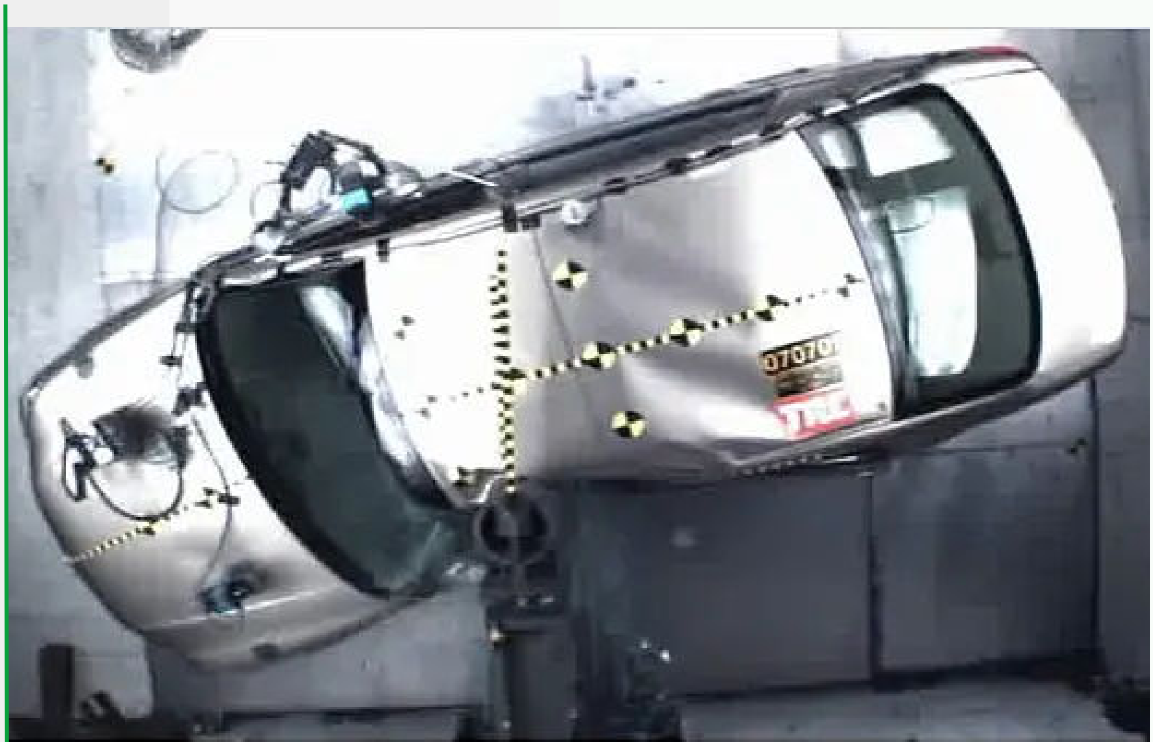
EV BATTERY CRASH PROTECTOR

REINFORCED BY
CFIP TECHNOLOGY

CASE STUDY



New Side-Impact Test to Be Added. The New York Times. Kevin Cameron, November, 2009

