Task 1-117: TD 41 & TD 42 Safety Research

Findings Report

Highways England

Project Sponsor: Nicholas Bentall

April 2017

Contains *sensitive* information

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to Task 1-117: TD 41& TD 42 Safety Research.

Atkins assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

Document history

Job number: 5153315			**Document ref: 5153315.70.001**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Initial Issue	M Holt	D Thomas-Keeping	JP Doherty	A Powell	23/03/17
Rev 1.1	Final Issue	M Holt	D Thomas-Keeping	JP Doherty	A Powell	21/04/17

Table of contents

Executive summary

Atkins has been commissioned by Highways England to undertake research into the visibility requirements currently prescribed by the following documents:

- TD 41/95 - Vehicular Access to All-Purpose Trunk Roads; and
- TD 42/95 - Geometric Design of Major Minor Priority Junctions.

The primary objectives of which are:

- To study visibility and collision records for major/minor junctions to identify whether there is a strong correlation between levels of visibility (both limited and excessive) and collision rates;

- To interpret findings from the above to determine whether it may be appropriate to develop a revised set of visibility requirements; and

- To indicate the potential savings that could be made should the requirements be revised. This will be based on the numbers of DfS submissions contained in the Departure Approval System (DAS) which would no longer be required, rather than any potential savings in terms of design and construction costs (as these would vary significantly on a site-by site basis).

The visibility requirements at junctions are expressed in terms of 'X', 'Y' and 'Z' distances. In any analysis that deals with more than one test variable, it is difficult to highlight the factor that may be producing a potential outcome. As such, dealing with only one variable in a particular test situation provides a greater level of confidence that the element being tested is causing the outcome. As the 'Y distance is the defining element of the visibility requirements, this is the key variable that has been tested as part of this study.

The research looks at simple, ghost island and single lane dualing junctions only. While field access and single dwelling layouts are included in TD 41, these have been excluded given the low flows and collisions rates that are likely to occur at these locations i.e. analysis of them would be unlikely to provide any statistically significant results.

Visibility has been measured using Highways England's existing inventory of driven LiDAR data. This data is accurate to +/- 30mm, which allows for highly accurate measurements to be taken from the 3D models created from it. Using LiDAR data, instead of conventional, manual methods of measurement, has allowed for a significant number of junctions to be analysed across the UK. In total, the visibility splays at 310 junctions have been measured.

The level of compliance with the 'Y' visibility requirements have been compared with the collision rates at each junction and graphs produced to illustrate how the average collision rates change as compliance with the visibility requirement reduces. In general, the graphs do not indicate any clear relationship between collision rates and decreasing levels of non-compliance with the 'Y' visibility requirements. While there are a multitude of factors that influence collisions (most notably of which is likely to be human behaviour), if substandard levels of visibility is a key contributory factor, then it would be expected that a clearer link between collision rates and visibility would be evident in the findings.

Looking at historic DfS data, a vast proportion of submissions for substandard visibility are for 'Y' distances between 70% and 100% of the requirement based on the design speed of the major road. This equates to approximately a one-step reduction in provision (as defined in TD 9 Table 2). Furthermore, the majority of these submissions are for designs speeds between 70kph and 120kph (there were very few submissions for 50kph or 60kph design speeds). Of the DfS submitted that match this criteria, the vast majority of them (89%) were approved. Based on this finding and the lack of correlation between collision rates and substandard 'Y' distance levels, it is considered appropriate to allow what is already largely being approved across the network as a defined relaxation with the standards i.e. a one-step relaxation in 'Y' distance at priority junctions located on major roads with a design speed of 70kph, 75kph, 100kph or 120kph (see below summary of recommendations for further details).

While no clear link between prevailing levels of ‘Y’ visibility and collision rates have been identified, this research has shown that there is a link between ‘too much visibility’ back along the minor road (i.e. a lack of compliance with the ‘X’ distance requirements) and higher collision rates.

In general, SLD junctions performed worse than simple and ghost island junctions in the majority of the tests. In relation to other factors, there was a significantly higher proportion of cycle collisions and collisions involving larger vehicles e.g. HGVs at SLD junction. Given SLD junctions are significantly more expensive to construct than ghost island or simple junctions they should perform better in safety terms.

Based on the findings of this research, the following recommendations are made:

a) Retain and give more prominence within the standards to the ‘X’ visibility requirement to prevent ‘too much’ visibility back along the minor road;

b) Allow a one-step relaxation in ‘Y’ distance at priority junctions where the design speed of the major road is 70kph, 75kph, 100kph or 120kph. To prevent designers from automatically selecting the relaxation, the new requirements should be written in a manner that requires the designers to justify why they are not providing the full visibility splay[1].

c) For the replacement TD 41 & 42 RAD, further consideration should be given to the continued use of single lane dualing junctions that permit all turning movements, given the finding that they do not perform better than simple or ghost island junctions and are significantly more expensive to construct.

[1] In the draft update of Interim Advice Note 149, the designer is required to undertake an assessment in order to use certain relaxations. A similar solution could be adopted for the relaxation of the visibility requirements in the replacement TD 41/42 RAD.

1. Introduction

1.1. Scope and Purpose

Atkins has been commissioned by Highways England to undertake research into the visibility requirements currently prescribed by the following Design Manual for Roads and Bridges (DMRB) Requirement and Advice Documents (RADs):

- TD 41/95 Vehicular Access to All-Purpose Trunk Roads; and
- TD 42/95 Geometric Design of Major Minor Priority Junctions.

These RADs are herein referred to simply as 'TD 41' and 'TD 42' respectively.

This reports outlines the research undertaken and the findings thereof, which will be used to support the future development of the documents when they are updated as part of a separate commission.

It should be noted that TD 41 and TD 42 both refer to 'major/minor priority junction'. This term is simply referred to as 'priority junction' in this report, which should align with the revised terminology to be used in the updated RADs.

1.2. Background

Highways England have a key performance indicator (KPI) safety target to reduce the number of people Killed or Seriously Injured (KSI) on the trunk road network by 40% by 2020. This is to be achieved at the same time as fulfilling the licence requirements of supporting sustainable development as detailed below in an extract from the licence:

"5.36 Unless otherwise directed by the Secretary of State, consider granting permission in light of the nature of the road in question and the consequences of the new connection, having particular regard to:

i. In the case of sections of the network designed for high-speed traffic, with partially or comprehensively limited access, there should be a presumption against connection, except where it can be provided safely and where there is a demonstrable benefit to the economy;

ii. On all other sections of the network there should be a presumption in favour of connection, except where a clear case can be made to prohibit connection on the basis of safety or economic impacts."

While the above clauses protect the motorway and high speed dual carriageway from the proliferation of new connections, the single carriageway all-purpose trunk road network is subject to regular applications from third parties for new or altered direct access/junctions. As such, Highways England requires up-to-date evidence to help support safe designs and give a firm rebuttal to proposals that are likely to create a safety issue.

Meanwhile, a combination of the Road Investment Strategy (RIS) and third party development proposals is significantly increasing the number of schemes being developed on or close to the motorway and trunk road network. This is placing considerable pressure on Highways England's resources in administering the Departures from Standard (DfS) approval process. As a result, there is a drive to reduce the number of DfS generated by the DMRB where this can be achieved without negatively impacting on the safety target.

Following the recommendations of an earlier scoping study (completed in 2016 by Atkins), Highways England is intending to update and combine TD 41 and TD 42 into a single RAD. This upcoming update provides an opportunity to reconsider the requirements relating to visibility at accesses and major/minor priority junctions. However, in order to change any requirements, a robust evidence base is needed to give confidence to the decision making process.

1.3. Research Objectives

The Highways England objectives for this research task were:

1. To study visibility and collision records for major/minor junctions to identify whether there is a strong correlation between levels of visibility (both limited and excessive) and collision rates;
2. To interpret findings from the above to determine whether it may be appropriate to develop a revised set of visibility requirements; and
3. To indicate the potential savings that could be made should the requirements be revised. This will be based on the numbers of DfS submissions contained in the Departure Approval System (DAS) which would no longer be required, rather than any potential savings in terms of design and construction costs (as these would vary significantly on a site-by site basis).

1.4. Report Structure

This report has been collated to provide both an account of the findings of the study and the process followed to determine the recommendations. The methodology used to investigate the relationship between collision rates and visibility levels is described in Section 2. Section 3 details the various types of data used and how this was obtained.

Section 4 describes the collision analysis undertaken using the base data and the key findings, along with an interpretation of what the outputs may mean.

Section 5 looks at the DfS submitted against TD 41 and TD 42 in order to ascertain what savings could be made in lieu of any changes to visibility requirements.

As noted in the task specification, identification of any other factors that could impact safety performance is an important consideration to Highways England. This complimentary analysis of non-visibility related or ‘other factors’ is included in Section 6.

Due to the nature of this research task, there are limitations which need to be taken into account when drawing any conclusions. These limitations, along with narrative on the impact they may have on the findings of the research are discussed in Section 7.

Section 8 draws the research to a conclusion and provides recommendations.

1.5. Accompanying Information and Added Value

An accompanying analysis spreadsheet[2] includes all the base data and analysis reported on in this document. The spreadsheet has been developed to allow the findings of this research to be easily verified and interrogated further in the future. The analysis of the base data has been completed using PivotTables and PivotCharts to ensure the outputs are fully referenced back to the base data.

KMZ files have been produced that contain the measured visibility splays for each junction analysed using the LiDAR data. These files can then uploaded to GoogleMaps (or other GIS tools) to provide a visual representation[3] of the measured visibility splays overlaid on base mapping including satellite/ GoogleEarth imagery.

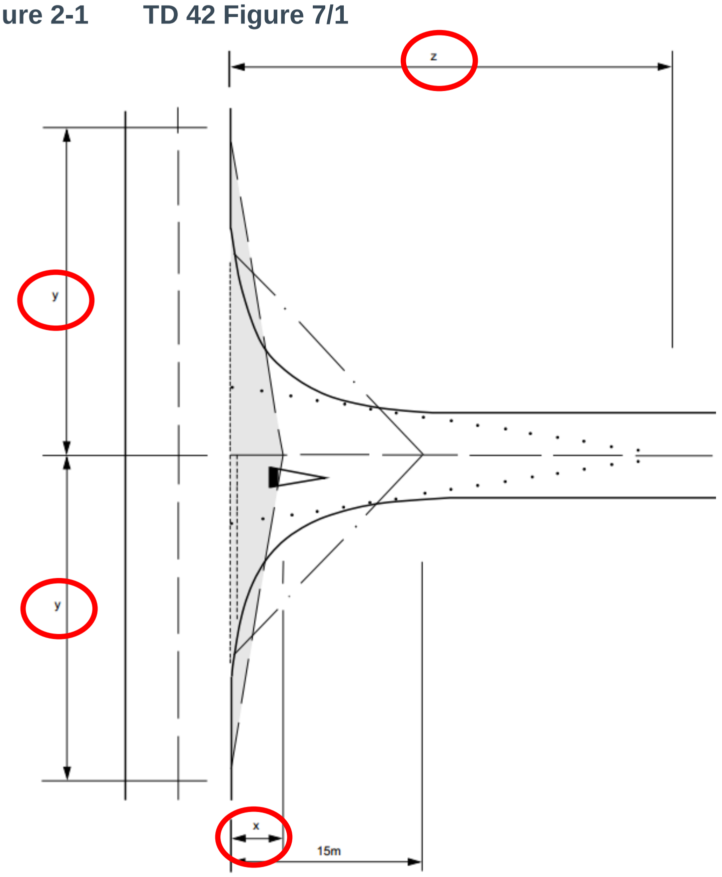
[2] Atkins document reference 5153315.70.002 – TD 41/42 Analysis.
[3] While the visibility splays have been drawn in AutoCAD and are therefore accurate, when uploaded to platforms such as GoogleMaps, they might appear slightly out of sync with the base mapping.

2. Research Methodology

2.1. Defining the variable to be tested

As illustrated by Figure 2-1, the visibility requirements at junctions are expressed in terms of 'X', 'Y' and 'Z' distances[4]. In any analysis that deals with more than one test variable, it is difficult to highlight the factor that may be producing a potential outcome. As such, dealing with only one variable in a particular test situation provides a greater level of confidence that the element being tested is causing the outcome.

Figure 2-1 TD 42 Figure 7/1



2.1.1. 'Z' Distances

The TD 41 and TD 42 scoping study included a detailed review of the DfS submitted against these documents. This review did not highlight any particular issues with 'Z' distance compliance i.e. there were few DfS submitted against this parameter. This suggests that the 'Z' distance requirements are not particularly onerous, meaning there is no particular driver for investigating whether they can be relaxed (particularly from a DfS workload point of view). An analysis of 'Z' distances has therefore not be included as part of this study.

2.1.2. 'X' and 'Y' Distances

While 'X' and 'Y' distances are intrinsically linked (it is not possible to measure one without the other), it is the 'Y' distance that is the most critical driver for decision making. The 'X' distance fundamentally serves to provide a suitable point back along the minor road at which to measure the 'Y' distance. This is supported by the way in which the requirements in TD 41 and TD 42 are listed. In both documents, relaxations for 'Y' distances are not permissible. In other words, if the specified 'Y' distance cannot be achieved, a DfS is required. The key variable tested as part of this study is therefore the 'Y' distance.

[4] While TD 41 does not include requirements for 'Z' distance, it is likely that only field and single dwelling accesses will not be subject to 'Z' distance requirements in the updated and combined RAD. This is due to overlap between layouts in the current documents.

2.2. Measuring the ‘Y’ distance

2.2.1. In relation to ‘X’ distance

As mentioned above, ‘Y’ visibility is always measured from a distance ‘X’ along the minor road. While different ‘X’ distances are mentioned in the RADs, it is only the 2.4m ‘X’ distance that is a firm requirement. The achievement of ‘Y’ at other distances specified (4.5m and 9.0m) are desirable, but not essential.

