Synthesis title:

Rural Roads

Category: Roads

Other Relevant Topics:

- Speed (Roads)
- Speed Limits
- Signing and Marking (Roads)
- Street Lighting (Roads)
- Surfaces (Roads)
- Safety Cameras (Drivers)

Keywords:

Accident rate, Enforcement, Forgiving roads, Lighting, Overtaking, Response time, Rural severity, Speed, Verge

About the Road Safety Observatory

The Road Safety Observatory aims to provide free and easy access to independent road safety research and information for anyone working in road safety and for members of the public. It provides summaries and reviews of research on a wide range of road safety issues, along with links to original road safety research reports.

The Road Safety Observatory was created as consultations with relevant parties uncovered a strong demand for easier access to road safety research and information in a format that can be understood by both the public and professionals. This is important for identifying the casualty reduction benefits of different interventions, covering engineering programmes on infrastructure and vehicles, educational material, enforcement and the development of new policy measures.

The Road Safety Observatory was designed and developed by an Independent Programme Board consisting of key road safety organisations, including:

- Department for Transport
- The Royal Society for the Prevention of Accidents (RoSPA)
- Road Safety GB
- Parliamentary Advisory Council for Transport Safety (PACTS)
- RoadSafe
- RAC Foundation

By bringing together many of the key road safety governmental and non-governmental organisations, the Observatory hopes to provide one coherent view of key road safety evidence.

The Observatory originally existed as a standalone website, but is now an information hub on the RoSPA website which we hope makes it easy for anyone to access comprehensive reviews of road safety topics.

All of the research reviews produced for the original Road Safety Observatory were submitted to an Evidence Review Panel (which was independent of the programme Board), which reviewed and approved all the research material before it was published to ensure that the Key Facts, Summaries and Research Findings truly reflected the messages in underlying research, including where there may have been contradictions. The Panel also ensured that the papers were free from bias and independent of Government policies or the policies of the individual organisations on the Programme Board.

The Programme Board is not liable for the content of these reviews. The reviews are intended to be free from bias and independent of Government policies and the policies of the individual organisations on the Programme Board. Therefore, they may not always represent the views of all the individual organisations that comprise the Programme Board.

Please be aware that the Road Safety Observatory is not currently being updated; the research and information you will read throughout this paper has not been updated since 2017. If you have any enquiries about the Road Safety Observatory or road safety in general, please contact **help@rospa.com** or call **0121 248 2000**.

How do I use this paper?

This paper consists of an extensive evidence review of key research and information around a key road safety topic. The paper is split into sections to make it easy to find the level of detail you require. The sections are as follows:

Key Facts	A small number of bullet points providing the key facts about the topic, extracted from the findings of the full research review.
Summary	A short discussion of the key aspects of the topic to be aware of, research findings from the review, and how any pertinent issues can be tackled.
Methodology	A description of how the review was put together, including the dates during which the research was compiled, the search terms used to find relevant research papers, and the selection criteria used.
Key Statistics	A range of the most important figures surrounding the topic.
Research Findings	A large number of summaries of key research findings, split into relevant subtopics.
References	A list of all the research reports on which the review has been based. It includes the title, author(s), date, methodology, objectives and key findings of each report, plus a hyperlink to the report itself on its external website.

The programme board would like to extend its warm thanks and appreciation to the many people who contributed to the development of the project, including the individuals and organisations who participated in the initial consultations in 2010.

Key facts

- Rural roads in the UK are defined as major and minor roads outside urban areas that have a population of less than 10,000 (RRCGB, DfT, 2016).
- Most accidents in the UK occur within urban areas; however, a greater number of *fatal* accidents occur in rural areas. (RRCGB, DfT, 2016)
- While accidents on rural roads accounted for 34% of all traffic accidents in 2015, they accounted for 64% of user fatalities (RRCGB, DfT, 2016).
- In the EU, in 2015 over 60% of the road users losing their lives in Single Vehicle Collisions (nearly 7,300) occurred on rural roads. Young drivers and riders are at a greater risk of becoming involved in fatal single vehicle collisions than any other road user age group. This risk is twice as high for the 18-24 age group compared to the 25-49 age group (ETSC, 2017).
- The proportion of accidents and fatalities occurring on rural roads was fairly consistent for different vehicle types in 2015 (e.g. 31% of all motorcycling accidents and 66% of fatal motorcycling accidents occurred on rural roads; 40% of all car accidents and 68% of fatal car accidents occurred on rural road; 40% of accidents involving vans and LGVs and 65% of all fatal accidents involving this vehicle type occurred on rural roads). (RRCGB, DfT, 2016).
- In Lincolnshire, reductions from the National Speed Limit to 50mph on certain high-risk routes resulted in a 76% reduction in KSI collisions and an overall 35% reduction in collisions (DfT, 2010).
- In April 2015, new national speed limits came into force for heavy goods vehicles (HGVs) over 7.5 tonnes on single carriageway and dual carriageway roads in England and Wales. The new limits are:
    - 50 mph (up from 40 mph) on single carriageway roads
    - 60 mph (up from 50 mph) on dual carriageway roads

  In the period following the introduction of the new speed limits there is preliminary evidence of a reduction in HGV collisions estimated to be between 10% and 36%, however, it is not possible to attribute this directly to the speed limit changes (Department for Transport, UK, 2016).
- The removal of vegetation in verges can increase sightlines and be associated with an increase in both vehicle speeds and collisions (DfT, 2010).
- Incomplete removal of road works markings, no guide signs or incorrect positions for guide signs of road works increase crash probability by over 200% (Lopez, de Ona, Garach & Baena, 2016).
- Rear facing average speed cameras and/or the use of Variable Message Signs (VMS) can be associated with significant reductions in contraventions of the speed limit (DfT, 2010).

- Crash frequency and severity increases when the verge lateral clearance width (hard shoulder or clear verge width) decreases (Peng, Geedipally & Lord, 2012).
- The oldest and youngest drivers, and drivers from rural areas, are at particularly high risk on rural roads (Thompson, Baldock, Mathias & Wundersitz, 2010; Fosdick, 2012).
- Drivers perceive rural roads as less risky than urban roads, even when similar scenarios occur in both environments (Cox, Beanland & Filtness, 2016).
- Although slow moving vehicles are rare, accidents involving them tend to be high in severity (Hawkins, Kinzenbau & Hallmark, 2009).
- Safety knowledge is not always associated with safe riding behaviour; unsafe riding behaviour is strongly associated with having been in a crash (Jennisen, Hartland, Wetjen, Hoogerwerf, O'Donnel & Denning, 2017).
- Many rural accidents involve overtaking. Where there is demand for overtaking, overtaking lanes can facilitate safer overtaking and yield significant safety improvements. A small minority of drivers continue to overtake when prohibitions are introduced (Hegeman, 2004; Tuovinen & Enberg, 2003; Weber & Jahrig, 2010).
- A large proportion of overtaking accidents occur in areas with insufficient overtaking sights and where no configurations of traffic regulation have been taken to counter overtaking manoeuvres. The assumption that drivers can detect insufficient overtaking sights independently and therefore do not begin to overtake, is wholly inadequate, because the complex weighting process of existing overtaking possibilities contains errors. Miscalculations of overtaking sights as well as speed of and distance to oncoming vehicles are the main problem areas. Missing configurations of traffic regulation can negatively warp the drivers' perception. Instead, drivers must be supported in road sections with insufficient overtaking sights through operational measures in their task of driving (Richter, Ruhl, Ortlepp & Bakaba, 2017).
- Having a paved shoulder on an uphill segment of a rural road appears to provide significant benefits, including reducing the likelihood of a centreline crossing by nearly 80%, and from encroaching into oncoming traffic by over 50% (Chapman, 2017).

- The presence of a cyclist as an influence on a driver's behaviour depended on geometric elements; On tangents, the lowest lateral clearances were recorded and no speed reduction was observed, compared to a scenario with no cyclists; On the left curve, the higher lateral clearance was recorded, due to the concordant tendencies of the driver to move away from the cyclist and to cut the curve. This determined an excessive and risky displacement of the vehicle to the opposing lane, whose criticality was also emphasized by the high speed adopted by the driver; On the right curve, the lateral clearance was higher than that recorded on the tangents, probably due to the necessity of the driver to perform the demanding manoeuvre of entering the right curve, which also determined a speed reduction compared to the cyclist absence condition (Bella & Silvestri, 2017).
- The proximity of a hospital and the emergency service response time can be a critical factor determining the severity of the outcome and the survivability of an accident, which has obvious relevance to rural roads given their greater likelihood of being in remote locations (National Safety Council, 2008; Prato, Rasmussen & Kaplan, 2014).
- The development and implementation of eCall technology in vehicles could significantly reduce the fatality rates on rural roads (European Transport Safety Council, 2013).

Summary

- Rural roads in the UK are defined as major and minor roads outside urban areas, in an area that has a population of less than 10,000 (RRCGB, DfT, 2016).
- Analyses of accidents have been undertaken using different definitions of rural roads in the UK and the results compared. While accident numbers differ between the road classification methods, the trends remain similar.
- Crashes on rural roads are a major road safety problem, accounting for up to two-thirds of deaths and serious injuries worldwide. Rural intersections are often particularly hazardous, with over 30 per cent of rural crashes occurring at intersections (Corben, Oxley, Koppel & Johnston, 2005).
- Although safer infrastructure and appropriate speed limits have helped reduce deaths on rural roads in the EU, in 2015 over 60% of fatalities in Single Vehicle Collisions occurred on rural roads. Young drivers and riders are at a greater risk of becoming involved in fatal single vehicle collisions than any other road user age group. This risk is twice as high for the 18-24 age group compared to the 25-49 age group (ETSC, 2017).
- In September 2014-October 2015 rural roads saw the highest increase in road traffic volume, with a 5.8% increase on minor rural roads (provisional data; DfT, 2015c).
- In 2015, 63% of all fatal accidents occurred on rural roads (RRCGB, DfT, 2016.
- The proportion of accidents and fatalities occurring on rural roads was fairly consistent for different vehicle types in 2015 (e.g. 31% of all motorcycling accidents and 66% of fatal motorcycling accident occurred on rural roads; 35% of all car accidents and 68% of fatal car accidents occurred on rural road; 40% of accidents involving vans and LGVs and 65% of all fatal accidents involving this vehicle type occurred on rural roads) (RRCGB, DfT, 2016).
- In Lincolnshire, reductions from the National Speed Limit to 50mph on certain high-risk rural routes resulted in a 76% reduction in KSI collisions and an overall 35% reduction in collisions (DfT, 2010).
- In April 2015, new national speed limits came into force for heavy goods vehicles (HGVs) over 7.5 tonnes on single carriageway and dual carriageway roads in England and Wales. The new limits are:
    - 50 mph (up from 40 mph) on single carriageway roads
    - 60 mph (up from 50 mph) on dual carriageway roads

In the period following the introduction of the new speed limits there is preliminary evidence of a reduction in HGV collisions estimated to be between 10% and 36%, however, it is not possible to attribute this directly to the speed limit changes (Department for Transport, UK, 2016).

- Enhanced verge maintenance and removal of vegetation on rural roads in Lincolnshire and in Norfolk increased sightlines and was associated with an increase in both vehicle speeds and collisions (DfT, 2010).
- Incomplete removal of road works markings, no guide signs or incorrect positions for guide signs of road works increase crash probability by over 200% (Lopez, de Ona, Garach & Baena, 2016).
- There were reductions in recorded speeds on rural roads in Lincolnshire where VMSs were introduced at a number of locations (DfT, 2010).
- Rear facing average speed cameras in Norfolk were associated with significant reductions in contraventions of the speed limit (DfT, 2010).
- Most collisions at rural intersections in Australia occur in high-speed settings, at intersections that are uncontrolled or controlled by stop or give-way signs, and often on low-traffic-volume, single-carriageway roads (Corben et al., 2005).
- Cost-effective measures to improve safety on rural roads include:
    - Measures to reduce speed and therefore injury severity.
        - These measures include physical and perceptual speed reduction treatments.
    - Improvements to reduce the occurrence or severity of side impact crashes, including roundabouts, traffic signals, grade separation, channelisation, signing to clarify priority, removal of sight distance obstructions, and limited access from side roads/driveways.
    - Improvements to reduce the occurrence or severity of head on crashes, such as provision of medians or other measures to prevent overtaking in unsuitable locations, or provision for safe overtaking.
    - Improvements to reduce the occurrence or severity of run-off crashes, such as removal of road side obstacles, use of safety barriers, and skid resistant pavements at bends or specific hazards.

(Corben et al, 2005)

- Rumble strips in the centre of two-lane rural roads are a countermeasure to help drivers who are unintentionally about to leave the lane, for example, due to sleepiness or inattention. Installing centreline milled rumble strips on two-lane rural roads 8–10 metres wide is a measure to consider to increase safety. Research indicate a significant decrease in all types of severe injury crashes, a 20% (±13%) reduction in the number of fatalities and seriously injured people (all crash types) and a 27% (±18%) reduction in the number of fatalities and severely injured people in single-vehicle crashes, in a study on two-lane roads in Sweden (Vadeby & Anund, 2017).
- Having a paved shoulder on an uphill segment of a rural road appears to provide significant benefits, including reducing the likelihood of a centreline crossing by nearly 80%, and from encroaching into oncoming traffic by over 50% (Chapman, 2017).
- The presence of a cyclist as an influence on a driver's behaviour depended on geometric elements; On tangents, the lowest lateral clearances were recorded and no speed reduction was observed, compared to a scenario with no cyclists; On the left curve, the higher lateral clearance was recorded, due to the concordant tendencies of the driver to move away from the cyclist and to cut the curve. This determined an excessive and risky displacement of the vehicle to the opposing lane, whose criticality was also emphasized by the high speed adopted by the driver; On the right curve, the lateral clearance was higher than that recorded on the tangents, probably due to the necessity of the driver to perform the demanding manoeuvre of entering the right curve, which also determined a speed reduction compared to the cyclist absence condition. Whilst not specific to rural roads, these geometric elements are prevalent in rural areas. (Bella & Silvestri, 2017).
- Analyses shows that the UK urban accident rate (per billion vehicle km) is more than double that of rural roads. However, accidents on rural roads have a higher severity, as 2% of accidents on rural roads are fatal compared with 0.3% on urban roads. Similarly, 19.5% of accidents on rural roads led to serious injuries compared with 8.6% on urban roads (DfT, 2015b).
- Speeds on single carriageway rural roads are generally well within the national 60mph speed limit. Observations from 270 sites around England show a wide distribution of mean speeds on roads with speed limits of 60mph. The speed assessment framework operates on the principles that the speed limit choice should be guided by assessing actual accident rates relative to defined thresholds (DfT, 2006).
- The length of time for US emergency medical services to arrive at the scene is longer in rural areas than in urban areas (Burgess, 2005; National Safety Council, 2008).

Methodology

A detailed description of the methodology used to produce this review is provided in the Methodology section of the Observatory website at http://www.roadsafetyobservatory.com/Introduction/Methods.

This synthesis was compiled during November to December 2013, and was first updated in January 2016 and later in September 2017. Searches were carried out on the pre-defined sources identified in this link. Search terms used to identify relevant papers included:

rural roads, safety, behaviour, attitudes, risk perception, self-explaining, policy, crash, collision, accident, restraint system, verges, roadside features, weather, speeding, speed limits, lines, road markings, signs, passive safety, run off, single vehicle, bends, skid, lighting, trees, verge markers, intervention and enforcement.

Selection criteria

Research articles were scored on their relevance and quality. A rating of 'high', 'medium' and 'low' was given to each article under the following criteria:

For relevance

- 'High' refers to data on a parameter clearly relevant to the topic under investigation
- 'Medium' refers to data on a parameter that is probably relevant to the UK (e.g. interventions targeting drug driving with a similar prevalence to the UK)
- 'Low' does not refer to data relevant to the topic under investigation

For quality

- 'High'= from a high-quality peer-reviewed publication, with clear and appropriate methods
- 'Medium'= from an academic source (e.g. book chapter, conference) but without peer-review, and/or possessing some methodological weakness (e.g. some possible confounding factors)
- 'Low'= from a more 'general' source (e.g. conference, trade paper) and/or clearly being methodologically weak or inappropriate (e.g. failing to address random variability by use of appropriate statistical techniques)

Forty-six pieces of research, statistical reports or policy documents associated with rural roads have been included in this review. Seventeen additional pieces of research were added at the later update.

Key statistics

- Rural roads in the UK are defined as major and minor roads outside urban areas with a population of less than 10,000 (DfT, 2015a).
- Analyses of accidents have been undertaken using different definitions of rural roads in the UK and the results compared. While accident numbers differ between the road classification methods, the trends remain similar.
- In 2015, 63% of all fatal accidents occurred on rural roads (RRCGB, DfT, 2016.
- The proportion of accidents and fatalities occurring on rural roads was fairly consistent for different vehicle types in 2015 (e.g. 31% of all motorcycling accidents and 66% of fatal motorcycling accident occurred on rural roads; 35% of all car accidents and 68% of fatal car accidents occurred on rural road; 40% of accidents involving vans and LGVs and 65% of all fatal accidents involving this vehicle type occurred on rural roads) (RRCGB, DfT, 2016).
- In the EU, in 2015 over 60% of the nearly 7,300 road users losing their lives in Single Vehicle Collisions occurred on rural roads. Young drivers and riders are at a greater risk of becoming involved in fatal single vehicle collisions than any other road user age group. This risk is twice as high for the 18-24 age group compared to the 25-49 age group (ETSC, 2017).
- In 2014, 31% of all collisions involving a motorcyclist occurred on rural roads. However, 70% of fatal motorcycling collisions occurred on rural roads (DfT, 2015b).
- In the period September 2014-October 2015 all roads types in Great Britain saw an increase in traffic volume, but the greatest increase was seen on minor rural roads with a 5.8% increase in traffic flow. This led to 45.4 billion vehicle miles being travelled on minor rural roads. Vehicle miles on rural A roads rose to 90.7 billion vehicle miles, a 2% increase compared with September 2014 (provisional data; DfT, 2015c).
- In April 2015, new national speed limits came into force for heavy goods vehicles (HGVs) over 7.5 tonnes on single carriageway and dual carriageway roads in England and Wales. The new limits are:
    - 50 mph (up from 40 mph) on single carriageway roads
    - 60 mph (up from 50 mph) on dual carriageway roads

  In the period following the introduction of the new speed limits there is preliminary evidence of a reduction in HGV collisions estimated to be between 10% and 36%, however, it is not possible to attribute this directly to the speed limit changes (Department for Transport, UK, 2016).

