Creating the future of transport

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Accidents at roundabouts

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Project for UK Highways Agency on geometric design of roundabouts

- International review of design
- Review of Standard
- Consultation with practitioners
- Accident study
- Consider provision for non-motorised users
- Develop a hierarchical approach
- Revise Standard
A typical four-arm roundabout in the UK
A typical three-arm roundabout in the UK
Review of design in other countries

- Emphasis on safety rather than capacity
- Roundabouts smaller than in UK
- Single or double lane designs
- Limited flaring
- Outward-sloping crossfall on circulatory carriageway
  
  Easier to construct
  Drainage
  More conspicuous central island
  No crown line
Typical crossfall in the UK

- a Crown Line
- b Smooth crown

Section x-x
### Personal injury accidents in 2003

<table>
<thead>
<tr>
<th></th>
<th>No. of accidents</th>
<th>% fatal and serious</th>
<th>Average accident cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>All roads</td>
<td>214,000</td>
<td>15%</td>
<td>£61,100</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>18,700</td>
<td>8%</td>
<td>£34,600</td>
</tr>
<tr>
<td>Other junctions</td>
<td>111,000</td>
<td>14%</td>
<td>£52,000</td>
</tr>
<tr>
<td>Non-junction</td>
<td>85,000</td>
<td>15%</td>
<td>£78,800</td>
</tr>
</tbody>
</table>
Differences between countries when comparing accidents at roundabouts

- Higher flows / multiple lanes in the UK
- Difference in definition of:
  - junction accident
  - injury accident
- Cultural differences
- Main UK study is old (1984)
- Accident rates from current UK study are for high flow roundabouts only
## Comparison of accident frequencies (injury accidents per year)

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of roundabouts</th>
<th>Accident frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>290</td>
<td>0.6</td>
</tr>
<tr>
<td>France</td>
<td>12,000</td>
<td>0.1</td>
</tr>
<tr>
<td>New Zealand</td>
<td>95</td>
<td>0.51</td>
</tr>
<tr>
<td>UK (old – 4-arm only)</td>
<td>84</td>
<td>2.36 to 4.38</td>
</tr>
<tr>
<td>UK (current )</td>
<td>1162</td>
<td>1.77</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>46</td>
<td>0.23</td>
</tr>
<tr>
<td>US</td>
<td>11</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Accident frequency as a function of number of arms at the roundabout

Accident frequency (accidents per year)

Number of arms

Accident frequency

3  4  5  6
<table>
<thead>
<tr>
<th>No. of arms</th>
<th>No. of sites</th>
<th>Single cway roads</th>
<th>Dual cway roads</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>326</td>
<td>0.63</td>
<td>1.28</td>
<td>9.3%</td>
</tr>
<tr>
<td>4</td>
<td>649</td>
<td>1.08</td>
<td>2.65</td>
<td>7.1%</td>
</tr>
</tbody>
</table>
### Comparison of accident rates (injury accidents per 100 million vehicle-km)

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of roundabouts</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>-</td>
<td>4-8</td>
</tr>
<tr>
<td>France</td>
<td>179</td>
<td>4</td>
</tr>
<tr>
<td>Germany (includes damage only)</td>
<td>-</td>
<td>53-162</td>
</tr>
<tr>
<td>UK (old)</td>
<td>84</td>
<td>21-37</td>
</tr>
<tr>
<td>UK (current – high flow)</td>
<td>44</td>
<td>36</td>
</tr>
<tr>
<td>Sweden</td>
<td>182</td>
<td>2-16</td>
</tr>
<tr>
<td>US</td>
<td>11</td>
<td>8</td>
</tr>
</tbody>
</table>
Accident models

Accident frequency on each arm related to flow

\[ A = k Q^\alpha \]

or

\[ A = k Q_1^\alpha Q_2^\beta \]

These models were extended to include geometric and layout variables:

\[ A = k Q_1^\alpha Q_2^\beta \exp( \sum g_i G_i ) \]
Variables affecting safety

- Entry path curvature (deflection)
- Entry width and approach width
- Inscribed circle diameter
- Central island diameter
- Proportion of motorcycles
- Angle with next arm
- Approach curvature
- (Visibility)
<table>
<thead>
<tr>
<th></th>
<th>Small</th>
<th>‘Conventional’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single vehicle</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td>Approaching</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>Entering-circulating</td>
<td>71</td>
<td>20</td>
</tr>
<tr>
<td>Other vehicle</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Roundabout with single vehicle accident problem

- Approach is downhill
- Problem with vehicles over shooting
- Danger of vehicle reaching motorway below

North Lincolnshire roundabout
Roundabout with single vehicle accident problem

- Circulatory carriageway cannot be seen
- Chevrons appear to be on splitter island
- People mark possible delineation effect of reflective marker posts
<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>% of accidents</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal cycles</td>
<td>8.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>14.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Large goods vehicles</td>
<td>9.3</td>
<td>8.0</td>
</tr>
<tr>
<td>Cars</td>
<td>76.7</td>
<td>7.1</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>2.8</td>
<td>22.6</td>
</tr>
</tbody>
</table>
Pedal cyclists at roundabouts

- Relative involvement rate high
- Move against new roundabouts?
- Experienced v novice cyclists
- Cycles mix with other vehicles
  Low flow, compact design
- Cycle facilities
  Underpass
  Cycle lane on roundabout
  Cycle path with crossings
Roundabout in Calais with outer cycle path

- Novice / cautious cyclist on outer cycle path
- Experienced cyclist mixes with traffic rides in centre of lane
Cycle lane on circulatory carriageway
UK roundabout in York with cycle lane
Eye-level view of UK roundabout in York with cycle lane
Pedestrians at roundabouts

- Small proportion of accidents (but high severity)
- Pedestrian facility
  - Splitter island
  - Uncontrolled crossing (zebra)
  - Signal controlled crossing
  - Subway / overbridge
- Optimum location of crossing from roundabout
  - Zebra crossing at 5 to 20m
  - Signal controlled crossing at 20m or >60m
- Flaring and geometric delay
Pedestrian crossings at roundabouts

Brent / Harrow

Basingstoke
Overturning of large goods vehicles

- Long straight high speed approach
- Inadequate entry deflection
- Low circulating flow past an entry
- Excessive visibility to the right
- Significant tightening of turn radius partway round the roundabout
- Crown lines
Possible changes to UK Standard

- New design hierarchy
- New compact design with single lane entry
- Greater emphasis on provision for non-motorised
- Allow outward-sloping crossfall at urban roundabouts on single-carriageway roads
- At dual-carriageway roundabouts limit visibility to right until vehicles within 15m of give way line
Signalised roundabout with through traffic on main road across central island
Hot cross bun (‘double-through-about’)
End of Presentation

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