



## Thesis proposal for a Doctoral position 2017-2020

<b>Title</b>	<b>Experimental and numerical study of the behavior of hybrid unidirectional/woven composite laminates under impact loading.</b>
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### Research project description :

In the field of aeronautics, structures are largely made using composite materials, which leads to great weight improvements. A large number of parts are made of thin woven composite laminates. A solution for the improvement of that kind of structures would be to combine, within the same laminate, woven plies and unidirectional plies.

Impacts on composites structures are one of the most damaging load case. Indeed, as composite materials are brittle, impact loadings can lead to numerous degradations (matrix cracks, fiber failures, delamination)[1].

The main goal of this thesis work will be the study of low velocity and medium velocity impact response of hybrid unidirectional/woven composite laminates. This work will rely on existing studies concerning impacts on woven composite laminates [2]. A complete experimental study will be performed in order to identify the damage mechanisms within hybrid composite laminates during impact. Thus, drop weight and gas-gun impact tests will be performed. The tests results will be used for the development of a new and specific finite element model. It will be based on the semi-continuous modelling strategy set up at ICA [3-6]. With this strategy, the representation of matrix cracked and the modelling of fiber breakage is separated. At the end of this thesis work, proposals for the optimization of thin composite laminates will be given.

This work will be held in collaboration with Pr Serge ABRATE (Southern Illinois University, USA), specialized in impacts on composite materials.

[1] S. Abrate. Impact on composite structures. Cambridge University Press (1998)

[2] P. Navarro, J. Aubry, S. Marguet, J.-F. Ferrero, S. Lemaire and P. Rauch. Experimental and numerical study of oblique impact on woven composite sandwich structure : Influence of the firing axis orientation. Composite Structures. 94(6)1967-1972. 2012

[3] P. Navarro, J. Aubry, S. Marguet, J.-F. Ferrero, S. Lemaire and P. Rauch . Semi-continuous approach for the modelling of thin woven composite panels applied to oblique impacts on helicopter blades. Composites - Part A: Applied Science and Manufacturing. 43(6)871-879. 2012

[4] P. Navarro, S. Marguet, J.-F. Ferrero, J.-J. Barrau and S. Lemaire. Modelling of impacts on sandwich structures. Mechanics of Advanced Materials and Structures. 19(7)523-529. 2012

[5] P. Navarro, F. Pascal, J. Aubry, S. Marguet, J.-F. Ferrero, S. Lemaire and P. Rauch. Semi-continuous approach for the study of impacts on woven composite laminates: modeling interlaminar behaviour with a specific interface element. International Journal of Impact Engineering. , . 2014

[6] F. Pascal, P. Navarro, S. Marguet and J.-F. Ferrero. On the modelling of low to medium velocity impact onto woven composite materials with a 2D semi-continuous approach. Composite Structures. 134, 302-310. 2015