TECHNICAL ARTICLE
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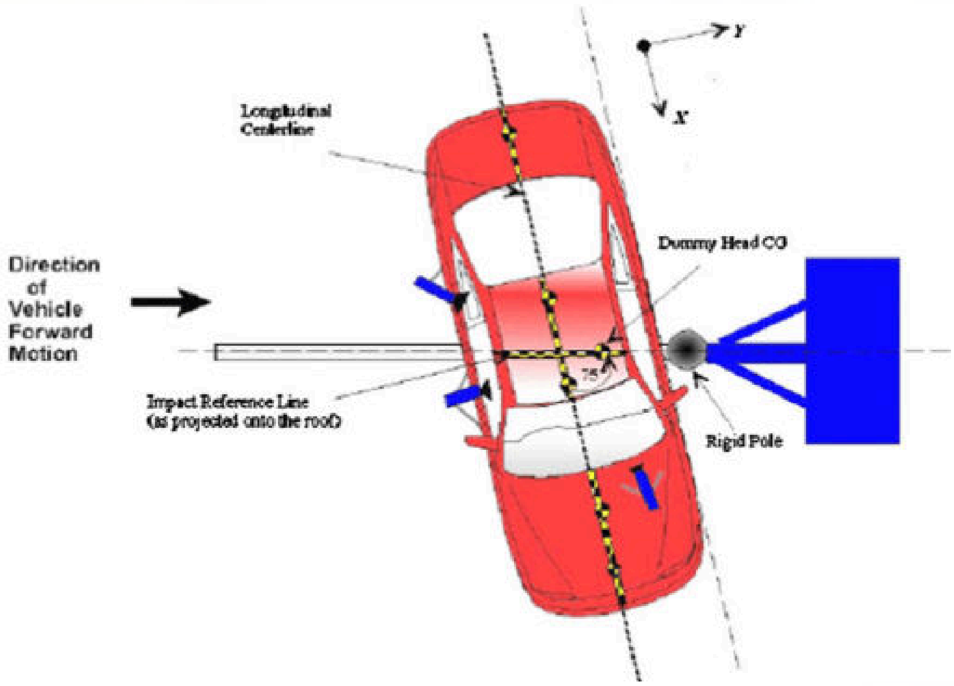
1. Introduction

The rapid development of electric vehicles (EVs) has increased the demand for advanced structural solutions capable of **ensuring battery protection under side-impact crash scenarios.** Due to their location within the vehicle architecture, battery systems are particularly **exposed to lateral impacts**, making structural integrity in this area a critical design requirement.

The rocker panel plays a key role in this context, acting as **the primary energy absorption component along the vehicle side.** Consequently, it must provide high crash performance while complying with strict constraints in terms of weight, cost, and manufacturability.

Conventional rocker solutions are typically manufactured by extrusion or stamping in metal, offering a balanced combination of mechanical performance, lightweight design, and industrial scalability. However, increasingly stringent safety and performance requirements demand further **improvements in energy absorption and weight reduction.**

This work presents a reinforcement strategy based on Continuous Fiber Injection Process (CFIP), enabling significant performance gains **by integrating continuous carbon fiber reinforcement into conventional extruded aluminium structures.**



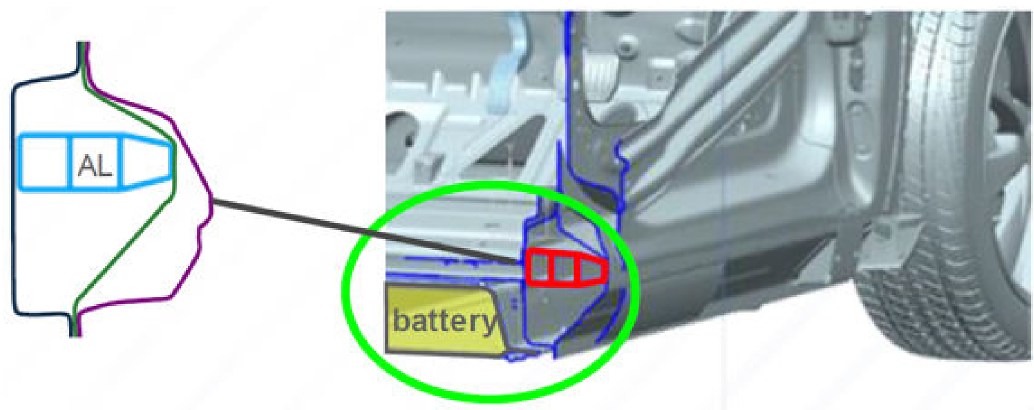
FMVSS Standard No. 214. Amending side impact dynamic test adding oblique pole test, US DoT/NHTSA Final Regulatory Impact Analysis; August 2007

