

PhD proposal 2023-2026

Development of an experimental set-up for the study of the dynamic damage of metals

Context

During the nominal or accidental operation of a weapon, the release of gases generated by the detonation of the explosive charge causes the metal shell to swell violently, causing it to crack and dynamically fragment. The bursts generated are projected at very high speeds and at potentially large distances, which must be predicted.

More generally, the study of the damage mechanism leading to the collapse of metal structures during high-speed loading is of interest to CEA-DAM. It is now a matter of enriching the modelling in order to increase the predictive capacity. In this approach, the consideration of elementary phenomena such as the dependence of pore growth on the stress triaxiality ratio is currently being studied, notably by the Gurson model and its GTN extension. The validation of this modelling by discriminating experimental campaigns is a key point.

Objectives :

The objective of the PhD student will be to participate in the development of an experimental set-up to study the development of damage in a dynamically expanding metal structure (ring). Currently, a PhD work conducted at CEA-DAM Gramat in collaboration with ISAE-SUPAERO/ICA Toulouse has led to the development of an experimental set-up to study the dynamic radial expansion of a metal ring and to observe its fragmentation. The configuration is, for the moment, limited to a range of speeds and geometries which it is necessary to extend. The results obtained should make it possible to enrich the understanding and the modelling of the phenomena of damage and fragmentation via in particular numerical simulation.

Approach

The first part of the PhD work will be to establish a state-of-the-art model of the ductile damage of metals and associated experimental configurations. It will then be necessary to adapt the current experimental

system to meet the needs of the configurations, based on experimental, numerical and analytical expertise. Special attention will then be paid to the specification and implementation of in situ and post-mortem experimental diagnostics. Finally, the candidate will conduct experiments to create an experimental database for the validation of the numerical damage model.

Keywords :

Dynamic fragmentation, high loading rate experimentation, nonlinear constitutive modelling, numerical simulation

Conditions and prerequisites:

European Union or Swiss citizen
Master of Science or equivalent
Skills in Mechanics of materials
Coding (fortran, python)
Mobility

Supervision :

Academic supervisor : Patrice Longère, ISAE-SUPAERO / ICA (UMR CNRS 5312)
Industrial supervisor : Gabriel Seisson, CEA-DAM Gramat

Location :

To be shared in 2 periods between ISAE-SUPAERO/ICA Toulouse and CEA-DAM Gramat

Start :

2023 (depending on CEA-DAM clearance)

Contact

CV and letter of motivation to be sent to

patrice.longere@isae.fr

gabriel.seisson@cea.fr