Aluminium innovation for EV chassis components: hybrid solutions developed in the Fatigue4Light project

Fatigue modelling and fast testing methodologies to optimise part design and to boost lightweight materials deployment in chassis parts

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Fatigue4Light general overview

Fatigue modelling and fast testing methodologies for Electric Vehicles chassis weight reduction

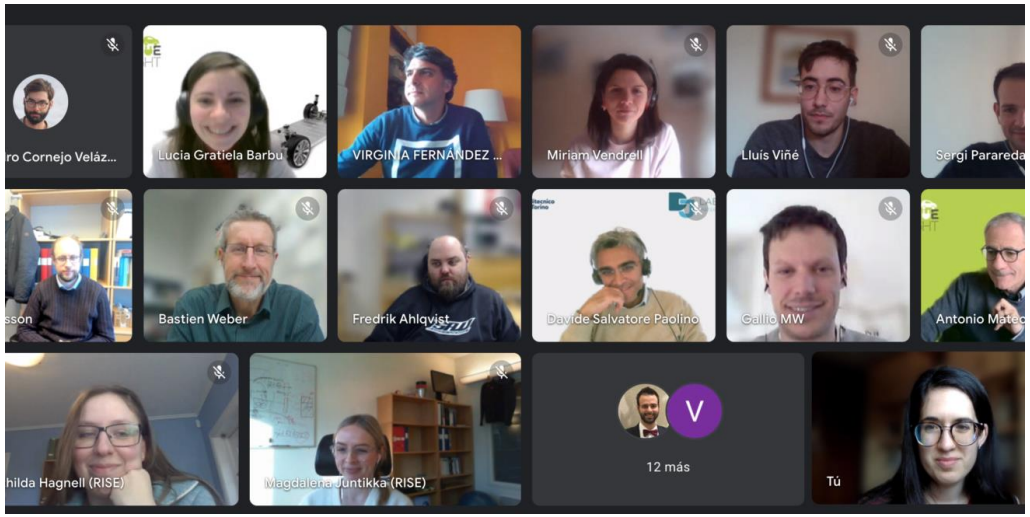
- European project funded under the topic: *LC-GV-06-2020 - Advanced light materials and their production processes for automotive applications*
- **3 years** duration, from 1/02/2021 to 31/01/2024
- **Budget**: 5,5 M€, of which 4,9 M€ funded by the EC
- **13 partners** from **4** different **European countries**
- Coordinated by **CIMNE,** RTO
- **Grant agreement ID**: 101006844

Consortium

13 partners from 4 European countries

3	3	6	1
Research institutions	Universities	Industrial companies	Standardisation body