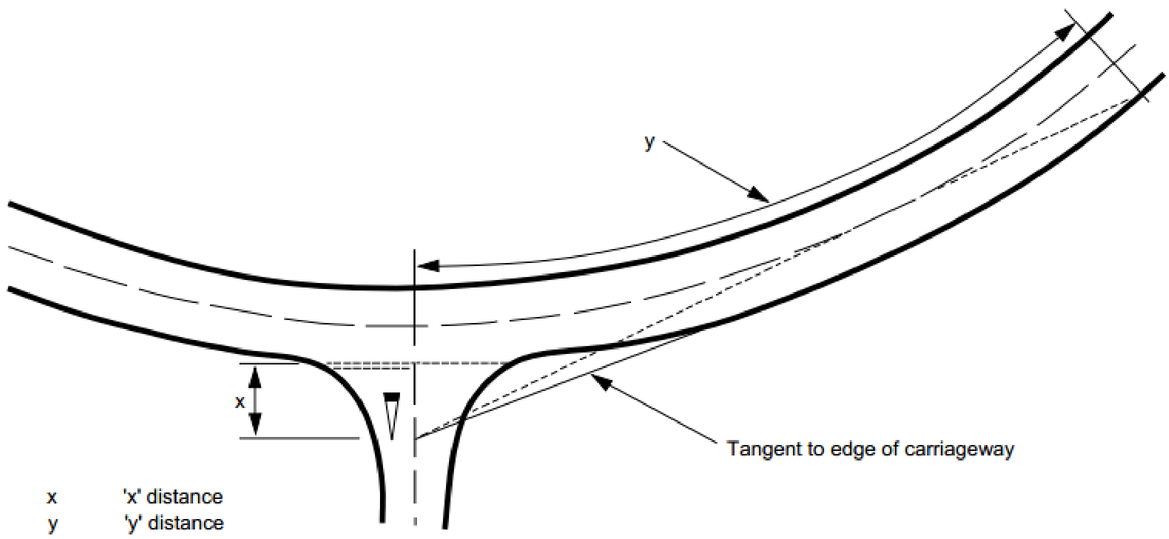
At this point it is worth noting that in TD 42, ‘too much visibility’ back along the minor road would result in the layout being non-complaint. This is defined as the full visibility splay being achievable from a point greater than 9m back along the minor road. For example, the required ‘Y’ distance where the major road speed is 100kph is 215m. If 215m is achievable from any point greater than 9.0m back along the minor road then this would make the junction non-compliant.

In light of the above, ‘Y’ visibility distances in this study have been measured at ‘X’ distances of 2.4m and 9.1m for each junction. This reveals the sightlines along the major road from the extremes of the visibility splay. In all cases, the ‘Y’ distance has been compared to the major road speed (refer to Section 2.2.4) to indicate whether this meets, exceeds or provides limited visibility compared to requirements.

2.2.2. Curvature of Major Road

When measuring the ‘Y’ distance, it is important to take account of any curvature of the major road. As required by TD 42 paragraph 7.2 and illustrated in TD 42 Figure 7/2 (copied below as Figure 2-2), where the line of vision lies partially within the major road carriageway, the ‘Y’ distance has been measured so that it lies tangential to the near carriageway edge.

Figure 2-2 TD 42 Figure 7/2



2.2.3. Envelope of Visibility (Driver’s Eye Height)

Both TD 41 and TD 42 require an envelope of visibility to be available across the ‘Y’ distance. Reference is made back to TD 9 which specifies that the envelope of visibility “shall be from a minimum driver's eye height of between 1.05m and 2.00m, to an object height of between 0.26m and 2.00m”.

Aside from temporary obstructions in the form of street furniture e.g. lighting columns, it is unlikely that it would not be possible to achieve visibility to the 2.00m object height if visibility to the 0.26m has already been proven. ‘Y’ distance has therefore be measured from a point 1.05m above carriageway at the junction to a point 0.26m above the carriageway at the maximum horizontal ‘Y’ distance prior to visibility being obstructed in either the vertical or horizontal plane.

2.2.4. Major Road Design Speed

In both TD 41 and TD 42, the required 'Y' visibility is based on the major road design speed. The only way to establish the design speed of a road (in the absence of any historic construction information), is to calculate it based on longitudinal curvature and compare these findings against TD 9 figures. This is not a straight forward process however, particularly when factors such as superelevation need to be taken into account. To complete this level of analysis at a large number of sites would be extremely time consuming and therefore impractical for this research task.

As an alternative to design speed, the most reliable and available measure for each junction is the signed speed limit. Using the speed limit of the major road to determine the visibility requirement is considered at the very least a more consistent approach than estimating design speed; however, only junctions where the major road speed limit has not changed over the five year collision data period have been included in the research. The reason being is that if a speed limit has changed over the collision period, the required visibility splay based on our methodology will have changed. This would make it impractical to draw a fair comparison between the variance in visibility and the average annual collision rate. Whether the speed limit of a road has remained constant over the collision data period has been ascertained using Google Street View's timeline function[5].

2.3. Junction Types

Across TD 41 and TD 42 there are effectively five types of priority junctions that can be provided on a single carriageway road. These are:

- Field access;
- Single dwelling access;
- Simple;
- Ghost island; and
- Single Lane Dualling (SLD).

Field and single dwelling accesses (TD 41 layouts 1 and 2) are likely to be subject to low turning flows and collision rates, meaning any analysis of them may not provide statistically significant results. Notwithstanding this, a sufficient number of suitable simple, ghost island and SLD junctions were identified across the network (refer to Section 4.1) meaning it has not been necessary to include these layouts in the research. This does not necessarily mean that any revised visibility requirements derived from the analysis would not be suitable for simpler, single dwelling and field access layouts however.

In order to draw a fair comparison, more complex variations of junctions have also been excluded from the research. For example, it would not be appropriate to compare the performance of a staggered ghost island junction arrangement with a standard ghost island junction. The reason being that the complexity of manoeuvres is much greater in one layout than the other, effectively introducing another significant variable.

It is also important to consider whether the nature of the junction has changed over the collision data period. Where the layout has been altered such that the change is likely to have had a notable effect on the collision rates (such as the upgrade of one junction type to another), these junctions have been omitted from the study. Again, Google Street View's timeline function has been used to ascertain whether a junction is suitable based on this criteria.

[5] Google Street View's timeline function allows users to view the street view imagery of a road at each point in time it was surveyed since UK data was first added. For significant routes such as trunk roads, Street View data has been regularly updated (for example, the A628 trunk road has been surveyed a total of seven times between October 2008 and July 2016) making it an effective tool for the initial junction selection work.

2.4. Summary of Analysis Decisions

The following is a summary of the analysis decisions discussed in the previous sections, which have been used to form the basis of the research methodology:

- Only Simple ‘T’ junctions/accesses, ghost island and SLD junctions on single carriageways that meet the following criteria have been included in the study:
    - The junction is not a complex variation of the aforementioned e.g. a staggered junction;
    - The junction has not been significantly altered (e.g. upgraded from one junction type to another) over the collision data period; and
    - The speed limit of the major road has not changed over the collision data period.
- The key test variable is the ‘Y’ distance, which has been measured:
    - At ‘X’ distances of 2.4m and 9.1m in the horizontal plane; and
    - From the driver’s eye height of 1.05m to an object height of 0.26m in the vertical plane.
- The required ‘Y’ distance is based on the speed limit of the major road; and
- ‘Z’ distances have not be considered.

3. Data Collection

3.1. Measurement of Visibility

In order to measure visibility splays accurately and as safely as possible (i.e. not exposing staff to the hazard of live traffic), Highways England's existing inventory of driven LiDAR data has been used (provided to Atkins on behalf of Highways England by IBI Group). LiDAR is a laser scanning survey technique that produces a 3D model of the surrounding area, comprising millions of 3D points. Highways England's data is accurate to +/- 30mm and therefore allows for highly accurate measurements to be taken. For each junction, the LiDAR data was loaded into Bentley's MX software to measure the visibility splays in a 3D environment.

Examples of the 3D models created from the LiDAR data and the measured visibility splay are shown in Figure 3-1 and Figure 3-2 below.

As mentioned above, LiDAR data is extremely detailed and requires significant computing power to process. The more data imported into a model the more time consuming it is to analyse. For practicable reasons, the maximum 'Y' distance measured where the major road is very straight and flat has been capped at 500m (over twice the maximum 'Y' distance required for any single carriageway road). Limiting the data set to a kilometre stretch of road (500m each side of the junction) represents a suitable, yet manageable volume of data for each junction.

Figure 3-1 High level view of the LiDAR model with visibility splays overlaid

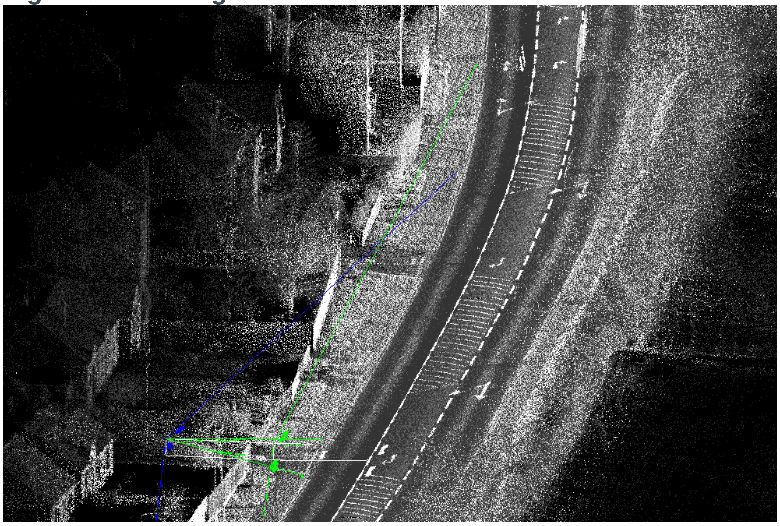
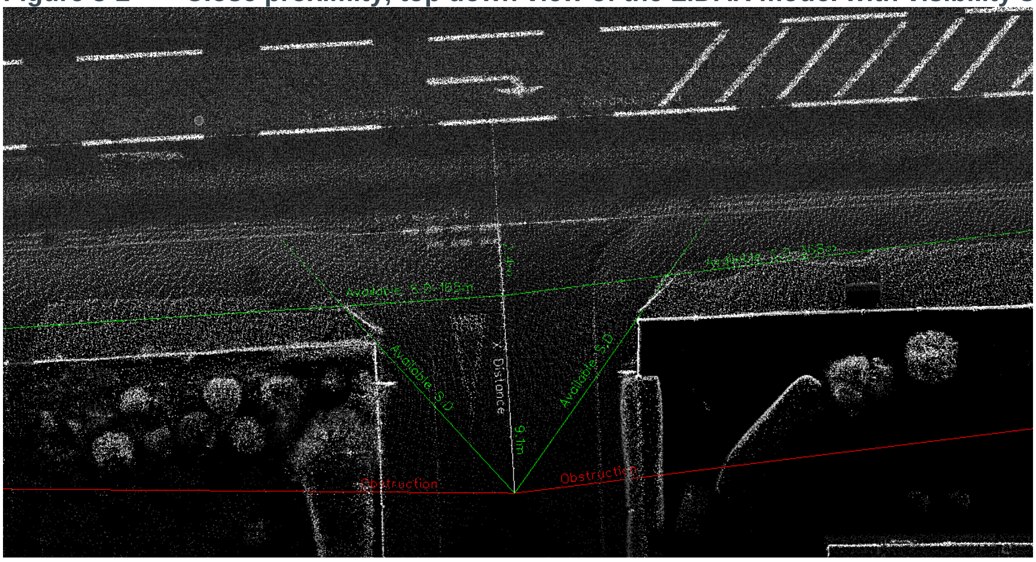


Figure 3-2 Close proximity, top down view of the LiDAR model with visibility splays overlaid

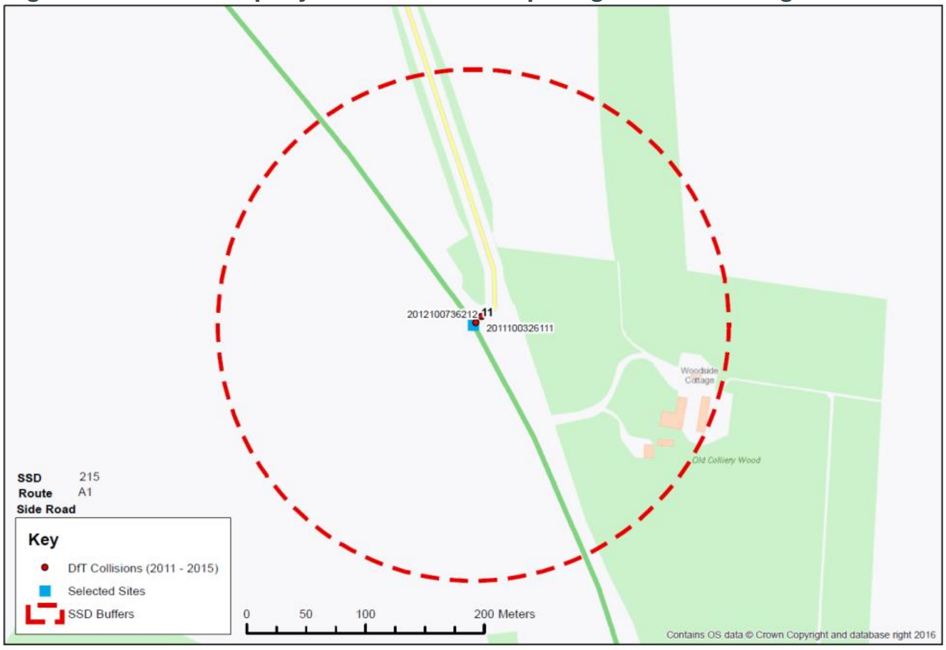


3.2. Collision Data

STATS 19 Collision data is required to determine the collision rates at the junctions. The most recent available five year data period from 2011 to 2015[6] has been used to ensure a sufficiently robust dataset for the study. Although older data could be used there is a risk this would be further compromised by network changes such as junction improvements and developments. The collision data has been obtained from the road safety data page on data.gov.uk.

