FRACTURE MECHANICS

Level: Master and PhD

Total number of hours: 30

Semester: Spring 2018

Instructor: Dr. Christian Carloni

COURSE OBJECTIVES

The field of fracture mechanics was virtually nonexistent prior to War World II, but has since grown and it is now a mature discipline. The first fundamental works by Inglis (1913), Griffith (1922, 1924), and Irwin (1957) pointed toward the direction of determining the effect of a crack on the stress field of a continuum and under which conditions the crack would grow. The assumption of a linear elastic behavior was made at the early stages of fracture mechanics. However, it was soon recognized that linear elastic fracture mechanics (LEFM) yielded good predictions only when fracture was very brittle, hence the structures had to remain elastic until the initiation of fracture. For materials such as steel or concrete this was not the case and various nonlinear fracture mechanics theories were developed. For ductile materials, elastoplastic fracture mechanics was developed, whereas for quasi-brittle materials such as concrete the two major approaches were the equivalent elastic crack model and the cohesive crack model.

This course presents fundamental topics of fracture mechanics, spanning from linear elastic fracture mechanics to the cohesive crack model of quasi-brittle materials. The size effect will be presented and some basic aspects of fatigue will be discussed within the framework of fracture mechanics.

COURSE MATERIAL

Anderson, T.L. (2004), Fracture mechanics: fundamentals and applications, Boca Raton, Florida, CRC Press.

Bazant, Z.P. and Planas, J. (1997), Fracture and size effect in concrete and other quasibrittle materials, Boca Raton, Florida, CRC Press.

TENTATIVE SCHEDULE

3-hour lectures will be held from 2:00 pm to 5:00 pm unless otherwise noted. As part of the course, a project will be assigned and a laboratory session will be organized to show how fracture tests on brittle and quasi-brittle materials are conducted. A final exam will be scheduled and be part of the course.

Feb 2nd: Introduction to Fracture Mechanics. Linear Elastic Fracture Mechanics: the energy approach.

Feb 5th : Linear Elastic Fracture Mechanics: the energy approach (continued) vs. the local approach. The stress intensity factor (SIF).

Feb 12th: Advanced topics in Linear Elastic Fracture Mechanics: mixed-mode loading, methods to determine the stress intensity factors, elliptical (3D) cracks, and triaxial states in 2D cracks.

Feb 16th: Non-Linear Fracture Mechanics: Irwin and Dougdale's approaches for plastic materials.

Feb 19th: J-integral and R-curves.

Feb 23rd: Non-Linear Fracture Mechanics: cohesive crack model. (2:00-6:00 pm)

Feb 26th: Laboratory. (To be confirmed, 2:00-6:00 pm)

March 2nd: Non-Linear Fracture Mechanics: cohesive crack model vs. other models for quasi-brittle materials.

March 7th: Size effect in Fracture Mechanics. Fundamentals of Fatigue. (2:00-6:00 pm)

April 7th: Final Exam

Enrollment is mandatory. Students and professionals who are interested in the course can enroll in the course by sending an email to christian.carloni@unibo.it.