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R. Akiki[1], C. Giry[1], and F. Gatuingt[1]

LMT-Cachan (ENS Cachan/CNRS/Université Paris-Saclay), 61 avenue du Président Wilson, 94235 Cachan Cedex, France

Abstract: The fracture process of a prismatic notched beam subjected to a dynamic loading was investigated numerically. Two different approaches for post-treating the finite element analysis performed at the structural scale were tested. First results of the predictions of crack location and opening for the two approaches at different loading steps are presented and compared to the experimental data.

1. Introduction

The analysis and prediction of the degradation process and cracking of fiber-reinforced concrete structures with numerical models is an important issue in the field of civil engineering. Continuum damage mechanics succeed in predicting the strongly non-linear behaviour of such structures. However, in order to obtain precise quantative information about cracks like spacing and openings, the macroscopic model fails. The objective of this research is to extract local information such as cracking using two post-treatment methods of a global finite element analysis.

2. Methods & Results

First, a global non-linear finite element analysis of the whole structure is performed. This analysis reveals the zones of degradation that are to be reanalyzed via a local analysis using two post-treatment methods. The displacement fields obtained from the FE analysis are compared to the experimental data provided from the post-processing of the actual test (more details in [4]) in order to ensure the concordance of the results on the global scale (Figure 1).

(a) (b)

Figure 1. Displacement fields resulting (a)from the global FE analysis and (b)from experimental test using DIC [5].

The first method combines a topological search method used to locate cracks developed by Bottoni[1] and a continuous/discontinuous approach used to compute the crack opening initially proposed by Dufour[2]. It consists in comparing the computed strain fields ε_{FE}, with the analytical one derived from the displacement profile described as a strong discontinuity. Both strain fields are regularized using a Gaussian function. The crack opening $[U]$ can then be adjusted so as to reduce the gap between the regularized strain field $\overline{\varepsilon_{EF}}$ and the regularized strong discontinuity strain field $\overline{\varepsilon_{SD}}$.

[1] Corresponding author
E-mail address: akiki@lmt.ens-cachan.fr (R. Akiki)

The second method is a non-intrusive reanalysis at the local scale performed with a discrete model in order to extract fine information about crack opening. A region of interest (ROI) corresponding to the damaged area obtained from the global analysis is defined. Then, the loading steps corresponding to the steps of reanalysis are determined, where boundary conditions are extracted from the continuous displacement field and applied on the non-free surfaces of the ROI. The material is described with a discrete element approach based on an assembly of polyhedral particles linked by Euler–Bernoulli beams with brittle behaviour. Further details concerning the discrete model used at the local scale can be found in [3].
First results concerning the crack pattern and opening obtained by both methods are shown in Figure 2.

(a) *(b)*

Figure 2. Crack field at the last step of the computation: (a) topological search and crack opening estimation and (b) global/local method.

3. Conclusions

This contribution aims to determine crack opening of a notched fiber-reinforced concrete beam subjected to a dynamic one-point bending test with the use of finite element analysis performed at the structural scale followed by two post-treatment methods. The first one consists in a topological search method used to locate cracks and then the crack opening is computed by comparing the regularized strain field obtained numerically and the analytical one derived from the strong discontinuity representative of a discrete crack. The second is a global/local method which introduces a discrete mechanical model at the finer scale to obtain crack properties using the finite element displacement field as boundary conditions. These two approaches are compared in terms of crack opening prediction and seem to give promising first results. Further studies are ongoing in order to improve the methods and confirm these results.

Acknowledgements

The authors would like to acknowledge the financial support of AREVA.

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