An advanced finite elemet method for three-dimensional V-shape corners in a hole defect

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Abstract

Three-dimentional hole defects with V-shape corner and circumferential corner fronts often contain in metals, ceramics, plastics and composites, etc, and the local stress singularities are easy to cause crack initiation. In this paper, generalized stress intensity factors K_I, K_{II}, and K_{III} are calculated for this kind of corner defects using an advanced finite element method. The advanced finite element method is composed of super corner front elements along the corner front and conventional three-dimensional linear brick elements at other positions. Three-dimentional numerical series eigen-solutions in local coordinate system are solved and incorporated into the Hellinger-Reissner variational principle to establish element stifness matrix of the super crack front element. The element can be directly connected with the existing three-dimensional linear brick elements without using transition elements. In order to analyze the problem accurately, the number of terms in series solutions including both stress singularity and high order terms obeys Ladyzhenshaya-Babuski-Brezzi conditions for two dimensional problems although the super corner front element is a three-dimensional one. Generalized stress intensity factors at the circumferential corner front are systematically calculated for various shapes of hole defects. The effects of corner angle, corner orientation, remote loadings and interacting of two corners on the generalized stress intensity factors are investigated, the results can be regarded as a judging criterion to predict crack initiation at circumferential hole edge.

Keywords: hole defect, V-shape corner, singular stress, advanced finite element method,

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