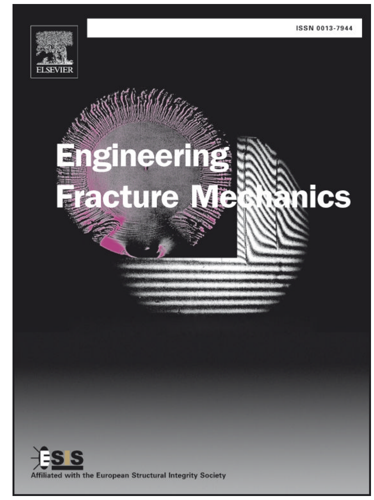

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Siro Casolo, Vito Diana

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Modelling laminated glass beam failure via stochastic Rigid Body-Spring Model and Bond-Based Peridynamics

Siro Casolo[a,*], Vito Diana[a]

[a]*Department ABC, Politecnico di Milano, Italy*

Abstract

The failure of a laminated glass beam is investigated by two full discrete numerical approaches: a Rigid Body-Spring Model (RBSM) and a mesh-free numerical method arising from bond-based Peridynamics (PD). The brittle nature of the failure has been modelled and investigated by exploiting the discrete nature of these models, and specifically the PD which allows the bond/spring strengths to be explicitly related with the size and orientation of the defects in the structure. Strength values have been assigned randomly, within the beam, by a Monte Carlo simulation, according to Weibull statistical distributions calibrated on experimental results obtained from literature. For the first time, the differences and analogies of the two discrete approaches are shown and discussed together with the analysis of variability of the load capacity of the beam related to the statistical presence of flaws in the structure. Results show that, due to the heterogeneous strength properties of the numerical models and mechanical features of the inter-layer, multiple cracking stages can be distinguished for the structural element, thus different cumulative distribution function of limit load can be obtained.

Keywords: Discrete approaches, RBSM, Peridynamics, Brittle failure, Monte Carlo simulation, Laminated glass

1. Introduction

The discrete approaches, in modern mechanics can be traced back to the ideas proposed by Poisson who laid the foundations of molecular theory of elasticity [1] along with Cauchy and Navier [2, 3], until the fundamental contribution of Voigt [4] who overcame the *rari-constant* limitations of the early approaches. In the last two decades, the interest towards the computational models based on a full discrete approach is growing, especially when dealing with the post-failure behaviour of fragile and/or heterogeneous materials. Various approaches, sometimes following a mainly mechanistic approach, have been proposed for structural mechanics applications. Among these, the spring network models, or lattice models in which the solid is imagined as an assembly of masses connected by springs or like a grid of beams, as well as the numerical models arising from peridynamics, have proved as a promising approaches [5, 6, 7, 8, 9, 10, 11].

*Corresponding author, e-mail: siro.casolo@polimi.it