

TABLE OF CONTENT

CERTIFICATE	i
CERTIFICATE	ii
DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENT	vi
LIST OF FIGURES	vii
LIST OF TABLES	viii
CHAPTER 1	1
INTRODUCTION	1
1.1 COMPOSITE MATERIALS:	1
1.2 CLASSIFICATION OF COMPOSITE MATERIALS:	1
1.2.1 Classification on the Basis of Reinforcement:	1
1.2.1.1 Particulate reinforced composite:	1
1.2.1.2 Flake reinforced composite:	1
1.2.1.3 Fiber Reinforced composites:	2
1.2.2 Classification on the Basis of Types of Matrix Material:	2
1.2.2.1 Polymer matrix composite:	2
1.2.2.2 Metal matrix composite:	2
1.2.2.3 Ceramic matrix composite:	3
1.2.2.4 Carbon- carbon composite:	3
1.3 ADVANTAGE OF COMPOSITE MATERIAL:	3
1.4 APPLICATION OF COMPOSITE MATERIALS:	3
1.5 LAMINA AND LAMINATE:	3
1.5.1 Symmetric Laminate:	4
1.5.2 Cross Ply Laminate:	5
1.5.3 Angle Ply Laminate:	5
1.5.4 Anti-symmetric Laminate:	5
1.5.5 Balanced Laminate:	6
1.5.6 Quasi isotropic Laminate:	6
1.6 BAMBOO:	6
1.6.1 Different Species of Bamboo:	6

1.6.2 Bamboo Anatomy	7
1.6.3 Bamboo Fiber Composite:	8
1.6.4 Bamboo Treatment:	8
1.6.4.1 Alkali treatment:	8
1.7 RESIN:	8
1.8 ORGANIZATION OF THE THESIS:	8
CHAPTER 2	10
LITERATURE REVIEW	10
2.1 LITERATURE REVIEW ON BAMBOO FIBER/EPOXY COMPOSITE MATERIAL:	10
2.2 RESEARCH GAP IN EXISTING LITERATURE:	12
2.3 OBJECTIVE OF THE PRESENT WORK:	13
CHAPTER 3	14
SINGLE BAMBOO FIBERS STRIP PHYSICAL PROPERTY AND ITS ANALYSIS	14
3.1 INTRODUCTION:	14
3.2 SINGLE BAMBOO FIBER STRIP SAMPLE PREPARATION:	15
3.2.1 Tensile Test Specimen and Testing:	15
3.2.2 Interfacial Shear Strength (IFSS) Test Specimen and Testing:	16
3.2.3 SEM Sample and Set up:	17
3.3 RESULT AND DISCUSSION:	18
3.3.1 Tensile Strength:	18
3.3.2 Interfacial Shear Strength (IFSS):	19
3.3.3 Scanning Electron Microscopic View:	20
CHAPTER 4	23
FABRICATION OF A MANUAL COMPRESSION MACHINE FOR FRP COMPOSITES	23
4.1 INTRODUCTION:	23
4.2 CAD MODELLING:	23
4.3 MATERIAL AND CONSTRUCTION:	24

4.3.1 Different Parts Used:	24
4.3.2 Scissor Jack:	25
4.3.3 Different Operations:	25
4.4 WORKING OF THE COMPRESSION MACHINE:	27
4.5 LOAD CALCULATION AND MECHANICAL ADVANTAGE:	27
CHAPTER 5	30
BAMBOO FIBER STRIP/EPOXY COMPOSITE MATERIALS AND ITS MECHANICAL PROPERTIES	30
5.1 INTRODUCTION:	30
5.2 PREPARATION OF COMPOSITE:	30
5.2.1 Moulding Box:	31
5.2.2 Cutting Strips and Alkali Treatment:	31
5.2.3 Preparation of Bamboo Mat:	32
5.2.4 Matrix Material:	32
5.2.5 Fabrication of Composite Material:	33
5.2.5.1 Type-I: Hand Lay-up Followed by Compression Moulding:	33
5.2.5.2 Type-II: Hand Lay-up:	35
5.3 PREPARATION OF SAMPLES AND TESTING:	36
5.3.1 Density of The Composite:	36
5.3.2 Tensile Testing:	37
5.3.3 Flexural Testing:	38
5.3.4 Impact Testing:	39
5.3.5 Hardness Testing:	40
5.3.6 Thermogravimetric Analysis (TGA):	41
5.4 RESULT AND DISCUSSION:	42
5.4.1 Percentage Weight Loss after Alkali Treatment:	42
5.4.2 Density:	42
5.4.3 Tensile Strength:	43
5.4.4 Flexural Strength:	44
5.4.5 Impact Strength:	46
5.4.6 Hardness:	47
5.4.7 Thermogravimetric Analysis (TGA):	48
CHAPTER 6	50
CONCLUSION AND SCOPE FOR FUTURE WORK	50
6.1 CONCLUSION:	50

6.2 SCOPE FOR FUTURE WORK:	51
BIBLIOGRAPHY	52

LIST OF FIGURES:

