TRANSPORT and ROAD
RESEARCH LABORATORY

Department of the Environment
Department of Transport

TRRL LABORATORY REPORT 913

A SURVEY OF MOTORCYCLE ACCIDENTS

by

J Whitaker

Vehicle Safety Division
Safety Department
Transport and Road Research Laboratory
Crowthorne, Berkshire
1980
ISSN 0305–1293

CONTENTS

A SURVEY OF MOTORCYCLE ACCIDENTS

ABSTRACT

This survey looks at a sample of 450 injured motorcyclists involved in 425 accidents over a period of one year (1974). A comparison of several aspects of the accident situation between the sample and national accident data indicated that the detailed information gained from the survey is representative of motorcycle accidents reported nationally by the police. The study examines the accident situation, causes of injury to riders, crash helmet performance, and the motorcycles involved. Some of the main findings are:–

(i) The high incidence of accidents where other road users fail to see the motorcyclist whilst negotiating a junction. Thus the motorcycle is usually travelling at between 20–30 mile/h just prior to the accident.

(ii) Other vehicles were the main cause of serious injuries to motorcyclists. Riders' legs were particularly prone to severe injury.

(iii) There was some evidence that helmets conforming to the higher British Standards slightly reduced the likelihood of head injury below that for lower standard helmets. The use of full face helmets was shown to reduce the chance of facial injury.

1. INTRODUCTION

This survey set out with two objectives:–

(a) to identify the prominent features of present day motorcycle accidents,
(b) to identify lines of research which would lead to fewer accidents and injuries.

Many of the findings from this work are being or have already been implemented. National data[1] compiled from police reports can provide some of the accident information (rider injury severity, age, urban or rural site, etc) but do not give much detail about the accident situation or the motorcyclist's riding experience.

The survey was designed to collect information on the circumstances of each accident, causes of injury, conspicuity, riding experience, safety helmets and the motorcycle's braking and handling performance. It makes no attempt to attach blame to any parties in the accidents.

2. THE SAMPLE

2.1 Geography

An area of 1640 km^2, covering most of Berkshire and parts of Buckinghamshire and Oxfordshire was studied for this survey (Figure 1). It included four towns of population greater than 20,000 and one greater than 50,000. The motorcycle population of the area was estimated roughly at 10,000 motorcycles.

Arrangements were made with the Slough and Newbury divisions of the Thames Valley Police for them to inform the Laboratory of all the motorcycle accidents notified to them during 1974.

2.2 Casualties

All motorcycle accidents reported to the police were studied, and each motorcycle was treated as a separate accident. This led to some inconsistency in the actual and recorded number of accidents (but not casualties) as 14 accidents involved two motorcycles. Five hundred and one accidents were recorded, and data were available on 483 of them. Forty-three pillion passengers were involved. Seventy-six riders and passengers were uninjured leaving 450 injured motorcyclists involved in 425 accidents. A summary is given in Table 1. Injuries to other road users involved in the accidents were not recorded.

TABLE 1

Breakdown of sample by (a) accidents, (b) casualties

(a) *Accidents*

Status of motorcyclists	Solo motorcycles	Motorcycles with pillion passengers	Total
Injured	389	36	425
Not injured	51	7	58
Total	440	43	483

(b) *Casualties*

Status of motorcyclists	Solo riders	Riders carrying pillion passengers	Pillion passengers	Total
Injured	389	32	29	450
Not injured	51	11	14	76
Total	440	43	43	526

This report considers only the injured casualties as its sample. Most 'damage only' accidents are not reported to the police, and those in this survey are incidental. However, when riders were interviewed, some of the accidents recorded by the police as 'damage only' were discovered to have caused minor injury to the riders. These were recoded for the purpose of the survey as 'injury' accidents.

Grattan and Keigan[2] give evidence that up to 30 per cent of motorcyclists reporting to hospital with road traffic accident injuries do not appear on police accident records and would not, therefore, be present in this sample. Most of them were single vehicle accidents involving minor injury. (There is no legal requirement to report such an accident if no third party is involved[3].)

2.3 Data collection

All accidents reported to the police were studied. The police officer reporting the accident was asked to complete a questionnaire (Appendix 1) provided by the Laboratory. He was asked to use all sources of information available to him including the people involved in the accident, witnesses, damaged vehicles, skidmarks on the road, etc.

The Laboratory's medical team obtained injury data on the casualties and motorcyclists themselves were interviewed at home by trained Laboratory staff using the four page questionnaire shown in Appendix 2. People who lived too far away to be interviewed were sent the same forms by post as were used by the interviewers. They accounted for about 10 per cent of the sample. In multi-vehicle accidents,* drivers of other vehicles were not interviewed by the Laboratory although the police may have taken a statement from them, the relevant details of which would be passed on to the Laboratory by the reporting officer. Where accidents involved head injuries riders helmets were borrowed for examination at the Laboratory.

A reply was received from all three sources of information in 87 per cent of cases. Where minor cuts and abrasions were mentioned by the rider when interviewed, they were included in his injury profile. In the five cases where the motorcyclist was killed, post-mortems and coroners' inquests were obtained in addition to the form completed by the reporting police officer.

The information was coded onto a computer to assist analysis.

The 'not known' (NK) which appear in the tables arise from returned questionnaires being incompletely answered. Percentage figures are calculated on the basis of positive answers. 'not knowns' are not quoted except when they exceed 10 per cent of the sample.

2.4 Relation to national data

Several aspects of the survey were compared with national accident data. Detailed comparisons are made in Appendix 3 and show acceptable agreement on rider injury severities, the proportions in built up† and non built up areas, male and female riders, drivers and pillion passengers, conditions of the road surface, road types, days of the week, hours of the day and lighting conditions. Compared with national figures the sample over-estimated the number of 16 year olds and the proportion of mopeds. Distribution of accidents by month of the year was more scattered in the local sample. Appendix 4 gives the classification of injury used in the survey. This is different from the classification used nationally which is also given in Appendix 4.

It was not a requirement of the survey that the proportions should match exactly. It is felt that the sample proportions are sufficiently similar to national data to indicate the main problem areas and so the more detailed information of the local survey is relevant to motorcycle accidents nationally.

3. RIDERS

3.1 Age

Figure 2 shows the age distribution of all injured casualties in the sample and also those severely†† or fatally injured. The largest group in both cases is for 17 year olds but 16 year olds also account for a

* more than one vehicle

† defined as having a speed limit of 40 mile/h or less

†† Appendix 4

large number of the casualties. The frequency then dwindles as age above 17 increases. Sixty-three per cent of injured casualties were less than 20 years old. No age group, including those over 40, had a greater proportion of serious injury than any other.

3.2 Sex

Nine per cent of the sample were females. A higher proportion of women rode mopeds rather than motorcycles (52 per cent of females rode mopeds, 26 per cent of males) and a higher proportion were pillion passengers (39 per cent of females were pillion passengers, 3 per cent of males) than in the whole sample.

3.3 Passengers

Although accidents to motorcycle combinations were to be included in the sample, none was reported. Twenty-nine pillion passengers were injured (6 per cent of injured motorcyclists). In terms of injury they fared neither better nor worse than their drivers.

Note: The data in the following four sections relates to the accident sample. It cannot be fully analysed without comparing it to similar information on the normal usage of motorcycles, and this is not currently available.

3.4 'Learner' drivers

Seventy-one per cent of the riders involved had not passed the official motorcycle driving test, although 43 per cent of these 'learners' had been riding for over a year and 57 per cent for less. It is not known whether the people had not applied for a test, or had taken it and failed.

It was noted that learners had a higher proportion of their accidents in built up areas and at lower speeds than qualified riders. However, the proportion of severe injuries among 'L' riders was no smaller than for qualified riders.

Riders who had passed their motorcycle driving tests had much the same proportion of single vehicle or loss of control type accidents as learners.

Only 12 riders out of 425 rode a moped on a full car licence. All but one of these were over 25 years old, and 5 of them were over 60.

3.5 Riding experience

Motorcyclists were interviewed about their riding experience to assess this as a factor in accident causation. Data were not collected on the training that riders may have had.

Most riders in the survey rode their motorcycles regularly. Sixty-eight per cent of riders claimed they had ridden over 2000 miles in the previous year and 35 per cent said they had ridden over 5000 miles in the previous year. Ninety-four per cent rode their motorcycles four or more days a week. Out of 235 injured riders 59 had been driving less than 3 months when they had their first accident, and 85 had been driving for less than 6 months (Table 2).

TABLE 2

Experience of motorcycling on public roads prior to first accident

Experience (months)		No. of first time accidents
Over	Not over	
	1	26
1	3	33
3	6	26
6	12	41
12	24	36
24		73
Total		235

3.6 Riding habits

Again, these data are for the accident sample and should not be confused with usage sample. The information collected on motorcyclists' driving habits are summarised in Table 3. Distinction is now made between riders of mopeds and other motorcycles.

TABLE 3

Riding habits of injured motorcyclists by type of motorcycle

Percentages (NK)

Riding Habits	Mopeds (115)	Motorcycles and Scooters (306)	All m/c (421)
Road type driven on:–			
Drives mostly on town roads	44	32	36
Drives mostly on country roads	20	15	17
Drives equally on town and country roads	35	46	43
Drives equally on town and country roads, and motorways	–	7 (11 NK)	5
Length of journey:–			
Most journeys are less than 5 miles (8 km)	59	41	46
Most journeys are more than 5 miles (8 km)	30	43	40
Roughly equal number of long and short journeys	11	15 (12 NK)	14 (11 NK)
Avoidance of weather conditions:–			
Tries to avoid driving in the wet	34 (10 NK)	25 (13 NK)	28 (12 NK)
Tries to avoid driving in icy conditions	60 (19 NK)	50 (20 NK)	53 (20 NK)
Tries to avoid driving in fog	33 (19 NK)	29 (19 NK)	30 (19 NK)
Riding position on road:–			
Drives on nearside of line of traffic	61	38	45
Drives in centre of line of traffic	26	40	36
Drives on offside of line of traffic	13	22 (12 NK)	19 (11 NK)

3.7 Accident history

Sixty-one per cent of riders in this survey said that they had had no previous accidents. Three riders had been severely injured in more than one accident. Table 4 gives the number of accidents riders in the sample have had for different categories of accident.

TABLE 4

Accident history of 382 injured riders (43 not known)

Percentages

Type of accident	Number of previous accidents				
	0	1	2	3	>3
All previous m/c accidents	61	25	11	2	1
Previous serious accidents	98	2	–	–	–
Previous collisions	84	15	1	1	–
Previous loss of control accidents	72	19	7	1	1
Previous accidents as 'learner'	71	20	8	1	1

4. ACCIDENT SITUATION

4.1 Other road users

Seventy-eight per cent of the motorcycle accidents involved other road users and 22 per cent were single vehicle accidents. As has been shown previously[2], this probably underestimates single vehicle accidents since they are less likely to be reported to the police. Of the 333 accidents involving others, 95 per cent involved other vehicles (including motorcycles and HGVs), 4 per cent involved pedestrians, and 2 per cent involved pedal cyclists.

Over half the other road users involved told the police afterwards that they had not seen the motorcyclist prior to the accident (Table 5). However the pattern altered when the motorcyclist was performing a manoeuvre (Table 6). Most drivers saw the motorcyclist prior to the impact when he was about to turn right, but most did not when the motorcyclist was overtaking. It was interesting to note that in 5 per cent of the multi-vehicle accidents the offending road user was a motorcyclist who did not see another rider. The number of these accidents is thus in proportion to the populations of motorcycles and other vehicles (6 per cent of vehicles are motorcycles). This means that motorcyclists are just as likely to not see or misjudge other motorcycles as are other vehicle users.

TABLE 5

Observance of riders by other road users in motorcycle accidents

Other driver saw motorcycle?	Multi vehicle daylight	Multi vehicle dark	All multi vehicle accidents
Yes	94	34	128
No	111	43	154
Not applicable	13	3	16
Not known	21	14	35
Total	239	94	333

TABLE 6

Observance of motorcyclists performing a manoeuvre

Other driver saw motorcycle?	Motorcycle manoeuvre			
	Left turn	Right turn	Overtake	All
Yes	9	20	13	42
No	6	5	30	41
Not applicable	5	5	5	15
Not known	2	2	5	9
Total	22	32	53	107

4.2 Conspicuity

It was stated in Section 4.1 that over half the other road users involved in the accidents did not see the motorcycle prior to the accident. A factor in the problem is the 'conspicuity' or 'attention grabbing capability' of the motorcyclist. If he contrasts strongly with the background he will obviously be more noticeable than if he blends in with it.

