UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF STITCHING ON WOVEN JUTE FABRIC EMBEDDED WITH THERMOPLASTIC BINDER SYSTEM IN INTRAPLY COMPOSITE

This report is submitted in accordance with the requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Process) with Honours.

by

DUNCAN LING RUEY SHAN

B071510608

941115-13-5867

FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY

2019

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk:EFFECT OF STITCHING ON WOVEN JUTE FABRIC EMBEDDED WITH THERMOPLASTIC BINDER SYSTEM IN INTRAPLY COMPOSITE

Sesi Pengajian: 2019

Saya **duncan ling ruey shan** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐	SULIT*	Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD* — Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,	Disahkan oleh penyelia:
....	....
duncan ling ruey shan	Professor Madya Ir. Dr. Mohd Yuhazri Bin Yaakob
Alamat Tetap:	Cop Rasmi Penyelia
247, Lorong 18,	ASSOCIATE PROF. IR. TS. DR. MOHD YUHAZRI BIN YAAKOB
Taman Sri Iskandar	Deputy Dean (Research & Industrial Link)
36400 H. Melintang, Perak	Faculty of Mechanical and Manufacturing Engineering Technology
	Universiti Teknikal Malaysia Melaka
Tarikh:	Tarikh:

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared that this report entitled "Effect of stitching on woven kenaf fabric embedded with thermoplastic binder system in intraply composite" is the results of my own research except as cited in references.

Signature : ....

Author's Name : DUNCAN LING RUEY SHAN

Date : 12th DECEMBER 2018

APPROVAL

This report is submitted to Faculty Of Mechanical And Manufacturing Engineering Technologyof UTeM as a partial fulfilment of the requirement for Degree of Manufacturing Technology Engineering (Process and Technology) (Hons.). The member of the supervisory committee is as follow:

....

(PROFESSOR MADYA IR. DR. MOHD YUHAZRI BIN YAAKOB)

ASSOCIATE PROF. IR. TS. DR. MOHD YUHAZRI BIN YAAKOB
Deputy Dean (Research & Industrial Link)
Faculty of Mechanical and Manufacturing Engineering Technology
Universiti Teknikal Malaysia Melaka

ABSTRACT

Since decades ago, composite material has gain the attention of the researchers due to its abundance of resources, low cost and good in mechanical and physical properties. Due to the advantages of composite material can provide, numerous development has been conducted constantly.This research's objective is to investigate the effect of stitching on the jute fiber reinforced thermoplastic composite. The woven jute is fabricated manually with different design of stitching follows byapplying hot press machine with polypropylene as reinforcing material. Furthermore, the fabricated composite is tested with tensile test, impact test, and hemispherical test according to ASTM standard in order to study the mechanical and physical properties of the intraply composite. In this study, the result revealed that T60/60 stitch woven jute produced the best mechanical performance by increased the specific strength of 20.42% compared to unstitched woven jute. From the study, the performance of the best stitch design has potential to produce shin guard as to replaced synthetic thermoplastic to enchance the impact and tensile properties of the composite.

ABSTRAK

Sejak beberapa dekad yang lalu, bahan komposit telah mendapat perhatian para penyelidik kerana banyaknya sumber, kos yang rendah dan baik dalam sifat mekanikal dan fizikal. Oleh kerana kelebihan bahan komposit dapat disediakan, banyak pembangunan telah dijalankan secara berterusan. Objektif kajian ini adalah untuk mengkaji kesan jahitan pada komposit termoplastik bertetulang gentian jute. Jut tenunan dibuat secara manual dengan reka bentuk jahitan yang berbeza berikut dengan menggunakan mesin akhbar panas dengan polipropilena sebagai bahan pengukuhan. Selain itu, komposit fabrikasi diuji dengan ujian tegangan, ujian impak, dan ujian hemispherical mengikut piawaian ASTM untuk mengkaji sifat mekanikal dan fizikal komposit intraply. Dalam kajian ini, hasil kajian menunjukkan bahawa T60 / 60 stitch joven jut menghasilkan prestasi mekanikal yang terbaik dengan meningkatkan kekuatan spesifik sebanyak 20.42% berbanding jute tenunan yang tidak dijahit. Dari kajian ini, prestasi reka bentuk jahitan yang terbaik berpotensi untuk menghasilkan pengawal shin untuk menggantikan termoplastik sintetik untuk mengatasi kesan dan sifat tegangan komposit.