Consortium



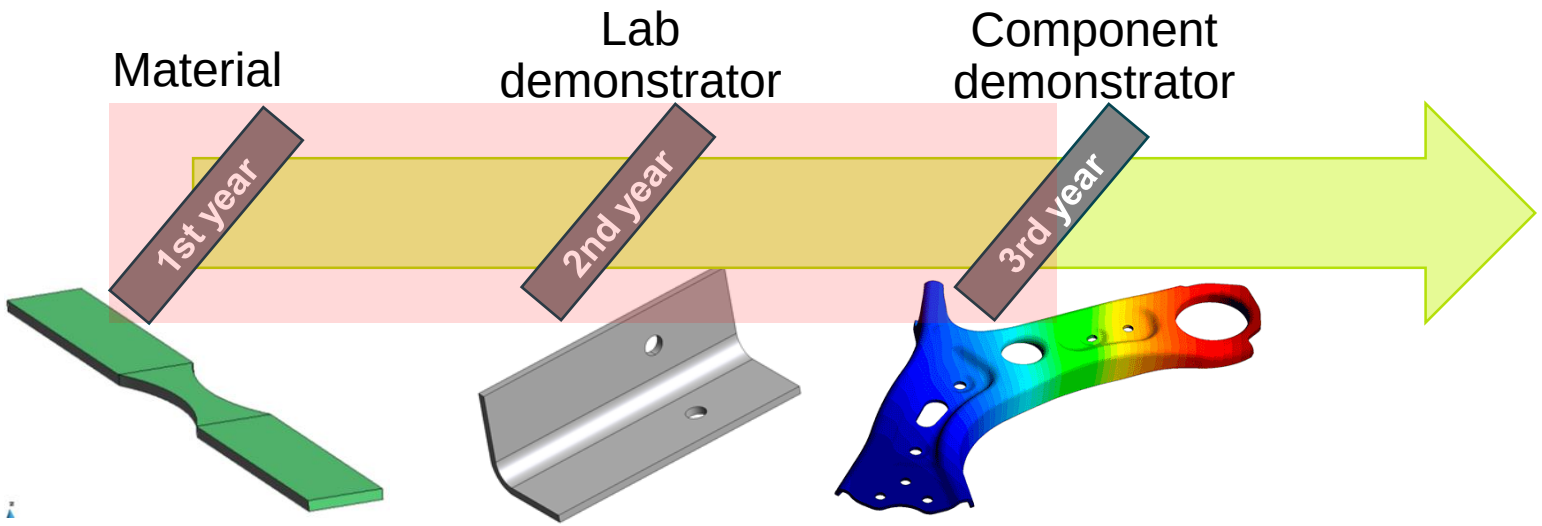
M12 meeting

M18 meeting

M24 meeting

M30 meeting

Project phases



Materials development for chassis parts

Development of tools for lightweighting

Computer and simulation methods

Validation of developed solutions at lab and industrial scale

1. Material solutions based on **AHSS, Al alloys, Press-hardened steel and multi-material hybrid composite** solutions.

2. **New fast-fatigue experimental methods** to reduce costly experimental campaigns.

3. **New computer simulation methods** to better estimate the fatigue life of chassis components and to select the optimal materials for lighter vehicle chassis.

4. Six demonstrators for chassis' parts have be used for **validating the modelling approach and the lightweight efficiency of the Fatigue4Light material solutions.**

Research beyond the state of the art

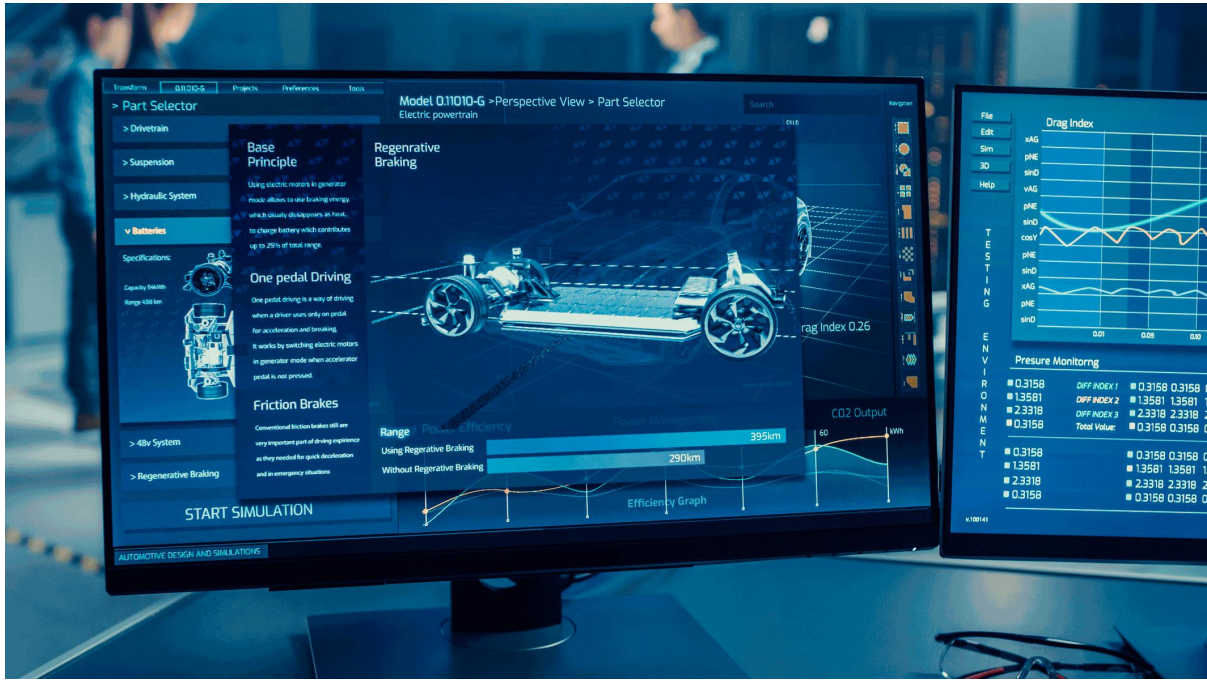
Fatigue4Light goes one step ahead from the current fatigue modelling procedures through two modelling approaches in order to **optimise the selection of new materials** and **reduce the implementation time between material development and the design of a new chassis part.**

Process modelling approach

Based on the determination of the damage caused by the manufacturing processes such as cutting, forming and welding.