Although the proportion of motorcyclists not seen is the same in daylight and darkness (Table 5), it is suspected that the reasons are different. Work by Kirkby and Fulton established that the colour of the large area of the jacket has the most marked effect on the conspicuity of the motorcyclists in daylight. This criterion was taken as a measure of daytime conspicuity in the present survey (the use of daytime headlights had not been publicised at the time). Yellow, orange, bright red and white were identified as conspicuous colours, and all others were classified as non-conspicuous. A suitable criterion for conspicuity at night has not yet been devised. It was not possible to conduct a satisfactory numerical analysis of the data since out of 250 casualties involved in multi-vehicle daylight accidents only eight were wearing conspicuous jackets. This does not, however, illustrate the efficacy of conspicuous clothing in preventing accidents, since a similarly low proportion (2 out of 53) of riders involved in single vehicle accidents (where conspicuity has little relevance) were wearing conspicuous jackets. Because of the low wearing rate of conspicuous clothing in 1974 no conclusions on the merits of conspicuity can be drawn from this survey. On the other hand, several factors indirectly suggest that improving conspicuity should help to prevent accidents.

1. In the majority of multi vehicle junction accidents the driver of the other vehicle manoeuvred into the path of the oncoming motorcycle.

2. Over half the drivers involved said they did not see the motorcycle before the accident.

3. Fifty-nine per cent of motorcycle impacts were frontal, and the area of motorcycle and rider visible to drivers at junctions was small.

4.3 Types of conflict

These are ranked in descending order of importance in Table 7 (see Section 5.1 and Appendix 5). Fatal conflicts were included with severe conflicts in the rating as they were too few to be representative. The first four conflicts mentioned in Table 7 were each responsible for more than 10 per cent of severe

casualties. The most common conflict was that of a vehicle turning right out of a junction into the path of a motorcycle approaching from the right.

TABLE 7

Conflicts by severity of injury of motorcyclists (percentages)

Movements before accident	Injury severity of motorcyclists[1,2]			Weighted percentages of all conflicts (excluding fatal)[3]
	Minor (242 casualties)	Moderate (122 casualties)	Severe and Fatal (83 casualties)	
Vehicle emerged turning right into path of motorcycle coming from right	34	13	10	13
Two vehicles facing the same direction of travel	31	11	10	12
Two vehicles from opposite directions in collision	15	13	9	11
Single motorcycle going ahead	17	13	8	10
Vehicle turned right across path of oncoming motorcycle	16	15	6	8
Motorcycle in collision with parked unattended vehicle	12	7	6	7
90^{o} collision (including pedestrian impacts)	28	13	4	7
Vehicle turned right across path of following or overtaking motorcycle	18	9	5	7
Single motorcycle turning left or negotiating left hand bend	4	4	4	4
Vehicle turned left across path of motorcycle following or coming up on inside	4	2	3	3
Single motorcycle turning right or negotiating right hand bend	15	6	1	2
Vehicle entering roundabout into path of motorcycle already on roundabout	5	1	2	2
Vehicle emerged turning right into path of motorcycle from the left	9	0	0	1
Vehicle emerged left into path of motorcycle from the right	4	1	0	0
Other	30	14	10	13

Notes

1. Numbers in table refer to numbers of casualties in each classification.
2. See Section 5.1 for definitions.
3. See Section 5.1 and Appendix 5.

In this survey 78 per cent were multi-vehicle accidents (involving more vehicles than just the motorcycle) and 65 per cent of these happened at junctions, roundabouts or private entrances. The rest occurred on bends or going straight ahead. The motorcycle was going ahead, and the other vehicle manoeuvring in 72 per cent of multi-vehicle junction accidents.

One hundred and seven motorcyclists were making a manoeuvre at the time of the accident, while the remainder (318) were simply going ahead.

In accidents where the motorcycle was making a manoeuvre, turning right at a junction, overtaking other vehicles at junctions, and overtaking vehicles on straight roads were predominant (Table 8).

TABLE 8

Motorcycle manoeuvres by location of accident

	Motorcycle turns left	Motorcycle turns right	Motorcycle overtakes	All motorcycle manoeuvres	Motorcycle going ahead	All motorcycle accidents
Roundabout	12	2	0	14	8	22
Junction	3	21	17	41	130	171
Private entrance	1	7	9	17	34	51
Bend	2	1	4	7	54	61
Other	4	1	23	28	92	120
All locations	22	32	53	107	318	425

A collision occurred at some point in the accident in 87 per cent of cases (371 accidents). They were classified by direction and location of impact as shown in Figure 3.

4.4 Loss of control and single vehicle accidents

Single vehicle accidents accounted for 18 per cent of accidents in built up areas and 34 per cent in non built up areas and together these comprised 22 per cent of the total in the survey which, as already explained, greatly under-reports such accidents. A quarter of the single vehicle accidents were caused by collisions with parked unattended vehicles; another third happened while negotiating bends or corners, and the rest were an assortment of incidents such as hitting kerbs, losing control on bumpy and slippery roads (especially roadworks) and animals running into the road. About half of the single vehicle accidents happened at night. It was noted that 3 of the 5 fatal accidents resulted from single vehicle accidents. It is not known if the comment is significant, but the severity of the injury was generally higher in single vehicle accidents. This again is put down to the generally higher speeds in this group.

Accidents were also classified into loss of control accidents and collisions. Loss of control accidents were those in which no contact was made with other obstacles even though a hazard that the rider avoided may have been present. Collisions included accidents involving skidding of the motorcycle in a straight line with heavy braking prior to impact. About 15 per cent of the sample were multiple event accidents where loss of control and collision occurred as two separately identifiable events, eg a glancing blow from a car travelling in the same direction followed by an unsuccessful attempt to control the motorcycle, or a collision resulting from losing control of the motorcycle. Table 9 shows that collisions were the primary

cause of injury producing accidents in 76 per cent of cases reported and loss of control the primary cause in the remainder. Loss of control accounted for 20 per cent of accidents in built up areas and 37 per cent in non built up areas.

TABLE 9

Types of motorcycle accident

Type of accident	Number	Per cent
Collision	306	72
Collision and loss of control	16	4
Loss of control	54	13
Loss of control and collision	49	12
Total	425	100

The biggest single factor in loss of control accidents was losing traction whilst steering round bends, roundabouts or junctions. This should not, however, be considered in isolation, as any of the other factors mentioned in Table 10 may have been contributing at the same time. A higher proportion (significant at the 5 per cent level) of loss of control accidents happened in the wet (38 per cent) than did collisions (27 per cent). Twenty-eight per cent of loss of control accidents were directly due to braking errors.

TABLE 10

Factors in 103 loss of control accidents

Steering round bend, roundabout, junction	53
Wet road surface	39
Braking	29
Slippery surface (eg mud, gravel)	22
Rider misjudgement, inattention	21
Panic swerve	15
Potholes, uneven road surface	10
Motorcycle fault	5
Strong wind	3
Dazzle from oncoming vehicle	3
'Intimidation' by positioning of other vehicle	2

4.5 Speed

Speeds were taken from rider interviews and statements made by participants and witnesses to the police. In interviews with the motorcyclists, the general interpretation to the question "What do you estimate the speed of the motorcycle/other vehicle to be prior to the accident?", was to give the estimated speed prior to the emergency, and not the speed at which impact occurred. Since vehicle speeds were estimated only on the basis of human observation, they are not likely to be very accurate, and should be treated with caution.

The main feature noticed was the predominance of impacts occurring at 21–30 mile/h (33–48 km/h). This was the most common speed of nearly all groups of riders. Half of all the motorcycle accidents were in this speed range (Figure 4). This reflects the high proportion of accidents where the rider was travelling at normal traffic speed when confronted with a hazard. One per cent of the (injury producing) accidents happened with the motorcycle stationary. In 75 per cent, the motorcycle was travelling at less than 30 mile/h and in 93 per cent, less than 40 mile/h. Figures 5–10 show the speed distributions for different groups of motorcyclists. Above average speeds were observed for accidents in non built up (rural) areas, in single vehicle accidents and motorcycles of over 250 cc engine capacity. Step through machines and mopeds had accidents at below average speeds (40 per cent of mopeds were step throughs). A greater proportion of severe and fatal accidents happened at higher speeds. It is known that three of the five fatals were travelling faster than 40 mile/h (64 km/h).

The speeds of other vehicles involved in the accidents are shown in Figure 7. Sixty-two per cent of these were below 10 mile/h.

The most common group was in a frontal direction to the front of the motorcycle (59 per cent of collisions). However it was noted that in many cases the object hit (usually a car) was not perpendicular to the direction of travel of the motorcycle and there was a glancing impact. This is important because the injury pattern, particularly to the legs, was different from that in a normal impact.

Thirty-eight per cent of collisions were side impacts and only 3 per cent were rear end impacts.

TABLE 11

Objects hit by motorcycle

Object hit	Multi vehicle accidents	Single vehicle accidents	All accidents
Other vehicle using road	290	–	290
Other vehicle parked	1	23	24
Pedestrian	13	1	14
Cyclist	5	–	5
Other object	7	33	40
No objects	17	34	51
Not known	–	1	1
All objects	333	92	425

Table 11 shows that 78 per cent of the objects hit by the motorcycle were other vehicles using the road, 6 per cent were parked vehicles, 5 per cent were pedestrians or cyclists, and 11 per cent were other objects. In single vehicle accidents an object was struck in 63 per cent of cases. In multi-vehicle accidents no object was struck in 5 per cent of cases; the rider avoided others but lost control of the motorcycle.

5. INJURIES

5.1 Classification

In this survey injuries were classified using the TRRL classification which was used on data acquired before 1975. It gives a reliable guide to severity of injury measured in clinical terms. This scale approximates to the Abbreviated Injury Scale[4] in that minor corresponds to AIS 1, moderate to AIS 2, severe to AIS 3, 4 or 5 and fatal to AIS 6 or to any lower AIS category which results in death within 30 days of an accident. A TRRL leaflet LF 130[5] gives details of the specific injuries used in the classification and is reproduced in Appendix 4(a).

A weighting scale was derived to assess approximately the relative importance of each severity group when looking at the number of motorcycles involved in different aspects of the accident situation. Taking into account financial cost and length of stay in hospital, the following scale was produced:–

Minor	1
Moderate	1.5
Severe	15
Fatal	90

A derivation of this scale is given in Appendix 5. Because of the variety of injuries included in each severity group, the above scale can be used only as a guide. The numbers refer to the relative importance which may be attached to an individual motorcyclist with a particular injury severity rating. By summing the numbers for all the riders in each group being considered, it is possible to identify the outstanding features of the sample.

Causes of injury were obtained from interviews with the riders. Many minor injuries were reported which did not appear on official records. They were included in the rider's injury profile.

5.2 Injury pattern

The severity of injury of the 450 motorcycle casualties was distributed as follows:

TABLE 12

Injury severity of riders

	Casualties	Percentage	Weighted percentages using scale
Minor	242	54	12
Moderate	122	27	9
Severe	78	17	57
Fatal	5	1	22
Not known	3		
Total	450	100	100

Eighty-one per cent of the casualties received either minor or moderate injuries while only 19 per cent received severe or fatal injuries. However, if the results are weighted according to the above scale, 57 per cent of the 'cost' of motorcycle accidents arises from severe casualties and 22 per cent from fatal casualties.

The distribution of injuries over the body varied little amongst the three non fatal groups (Figure 11) except that a relatively high proportion of moderate injuries were to the head. There was no significant difference in the numbers of injuries to the left and right of the body in any category. The inclusion of only one entry for any number of injuries to any one region of the body under-emphasises injuries to the torso.

Most injuries were to the legs, which received 62 per cent of all severe injuries. Lower legs were more likely to be injured than upper legs. Knees were particularly prone to minor cuts and abrasions (22 per cent of all minor injuries) (Table 13).

TABLE 13

Distribution of injuries(1) by severity

	Minor	Moderate	Severe	Fatal
Head	64	61	6	4
Chest	35	7	3	1
Abdomen	24	6	7	
Left upper arm	20	9	4	
Left elbow	28	1	2	
Left lower arm	53	11	6	
Right upper arm	24	10	2	
Right elbow	21	2	2	
Right lower arm	55	11	4	
Left upper leg	54	4	9	
Left knee	80	17	6	
Left lower leg	74	11	17	
Right upper leg	55	6	11	
Right knee	80	10	3	
Right lower leg	63	12	13	
Total	730	178	95	5
Injuries per casualty(2)	1.6	0.4	0.2	0.01

Notes

1. Only one injury per body site is recorded in this table. In some cases 2 or more injuries were noted.
2. Based on average injuries per casualty for any injured rider involved in a motorcycle accident (450 casualties).

Fifty-seven out of 64 severe leg injuries were fractures. There were slightly more fractures of tibias and fibulas than femurs. (Significant at the 5 per cent level). About one-third of leg fractures occurred near the ends or at the joints of the long bones and about half of the fractures were complicated by being

comminuted, compound, displaced, or the joint being dislocated. Eight people received severe foot or ankle injuries from cars (especially bumpers) striking the riders whilst they were on their motorcycles.

