MONITORING AND MODELLING OF PROPAGATION PATHS IN CRACKED BRITTLE SOLIDS

Research group: Camilla Colla, **Elena Ferretti**, Alessandro Marzani, **Giovanni Pascale**, Erasmo Viola

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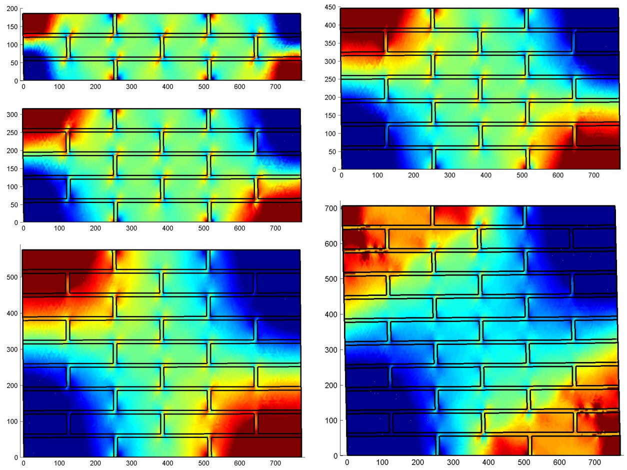

Fig.1 stress field for masonry wall in shear-test

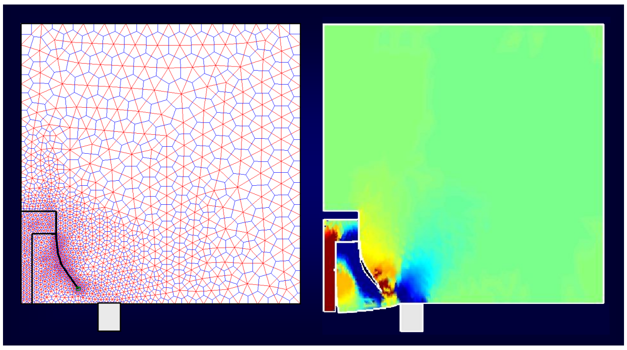

Fig.2 propagation path for the Lok-Test on concrete

The monitoring of existing cracks can be performed by means of several non-destructive techniques. A part of the research activity has been dedicated to new techniques for SHM (structural health monitoring), with particular regard to the assessment of externally bonded FRP (fiber reinforced polymer) strengthening systems.

The use of FOS (fiber optic sensors) has been taken into account, and some new applications have been developed. A ultrasonic technique has been proposed for detecting defects at the concrete-FRP interface.

Defining the crack path numerically is not easy, due to several unknowns: if the direction of crack propagation can be computed by means of one of the existing criteria, it is not known whether this direction will remain constant during crack propagation. A crack initiation leads to an enhanced stress field at crack tip, which propagates into the solid during propagation, locally interacting with the pre-existing stress field. This interaction can lead to modifications of the propagation direction or crack arrest.

A numerical code for use with the CM has been developed which returns accurate crack paths for brittle and non-brittle cracks. The CM code has been employed for modelling crack propagation in concrete and masonry. The main advantage of using the CM for numerical analyses of masonry is that mortar, bricks and interfaces between mortar and bricks can be modelled without any need to use homogenization techniques. The capability of the CM to handle domains with more than one material has been exploited to capture how the propagation direction changes when the crack overcome the joints or passes from the brick to the interface and to the mortar. The CM code is able to self-compute the position of crack initiation, manage several cracks propagating at the same time, take into account interactions between propagating cracks, self-estimate whether or not one or more cracks bifurcate and follow the propagation of each branch of bifurcation.

Links

elena.ferretti2@unibo.it
giovanni.pascale@mail.ing.unibo.it
www.dicam.unibo.it/DICAM/Risorse e strutture/Laboratori

Main Publications

F. Daghia, A. Giammarruto, G. Pascale. (2009). Monitoring with FBG to control cracking of r.c. structures before retrofitting. In FURUTA, FRANGOPOL & SHINOZUKA . Safety, Reliability and Risk of Structures, Infrastructures and Engineering Systems . 10th International Conference on Structural Safety and Reliability ICOSSAR2009. Osaka. September 13-17, 2009. (pp. 1 - 10). ISBN: 978-0-415-47557-0. LONDON: Taylor & Francis Group (UNITED KINGDOM).

