



## Project: Neck Injury Prevention

Discussion and summary of Centaur technical report:  
**Evaluation of a slow recovery plastic foam in head restraints for better protection during rear-end impact.**



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Soft tissue neck injuries represent a major part of the low severity injuries sustained in car accidents. They result in huge socio-economic costs. Most head restraints are able to protect the passenger from severe neck injuries, but the number of so-called low severity injuries, popularly referred to as whiplash injuries, continues to increase in some countries. Problems in diagnosing the injuries and understanding the mechanisms causing them make this a complicated issue. However, although a lot of work has been done to reduce whiplash-related injuries, which hopefully will be seen in tomorrow's car accident statistics, there is still a lot of room for improvement.

### The foam in the seat plays a vital role

Measurements of head restraint geometry reveal that a majority of current cars exhibit only "acceptable" or, in some cases, even "poor" head restraint geometry. The car industry has come up with solutions for reducing whiplash-related injuries, and some of them seem promising when tested with today's available methodology and evaluation models. However, an aspect that has been somewhat neglected is the foam with which the seat is filled. It is thought that a high rebound velocity of the occupant during a rear-end collision can cause soft tissue neck injuries. As such, the foam in the seat plays a vital role. A special slow recovery plastic foam is now available that reduces whiplash-related injury criteria. A previous series of component tests (G. Baltzer) showed that this foam had a remarkable hysteresis effect, witnessed in the low rebound velocities, that this material produced compared to standard head restraints. The aim of this test series, sponsored by Skyttfonden, SNRA, was to evaluate the effect of said foam on a whole seat system. Rear end collisions at 15 km/h were simulated in a two sled system.

### The test indicate a significant improvement

A special "whiplash dummy", developed by Chalmers University of Technology, was used in the test series, performed at Chalmers' own crash laboratory. The results indicate a significant improvement when the head restraints were equipped with the new type of material. The tests were conducted according to a standard about to be implemented in future ISO regulations to improve the protection of the car occupant. Guidelines for these tests have been taken from an IRCOBI report by Langwieder et al. In this report, four injury criteria are presented: neck loads, relative motions of the head and lower neck, elasticity of head restraint and the rebound velocity of the head during the time when the head returns to its initial position. Three different north European seat types were tested in three test modes:

1. Standard configuration
2. With a square shaped, 75-mm thick, slow recovery foam strapped to the head restraint.
3. With the head restraint replaced by a new one, consisting of a simple metal plate with a 75-mm plastic foam attached onto it.

### The new foam makes a substantial reduction of the injury risk

A linear calculation was used to add the values from the four criteria into a total score. In the three seat types tested, an improvement was seen in test mode two and three. The neck loads were reduced in all the seats equipped with the foam, and the rebound and NIC-values were reduced in a majority of the tests.

The results indicate that through a simple accessory, e.g. a pillow, made of this material strapped onto the head restraint, a substantial reduction of the injury risk can be achieved. This material could also be implemented in the seats with the aim of optimising its protection performance. Further tests and analysis will have to be carried out in order to optimise the importance of this material as regards geometry, seat frame structure and recliner mechanisms.

## References

- 1 "Evolution of dynamic test standard proposal for a better protection after rear-end impact." Langwieder K., Hell W, Schick S. (GDV-Munich), Muser M., Walz F. (ETH-Zurich), Zellmar (Autoliv – Germany)
- 2 "A new neck injury criterion candidate for rear-end collisions taking into account forces and bending moments" Schmitt K.-U., Muser M., Niederer P. (ETH – Zurich)
- 3 "Biomechanical significance of the rebound phase in low speed rear-end impacts." Muser M., Walz F. (ETH – Zurich) and Zelmer H. (Autoliv – Germany)
- 4 "Test of head restraints in standard configuration and after addition of a slow recovery foam cushion." Gunnar Baltzer (Skydd mot whiplash e. f.)

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