For each junction, collisions that fall within the required 'Y' distances have been recorded. In this way, collisions at or approaching the major/minor junction are captured. This large area is proposed to capture the wider effects of a sub-optimal junction e.g. shunts on the approach caused by vehicles pulling out into small gaps. The coordinates of each collision that fall within the visibility splay 'buffers' have been mapped with open source ordnance survey data to create collision plans for each junction (see example in Figure 3-3). Each of the plans have been manually interrogated to identify any collision, where it can be determined with a good level of confidence, that it was the result of another junction or feature close-by. These collisions have then been omitted from the data set.

Figure 3-3 Example junction collision plan generated using GIS



3.3. Traffic Flow Data

In order to generate comparable collisions rates, traffic flow data is required. Traffic flow data for the major road has been obtained from the traffic count page on the dft.gov website. For each junction, the most relevant count site available has been selected. If there is no count site that can be considered to be at least broadly representative of the traffic flows for a given junction, the intention was to eliminate the junction from the study; however, given that traffic flow data is more readily available for trunks roads, it has not been necessary to eliminate any junctions from the study. Notwithstanding this, there are still limitations to this approach (refer to Section 7.1. for details).

3.4. Departures from Standard Data

Historic DfS data is required to determine whether any potential changes to the visibility requirements are likely to reduce the number of future DfS submissions (and therefore the workload required to administer them). A comparison of the substandard visibility splays applied for against any potential relaxations to the requirements recommended by this work will allow for a reasonable estimate of potential future DfS saving. The DfS data for this study has been accessed directly from DAS from Highways England's Guildford office.

[6] 1st of January 2011 to 31st of December 2015.

4. Analysis

This section provides an overview of the findings of the research. All the data presented and commented on has been extracted from the companion analysis spreadsheet (refer to Section 1.5).

4.1. Junction Sample Size

380 junctions were originally identified as being potentially suitable for analysis. A further 14 of which were later discounted following a final review of their suitability, leaving a total of 366 junctions to be taken through to the analysis stage.

Of the 366 junctions, LiDAR data was not available for 56 of them, leaving a total of 310 junctions where it has been possible to measure the visibility splays. Table 4-1 details the number of each junction type analysed. While a significant number of suitable simple and ghost island junction types were identified, due to the nature and configuration of SLD junctions, only twelve of these have been included (refer to the Section 7.4 for further information on this limitation).

Table 4-1 Total number of junctions by type.

Junction Type	No.
Simple	185
Ghost Island	113
SLD	12
All	310

Figure 4-1 shows the percentage split of junctions by speed limit of the major road. While the decision to provide one form of junction over another is based primarily on traffic flows (refer to Figure 2/2 of TD 42) it is not surprising to see that the more complex junctions feature more predominately on faster routes where safety plays a more significant role in the selection of an appropriate junction form.

Figure 4-2 shows the average number of collisions per billion vehicle miles for each junction type. The average is for all junctions analysed and does not take into account compliance with the visibility requirements. While only a small number of SLD junctions have been analysed, the graph suggests that ghost island junctions are the safest form of priority junction. It also suggests that in general, SLD junctions perform worse in safety terms than other priority junction forms. Notwithstanding this, SLD junctions are typically introduced where side road traffic flows are greater, which may act to push up the average collision rate given that the rates derived for this study are based on major road traffic flow figures (refer to 7.1 for further details).

Figure 4-1 Split of junctions by speed limit of the major road

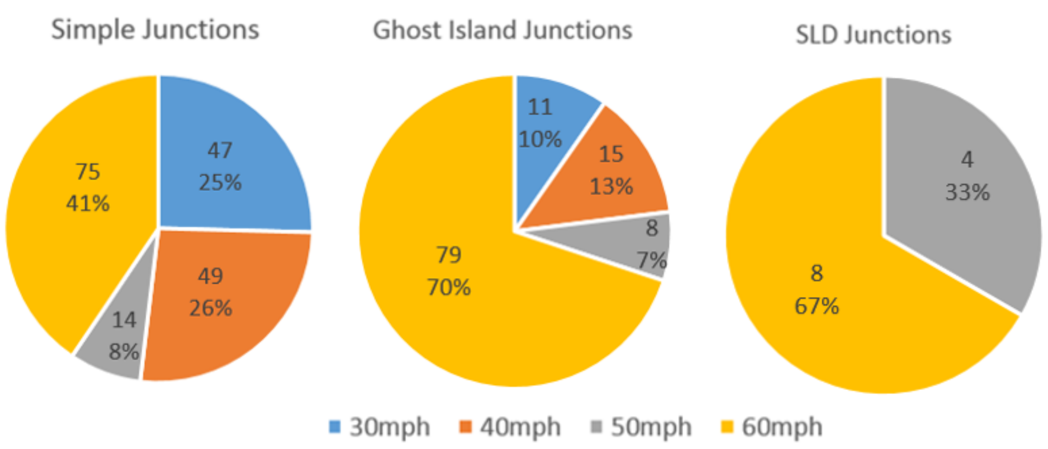
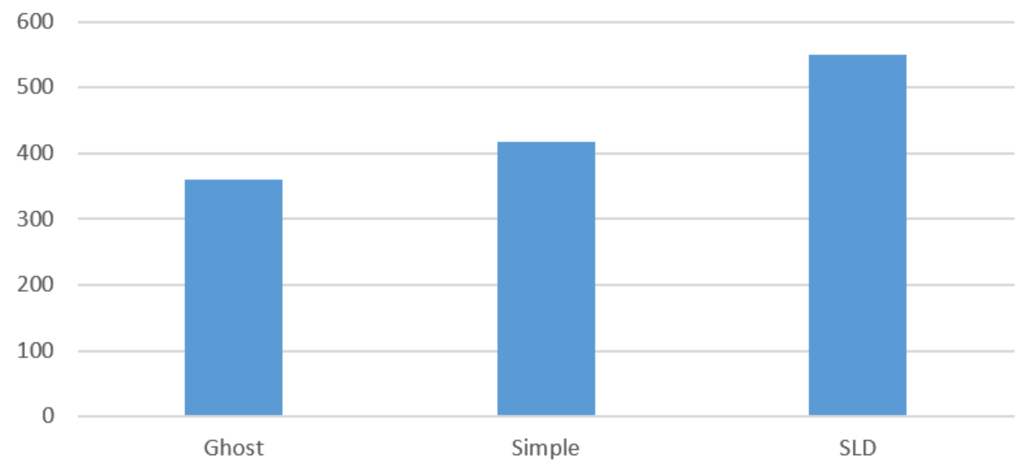


Figure 4-2 Average annual number of collisions per billion vehicle miles for each junction type

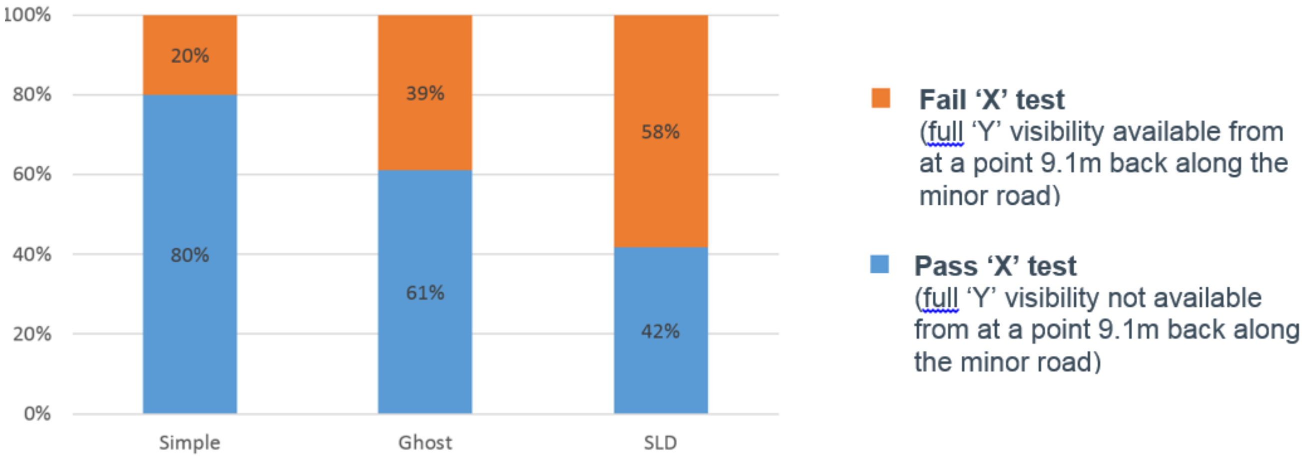


4.2. 'X' Visibility Compliance

As detailed in Section 2.2.1, if the full 'Y' distance is achievable from a point greater than 9.0m back along the minor road, then the junction would be non-compliant. Figure 4-3 illustrates the proportion of junctions that comply with the 'X' distance requirements. Where junctions fail the 'X' test, this means that the full 'Y' distance visibility is achievable from a point 9.1m back along the minor road.

Overall, nearly 30% of the 310 junctions analysed failed the 'X' test; however, a review of the historic DfS data indicates that no submissions against this requirement has been made since the switch to DAS[7]. This suggest that excessive visibility back along the minor road is often ignored or overlooked in the design process. The problem is greater with the larger junction forms, with 38% of ghost island and a majority (58%) of SLD junctions having excessive visibility back along the minor road. For SLD junctions this finding is not unexpected. The additional complexity of the minor road layout of SLD junctions can make it difficult to comply with the 'X' distance requirement whilst also providing a geometrically compliant layout.

Figure 4-3 Proportion of junctions compliant with the 'X' visibility requirements.



[7] Two DfS have been submitted against TD 42 clause 7.8 (which outlines the requirement that full visibility shall not be available from greater than an 'X' distance of 9m); however, these DfS did not actually seek approval for non-compliance with the 'X' distance requirement. It should also be noted that it is only TD 42 that includes a requirement relating to excessive visibility. There is no equivalent requirement in TD 41.

Figure 4-4 shows the average collision rate for each junction type based on compliance with the 'X' distance requirements. For each junction type, the average collision rate is higher where the junction is non-compliant i.e. there is 'too much' visibility back along the minor road. By omitting those junctions that are not compliant with the 'Y' visibility requirements, the difference in the collisions rates is more significant (refer to Figure 4-5). Isolating only one area of non-compliance with the visibility requirements makes it possible to state with a higher level of confidence that the variable being tested i.e. compliance with the 'X' distance requirements, is causing the difference. This finding therefore supports the existing TD 42 principle that too much visibility back along the minor road can be unsafe.

Figure 4-4 Average annual number of collisions per billion vehicle miles for each junction type based on compliance with the 'X' distance requirement

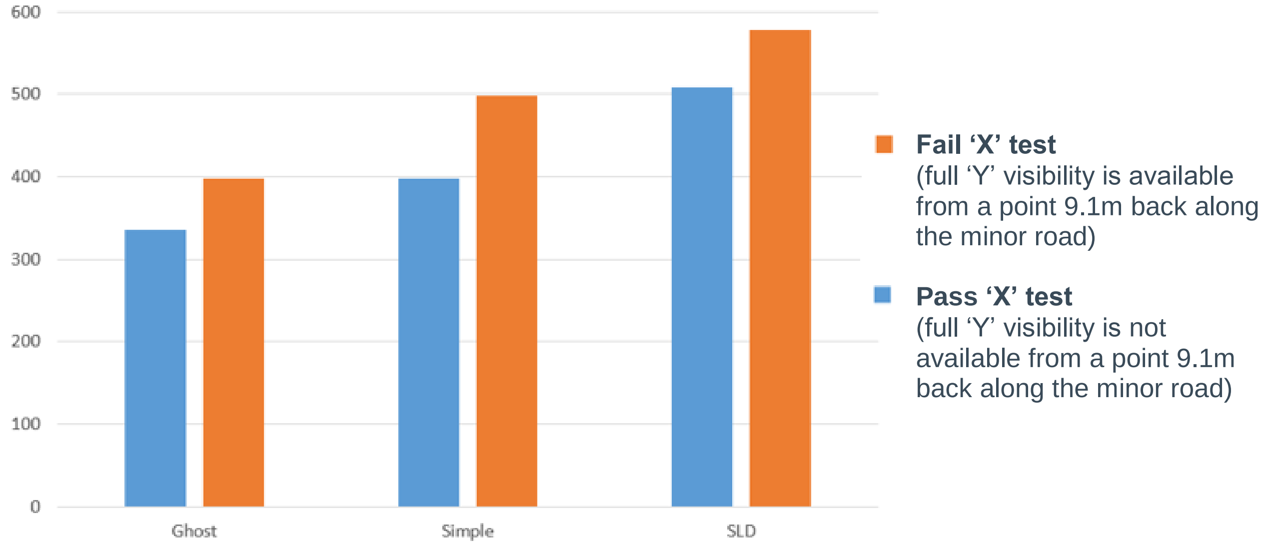
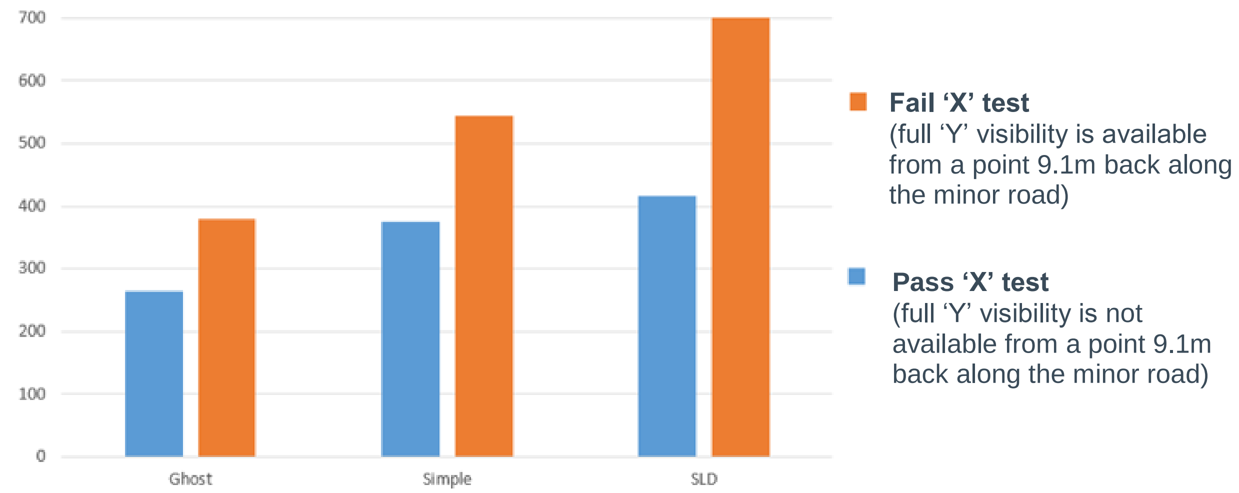


Figure 4-5 Average annual number of collisions per billion vehicle miles for each junction type based on compliance with the 'X' distance requirement (compliant 'Y' visibility only)



4.3. General 'Y' Visibility Compliance

Figure 4-6 illustrates the level of compliance with the 'Y' visibility requirements for each junction type. Table 4-2 details the four different categories reported on.

