european aluminium association

Aluminium for safer trucks

1. INTRODUCTION

Road safety and fuel efficiency are without doubt two major priorities for EU policy makers. One area where a lot can be done for the road safety is to reduce the severity of accidents between large trucks and smaller personal vehicles and vulnerable road users. Due to restrictions in the dimensions of heavy duty vehicles (EU Directive 96/53/EC), tractors are normally designed in a very compact way in order to maximise the volume of goods that can be carried. The compact design leads to a flat front which in the event of a crash with a smaller vehicle absorbs very little crash energy. A study was consequently launched to investigate if a tractor optimised for better aerodynamics and pedestrian safety could be equipped with an energy-absorbing crash management system (CMS). The aerodynamic design lead to an extra space in the front of the tractor and this space was identified as a good place to mount this energy absorbing structure.

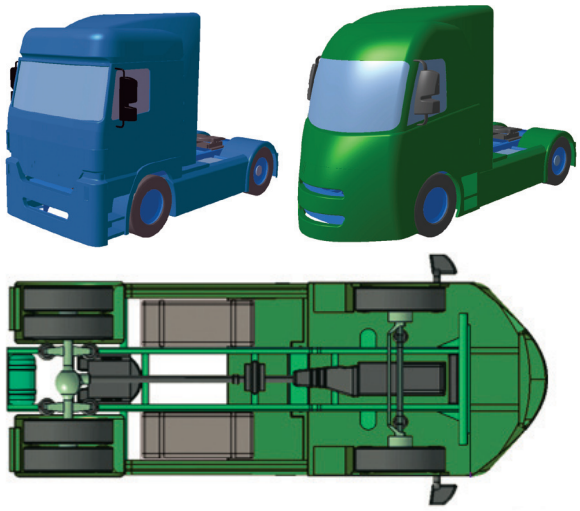


Figure 1: Extension of the tractor front

The study was conducted and published by the Institut für Kraftfahrzeuge of RWTH Aachen University. The report shows that increasing the energy absorbing capacity of the truck front structure can greatly improve its behaviour in the event of a crash. But the adoption of devices into the design of new trucks must not be penalized. Thus a change in the size and weight directive 96/53/EC is needed so that an improvement of the safety or the fuel efficiency does not influence the payload capacity.

2. DESIGN OF A STATE-OF-THE-ART CRASH MANAGEMENT SYSTEM

The objective of this design was to develop a Crash Management System (CMS) that considerably improves passive safety for a passenger car in the event of a crash with a truck. Both head-on crashes and a truck crashing into the rear of a passenger car were investigated. The starting point of the CMS design was to use the extra space in the front of a tractor, previously optimised for better aerodynamics and pedestrian safety, to incorporate an energy-absorbing structure. Several design options were considered during the development of the advanced CMS, and a topology optimisation was performed in order to obtain a first design. Other criteria for the design were to minimise the extra weight of the CMS and to comply with the ECE-R 93 requirements that specify the minimum forces that the CMS have to withstand without collapsing.

The resulting design of the CMS can be seen in Figure 2. The lower structure is an energy-absorbing Front Under-run Protection (ea-FUP), which softens the impact of the crash and prevents passenger cars from being run over by the truck. The upper structure acts mainly as protection for the truck driver.

Advanced aluminium alloys were used due to its high specific energy absorption capacity compared to other materials. This resulted in a very modest weight increase of 10 kg compared to a CMS from a conventional tractor with a much lower energy absorption capacity. Furthermore, by designing the CMS with extruded aluminium profiles, it was possible to keep the cost of the CMS low.

