

OTS Road Collision Research

Roadside objects struck by powered two wheelers

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Please note: the VSRC is changing name to become the **Transport Safety Research Centre (TSRC)** to reflect the broad range of research conducted.

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EXECUTIVE SUMMARY

The use of On The Spot (OTS) data to consider the role of road-side objects in the injury outcome of crashes has been proposed previously. This study focuses on one road user group that is known to be particularly vulnerable to interactions with roadside objects, namely motorcycle, moped and scooter riders, also known as powered two wheeler (PTW) riders.

Review of the OTS database considering PTW crashes where roadside infrastructure has been involved provides the opportunity for closer examination of the causes of these crashes and resulting injuries and will enhance the current understanding of the objects that are hit, in what circumstances they are hit, by which vehicles and with what injury outcomes for those involved. It is also possible to evaluate the performance of the current roadside furniture with examples of the existing PTW vehicle fleet and also the potential for improved injury outcome with the new improved generation of road furniture, had it been employed.

A cluster analysis of STATS19 data for 2008 was carried out on 2,030 PTW cases, out of the total 22,427 PTW cases, which had 'hit a fixed object in the carriageway' or 'hit an object off the carriageway'. Six important clusters, based on variables contributing to the crash, were identified.

A similar cluster analysis has not yet been conducted on the OTS data but it will be interesting to learn if a similar pattern emerges.

From the analysis of STATS19 it was found that, of the 22,427 PTW cases in 2008, 2,559 (11%) hit an object in or off the carriageway. The proportions are very different in OTS where, of the 461 PTW cases 138 (30%) involve a roadside or other object with or without the involvement of another road user, 314 (68%) involved another vehicle only and 9 (2%) involved no collision partner or object. That these proportions are so different may be explained by the greater detail collected in OTS but this difference requires further investigation.

Of the 28 OTS in-depth cases which were reviewed examples of cases were identified for some, but not all, of the clusters from the cluster analysis. For example, Cluster 1 Cases 4, 5,10; Cluster 4 Case 7. Given the small number of cases involved it is not necessarily surprising that all of the clusters are not specifically represented. However, using this cluster approach to focus in-depth case reviews in future will be a worthwhile avenue to explore.

A total of 28 in-depth case reviews have been conducted. For each case an overview has been prepared that considers the accident circumstances, the vehicle type, the causation factors and the injury outcomes, in relation to the involvement of roadside objects in PTW crashes. A site visit was made to each of the collision locations and, where possible, information from local authority collision records was sought. A case conference was conducted in which each case was reviewed and the issues of relevance from the case records, the site visit and the expertise of the participants discussed and considered. On this basis, comments and recommendations have been made for each case regarding the involvement and performance of road and roadside objects, possible injury reduction solutions and other associated safety improvements, such as remedial site works, protective clothing and training.

The 28 in-depth case reviews, with the specific focus on the design, installation and recommendations regarding roadside objects, have highlighted that in 18 of the cases there are no improvements to make to the road environment, in 6 cases improvements are possible and in 4 cases improvements have already been made to the road surface and/or objects. This suggests that, whilst Local and Highways Authorities are responding to safety issues presented by PTW crashes, there are still roadside and other objects which need to be improved in order to improve PTW protection and reduce injuries. Specific examples of such improvements have been identified on a case by case basis.

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1. INTRODUCTION

1.1. Background

The use of On The Spot (OTS) data to consider the role of road-side objects in the injury outcome of crashes has been proposed previously. This study focuses on one road user group that is known to be particularly vulnerable to interactions with roadside objects, namely motorcycle, moped and scooter riders, also known as powered two wheeler (PTW) riders.

Review of the OTS database considering PTW crashes where roadside infrastructure has been involved provides the opportunity for closer examination of the causes of these crashes and resulting injuries and will enhance the current understanding of the objects that are hit, in what circumstances they are hit, by which vehicles and with what injury outcomes for those involved. It is also possible to evaluate the performance of the current roadside furniture with examples of the existing PTW vehicle fleet and also the potential for improved injury outcome with the new improved generation of road furniture, had it been employed.

National accident data (STATS19) shows, excluding pedestrian involvement, almost 20% of injury accidents involve just a single vehicle. The rate of accidents classified as killed or seriously injured (KSI) in single vehicle accidents is 20% compared with 12% for those with more than one vehicle, illustrating the high severity of these events.

The Vehicle Safety Research Centre (VSRC) and TMS Consultancy played a central role in the now completed EC research project called RISER (Roadside Infrastructure for Safer European Roads) (2006). The project made detailed evaluations of single vehicle accident data, examined existing national guidelines and proposed a way forward for European guidelines on design and maintenance of roadside infrastructure. A number of research approaches were developed which could usefully be applied to the UK in-depth (OTS) and national (STATS19) databases.

Detailed accident data (OTS) shows that out of 1300 single vehicle off road collisions, the majority of those allocated a definitive code were pole/post impacts including lampposts, road signs and trees (23%) (Cuerden et al 2008). However, more than one third (35%) of national accident reports (STATS19) do not specify the precise nature of the object struck, simply describing the object as 'other'. A review of the more complete and detailed OTS database would therefore be beneficial in order to enhance the current understanding of the 'object hit' in PTW single vehicle run-off road accidents. In addition to understanding what is hit, the OTS data can also provide a rationale for why it was hit using the causation data.

Attention is increasingly being given to the safety of motorcycles, mopeds and scooters users at both national and European levels. This is due to their high representation in the casualty figures (number and severity) when considered against their exposure (number of riders/registered vehicles and journeys/miles travelled) (DfT 2008).

The design of the road layout and roadside objects and the injury risk presented by them is particularly pertinent to motorcycle riders. Work has recently been concluded on the EC funded integrated project APROSYS (Advanced PROtection SYStems). This project included a sub-project SP4: Motorcycle Accidents of which a significant amount of work was carried out on the issue of the design of roadside barriers. As a context for this work it was stated

that 'more than 40% of motorcycle deaths are due to impact with obstacles located alongside the roadside infrastructure'.

Whilst much work has been undertaken with regard to the injury biomechanics of car occupants, less has been done with specific regard to motorcyclists and this is compounded by the greater complexity of motorcycle crashes. It is particularly difficult to understand the rider kinematics and injury biomechanics, not least when riders come into contact with roadside objects.

This study has therefore focused on the subset of PTW crashes and the injuries resulting from the interaction with roadside furniture.

1.2. Key Research Questions

1. Understand, using in-depth accident data, the causes of crashes and the object hit in PTW single vehicle, non pedestrian, run-off road collisions, including both single and multi-vehicle crashes, where roadside objects have been involved.
2. Set this understanding of the in-depth data in the context of current knowledge regarding PTW's and roadside furniture and with wider reference to national data (STATS19 and Road Casualties Great Britain).
3. Consider the effectiveness of road-side safety features, including passive safety devices, using the available OTS cases for PTW's;
4. Utilise this in-depth data to identify the PTW crash parameters and, where possible, the rider kinematics in a range of different crash circumstances;
5. Evaluate for different motorcycle crash circumstances how the existing roadside furniture contributed to the crash and injury outcomes and whether changes in the design or installation would have prevented or mitigated against the injury outcome and consider whether alternative roadside furniture would have resulted in different crash and injury outcomes.

1.3. Methodology

The main emphasis of the study is on conducting in-depth case reviews of the OTS with the selection of cases made on the basis of an analysis of the OTS database.

The focus of the study is on accidents involving motorcycles, mopeds and scooters in order to understand the crash circumstances of as wide a sample of powered two-wheeler crashes as possible. These have included the single vehicle (SV) crashes but have also included crashes where the PTW has hit an object in the road or another vehicle and then hit a roadside object. The in-depth data has been used to identify the crash parameters and, where possible, the rider kinematics in a range of different crash circumstances involving roadside furniture. The review of the in-depth data has been undertaken in the context of the current knowledge regarding roadside furniture and the current UK guidelines for roadside design and for the different motorcycle crash circumstances, an evaluation has been made of how the existing roadside furniture contributed to the crash and injury outcomes and whether changes in the design or installation would have prevented or mitigated the injury outcome. In addition, consideration has been given to whether alternative roadside furniture would have resulted in different crash and injury outcomes.

Relevant cases have been identified from the OTS database and, for a selection of these cases, an overview prepared that considers the accident circumstances, the vehicle type and the causation factors and the injury outcomes, in relation to the involvement of roadside objects in PTW crashes. A site visit has been made to each of the collision locations and, where possible, information from local authority collision records has been sought. A case conference has been conducted in which each case was reviewed and the issues of relevance from the case records, the site visit and the expertise of the participants discussed and considered. On this basis, comments and recommendations have been made for each case regarding the involvement and performance of road and roadside objects, possible injury reduction solutions and other associated safety improvements, such as remedial site works, protective clothing and training.

An analysis of STATS19 data has been undertaken to establish the role of road and roadside objects in the national data. An analysis has also been included to describe the OTS case data.

Deliverable

The deliverable of this study is this report which presents in-depth case reviews of a selection of OTS cases, with the focus on the role of roadside furniture and infrastructure, and which also provides an overview of the OTS data. This is complemented by a cluster analysis of STATS19 data.

2. STATS19 ANALYSIS

The STATS19 data for 2008 was used for this analysis.

Of the 311,604 vehicle records there are 22,427 PTW's which include motorcycles, mopeds, scooters and other motorised 2 wheeled vehicles classified into 4 categories by cc, shown in Table 1.