For simple junctions, the graph shows that less than half (43%) of the junctions analysed comply with the 'Y' visibility requirements. For ghost island junctions, the majority comply with the 'Y' visibility requirements but there is still a high proportion (40%) that don't. This is also true for SLD junctions. In general, Figure 4-6 illustrations that there is a significant level of non-compliance with the current 'Y' distance requirements across the trunk road network.

Table 4-2 'Y' visibility compliance categories

Category	Visibility to the left	Visibility to the right
Pass	To standard	To standard
Left failure	Substandard	To standard
Right failure	To standard	Substandard
Left and right failure	Substandard	Substandard

Figure 4-6 Level of compliance with 'Y' visibility requirements for each junction type

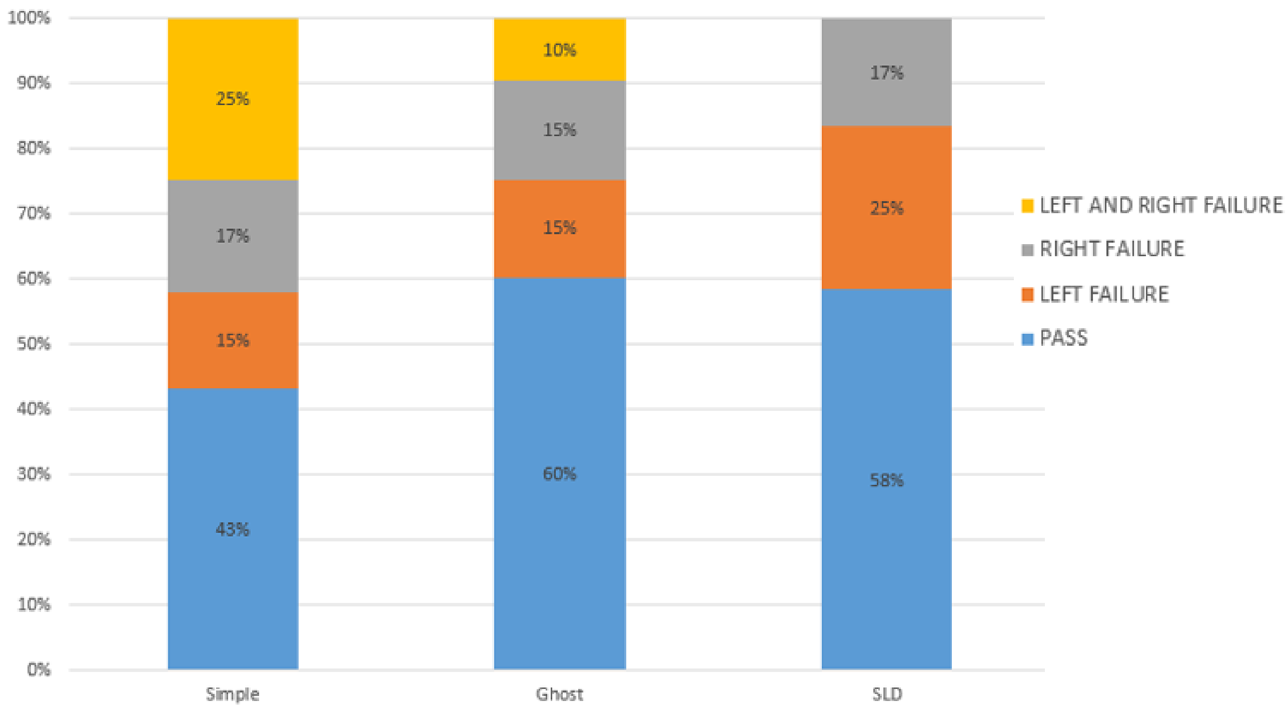


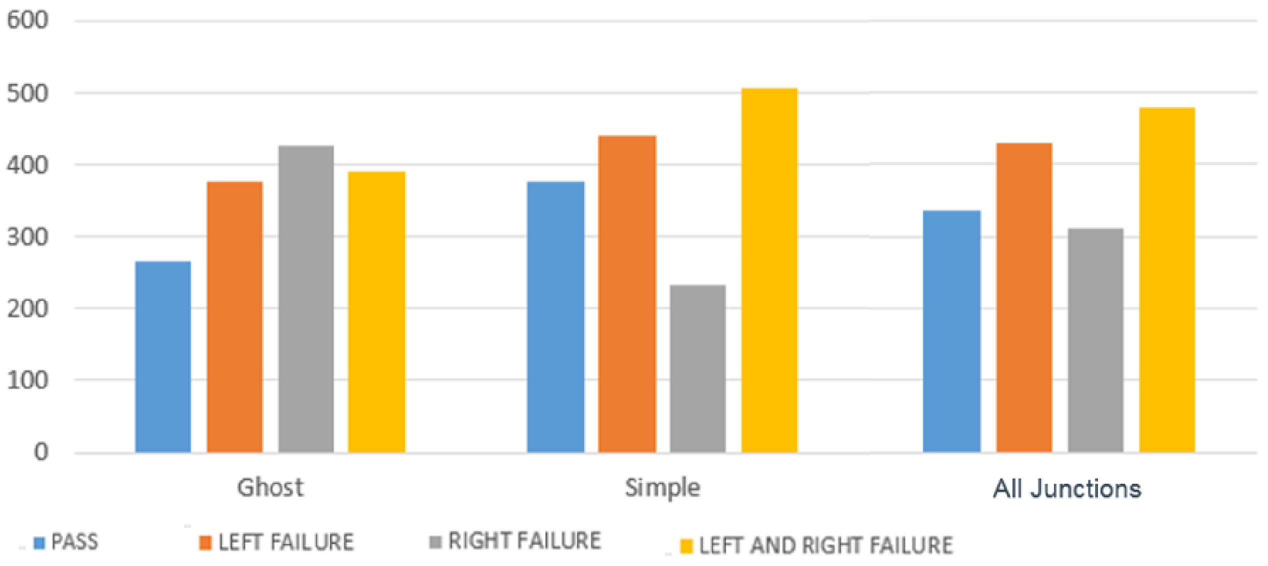
Figure 4-7 illustrates the average collision rate for each junction based on compliance with the 'Y' visibility requirements (the categories are as given in Table 4-1). Only those junctions that comply with the 'X' distance requirements have been included. SLD junctions have not been included in this test as there is not enough data for this junction type to provide any statistically meaningful results.[8]

For ghost island junctions, the collision rate is lower for junctions that fully comply with the 'Y' visibility requirements than those that do not. While there is very little difference between the collisions rates for the failure categories, the key finding for ghost island junctions is that where there is full compliance, the junction performs better.

For simple junctions, the collision rate is lower for junctions that fully comply with the 'Y' visibility requirements than those with non-compliant visibility to the left and also non-compliant visibility to both the left and right; however, for non-compliant visibility to the right of the junction, the collision rate is markedly lower than fully compliant junctions. This reason for this is not clear. The average collision rate for this category is based on data for 35 simple junctions and a more detailed review of the source data does not highlight any particular reason why this rate would be notably lower.

When all junctions are considered together (including SLD junctions), the average collision rate increases in line with expectations i.e. junctions that have substandard visibility to the left of the junction are less safe than compliant junctions and junctions with substandard visibility to the left and right perform even worse. The only exception is the 'right failure' category, although there is only marginal difference between this category and the fully compliant category.

Figure 4-7 Average annual number of collisions per billion vehicle miles for each junction type based on compliance with the 'Y' distance requirements (compliant 'X' visibility only)



[8] Only seven SLD junctions analysed passed the 'X' test and these seven would need to be split out over four categories in this particular test.

4.4. Main ‘Y’ Visibility Compliance

4.4.1. Overview

This section comprises the key output of this study. The graphs in Figure 4-8 to Figure 4-11 illustrate how the average collision rate varies as the level of compliance with the ‘Y’ visibility requirements deteriorate (only those junctions with compliant ‘X’ visibility have been included). The level of non-compliance is based on the percentage variance with the required visibility splays. As an example, if the required ‘Y’ distance is 215m but only 160m is available, then the level of compliance would be approximately 74%.

For each graph, the average collision rate for junctions that are fully compliant with the visibility requirements is provided as a benchmark for comparison. Each column includes the number of junctions that generate the average collision rate. Due to the small number of SLD junctions captured as part of the study and the fact that the majority of ghost island junctions do not comply with the ‘X’ visibility requirements, it is only appropriate to report for simple junctions and ‘all junctions’.

4.4.2. Visibility to the Left of the Minor Road

Figure 4-8 illustrates the collision rates for simple junctions with substandard visibility to the left of the minor road. The average collision rate for half of the substandard visibility groupings are broadly in keeping with the average rate for the compliant junctions. This also includes the 10-20% compliance group which represents a significant departure from the current ‘Y’ visibility requirements. For junctions with 40-70% of the required visibility, the average collision rate is notably lower than that for the compliant junctions.

Notwithstanding the above, the only notably outlier in this graph is the collision rate for junctions where the available visibility is between 0% and 10% of that which is currently required. For these junctions, the average collision rate is approaching twice the average rate of the complaint junctions.

If a trend line is added to the Figure 4-8 graph, it would show that the worse the visibility to the left of the junction gets, the worse the average collision rates gets; however, this is significantly impacted on by the high average rate for the 0-10% non-compliance category and is therefore not considered a useful finding.

Figure 4-9 provides the same information as Figure 4-8 but for all junctions. Although opening up the analysis to all junction types brings the total number of non-compliant junctions up from 69 to 95, this has not had any notable impact on the collision rate trends. The average collision rates for all junctions versus just simple junctions are broadly comparable.

4.4.3. Visibility to the Right of the Minor Road

Figure 4-10 and Figure 4-11 illustrate the collision rates for simple junctions with substandard visibility to the right of the minor road. As found with Figure 4-8 and Figure 4-9, the average collision rates for just simple junctions (73 in total) and all junctions (102 in total) are broadly comparable.

Figure 4-10 and Figure 4-11 show that for substandard visibility to the right of the junction, half of the groupings (30-70% and 80-90%) have notably higher average collision rates than the compliant junctions. The graphs show that the average collision rates are on a slight downwards trend i.e. the less visibility to the right of the junction there is, the better the junction has performed in safety terms.

4.4.4. Summary

While some specific findings have been highlighted above, in general there is no clear pattern illustrated by any of the four graphs to indicate that increasing levels of non-compliance with the ‘Y’ visibility requirements has had any notable impact on collision rates. While there are a multitude of factors that influence collisions (most notably of which is likely to be human behaviour), if substandard levels of visibility is a key contributory factor, then it would be expected that a clearer link between collision rates and visibility would be evident in the findings.

Figure 4-8 Average number of collisions per billion vehicle miles based on level of non-compliance with 'Y' visibility requirements to the left of the minor road – Simple junctions only

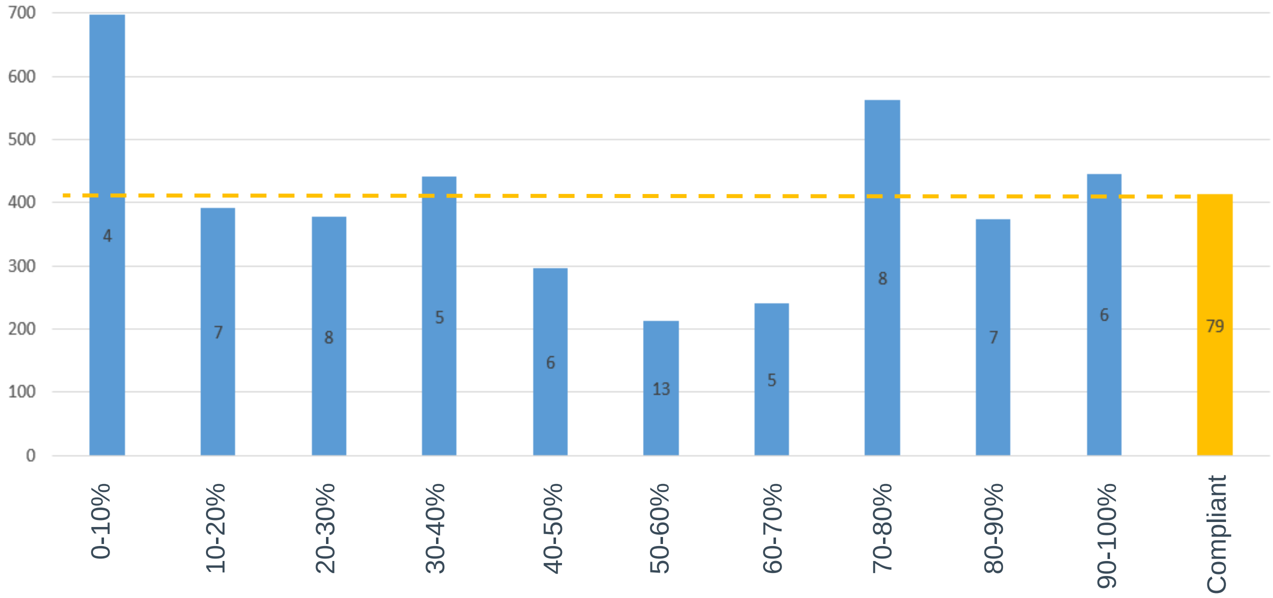


Figure 4-9 Average number of collisions per billion vehicle miles based on level of non-compliance with 'Y' visibility requirements to the left of the minor road – All junctions

