Performance and Sustainability in Energy-Absorbing Structures

JEC Forum Italy 2025

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R&D Project Manager

HP Composites
Overview

The new composites generation

Design and production of structural and cosmetic components made by advanced composite materials.

Part of the Everspeed Group.

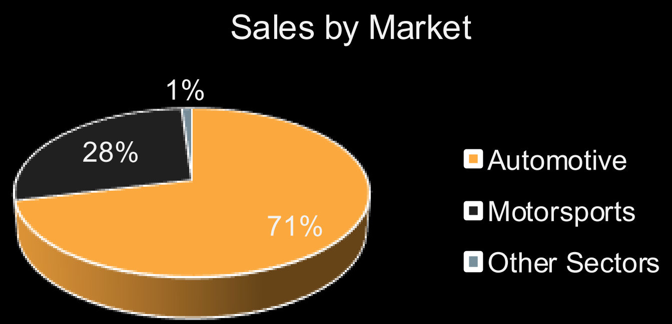
Location

Ascoli Piceno (Italy)

Markets

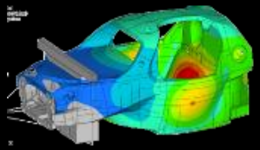
Core business in motorsport and automotive sector.

HP Composites
Key figures and competences



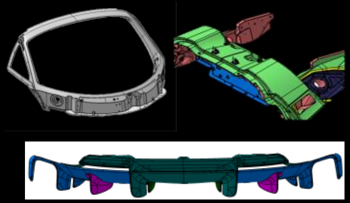
- 5 Production plants
- Tot. 22.000+ sqm
- 600 + resources (Q4 2024)

1.Engineering
Part and process design, material definition, FEM, support up to final homologation.



2.Research & Development
Development of innovative tecnologies. Testing in-house, material card definition, etc.

3.Tooling
Design, production of tooling equipment



4.Part Manufacturing
Tier 1 for OEM, in-house production of high quality components (IATF certification), carbon look/painting/primer, structural and cosmetic parts

5.Industrialization & Alternative technology to autoclave
Long term projects with high volumes and high production rate 20-30 pcs/day

HP Composites
Motorsport

Track Record & Experience

Over 25 years of experience in designing and manufacturing complex structural composite structures

~30% of sales (2023-24)

+1500 Tubs Single Seater Formula
+400 Le Mans Prototype
+120 Supercars
+10 Private Formula

Total: +2000 Tubs


Motorsport
The New Challenges

- **Increased Safety Requirements**
Regulatory bodies are raising the bar: energy absorption capacity, peak deceleration limits, and structural integrity under extreme conditions are under stricter control.

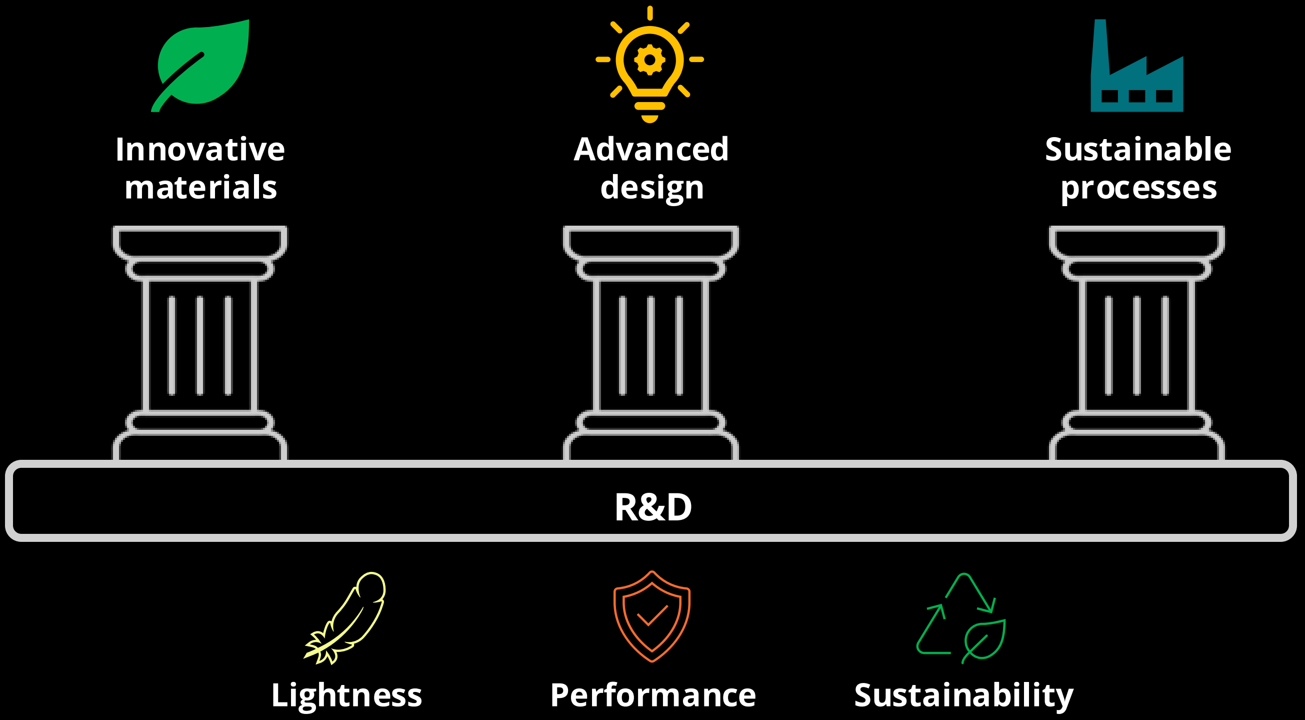
- **Environmental Pressure**
Motorsport is no longer exempt from environmental accountability. There is a strong push to reduce the carbon footprint of materials and manufacturing processes.

- **Design Trade-offs**
Achieving both top-tier performance and sustainability is a complex engineering challenge. Traditionally, enhancing one compromises the other.

