



Internship at ISAE-SUPAERO / ICA for six/eight month

Title: Damage and failure identification of composite laminates with carbon fibers and thermoplastic matrix under static and dynamic loadings

Supervisor : Pr. Frédéric LACHAUD / Pr. Eric PAROISSIEN / Pr. Laurent MICHEL

1) Background

This work concerns the modelling of damage and failure of unidirectional carbon composite laminates with a specific thermoplastic matrix.

ISAE-SUPAERO (<https://www.isae-supaeero.fr/fr/>) and Institut Clément Ader (ICA: <https://ica.cnrs.fr/>) work on the design of a specific composite panel for impact protection. Laminated composite materials using thermoplastic matrices seem to be good materials for better impact resistance. In order to better predict this impact resistance, damage and failure must be introduced with robust approach in the numerical modelling. For these methods, it's necessary to determine initiation and failure criterion. It is also important to develop numerical models according to these criteria in order to make the numerical tools robust.

The objective during this work is to determine a methodology to identify the damage/failure behavior of thermoplastic matrix composite laminates. under static and dynamic loadings. After bibliography, training concerning damage and failure, student will realize tests on tensile machine, on drop tower and Finite Element Numerical modeling on ABAQUS Implicit/Explicit software with User Element and User Material FORTRAN routines.

2) The Internship

In this context the objective of the intern is:

Bibliography

- Damage and failure of composite laminates
- Continuum Damage model / Discrete Damage model
- Damage and Failure identification
- Implicit / Explicit Computation

Training 10 h(teacher: Frédéric LACHAUD)

- Specific Damage and failure courses of composites materials
- *Abaqus UMAT and VUMAT creation*
- *How to realize a good experimental/numerical tests*

Test campaign

- Define identification of specific damage/failure behavior
- Test for damage and failure identification: Tensile, Compressive Tests, CT/CC tests,
- Test for delamination propagation identification (DCB, ENF, ELS...)
- Impact test of UD carbon composite laminates. Structural tests analysis

Numerical approach

- Three point bending numerical tests for damage initiation validation,
- Fracture mechanic test modelling with different numerical methods,
- Impact modeling on Abaqus explicit / LSDYNA of 3D woven composites
- Perform comparison study

The candidate should have knowledge on composite materials, FE modeling, programming, Python.

This research internship is in collaboration with an aeronautical industry in Toulouse

3) To apply

Date: from October/November 2022 to April/May 2023 or March 2023 to August/September 2023

Duration: 6 / 7 months

Remuneration: 650€ per month

Contacts : send a CV and letter

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References

- **Yadan Li a, Hui Jia b, Xiaohua Cui a, Wen Qin c, Shengnan Qin d, Yang Wu e, Mingyu Bai a, Xiaqing Liu b, Fan Feng a, Jing Ma c,* , Ying Li a,b,***

Bending Properties, compression Properties, biocompatibility and bioactivity of sulfonated carbon Fibers/PEEK composites with graphene oxide coating

<https://doi.org/10.1016/j.apsusc.2021.151774>

- **S. Sivashanker 1**

Damage growth in carbon fibre–PEEK unidirectional composites under compression
Materials Science and Engineering A249 (1998) 259–276

- **Jiqiang Hu, Chunming Ji, Shuai Chen, Shuai Li, Yajun Zou, Zhengong Zhou, Bing Wang ***

Two-position impact behavior and interference mechanism of CFF/PEEK thermoplastic composites

<https://doi.org/10.1016/j.ijmecsci.2022.107644>