing more median and roadside barriers and addressing drunk, drugged, speeding or disobeying a road law (e.g. running a red light) risky behaviour will yield greater gains in reducing casualties.

• Target higher volume/higher serious casualty motorcycle routes (Great Ocean Road, Gorge Road, etc.) for any retrofit or motorcycle friendly routes but combine with speed enforcement to account for risk compensation phenomenon.

Recommendations

• Require that a person must have a full driver’s licence before they can apply for a motorcycle licence.

• "returning" riders: Re-testing at various intervals in order to retain licence currency (once obtained it seems they remain forever, even if no riding has occurred for years.)

• Require ISA speed limiters for motorcycles.

• Require alcohol interlocks for motorcycles.

Recommendations

• Require ABS breaking.

• For barrier testing, introduce an upright test and require measurement of chest accelerations and compression.

• Continue research on frangible posts for motorcycle impact for wire-rope barriers

• Continue research on post padding, rub rails, post caps, etc.
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Australian Automobile Association
Centre for Road Safety
Motor Accident Authority of Australia and Transport Accident Commission

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Accident Compensation Corporation ACC
RAAC Trust

UNSW
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