Stress-strain behavior of fiber reinforced concrete in uniaxial tension based on statistical damage model

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Abstract

Based on statistical damage theory and macroscopic experimental phenomena, the damage constitutive model for fiber reinforced concrete under uniaxial tension is established. Firstly, the damage evolution mechanism of concrete under uniaxial tension is discussed in detail by using the improved parallel bar system (IPBS). It is assumed that there are two kinds of damage evolution process of fracture and yield on a meso-scale, which ultimately determines the macroscopic nonlinear stress-strain behavior of concrete. Yield damage mode reflects the potential mechanical capacity (adjustment capacity of force skeleton in microstructure) of materials and plays a key role in the whole process. Evolutionary factor is introduced to reflect the development of the potential mechanical capacity of materials. Two characteristic states, the peak nominal stress state and the critical state, are distinguished. The whole deformation-to-failure process is divided into uniform damage and local breach phases by the critical state. Subsequently, it is assumed that the two kinds of damage evolution follow the independent triangular probability distribution, which could be represented by four characteristic parameters. Through the analysis of the variation law of the above parameters, the influence of fiber content on the initiation and propagation of micro-cracks and the damage evolution of concrete would be revealed. The validity of the proposed model is verified by two sets of test data of steel fiber reinforced concrete. The results show that, the addition of fiber changes the composition of microstructure, restricts the initiation and expansion of microcracks, and also changes the damage evolution process on meso-scale. When only the fiber content is changed, the shape of the macroscopic nominal stress-strain curve will show a good law of similarity. Meanwhile, the characteristic parameters representing the two types of damage evolution on meso-scale, have obvious linear variation law. The relations among physical mechanism, mesoscopic damage evolution mechanism and macroscopic nonlinear mechanical behavior of fiber reinforced concrete are discussed.

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