- In 2013, car occupants represented the majority of KSI casualties on rural roads (53% of all casualties), with motorcyclist representing over a quarter of those killed or seriously injured on rural roads in Great Britain (DfT, 2014).
- Young drivers who live in rural areas in the UK are 37% more likely to be involved in an injury collision than their urban counterparts. Rural drivers who are over 30 years old are only 8% more likely to be involved in an injury collision than their urban counterparts so rural residency alone cannot account for young rural drivers' increased risk (Fosdick, 2012).
- Rural drivers in the UK have 31% higher mileage than their urban counterparts which probably accounts for a significant part of the increased risk to young rural drivers, though average annual mileage travelled appears to have little effect on adult collision risk (Fosdick, 2012).
- In 2011, 66% of road deaths in Britain occurred on rural roads; 51% of these road deaths occurred on rural single carriageway roads subject to the National Speed Limit of 60 mph (for cars) (DfT, 2010).
- In USA there are approximately 42% more fatal crashes in rural[1] areas than in urban areas; however there are fewer vehicle miles travelled in rural areas than urban areas. In addition, fatal rural crashes are more likely to involve multiple fatalities, rollovers, and HGVs. Fatal rural crashes more often occur on curved roadways and have greater vehicle damage. Head-on crashes are more prevalent in rural areas than in urban areas. Finally, the length of time for emergency medical services to arrive at the scene is longer in rural areas than in urban areas (Burgess, 2005).
- In Wisconsin, it was found that despite the frequent comment from bicyclists that drivers passed too closely, these actions were actually quite rare and accounted for only 0.5% of all the observed overtaking interactions on rural roads (6 out of 1,151) (Chapman & Noyce, 2012).

[1] Urban areas in the USA are defined as areas with a 'densely settled core of census tracks or blocks that meet minimum population density requirements, along with adjacent territory containing non-residential urban land uses, as well as a territory with low population density to link densely settled territory with densely settled core' (The area must encompass at least 2500 people, of which at least 1500 of which live outside institutional group quarters). Rural areas include all population, housing and land that does not meet the urban criteria (United States census bureau, 2010, http://www.census.gov/geo/reference/ua/urban-rural-2010.html),

- The presence of a cyclist as an influence on a driver's behaviour depended on geometric elements; On tangents, the lowest lateral clearances were recorded and no speed reduction was observed, compared to a scenario with no cyclists; On the left curve, the higher lateral clearance was recorded, due to the concordant tendencies of the driver to move away from the cyclist and to cut the curve. This determined an excessive and risky displacement of the vehicle to the opposing lane, whose criticality was also emphasized by the high speed adopted by the driver; On the right curve, the lateral clearance was higher than that recorded on the tangents, probably due to the necessity of the driver to perform the demanding manoeuvre of entering the right curve, which also determined a speed reduction compared to the cyclist absence condition (Bella & Silvestri, 2017).
- In the Netherlands, up to 10% of drivers perform overtaking manoeuvres on sections of rural road that do not have overtaking prohibitions. On sections with prohibitions on overtaking, 1% of drivers disobey this traffic rule (Hegeman, 2004).
- In Finland on three-lane roads, prohibited overtaking occurs in the single lane direction using the opposing passing lane. In one study a proportion of drivers continued to overtake when a prohibition was introduced. Specifically, between 4% and 17% of the vehicles who overtook when it was permissible to do so continued to overtake when it was prohibited (Tuovinen & Enberg, 2003).
- Having a paved shoulder on an uphill segment of a rural road appears to provide significant benefits, including reducing the likelihood of a centreline crossing by nearly 80%, and from encroaching into oncoming traffic by over 50% (Chapman, 2017).
- In Lincolnshire, speed limits on 13.4 miles of road were reduced from the National Speed Limit to 50mph; overall KSI collisions fell by 76% and all collisions fell by 35% (DfT, 2010).
- A programme of enhanced verge maintenance on sections of the B1188 and A15 in Lincolnshire saw an increase in both vehicle speeds and collisions. Following the removal of vegetation in order to remove roadside obstacles in Norfolk, vehicle speeds increased. This result was statistically significant. The proportion of vehicles travelling between 56 and 61mph tended to increase by around 8%, while the proportion travelling between 61 and 65mph increased by around 15-20%. It is possible that the removal of vegetation and resulting increased visibility has contributed to this (DfT, 2010).

- Raised profile lines in the centre of two-lane rural roads are a countermeasure to help drivers who are unintentionally about to leave the lane, for example, due to sleepiness or inattention. Installing centreline raised profile lines on two-lane rural roads 8–10 metres wide is a measure to consider to increase safety. Research indicates a significant decrease in all types of severe injury crashes, a 20% (±13%) reduction in the number of fatalities and seriously injured people (all crash types) and a 27% (±18%) reduction in the number of fatalities and severely injured people in single-vehicle crashes, in a study on two-lane roads in Sweden (Vadeby & Anund, 2017).
- There were reductions in recorded speeds in Lincolnshire where VMSs were introduced at a number of locations subject to 30, 40 and 50 mph limits. On average there was a 32% reduction in the percentage of the overall flow of vehicles travelling 10mph or above the posted speed limit when comparing speeds before the introduction of the signs with speeds recorded six months after installation (and 40% after 12 months) (DfT, 2010).
- Rear facing average speed cameras were installed on over seven miles of the A149 in Norfolk to reduce the excessive speeds practised by some motorcyclists, and other road users. The 85th percentile traffic speed fell by 7.2% from 57.9mph to 53.7mph and the number of vehicles travelling over 60mph fell from 6,614 to 697 (a fall of almost 90%). However, the traffic flow after the intervention was 8% lower than that before the intervention. Even when this was taken into account, the fall in the proportion of vehicles travelling over 60mph was 88% (DfT, 2010).

Research findings

Summaries of key findings are given below. Further details of the studies reviewed, including methodology and findings, and links to the reports are given in the References section.

Accident Causation / Risk Factors

- In 2006, 35% of motorcycle KSI collisions in Great Britain occurred on rural non-built up roads (DfT, 2010).
- A programme of enhanced verge maintenance on sections of the B1188 and A15 in Lincolnshire saw an increase in both vehicle speeds and collisions. The removal of vegetation in order to remove roadside obstacles in Norfolk had the effect of increasing vehicles speeds. This result was statistically significant. The proportion of vehicles travelling between 56 and 61mph tended to increase by around 8%, whilst the proportion travelling between 61 and 65mph increased by around 15-20%. It is possible that the removal of vegetation and resulting increased visibility has contributed to this (DfT, 2010).
- Rural young drivers in the UK are 37% more likely to be involved in an injury collision than their urban counterparts. Rural drivers who are over 30 years old are only 8% more likely to be involved in an injury collision than their urban counterparts so rural residency alone cannot account for young rural drivers' increased risk (Fosdick, 2012).
- Rural drivers in the UK have on average a 31% higher mileage than their urban counterparts which probably accounts for a significant part of the increased risk to young rural drivers, though average annual mileage travelled appears to have little effect on adult collision risk (Fosdick, 2012).
- Slow moving vehicles (SMVs) include vehicles that do not maintain a constant speed of 25mph, such as large farm equipment, construction vehicles, or horse-drawn buggies. Although the number of crashes involving SMVs is relatively small, they tend to be severe (Hawkins et al., 2009).
- In Scotland, the ten contributory factors reported most frequently for rural roads were loss of control; travelling too fast; failing to look properly; slippery road due to weather; carelessness, recklessness or being in a hurry; failure to judge other person's path or speed; poor turn or manoeuvre; impairment by alcohol; inexperience; and road layout (Crinson, Scoons & Broughton, 2008).
- In Great Britain, the four contributory factors reported most frequently for rural roads and urban roads were failing to look properly; failing to judge another person's path or speed; loss of control; and being careless, reckless or in a hurry. However, loss of control was reported more frequently on rural roads than on any other road type. (DfT, 2015b).).

- In Texas, shoulder width, lateral clearance and side slope condition had a significant effect on roadway departure crashes. Crash frequency and severity increased when lateral clearance or shoulder width decreased and when the side slope condition became worse. The reduced accident rate associated with a greater lateral clearance may be associated with increased ability to return to the carriageway and a lower reporting rate associated with lesser incident severity (Peng et al., 2012).
- Analysing the relationship between road crashes in two-lane rural highways and certain deficiencies in signalling, research found the following results:
    - Incomplete removal of road works markings produce the highest crash probability;
    - No guide sign or incorrect positions also give rise to high crash probability;
    - The crash probability increases over 200% when some of these deficiencies appear.

  Authors suggest that in view of these results, governmental agencies should verify that the original conditions of a highway are re-established after any construction work is completed. They should also continuously follow up on the signalling of this type of highway in order to maintain optimal conditions (Lopez, de Ona, Garach & Baena, 2016).
- In 2013, while only 19% of the population of the United States lived in rural areas, 53% of all fatal accidents in the US occurred on rural roads. Fatality rates per 100 million vehicle miles travelled were 2.6 times higher in rural areas than in urban areas (NHTSA, 2015).
- In 2013 in the USA, 30% of fatalities in rural areas were speeding-related. In addition, over half of the fatalities that occurred as a result of drink-driving occurred in rural areas. Young adults aged 21 to 24 were found to have the highest percentage of alcohol-impaired crashes, both on urban and rural roads. However, the rate of alcohol-impaired crashes in this age group was higher on rural roads than on urban roads (35% and 31% respectively). Despite these high levels, 2013 saw the number of drink-driving related accidents decrease by 29% from 2004 in rural areas (7661 fatalities in 2004 compared with 5473 in 2013), compared with a 15% decrease in urban areas (5415 fatalities in 2004 compared with 4590 fatalities in 2013) (NHTSA, 2015).
- A study of 635 surveys from Farm Progress Show attendees in 2012 in Iowa and in 2013 in Illinois, aiming to determine characteristics and outcomes of all terrain vehicle (ATV) use and to assess basic ATV-related safety knowledge found that:

- Over 90% of survey participants at a large agricultural fair had ridden on an ATV
- The vast majority reported having engaged in one or more unsafe riding behaviours
- Nearly 40% of those who had ridden on an ATV reported having been in a crash
- Unsafe riding behaviours were strongly associated with having been in a crash
- Safety knowledge was not always associated with safe riding behaviour

(Jennissen, Hartland, Wetjen, Hoogerwerf, O'Donnel & Denning, 2017)

- Crashes involving drivers resident in rural areas aged 75 and over in Australia were more likely to have resulted in a serious or fatal injury than crashes involving their urban counterparts. The results indicate that rural older drivers present a unique road safety problem (Thompson et al., 2010).
- A later study in Australia found that a number of environmental and driver factors had an impact on the level of severity of accidents involving rural drivers aged 75 and over. The results showed that the road layout (undivided roads), road surface (unsealed roads), horizontal (curved roads with open and obscured roads) and vertical alignment (slopes and on the crest of a hill) and speed (50, 80, 100 and 100km/h) had a significant impact on the level of severity of accidents involving older rural drivers. Older drivers were also found to be more likely to disobey give way signs and fail to give right of way, and were most likely to be hit by another car at a right angle, hit a fixed object and experience roll-over. These results provide further evidence that rural drivers present a unique road safety problem (Thompson et al., 2013).
- Exploring factors that are likely to influence perceptions of risk and safety regarding changing visual information in the driving environment, researchers found that hazard ratings were found to be higher in urban compared with rural driving environments, even when changes were matched between environments. The study demonstrates that drivers perceive rural roads as less risky than urban roads, even when similar scenarios occur in both environments (Cox, Beanland & Filtness, 2016).
- In Wisconsin, it was found that despite the frequent comment from bicyclists that drivers passed too closely to them on rural roads, these actions were actually quite rare and accounted for only 0.5% of all the observed overtaking interactions on rural roads (six of 1,151). Drivers were far more likely to give bicyclists more room than required and risked a centreline violation, even when conditions were not safe to do so (Chapman & Noyce, 2012).

- An Australian review of international research showed that a number of environmental factors can increase the risk of serious injuries in a collision. These include: the presence of roadside hazards (e.g. trees and poles), intersections (including their design, operational features, alignment and design speed) and road surface conditions (Oxley, Corben, Koppel, Fildes, Jacques, Symmons & Johnston, 2004).
- Examining factors associated with the rate of high beam use of isolated vehicles on a variety of roadways in Michigan area, researchers found that vehicles at rural sites and sites at the boundaries of Ann Arbor were more likely to use high beams than vehicles at urban sites. Maximizing visibility available to drivers from headlights includes addressing the substantial underuse of high beam headlamps. Advanced technologies such as high beam assist, which switches automatically between high and low beam headlamps depending on the presence of other traffic, can help to address this problem (Reagan, Brumbelow, Flannagan & Sullivan, 2016).
- The most strategically important measures to reduce rural crash and injury risk are: i) introduction of grade-separated intersections; ii) construction of roundabouts; iii) installation of crashworthy barrier systems; and, iv) introduction of speed reduction measures (Corben et al., 2005).
- When exploring the effects of geometric road features on driver speed behaviour in order to identify unsafe road segments, research found total segment length, lane width, curvature of the road element, the curvature change rate on homogeneous road segments, and the number of residential driveways per km as explanatory variables for the prediction models (Russo, Biancardo & Busiell, 2016).

Overtaking (including compliance with restrictions)

- In the Netherlands, up to 10% of drivers perform overtaking manoeuvres on sections of rural roads that do not have overtaking prohibitions. On sections with overtaking prohibition, about 1% of drivers disobey this traffic rule (Hegeman, 2004).
- In Finland, prohibited overtaking still occurs in the single lane direction using the opposing passing lane. However, the number of drivers overtaking and the overtaking rate in the single lane direction has decreased by 83-96% after the road markings were changed so as to prohibit overtaking. That is, between 4% and 17% of the number of vehicles which previously overtook when it was permissible overtook when it was prohibited. The safety implications of this are not investigated and it is possible that the accident rate will not reduce proportionately due to the risk-taking nature of the prohibited overtaking and the unexpectedness of this for oncoming traffic (Tuovinen & Enberg, 2003).

- A study in the USA found that geometric design elements accounted for 38% of the variability in driver behaviour when overtaking bicycles on rural roads. The geometric elements with the greatest impact on how drivers behaved on the roadway were: presence and width of paved shoulder, road grade, marked centreline and road speed design. The research found that the inclusion and/or widening of a paved shoulder could reduce the severity and frequency of accidents occurring as a result of cars overtaking bikes (Chapman & Noyce, 2014).

- Aiming to determine the infrastructural and traffic related variables which influence the occurrence and consequences of overtaking accidents as well as the overtaking behaviour of drivers on two-lane rural roads, research revealed that a large proportion of overtaking accidents occur in areas with insufficient overtaking sights and where no configurations of traffic regulation have been taken to counter overtaking manoeuvres. The assumption that drivers can detect insufficient overtaking sights independently and therefore do not begin to overtake is wholly inadequate, because the complex weighting process of existing overtaking possibilities contains errors. Miscalculations of overtaking sights as well as speed of and distance to oncoming vehicles are the main problem areas. Missing configurations of traffic regulation can negatively warp the drivers' perception.Instead, the drivers must be supported in road sections with insufficient overtaking sights through operational measures in their task of driving (Richter, Ruhl, Ortlepp & Bakaba, 2017).
- In Spain, analysis of compliance and adequacy of the 1.5 m lateral distance criterion for two-lane rural roads, with respect of objective and subjective risk measures, found:
    - Lateral clearance is not the only factor that influenced rider's risk perception, although current standards are only related to it;
    - A combined factor of lateral clearance, vehicle type and vehicle speed had a more significant correlation with the perceived risk;
    - Results showed that effect of heavy vehicles on bicyclists was also strong;
    - The combined factor of clearance and speed was higher on tangent sections where overtaking was permitted.

