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三轴压缩下含瓦斯煤岩弹塑性损伤耦合本构模型

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Elastoplastic damage coupled model for gas-saturated coal under triaxial compression

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摘要 通过引入与塑性屈服准则相关联的各向异性损伤因子和损伤准则来描述含瓦斯煤岩的塑性变形及损伤演化过程。在多孔介质有效应力原理中引入瓦斯吸附的膨胀应力，得出了适用于含瓦斯煤岩的有效应力计算公式。利用不可逆热力学原理，对含瓦斯煤岩的损伤演化规律及塑性变形与损伤之间的耦合效应进行了有效描述。根据实验结果，采用非关联塑性流动法则，建立了能反映含瓦斯煤岩在各种应力条件下力学行为的弹塑性损伤耦合本构模型，并给出了本构模型的参数确定方法。通过理论与实验的比较可知：所提出的弹塑性损伤耦合本构模型能真实有效地描述含瓦斯煤岩在不同应力条件下的力学特性。

关键词： 三轴压缩   各向异性损伤   弹塑性本构模型   多孔介质   含瓦斯煤岩

Abstract： An anisotropic damage, which is related to the plastic yield criterion, and a damage criterion are introduced to adequately describe the plastic deformation and the damage evolution of gas-saturated coal. The effective stress formulation for gas-saturated coal is derived by introducing the swell stress of gas adsorption into the effective stress principle of porous media. The damage law and the coupling effect between plastic deformation and material damage are represented sufficiently by using the framework of irreversible thermodynamics. On the basis of the experimental results, a general coupled elastoplastic damage constitutive model is developed for describing the mechanical responses of gas-saturated coal under various loading conditions by adopting a non-associated plastic flow rule. Moreover, the method for determining the constitutive model's parameters is discussed. The comparison between simulation data and experimental data shows that the proposed model is able to depict effectively the main features of mechanical behaviors observed in gas-saturated coal.

Keywords： triaxial compression   anisotropic damage   elastoplastic constitutive model   porous medium   gas-saturated coal

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