	Frequency	Percent
2 Motor cycle 50cc and under	4247	18.9
3 Motor cycle 51cc - 125cc	6314	28.2
4 Motor cycle 126cc - 500cc	2967	13.2
5 Motor cycle over 500cc	8899	39.7
Total	22427	100.0

Table 1. PTW's classified by engine size (cc)

Analysis that was carried out found that of the 22,427 PTW records 2,559 (11.4%) struck an object in or off the carriageway and 19,868 (88.6%) did not strike an object in or off the carriageway (including those where the PTW was in collision with another vehicle).

The breakdown of the objects hit both on and off the carriageway is shown in Table 2.

Analysis of the 19,868 that did not strike an object in or off the road found that 5206 did not have a vehicle collision partner and of these 5206, 937 struck a pedestrian.

This would seem to imply that of the 19,868 that did not strike an object in or off the road 4,269 just slid along the road or ground without striking anything whatsoever.

From the 2,559 PTW's which struck an object in or off the carriageway a subset was defined such that all those PTW's which 'hit a fixed object in the carriageway' or 'hit an object off the carriageway' were included. Thus cases where the object struck was not fixed (eg 'road works' or 'parked vehicle') were removed. In addition cases were removed with unknown or missing data. This resulted in a sample of 2030 cases for detailed analysis.

Hit object in carriageway	First object hit off carriageway					
	0 None	1 Road sign or traffic signal	2 Lamp post	3 Telegraph or electricity pole	4 Tree	5 Bus stop or bus shelter
0 None	19868	106	92	21	111	2
1 Previous accident	5	0	0	0	0	0
2 Road works	10	1	1	0	0	0
4 Parked vehicle	299	0	1	0	1	0
6 Bridge (side)	7	0	1	0	0	0
7 Bollard or refuge	85	3	3	0	1	1
8 Open door of vehicle	27	0	0	0	0	0
9 Central island of roundabout	18	7	0	0	1	0
10 Kerb	394	25	30	5	12	3
11 Other object	95	0	0	0	4	0
12 Any animal (except ridden horse)	88	0	0	0	0	0
	20896	142	128	26	130	6

Hit object in carriageway	First object hit off carriageway					TOTAL
	6 Central crash barrier	7 Near/offside crash barrier	8 Submerged in water	9 Entered ditch	10 Other permanent object	0 None
0 None	87	88	2	193	551	21121
1 Previous accident	0	0	0	0	0	5
2 Road works	1	0	0	0	1	14
4 Parked vehicle	0	0	0	0	12	313
6 Bridge (side)	0	0	0	0	1	9
7 Bollard or refuge	9	2	0	1	13	118
8 Open door of vehicle	0	0	0	0	0	27
9 Central island of roundabout	0	2	0	1	10	39
10 Kerb	10	8	1	8	80	576
11 Other object	2	1	0	0	7	109
12 Any animal (except ridden horse)	0	0	0	4	4	96
TOTAL	109	101	3	207	679	22427

Table 2. Object hit in and first object hit off the carriageway

A hierarchical, ascending (agglomerative) cluster analysis was then performed on the 2030 case sample in order to obtain representative scenarios for this sample of PTW's. The key points of this analysis are presented below.

Where the categories for each field differ from those in STATS19, they were formed by aggregating categories in the source database.

The outcome of the cluster analysis is shown in Table 3. Each column describes the characteristics of a cluster. Cells highlighted are over-represented with 99.5% certainty (chi-square test) relative to the population of 2030 PTW's. The 'representativeness' figures are derived directly from the 'accident severity' category, expressing the latter as row percentages.

Cluster 1 can serve to illustrate the interpretation of Table 3. It is the largest cluster, containing 877 of the PTW's. This is 43% of the sample population (2030), and contains 45% of the serious and 36% of the fatal injury cases of the sample population. All 877 crashes occurred in dry conditions and the vast majority (832) occurred in daylight. They were all single vehicle crashes and the manoeuvre 'going ahead on a bend' is significantly over-represented (451) as are roads with higher speed limits (118 on roads 40-50 and 479 on roads 60-70 mph). Finally the involvement of motorcycles by size (cc) shows that PTW's 126cc-500 and 500+ are over represented with 500+cc making up by far the largest group (526 of 877).

Considering this, the analysis highlights the following scenarios where a PTW 'hit a fixed object in the carriageway' or 'hit an object off the carriageway':

- 1 Larger capacity motorcycles involved in single vehicle accidents (SVAs) going ahead on bends on dry roads with higher speed limits in daylight (43% of all casualties, 45% of serious injury casualties, 36% of fatalities).
- 2 Larger motorcycles (over 500 cc) going ahead, overtaking or changing lane and colliding with a passenger car that was most often turning or going ahead (12% of all casualties, 12% of serious casualties, 14% of fatalities).
- 3 Single vehicle accidents in daylight on not dry (wet or damp, snow, frost or ice, etc) roads involving all motorcycle sizes and vehicle manoeuvres. (11% of all casualties, 9% of serious casualties, 6% of fatalities).
- 4 Single vehicle accidents in darkness on dry roads, especially smaller vehicles (up to 125 cc) with lower speed limits (20–40 mph) where the vehicle was going ahead without overtaking, changing lane or negotiating a bend (10% of all casualties, 12% of serious casualties, 15% of fatalities).
- 5 Single vehicle accidents in darkness on not dry (wet or damp, snow, frost or ice, etc) roads, especially small vehicles (up to 125 cc) going ahead and on bends (6% of all casualties, 4% of serious casualties, 7% of fatalities).
- 6 Larger motorcycles (over 126 cc) on high-speed roads (60–70 mph) colliding with cars and other vehicles on bends (4% of all casualties, 4% of serious casualties, 6% of fatalities).

	Cluster							Total
	1	2	3	4	5	6	7-26	
Cluster representativeness (%)								
Slight	42	11	14	8	7	3	16	100
Serious	45	12	9	12	4	4	13	100
Fatal	36	14	6	15	7	6	17	100
Total	43	12	11	10	6	4	15	100
Accident severity								
Slight	405	102	129	81	62	24	150	953
Serious	408	110	83	104	38	37	118	898
Fatal	64	25	10	26	12	11	31	179
Total	877	237	222	211	112	72	299	2030
Speed limit								
20-30	280	137	94	138	50	10	149	858
40-50	118	25	28	36	14	2	48	271
60-70	479	75	100	37	48	60	102	901
Total	877	237	222	211	112	72	299	2030
Light conditions								
Daylight	832	237	215	0	0	72	197	1553
Darkness	45	0	7	211	112	0	102	477
Total	877	237	222	211	112	72	299	2030
Road surface condition								
Dry	877	234	0	211	0	71	187	1580
Not dry	0	3	222	0	112	1	112	450
Total	877	237	222	211	112	72	299	2030
Motorcycle type (cc)								
1-50 cc	82	14	27	30	20	2	39	214
51-125 cc	160	37	47	89	37	6	63	439
126-500 cc	109	27	36	20	13	10	35	250
500+ cc	526	159	112	72	42	54	162	1127
Total	877	237	222	211	112	72	299	2030
Vehicle manoeuvre								
Going ahead	341	164	98	142	60	0	131	936
Going ahead on bend	451	0	89	43	48	72	42	745
Overtaking or changing lane	43	70	16	10	4	0	98	241
Turning	42	3	19	16	0	0	28	108
Total	877	237	222	211	112	72	299	2030
Other vehicle								
SVA	877	0	222	211	112	0	0	1422
Car	0	237	0	0	0	60	197	494
Other	0	0	0	0	0	12	102	114
Total	877	237	222	211	112	72	299	2030
Other vehicle manoeuvre								
SVA	877	0	222	211	112	0	0	1422
Going ahead	0	65	0	0	0	15	126	206
Going ahead on bend	0	0	0	0	0	52	33	85
Overtaking or changing lane	0	34	0	0	0	2	33	69
Turning	0	123	0	0	0	3	89	215
Other	0	15	0	0	0	0	18	33
Total	877	237	222	211	112	72	299	2030

Table 3. Clusters for PTW's which have hit a fixed object in the carriageway or an object off the carriageway

3. OTS ANALYSIS

3.1. OTS database

The On The Spot (OTS) database contains detailed crash data which are used for the in-depth analysis of crash and injury causation. As described in Hill (2005) the areas chosen for OTS (in Nottinghamshire and Thames Valley) were selected to ensure that when the data from both areas was combined the severity distribution of road accidents was representative of the severity of accidents occurring nationally and also that the sample was representative of the different road users. Thus the dataset can be used to inform research questions which are relevant to the national situation.

The PTW cases within the OTS database were analysed to obtain an understanding of the nature of the cases. This analysis was carried out as part of a complimentary study for the Department for Transport, (Frampton et al, 2010) but serves to describe the OTS PTW sample for this study.

3.2. Powered Two Wheeler Types

The OTS data contained 461 powered two wheelers (PTW's) of various types that had been involved in a crash. Table 4 shows the distribution of PTW type.

PTW Type	N	Percentage
Roadster	122	26%
Sports	138	30%
Tourer	31	7%
Cruiser/Chopper	12	3%
Adventure	18	4%
Moped	69	15%
Scooter > 51 cc	44	9%
Other	27	6%
Total	461	100%

Table. 4 PTW Type

Roadsters, Sports bikes (also referred to as Road Race Replicas) and Mopeds together formed the majority of the PTW's (71%) with Sports bikes forming the single largest group. The UK, in comparison to other motorised EU states has frequently shown a high proportion of sports motorcycles in the vehicle park and a lower proportion of lower powered scooters. Table 5 shows the distribution of PTW engine capacity in cubic centimetres. The distribution was calculated from cases where cubic cc was known.