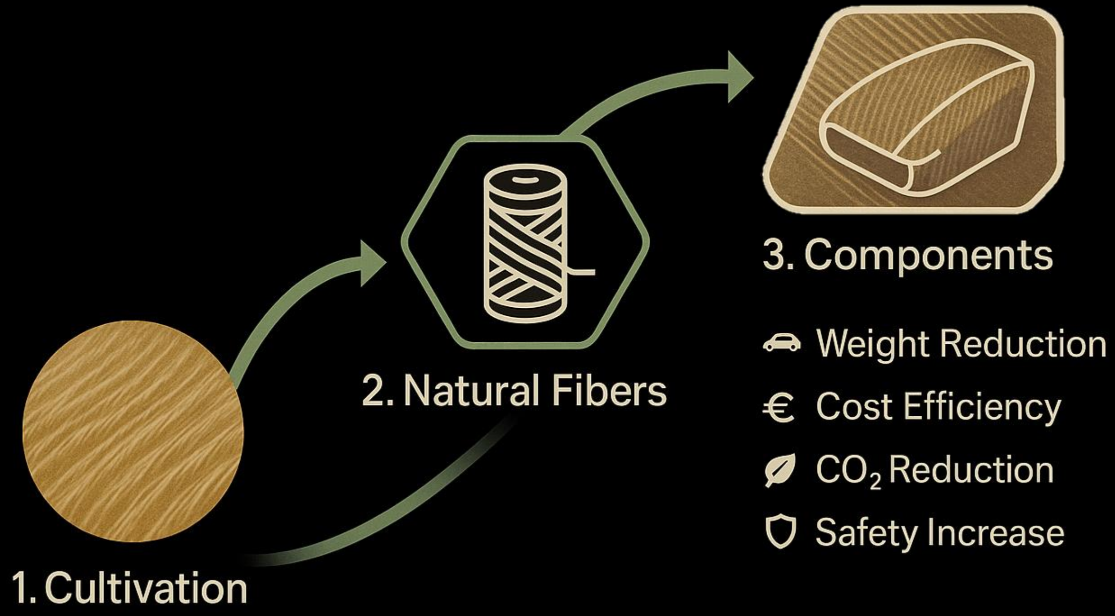
- **A Paradigm Shift is Needed**
Innovation must deliver lightweight, high-performance solutions without sacrificing environmental responsibility.

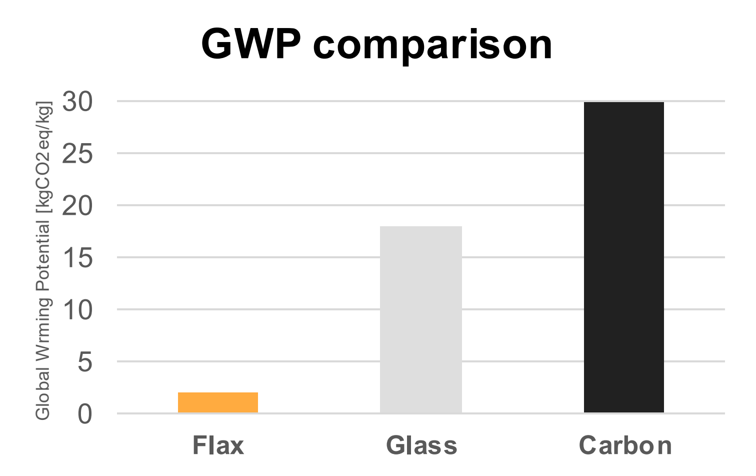
Our strategy

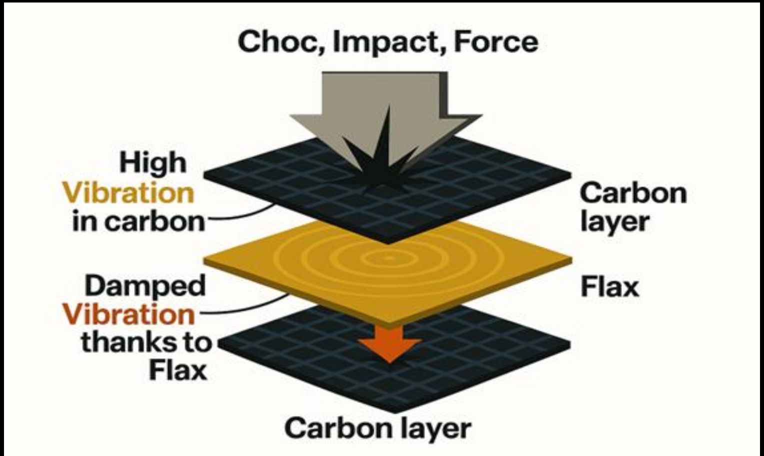
R&D as main pillar



Biocomposites
From Nature to Performance







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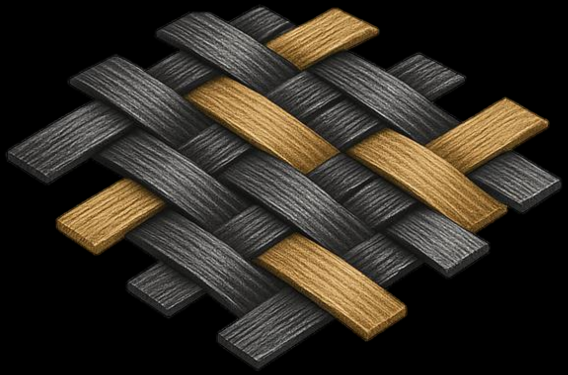
Hybrid Composite

Carbon-flax

Hybrid composites are effective solutions for creating high-performance components by combining the advantages of the two materials allowing:

- similar performance compared to carbon fiber
- weight reduction
- energy absorption
- CO_2 saving



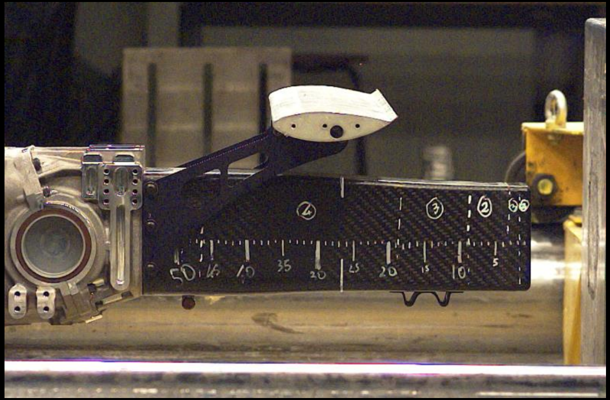
Energy absorbing structures
Application of green materials

- Experimental and numerical investigation of biocomposites solutions for structural applications

- Re-design structural parts using natural fibers (in parts or fully) in order to pass technical regulations and guarantee high mechanical strength, low weight and low environmental impacts

