AN EXPERIMENTAL AND THEORETICAL STUDY OF THE PHENOMENON OF FATIGUE CRACK CLOSURE AND ITS EFFECTS ON FATIGUE CRACK PROPAGATION IN THIN METALLIC SHEETS

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CERTIFICATE

This is to certify that the thesis entitled "An Experimental and Theoretical Study of the Phenomenon of Fatigue Crack Closure and its Effects on Fatigue Crack Propagation in Thin Metallic Sheets" being submitted by Swami Piara Saini to the Indian Institute of Technology, Delhi (India) for the award of the degree of Doctor of Philosophy in Applied Mechanics is a record of bonafide research work carried out by him under our supervision and guidance. The thesis work, in our opinion, has reached the standard fullfilling the requirements for the Doctor of Philosophy Degree. The research report and results presented in this thesis have not been submitted in part or in full to any other university or Institute for the award of any degree or diploma.

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ABSTRACT

This investigation is concerned with the study of Crack Closure Behaviour in Thin Sheets of Cold Rolled Copper. Both experimental and theoretical investigations have been carried out. The main emphasis of the study is to compare the experimental results with those from theoretical considerations.

An experimental set-up has been developed for conducting the experimental investigations. A Servo-hydraulic Fatigue Pulsating machine of 2 tons capacity has been used. A suitable device for holding the specimen has been designed. The measurements of crack closure have been carried out using the potential technique. A constant current source supply fabricated locally and an amplifier designed and fabricated in the laboratory have also been employed alongwith an x-y recorder for sketching crack closure graphs. Experiments have been conducted under (a) constant amplitude loading (b) spike overload, (c) low to high block loading and (d) high to low block loading. Detailed results concerning crack closure loads at various levels of crack opening and different loading conditions have been reported.

A finite element based computer program has been developed for simulation of crack propagation behaviour in Mode I. The program in its present form can handle different boundary conditions and is capable of depicting the non-linear strain hardening behaviour of the material.

Triangular elements have been used and a very fine mesh has been utilised in the crack tip region. An approximate procedure for simulating the behaviour of a propagating fatigue crack after sufficient progress of the crack is described. Detailed computer results have been obtained to study the variation of crack closing andopening loads of the specimen, under different conditions of loading as discussed in the context of experimental study.

The general trends of crack closure behaviour under different types of variable amplitude loading are found to be in good agreement with the experimental results. Thus the present study has ensured beyond doubt the utility of the finite element method for accurate simulation of crack growth behaviour in practical applications with reasonable computer cost.

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