Fifteen out of 22 severe arm injuries were fractures and three-quarters of these were at the extremities of the long bones. Most of the rest were dislocations. Lower arms, elbows and hands were more frequently severely injured than upper arms. (Significant at the 5 per cent level). Only a quarter of arm fractures were simple fractures. Most of the 61 moderate head injuries were mild concussion from hitting the road or another object. (All but three riders in the sample wore crash helmets).

Twenty-two severe injuries to the head and trunk were recorded and 12 of these were fractures. Fractures to skull, face, ribs, vertebrae, sternum and pelvis were all observed. There were 10 injuries to organs of the head, chest and abdomen. No site on the head and trunk seemed more prone to severe injury than other sites.

Five riders were killed. Four died from skull fractures and cerebral haemorrhage or contusion and one died from a ruptured aorta and chest haemorrhage. All were wearing safety helmets. No conclusion is drawn about the distribution of fatal injuries from a sample this small. Grattan and Clegg[6], with a slightly larger sample, showed that fatal injuries were equally divided between head and chest, while others died from asphyxia or post injury complications.

5.3 Causes of injury

Table 14 gives a summary of data collected on causes of injury to the motorcyclist at different severity levels.

TABLE 14

Objects causing injury to motorcyclists by severity

Object causing injury	Injury severity				All severities		
	Minor	Moderate	Severe	Fatal	Total	Total %	Weighted on scale
Handlebars	46	5	3		54	6	3
Petrol tank	5	3	1		9	1	1
Other motorcycle part	34	7	1		42	5	2
Road	399	76	20	1	496	53	30
Other vehicle	134	47	36	2	219	24	40
Other object	35	12	9	1	57	6	13
Trapped between motorcycle and other object	22	15	15		52	6	11
Not known	55	13	10	1	79		
Total	730	178	95	5	1008	100	100

The biggest single cause of this sample of a hundred severe and fatal injuries was the rider hitting another vehicle involved in the accident. Forty-three per cent of severe and fatal injuries were due to this. The road was responsible for another 24 per cent and street furniture such as gate posts and lighting columns a further 11 per cent. Another common cause of severe injuries was riders' legs being caught between their motorcycles and other objects (17 per cent). These objects were usually cars.

The motorcycles themselves caused only 5 per cent of severe injuries. Handlebars were responsible for 3 of the 5.

The road accounted for the biggest proportion of minor and moderate injuries, while impacts with other vehicles were less important.

When the causes of injury are drawn together for all severities and weighted according to the preceding scale, other vehicles are clearly the most important cause of injury to motorcyclists. The road surface is also an important factor in this respect. Broadly, over 80 per cent of rider injuries happen after the motorcyclist has been ejected from his motorcycle. Only about 6 per cent are caused by the motorcycle directly, and the remainder are from the involvement of the legs of riders between their motorcycles and cars, the road or other obstacles.

When looking in detail at the objects causing injury, several points can be made:

(i) *Motorcycles* Injuries from handlebars, petrol tank, and other parts of the motorcycle occurred mainly to the legs and abdomen. The handlebars also caused several minor injuries to the lower arms and hands.

(ii) *Road* The road caused injuries all over the body, especially to the head and arms. Most minor leg injuries were also attributable to the road. Over half of minor and moderate head injuries, all six of the severe, and one fatal head injury resulted from impact with the road. Four of the severe head injuries were to the cranium, and two to the face. The most common moderate head injury was mild concussion. Most of the upper arm injuries and all 13 fractured clavicles arose from impact with the road.

(iii) *Other vehicles* Other vehicles involved in the accident were the predominant cause of severe and fatal injuries. They caused injuries all over the body, especially the legs. Car bumpers in particular caused many lower leg, ankle and foot fractures. A quarter of moderate head injuries (especially concussion) were caused by other vehicles. Two people were killed by hitting other vehicles, one with his head, and one with his chest.

(iv) *Other objects* Injuries to riders hitting obstacles of street furniture were present all over the body. One rider received a fatal head injury from hitting a lighting column.

(v) *Trapping between motorcycle and other object* Several riders received injuries from being caught between their motorcycles and an object. The object was usually a car, and injuries were almost exclusively the legs. Lower legs were more frequently injured than upper legs. Two-thirds of this type of accident were impacts to the side of the motorcycle although the direction of impact of the offending obstacle was evenly spread from forward to lateral directions.

5.4 Factors affecting the severity of injury

Motorcycle speed and obstacles hit by the rider were the only factors which had a direct effect on the severity of injury of the riders in this sample. Patterns in all other aspects of the accident situation did not vary significantly from one injury class to another. These included the type of conflict, the proportion of skidding to collision accidents, speed of the other vehicle, the proportion of single to multi vehicle accidents and the number of step through and conventionally framed motorcycles etc. There was no correlation between the distribution of the severities of injury of the rider and the engine size of his motorcycle, although national data shows that riders of large motorcycles are more prone to serious injury than riders of small motorcycles. This may be because the present sample is too small. The location of impact on the motorcycle does not affect the severity of injury of the rider, although it does affect the distribution of injuries (casualties of side impacts received significantly more leg injuries).

There is a higher proportion of severe and fatal rather than lesser casualties in non built up areas when compared with built up areas, but this is entirely accounted for by the higher speeds observed there. Figure 12 shows that high speed accidents contain a greater proportion of severe and fatal accidents, so that only 14 per cent of the casualties in accidents below 30 mile/h received severe injuries, while above 40 mile/h, 44 per cent received severe or fatal injuries. It is known that 3 of the 5 fatal casualties were travelling faster than 40 mile/h (64 km/h).

A study of obstacles struck by the rider (see Table 14) shows that hitting other vehicles, other objects, or the rider's leg being trapped between his motorcycle and an obstacle, are much more likely to cause severe injury to the rider than hitting either the road or the motorcycle. In each case more than 15 per cent of the injuries were severe, with 29 per cent in the case of the legs being trapped. Less than 5 per cent of the injuries from the motorcycle or the road were severe.

5.5 Factors affecting the distribution of injuries

A significantly higher proportion of leg injuries were observed in casualties from side impacts. Eighty-one per cent of the severe injuries from side impacts were to the legs, compared with 52 per cent for front and oblique impacts.

A higher proportion of head and arm injuries was observed in loss of control accidents; conversely more leg injuries occurred in collisions.

6. SAFETY HELMETS

6.1 Types worn

Compulsory wearing of safety helmets for motorcyclists was introduced in Great Britain in 1973. In this sample helmets were worn by 409 of the 450 injured riders, and not worn by 3 (38 not known). In the whole survey, including uninjured riders who may have hit their heads, 468 wore helmets, and 3 did not (55 not known). Helmets to the various British Standards, applicable at the time of the survey, were worn in the following proportions:–

BS 2001	57 per cent
BS 1869	33 per cent
BS 2495	5 per cent
Foreign Standards	4 per cent
Not worn	1 per cent

The helmet standard was not known in 39 per cent of cases.

There were about five times as many open face helmets as full face, and only a small number of the hard cap type. Chin cups were present on single strap helmets in about half the sample.

6.2 Helmet loss during impact

The helmets of seven riders did not have their straps fastened at the time of the accident, and three of these came off during the impact. Fourteen helmets came off when the strap was fastened, twelve of which were fitted with chin cups. Three of the riders who lost their helmets received minor head injuries, 3 received moderate head injuries and one received a severe head injury. In nearly all cases the injury was sustained after the helmet had come off the head.

6.3 Performance of British Standard helmets

Out of 526 riders in 483 accidents, 390 helmet wearers were recorded as striking their heads on an obstacle. Two hundred and fifty-seven of these riders completely escaped head injury, and a further 64 received only facial injuries, an area of the head not usually protected by a helmet (see Section 6.4). Thus, in 390 head impacts, only 69 people suffered non-facial head injuries. These were distributed by helmet standard and injury severity as shown in Table 15.

Head injuries of BS 2001 helmet wearers and BS 1869 helmet wearers were compared. To ensure that the two groups were exposed to similar ranges of head impact severity, only those whose accidents occurred in the estimated speed range 21–40 mile/h and who were wearing open face helmets were examined (Table 16).

TABLE 15

Riders whose heads hit an obstacle
Non-facial head injury severity against helmet standard

Helmet Standard	Severity of head injury					
	Uninjured or facial	Minor	Moderate	Severe	Fatal	Total
BS 2001	98	4	23	3	1	129
BS 1869	63	2	7	0	0	72
BS 2495	7	1	1	0	0	9
Other	9	0	0	0	0	9
Not known	144	10	13	1	3	171
All helmets	321	17	44*	4	4	390

* Includes 10 casualties with additional facial injuries.

The table indicated a slightly significant reduction in the number of head injuries to wearers of higher standard (BS 1869) helmets over those wearing lower standard (BS 2001) helmets. Bearing in mind the small number of injured casualties and the likely variability in the severity of head impacts, it is concluded that while there is some evidence to suggest that higher standard helmets reduce the number of head injuries to motorcyclists, the numbers in this sample are insufficient to establish the case beyond doubt.

TABLE 16

Non-facial head injury against helmet standard

Helmet Standard	Uninjured and facial	Injured	Total
BS 2001	61	21	82
BS 1869	33	4	37
Total	94	25	119

Notes

1. Riders wearing open face helmets whose head hit an obstacle.
2. Estimated motorcycle speed prior to accident 21–40 mile/h.
3. Differences significant at the 10 per cent level.

6.4 Open versus full face helmets

The type of helmet (full or open face) was known in 260 of the 390 cases of head impacts. Two hundred and twenty-one of these riders were wearing open face helmets and 39 were wearing full face helmets. To determine whether there were any differences in the protection offered by the two types, head injuries were divided into facial and non-facial injuries. Eight casualties wearing open face helmets received facial and non-facial head injuries and were included in both sets of data.

From the evidence of Section 6.3, helmet standards cannot be grouped when examining non-facial head injuries. Since no BS 2001 full face helmets were observed, only data for BS 1869 helmets were suitable for analysis and are included in Table 17(a). It shows that there is no significant difference in the proportion of non-facial head injuries for open and full face helmets (for BS 1869). This would be expected since similar types of construction are used for the two styles of helmet in the area of protection common to both.

On the other hand, it can be reasonably argued that the helmet standard would not affect the acquisition of facial injuries, so data from all the helmets are included in Table 17(b) for comparing facial injuries with open and full face helmets.

Table 17(b) shows that the difference in the proportion of facial injuries between open and full face helmets is significant (at the 2½ per cent level). Full face helmets give a lower relative incidence of facial injury when compared with open face helmets. Thus, on the evidence of these results, it appears that full face helmets reduce the chance of head injury by reducing facial injuries.

For open face helmets 37 facial injuries were minor, 14 were moderate, and 3 were severe. For full face helmets 1 was minor and 2 were moderate.

TABLE 17(a)

Non-facial head injuries of casualties wearing open and full face helmets
(BS 1869 only)

Type of helmet	Non-facial head injury		
	Not injured	Injured	Total
Open face	42	5	47
Full face	20	4	24
Total	62	9	71*

* One case where type of helmet not known. Differences not significant.

TABLE 17(b)

Facial head injuries of casualties wearing open and full face helmets
(All Standards)

Type of helmet	Facial injury		
	Not injured	Injured	Total
Open face	167	54	221
Full face	36	3	39
Total	203	57	260*

* 130 cases where type of helmet not known. Differences significant at the 2½ per cent level.

6.5 Severity of head injury versus obstacle hit

It has been suggested that hitting one's head on the road surface causes less severe injuries than hitting other types of obstacles, since the head impact speed on the road is governed only by the vertical height of the rider's head above the ground. On the other hand, the impact speed of the head against vertical or oblique obstacles depends, to a large extent, on the speed of the motorcycle before impact.

Table 18 shows that a higher proportion (significant at the 10 per cent level) of riders whose heads hit obstacles such as other vehicles, street furniture, kerbs etc, were injured compared with those who hit their heads on the road surface. The difference becomes significant at the 2½ per cent level when the more serious (moderate, severe and fatal) head injuries are grouped together and compared with the rest.

TABLE 18

Head injury severity against obstacle hit by head

	Head injury severity					
	Uninjured	Minor	Moderate	Severe	Fatal	Total
Head hit road	133	39	31	5	1	209
Head hit other obstacle	36	12	20	0	2	70
Total	169	51	51	5	3	279*

* 111 cases where object struck unknown.

6.6 Head injuries

It is recognised that the number of severe (6) and fatal (4) head injuries in this sample is small, but it may be useful to give a brief account of the type of injuries sustained. All these riders were wearing helmets.

All four fatal head injuries involved both skull fracture and intracranial haemorrhage. One rider received his injury when he hit the back of a lorry; another hit a lighting column, and another hit the road with his head. The cause of the fourth rider's head injury was unknown.