Fatigue modelling

Focusing on the influence of manufacturing process' damage distribution on the long-term behaviour of the chassis component under cyclic loads inducing fracture by fatigue. The focus is on following the crack propagation under cyclic loads for lives well beyond dozens of thousands of cycles.



New lightweight materials for Electric Vehicles' chassis parts

Advanced High Strength Steels

New CP-like steels in the strength range of 800-1000 MPa.

Hybrid materials & stainless steels

Metal-composite sandwich material will be developed. The outer layers will be steel or Al and the inner core will be GFRP or CFRP. New martensitic stainless steels, adapted for press hardening.

Press hardening steels (PHS)

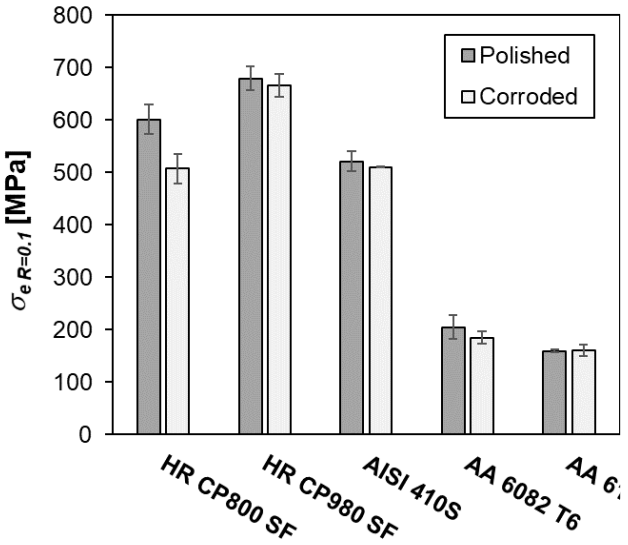
Advanced boron steel developed for press hardening of thick sheets with high fatigue resistance.

