PhD proposal on Mechanics

Experimental testing of masonry structures subjected to extreme loads

(École Centrale de Nantes, France)

Research context History shows that extreme loads, such as explosions, are a major threat for our cultural heritage. Regarding the former, well-known examples are, among many others, the explosion of Parthenon (1687), of Palmyra in 2015/2016, and, of the Great Mosque of al-Nouri, in 2017. Explosions are also a threat for our modern built environment, which should show high resilience and minimize human injury and loss risk.
There is hence the need to better assess the threat of explosions meant to destroy civil engineering assets.

In order to better understand the dynamic behavior of such kind of assets and identify the dominant parameters that influence their response under extreme, fast-dynamic loads, experimental testing is a key element. Nevertheless, performing blast experiments in full-scale presents many difficulties, due to the nature of the loading action (e.g. need of specialized personnel, risks, measuring devices, lack of repeatability, uncontrolled uncertainties etc.). These difficulties are also accentuated due to the complexity related to the structural response.
In the proposed Thesis we overcome many of the these problems by the design of in-scale laboratory safe tests. These tests guarantee a high degree of repeatability and allow testing under conditions that can be hardly reproduced in full-scale models.

Available position Successful candidates are expected to have strong scientific skills and high motivation to fulfill the requirements of this doctoral Thesis. Fluency in spoken and written English is required. French is not required, but is appreciated.
The students will carry out their research project, write scientific articles and their PhD thesis in close collaboration with their supervisor and the members of the research group *BLAST*.

Laboratory experiments in reduced scale will be performed using 3D printed geometries of modern and monumental structures. The candidate should have:

- Strong background in dynamics of structures
- Interest in mechanical design and prototyping
- Strong taste in experimental testing

Good knowledge of mathematics, mechanics and programming will be highly appreciated.
The PhD work can be decomposed into the following tasks (with increasing complexity):

- Familiarization with masonry structures, extreme loading (blast loads) modeling and fast-dynamics metrology and literature review$-$*6 months*
- Design of experiments $-$*6 months*

- Execution of reference benchmark laboratory tests, i.e. case studies of reduced geometric complexity in 2D and 3D−*9 months*
- Experimental testing of characteristic real cases−*9 months*
- Articles and Thesis writing−*6 months*

The PhD student will carry out her/his research project, write scientific articles and her/his PhD dissertation in close collaboration with her/his supervisor and members of his research group.

Related references

- Kingery, C.N. and Bulmash, G. (1984). Technical report ARBRL-TR-02555: Air blast parameters from TNT spherical air burst and hemispherical burst. AD-B082, 713.
- Logan, J.D., 2013. Applied mathematics. John Wiley Sons.
- Masi, F., Stefanou, I., Vannucci, P. (2018). A study on the effects of an explosion in the Pantheon of Rome. Engineering Structures, 164, 259–273.
- Masi, F., Stefanou, I., Vannucci, P. and Maffi-Berthier, V. (2019). Rocking response of inverted pendulum structures under blast loading. International Journal of Mechanical Sciences, 157, pp.833-848.
- Masi, F., Stefanou, I., Maffi-Berthier, V. and Vannucci, P. (2020). Discrete Element Method based-approach for arched masonry structures under blast loads. Engineering Structures, In press.

General condition The appointment forms part of the Connect Talent project "Controlling ExtremeEvents" (CEEV), funded by the Pays de la Loire. The successful candidate will join the team MEO[1] of GeM laboratory[2] in ECN. The position offers the opportunity of working on challenging scientific topics and in a stimulating research environment, with high scientific and societal impact of the conducted research. Other activities will include interaction with Master and undergraduate students. The project will cover travel expenses for attending international conferences and workshops.

Application The position is open and will start upon agreement. Suitable, highly-motivated candidates should send an application (including a CV, a cover letter describing interests and qualifications related to the PhD Thesis and contact details of at least two reference Professors, all compiled in a single PDF file) to:

Ioannis Stefanou, ioannis.stefanou@ec-nantes.fr.

Candidate selection will be performed on the basis of the excellence of the CV and motivation.

[1] MEO - Matériaux-Environnement-Ouvrages, website.
[2] GeM - Institut de Recherche en Génie Civil et Mécanique, website.