SUMMER RESEARCH 2024/25
PROJECT ABSTRACT

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

PROJECT # 32

SUPERVISOR/S:	Dr Christian Gauss & William Allouche
PROJECT TITLE:	Towards alternative building systems: experimental investigation of 3D-printed natural-fibre reinforced composites for structural applications
FIELD:	Materials and process engineering / mechanical engineering
DIVISION/SCHOOL:	HECS - Te Kura Mata Ao School of Engineering
PROJECT LOCATION:	Hamilton

PROJECT ABSTRACT:

The high contribution of the building sector to the negative environmental impact of human activity is due to the "take-make-dispose" model that promotes a linear use of material resources (from extraction, to use and disposal). In contrast, the circular economy model has the potential to maximise the efficiency of building materials by keeping them in use and delaying their disposal through sustainable practices such as reuse, repair and recycling. The reuse and repair of components, or the recycling of materials are possible if the buildings are designed for disassembly, thus facilitating the separation of their individual elements. In parallel, building materials can have high embodied carbon emissions and sustainable material selection is essential to minimise the carbon footprint of buildings. Furthermore, buildings are long-lasting products designed to last >50 years. This long lifecycle is an opportunity for climate change mitigation by favouring carbon-sequestering materials to store carbon in the built environment as long as possible. Biobased materials such as timber and plant-based natural fibres naturally sequester carbon during their growth, thus making them ideal renewable and carbon-storing materials.

Natural-fibre reinforced thermoplastics (NFRTPs) are defined by the use of natural fibres as reinforcement for a thermoplastic matrix. Ongoing research in our group employs Finite Element Analysis (FEA) to generate optimal geometries of NFRTP building systems based on approximated material properties. This project aims to support this research that investigates the use of NFRTPs as load-bearing and bracing materials for the structure of a building by providing experimental results to correlate with numerical models. The student will begin the project with a literature review on additive manufacturing techniques combined with NFRTPs. The next task will involve defining and prototyping a test bench that corresponds to the load case used in the FEA simulations. Topologically optimised geometries will then be 3D-printed using NFRTP filaments before being tested on the experimental test bench. Experimental findings will be compared with numerical results to feed the FEA model and improve the simulation of NFRTPs.

STUDENT SKILLS:

- Good knowledge of the mechanical behaviour of materials (solid mechanics, strength of materials)
- Willingness to learn and work with laboratory equipment
- Teamwork
- Comfortable in writing technical reports
- Laboratory skills and experience with Finite Element Analysis are an advantage

PROJECT TASKS:

1. Literature review.
2. Composite processing of samples through 3D printing (Fused Deposition Modelling)
3. Prototyping of a test setup and mechanical testing of samples
4. Data analysis
5. Writing the report

EXPECTED OUTCOMES:

- Student's Research Poster (as per clause 6 of the Scholarship regulations)
- Literature review on the use of additive manufacturing with NFRTPs
- Understanding of the correlation between experimental conditions and numerical models for NFRTPs
- Identification of the essential parameters affecting the load-bearing and bracing capabilities of 3D-printed NFRTPs