Complete Tangent Stiffness for eXtended Finite Element Method by including crack growth parameters - DTU Orbit (02/10/2019)

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The eXtended Finite Element Method (XFEM) is a useful tool for modeling the growth of discrete cracks in structures made of concrete and other quasi-brittle and brittle materials. However, in a standard application of XFEM, the tangent stiffness is not complete. This is a result of not including the crack geometry parameters, such as the crack length and the crack direction directly in the virtual work formulation. For efficiency, it is essential to obtain a complete tangent stiffness. A new method in this work is presented to include an incremental form the crack growth parameters on equal terms with the degrees of freedom in the FEM-equations. The complete tangential stiffness matrix is based on the virtual work together with the constitutive conditions at the crack tip. Introducing the crack growth parameters as direct unknowns, both equilibrium equations and the crack tip criterion can be handled within the same standard nonlinear iterations. This new solution strategy is believed to provide the modeling capabilities to deal with simultaneous growth of several cracks. A cohesive crack modeling is used. The method is applied to a partly cracked XFEM element of linear strain triangle type with the crack length as the unknown crack growth parameter. In this paper, two examples are given. The first example verifies the theory and the implementation. The second example is the benchmark test three point bending test, where the efficiency of the complete tangential behavior is shown. Copyright © 2013 John Wiley & Sons, Ltd.

General information
Publication status: Published
Organisations: Department of Civil Engineering, Section for Structural Engineering
Contributors: Mougaard, J., Poulsen, P., Nielsen, L.
Pages: 33-45
Publication date: 2013
Peer-reviewed: Yes

Publication information
Volume: 95
Issue number: 1
ISSN (Print): 0029-5981
Ratings:
  BFI (2013): BFI-level 2
  Scopus rating (2013): CiteScore 2.8 SJR 2.358 SNIP 1.857
  Web of Science (2013): Impact factor 1.961
  ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Original language: English
Keywords: Fracture mechanics, Cohesive cracks, XFEM, Convergence rate, Complete tangent stiffness, Crack geometry parameters, Partly cracked elements
DOIs:
  10.1002/nme.4497
Source: dtu
Source ID: n:oai:DTIC-ART:wiley/388208284::29300
Research output: Contribution to journal › Journal article – Annual report year: 2013 › Research › peer-review