New truck front to save lives

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Researchers at Chalmers University of Technology, in Sweden, have developed a new truck front concept to significantly reduce fatal crashes in car-truck collisions. The new truck front comes after the EU regulations for the maximum length of a truck were lifted. Crash tests on the new truck front were carried out by the Swedish Transport Administration, Trafikverket, and show that better truck designs can reduce passenger car compartment deformations by 30-60 percent. This reduces the risk of injury and possible death for the car occupants. Credit: Trafikverket

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Fatal crashes between heavy goods vehicles (HGVs) and passenger cars account for between 14 to 16 percent of all car occupant fatalities in both the EU and the US. In over 90 percent of traffic accidents involving HGVs, it is the other party who dies, usually in a passenger car.

The most common accident types in these collisions are head-on crashes on rural roads and rear-end crashes on highways (the HGV drives into the rear of the car in front). It is therefore important to investigate car-to-HGV crashes further to improve the survival rates of passengers in the cars of such collisions.

A truck front designed not to kill

It is widely accepted that two modern passenger cars of the best safety standards should be able to cope with a collision, 80 kilometers per hour, without fatal consequences. This is not the case for collisions between trucks and cars. While the velocity is often moderate in truck-car collisions, the crash severity is still high due to geometry, stiffness, and mass incompatibility between the two vehicles.

In order for a passenger car occupant to survive a head-on collision with a truck, the cabin in the passenger car needs to be kept intact. This is not something that is possible to guarantee today, even in the most modern

cars, so the new truck front research aims to find the best ways to protect car passengers, as well as truck drivers, in the future.

Cars and trucks have discrete structural elements (bumpers, energy-absorbing beams, passenger compartment frames) that are designed to deform and absorb energy or remain intact and protect occupants. It has been observed in real-world crashes that these localized structures rarely interact the way they were designed.

This leads to a less efficient crash response. A team of researchers at Chalmers University of Technology designed a truck front that would improve the collision process. This latest design was based on earlier research carried out at Chalmers.

"We know that providing a distributed force over the struck car would allow its crash structures to perform more efficiently. From the first test, we could also see that the energy levels observed were high and better energy absorption by the truck was needed. Another challenge was also trying to direct the car away from the truck's forward path," says Professor Robert Thomson, Division of Vehicle Safety at Chalmers University of Technology.

New EU regulations allow for change

The new front was designed with the goal of demonstrating potential design principles to be interpreted and adapted by manufacturers.

"The internal design of the new truck front is aluminum honeycomb. This is a structure composed of repeating hexagonal tubes made from aluminum foil. This is ideal for a lightweight, energy-absorbing structure since around 97 percent of its volume is air. Aluminum honeycomb is used in many crash test barriers to provide a distributed force and absorb energy."

"By changing the foil thickness, we can change the force and deformation characteristics. It also has the manufacturing flexibility needed to create 'one-off' prototypes and demonstrate 'proof-of-concept,'" says Professor Thomson.

One of the main contributions was to take advantage of the new truck dimension regulations in Europe that were amended in 2019 (Decision (EU) 2019/984).

This relaxed the previous maximum limit to a truck combination length which led to "flat front" trucks in Europe that maximized cargo space on a truck within a fixed length. This resulted in limited design space and little opportunity to integrate crashworthiness designs, like those found in passenger cars and trucks.

Unique tests show 30-60 percent less impact in crash

The new truck front was tested by The Swedish Transport Administration, Trafikverket, at the Autoliv test track in Vårgårda in a set of unique tests. The tests showed measurable results and clearly highlighted that the new truck front made a big difference. The crash tests show that better truck designs can reduce passenger car compartment deformations by 30-60 percent, which reduces the risk of injury for the car occupants.

Deformation of the truck was also reduced in sensitive areas and improved truck driver safety and cargo security. Steering, braking, and suspension components are at risk of being damaged if not protected. Protecting these components reduces the risk of subsequent crashes or even rollovers of the truck.

"A truck is involved in every fifth fatal accident in road traffic. Despite the fact that trucks only account for 6 percent of the traffic volume in

Sweden, where the tests were carried out, around 45 people die a year in traffic accidents involving heavy trucks, and in over 90 percent of these, it is the other party who dies, usually in a passenger car."

"The goal is to develop a standard for crash tests for trucks that can be introduced in Euro NCAP's consumer tests in 2030. We want the people in a passenger car to be able to survive a head-on collision with a truck because the car compartment remains intact," says Rikard Fredriksson, Senior Advisor at Trafikverket and Adjunct Professor at Chalmers.

The test was based on a modern passenger car and heavy truck crashing at speeds that would result in a fatal accident. The crash test was run at 50 kilometers per hour but simulates an original travel speed of 80 that is reduced by 30 kilometers per hour by automatic emergency braking systems (AEB) that are required in newer cars and trucks.

Chalmers University of Technology, The Swedish Transport Administration, and the automotive industry are working together to further develop the tests with the truck front.

Provided by Chalmers University of Technology

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