Research Intersnhip Proposal M1/M2
Institut Clément Ader CNRS UMR 5312

3 months

Period of internship : may-july 2020

Titre	Influence of the time and space distribution of the pressure generated by a lightning strike on the damage created in a composite aeronautic panel
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Context and purposes

Lightning strikes hitting a composite panel create damage as a direct effect. Damage is of two kinds. Surface burning zones are always present on the exposed side, even if the structure is protected by Lightning Strike Protection (LSP) layers. Core damage is typical of composite panels' damage and consists in cracks and delamination. Core damage is crucial for the design of the structure because of damage resistance and tolerance requirements fulfilment in aeronautics. In order to design the lightning protection layers that are mainly composed of metallic grids, it is important to discriminate the contribution of the different parts of this multi-physical load. Indeed, lightning strikes are considered by regulations in the shape of current waveforms of different prescribed peak loads and action integrals depending on the zone of the airplane. Previous works done in the lab have demonstrated that the global amount of delamination can be predicted given the kind of protection layer, as a damage resulting from an equivalent purely mechanical impulse load generated by complex electro-thermal-mechanical phenomena arising in the LSP [1]. As a first limitation of our model nevertheless, the damage distribution in the laminate thickness cannot be obtained from the simple pressure distribution in time and space. More recent work [2] have proved that the main event that creates the pressure if the LSP vaporisation and gives an estimation of it [2].

In this study, it is expected to determine pressure profiles that should be applied to reproduce the final damage distribution in the laminate thickness and the laminate rear face velocity in time.

Issues and key points

The proposed work is in the frame of the use computational mechanics and experimental plans. Previous work done in the lab allowed us to try different combinations of load in time and space distribution in order to evaluate their contribution on the kinematics and on the final damage. It has been shown that the pressure should be composed of a short time impulse and a long time pressure.

The object of this work is to enhance this first work and try to reproduce chosen real tests done in the lab. Analytical 1D models of shock propagation will be developed to help deriving a numerical model suitable for the 2D or the 3D simulations. The following steps will be followed:

- literature survey of newly published studies regarding lightning tests and simulations;
- learning how to use Abaqus or LS-DYNA to run shock simulations that give as an output the structural behaviour and damage in the thickness;
- sensitivity analysis against material properties and load combinations ;
- final conclusions.

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Profile and skills of the applicants

He or she is a Master student (M1 or M2) and have the following skills :

- strong experience in FE simulation and Matlab programming;
- strong knowledge of material science, mechanical structure analysis;
- basis knowledge in non-linear behaviour of materials, electromagnetism (bachelor level).

Complementary scientific background and skills :

- basis of sensitivity analysis or experience plans; first experience of transient dynamics
- communicant, autonomous
- reporting in English or French (scientific).

Duration and allowance

May-July 2020 (3 months). CHARPAK LAB PROGRAM students, no allowance.

Contact

Send complete CV, letter of motivation, diploma with marks, institution enrollment or registration certificate, Charpak funding certificate and copy of the visa to Christine.espinosa@isae-supaero.fr

References

[1] F. Soulas, C. Espinosa, F. Lachaud, S. Guinard, B. Lepetit, I. Revel, Y. Duval
A method to replace lightning strike tests by bal limpacts in the design process of lightweight composite aircraft panels. International Journal of Impact Engineering 111(2018) pp165-176. http://dx.doi.org/10.1016/j.ijimpeng.2017.09.007

[2] YA. Bigand, Ch. Espinosa, J.M. Bauchire
Lightning surface explosion impact study on damage generation into composite. 2019 International Conference on Lightning and Static Electricity, Wichita (2019). 9-13 sept. 2019