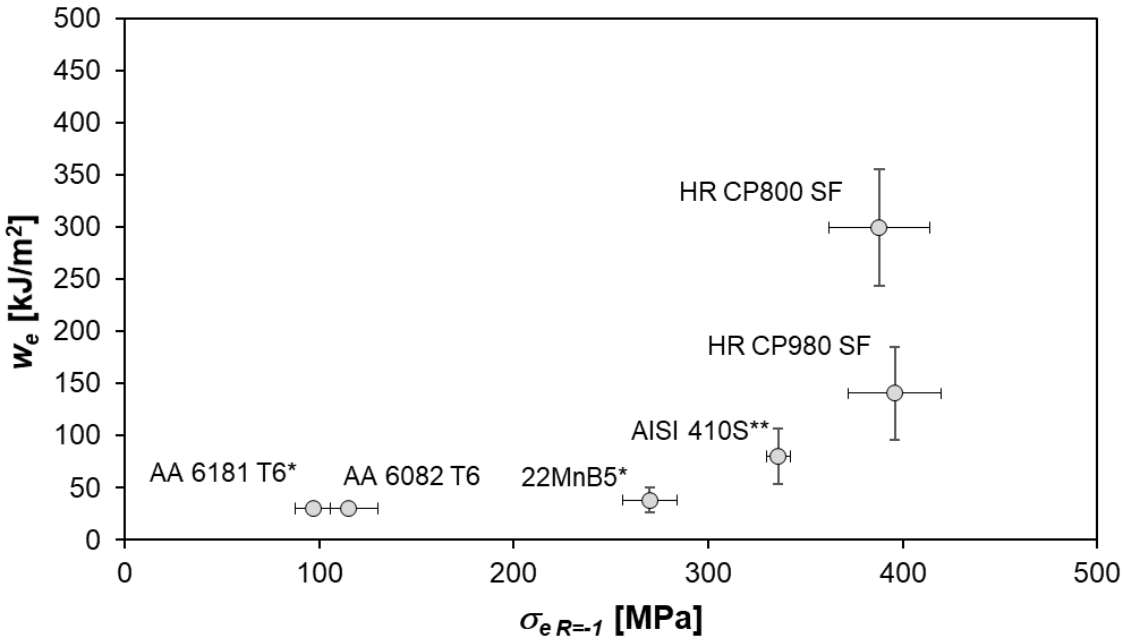
Al alloys

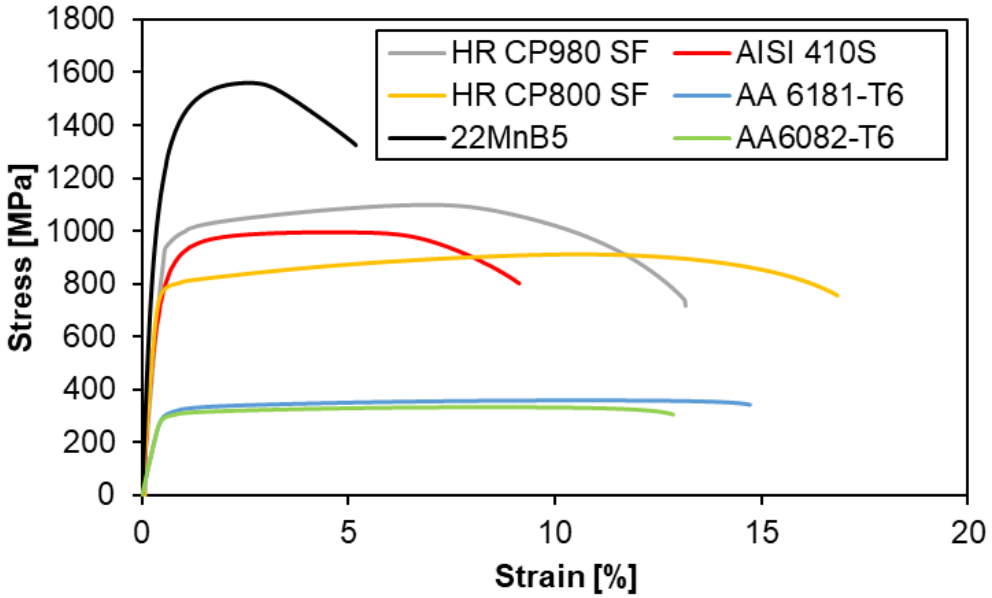
With improved fatigue resistance, reduced costs and improved environmental profile thanks to a higher amount consumption of scrap

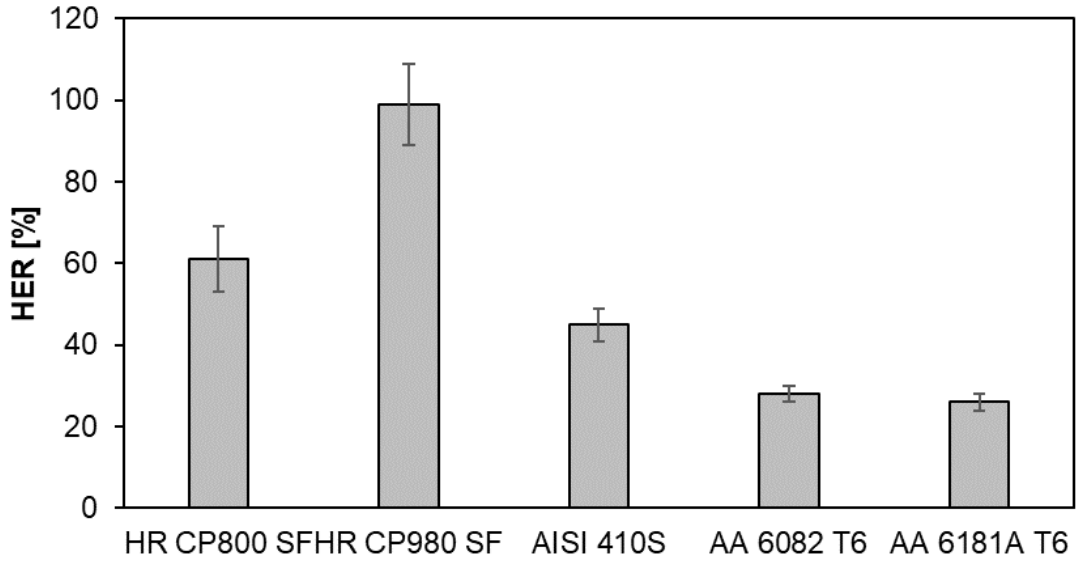
Results – material level

1. **Tensile test**
2. **Local formability** (Hole Expansion Test)
3. **Fracture toughness**
4. **Environmental effects:** corrosion test





