A PROPOSAL FOR REAR SEAT HEAD RESTRAINT GEOMETRIC RATINGS

Avery, Matthew
Weekes, Alix Mary
Brookes, David
Thatcham, UK

Paper Number 11-0131

ABSTRACT

Consumer safety ratings organisations have published static ratings of the head restraint geometry, with the aim of raising public awareness of correct head restraint positioning, and encouraging vehicle manufacturers to improve geometry. The geometry of front seat head restraints has improved each year, but the rear seats have not been investigated. Research into protection against whiplash injuries has shown that reducing the head restraint backset and improving height is effective in reducing real world injury risk. In comparison to the front seats whiplash injuries occur less frequently in the rear seats, but rear seat occupancy can be as high as 12%. The research objective in this paper is therefore to examine the head restraint geometry of the rear seats in comparison to the front seats, by presenting a feasibility study for geometric rating of the rear seats and an initial set of ratings for over 100 car models.

The RCAR-IIWPG procedure for static geometric rating of head restraints was adapted for use in the rear seats, allowing for the associated space and practical considerations. An H-Point Machine (HPM) with Head Restraint Measuring Device (HRMD) fitted was used to measure the horizontal backset from the head to the head restraint, and the height from the top of the head to the top of the head restraint. The measurements were rated according to zones of Good, Acceptable, Marginal, and Poor.

115 rear seats were rated from a variety of mainstream cars, with the top sellers selected for each vehicle manufacturer. Both the outboard and centre seats were rated where applicable. Only 9% of outboard rear seats rated as Good, but 2% of centre seats. 42% of the outboard seats rated as Poor, but for centre seats this was increased to 69%.

In comparison to the front seats the rear seat ratings were much poorer. The front seats have 91% rated Good, and 0% rated Poor. However nearly half the rear seats are rated Poor, and only 9% are rated Good. Whiplash prevention technologies have focussed on the front seats, but consideration must now be given to the rear seats.

The paper offers a new insight into the protection offered by rear seat head restraints against whiplash injuries. The ratings can be used by consumer safety organisations to increase public awareness and to encourage development of rear seats that can offer protection against whiplash injuries.

INTRODUCTION

A number of consumer safety ratings organisations have published static ratings of the head restraint geometry since 2003, with the aim of raising public awareness of correct head restraint positioning, and encouraging vehicle manufacturers to improve geometry. These geometric ratings assess the proximity of head restraint to the head of a 50th percentile male occupant, using a H-Point Machine (HPM) and Head Restraint Measuring Device (HRMD) [1]. These ratings were published by the International Insurance for Whiplash Prevention Group (IIWPG), and later this rating protocol was adopted by the Research Council for Automobile Repairs (RCAR), and incorporated into the adult occupant score of Euro NCAP. The geometry of head restraints has improved each year. Research into protection against whiplash injuries has shown that improving the head restraint height and reducing backset is effective in reducing real world injury risk [2,3,4,5].

Jakobsson et al. [6] examined rear seat occupancy in the development of the WHIPS system. This study examined insurance claims data on initial symptoms (excluding long-term disability information) and showed that the driver is at significantly greater risk than passengers, of which the front passenger is at greater (although not significantly) risk than passengers in the rear. The female passengers in the rear seats are reported to be over 25%, and for males the risk is over 15%. This study also showed that females are consistently at greater risk than males. Similarly, a study by Berglund et al. [7] examined insurance claims using a patient questionnaire a few days after the collision and found that risk was lower in the rear than in the front seats of cars. Krafft et al. [8] examined real world injury claims comparing the risk for front and rear seats, but using long term disability information a year after the collision. The study showed the risk for males as rear seat passengers was lower than for front passengers and drivers. For females the risk was lower for rear seat occupants than for drivers, although the risk was higher for rear seat passengers than for front seat passengers.

