

CONTENTS

Candidate's Declaration.....	i
Acknowledgments.....	ii
Abstract.....	iv
List of Publications.....	vi
List of Figures.....	x
List of Tables.....	xvi
List of Abbreviations	xvii
List of Symbols.....	xviii
CHAPTER 1- INTRODUCTION.....	1
1.1 Laser Bending Process.....	3
1.1.1 Temperature Gradient Mechanism (TGM).....	4
1.1.2 Buckling Mechanism (BM).....	4
1.1.3 Upsetting Mechanism (UM).....	5
1.2. Electromagnetic-Force-Assisted Laser Forming (EMFLF).....	6
1.3 Applications of Laser Bending.....	6
1.4 Advantages and Disadvantages of Laser Bending.....	7
1.5 Scope of the Present Thesis.....	8
1.6 Organization of the Thesis.....	8
CHAPTER 2-LITERATURE REVIEW.....	10
2.1. Materials used for Laser Bending Process.....	10
2.2. Process Parameters in Laser Bending.....	13
2.1.1. Laser Power.....	14
2.2.2. Scan Speed.....	17
2.2.3. Beam Diameter	19
2.2.4. Duty Cycle and Pulse Duration.....	21
2.2.5. Number of Laser Scans.....	21
2.2.6. Absorptivity	24
2.2.7. Workpiece Geometry.....	25
2.2.8. Workpiece Clamping.....	27
2.2.9. Mechanical Properties.....	27
2.2.10. Thermal Properties.....	29
2.2.11. Forced Cooling.....	30

2.2.12. External Load.....	34
2.3. Edge Effect in Laser Bending Process	40
2.4. Mechanical and Microstructural Properties.....	43
2.4.1. Microstructural Properties.....	43
2.4.2. Mechanical Properties.....	44
2.5. Research Gaps	44
2.6. Research Objectives.....	46
CHAPTER 3 – EXPERIMENTATION.....	49
3.1. Material.....	49
3.2. Preparation of Specimen.....	49
3.3. Experimental Setup.....	50
3.4. Selection of Process Parameters.....	50
3.5. Experimental Conditions.....	53
3.6. Experimental Procedure.....	53
3.6.1. Natural and Forced Cooling Laser Bending.....	53
3.6.2. Electromagnetic Force-Assisted Laser Bending.....	55
3.6.3. Development of Electromagnet.....	55
3.6.4. Experimentation.....	56
3.7. Testing and Analysis.....	57
3.7.1. Bend Angle Measurement.....	57
3.7.2. Temperature Measurement.....	58
3.8. Study on Metallographic Sample Preparation and Examination.....	59
3.8.1. Sample Cutting.....	60
3.8.2. Sample Mounting.....	60
3.8.3. Sample Polishing.....	60
3.8.4. Scanning Electron Microscopy (SEM).....	61
3.8.5. Micro-Hardness Testing.....	62
3.8.6. Tensile Testing.....	63
3.9. Edge Effect.....	64
3.10. Summary.....	64
CHAPTER 4 – FORCED COOLING ASSISTED LASER BENDING.....	66
4.1. Bend Angle.....	66
4.2. Temperature Analysis.....	70

4.3. Edge Effect.....	73
4.4. Microstructure Analysis.....	76
4.5. Micro-Hardness.....	80
4.6. Tensile Testing.....	84
4.7. Summary.....	89
CHAPTER 5- ELECTROMAGNETIC FORCE ASSISTED LASER BENDING....	90
5.1. Bend Angle.....	90
5.2. Edge Effect.....	95
5.3. Microstructure Analysis.....	99
5.4. Micro-Hardness.....	101
5.5. Tensile Strength.....	104
5.6. Summary.....	105
CHAPTER 6 - CONCLUSION AND FUTURE SCOPE.....	107
6.1. Forced Cooling Assisted Multi-Scan Laser Bending.....	107
6.2. Electromagnetic Force Assisted Laser Bending.....	109
6.3. Scope for Future Work.....	110
6.4 Limitations of Present work.....	110
References.....	112
Appendix.....	134