# Configurational damage model

# with material forces as internal variables

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## Abstract

In this study, a novel damage continuum constitutive model is proposed to describe the failure process of materials which is capable of including the effect of anisotropic damage evolution for initial isotropic material. The material configuration force vectors are adopted as damage internal variables within the framework of continuum damage mechanics. The material forces are explored as the gradient of energy potential due to the unit coordinate translation on the damaged material point. They are considered as the damage driving force of the degradation behavior of material properties in material space. Since the material configuration forces have their own distinct directions, this proposed damage theory is used to describe the process of damage evolution combined with anisotropic effects. It is constructed that the material degradation is evolved along the direction of material configurational resultant force, which can identify the direction of micro-damage. The constitutive equation together with the damage evolution law is obtained by introducing the concept of damage effect tensor $M(\omega)$. It integrates a compositive influence of damage variables in each orientation on the results of the damage value distribution even from an initially isotropic material. Numerical values of damage internal variables at nodes are calculated via the finite element method (FEM). Moreover, a series of experimental tests and numerical examples are carried out to illustrate the validity of the damage model. It is suggested that the presented damage model by using the concepts of material configuration forces can effectively describe the material damage evolution and predict the material degradation behaviors considering the effect of anisotropy in damage mechanics.

**Keywords:** Damage, material forces, internal variables, anisotropic damage evolution, computational mechanics

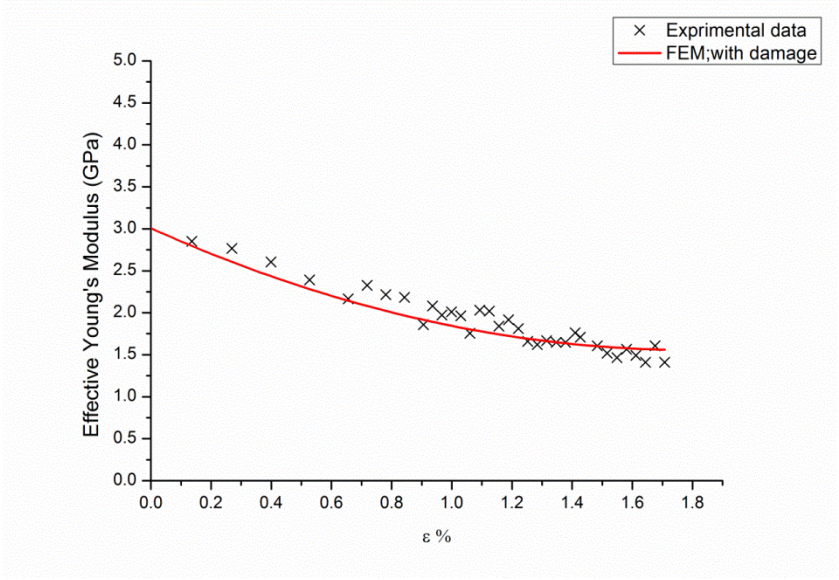
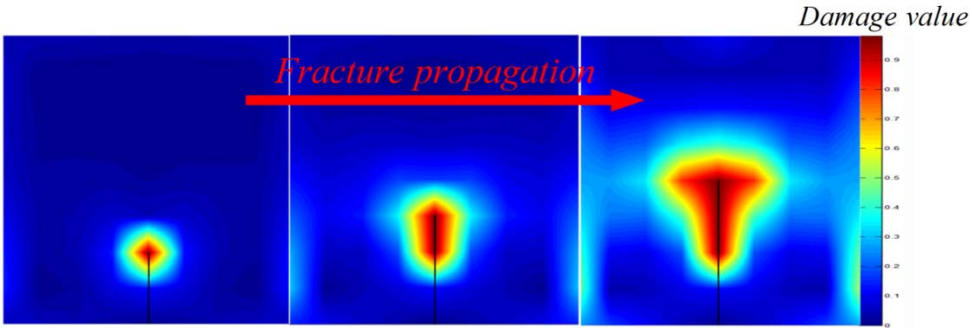
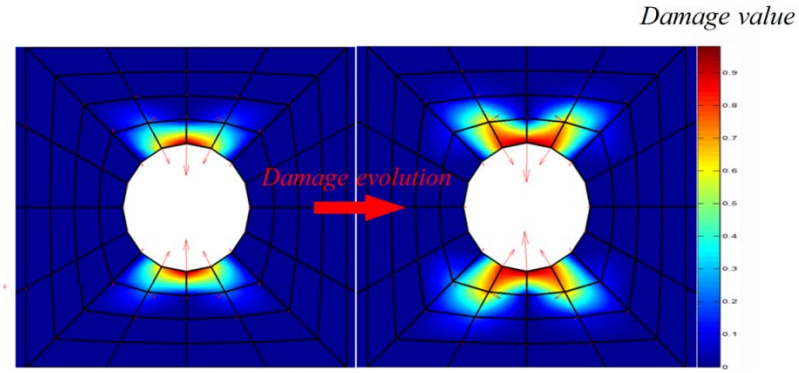



**Figure. 1 The degradation of effective Young's modulus during tensile loading**




**(a)**




**(b)**

**Figure.2 Contour plot of the damage values of the failure evolution,**

**where the small arrow symbols in figure (b) denote the orientation of the micro-defect.**