Internship offer

Location : ISAE SUPAERO, Toulouse, France

Department : DMSM (Mécanique des Structures et Matériaux)

Supervisor : Éric PAROISSIEN, Frédéric LACHAUD, Mario PLANAS ANDRES

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OFFER DESCRIPTION

Title: Finite element analysis of adhesively bonded joints in a recyclable wind turbine blade.

Proposed duration and period: 6 months, S1 2023

Context

Non-recyclable waste generation at the end of life cycle is currently one of the main problems arising from the use of composite materials in many industries: aerospace, automotive, marine…The wind industry is not exempt from this concern, as wind turbine blades are mostly manufactured using composites. Although at the current time there are several methods to recycle these components, and some circular-economy alternatives, redefining the base materials for manufacturing the blades is still one of the most interesting technological solutions for achieving recyclability.

As wind turbine blades are normally made up of several parts that are eventually joined by adhesive bonds, namely two aerodynamic GFRP stiffened shells and a sandwich load-carrying beam enclosed by the firsts, and both the matrix of this composite-based components and the adhesive used to assemble them contain non-recyclable thermosetting resins, one of the most followed solutions is the passage from the use of thermosetting to thermoplastic resins. These not only allow for recycling but also for reducing the mass and the manufacturing costs as some of these resins do not require a hot cure cycle. However, a verification of the structure's integrity against their use must be done, particularly for the adhesively bonded joints, since these are the critical structural areas.

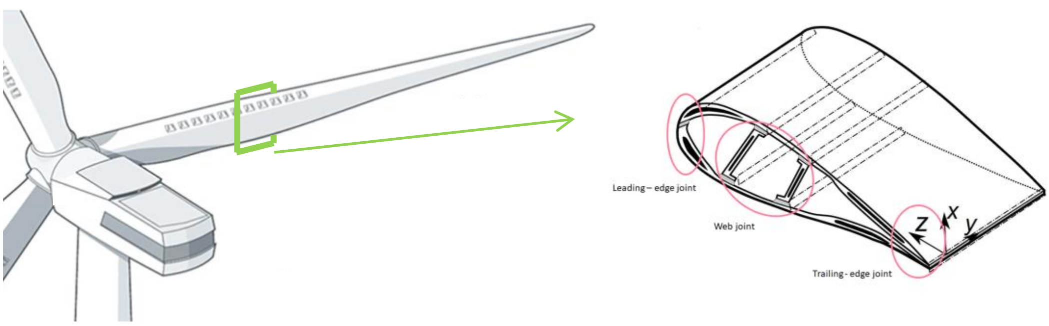

Fig 1. Classical adhesively bonded joints in a wind turbine blade. Adapted from [1].

Within this context, a french company leader in specialty materials has developed a series of new thermoplastic resins for the manufacturing of sustainable wind turbine blades. A PhD is being done at ISAE SUPAERO in collaboration with them in order to characterize the mechanical behavior of this type of resins and their influence on the global response of the structure. This internship appears as a support for this PhD.

Objectives and work

Your mission will be to:

- Identify the critical design loads amongst the aerodynamic, gravitational, inertial and operational loads.
- Develop a Global FE model of the wind turbine blade which resorts to cohesive elements [1] to model the adhesive joints: leading-edge joint, trailing-edge joint and web joint.
- Identify the influence of the adhesive properties and the choice of the Traction-Separation law defining the cohesive zone model [2] (CZM) on the global response of the structure.
- Propose innovative design guidelines to ensure sufficient mechanical performance when generally using thermoplastic resins.

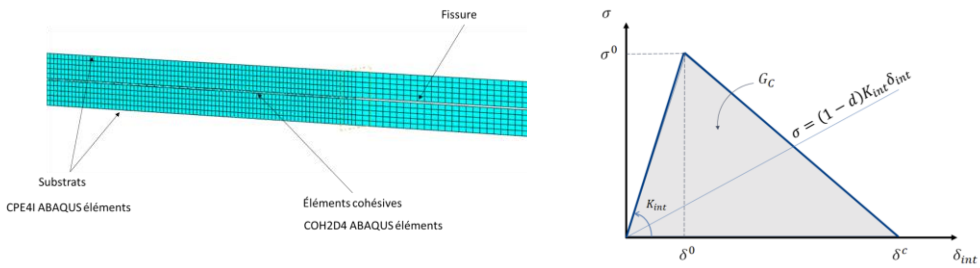

Fig 1. Example of the use of cohesive elements (left) and classic bilinear Traction-Separation law (right).

[1] Cohesive elements are a special type of finite element used to model, inter alia, adhesives in adhesively bonded joints.

[2] The mechanical behaviour of cohesive elements is governed by Traction-Separation laws defining their response to external applied loads. These laws are able to model a wide-ranging variety of behaviours including linear elasticity, viscoelasticity, viscoplasticity and degradation of the adhesive layer through the use of a damage variable.

The use of cohesive elements to model the adhesively bonded joints in a FE model allows for greatly reducing computational costs.

Possibility to continue with a PhD (Yes/No) : TBD

REQUIRED APPLICANT PROFILE AND SKILLS

Study level	☐ Undergraduate students (3rd or 4th year) ■ Master students (1st or 2nd year) ☐ PhD students
Required profile and skills	You are a student in the last year of a MSc in Aeronautical or Mechanical Engineering and you have the following qualities: • You have an extensive knowledge in composite materials • You are familiarized with the FE Method. • You are familiarized with ABAQUS or you are willing to learn. • **Languages:** Advanced English. French is a plus.
Other useful information	Gratification is around 600 €/month depending on working days. Do not hesitate to contact us!
References	[1] J. B. Jørgensen, "Adhesive Joints in Wind Turbine Blades"; 2017.