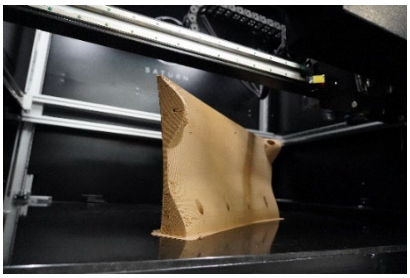
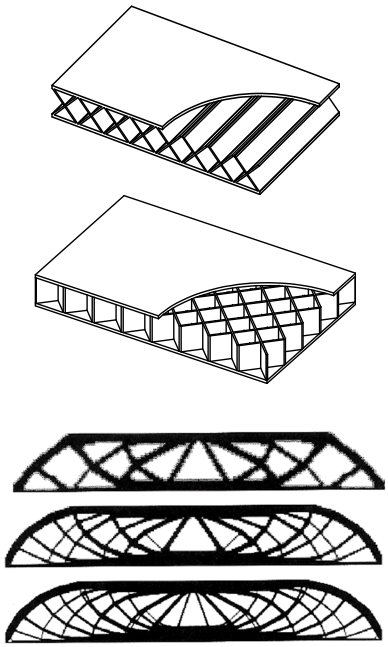
ILEK BioMat.

Master thesis

# Synthesis and simulation of 3D printed beams with natural fibre filament





The clear link between climate change and the environmental impact of the construction industry calls for innovative design approaches as well as alternative material solutions. Novel design strategies are emerging through the integration of advanced material research, computational design, and fabrication techniques. This higher level of integration allows materials that were previously considered as structurally insufficient, such as biomaterials, to be used in the context of built environment. By employing computer-aided shape optimization and form-finding, geometries that are most appropriate for given material properties can be obtained. In addition, 3D printing enables fabrication of complex geometries that are otherwise infeasible through conventional means.

Currently, large-scale 3D printing of Natural Fibre-Reinforced Polymers (NFRPs) has not yet been fully explored, especially in the use of continuous fibre filaments. From load-bearing point of view, the integration of continuous fibre within structural elements can be advantageous since it allows a contiguous distribution of forces. Conventional techniques for manufacturing continuous Fibre-reinforced polymers (FRPs) include several complex processes and steps, resulting in intense labour and energy expenditure. On the other hand, 3D printing of fibre filaments can produce complex geometries through the combination of fibre impregnation, deposition, and curing within a one-step process that can accommodate single or multi-material deposition.

In this project, a proof-of-concept prototype of 3D printed beam will be synthesized through topology optimization and then fabricated. To this end, the candidate will be expected to complete the following work packages: **(1)** literature review on biomaterials and 3D printed structures; **(2)** material characterization of 3D printed NFRP from existing empirical data and testing of new specimens; **(3)** topology optimization and modelling of the beam prototype **(4)** fabrication of 3D printed beam.

Note that thesis supervision, writing, and examination will be carried out in English.

**Key requirements:**

- Bachelor's degree in civil engineering or architecture.
- Good knowledge of form-finding and finite element (FE) modelling.
- Notional knowledge or interest in structural optimization.
- Fluency in FE software (Abaqus/SOFiSTiK) and programming (Python/MATLAB).
- Experience and interest in 3D printing and/or biomaterials are an advantage.
- Proficiency in spoken and written English.

**Contact:**
Dr. ès sc. Arka P. Reksowardojo
Vanessa Costalonga, M.Sc.

✉ arka.reksowardojo@ilek.uni-stuttgart.de
✉ vanessa.costalonga@itke.uni-stuttgart.de

**Earliest starting date:**
01.08.2023