

THE WINDOWBAG: AN INNOVATION IN SIDE IMPACT PROTECTION

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Abstract

A new additional airbag system will provide enhanced protection in side impact collisions. The so - called Window Bag will be installed in some Mercedes cars beginning with the E-Class Sedan for the MY99 and in the new S - Class.

Introduction

First of all, let us consider the global need to further improve side impact protection.

The incidence of side collisions in relationship to the total number of injuries and deaths in car crashes has clearly increased in the last years.

Looking at a summary of the type of collisions involving Mercedes -Benz vehicles with injured occupants over the last 18 years (Figure 1), the average percentage of side impacts is 21% showing an increasing tendency.

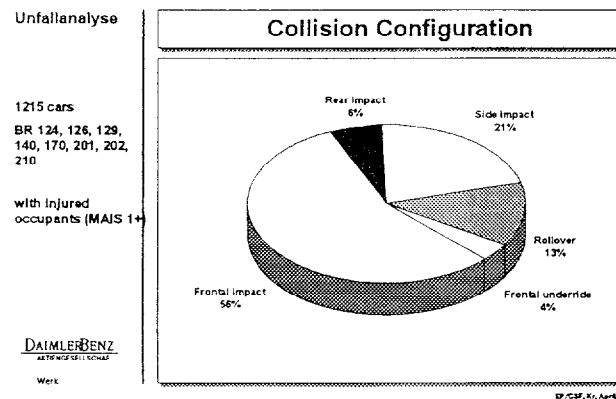


Figure 1: Types of M-B collisions

Much more dramatic is the relevance of side impacts by considering only fatal crashes for the same time period.

In this case, the percentage increase is up to 44% (Figure 2).

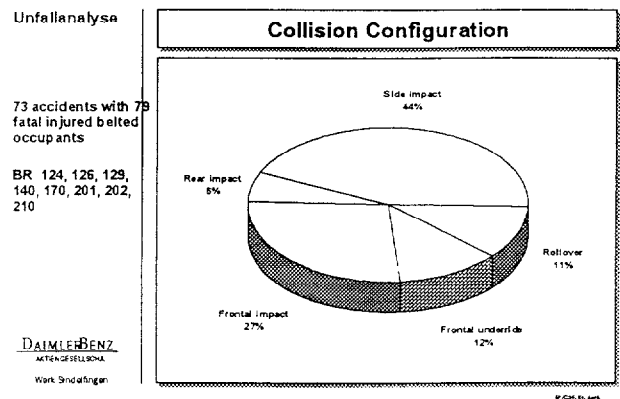


Figure 2: Collision Analysis

This development is mainly related to the improvements made for occupant protection in frontal impacts. Better car structures, restraint systems, and test methods in the last 20 years have continuously reduced the risk to be injured in head - on collisions. As a consequence the relative incidence of side crashes in terms of injuries and deaths has increased. According to this considerations, it is not surprising that car manufacturers have been working for several years on improving side impact safety.

Side impact protection systems

The Daimler-Benz Accident Research Department has shown that the most frequently occurring severe side impact injuries are to the thorax. (Figure 3).

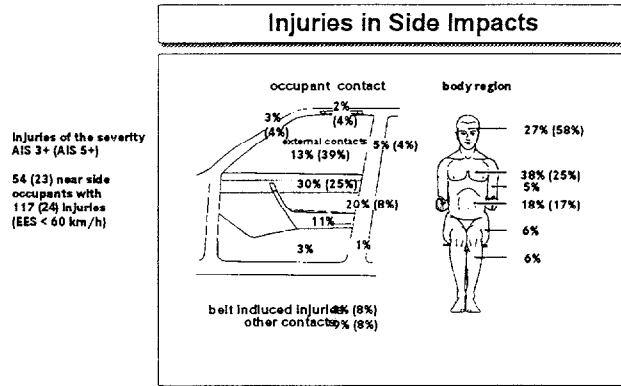


Figure 3: Frequency of side impact injuries

For this reason, Mercedes cars have been equipped beginning with the E - Class in 1995 (or MY96) with side air bags in the front doors.

