# Crash compatibility between passenger cars and trucks

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Project within Vehicle and Traffic Safety

# Content



**FFI in short**

FFI is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety. FFI has R&D activities worth approx. €100 million per year, of which half is governmental funding. The background to the investment is that development within road transportation and Swedish automotive industry has big impact for growth. FFI will contribute to the following main goals: Reducing the environmental impact of transport, reducing the number killed and injured in traffic and Strengthening international competitiveness. Currently there are five collaboration programs: **Vehicle Development, Transport Efficiency, Vehicle and Traffic Safety, Energy & Environment and Sustainable Production Technology.**

**For more information:** www.vinnova.se/ffi

# 1. Executive summary

The overall aim of this project has been to develop methods and knowledge to effectively further develop protection for passenger cars in frontal accidents with trucks.

The project has implemented the following sub-deliveries to meet the overall objective of the project.

- An analysis of how future active protection systems may impact the passive safety systems during a collision between a car and a truck has been performed. The analysis shows that it is not justified to reduce the passive safety due to the development of active safety systems in the near future.
- Desirable structural behaviour of the passenger car and truck has been studied. A simulation study has been done for a number of different load cases where A-pillar deformation has been the main focus during the evaluation phase. The study shows that it is important for the truck to give a "good interface" for the car so that a desired deformation of the passenger car can take place and thus reduce the A-pillar deformation in the car.
- Further development of internal visions and evaluation methods for the development of future under-run protection systems has been made.
- Geometric conceptual under-run protection systems with the intent on global properties of the truck have been studied. Here the geometric conditions have been developed depending on the load case you want to reward. It remains to define how this geometry should be anchored to the underlying structure in a weight effective manner.
- The results have been presented internally and externally at AB Volvo, at Volvo Cars and at SAFER.

# 2. Background

Heavy vehicles are involved in more than 5,000 fatalities annually in the EU. In Sweden, the heavy vehicles are involved in 20% of all fatal traffic accidents even though they only represent 10% of the traffic. Of these accidents, the truck front is involved in 65% and a third of these involve also a passenger car front. To reduce the risk of injury, there is a legal requirement that trucks must be equipped with under-run protection. Knowledge of how the under-run protection should behave in a collision is not high enough.

Compatibility between passenger cars and heavy vehicles is complex and has been studied previously in other projects; VC Compat, FFI Safe Coach and a master thesis "Truck-to-Car Frontal Crash Compatibility" at AB Volvo. However, it is certain aspects not investigated fully; such as small overlap, and an evaluation with "state of the art" computational model.

## 3. Objective

The overall objective of this project was to develop methods and knowledge to effectively develop further protection for passenger cars in frontal accidents with trucks.

## 4. Project realization

The following activities have been implemented in the project.

- An analysis of how future active protection systems may impact the passive safety systems of the collision between a car and a truck.
- Study of desirable structural behaviour of the passenger car and the truck.
- Further development of internal visions and evaluation methods for the development of future under-run protection systems.
- Development of geometric conceptual under-run protection systems with the intent on global properties of the truck.
- The results have been presented internally and externally at Volvo Cars and at SAFER.

## 5. Results and deliverables

1. A small literature study has been conducted and a discussion to explore how future active protection systems could affect the vision of future passive safety systems in frontal collisions between cars and trucks. According to accident statistics, accidents with deadly and seriously injured car occupants occur in much higher closing speed than today's under-un protection systems are developed for. To reduce the risk of injury to a larger proportion of casualties, both active and passive safety systems may be used. The study show that the estimated reduction in closing speeds of future active systems is not sufficient to cover the closing speeds coming from the accident statistics used in this study within a foreseeable future.
2. A simulation study has been conducted to investigate desirable structural behaviour of a passenger car and a truck. Volvo Cars state of the art simulation model has been used in the study. The simulation study has been done for a variety of different load cases where A-pillar deformation has been the main focus of the evaluation work. The study shows that it is important for the truck to give a "good interface" for the passenger car so that a desired deformation of the car can take place and thus reduce the A-pillar deformation. Furthermore, the project looked at the forces that the backup structure should coup with in the truck and also geometric conditions of different passenger cars and trucks.

3. Further development of internal visions and evaluation methods have been based on simulations with Volvo Cars state of the art simulation model. Through knowledge from Volvo Cars a better understanding has been gained of how to evaluate the passenger car.

   - A-pillar intrusion

   - Injuries to the occupants calculated by using the vehicle acceleration (OLC: occupant loading criterion) or $\Delta Vy$
4. Development of conceptual under-run protection systems has been made based on global properties and how they should engage the passenger car in a front-to-front collision with a truck. The project has not had time to study new weight efficient conceptual under-run protection systems to the extent that was originally planned as it took more time to investigate desirable structural behaviour and study of conceptual solutions based on global properties. The project has, however, chosen to perform more simulations than was thought at the start of the project as well as a deeper analysis of available crash data from e.g. EuroNCAP. This has been done to get a better understanding of how different cars behave at different overlapping, 100%, 40%, and small overlap. The introduction of these additional analyses has increased the robustness of the study which the project has found to be valuable.
5. Reporting has occurred primarily through internal meetings and presentations for AB Volvo, but also to some extent externally through the presentation of the project at Volvo Cars and at SAFER. Volvo Cars is not an active party in the project but has contributed to with a state of art passenger car model as well as knowledge on how to evaluate passenger cars in frontal collisions.

### 5.1 Delivery to FFI-goals

The outcome from the project has contributed to the FFI program's overall goals through skills and improved understanding of how a truck and a passenger car interact in front-to-front collisions. This becomes an important tool to the objectives to implement industrially relevant development measures and to work for new knowledge to be developed and implemented in industrial applications.

The work within this project has also raised the level of knowledge on how to evaluate passenger cars in frontal collisions. This has created strategic tool that is a prerequisite for the Swedish-made heavy vehicles to be able to retain its position as one of the safest trucks on the market. This is a very important contribution to the goal of contributing to a continued competitive automotive industry in Sweden.

# 6. Dissemination and publications

### 6.1 Knowledge and results dissemination

The results have been presented internally at AB Volvo, externally at Volvo Cars and at SAFER. The results will also be used for further communication of passive safety in the AB Volvo organization.

### 6.2 Publications

No scientific publications have been made in this project.

# 7. Conclusions and future research

- The outcome from the project has generated skills and an understanding of how passenger cars and trucks interact in front-to-front collisions. These results becomes an important tool to reach the goals to *perform relevant development activities* and to *strive for that new knowledge is developed and implemented and that existing knowledge is implemented in industrial applications.*
- A natural continuation of this project would be to examine how the geometric guidelines and desirable structural behaviour of the passenger car and the truck could be realized in a future technological solution with a focus on weight efficiency. The idea was that weight efficiency would be included in this project but the project did not progress as far as the vision was at the start of the project. The project decided that it was important to finalize the work on desired structural behaviour of the car and the truck as well as the development of geometric conceptual under-run protection systems with the intent on global properties of the truck before proceeding to look at technical solutions at a more detailed level.

# 8. Participating parties and contact person


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