Cubic Capacity of Engine (cc)	All PTW's (N=448)
<= 50	18%
51-125	20%
126-250	4%
251-500	6%
501-650	21%
651-1000	19%
>1000	12%
Total	100%

Table 5. Distribution of Engine Sizes

Larger capacity bikes above 500cc form the majority (52%) of the sample whilst the smaller capacity machines (up to 125cc) favoured by learner riders account for some 38%. Machines in the mid range between 125 and 500cc account for only 10% of the sample.

The distribution of PTW registration year is shown in table 6. The distribution was calculated from cases where registration year was known.

Year	All PTW's (N=441)
Pre-1988	5%
1988-1993	10%
1993-1998	17%
1998-2003	48%
2003-2008	20%
Total	100%

Table 6. PTW Registration Year

By far the largest majority of motorcycles were registered between 1998-2003 (48%). The motorcycles most likely to be fitted with current safety technology, such as ABS, linked brakes and traction control would be found in the youngest group of machines, post 2003, which form 20% of the sample. It should be noted however, that currently in 2010, most new motorcycles still do not have these technologies fitted as standard.

3.3. Crash Characteristics

Previous motorcycle research has shown that different motorcycles are used in different ways by different riders and this has bearing on the likelihood of a crash as well as the type of crash (Christmas et al, 2009). For further analysis in this study, PTW's were grouped into four main types which together account for 94% of PTW's in the sample. The group classed as "Road bike" includes roadsters, tourers, cruisers, choppers and adventure bikes which are predominantly used on the road (such as the BMW R1200GS and Suzuki DL650 V-Strom). The second group of PTW's classed as "Sport bike" includes machines based on race replicas. The third group classed as "Moped" includes traditional or scooter style machines with up to 50cc engine capacity. The fourth group "Large scooters" comprises a scooter style machine with engine capacity above 50cc. The new Road bike group accounted for 40% of all bikes, Sport bikes for 30%, Mopeds for 15% and Large scooters for 9%. Table 7 shows the road speed limit at the point of the crash in which these machines were involved. The distributions were calculated from cases where speed limit was known.

Speed Limit (mph)	All PTW's N=459	Road bike N=183	Sport bike N=137	Moped N=69	Large Scooter N=44
0	-	1%	-	-	-
20	-	1%	-	1%	-
30	51%	41%	43%	77%	70%
40	17%	21%	18%	12%	9%
50	5%	8%	7%	-	2%
60	17%	19%	20%	4%	14%
70	9%	10%	12%	6%	5%
Total	100%	100%	100%	100%	100%

Table 7. Speed Limit at Point of Crash

Most PTW crashes (51%) in the sample occurred in a 30 mph zone. While 26% occurred on derestricted A roads and dual carriageways/motorways. The proportions of Road bikes and Sport bikes which crashed on derestricted roads was similar (29% and 32%) however, very few Mopeds (12%) crashed on those types of road. In contrast to Road bikes and Sport bikes, a very large proportion (77%) of Mopeds and Large scooters (70%) crashed in a 30mph zone.

Table 8 shows the first object interaction for each type of PTW. Data was available for all PTW's in the sample.

First Object Interaction	All PTW's N=461	Road bike N=183	Sport bike N=138	Moped N=69	Large Scooter N=44
Car	62%	63%	57%	71%	64%
Other vehicle with >3 wheels	7%	8%	7%	4%	9%
Bicycle	1%	1%	1%	-	2%
Other PTW	2%	2%	1%	3%	2%
pedestrian	1%	1%	2%	-	2%
roadside furniture	6%	4%	9%	3%	2%
animal	1%	2%	-	-	-
barrier, ditch, kerb	3%	2%	6%	1%	2%
Other	17%	17%	17%	17%	17%
total	100%	100%	100%	100%	100%

Table 8. First Object Interaction

All PTW's, irrespective of type interacted predominantly with a car as the first struck object. Man made roadside objects were not a common source of first interaction, although Sports bikes showed a higher likelihood of interacting with these objects (15%) than other PTW types.

Table 9 shows pre impact movement for each type of PTW. Data was available for all PTW's in the sample. For all PTW's, by far the most common pre impact movement was driving along a straight road (47%). The second and third most common pre impact movement for all PTW's was overtaking a moving vehicle on the left (14%) and going round a right or left hand bend (13%). The fourth most common movement was going round a roundabout (6%). Given that the most common first object interaction is with another car (Table 8) this would suggest that the most common cause of crashes concerns either a car moving into or stopping in the path of the PTW. Looking at PTW's by individual type showed a broadly similar pattern to that for all PTW's. There were, however, some differences between PTW types. Mopeds were generally less likely to be involved in crashes on bends compared to other PTW types and they were more likely to be involved in crashes going along a straight road.

Pre Impact Movement	All PTW's N=461	Road bike N=183	Sport bike N=138	Moped N=69	Large scooter N=44
Going along a straight road	47%	44%	47%	58%	43%
Overtaking a moving vehicle on the left	14%	18%	14%	12%	9%
Going round a right or left hand bend	13%	13%	17%	7%	9%
Going round a roundabout	6%	6%	4%	4%	16%

Table 9. Most Common Pre Impact Movement by PTW Type

3.4. Rider Characteristics

The 461 PTW's in this study carried 491 riders. Therefore 30 PTW's (7%) carried a pillion rider. Table 10 shows the gender distribution of the riders. The distributions were calculated from cases where gender was known.

Gender	All PTW's N=484	Road bike N=196	Sport bike N=143	Moped N=69	Large scooter N=47
Male	90%	88%	94%	81%	96%
Female	10%	12%	6%	19%	4%
Total	100%	100%	100%	100%	100%

Table 10. Rider Gender Distribution

The largest majority of riders by far were males with Sport bikes and Large scooters showing the highest proportion of male riders (94% and 96% respectively). Mopeds were ridden by the highest proportion of females (19%).

Table 11 shows the distribution of rider ages by PTW type. The distributions were calculated from cases where age was known.

Age (years)	All PTW's N=430	Road bike N=176	Sport bike N=127	Moped N=69	Large scooter N=47
10-14	1%	1%	-	-	-
15-19	16%	3%	6%	57%	24%
20-24	16%	10%	16%	18%	26%
25-29	15%	11%	26%	5%	4%
30-34	15%	17%	23%	1%	4%
35-39	9%	11%	11%	6%	4%
40-44	8%	11%	9%	1%	9%
45-49	6%	10%	4%	1%	4%
50-54	6%	13%	2%	1%	-
55-59	4%	6%	2%	-	6%
60-64	2%	4%	1%	-	-
65-69	1%	2%	-	-	4%
70+	1%	1%	-	10%	15%
Total	100%	100%	100%	100%	100%

Table 11. Rider Ages by PTW Type

Mopeds had by far the largest proportion of riders under 20 years old (57%) followed by large scooters (24%). Mopeds had the largest proportion of riders under 25 years old (75%) followed by large scooters (50%). Road bikes had the largest proportion of riders over 40 years old (47%) followed by large scooters (38%). Sport bikes had the largest proportion of riders aged 20 to 39 (76%) followed by road bikes (49%) large scooters (38%) and then Mopeds (30%). It appears that Mopeds are ridden by younger riders whilst Roadsters and large scooters are ridden by older riders.

4. IN-DEPTH CASE REVIEW

4.1. Case Review Process

An initial meeting was held at which the issues of interest to the study were discussed and a set of case selection criteria were agreed. Following this meeting the analysis reported in the previous section was undertaken and from that a list of potential cases from the OTS database was also identified for further consideration.

As previously discussed the focus of this study is on accidents involving roadside objects. As shown in Table 8, 9% of the PTW cases the first object struck was 'roadside furniture' (6%) or 'barrier, ditch, kerb' (3%). However, as has been shown in Table 2 there are objects hit both in and off the carriageway and therefore when considering the role of objects in PTW crashes it is worthwhile considering all cases where the PTW has interacted with an object whether it was on or off the carriageway and whether or not another vehicle was also involved.

For this reason a further analysis of the cases in OTS was made considering the involvement of all of the objects hit and the order in which they were hit. This was summarised by a code shown in Table 12. By way of explanation of this code each digit is defined as follows:

1 = other OTS road user

2 = roadside or other object

7 = N/A or unknown

The order is hit first, second, third or fourth.

Thus '1227' are cases where the PTW was in collision with an OTS road user (1), followed by a roadside or other object (2), followed by another roadside or other object (2) and no fourth object.

Similarly, '2777' are cases where the PTW hit only a roadside or other object.

Not all of the combinations are present in each Phase of OTS.

Of the 461 PTW cases 138 (30%) involve a roadside or other object with or without the involvement of another road user, 314 (68%) involved another vehicle only and 9 (2%) involved no collision partner or object.

From the cases highlighted in Table 12 ultimately 28 OTS cases were selected from Phase 3 for in-depth review. These cases therefore all involved a road or roadside object and may also have included another road user.

The 28 in-depth cases are summarised in Table 13.