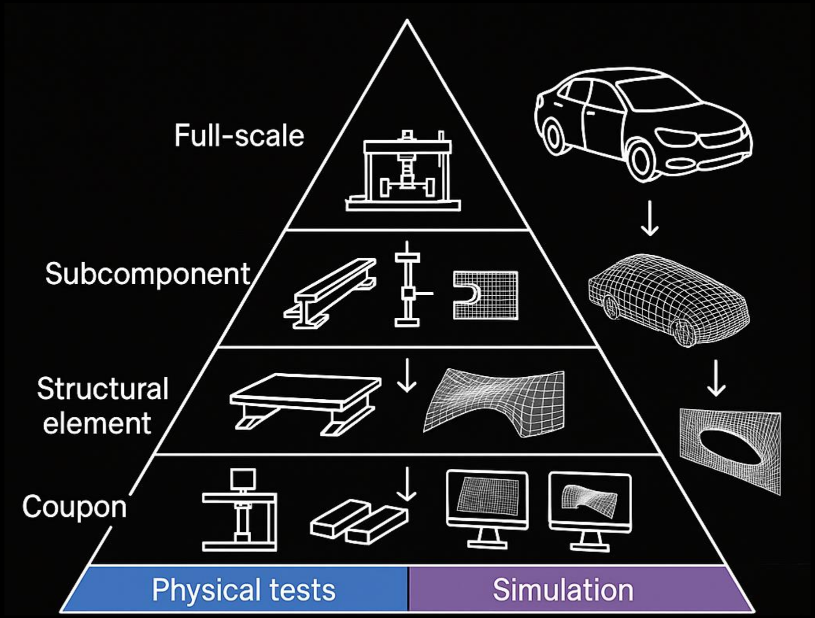
Achievements:
- Mechanical characterization of Carbon/epoxy, Flax/epoxy and Carbon-Flax/epoxy laminates

- Design of numerical models (FEM) for structural applications



Building block
Approach

- Building Block Approach have been applying for analyzing **different phenomena** separately
- Methodology involves **finite element analyses** and **experimental activities**
- **Different stacking sequences** have been investigated
- **Materials**:
  - Carbon
  - Flax
  - Hybrid



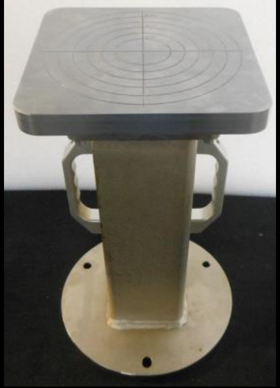
Crashworthiness

Testing

- Up to date there is **no standard test method** to characterize the **crashworthiness** of composites.

- Flax and Carbon/Epoxy composites have been mechanically characterized through tensile, compression, ILSS and DCB, 4ENF tests.

- **Dynamic crashworthiness testing** has been performed and numerical model developed:
    - Tube
    - Flat in-plane
    - Feraboli



Tube Axial Crushing
Set-up

Standard: none

Testing machine: Instron 9450 drop tower with flat disk impactor

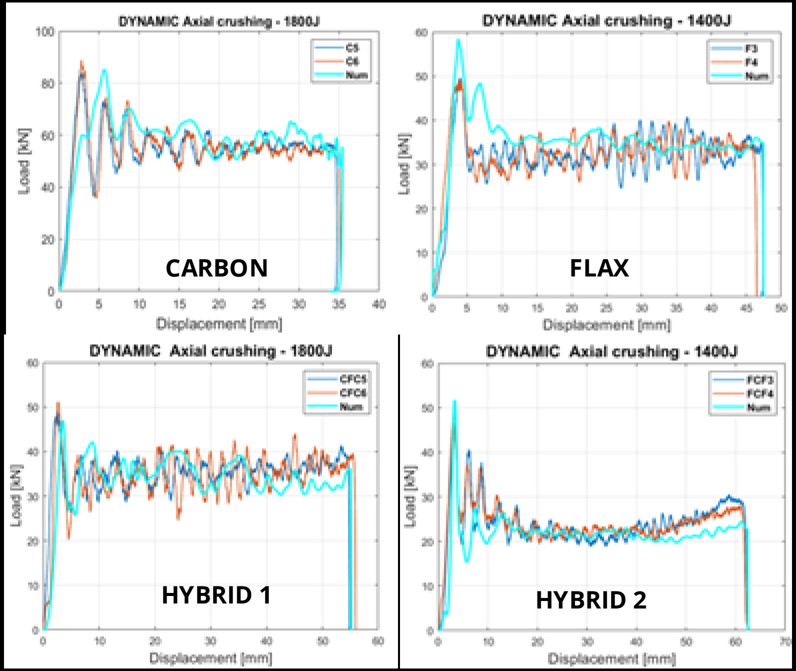
Specimen geometry and stacking: tubular - 0°, 90°, quasi-ISO

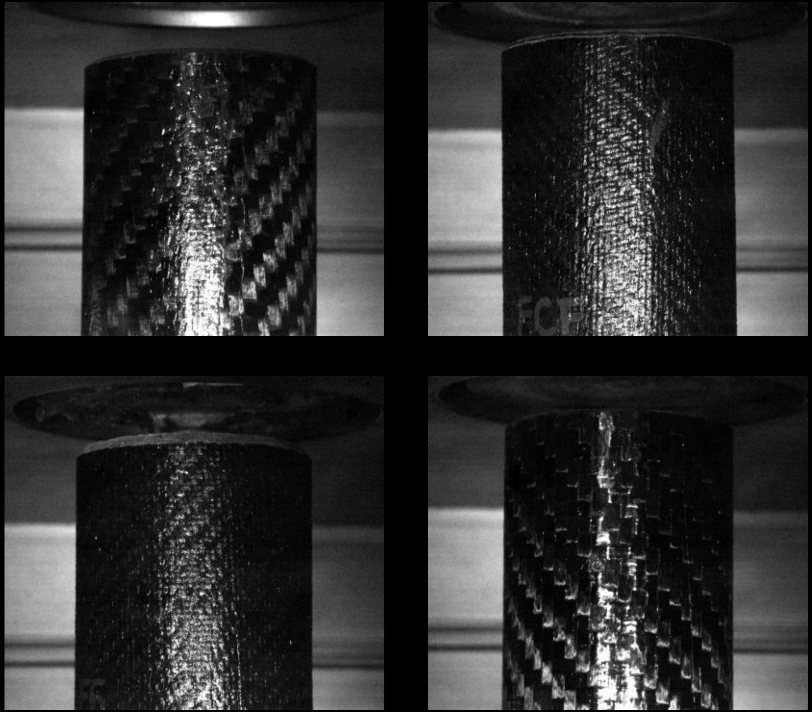
Specimens dimensions: d70 [mm] x 100 [mm] x 2 [mm]

