POSTER REFERENCE: ICF100145PR

STUDY ON CRACKPATH STABILITY OR INSTABILITY IN A BODY

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ABSTRACT

The crackpath prediction plays an essential role in the estimation of the final shape of broken solids and structures. Furthermore, the study of the crackpath in broken specimens renders the loading conditions just before fracture. Experiments on brittle materials, pre-cracked specimens of the same geometry, under similar loading conditions, occasionally resulted in different trajectories of the crack propagation. The already proposed theories for the prediction of the crackpath stability or instability are based on the perturbation method in combination with analytical and finite elements methods; however, they require the knowledge of the toughness equations. Therefore they can only be applied in specimens with uncomplicated geometry on straightforward loadings. In the present paper the problem of the crackpath stability or instability, is approached from a different viewpoint. The method of dealing with the problem using the estimation criterion is described. Using a finite element program the stress field is calculated and consequently a plotting program constructs the contours map of the strain energy density on the idealization geometry of the specimen or structure. The contours map recovers the stress field on the instance that the crack begins the unstable propagation. For the determination of the predicted trajectory of the crack propagation of the existing crack, the minimum of the strain energy density criterion (SED) is used. The forecasted trajectory appears with the drawing of the "gorge" on the contour map of the strain energy density. Based on the estimation criterion, which claims that the degree of stability is a function of the sharpness of the gorge plot, we can predict the degree of the crackpath stability. Therefore, this simple method offers a good reliability in the prediction of the crackpath stability for problems with complex geometry structures and random loadings. The above consideration offers a classification of the crackpath stability or instability in the following cases: (i) The predicted propagation crackpath is stable for symmetric geometry and loading ($K_{II}=0$), and has the shape of a straight line or a curve outside its initial direction. (ii) The predicted propagation crackpath is unstable, and follows many discrete curves, including the straight line. In order to clarify the suggested prediction method, we apply it on DCB-type specimens, where a rich international theoretical and practical experience exists. The results on the crackpath stability presented in this work are in good agreement with experimental observations.