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三轴围压下砂浆弹塑性损伤变形过程的细观力学分析

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MICROMECHANICAL ANALYSIS OF MORTAR IN ELASTO-PLASTIC DAMAGE DEFORMATION PROCESS UNDER TRIAXIAL HYDROSTATIC COMPRESSION

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摘要 基于对泛函势和Cauchy-Born准则，抽象出弹簧束构元和体积构元，组集两种构元的力学响应，给出了材料的弹性损伤本构关系；考虑滑移作为主要的塑性变形机制，提出了滑移构元，给出了材料的塑性本构关系；利用变形分解机制，得到了由三种构元共同描述的弹塑性损伤本构关系。阐述了在给定应变条件下弹塑性损伤本构关系的计算迭代流程。利用单轴拉伸算例详细阐述了模型参数的标定过程。对有围压作用下砂浆材料的压缩行为进行了模拟，从材料细观变形角度解释了随着围压增加，材料承载能力增加的现象。模型预测结果与试验结果符合较好，初步验证了模型具有处理非比例加载问题的能力。

关键词： 弹塑性损伤本构关系 三轴围压 构元组集模型 非比例加载 砂浆

Abstract： Based on pair functional potentials and Cauchy-Born rule, spring-buddle components and cubage component were abstracted. Integrating the mechanical responses of the two kinds of components, the paper derived the corresponding elasto-damage constitutive relation. Recognizing that the slip is the main plastic deformation mechanism, the paper proposed slip components to describe the plastic deformation, and then derived the corresponding plastic constitutive relation. Based on the decomposition of deformations, the elasto-plastic damage constitutive relation described by three kinds of components was derived. The numerical iteration algorithm under given strain was presented. The calibration of model parameters was illustrated through a tensile numerical case. Simulation of mortar under hydrostatic compression was performed. It is explained from the point of the mesoscopic deformation that the bearing capacity increases as the hydrostatic pressure increases. The numerical results agree well with experimental data, which demonstrates that this model has the capability to deal with nonproportional loading preliminarily.

Key words： elasto-plastic damage constitutive relation triaxial hydrostatic compression component assembling model nonproportional loading mortar

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