Cohesive zone properties and R-curve in quasibrittle fracture

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Abstract:

The connections between the cohesive zone properties and the R-curve are studied in the case of quasibrittle fracture. On the basis of a bilinear cohesive function, well-known to successfully describe the quasibrittle failure of a wide group of materials [1, 2], the fundamental connection between the plateau value of the R-curve and the cohesive fracture energy characterizing the area under the cohesive function is shown [3]. On this basis, the shape of the cohesive function is characterized from a ratio characterizing the energy distribution in the softening function, the critical opening and the tensile strength of the cohesive interface [4]. It is shown that the Load-Displacement response and its corresponding R-curve [5] obtained from the cohesive crack simulations are mainly governed by this energy distribution and by the critical opening of the cohesive zone. The critical opening has a direct influence on the crack length for which the plateau value of the R-curve occurs, while the energy distribution influences significantly the intermediate part of the Load-Displacement curve around the peak load and especially the maximum load itself as well as the middle half of the raising part of the R-curve. On the other hand, the influence of the tensile strength appears mainly significant on the initial deviation from linearity in the Load-Displacement response which corresponds to the initial part of the R-curve. From these different results, it is shown that the four parameters which characterize the bilinear softening curve influence the R-curve in ways much neater than their influences on the Load-Displacement curve. Moreover, even though the connections between the cohesive properties and the R-curve are geometry and material dependent, their trends are preserved whatever the specimen geometry and the material are. As a consequence, it is shown that the R-curve analysis, which is straightforward to carry out from experimental and numerical tests, can be used to determine the softening curve in a more efficient way than “blind fitting” procedures or than more optimized methods funded, for instance, on genetic algorithm [6]. The outline of a general procedure is proposed.

Mots clefs : Quasibrittle fracture, R-curve, cohesive zone model, bilinear softening function, energy distribution, critical opening, plateau value of the resistance, cohesive fracture energy

Références