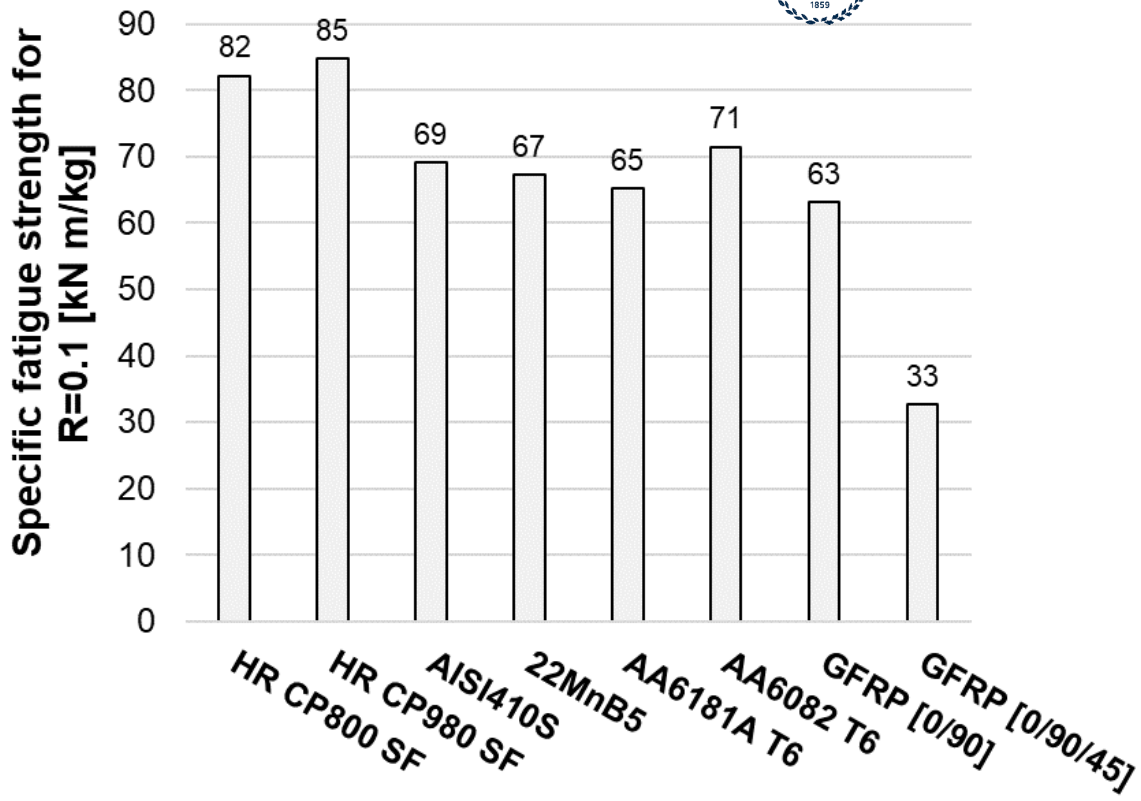




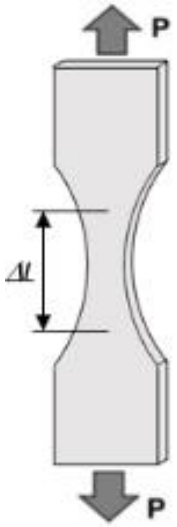
Results – material level

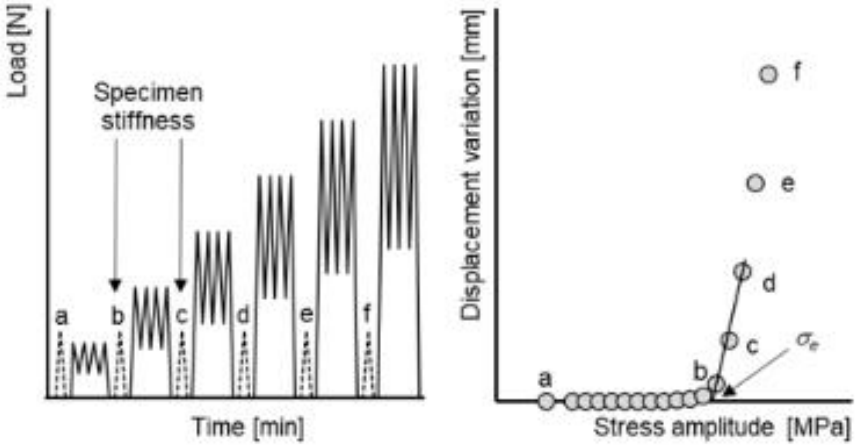
5. Fatigue:

- Conventional staircase method
- Self-heating method
- Stiffness method
- VHCF method



Fatigue tests - Stiffness method





3 hourglass specimens
(120 x 20mm – Kt=1.03)

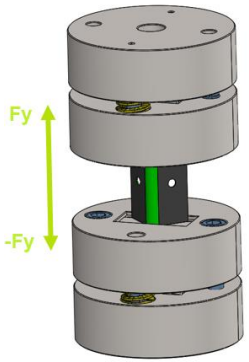
Effect of:

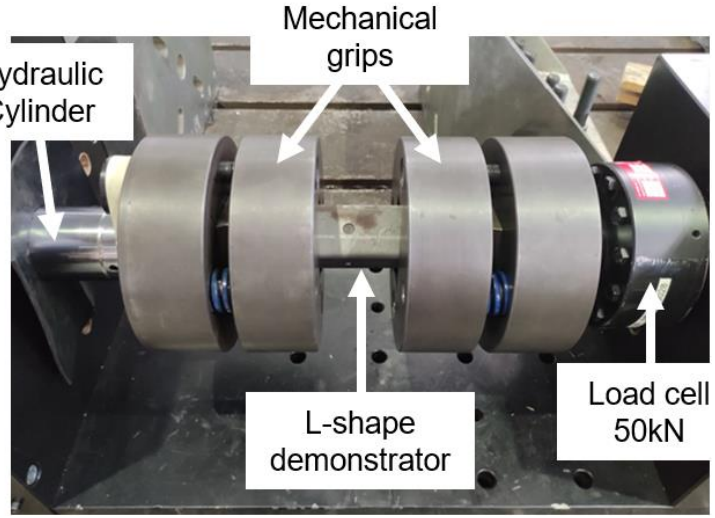
- Trimming - punching
- Forming
- Corrosion

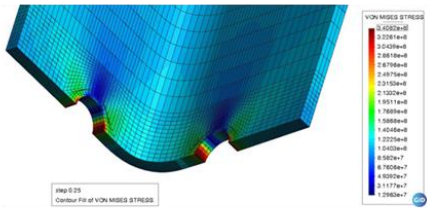
https://www.sciencedirect.com/science/article/pii/S0142112321004874?via%3Dihub

Results – lab scale demonstrator level

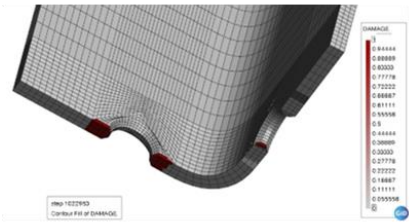
Lab-scale demonstrator in tension-compression



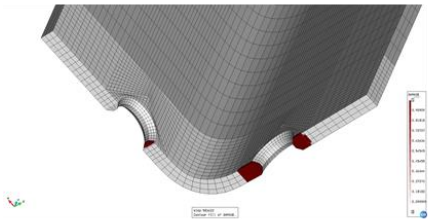




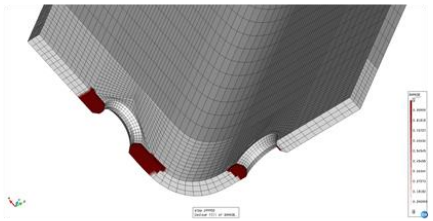
HRCP800SF – 3,45 mm
Full polished
Num: Runout
Exp: Runout



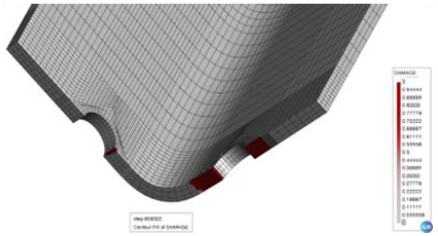
HRCP800SF – 3,45 mm
Half polished
Num: 1 022 993 cycles
Exp: 1 023 522 cycles