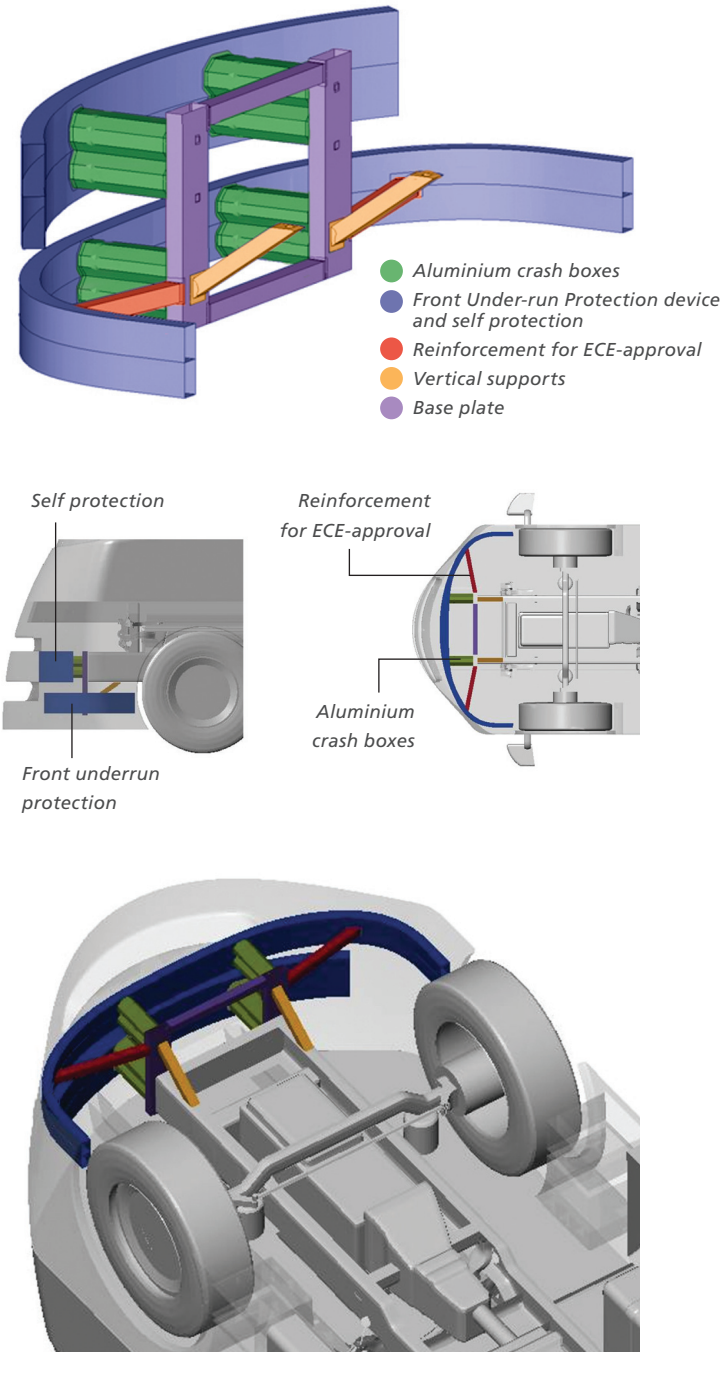


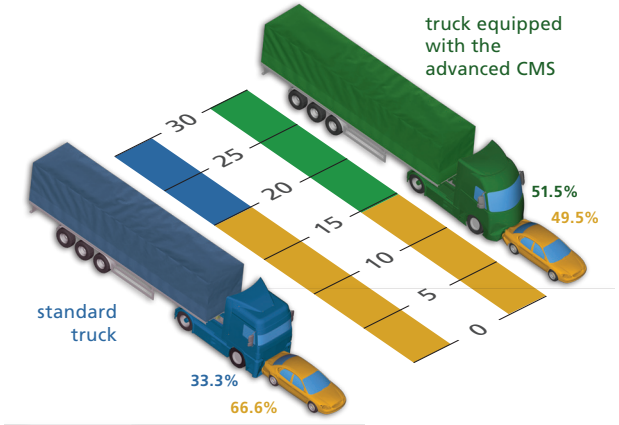
Figure 2: Design of the aluminium CMS for a truck with extended front.

3. RESULTS

Numerical models of the car and the truck were used to simulate the different crash scenarios. The blue vehicle represents a standard truck and the green vehicle represents a truck equipped with the advanced CMS.