The Final Regulatory Impact Analysis from the National Highway Traffic Safety Administration for FMVSS 202 showed that 8% of whiplash injuries occur for occupants in the rear seats. A real world survey of rear seat occupancy by Thatcham has shown that 12% of rear seats are occupied. This survey recorded 1000 cars on an urban A road, and examined the age and gender of occupants seated in the rear. 33% of the rear seat passengers were teenagers or older, and were not small children that might be offered protection by child restraints. 63% of the rear seat passengers were not adequately protected by a correctly positioned head restraint. Overall the risk of injury is smaller for occupants in the rear seats, but is enough to warrant consideration, especially since around 12% of rear seats are occupied and so few have a correctly adjusted head restraint.

The research objective in this paper is therefore to examine the head restraint geometry of the rear seats in comparison to the front seats, by presenting a feasibility study of a procedure for geometric rating of the rear seats and an initial set of ratings for over 100 car models.

METHOD

The RCAR-IIWPG procedure for static geometric rating of head restraints [1] was adapted for use in the rear seats by making allowances for the associated space and practical considerations. In summary, an HPM is seated in the rear seat. An HRMD was fitted and used to measure the horizontal backset from the head to the head restraint, and the height from the top of the head to the top of the head restraint. An example of the HPM with HRMD installed in an outboard rear seat is given in Figure 1. The measurements are rated according to zones of Good, Acceptable, Marginal, and Poor (Figure 2).

Figure 1. HPM with HRMD installed in rear seat.

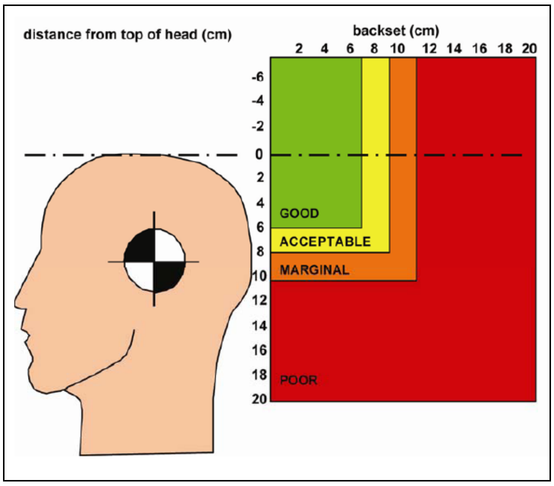

Figure 2. Head restraint rating zones.

Whilst the method of measurement was based on the standard geometric procedure prescribed by the RCAR-IIWPG [1], there were some differences. For example the installation of the HPM and legs was slightly altered to accommodate the smaller occupant space. On initial installation (without weights) of the HPM into the seat the femur angle was recorded. The legs were then fitted at the 50th percentile lengths, and width at the 5th position placing the knees 250mm apart. If there was interference with the feet or legs by some part of the vehicle floor structure or seat, then the legs were adjusted on the width until a clearance of 25mm was made. The knee spacing was kept equidistant. The femur angle was then re-measured to see if the HPM base pan was being raised off the seat, since this would indicate an unstable installation making it difficult to accurately record head restraint measurements. If the femur angle was ±1° of the initial installation then the legs remained at 50th percentile length. If the femur angle was increased to +1° above the level of the initial installation, then the legs were shortened incrementally until the initial femur angle was matched to ±1°. If it was found to be impossible to fit the legs and feet of the HPM, then these were omitted from the installation. In the majority of vehicles the centre tunnel in the rear seat footwell precluded fitment of the legs. The exceptions to this were MPVs that have a more spacious leg area in the rear so that the centre seat matches the outboard seats and there was room to install the legs (examples included the Volkswagen Sharan and the Citroen C4 Grand Picasso).

Another difference between the front seat geometric procedure and the rear seat measurement method was the installation of the height probe. In some cases the height probe could not be fitted due to interference with car interior, e.g. roof lining, as shown in Figure 3. Therefore in these cases the height probe was removed and reversed for fitment, as shown in Figure 4. In these cases 25mm was added to the height measurement to compensate for the reversed probe level.

Figure 3. Height probe interference with roof lining.

Figure 4. Height probe reversed.