E. Ferretti. (2009). Cell Method Analysis of Crack Propagation in Tensioned Concrete Plates. COMPUTER MODELING IN ENGINEERING & SCIENCES. vol. 54, pp. 253 - 282 ISSN: 1526-1492.

E. Ferretti. (2004). A Cell Method (CM) Code for Modeling the Pullout Test Step-Wise. COMPUTER MODELING IN ENGINEERING & SCIENCES. vol. 6, pp. 453 - 476 ISSN: 1526-1492.

E. Ferretti. (2004). Crack-Path Analysis for Brittle and Non-Brittle Cracks: a Cell Method Approach. COMPUTER MODELING IN ENGINEERING & SCIENCES. vol. 6, pp. 227 - 244 ISSN: 1526-1492.

E. Ferretti, E. Casadio, A. Di Leo. (2008). Masonry Walls under Shear Test: a CM Modeling. COMPUTER MODELING IN ENGINEERING & SCIENCES. vol. 30, pp. 163 - 190 ISSN: 1526-1492.

F. Lanza di Scalea, P. Rizzo, S. Coccia, I. Bartoli, M. Fateh, E. Viola, G. Pascale. (2005). Non-contact ultrasonic inspection of rails and signal processing for automatic defect detection and classification. INSIGHT. vol. 47(6), pp. 346 - 353 ISSN: 1354-2575.

G. Pascale. (2008). Diagnostica ad ultrasuoni per l'edilizia: strutture civili, beni culturali. (pp. 131). ISBN: 978-88-7758-642-1.

G. Pascale. (2007). La valutazione del calcestruzzo nelle strutture esistenti. IN CONCRETO. vol. 78, pp. 64 - 73.

G. Pascale, F. Bastianini. (2009). The role of quality control and of long-term monitoring in the structural applications of composite materials. In A. DI TOMMASO. Meccanica delle strutture in muratura rinforzate con compositi. Convegno Nazionale MURICO3 - Meccanica delle strutture in muratura rinforzate con compositi. Venezia. 22-24 aprile 2009. (pp. 399 - 406). ISBN 88-371-1771-. BOLOGNA: Pitagora (ITALY).

G. Pascale, B. Bonfiglioli. (2006). Dynamic assessment of reinforced concrete beams repaired with externally bonded FRP sheets. MECHANICS OF COMPOSITE MATERIALS. vol. 42, pp. 1 - 12 ISSN: 0191-5665.

T. Stratford; G. Pascale; O. Manfroni; B. Bonfiglioli. (2004). Shear strengthening masonry panels with sheets. JOURNAL OF COMPOSITES FOR CONSTRUCTION. vol. 8(5), pp. 434 - 443 ISSN: 1090-0268.

A. Strauss; K. Bergmeister; B. Bonfiglioli; G. Pascale. (2005). Basic Study of Monitoring with FRP. SMART MATERIALS AND STRUCTURES. vol. 14, pp. S12 - S23 ISSN: 0964-1726.

Research Projects

- SMooHS - Smart Monitoring of Historical Structures, Unità di Bologna, European Research project ENV.2007.3.2.1.1.
- A. Di Leo. (2006). Homogenization of elementary cells of masonry by means of the Cell Method, PRIN.
- Di Leo. (2004). Historical-monumental heritage: modelling and stochastic identification of damage and risk, PRIN.

ALMA MATER STUDIORUM • UNIVERSITÀ DI BOLOGNA
VIALE DEL RISORGIMENTO, 2 - 40136 BOLOGNA - ITALIA - TEL. +39 051 2093237 - 2093502 - FAX +39 051 2093253
VIA TERRACINI, 28 - 40131 BOLOGNA - ITALIA - TEL. +39 051 2090312 - FAX +39 051 2090322
www.dicam.unibo.it