Two of the severe head injuries were fractures to the back of the skull. One of these casualties also received moderate neck and facial injuries. Two others received severe fractures of facial bones, one of whom also received a mild concussion (moderate). The fifth rider suffered severe concussion and cerebral atrophy. The sixth had severe concussion and several moderate facial injuries. All six of the severe head injuries arose from hitting the road.

Whilst all the fatals suffered skull fracture and brain injury, examples were seen in the severe head injuries of fracture without brain injury, and brain injury without fracture. It was apparent that at least two of the severe casualties received concussion from a blow to the face.

Most of the moderate head injuries were mild concussion and most of the minor head injuries were cuts and abrasions to the face.

6.7 Helmet damage

Helmet damage was assessed as none, minor or major, where major damage was defined as permanent deformation or cracking of the shell or inner liner. Minor damage generally consisted of superficial scratching of the shell, or the helmet peak being broken, and would not normally require replacement of the helmet.

Helmet damage was known in 287 of the 390 head impacts. Thirty-eight of these (13 per cent) suffered major damage.

Impacts with the road resulted in much less helmet damage than impacts with other obstacles. This is in agreement with the observations in Section 6.5 that head injuries received from the road were less traumatic than those from other obstacles. Helmet damage also corresponded to head injury severity. Damage was appreciably greater for casualties receiving moderate or worse head injuries over those with only minor injuries. Of the four fatal head injuries, damage to the helmet was major in one case but unknown in the other three.

As would be expected, there was a strong correlation between the amount of helmet damage and the speed of the motorcycle prior to the accident. In 54 per cent of cases of major helmet damage, the speed was over 30 mile/h and in 92 per cent it was over 20 mile/h.

7. MOTORCYCLE DESIGN FACTORS

From previous experimental work on frontal impacts of motorcycles at the Laboratory[7], characteristic differences have been noted between the ejection of dummy riders from conventional motorcycles and from those of the 'step through' design. A record was therefore made of the frame design in each accident to see if this had some bearing on the types of injuries received. Seventy per cent of the motorcycles were of the conventional design, where the petrol tank was situated between the rider's knees, and 30 per cent were 'step through' types. Generally the 'step through' motorcycle is a lightweight machine (90 cc or less), and this may also be a factor in injuries to riders. Nineteen scooters, which are somewhat heavier, were also included in the 'step through' group.

Various other features of the motorcycles were noted to see if they played any part in rider injuries, as follows:–

Fairing	14 (out of 425 motorcycles)
Wind shield	39
High handlebars	24
'Chopper' forks	2
Leg shields	94
Crash bars	33
Fibreglass tank	6
Turn indicators	233

Riders of conventional and step through motorcycles received minor and moderate injuries in the same proportion as their numbers, but riders of conventional motorcycles appeared to be more likely to receive severe injuries than those riding step throughs (significant at the 1 per cent level). However since no particular injury pattern was apparent the cause may be put down to the higher speed of conventional motorcycles (Section 4.4).

In fact, so few injuries were caused by the motorcycles themselves, that different injury patterns from particular design features of motorcycles could not be detected. Fairings, high handlebars, 'chopper' style forks, and fibreglass fuel tanks were seen in only very few accidents but appeared not to present any outstanding injury hazard. Wind shields caused 4 minor and one moderate injury out of 39 cases where a wind shield was present.

Apart from scooters all the motorcycles fitted with leg shields were under 150 cc. The leg shields were generally light plastic, solely provided for weather protection. The only injuries observed from leg shields were two minor leg injuries from the metal leg shields of scooters.

Thirty-three motorcycles were fitted with crash bars. They were usually conventionally framed machines and their distribution of speeds before the accident was similar to that of other conventionally framed motorcycles. Comparing leg injuries of the riders in these two groups showed the severity and

frequency of injuries to be similar in both classes. Leg injuries to riders of motorcycles fitted with crash bars were (from rider interviews) mostly caused by other vehicles or the road. The crash bars therefore do not appear to be doing their job in keeping legs away from harmful obstacles. It is apparent that a well designed crash bar should serve two purposes. Firstly it must prevent crushing of the leg in the initial impact, and secondly it must prevent legs from hitting hard objects near the motorcycle later in the crash. Present crash bars do not appear to fulfil this second function.

The fuel systems on the motorcycles in this sample gave little cause for concern with regard to fire risk. One motorcycle caught fire (out of 425) and another's steel petrol tank split on impact and emptied its contents onto the road but did not catch fire. Both were struck in the side by cars. No injuries resulted from the single fire but a few burns from exhaust pipes were noted in other accidents. Petrol loss was assessed by the motorcyclist and the police on the scene as none, slight or heavy, with the following results:

No petrol loss	68 per cent
Slight petrol loss	21 per cent
Heavy petrol loss	10 per cent

The location of leaks was not recorded.

There appeared to be no connection between the speed of impact of the motorcycle and the amount of petrol lost. This suggests that leakage may usually arise from the design and position of the filler cap and the various vents of the fuel system when the motorcycle is lying down, rather than from damage to components. In spite of the examples quoted above, motorcycles involved in side impacts leaked no more badly than those involved in other types of accidents.

Nearly all the petrol tanks were steel. None of the fibreglass tanks exhibited any outstanding faults, but since there were only six in the sample, the evidence is not conclusive.

8. DISCUSSION AND CONCLUSIONS

The major characteristics of motorcycle accidents, as determined from this survey, are as follows.

(i) *Types of accidents*

Accidents were classified by type into loss of control accidents and collision accidents. Loss of control of the motorcycle was the primary cause of a quarter of the accidents in the sample. This is a low estimate of the actual proportion of such accidents since many involve only one vehicle and these need not be reported. The most common factor in such accidents was losing traction whilst steering round bends. Braking errors were responsible for a quarter of the loss of control accidents.

Collisions were mainly frontal impacts for the motorcycles, but often the obstruction was a car which was not perpendicular to the motorcycle and the motorcycle glanced off it. Over a third of the collisions were impacts to the sides of motorcycles, although in many of these the motorcycle hit the obstruction at an oblique angle. Rear end impacts were very infrequent.

Half of all the accidents in the survey involved other road users manoeuvring at junctions or round-abouts into the paths of motorcyclists travelling at normal traffic speeds. These accidents happened much more often than motorcyclists moving into the paths of other road users, indicating that, for one reason or another, other road users (including motorcyclists themselves) are not conditioned to anticipate approaching motorcycles.

One half of the motorcycles in this survey were said to be travelling at between 20–30 mile/h (32–48 km/h) at the time of the accident (an urban traffic speed). At the same time, most of the other vehicles involved were travelling at less than 10 mile/h (16 km/h). This is consistent with the type of multi-vehicle junction accident previously described.

Not unexpectedly, the severity of injury of the rider increased with the speed of the motorcycle before the accident, so that, below 30 mile/h (48 km/h), only 14 per cent of the casualties were severely injured, while above 40 mile/h (64 km/h), 44 per cent received severe or fatal injuries.

All five of the fatal casualties died from impacts with unyielding obstacles at high speed. Four were head injuries and one was a chest injury. In three cases where the speed was known, the rider was travelling faster than 40 mile/h (64 km/h) before the accident. Direct impact at such speeds for unprotected road users cannot possibly be survived, and radical design changes to the motorcycle and the clothing of the rider seem to be the only ways of increasing the chances of survival for the rider.

(ii) *Causes of injury*

Almost two-thirds of severe injuries were to the legs; this gives cause for concern because such leg injuries take longer to heal than most other injuries and can incapacitate a casualty for several months[2]. Half of the leg injuries resulted from hitting other vehicles after the rider was thrown from his machine. Another quarter were caused by the leg being trapped between the motorcycle and an obstacle. It follows that there is an opportunity to reduce severe injuries substantially by protecting the legs. An effective form of leg guard offers the largest single opportunity for reducing casualties of motorcycle accidents. Current 'crash bars' do not appear to offer suitable protection, and some investigations are required to arrive at a suitable design.

The road ranked second as a cause of severe injury, and was responsible for most of the injuries to the upper half of the body. In general, these injuries were not as severe as leg injuries from hitting cars. Most minor injuries were caused by the road and were spread all over the body. Injuries from the motorcycle itself were not very common, and it is felt that effort directed at protecting the rider from his motorcycle would only marginally reduce injuries.

(iii) *Safety helmets*

It was concluded that the better performance of higher standards of helmet was not often put to use in the spectrum of motorcycle accidents. However, with only ten severe and fatal head impacts in the sample, variations in performance under severe impact conditions could not be analysed. Accidents involving severe head impacts, with and without injury, warrant further study for this problem. If greatly improved protection can be incorporated in helmets, then they would be a viable and economical means of reducing fatal casualties noticeably, since a high proportion result from head injuries.

The use of full face helmets has been shown to reduce the chance of facial injuries, and if no other penalties are incurred (eg cost, weight, vision) their use should be encouraged. The use of chin cups increases the chance of helmet loss during an accident. Chin cups are not now fitted to single strap helmets for this reason, and it is recommended that they should be removed from older ones and the strap fastened under the chin.

(iv) *Other drivers*

The fact that half of the car drivers stated that they did not see the motorcycle before the accident supports the view that an improvement in the conspicuity of the motorcyclist and his machine would help, although there were insufficient data to establish this in the present survey. Other questions about car drivers are also raised, such as their evaluation of the speed of an approaching motorcycle, their expectancy of seeing a car or other large vehicle rather than a two-wheeler when negotiating a junction and their attitude to motorcyclists when driving.

In nearly all the accidents in this survey, only the rider was injured, while the other road user escaped unhurt, thus supporting the value of publicising to other road users the vulnerability of motorcyclists. However, it is clear that motorcyclists could help themselves substantially if they keep alert to the hazards in their surroundings and to the movement of others on the road especially at junctions.

9. ACKNOWLEDGEMENTS

The work described in this report forms part of the research programme of the Vehicle Safety Division (Division Head: Mr I D Neilson) of the Safety Department of TRRL.

The assistance of the Slough and Newbury Divisions of the Thames Valley Police, and the staff of the several hospitals in the same area is gratefully acknowledged. Thanks are also due to E Grattan and Dr N G Clegg and to J Hobbs, and R D Stone of Accident Investigation Division, TRRL, for their help in collecting and processing the medical and other data, and to Mrs M Pattinson and her staff for interviewing the motorcyclists.

10. REFERENCES

1. DEPARTMENT OF THE ENVIRONMENT. Road Accidents Great Britain. London, 1976 (H M Stationery Office).

2. GRATTAN, E and Maureen E KEIGAN. Patterns and severity of injury in a hospital sample of road traffic accident casualties. *5th International Conference of the International Association for Accident and Traffic Medicine,* London, September 1975.

3. ROAD TRAFFIC ACT 1972. Section 25.

4. THE ABBREVIATED INJURY SCALE. Proceedings of the 19th Conference of the American Association for Automotive Medicine, 1975.

5. TRANSPORT AND ROAD RESEARCH LABORATORY. The classification of injuries sustained in road accidents. *TRRL Leaflet* LF 130. Issue 3. Crowthorne, January 1974 (Transport and Road Research Laboratory).

6. GRATTAN, E and N G CLEGG. Clinical causes of death in different categories of road user. International Research Committee on Biokinetics of Impacts, Conference Proceedings June 26–27, 1973. (Instituut voor Biomechanica en experimentele revalidatie.)

7. TRANSPORT AND ROAD RESEARCH LABORATORY. Motorcycle Accidents: Frontal Impacts. *TRRL Leaflet* LF 472. Crowthorne, March 1975 (Transport and Road Research Laboratory).

8. DEPARTMENT OF THE ENVIRONMENT. Transport Statistics Great Britain 1964–1974. London, 1976 (H M Stationery Office).

9. MINISTRY OF TRANSPORT, ROAD RESEARCH LABORATORY. Road Research 1965–66. Annual report of the Road Research Laboratory. London, 1967 (H M Stationery Office).

10. DAWSON, R F F. Current costs of accidents in Great Britain. *Ministry of Transport, RRL Report* LR 79. Crowthorne, 1967 (Road Research Laboratory).

11. DAWSON, R F F. Current costs of accidents in Great Britain. *Ministry of Transport, RRL Report* LR 396. Crowthorne, 1971 (Road Research Laboratory).

