PhD proposal 2023-2026

Physico-numerical modelling of the impact resistance of metallic structures

Context

The overall project of this PhD work aims to numerically reproduce the response until the rupture of (naval, aeronautical, etc.) metal structures of large dimensions in the face of accidental overloads (collision, shock, etc.) involving large strains and high strain rates.

Objectives :

The objective is to reproduce in a unified methodology, based on the finite element method, the successive stages (ductile damage/localization of deformation/crack propagation) leading to the ultimate failure of the structure when the latter is subject to severe loads and in particular impact loads.

Previous work (PhD thesis by Konstantinos Nikolakopoulos, 2020) have shown promising results on the scale of a simple 3D structure when associating the GTN microporous plasticity model and the incorporation of a cohesive segment then of a strong discontinuity in the finite element in an X-FEM formulation (developed in the Abaqus commercial code). Recent work (PhD thesis by Antonio Kaniadakis, in progress) has made it possible to extend the model to large elasto-plastic deformations and to formulate a more physical cohesive model based on the coalescence of voids in the localization band.

The first scientific challenge of the PhD work is to formulate the model in the transient dynamic framework. The second challenge is to propose transition criteria for 'damage to localization' and 'localization to cracking' as well as a model of localization band behaviour, able to account for the physical mechanisms operating within the material. The influence of the loading type and rate on the one hand and the competition between hardening mechanisms (strain hardening, viscoplasticity) and softening mechanisms (damage, self-heating) on the other hand during these different phases (transition/evolution) will be studied and taken into account. This will be done in particular on the basis of experimental tests which have been carried out or/and will be carried out in the laboratory.

Keywords :

Ductile damage, crack propagation, XFEM, cohesive law, severe loads, impact

Conditions and skills :

* EU, UK or Swiss national
* Master or equivalent
* Computational and/or non-linear materials mechanics skills
* Taste for programming (fortran, python)

Supervisors :

Advisor : Patrice Longère
ISAE–SUPAERO / ICA (UMR CNRS 5312)
Co-advisor : Jean-Philippe Crété
ISAE-SUPMECA/QUARTZ (EA 7393)

Location :

Institut Clément Ader CNRS 5312, Toulouse.
Laboratoire Quartz EA7393, Saint-Ouen

Average salary (over the 3 years) :

Around 2000 euros net per month

Beginning :

October 2023

Contacts

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