Trigger mechanism: 45° external chamfering

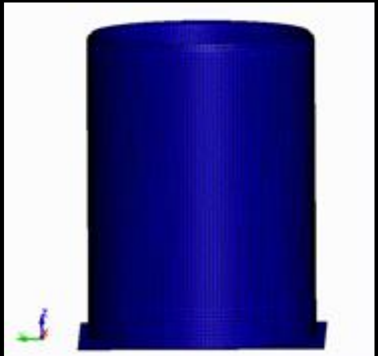
Energy tested: 1000 J, 1400 J and 1800J

Tube Axial Crushing
Results

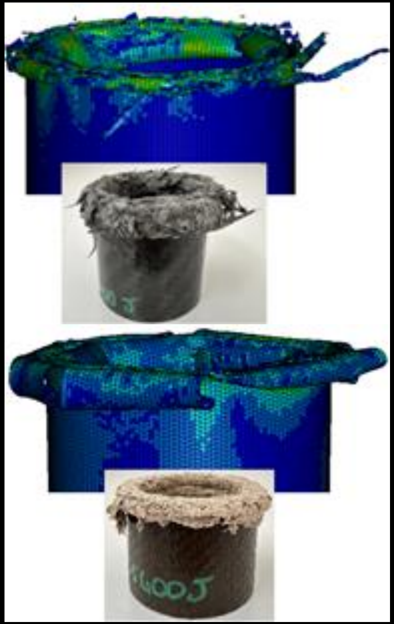


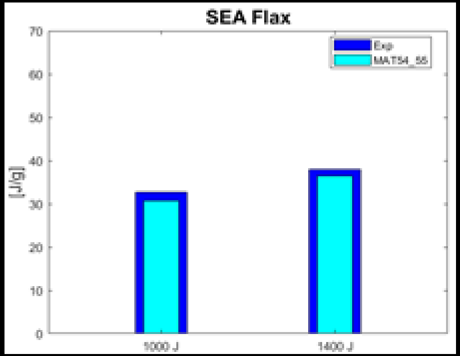


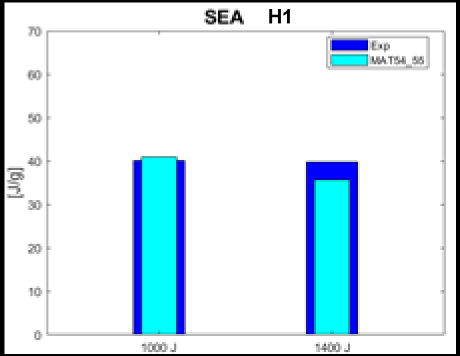
Tube Axial Crushing
SEA

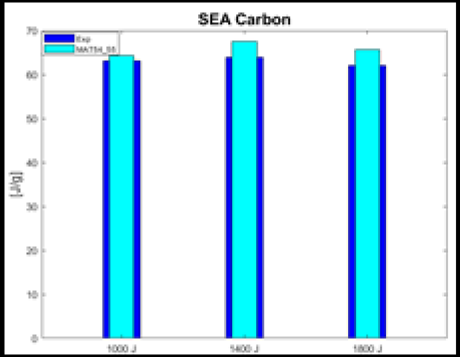


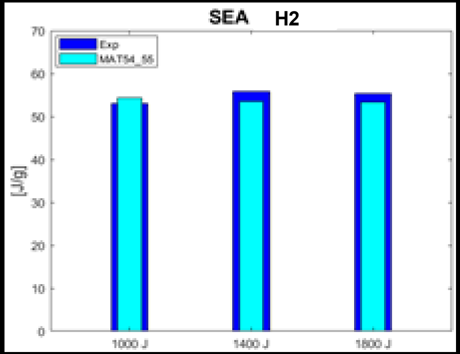
1400 J











In-plane Crushing
Set-up

Standard: none

Testing machine: Instron 9450 drop tower with flat disk impactor

Specimen geometry and stacking : Flat - 0°, 90°, quasi-ISO

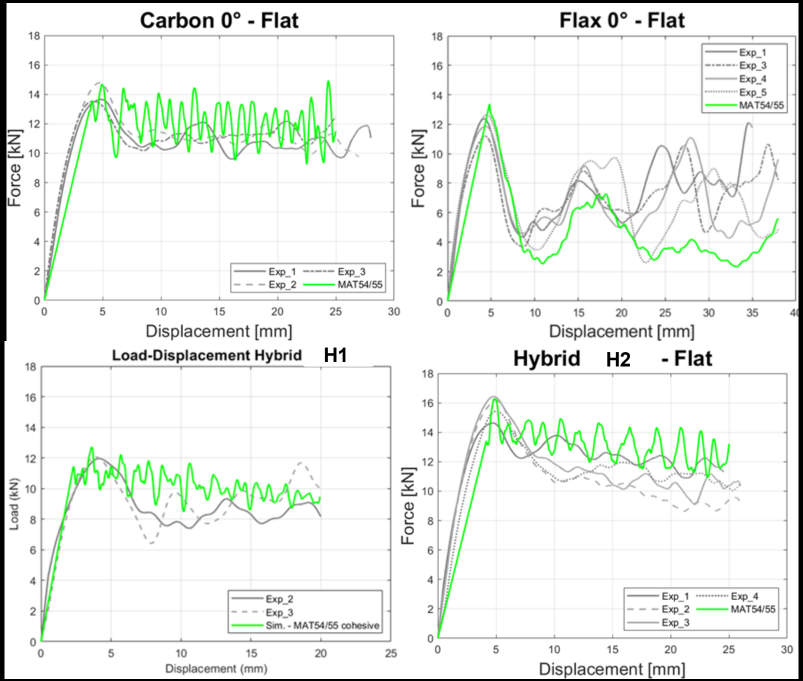
Specimens dimensions: 150 [mm] x 50 [mm]