Finally if the height probe is reversed and it is still found to be impossible to fit the HRMD in order to make a geometric assessment due to inability to level the HRMD (see Figure 5), then an assessment of the head restraint height can be made by using the standard HPM head room probe and the geometry of the HRMD relative to the H-Point (see Figure 6) [9]. This method was not used in this study, but there could be vehicles where rear accommodation is so restricted that it is necessary to use this method instead of using the HRMD, and the proposed method is as follows. In the case where the HRMD cannot be levelled, it should be removed along with the supplementary torso weights. The 4 standard torso weights should be installed to the HPM, and the torso angle recorded.

The backset is calculated as follows, and is shown in Figure 7 and Figure 8. The head room probe is inclined to 90°, the vertical height at which measurement is taken is calculated, and the horizontal distance is measured between the probe and the head restraint 'X'. The backset is then calculated as (1.):

$$\textbf{Backset} = X - (504.5 \sin\theta + 71) \qquad \textbf{(1.)}$$

Figure 5. HRMD cannot be levelled, alternative measurement method required.

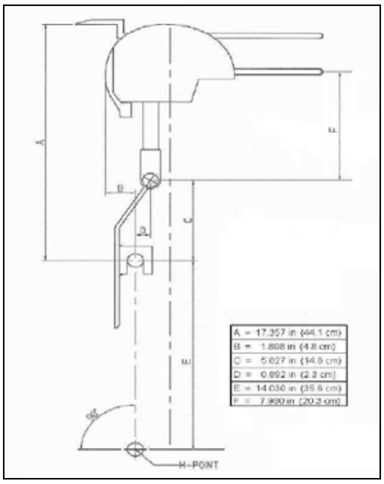

Figure 6. HRMD geometry in relation to the H-Point.

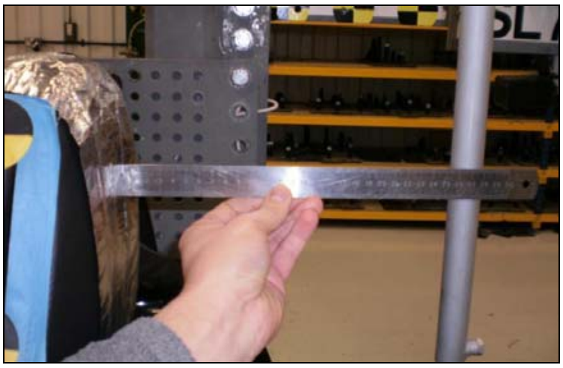

Figure 7. Backset measurement X.

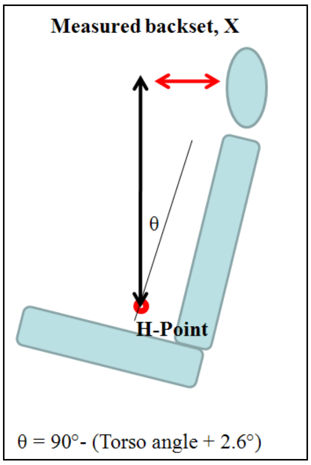

Figure 8. Backset calculation using HPM head room probe.

To measure the height of the head restraint, a similar method is used, and is shown in Figure 9 and Figure 10. The head room probe is inclined to 90°, the vertical distance between the top of head restraint and H-point aligned to the height probe 'Z' is measured. The height is then calculated as (2.):

$$\mathbf{Height = (504.5 \cos\theta + 293) - Z} \qquad \mathbf{(2.)}$$

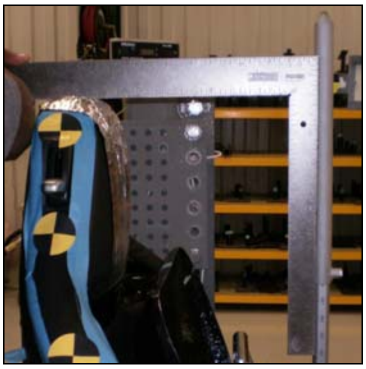

Figure 9. Height measurement Z.

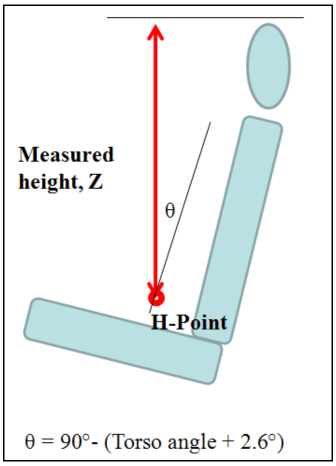

Figure 10. Height calculation using HPM head room probe.