  (Llorca, Angel-Domenech, Agustin-Gomez & Garcia, 2017)

Rural Accident Rates

- In 2014 nearly 60% of fatal accidents occurred on rural roads. Rural roads were the location for 55% of pedal cyclist fatalities, 72% of car fatalities, 9% of bus and coach fatalities, 64% of van and LGV fatalities, 57% of HGV fatalities, 70% of motorcycling fatalities and 31.3% of pedestrian fatalities (DfT, 2015b).
- In 2013, 70% of pedal cyclist traffic occurred on urban roads, and urban roads accounted for 60% of causalities. While rural roads only accounted for 30% of pedal cyclist traffic it accounted for 58% of pedal cyclist fatalities, 28% of those seriously injured and 17% of those slightly injured. In other words while a majority of accidents occurred on urban roads (partly due to the increased opportunity for interaction with other road users) the accidents occurring on rural roads were more serious. In the European Union in 2012, 69% of all car occupant deaths occurred on rural roads (ETSC, 2014).
- Although safer infrastructure and appropriate speed limits have helped reduce deaths on rural roads in the EU, in 2015 over 60% of the nearly 7,300 road users losing their lives in Single Vehicle Collisions occurred on rural roads. Young drivers and riders are at a greater risk of becoming involved in fatal single vehicle collisions than any other road user age group. This risk is twice as high for the 18-24 age group compared to the 25-49 age group (ETSC, 2017).
- By 2012, GB had the lowest proportion of drivers (10%) exceeding the speed limit on rural roads throughout the European Union (ETSC, 2014).
- In 2011, 66% of road deaths occurred on rural roads in Britain; 51% of these road deaths occurred on single rural carriageway roads subject to the National Speed Limit of 60 mph (for cars) (DfT, 2013).
- The proportion of accidents and fatalities involving different vehicle types and occurring on rural roads was fairly constant across vehicle types in 2014 (e.g. 31% of all motorcycling accidents and 70% of fatal motorcycling accident occurred on rural roads; 31% of all car accidents and 72% of fatal car accidents occurred on rural road; 35% of accidents involving vans and LGVs and 64 of all fatal accidents involving this vehicle type occurred on rural roads) (DfT, 2015b).
- In USA there are approximately 42% more fatal crashes in rural areas than in urban areas; however there are fewer vehicle miles travelled in rural areas than in urban areas. In addition, fatal rural crashes are more likely to involve multiple fatalities, rollovers, and HGVs. Fatal rural crashes more often occur on curved roadways and have greater vehicle damage. Head-on crashes are more prevalent in rural areas than in urban areas. Finally, the length of time for emergency medical services to arrive at the scene is longer in rural areas than in urban areas (Burgess, 2005).

- Aiming to examine whether social capital's protective effects have equivalent force with respect to fatalities occurring on rural and urban roads in the US, research findings suggest that the relative prevalence of certain risk behaviours (e.g., speeding) skew rural environments toward crash situations where the critical safety factors are orthogonal to social capital influence. The estimation of simultaneous equation systems of complementary traffic incident types on a panel of US states reveals a significantly lower protective effect on rural roads (Nagler & Ward, 2016).

- A higher proportion of rural accidents in the USA involve drunk drivers than do those in urban areas (National Safety Council, 2008).
- In the USA, highways with very narrow hard shoulders (less than 1ft) showed an average increase in crashes of 16% when compared with highways with a 3ft shoulder width (Abdel-Rahim & Sonnen, 2012).
- Highway sections with a hard shoulder width of 8ft or more indicate an average reduction in crashes of approximately 13% when compared with highways with a 3ft shoulder width (Abdel-Rahim & Sonnen, 2012).
- Crashes on rural roads account for up to two-thirds of road deaths and serious injuries sustained in road crashes worldwide. Rural intersections, in particular, account for over 30% of these crashes (Corben et al., 2005).
- A study carried out in Alberta comparing accidents occurring between 2008 and 2012 at rural and urban intersections found that accidents at rural intersections were far more likely to lead to fatalities (2.1% of accidents compared with 0.2% on urban roads) and serious injuries (33.1% compared with 21.1%). This could partly be attributed to the increased response time for emergency services for accidents occurring on rural roads (Tay, 2015).
- The Alberta study also found that accidents reported to the police on rural intersections were more likely to occur at night (24% compared with 18% for urban intersections), involve 'run-off-road' accidents (23% rural, 6% urban), and occur on curved roads (11% rural, 6% urban). Special road facilities such as bridges and tunnels were also found to present a challenge on rural roads (a feature of 17% of accidents on rural roads compared with 3% on urban roads) (Tay, 2015).

Response Times

- In the USA, on average, crash victims arrive at a hospital 52 minutes after a rural crash has occurred (National Safety Council, 2008).
- In the USA in 2013, 64% of rural drivers died at the scene compared with 49% in urban areas, and 65% of drivers dying en route to hospital were rural drivers (NHTSA, 2015).
- A study carried out in Denmark investigating safety on low volume rural roads found that the distance from the nearest hospital is an important factor in the severity and survivability of an accident. This is similar in effect to the proximity of emergency services and the emergency response times (Prato et al., 2014).
- A recent report by the European Transport Safety Council highlighted the necessity for better response times. It reported that 50% of deaths from road traffic crashes occurred within minutes, either at the scene or while in transit to a hospital. For those taken to hospital around 15% of deaths occurred between one and four hours after the accident (ETSC, 2013).

Safety cameras and enforcement

- Rear facing average speed cameras were installed on over seven miles of the A149 in Norfolk to reduce excessive speeds. Between 2008 and 2010 the 85th percentile traffic speed fell by 7.2% from 57.9mph to 53.7mph and the number of vehicles travelling over 60mph fell from 6,614 to 697 (a fall of almost 90%). The traffic flow after the intervention was 8% lower than that before the intervention, but even when this was taken into account, the fall in the proportion of vehicles travelling over 60mph was 88% (DfT, 2010).
- One study on drivers' attitudes to speed cameras in rural England placed drivers into different categories depending on their approach to speed enforcement, and concluded:
    - Speeding has been shown to be perceived as widespread and normal; some respondents considered that safety cameras in themselves caused dangerous driving.
    - Conformers were the least likely to state that a prosecution had deterred them from further speeding behaviour.
    - The deterred drivers were most likely to express long-term intentions to continue to avoid further speeding.
    - Manipulators and defiers tended to report that they had deliberately chosen to infringe the speed limits.
    - Manipulators often acknowledged that their style of driving was dangerous.

(Blincoe, Jones, Sauerzapf & Haynes, 2006)

- Findings suggest that future campaigns should highlight the inconsistencies and dangers that can arise from an overconfident assessment of personal driving abilities, and publicise more convincingly the evidential link between camera activity and saving lives (Blincoe et al., 2006).

Speed Limits

- In Lincolnshire, speed limits on 13.4 miles of rural road were reduced from the National Speed Limit to 50mph; overall KSI collisions fell by 76% and all collisions fell by 35% (DfT, 2010).
- There were reductions in recorded speeds in Lincolnshire where VMSs were introduced at a number of rural locations subject to 30, 40 and 50 mph limits. On average there was a 32% reduction in the percentage of the overall flow of vehicles travelling 10mph or above the posted speed limit when comparing speeds before the introduction of the signs with speeds recorded six months after installation (40% after 12 months) (DfT, 2010).
- Speeds of vehicles on single carriageway rural roads are generally well within the national 60mph speed limit. Observations from 270 sites around England show a wide distribution of mean speeds on roads with speed limits of 60mph (DfT, 2006).
- In April 2015, new national speed limits came into force for heavy goods vehicles (HGVs) over 7.5 tonnes on single carriageway and dual carriageway roads in England and Wales. The new limits are:
    - 50 mph (up from 40 mph) on single carriageway roads
    - 60 mph (up from 50 mph) on dual carriageway roads

  In October 2015, the Department for Transport commissioned a 3-year evaluation of these speed limit changes. In the period following the introduction of the new speed limits there is preliminary evidence of a reduction in HGV collisions estimated to be between 10% and 36%, however, it is not possible to attribute this directly to the speed limit changes (Department for Transport, UK, 2016).
- When defining the speed limit on single carriageway rural roads it is important to take a number of factors into consideration in order to ensure that it is the most appropriate speed to promote road safety. These factors include: collision history, road function, existing mean traffic speed, use by vulnerable road users, road environment, including the level of road side development and the road's geometry and engineering (DfT, 2013).
- Rural dual carriageways with grade-segregated junctions and facilities for vulnerable road users would generally be suitable for 70mph limits. However, a lower limit may be appropriate if, for example, a collision history indicates that this cannot be achieved safely (DfT, 2013).

- It is government policy that a 30mph speed limit should be the norm in villages. It may also be appropriate to consider 20mph zones and limits in rural built-up village streets (DfT, 2013).
- It is recommended that the minimum length of a village speed limit should be 600 metres. However, traffic authorities may lower this to 400 metres, and in exceptional circumstances to 300 metres (DfT, 2013).

Effectiveness of Remedial Measures

- In Ireland it was found that, as the quality of rural roads improves, the overall accident rate falls. However the likelihood of a fatal accident increases, up to a certain threshold, before it begins to fall. This more accurate modelling of accident rates leads to a situation where road quality improvements can result in an increase in the seriousness and the economic cost of accidents, with major implications for cost-benefit analysis of rural road improvement schemes (Laird & Harris, 2010).
- A Danish synthesis evaluating bicycle paths found that the implementation of bicycle tracks[2] in rural areas were much more effective in reducing crashes and fatalities than those implemented in urban environments. When bicycle tracks were introduced along roads in rural areas a 62% reduction in crashes was observed, as well as an 80% decrease in fatalities. This could be due to the higher speed levels on rural roads, meaning that the physical segregation of cyclists and cars could lead to a significant reduction in the number of crashes and fatalities (OECD/International Transport Forum, 2013).
- Use of combinations of signs, markings, and physical measures can achieve speed reductions and consequent reductions in accident frequencies (DfT, 2007). A large scale evaluation of the use of vehicle activated signs (VAS) indicated that at speed limit roundel signs, mean speeds of the traffic as a whole were reduced by between 1mph and 14mph, the higher reductions being where the speed limit had also been reduced by 10mph. The average reduction in mean speed where there had been no change in the speed limit was 4mph. The junction and bend warning signs reduced mean speeds by up to 7mph, and the safety camera repeater signs yielded a reduction of up to 4mph (Winnett & Wheeler, 2002).

[2] Bicycle tracks: Reserved space specifically for cyclists along a road, this allows for physical separation from vehicles, parking lanes and pavements:

- US research in Pennsylvania aiming to quantify the safety performance of horizontal curves on two-way, two-lane rural roads relative to tangent segments indicates that both the presence of a horizontal curve and its degree of curvature must be considered when predicting the frequency of total crashes on horizontal curves. Both are associated with an increase in crash frequency. Mixed effects negative binomial regression models for total crash frequency on horizontal curves indicate that the distance to adjacent curves is not statistically significant. However, the degree of curvature of adjacent curves in close proximity (within 0.75 miles) was found to be statistically significant and negatively correlated with crash frequency on the subject curve. This is logical, as drivers exiting a sharp curve are likely to be driving slower and with more awareness as they approach the next horizontal curve (Gooch, Gayah & Donnell, 2016).
- Use of optical speed bars at five sites in the USA (known as transverse bar markings in the UK) showed significant reductions in mean speeds and speed variance at the downstream end of the optical speed bars at four of the five sites (Balde & Dissanayake, 2013).
- Raised profile lines in the centre of two-lane rural roads are a countermeasure to help drivers who are unintentionally about to leave the lane, for example, due to sleepiness or inattention. Installing centreline raised profile lines on two-lane rural roads 8–10 metres wide is a measure to consider to increase safety. Research indicates a significant decrease in all types of severe injury crashes, a 20% (±13%) reduction in the number of fatalities and seriously injured people (all crash types) and a 27% (±18%) reduction in the number of fatalities and severely injured people in single-vehicle crashes, in a study on two-lane roads in Sweden (Vadeby & Anund, 2017).
- Research aiming to evaluate lateral clearance distances between vehicles and bicycles during overtaking manoeuvres on rural roads in Dane County, Wisconsin, US found that:
    - Drivers were far more likely to cross a solid (or double) yellow centreline, regardless of oncoming traffic, when a paved shoulder was not present on uphill segments;
    - The reduction in centreline crossings due to the presence of a paved shoulder is significant;
    - Having a paved shoulder on an uphill segment of a rural road appears to provide significant benefits, including reducing the likelihood of a centreline crossing by nearly 80%, and from encroaching into oncoming traffic by over 50%;

  These safety benefits can also be achieved with minimal additional cost to a road project (Chapman, 2017).

- Aiming to analyse the effects that three cross-section configurations of a two-lane rural road and four geometric elements of the road have on driver behaviour, during the interaction with a cyclist, a driving-simulator based research found that:
    - The interferences of the cyclist on driver's behaviour depended on the geometric elements;
    - On tangents, the lowest lateral clearances were recorded and no speed reduction was observed, compared to the cyclist absence condition;
    - On the left curve, the higher lateral clearance was recorded, due to the concordant tendencies of the driver to move away from the cyclist and to cut the curve. This determined an excessive and risky displacement of the vehicle to the opposing lane, whose criticality was also emphasized by the high speed adopted by the driver;
    - On the right curve, the lateral clearance was higher than that recorded on the tangents, probably due to the necessity of the driver to perform the demanding manoeuvre of entering the right curve, which also determined a speed reduction compared to the cyclist absence condition;

  The obtained results provide suggestions for the most efficient cross-section reorganization of existing two-lane rural roads in order to improve the road safety (Bella & Silvestri, 2017).
- Australian research showed that travel speeds are reduced following a speed limit reduction, with clear safety benefits (26.7% reduction in casualty crashes) consistent with a power model (Bhatnagar, Saffron, de Roos & Graham, 2010).
- An increase in the number of speed cameras and red light cameras on rural roads in Australia was associated with a steady increase in speed compliance over 13 years. The baseline compliance rate was 60.6% and reached 70.3% in 2013. The percentage of drivers travelling more than 10km/h over the speed limit also reduced from 8.6% to 5% (Radalj & Sultana, 2014).
- In Holland, similar decreases in speeding were found at both enforced roads and at the nearby comparison roads that were not subjected to a targeted speed enforcement project. The best estimate for the safety effect of the enforcement project is a reduction of 21% in both the number of injury accidents and the number of serious casualties. The enforcement was unobtrusive rather than high-profile or overt. Reductions in speeds at the nearby control sites were attributed to 'spillover effects', although it could reflect a more general trend (Goldenbeld & van Schagen, 2005).

- German research found that speed enforcement had a very positive impact on accident frequency and severity. Three years after the implementation of the speed cameras accidents leading to serious injuries were on average reduced by 37.5%. Installation of passing lanes has been very successful, too. In a two-year period head on crashes were reduced to zero. At the locations with a pair of passing lanes the overtaking moved to the passing lane downstream of the no-overtaking zone. This improves traffic safety providing that the downstream passing lanes are long enough (Weber & Jahrig, 2010).
- Norwegian research found that experience from other countries has shown that rural 2-minus-1-roads (where the number of driving lanes is reduced from two to one and the shoulders are widened – effectively creating a single track road with hard shoulders on either side) do not lead to the expected speed reductions. It also found that overtaking vehicles pass closer to cyclists because cyclists cycle further away from the edge of the road than on roads without extended shoulders. There is also confusion among road users as to what rules apply on 2-minus-1-roads (Erke & Sorensen, 2008).

  Average speed enforcement has been found to reduce mean speed and the 85th percentile speed by a third. Research has found that KSIs reduce between 33% and 85% after the installation of average speed cameras. They are also perceived as being fairer by drivers, as they monitor behaviour over a longer period of time and not at a single moment in time which might be argued as being a poor reflection of overall driving behaviour. In turn this has meant that drivers have been more supportive of their introduction on rural roads (Soole, Watson & Fleiter, 2013).

Run-off crashes:

In Australia, the use of raised tactile edge lines has reduced lane departures (run-off accidents) by around 49% in New South Wales (Tziotis, Pyta, Mabbott & Mclean, 2010).

In Spain, a targeted programme of Sideway-force Coefficient Routine Investigation Machine (SCRIM) skid resistance measurement and friction enhancement was associated with significant accident reductions at intersection and curve run-off incidents (Pardillo-Mayora & Jurado-Pina, 2008).

- SCRIM analyses in Spain have shown that during resurfacing, the effect on intersection and run-off incidents of improving pavement friction from a mean SCRIM value below 50 to a value above 60 was an average reduction of wet pavement crash rates of 68% (Pardillo-Mayora & Jurado-Pina, 2008).

- The use of shoulder rumble strips was found to reduce the number of run-off crashes on rural roads in Idaho. After the installation of the rumble strips there was an overall reduction of 14% in run-off crashes. The rumble strips were most effective on roads with moderate horizontal curves, where a 29% reduction was found. They also led to a 22% reduction on roads with no horizontal curve, as well as an 8% reduction on roads with sharp horizontal curves. (Khan, Abdel-Rahim & Williams, 2015).

Intersection/junction crashes:

- The provision of lighting at rural intersections in Minnesota reduced the incidence of fatal accidents during the hours of darkness (Isebrands, Hallmark, Li, McDonald, Storm & Preston, 2010).
- Investigating lighting condition differences in the injury severity of crashes using 3-year (2009–2011) crash data of two-lane rural roads of the state of Washington, research highlights the importance of deploying street lights at and near intersections (or access points) on two-lane rural roads because injury severity highly increases when crashes occur at these points in dark conditions (Anarkooli & Hosseinlou, 2016).
- Wisconsin's Department of Transport have found that transverse bar markings installed on the approaches to rural intersections can cause drivers to reduce speed earlier and to a greater extent. This can significantly reduce the numbers of those types of accidents most susceptible to correction by transverse bar markings, including rear-end collisions and frontal impact crashes (Wisconsin DoT Transport Synthesis Report, 2007).

  In Australia, cost-effective measures at intersections include measures to reduce speed and speeding and the injury consequences. These include speed perception measures, roundabouts, traffic signals, grade separation, channelisation, signing to clarify priority, removal of sight distance obstructions, provision of medians, skid-resistant pavements and limited access from side roads and driveways (Corben et al., 2005).