DEDICATION

Dedicated to my beloved father, Philip Ling Liang Chun,

my loving mother, Tsai Mei Fang,

my awesome brothers, Ling Jem Shan, George Ling Yeong Shann

my teammate, Michelle Lye Chuok Fang, AngSiewKhim, FiniksAnak Kanis and my special friend, NurFatin binti Zaharuddin,

giving me moral support, cooperation, encouragement and understandings.

I love you all forever. Thank you.

ACKNOWLEDGEMENT

I would like to take this opportunity to thank my diligent supervisor PM.Ir. Dr.MohdYuhazri Bin Yaakob CEng MIMechE who had spent his precious time to guide us in this research. His effort and support has given me strength to exert my best endeavour and pushed me to my limits. Again, thanks to PM. Ir. Dr.MohdYuhazri Bin Yaakob CEng MIMechE, a noble educator.

Besides, I have to thank my coursemates AngSiewKhim, and Michelle Lye Chuok Fang whom have lent a hand to me during crucial moment. The time we spent together shall never be forgotten. Not to forget my family for providing such warmth upbringing before stepping into society.

Finally, to Universiti Teknikal Malaysia Melaka, thank and appreciate for giving the chance on implementation of the final year project with assistance by lab engineer, as this create a wonderful memory for my university life.

TABLE OF CONTENT

Declaration		iii
Approval		iv
Abstract		v
Abstrak		vi
Dedication		vii
Acknowledgement		viii
Table of contents		ix
List of Figures		xii
List of Tables		xvii
List of Abbreviations		xix
CHAPTER 1: INTRODUCTION		
1.1	Background of Research	1
1.2	Problem Statement	4
1.3	Objectives	6
1.4	Scopes	6
1.5	Rational of Research	7
1.6	Summary of Methodology	8
1.7	Thesis Arrangement	9
CHAPTER 2: LITERATURE REVIEW		
2.1	Introduction to Composite	10
	2.1.1 Intraply composite	12
2.2	Jute	14
	2.2.1 Jute composite	15
	2.2.2 Thermoplastic matrix in jute composites	16
2.3	Binder System	17
2.4	Stitching	19
	2.4.1 Type of stitching	21
	2.4.2 Stitching material	22
	2.4.3 Process of stitching	24
2.5	Woven Fabric	26
	2.5.1 Structure and design of woven fabric	27
	2.5.2 Fabrication of woven fabric	29
	2.5.3 Testing on woven fabric	30
2.6	Synthetic Intraply	33
2.7	Natural Intraply	34
2.8	Summary and Research Gap	35
CHAPTER 3: METHODOLOGY		
3.1	An Overview of Methodology	37
3.2	Raw Material Preparation	39
	3.2.1 Jute fiber	39
	3.2.2 Woven jute woving	40
3.3	Polypropylene	40
3.4	Stitching Design on Woven Jute Fabric	41
3.5	Stitching Process	42

3.6 Intraply Composite Preparation 43
3.7 Mechanical Testing 44
3.7.1 Tensile test 44
3.7.2 Impact test 46
3.7.3 Hemisphere pressure clamed test (3D stamping test) 47
3.8 Scanning Electron Microscope 48