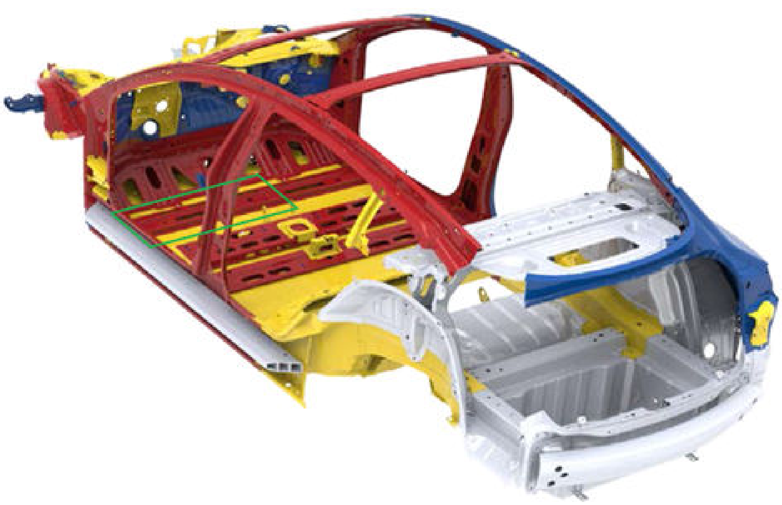
2. Benchmark rocker

The reference configuration considered in this study corresponds to a **rocker structure for a mid-sized SUV,** based on an **extruded aluminium profile** with an overall mass of approximately 19 kg per vehicle[1].

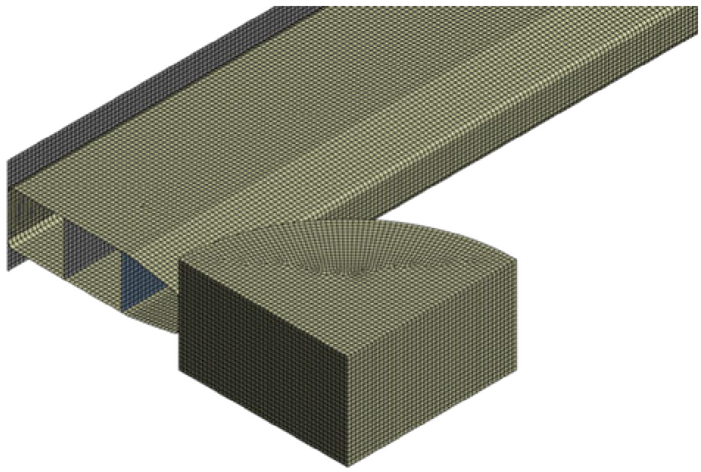
A finite element model based on the explicit method was built using Ansys, to evaluate the **structural performance under side-impact conditions.** The rocker geometry was meshed using shell elements and material plasticity was modelled through a bi-linear law. Only the half of the rocker was modelled using symmetry conditions to maximize the computational efficiency of the model. This simulation model provided baseline data **in terms of displacement and absorbed energy**, serving as a reference for comparison with the reinforced configuration.

[1] Multi-Cell UHSS Side Sills for Battery Electric Vehicles. Hannes Fuchs. Great Designs In Steel (GDIS).





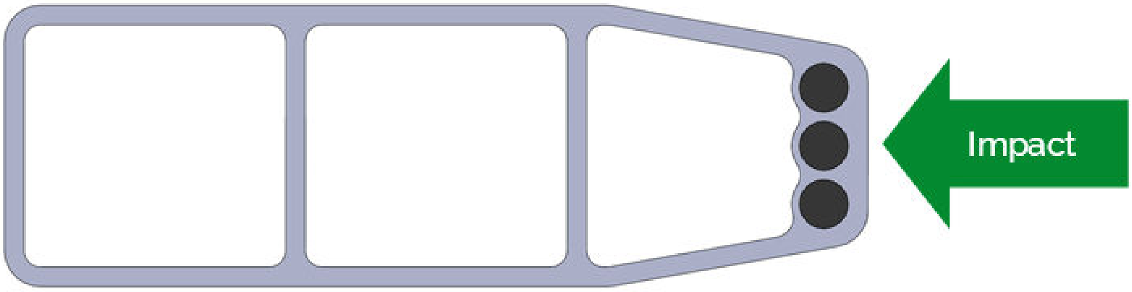
Rocker structure used as benchmark for this study