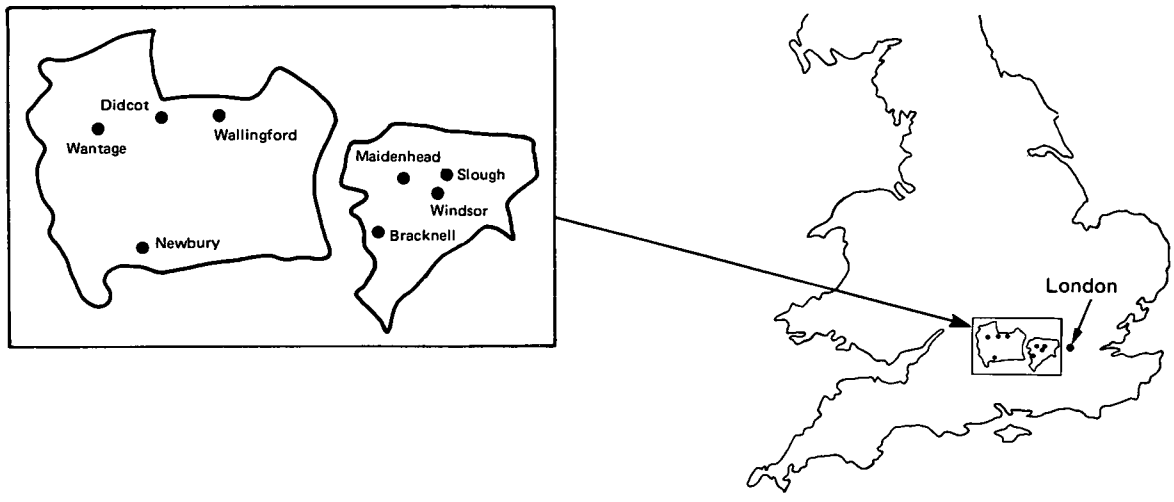


Fig. 1 SURVEY AREA

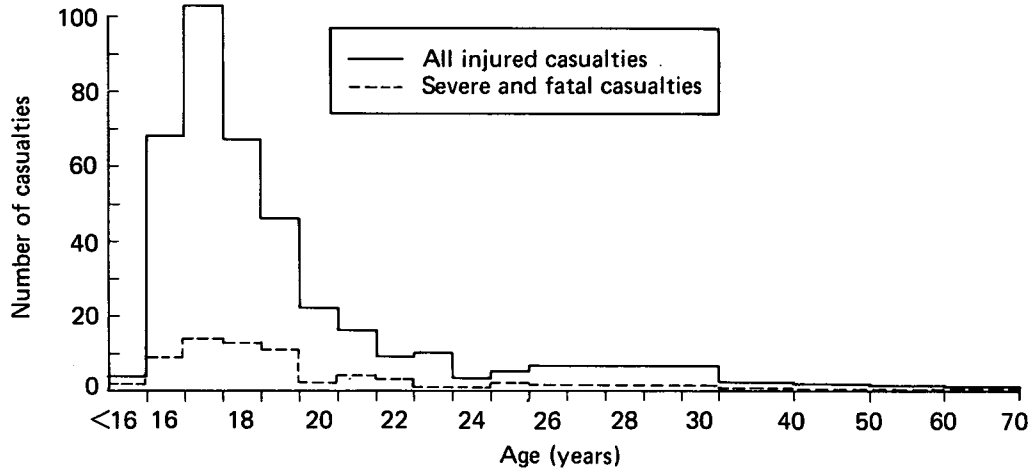


Fig. 2 AGE DISTRIBUTION OF INJURED MOTORCYCLISTS

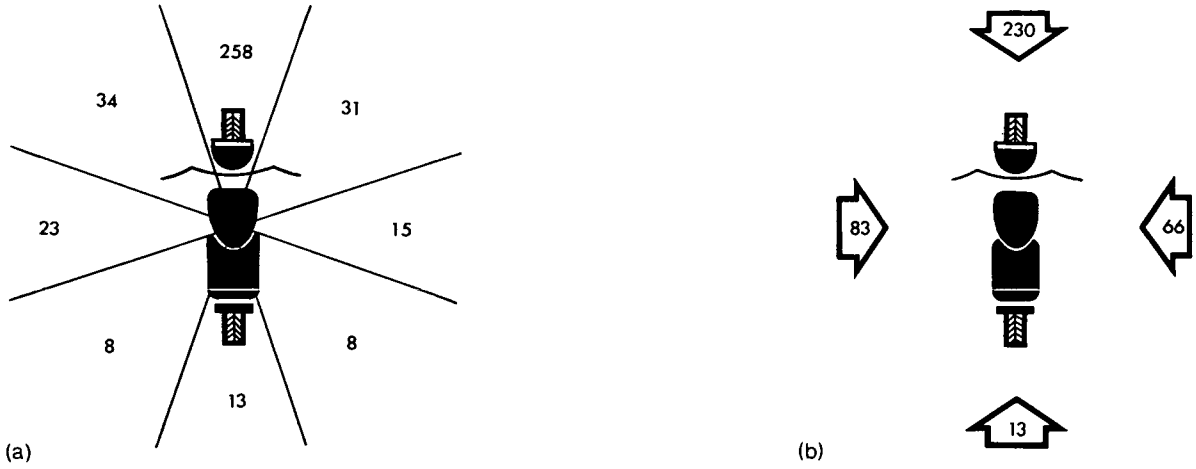


Fig. 3 (a) DIRECTION AND (b) LOCATION OF IMPACT

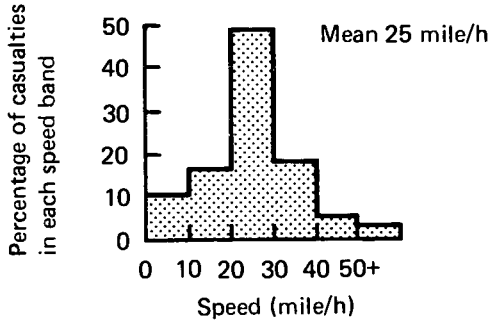


Fig. 4 DISTRIBUTION OF ESTIMATED SPEEDS IN INJURY-PRODUCING MOTORCYCLE ACCIDENTS (425)

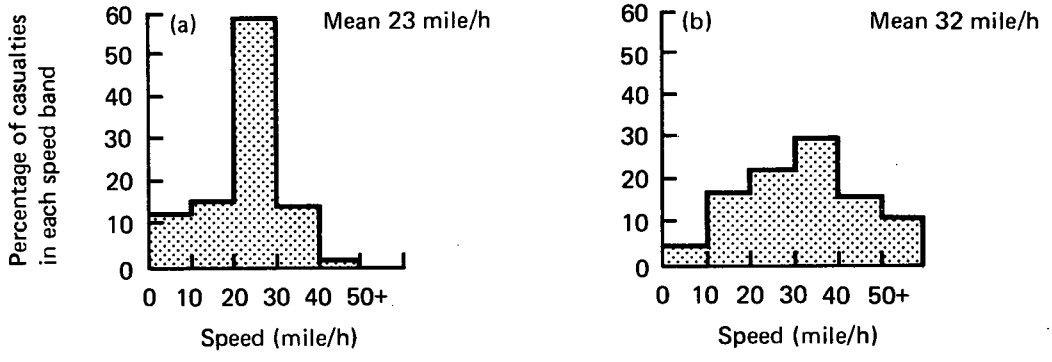


Fig. 5 DISTRIBUTION OF ESTIMATED SPEEDS IN (a) BUILT UP (319) (b) NON BUILT UP (106) AREAS

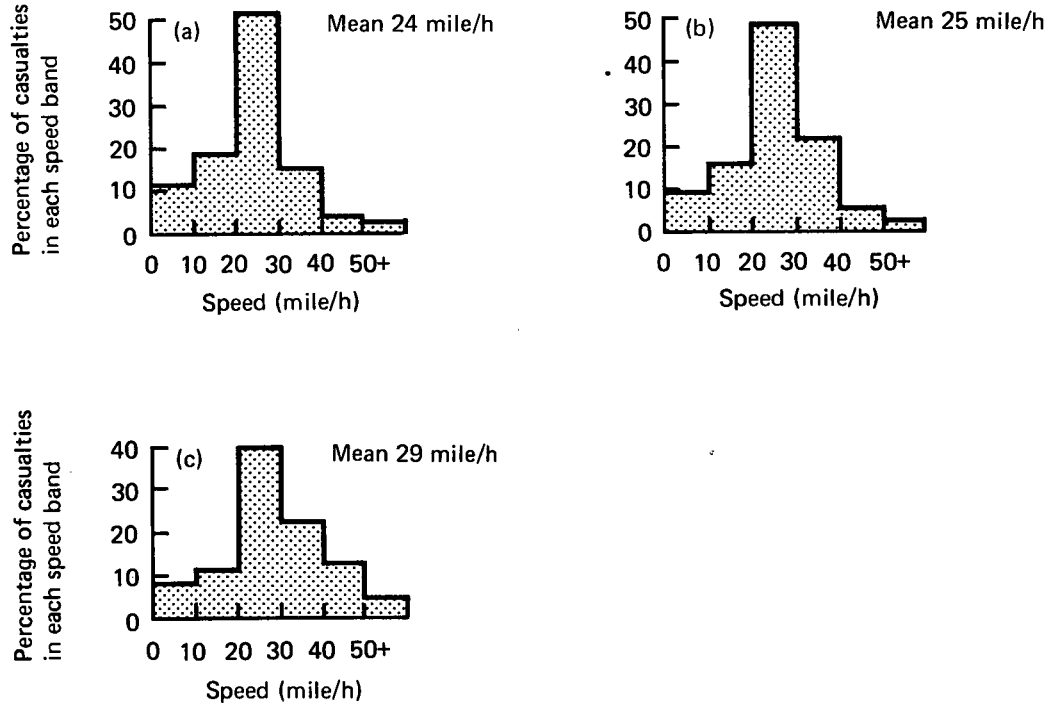


Fig. 6 DISTRIBUTION OF ESTIMATED SPEED FOR (a) MINOR CASUALTIES (242) (b) MODERATE CASUALTIES (122) (c) SEVERE & FATAL CASUALTIES (83)

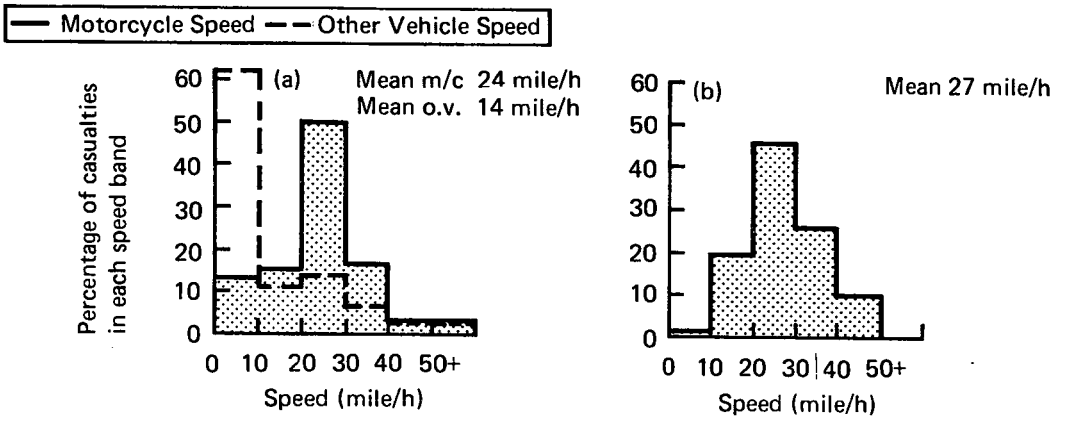


Fig. 7 DISTRIBUTION OF ESTIMATED SPEEDS IN (a) MULTI VEHICLE ACCIDENTS (332) (b) SINGLE VEHICLE ACCIDENTS (93)

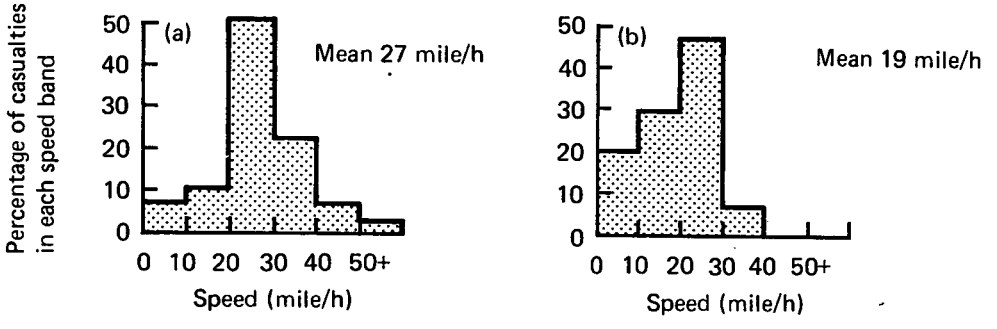


Fig. 8 DISTRIBUTION OF ESTIMATED SPEEDS FOR (a) CONVENTIONAL M/C'S (310) (b) STEPTHROUGH M/C'S (115)