CHAPTER 4: RESULTS AND DISCUSSION 50
4.1 Overview 50
4.2 Properties of Original Woven Jute Fibre 52
4.2.1 Tensile performance of O 54
4.2.2 Impact performance of O 56
4.2.3 Hemisphere performance of O 58
4.3 Properties of Vertical Stitch on Woven Jute Fibre 59
4.3.1 Tensile performance of V stitch 61
4.3.2 Impact performance of V stitch 64
4.3.3 Hemisphere performance of V stitch 66
4.4 Properties of Tilt 60° Stitch on Woven Jute Fibre 67
4.4.1 Tensile performance of T60 stitch 69
4.4.2 Impact performance of T60 stitch 71
4.4.3 Hemisphere performance of T60 stitch 73
4.5 Properties of Tilt 30° Stitch on Woven Jute Fibre 74
4.5.1 Tensile performance of T30 stitch 76
4.5.2 Impact performance of T30 stitch 79
4.5.3 Hemisphere performance of T30 stitch 81
4.6 Properties of Horizontal Stitch on Woven Jute Fibre 82
4.6.1 Tensile performance of H stitch 84
4.6.2 Impact performance of H stitch 86
4.6.3 Hemisphere performance of H stitch 89
4.7 Properties of Box Stitch on Woven Jute Fibre 90
4.7.1 Tensile performance of Box stitch 92
4.7.2 Impact performance of Box stitch 94
4.7.3 Hemisphere performance of Box stitch 96
4.8 Properties of Tilt 30°/ Tilt 30° Stitch on Woven Jute fibre 97
4.8.1 Tensile performance of T30/30 stitch 99
4.8.2 Impact performance of T30/30 stitch 102
4.8.3 Hemisphere performance of T30/30 stitch 104
4.9 Properties of Tilt 45°/ Tilt 90° Stitch on Woven Jute fibre 105
4.9.1 Tensile performance of T45/T90 stitch 107
4.9.2 Impact performance of T45/T90 stitch 109
4.9.3 Hemisphere performance of T45/T90 111
4.10 Properties of Tilt 30°/ Tilt 30° Stitch on Woven Jute fibre 112
4.10.1 Tensile performance of T30/30 stitch 114
4.10.2 Impact performance of T30/30 116
4.10.3 Hemisphere performance of T30/30 118
4.11 Comparison Effect of Tensile Strength in Different Stitching Design 119
4.12 Comparison Effect of Impact Strength in Different Stitching Design 125
4.13 Comparison Effect of Hemisphere Test in Different Stitching Design 129
4.14 Summary of Analysis Finding 133

CHAPTER 5: CONCLUSION AND RECOMMENDATION 136
5.1 Conclusion 136
5.2 Recommendation 140
5.3 Sustainability Element 140
5.4 Commercial Value and Potential 143

REFERENCES 145

GANTT CHART PSM 2

APPENDIX
TURNITIN

LIST OF FIGURES

No.	Title	Page
2.1	Type of fibers; (a) Continuous fiber, (b) Discontinuous	12
2.2	(a) Unidirectional lay-up (intraply), (b) Directional lay-up (interplay)	13
2.3	Three main hybrid configuration, (a) interlayer, (b)intralayer, (c) intrayarn	13
2.4	Stacking sequence of jute preform, (a) 0/0/0/0, (b) 0/+45/-45/0 (c) 0/90/90/0	18
2.5	The pultrusion method	19
2.6	Type of stitches (a) tricot stitch, (b) pillar stitch, (c) hybrid stitch	21
2.7	Type of stitching pattern used for joining multi-layer samples	22
2.8	The key aspects to stitching formation	24
2.9	The outline of framework for lock stitch	25
2.10	The modified lock stitch	25
2.11	Schematic diagrams of one-sided stitch pattern	26
2.12	Type of weave pattern (a) Plain weave, (b) Twill weave, (c) Basket weave (c) Basket weave, (d) Satin weave, (e) Leno weave, (f) Mock leno weave	28
2.13	3 different warp structural diagram for 3D-woven fabric	30
2.14	Drop weight tester (a) machine overview, (b) impactor, (c) support fixture	32
2.15	Modified pneumatic based formability	33
3.1	Flowchart of methodology	38
3.2	Jute fiber	40

3.3	Plain jute weave design	40
3.4	Polypropylene pallets	41
3.5	Type of stitch design	42
3.6	Singer 7422 FS advance electronic sewing machine	43
3.7	Vacuum for fabricate intraply composite	44
3.8	Instron 50kN universal testing machine	45
3.9	The dimension of tensile testing sample (ASTM D3039)	46
3.10	Impact testing machine	46
3.11	Geometry of specimen	47
3.12	3D stamping test for woven fabric	47
4.1	Plain weave woven jute fibre	53
4.2	O design woven jute fibre embedded with PP resin	53
4.3	Specimens of O1 (a) before (b) after tensile test	55
4.4	Tensile strength of unstitch woven jute	55
4.5	Micrograph of unstitch woven jute reinforced polypropylene composite	56
4.6	Impact toughness and energy absorption of unstitch woven jute	57
4.7	Failure mode of unstitch woven jute after impact test	58
4.8	The deformed of unstitch woven jute	59
4.9	V-stitched woven jute fibre	60
4.10	V-stitched woven jute fibre after embedded with PP resin	60
4.11	Specimens of V1 (a) before (b) after tensile test.	62
4.12	Tensile strength and average of v stitch woven jute	63
4.13	Micrograph of V stitch woven jute reinforced PP composite	64
4.14	: Impact toughness and energy absorption of V stitch woven jute	65
4.15	Failure mode of V-stitched woven jute after impact test	66