Side air bags offer an additional protection to the occupant on the struck side. The structural behavior of the car, the interior door, and side wall trim all play a major role to enhance occupant safety in the variety of side impact collisions on the road.

For individuals fatally injured in side impact collisions, the head region shows the largest percentage of injury- 58%, because of the large movement of the head resulting in massive contacts with vehicle or intruding parts.

Furthermore, 48 % of side impacts involving fatalities were single vehicle collisions into a pole or tree.

To reduce the likelihood of severe or fatal injuries in these types of crashes, Daimler-Benz has developed with Autoliv Corporation a unique head protection system which we call the Window Bag.

System Description and Evaluation

The inflated Window Bag consists of a nearly two meter long, thirty-five centimeter wide and six centimeter thick cushion which is intended to protect front and rear occupants on the struck side (Figure 4).

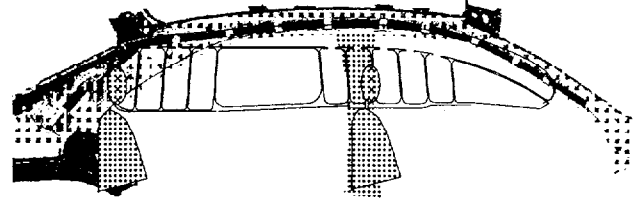


Figure 4: Windowbag

The Window Bag consists of a gas generator, a bag, a thin cover and the mounting hardware. The gas generator is a hybrid type device with 3 grams of composite generant and pressurized argon gas at 300 bar. The air bag is woven as one piece and is made of polyamide fabric with a silicon coating.

The Window Bag is fixed to the A - pillar, the side roof frame, and the C - pillar and is hidden under the corresponding interior trim.

The gas generator is mounted to the C - pillar and is directly connected to the air bag.

Furthermore, the air bag is divided into 9 vertical chambers and when fully deployed covers an occupant's potential contact area with the side of the vehicle. The total overall volume of the Window Bag is twelve liters.

The folded bag is like a flexible tube inside of a thin polyamide cover which includes the gas generator and mounting hardware, and is delivered ready to mount. Plastic mounting clips and brackets allow the air bag unit to be fixed to the car roof and pillars, and also insures a controlled and quick positioning of the Window Bag.

The complete module weighs 1.3 kilograms.

Function and performance

In the case of a side collision where the sensing threshold is reached, the window and side air bags are activated at the same time by an electronic control unit. The control unit measures lateral as well as longitudinal car decelerations and is the same device that activates the driver and passenger air bags in a frontal impact. To quickly sense a side collision, the central unit is assisted by additional deceleration sensing devices on both sides of the car.

After activation the Window Bag inflates along the side wall coming out of the roof trim and expands like a curtain in front of the side windows. The unique design of the gas flow optimally positions and tightens the Window Bag between the A- and the C-pillars in an inflation time of approximately 25 ms at ambient temperature.

The Window Bag's internal pressure has a mean pressure of 1.5 bar.

Out - of - position tests show no additional risk of injury due to the inflating Window Bag's deployment velocity of 50 km/h.

To validate the system efficiency and to optimize the performance, computer programs were run in collaboration with the system supplier. The results, as expected from the collision analysis, clearly showed the most critical case is a side impact of the car into a pole (Figure 5).