Head-on crashes

- Head-on crashes are generally among the most severe of all vehicle crash types. This crash type occurs when one vehicle leaves its path and comes into the path of another oncoming vehicle. In some instances this type of crash results from a steering wheel overcorrection, e.g. a driver veers to the roadside, instinctively turns the steering wheel to return to the road and travels across the carriageway. Therefore, ways to treat this crash type include treatments in the centre of the road, but also at the side. The chance of over-steering will be increased if there is a drop off between the road and the roadside or shoulder (an 'edge drop'), making it more difficult to return to the roadway. Excessive drop offs should be avoided (iRAP, 2010).
- In rural areas central hatching can be used with longitudinal rumble strips or pavement markers to alert drivers when they are leaving their lane, achieving a 10-25% reduction in crashes (iRAP, 2010).
- Median barriers physically separate opposing traffic streams and help stop vehicles travelling into opposing traffic lanes. Research has shown that they can reduce head on collisions by up to 60% (iRAP, 2010). (iRAP, 2010).
- A study carried out in the USA investigated the effectiveness of centreline rumble strips in reducing lane departure crashes (either head-on crashes or accidents involving a vehicle crossing into the wrong lane) on undivided rural roads. The two locations, Mendon-Killington and Sheldon, both saw a decrease in the number of crashes. In Mendon-Killington there were 189 crashes in the nine years prior to the installation of the rumble strips, with head-on crashes accounting for 48% of these. In the five years after the installation there were 77 crashes, 47% of which were head-on crashes. While, the proportion of head-on-crashes remained fairly similar across both time conditions, the average head-on crash total decreased from 12.86 to 7.2 crashes per year, showing a 46% decrease in annual rates of head-on crashes and a 43% reduction in annual rates of overall crashes. In Sheldon, there were 65 crashes in the eight years prior to the installation of the rumble strips, 32% of which were head-on crashes. In the four years after the installation, there were 41 crashes, nine of which were head-on, showing a 10.3% decrease in head-on crashes. The average head on crash total per year decreased from 2.63 to 2.25, while the average overall crashes per year increased from 8.13 to 10.25 (Ellis, 2015).

Technology

- Recently the European Commission approved the development and implementation of eCall technology and infrastructure required for the handling of e-calls. The system will allow for emergency calls to be generated either manually or automatically from a crashed vehicle immediately after a collision has occurred. A study carried out to measure the effectiveness of this in-built technology found that it would lead to a 50% rescue time improvement in rural areas, representing a net gain of approximately ten minutes in rural areas. While this system is still in its very early stages, its development could have a significant impact on the number of collisions leading to fatalities or serious injuries on rural roads (ETSC, 2013).
- Zwickau University has developed a new multi-stage methodology for the complex design process of upgrading rural roads. Using virtual journeys (automatically defined driver profiles or simulation using driving simulators), expected driving behaviour can be assessed using characteristic feature graphs and the derived quantitative parameters. The results have clearly demonstrated that driving behaviour can be reliably assessed during the design process by means of virtual driving sessions. The new kind of methodology developed forms a solid foundation for developing a standard procedure for the design process for modification and upgrading work (Kuhn, 2017).

References

Title:	**Potential Safety Effects of Lane Width and Shoulder Width on Two-Lane Rural State Highways in Idaho**
Published:	Abdel-Rahim, A. & Sonnen, J. (2012) Idaho Transportation Department Research Program.
Link: **Free/priced:**	http://ntl.bts.gov/lib/46000/46300/46364/RP200Final.pdf Free
Objectives:	A comprehensive evaluation of the relationship between crash rates and shoulder width and lane width for two-lane rural state highways in Idaho.
Methodology:	The research was conducted in two stages. The first stage comprised a literature review and the development of methodology for data collection and analysis. In the second stage, data were collected and analysed to develop an understanding of the safety impacts of shoulder width and lane width.
Key Findings:	The results of the analysis showed that there is no significant difference between 12ft lanes and 11ft lanes in terms of safety for all types of crashes. Highways with very small shoulders (less than 1ft) showed an average increase in crashes of 16% when compared with highways with a 3ft shoulder width. Highway sections with a shoulder width of 8ft or more indicate an average reduction in crashes of approximately 13% when compared with highways with a 3ft shoulder width. Idaho's crash data also showed that roadway sections with a right paved shoulder width of 4ft to 6ft had the lowest number of pedestrian and bicycle crashes. The probability for a pedestrian/bicycle crash increases significantly for roadway sections with shoulder widths less than 3ft. The likelihood of a crash also increases for roadway sections with shoulder widths of 8ft or more.
Keywords:	Highway Safety Improvement Program, crash reduction factor, lane width, shoulder width.
Comments:	

Title:	**Effectiveness of Optical Speed Bars in Reducing Approach Speeds to Rural Communities**
Published:	Balde, A. D. & Dissanayake, S. (2013) Journal of Transportation Safety & Security 5(3): p 240-256.
Link: **Free/priced:**	http://dx.doi.org/10.1080/19439962.2012.756090 Priced £28 for article
Objectives:	To evaluate the effectiveness of optical speed bars (OSB) in reducing approach speeds on two-lane, rural undivided highways approaching small communities.
Methodology:	Speed data were collected and analysed before and after installation of the OSBs at five such sites. Effectiveness of the OSBs was evaluated using changes in mean and 85th percentile speeds under different categories by considering all vehicles, vehicle classification, days of the week, and time of day.
Key Findings:	Significant reductions in mean speeds and speed variance were observed at the end of the OSBs at four of the five sites, and one site showed no statistically significant change in speeds. Speed reductions were higher during daytime and weekdays. Higher speed reductions for two-axle vehicles were observed, with the exception of the Belvue test site. Speed increased in the opposite direction and at data collection points ahead of OSBs in the treatment direction, whereas there were reductions in speeds at the end of OSBs, indicating that OSBs seem to be effective in reducing approach speeds.
Keywords:	Optical speed bars, speed management, approach speed, speed drops, operating speed.
Comments:	

Title:	**Changes to speed limits and crash outcome: Great Western Highway case study**
Published:	Bhatnagar, Y., Saffron, D., de Roos, M., & Graham, A. (2010) 2010 Australasian Road Safety Research, Policing and Education Conference Canberra.
Link: **Free/priced:**	http://acrs.org.au/publications/conference-papers/database/ Free
Objectives:	To study the relationship between changes in the posted speed limits and crash history.
Methodology:	Case study of crash history for a section of the Great Western Highway in rural NSW, where the speed limit was reduced from 110km/h to 100km/h
Key Findings:	This study showed that travel speeds are reduced following a speed limit reduction, with clear safety benefits (26.7% reduction in casualty crashes) consistent with a power model.
Keywords:	Accident analysis, accident rates, countermeasures, rural areas, speed control, speed limits.
Comments:	

Title:	**Speeding Drivers' Attitudes and Perceptions of Speed Cameras in Rural England**
Published:	Blincoe, K.M., Jones, A.P., Sauerzapf, V. & Haynes, R. (2006) Accident Analysis & Prevention 38(2): p 371-378.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/B6V5S-4HMNG5G-2/2/7f2ca1bfcffb3b682610edbc589bd743 Priced
Objectives:	To understand why drivers exceed speed limits.
Methodology:	A questionnaire was sent to drivers of vehicles that were photographed exceeding the speed limit at one of the 45 speed camera locations operated by the Norfolk Casualty Reduction Partnership (of these camera sites, 31 were situated in a predominantly rural location whilst the remaining 14 were in a principally urban area). A total of 1500 questionnaires were sent to drivers during April 2003. Respondents were categorised into a four group driver typology comprising conformers (those who report they never exceed limits) deterred drivers (those put off speeding by the presence of cameras), manipulators (those who slow only at camera locations) and defiers (those who exceed limits regardless of cameras), and the consistency of opinions was compared between the groups.
Key Findings:	Speeding was perceived as widespread and normal. Some respondents considered that cameras in themselves caused dangerous driving. Conformers were the least likely to state that the prosecution had deterred them from further speeding behaviour. The deterred drivers were most likely to express intentions to avoid further speeding. Manipulators and defiers tended to report that they had deliberately chosen to infringe the speed limits. Manipulators often acknowledged that their style of driving was dangerous. Findings suggest that future campaigns should highlight the inconsistencies and dangers that can arise from an overconfident assessment of personal driving abilities, and publicise more convincingly the link between camera activity and saving lives.
Keywords:	Driver behaviour, speeding, perceptions, speed cameras, campaigns.

Title:	**Contrasting Rural and Urban Fatal Crashes 1994-2003**
Published:	Burgess, M. (2005) (No. HS-809 896).
Link: **Free/priced:**	http://www-nrd.nhtsa.dot.gov/Pubs/809896.pdf Free
Objectives:	To provide a reference tool for those who wish to examine rural and urban fatal crashes, rather than support a particular policy.
Methodology:	Data from the Fatal Accident Reporting System (FARS) were used to examine the similarities and differences between rural and urban fatal crashes.
Key Findings:	The study found that there are approximately 42% more fatal crashes in rural areas compared to urban areas; however there are fewer vehicle miles travelled in rural areas than urban areas. In addition, fatal rural crashes are more likely to involve multiple fatalities, rollovers, and more trucks. Fatal rural crashes more often occur on curved roadways and have greater vehicle damage. Head-on crashes are more prevalent in rural areas than in urban areas. Finally, the length of time for emergency medical services to arrive at the scene is longer in rural areas than in urban areas.
Keywords:	Fatalities, rural, urban, crash rate, road type, speed limit, EMS arrival, time of day, day of week, roadway profile, manner of collision, rollover, fire, trailing vehicle, alcohol involved drivers, license status, speeding, violations, manoeuvre, ejection, extrication, restraint use, severity, age.
Comments:	

Title:	**Observations of Driver Behavior During Overtaking of Bicycles on Rural Roads**
Published:	Chapman, J.R. & Noyce, D.A. (2012) Transportation Research Record: Journal of the Transportation Research Board (2321): p 38–45.
Link: **Free/priced:**	https://trb.metapress.com/content/a2010217380kx457/resource-secured/?target=fulltext.pdf £25
Objectives:	To investigate the interaction of cyclists and drivers on rural roads.
Methodology:	The study collected real-time interaction data between bicycles and motorized vehicles on rural roads, with Dane County, Wisconsin, as a field laboratory. Researchers collected video and sensor data for 1,151 interactions between bicycles and motorized vehicles. This paper provides initial observations drawn from these interactions.
Key Findings:	This study found that drivers operated in a technically unsafe manner by frequently performing passing manoeuvres outside designated areas. This study also found that despite the frequent comment from bicyclists that drivers passed too closely, these actions were actually quite rare and accounted for only 0.5% of all the observed interactions (six of 1,151). Drivers were far more likely to give bicyclists more room than required and risked a centreline violation, even when conditions were not safe to do so.
Keywords:	Cycle, bicycle, overtake, rural road.
Comments:	Although the highway context will vary between Wisconsin and other locations, it seems likely that the broad principles of cyclist and driver interaction on rural roads will be similar.

Title:	**Influence of roadway geometric elements on driver behavior when overtaking bicycles on rural roads**
Published:	Chapman, J.R. & Noyce, D.A. (2014) Transportation Research Record: Journal of the Transportation Research Board (2321): p 38–45.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S2095756415300866 Priced
Objectives:	To determine what influence geometric design elements of roadways have on driver behaviour when overtaking.
Methodology:	The study reported in this paper collected real-time interaction data between bicycles and motorised vehicles on rural roads, with Dane County, Wisconsin, as a field laboratory. Researchers used 1151 observations from a previous study and 40 different independent variables (all relating to geometric design, both directly and tangentially). The analysis was carried out using a multiple regression model.
Key Findings:	This study found that using only geometric roadway features as independent variables 38% of the variability in driver behaviour when overtaking a bicycle could be explained. Geometric elements were found to impact how drivers used rural roads when overtaking cyclists. The variables with the greatest impact on drivers' behaviour were the road grade, the presence and width of a shoulder, marked centreline and road design speed. The inclusion and widening of paved shoulders could help to reduce this type of collision.
Keywords:	Cycle, bicycle, overtake, rural road, geometric elements.

Title:	**Cost-effective measures to improve crash and injury risk at rural intersections**
Published:	Corben, B., Oxley, J., Koppel, S. & Johnston, I. (2005) ARSPE Conference Database.
Link: **Free/priced:**	http://acrs.org.au/publications/conference-papers/database/ Free
Objectives:	Paper presents a detailed review of the problems at rural intersections and makes recommendations for fundamental infrastructure improvements to the design and operation of rural intersections aimed to reduce crash and injury risk.
Methodology:	An overview of a systematic review of international literature, identifies 'best-practice' measures to reduce crash and injury risk at rural intersections and describes cutting-edge strategies and evaluation of infrastructure measures for managing safety at rural intersections.
Key Findings:	Crashes on rural roads are a major road safety problem, accounting for up to two-thirds of road deaths and serious injuries worldwide. Rural intersections, in particular, are dangerous locations, accounting for over 30% of these rural crashes. Rural intersections, in particular, are dangerous locations, accounting for over 30% of these rural crashes. Most collisions at intersections occur in high-speed settings, at intersections that are uncontrolled or controlled by stop or give-way signs, and often on low-volume, single-carriageway roads. Cost-effective measures include: measures to reduce speed and speeding and the injury consequences, speed perception measures, roundabouts, traffic signals, grade separation, channelisation, signing to clarify priority, removal of sight distance obstructions, provision of medians, skid-resistant pavements and limited access from side roads and driveways.
Keywords:	Accident countermeasure, controlled intersection, road geometry, road safety, rural are, speed, traffic signal, uncontrolled intersection.
Comments:	

Title:	**Rural road safety: drivers and driving - annex: factors contributing to rural road accidents in Scotland**
Published:	Crinson, L., Scoons, J. & Broughton, J. (2008) Transport Research Laboratory (TRL) Scottish Government Social Research.
Link: **Free/priced:**	http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&cad=rja&ved=0CDoQFjAA&url=http%3A%2F%2Fwww.scotland.gov.uk%2FPublications%2F2008%2F10%2F03140628&ei=z5fJUsjLJtL20gX28YCgDw&usg=AFQjCNEf8aKFrWyC0LiC7l21SkHiZoWWwA Free
Objectives:	This looks at factors contributing to rural accidents in Scotland.
Methodology:	It presents initial analyses of the Scottish STATS 19 data, including contributory factors. The contributory factor analyses look at all accidents, loss of control accidents, single car accidents, car-car accidents, pedestrian accidents, single motorcycle accidents, motorcycle-car accidents, and other accidents.
Key Findings:	The ten factors reported most frequently were loss of control, travelling too fast, failing to look properly, slippery road due to weather, carelessness recklessness or being in a hurry, failure to judge other person's path or speed, poor turn or manoeuvre, impairment by alcohol, inexperience; and road layout.
Keywords:	Accident rates; cause; rural road.

Title:	**Reported Road Casualties in Great Britain: notes, definitions, symbols and conventions**
Published:	Department for Transport (2015a).
Link: **Free/priced:**	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/463038/notes-and-definitions-2014.pdf Free
Objectives:	Definitions for the terms used in the STATS19 statistics used and published by the Department for Transport.
Methodology:	Notes and definitions relating to STATS statistics published by the DfT
Key Findings:	Rural roads in UK are defined as major and minor roads outside urban areas and having a population of less than 10,000.
Keywords:	Rural

Title:	**Reported Road Casualties Great Britain 2014**
Published:	Department for Transport (2015b).
Link: **Free/priced:**	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/463797/rrcgb-2014.pdf Free
Objectives:	The Reported Road Casualties in Great Britain (RRCGB) Annual Report: 2014 presents detailed statistics about the circumstances of personal injury accidents, including the types of vehicles involved, the resulting casualties and factors which may contribute to accidents.
Methodology:	National statistics
Key Findings:	• Deaths are disproportionately likely to occur on rural roads. • In 2014, they carried 53% of traffic, but accounted for around two thirds of road deaths. A similar split has been seen over the last decade. • Mile-for-mile, the risk of death on rural roads is around 1.7 times that on urban roads. • Around 2% of reported accidents on rural roads are fatal, compared with less than 1% in urban areas. • Accidents on rural roads are more likely to be fatal than accidents on urban roads because rural roads have a much higher average speed than urban roads. • Exceeding the speed limit was recorded as a contributory factor for 19% of fatal accidents on urban roads and 15% of fatal accidents on rural roads. In contrast, 14% of fatal accidents on rural roads were recorded with the contributory factor travelling too fast for the conditions, compared with only 7% of fatal accidents on urban roads. • Rural roads are often more sinuous and narrow in nature with blind blends, dips and other distractions which means that it is easier for road users to travel too fast to miss these dangers or fail to slow down when approaching them.
Keywords:	Rural.
Comments:	Detailed tables are included that give breakdowns of involvement of various vehicle types and road user groups involved in collisions on rural roads as well as breaking down casualties by built-up and non-built-up areas.

Title:	**Provisional road traffic estimates Great Britain: October 2014 - September 2015**
Published:	Department for Transport (2015c).
Link: **Free/priced:**	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/475125/provisional-road-traffic-estimates-great-britain-oct-2014-sep-2015-report.pdf Free
Objectives:	Presents provisional estimates for road traffic in Great Britain, across all road types and vehicle types
Methodology:	National statistics
Key Findings:	Traffic across the entire road network was the highest it has ever been. All road classes experienced higher volumes of traffic, but traffic on minor rural roads saw the highest increase with a 5.8% increase in traffic volume, reaching 45.4 billion vehicle miles . The traffic volume on rural A roads rose by 2% reaching 90.7 billion vehicle miles. On rural A roads, the amount of cars increased by 0.9%, the amount of light good vehicles increased by 7.6% and the amount of HGVs increased by 2.7%. Minor rural roads saw an 11% increase in LGVs.
Keywords:	Rural, traffic volume, road type, vehicle type
Comments:	The figures presented in this report are provisional, and are part of the quarterly publications produced by the Department for Transport. These remain provisional until the annual estimates will be published in the summer of 2016. However, they provide a good indication of the current road traffic statistics.

