STRESS ANALYSIS OF CRACK IN PRESENCE OF RESIDUAL STRESS FIELD USING THE FINITE ELEMENT METHOD

by

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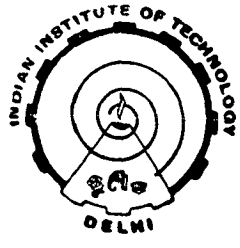

Department of Mechanical Engineering
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TO MY PARENTS, BROTHERS AND SISTERS

WHOSE MORAL SUPPORT AND LOVE MADE THIS POSSIBLE

CERTIFICATE

This is to certify that the thesis entitled,"Stress Analysis of Crack in Presence of Residual Stress Field Using the Finite Element Method", being presented by Miss Geeta Agnihotri, is worthy of consideration for the award of the degree of 'Doctor of Philosophy' and is a record of the original bonafide research work carried out by her under my guidance and supervision and that the results contained in it have not been submitted in part or full to any University or Institute for the award of any degree or diploma.

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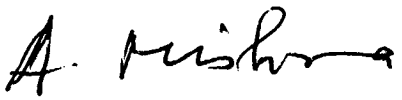

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ABSTRACT

A rectangular structural steel plate with a sharp crack has been selected to develop a two dimensional finite element model to obtain numerical results of displacements and stresses around the crack tip for linear elastic as well as elastic-plastic situation of loadings. Crack tip as well as cubic isoparametric elements are used throughout the analysis of elastic and elastic-plastic conditions. The spread of the plastic zone is shown to present the elastic-plastic boundaries for various load levels around the crack tip. Convergence tests are carried out to check the accuracy of the finite element model. The results of the convergence tests are compared with the theoretical Westergaard solution. Mouth Opening Displacements (MOD) are obtained experimentally under uniaxial stepped loadings for the same specimen size which is used in two and three dimensional finite element analysis.

A three dimensional finite element is developed to study the influence of residual stress on stress field of a single edge cracked plate subjected to an applied nominal stress of known magnitude. The nature and magnitude of residual stresses superposed on the applied nominal stress are idealized to present the residual stress state induced by the grinding process. The magnitudes of all the six components of stresses are estimated in presence of residual stress field near and away from the crack front. The variation of stresses around the crack front with the thickness of the cracked plate for different loading conditions is presented in the thesis.

It is found that the stress state around the crack front subjected to tensile loading is influenced by the presence of residual stress field.

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G Agnihotri

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