	Objects hit in order	Thames Valley	Nottinghamshire	TOTAL
OTS Phase 1 (2000 to 2003)	1177	7	1	8
	1217	1	0	1
	1277	0	3	3
	1771	1	2	3
	1777	57	42	99
	2277	1	0	1
	2712	1	0	1
	2772	0	2	2
	2777	12	25	37
Total		80	75	155
OTS Phase 2 (2003 to 2006)	1117	1	0	1
	1171	0	1	1
	1177	5	4	9
	1277	5	4	9
	1771	0	2	2
	1777	36	57	93
	2227	1	0	1
	2277	0	2	2
	2777	19	13	32
Total		67	83	150
OTS Phase 3 (2006 to 2009)	1177	3	2	5
	1217	1	1	2
	1227	2	2	4
	1277	3	0	3
	1727	1	0	1
	1777	48	45	93
	2277	4	7	11
	2777	12	16	28
	7777	6	3	9
Total		80	76	156
TOTAL		227	234	461

Table 12. Analysis of OTS cases by object and OTS road user/other involvement

	TMS	Interaction 1	Interaction 2	Interaction 3	Gender	Motorcycle type	Engine cc	OTS Causation code
1	2	Other (give details)	n/a	n/a	Male	Off road (exclusively off road vehicle)	500	Driving too fast
2	5	Other roadside furniture	n/a	n/a	Male	Road Race Replica	998	Driving too fast
3	11	Lamppost	Tree	n/a	Male	not applicable [3]	49	Lost control of vehicle
3	11	Lamppost	Tree	n/a	Female	not applicable [3]	49	Lost control of vehicle
4	12	Ditch [3]	Bridge	n/a	Male	Road Race Replica	599	Lost control of vehicle
5	13	Ditch [3]	Wall	n/a	Male	Standard Street	400	Driving too fast
6	17	Wall	n/a	n/a	Male	Standard Street	125	Driving whilst under the influence of alcohol or drugs
7	20	Barrier [3]	n/a	n/a	Male	Road Race Replica	124	Lost control of vehicle
8	22	Kerb [3]	Wall	n/a	Male	Standard Street	599	Driving too fast
9	T3	Other (give details)	ditch [3]	n/a	Male	Road Race Replica	749	Driving too fast
10	T4	Road sign	ditch [3]	n/a	Male	Road Race Replica	599	Lost control of vehicle
11	1	Kerb [3]	Vegetation [3]	n/a	Male	Road Race Replica	998	Lost control of vehicle
11	1	Kerb [3]	Vegetation [3]	n/a	Female	Road Race Replica	998	Lost control of vehicle
12	3	Building	n/a	n/a	Male	Standard Street	600	Lost control of vehicle
13	4	Car/CDV	Vegetation [3]	Car/CDV	Male	Standard Street	599	Error of judgement
14	7	Other (give details)	n/a	n/a	Male	Standard Street	97	Error of judgement
15	8	Other (give details)	n/a	n/a	Female	Tourer	124	Error of judgement
16	9	Other (give details)	n/a	n/a	Male	Cruiser	535	Vehicle not to blame
17	10	Other (give details)	n/a	n/a	Male	Standard Street	747	Lost control of vehicle
18	14	Car/CDV	Other roadside furniture	fence [3]	Male	Road Race Replica	748	Driving too fast
19	15	Road sign	n/a	n/a	Male	Moped without pedals	124	Driver made reckless road manoeuvre
20	18	Other (give details)	n/a	n/a	Male	Standard Street	998	Lost control of vehicle
21	19	Motorbike over 125 cc	Vegetation [3]	Other roadside furniture	Male	Other (give details below)	1,285	Error of judgement
22	19	Other type of vehicle (inc trailer) [3]	n/a	n/a	Male	Standard Street	748	Vehicle not to blame
23	21	Other (give details)	n/a	n/a	Female	Moped without pedals	49	Lost control of vehicle
24	23	Other (give details)	n/a	n/a	Female	Scooter	49	Lost control of vehicle
25	T1	Car/CDV	kerb [3]	Tree	Male	Road Race Replica	125	Lost control of vehicle
26	T2	Barrier [3]	n/a	n/a	Male	Road Race Replica	998	Lost control of vehicle
27	6	Kerb [3]	n/a	n/a	Male	Off road (exclusively off road vehicle)	125	Driving whilst under the influence of alcohol or drugs
28	16	Animal	88	n/a	Male	Standard Street	748	Vehicle not to blame

Table 13. Summary of 28 in-depth cases

The collision sites of these cases were visited by the TMS investigators, who are all experienced road safety auditors. A site checklist was used in order to gather consistent information across the study and photographs taken. A total of 24 sites in Nottinghamshire and 4 in the Thames Valley were investigated. A site report for each case was prepared.

The purpose of the visits and the related reports was to try to identify the object struck in the collision, any injury causation mechanisms, whether the object had been replaced or road design changes introduced and finally whether any lessons can be learnt for the future regarding off road objects struck by powered two-wheelers.

The details of each site visit report and the relevant OTS case material were then considered at a case review meeting. Additional notes were added to the site reports and conclusions and recommendations were made about the role of roadside objects for all of the cases examined.

4.2. In-depth case reviews

4.2.1. Case Review 1

Site Visit Number	2
Description	Path 1 Vehicle 1, a motorcycle, lost control on a right hand bend in very heavy rain resulting in the rider falling off. No other vehicles were involved and the rider was taken to hospital with a shoulder injury.
Motorcycle – make/model, type and size (cc)	500 cc Roadster (OTS – off road)
Rider – age and gender	Male rider
Rider - experience	Not a learner - would appear to be experienced
OTS Causation Code	Driving too fast
Manoeuvre – type and appropriateness	Following the road through a right hand bend passing under a bridge. The damage to the motorcycle would suggest that the rider responded in a reasonable manner to that expected in this type of event. Not sure in the impact location was 'chosen' or not. Riding too fast for the wet conditions - heavy rain, wet road surface and standing water – training?
Comment on any violations	
Clothing	Appropriate clothing - Leather and reflective jacket, leather trousers, gloves, boots
Injuries	Bruising right shoulder, right ankle injury, source not known
Likely cause of injuries	Wooden post and rail fence with posts on traffic side of rails. Appears fence was struck.
Potential reduction in injury severity - comments	The rider sustained slight injuries. This was as a result of the precise location of the impact (into a wooden fence and vegetation), the relatively low speed of the impact and possibly the clothing worn (dedicated motorcycle jacket and trousers (leather) and gloves and boots), Rider avoided striking wall/bridge parapet – potential for much more serious injuries However, there was real potential for a more serious injury outcome in this case. The roadside objects at the pavement edge that the motorcycle could have struck included:

	<ul style="list-style-type: none"> • A curb-side reflective bollard • a brick wall (with damage from a previous impact) • a lamppost • the wooden fence (struck) • a brick bridge parapet <p>Had the rider's trajectory been different as he left the road (by travelling at a faster or slower speed, applying the brakes sooner, losing control at a different point, etc) it is possible that he would have impacted any one of the other three objects and, in doing so, would probably have sustained more serious injuries as a result.</p>
<p>Site observations</p>	<p>8m road, right hand bend, slight uphill, 30mph speed limit with speed indication devices. Double white line system, new antiskid, edge of carriageway marker posts</p>
<p>Highways - comments</p>	<p>Previous collision damage at this location at the time of the collision.</p> <p>No super-elevation</p> <p>Clearly the authority identified the risk at this crash site and has carried out remedial treatment since collision to add anti-skid road surface to bend.</p> <p>However the bridge parapet remains unprotected.</p>
<p>Other comments</p>	<p>From the scene photos it can be seen that a similar impact had occurred recently from the damaged to the wall and traffic cones present. It would appear that another vehicle had also left the road and impacted the wall in the same vicinity as the motorcycle.</p> <p>Information provided by Nottingham County Council regarding events at the same location:</p> <p>2006 = 0</p> <p>2007 = 1 Serious M/C Loss of control Wet Road (this case)</p> <p>2008 = 1 serious 2 slight [no motorcycles] all three wet loss of control leading to head-ons</p> <p>HSRS Anti-skid surfacing laid 17/10/2009, all four accidents involved excessive speed.</p>
<p>Recommendations</p>	<p>Road surface has been improved</p> <p>Training (re braking in wet)</p>

4.2.2. Case Review 2

Site visit Number	5
Description	Path 1 Vehicle 1, a motorcycle, lost control on a left hand bend and left the carriageway to the left. The rider fell from the motorcycle after colliding with reflector posts and the motorcycle came to rest further along the grass verge having been stopped by a chain link fence. The rider came to rest in the carriageway a similar distance along the carriageway to the motorcycle.
Motorcycle – make/model, type and size (cc)	998cc Sports bike (OTS – Road Race Replica)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Driving too fast
Manoeuvre – type and appropriateness	Riding too fast
Comment on any violations	
Clothing	Full protection
Injuries	numerous lacerations and abrasions, closed bending wedge fractured mid shaft left humerus, undisplaced posterior malleolar fractured right ankle
Likely cause of injuries	Road surface, concrete base of marker post (proud of the ground)
Potential reduction in injury severity - comments	No specific
Site observations	Road surface in poor condition with edges rutted. Gap in edge of carriageway marker posts. Edge of carriageway markings, verge and fence.
Highways - comments	Motor cyclist appears to have struck raised concrete footing of edge of carriageway marker post – supposed “safety feature” – leading to loss of control
Recommendations	Could improve road environment/objects Speed

Case Review 3

Site Visit Number	11
Description	Path 1 Vehicle 1, a scooter, lost control for unknown reasons on a right hand bend and left the carriageway to the left. The rider and pillion were thrown from the scooter and the rider collided with a lamppost and suffered fatal injuries as a result.
Motorcycle – make/model, type and size (cc)	49cc scooter (OTS – not applicable)
Rider – age and gender	Male rider Female pillion
Rider - experience	learner rider
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	Loss of control
Comment on any violations	Not licensed to carry pillion “Borrowed” scooter
Clothing	Rider: full face helmet comes off Pillion: no helmet
Injuries	Fatal – multiple injuries
Likely cause of injuries	Lamp post and tree (fatal)
Potential reduction in injury severity - comments	If riders’ helmet had stayed on may not have been killed – helmet came off prior to fatal injury (on tree) If lamp column had been set back then possible that it would not have been struck and collision pattern would have been different
Site observations	8m dual carriageway, right hand bend, super elevated, 40 mph speed limit. Offside hatching with red slurry seal and bifurcation lane arrow
Highways - comments	Lamp column close to edge of carriageway
Recommendations	Could improve road environment/objects