4.16 Tensile strength and average of v stitch woven jute 67
4.17 T60-stitched woven jute fibre 68
4.18 T60-stitched woven jute fibre after embedded with PP resin 68
4.19 Tensile strength of T60 stitch woven jute 69
4.20 Specimen of T60 (a) before (b) after tensile test 70
4.21 Micrograph of T60 stitch woven jute reinforced polypropylene composite 71
4.22 Impact toughness and energy absorption of T60 stitch 72
4.23 Failure mode of T60-stitched woven jute after impact test 73
4.24 The deformed of T60 stitch woven jute 74
4.25 T30 stitch on woven jute fibre 75
4.26 Shape of woven jute fibre oblique to the left 75
4.27 Tensile strength of T30 stitch woven jute 77
4.28 Specimen of T30 (a) before (b) after tensile test 77
4.29 Micrograph of T30 woven jute reinforced PP composite 79
4.30 Impact toughness and energy absorption of T30 stitch 80
4.31 Failure mode of T30 stitch woven jute after impact test 81
4.32 The deformed of T30 stitch woven jute 82
4.33 H-stitched woven jute 83
4.34 H-stitched woven jute embedded with PP resin 83
4.35 Specimen of H (a) before (b) after tensile test 85
4.36 Tensile strength of H stitch woven jute 85
4.37 Micrograph of H stitch woven jute reinforced polypropylene composite 86
4.38 : Impact toughness and energy absorption of H stitch. 87
4.39 Failure mode of H stitch woven jute after tensile test 88
4.40 The deformed of H stitch woven jute 90

