PAPER REF: 4351

MODE II FRACTURE CHARACTERIZATION OF BOVINE BONE USING THE ENF TEST

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ABSTRACT

A miniaturized testing device of the end notched flexure (ENF) test was conceived to evaluate energy release rate under mode II loading of bovine bone. In order to overcome the difficulty inherent to crack length monitoring during propagation, a new data reduction scheme based on crack equivalent concept was used. This method uses the specimen compliance and the beam theory to assess the evolution of the energy release rate as a function of crack extension, i.e., the so-called *R*-curve under pure mode II loading. A numerical analysis was used to validate the procedure using cohesive zone modelling. The trapezoidal cohesive damage law was verified to accurately reproduce the fracture behaviour of bone. The proposed miniaturized version of the ENF test together with the used data reduction scheme revealed to be effective concerning fracture characterization of bone under pure mode II loading.

Keywords: bone, mode II, fracture characterization, end notched flexure test, cohesive zone modelling.

INTRODUCTION

Fracture characterization of bone has been attracted the attention of several researchers (Norman, 1995; Yang, 2006; Morais, 2010). Most of these authors have studied bone fracture under mode I loading. However, fracture under mode II has not received practically any attention although it plays a fundamental role in bone fracture due to shear and twist effects. As a result, fracture characterization under mode II is a fundamental topic does must deserve a special attention. As a consequence of this observation, in the present work a miniaturized version of the end notched flexure (ENF) is used to characterize bone fracture (Figure 1). The ENF is widely used in other materials with success (de Moura, 2009).

RESULTS AND CONCLUSIONS

Numerical simulations using the finite element analysis with cohesive zone modeling was performed. It was verified that a trapezoidal cohesive law (Figure 2) well reproduces the fracture behavior of bone. In fact, the agreement between the numerical and experimental load-displacement curves was excellent when the referred law was used. This reveals that the proposed test method and data reduction schemes are powerful tools concerning mode II fracture characterization of bone.

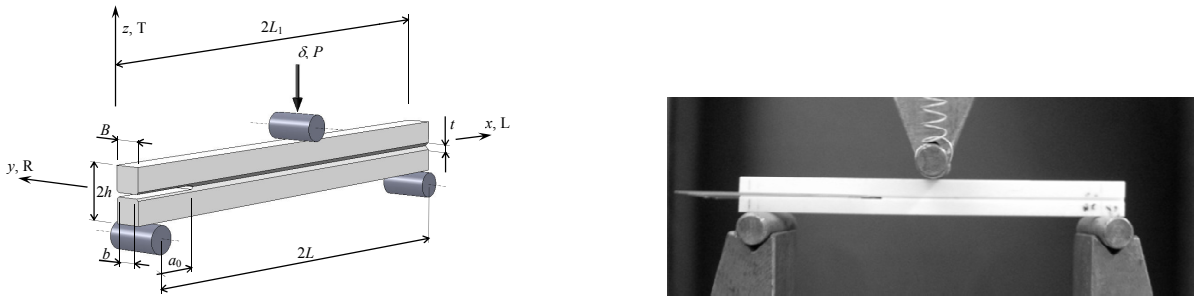

Fig. 1 - Schematic representation and experimental setup of the ENF test

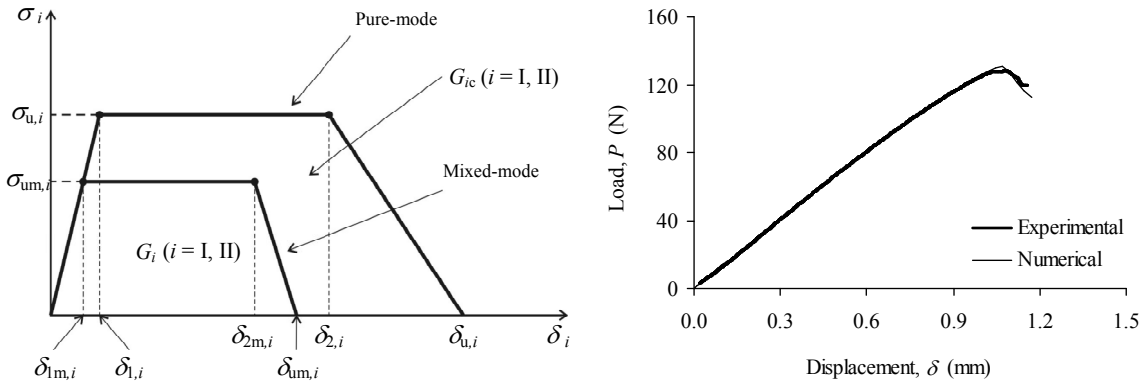

Fig. 2 - Cohesive law and load-displacement curves

ACKNOWLEDGMENTS

The authors acknowledge the Portuguese Foundation for Science and Technology (FCT) for the conceded financial support through the research project PTDC/EME-PME/119093/2010.

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