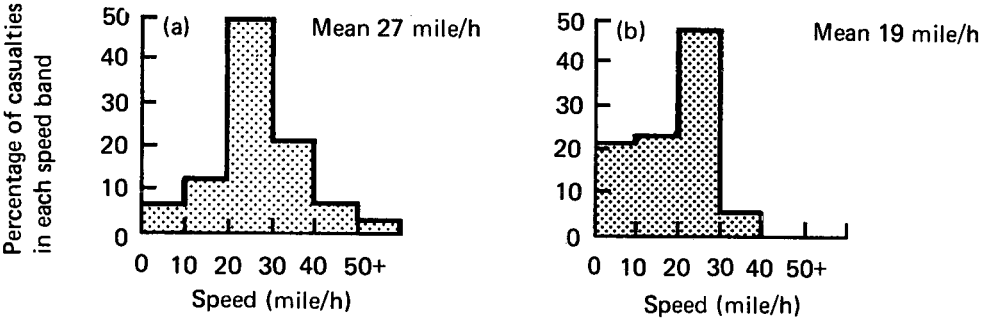


Fig. 9 DISTRIBUTION OF ESTIMATED SPEEDS FOR (a) MOTORCYCLES & SCOOTERS (309) (b) MOPEDS (116)

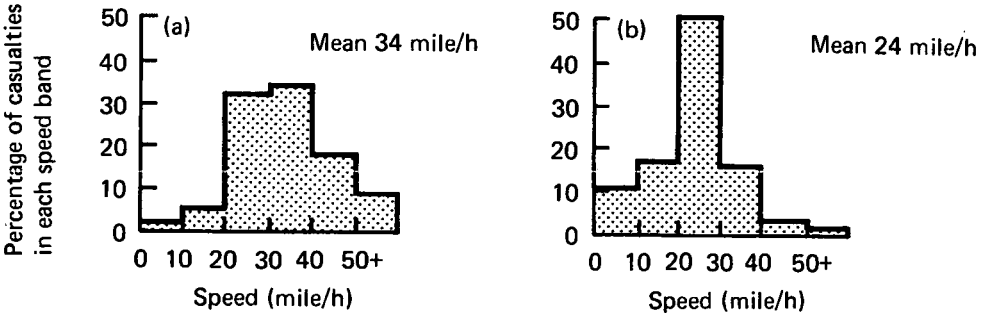
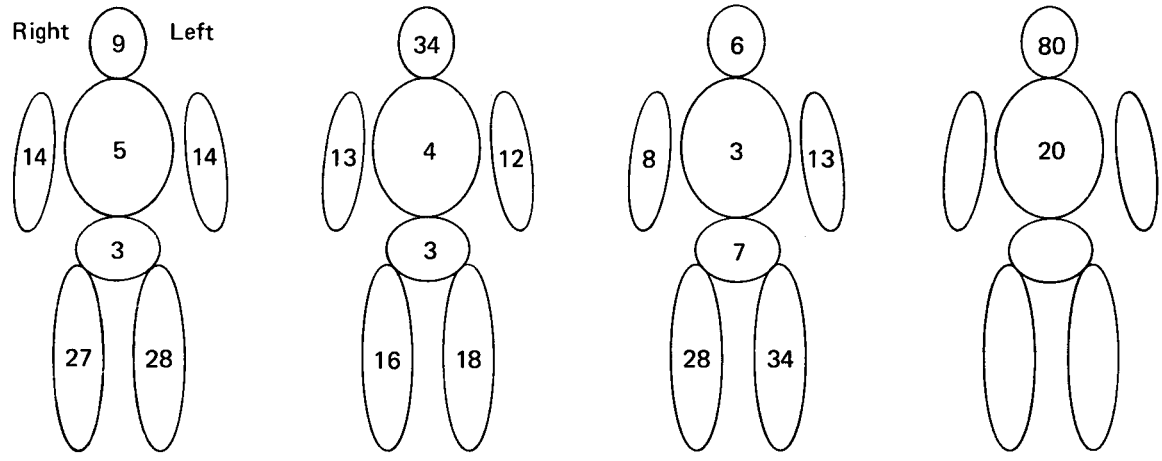


Fig.10 DISTRIBUTION OF ESTIMATED SPEEDS FOR (a) M/C'S OVER 250cc (46) (b) M/C'S UNDER 250cc (379)



(a) Minor (730 injuries) (b) Moderate (178) (c) Severe (95) (d) Fatal (5)

Fig. 11 DISTRIBUTION OF REGIONS OF BODY INJURED BY SEVERITY (PERCENTAGES)

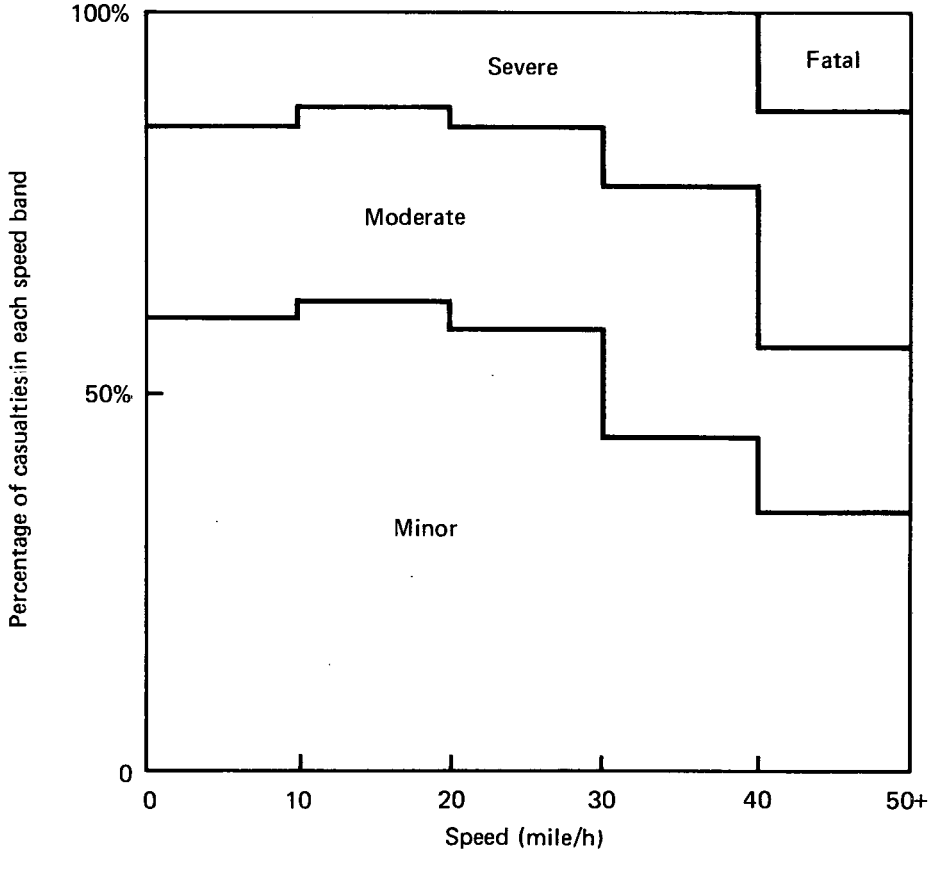


Fig. 12 SPEED OF MOTORCYCLE BY INJURY SEVERITY

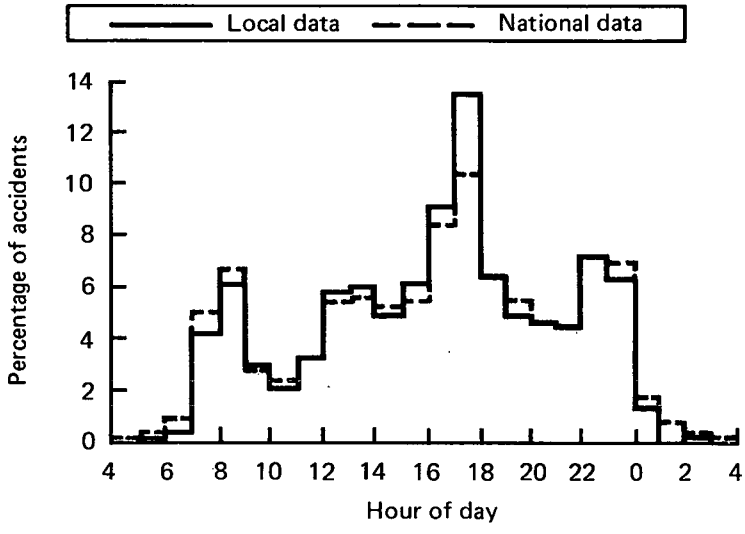


Fig. 13(a) MOTORCYCLE ACCIDENTS BY TIME OF DAY

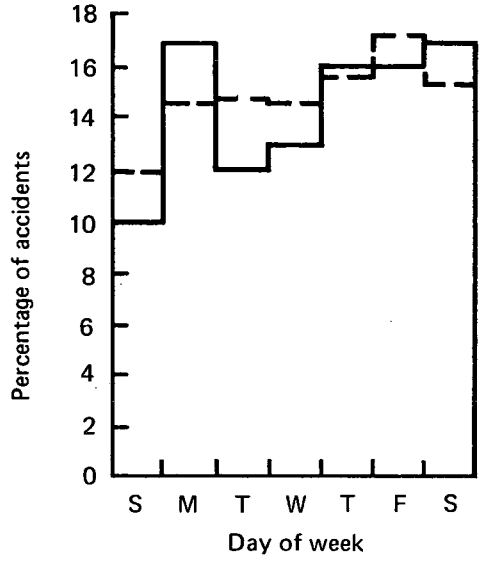


Fig. 13(b) MOTORCYCLE ACCIDENTS BY DAY OF WEEK

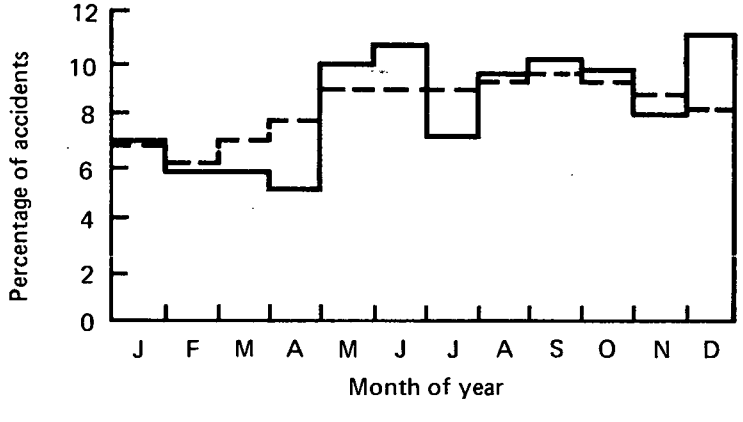


Fig. 13(c) MOTORCYCLE ACCIDENTS BY MONTH OF YEAR

APPENDICES

11. APPENDIX 1. QUESTIONNAIRE COMPLETED BY REPORTING POLICE OFFICER

TRANSPORT AND ROAD RESEARCH LABORATORY MOTORCYCLE ACCIDENT REPORT

This survey is being conducted by the Transport and Road Research Laboratory, Crowthorne, to obtain information on motorcycle accidents. The Laboratory would appreciate your filling in the form using all sources of information available to you and then returning it to:- Vehicles Division
Transport and Road Research Laboratory
Crowthorne
Berks

MOTORCYCLISTS

Name of rider | Sex | Age yrs

Address of rider

Did rider or pillion passenger attend hospital ?

	Yes	No
Rider		
Pillion passenger		

If so, which hospital ?

Was rider a 'learner' driver (tick one)

Yes
No

Name of pillion passenger (If none write 'NONE') | Sex | Age yrs

SITE

Place of accident

ACCIDENT

Type of accident suffered by motorcycle (tick one)

Collision
Skidding
Collision before skidding
Skidding before collision
Don't know

Please provide arrow to indicate point and direction of impact on motorcycle. If more than one impact provide arrows for each one and label them with the obstacle involved

Date of accident

Day Month Year

Time of accident

Type of motorcycle (tick one)

Moped
Solo Scooter
Solo motorcycle
Other

Obstacles hit by motorcycle (tick any)

Other vehicle using road
Other vehicle parked
Pedestrian or cyclist
Any other object
No objects
Don't know

Was rider thrown clear of motorcycle (tick one)

Rider thrown clear of motorcycle
Rider not thrown clear of motorcycle
Don't know

Obstacles hit by rider (tick any)

Other vehicle, using road
Other vehicle, parked
Road surface
Any other object
Don't know

Speed prior to accident

Estimated speed of motorcycle If unknown write '?'. mph

If another vehicle was involved estimate its speed prior to the accident. If unknown write '?' mph

Did driver of other vehicle see motorcyclist (tick one)

Yes
No
Don't know
Not applicable

If motorcyclist was overtaking or turning did he use

Hand signals
Turn indicators
No signal
Don't know
Not applicable

Was signal seen by other driver? (tick one)

Yes
No
Don't know
Not applicable

How much petrol loss was there from the motorcycle fuel tank or fuel system

None
Slight
Heavy
Don't know

CONDITIONS

Light (tick one)

Daylight
Dark, street lighting on
Dark, street lighting off
Dark, no street lighting

Weather (tick one)

Fair
Raining
Snowing
Fog
Other

Condition of road surface (tick one)

Dry
Wet
Ice or Snow

Visibility (tick one)

Fair
Poor

FOLLOW UP

Police accident reference no.

