OPTIMIZED 3D-PRINTED INTERNAL STRUCTURE OF CFRP BEAMS

H2020 SOCIETAL CHALLENGES

Climate action, environment, resource efficiency and raw materials

The Industrial Problem

Lightweight and stiff in bending, thin-walled carbon fiber reinforced polymers (CFRP) suffer from wall instabilities. Mitigating this problem in current solutions is labor-intensive and structurally and economically inefficient.

MECHANICS AND MECHATRONICS

Research group

Open Mechanics @ CTU

We fancy curiosity-driven research spanning the fields of computational mechanics, materials science, applied mathematics, and informatics.

Company

Compo Tech PLUS spol. s r.o.

Composite engineering company providing a design, analysis, and manufacturing service based around their fiber-winding and laying technology.

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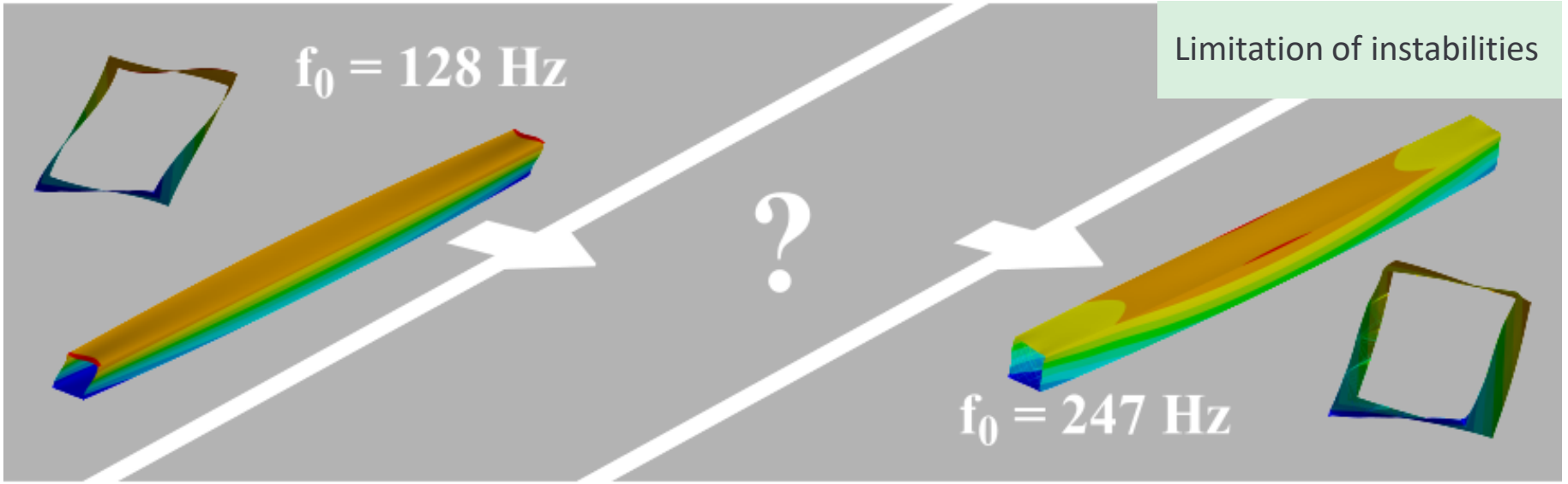
Challenges & Goals

- Increase the lowest free-vibration eigenfrequency to limit wall instabilities
- Maintain low weight
- Ensure low deflections under a manufacturing load case
- Develop a fully automatic and application-specific design procedure
- Enable economical manufacturing process