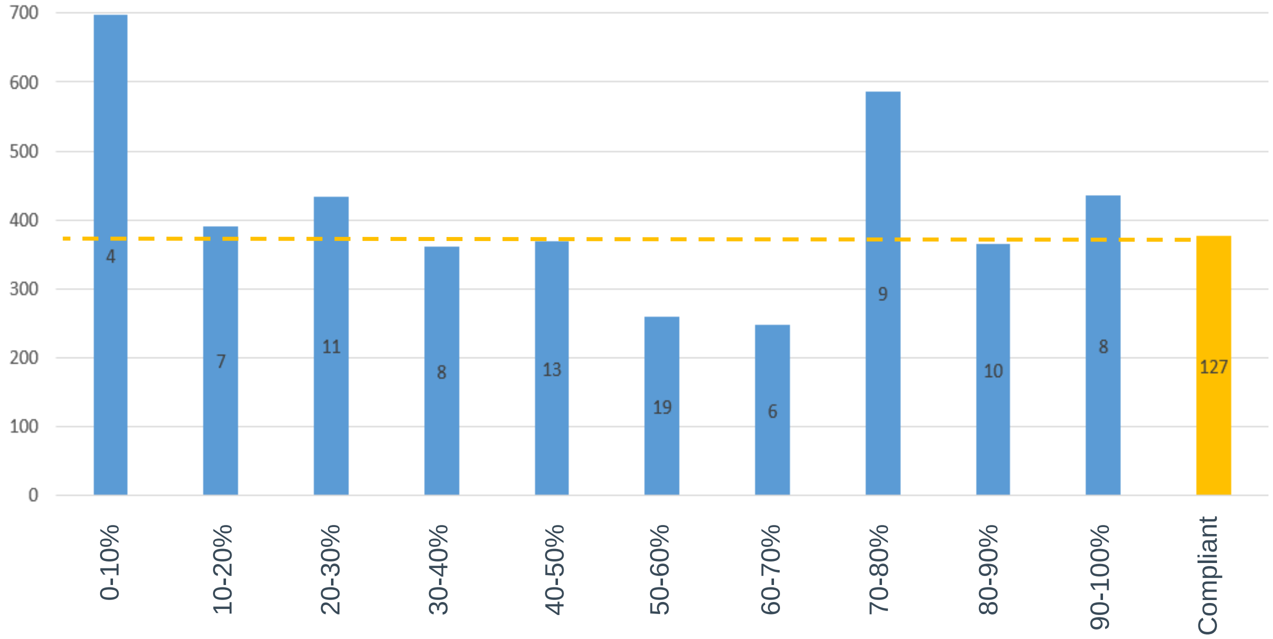


Figure 4-10 Average number of collisions per billion vehicle miles based on level of non-compliance with 'Y' visibility requirements to the right of the minor road – Simple junctions only

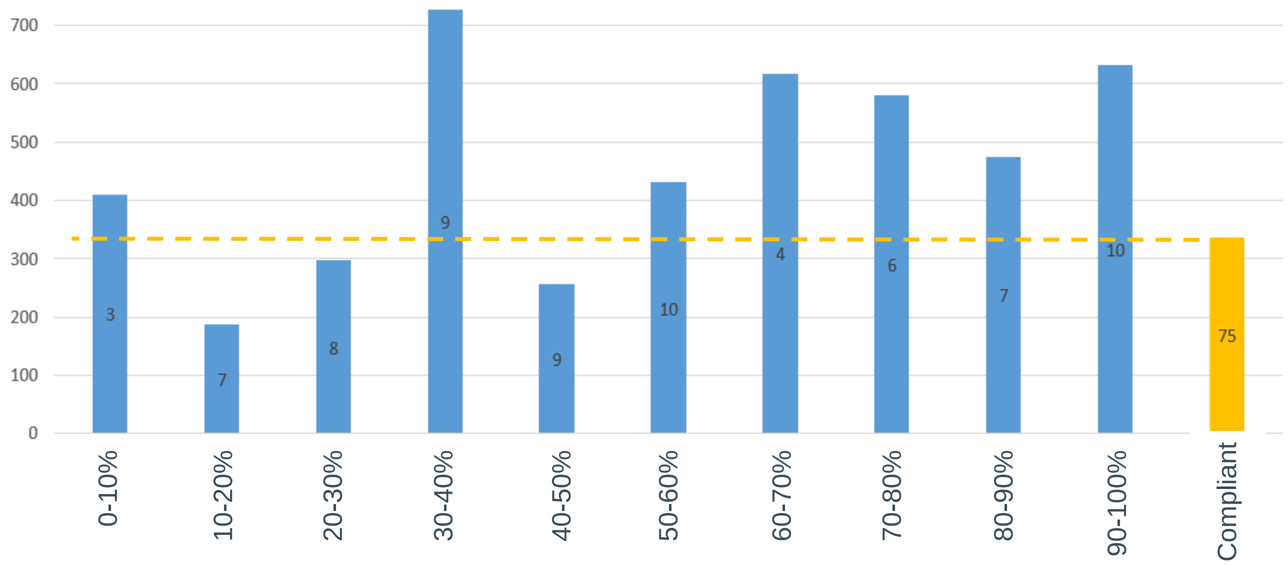
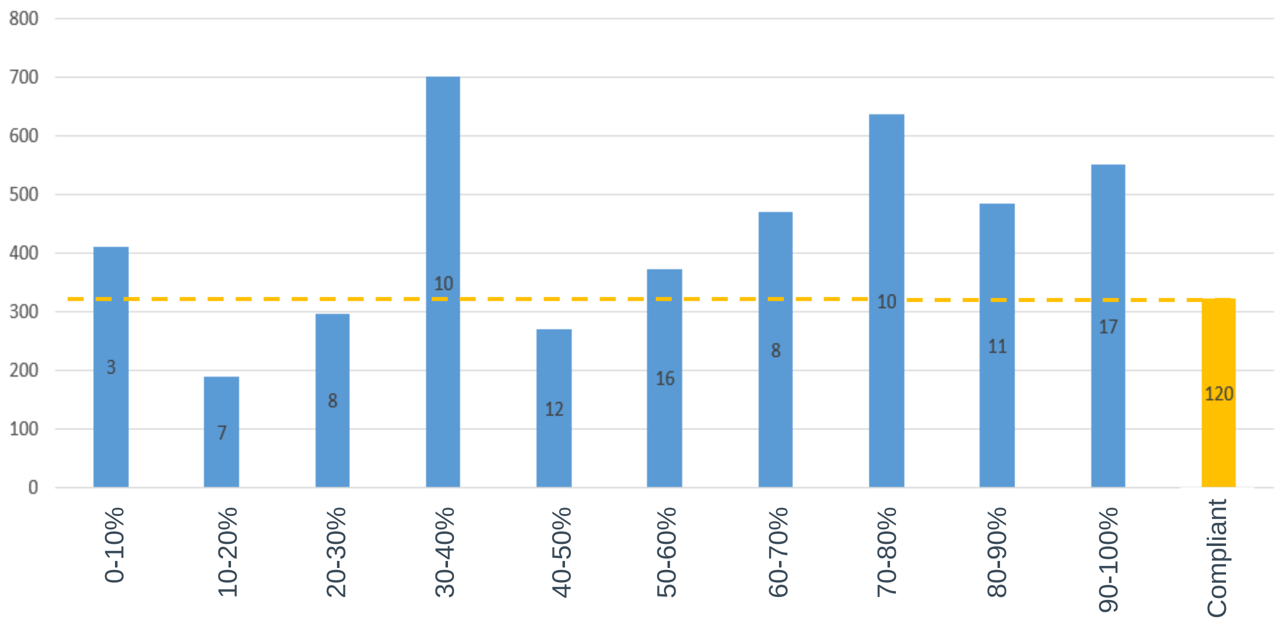


Figure 4-11 Average number of collisions per billion vehicle miles based on level of non-compliance with 'Y' visibility requirements to the right of the minor road – All junctions



5. Departures from Standard

5.1. Overview

This section looks at the number of DfS submitted against the visibility clauses in TD 41 and TD 42. As the current visibility requirements are not written in a particularly clear manner, there are a variety of clauses that DfS have been submitted against for reduced visibility. In order to capture all relevant DfS, searches have been made against the following clauses:

- TD 41 paragraphs 2.15 to 2.26; and
- TD 42 paragraph 7.3 to 7.11.

For TD 42, a total of 89 individual DfS have been submitted. For TD 41, 120 individual DfS have been submitted. This gives a total of 209 DfS across the documents. This figure represents all the DfS submitted since DAS was introduced.

The summary information for each of the 209 DfS has been reviewed to determine whether they actually relate to reduced 'Y' distances. Following this review, 13 of the 120 DfS submitted against TD 41 and 20 of the 89 DfS submitted against TD 42 have been omitted. For a further 20 DfS, the summary information does not make it clear what requirement is being departed from. These 20 DfS could relate to reduced 'Y' visibility but it cannot be said with a high level of confidence that they are.

A reoccurring reason for omitting a DfS was the submission requesting approval for measuring the 'Y' distance from an 'X' distance of 2.4m rather than 9m or 4.5m. A good example of this is DfS reference 74326 (ultimately withdrawn), which reads:

"Visibility can only be provided from an x-distance of 2.4m as opposed to a normal 4.5m. The proposer believes it would only become a departure if the x-distance dropped below 2.4m and does not feel that this proposal constitutes a departure, but the form is completed for the avoidance of doubt. In this instance, as will be shown, it is likely to be safer than providing the standard "x" distance."

DfS submitted for not using 'X' distances of 9m or 4.5m are particularly common in the TD 42 data set. This illustrates how users are misinterpreting the requirements, which supports the view that they are unclear.

5.2. Analysis

Figure 5-1 to Figure 5-4 illustrate the percentage variance between the required 'Y' visibility and the substandard 'Y' visibility requested in the same manner as the graphs within the preceding section (refer to 4.4.1). These graphs will be used to help determine the impact that potentially altering the visibility requirements may have on DfS workload.

The remaining 156 DfS include requests for 205 instances of substandard 'Y' visibility[9]. Table 5-1 details the number of requests for substandard 'Y' visibility in relation to direction. For those requests listed as 'direction unknown', the DfS summary did not include sufficient information to allow for the direction to be deduced.

Table 5-1 Number of requests for substandard 'Y' distances across the DfS.

Instances of requests for substandard 'Y' distances			Total
Left of junction	Right of Junction	Direction Unknown	
65	77	63	205

[9] Due to bulk DfS i.e. a single DfS containing requests for substandard visibility at a number of junctions across a scheme, or a single DfS containing a request for substandard 'Y' visibility in more than one direction at a particular junction.

Figure 5-1 Number of requests for substandard 'Y' visibility to the left of the junction based on the percenragte variation with the required visibility

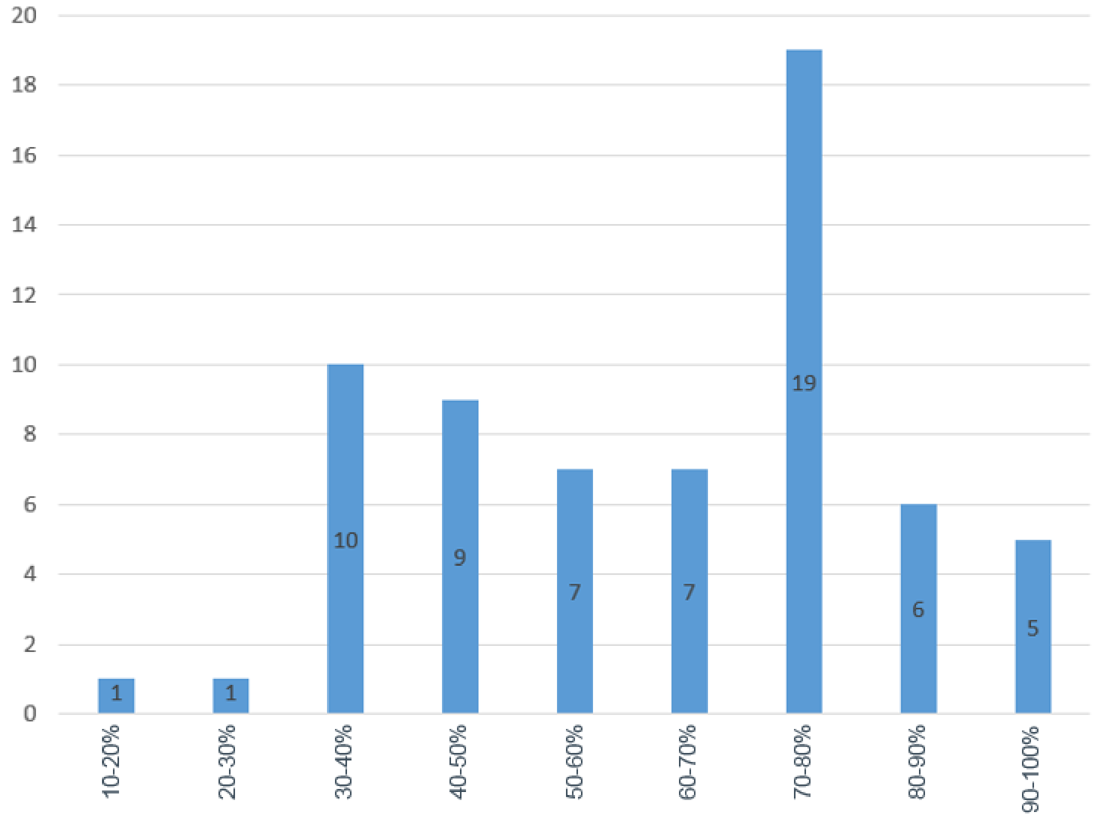


Figure 5-2 Number of requests for substandard 'Y' visibility to the right of the junction based on the percenragte variation with the required visibility