Title:	**Reported Road Casualties Great Britain 2013**
Published:	Department for Transport (2014).
Link: **Free/priced:**	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/359311/rrcgb-2013.pdf Free
Objectives:	To present detailed statistics about the circumstances of personal injury accidents, including the types of vehicles involved, the resulting casualties and factors which may contribute to accidents.
Methodology:	National statistics
Key Findings:	• Deaths are disproportionately likely to occur on rural roads. • In 2013, they carried 53% of traffic, but accounted for around two thirds of road deaths. A similar split has been seen over the last decade. • Mile-for-mile, the risk of death on rural roads is around 1.7 times that on urban roads. • Around 2% of reported accidents on rural roads are fatal, compared to less than 1% in urban areas. • On rural roads, car occupants are the majority of KSI casualties (53% in 2013) with motorcyclists a further quarter and pedal cyclists and pedestrians each accounting for around 10%.
Keywords:	Rural.
Comments:	Detailed tables are included that give breakdowns of involvement of various vehicle types and road user groups involved in collisions on rural roads as well as breaking down casualties by built-up and non-built-up areas.

Title:	**Setting Local Speed Limits – Circular 01/2013**
Published:	Department for Transport (2013).
Link: **Free/priced:**	https://www.gov.uk/government/publications/setting-local-speed-limits Free
Objectives:	The provision of up-to-date and consistent advice to traffic authorities. Improved clarity which will aid greater consistency of speed limits across the country. Enabling the setting of more appropriate local speed limits, including lower or higher limits where conditions dictate. Achieving local speed limits that better reflect the needs of all road users, not just motorised vehicles. Ensuring improved quality of life for local communities and a better balance between road safety, accessibility and environmental objectives, especially in rural communities. Improved recognition and understanding by road users of the risks involved on different types of road, the speed limits that apply, and the reasons why. Improved respect for speed limits, and in turn improved compliance. Continued reductions in the number of road traffic collisions, injuries and deaths in which excessive or inappropriate speed is a contributory factor.
Methodology:	Review of previous policy and research to provide background information to the application of a Speed Limit Assessment Tool. The tool is available at : https://www.gov.uk/government/publications/speed-limit-appraisal-tool
Key Findings:	The national speed limit on the rural road network is 60mph on single carriageway roads and 70mph on dual carriageways. Rural dual carriageways with segregated junctions and facilities for vulnerable road users would generally be suitable for 70mph limits. However, a lower limit may be appropriate if, for example, a collision history indicates that this cannot be achieved safely.

	In 2011, 66% of road deaths in Britain occurred on rural roads, and 51% of road deaths occurred on single rural carriageway roads subject to the National Speed Limit of 60mph. The speed limit on single carriageway rural roads should take into account the history of collisions, the road's function, existing mean traffic speed, use by vulnerable road users, the road's geometry and engineering, and the road environment including level of road-side development. It is government policy that a 30mph speed limit should be the norm in villages. It may also be appropriate to consider 20mph zones and limits in built-up village streets. It is recommended that the minimum length of a village speed limit should be 600 metres. However, traffic authorities may lower this to 400 metres, and in exceptional circumstances to 300 metres.
Keywords:	Speed limits, rural single carriageways, rural dual carriageways, village speed limits.
Comments:	

Title:	**LTN/1/07 Traffic Calming**
Published:	Department for Transport (2007).
Link: **Free/priced:**	http://assets.dft.gov.uk/publications/local-transport-notes/ltn-1-07.pdf Free
Objectives:	To bring together a summary of the research commissioned by the Department for Transport, together with research from external sources, to provide advice on the use of traffic calming measures today.
Methodology:	A review of traffic calming research commissioned by DfT so that a comprehensive summary of types of calming measures, their effectiveness, cost and environmental impact could be presented in one document.
Key Findings:	VISP summary showed across all villages (56 in total), all accidents and KSI accidents were reduced by about one quarter and one half respectively. The higher the speed reductions in the village – generally commensurate with the use of more extensive measures – the greater the reduction in accidents. The schemes included above used a combination of signs, markings and physical measures to achieve their speed reductions and consequent reductions in accident frequencies. An alternative approach is to consider how natural traffic calming features work to slow people down. The Department commissioned research to identify potential 'psychological' calming measures and test their effectiveness. These techniques were tested is in the village of Latton, Wiltshire. Mean speeds within the village have been reduced by 7–8mph, with 85th percentile reductions of 8–10mph
Keywords:	Village sped reduction; gateways; physical measures, psychological traffic calming.
Comments:	Comprehensive summary document. Pages 42- 46 summarise work on villages and rural areas up to and including 2007. Detailed measures are discussed later in the document.

Title:	**TAL 2/06 Speed assessment framework - balancing safety and mobility objectives on rural single carriageway roads**
Published:	Department for Transport (2006).
Link: **Free/priced:**	http://assets.dft.gov.uk/publications/tal2-06/tal2-06.pdf Free
Objectives:	Updated guidance on setting local speed limits to balance the need to travel and the need to improve quality of life.
Methodology:	Policy document.
Key Findings:	Speeds on single carriageway rural roads are generally well within the national 60mph speed limit. Observations from 270 sites around England show a wide distribution of mean speeds on roads with speed limits of 60mph. The speed assessment framework operates on the principles that the speed limit choice should be guided by whether the accident rate on a section of road is above or below the respective 35 or 60 injury accident per 100 million vehicle kilometre thresholds.
Keywords:	Policy, risk, rural area, safety, speed, speed limit.
Comments:	Superseded by SLAT and Circular 1/2013 although it retains and builds on many of the underlying principles.

Title:	**New Pan European Emergency Call system**
Published:	European Transport Safety Council (2013).
Link: **Free/priced:**	http://etsc.eu/wp-content/uploads/2014/03/eCall_ETSC_Position_30-September-2013.pdf Free
Objectives:	Present research into the development and implementation of eCall technology.
Methodology:	Review of eCall technology: how it works, it's benefits and guidance for future improvements
Key Findings:	ECall technology will allow for emergency calls to be generated either manually or automatically from a vehicle immediately after a road collision has occurred. The system will allow for basic data to be gathered (location of the vehicle) which will then be transmitted to an operator while maintaining a voice communication channel with the vehicle occupants. This technology is believed to be particularly useful in terms of reducing the response time for emergency services in remote rural areas. Research estimates that it could reduce rescue time by 50% in rural areas. The European Parliament and EU members have agreed that from 2017 all vehicles of categories M1 and N1 entering the European market should have an in-vehicle eCall system. A number of additional facilities will have to be developed in order to ensure the effectiveness of the eCall system such as the ability of the network operators to transmit messages in a certain format and the implementation of emergency call centres to receive the calls.
Keywords:	Road safety, eCall technology, response time, rural areas, policy
Comments:	

Title:	**Ranking EU progress on car occupant safety: PIN flash report 27**
Published:	European Transport Safety Council (2014).
Link: **Free/priced:**	http://etsc.eu/wp-content/uploads/pin_flash_27_v2.pdf Free
Objectives:	Compare and present the levels of road safety in terms of road deaths of car occupant in the 28 countries of the EU as well as Israel, Norway, Republic of Serbia and Switzerland.
Methodology:	Review of the current levels of car occupant safety across countries of the EU.
Key Findings:	In 2012 throughout the European Union approximately 69% of all car occupant deaths occurred on rural roads. Great Britain was found to have the lowest level of drivers travelling faster than the speed limit on rural roads (10%) – across the European Union between 10% and 60% of drivers were found to exceed the speed limit on urban roads. There is mixed progress in terms of speeding on rural roads: while in some countries average speeds have decreased, it has been found to increase in a number of countries. In Latvia, Estonia, Finland, Ireland, France, Sweden, Czech Republic, Denmark, Slovakia, Germany, Hungary, UK, Austria, Slovenia, Luxembourg and Spain a higher proportion of car occupant deaths occur on rural roads, than on all other roads (motorways and/or urban roads). In some countries this is due to the higher traffic volumes on rural roads, but in others it is due to the safety quality of roads being far below expected standards.
Keywords:	Car occupant deaths, car occupant safety, EU
Comments:	

Title:	**Evaluation of the effectiveness of centreline rumble strips on rural roads**
Published:	Ellis, W.M (2015) Report 2015-07, State of Vermont, Agency of Transportation.
Link: **Free/priced:**	http://vtransplanning.vermont.gov/sites/aot_policy/files/documents/planning/2015%20-%2007%20Evaluation%20of%20the%20Effectiveness%20of%20Centerline%20Rumble%20Stripes%20on%20Rural%20Roads_0.pdf Free
Objectives:	The study aimed to evaluate the effectiveness of centreline rumble strips in reducing lane departure crashes and improving safety on undivided rural roads.
Methodology:	Two sites in the USA (Mendon-Killington and Sheldon) were used to compare the effectiveness of rumble strips. The study compared the crash rate from the nine years prior to the installation of the rumble strips with the crash rates in the five years following their installation. The model account for potential explanatory factors that could have impacted the crash rates (e.g. weather, time of year).
Key Findings:	In both locations the centreline rumble strips were found to have a positive effect on crash reduction. In the nine years prior to the installation of the rumble strips there were 189 crashes at the Mendon-Killington location, 47.6% of which were head on collisions. After the installation, 77 crashes occurred in five years, 46.7% of which were head on collisions. The average number of head on crashes per year was reduced from 12.86 to 7.2, a 46% reduction. There was also a 43% reduction in overall annual crashes. At the Sheldon location there were 65 crashes prior to the installation of the rumble strips, 32.3% of which were head on collision. After the installation of the rumble strips, 41 crashes 9 of which were head on collisions reflecting at 10.3% reduction in head on crashes overall.
Keywords:	Rumble strips, centreline rumble strips, rural roads, head-on collisions
Comments:	

Title:	**Extended Road Shoulders on Rural Roads: A Measure for Cyclists and Pedestrians**
Published:	Erke, A. & Sorensen, M. (2008) Norwegian Institute of Transport Economics, p 90.
Link: **Free/priced:**	http://www.ntis.gov/search/product.aspx?ABBR=PB2009100937 £15
Objectives:	To investigate the use elsewhere of 2-minus-1-roads which aim to improve cycling and walking conditions along low traffic rural roads. They provide more space to vulnerable road users, the number of driving lanes is reduced from two to one and the shoulders are widened.
Methodology:	Research literature review.
Key Findings:	Experience from other countries has shown that 2-minus-1-roads do not lead to the expected speed reductions and that overtaking vehicles keep less distance to cyclists because cyclists cycle further away from the edge of the road than on roads without extended shoulder. There is also confusion among road users as to what rules apply on 2-minus-1-roads.
Keywords:	Bicycles, cycle lane, cyclists, driving patterns, extended shoulder road, foreign technology, motor vehicle drivers, pedestrians, road shoulder, rural areas, speed, traffic safety, walking.
Comments:	

Title:	**Young Drivers' Road Risk and Rurality**
Published:	Fosdick, T. (2012) Road Safety Analysis, p 24.
Link: **Free/priced:**	http://www.roadsafetyanalysis.org/wp-content/uploads/sites/17/2012/02/Young-Drivers-Road-Risk-and-Rurality.pdf
Objectives:	It was hypothesized that young drivers who live in rural areas are more at risk of collision involvement than their urban counterparts.
Methodology:	Postcode data from young drivers who had been involved in injury collisions in Great Britain from 2006 to 2010 were used to determine the number of drivers from each rural, urban and town small areas of the country. For the purposes of the analysis, young drivers were classified as 16 to 29 years old.
Key Findings:	Rural young drivers are 37% more likely to be involved in an injury collision than their urban counterparts. Rural drivers who are over 30 years old are only 8% more likely to be involved in an injury collision than their urban counterparts so rural residency alone cannot account for young rural drivers' increased risk. Of all the vehicle types, young rural car drivers are most at risk of being involved in an injury collision and are 40% more likely to be involved in a collision than their urban counterparts. Rural drivers have 31% higher mileage than their urban counterparts which probably accounts for a significant part of the increased risk to young rural drivers, though average annual mileage travelled appears to have little effect on adult collision risk.
Keywords:	Rural residency, accident rates, young drivers.
Comments:	

Title:	**The Effects of Speed Enforcement with Mobile Radar on Speed and Accidents: An Evaluation Study on Rural Roads in the Dutch Province Friesland**
Published:	Goldenbeld, C. & van Schagen, I. (2005) Accident Analysis & Prevention, Volume 37(6): p 1135-1144.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457505001089 $41.95
Objectives:	This was an evaluation study to determine the effects of targeted speed enforcement on speed and road accidents and the evaluated speed enforcement project was conducted in the Friesland province, located in the northern part of the Netherlands.
Methodology:	The evaluation study covered a five year period of intensified speed enforcement along 28 above-average dangerous road stretches of the rural network with mainly unobtrusive mobile radar equipment. The evaluation study covered a period of 5 years of enforcement.
Key Findings:	Researchers found similar decreases in speeding at both the enforced roads and at the nearby comparison roads that were not subjected to the targeted speed enforcement project. The best estimate for the safety effect of the enforcement project is a reduction of 21% in both the number of injury accidents and the number of serious casualties.
Keywords:	Speed, enforcement, camera.
Comments:	The enforcement was unobtrusive rather than high-profile or overt. Reductions in speeds at the nearby control sites were attributed to ‘spillover effects’, although it could reflect a more general trend.

Title:	**Improving Safety for Slow Moving Vehicles on Iowa's High-Speed Rural Roadways**
Published:	Hawkins, N. R., Kinzenbau, C. & Hallmark, S. (2009) Iowa Department of Transportation.
Link: **Free/priced:**	http://ntl.bts.gov/lib/31000/31100/31186/TR-572_Final.pdf Free
Objectives:	This report investigates the hazards associated with slow moving vehicles (SMVs). SMVs include vehicles that do not maintain a constant speed of 25mph, such as large farm equipment, construction vehicles, or horse-drawn buggies.
Methodology:	This report includes a literature review that shows various SMV statistics and laws across the United States, a crash study based on three years of Iowa SMV crash data, and recommendations from the SMV community.
Key Findings:	Though the number of crashes involving SMVs is relatively small, SMV crashes tend to be severe.
Keywords:	Tractor, abnormal load, slow moving, farm.
Comments:	Although the research considers the US context, the principles and issues will apply in many other situations.

Title:	**Road Safety Toolkit**
Published:	I-RAP (2010).
Link: **Free/priced:**	http:// toolkit.irap.org Free
Objectives:	Based on decades of road safety research it helps engineers, planners and policy makers develop safety plans for car occupants, motorcyclists, pedestrians, bicyclists, heavy vehicle occupants and public transport users.
Methodology:	The Road Safety Toolkit is the result of collaboration between the International Road Assessment Programme (iRAP), the Global Transport Knowledge Partnership (gTKP) and the World Bank Global Road Safety Facility. ARRB Group, Kate McMahon and John Fletcher (TRL) provided expert advice during the Toolkit's development. Austroads provided permission to use concepts and information from Austroads road safety engineering toolkit (www.engtoolkit.com.au) in this website. The Austroads toolkit fulfils a similar purpose to this website, although is aimed at Australian and New Zealand practitioners specifically.
Key Findings:	The toolkit provides a wide range of interventions and possible remedial treatments for all types of road conditions. In particular it identifies that: Research suggests that the use of median barriers can reduce head on collisions by up to 60% (iRAP, 2010). Even using central hatching and tactile markings can reduce head on collision by 10-25%
Keywords:	Road crashes, interventions.
Comments:	A wide ranging resource with international case studies of interventions that is too expansive to detail here and is worth closer examination for those interested in effective interventions.

Title:	**Overtaking Prohibition Safety Effects on Two Lane Rural Roads**
Published:	Hegeman, G. (2004) Cost-effective solutions for improving road safety in rural areas - integrating the four Es - education, enforcement, engineering and electronics - proceedings of the 17th ICTCT workshop, Tartu, Estonia, October 2004.
Link: **Free/priced:**	http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.103.8236&rep=rep1&type=pdf Free
Objectives:	This paper presents the results of a cost-effectiveness study concerning the effects of an overtaking prohibition on two lane rural roads in the Netherlands.
Methodology:	Overtaking frequency on road sections with and without overtaking prohibition is measured by means of camera observations. Overtaking frequencies were determined by comparing the order of vehicles at the start and end of a road segment without junctions. Overtaking actions were assessed by means of changes in the order of the vehicles.
Key Findings:	Up to 10% of drivers perform overtaking manoeuvres on normal road sections. On sections with prohibition, about 1% of drivers disobey this traffic rule.
Keywords:	Overtaking, prohibition, contravention.
Comments:	

Title:	**Roadway Lighting Shows Safety Benefits at Rural Intersections**
Published:	Isebrands, H.N., Hallmark, S.L., Li, W., McDonald, T., Storm, R. & Preston, H. (2010) Journal of Transportation Engineering, Volume 136 (111): p 949-955.
Link: **Free/priced:**	http://ascelibrary.org/doi/abs/10.1061/%28ASCE%29TE.1943-5436.0000161 Price depends on download option chosen.
Objectives:	The evaluation of the safety benefits of providing lighting at intersections in Minnesota.
Methodology:	Before and after analyses.
Key Findings:	Results indicated that the night crash rate was 37% lower after lighting was installed and was statistically significant.
Keywords:	Lighting, accident rates.
Comments:	The analyses quoted rely on data for fatal accidents rather than all injury accident data and the sample is therefore smaller and selective. The intersections that were lit may have been ones where most accidents occurred and where the potential reduction was greatest.