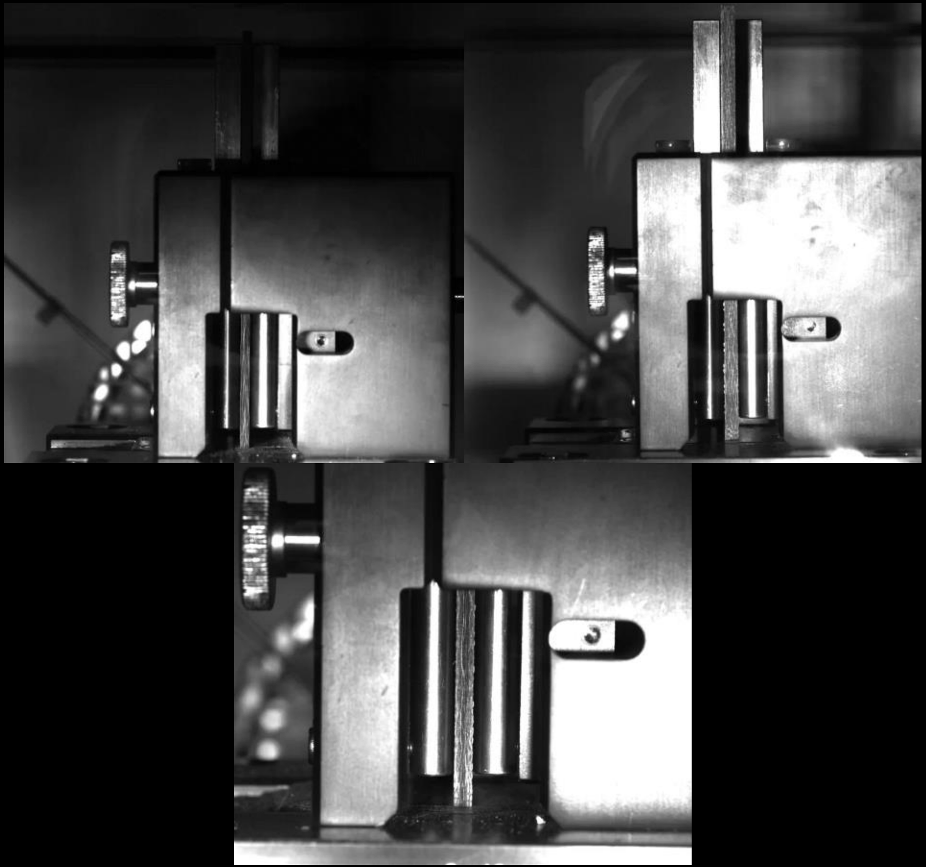
Trigger mechanism: Saw-tooth+crack

Energy tested: 300 J

In-plane Crushing

Results





In-plane Crushing
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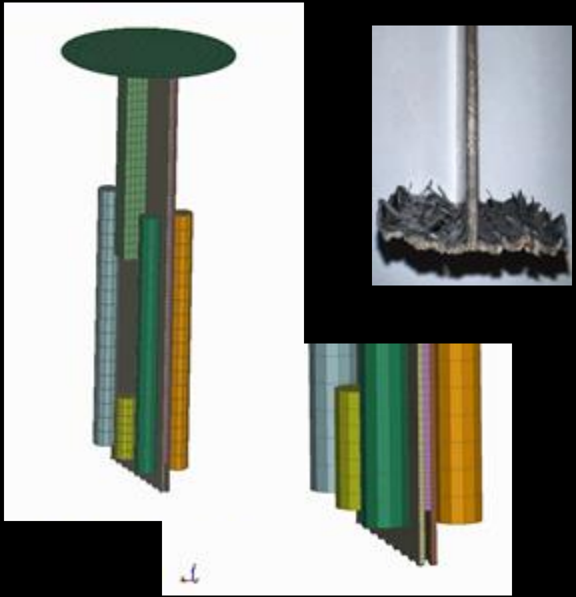
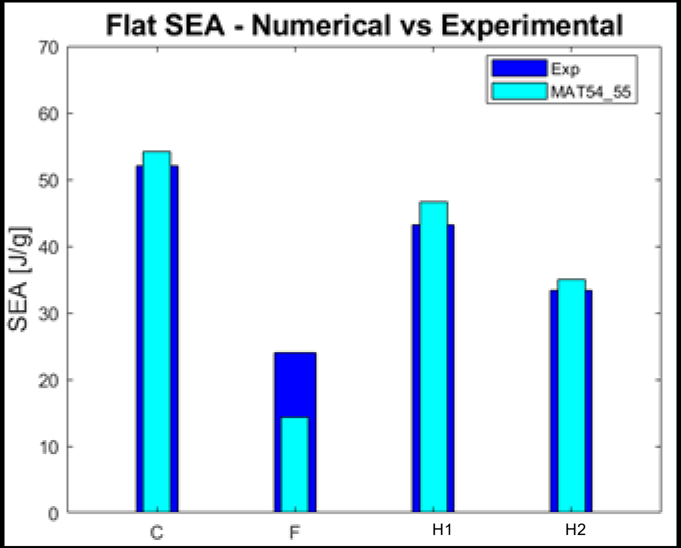




Feraboli Crushing
Set-up

Standard: none

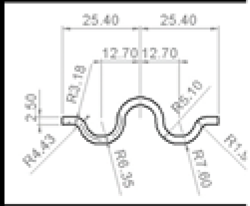
Testing machine: Instron 9450 drop tower with flat disk impactor

Specimen geometry and stacking: Corrugated - 0°, 90°, quasi-ISO

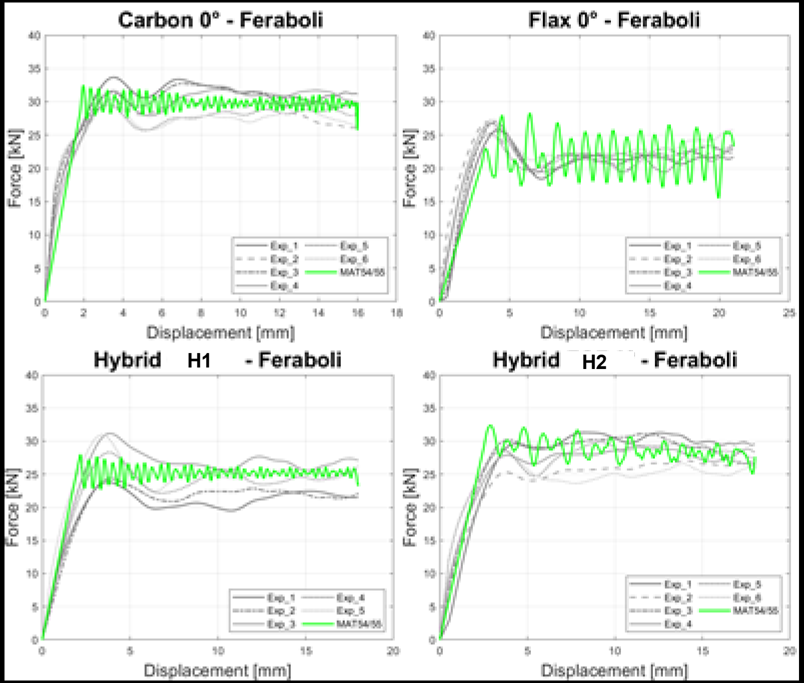
Specimens dimensions: 150 [mm] x 50 [mm]

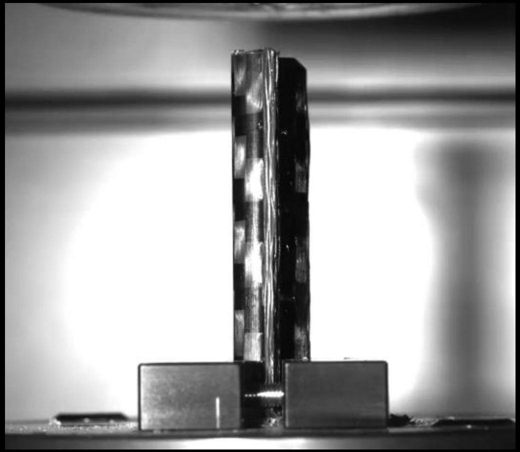
Trigger mechanism: 45° external chamfering