4.41 : Box stitch on woven jute fibre 91

4.42 :Box stitch on woven jute fibre after embedded with PP resin 91

4.43 Tensile strength of Box stitch woven jute 92

4.44 Specimen of Box (a) before (b) after tensile test 93

4.45 Micrograph of Box stitch woven jute reinforced composite 94

4.46 Impact toughness and energy absorption of Box stitch 95

4.47 : Failure mode of Box stitch woven jute after impact test 96

4.48 The deformed of Box stitch woven jute 97

4.49 T30/30 stitch on woven jute fibre 98

4.50 T30/30 stitch on woven jute fibre after embedded with polypropylene resin 99

4.51 : Tensile strength of T30/30 stitch woven jute 100

4.52 Specimen of T30/T30 (a) before (b) after tensile test 101

4.53 Micrograph of T30/30 stitch woven jute reinforced polypropylene composite 102

4.54 Impact toughness and energy absorption of T30/30 stitch 103

4.55 Failure mode of T30/30 woven jute after impact test 104

4.56 The deformed of T30/30 stitch woven jute 105

4.57 T45/90 stitch on woven jute fibre 106

4.58 T45/90 stitch on woven jute fibre after embedded with PP resin 106

4.59 Tensile strength of T45/90 stitch woven jute 107

4.60 Specimen of T45/T90 (a) before (b) after tensile test 108

4.61 Micrograph of T45/90 stitch woven jute reinforced PP composite 109

4.62 Impact toughness and energy absorption of T45/90 stitch 110

4.63 Failure mode of T45/90 stitch woven jute after impact test 110

4.64 The deformed of T45/90 stitch woven jute 112

4.65 T60/60 stitch on woven jute fibre 112

4.66 T60/60 stitch on woven jute fibre after embedded with PP resin 113

4.67 Tensile strength of T60/60 stitch woven jute 114

4.68 Failure mode of T60/60 stitch woven jute after tensile test 115

4.69 : Micrograph of T60/60 stitch woven jute reinforced PP composite 116

4.70 Impact toughness and energy absorption of T60 stitch 117

4.71 Failure mode of T60/60 stitch woven jute after impact test 117

4.72 : The deformed of T60/60 stitch woven jute 119

4.73 Average tensile strength of all stitching designs of woven jute. 123

4.74 Specific strength of all stitching designs of woven jute 124

4.75 Impact toughness and energy absorption of all stitching designs of woven jute 128

4.76 Maximum load of all stitching designs of woven jute 131

4.77 Illustration specific strength of (a) single stitch designs (b) double stitch designs. 134

4.78 Illustration of hemisphere performance of (a) single stitch (b) double stitch 135

5.1 The examples of shin guard 142

LIST OF TABLES

No.	Title	Page
2.1	The physiochemical properties of jute fibers	15
2.2	The mechanical properties of jute reinforced thermoplastic composites	17
3.1	Summary table of jute	39
3.2	Specific data polypropylene	41
3.3	Specification of cotton fibre	43
3.4	Testing standard for mechanical testing	44
3.5	ASTM standard for physical	49
4.1	Summary type of stitching design	51
4.2	9 types of stitch woven jute	51
4.3	Average properties of unstitch woven jute	53
4.4	The properties of hemispheric performance of unstitch woven jute	59
4.5	Average properties of V stitched design woven jute	60
4.6	The properties of hemispheric performance of V-stitched woven jute	67
4.7	Average properties of T60 stitch woven jute	68
4.8	The properties of hemispheric performance of T60-stitched woven jute	74
4.9	Average properties of T30 stitch woven jute	75
4.10	The properties of hemispheric performance of T30-stitched woven jute	81
4.11	Average properties of H stitch woven jute	83
4.12	The properties of hemispheric performance of H-stitched woven jute.	88

4.13	Average properties of Box stitch woven jute	90
4.14	The properties of hemispheric performance of Box-stitched woven jute	96
4.15	Average properties of T30/30 stitch woven jute.	98
4.16	The properties of hemispheric performance of T30/30 stitched woven jute.	104
4.17	Average properties of T45/90 stitch woven jute.	105
4.18	The properties of hemispheric performance of T45/90stitched woven jute	110
4.19	Average properties of T60/60 stitch woven jute	112
4.20	The properties of hemispheric performance of T60/60stitched woven jute	117
4.21	Summary tensile strength for all type of stitching design	119
4.22	Summary specific strength for all type of stitching design.	120
4.23	Summary of impact toughness and energy absorption for all stitching designs.	126
4.24	Summary hemisphere performance for all type of stitching design.	129
4.25	Overview deformation of all types stitching woven jute.	131

LIST OF ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
CFRP	-	Carbon fiber reinforced polymer
FRP	-	Fiber reinforced polymer
RTM	-	Resin Transfer Molding
SEM	-	Scanning electron microscope
PP	-	Polypropylene

CHAPTER 1

INTRODUCTION

This chapter explained and defined the prior background of stitching, woven fabrics and intraply composites materials. The idea for this research problem is emerged from engineering magazines, theories and other research studies. Therefore, numerous problems are mentioned and listed to allow the refinement to be made in this research. In addition, objectives and scopes of this research are specifically stated and mentioned in this chapter for introduction purpose about this research.

1.1 Background of Research

According to Abramovich *et al.* (2017), a composite material is a blend of two parts which would bring about properties superior to those of the individual segments when they are utilized alone. The composite is made of two constituents which are the fibre, otherwise called support and glue, known as the matrix. The utilization of composites in different applications in daily life has enhanced one capacity, quality and hardness. Campbell (2010) has stated in his paper that the use of composite materials are generally utilized as a part of aviation, transportation, marine products, sporting products, and current infrastructure. The composite material offers the producers longer life expectancy and higher quality with lesser weight and furthermore rustproof. Jute composite is characterized as a blend of jute as a strengthening agent with a material purposely to improve the mechanical normal for a composite material. Jute has been generally utilized as a strengthening agent to substitute man-made fibre in numerous applications because of its minimal pricing, eco-friendly and average mechanical properties (Hossain *et al.*, 2013). It is identified as the Golden Fibre of Bangladesh (Gupta *et al.*, 2015). Jute is a bast fibre from Tiliacae family scientifically named Corchorus capsularis (Sanjay *et al.*, 2016). The plant of jutes needs no less than 3 months to develop to a height of 12 to 15 feet. Due to necessity of moist air, the jute plant is developed in Asia and South America.