4.2.3. Case Review 4 & 5

Site Visit Number	12	13
Description	Path 1 Vehicle 1, a motorcycle, lost control on a right hand bend and left the carriageway to the left, skidding into the ditch and colliding with a concrete wall at the entrance to a field. The rider was thrown across the field entrance and came to rest in the ditch on the other side, and the motorcycle flipped back out of the ditch and came to rest on its side in the field entrance/gateway.	Path 1 Vehicle 1, a motorcycle, lost control on a right hand bend and left the carriageway to the left, sliding across the verge and into the ditch. No other vehicles were involved.
Motorcycle – make/model, type and size (cc)	600cc sports motorcycle (OTS – Road Race Replica)	400cc Roadster (OTS – Standard Street)
Rider – age and gender		28 year old male rider Male rider
Rider - experience		
OTS Causation Code	Lost control of vehicle	Driving too fast
Manoeuvre – type and appropriateness		
Comment on any violations		
Clothing		full protection
Injuries	Small of subarachnoid blood in occipital horn of lateral ventricle, fracture R 1/3rd distal clavicle	dislocated right shoulder – street furniture, T10 vertebral body crush fracture 10-15% anterior loss fracture going through pedicle and spinous process, T11 fracture, R upper and lower lobe contusion, Tiny R postero-medial pneumothorax, all from collision with wall
Likely cause of injuries	In both cases large hedge and unprotected concrete culvert head wall at field entrance	

Potential reduction in injury severity - comments	Improve the warning of the bend, protect the roadside objects or move the site of the field access
Site observations	6m wide road, right hand bend, super-elevation, edge of carriageway marker posts, 60mph speed limit, verge, hedge, large chevron signs and anti-skid erected since collision
Highways - comments	12: daylight 13: dark Measures have been installed to keep vehicles on road and avoid loss of control. Anti-skid road surface laid and bend now highlighted with chevron signs erected since collisions took place. However, head wall still in situ. Could move farm entrance and/or sink culvert but expensive
Other comments	Information provided by Nottingham County Council regarding previous accidents at the same location: 2006 = 0 2007 = 1 wet Serious loss of control northbound leading to head on 2008 = 2 serious southbound motorcycle loss of controls, one wet. (these cases) Antiskid laid and flexible chevrons April 2009
Recommendations	Road surface and signing has been improved Speed

4.2.4. Case Review 6

Site Visit Number	17
Description	Path 1 Vehicle 1, a motorcycle, being ridden by a disqualified male under the influence of alcohol has left the road to the O/S and mounted the kerb. P1V1 has contacted a concrete wall before the motorcycle has skidded along the carriageway and come to rest.
Motorcycle – make/model, type and size (cc)	125cc solo motorcycle (OTS – Standard Street)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Driving whilst under the influence of alcohol or drugs
Manoeuvre – type and appropriateness	Loss of control
Comment on any violations	Disqualified, under influence of alcohol
Clothing	Helmet but no other protection – track suit top and joggers
Injuries	Abrasions with gravel embedded lumbar spine area, bruising left leg from road surface, 8 x 3 cm laceration extending into R knee joint
Likely cause of injuries	Vertical wall and road surface Rider mounted sloping kerb, stays on machine and slides along “serrated” wall
Potential reduction in injury severity - comments	Serrated wall could have contributed to the severity of injury - a smooth wall may have reduced some injuries, although given lack of clothing he appeared to get off quite lightly. Protective clothing may also have reduced the injury severity
Site observations	5m wide slip road, straight, slight downhill, 40 mph speed limit, edge of carriageway markings, serrated wall
Highways - comments	The sloping kerb allowed the rider to remain upright as opposed to throwing from machine with a full height kerb (as in previous cases)
Recommendations	Nothing needs to be improved Alcohol

4.2.5. Case Review 7

Site Visit Number	20
Description	Path 1 Vehicle 1, a motorcycle, was travelling along in lane one of a two lane dual carriageway, when the rider lost control and veered to the nearside colliding with a TCB (tensioned corrugated beam) barrier. P1V1 then continued sliding down the barrier until the rider was able to regain balance and continue along the carriageway until coming to a convenient stopping place. The rider claimed the rear tyre deflated.
Motorcycle – make/model, type and size (cc)	125cc Race Replica (OTS – Road Race Relica)
Rider – age and gender	Male rider
Rider - experience	Learner rider
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	
Comment on any violations	None apparent
Clothing	Rider wearing trainers
Injuries	Phalanx (top of foot/toe), 8-10cm skin loss left ankle with exposed tendon
Likely cause of injuries	Front face of crash barrier
Potential reduction in injury severity - comments	Rider managed to stay on the motorcycle Boots would have reduced extent of injury Very fortunate not to have sustained worse injury (see below)
Site observations	2 lane dual carriageway, straight section, flat, 70 mph speed limit, lane and edge of carriageway markings, direction sign outside of protection by barrier in advance of barrier, steel barrier with old wooden posts, central section replaced with steel posts from other collision, barrier protects steep bank and water
Highways - comments	Avoided launch off end terminal, stayed on machine Avoided striking posts

	Avoided toppling onto fence Appeared to ride up kerb and maintain control 1m strip at edge of carriageway – was he riding along this?
Recommendations	Nothing needs to be improved Training

4.2.6. Case Review 8

Site Visit Number	22
Description	Path 1 Vehicle 1, a motorcycle, travelling at suspected excessive speed over a speed calming traffic table, which has caused the rider to lose control of the motorcycle with the rear wheel snaking along highway. The rider braked sharply with the front brake, which caused the rider to lose further control of motorbike, which then fell to the floor and skidded along the carriageway some way before hitting the kerb of a pedestrian refuge then coming to rest against a boundary wall on the offside of the road.
Motorcycle – make/model, type and size (cc)	599cc solo motorcycle (OTS – Standard Street)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Driving too fast
Manoeuvre – type and appropriateness	Uphill gradient and potentially accelerating hard. Travelling too fast
Comment on any violations	
Clothing	Not known
Injuries	Abrasion right inner elbow, abrasion central right buttocks/sacrum/ hip, right knee all from road surface. Spine strain non contact. Sacral fracture with superficial haematoma, unstable T12 compression fracture (burst) with fragments occupying 50% canal from contact with wall
Likely cause of injuries	Road surface and wall Rider slid with bike
Potential reduction in injury severity - comments	Wall not forgiving
Site observations	Several other road markings that could disguise the arrow heads on the ramp for the speed table, the speed table is on a slight left hand bend, the zebra crossing speed table is located approximately 90m north of puffin crossing speed table. High Friction Surfacing and road markings are partially worn.

<p>Highways - comments</p>	<p>Loss of control on left hand bend after raised table zebra crossing</p> <p>Possibly struck central island kerb and refuge</p> <p>Road markings and different road surface materials make table difficult to see – white arrows in incorrect position line up with zebra markings</p> <p>Metal cover immediately in advance of raised table</p> <p>Anti-skid surface</p>
<p>Recommendations</p>	<p>Could improve road markings</p> <p>Speed</p>

4.2.7. Case Review 9

Site Visit Number	T3
Description	<p>Two motorcyclists were riding together along a straight, long single carriageway country road. The motorcyclist in front was some distance ahead and not directly involved with this accident, but did give evidence to the speed they were travelling at.</p> <p>At the time of the accident, the weather was very hot and sunny and the carriageway was dry with very light traffic.</p> <p>The motorcyclist that was involved in the accident, Path1 Vehicle1, had 5-6 years experience of riding a motorcycle. Whilst riding this motorcycle, along the straight downhill section of this road, he lost control for no obvious reason, and veered off the road to the offside. He hit the raised grass verge here, detaching him from the motorcycle and launching him over 20m through the air and into a ditch that runs parallel with the road. The motorcycle skimmed through the long grass on this verge and also came to rest in the ditch, approximately 20m further along.</p> <p>His friend admitted that at the time of the accident he was travelling at around 140mph and rider that lost control was behind him moving at 120-130mph.</p> <p>The only possible site contributory factor is that this downhill section of road suddenly levels out at the point the rider lost control and then begins to drop down again after the locus.</p> <p>The rider suffered head, neck and chest injuries as a result and was in a critical condition after the accident.</p> <p>Upon further diagnosis the rider was found to have: a slight head injury, 3 fractured ribs, 5 fractured vertebrae and a collapsed lung. He is expected to make a full recovery.</p>
Motorcycle – make/model, type and size (cc)	750cc Road Race Replica (OTS – Road Race Relica)
Rider – age and gender	25 year old male rider
Rider - experience	
OTS Causation Code	Driving too fast
Manoeuvre – type and appropriateness	

Comment on any violations	
Clothing	Full face helmet, jumper, jeans, trainers, M/C gloves
Injuries	Multiple injuries
Likely cause of injuries	Ditch and hedge
Potential reduction in injury severity - comments	Clothing – protective clothing would have reduced lacerations and abrasions. Back protector may be relevant regarding the thoracic vertebra fractures
Site observations	7.3m wide road, straight, undulating, 60 mph speed limit, centre markings
Highways - comments	Long straight road with no apparent reason to lose control
Recommendations	Nothing needs to be improved Speed

