

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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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.

CONTENTS

<u>CHAPTER</u>		<u>Pages</u>
I	GENERAL INTRODUCTION	1 - 13
	1.1 Introduction (1)	
	1.2 Brief Review of Available Solutions (2)	
	1.3 The Present Work on Upper-Bound Solutions (4)	
	1.4 The Proposed Dynamic Plasticity Solution (7)	
	1.5 Stress-Strain Relations (9)	
	1.6 Relationships Between Resolved Components Of The Resultant Cutting Load (13)	
II	EXPERIMENTAL OBSERVATION AND ANALYSIS OF EXPERIMENTAL DATA ON CHIP CURL AND CUTTING FORCES	14 - 29
	2.1 Introduction (14)	
	2.2 Description Of Apparatus (14)	
	2.3 Observation (17)	
	2.4 Analysis Of Experimental Data (20)	
III	UPPER-BOUND SOLUTIONS FOR FORCES IN CONTINUOUS CURLED CHIP FORMATION	30 - 57
	3.1 Introduction (30)	
	3.2 Formulation Of Basic Equations For A Rigid - Perfectly Plastic Work-Material (32)	
	3.3 Optimisation Of Energy Consumption (36)	
	3.4 Formulation Of Basic Equations For A Rigid - Linearly Hardening Material (39)	

3.5 Use Of Hertz Law Of Contact (45)

3.6 Straight Chip Formation As A
Special Case Of Curled Chip
Formation (52)

IV UPPER-BOUND SOLUTIONS FOR FORCES IN
CHIP FORMATION WITH A BUILT-UP EDGE 58 - 78

4.1 Introduction (58)

4.2 Straight Chip Formation With A
"Short" Built-Up Edge (60)

4.3 Straight Chip Formation With A
"Long" Built-Up Edge (68)

4.4 Curled Chip Formation With A
"Long" Built-Up Edge (74)

V UPPER-BOUND SOLUTIONS FOR FORCES IN
STRAIGHT CHIP FORMATION INVOLVING
SECONDARY DEFORMATION 79 -101

5.1 Introduction (79)

5.2 Formulation Of Basic Equations
For Chip Formation Involving
Secondary Deformation (81)

5.3 Plane Strain Secondary
Deformation (89)

5.4 Plane Stress Secondary Deformation
With Variable Side Flow (92)

5.5 Plane Stress Secondary Deformation
With Uniform Side Flow (95)

VI UPPER-BOUND SOLUTIONS FOR FORCES IN
STRAIGHT CHIP FORMATION USING TWO
INTERSECTING VELOCITY DISCONTINUITY
LINES 102 -113

6.1 Introduction (102)

6.2 Formulation Of Basic Equations For
A Rigid - Perfectly Plastic Work-
Material (104)

- 6.3 Formulation Of Basic Equations
For A Rigid - Linearly Hardening
Work-Material (107)
- 6.4 Special Case Of Two Equal Velocity
Discontinuity Lines (111)

VII

A DYNAMIC PLASTICITY SOLUTION TO A FICTITIOUS MODEL OF TWO-DIMENSIONAL HIGH SPEED CUTTING

114 - 135

- 7.1 Introduction (114)
- 7.2 A Fictitious Model of Tool
And Work Pair (114)
- 7.3 Formulation Of The Basic
Equations Of Motion (116)
- 7.4 The Limiting Case of High-Speed
Cutting (119)
- 7.5 Maximum Stress Level (120)
- 7.6 Tracing The Work-Material
Build-Up Profile (121)
- 7.7 Discussion (124)

REFERENCES

136 - 140

APPENDICES

141 - 192