Microscopic Model Containing Micro-Voids for Analysis of Cement Mortar Damage Fracture Process

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Abstract: Cement mortar is an important component of many composite materials and one of the most widely used materials in engineering construction. At microscopic level, cement mortar can be regarded as a multiphase material composed of fine aggregates, cement paste, and a great many of initial defects, the form of which are micro-cracks and micro-voids. The macroscopic properties of cement mortar will be influenced by mechanical properties of different constituents and complex internal structures. The microscopic model containing micro-voids is established by the method of secondary development. The process of cement mortar damage fracture is studied. The fracture toughness of fine aggregates is much higher than that of cement paste, so, it is assumed that the crack will not pass through fine aggregates and the damage of aggregates will not be considered. Cement paste is a quasi-brittle material with strain softening characteristics. Its mechanical behavior is simulated by a plastic damage model which can reduce the sensitivity of mesh scale to some extent. The result agrees well with the experiment, the crack initiation in cement mortar is closely related to the stress concentration near micro-voids. A series of micro-void belts perpendicular to load direction are connected to be cracks which causes the failure of specimen. The increment of cement paste strength increases the equivalent elastic modulus and peak displacement of cement mortar and the increment of porosity reduce its equivalent elastic modulus.

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