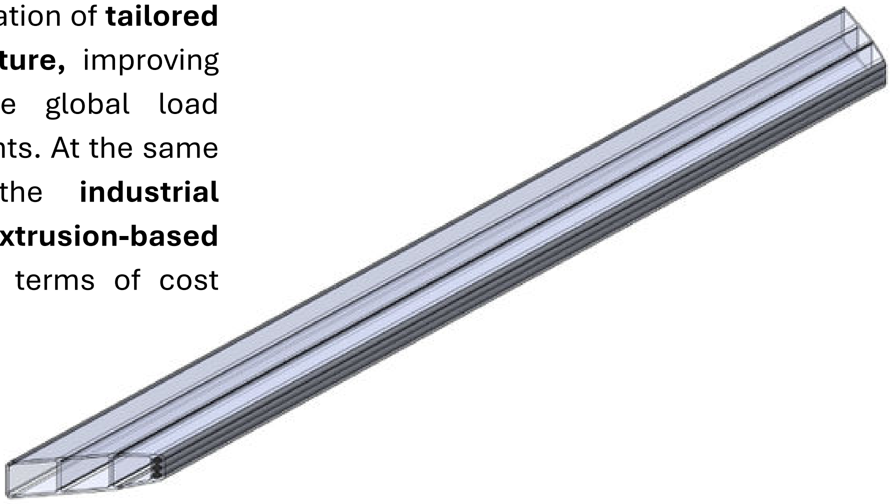
Finite element model of the benchmark rocker: mesh

3. CFIP reinforced rocker

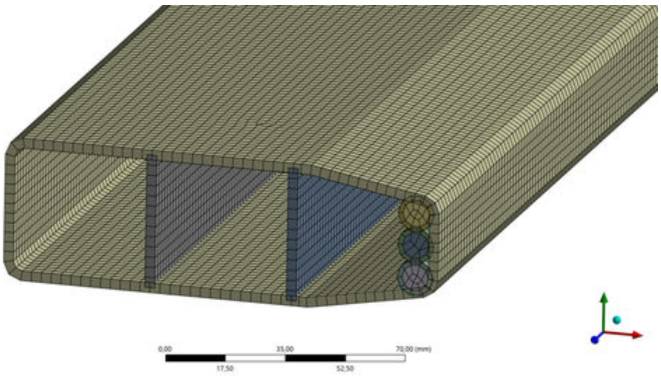
The proposed solution builds upon the **conventional extruded aluminium rocker by integrating CFIP** reinforcement as an internal structural enhancement. The concept consists of injecting continuous carbon fibers within predefined internal channels in the aluminium profile. These fibers are injected together with a liquid resin, which after curing, generates the final reinforced structure.



This approach enables the creation of **tailored load paths within the structure,** improving stiffness and enhancing the global load distribution during impact events. At the same time, it fully preserves the **industrial advantages of extrusion-based manufacturing,** especially in terms of cost efficiency and scalability.

