ABSTRACT

This thesis is concerned with the stress intensity factors of a deep semi-elliptical surface crack in a flat plate with finite thickness.

The stress intensity factors of variety crack configurations and loading conditions have been reported in the literature. In the case of deep surface crack, however, the crack depth ratio (a/t) was limited to 0.8. Beyond this limit, the stress intensity factor has to be obtained by extrapolation and hence imposed an inaccessible error in the subsequent estimations such as the crack growth rate. To break through this barrier, obtaining the accurate stress intensity factors in this intact region became the critical step. This calculation has been carried out in the current work.

It has been common to calculate the stress intensity factors by the J-contour integral. In the case of a very small ligament behind the crack front such as a deep crack, space available for carrying out the J-contour integral was very limited which led to a questionable reliability of the result. Consequently, an alternative method, namely the nodal displacement method, was adopted.

The finite element method was adopted for the three dimensional stress analyses in the current work. The crack configurations covered in this finite element analysis was not reported in the literature, namely $0.8 < \frac{a}{t} < 1.0$. Based on the result of the finite element analyses, the nodal displacements near the crack front were extracted for calculating the stress intensity factors by the nodal displacement method. Extra attention was paid on the stress intensity factors at the deepest point and the surface point on the crack front due to relative significance in, for instance, fatigue behavior. This result was able to fill up a part of the lack part of the stress intensity factors data base.

A comparison of nodal displacement method and J-contour integral method was also made. It was found that, for the crack being considered, the stress intensity factors at the deepest point obtained by these two methods were more or less the same.