Throughout the years, stitching has dependably been utilized as a part of composites material to improve the de-lamination strength and additionally other basic properties, for example, damage tolerance and fracture resistance. From the research studies of Tan *et al.* (2010), the author has discovered that the specimens with a higher stitch density and thread thickness are more capable of impeding delamination growth by bridging delamination cracks. In addition, different sort of sewing strings has likewise impact the performance of sewing. Vaida and Milda (2006) has done examine on the effect of mechanical properties of sewing threads on seam pucker shows that the universal sewing threads is the most appropriate for sewing light textures as the seam pucker is least noticeable. Furthermore, the influence of weave type, stitching and binder system also might affect the mechanical properties of a composite. Yudhanto *et al.* (2012) has proposed that the effect of stitch orientation on the plain weave gives impact to the tensile strength by conducting open-hole tensile test. Therefore, to enhance the execution of the composites, the textile technologies ought to be considered to apply, for example, sewing, weaving and plaiting to make the best material before conducting the test.

Nowadays, fibre reinforced composites utilizing thermoplastics matrix are broadly applied for composite research studies as thermoplastics composites have better impact strength and recyclable. Thus, since the mechanical properties of thermoplastics composites are lower compared to thermoset composites, it is imperative to think about the relationship of the mechanical properties of fibre-strengthened composites. Kim *et al.* (2008) has studied the mechanical properties of polypropylene/natural fibre composites of cotton fibre compared with wood fibre and proved that thermoplastics matrix which is polypropylene improve the tensile strength of natural fibre composites. Furthermore, Zampolani *et al.* (2007) also has done research on the fabrication of kenaf fibre reinforced polypropylene sheets that could be thermoformed for wide variety of application and shows positive results where kenaf-PP composites have prevalent tensile and flexural strength when contrasted with other compression molded natural fibre composites.

Recently, some researchers have conducted investigation on the effect of stitching on woven fabrics which can be mixed together with polymer categories. Commonly there are two main types of stitching which are extensively applied in the industries that are lock stitch and chain stitch. Aymerich *et al.* (2006) has done analysis on the effect of stitching on fatigue strength of composites and showed stitching prolonged the fatigue life of the composites. However, there has been no research done yet about the effect of stitching on woven jute fabric. Therefore, this researched is proposed to obtain a clear result after testing have been tested out. In addition, woven textures are made by joining twist and weft yarns at the correct angles following the predetermined weave. In the research studies of Yuhazri *et al.* (2016), the author has described a few sorts of weaves which are plain, twill, basket, satin, leno and mock-leno. The author has discovered that dissimilar types of weave designs affect the mechanical behavior of the fabrics. Besides, the author has also discovered that mock-leno weaves demonstrates better mechanical properties and lessening the thickness will build the tensile strength of lamina.

Nonetheless, the scientific research on the effect of stitching on jute woven fabric embedded thermoplastic binder system in intraply composites is deficient. Therefore, the evolution on outcome of stitching on jute woven fabrics has become interesting to be investigated thoroughly to obtain new information in fibre-reinforced composites.

1.2 Problem Statement

In the current technologies, the demanding over the products using composites fibres are increasing due to its light in weight and high durability with cheap cost in production. The composites fibres are divided into two which are natural fibres and synthetic fibres. However, there have been debates on going between the researchers to obtain the best in mechanical behavior among the two composites. According to Campbell (2010), the composite material ought to have high quality and stiffness, accompanies with low density and permit weight lessening of completed parts.

Natural fibres are presently progressively utilized as fortification in biocomposites as a result of numerous points of interest, for example, cost-adequacy, lightweight, simple to process, sustainable, recyclable, accessible in immense amounts, low fossil-powered vitality necessities and furthermore, above all their high specific strength-to-weight ratio (Ku *et al*., 2011). Among lignocellulosic fibres, jute is a natural fibre with unlimited resources utilized as a fortification in biocomposites (Corrales *et al*., 2007) and stand in second place in terms of world production levels of cellulosic fibres after cotton (Cai *et al*., 2000). It has been applied numerously by the researchers as reinforcing agent of natural fibre composite in woven fabric but there are still lacking of studies on jute as the woven fabric itself. For example, Rajesh *et al*. 2018 has studied the mechanical behavior of jute-banana woven fabric composite. Therefore, this will be an opportunity to study the mechanical properties of jute itself as woven fabric in this research.

Intraply and intraply hybrid composites are two different type of weaving pattern on a single ply that the researchers have normally applied on to study the mechanical properties of the natural fibre composite. However, most of the researches are mostly focusing on the intraply hybrid lamina composite due to its better dispersion of fibres compare to intraply composite. For example, Yuhazri *et al*. 2016 has studied the influence of sewing pattern on