Analysis of discontinuous failure in quasi-brittle materials using VEM and interfaces

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In this work the capabilities of the approach based on the combination between Virtual Elements (VEM) and non-linear, cohesive, interfaces (IF) for analyzing failure behavior of quasi-brittle materials like concrete at different scales of observation are presented, including multiscale assessments involving macro-mesoscopic interactions.

After a brief presentation of the fundamentals of the VEM and IF model formulations, the elastic and inelastic predictions of planar components with inclusions obtained with VEM, and VEM + IF discretizations, respectively, are discussed.

The presentation then focuses on the evaluation of the capabilities of the VEM + IF approach to predict the failure behavior of concrete through a concurrent multiscale scheme, characterized by abrupt transitions between macroscopic and mesoscopic zones. For this purpose, use is made of the hanging nodes property of the VEM. The results show the ability of the discretization methodology based on VEM + IF to analyze the influences of the size and the random distribution of aggregates on the failure behavior of concrete components. Likewise, the influence of mesh densities in the macroscopic and mesoscopic zones is analyzed and shown.

Next, a methodology is presented to analyze the ergodic behavior of concrete components subjected to failure processes, regarding the refinement of discretizations composed of VEM and IF. The final objective is to establish a systematic and efficient procedure for the analysis of concrete failure processes through discretizations. With limited element densities and based on the ability of Voronoi meshes with polyhedral VEM and non-linear interfaces to predict the intricate crack paths of concrete.

The results show the benefits of the discretization methodology based on VEM and cohesive interfaces for the analysis of failure processes in quasi-fragile materials like concrete at macroscopic levels of observation, and its potential for multiscale analysis.

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