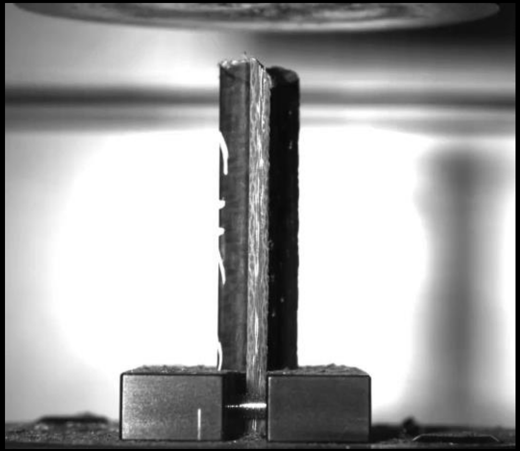
Energy tested: 400 J and 500 J



Feraboli Crushing
Results







Feraboli Crushing
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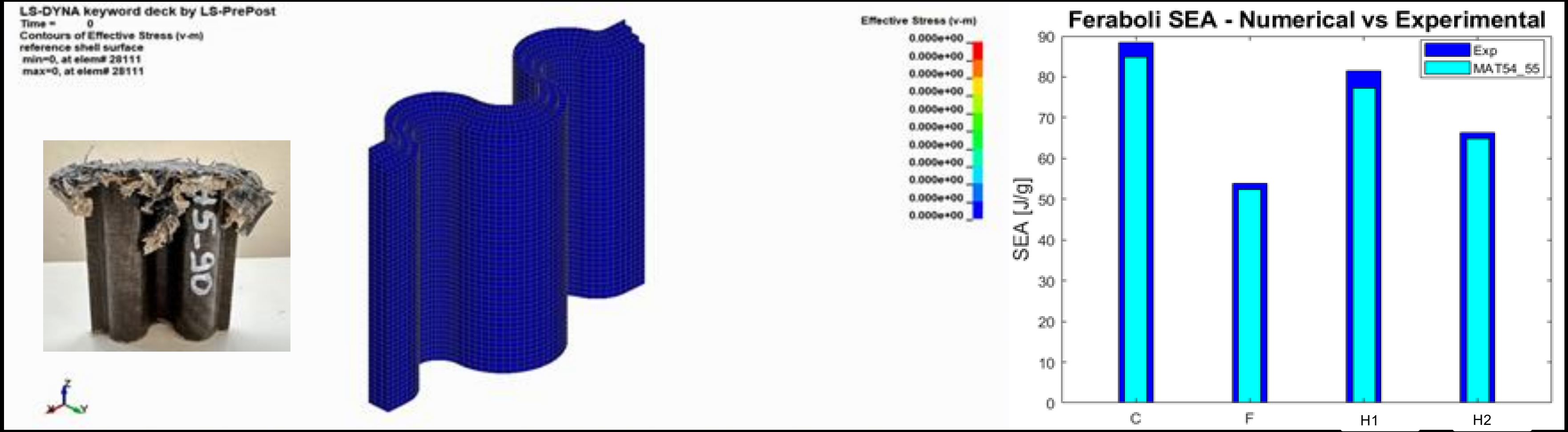
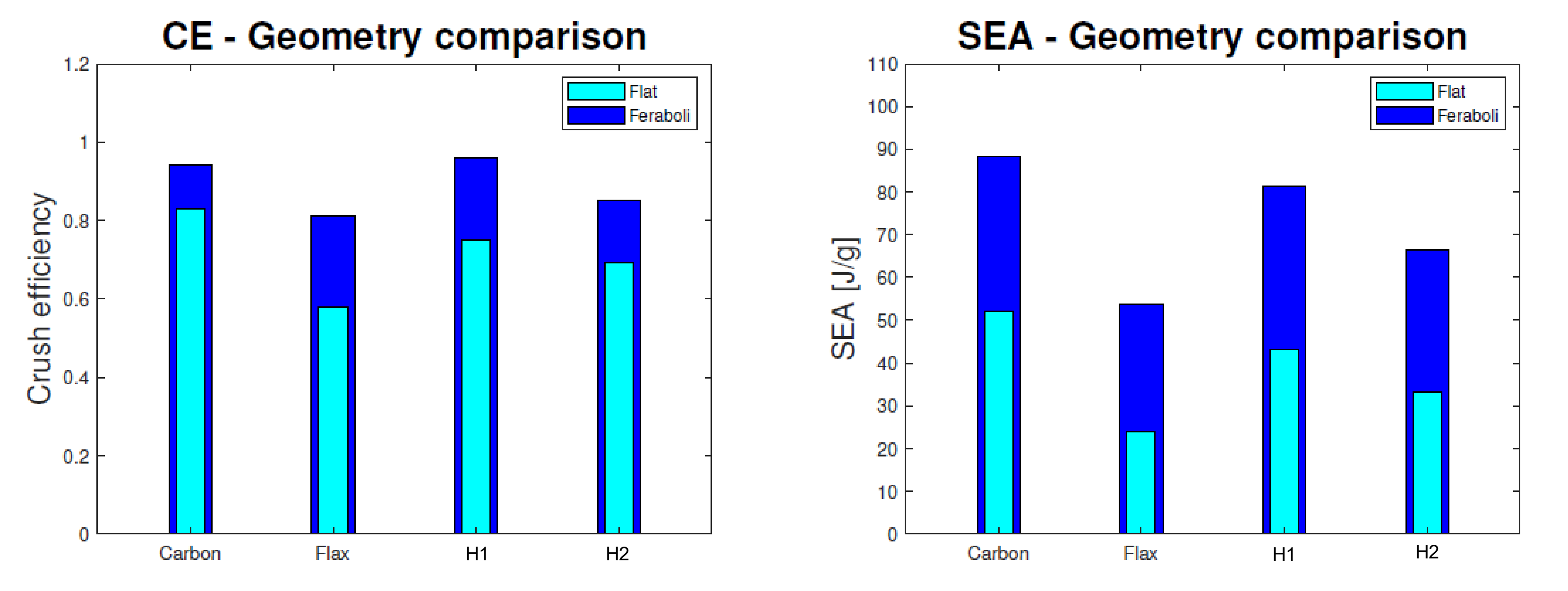


Feraboli Vs In-plane Crushing

SEA



Focus Component
Rear Crashbox

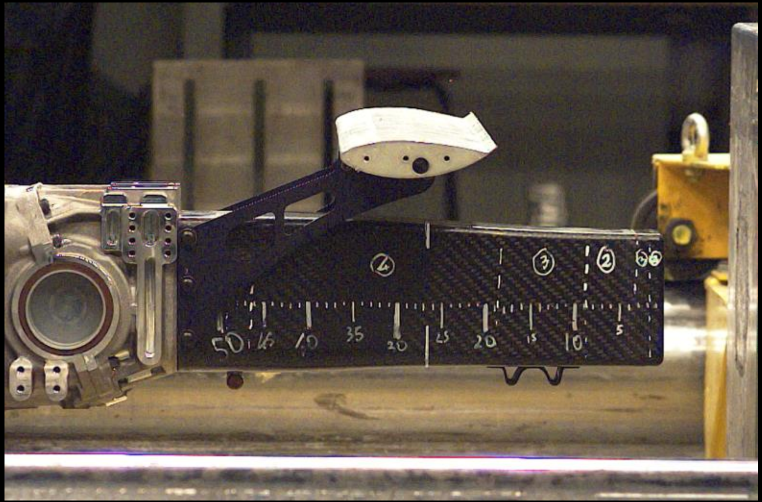
Component: Carbon fiber rear crashbox for motorsport application.

