ANALYSIS OF ELASTIC-PLASTIC DEFORMATION IN PRESENCE OF TEMPERATURE FIELD

by

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DEDICATED TO MY WIFE
MRS. SWARANLATA
AND
CHILDREN

THE TIME I SPENT ON
THIS WORK ACTUALLY
BELONGED TO THEM

ABSTRACT

The present investigation is an effort in the direction of developing an analytical procedure for a systematic analysis of elastic-plastic deformation in presence of temperature field covering some major aspects of the problem. The process of surface grinding has been simulated to represent the case of moving mechanical force and a moving heat source (responsible for producing the temperature field), both distributed over the contact area between the wheel-workpiece interface. The magnitudes of the mechanical force and the strength of the heat source for the case of a semi-infinite solid are estimated from the grinding parameters with the help of the established relationships.

The analysis involves two aspects. Firstly, the temperature field within the workpiece due to moving heat source is obtained. Secondly, the elastic-plastic stress-strain distribution caused by the plastic deformation due to the combined effects of moving force and the temperature field is computed by the Finite Element Model. An alternative procedure is then employed for step-by-step movement of the mechanical force and the thermal load in order to simulate the movement of the grinding wheel over the workpiece surface. The elastic-plastic stress-strain histories are then computed culminating in the residual stress and strain states of the workpiece under investigation.

The computer program developed here makes it possible to estimate the individual contributions to residual stresses, of the thermal and mechanical aspects for various conditions encountered in practice.

The study in respect of relative contributions of thermal and mechanical moving loads reveals that the thermal factor predominates in inducing residual stresses. There is clear indication of the fact that changing the thickness of the workpiece brings out noticeable changes in the residual stress distribution. The size of the specimen in studies of this nature plays an important role in affecting the residual stress distribution in case of models deviating from the semi-infinite solid configuration. Surface alterations caused by the bending action of the residual stresses have also been noticed.

It is hopped that the present analysis, with its computational capabilities as inherent in the 'incremental' approach can be conveniently used in further investigations of this nature with appropriate modifications where needed.

CERTIFICATE

This is to certify that the thesis entitled "Analysis of Elastic-Plastic Deformations in the Presence of Temperature Field" by V.P.S. Sorayan has been prepared under my supervision in conformity to the rules and regulations of the Indian Institute of Technology Delhi. I further certify that the Thesis has attained a standard required for a Ph.D. Degree of the Institute. The research report and results presented in the thesis have not been submitted for any degree in any University.

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