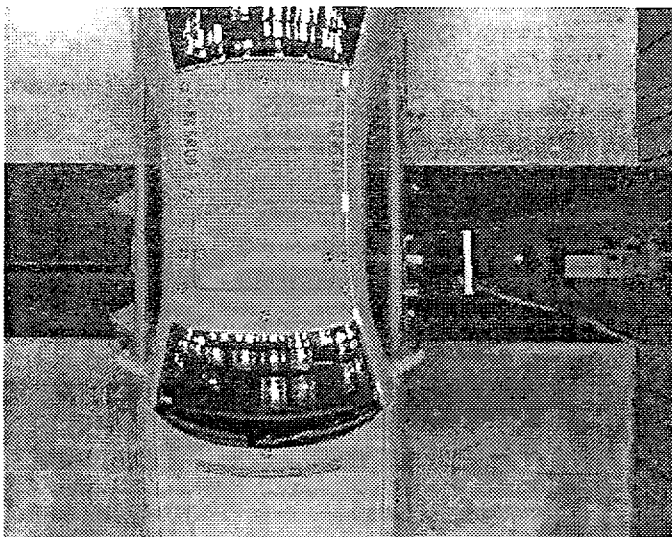


Figure 5, Car to pole crash

Therefore, hardware validation for a car - to - pole crash was conducted first with body in white, and finally with complete cars at an impact speed of about thirty kilometers per hour. The contact area of the pole was aimed at an occupant's head for tests in both the front and in the rear. The pole diameter measured 254 millimeters.

Without the Window Bag, there was massive contact between the head and the intruding pole for the driver, and between the rear passenger's head and the intruding rear car structure. The HIC exceeds 4000 in the front (Figure 6).

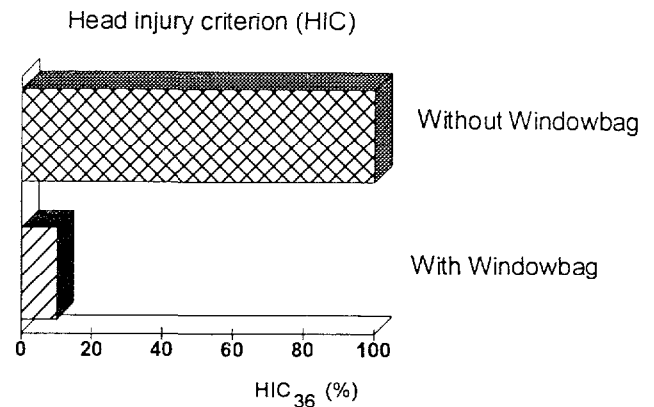


Figure 6: Head Injury Criterion

The Window Bag is able to help avoid severe direct contacts and reduces the HIC values well below the limit of one thousand.

Additionally according to recent studies conducted by Bohmen et al, a device like the Window Bag can also reduce peak angular velocity and acceleration of the head which may contribute to a reduction in brain injuries.

Conclusion

The goal to offer additional protection for the head in side collisions for a front and rear car occupant is fully reached with the introduction of the Window Bag.

This efficiency in reducing injury potential is especially demonstrated in car - to - pole or tree collisions, which according to the Daimler Benz crash statistic causes nearly 50% of the fatalities in side impact collisions.

Due to the large Window Bags's surface, we also expect better protection against contact within the car's interior, the windows, as well as against intruding objects and broken glass independent of occupant size and seating position.

Out - of - position tests did not indicate risk from the inflating Window Bag.

The Window Bag is already recognized as a complement to the additional padding which is necessary to fulfill the FMVSS 201 head impact requirement. For the contact area covered by the Window Bag, a reduced impact speed of 12mph is allowed instead of 19mph.

However, additional protection is also expected in oblique collisions or in rollovers which could occur after a side impact, thereby reducing the risk of head ejection.

Considering that the Window Bag has a great potential to also improve the occupant protection in rollovers, this device is a promising additional inflatable system for overall increased protection in car crashes.

References

Bohman Katarina, Haland Yngve
Autoliv Research
Sweden

Aldman Bertil
Chalmers University of Technology
Sweden

REDUCTION OF HEAD ROTATIONAL MOTIONS IN
SIDE IMPACTS DUE TO THE INFLATABLE
CURTAIN - A WAY TO BRING DOWN THE RISK OF
DIFFUSE BRAIN INJURY

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