Postdoctoral position at FEMTO-ST Institute

Title : **Probabilistic multi-scale and multi-objective optimization of wood/natural fiber composite hybrid laminates**

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Duration 12 months (December 2021 – November 2022)

Salary (gross annual) 32 k€

Location FEMTO-ST Institute
Departments of Applied Mechanics
24 rue de l'Epitaphe – 25000 Besançon, France
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Context

The post-doctoral work is part of the ISITE-BFC project WooFHi (Wood/natural Fiber High homogeneity/performance composite). The WooFHi project aims at developing a new sustainable class of hybrid composite materials whose constituents come from the local biomass. The development of value chains for the transformation of local vegetal biomass, such as wood, hemp, and flax, into engineering materials is necessary to answer to the global concerns over environmental issues and to ensure an ecological transition towards the sustainable development of various industrial sectors such as transportation and construction. This class of materials can be an alternative to traditional materials to reduce the carbon footprint and strain on the environment.

The main objective of WooFHi is to optimize and homogenize heterogeneous and variable wood-based materials by lamination and hybridization with natural fibre composites and to study their durability for structural applications targeted in the transportation sector. The project brings together three research teams from the University of Bourgogne-Franche-Comté (UBFC), namely FEMTO-ST Institute in Besançon, LaBoMaP from Arts et Métiers Institute of Technology in Cluny and DRIVE at ISAT in Nevers, with complementary skills and internationally recognized for their unique expertise in the field of wood, plant fibres and biobased composites.

One of the methods to better control the mechanical properties of wooden structures is to use reconstituted materials, such as CLT (Cross Laminated Timber) or LVL (Laminated Veneer Lumber). In the latter case, thin layers of wood (veneers) are obtained by peeling a log, and assembled to obtain homogenized properties. But even in this case, the mechanical performance remains very variable compared to synthetic materials, and their use requires high safety factors. This limits their applicability in fields such as transport where the dimensioning must be done as accurately as possible in terms of weight/volume.

The reinforcement of wood by organic matrix composites is a solution to improve and homogenize further the characteristics of this material. Studies using glass or carbon fibers have already been carried out, but the use of natural fibers (such as flax or hemp) seems more appropriate when the minimization of the environmental footprint of the solution is of prime concern. This association of wood and natural fiber composites should also allow the use and valorization of local wood of secondary quality and variable properties by controlling in a methodical way the structuring of the hybrids to obtain homogeneous final properties.

Objective and tasks

The main objective of this postdoctoral fellowship is the multi-objective optimization of wood/natural fiber composite hybrid laminates. To do so, the uncertainties and variability of the input parameters will be considered at different scales to maximize the bending strength and rigidity while minimizing the areal weight of the resulting hybrid laminates. The approach will, in particular, consider the spatial heterogeneity of the orthotropic elastic properties of wood veneers, the uncertainties on the nominal elastic properties of plant fiber composite plies and on the geometrical of wood and composite plies. The work will be performed by using a numerical tool developed in the team, based on Finite Elements Analysis and an in-house software developed for uncertainty propagation**.**

Profile required

- PhD thesis related to the mechanical modelling of composite materials and/or wooden materials.
- Proficiency in sensitivity analysis for optimization problems.
- Softwares: proficient with Matlab and FEM (ABAQUS)
- Curious, self-motivated, hard-worker
- English: fluent reading, writing and speaking with ease.

Application procedure

Please send the following documents (all in one PDF file) by e-mail to vincent.placet@univ-fcomte.fr :

1) For EU candidates: Copy of your national ID card or of your passport page where your photo is printed.

   For non-EU candidates: Copy of your passport page where your photo is printed.

2) Curriculum Vitae (may include hyperlinks to your ResearchID, Research Gate Google Scholar accounts).

3) Detailed list of publications (may include hyperlinks to DOI of publications).

4) Letter of motivation relatively to the position (Cover Letter) in which applicants describe themselves and their contributions to previous research projects (maximum 2 pages)

5) Copy of your PhD degree if already available.

6) Coordinates of reference persons (maximum 3, at least your master thesis supervisor):

   Title, Name, organization, e-mail.

Recent Team's Publications

- Benjamin Sala, Xavier Gabrion, Violaine Guicheret-Retel, Vincent Placet. Influence of the stress level and hygrothermal conditions on the creep/recovery behaviour of high-grade flax and hemp fibre reinforced GreenPoxy matrix composites. Composites Part A: Applied Science and Manufacturing, 2021, 141, 106204
- Romain Viala, Vincent Placet, Scott Cogan. Simultaneous non-destructive identification of multiple elastic and damping properties of spruce tonewood to improve grading. Journal of Cultural Heritage, 2019. https://doi.org/10.1016/j.culher.2019.09.004.
- Jeannin T, Berges M, Gabrion X, et al. Influence of hydrothermal ageing on the fatigue behaviour of a unidirectional flax-epoxy laminate. Composites Part B: Engineering 2019; 174: 107056.
- Jeannin T, Gabrion X, Ramasso E, Placet V. About the fatigue endurance of unidirectional flax-epoxy composite laminates. Composites Part B: Engineering 2019; 165: 690.
- Del Masto A, Trivaudey F, Guicheret-Retel V, Placet V, Boubakar L. Investigation of the possible origins of the differences in mechanical properties of hemp and flax fibres: A numerical study based on sensitivity analysis. Composites Part A: Applied Science and Manufacturing 124:105488, 2019. https://doi.org/10.1016/j.compositesa.2019.105488