Dottorato di Ricerca in Ingegneria e Architettura XXXV° ciclo

Coordinator: Sandro Longo

RESEARCH ACTIVITY

Phase-Field approach for brittle fracture

UNIVERSITÀ
DI PARMA

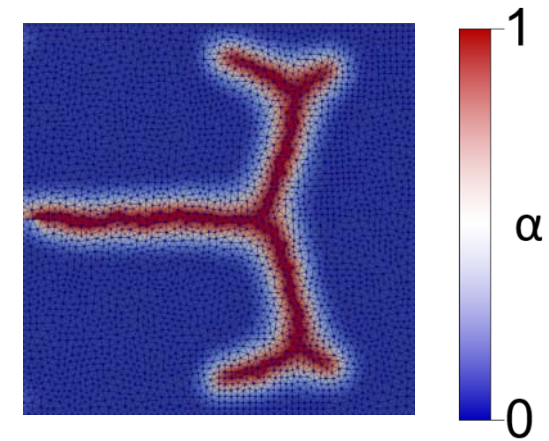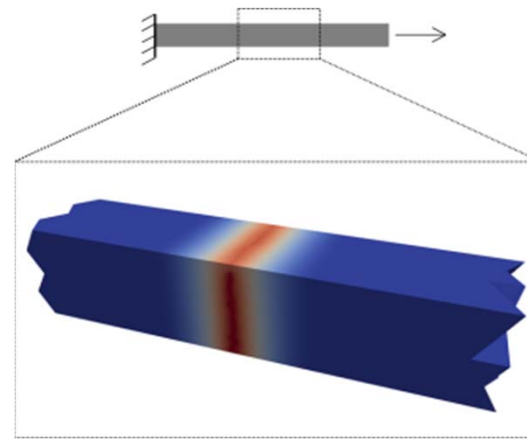PhD student: Lorenzo Mingazzi

Tutor: Francesco Freddi

A. A. 2020/2021

04/02/2021

PHASE-FIELD

- Variational approach based on the Griffith's fracture theory for brittle material;

- Damage is represented by a smooth scalar field where cracks are described as a transition zone between broken and unbroken material;

- Cracks nucleation and propagation are described via the minimization of a two field (displacement and damage) energy functional;
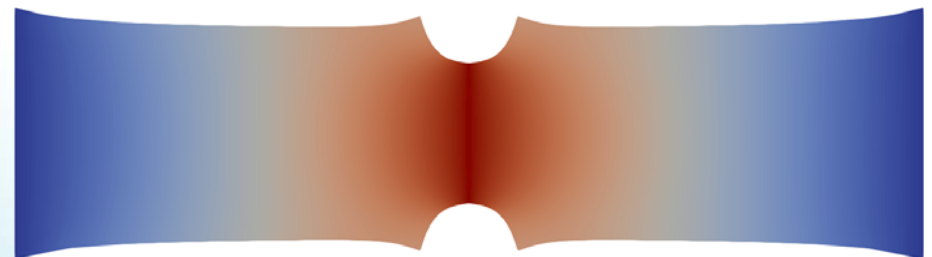

$$\Pi_l(\mathbf{u}, \alpha) = \int_\Omega \left((1-\alpha)^2 + k_l\right) \left(\frac{1}{2}\mathbb{C}\mathbf{E}(\mathbf{u}) \cdot \mathbf{E}(\mathbf{u})\right) dx \quad + \quad \frac{\gamma}{2}\int_\Omega \left(l\|\nabla\alpha\|^2 + \frac{\alpha}{l}\right) dx$$

$\underbrace{}$ **Strain Energy** $\qquad\qquad\qquad$ $\underbrace{}$ **Fracture Energy**

Current topics of research:

RC COVER CRACKING

FRACTURE IN HYPERELASTIC MATERIALS

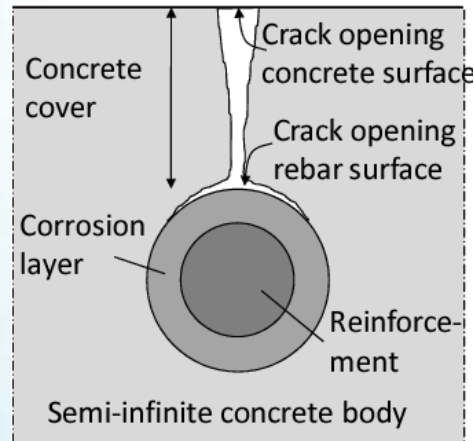Tutor: Francesco Freddi $\qquad\qquad$ PhD student: Lorenzo Mingazzi $\qquad\qquad$ A.A. 2020/2021

RC COVER CRACKING

- Simulation of the corrosion induced cover cracking phenomenon via a numerical model which can describe:

  1 - CO_2 diffusion within concrete

  2 - Swelling of the steel rebar

  3 - Cover cracking via the phase-field method

FRACTURE IN HYPERELASTIC MATERIALS

- Usage of the different strain energy function to reproduce the mechanical behavior of different biological tissues (Neo-Hookean, Mooney-Rivlin, etc);

- Extension of the phase-field model to describe fracture in hyperelastic materials;
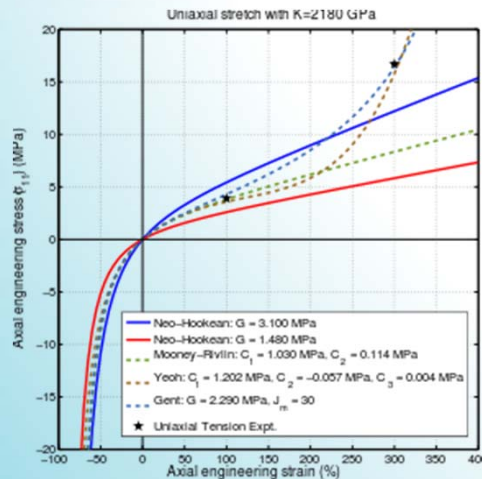
PUBLICATIONS

1. R. Alessi, F. Freddi, L. Mingazzi, ''Phase-field numerical strategies for deviatoric driven fractures'', Comput. Methods Appl. Mech. Engrg. 2020, vol. 359, DOI: https://doi.org/10.1016/j.cma.2019.112651

2. Freddi F., Mingazzi L., ''Phase-fiel simulations of laminated glass beams'', Materials, 2020, vol. 13, DOI:https://doi.org/10.3390/ma13143218

TOPIC of the THESIS

''Phase-field approach for fracture problems in hyperelastic materials''

Tutor: Francesco Freddi   PhD student: Lorenzo Mingazzi   A.A. 2019/2020