Structural Testing of Composite Crash Structures

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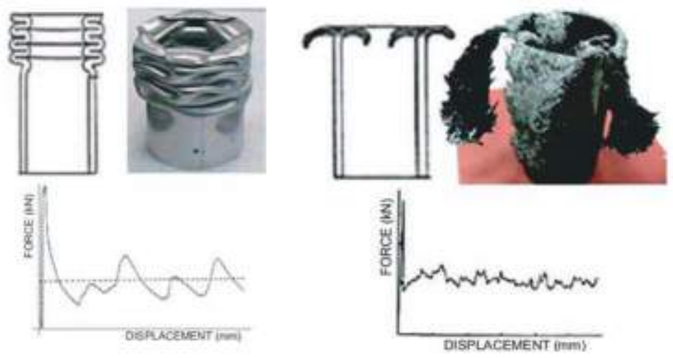
Introduction

The underlying frame of the Alfa Romeo 4C. [1]

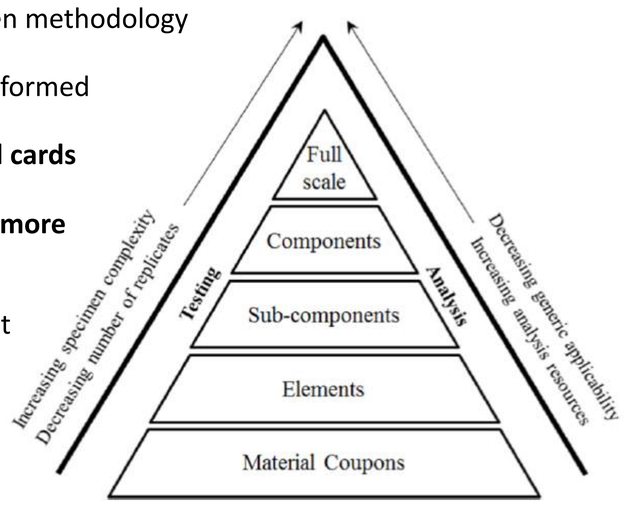


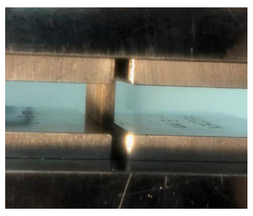
Differences between crushing of aluminum and CFRP samples. [2]

- Develop an **innovative testing campaign**
- **Assess composites** according to **automotive standard**
- **Application of composites** in the other parts of the car
- **Test demonstrators** using crash sled

Methodology

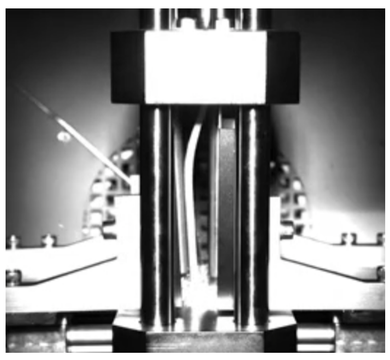
- **Building Block Approach**[3] is the chosen methodology
- First level **coupon tests** have been performed
- Obtained results are used for **material cards**
- The **higher level** in this approach, the **more complicated** and **expensive** the tests
- **Flat specimens** are chosen for the next level because of their **simplicity** over self supporting ones





Standard		No.	Tab
ASTM D3039	Traction	10	No
ASTM D0790	3 Point Flexural	10	No
D695 Modified	Compression	10	Yes
D695 Modified	Compression	10	No
ASTM D3518	Shear	10	No
ASTM D7136	Impact	10	No
ASTM D6641	Compression	10	No

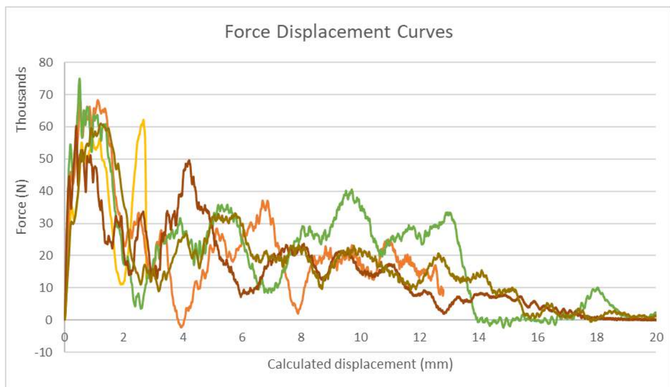
- **Anti-buckling** fixture is designed and manufactured
- It can be seen under Instron **drop tower** machine
- Specimen dimensions are as in **ASTM D7136** standard
- **Sawtooth** triggers to initiate steady crush for better energy absorption
- Up to 40 mm of the specimens can be crushed under impact which is enough for **Specific Energy Absorption** calculation
- First design showed huge **bending of specimen** which with the help of better supports was **solved**
- These images shows **specimens under impact**



Improvement of the supporting structures

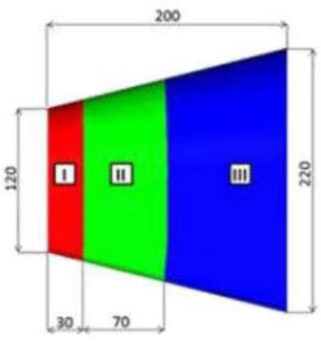
Results

- Sawtooth triggers have shown to be **perfect** in initiating the **steady crush**
- The energy absorption mechanisms are **delamination** and **fragmentation**
- Area under **force-displacement** diagrams is the **absorbed energy** and is used for **SPA** calculation
- Important points on the diagram are **peak force**, when the specimen starts to crush, and **average crush force**, during the steady state crushing



Future Works

- **Quasi-static tests** to understand the **performance of the trigger**
- **Dynamic tests** at the speed of **7 m/s** with a **300 kg** mass (**7350** J energy)
- More **dynamic tests** with **higher energy** and impact **speed**
- Results will be used as **proof of concept** and **validation** of the **proposed methodology**



References

1-https://driving.ca/alfa=romeo/reviews/road-test/first-drive-2015-alfa-romeo-4c-spider

2- S. Boria, G. Belingardi, Numerical Investigation of Energy Absorbers in Composite Materials for Automotive Applications, International Journal of Crashworthiness, 17 (4), 345-356, 2012.

3- Composite Materials Handbook, Volume 3. Polymer Matrix Composites Materials Usage, Design, And Analysis, Chapter 4

Acknowledgments

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