115 rear seats were rated from a variety of mainstream cars, with the top sellers selected for each vehicle manufacturer. Both the outboard and centre seats were rated where applicable. In a few cases the seat was impossible to measure because the HPM with HRMD could not be installed in a stable manner, and these are marked as "N/A".

RESULTS

115 rear seats have been measured in this feasibility study, for both the outboard and centre seats, and these ratings are given in Table 1. The distribution of the ratings for the outboard seats are summarised in Figure 11, and for centre seats in Figure 12. Only 9% of outboard seats rated as Good, but 2% of centre seats. 42% of the outboard seats rated as Poor, but for centre seats this was increased to 69%.

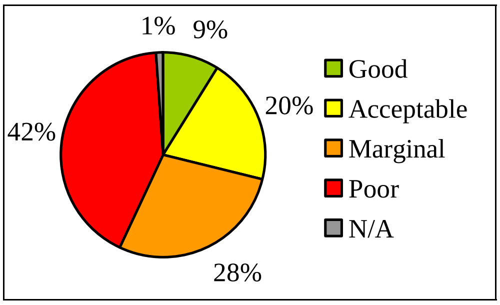

Figure 11. Outboard seats.

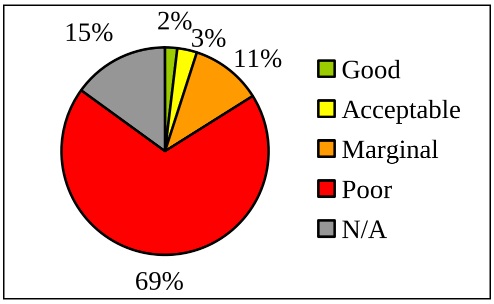

Figure 12. Centre seats.

There were 12 models that had no centre seat position available, so these could not be rated. There were some seats where the HPM could not be stably installed, so these also were not rated, but instead marked as "N/A". These N/A ratings only accounted for 1% of seats in the outboard position, but 15% in the centre position.

Table 1.
Rear seat outboard and centre geometric head restraint ratings.

Manufacturer	Model	Outboard	Centre
Alfa Romeo	159 Sportswagon	Marginal	Poor
Alfa Romeo	Giulietta	Poor	Poor
Alfa Romeo	GT	N/A	N/A
Alfa Romeo	MiTo	Poor	N/A
Audi	A1	Acceptable	N/A
Audi	A3	Poor	Poor
Audi	A4 Saloon	Marginal	Poor
Audi	A5 Coupe	Marginal	Poor
Audi	A5 Sportback	Marginal	Poor
Audi	A6 Avant	Poor	Poor
Audi	Q5	Poor	Poor
Audi	Q7	Good	Poor
Audi	S3	Poor	Poor
BMW	1 Series	Good	Poor
BMW	3 Series Saloon	Marginal	Poor
BMW	5 Series Saloon	Acceptable	Poor
BMW	X3	Marginal	Poor
Citroen	C1	Poor	-
Citroen	C3	Poor	Marginal
Citroen	C3 Picasso	Acceptable	Marginal
Citroen	C4 Hatchback	Acceptable	Poor
Citroen	C4 Picasso	Acceptable	Acceptable
Citroen	C5 Saloon	Marginal	N/A
Citroen	C-Crosser	Marginal	Poor
Citroen	DS3	Poor	Marginal
Citroen	Grand C4 Picasso	Acceptable	Acceptable
Citroen	Nemo Multispace	Marginal	Marginal
Fiat	500	Acceptable	-
Fiat	500 C	Acceptable	-
Fiat	Bravo	Marginal	Poor
Fiat	Grande Punto	Marginal	Poor
Fiat	Panda	Poor	-
Fiat	Panda 4x4	Poor	-
Fiat	Punto Evo	Marginal	Poor
Fiat	Qubo	Marginal	Marginal
Fiat	Sedici	Good	N/A
Ford	C-Max	Marginal	Good
Ford	Fiesta	Acceptable	Poor
Ford	Focus	Marginal	Poor
Ford	Mondeo	Good	Marginal
Honda	Civic 5 door	Poor	Poor
Honda	Insight	Poor	N/A
Honda	Jazz	Poor	Poor
Hyundai	i10	Poor	N/A
Hyundai	i20	Marginal	Marginal
Hyundai	i30	Poor	Poor
Hyundai	ix35	Marginal	Poor
Hyundai	Santa Fe	Poor	Poor
Jaguar	XF	Marginal	N/A
Kia	Cee'd	Poor	Poor
Kia	Picanto	Poor	N/A
Kia	Sportage	Marginal	Poor
Kia	Venga	Marginal	Marginal
Land Rover	Discovery 4	Acceptable	Poor
Mazda	2	Acceptable	Poor
Mazda	3	Poor	Poor
Mazda	5	Marginal	Poor
Mazda	6	Poor	Poor