Fig 1.1 Particulate reinforced composite	1
Fig 1.2 Flake reinforced composite	2
Fig 1.3 Fiber reinforced composite	2
Fig 1.4 Lamina containing fiber and epoxy	4
Fig 1.5 Different orientation of lamina to form a laminate	4
Fig 1.6 Symmetric laminate	5
Fig 1.7 Cross ply laminate	5
Fig 1.8 Angle ply laminate	5
Fig 1.9 Anti-symmetric laminate	6
Fig 1.10 Balanced laminate	6
Fig 1.11 World percentage of bamboo from different continents	7
Fig 1.12 Chemical constituents of bamboo fiber	7
Fig 3.1 Litmus test for alkali treated bamboo fiber strip	14
Fig 3.2 Bamboo fiber strips	15
Fig 3.3 Tensile test specimen	15
Fig 3.4 Single bamboo strip tensile test in UTM	16
Fig 3.5 Rubber moulding box	
Fig 3.6 Embedded bamboo strip in resin	16
Fig 3.7 IFSS sample before test	
Fig 3.8 IFSS sample after test	17
Fig 3.9 SEM set up	17
Fig 3.10 Stress strain curve of bamboo strip treated with different alkali concentration	18
Fig 3.11 IFSS of different naoh concentrated sample	19
Fig 3.12 SEM images of 4 wt % NaOH treated bamboo fiber strip with different resolution	20
Fig 3.13 SEM images of 6 wt % NaOH treated bamboo fiber strip with different resolution	20
Fig 3.14 SEM images of 10 wt % NaOH treated bamboo fiber strip with different resolution	20
Fig 3.15 SEM images of untreated bamboo strip with different resolution	21
Fig 3.16 SEM images of 5 wt % NaOH treated bamboo fiber strip with different resolution	21

Fig 3.17 SEM images of 8 wt % NaOH treated bamboo fiber strip with different resolution	21
Fig 3.18 SEM images of 12 wt % NaOH treated bamboo fiber strip with different resolution	21
Fig 3.19 SEM images of 15 wt % NaOH treated bamboo fiber strip with different resolution	22
Fig 4.1 (a) Scissor jack, (b) Sliding pair, (c) M8 nut bolt, (d) jack base support plate	23
Fig 4.2 (a) Exploded view of press machine, (b) Final assembly of press machine	24
Fig 4.3 Scissor jack and lever	25
Fig 4.4 Circular bar cutting using power hacksaw	
Fig 4.5 Facing and drilling	25
Fig 4.6 Drilling operation	26
Fig 4.7 Compress machine frame	26
Fig 4.8 Machine with spring and slider	26
Fig 4.10 Final product	27
Fig 4.9 Scissor jack assembling	27
Fig 4.11 2D CAD model of compression moulding machine	28
Fig 5.1 Aluminium moulding box	31
Fig 5.2 Bamboo fiber mat with end tied	32
Fig 5.3 Bamboo mat tied with thread to eliminate lateral displacement of fiber due to load	32
Fig 5.4 Sample prepared by 46% wt fraction of bamboo strip	34
Fig 5.5 Sample prepared by 43.71% wt fraction of bamboo strip	34
Fig 5.6 Sample prepared by 42.52% wt fraction of bamboo strip	35
Fig 5.7 Final type-I sample for mechanical testing	35
Fig 5.8 Final product using hand lay-up method	36
Fig 5.9 Voids present in composite type-II	36
Fig 5.10 Set up to measure density	37
Fig 5. 11 (a)Tensile test setup, (b)Extension meter setup	38
Fig 5.12 Tensile test specimen	38
Fig 5.13 (a) Shear strength set up, (b) Shear strength sample, (c) Failed shear test sample	39
Fig 5.14 (a) Impact testing machine, (b) Impact test specimen	40
Fig 5.15 (a) Rockwell hardness testing machine, (b) Sample setup rockwell hardness tester	41
Fig 5.16 TGA set up	41

Fig 5.17 Type-I sample failed in mechanical testing	43
Fig 5.18 Type-II sample failed in mechanical testing	43
Fig 5.19 Stress-strain curve for tensile test specimen of type-I composite	43
Fig 5.20 Stress-strain curve for tensile test specimen of type-II composite	44
Fig 5.21 Flexural test specimen after failure	45
Fig 5.22 Slope of type-I and type-II composite	45
Fig 5.23 Load vs extension graph of type-I composite	46
Fig 5.24 Load- extension graph of type-II composite	46
Fig 5.25 Impact test specimen after fracture	47
Fig 5.26 Thermal degradation for both the composite in three stages	48
Fig 5.27 (a, b) Degradation in two different stages of both the composite	49

LIST OF TABLES:

Table 3.1 Tensile properties of bamboo strip treated with different alkali concentration	18
Table 4.1 Final results of moulding machine analysis	29
Table 4.2 Cost of the machine	29
Table 5.1 Properties of matrix material	33
Table 5.2 Different weight fraction of bamboo strip and matrix material taken	33
Table 5.3 Percentage loss of hydroxyl group after alkali treatment	42
Table 5.4 Density of composite of Type-II	42
Table 5.5 Density of the composite of Type-I	42
Table 5.6 Flexural properties for type-I composite.	44
Table 5.7 Flexural properties for type-II composite.	45
Table 5.8 Impact test results	47
Table 5.9 Hardness values of different samples	48