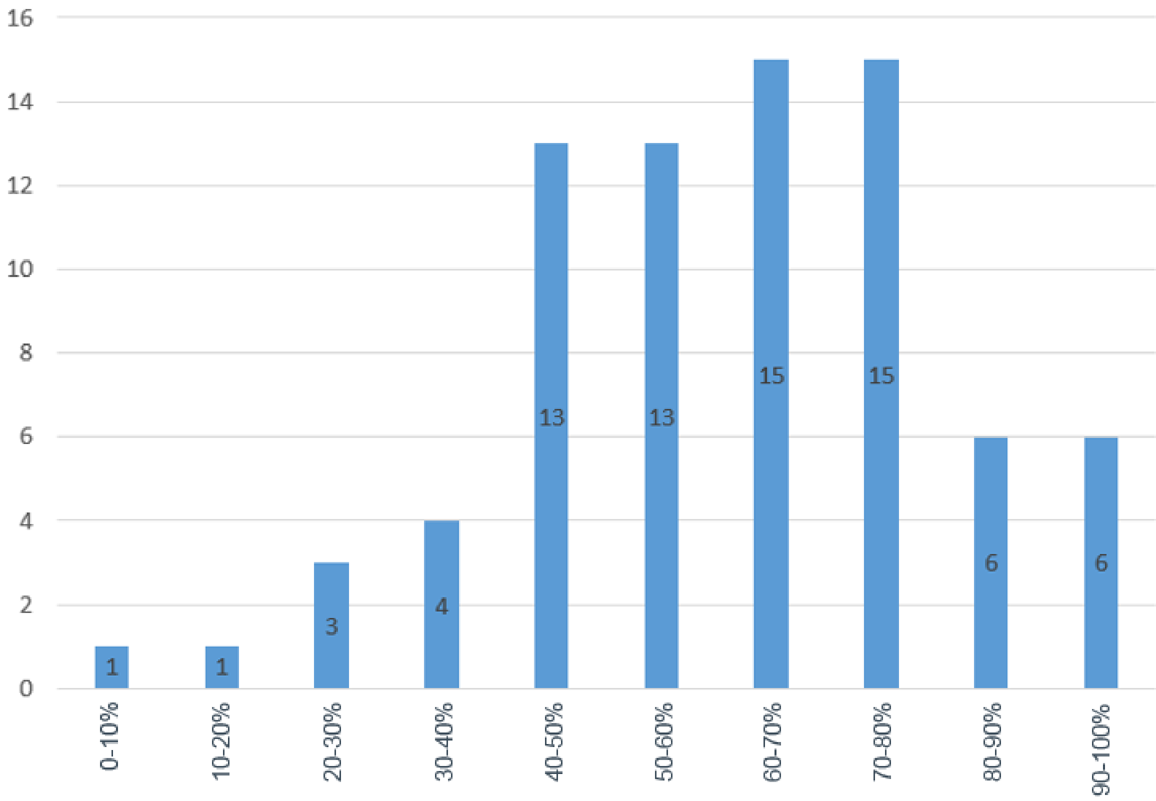


Figure 5-3 Number of requests for substandard 'Y' visibility where the <u>direction is unknown</u> based on the percenragte variation with the required visibility

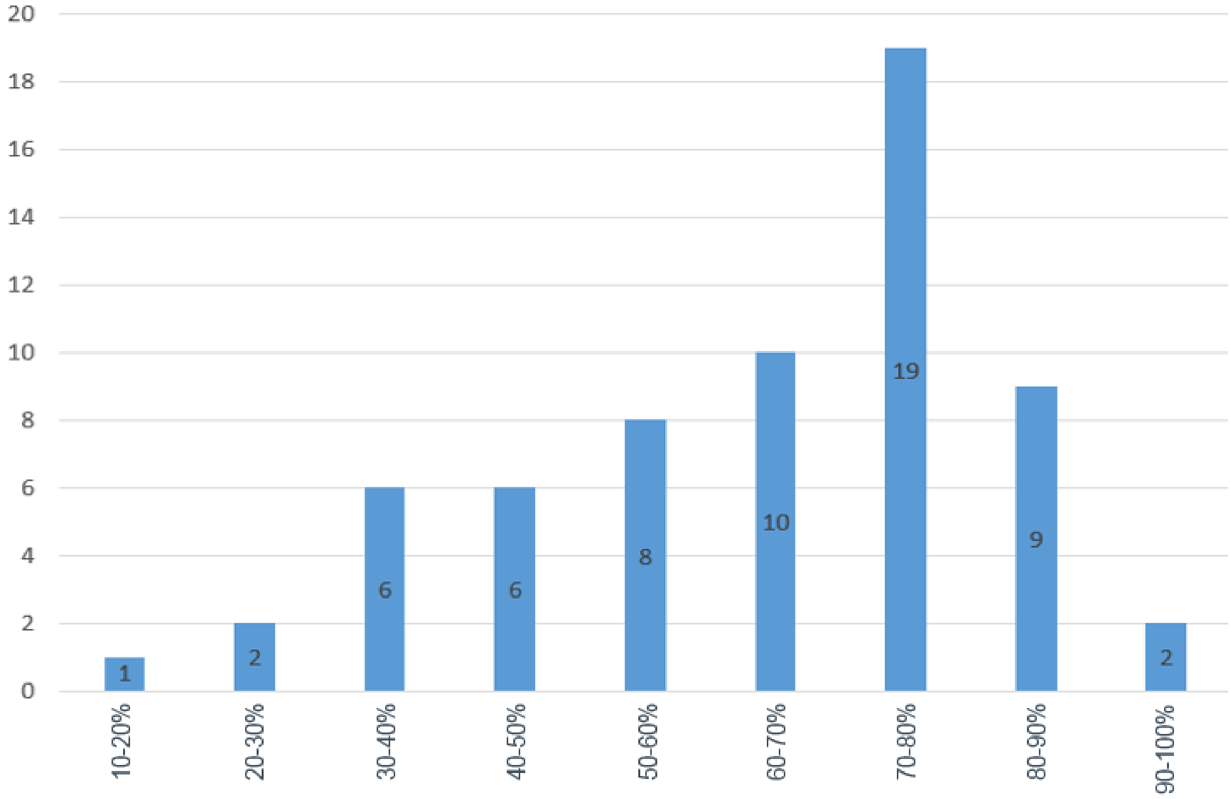
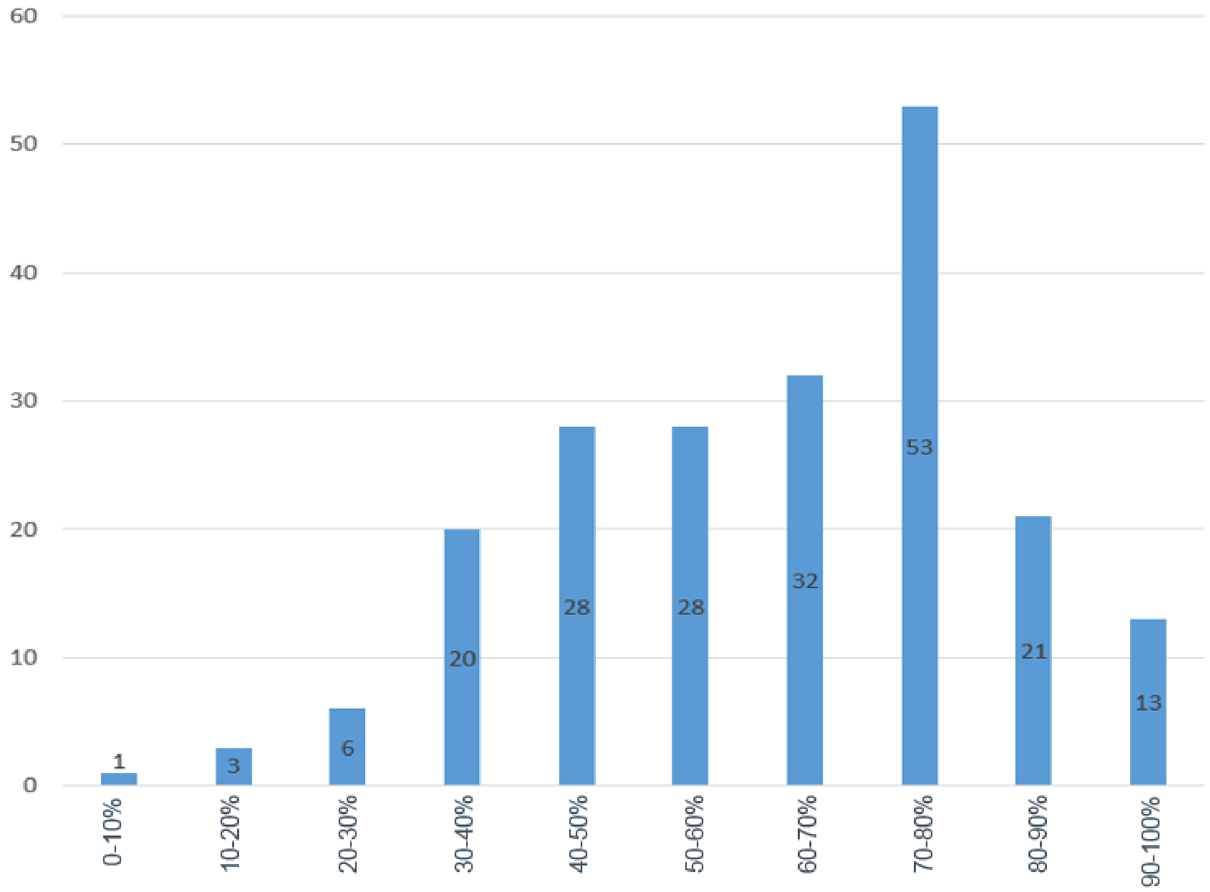


Figure 5-4 Number of requests for substandard 'Y' visibility to the <u>left and right of the junction</u> based on the percenragte variation with the required visibility



When all the requests for substandard ‘Y’ visibility to both the left and right of the junction are combined (Figure 5-4), a clear trend emerges. Starting at a compliant level of visibility, the number of requests for substandard visibility increases until the 70-80% mark where it reaches a peak. At this point the number of requests steadily reduce as the level of compliance reduces towards maximum non-compliance.

Figure 5-4 shows that 70-100% compliance with the visibility requirements accounts for approximately 42% (87 of 205) of all the substandard ‘Y’ distances requested. As illustrated by Table 5-2, a 30% reduction in ‘Y’ distance visibility broadly equates to a one step reduction in Stopping Sight Distance (SSD).

Table 5-2 One step reduction in SSD (Table 2 of TD 9) compared to a 30% reduction

Design Speed	SSD (required ‘Y’ visibility)	One step reduction	30% reduction	Reduction difference
120kph	295m	215m	207m	8m
100kph	215m	160m	151m	9m
85kph	160m	120m	112m	8m
70kph	120m	90m	84m	6m
60kph	90m	70m	63m	7m
50kph	70m	50m	49m	1m

Looking at the 70-100% range in isolation, the vast majority of the requests for reduced ‘Y’ distances are for roads with a design speed of 70kph, 85kph and 100kph (refer to Figure 5-5). Given the nature of the single carriageway roads that make up the trunk road network this finding is not surprising.

DAS went live in January 2001[10]. Based on the number of years DAS has been in service, 4 DfS in total equates to a future saving of approximately 0.25 DfS per year. A relaxation of the ‘Y’ distance visibility for 50kph and 60kph roads would therefore provide a very limited benefit in terms of DfS workload; however, a relaxation of one design speed for the 100kph, 85kph and 70kph design speeds would likely to have a more noticeable beneficial impact on DfS workload, with a potential future saving of approximately 4.5 DfS per year.

Of the 83 DfS submitted in the 70-100% compliance range for 70kph to 120kph design speeds, 10 were withdrawn. As illustrated in Figure 5-6, of the remaining 73 DfS, a significant proportion were approved (65 in total[11]) with only handful of them rejected (8 in total). This means that in most cases a one-step reduction in ‘Y’ distances for 70kph to 120kph roads is already predominately being accepted on the network.

[10] Some historic DfS data was added to the system; however, the reference IDs for these are less than 30000. None of the DfS records analysed as part of this research have an ID number smaller than 30000 (the lowest ID number within the data set is 30093), meaning no DfS analysed as part of this research predates DAS.

[11] This figure is made up of DfS categorised as ‘approved’, ‘approved with comments’ and ‘application received’. The ‘application received’ category is effectively confirmation of an approval for DBFO schemes; however, as Highways England do not technically approve these DfS they are not specifically categorised as such.