Material: High-strength carbon fiber composite.

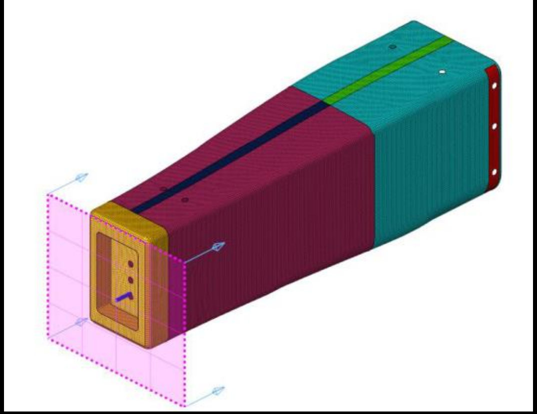
Test conditions:
- Mass: 700 kg
- Impact velocity: > 11 m/s
- Test setup: dynamic crash test on dedicated rig.

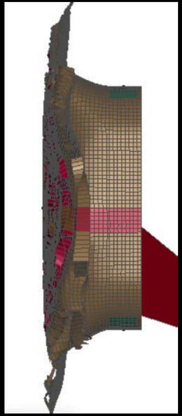
Structural Resistance Criteria:

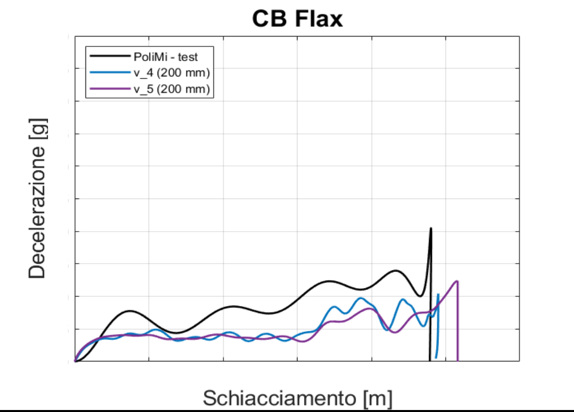
- The peak deceleration in the first 225 mm of deformation must not exceed 23g.
- The maximum deceleration must not exceed 23g for more than 15 ms cumulative.
- All damage must be contained within the rear impact absorbing structure.



Rear Crashbox
Flax

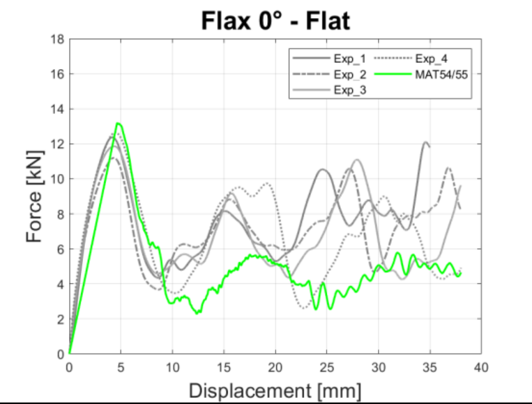


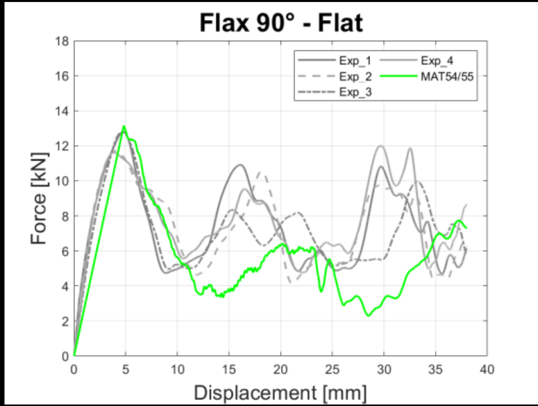


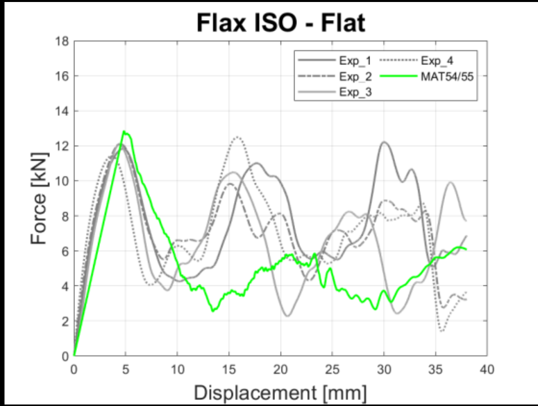


Reference	Ave Force [kN]	Ave deceleration [g]	Variation [%]
Experimental (black curve)	66.93	10.06	-
Simulation (purple curve)	35.35	5.32	89

Rear Crashbox
Flax Underestimation

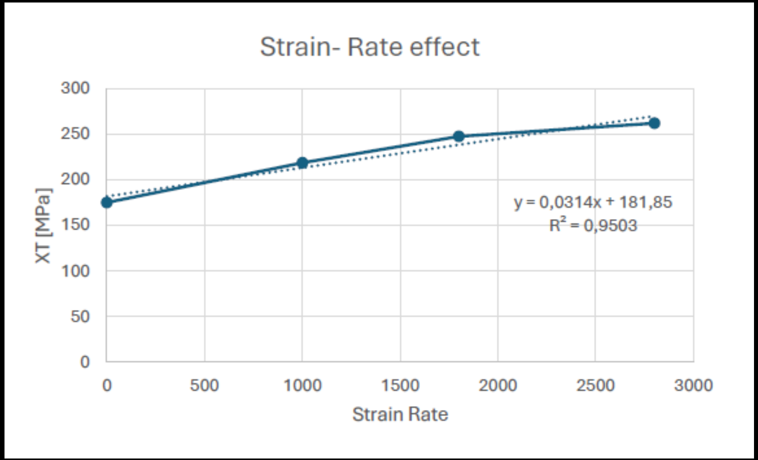


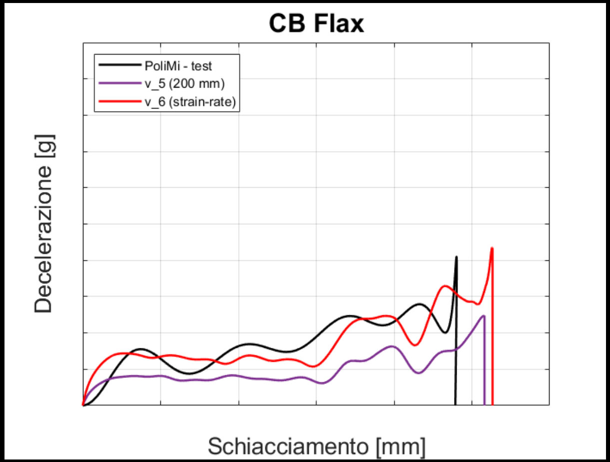




Reference	Ave Force [kN]	Deviation experimental-numerical [%]
Experimental	6.63	-
Simulation (green curves)	4.19	58