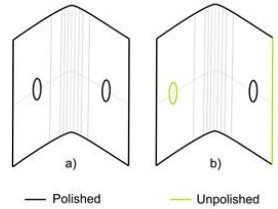
HRCP980SF – 3,51 mm
Full polished
Num: 583 622 cycles
Exp: 618 929 cycles



HRCP980SF – 3,51 mm
Half polished
Num: 400 115 cycles
Exp: 418 692 cycles

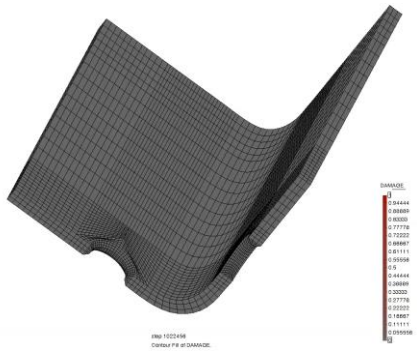


HRDP600 – 4,32mm
Full polished
Num: 808 362 cycles
Exp: 807 657 cycles



Half polished configuration

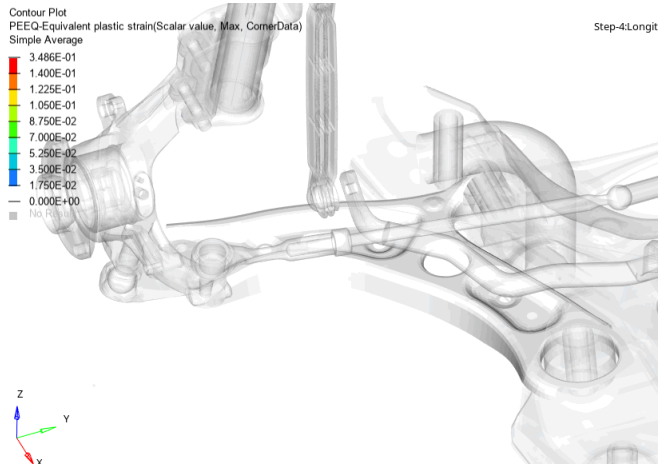
CP800 steel



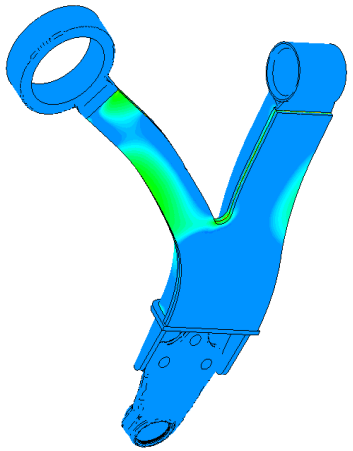
1.022.993 cycles

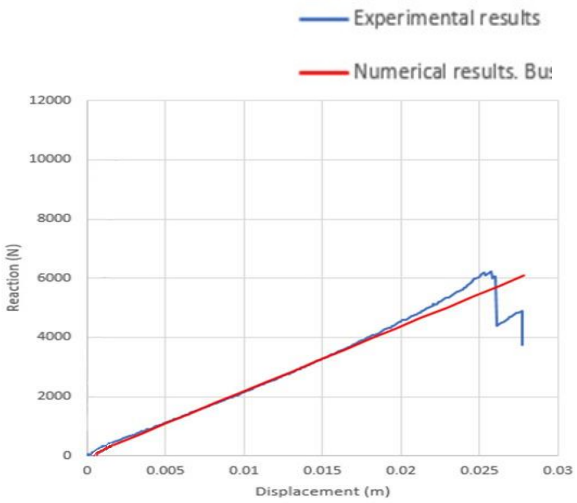
Results – demonstrator level

Steel lower control arm



Hybrid Al-GFRP lower control arm





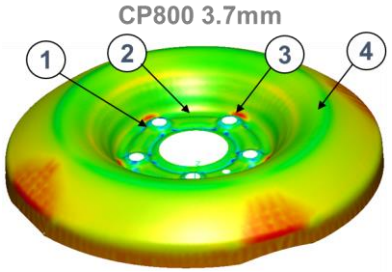
Results – demonstrator level

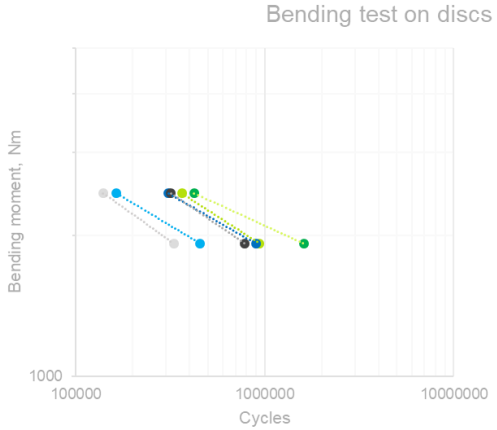
Hybrid Al-GFRP lower control arm manufacturing