Figure 5-5 Number of requests for substandard visibility per design speed within the 70-100% compliance range from Figure 5-4

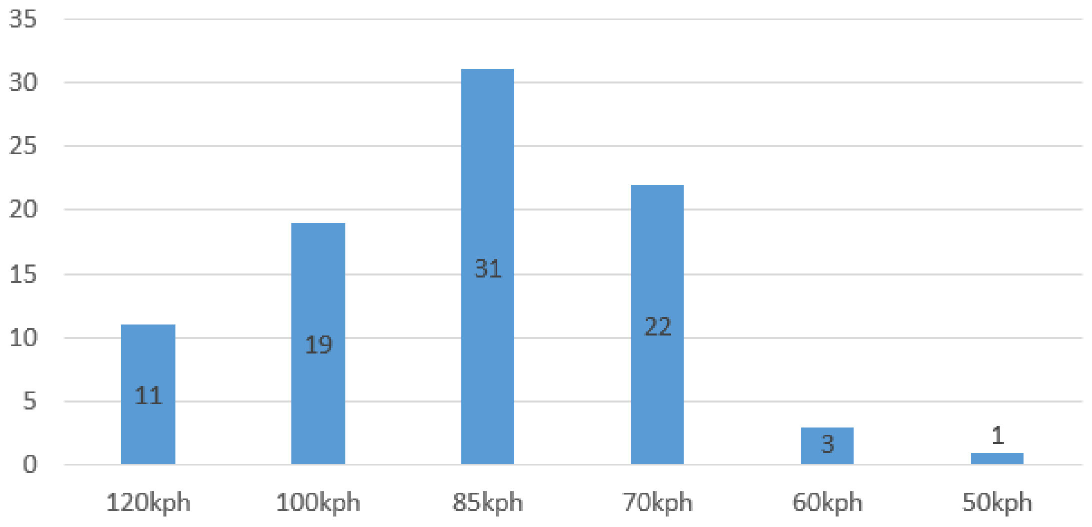
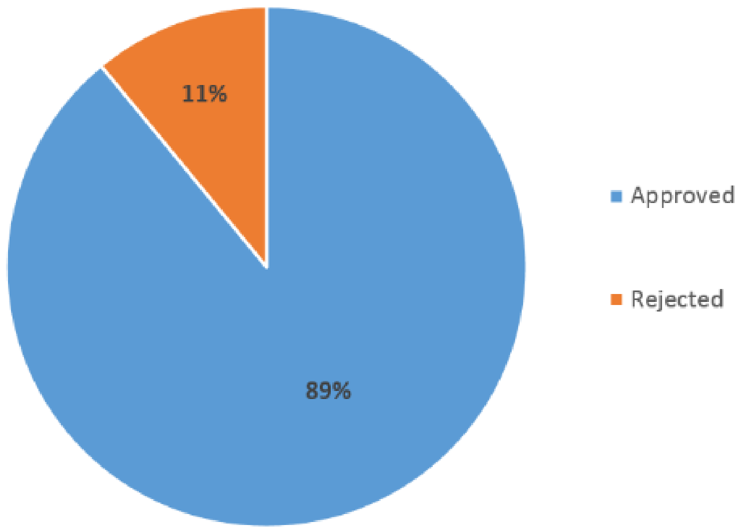


Figure 5-6 Proportion of approved and rejected DfS in the 70 to 100% compliance range for 70kph to 120kph design speeds



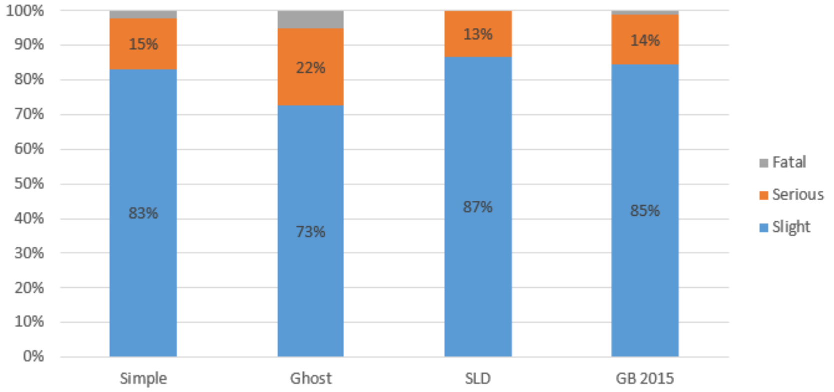
6. Other Factors

This section described the analysis of non-visibility related or 'other factors', which is complimentary to the main research objectives. The purpose of this analysis is to determine whether there are any other significant issues arising from the collisions at the priority junctions included in the study that may be of interest in the wider context. Where comparisons are made to national statistics, the data has been taken from Reported Road Casualties Great Britain (RRCGB) 2015 (specifically tables RAS 10005 & RAS 10006).

6.1. Collision Severity

Figure 6-1 illustrates the percentage split of collisions at each junction by severity against the national rate for all roads in Great Britain. The proportional split of severity at each junction type is broadly in line with the national trend. The only slight exception is ghost island junctions which have a slightly higher proportion of serious and fatal collisions and a slightly lower proportion of slight; however, the difference is not significant enough to draw any definitive conclusions.

Figure 6-1 Proportion of collisions by severity

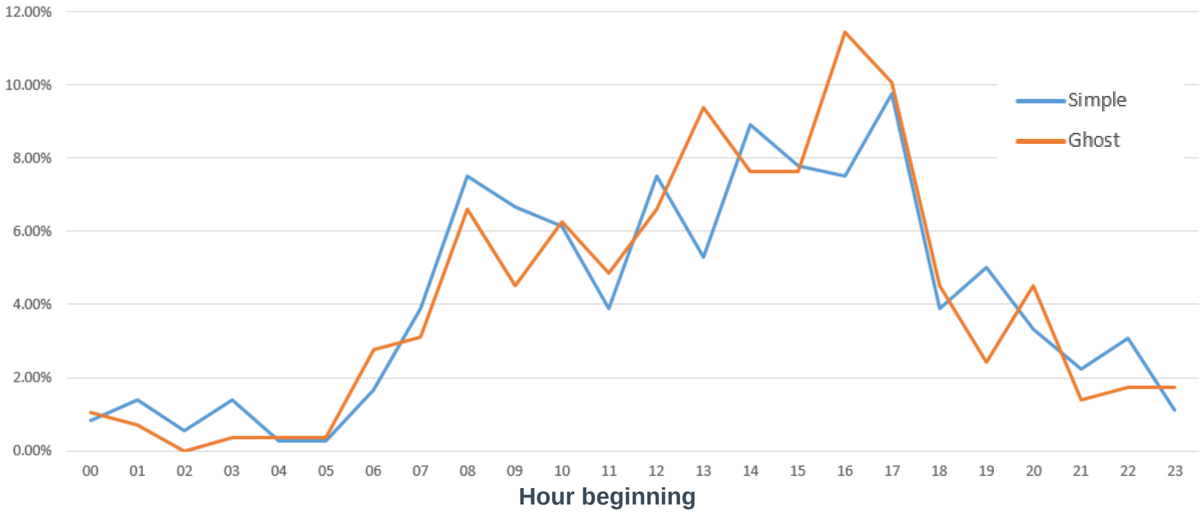


6.2. Collisions by Time of Day

Figure 6-2 illustrates the proportion of collisions that have occurred at simple and ghost island junctions by time of day. SLD junctions have not been included as there is insufficient data for this junction type.

While RRCGB 2015 does not provide sufficiently detailed data to compare against, there does not appear to be anything unusual about the spread of collisions at either junction type. For each junction type, the majority of collisions occurred during the daytime period with the highest concentration in the evening peak. Most importantly, the spread of collisions is broadly comparable across the two junction types.

Figure 6-2 Proportion of collisions by time of day (simple and ghost island junctions only)



6.3. Collisions by Conditions

Figure 6-3, Figure 6-4 and Figure 6-5 illustrate the proportion of collisions at each junction type by street lighting provision, weather and road surface conditions.

In each graph, the proportion of collisions for each junction type is broadly comparable to the national rate. The only slight exception is that SLD junctions have a higher proportion of collisions in daylight; however, given the small number of junctions in this sample, the difference is not significant enough to carry any particular importance.

Figure 6-3 Proportion of collisions by street lighting

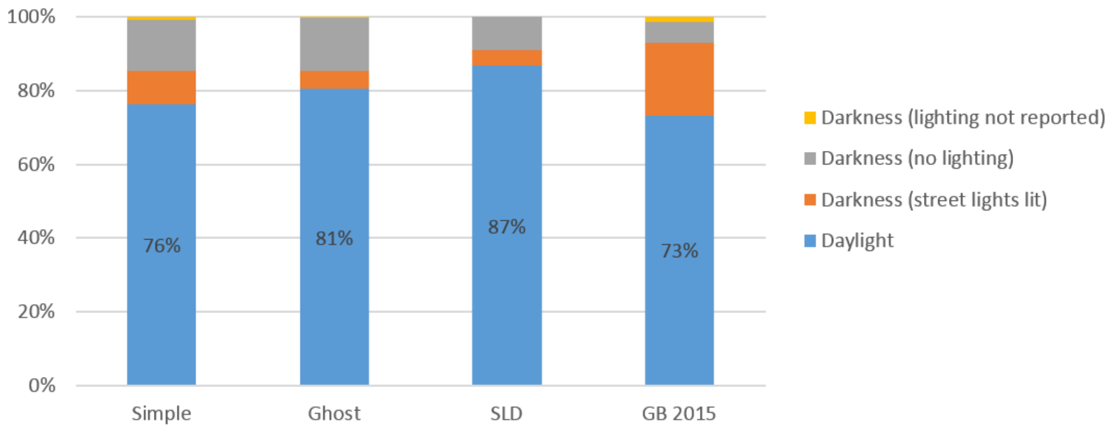


Figure 6-4 Proportion of collisions by weather condition

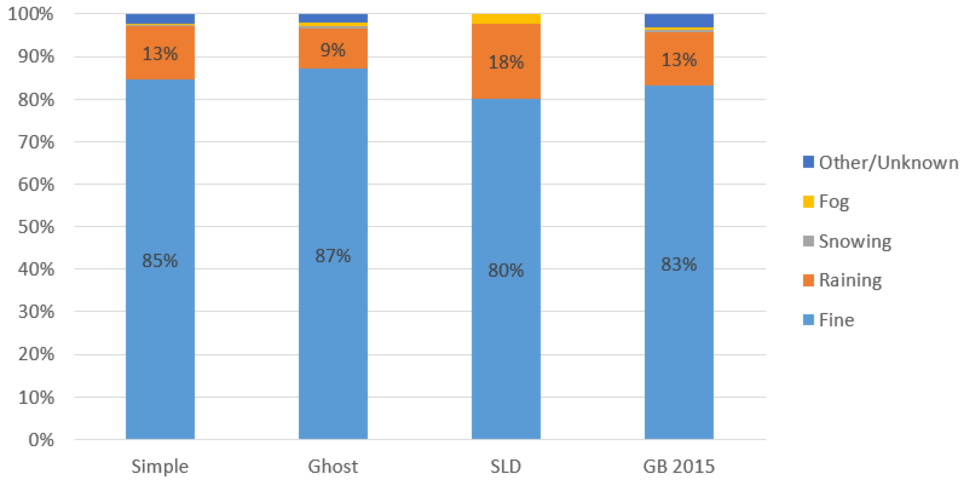
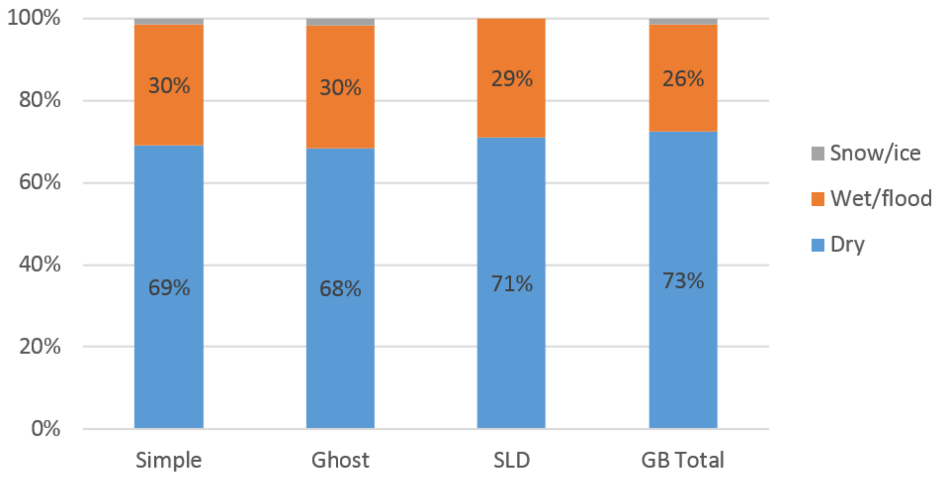


Figure 6-5 Proportion of collisions by road condition



6.4. Vulnerable Road Users

Figure 6-6 illustrates the proportion of collisions at each junction type involving vulnerable road users.

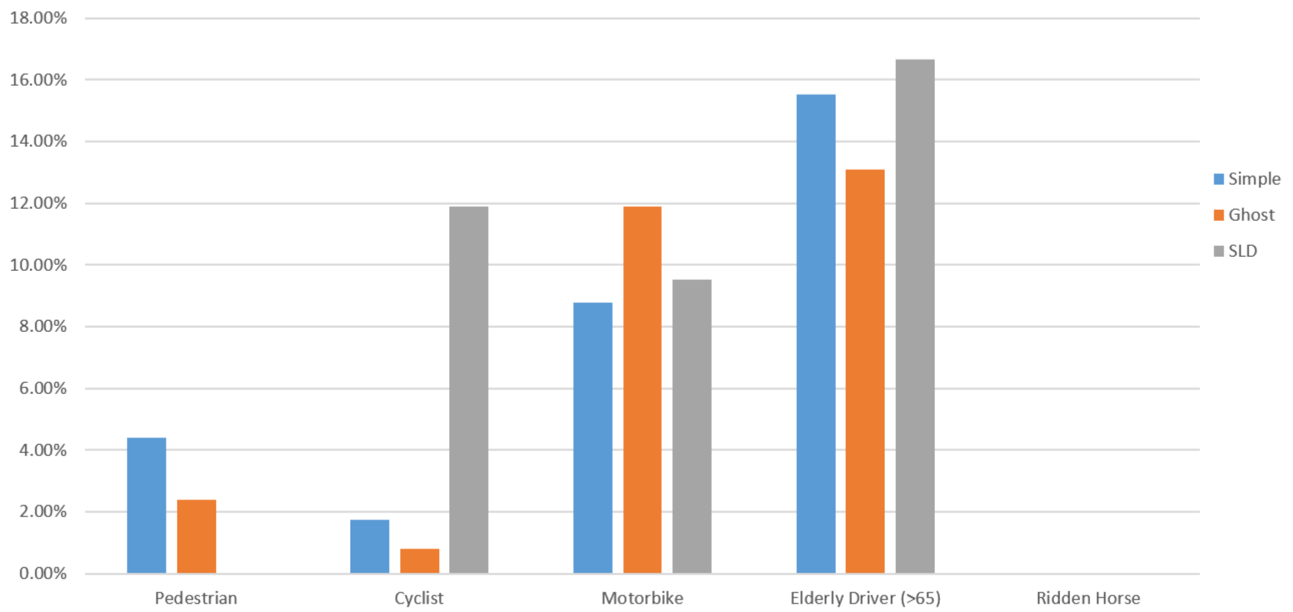
The proportion of collisions involving pedestrians at simple junctions is almost double that of ghost island junctions. In contrast, no collisions involving pedestrians occurred at any of the SLD junctions analysed. This level of difference is not unexpected. Simple junctions are more likely to feature in urban environments where there is a greater level of pedestrian activity, whereas SLD junctions are more likely to be located in rural environments where there will be little or no pedestrian movements. Ghost island junctions are frequently used in both urban and rural environments. In addition, ghost island junctions may include pedestrian refuge islands within the hatching to allow crossing movements to be completed in two stages. This may explain the almost incremental step in the proportion of pedestrian collisions between the three junction types.

