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A Nonlocal Lattice Particle Model for Fracture Simulation of Anisotropic Materials

Hailong Chen, Yang Jiao, Yongming Liu[1]

School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ, 85287, U.S.A.

Abstract

A novel nonlocal lattice particle model for fracture simulation of anisotropic materials is proposed. The key idea is to handle material anisotropy by rotating topological lattice structure rather than transforming material stiffness matrix. One major advantage of this model is that the crack path preference of anisotropic materials is naturally incorporated by underlying lattice structure. First, analytical derivation and formulation of the proposed model is given. The equivalency of lattice structure rotation and stiffness transformation is discussed. Following this, numerical examples are used to demonstrate the modeling capability of proposed methodology. Discussions and future work are given based on the current investigation.

Keywords: A. Laminates; B. Delamination; B. Fracture; C. Computational modeling

1. Introduction

Modelling of fracture behavior of isotropic brittle materials can be traced back to Griffith [1]. One important issue in fracture simulation is the propagation path determination. Under quasi-static loading, several popular failure criteria have been used along with the Griffith's theory to determine the crack path, such as the maximum energy release rate [2], the minimum strain energy density [3], and the maximum circumferential stress [4]. Unlike isotropic material, properties of anisotropic material are orientation dependent. Thus, modeling of various phenomena of anisotropic material, such as fracture, is much more complicated. And usually, these failure criteria are generally not accurate if the anisotropy of material properties are considered [5], [6], [7].

* Corresponding author. Tel.: +1 480 965 6883
E-mail address: Yongming.Liu@asu.edu