https://www.youtube.com/watch?v=P2YZmpO4s78

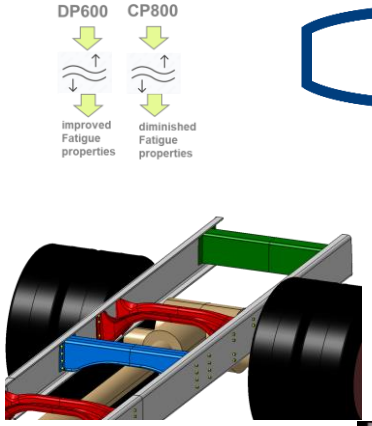
Results – demonstrator level

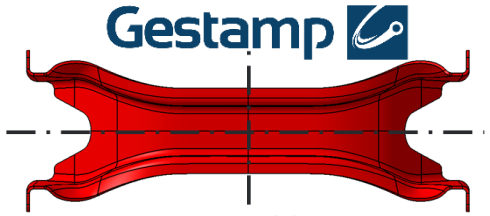
Disc proto SUV



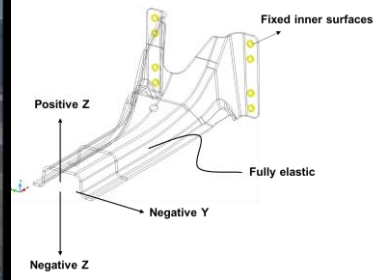


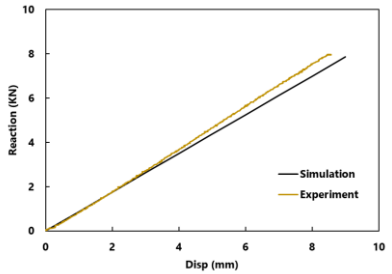
Crack propagation at 611.000 cycles

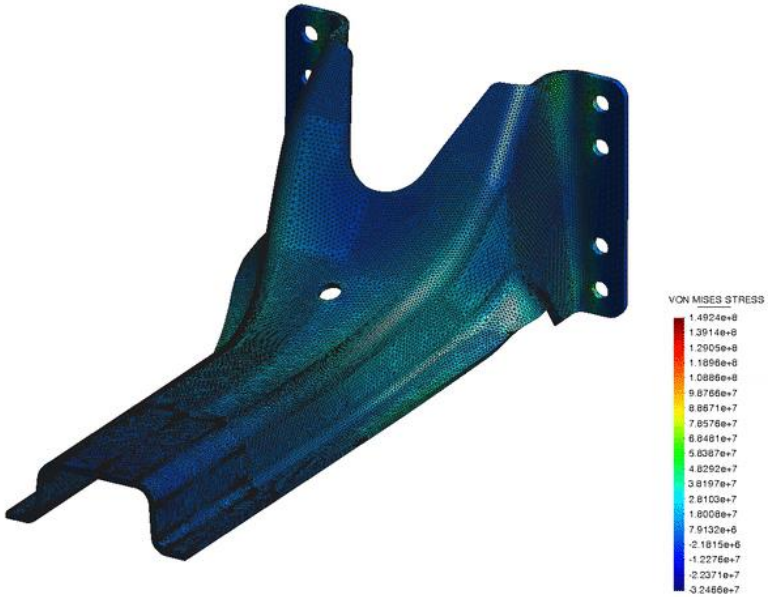




Cross-member beam







Results – demonstrator level

https://fatigue4light.eu/

What about Eco-design assessment?

Functional unit:
- Km (Electric vehicle)

images: Flaticon.com'. These covers has been designed using resources from Flaticon.com

To Be Continued…

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Thank you!

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