Study on Fractional-Order Creep Damage Model for Deep Hard-Brittle Rock Postprint

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Abstract

Hard-brittle rocks, like weak rocks, are also susceptible to creep failure; therefore, investigating their creep characteristics is of significant importance for surrounding rock stability. Assuming the viscosity coefficient to be proportional to a power function of the initial elastic modulus to characterize the influence of the rock's initial hardness and compactness on its creep behavior, an improved fractional-order nonlinear viscous element is proposed to describe the viscoelastic features of the attenuation and steady-state creep stages. Based on continuum damage mechanics theory, a damage factor is introduced to establish a fractional-order nonlinear damage viscoplastic element accounting for time-dependent damage, thereby capturing the mechanical behavior of the accelerated creep stage. By connecting a Hookean element, the improved fractional-order nonlinear viscous element, and the fractional-order nonlinear damage viscoplastic element in series, a nonlinear creep damage model for hard-brittle rocks is established and its rationality is verified. The experimental curves exhibit good agreement with the model's theoretical curves, demonstrating that the model can effectively describe the entire creep process of hard-brittle rocks. A sensitivity analysis of the model parameters is performed to discuss their influence on creep behavior, and the results indicate that the relevant parameters play a crucial role in accurately characterizing the creep behavior of hard-brittle rocks.

Full Text

Preamble

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