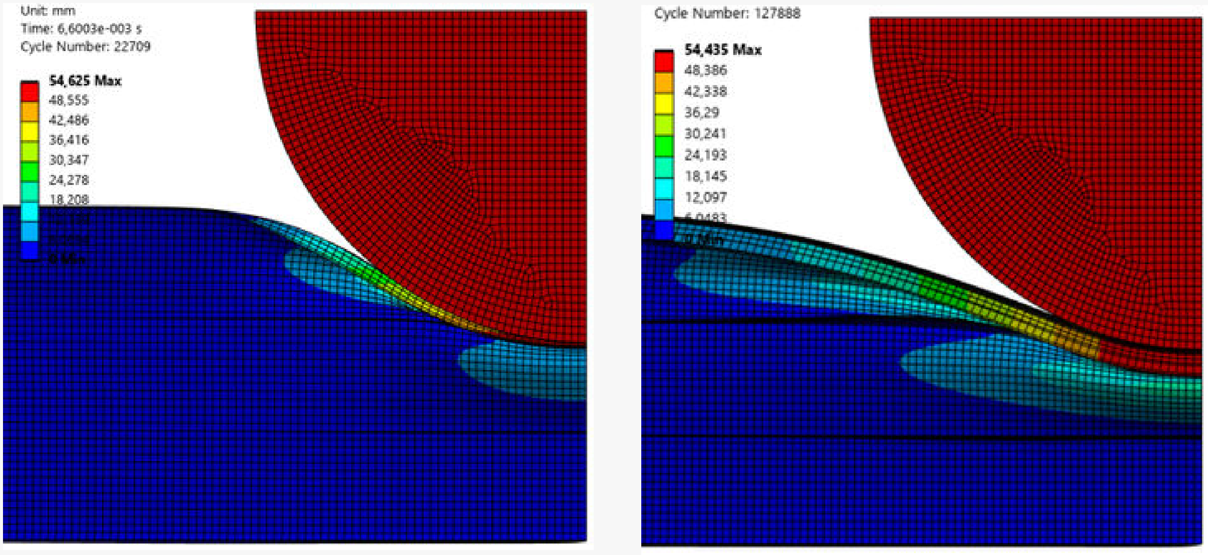


3 CFIP units of 8 mm each were designed at the impact face of the rocker structure. A finite element model was also built for this design using the same configuration and modelling strategy as for the benchmark.
The reinforcement was **modelled using an orthotropic material model.**



4. Results and discussion

The images below show the **deformation plots for both rockers.** As it is observed, the CFIP reinforcement contributes to distribute the deformation in a significantly higher area.

