Future Accident Scenarios involving Small Electric Vehicles

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I. INTRODUCTION

In the next 20 years the number of lightweight Small Electric Vehicles (SEVs) are expected to increase substantially and become one of the future solutions for urban mobility due to their small footprint. These vehicles will likely have short front and rear overhangs and be dedicated for less than five occupants. Collisions of SEVs with vulnerable road users (VRU) and other, heavier vehicles will differ from those of current traditional cars. VRU protection, compatibility with heavier opponents and new active safety systems have to be considered to ensure adequate SEV safety in future regulations.

An increasing number of active safety systems have become available; for instance, Anti-Locking Brakes (ABS), Electronic Stability Control (ESC), Lane Keep Assistance (LKA) and Autonomous Emergency Brake (AEB).

Four projects – SafeEV, ENLIGHT, ALIVE and MATISSE – dealing with the safety of future vehicles were funded by the European Commission starting in 2012. In order to coordinate and harmonise these four projects a cluster called SEAM has been established.

The present work was carried out within SafeEV (http://www.project-safeev.eu/) that aims to define advanced test scenarios and evaluation criteria for VRU, car occupant safety and crash compatibility of SEVs based on future accident scenarios (target year 2025). With new SEVs designs, the accident outcomes will be different and new protection approaches will be needed. New virtual test methods will come into use. Best practice guidelines for VRU and occupant safety evaluation of SEVs will ensure a sustainable impact for industry and regulatory agencies beyond the project duration.

MATISSE addresses the crash behaviour of Fibre Reinforced Polymer (FRP) composite structures for small energy-efficient Alternatively Powered Vehicles (APV). Future crash scenarios (target year 2025) will be assessed and new evaluation criteria regarding safety will be developed. In the initial stage of Matisse it was concluded that Driver Assistance Systems (DAS) would be able to prevent a large portion of the accidents with higher efficiency in the longitudinal direction than in side-collisions. Side collisions will thus need higher priority in crash safety assessment. In the remaining accidents the collision speed is expected to decrease by 10km/h on average. There will still be a high share of conventional cars in urban areas so mass incompatibility will become an increased challenge in crash safety. Intersection accidents will remain a major cause of severe injuries and in cases where DAS systems mitigate the collision severity. The principal direction of collision force will remain very similar to current accidents.

The aim of the present work was to carry out additional work to provide a well-based prediction of the accident scenarios for SEVs in urban areas in Europe in 2025. In order to add increased robustness to the MATISSE outcomes the two following methods were applied: 1) Review of current car accidents and their relevance for future scenarios in view of forecasted developments of safety systems and 2) a comparison of smaller and larger M1 vehicle models in a subset of urban cases of the GIDAS (German In-Depth Accident Study) database to indicate representative collision conditions for small cars in urban areas.

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II. METHODS

Trends in active safety systems development and the influence on accident scenarios

Strandroth [2] investigated the trends in the implementation and efficiency of active safety systems and based on that work we estimated the implementation of available active safety systems according to the following list:

Safety improvements	Prediction of implementation	
- LKA	100% among new passenger cars from	2015
- ESC	– „ –	2008
- AEB for rear-end crashes	– „ –	2015
- Seat Belt Reminder front seats	– „ –	2009
- Seat Belt Reminder back seats	– „ –	2015

These results were combined with Swedish in-depth accident investigations to determine how many

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fatalities could have been avoided if the best of the currently available safety technologies had been implemented. Of the 156 fatalities occurring among car occupants in Sweden in 2010 it was estimated that 45 cases will remain in 2025.

Comparison of Accident Occurrence of M1 Vehicles / Small Urban Vehicles

Input to this part of the study was prepared within the German collaborative research project, VisioM. The aim of the study was to compare current accident occurrence of general M1 vehicles and the accident occurrence expected for small urban vehicles, here represented by a subset of smaller M1 (VisioM-type) vehicles (average mass of 1150 kg). Accidents with VisioM-type vehicles were filtered out of the GIDAS accident database and compared with the regular M1 vehicle data. Only vehicles occupied by a maximum of two persons were considered. Vehicles with a payload capacity of more than 100 kg were excluded. The initial speed before the collision was maximum 100 km/h. Accidents that occurred more than 100 km from the origin or from the destination were excluded.

I. RESULTS

The following assumptions were established:

- ~100% of the APVs manufactured in 2025 will be equipped with LKA, ESC and AEB.
- >50% of the oncoming vehicles will (will not) be equipped with LKA or AEB.
- ~100% of the oncoming vehicles will be equipped with ESC.
- For front-to-front collisions, a closing speed reduction of at least 18 km/h is expected with AEB, and 30 km/h if both cars involved have the systems. For side impacts, DAS for crossings and intersections are under development and partly in production (Mercedes crossing assistant for brake assist from 2012).

The following changes in the basic collision modes were identified,

Front-to-front: ~90% reduction is expected of APVs drifting over to the opposite lane. ~45% reduction is expected for oncoming cars drifting over. A total reduction of about 67% is thus expected in 2025. A closing speed reduction of at least 18 km/h is expected in the remaining cases.

Front-to-side: - Loss of control of the opponent vehicle will be almost eliminated. Crashes in urban intersections will remain. DAS for intersections with reasonable visibility will be introduced (Mercedes crossing assistant from 2012).

Front-to-rear: AEB is expected to become 100% effective in typical cases.

Side-to-front: The major part of loss-of-control crashes will be eliminated by ESC. Crashes in intersections will remain. DAS for intersections are currently under introduction.

Rear-to-front: A closing speed reduction is expected as a result of AEB for 50% of the impacting cars.

- VisioM vehicles had a higher share (79%) of inner urban accidents compared to larger M1 vehicles (66%).
- VisioM vehicles were more represented in intersection accidents (35% compared to 25%).
- VisioM vehicles had on average a somewhat lower collision speed but the collision severity was unchanged due to the lower vehicle mass.
- The distribution of Principal Direction of Force (PDOF) had a reduction of about 15% in the longitudinal direction and a similar increase in oblique frontal impacts.

II. CONCLUSIONS

Different and independent methodologies have been applied. They all include significant uncertainties. It is thus reassuring to be able to conclude that they all forecast similar trends. Certain collision types will be reduced, but side collisions in intersections will remain. The general public have become used to the current vehicle safety level and will have limited acceptance for increased injury risks with downsizing of the cars.

III. REFERENCES

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