Accepted Manuscript

A micro-mechanical modeling approach for dynamic fragmentation in brittle multi-phase materials

David Cereceda, Dmitriy Kats, Nitin Daphalapurkar, Lori Graham-Brady

 PII:
 S0020-7683(17)30487-0

 DOI:
 10.1016/j.ijsolstr.2017.10.026

 Reference:
 SAS 9778

To appear in: International Journal of Solids and Structures

Received date:22 November 2016Revised date:19 October 2017Accepted date:23 October 2017

Please cite this article as: David Cereceda, Dmitriy Kats, Nitin Daphalapurkar, Lori Graham-Brady, A micro-mechanical modeling approach for dynamic fragmentation in brittle multi-phase materials, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.10.026

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



A micro-mechanical modeling approach for dynamic fragmentation in brittle multi-phase materials

³ David Cereceda^{a,*}, Dmitriy Kats^{a,b}, Nitin Daphalapurkar^{a,b}, Lori Graham-Brady^{a,c}

- ^aHopkins Extreme Materials Institute, Johns Hopkins University, Baltimore, MD 21218, USA
- ^bDepartment of Mechanical Engineering, Johns Hopkins University, Baltimore, MD 21218, USA
- ^cDepartment of Civil Engineering, Johns Hopkins University, Baltimore, MD 21218, USA

7 Abstract

4

5

6

Understanding the response of structures exposed to high rate mechanical loading is im-8 portant for improved protection and security. Modeling the behavior of these structural 9 materials and components can be performed at different scales. However, a detailed pic-10 ture of the behavior of the material under high strain rates can only be gained by treating 11 each of its components independently. In this work, we present a one-dimensional finite ele-12 ment model to study dynamic fragmentation in multi-phase materials, and we applied it to 13 study masonry as an example of multi-phase material for structural applications. The model 14 follows a micro-mechanical approach where the matrix (brick), inclusions (mortar), and in-15 terfaces between matrix and inclusions are represented separately. Within each constituent, 16 the heterogeneity in the material is introduced through a critical strength distribution. A 17 cohesive zone model has also been incorporated to model progressive damage. Results show 18 the influence of the volume fraction and the inclusion size on the average fragment-size and 19 fragment-size distributions for strain rates between 10^2 and 10^5 s⁻¹. Based on these results, 20 a mathematical expression that captures the dependence of the average fragment-size on the 21 strain rate, volume fraction and inclusion size has also been formulated. The observed in-22 crease on the average fragment-size with decreasing the inclusion size suggests the existence 23 of a critical length that depends on the strain rate and material properties below which, no 24 additional fragments of the inclusion-material are created. 25

Keywords: dynamic fragmentation, multi-phase composite, micro-mechanical, cohesive model,
 masonry

28 1. Introduction

²⁹ Unraveling the response of composite materials subjected to extreme environments is ³⁰ critical from both scientific and engineering viewpoints. In particular, high strain-rates

Preprint submitted to International Journal of Solids and Structures

^{*}corresponding author

Email addresses: david.cereceda@jhu.edu (David Cereceda), dkats1@jhu.edu (Dmitriy Kats), nitin@jhu.edu (Nitin Daphalapurkar), lori@jhu.edu (Lori Graham-Brady)

Download English Version:

https://daneshyari.com/en/article/6748423

Download Persian Version:

https://daneshyari.com/article/6748423

Daneshyari.com