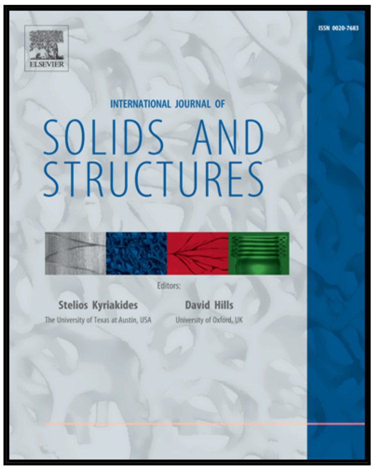

Dynamic fracture of a discrete media under moving load.

Nikolai Gorbushin, Gennady Mishuris

PII: S0020-7683(17)30436-5
DOI: 10.1016/j.ijsolstr.2017.09.026
Reference: SAS 9743

To appear in: *International Journal of Solids and Structures*

Received date: 17 December 2016
Revised date: 2 August 2017
Accepted date: 21 September 2017

Please cite this article as: Nikolai Gorbushin, Gennady Mishuris, Dynamic fracture of a discrete media under moving load., *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.09.026

Dynamic fracture of a discrete media under moving load.

Nikolai Gorbushin, Gennady Mishuris*
Department of Mathematics, Aberystwyth University,
Ceredigion SY23 3BZ, Wales, UK

September 28, 2017

Abstract

Most of the research concerting crack propagation in discrete media is concerned with specific types of external loading: displacements on the boundaries, or constant energy fluxes or feeding waves originating from infinity. In this paper the action of a moving load is analysed on the simplest lattice model: a thin strip, where the fault propagating in its middle portion as the result of the moving force acting on the destroyed part of the structure. We study both analytically and numerically how the load amplitude and its velocity influence the possible solution, and specifically the way the fracture process reaches its steady-state regime. We present the relation between the possible steady-state crack speed and the loading parameters, as well as the energy release rate. In particular, we show that there exists a class of loading regime corresponding to each point on the energy-speed diagram (and thus determine the same limiting steady-state regime). The phenomenon of the "forbidden regimes" is discussed in detail, from both the points of view of force and energy. For a sufficiently anisotropic structure, we find a stable steady-state propagation corresponding to the "slow" crack. Numerical simulations reveal various ways by which the process approaches - or fails to approach - the steady-state regime. The results extend our understanding of fracture processes in discrete structures, and reveal some new questions that should be addressed.

Keywords: Fracture, discrete structure, Wiener-Hopf method, numerical simulations

1 Introduction

Theoretical works on a crack propagation in structured media have revealed various phenomena that are not observable when considering the cracks in an elastic continuum. One of the major observations following from the study of cracks in a lattice is that the static crack becomes unstable by application of displacements which almost twice exceed the size predicted by using the energy criterion; this effect was referred to as as lattice trapping in [50]. The development of a consistent theory of crack propagation in such structures originates in work by Slepyan [49] for the Mode III crack (rectangular lattice) and the Mode I and II [19] (triangular lattices), leading eventually to a fully comprehensive study in [48]. The proposed methods appeared to be extremely efficient in examining various fracture problems and capable of explaining various related phenomena [18, 24, 48]. In particular, apart from explaining trapping in various lattice structures [6, 48], it was also instrumental in recognizing the role of the dissipation mechanism in fracture mechanics [21, 43, 48] in the description of a crack propagation in discrete and structural waveguides [3, 4, 25] and the analysis of the phase transitions and bistable structures [5, 51, 52, 53]. The method is equally efficient for structures of distinct geometries (rectangular and triangle lattices), fracture modes, for both open cracks and bridge cracks [26, 28], and both homogeneous and inhomogeneous structures [27, 29, 38]. Although most of the works so far have been concerned with the

*corresponding author: ggm@aber.ac.uk