Research project offer

Location : ISAE SUPAERO, Toulouse, France

Department : DMSM

Research group : "Joining" transversal axis [MS2M and MSC]

Supervisor : Éric PAROISSIEN, Michel SALAÜN, Sébastien SCHWARTZ

Email : eric.paroissien@isae-supaero.fr, michel.salaun@isae-supaero.fr, sebastien.schwartz@isae-supaero.fr

OFFER DESCRIPTION

Title : Influence of design parameters on the mechanical behavior of single-lap bonded joints as a function of reference analytical models

Proposed duration and period : 6 months in 2022

Context

Aircraft structures are designed by the assembly of beams with concentrated caps and of thin plates. The objective is to set the material where it is needed to maximize the strength-to-mass ratio. The aircraft structural components are mainly assembled thanks joining technologies related to bolting. If bolting joining technologies are well controlled, its main drawback is the local reduction of the strength-to-mass ratio. Indeed, to reduce the local stress level to be transferred, the joining areas are mainly characterized by an increase of the thickness of materials to be assembled. On the contrary, it is acknowledged that the adhesive bonding technology allow for the increase of static and fatigue strength while reducing the mass. As a result, in the frame of the cost reduction, a solution for the design of aircraft structures could be built them by laying up adhesively bonded material sheets, in order to locally set the material where it is needed while avoiding over thicknesses.

The Finite Element (FE) method is able to address the stress analysis of multilayered structures. Nevertheless, since analyses based on FE models are computationally costly, it would be profitable both to restrict them to refined analyses and to develop for designers simplified approaches, enabling extensive parametric studies. As highlighted in several literature surveys [1-3], a large number of simplified approaches for the stress analysis of bonded joints exist in literature.

Nevertheless, if the application field of simplified approaches can be deduced from the simplifying hypothesis, the level of fidelity of results with the real behavior cannot be found in the literature. In other words, the designer needs a rationale to select the suitable simplified approach.

The present research project will be performed in accordance with CETIM.

Objectives and work

The objective of the present Research project is to assess (i) the influence of design parameters on the mechanical behaviour of the single-lap bonded joints as function of various reference simplified approaches and (ii) the differences compared to refined finite element (FE) models. The size of numerical test matrices is expected to be large. A first task of the project shall be to suggest a methodology based on design of experiments.

The works includes include:

- bibliographic review on the stress analysis of single lap bonded joints
- development of a methodology to manage large numerical test campaign
- numerical testing based on simplified stress analyses and FE analyses

References

[1] JW van Ingen, and A Vlot. Stress analysis of adhesively bonded single lap joints. (Report LR-740). Delft University of Technology (April 1993).

[2] MY Tsai, and J Morton. An evaluation of analytical and numerical solutions to the single-lap joint. Int J Solids Structures. 31, pp. 2537-2563 (1994).

[3] LFM da Silva, PJC das Neves, RD Adams, and JK Spelt. Analytical models of adhesively bonded joints-Part I: Literature survey. Int J Adhesion Adhesives. 29, pp. 319-330 (2009).

Possibility to continue with a PhD (Yes/No) : TBD	
REQUIRED APPLICANT PROFILE AND SKILLS	
Study level (tick possible choices)	☐ Undergraduate students (3rd or 4th year) ■ Master students (1st or 2nd year) ☐ PhD students
Required profile and skills	This offer is suitable to students in last year of MSc, MEng in Solids Mechanics, Structures Mechanics. The expected specific skills are : • Fundamentals of strength of materials • Basics on the FE method
Other useful information	Feel free to take contact