

Ain Shams University Women's College <u>Home Economic Department</u>

Thesis

Submitted in requirements PhD.

(Home Economics- Textile & Clothing)

<u>Entitled</u>

The low stress mechanical properties of fabrics produced

from different spinning systems and their economical

impact

<u>By</u>

ENAS M. ABD-ALFATAH MOSLHI SAKR

Supervised by

Prof. Dr. Ahmad A. Salman

Prof. Dr. Sanaa S. Saleh

Weaving and knitting department College of applied art Helwan University Clothing and Textile department College of Women Ain Shams University

Prof. Ass.Dr. Mamdoh Sharkas

Clothing and Textile department College of Women Ain Shams University

2017

Acknowledgment

Thanks god for the giving helps during the course of this study.

I would like to express my great gratitude to my supervisors:

I would like to extend my appreciation to **Prof.Dr. Ahmed salman** for her support and experiences he gave to me.

I am deeply indebted to my supervisor Prof.Dr. Sana

S.Saleh who help, stimulating, suggestion, and encouragement and helped me in all time of research. Great thanks for her.

I would like to thank **Dr.mamdouh Sharkas** May God have mercy on him, for his advises and encouragements during this study

Also especial thank goes to all companies that facilitated the completion of the practical part of this thesis.

I would like to thank all the distinguished professors who arbitrate this thesis.

I would like to thank **My Parents and my sister**. Without their love, support and encouragements this work would not have been possible.

Last but not least, great thanks and appreciation go to **my husband** and **my kind's** youssef, yassin & yasmmin for their love, support, assistance and encouragement.

Thanks for everyone who helped and supported me during the course of this thesis.



Enas Mohamed



Contents



Contents

List of Fig	ures	vi
List of Tab	les	xvi
Summary.		xxiv
1.	Introduction and literature reviews	1
1.1.	Introduction	1
1.2.	Literature reviews	3
1.3.	Textile fibers and their properties	8
1.4.	Yarn types and their classification	9
1.4.1.	Classification of yarns spinning system	9
1.5.	Overview of yarn requirements for weaving and knitting	10
1.6.	Spinning	11
1.6.1.	Ring Spinning	12
1.6.1.1.	End uses of ring spinning process	13
1.6.1.2.	Advantages of ring spinning system	13
1.6.1.3.	Carded yarns	14
1.6.1.4.	Combed yarns	14
1.6.2.	Open-end spinning	15
1.6.2.1.	Advantages of open-end spinning system	16
1.6.3.	Comparison of physical properties of fabrics woven from open-end and ring yarns	18
1.6.4.	Polyester Microfiber yarns	19
1.6.5.	Effect of Different Spinning System on The Low Stress Mechanical Properties of Fabrics	21
1.7.	Fabric Objective Measurement (FOM)	22
1.8.	Fabric Mechanical Properties	23
	Tensile Strength Property	23
	Elongation Property	24
	Crease Recovery Property	24
	Tearing Strength Property	24
	Absorption Property	25

1.9.	Definitions of The Properties Measured by the	25
	A Thickness/ Surface Thickness FAST-1	25
	B. Bending Length, Bending Rigidity, FAST-2	26
	C. Extensibility (FAST-3)	26
	D. Shear rigidity (FAST-3)	27
	E. Formability	27
1.10.	The Weaves	28
1.10.1.	Basic Weaves	28
1.10.1.1	Plain Weave	28
1.10.1.2	Twill Weave	29
1.10.1.3	Satin Weave	30
1.11.	Impact Of Fabric Structure And Fabric Setting	31
2	On Low Stress Mechanical Properties	22
2.	Aim of the work	33
3.	Experimental work	35
3.1.	Materials used and fabric production machine	36
3.2.	Yarn Test Methods and its instruments used	38
3.2.1.	Mechanical properties of cotton yarn	38
3.2.1.1.	Yarn twists testing and twist factor	38
3.2.1.2.	Yarn tensile strength and elongation testing	38
3.2.1.3.	Yarn evenness and yarn hairiness testing	39
3.3.	Woven Fabrics Test Methods and Its	39
2 2 1	instruments used	20
3.3.1.	Mechanical properties of woven fabrics	39
3.3.1.1.	FabricTensileStrengthandElongationTesting	40
3.3.1.2.	Fabric Tearing Strength Testing	40
3.3.1.3.	Fabric Crease Recovery Testing	41
3.3.1.4.	Fabric Water Resistance Testing	41
3.3.2.	The low stress mechanical properties of woven fabrics (FAST Instruments)	42