4.2.8. Case Review 10

Site Visit Number	T4
Description	<p>A 21 year old male had been out riding his motorcycle with friends all Sunday afternoon, and on the journey home along a winding rural road was involved in a serious collision.</p> <p>This rider was travelling along a single carriageway B-class road, some distance ahead of his friends (so they are not thought to have contributed to the accident) when he lost control on a sharp right hand bend. It is likely that he panicked on the entry to this bend believing that he was travelling too fast, and so applied the front brake to slow himself. This was the incorrect course of action and caused him to straighten up and run off the nearside edge of the carriageway. Here he collided with the bend chevron signs that run around the outside of this bend, crashing through them and detaching from the motorcycle. He was continually braking up to this point.</p> <p>It is likely that this loss of control was a direct result of lack of riding experience as this rider had held his licence for only 4-5 months. It is also likely that inattention or fatigue also contributed, as this was the end of a long ride.</p> <p>On the other side of the chevrons the rider bounced into a shallow ditch and came to rest amongst the rough vegetation.</p> <p>The rider suffered multiple serious injuries such as a compound fractured and lacerated lower left leg, multiple abdominal injuries and a head injury. He also suffered a large amount of blood loss from the leg injury.</p> <p>This collision occurred at dusk when the light levels were beginning to become difficult, but other conditions at the time were excellent as it was warm, dry and clear.</p> <p>The road that this accident occurred on has a permanent 50 mph speed limit in effect.</p>
Motorcycle – make/model, type and size (cc)	599cc Road Race Replica (OTS – Road Race Replica)
Rider – age and gender	20 year old Male rider
Rider - experience	
OTS Causation Code	Lost control of vehicle

Manoeuvre – type and appropriateness	Possibly travelling too fast for bend. Braked and lost control.
Comment on any violations	None apparent
Clothing	Not known
Injuries	Multiple injuries
Likely cause of injuries	Road surface, possibly road sign, ditch, small tress
Potential reduction in injury severity - comments	possibly road sign in different position
Site observations	7.0m wide single carriageway road, 90o bend, slightly downhill, 60mph limit, centre line and double yellow lines.
Highways - comments	Sign face has been replaced on like for like posts Although the sign posts are passively safe in that they are less than 89mm diameter, they may not be passively safe for a motorcyclist. In addition the sign face may have been struck in the collision contributing to some of the injuries.
Recommendations	Could improve road environment/objects Training

4.2.9. Case Review 11

Site Visit Number	1
Description	Path 1 Vehicle 1, a HGV, turned right from a side road onto a main road into the path of Path 2 Vehicle 1, a motorcycle. P2V1 took evasive action, swerving into the nearside of the carriageway, but clipped the nearside kerb and the rider, pillion and motorcycle skidded along the nearside footpath sideways, coming to rest on the footpath. P1V1 drove away unaware but was flagged down further up the road by other motorists.
Motorcycle – make/model, type and size (cc)	998cc Sports bike (OTS – Road Race Replica)
Rider – age and gender	Male rider Female pillion
Rider - experience	
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	Reacted to other vehicle but lost control
Comment on any violations	None apparent
Clothing	Rider: full face helmet, leather jacket, gloves, boots, cotton trousers Pillion: full face helmet, no other protection (cotton T shirt, jeans, trainers)
Injuries	Fractured ribs and abrasions
Likely cause of injuries	Road surface Road surface, kerb, footway
Potential reduction in injury severity - comments	Full clothing should have reduced some of these injuries, particularly for pillion passenger
Site observations	13m wide road, slight right hand bend, flat, 30 mph speed limit, centre and lane markings and double yellow lines
Highways - comments	Lamp columns at rear of footway avoided a worse outcome as rider and pillion skidded along footway
Recommendations	Nothing needs to be improved Other vehicle

4.2.10. Case Review 12

Site Visit Number	3
Description	Path 1 Vehicle 1, a motorcycle, lost control on a straight road and left the carriageway to the right, where it mounted the footpath and went through a hedge before colliding with the rear door to a house garage. The vehicle and rider went through the door and collided with two motorcycles inside the garage and a car also parked inside the garage. The rider was thrown from the motorcycle and after hitting the main garage door at the opposite end of the building and came to rest outside the garage on the floor in the back garden. The rider subsequently died from the injuries sustained.
Motorcycle – make/model, type and size (cc)	600cc solo motorcycle (OTS Standard Street)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Driving too fast
Manoeuvre – type and appropriateness	Loss of control
Comment on any violations	
Clothing	Not known
Injuries	Fatal – multiple injuries
Likely cause of injuries	Hedge, door surround, house structure, vehicles in garage (fatal)
Potential reduction in injury severity - comments	No specific
Site observations	7.3m wide road, straight, slight uphill. 30 mph speed limit, Traffic calming with speed cushions and cycle bypass
Highways - comments	Loss of control following traversing of speed cushions (or avoidance). 2nd example of loss of control near to vertical traffic calming
Recommendations	Nothing to improve regarding road environment/objects Speed/under the influence

4.2.11. Case Review 13

Site Visit Number	4
Description	Path 1 Vehicle 1, a motorbike, started to overtake Path 1 Vehicle 2, a car, which was turning right into a farm entrance. P1V2 continued with the turn, unaware that P1V1 had started to overtake and the two vehicles collided in the opposing traffic lane. P1V1 was forced off the road to the right, in front of P1V2 and both vehicles came to rest on the grass verge hedge row just past the farm entrance.
Motorcycle – make/model, type and size (cc)	599cc sports bike (OTS – Standard Street)
Rider – age and gender	17 years old Male rider
Rider - experience	
OTS Causation Code	Error of judgement
Manoeuvre – type and appropriateness	Overtake as other vehicle turned right possible error of judgement
Comment on any violations	Bike registered to rider but not old enough - not legally ridden
Clothing	Full protection
Injuries	fracture left humerus, bruising left arm
Likely cause of injuries	Collision with car prior to loss of control. Rider landed on verge
Potential reduction in injury severity - comments	Rider/motorcycle hit car and left bike prior to the machine hitting hedge and avoided contact with hedge and wall. Soft verge to land on
Site observations	8m wide road, slight bend to right, crest of hill, 50 mph speed limit, single white centre line to prevent overtaking in opposite direction
Highways - comments	No specific
Recommendations	Nothing needs to be improved Training

4.2.12. Case Review 14

Site Visit Number	7
Description	Path 1 Vehicle 1, a motorcycle, braked hard as traffic in front stopped in a queue, causing his front wheel to lock in the wet conditions. The motorcycle slid and the rider lost control falling from the bike into the road. No other vehicles were involved in the collision.
Motorcycle – make/model, type and size (cc)	97cc cruiser (OTS – Standard Street)
Rider – age and gender	Male rider 38 years old
Rider - experience	learner rider
OTS Causation Code	Error of judgement
Manoeuvre – type and appropriateness	Lost control under braking in wet
Comment on any violations	None apparent
Clothing	Open face helmet, leather jacket, trousers, no gloves, ordinary shoes
Injuries	Abrasions to face
Likely cause of injuries	Road surface
Potential reduction in injury severity - comments	A full face helmet may have reduced injuries
Site observations	14m wide road, straight, slight downhill, 30 mph speed limit, lane and hatch markings, road surface very poor friction with slurry finish
Highways - comments	No specific
Recommendations	Nothing needs to be improved Training (re braking in wet)

4.2.13. Case Review 15

Site Visit Number	8
Description	Rider of Path 1 Vehicle 1, a motorcycle, braked hard when traffic in front braked in a traffic queue. P1V1 locked the front wheel and rider and bike fell to the floor. No other vehicles were involved.
Motorcycle – make/model, type and size (cc)	124cc tourer (OTS – Tourer)
Rider – age and gender	Female rider
Rider - experience	
OTS Causation Code	Error of judgement
Manoeuvre – type and appropriateness	Rider braking hard – error of judgement Lost control under braking in wet
Comment on any violations	None apparent
Clothing	Kevlar jacket, motor cycle boots and gloves Cotton trousers
Injuries	Bruising right upper lateral leg, bruising right lower lateral leg -motor bike on leg. 24x40mm R adrenal haematoma - blunt trauma. Bruising right shoulder, bruising right dorsum hand, bruising right upper and lower medial leg, bruising and abrasion right knee, bruising right shin. Neck strain
Likely cause of injuries	Vehicle damage to right side – injuries to right Bike falling on rider Road surface
Potential reduction in injury severity - comments	Motor cycle trousers would have reduced road surface injuries
Site observations	10m wide road, straight, flat, 40 mph speed limit, hatched central area with islands, kerb edge with verge and hedge
Highways - comments	No specific
Recommendations	Nothing needs to be improved Training (re vehicle control - braking)

4.2.14. Case Review 16

Site Visit Number	9
Description	Path 1 Vehicle 1, a car, turned right out into oncoming traffic from a parked position at the nearside of the road, intending to complete a 'U' turn to travel off in the opposite direction. P1V1 moved out across the path of Path 2 Vehicle 1, a motorcycle, which was travelling along the main carriageway behind P1V1. P2V1 took evasive action and fell from the bike sliding down the carriageway missing P1V1 as it moved into the central hatched markings where it stopped and the driver got out seeing if the rider of P2V1 was OK. No contact was made between the two vehicles.
Motorcycle – make/model, type and size (cc)	535cc Cruiser (OTS – Cruiser)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Vehicle not to blame
Manoeuvre – type and appropriateness	Reacted to other vehicle and avoided hitting it
Comment on any violations	None apparent
Clothing	Ordinary clothes Coat, trousers, shoes
Injuries	neck and spine strain, soft tissue injury left wrist
Likely cause of injuries	Damage to right side of bike – injury to left wrist Road surface No contact with vehicles
Potential reduction in injury severity - comments	Clothing could have reduced extent of injuries
Site observations	10m wide road, RHB towards motorway bridge, slight downhill, 30 mph speed limit, hatching, refuges
Highways - comments	Road works present
Recommendations	Nothing needs to be improved Other vehicle

