Brittle's CODEX chair PhD proposal 2017-2020

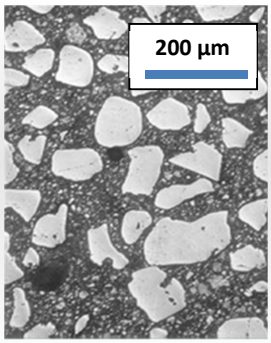
With the patronage support of:

Experimental testing and numerical modelling of the tensile and compression damage in ultra-high performance concrete under impact loadings

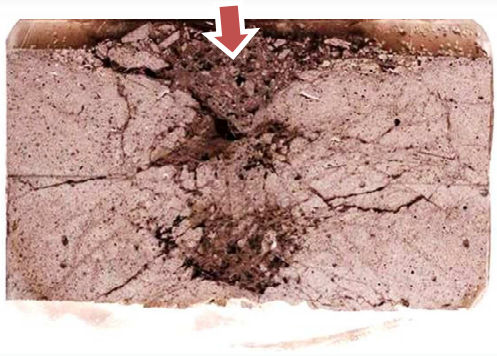
CONTEXT AND AIM OF THE PHD THESIS

The context of the present PhD concerns the use of ultra-high performance fibre-reinforced concrete (UHPFRC) for building protective structures such as headquarters, nuclear power plants or critical civil engineering structures. Under rigid projectile impact, blast loading or contact detonation, concrete is exposed to very high confinement stresses and dynamic tensile loading which lead to severe damage modes such as pore collapse, shear fracturing, spalling, cratering, and multiple fragmentation. It is essential to understand the main properties of damage processes (namely, characteristic time to damage, density, orientation and extension of cracking, ultimate strength) as functions of the loading rate, the microstructure of the tested concrete and the fibre reinforcement.

In the framework of present PhD work, plate-impact testing techniques will be developed and conducted which should produce smoothed (shockless) loading of the sample. Such a pulse shaping technique will allow controlling the loading-rate which is applied to the sample. 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 lead to better understanding and modelling of the behaviour of UHPFRC at very high strain-rate loadings. The modelling tools developed in the framework of the project will be employed to simulate numerically impact experiments and to improve the design of protective solutions made of such concrete.



UHPC microstructure



Damage in UHPFRC under impact loading

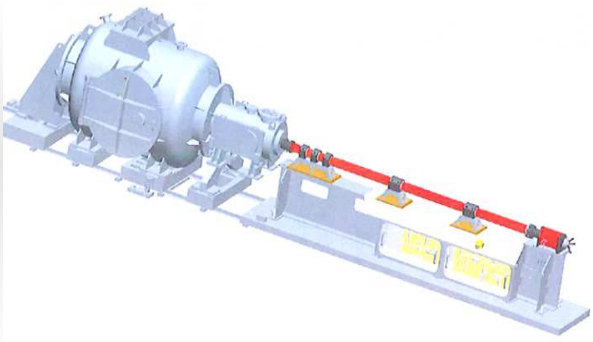


Plate-impact testing facility in 3SR

KEYWORDS: Concrete, 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 PROFIL

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

We are looking for highly motivated candidates who want to pursue a scientific career in mechanical or civil engineering (academic or industrial). An ideal candidate would have a good background in mechanics and 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 Lafarge-Holcim R&D centre near Lyon where UHPFRC are developed.

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

Lukić B., Forquin P. (2016) Experimental characterization of the punch through shear strength of an ultra-high performance concrete. Int. J. Impact Eng. 91, pp. 34-45. DOI: 10.1016/j.ijimpeng.2015.12.009.

- Investigation of the dynamic shear strength of concrete by means of PTS tests

Erzar B., Forquin P. (2014) Analysis and modelling of the cohesion strength of concrete at high strain-rates. Int. J. Solids Struct. 51(14), pp. 2559-2574.

- Experimental and numerical study of the dynamic tensile strength of concrete

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