

Contents

Contents	5
List of Figures	9
List of Tables	13
List of Abbreviations and Symbols	15
Abstract	17
Structure of Thesis	19
1 Introduction	21
1.1 Full-field Measurements	21
1.2 Fracture Parameters	21
1.3 Motivation	23
1.4 Aim of Work and Summary of Main Contributions	24
2 Elastic-Plastic Fracture Mechanics	27
2.1 J-integral	27
2.2 CTOD	28
2.3 Crack Growth Resistance Curves	29
2.4 Standard Fracture Toughness Testing	30
3 Methodology	33
3.1 Digital Image Correlation	33
3.1.1 DIC Types	34
3.1.2 Principles of 2D DIC	34
3.1.3 2D DIC Algorithm	36
3.1.4 Uncertainty and Errors	40
3.2 Out-of-plane Motion	41
3.2.1 Pinhole Camera Model	42
3.2.2 Telecentric Camera Model	45
3.2.3 Correction Method	47
3.3 Treatment of Specimen Surface	47

3.4	Full-field Measurement	49
3.4.1	Displacement	49
3.4.2	Strain.....	51
3.4.3	Stress.....	53
3.5	Extraction of Fracture Parameters	57
3.5.1	J-integral	57
3.5.2	CTOD	58
4	Calibration of 2D DIC Laboratory System.....	61
4.1	Calibration Specimen.....	61
4.2	Calibration Experiment.....	62
4.3	Calibration Results.....	63
5	Experimental Work I (MT Specimen).....	67
5.1	Material and Specimen	67
5.2	Specimen Preparation	70
5.3	Fracture Test	71
5.4	Results.....	72
5.4.1	Mesh	73
5.4.2	Displacement	73
5.4.3	Strain	74
5.4.4	Stress	75
5.4.5	J-integral	77
5.4.6	<i>J-R</i> Curve.....	79
5.4.7	CTOD	81
5.4.8	Summary for Critical J-integral (Fracture Toughness).....	83
6	Experimental Work II (CT Specimen)	85
6.1	Material and Specimen	85
6.2	Fracture Test	86
6.3	Results.....	88

6.3.1.	Mesh.....	88
6.3.2.	Displacement.....	89
6.3.3.	Strain	89
6.3.4.	Stress	90
6.3.5.	J-integral.....	91
6.3.6.	CTOD.....	92
6.3.7.	J-integral according to ASTM Standard	94
6.3.8.	Summary for Critical J-integral (Fracture Toughness).....	95
7	Conclusions.....	97
	References.....	99
	List of Publications of Author related to Thesis	103