Station reporting

P.C. reporting

Telephone

Motorcycle taken away to:-

Brief description of accident + sketch

If possible give brief account of path taken by rider during the accident, stating what part of the rider was hit by what object.

continue overleaf

12. APPENDIX 2. QUESTIONNAIRE COMPLETED BY MOTORCYCLIST

TRANSPORT AND ROAD RESEARCH LABORATORY - MOTORCYCLE ACCIDENT REPORT

Accident Number

This survey is being conducted by the Transport and Road Research Laboratory, Crowthorne, to obtain information on motorcycle accidents. With this information the Laboratory hopes to find out the most likely causes of motorcycle accidents, and the injuries resulting from them. From the results it may be possible to identify faults or find room for improvements in particular aspects of motorcycle design.

All information you supply will be treated in strict confidence and will only be used within the Laboratory. No names will be used in any discussion or written work on the survey. It is not the purpose of this form to attach blame to any individual, but merely to see in how many other accidents similar circumstances occur.

Except where otherwise stated 'motorcycles' include mopeds, scooters and combinations.

A. Riding Experience Tick the boxes which apply and give dates in questions 2 & 3.

1. Which class of road user are you?

(a) 'Learner' driver	
(b) Have passed a motorcycle driving test	
(c) Ride a moped on a full car licence	

2. If you ticked 1(b), please give date of passing motorcycle driving test

Month	Year

3. When did you first start riding motorcycles on public roads?

Month	Year

4. How often do you usually use your motorcycle?

4 or more days a week	
Between one and three days a week	
Less than once a week	

5. How many miles do you estimate you have ridden on your motorcycle over the last year?

0 - 500	
501 - 1000	
1001 - 2000	
2001 - 5000	
5001 - 10000	
10001 +	

6. On which type of road do you mostly drive?

Town roads	
Country roads	
Motorways	
Don't know	

7. Are most of your motorcycle journeys

Short journeys (less than 5 miles)	
Long journeys	
About the same number of each	

8. Do you usually avoid using your motorcycle in

Wet weather	
Snow or ice	
Fog	

9. When riding in a line of traffic do you usually drive

On the nearside of the line of traffic	
In the centre of the line of traffic	
On the offside of the line of traffic	

B. Accident History

Please include your most recent accident and all previous accidents and minor spills

Accident	Age at time of accident (yrs)	Hospital (tick one of 4 columns)				Type of accident (see Note (i))	Engine capacity of bike (cc)	Type of bike (See Note (ii))	Write 'L' if you were a Learner at the time of the accident
		In Patient	Out Patient	Other Medical Attention	Did not attend				
1									
2									
3									
4									
5									
6									

NOTES

(i) Please use the following notation for the type of accident

C	For collision
S	For skidding
CBS	For collision before skidding
SBC	For skidding before collision

(ii) Please use the following notation for the type of bike

M	For moped
S	For solo scooter
M/C	For solo motorcycle
O	For any other type

C. Details of last accident

1. Date of accident

Day Month Year

2. Give age and sex of pillion passenger.
If none present write 'NONE'

Age	Yrs
Sex	

3. Was a crash helmet worn?

	Rider	Pillion
Crash helmet worn		
Crash helmet not worn		

4. Description of motorcycle

Make _____ Model _____

Engine capacity (cc) _____ cc

Conventional frame	
Step through frame	

tick one

Tick any of the following features that were present

Full fairing		Legshields	
Windshield		Crash bars	
High handlebars		Metal fuel tank	
Turn indicators		Fibreglass fuel tank	
Extended front forks (chopper style)			

5. Conspicuity -
Colour of clothing

	Rider	Pillion
Helmet		
Jacket		
Leg garment		

Colour of bike

6. Did you notice any fuel loss from your petrol tank or fuel system?

None	
Slight	
Heavy	
Don't know	

Tick one

7. Where is the bike now?

8. Description of accident

Collision	
Skidding	
Collision before skidding	
Skidding before collision	

(tick one)

Please provide arrow indicating point and direction of impact

Brief description of accident + sketch

continue overleaf

9. Do you know what caused any of your injuries?
(eg handlebars, road surface etc)

10. Speed prior to accident

Estimated speed of motorcycle _____ mph

If another vehicle was involved, estimate its speed prior to accident _____ mph

If you don't know write D.K.

11. Tick if you were in the process of, or about to perform, any of the following

Left turn	
Right turn	
Overtaking	

If you ticked any of the boxes, did you use

Hand signals	
Indicators	
No signal	

12. Conditions

Weather: Fair ☐ Rain ☐ Snow ☐ Fog ☐ Other ☐

Road surface: Dry ☐ Wet ☐ Snow/ice ☐

Visibility: Fair ☐ Poor ☐

ADDITIONAL QUESTIONS

Crash helmet:—

(a) What is the make of the crash helmet you were wearing?

(b) What is the type or model?

(c) Was the strap fastened at the time of the accident?
Yes
No

(d) Were you wearing a chin-cup at the time of the accident?
Yes
No

(e) Did your helmet come off during the accident?
Yes
No

(f) Did your head or crash helmet hit *any* object during the accident? (Please specify)
Yes
No
D.K.

(g) Was the helmet damaged in any way by the accident? (Please specify)
Yes
No
D.K.

13. APPENDIX 3

COMPARISON OF LOCAL AND NATIONAL DATA

Table 19 and Figure 13 present local data in comparison with published national data. More detailed comparisons were made by using the computer records of the national accident data from which the published information was extracted.

TABLE 19

Comparison of local and national accident data

		National Data		Local survey	
			(per cent)		(per cent)
Built up[1]		37,391	80	336	75
Non built up		9,422	20	114	25
Casualties[1]	Fatal	796	1.7	5	1.1
	Serious	13,905	30	200	44
	Slight	32,133	69	242	54
Age[1]	<16	181	1.2	3	1.4
(fatal and	16	1,479	10	31	15
serious)	17	2,973	20	45	21
	18–19	3,485	24	54	26
	20–24	2,745	19	27	13
	25+	3,832	26	52	25
Male[1]	(f and s)	13,458	92	187	90
Female		1,237	8	21	10
Lighting[1]	Day	30,590	65	303	67
	Dark lit	12,718	27	102	23
	Dark unlit	3,498	8	45	10
Driver[1]	(f and s)	13,431	91	212	92
Pillion		1,264	9	18	8
m/c manoeuvre[2]	Left turn	985	2	22	5
	Right turn	2,665	6	32	8
	Overtake	6,073	13	53	12
Road surface[2]	Dry	34,484	71	299	71
	Wet	13,946	29	125	29
	Ice	327	0.7		0
Day of week[1]	M–F	34,070	73	330	73
	Sat	7,150	15	75	17
	Sun	5,558	12	45	10
Type of m/c[2]	Moped	9,684	20	116	27
	Scooter	4,239	9	19	4
	M/c	34,914	71	290	68
Length of road	Trunk	15,262	10	335*	12
(km)	Principal	32,854	21	611	21
	Non principal	107,649	69	1,934	67
	Total	155,765		2,880	

(1) All casualties (except where stated).
(2) All motorcycles, scooters and mopeds.
* Figures for counties of Berkshire and Buckinghamshire (see text).

13.1 Riders

Approximating the MOT definitions of injury severity of slight to equal TRRL minor, and serious to equal TRRL moderate and severe, indicates a higher proportion of motorcyclists were seriously injured and a corresponding lower proportion slightly injured in the local survey. However a previous study by the Laboratory[2] showed that the MOT system of defining injury severity underestimates clinically serious injuries in favour of slight injuries, and thus the distribution of injury severities in the local sample is fairly close to the national situation. Incidence of fatal casualties was similar considering the small number in the local sample (1.1 per cent local to 1.7 per cent national).

Age groups showed that more 16 year olds and less 20–24 year olds were involved in the local sample. The proportions of male to female riders and drivers to pillion passengers agreed quite well with national data (Table 19).

13.2 Motorcycles

Mopeds were over-represented in the local sample (Table 19) and this may be connected with the higher proportion of 16 year olds observed locally. The proportion of motorcycles and their distribution by engine capacities in the local sample agreed well with national data (Table 20).

TABLE 20

Engine size of motorcycles involved in accidents
(per cent in brackets (by columns))

(a) *Local*

Engine size (cc)	Mopeds	Scooters	Motor-cycles	All types
50	116 (100)		36 (14)	152 (38)
50–149		5 (26)	70 (27)	75 (19)
150–249		14 (74)	112 (43)	126 (32)
250–649			16 (6)	16 (4)
650+			29 (11)	29 (7)
N.K.			27	27
Total	116	19	290	425

(b) *National*

Engine size (cc)	Mopeds	Scooters	Motorcycles	All types
50	9684(1) (100)	204 (6)	3776 (14)	13664 (33)
50–149		2125 (63)	7100 (26)	9225 (23)
150–249		1008 (30)	12037 (43)	13045 (32)
250–649		} 28 (8)	} 4875 (18)	} 4903 (12)
650+				
N.K.		874	7126	8000
Total	9684	4239	34914	48837

(1) Includes 6685 mis- or unreported moped engine capacities.

It can be seen that 50 cc motorcycles (including mopeds) are the most common sort to be involved in accidents, with 150–250 cc the next largest group. Almost 90 per cent of the accidents occurred on motorcycles of less than 250 cc.

13.3 Location

Because of the discrepancy between county boundaries and the police districts, it has not been possible to determine the exact proportions of road types in the sample area. However road mileages of trunk, principal and non-principal roads for the counties of Berkshire and Buckinghamshire[8] are in the same proportions as the distribution of road types in Great Britain (Table 19).

Seventy-five per cent of the accidents in the local survey occurred in built up areas, compared with 80 per cent nationally (Table 19). A split by injury severity gave similar patterns in both sets of data, with a higher proportion of serious injuries occurring in non built up areas (Table 21). This is presumably because of the higher speeds on rural roads. A higher proportion of 'single vehicle' accidents occurred on bends and straight roads, while more 'multi vehicle' accidents happened at junctions (Table 22). Both surveys underreport single vehicle accidents which do not have to be reported to the police by the riders concerned.

TABLE 21

Casualties in built up and non built up areas
(Percentages in brackets (by columns))

(a) *Local data*

	Built up	Non built up	Total
Minor	198 (59)	44 (39)	242
Moderate	89 (27)	33 (29)	122
Severe	47 (14)	31 (27)	83
Fatal	0 (0)	5 (4.4)	3
Not known	2	1	
All severities	336	114	450

(b) *National data*

	Built up	Non built up	Total
Slight	26941 (72)	5216 (55)	32157
Serious	10023 (27)	3890 (41)	13913
Fatal	454 (1.2)	343 (3.6)	797
All severities	37418	9449	46867

TABLE 22

Accident sites
(Percentages in brackets (by columns))

(a) *Local data*

Accident sites	Multi-vehicle	Single vehicle	Total
Roundabout	17 (5)	5 (5)	22 (5)
Junction	165 (50)	6 (7)	171 (40)
Private entrance	51 (15)	0 (0)	51 (12)
Bends	27 (8)	34 (37)	61 (14)
Other (inc. ahead)	73 (22)	47 (51)	120 (28)
Total	333	92	425

(b) *National data*

Accident sites	Multi-vehicle	Single vehicle	Total
Roundabout	1082 (3)	470 (5)	1552 (4)
Junction	21558 (63)	3019 (34)	24577 (57)
Private entrance	2364 (7)	65 (1)	2429 (6)
Other	9106 (27)	5318 (60)	14424 (34)
Total	34110	8872*	42982*

* Excludes 4862 single vehicle/pedestrian accidents.

13.4 Time

Figure 12 shows the hours of the day, the days of the week, and the months of the year when motorcycle accidents happened for the local and national situations.

There are expected peaks during the morning and evening 'rush hours', the evening period from 16.00 to 18.00 being more pronounced. There is also a peak during the hours of 22.00 and 24.00, presumably because this is when public houses, cinemas, etc, close (the influence of alcohol in accidents has not been studied in this survey).

Accidents by month of the year increase from January to May and then stay fairly constant until October. The local sample was more variable but with the same overlying pattern. A sudden accident peak in December in the local sample cannot be explained.