3.3.2.1.	Testing procedure	42
3.3.2.1.1.	Fabric Weight Test	42
3.3.2.1.2.	Preparation of FAST test samples	43
4.	Results & Discussion	45
4.1.	Results analysis of cotton spinning yarns used	45
4.2.	Results analysis of woven fabrics Mechanical properties	47
4.2.1.	Tensile strength property	52
4.2.1.1.	Tensile strength property results of fabrics produced from cotton yarns	52
4.2.1.2.	Tensile strength property results of fabrics made from polyester microfiber	65
4.2.1.3.	Tensile strength property result of a blended fabric	67
4.2.2.	Elongation property	68
4.2.2.1.	Elongation property results of fabrics produced from cotton yarns	68
4.2.2.2.	Elongation property results of fabrics made from polyester microfiber	81
4.2.2.3.	Elongation property result of a blended fabric	82
4.2.3.	Crease recovery property	83
4.2.3.1.	Crease recovery property results of fabrics produced from cotton yarns	83
4.2.3.2.	Crease recovery property results of fabrics made from polyester microfiber	95
4.2.3.3.	Crease recovery property result of a blended fabric	96
4.2.4.	Tear strength property	97
4.2.4.1.	Tearing property results of fabrics produced from cotton yarns	97
4.2.4.2.	Tearing strength property results of fabrics made from polyester microfiber	110
4.2.4.3.	Tearing strength property result of a blended	111

	fabric	
4.2.5.	Absorbency property	112
4.2.5.1.	Absorbency property results of woven fabrics produced from cotton yarns	112
4.2.5.2.	Absorbency property results of fabrics made from polyester microfiber yarns and a blended fabric p/c	113
4.3.	Radial Analysis of mechanical properties of cotton fabrics produced from different spinning yarns	114
4.4.	Findings	131
4.5.	Results analysis of woven fabrics low stress mechanical properties	133
4.5.1.	Thickness and Surface thickness properties (FAST-1).	138
4.5.1.1.	Thickness and Surface thickness properties results of cotton fabrics	138
	Fabrics thickness results at 2gf/cm ²	138
	Fabric thickness results at100gf/cm ²	149
	Fabric surface thickness results	160
4.5.1.2.	Thickness and Surface thickness properties results of polyester microfibers fabrics	172
4.5.2.	Bending properties (FAST-2)	173
4.5.2.1.	Bending length, bending rigidity properties results of cotton fabrics	173
	Bending length results of woven fabrics (BL)	174
	Bending rigidity results of woven fabrics (BR)	186
4.5.2.2.	Bending length, bending rigidity properties results of polyester microfibers fabrics	198
4.5.3.	Extensibility properties (FAST-3)	199
4.5.3.1.	Extensibility properties results of cotton fabrics	199 200
	Extensibility results at Sgf/cm of cotton woven	200

	Arabic Summary	_1_
	References	292
5.	Conclusion	285
4.8.	from different spinning yarns	281
т. / .		211
<i>4</i> 7	properties of cotton fabrics produced from different spinning types	277
4.6.	Shearing rigidity results of polyester microfibers fabrics (G) Radial Analysis of low stress mechanical	259 260
	Shearing rigidity results of cotton fabrics (G)	246
4.5.3.2	Extensibility properties and formability results	245
	woven fabrics (E100%) Formability results of cotton fabrics (F)	231
	fabrics (E20%) Extensibility results at 100gf/cm of cotton	218
	Extensibility results at 20gf/cm of cotton woven	209
	fabrics (E5%)	

List of figures

Figure (1): The comparison between carded and combed yarns (a)	15
Eigure (2): Comparison of your structure of OE your (loft) and ring	18
Figure (2): Comparison of yarn structure of OE yarn (left) and ring	10
yarn (right)	•
Figure (3): Plain 1/1 structure.	29
Figure (4): Twill 2/2 structure	29
Figure (5): Satin 4 structure	30
Figure (6): Spray Tester	41
Figure (7): Preparation of samples FAST testing	43
Figure (8): Properties of different cotton spun yarns which were used	46
in fabrics production	
Figure (9): Relationship between weft setting and fabric structure on	52
tensile strength properties	
Figure (10): Relationship between weave coefficients and tensile	54
strength of different spinning system at 18 picks	
Figure (11): Relationship between weave coefficient and tensile	56
strength of different spinning system at 21 picks	
Figure (12): Relationship between weave coefficient and tensile	58
strength of different spinning system at 24 nicks	
Figure (13): Relationship between different picks numbers and	60
tensile strength of different spinning system using plain	00
$\frac{1}{1}$ structures	
Figure (14): Deletionship between different pieles numbers and	62
Figure (14). Relationship between different picks numbers and	02
tensile strength of different spinning system using twill	
2/2 structures.	()
Figure (15): Relationship between different picks numbers and	64
tensile strength of different spinning system using satin 4	
structures	
Figure (16): Tensile strength property of woven fabrics made of	66
polyester microfiber yarn	
Figure (17): Tensile strength property of woven fabrics made from	67
blended polyester/cotton yarn	
Figure (18): Relationship between weft setting and fabric structure	68
on Elongation properties	