4.2.15. Case Review 17

Site Visit Number	10
Description	Path 1 Vehicle 1, a motorcycle, was overtaking standing traffic on the approach to a 'T' junction to the left. The traffic had stopped to allow an unknown vehicle to turn right out of the 'T' junction. The unknown vehicle apparently however stopped across the front of the stationary vehicles waiting, whilst making safety checks that the way ahead was clear before moving off. Rider of P1V1 panicked and braked locking the front wheel of the motorcycle, skidding and losing control. The rider fell off and separated from the motorcycle. No contact was made between the vehicles and the unknown vehicle was untraced.
Motorcycle – make/model, type and size (cc)	747cc roadster (OTS – Standard Street)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	Reacted to other vehicle but lost control
Comment on any violations	None apparent
Clothing	Not known
Injuries	Weber type A fracture L ankle - lateral malleolus/distal fibula
Likely cause of injuries	Road surface – motor cyclists separated from machine
Potential reduction in injury severity - comments	Possibly clothing
Site observations	8m wide road, straight, flat, 30 mph speed limit, centre hatched markings, kerb edge, footway and wall.
Highways - comments	No specific
Recommendations	Nothing needs to be improved Other vehicle

4.2.16. Case Review 18

Site Visit Number	14
Description	Path 2 Vehicle 1, a motorcycle, was travelling north bound downhill, Path 1 Vehicle 1, a car, turned right out of a side road in front of P2V1, in a sideswipe type impact. P2V1 hit the pedestrian refuge, ejected the rider and continued down the road where it mounted the kerb, striking a section of fencing before rebounding back across the footway and finally coming to rest in the middle of the carriageway. The exact final resting position of the rider of P2V1 is unknown.
Motorcycle – make model, type, size (cc)	748cc solo motorcycle (OTS – Road Race Replica)
Rider – age and gender	17 year old Male rider
Rider - experience	no licence
OTS Causation Code	Driving too fast
Manoeuvre – type and appropriateness	Other vehicle pulled out into pat of PTW
Comment on any violations	Rider had no licence, no insurance
Clothing	Full face helmet, gloves clothing not known
Injuries	Fatal injuries – brain, spine, lungs, spleen
Likely cause of injuries	Road surface and/or kerb
Potential reduction in injury severity	Absence of central refuge?
Site observations	The approach to the junction is down hill. There are two traffic islands either side of the junction (one being a pedestrian refuge island). The downhill approach for the motorcyclist could encourage speed. Visibility to the right from Station Road is influenced by a low wall, although this does not appear to restrict visibility significantly.
Highways - comments	Rider lost control after striking kerb of central pedestrian refuge and being thrown from machine (fatal) Motorcycle went on to strike low level fence but rider did not contact fence
Recommendations	Nothing needs to be improved Other vehicle

4.2.17. Case Review 19

Site Visit Number	15
Description	Path 1 Vehicle 1, a moped, was undertaking a bus that was travelling in lane 2. As the two vehicles have rounded the bend, the bus has begun to move across from lane 2 into the bus lane and in doing so has forced path 1 vehicle 1 up onto the pavement. P1V1 has then lost control before colliding with a sign post, coming to rest on the footpath.
Motorcycle – make/model, type and size (cc)	124cc solo motorcycle (OTS – moped without pedals)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Driver made reckless road manoeuvre
Manoeuvre – type and appropriateness	Following inside lane in 2/3 lanes on inside of bus
Comment on any violations	
Clothing	Trainers on feet
Injuries	Comminuted fracture to proximal phalanx with rotational deformity L great toe
Likely cause of injuries	Road sign
Potential reduction in injury severity - comments	Boots should have reduced foot injury severity
Site observations	90 degree turn, traffic signals, adverse camber, 30 mph speed limit. Lane markings and bus lane, double yellow lines
Highways - comments	Sign moved subsequent to collision
Recommendations	Improvement has been made – sign moved Training and road awareness

4.2.18. Case Review 20

Site Visit Number	18
Description	Path 1 Vehicle 1, a motorcycle, has lost control whilst turning right at a crossroads (due to the layout of the junction, it is effectively a sweeping right hand bend) as a result the rider has separated from the motorcycle and slid across the road surface before coming to rest.
Motorcycle – make/model, type and size (cc)	600cc Sports bike (OTS – Standard Street)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	Possible braking error
Comment on any violations	None apparent
Clothing	Dedicated motor cycle clothing
Injuries	Fractured L clavicle (might have expected right)
Likely cause of injuries	Rider leaning to the right but injury to left side – not clear how injuries sustained Road surface only
Potential reduction in injury severity - comments	Clothing protected rider
Site observations	5 arm traffic signal junction, RH bend for rider, 2-3 lane approach riding in outside lane into centre of junction, 30mph speed limit, white paint in centre of junction in location where m/c lost control, crown of road gives adverse camber
Highways - comments	Road markings, metal chamber covers and camber within motor cycle path could have contributed to loss of control. Markings refreshed since collision (likely maintenance)
Recommendations	Could improve road surface Training (re vehicle control - braking)

4.2.19. Case Review 21 & 22

Site Visit Number	19
Description	An unknown vehicle had slowed to turn at a crossroads junction on the main carriageway with several vehicles slowing and stopping behind. Path 1 Vehicle 2, a motorcycle, had braked to come to a stop behind the queuing traffic. Path 1 Vehicle 1, a trike, based on a VW beetle, following too close behind failed to stop and collided into the rear of P1V2 before swerving to the left and rolling into the verge.
Motorcycle – make/model, type and size (cc)	trike (V1) and 750cc solo motorcycle (V2) (OTS – other) (OTS – Standard Street)
Rider – age and gender	Both male riders
Rider - experience	
OTS Causation Code	Error of judgement (V1) Vehicle not to blame (V2)
Manoeuvre – type and appropriateness	large group of motor cyclists on trip trike (V1) ran into the back of the 750 Honda motorcycle error of judgement by trike rider (V1)
Comment on any violations	None apparent
Clothing	Full protection for motor cyclist
Injuries	Motorcyclist – abrasions Trike rider – rib injuries, L2 and L3 transverse process, abrasions left knee and ankle from road surface, spleen laceration, midshaft left humerus bending wedge butterfly fragment with radial nerve
Likely cause of injuries	Road surface
Potential reduction in injury severity	No specific
Site observations	7.5-8m wide road, straight, uphill (2%), undulating, 40mph road works present. Edge of carriageway marker posts. Nearside verge with temporary fence posts
Highways - comments	Road works present for road widening leading to queuing traffic. Although road construction had started, speed limit and fence boundary not in place at time of collision. Splay kerb in place with marker posts and verge with down gradient
Recommendations	Nothing needs to be improved Training for V1 nothing for V2

4.2.20. Case Review 23

Site Visit Number	21
Description	Path 1 Vehicle 1, a moped, travelling along the highway when the rider applied the brakes due to vehicles slowing down in front. Due to a wet and slippery road surface, the rider of the vehicle lost control of the moped due to the front wheel skidding on the road surface.
Motorcycle – make/model, type and size (cc)	49cc moped (OTS – moped without pedals)
Rider – age and gender	Female rider
Rider - experience	Learner rider
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	Braking on wet road Lost control under braking
Comment on any violations	None apparent
Clothing	Unknown
Injuries	abrasion to left lower leg
Likely cause of injuries	Damage to right side of scooter – injury to left Road surface
Potential reduction in injury severity - comments	Clothing unknown – protective clothing may have helped
Site observations	8m wide road, straight between two bends, slight downhill, 30 mph speed limit, centre line markings, edge of carriageway
Highways - comments	No specific
Recommendations	Nothing needs to be improved Training (re braking in wet)

4.2.21. Case Review 24

Site Visit Number	23
Description	Path 1 Vehicle 1, a moped, has been travelling along a straight downhill section of road and approaching a set of traffic lights. The road was wet at the time of the collision occurring. The rider has braked for the traffic ahead but in doing so has applied excessive front wheel braking causing the wheel to lock and for the rider to fall from the scooter and onto the carriageway.
Motorcycle – make/model, type and size (cc)	49cc moped (OTS – scooter)
Rider – age and gender	Female rider
Rider - experience	Learner
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	Lost control under braking in wet
Comment on any violations	None apparent
Clothing	Not known
Injuries	lip laceration from bite, abrasions left thumb, left knee, left foot
Likely cause of injuries	Road surface
Potential reduction in injury severity - comments	No specific, possibly clothing
Site observations	Downhill approach to controlled crossing with no High Friction Surfacing, slightly uneven and rutted carriageway.
Highways - comments	Metal chamber covers on approach to crossing No anti-skid – but although this may help riders to brake and not lose control, if they do lose control abrasions could be more severe
Recommendations	Nothing needs to be improved Training (re braking in wet)

4.2.22. Case Review 25

Site Visit Number	T1
Description	V2 (Yamaha motorcycle) was in lane 2 of 3 on a one way road. V2 pulled into lane 3 attempting to overtake congested traffic. Rider was travelling at approximately 40mph. V1 (a BMW car) pulled into path of V2. V2 applied brakes locking up rear wheel and skidding to offside. V2 then struck the kerb and fell to offside on footway, skidding on bodywork until colliding with a tree stump on footway. Then the vehicle spun into lane 3.
Motorcycle – make/model, type and size (cc)	125cc Road Race Replica (OTS – Road Race Replica)
Rider – age and gender	20 year old male rider
Rider - experience	Learner rider
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	
Comment on any violations	None apparent
Clothing	Leather jacket, jeans, gloves, trainers
Injuries	Abrasion to leg (from gravel rash sliding along the ground) left/right not specified. Abrasion to ankle (from gravel rash sliding along the ground) left/right not specified
Likely cause of injuries	Road surface, possibly second vehicle
Potential reduction in injury severity - comments	Protective trousers may have reduced road surface abrasions
Site observations	9.0m wide, 3 lane one-way road, straight and flat, 30mph but with higher 85th percentile speed, lane lines and double yellow lines.
Highways - comments	No specific
Recommendations	Nothing needs to be improved Other vehicle