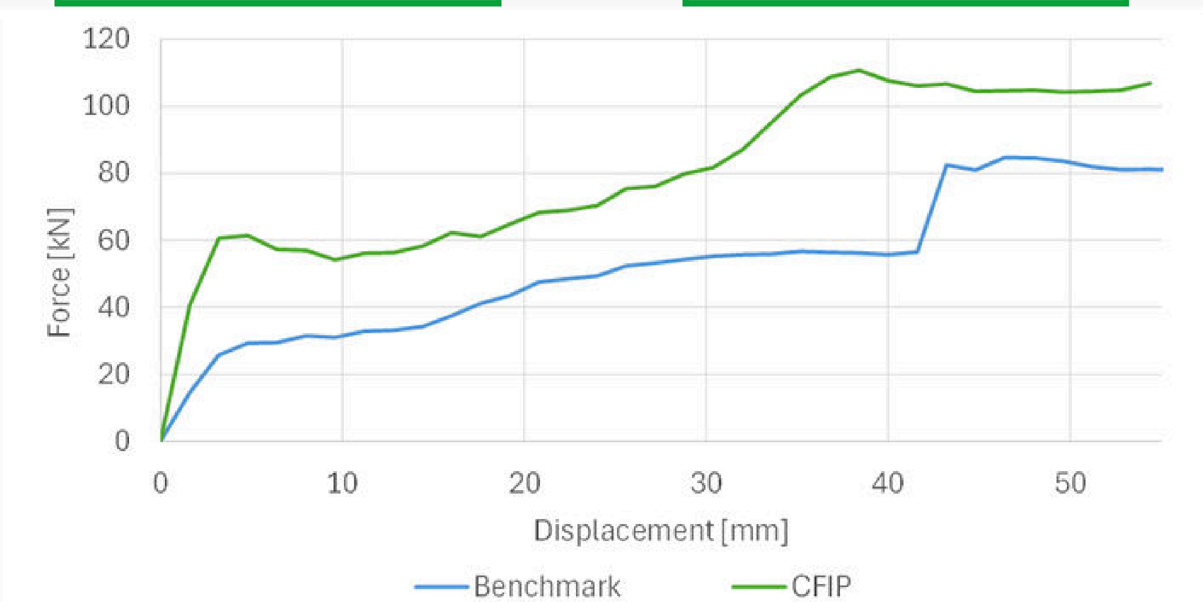


Deformation plots for the benchmark (left) and CFIP (right) rockers.

The simulation results were also analysed in terms of **force-displacement evolution and absorbed energy in absolute and specific terms** (i.e. considering the weight of the structure). As shown in the graphs below, the introduction of CFIP reinforcement resulted in a **significant increase in crash and lightweight performance,** more specifically:

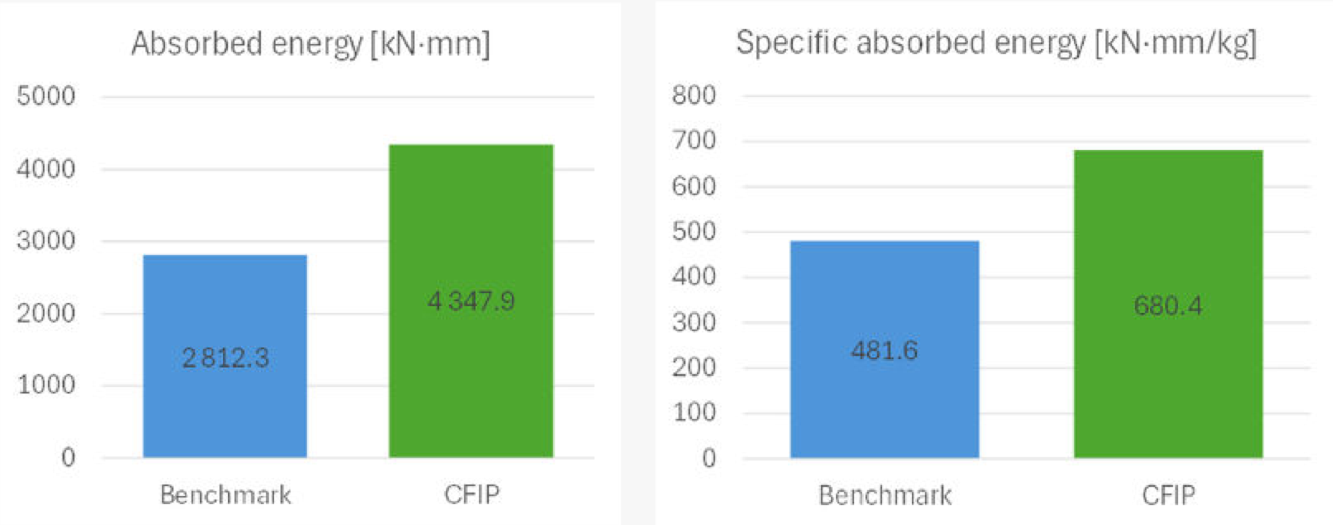
+55%
in absorbed energy

+41%
in specific absorbed energy



Force-displacement evolution for the analysed rockers

4. Results and discussion



Energy absorption results for the analysed rockers

These improvements are primarily driven by the ability of continuous fibers to redistribute loads more efficiently and to delay the onset of localized failure mechanisms. The resulting structure exhibits **a more progressive and stable deformation behaviour under impact conditions.**

