Brittle's CODEX chair PhD proposal 2017-2020

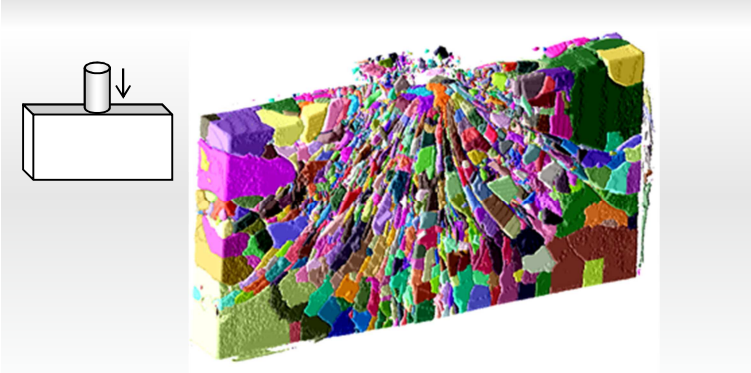
With the patronage support of:

Experimental investigation and multi-scale modelling of damage processes in armour ceramics under high-strain-rate tensile and compression loadings

CONTEXT AND AIM OF THE PHD THESIS

Due to their high compressive strength, high hardness and low density ceramics are largely used in armour systems, especially in lightweight armour solutions. During a ballistic impact of a projectile against a ceramic target severe damage modes develop in the ceramic resulting from compression and tensile high-strain-rate loadings. Compression stresses above the Hugoniot produce plasticity and microcracking mechanics while the dynamic tensile stresses that develop in the whole ceramic plate lead to an intense fragmentation made of numerous oriented cracks. New dynamic testing methods need to be developed to investigate the compression and tensile behaviour of ceramics as function of strain-rate.

In the framework of present PhD work plate-impact testing technique will be developed and conducted considering heterogeneous or specially machined flyer-plates that should produce smoothed (shockless) loading of the sample. This pulse shaping technique will allow the loading-rate applied to the sample to be controlled. In addition "sarcophagus configuration" will be developed to analyse "post-mortem" damage processes within the tested specimens by means of micro-tomography analysis. These experiments will enable advances to be made regarding the understanding and modelling of the behaviour of ceramics at very high strain-rate loadings. The modelling tools developed in the framework of the project will be employed to improve the design of protective solutions.



Use of micro-tomography to quantify fragmentation

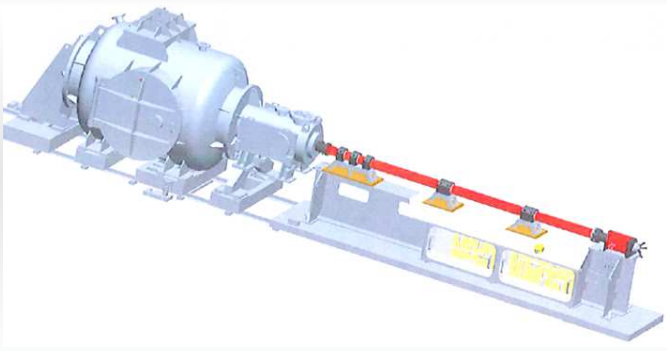


Plate-impact testing facility in 3SR

KEYWORDS : Ceramics, Armour, Damage and fragmentation, Plate-impact experiments, Numerical modelling

HOST : 3SR Laboratory, Univ. Grenoble Alpes, Grenoble, France.

PHD SUPERVISORS : Pr. Pascal FORQUIN (3SR/UGA), Dr. Dominique SALETTI (3SR/UGA), Dr. Edward ANDO (3SR/UGA).

CONTACT DETAILS

Pr. Pascal FORQUIN
Laboratoire 3SR (Sols, Solides, Structures, Risques), BP 53, 38041 Grenoble Cedex 9, FRANCE
E-mail : pascal.forquin@3sr-grenoble.fr, Tel.: +33 (0)4 76 82 52 48
Page web : https://www.3sr-grenoble.fr/spip.php?article758

CANDIDATE PROFILE

Level:	Master or engineering school (Bac +5)
Results in master:	Outstanding results
Fields:	Mechanics, materials, space and aircraft industry
Nationality:	No specifications

We are looking for highly motivated candidates who want to pursue a scientific career in mechanical engineering (academic or industrial). An ideal candidate would have a good background in mechanical or civil engineering, physics or applied mathematics, with strong analytical and computational skills and with interest for collaborating in an interdisciplinary project with a team-working attitude. Good communication in English is required.

APPLICATION

The candidates must provide a letter of motivation where they clearly state why, under their point of view, they should be enrolled in the project. At least, one recommendation letter from the scientist/s who mentored the candidate during her/his master studies is required. The letter must clearly expose the profile of the candidate with emphasis on the qualities making her/him suitable for being recruited. Additional recommendation letters from any other professor/professional will be welcomed.

BENEFITS

The successful candidate will be employed for 3 years and receive a salary about 2000 € per month. The PhD thesis will be conducted in relation with Saint-Gobain R&D centre near Cavaillon, France.

REFERENCES

Forquin P., Zinszner J.-L. (2017) A pulse-shaping technique to investigate the behaviour of brittle materials subjected to plate-impact tests. Phil. Trans. R. Soc. A 20160333. DOI: 10.1098/rsta.2016.0333

- Numerical design of an experimental testing technique based on plate-impacts

Forquin P., Ando E. (2017) Application of micro-tomography and image analysis to the quantification of fragmentation in ceramics after impact loading. Phil. Trans. R. Soc. A 20160166. DOI: 10.1098/rsta.2016.0166.

- Analysis of damage in impacted ceramics by means of X-ray micro-tomography analysis

Zinszner J.-L., Erzar B., Forquin P., Buzaud E. (2015) Dynamic fragmentation of an alumina ceramic subjected to shockless spalling: an experimental and numerical study. J. Mech. Phys. Solids, 85, 112–127.

- Investigation of the tensile strength of alumina ceramics by means of spalling tests

Zinszner J.-L., Forquin P., Rossiquet G. (2015) Experimental and numerical analysis of the dynamic fragmentation in a SiC ceramic under impact, Int. J. Impact Eng., 76, 9-19.

- Experimental and numerical study of fragmentation in SiC ceramic under impact

Forquin P., Hild F. (2010) A probabilistic damage model of the dynamic fragmentation process in brittle materials. Advances in Applied Mech. Giessen & Are feds. 44, pp. 1-72. Academic Press, San Diego, CA.

- Analytical and numerical modelling of the dynamic fragmentation process

Start of PhD thesis: from October 2017 to February 2018