A THESIS ON
MECHANICS OF CHIP FORMATION IN TWO - DIMENSIONAL CUTTING

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CERTIFICATE

This is to certify that the thesis entitled, "Mechanics of Chip Formation in Two-Dimensional Cutting," which is being submitted by Mr. Gursharan Singh Sekhon to the Indian Institute of Technology, Delhi for the award of the Degree of Doctor of Philosophy in Mechanical Engineering, is a bonafide research work carried out by him during the last two years and nine months. He has worked under my guidance and supervision for the last one and a half years. His thesis has reached the standard fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted in part or full, to any other university or institution for the award of any degree or diploma.

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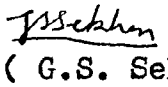

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PREFACE

The study of mechanics of chip formation finds its application in the study of tool wear, surface finish on the machined component and chatter, and in the design of the cutting tool, machine tool and tooling fixtures. Although many slip-line solutions for two-dimensional cutting are available in the existing literature, no pure upper-bound solutions, except the classical ones due to Ernst and Merchant, and Piispanen, have come to the notice of the author. Therefore some upper-bound solutions for forces in curled chip formation, chip formation with a built-up edge, chip formation involving secondary deformation and chip formation using two intersecting velocity discontinuity lines, have been proposed. On comparison with experimental data, it was found that in common with the existing slip-line solutions, the upper-bound solutions predict, for a given frictional resistance at the rake face, smaller cutting forces than the actual. It was considered that the inadequacy of the present solutions may be due to the fact that they do not take into consideration the inertia forces of the dynamic situation. Consequently, a dynamic plasticity solution to a fictitious model of two-dimensional high-speed cutting was proposed. The problem was idealised in order to overcome mathematical hurdles in theoretical development. Still the results

obtained from the present solution to the idealised problem agreed with the experimental results to a far greater extent than any of the results obtained from the various upper-bound solutions.

To the mind of the author, the value of this thesis is in establishing the promise of the dynamic plasticity approach for eventually providing an exact solution to such problems of metal cutting as stress distribution in the deforming work-material, chip thickness, chip curl and chatter. The present work also shows the possibility of obtaining upper-bound solutions to problems in mechanics of two-dimensional cutting more easily than the corresponding slip-line solutions. Also the variation of chip curl and cutting forces with respect to cutting conditions has been experimentally observed, and analysed with the help of upper-bound solutions.

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