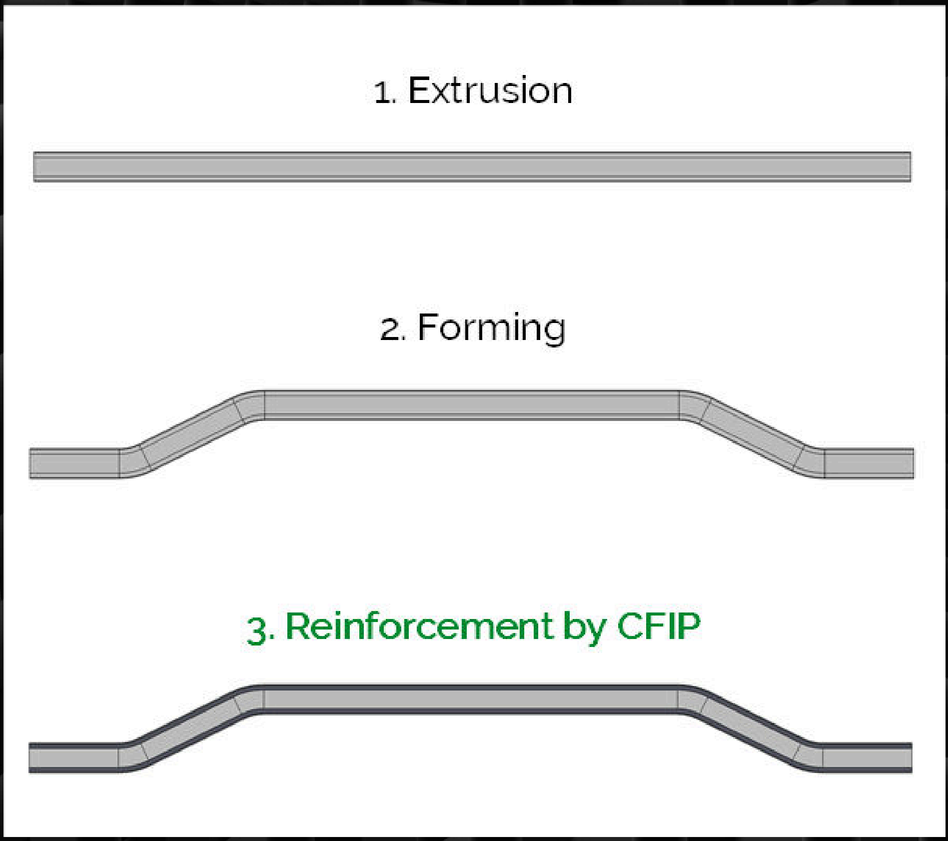
It is important to note that these results still have significant potential for further optimisation. In particular, the number of reinforcements and **how they are distributed within the structure, as well as the shape and thickness** of the aluminium profile offer additional margin to further enhance performance.

5. Industrial advantages

Beyond the demonstrated performance improvements, the proposed solution also offers strong industrial advantages, especially **in terms of cost efficiency and scalability**, thanks to the combination of CFIP with efficient manufacturing methods such as extrusion.

Combined with its compatibility across manufacturing technologies, this capability allows the **solution to be extrapolated to a wide range of vehicle components**, where enhanced mechanical performance, including strength, stiffness, and impact resistance, can be achieved together with reduced weight.

This approach also enables the efficient manufacturing of curved reinforced profiles, expanding the **design space beyond straight extrusions and enabling more complex geometries.**



As a result, CFIP-reinforced solutions present a **strong value proposition for mainstream automotive applications**, delivering improved performance, lightweighting, and industrial efficiency within cost and production constraints.

6. Conclusions

This study demonstrates that CFIP reinforcement applied to extruded aluminium rocker structures provides a **highly effective and industrially viable solution for improving crash performance in EV side-impact scenarios.** The results show substantial **gains in energy absorption and lightweighting** while maintaining compatibility with existing manufacturing processes.

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At the same time, the inherent versatility of CFIP enables its integration across different **materials and production technologies,** reinforcing its role as a key enabler for scalable and high-performance structural solutions. The combination of conventional manufacturing and advanced continuous fiber reinforcement opens a clear pathway for the development of **next-generation lightweight components,** with broad applicability across multiple areas of the vehicle.

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