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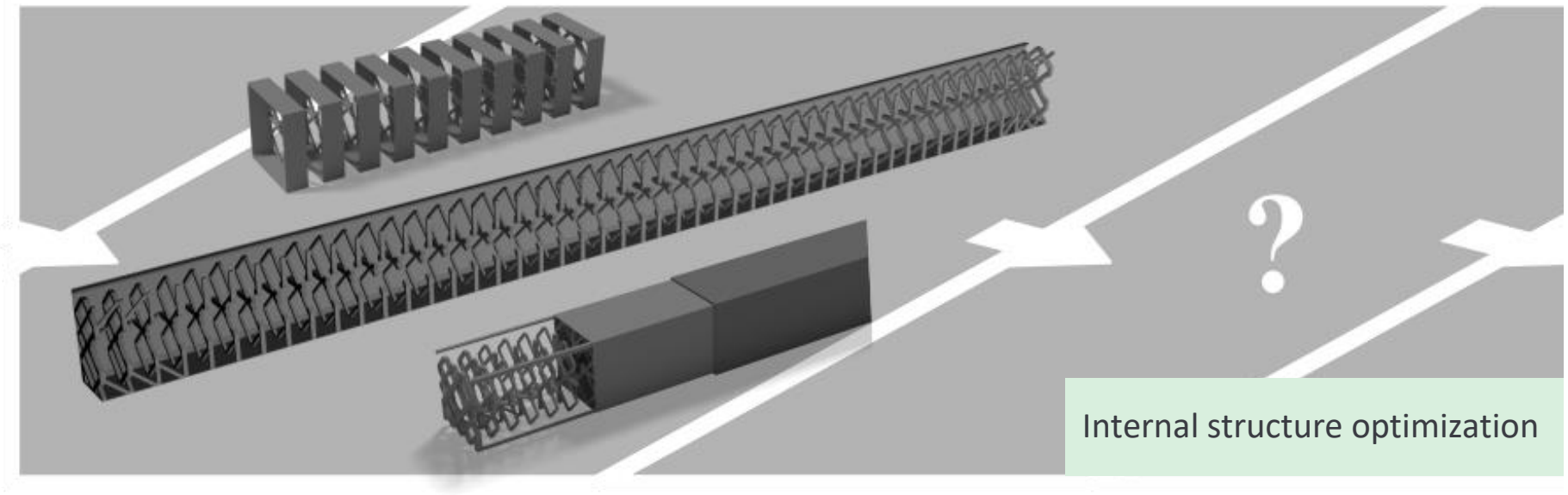
Mathematical and computational methods and techniques applied

- Finite Element Method for modelling the response of the CFRP beam
- Truss Topology Optimization for designing optimal internal structure
- Optimization problem formulated as a convex semidefinite program
- Efficient solution accelerated by exploiting the problem structure
- Simple bounds on what can be achieved in the optimization



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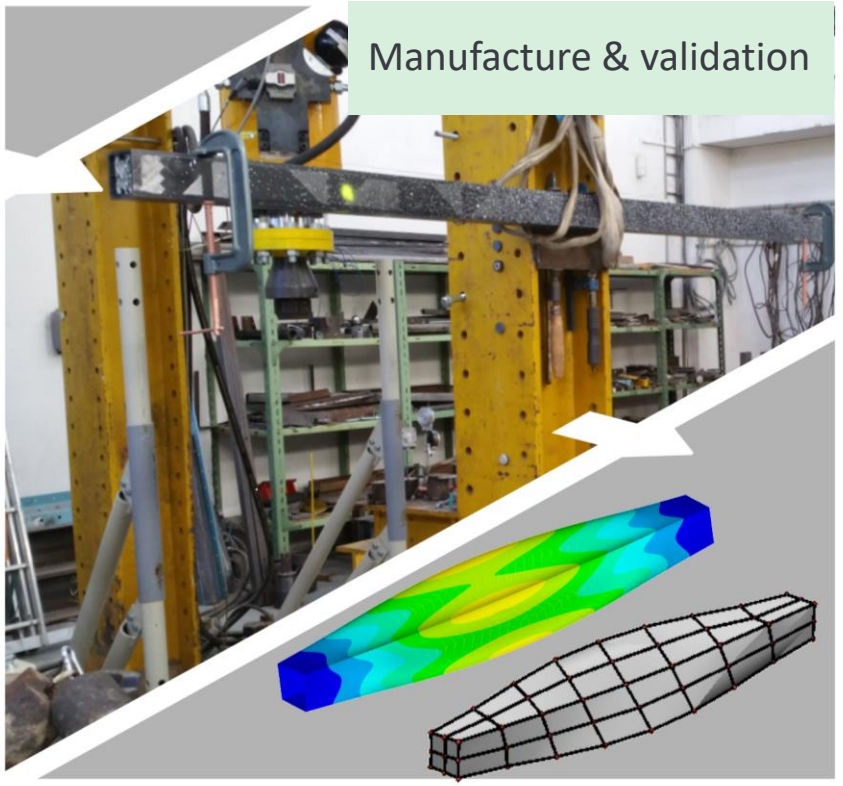
Results & Benefits to the company

- Customized structurally efficient yet lightweight internal structure design
- Fully automated design procedure relying on accurate numerical model validated against experiments
- Segment production by conventional additive manufacturing (with potential for robotic assembly)
- => Improved mechanical response
- => Improved economy and reduced manual work



Structurally efficient, lightweight, application-specific internal structure design.