TRANSPORT and ROAD
RESEARCH LABORATORY

Department of the Environment
Department of Transport

SUPPLEMENTARY REPORT 289

ALLEVIATION OF INJURIES BY USE OF SEAT BELTS

by

Barbara E Sabey, B E Grant and C A Hobbs

A Paper presented to the Sixth International Conference of the International Association for Accident and Traffic Medicine: Melbourne, February 1977

Accident Investigation Division
Safety Department
Transport and Road Research Laboratory
Crowthorne, Berkshire
1977

ISSN 0305-1315

Ownership of the Transport Research Laboratory was transferred from the Department of Transport to a subsidiary of the Transport Research Foundation on 1st April 1996.

ALLEVIATION OF INJURIES BY USE OF SEAT BELTS

Introduction

As a supplement to Dr Mackay's paper,[1] this paper presents some results of very recent studies of occupant injury carried out by the Transport and Road Research Laboratory. These studies were specifically designed to give a representative sample of vehicle *occupants*, including the uninjured, ie to cover the whole range of levels of injury and to overcome sampling difficulties mentioned by Dr Mackay. The reason for choosing this sampling procedure was that one of the main aims was to assess the effectiveness of belts in terms of risks of injury related to severity, location and nature of the injury. As a background to these studies it is useful to describe the overall situation in Great Britain as far as seat belt wearing and reduction in injuries are concerned.

National situation

Between 1967, when legislation requiring fitting of belts was introduced, and 1972, wearing rates increased slowly from about 9 per cent to 18 per cent. Then in 1973 extensive publicity campaigns designed to encourage wearing prompted increased public discussions on the value of safety belts. Wearing rates increased sharply, doubling overall, and rising to 46 per cent on motorways: a clear demonstration of the effectiveness of publicity. Subsequently, rates have remained at the average level of 33 per cent, but regrettably have not increased. Although this is disappointing in the light of experience in other countries, nevertheless the savings in injuries should not be overlooked. From the national police records of injury accidents it has been possible to estimate savings already made and the potential for further improvement.[2]

TABLE 1

National savings due to seat belt wearing

	Wearing rate - per cent	Injuries saved in 1973 Fatal + serious	Total	Additional potential* savings - no per year Fatal + serious	Total
Motorways	46	320	540	270	460
Rural roads 50-70 mile/h	37	5240	10330	6800	13400
Urban roads 30-40 mile/h	23	2200	6060	5930	16340
All roads	33	7760	16930	13000	30200

* assumes 85 per cent wearing rate

The injuries saved in 1973 totalled nearly 8000 fatal and serious, and 17000 for all levels of injury. These classifications are not clinical descriptions of severity, but very roughly 'fatal plus serious' approximates to AIS 2-6 combined. The estimated savings per year since 1973 have remained at the same level: the potential for further savings, assuming 85 per cent

wearing rate for front seat occupants only, is 13000 fatal plus serious or 30000 in total per year. If anything, because of under-reporting of injuries to the police, these will be under-estimates. However the savings already achieved represent 5 per cent of the total casualty toll: the potential (if an estimate is also added for wearing of rear seat belts) is a further 10 per cent per year.

Depth investigations

Between 1974 and 1976 an in-depth study was made of a representative sample of injuries to vehicle occupants in 1126 accidents. The accidents were those in which at least one person had attended one large accident hospital, ie they included all injury accidents in the locality except the very minor ones. By identifying all vehicle occupants in these accidents (whether injured or not), their seating positions and seat belt usage, it was possible to assess relative risks of injury and different characteristics of injury for belted and unbelted persons. The total sample numbers 2879 vehicle occupants, including 1100 who were uninjured. For the assessment of seat belt injuries, the comparisons were restricted to front seat occupants of cars, of which 490 were wearing seat belts, 1163 were not, and in 303 cases belt wearing was not known. The injuries were classified according to the internationally used 'Abbreviated Injury Scale' (AIS) and where possible the vehicles involved were examined to establish causes and mechanisms of injury.

Severity of injury

Where seat belts were worn a comparison was made between the levels of injuries received and those that would have been expected if belts had not been worn. The use of seat belts resulted in a statistically significant reduction in life threatening injuries (AIS 4-6) of 86 per cent from the expected level (Table 2). Significant reductions also occurred in the less severe categories of injury but these appear smaller due to the general downward shift in injury severity associated with seat belt wearing. Of the belted occupants 42 per cent escaped injury altogether compared to 28 per cent of the unbelted ones: in other words, belt wearing resulted in a 50 per cent increase in *uninjured* persons.