4.2.23. Case Review 26

Site Visit Number	T2
Description	<p>Path1 Vehicle1, a Yamaha R1 motorbike, was stationary at a red traffic light stopped next to P1V2 an untraced vehicle (Jensen car). Drivers were intending to race away from traffic lights. P1V2 accelerated at high speed away from the lights and continued along in lane 2 of a two lane dual carriageway, P1V1 was following closely behind.</p> <p>P1V2 noticed vehicles ahead were stationary at the last minute and braked heavily. P1V1 also braked heavily, locking the front wheel of the motorcycle and losing control. The motorcyclist then fell to the nearside and slid under barrier and in between the two central barriers. The motorcyclist then bounced along up the central reservation and then hit a lamp post head first coming to a stop.</p> <p>The motorcycle continued along the carriageway skidding on it's bodywork and came to a rest further along the road in between lane 1 and lane 2.</p> <p>The driver of P1V2 failed to stop and was not impacted at all.</p>
Motorcycle – make/model, type and size (cc)	<p>1000cc sportsbike (OTS – Road Race Replica)</p> <p>Polish registered, race components added</p>
Rider – age and gender	<p>25 year old</p> <p>Male rider</p>
Rider - experience	
OTS Causation Code	Lost control of vehicle
Manoeuvre – type and appropriateness	
Comment on any violations	Rider apparently racing other vehicles
Clothing	Not known
Injuries	Fatal – multiple injuries
Likely cause of injuries	Front face of crash barrier, objects within close proximity of barrier edge? Crash barrier posts?
Potential reduction in injury severity - comments	Motorcycle friendly barrier with fully boxed in section – or concrete barrier, appropriate set back or working width for objects within central reserve crash barrier

Site observations	8.0m wide 2 lane dual carriageway, straight, slightly uphill, 70mph, lane lines.
Highways - comments	<p>3rd crash barrier collision in sample</p> <p>A previous collision had led to the Armco barrier deforming reducing the working width to the central reserve lamp columns further. Due to the narrow central reserve both the set back of barrier and the working width were compromised, reducing the safety benefits of the barrier in an impact and making the central reserve lamp columns more intrusive that they otherwise would be</p>
Other comments	<p>Could improve barrier</p> <p>Speed</p>

4.2.24. Case Review 27

Site Visit Number	6
Description	Path 1 Vehicle 1, an off road motorcycle, was witnessed riding along a footpath. The rider having intended to cross the junction mouth of a side road but misjudged mounting the kerb and has lost control. The rider then fell from the machine coming to rest on the footpath.
Motorcycle – make/model, type and size (cc)	125cc off road (OTS – off road)
Rider – age and gender	
Rider - experience	
OTS Causation Code	Driving whilst under the influence of alcohol or drugs
Manoeuvre – type and appropriateness	
Comment on any violations	Not a road accident – off road bike being ridden on pavement Alcohol or drugs
Clothing	Helmet unfastened – came off
Injuries	abrasions, laceration, bruising forehead, parietal and occipital areas, abrasion right scapula
Likely cause of injuries	Road surface, possibly barrier
Potential reduction in injury severity - comments	Clothing and fastened helmet would have reduced injury
Site observations	12m wide road but riding on 1.5m wide footpath, straight and flat, 60mph speed limit, RT lane markings on road. Steel safety fence protecting water hazard
Highways - comments	Hit barrier head on at right angle but did not topple over Barrier protecting water hazard Avoided collision with lamp post – could have had worse consequences
Recommendations	Nothing needs to be improved Training (re importance of safety – alcohol/drugs, helmet, clothing)

4.2.25. Case Review 28

Site Visit Number	16
Description	Path 1 Vehicle 1, a motorcycle, has been travelling along the road when a pheasant has collided with the helmet of the rider of P1V1. P1V1 lost control and came to rest on the nearside verge.
Motorcycle – make/model, type and size (cc)	750cc street bike (OTS – Standard Street)
Rider – age and gender	Male rider
Rider - experience	
OTS Causation Code	Vehicle not to blame
Manoeuvre – type and appropriateness	Riding along when hit in face by bird
Comment on any violations	None apparent
Clothing	Full face helmet, Kevlar jacket/ trousers, gloves, boots
Injuries	nose injury from vehicle, neck strain, bruising left upper arm and posterior hips
Likely cause of injuries	Face injuries from contact with bird Road surface
Potential reduction in injury severity - comments	Kevlar body armour protected rider from worse injury
Site observations	12m road width, series of bends, flat vertical profile, 60 mph speed limit, right turn lanes with double white centre lines and edge of carriageway markings
Highways - comments	Rider was hit by pheasant and having lost control rider avoided ditch and fence which could have worsened injury
Recommendations	Nothing needs to be improved

4.2.26. Case Review Conclusions

Considering the information from the case reviews and the specific recommendations made, it is possible to draw the following conclusions.

The first 10 cases can be described as single vehicle accidents and all the casualties sustained injuries from impact with a roadside object. Of these, in 3 cases there are no improvements to make to the road environment, in 4 cases improvements are possible and in 3 cases improvements have already been made to objects and/or road surfaces.

In 6 of these cases the riders were travelling too fast and 1 was under the influence of alcohol and in 3 cases the circumstances suggest that training would be beneficial.

There were 16 cases which occurred in traffic conditions. In these cases 9 of the casualties sustained their injuries from the road surface, 6 from road or roadside objects and 1 from another vehicle. In 13 of the cases there are no improvements to make to the road environment, in 2 cases improvements are possible and in 1 case improvements have already been made to roadside objects.

Of these cases, 5 directly involved another vehicle and in 2 cases the riders were travelling too fast. The circumstances suggest that training would be beneficial in 8 cases, 4 regarding braking in the wet and 4 regarding vehicle manoeuvres.

Of the remaining 2 cases, 1 was not a road accident but involved an off road bike being ridden on the pavement by a rider under the influence of alcohol. The rider was injured by an impact with a barrier but there are no improvements to make. The final case involved the rider being struck by a bird and falling to the ground, and again there are no improvements to make to the road environment.

In summary regarding the 28 cases, in 17 of the cases the casualties sustained injuries from an impact with a roadside object, in 10 from the road surface and in 1 from another vehicle. In 18 of the cases there are no improvements to make to the road environment, in 6 cases improvements are possible and in 4 cases improvements have already been made to the road surface and/or objects.

While the number of cases that have been considered is small it is interesting to note that, whilst the majority of injuries were sustained from an impact with a roadside object, the number of cases where there was no impact with an object (ie just the road surface) is also of significance.

5. CONCLUSION

A cluster analysis of STATS19 data for 2008 was carried out on 2,030 PTW cases, out of the total 22,427 PTW cases, which had 'hit a fixed object in the carriageway' or 'hit an object off the carriageway'. Six important clusters, based on variables contributing to the crash, were identified:

- 1 Larger capacity motorcycles involved in SVAs going ahead on bends on dry roads with higher speed limits in daylight (43% of all casualties, 45% of serious injury casualties, 36% of fatalities).
- 2 Larger motorcycles (over 500 cc) going ahead, overtaking or changing lane and colliding with a passenger car that was most often turning or going ahead (12% of all casualties, 12% of serious casualties, 14% of fatalities).
- 3 Single vehicle accidents in daylight on not dry (wet or damp, snow, frost or ice, etc) roads involving all motorcycle sizes and vehicle manoeuvres. (11% of all casualties, 9% of serious casualties, 6% of fatalities).
- 4 Single vehicle accidents in darkness on dry roads, especially smaller vehicles (up to 125 cc) with lower speed limits (20–40 mph) where the vehicle was going ahead without overtaking, changing lane or negotiating a bend (10% of all casualties, 12% of serious casualties, 15% of fatalities).
- 5 Single vehicle accidents in darkness on not dry (wet or damp, snow, frost or ice, etc) roads, especially small vehicles (up to 125 cc) going ahead and on bends (6% of all casualties, 4% of serious casualties, 7% of fatalities).
- 6 Larger motorcycles (over 126 cc) on high-speed roads (60–70 mph) colliding with cars and other vehicles on bends (4% of all casualties, 4% of serious casualties, 6% of fatalities).

A similar cluster analysis has not yet been conducted on the OTS data but it will be interesting to learn if a similar pattern emerges.

From the analysis of STATS19 it was found that, of the 22,427 PTW cases in 2008, 2,559 (11%) hit an object in or off the carriageway whilst 19,868 (89%) did not. The proportions are very different in OTS where, of the 461 PTW cases 138 (30%) involve a roadside or other object with or without the involvement of another road user, 314 (68%) involved another vehicle only and 9 (2%) involved no collision partner or object. That these proportions are so different may be explained by the greater detail collected in OTS but this difference requires further investigation.

Of the 28 OTS in-depth cases which were reviewed examples of cases were identified for some, but not all, of the clusters from the cluster analysis. For example, Cluster 1 Cases 4, 5,10; Cluster 4 Case 7. Given the small number of cases involved it is not necessarily surprising that all of the clusters are not specifically represented. However, using this cluster approach to focus in-depth case reviews in future will be a worthwhile avenue to explore.

The 28 in-depth case reviews, with the specific focus on the design, installation and recommendations regarding roadside objects, have highlighted that in 18 of the cases there are no improvements to make to the road environment, in 6 cases improvements are possible and in 4 cases improvements have already been made to the road surface and/or objects. This suggests that, whilst Local and Highways Authorities are responding to safety issues presented by PTW crashes, there are still roadside and other objects which need to

be improved in order to improve PTW protection and reduce injuries. Specific examples of such improvements have been identified on a case by case basis.

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