Advances in Concrete Construction, *Vol. 5, No. 3 (2017) 221-240*
DOI: https://doi.org/10.12989/acc.2017.5.3.221

Analysis of quasi-brittle materials at mesoscopic level using homogenization model

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(Received February 26, 2017, Revised May 16, 2017, Accepted May 23, 2017)

Abstract. The modeling of the mechanical behavior of quasi-brittle materials is still a challenge task, mainly in failure processes when fracture and plasticity phenomena become important actors in dissipative processes which occur in materials like concrete, as instance. Many homogenization-based approaches have been proposed to deal with heterogeneous materials in the last years. In this context, a computational homogenization modeling for concrete is presented in this work using the concept of Representative Volume Element (RVE). The material is considered as a three-phase material consisting of interface zone (ITZ), matrix and inclusions-each constituent modeled by an independent constitutive model. The Representative Volume Element (RVE) consists of inclusions idealized as circular shapes symmetrically and non-symmetrically placed into the specimen. The interface zone is modeled by means of cohesive contact finite elements. The inclusion is modeled as linear elastic and matrix region is considered as elastoplastic material. A set of examples is presented in order to show the potentialities and limitations of the proposed modeling. The consideration of the fracture processes in the ITZ is fundamental to capture complex macroscopic characteristics of the material using simple constitutive models at mesoscopic level.

Keywords: concrete; fracture mechanics; finite element; homogenization; plasticity

1. Introduction

The modeling of the mechanical behavior of quasi-brittle materials is still a challenge task, mainly in failure processes when fracture and plasticity phenomena play important roles in dissipative processes which occur in materials like concrete. In fact, as the concrete is a composite material, it presents a very complex mechanical behavior that is very hard to be modeled (see Pituba and Fernandes 2011, Brancherie and Ibrahimbegovic 2009, Zhu *et al.* 2008 and others). Initially, the constitutive phenomenological theories have been represented satisfactorily the mechanical behavior of such materials. As example, the Continuum Damage Mechanics (CDM) provided sophisticated constitutive models to simulate the mechanical behavior of heterogeneous materials, mainly concrete, presenting satisfactory results (see Pituba *et al.* 2016, Pereira Jr *et al.*

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http://www.techno-press.org/?journal=acc&subpage=7 ISSN: 2287-5301 (Print), 2287-531X (Online)

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