Manufacturer	Model	Outboard	Centre
Mazda	CX-7	Poor	Poor
Mercedes	A-Class	Poor	Poor
Mercedes	B-Class	Poor	Poor
Mercedes	C-Class	Marginal	Poor
Mercedes	E-Class	Acceptable	Poor
Mini	Clubman	Poor	Poor
Mitsubishi	ASX	Marginal	Poor
Nissan	Cube	Poor	N/A
Nissan	Leaf	Poor	Poor
Nissan	Micra	Acceptable	N/A
Nissan	Note	Poor	Poor
Nissan	Pixo	Marginal	-
Nissan	Qashqai	Marginal	Poor
Peugeot	107	Poor	-
Peugeot	207	Poor	Poor
Peugeot	308	Poor	Poor
Peugeot	3008	Marginal	Poor
Peugeot	5008	Marginal	Marginal
Peugeot	207 SW	Acceptable	Acceptable
Peugeot	Bipper	Marginal	Marginal
Renault	Megane CC	Acceptable	N/A
Saab	9-3 Convertible	Marginal	-
Saab	9-3 Saloon	Poor	Poor
Saab	9-5 Saloon	Poor	Poor
Seat	Alhambra	Poor	Poor
Seat	Exeo	Poor	Poor
Seat	Ibiza 5 door	Poor	Poor
Seat	Leon	Poor	Poor
Skoda	Fabia Hatchback	Poor	Poor
Skoda	Octavia Estate	Poor	N/A
Skoda	Roomster	Poor	Poor
Skoda	Superb Estate	Poor	Poor
Skoda	Yeti	Poor	Poor
Suzuki	Alto	Marginal	-
Suzuki	Grand Vitara	Marginal	Poor
Suzuki	Splash	Good	N/A
Suzuki	Swift	Acceptable	-
Suzuki	SX4	Good	N/A
Toyota	Aygo	Poor	-
Toyota	Land Cruiser	Poor	Poor
Vauxhall	Agila	Good	N/A
Vauxhall	Antara	Acceptable	Poor
Vauxhall	Corsa	Poor	Poor
Vauxhall	Insignia	Poor	Poor
Vauxhall	Astra	Poor	Poor
Vauxhall	Meriva	Acceptable	Poor
Vauxhall	Zafira	Good	Good
Volkswagen	Golf	Poor	Poor
Volkswagen	Passat Saloon	Good	Poor
Volkswagen	Polo	Marginal	Poor
Volkswagen	Sharan	Poor	Poor
Volvo	C30	Acceptable	-
Volvo	S40	Acceptable	Poor
Volvo	S80	Good	Marginal
Volvo	V50	Acceptable	Poor
Volvo	XC60	Acceptable	Poor
Volvo	XC90	Acceptable	Poor

Note:
"-" ratings indicate no centre seat.
"N/A" indicates that the HPM/HRMD could not be set correctly to take measurements, due to space constraints or not remaining stable, i.e. sliding forward.

