

非饱和多孔介质中热-渗流-力学耦合的混合元法

刘泽佳, 李锡夔

广州华南理工大学交通学院

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摘要 提出了一个非饱和多孔介质中热-渗流-力学耦合分析的混合有限元方法. 固相位移、应变和净应力; 孔隙水和气的压力、压力空间梯度和Darcy速度; 多相混合介质的温度、温度空间梯度和热流量在单元内均为独立变量分别插值. 基于胡海昌-Washizu 三变量广义变分原理给出的多孔介质中热-渗流-力学耦合问题控制方程的单元弱形式, 导出了单元公式. 采用共旋公式进行几何非线性分析. 数值结果证明了所提出的单元模拟以应变局部化为特征的渐进破坏的能力

关键词 [非饱和多孔介质,混合元,热-渗流-动力耦合分析,应变局部化,渐进破坏](#)

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Mixed finite element method for coupled thermo-hydro-mechanical in unsaturated porous media

广州华南理工大学交通学院

Abstract

A mixed finite element for coupled thermo-hydro-mechanical (THM) analysis in unsaturated porous media is proposed. Displacements, strains, the net stresses for the solid phase; pressures, pressure gradients, Darcy velocities for pore water and pore air phases; temperature, temperature gradients, the heat flux of the three phase mixture are interpolated as independent variables. The weak form of the governing equations of coupled thermo-hydro-mechanical problems in porous media within the element is established on the basis of the Hu-Washizu three-field variational principle. The proposed mixed finite element formulation is then derived. For geometrical non-linearity, the co-rotational formulation approach is used. Numerical results demonstrate the capability and the performance of the proposed element in modelling progressive failure characterized by strain localization.

Key words [unsaturated porous medium](#) [mixed finite element](#) [coupled thermo-hydro-dynamic analysis](#) [strain localization](#) [progressive failure](#)

DOI:

通讯作者 xikuili@dlut.edu.cn; zjliu@scut.edu.cn

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