Figure (19): Relationship between weave coefficients and elongation of different spinning system at 18 picks	70
Figure (20): Relationship between weave coefficient and elongation of different spinning system at 21 picks	72
Figure (21): Relationship between weave coefficient and elongation of different spinning system at 24 picks	74
Figure (22): Relationship between different picks numbers and elongation property of different spinning system using plain 1/1 structures	76
Figure (23): Relationship between different picks numbers and elongation property of different spinning system using twill 2/2 structure	78
Figure (24): Relationship between different picks numbers and elongation property of different spinning system using satin 4 structures	80
Figure (25): Elongation property of woven fabrics made from polyester microfiber yarns	82
Figure (26): Elongation property of a blended fabric made from polyester/cotton yarns (60/40)	82
Figure (27): Relationship between the weft setting and fabric structure on the crease recovery properties	83
Figure (28): Relationship between weave coefficient and crease recovery of different spinning system at 18 picks	84
Figure (29): Relationship between weave coefficients and crease recovery of different spinning system at 21 picks	86
Figure (30): Relationship between weave coefficient and crease recovery of different spinning system at 24 picks	88
Figure (31): Relationship between different picks numbers and crease recovery property of different spinning system using plain 1/1 structures	90
Figure (32): Relationship between different picks numbers on crease recovery property of different spinning system using twill 2/2 structure.	92
Figure (33): Relationship between different picks numbers on crease recovery of different spinning system using satin 4 structures.	93

Figure (34): Crease recovery property of woven fabrics producing	95
Figure (35): Crease recovery property of a blended fabric made	96
from polyester cotton varns	
Figure (36): Relationship between the weft setting and fabric structure on the tearing strength	97
Figure (37): Relationship between weave coefficient and tearing	99
strength of different spinning system at picks 18 yarns	101
Figure (38): Relationship between weave coefficients and tearing	101
strength of different spinning system at 21 picks	
Figure (39): Relationship between weave coefficients and tearing	103
strength of different spinning system at 24 picks	
Figure (40): Relationship between different picks numbers and	105
tearing strength of different spinning system using	
plain 1/1 structures	
Figure (41): Relationship between different picks numbers and	106
tearing strength of different spinning system using twill	
2/2 structure	
Figure (42): Relationship between different picks numbers and	108
tearing strength of different spinning system using satin	
4 structure	
Figure (43): Tearing strength property of woven fabrics made from	110
Figure (44): Teoring strength property of a blanded fabric mode from	110
polyester/cotton yarns	119
Figure (45): Sorption property of woven fabrics made from cotton	112
yarns with different variables	
Figure (46): Relative area of mechanical properties of plain 1/1	119
fabrics structure of three different spinning at 18picks	
Figure (47): Relative area of mechanical properties of plain 1/1	120
woven fabrics structure of three different spinning at	
21picks.	
Figure (48): Relative area of mechanical properties of plain 1/1	121
woven fabrics structure of three different spinning at 24	
picks	

Figure (49): The relative area of mechanical properties of Twill 2/2 woven fabrics structure of three different spinning at 18 picks	122
Figure (50): Relative area of mechanical properties of Twill 2/2 woven fabrics structure of three different spinning at 21 nicks	124
Figure (51): Relative area of mechanical properties of Twill 2/2 woven fabrics structure of three different spinning at 24 nicks	125
Figure (52): Relative area of mechanical properties of satin 4 woven fabrics structure of three different spinning at 18 nicks	126
Figure (53): Relative area of mechanical properties of satin 4 woven fabrics structure of three different spinning at 21 nicks	127
Figure (54): Relative area of mechanical properties of satin 4 woven fabrics structure of three different spinning at 24 nicks	128
Figure (55): Relationship between the weft setting and fabric structures on the thickness property at 2 gf/cm^2	138
Figure (56): Relationship between weave coefficient and fabric thickness at 2gf/cm2 of different spinning system at 18 nicks	140
Figure (57): Relationship between weave coefficients and fabric thickness at 2gf/cm2 of different spinning system at 21 nicks	142
Figure (58): Relationship between weave coefficient and fabric thickness at 2gf/cm2 of different spinning system at 24 nicks	143
Figure (59): Relationship between different picks numbers and fabric thickness at 2gf/cm2 of different spinning system using plain 1/1 structure	145
Figure (60): Relationship between different picks numbers and fabric thickness at 2gf/cm ² of different spinning system using twill 2/2 structure.	146