NON-USE POSITIONS

A current feature of some rear seat head restraints is the ‘non-use’ position. This is a position where the head restraint is stowed, and not designed for protection of the head. Examples are shown in Figure 13. This non-use position should discourage use with an occupant in the seat, and it should encourage an occupant to adjust the head restraint to its proper use position.

Stowed Use

Figure 13. Two examples of use and non-use head restraint positions.

However in the real world some occupants do not adjust the head restraint to its correct use position, and simply leave it stowed despite the possible discomfort caused. For example, the lower example in Figure 13 might not cause enough discomfort to the occupant to make them adjust the height of the head restraint properly; whereas the upper example would clearly be extremely unusable. The difference is the level of discomfort caused, and whether the seat becomes so uncomfortable that it becomes unusable. Some non-use positions for head restraints seem to be less successful in discouraging occupants from using them. This issue is of relevance because in a non-use position a head restraint is not effective in protecting against whiplash injuries. A front seat head restraint offers some level of protection, even if unadjusted; whereas a rear seat head restraint in the non-use position in unlikely to even offer that basic level of protection. Also, since the rear seats might yield less under the forces of the occupant in a rear crash, the risk of injury with an unadjusted head restraint might be higher for the rear seat than for the front seats.

Another real world usage issue is that if a head restraint in its non-use position interferes with the fitment of a child restraint system, then people might remove the head restraint entirely. This is not a problem if the head restraint is then replaced when the child restraint is removed. However if the head restraint is removed completely from the car, and is not needed for several years, then there is a risk that it might be lost or never returned to the vehicle, in which case the rear seat occupants will have a higher risk of injury. Therefore the head restraint design must not only consider use and non-use positions, but also how the head restraint interacts with child seats.

Regulatory requirements are beginning to address the issue of non-use positions. For example ECE 17 [10] allows displacement of the head restraint, but only if the position is ‘clearly recognisable to the occupant’ as not being included for the use of the head restraint. Some examples are given in Figure 14 how different vehicle manufacturers seem to have responded to this requirement by providing various labels to inform the occupant of the use and non-use positions. These labels have different locations, one on the rear head restraint itself, one on the back of the seat in front, and one on the rear window behind the row of front seats. These labels will have differing levels of effectiveness in informing the occupants, based on their clarity and their visibility. However the FMVSS 202aS [11] is clearer, requiring that the non-use position provides an ‘unambiguous physical cue’. This physical cue proposed was defined as a torso angle change of 10°, although that was not accepted into regulation [12]. The data sheet [11] states that if the head restraint does not automatically return to a use position when occupied by a 5th percentile female, then it must rotate at least 60° for the non-use position. The provisional GTR [9] defines the previously mentioned 10° torso angle change and 60° rotation of the head restraint, as well as a ‘discomfort’ metric. This discomfort metric defines the minimum protrusion of the head restraint, and the position of its lower edge, in order to specify a non-use position. Overall, the regulatory requirements indicate that there is a need to address the issue of providing non-use positions that properly discourage use, in order to best protect the occupant. However the ECE regulation only requires the non-use position to be ‘clearly recognisable’, which is difficult to quantify and assess. The requirements of the regulations are also only enforced if a head restraint is fitted in the rear, so there is a risk that vehicle manufacturers might simply cease to fit rear head restraints, and therefore the occupant is offered no protection against injury.

	Label on side of head restraint
	Label on rear quarter window, behind row of rear seats
	Large label on back of front seat

Figure 14. Examples of labels describing use and non-use positions for rear head restraints.

DISCUSSION

In comparison to the front seats the rear seat ratings were much poorer. Based on static geometry ratings from the 2010 model year the front seats have 91% rated Good, and 0% rated Poor. However nearly half the rear seats measured in this study are rated Poor, and under 10% are rated Good. This highlights the potential difference in protection offered by head restraints in the front seats compared to the rear seats.

