Title: Influence of the strength of the adhesive layer on the performance of a ceramic-adhesive-composite system

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Context and Stakes
These works are related to a PhD Thesis (2016-2019) performed in collaboration with the following laboratories ICube, ICA and ISL.

The PhD Thesis deals with the performance of shielding made of a ceramic layer and a backing composite layer. The main function of the ceramic layer is to slow down the advance of the impacting projectile. The main function of the composite backing layer is to retain the ceramic fragments. An adhesive layer is used to join the ceramic and composite layers.

If it is of highest relevance to understand the fragmentation modes of the impacting layers (Michel et al. 2006), it is required to take into account for the influence of the strength of the adhesive layer on failure modes. Indeed, the deflection of the backing adhesive layer is restricted – preventing from dramatic perforation – while the adhesive layer offers a sufficient stiffness.

The objectives of works are to better understand the structural effects of the three-layers system and of the adhesive layers under various strain rates. These works will be led at two scales to reach two different objectives.
1. experimental investigations: in order to characterize the behavior of the three-layers system and of the adhesive layer
2. experimental and numerical modeling: to suggest a methodology for simplified and/or refined simulations.

Description
Objective 1: experimental investigations
The mechanical behavior of the three-layers system and of the adhesive layer will be investigated under various loading conditions: quasi-static, Charpy, Hopkinson and other dynamic tests (Colard 2015) (Francart 2017).

Objective 2: experimental and numerical modeling
The simplified modelling could be based on the macro-element technique (Paroissien et al. 2018) and/or the use of cohesive zone modeling. The main difficulty in this part is the development...
of algorithms allowing for the integration of the mechanical behavior as functions of strain rates. If an implicit computation scheme is already available, one objective is the addition of an explicit computation scheme, possibly coupled with the implicit one.

The goal is to provide methods and tools for the prediction of the strength of the multilayered adhesively bonded system.

**Location**

The works will mainly be performed at ICA in Toulouse, France (F-31). Some experimental tests will be performed at Icube (Strasbourg, France, F-67) and ISL (Saint-Louis, France, F-68).

**References**

(Colard 2015) L. Colard, Etude du comportement sous impact balistique d’un blindage multicouche à composantes carbure de bore et aluminium, thèse de doctorat, Université de Lorraine, 2015.


**Profile and skills of applicants**

The applicant will have a PhD Thesis or have an experience in research activities and an engineer or MSc diploma. The main following skills are expected:

- to have basics on the mechanical behavior of polymeric materials
- to tailor the Finite Element Method
- to be autonomous in the development of MATLAB codes
- to be experienced in experimental testing under quasi-static and transient dynamic
- to be experienced numerical testing under quasi-static and transient dynamic

**Conditions and salary**

Fixed-term contract for duration of 36 months. Salary according to ISAE-SUPAERO scale.

The justified applications shall be sent to Christine Espinosa, Frédéric Lachaud and Éric Paroissien.

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