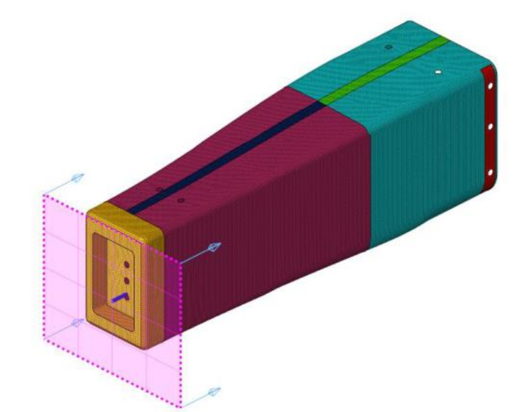
Rear Crashbox
Flax Strain Rate Effect

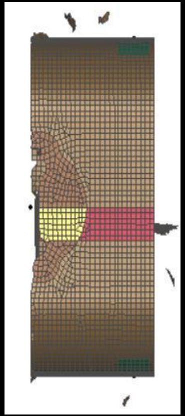


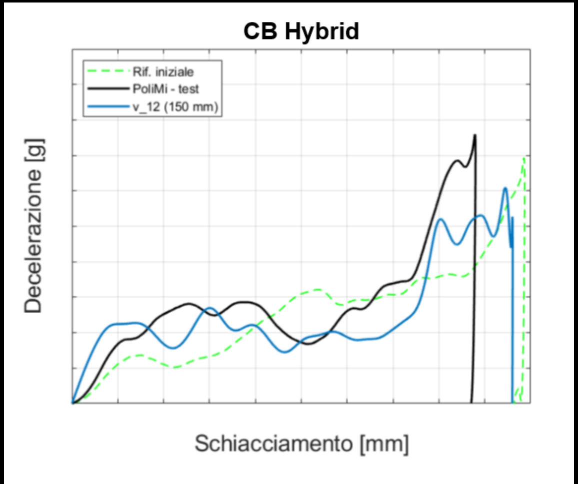


Reference	Ave Force [kN]	Ave deceleration [g]	Deviation [%]
Experimental (black curve)	66.93	10.06	
Simulation strain rate (red curve)	66.58	10.01	0.5

Rear Crashbox
Hybrid



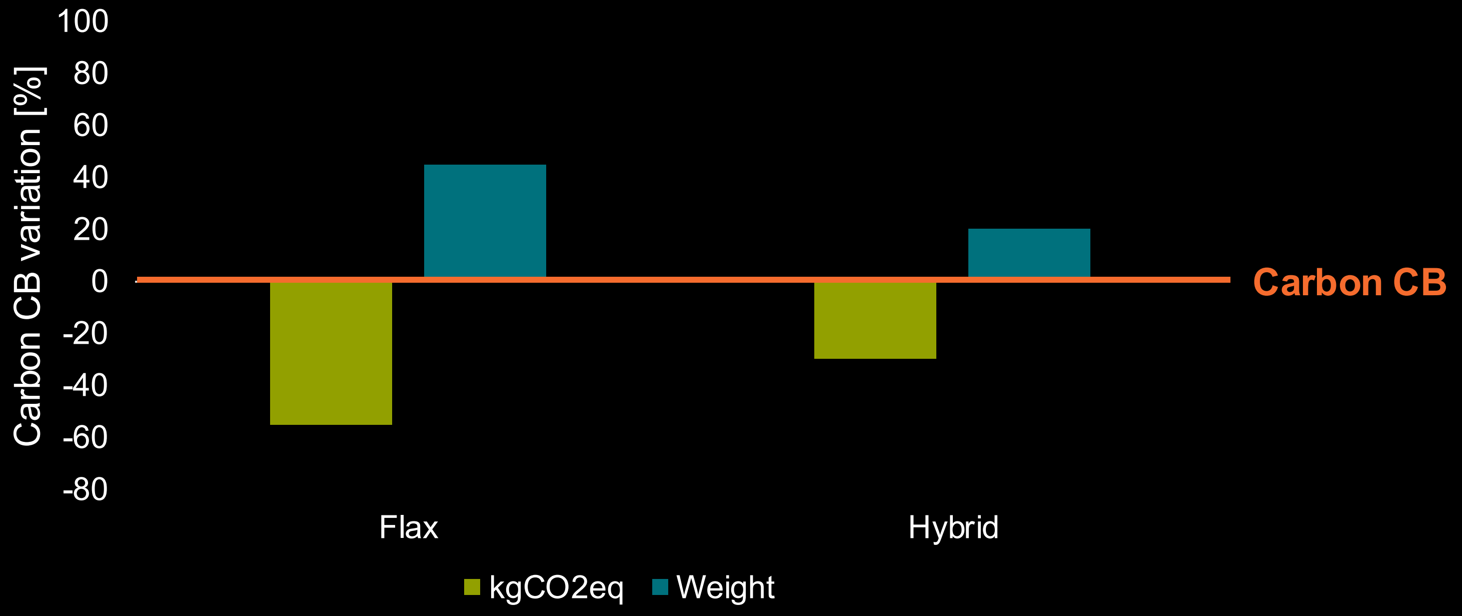




Reference	Ave deceleration [g]	Ave Force [kN]	Variation [%]
Experimental (black curve)	17.83	122.82	-
Simulation (blue curve)	15.05	103.56	18.5

Rear Crashbox

Advantages at same performance



Beyond Motorsport
Extended Applications

Potential of solutions developed in other sectors:

- **Automotive** (road vehicles, EV).
- **Aerospace** (passive safety components).
- **Nautical** and **Defense**.

Energy absorbing structures
Conclusions and Future Outlook

- **Safety** and **sustainability** challenges are driving **innovation**.
- HP Composites leads the way with **green materials** and **hybrid designs**, validated down to the component level.
- Rigorous validation confirms the **effectiveness** of the solutions.
- **Higher performance** is **possible** with reduced environmental impact.
- Take-home Message: Composite **innovation is the key** to a safer, more performing and more respectful mobility of the future.

Thanks

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