It is of interest that insufficient height adjustment of the rear outboard head restraints is the reason for most Poor ratings. Analysis of the outboard backset measurements reveals that 67% of the head restraints achieve a Good rating (when height is excluded from consideration, see Figure 15). So in order the gain a better rating, and to better protect occupants against whiplash, the vehicle manufacturers' first improvement could be to improve the height adjustment range of the rear head restraints. One possibility is therefore to have a rating system that only considers the height of the head restraint. However many research studies have established that reduced backset of the head restraint can help to reduce whiplash injuries [2,3,4,5], and the HRMD is an established tool for head restraint measurements. Furthermore, the centre seat generally has a larger spread of backset (Figure 16), and if only the height adjustment were increased there would be less improvement to overall geometry. Therefore it is important to consider both backset and height of the rear head restraints, as this feasibility study has shown, in order to provide protection to the rear seat occupants.

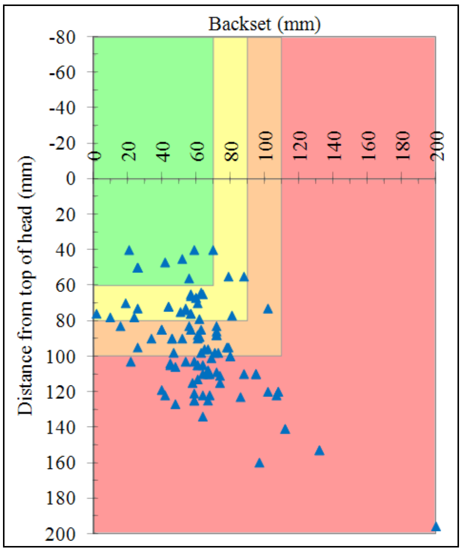

Figure 15. Outboard seats: Only 10% have Poor backset.

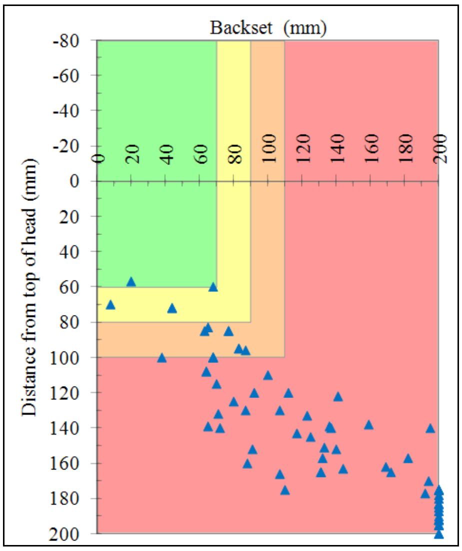

Figure 16. Centre seats: Greater range in backset and height than outboard seats.

In the front seats there are different types of anti-whiplash system that are design to help reduce the risk of whiplash symptoms and injuries occurring in rear impact. For example, a reactive head restraint (RHR) responds to the rearward motion of the body in the seat so that a mechanism moves the head restraint upward and forward to meet and support the head earlier in the crash. A pro-active head restraint (PAHR) has a similar movement upward and forward, but is actuated by crash sensors around the vehicle in order to provide protection even more quickly. A reactive seat (RAS) design is focussed on energy absorption in the seat back and head restraint; and a passive seat

(PAS) uses passive foam technology to absorb the energy of the crash and allow the occupant to engage the head restraint without neck distortion. All of these four designs might also be feasible for the rear seat. However due to vehicle design the rear seats have less ability to flex in the rearward direction, so designs that rely on rearward distortion of the seat to allow energy absorption might be less feasible. Ultimately the protection offered by the rear head restraint is a compromise with many other factors that a vehicle manufacturer must consider, including the available space, cost, comfort for the occupant, weight etc. Thatcham is monitoring the rear seat designs to identify those that appear to offer the potential to reduce whiplash injury risk.

In the development of the RCAR-IIWPG front seat whiplash procedures, the initial work focussed on the static geometric rating of the seats, and then progressed to development of a dynamic test to assess the performance of the front seats in an impact. Similarly, it is possible to develop a dynamic rear seat test. Thatcham will continue to investigate the feasibility of dynamic rear seat testing. However since the improvements in front seat geometry have been shown to be effective in reducing real world whiplash injuries, the main focus will remain on rear seat geometry.