13.5 Lighting conditions

The proportion of motorcycle accidents in the survey which occurred under different lighting conditions closely matched the national situation (Table 19). Two-thirds occurred in daylight and one-third in darkness. About three-quarters of the night time accidents occurred on lit roads.

Table 23 compares the local and national lighting conditions in accidents, and the influence of some other accident factors. The following observations were made:

(i) the proportion of daylight and darkness accidents is the same in built up and non built up areas,

(ii) a higher proportion of multi vehicle accidents, compared with single vehicle accidents, occurred in daylight, and a lower proportion occurred on dark unlit roads,

(iii) nearly half of the night time accidents on unlit roads were single vehicle accidents. This compares with 18 per cent in daylight.

(iv) a disproportionately high number of accidents on dark unlit roads resulted in severe or fatal injuries to the motorcyclist.

TABLE 23

Lighting conditions and other accident factors
(Percentages in brackets (by columns))

(a) *Local data*

Accident factor	Daylight	Dark lit	Dark unlit	Total
Built up	215 (67)	90 (28)	15 (5)	320
Non built up	74 (70)	6 (6)	25 (24)	105
Total	289 (68)	96 (23)	40 (9)	425
Single vehicle	50 (54)	24 (26)	18 (20)	92
Multi vehicle	239 (72)	72 (22)	22 (7)	333
Total	289 (68)	96 (23)	40 (9)	425
Injury severity of rider				
Minor	175 (72)	48 (20)	19 (8)	242
Moderate	77 (63)	36 (30)	9 (7)	122
Severe	45 (58)	18 (23)	15 (19)	78
Fatal	4 (80)	0 (0)	1 (20)	5
Not known	2	0	1	3
Total	303 (67)	102 (23)	45 (10)	450

(b) *National data*

Accident factor	Daylight	Dark lit	Dark unlit	Total
Built up	26416 (67)	11839 (30)	918 (2)	39173
Non built up	5676 (66)	677 (8)	2242 (26)	8595
Total	32092 (67)	12516 (26)	3160 (7)	47768
Single vehicle*	5071 (59)	2300 (27)	1216 (14)	8591
Multi vehicle	23613 (69)	8961 (26)	1513 (5)	34110
Total	28684 (67)	11261 (26)	2729 (6)	42701
Injury severity of rider				
Slight	21886 (68)	8394 (26)	1858 (6)	32138
Serious	8340 (60)	4079 (29)	1485 (11)	13904
Fatal	381 (48)	261 (33)	155 (19)	797
Total	30607 (65)	12734 (27)	3498 (7)	46839

* Excluding 4862 single vehicle/pedestrian accidents.

13.6 Weather

National and local data agree well on weather conditions in accidents. The weather was fair in 85 per cent of national accidents (83 per cent local) and raining in 15 per cent (17 per cent local). One per cent were in other bad weather conditions such as fog, snow and high winds.

More important than the amount of rain was the condition of the road surface (Table 19). The road was wet in 29 per cent of accidents both locally and nationally. The road was actually wet for 31 per cent of the time during 1974 (reference 9). From the local sample, 27 per cent of collisions occurred on wet roads, and 39 per cent of loss of control accidents occurred on wet roads. Other things being equal, a figure of 31 per cent in each case would be expected. The slightly low number of collisions may be put down to lower usage in wet weather (Section 3.6), while on the other hand, the increased risk of a loss of control accident in wet weather is clearly demonstrated.

In the local survey, poor visibility was noted in 6 per cent of the accidents (Table 24). Most occurred at night and visibility was usually impaired by headlamp dazzle or distracting light reflections in wet weather.

Wet weather did not affect visibility on dark unlit roads.

TABLE 24

Visibility in different lighting conditions
(from local data)

	Fair	Poor	Total
Daylight	279	10	289
Dark lit	88	8	96
Dark unlit	33	7	40
Total	400	25	425

14. APPENDIX 4

CLASSIFICATION OF SEVERITY OF INJURY – DEPARTMENT OF TRANSPORT

CODES

1. Fatal.
2. Serious.
3. Slight.

NOTES

A. Code 1. FATAL INJURY includes only those cases where death occurs in less than 30 days as a result of the accident. FATAL does not include death from *Natural Causes.*

B. Code 2. Examples of SERIOUS INJURY are:–
Fracture.
Internal injury.
Severe cuts and lacerations.
Crushing.
Concussion.
Severe general shock requiring hospital treatment.
Detention in hospital as an in-patient, either immediately or later as a result of the injuries.
Injuries to casualties who die on or after 30 days as a result of the accident.

C. Code 3. Examples of SLIGHT INJURY are:–
Sprains.
Bruises.
Cuts judged not to be severe.
Slight shock requiring roadside attention.

(Persons who are merely shaken and who have no other injury should not be included unless they receive or appear to need medical treatment.)

CLASSIFICATION OF SEVERITY OF INJURY – TRRL

CATEGORY OF INJURY	TYPE OF INJURY	DEGREE AND SITE OF INJURY
MINOR	Contusions Abrasions	Not extensive, ie not more than 10 per cent of the body surface
	Lacerations	Surface, ie skin and subcutaneous tissues, 2″ (5cm) or less in length but 1″ (2.5cm) or less for the face
	Burns	First degree, of 10 per cent or less in area
	Injury to the teeth	Loosening only of permanent teeth or loss or breakage of deciduous teeth
	Concussion (minor)	ie No loss of consciousness but some PTA
	Injury to the eye	Surface injury with no loss of visual function
	Sprains	All; including stiff neck, duration not more than 10 days
	Fractures	Simple undisplaced, of toes, hands or nose
	Haemorrhage	No significant loss, ie less than half a pint (250cc)
MODERATE	Contusions Abrasions	Extensive, ie more than 10 per cent of the body surface
	Lacerations	Surface, ie skin and subcutaneous tissues, over 2″ (5cm) in length. For the face, lacerations over 1″ (2.5cm) but not over 4″ (10cm) in length
	Penetrating wounds into Oral cavity	Penetrating wounds into the mouth 1″ (2.5cm) or less in length
	Burns	First degree of more than 10 per cent in area. Other degrees of burn not over 10 per cent in area
	Injury to teeth	Loss or breakage of permanent teeth
	Concussion (mild)	ie Loss of consciousness, but conscious on admission to hospital
	Injury to eye	Surface injury of cornea with minor loss of visual function, ie better than 6/18 uncorrected
	Rupture of ear drum	With no permanent disability
	Painful neck without radiological abnormality	Duration more than 10 days
	Fractures (simple and not requiring reduction)	Of upper limbs, including shoulder girdle, but excluding hands Of face, including upper jaw, but excluding nose Of lower jaw Of transverse and spinous processes of spine Of ribs, but not more than 3 in number; or incomplete fracture of sternum or complete sternal fracture without displacement Of certain lower limb fractures without displacement, ie of patella, of shaft of fibula Of internal or external malleolus, of tarsus or metatarsus Of one pubic ramus of pelvis
	Fractures (displaced and requiring reduction or compound)	Of toes, nose or hands
	Dislocations or sub-luxations (uncomplicated)	Of upper limbs, of lower jaw, of toes
	Amputations	Of the whole or part of one digit, but excluding thumb
	Abdominal injury	Bruising of viscera with or without laparotomy
	Haemorrhage	Not more than 2 pints (1000cc)
SEVERE	Lacerations	Over 2″ (5cm) in length and involving structures deep to the deep fascia. For the face lacerations over 4″ (10cm) in length
	Penetrating wounds into Oral cavity	Penetrating wounds into the mouth more than 1″ (2.5cm) in length
	Burns	Over 10 per cent in area, excluding first degree burns
	Concussion (severe)	ie Loss of consciousness, and still unconscious on admission to hospital
	Injury to eye	Penetrating wound of eyeball or laceration involving naso-lacrimal duct; surface injury to the eye with uncorrected visual acuity 6/18 or worse
	Rupture of ear drum	With permanent disability
	Fractures (simple or compound and, where displacement, usually requiring reduction)	Of face, including upper jaw, with displacement, but excluding nose Of lower jaw, with displacement Of vault of skull with or without depression Of base of skull Of upper limbs, with displacement, including shoulder girdle but excluding hands Of spine, excluding transverse or spinous processes Of lower limbs, but excluding toes and any simple undisplaced fractures included in Moderate Category Of pelvis, but excluding fracture of one pubic ramus Of ribs, but more than 3 in number Of sternum, complete fracture, with displacement
	Dislocations or sub-luxations (uncomplicated)	Of lower limbs, but excluding toes Of spine
	Dislocations (complicated)	Of upper limbs Of spine Of lower limbs
	Amputations	Of a limb or part of a limb including thumb, but excluding loss of any other single digit or part of a digit
	Injury to Viscera and other deep structures	To cranial contents To spinal cord To thoracic contents To abdominal contents intra or extra peritoneal but excluding bruising of viscera To the deep structures of the face or neck To the main nerve or arterial supply of the limbs, or rupture or division of muscles or tendons
	Haemorrhage	Of more than 2 pints (1000cc)
FATAL	Death within 30 days of the accident	

15. APPENDIX 5

A 'WEIGHTING' SCALE FOR THE SEVERITY OF ACCIDENTS TO MOTORCYCLISTS

Traffic accident costs for 1974 using the police classification of accident severity are estimated[1,10,11] as follows:–

Slight	£380
Serious	£2,300
Fatal	£33,000

To adapt this scale to the TRRL classification of casualty injury severity used in this survey it was assumed that 'slight' was equivalent to 'minor', and 'serious' was equivalent to 'moderate' and 'severe'. Since the riders themselves are usually the only casualties of their accident it was also assumed that the cost of the accident was proportional to the time spent in hospital by the motorcyclist.

In a recent study[2], the lengths of stay in hospital of non fatal motorcycle casualties were reported according to the TRRL severity classification: viz:–

2.25 days per person for minor casualties
3.9 days per person for moderate casualties
33.9 days per person for severe casualties

In this sample of 242 minor casualties, 122 moderate casualties, 78 severe casualties, the 'serious' accidents led to (122 x 3.9) days lost through moderate injuries and (78 x 33.9) days lost through severe injuries, ie 15 per cent of the total time lost from serious injuries was from moderate injuries and 85 per cent was from severe injuries. Thus in the serious accidents in this sample costing an estimated £460,000, £70,150 (15 per cent) was spent on moderate casualties and £389,850 (85 per cent) on severe casualties, ie £575 per person moderately injured and £5,000 per person severely injured.

So the estimated costs of motorcycle accidents using the TRRL classification for severity of injury are:–

Minor	£380 or as a ratio (approx)	1
Moderate	£575	1.5
Severe	£5,000	15
Fatal	£33,000	90

(511) Dd0536361 1,700 4/80 HPLtd So'ton G1915
PRINTED IN ENGLAND

ABSTRACT

A survey of motorcycle accidents: J WHITAKER: Department of the Environment Department of Transport, TRRL Laboratory Report 913: Crowthorne, 1980 (Transport and Road Research Laboratory). This survey looks at a sample of 450 injured motorcyclists involved in 425 accidents over a period of one year (1974). A comparison of several aspects of the accident situation between the sample and national accident data indicated that the detailed information gained from the survey is representative of motorcycle accidents reported nationally by the police. The study examines the accident situation, causes of injury to riders, crash helmet performance, and the motorcycles involved. Some of the main findings are:–

(i) the high incidence of accidents where other road users fail to see the motorcyclist whilst negotiating a junction. Thus the motorcycle is usually travelling at between 20–30 mile/h just prior to the accident.

(ii) Other vehicles were the main cause of serious injuries to motorcyclists. Riders' legs were particularly prone to severe injury.

(iii) There was some evidence that helmets conforming to the higher British Standards slightly reduced the likelihood of head injury below that for lower standard helmets. The use of full face helmets was shown to reduce the chance of facial injury.

ISSN 0305–1293

ABSTRACT

A survey of motorcycle accidents: J WHITAKER: Department of the Environment Department of Transport, TRRL Laboratory Report 913: Crowthorne, 1980 (Transport and Road Research Laboratory). This survey looks at a sample of 450 injured motorcyclists involved in 425 accidents over a period of one year (1974). A comparison of several aspects of the accident situation between the sample and national accident data indicated that the detailed information gained from the survey is representative of motorcycle accidents reported nationally by the police. The study examines the accident situation, causes of injury to riders, crash helmet performance, and the motorcycles involved. Some of the main findings are:–

(i) the high incidence of accidents where other road users fail to see the motorcyclist whilst negotiating a junction. Thus the motorcycle is usually travelling at between 20–30 mile/h just prior to the accident.

(ii) Other vehicles were the main cause of serious injuries to motorcyclists. Riders' legs were particularly prone to severe injury.

(iii) There was some evidence that helmets conforming to the higher British Standards slightly reduced the likelihood of head injury below that for lower standard helmets. The use of full face helmets was shown to reduce the chance of facial injury.

ISSN 0305–1293