Title:	**Cycling, Health and Safety**
Published:	OECD/International Transport Forum (2013) OECD Publishing/ITF.
Link: **Free/priced:**	http://www.internationaltransportforum.org/2014/free-publications/07.pdf Free
Objectives:	Presents recent research findings and evidence from surveys conducted by the International Transport Forum and OECD countries relating to cycling safety.
Methodology:	International statistics
Key Findings:	Bicycle accidents tend to occur more in urban areas. In some countries the split is more even but this tends to be due to the fact that the populations of these countries perform more cycling for leisure, and the countries have better inter-urban cycling facilities. Crashes are less common on infrastructure specifically designed for cycling than on roads not marked with bicycle lanes. Bicycle paths seem to be more effective in reducing crashes and fatalities in rural areas than urban areas. The implementation of bicycle paths on rural roads led to a 62% reduction in crashes involving bicycles and an 80% reduction in fatalities on rural Danish roads.
Keywords:	Cycling, cycling safety, cycling infrastructure, cycle lanes, cycling fatalities
Comments:	

Title:	**Potential crash reduction benefits of shoulder rumble strips in two-lane rural highways**
Published:	Khan, M., Abdel-Rahim, A & Williams, C.J. (2015) Accident, Analysis & Prevention, 75, 35-42.
Link: **Free/priced:**	http://docs.trb.org/prp/14-1740.pdf Priced
Objectives:	Examine the effectiveness of shoulder rumble strips in reducing run-off road crashes on rural highways.
Methodology:	Empirical Bayes before and after analysis was used to measure the impact of installing shoulder rumble strips on highways in Idaho. The crash data were obtained from four different sources (vehicle crash report data from Idaho's Office of Highway Safety; the office of highway operation and safety; yearly vehicle exposure data from the automatic traffic recorders; and satellite images from Google Earth for roadway sections) and covered the period between 2001 and 2009. Rumble strips were installed on three highways between 2004 and 2007, providing 38 treatment sites (total length of 178.63 miles).
Key Findings:	The results showed a 14% reduction in all run-off-road crashes after the installation of the rumble strips. In addition, the total number of run-off-road crashes on test sites was 92, compared with 106.5 on control sites. The road geometry also had an impact, with rumble strips being most effective on roads with a moderate horizontal curve where there was a 29% reduction in run-off-road crashes (compared to 22% on roads with no horizontal curves and 8% on roads with sharp horizontal curves). The width of the right hand shoulder also had an impact, with the most significant reduction being found for right paved shoulders measuring 3 feet or more
Keywords:	Shoulder rumble strips, run-off-road crashes
Comments:	Empirical Bayes analysis allows for a before and after comparison, while accounting for the regression to the mean effect and external causal factors that change with time. It also considers trends at the treatment sites prior to the installation and the safety performance and crash trend at similar control sites.

Title:	**Accidents on Rural Roads – For Better or Worse**
Published:	Laird, J. & Harris, R. (2010) European transport Conference, 2010 Proceedings.
Link: **Free/priced:**	http://www.starconference.org.uk/star/2010/accidents.pdf Free
Objectives:	Existing appraisal methods support the engineers' natural conviction that a better-designed road is a safer road. However, this contrasts with anecdotal evidence that as road improvements lead to increases in speeds and traffic flow, the likelihood of a fatal accident increases. This paper examines the statistics to address the safety issue in detail – does improving these roads make them safer or not? Are the claimed safety benefits well-founded?
Methodology:	For this analysis, the 34 National Secondary routes in Ireland have been broken up into 850 sections, each on average around 3 to 4km long. Each section has been allocated a road quality score based on bendiness, carriageway width and gradient. Econometric analysis of accident rates and types by road quality is undertaken.
Key Findings:	As road quality improves, the overall accident rate falls. But the likelihood of a fatal accident increases, up to a certain threshold, before it begins to fall. This more accurate modelling of accident rates leads to a situation where road quality improvements can result in an increase in the seriousness and the economic cost of accidents, with major implications for cost-benefit analysis of rural road improvement schemes.
Keywords:	Rural, alignment, improvement.
Comments:	

Title:	**Traffic Safety Facts: Rural/Urban Comparison, 2013 Data**
Published:	NHTSA (2015).
Link: **Free/priced:**	http://www-nrd.nhtsa.dot.gov/Pubs/812181.pdf Free
Objectives:	Fact sheet presenting and comparing the characteristics of urban and rural collisions.
Methodology:	National statistics
Key Findings:	In the USA 53% of all traffic accidents occurred in rural areas, accounting for 54% of fatalities. However there was a 30% decrease in rural fatalities between 2004 and 2013. The fatality rate per million vehicle miles travelled was 2.6 times higher in rural areas. Speeding was responsible for 30% of crashes in rural areas. Of all alcohol impaired driving fatalities 54% occurred on rural roads, although there was a 29% decrease in drink driving fatalities between 2004 and 2013. Of the fatalities occurring on rural roads, 39% were in a collision involving a roll-over .
Keywords:	National statistics, rural roads, comparison, speeding, fatalities, seriously injured, drink-driving
Comments:	

Title:	**Rural Road Safety a National Problem**
Published:	National Safety Council (2008) Traffic Safety, Volume 08 (6): p1.
Link: **Free/priced:**	ISSN: 0041-0721 Free
Objectives:	This article offers a brief statistical look at the problems of road safety in rural areas.
Methodology:	Data analyses.
Key Findings:	The 2006 fatality rate for rural crashes in the USA is more than twice that of urban crashes. The time between a crash and arrival at a hospital averages 52 minutes. A higher proportion of rural accidents involve drunk drivers than in urban areas.
Keywords:	Rural, fatality rate, emergency response time, alcohol.
Comments:	The higher fatality rate in rural areas is broadly consistent with that found elsewhere. The extended response times associated with some rural accidents will have an important bearing on the severity and survivability of any injuries sustained.

Title:	**Cost-Effective Infrastructure Measures On Rural Roads**
Published:	Oxley, J., B. Corben, S. Koppel, B. Fildes, N. Jacques, M. Symmons & I. Johnston (2004) MONASH University Accident Research Centre Report No. 217.
Link: **Free/priced:**	http://www.monash.edu/muarc/research/reports/muarc217 Free
Objectives:	Undertake a literature review to assess the current state of knowledge in regard to road infrastructure and how it can be improved to reduce the frequency and severity of rural road crashes.
Methodology:	Provide a review of current international literature in regard to road infrastructure and how it can be improved to reduce the frequency and severity of rural road crashes. The findings were used to compile a set of recommendations for cost-effective infrastructure measures.
Key Findings:	The following features of rural roads were shown to increase the risk of serious injury: the presence of roadside hazards such as trees and poles; intersections and their design and operational features; alignment and design speeds; and road surface conditions. Measures to address multi-vehicle crashes include: i) treatments to reduce speeds and speeding; ii) geometric improvements to intersections including conversion to roundabouts, grade-separation, improved channelisation, sight distance, and medians; iii) geometric improvements to road lengths including use of crashworthy barrier systems or medians and delineation; iv) conversion of undivided roads to divided roads; v)geometric improvements to curves; and, vi) improved road and shoulder surfaces. The most strategically important measures to reduce crash and injury risk are: i) introduction of grade-separated intersections; ii) construction of roundabouts; iii) installation of crashworthy barrier systems; and, iv) introduction of speed reduction measures.
Keywords:	Infrastructure, road design, rural roads, transportation, crash risk, injury risk, countermeasures.
Comments:	

Title:	**Effects of Pavement Friction Improvement on Crash Rates on Spanish Two-Lane Rural Roads**
Published:	Pardillo-Mayora, J. M. & Jurado-Pina, R. (2008) Transportation Research Board Annual Meeting 2008 Paper No. 08-1187. Accident Analysis and prevention, Volume 41(4): p881-886.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457509001055 Priced
Objectives:	To assess the effects of resurfacing schemes on safety.
Methodology:	Data of Sideway-force Coefficient Routine Investigation Machine (SCRIM) skid resistance values from over 1,750 km of two-lane rural roads in the Spanish National Road System were used in the study.
Key Findings:	Significant differences were found in mean wet pavement crash rates between segments with an average SCRIM coefficient above and below a threshold value of 55 both for tangents and for curves with a curvature radius equal or less than 500m. A before-after evaluation of wet pavement crash rates with a comparison group showed significant reductions of wet pavement crash rates as a result of pavement friction improvement treatments for segments with a SCRIM value below 50. The average safety effect of improving pavement friction from a mean SCRIM value below 50 to a value above 60 resulted in an average reduction of wet pavement crash rates by 68%.
Keywords:	Accident rates, collisions, highway curves, highway safety, pavement performance, rural highways, skid resistance, two lane highways.
Comments:	

Title:	**Effect of Roadside Features on Single-Vehicle Roadway Departure Crashes on Rural Two-Lane Roads**
Published:	Peng, Y., Geedipally, S.R. & Lord D. (2012) Transportation Research Record: Journal of the Transportation Research Board, Issue 2309, p 21–29.
Link: **Free/priced:**	http://trb.metapress.com/content/e18273l71156624g/?genre=article&id=doi%3a10.3141%2f2309-03 $25
Objectives:	Little attention has been paid to the relationship between roadway departure crashes and relevant roadside features such as lateral clearance, side slope condition, and driveway density.
Methodology:	The study used field data collected in four districts in Texas.
Key Findings:	The results showed that shoulder width, lateral clearance, and side slope condition had a significant effect on roadway departure crashes. Crash frequency and severity increased when lateral clearance or shoulder width decreased and when the side slope condition became worse.
Keywords:	Clearance, forgiving roads, lateral, street furniture, run off.
Comments:	Greater severity is perhaps to be expected where there are objects within the verge. The reduced accident rate associated with a greater lateral clearance may be associated with increased ability to return to the carriageway and a lower reporting rate associated with lesser incident severity.

Title:	**Risk Factors Associated with Crash Severity on Low-Volume Rural Roads in Denmark**
Published:	Prato, C. G., Rasmussen, T. K. & Kaplan, S. (2014) Journal of Transportation Safety & Security 6(1): p 1-20.
Link: **Free/priced:**	http://www.tandfonline.com/doi/full/10.1080/19439962.2013.796027 £27
Objectives:	The investigation of safety of low volume rural roads.
Methodology:	This study analyses the risk factors associated with crash severity on low-volume rural roads, including crash characteristics, driver attributes and behaviour, vehicle type, road features, environmental conditions, distance from the nearest hospital, and zone rurality degree.
Key Findings:	Crash injury severity is significantly associated with (1) alcohol and failure to wear seatbelts, (2) involvement of vulnerable road users (i.e., pedestrians, cyclists and motorcyclists), (3) involvement of heavy vehicles, (4) speed limits of 80–90 km/h, (5) longer distance to the nearest hospital, and (6) peripheral rural regions.
Keywords:	Low flow, low volume.
Comments:	The distance from the nearest hospital is an important factor in the severity and survivability of an accident. This is similar in effect to the proximity of emergency services and the emergency response times.

Title:	**Trends in driver speed behaviours on rural road network, 2000-2013**
Published:	Radalj, T. & Sultana, S. (2014) Perth, Australia: Main Roads Western Australia.
Link: **Free/priced:**	http://www.ors.wa.gov.au/Documents/Speed/ors-speed-driver-behaviours-rural.aspx Free
Objectives:	In order to reduce speed related crashes, Australian police services commissioned an increase in the use of speed and red light cameras. The study aimed to measure the changes in driver speed behaviour across the road network over time.
Methodology:	The study used ten annual speed surveys, conducted in rural areas between 2000 and 2013. The year 2000 was used as a baseline In the nine surveys conducted between 2003-2013 attempts were made to survey all sites chosen from the random sample of 95 sites chosen for the baseline surveys. Seven day speed data was collected at each site. Each survey resulted in over 1 million vehicles travelling in a free flowing traffic environment.
Key Findings:	At baseline the levels of compliance with the speed limits was 60.6%. By 2013 this had reached 70.8%. In addition, the number of drivers travelling at more than 10km/h above the speed limit decreased from 8.6% in 2000 to 5% in 2013. The number of speeding drivers in 2013 was 42% less than in 2000.
Keywords:	Speed limit, rural roads, speeding, enforcement, compliance
Comments:	

Title:	**Effects of average speed enforcement on speed compliance and crashes: A review of the literature**
Published:	Soole, D.W., Watson, B.C. & Fleiter, J.J. (2013) Accident, analysis and prevention, 54, 46-56.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457513000432 Priced
Objectives:	Review of the evidence regarding the impact of average speed cameras in reducing vehicle speeds and its impact on crash rates and road safety.
Methodology:	Identified relevant studies through a systematic search of key road safety databases (Science Direct, TRID, ATI). The reference lists of all retrieved research were also used and cross referenced for relevant studies. In addition grey literature was included (retrieved from key road safety organisations, police and transport authorities, manufacturers).
Key Findings:	Average speed enforcement was found to have a positive influence on speed reduction and road safety in general. It was found to reduce mean speed and 85th percentile vehicle speeds by up to a third. They show an increased compliance with the speed limit as well as decrease in speed variability. Similarly they have been found to reduce the levels of KSI (between 33% and 85% reduction). In addition, they have been found to be more well received by drivers who consider them as fairer as they monitor behaviour over a longer period of time and not at a single moment in time which may poorly reflect overall driving behaviour. In addition, the use of average speed cameras has reduced the stop-start motion often found with fixed and mobile speed cameras reducing speed variability and in turn improving traffic flow.
Keywords:	Average speed enforcement, speed enforcement, speed cameras, literature review
Comments:	

Title:	**A random parameters probit model of urban and rural intersection crashes**
Published:	Tay, R. (2015) Accident, analysis and prevention, 84, 38-40.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457515300221 Priced
Objectives:	Aimed to compare the characteristics of urban and rural intersection crashes.
Methodology:	Used a random parameters probit model to analyse the intersection crashes that occurred in Alberta, Canada between 2008 and 2012.
Key Findings:	Results showed that accidents at rural intersections were more likely to result in fatalities (2.1% of accidents compared with 0.2% at urban intersections) and injuries (33.1% compared with 22.1% at urban intersections). They were also more likely to occur on roads with higher speed limits. Similarly, a number of road features had an impact on the accident rates in rural environments. In rural environments 10.5% of accidents occurred on curved roads compared with 6.1% in urban environments. Similarly, 16.7% of rural accidents occurred at special facilities (such as bridges and tunnels) compared with 3.3% of accidents on urban roads. In addition, run-off-road crashes were more frequent at rural intersections, representing 22.6% of accidents compared with 6.3% at urban intersections.
Keywords:	Intersections, intersection crashes, rural and urban intersections
Comments:	The reason for the increased injury and fatality rate could be attributed to the increased response time for emergency services to attend the scene of the crash. This increased response time is due to the lower traffic in rural areas which could increase the notification time as well as the increased distance to reach the crash locations.

Title:	**Older drivers in rural and urban areas: comparisons of crash, serious injury, and fatality rates**
Published:	Thompson, J. P., Baldock, Mathias, M. R., J.L. & Wundersitz, L.N. (2010) Australasian Road Safety Research Policing Education Conference, 2010.
Link: **Free/priced:**	http://acrs.org.au/publications/conference-papers/database/ Free
Objectives:	Previous analyses of crash statistics have indicated that older drivers (aged 65 years and older) have fewer crashes than other age groups. However, they may have an elevated crash risk on a per kilometre driven basis and are at an increased risk of death and serious injury from crashes. Rural older drivers may be particularly at risk due to a greater dependence on driving, which may create a reluctance to cease driving.
Methodology:	A database of police-reported road crashes in South Australia, the Traffic Accident Reporting System, was used to obtain crash, serious injury, and fatality data for 2004 to 2008. The crash involvement of drivers of various age groups from both rural and urban areas was adjusted for population and licensure exposure measures.
Key Findings:	Crashes involving rural drivers aged 75 and over were more likely to have resulted in a serious or fatal injury than crashes involving their urban counterparts. The results indicate that rural older drivers present a unique road safety problem.
Keywords:	Older driver, elderly driver.
Comments:	

Title:	**An examination of the environmental, driver and vehicle factors associated with the serious and fatal crashes of older rural drivers**
Published:	Thompson, J. P., Baldock, Mathias, M. R., J.L. & Wundersitz, L.N. (2013) Accident, Analysis and Prevention, 50, 768-775.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457512002527 Priced
Objectives:	Accidents involving drivers aged 75 and above are more than twice as likely to result in a serious or fatal injury. This study aimed to identify the environmental, vehicle and driver factors associated with older rural drivers' crashes, as well as whether these factors were associated with an increased likelihood of serious or fatal injuries in younger drivers, for whom frailty does not contribute.
Methodology:	A database of police-reported road crashes in South Australia, the Traffic Accident Reporting System, was used to obtain crash, serious injury, and fatality data for 2004 to 2008. Background information about the crash and the driver were obtained (age, residential postcode, severity of injury), as well as a number of environmental factors.
Key Findings:	When comparing serious and fatal crashes involving rural and urban drivers, results showed that there was no significant difference in the impact of lighting, road and weather conditions. A number of other factors were found to have a significant impact on accident rates, with significant differences between rural and urban drivers. Rural drivers were found to be more likely to have accidents on: • undivided roads • unsealed roads • curved roads with open and obscured views • the slope or crest of a hill • roads with a 50, 80, 100 or 110km/h speed limit They were also more likely to disobey a give way sign and fail to give way to the right, and to be hit by another vehicle at a right angle or a fixed object and experience roll over. In addition, when compared with younger drivers these factors were found to have a much higher rate of causing serious or fatal injuries to older drivers.
Keywords:	Older drivers ,rural drivers, urban drivers, environmental factors, driver factors.

