Experimental characterization, modeling and simulation of fracture and subsequent acoustic emission.

Context

The development of reliable tools for predicting fracture in a structure is of primary importance in the design process of a part, since it allows reducing the number of characterization tests that may be costly and time consuming. The set up of predictive models and simulations still requires some experimental characterization of fracture in order to i) identify the input parameters and ii) validate the predicted results. These tests may be multi-instrumented in order to collect as much data as possible.

For instance, acoustic emission (AE) is a non-destructive instrumentation that allows the detection of phenomena such as cracking, which dissipates elastic waves resulting from local crack-induced displacement jumps within the material. Sensors placed at the surface of the tested specimen allows capturing the resulting signal. The use of AE thus allows tracking crack nucleation and propagation in the material at least from a qualitative point of view. Indeed, the signal induced by crack nucleation and propagation depends on the propagation media, the structure geometry and on the crack characteristics (*e.g.* size, crack velocity). Moreover, it may be modified by the type of sensors used, their placement on the specimen, the coupling between the sensor and the specimen or even the system acquisition parameters.

A more quantitative relationship between the original wave emitted by the source (*i.e.* the crack), and the captured signal could be established by means of numerical simulation of the acoustic wave propagation from the source to the sensor.

Objectives

The objective of this work is twofold: On the one hand, it aims at developing predictive and reliable models and simulations of crack initiation and propagation under quasi-static or dynamic loading conditions. On the other hand, it aims at simulating the acoustic emission, i.e. the wave propagation in the material due to fracture, in order to enrich the understanding in the use of acoustic emission during experimental tests. A model material such as PMMA will be studied in order to:

1) characterize experimentally crack initiation and propagation under different kind of loadings (quasi-static or dynamic, mixed mode) as well as resulting acoustic emission signals. To this aim, laboratory tests on specimens with a simple geometry will be adopted;

2) set up modeling and simulations of crack initiation and propagation under such conditions. These models will allow predicting both crack initiation and stable or unstable propagation under various loading conditions;

3) propose numerical simulations of acoustic emission within the material. This will for instance allow studying the influence of the type of sensors or their placement on the specimen, which is a key feature in order to optimize the acquisition set up.

Contacts

claudio.fusco@insa-lyon.fr

nathalie.godin@insa-lyon.fr

aurelien.doitrand@insa-lyon.fr