Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: S*TRMAT*
Corresponding author: TAILLEUR Alexy
e-mail of corresponding author: alexy.tailleur@univ-tlse3.fr,
Type: Oral
Status of corresponding author: Student

Title

A global-local defect/damage initiation and propagation model for launcher composite structures pre-sizing

Authors

Alexy TAILLEUR [1,2], Kévin Mathis [2], Ange Rogani[3], Pablo Navarro[1], Steven Marguet[1], Jean-François Ferrero[1]*

** Corresponding author*
[1] Université de Toulouse, Institut Clément Ader, UMR CNRS 5312, Toulouse, France, alexy.tailleur@univ-tlse3.fr, pablo.navarro@univ-tlse3.fr, steven.marguet@univ-tlse3.fr, jean-francois.ferrero@univ-tlse3.fr
[2] CNES Direction Des Lanceurs, Paris, France, kevin.mathis@cnes.fr
[3] CT Ingenierie, Toulouse, France, ange.rogani@ctingenierie.com

Abstract

COLIBRI is a platform developed and used by CNES for designing and dimensioning space launchers' composite structures [1]. This tool is composed of three modules: technology pre-selection, pre-sizing and dimensioning. Defects and damages in composite structures are currently taken into account during the final stage. Thus, the selected structure is optimal to meet the specifications but is not necessarily the most efficient to support defects or damage. Therefore, it is necessary to address defects and damage as early as possible in the development stages of the structure.
The objective of this work is to develop a defect/damage initiation and propagation numerical model for launcher composite structures at pre-sizing stage. The structures optimized in COLIBRI have large dimensions and performing damage calculations on those whole structures is not a feasible solution during the pre-sizing step. The approach proposed in this paper is based on submodelling. It allows to circumvent this problem and to significantly reduce the calculation time while keeping the desired accuracy. Indeed, in large-scale structures such as those optimized in COLIBRI, damage initiation and propagation are generally local phenomena that are mainly triggered in areas of pre-existing defects, manufacturing imperfections and accidental/service damage or inefficient maintenance [2].
The proposed methodology consists on a shell-to-solid submodeling where defects such as porosity, matrix cracking and delamination have been inserted. The presence of these defects plays a predominant role in the initiation and propagation of damage [3,4]. The methodology developed focuses firstly on the initiation of damage in the presence of defects. The approach adopted is therefore unidirectional: the information flows from the "global" model to the distinct "local" model. It is realized through the numerical solver Nastran.This numerical model will be compared with a future experimental campaign conducted on coupon test. These tests will allow to set up the test-calculation dialogue for the validation of the model. The very next step is to move towards a two-way global-local approach with weakly coupled models. Eventually, this numerical model will be included in the optimization process and the best architecture will be determined with respect to the specifications and its tolerance to damage in the presence of defects.

References

[1] Julien, C. ; Irisarri, F.X. ; Bettebghor, D. ; Lavelle, F. ; Mathis, K., JEC Composite 2017, Volume 112, 51-53.
[2] Labeas, G.N. ; Belesis, S.D. ; Diamantakos, I. ; Tserpes, K.I., International Journal of Damage Mechanics 2012, Volume 21 (issue 3), 441-462
[3] Ogin, S.L. ; Brøndsted, P. ;Zangenberg, J., Modeling Damage, Fatigue and Failure of Composite Materials 2016, Woodhead Publishing, 3-23
[4] Mehdikhani, M. ; Gorbatikh, L. ; Verpoest, I. ; Lomov, S.V., Journal of Composite Materials 2018, Volume 53 (issue 12), 1579-1669