

Simulation of the failure of quasi-brittle specimen with defects using the TLS damage model: Scale effect analysis

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Predicting the maximum load that a (quasi-)brittle specimen can sustain is an important scientific and practical issue. A natural approach is to search for a criterion. Strength and toughness criteria are well suited for simple specimen having either no defect or an existing crack. When defects (notches, or cavities, ...) are present, the criterion is more complex to set up.

Two approaches are considered in this work: the first is the coupled criterion which is introduced by [1]. It could be qualified as semi-analytical since it starts from analytical consideration finalized by (simple) numerical treatment.

The second one is pure numerical approach which allow us to perform a full numerical quasi-static analysis of the specimen with an increasing loading. The failure load is defined as the maximum load above which no quasi-static solution may be found (and the specimen goes into dynamics). Since we are discussing quasi-brittle failure, we use a damage model. It is well known that regularization is needed when addressing failure with such a model, otherwise failure may be reached for infinitely small loading. Here we consider the TLS (Thick Level Set) approach of graded damage modeling. A material length scale is introduced explicitly, and the model is closely connected to the cohesive zone model (CZM) [2]. Note that the coupled criterion contains a length scale since it is written in terms of toughness, strength and Young modulus from which a characteristic length may be extracted.

In this work, failure load is determined using the two approaches which is then compared to ones obtained experimentally. Then the influence of scale effect is investigated. More precisely, we analyze the role played by length ratio (notch or cavity size over characteristic length) on the predicted failure load.

References

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