For simple and ghost island junctions, the proportion of collisions involving cyclists is similar; however, the proportion of collisions involving cyclists is significantly higher at SLD junctions. This is the first instance where SLD junctions have performed significantly worse than the other priority junction types. Of the 42 collisions that occurred at the SLD junctions, 5 of them involved cyclists. While only a limited number of SLD junctions have been analysed as part of this study, the proportional difference compared to simple and ghost island junctions in this regard is notable and may justify further investigation.

The split of collisions involving motorbikes is broadly comparable for simple and SLD junctions. While there is a greater proportion of collisions involving motorbikes at ghost island junctions, the difference is not considered significant enough to carry any particular importance. The same is true for collisions involving elderly drivers; although it is interesting that the highest proportion of collisions involving this user group is at SLD junctions. The complexity of this junction type was highlighted as part of the TD 41 and TD 42 scoping study (completed in 2016 by Atkins) as being particularly challenging for elderly users. Notwithstanding this, the overall variance in collisions across the three junction types in this regard is not significant enough to draw any firm conclusions.

No collisions that occurred at any of the junctions analysed as part of this study involved ridden horses.

Figure 6-6 Proportion of collisions involving vulnerable road users

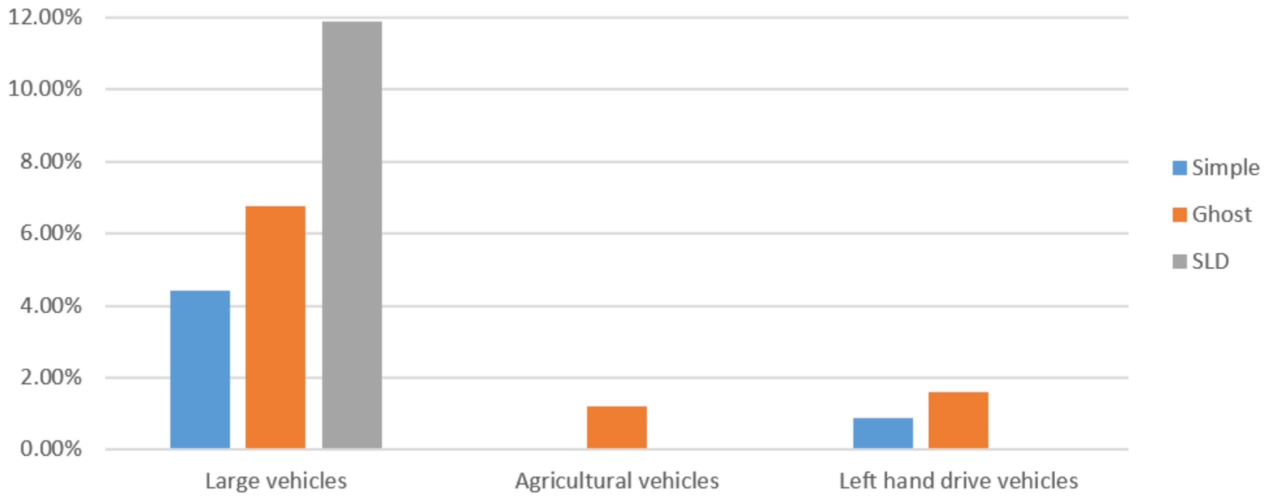


6.5. Larger and Slower Vehicle Types

Figure 6-7 illustrates the proportion of collisions at each junction type that involved either a large vehicle (goods vehicles over 7.5t, buses and coaches), an agricultural vehicle (such as a tractor) and left hand drive vehicles.

While there are no particular findings relating to agricultural vehicles or left hand drive vehicles, the number of collisions involving large vehicles at SLD junctions is significantly higher than at simple and ghost island junctions. This supports the findings of the earlier TD 41 and TD 42 scoping study that highlighted problems with SLD junctions being able to safely cater for larger vehicles such as HGVs. At many SLD junctions, the central opening is not sufficient to safely accommodate a HGV waiting to turn. In some documented cases, collisions have occurred as a result of a vehicle continuing ahead colliding into the trailer of a HGV waiting in the central opening. It is therefore not surprising that SLD junctions have a higher proportion of collisions involving larger vehicles.

Figure 6-7 Proportion of collisions involving particular vehicle types



7. Limitations of the Research

7.1. Traffic Flows

All collision rates calculated as part of this research are based on major road traffic flows. While traffic flow data for the trunk road network is readily available, this is not the case for the minor roads. In order to obtain traffic flow data for the minor roads, it would be necessary to commission a large amount of traffic data which is outside the remit of this research.

As a consequence of basing collisions rates on major road flows, the amount of turning traffic at each junction has not been factored into the results; however, the key element that determines a suitable type of priority junction is minor road traffic flow. This means that the volume of turning traffic at each junction type should be within a set range. As a result, basing the collision rates on major road flows is considered only a minor weakness of the research.

7.2. Collision Relevance

As this project involves the analysis of junctions across the whole of England, it has not been feasible to collate detailed STATS19 collision data due to the volume of work this would require and the short timeframe of this project. Instead, open source collision data that is readily available has been used.

The downside of using open source collision data is that the detailed description field, contributory factors and movement diagrams are not included. It has therefore not been possible to determine with a high level of confidence whether visibility may have been a contributory factor in the collisions that occurred at the junctions. What this means in practice is that it hasn't been possible to omit collisions that may have been removed if the aforementioned information was available to analyse.

Notwithstanding the above, the key to this research is the level of variance in the collision rates and not specifically the collision rate figures themselves. As a result, it is more important that a consistent approach is applied. As this has been achieved in the research methodology, not having detailed collision data is not considered a significant weakness. In addition, even if more detailed data was available, it would not be possible to rule out substandard visibility as a contributory factor at any of the substandard junctions.

7.3. Turning Movements

While turning movement classes are included in the data set, without the detailed description or movement diagrams available with more detailed collision data (refer to Section 7.2 above), it has not been possible to determine whether the driver of a vehicle turning out of the minor road was likely to blame for a collision. In addition, it has not been possible to determine which way that vehicle was turning when the collision occurred. This level of detail would provide a greater level of insight into the nature of the collisions that have occurred and whether the need for left/right visibility is greater when vehicles are turning left or right out of a junction.

7.4. SLD junctions

During the junction selection process, only twelve suitable SLD junctions were identified. The main reason for this is that there are not very many SLD junctions on the trunk road network. Where there are SLD type openings in the central reserve, these are mainly located on dual carriageway roads. In addition, due to the overall space required to introduce a SLD junction, they frequently overlap with other minor junctions resulting in a more complex layout that does not suit the suitability criteria for this research.

While it has not been possible to look at how varying levels of visibility effect collision rates specifically at SLD junctions, it should be noted that the visibility requirements at SLD junctions are currently no different than for other forms of priority junction. It is therefore expected that any recommendations arising from this research could be equally applied to SLD junctions; albeit them representing only a small proportion of the junctions analysed.

7.5. Changing Visibility Splays

Whether the visibility splays are measured manually or digitally (using LiDAR data), the measured visibility splays represent the actual visibility splays at one moment in time e.g. when they were manually measured or when the LiDAR data was collected. Due to hedges, trees and other foliage, the actually visibility splays at a given junctions could change over time. This means that the collisions could have occurred when either the visibility splay was less or more than the measured splay.

While the junction selection process has eliminated those junctions where significant changes have occurred, the impact of changing visibility splays owing to the growth of cutting back of foliage cannot be eliminated. With this said, fluctuations in visibility splays where foliage could be a factor are not likely to be a significant factor over a large number of sites.

7.6. Overall Number of Junctions

The most time consuming element of this research is measuring the visibility splays. While utilising LiDAR data has allowed for more junctions to be analysed than conventional methods, the number of junctions is still limited by time and budget constraints. Using LiDAR data, the original aim of this research project was to analyses at least 300 junctions. In order to provide a level of resilience, the junction selection exercise captured 380 suitable junctions across Highways England's network. Following a further review, and finding that LiDAR data was not available for 56 of these junctions, the final number of analysed junctions was 310.

As with any research project, a greater volume of data will reduce the risk of outline results (anomalies) impacting the results. Notwithstanding the budget/time limitations, the junction selection process looked at almost all single carriageway trunk roads across England. Of the 380 suitable junctions identified, this is considered to represent the vast majority of simple, ghost island and SLD junctions that could meet the junction selection criteria for this research project. Any further analysis aiming to look at a greater array of junctions is therefore unlikely to yield a significant number of additional, suitable junctions. The findings of this research are therefore considered representative.

7.7. Other Contributory Factors

There are a multitude of factors that influence collisions of which prevailing levels of visibility is only one. Even if the nature of each junction and the individual collisions that occurred were scrutinised to exhaustion, it is still highly unlikely that it would be possible to isolate substandard visibility as the only or even the overarching reason that a collision occurred. In analysis such as this, the goal is to eliminate as many variables as possible to provide a sufficient level of confidence that the variable being tested is impacting the result. To this end, the methodology developed for this research (with due consideration to the other limitations described in this section) is considered robust enough to demonstrate how varying levels of visibility impact on collision rates.

8. Conclusion and Recommendations

8.1. Summary of Findings

The following is a summary of the key findings of the research:

1. Ghost island junctions have the lowest overall collision rate of the three priority junction types, followed by simple junctions and then SLD junctions;

2. Approximately 30% of all junctions analysed do not comply with the ‘X’ distance requirements i.e. full ’Y’ visibility is available at 9.1m along the minor road. With no DfS submitted for substandard ‘X’ distance since DAS was introduced, this suggests that excessive visibility back along the minor road is often ignored or overlooked;

3. The average collision rate is higher for junctions that do not comply with the ‘X’ distance requirements across all junction types. This supports the theory that ‘too much’ visibility back along the minor road is a safety problem;

4. A significant proportion of junctions analysed do not comply with the ‘Y’ distance requirements i.e. they do not provide the required visibility splay. Only 43% of simple, 60% of ghost island and 58% of SLD junctions analysed have compliant ‘Y’ visibility;

5. Overall, the average collision rate for junctions with compliant ‘Y’ visibility to both the left and right of the minor road is less than junctions that have non-compliant visibility to the left of the minor road only and non-compliant visibility to both the left and right of the minor road; however, for junctions with non-compliant visibility to the right only, the average collision rate is slightly less than those that fully comply;

6. For each junction type, decreasing levels of compliance with the ‘Y’ distance requirements has no material impact on collision rates i.e. average collision rates do not obviously increase as the level of visibility decreases;

7. In general, the proportion of collisions at each junction form when looking at ‘other factors’ are either in line with national rates or comparable across the junction types. The only notable exceptions are:

   A) There is a significantly higher proportion of collisions involving cyclists at SLD junctions; and

   B) There is a notably higher proportion of collisions involving larger vehicles e.g. HGVs, at SLD junctions.

8.2. Conclusion

In general, this study has not identified a strong relationship between substandard ‘Y’ visibility levels and collision rates. It cannot be said with any confidence that degrading levels of ‘Y’ visibility has had a material impact on the collision rates at the junctions analysed i.e. collisions rates do not increase as the level of visibility decreases. While there are a multitude of factors that influence collisions (most notably of which is likely to be human behaviour which is outside of Highways England’s control), if substandard visibility is a key contributory factor in collisions at priority junctions, then it would be expected that a clearer link between the collision rates and visibility would be evident in the findings.

Looking at historic DfS data, a vast proportion of submissions for substandard visibility are for ‘Y’ distances between 70% and 100% of the requirement based on the design speed of the major road. This equates to approximately a one-step reduction in provision (as defined in TD 9 Table 2). Furthermore, the majority of these submissions are for designs speeds between 70kph and 120kph (there were very few submissions for 50kph or 60kph design speeds). Of the DfS submitted that match this criteria, the vast majority of them (89%) were approved. Based on this finding and the lack of correlation between collision rates and substandard ‘Y’ distance levels, it is considered appropriate to allow what is already largely being approved across the network as a defined relaxation with the standards i.e. a one-step relaxation in ‘Y’ distance at priority junctions located on major roads with a design speed of 70kph, 75kph, 100kph or 120kph.

While no clear link between prevailing levels of 'Y' visibility and collision rates have been identified, this research has shown that there is a link between 'too much visibility' back along the minor road (i.e. a lack of compliance with the 'X' distance requirements) and higher collision rates.

In general, SLD junctions performed worse than simple and ghost island junctions in the majority of the tests. In relation to other factors, there was a significantly higher proportion of cycle collisions and collisions involving larger vehicles e.g. HGVs at SLD junction. Given SLD junctions are significantly more expensive to construct than ghost island or simple junctions they should perform better in safety terms.

8.3. Recommendations

Based on the findings of this research, the following recommendations are made:

d) Retain and give more prominence within the standards to the 'X' visibility requirement to prevent 'too much' visibility back along the minor road;

e) Allow a one-step relaxation in 'Y' distance at priority junctions where the design speed of the major road is 70kph, 75kph, 100kph or 120kph. In order to prevent designers from automatically selecting the relaxation, the new requirements should be written in a manner that requires the designers to justify why they are not providing the full visibility splay[12].

f) For the replacement TD 41 & 42 RAD, further consideration should be given to the continued use of single lane dualing junctions that permit all turning movements, given the finding that they do not perform better than simple or ghost island junctions and are significantly more expensive to construct.

[12] In the draft update of Interim Advice Note 149, the designer is required to undertake an assessment in order to use certain relaxations. A similar solution could be adopted for the relaxation of the visibility requirements in the replacement TD 41/42 RAD.

JP Doherty
Atkins
The Exchange
2nd Floor
3 New York Street
Manchester
M1 4HN

Johnpaul.doherty@atkinsglobal.com
0161 245 3444