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考虑孔隙及微裂纹影响的混凝土宏观力学特性研究

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RESEARCH ON THE INFLUENCE OF PORES AND MICRO-CRACKS ON THE MACRO-MECHANICAL PROPERTIES OF CONCRETE

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摘要

混凝土是一种典型的多孔介质材料,孔隙分布错综复杂,孔径尺寸跨越微观尺度和宏观尺度,对混凝土弹性模量及强度等力学参数产生巨大影响.认为混凝土是由骨料、孔隙及砂浆基质组成的三相复合材料,采用Monte Carlo 法将孔隙、微裂纹及微缺陷与骨料颗粒随机投放在砂浆基质中.根据三相球模型及中空圆柱形杆件模型得到含孔材料的有效力学性质,并推导得到含孔材料的等效本构模型.建立含孔隙混凝土试件的细观单元等效化力学模型,对二级配含孔隙混凝土试件在单轴拉伸及压缩条件下的反应进行了非线性分析.结果表明:孔隙、微裂纹的存在对混凝土宏观弹性模量、强度及残余强度等力学性质都有很大影响,在对混凝土宏观力学特性分析及研究混凝土损伤断裂时不应忽略其影响.

关键词: 混凝土 孔隙 微裂纹 力学特性 细观单元等效化力学模型

Abstract:

Concrete is a typical porous medium permeated by an interconnected network of pores which have great influences on elastic modulus, strength and other mechanical parameters of concrete across both micro and macro scale. Concrete was considered as a three-phase composite with aggregates, pores and mortar matrix. Pores, micro crack, micro flaw and aggregates were put into the mortar matrix randomly by the Monte Carlo simulation method, and the effective mechanical properties of porous material was derived according to the three-phase sphere model and hollow cylindrical rod model. Then the effective constitutive model of porous material was established, and finally the meso element equivalent model of porous concrete specimen was built. Thus two-grade porous concrete specimen in uniaxial tensile and compression was analyzed by means of nonlinear method. The results indicated that the existence of pores and micro cracks had great influence on macro elastic modulus, strength and residual strength of concrete, which should not be neglected when analyzing the macro-mechanical properties and damage fracture of concrete.

Key words: concrete pores micro-crack mechanical properties meso element equivalent model

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