Figure (61): Relationship between different picks numbers and fabric thickness at 2gf/cm ² of different spinning system using	148
Figure (62): Relationship between weft setting and fabric structures on the thickness property at 100gf/cm ²	149
Figure (63):Relationship between weave coefficients and thickness at 100gf/cm ² of different spinning system at 18 picks	150
Figure (64): Relationship between weave coefficients and fabric thickness at 100gf/cm ² of different spinning system at 21 picks	152
Figure (65): Relationship between weave coefficients and fabric thickness at 100gf/cm ² of different spinning system at 24 picks.	153
Figure (66): Relationship between different picks numbers and fabric thickness at 100gf/cm ² of different spinning system using plain 1/1 structure.	155
Figure (67): Relationship between different picks numbers and fabric thickness at 100gf/cm ² of different spinning system using twill 2/2 structure	157
Figure (68): Relationship between different picks numbers and fabric thickness at 100gf/cm ² of different spinning system using satin 4 structure	158
Figure (69):Relationship between the weft setting and fabric structures on the surface thickness property	160
Figure (70):Relationship between weave coefficients and fabric surface thickness of different spinning system at 18 picks	162
Figure (71), Relationship between weave coefficient and fabric surface thickness of different spinning system at 21 picks	164
Figure (72):Relationship between weave coefficient and fabric surface thickness of different spinning system at 24 picks	165
Figure (73):Relationship between different picks numbers and fabric surface thickness of different spinning system using plain 1/1 structure	167

Figure (74):Relationship between different picks numbers and fabric surface thickness of different spinning system using	169
twill 2/2 structure	
Figure (75):Relationship between different picks numbers and fabric	170
surface thickness of different spinning system using	
satin 4 structures	
Figure (76):FAST-1 Compression meter results of polyester microfiber fabrics	172
Figure (77):Relationship between the weft setting and fabric	174
structures on fabrics bending length property	1,1
Eigure (79) Deletionship between weeve coefficients and febrie	175
Figure (78). Relationship between weave coefficients and fabric	175
bending length of different spinning system at 18 picks	177
Figure (79):relationship between weave coefficient and fabric	1//
bending length of different spinning system at 21 picks	
Figure (80):Relationship between weave coefficient and fabric	179
bending length of different spinning system at 24 picks	
Figure (81):Relationship between different picks numbers and fabric	181
bending length of different spinning system using plain	
1/1 structure	
Figure (82):Relationship between different picks numbers and fabric	182
hending length of different spinning system using twill	
2/2 structure	
Eigure (23): Palationship between different nicks numbers and fabric	184
Figure (65). Relationship between unterent picks numbers and fabric	104
bending length of different spinning system using satin	
4 structures.	100
Figure (84):Relationship between the weft setting and fabric	186
structures on the fabric bending rigidity property	
Figure (85):Relationship between weave coefficient and fabric	187
bending rigidity of different spinning system at 18	
picks	
Figure (86): Relationship between weave coefficient and fabric	189
bending rigidity of different spinning system at 21	
nicks	
Figure (87): Relationship between weave coefficient and fabric	190
hending rigidity of different spinning system at 24	170
niolea	
ріскя	

Figure (88): Relationship between different picks numbers and fabric binding rigidity of different spinning system using	192
Figure (89): Relationship between different picks numbers and fabric binding rigidity of different spinning system using twill 2/2 structure	194
Figure (90): Relationship between different picks numbers and fabric binding rigidity of different spinning system using satin 4 structure.	196
Figure (91): Values of bending properties of polyester microfiber fabrics	198
Figure (92): Relationship between weft setting and fabric structures on the fabric extension at 5gf/cm	200
Figure (93):Relationship between weave coefficient and fabric extension at 5gf/cm of different spinning system at 18 picks	201
Figure (94):Relationship between weave coefficient and fabric extension at 5gf/cm of different spinning system at 21 nicks	202
Figure (95):Relationship between weave coefficient and fabric extension at 5gf/cm of different spinning system at 24 picks	203
Figure (96):Relationship between different picks numbers and fabric extension 5gf of different spinning system using plain 1/1 structure	205
Figure (97):Relationship between different picks numbers and fabric extension 5gf of different spinning system using twill 2/2 structure	206
Figure (98): Relationship between different picks numbers and fabric extension 5gf of different spinning system using satin 4structure	207
Figure (99):Relationship between weft setting and fabric structures on the fabric extension at 20gf/cm	209
Figure (100):Relationship between weave coefficient and fabric extension at 20gf/cm of different spinning system at 18 picks	210