Location of injury

Seat belts eliminate or reduce injury by restraining the wearer and preventing him from coming into violent contact with parts of the vehicle interior during an accident. In so doing, seat belts themselves change the loading on the wearer and in extreme cases injuries may result. In some cases the seat belt may not be able to prevent occupant/vehicle contact, often because parts of the passenger compartment are crushed inwards. When injuries result they are almost always less severe than if the occupant had been unbelted.

At the levels of injury where there were significant reductions amongst belt wearers, ie AIS 2 and above, there was a lower incidence of injury for all regions of the body except the neck and feet (Table 3). Although neck injuries were slightly more numerous among belted occupants, all were of either minor or moderate (AIS 1-2) severity and the majority were 'stiff necks'. No fractures of the neck occurred.

TABLE 2

Overall injury severity of unbelted and belted front seat occupants of cars

AIS		Unbelted No.	%	Belted No.	%	Injury Reduction Attributable to Belt Wearing %
0 Uninjured		327	(28)	208	(42)	-
1 Minor	Non Life Threatening	468	(40)	195	(40)	1
2 Moderate	Non Life Threatening	261	(22)	62	(13)	44
3 Severe	Non Life Threatening	72	(6)	23	(5)	24
4 Serious	Life Threatening	8	(3)	0	(0.4)	86
5 Critical	Life Threatening	14	(3)	0	(0.4)	86
6 Maximum	Life Threatening	13	(3)	2	(0.4)	86
TOTAL		1163		490		
Died as a result of Accident		26	(2)	3*	(0.6)	73

Reductions in injuries at AIS levels from 2 to 6 were significant at the 1% level or better.

*One restrained occupant died as a result of a lung infection having inhaled dirty water in the accident.

TABLE 3

Injuries more severe than minor (AIS 2-6) based on 1163 unbelted and 490 belted front seat occupants of cars

	Injuries per 1000 occupants	
	Unbelted	Belted
Head	237	106
Neck	12	16
Spine	15	6
Shoulders	21	14
Arms	37	20
Chest	52	39
Abdomen	20	12
Pelvis	7	4
Hip joints	6	0
Thighs	21	6
Knees	22	18
Lower legs	15	6
Feet/ankles	15	24

The head was found to be the most commonly injured region of the body, and this was usually caused by contact with the steering wheel or the area surrounding the windscreen for unbelted occupants, and the steering wheel for those belted. For most other regions of the body contact with the side of the passenger compartment, usually in side impacts, was the main cause of injury although seat belts still offered some degree of protection. Although some injuries were due to direct seat belt loading most of these were of a minor (AIS 1) severity with only one injury being more severe than moderate (AIS 2).

Seat belts also offer protection by preventing the wearer from being thrown out of the vehicle in the accident. In the survey as a whole, just under a quarter of those who were thrown out of their vehicle were killed and this accounted for nearly a half of all the deaths. On the other hand, the risk of being trapped inside a vehicle which caught fire or was submerged in water was found to be minimal. In the whole survey only three vehicles caught fire and in these only one occupant was trapped. However, he had died before the fire started.

Type of belt

The type of belt in use was known in the case of just over half of the wearers (Table 4). A comparison between static and automatic lap and diagonal belts did not reveal any significant difference in their ability to prevent or reduce injury. This result represents the overall situation for belts as they are designed and used at the present time. It may of course mask any individual deficiencies such as incorrect wearing of static belts, or defective mechanisms, which the study did not attempt to assess. However, it is important to note that there was a higher wearing rate of 38 per cent for automatic belts fitted compared to 26 per cent for static belts.

TABLE 4

Injury severity of belted front seat occupants of cars by belt type

AIS	Lap and diagonal - static	%	Lap and diagonal - automatic	%
0 Uninjured	54	(31)	24	(35)
1 Minor	77	(44)	29	(43)
2 Moderate	31	(18)	10	(15)
3 Severe	14	(8)	4	(6)
4 Serious	-		-	
5 Critical	-		-	
6 Maximum	1		1	
Total	177		68	

Acknowledgements

The work described in this paper forms part of the programme of research of the Safety Department of the Transport and Road Research Laboratory, and the paper is published by permission of the Director.

The authors would like to thank the staff of Battle Hospital, Reading for their assistance in this research, and the Thames Valley Constabulary for their help and co-operation.

References

1. MACKAY G M. Belted occupants in frontal crashes. Paper presented to the VIth International Conference of the International Association for Accident and Traffic Medicine: Melbourne, February 1977.

2. SABEY B and J G WALL. Seat belts and survival. *New Society*, February 1976.

(847) Dd443233 1,300 5/77 HPLtd So'ton G1915
PRINTED IN ENGLAND