CONCLUSIONS

Whiplash prevention technologies have focussed on the front seats, but consideration should now be given to the rear seats. The paper offers a new insight into the protection offered by rear seat head restraints against whiplash injuries. It presents a feasibility study of using an adapted head restraint geometric measurement method for the rear seats. This reveals that from 115 models measured, less than 10% rated Good, which highlights the need to improve the level of protection against whiplash injuries offered by the rear seats. The ratings can be used by consumer safety organisations to increase public awareness and this will have two main benefits: firstly to raise public awareness and encourage correct use of the head restraint; and secondly to encourage development of rear seats that can offer protection against whiplash injuries.

LIMITATIONS

The sample of cars rated does not cover the entire current vehicle fleet, however the models selected were the top-sellers for each manufacturer.

This paper presents the RCAR-IIWPG geometry procedure [1] being applied to the rear seats as a feasibility study. The posture used by rear seat occupants might be different to the front seats, and this would need consideration to ensure that the measurements reflect a realistic posture.

The ratings zones defined by the existing front seat procedure are based on the zones in which geometry is proven to have an effect, but these may be different for rear seated occupants. An examination of real world insurance claims in relation to the measurements recorded could help to define zones that are better suited to driving seat designs to protect against whiplash injuries.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the work and support of the team of engineers in the Crash & Safety Department at Thatcham. Furthermore, the authors would like to thank the many car dealerships for allowing access to their vehicles for measurements.

REFERENCES

[1] Research Council for Automobile Repairs and International Insurance Whiplash Prevention Group (2008). RCAR-IIWPG Seat/Head Restraint Evaluation Protocol, Research Council for Automobile Repairs (RCAR) and International Insurance Whiplash Prevention Group (IIWPG). Version 3.0. March.

[2] Farmer, C.M., Wells, J.K. and Lund, A.K. (2003). "Effects of Head Restraint and Seat Redesign on Neck Injury Risk in Rear-End Crashes." Traffic Injury Prevention **4** (2):83-90.

[3] Jakobsson, L. (1994). Analysis of Head and Neck Responses in Rear End Impacts – A New Human Like Model, Volvo Cars. Safety Report.

[4] Olsson, I., Bunketorp, O., Carlsson, G., Gustafsson, C., Planath, I., Norin, H. and Ysander, L. (1990). An In-Depth Study of Neck Injuries in Rear-End Collisions. 1990 International IRCOBI Conference on the Biomechanics of Impacts Bron, France, 12th - 14th September.

[5] Farmer, C., Wells, J. and Werner, J. (1999). "Relationship of head restraint positioning to driver neck injury in rear-end crashes." Accident Analysis and Prevention **31** (6):719-728.

[6] Jakobsson, L., Lundell, B., Norin, H. and Isaksson-Hellman, I. (2000). "WHIPS - Volvo's whiplash protection study." Accident Analysis & Prevention **32**:307-319.

[7] Berglund, A., Alfredsson, L., Jensen, R., Bodin, L. and Nygren, A. (2003). "Occupant- and Crash-Related Factors Associated with the Risk of

Whiplash Injury." Annals of Epidemiology **13** (1):66–72.

[8] Krafft, M., Kullgren, A., Lie, A. and Tingvall, C. (2003). "The risk of whiplash injury in the rear seat compared to the front seat in rear impacts." Traffic Injury Prevention **4**:136-140.

[9] United Nations Economic Commission for Europe (2008). Global Technical Regulation on Head Restraints. Geneva, United Nations Economic Commission for Europe. GTR 7. 13th March. http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29registry/ECE-TRANS-180a7e.pdf.

[10] United Nations Economic Commission for Europe (2009). Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints. Geneva, United Nations Economic Commission for Europe. ECE R17. 6th November. http://www.unece.org/trans/main/wp29/wp29regs/r017r4a2e.pdf.

[11] National Highway Traffic Safety Administration (2011). Laboratory Test Procedure for FMVSS 202aS: Head Restraints - Dimensional and Static Testing. Washington D.C., National Highway Traffic Safety Administration. TP-202aS-01. 21st January.

[12] National highway Traffic Safety Administration (2004). Federal Motor Vehicle Safety Standards; Head Restraints. Washington D.C., National highway Traffic Safety Administration. http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/202FinalRule.pdf.