Fracture of 2-D Random Porous Media：Phase Field Modeling and Machine Learning

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Abstract

The study of fracture process of random porous media in pore scale is critical to understand theirs macroscopic failure behaviors. However, measuring the material properties or computing the mechanical response in both experiments and numerical simulation methods is different because of the heterogeneity and complexity of pore structure. In this study, a novel computational framework is proposed to simulate and predict fracture behavior by virtue of the phase field method and machine learning. The fracture process of one-cut Gaussian random field model is systematically calculated by phase field method, and the size effect of macro fracture is revealed in pore structure. The fracture behaviors observed in the experiments and simulations are remarkably similar to each other. A machine learning method is developed to further capture the regularities between the statistical parameters of the structure and the fracture behaviors. By combination the convolution neural network and generative adversarial networks the fracture load and crack propagation path can be predicted well. Through tuning the input data, it is proved that the mechanical variables before crack initiation determine the final fracture state. The computational framework developed in study provides an efficient and accurate solution scheme to the fracture problem of complex random materials.

Keywords: Random Porous Media; Phase Field Fracture; Machine Learning; Fracture Path