Title:	**Road markings on passing lane sections on rural two-lane roads - impact of no-passing lines on driving behaviour**
Published:	Tuovinen, P. & Enberg, A. (2003) Finnish Road Administration. Tiehallinnon selvityksia, Finnra reports, Volume TIEH 3200837(50), 2003: p 67, p 18a.
Link: **Free/priced:**	http://trid.trb.org/view.aspx?id=745981 ISBN: 951- 803-142-8 ISSN: 1457-9871
Objectives:	In 2001 the Finnish Road Administration decided to prohibit overtaking using the passing lane in the direction with the single lane on rural two-lane roads. This study investigated speeds and overtaking in these centre lanes before and after the new marking arrangements.
Methodology:	In this before-and-after study changes in the traffic flow characteristics were studied at three different locations on main road 1 and main road 2 in Southern Finland. All the passing lanes were upgraded and the speed limit was 100km/h.
Key Findings:	Overtaking still occurs in the single lane direction using the opposing passing lane, although it is prohibited. However, the number of overtaking and the overtaking rate in the single lane direction have decreased by 83-96 % after the changing of the road markings.
Keywords:	Overtaking, centre lane, prohibited.
Comments:	Between 4% and 17% of the number of vehicles which previously overtook when it was permissible overtook when it was prohibited. The safety implications of this are not investigated and it is possible that the accident rate will not reduce proportionately due to the risk-taking nature of the prohibited overtaking and the unexpectedness of this for oncoming traffic.

Title:	**Road safety engineering risk assessment part 10: rural run-off-road crashes**
Published:	Tziotis, M., Pyta, V. Mabbott, N. & Mclean, J. (2010) Austroads, Issue AP-T155/10, p 80.
Link: **Free/priced:**	https://www.onlinepublications.austroads.com.au/items/AP-T155-10 Free with registration: ISBN: 9781921709210
Objectives:	The investigation of the effectiveness of measures designed to reduce the incidence and severity of rural run-off crashes.
Methodology:	Before and after analyses.
Key Findings:	In Australia, the use of raised tactile edge lines has reduced lane departures in the order of 49 per cent in New South Wales.
Keywords:	Run off, raised rib, rumble strip.
Comments:	Raised rib edge-line treatments will be more suitable in some rural locations than in others but can be particularly effective where the road alignment is not clear or where fatigue or inattention is an issue.

Title:	**"AOSI" Improving Road Safety on Rural Roads in Germany**
Published:	Weber, R. & Jahrig, T. (2010) 4th International Symposium on Highway Geometric Design, 2010, p 8.
Link: **Free/priced:**	http://www.4ishgd.valencia.upv.es/index_archivos/16.pdf Free
Objectives:	Although the majority of road accidents happen in urban areas, 60% of all fatalities occur on rural roads. For this reason the Federal Highway Research Institute (BASt) established a task force to improve road safety on existing rural roads in Germany using short-term and medium-term measures. The analysis of severe accidents on rural roads found two main contributing factors: inappropriate speed and unsafe overtaking manoeuvres. For this reason the project focussed on the enforcement of speed limits (short-term measure) and the safeguarding of overtaking manoeuvres by constructing additional passing lanes (medium-term measure).
Methodology:	The project group chose ten roads with a high number of severe accidents. Where inappropriate speeds were a main contributing factor for accidents, speed cameras were installed. On the other roads, where unsafe overtaking manoeuvres were a main contributing factor to accident occurrence, short passing lanes were built to make overtaking safer.
Key Findings:	Speed enforcement had a very positive impact on accident frequency and severity. Three years after the implementation of the speed cameras, accidents leading to serious injuries were on average reduced by 37.5%.To this day the installation of passing lanes has been very successful, too. In a 2 years period head on crashes were reduced to zero. At the locations with a pair of passing lanes the overtaking manoeuvres moved to the passing lane downstream of the no-overtaking zone. This improves traffic safety providing that the downstream passing lanes are long enough.
Keywords:	Overtaking, speeding, enforcement.
Comments:	The optimal frequency of the overtaking or passing lanes is not specified, although significant benefits are reported when the desire to overtake is safely provided for.

Title:	**Vehicle Actuated Signs – A large scale evaluation**
Published:	Winnett, M. & Wheeler, A.H. (2002) TRL, Report TRL548.
Link: **Free/priced:**	https://trl.co.uk/reports/TRL548 Free
Objectives:	To assess the effect of the signs on speed and injury accidents, and drivers 'understanding of the signs. This information to then be used to develop best practice for sign installation.
Methodology:	Monitoring of the signs at over 60 individual installations involved: Before and After collection of speed data - the After data collected typically one month and at least one year after sign installation (also after three years at early installations). Obtaining accident data (for locations that had been in operation for more than one year) for sections of road appropriate to the type of sign or hazard. Nearly 450 drivers took part in opinion surveys at three locations in Norfolk and one in Wiltshire.
Key Findings:	At the speed limit roundel signs, mean speeds of the traffic as a whole were reduced by between 1mph and 14mph, the higher reductions being where the speed limit had also been reduced by 10mph. The average reduction in mean speed where there had been no change in the speed limit was 4mph. The junction and bend warning signs reduced mean speeds by up to 7mph, and the safety camera repeater signs yielded a reduction of up to 4mph. There has been a statistically significant one-third reduction in accidents across all of the Norfolk sites combined when compared with the number of accidents that would have been expected without the signs.
Keywords:	Highway curves, intelligent transportation systems, intersections, prevention, rural areas, safety, speed, speed limits, traffic actuated controllers, traffic signs, warning systems.

Title:	**Gauging the safety effects of rumble strips at rural intersections**
Published:	Wisconsin DoT Transport Synthesis Report (2007).
Link: **Free/priced:**	http://wisdotresearch.wi.gov/wpcontent/.../tsrintersectionrumblestrips.pdf Free
Objectives:	The Wisconsin DOT Bureau of Highway Operations asked WisDOT Research & Library Unit to gather a sampling of research studies and other documentation that objectively examine the safety effects of rumble strips installed on the approaches to rural intersections.
Methodology:	Review of relevant research studies published by State DOTs and Academia and the Transportation Research Board.
Key Findings:	Overall, the results of these studies indicate that rumble strips installed on the approaches to rural intersections can cause drivers to reduce speed earlier and to a greater extent, and can significantly reduce the types of accidents most susceptible to correction by rumble strips, including rear-end collisions and frontal impact crashes. In simulator tests, rumble strips also slowed the approach speed of commercial drivers. In one study located, researchers concluded that rumble strips were not successful at reducing approach speeds for the data analysed, and some negative impacts (speed increases) were recorded following the installation of rumble strips. Potential pitfalls that have been associated with the installation of rumble strips in the travelled way include inappropriate motorist responses such as using the opposing lanes to drive around the strips, and loss of control by motorcyclists and bicyclists.
Keywords:	Accident countermeasure, intersection, literature review, road safety, rumble strip, rural road, traffic control devices, traffic management.
Comments:	

Title:	**Taking on the Rural Road Safety Challenge**
Published:	Department for Transport (2010).
Link: **Free/priced:**	http://webarchive.nationalarchives.gov.uk/20121107103953/http://www.dft.gov.uk/publications/taking-on-the-rural-road-safety-challenge/ Free
Objectives:	This work is also known as the Rural Road Safety Demonstration Project. It showcases work done by four county councils in response to an invitation to apply for specific funding support from the Department for Transport and to show the impacts of measures to improve rural road safety.
Methodology:	Review of rural road safety improvement projects undertaken in Devon, Lincolnshire, Norfolk and Northamptonshire.
Key Findings:	**Motorcycles** In 2006, 35% of motorcycle KSI collisions in Great Britain occurred on rural non-built up roads. Nationally, 54% of KSI collisions involved bikes in excess of 500cc. **Speed limits** In Lincolnshire, speed limits on 13.4 miles of road were reduced from the National Speed Limit to 50mph; overall KSI collisions fell from 5.0 to 1.2 (76%) and all collisions from 22.3 to 14.4 (35%). **Verges** A programme of enhanced verge maintenance on sections of the B1188 and A15 in Lincolnshire saw an increase in both vehicle speeds and collisions. The removal of vegetation in order to remove roadside obstacles in Norfolk had the effect of increasing vehicles speeds. This result was statistically significant. The proportion of vehicles travelling between 56 and 61mph tended to increase by around 8%, whilst the proportion travelling between 61 and 65mph increased by around 15-20%. It is likely that the removal of vegetation has increased visibility. **Variable Message Signs** There were reductions in recorded speeds in Lincolnshire where Variable Message Signs was introduced at a number of locations subject to 30, 40 and 50 mph limits. On average there was a 32% reduction in the percentage of the overall flow of vehicles travelling 10mph or above the posted speed limit when comparing speeds before the introduction of the signs with speeds recorded 6 months after installation and 40% after 12 months.

	Average speed cameras Rear facing cameras were installed on over 7 miles of the A149 in Norfolk to reduce the excessive speeds practised by some motorcyclists, and other road users. The 85th percentile traffic speed fell by 7.2% from 57.9mph to 53.7mph and the number of vehicles travelling over 60mph fell from 6,614 to 697; a fall of almost 90%. However, the traffic flow after the intervention was 8% lower than that before the intervention. Even when this was taken into account, the fall in the proportion of vehicles travelling over 60mph was 88%.
Keywords:	Motorcycle, speed limit, verge, variable message signs, average speed cameras.
Comments:	This report describes outcomes from combinations of measures and it is therefore often not clear which measures have resulted in which safety improvement. In many other cases, the outcomes are inconclusive. Nevertheless, some pertinent findings have been identified and included.

Title:	**Reported Road Casualties Great Britain: 2015 Annual Report**
Published:	Department for Transport (2016).
Link: **Free/priced:**	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568484/rrcgb-2015.pdf Free
Objectives:	To present detailed statistics about the circumstances of personal injury accidents, including the types of vehicles involved, the resulting casualties and factors which may contribute to accidents.
Methodology:	National statistics
Key Findings:	• Rural roads in the UK are defined as major and minor roads outside urban areas that have a population of less than 10,000; • Most accidents in the UK occur within urban areas; however, a greater number of fatal accidents occur in rural areas; • In 2015, 63% of all fatal accidents occurred on rural roads; • The proportion of accidents and fatalities occurring on rural roads was fairly consistent for different vehicle types in 2015 (e.g. 31% of all motorcycling accidents and 66% of fatal motorcycling accident occurred on rural roads; 40% of all car accidents and 68% of fatal car accidents occurred on rural road; 40% of accidents involving vans and LGVs and 65% of all fatal accidents involving this vehicle type occurred on rural roads);
Keywords:	N/A
Comments:	Detailed tables are included that give breakdowns of involvement of various vehicle types and road user groups involved in collisions on rural roads as well as breaking down casualties by built-up and non-built-up areas.

Title:	**Evaluation of the national HGV speed limit increase in England and Wales: year 1 interim summary, September 2016**
Published:	Department for Transport, UK (2016)
Link: **Free/priced:**	https://www.gov.uk/government/publications/increased-speed-limit-for-heavy-goods-vehicles-over-75-tonnes-initial-summary-report/evaluation-of-the-national-hgv-speed-limit-increase-in-england-and-wales-year-1-interim-summary-september-2016 Free
Objectives:	In April 2015, new national speed limits came into force for heavy goods vehicles (HGVs) over 7.5 tonnes on single carriageway and dual carriageway roads in England and Wales. The new limits are: • 50 mph (up from 40 mph) on single carriageway roads • 60 mph (up from 50 mph) on dual carriageway roads In October 2015, the Department for Transport commissioned a 3-year evaluation of these speed limit changes. The primary aim is to determine and understand the impacts of the speed limit changes. A secondary aim is to generate evidence to support future policy decisions. This note presents a summary of the analysis for the first year of the evaluation.
Methodology:	Data from April to December 2014 were used for understanding the baseline situation (before the speed limit changes). Data from April to December 2015 were used for the analysis of the initial impact of the speed limit changes.
Key Findings:	In the period following the introduction of the new speed limits there is preliminary evidence of a reduction in HGV collisions estimated to be between 10% and 36%, however, it is not possible to attribute this directly to the speed limit changes.
Keywords:	N/A.
Comments:	Interim Report

Title:	**Reducing deaths in Single Vehicle Collisions (PIN Flash 32)**
Published:	ETSC (2017)
Link: **Free/priced:**	http://etsc.eu/reducing-deaths-in-single-vehicle-collisions-pin-flash-32/ Free
Objectives:	A third of road deaths in the EU are caused by collisions that involve a single motorised vehicle where the driver, rider and/or passengers are killed but no other road users are involved. These single vehicle collisions (SVCs), and how to prevent them occurring, are the subject of this report.
Methodology:	Report
Key Findings:	Nearly 7300 road users lost their lives in 2015 in SVCs in the EU. Around 94,800 people have died in such collisions in the last ten years. Over 60% of deaths in SVCs occur on rural roads. However, safer infrastructure and appropriate speed limits have helped reduce deaths on rural roads. Young drivers and riders are at a greater risk of becoming involved in fatal single vehicle collisions than any other road user age group. This risk is twice as high for the 18-24 age group compared to the 25-49 age group. Key Recommendations (relevant): • Implement the Infrastructure Safety Management Directive 2008/96 on all kinds of roads • Improve infrastructure safety on the whole network, applying the concepts of “self-explaining and self-enforcing roads” and “forgiving roadsides” • Eliminate all removable obstacles from the roadside; install safe side barriers where the obstacles cannot be removed on rural roads and motorways
Keywords:	N/A
Comments:	PIN Report

Title:	**Operating speed as a key factor in studying the driver behaviour in a rural context**
Published:	Russo, F., Biancardo, S.A. & Busiello, M. (2016) Transportation 31(2): p 260-270
Link: **Free/priced:**	http://www.tandfonline.com/doi/abs/10.3846/16484142.2016.1193054 Priced
Objectives:	To explore the effects of geometric road features on driver speed behaviour in order to identify unsafe road segments where high reductions in speed between successive road elements occur.
Methodology:	The testing was carried out on 567 study sites, of which 248 are on circular curves and 319 on tangents. Speed data collection was carried out in environmental and traffic conditions using a laser. The conditions were the following: dry roads, free flow conditions, daylight hours and good weather conditions. The main goal was to calibrate and validate different operating speed prediction models: a) one model on tangent segments; b) one model on circular curves; c) only one model to be used at the same time on tangents and circular curves.
Key Findings:	The models were developed using an Ordinary Least Squares (OLS) method. The explanatory variables were total segment length, lane width, curvature of the road element, the curvature change rate on homogeneous road segments, and the number of residential driveways per km. The results suggested the reliability of this hypothesis and its effectiveness in bringing advantages during the application phase.
Keywords:	Operating speed; Road; Impact; Statistical analysis; Vehicle
Comments:	

Title:	**Quantifying the safety effects of horizontal curves on two-way, two-lane rural roads**
Published:	Gooch, J.P., Gayah, V.V. & Donnell, E.T. (2016) Accident Analysis & Prevention 92: p 71-81
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457516301026?via%3Dihub Priced
Objectives:	The objective of this study is to quantify the safety performance of horizontal curves on two-way, two-lane rural roads relative to tangent segments.
Methodology:	The models estimated in the present study used eight years of crash data (2005–2012) obtained from over 10,000 miles of state-owned two-lane rural roads in Pennsylvania. These data included information on roadway geometry (e.g., horizontal curvature, lane width, and shoulder width), traffic volume, roadside hazard rating, and the presence of various low-cost safety countermeasures (e.g., centreline and shoulder rumble strips, curve and intersection warning pavement markings, and aggressive driving pavement dots). Crash prediction is performed by means of mixed effects negative binomial regression using the explanatory variables noted previously, as well as attributes of adjacent horizontal curves.
Key Findings:	The results indicate that both the presence of a horizontal curve and its degree of curvature must be considered when predicting the frequency of total crashes on horizontal curves. Both are associated with an increase in crash frequency, which is consistent with previous findings in the literature. Mixed effects negative binomial regression models for total crash frequency on horizontal curves indicate that the distance to adjacent curves is not statistically significant. However, the degree of curvature of adjacent curves in close proximity (within 0.75 miles) was found to be statistically significant and negatively correlated with crash frequency on the subject curve. This is logical, as drivers exiting a sharp curve are likely to be driving slower and with more awareness as they approach the next horizontal curve.
Keywords:	Horizontal curves; Adjacent curves; Crash modification factor; Propensity scores; Mixed effects negative binomial
Comments:	

Title:	**Influence of deficiencies in traffic control devices in crashes on two-lane rural roads**
Published:	Lopez, G., de Ona, J., Garach, L. & Baena, L. (2016) Accident Analysis & Prevention, Volume 96, November 2016, Pages 130-139
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S000145751630286X?via%3Dihub Priced
Objectives:	The paper analyses the relationship between road crashes in two-lane rural highways and certain deficiencies in signalling
Methodology:	The analysis was carried out using rules extracted from decision trees models.
Key Findings:	• Incomplete removal of road works markings producing the highest crash probability • No guide sign or in incorrect positions also give rise to high crash probability • The crash probability increases over 200% when some of these deficiencies appear. In view of these results, governmental agencies should verify that the original conditions of a highway are re-established after any construction work is completed. They should also continuously follow up on the signalling of this type of highway in order to maintain optimal conditions.
Keywords:	Traffic crashes; Road safety inspections; Sign and marking; Decision Trees; Decision rules; Traffic control devices
Comments:	