REAR SHUNT:

Truck crashes into the rear of the passenger car.
Truck speed: 20 km/h
Passenger car speed: 0 km/h



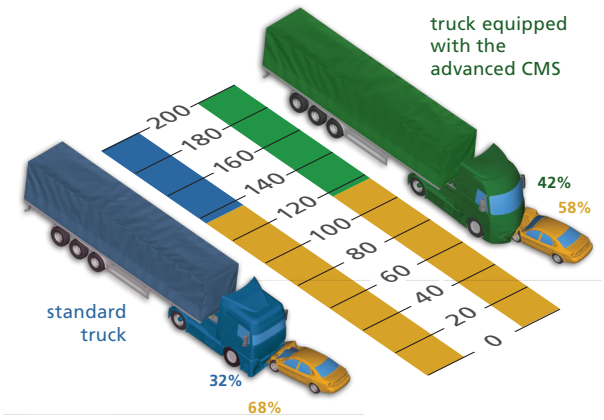
Color bars shows the energy absorbed by the truck and car respectively

This clearly shows that a much greater amount of energy is absorbed by the truck when it is equipped with the advanced truck CMS, thereby reducing the severity of the accident for the passenger car.

This results in a 65% reduction of the acceleration levels in the car. Acceleration levels are correlated to the risk of injury to the occupants of the vehicle.

HEAD-ON CRASH WITH OFFSET:

Truck crashes into the front of the passenger car.
Truck speed: 21 km/h.
Passenger car speed: 42 km/h. Offset 30%



Color bars shows the energy absorbed by the truck and car respectively

This clearly demonstrates that a greater amount of energy is absorbed by the truck when it is equipped with the advanced truck CMS, thereby reducing the severity of the accident for the passenger car.

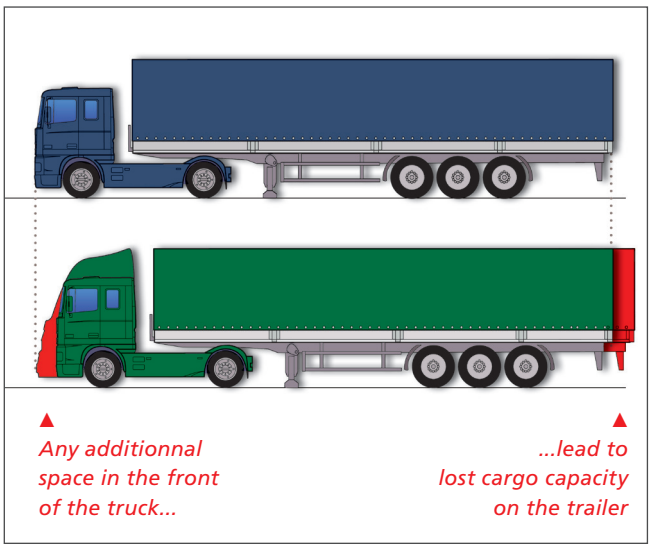
This results in a 17% reduction of the acceleration levels in the car. Acceleration levels are correlated to the risk of injury to the occupants of the vehicle.

Other scenarios can be found in the complete report available for download from www.alutransport.eu

4. CONCLUSIONS

The study demonstrates that the incorporation of energy-absorbing Crash Management Systems in the front of heavy-duty vehicles has enormous potential to improve passive road safety. By improving the CMS of the truck front, the severity of car to truck accidents can be significantly reduced, while at the same time the self-protection for truck drivers can be improved. A state-of-the-art aluminium CMS was

developed in this project; the safety improvements that it brings involve a very low weight increase of less than 10 kg compared to a CMS from a conventional tractor. To introduce this type of passive safety devices into trucks, the tractor would have to be extended in the forward section by 500-1000 mm. Since the existing Directive on the weight and dimensions of trucks (96/53/EC) governs the maximum total length of trucks, this might lead to a reduction of the actual payload area of the truck.



Under Directive 96/53/EC, a longer CMS would decrease the payload area of the truck.

In essence, any extra space used in the front of the truck for the purposes of improving passive safety and aerodynamic design will reduce the effective payload area of the truck. Consequently, to make it attractive for the manufacturers to focus on such important design changes, it would be preferable to regulate tractor and trailer lengths separately and to allow for extra length in the front of the tractor if it improves the safety and the fuel efficiency.

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