Title:	**Evaluation of the Potential Benefits of Rural Bicycle Climbing Lanes**
Published:	Chapman, J.R. (2017) Transportation Research Board, 96th Annual Meeting, Washington, DC
Link: **Free/priced:**	http://docs.trb.org/prp/17-01076.pdf Free
Objectives:	The objective of the paper was to evaluate lateral clearance distances between vehicles and bicycles during overtaking manoeuvres on rural roads.
Methodology:	The data collection process for this research effort collected 1151 observations through real-time, in-field sensor and video logging. The collected data was then used to evaluate lateral clearance distances between vehicles and bicycles either when a paved shoulder was, or was not, present.
Key Findings:	The evaluation shows, first, that drivers were far more likely to cross a solid (or double) yellow centreline, regardless of oncoming traffic, when a paved shoulder was not present on uphill segments. The reduction in centreline crossings due to the presence of a paved shoulder is significant. Having a paved shoulder on an uphill segment of a rural road appears to provide significant benefits, including reducing the likelihood of a centreline crossing by nearly 80%, and from encroaching into oncoming traffic by over 50%. These safety benefits can also be achieved with minimal additional cost to a road project.
Keywords:	Overtaking/passing a bicycle; lateral clearance; paved shoulder; vehicle/bicycle interaction; centreline crossing on an uphill.
Comments:	

Title:	**All-round methodology for upgrading existing rural roads that are prone to accidents using virtual driving simulation**
Published:	Kuhn, P.E.W. (2017) Transportation Research Procedia 25: p 1972-1988
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S235214651730563X?via%3Dihub Free
Objectives:	Zwickau University has developed a new multi-stage methodology for the complex design process of upgrading rural roads.
Methodology:	Using virtual journeys (automatically defined driver profiles or simulation using driving simulators), expected driving behaviour can be assessed using characteristic feature graphs and the derived quantitative parameters.
Key Findings:	The results presented have clearly demonstrated that driving behaviour can be reliably assessed during the design process by means of virtual driving sessions. A relative comparison between the existing and upgraded road is possible with the help of the assessment parameters developed here. Maximum or minimum figures for the individual assessment parameters still have to be determined as part of a validation process. If individual design parameters deviate from the standard values, the driving behaviour graphs and the associated quantitative assessment parameters must be drawn on as the professional basis for approving any exceptions. The new kind of methodology developed forms a solid foundation for developing a standard procedure for the design process for modification and upgrading work.
Keywords:	Road Design and Safety; Upgrading Existing Rural Roads; Human Factors; Driving Simulation
Comments:	For more information about the designed methodology, consult the full paper.

Title:	**Causes, consequences and countermeasures of overtaking accidents on two-lane rural roads**
Published:	Richter, T., Ruhl, S., Ortlepp, J. & Bakaba, E. (2017) Transportation Research Procedia 25: p 1989-2001
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S2352146517307020?via%3Dihub Free
Objectives:	The aim of this project was to determine the infrastructural and traffic related variables which influence the occurrence and consequences of overtaking accidents as well as the overtaking behaviour of drivers.
Methodology:	The study comprises a literature review, a macroscopic analysis of accidents in 5 German federal states between 2007 and 2009 and a microscopic analysis on 50 road intersections.
Key Findings:	The analyses revealed that a large proportion of overtaking accidents occurs in areas with insufficient overtaking sights and where no configurations of traffic regulation have been taken to counter overtaking manoeuvres. But the assumption that drivers can detect insufficient overtaking sights independently and therefore do not begin to overtake is wholly inadequate, because the complex weighting process of existing overtaking possibilities contains errors. Miscalculations of overtaking sights as well as speed and distance to oncoming vehicles are the main problem areas. Missing configurations of traffic regulation can negatively warp the drivers' perception. Instead, the drivers must be supported in road sections with insufficient overtaking sights through operational measures in their task of driving.
Keywords:	Accident prevention; traffic safety; overtaking accidents; overtaking behaviour; rural roads
Comments:	

Title:	**Motor vehicles overtaking cyclists on two-lane rural roads: Analysis on speed and lateral clearance**
Published:	Llorca, C., Sngel-Domenech, A., Agustin-Gomez, F. & Garcia, A. (2017), Safety Science 92: p 302-310
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0925753515002921?via%3Dihub Priced
Objectives:	The aim of the paper was the analysis of compliance and adequacy of the 1.5 m lateral distance criterion with respect of objective and subjective risk measures. The study had the following objectives: • Compare the effect of lateral clearance and overtaking vehicle speed (and their combination, in terms of aerodynamic forces) with a rider's subjective and relative risk perception on the different road segments. • Analysis of the compliance and adequacy of lateral clearance based criteria. • Analysis of the effect of bicycle type, road alignment and presence of opposing traffic. The initial hypothesis of the research was that both lateral clearance and overtaking vehicle speed affect the subjective perception of each road segment. The higher the lateral clearance and the lower the speed, the safer the rider perception.
Methodology:	The observation of overtaking manoeuvres was carried out using an instrumented bicycle. A professional cyclist rode the bicycle at speeds between 15 and 25 km/h, on seven rural road segments, resulting in the characterisation of each motor vehicle overtaking manoeuvre. 2928 overtaking manoeuvres were characterised.
Key Findings:	The analysis suggested that lateral clearance is not the only factor that influenced rider's risk perception, although current standards are only related to it. A combined factor of lateral clearance, vehicle type and vehicle speed had a more significant correlation with the perceived risk. Results showed that the effect of heavy vehicles on bicyclists was also strong. The combined factor of clearance and speed was higher on tangent sections where overtaking was permitted.
Keywords:	Bicycle; Overtaking; Sport cycling; Two-lane rural road; Lateral clearance; Instrumented bicycle; Risk perception
Comments:	Focused on cycling on rural roads

Title:	**Interaction driver–bicyclist on rural roads: Effects of cross-sections and road geometric elements**
Published:	Bella, F. & Silvestri, M. (2017) Accident Analysis & Prevention 102: p 191-201
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457517301069?via%3Dihub Priced
Objectives:	To analyse the effects that three cross-section configurations of a two-lane rural road and four geometric elements of the road have on driver behaviour, during the interaction with a cyclist.
Methodology:	A two-lane rural road, about 11 km long, was designed and implemented in an advanced-interactive driving simulator. Three different cross-sections (all with the same width, but with and without a bicycle lane and for different widths of bicycle lane) were tested. Forty participants carried out three driving sessions (one for each road alignment with different cross-section) and were exposed to the condition of bicycle traffic along four geometric elements of the alignment (2 tangents with different lengths, right curve and left curve). The driving simulator experiments were designed in such a way that, along the sections where the driver–cyclist interactions occurred, the oncoming traffic was absent. Overall, 468 speed profiles and 468 lateral position profiles were plotted to obtain the descriptive variables of the driver behaviour during the interaction with the cyclist. The influences of cross-sections, geometric elements and bicycle traffic conditions on driver behaviour were evaluated by a multivariate variance analysis.
Key Findings:	The interferences of the cyclist on driver's behaviour depended on the geometric elements. On tangents, the lowest lateral clearances were recorded and no speed reduction was observed, compared to the cyclist absence condition. On the left curve, the higher lateral clearance was recorded, due to the concordant tendencies of the driver to move away from the cyclist and to cut the curve. This determined an excessive and risky displacement of the vehicle to the opposing lane, whose criticality was also emphasized by the high speed adopted by the driver.

	On the right curve, the lateral clearance was higher than that recorded on the tangents, probably due to the necessity of the driver to perform the demanding manoeuvre of entering the right curve, which also determined a speed reduction compared to the cyclist absence condition. The obtained results provide suggestions for the most efficient cross-section reorganization of existing two-lane rural roads in order to improve the road safety.
Keywords:	Driver behaviour; Bicyclist; Driving simulator; Road safety
Comments:	

Title:	**All-terrain vehicle safety knowledge, riding behaviours and crash experience of Farm Progress Show attendees**
Published:	Jennissen, C.A., Harland, K.K., Wetjen, K., Hoogerwerf, P., O'Donnel, L. & Denning, G.M. (2017) Journal of Safety Research 60: p 71-78
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0022437516305023?via%3Dihub Free
Objectives:	To determine characteristics and outcomes of ATV use and to assess basic ATV-related safety knowledge.
Methodology:	Farm Progress Show attendees in 2012 (Boone, Iowa) and 2013 (Decatur, Illinois) were surveyed about ATVs, including riding behaviours, crash history, and safety knowledge. Descriptive and comparative analyses were performed (N = 635 surveys).
Key Findings:	• Over 90% of survey participants at a large agricultural fair had ridden on an ATV • The vast majority reported having engaged in one or more unsafe riding behaviours • Nearly 40% of those who had ridden on an ATV reported having been in a crash • Unsafe riding behaviours were strongly associated with having been in a crash • Safety knowledge was not always associated with safe riding behaviour
Keywords:	All-terrain vehicles; Occupational safety; Injury prevention; Agriculture; Safety training
Comments:	Although focused on ATV, the research is relevant for rural roads

Title:	**Effectiveness and acceptability of milled rumble strips on rural two-lane roads in Sweden**
Published:	Vadeby, A. & Anund, A. (2017) European Transport Research Review 9: 29
Link: **Free/priced:**	https://link.springer.com/article/10.1007%2Fs12544-017-0244-x Free
Objectives:	To estimate the effects of centreline milled rumble strips on rural two-lane roads in Sweden in a wide perspective.
Methodology:	To evaluate the traffic safety effects, an Empirical Bayes study comparing the outcome before and-after the introduction of rumble strips was conducted. This study is based on data from 2003–2012 from the Swedish national traffic accident database, STRADA. To capture driver experience and opinions about milled centreline rumble strips, focus groups and road-side interviews were performed.
Key Findings:	The results indicate a significant decrease in all types of severe injury crashes, a 20% (±13%) reduction in the number of fatalities and seriously injured people (all crash types) and a 27% (±18%) reduction in the number of fatalities and severely injured people in single-vehicle crashes. Participants in focus groups and road-side interviews generally favoured centreline rumble strips on rural roads, and up to 90% of the interviewed motorcyclists and commuters stated that the rumble strips would help improve traffic safety. **Conclusions** Rumble strips in the centre of two-lane rural roads are a countermeasure to help drivers who are unintentionally about to leave the lane, for example, due to sleepiness or inattention. Based on the results of this study, installing centreline milled rumble strips on two-lane rural roads 8–10 meters wide is a measure to consider to increase safety.
Keywords:	Milled rumble strips; Traffic safety; Driver acceptance; Focus groups; Road side interviews; Empirical Bayes
Comments:	

Title:	**Lonely Highways: The Role of Social Capital in Rural Traffic Safety**
Published:	Nagler, M.G. & Ward, N.J. (2016) Eastern Economic Journal 42(1): p 135-156
Link: **Free/priced:**	https://link.springer.com/article/10.1057%2Feej.2014.60 Priced
Objectives:	To examine whether social capital's protective effects have equivalent force with respect to fatalities occurring on rural and urban roads.
Methodology:	The authors explore the potential mediating effects of specific crash types and contexts and of behavioural risk factors on the relative protective effect of social capital on rural and urban roads, using data from the United States for the period 1997–2006.
Key Findings:	• The estimation of simultaneous equation systems of complementary traffic incident types on a panel of US states reveals a significantly lower protective effect on rural roads. • Potentially relevant differentials in crash-type/context exposure do not mediate this outcome. • It appears the relative prevalence of certain risk behaviours (e.g., speeding) skew rural environments toward crash situations where the critical safety factors are orthogonal to social capital influence.
Keywords:	Social capital; Trust; Rural culture; Risk behaviour; Driver care
Comments:	

Title:	**Risk and safety perception on urban and rural roads: Effects of environmental features, driver age and risk sensitivity**
Published:	Cox, J.A, Beanland, V. & Filtness, A.J. (2016) Traffic Injury Prevention 18(7): p 703-710
Link: **Free/priced:**	http://www.tandfonline.com/doi/abs/10.1080/15389588.2017.1296956?journalCode=gcpi20 Priced
Objectives:	The aim of the study was to explore factors that are likely to influence perceptions of risk and safety regarding changing visual information in the driving environment. Factors explored were the environment in which the change occurs (i.e., urban vs. rural), the type of object that changes, and the driver's age, experience, and risk sensitivity.
Methodology:	Sixty-three licensed drivers aged 18–70 years completed a hazard rating task, which required them to rate the perceived hazardousness of changing specific elements within urban and rural driving environments. Three attributes of potential hazards were systematically manipulated: the environment (urban, rural); the type of object changed (road sign, car, motorcycle, pedestrian, traffic light, animal, tree); and its inherent safety risk (low risk, high risk). Inherent safety risk was manipulated by either varying the object's placement, on/near or away from the road, or altering an infrastructure element that would require a change to driver behaviour. Participants also completed two driving-related risk perception tasks, rating their relative crash risk and perceived risk of aberrant driving behaviours.
Key Findings:	• Driver age was not significantly associated with hazard ratings, but individual differences in perceived risk of aberrant driving behaviours predicted hazard ratings, suggesting that general driving-related risk sensitivity plays a strong role in safety perception. • In both urban and rural scenes, there were significant associations between hazard ratings and inherent safety risk, with low-risk changes perceived as consistently less hazardous than high-risk impact changes; however, the effect was larger for urban environments.

	• There were also effects of object type, with certain objects rated as consistently more safety relevant. In urban scenes, changes involving pedestrians were rated significantly more hazardous than all other objects, and in rural scenes, changes involving animals were rated as significantly more hazardous. • Notably, hazard ratings were found to be higher in urban compared with rural driving environments, even when changes were matched between environments. **Conclusion** The study demonstrates that drivers perceive rural roads as less risky than urban roads, even when similar scenarios occur in both environments. Age did not affect hazard ratings. Instead, the findings suggest that the assessment of risk posed by hazards is influenced more by individual differences in risk sensitivity. This highlights the need for driver education to account for appraisal of hazards' risk and relevance, in addition to hazard detection, when considering factors that promote road safety.
Keywords:	Risk perception; Risk sensitivity; Safety perception; Rural roads; Urban roads
Comments:	

Title:	**Analysis of the injury severity of crashes by considering different lighting conditions on two-lane rural roads**
Published:	Anarkooli, A.J. & Hosseinlou, M.H. (2016) Journal of Safety Research 56: p 57-65
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0022437515001073?via%3Dihub Priced
Objectives:	The research investigates lighting condition differences in the injury severity of crashes using 3-year (2009–2011) crash data of two-lane rural roads of the state of Washington.
Methodology:	Separate ordered-probit models were developed to predict the effects of a set of factors expected to influence injury severity in three lighting conditions; daylight, dark, and dark with street lights. A series of likelihood ratio tests were conducted to determine if these lighting condition models were justified.
Key Findings:	The modelling results suggest that injury severity in specific lighting conditions are associated with contributing factors in different ways, and that such differences cannot be uncovered by focusing merely on one aggregate model. Key differences include crash location, speed limit, shoulder width, driver action, and three collision types (head-on, rear-end, and right-side impact collisions). **Practical Applications** The paper highlights the importance of deploying street lights at and near intersections (or access points) on two-lane rural roads because injury severity highly increases when crashes occur at these points in dark conditions.
Keywords:	Injury severity; Rural roads; Lighting condition; Ordered probit; Fixed effects
Comments:	

Title:	**High beam headlamp use rates: Effects of rurality, proximity of other traffic, and roadway curvature**
Published:	Reagan, I.J., Brumbelow, M.L., Flannagan, M.J. & Sullivan, J.M. (2016) Traffic Injury Prevention 18(7): 716-723
Link: **Free/priced:**	http://www.tandfonline.com/doi/abs/10.1080/15389588.2016.1228921?journalCode=gcpi20 Priced
Objectives:	The study examined factors associated with the rate of high beam use of isolated vehicles on a variety of roadways in the Ann Arbor, Michigan area.
Methodology:	Twenty observation sites were categorized as urban, rural, or on a rural/urban boundary and selected to estimate the effects of street lighting, road curvature, and direction of travel relative to the city on high beam use. Sites were selected in pairs so that a majority of traffic passing one site also passed through the other. Measurement of high beams relied on video data recorded for 2 nights at each site, and the video data also were used to derive a precise measure of the proximity of other traffic. Nearly 3,200 isolated vehicles (10 s or longer from other vehicles) were observed, representing 1,500-plus vehicle pairs.
Key Findings:	• Across the sample, 18% of the vehicles used high beams. Seventy-three percent of the 1,500-plus vehicle pairs used low beams at each paired site, whereas 9% used high beams at both sites. • Vehicles at rural sites and sites at the boundaries of Ann Arbor were more likely to use high beams than vehicles at urban sites, but use in rural areas compared with rural/urban boundary areas did not vary significantly. • Rates at all sites were much lower than expected, ranging from 0.9 to 52.9%. High beam use generally increased with greater time between subject vehicles and leading vehicles and vehicles in the opposing lane. • There were mixed findings associated with street lighting, road curvature, and direction of travel relative to the city.

	Conclusion Maximizing visibility available to drivers from headlights includes addressing the substantial underuse of high beam headlamps. Advanced technologies such as high beam assist, which switches automatically between high and low beam headlamps depending on the presence of other traffic, can help to address this problem.
Keywords:	Night time driving; Visibility; High beam headlamps; High beam assist; Adaptive driving beam
Comments:	

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