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"Influence of Some Woven Fabric Constructional Parameters on Seam Efficiency"

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Abstract: Fabric and seam strength is an important characteristic which affects the performance and durability of clothing during its usage life. This paper presents a study of the effect of some weaving parameters like cover factor; CF and weave structure of 100% linen fabric and polyester/linen blended fabric. Four weave structures and two levels of cover factors were used for each fabric.
Both Fabric and seam tensile strengths were measured using INSTRON tensile tester. The seam efficiency for warp and weft direction was calculated.
The effects of both cover factor and weave structures on the efficiency of sewn seams for the two types of fabrics have been investigated and the regression analysis were applied to get a mathematical relationship. The main conclusions were a direct relation between the CF and the seam efficiency, and a significant effect of the weave construction on the seam efficiency was found.
Keywords: polyester fabric, polyester/linen blend, seam strength, analysis of variance, regression analysis, average float, fabric cover factor.

Introduction:

Fabric and Seam strength

The Strength is considered one of the most important mechanical properties of woven fabrics. The manufacturers are using the stitches to make seams help determine the functional and aesthetic performance of apparel articles. The relationship between directly Strong stitches and seam strength is positive. The strength of the seam can be found within the seam type and seamed fabric. The overall construction of the garment depends on some elements such as the location and type of seam and must be suitable to withstand the stresses applied in such location. We can determine the quality of manufactured products by the tensile testing machine. Both the functional and aesthetic performance of an apparel product in terms of durability and stability are affected by seam strength. (Brown et al)[1].

Tensile strength and seaming properties are the key performance indicators for giving surety that the final apparel is fit or not for the end use at that time[2,3].

The characteristics of a properly constructed sewn seam are strength, elasticity, durability, security and appearance .These characteristics must be balanced with the properties of the material to be joined to form the optimum sewn seam[4].

Other factors also influence to accomplish of these characteristics in a properly constructed sewn seam. Such factors include type and weight of fabric, seam type, type of needle, thread type and size, and stitches per inch[2].

The efficiency of seam

The seam efficiency depends on the ratio between seam strength and fabrics strength while it is necessary to calculate the experiments with seams involved. We can calculate seam efficiency by using the following equation[1,5]:

Seam Efficiency = Fabric Strength with Seam / Fabric Strength without Seam, Or, Seam Efficiency% = Seam Strength / Fabric Strengthx100.[6]

Bharani et al. studied the seam strength and slippage of PC blend fabric with different woven structures and finish, and stated that the resistance to breakage at the application of load is more for polyester/cotton blend than the cotton fabric. Also concluded that the fabric construction (EPI, PPI, yarn count, weave type) proves to be playing a major role in the performance of seam. The cover factor increases with the increase in EPI and PPI, thus resulting in greater fabric strength, the greater is the resistance to fabric and seam breakage[6].

The (ASTM D1683-4) Standard Test Method is used to determine the fabric and seam strength and then calculate the seam efficiency[7].

The present article is aiming to study effect of some weaving parameters like cover factor; CF and weave structure of 100% linen fabric and polyester/linen blended fabric. Four weave structures and two levels of cover factors were used for each fabric.

Experimental Work:

1. Specimens:

In this study, the polyester fabric; (Fabric A), and the blended Polyester/Linen fabric; (Fabric B) were produced with four weave structures (Fancy Twill Weave, Crepe Weave, Honey Comb Weave, and Mock Leno Weave). Table 1 and table 2 show the fabrics specifications and weave structures.

The cover factors and average floats were calculated to the weave structures used under based on the following equations:

Cover factor:

The warp and weft cover was calculated by using the following formula recommended by Peirce[8].

Warp cover factor, k1 = n1 / √N1; where, n1= Ends per inch and N1 = Cotton count.

Weft cover factor, k2 = n2 / √N2; where, n2 = Picks per inch and N2 =Cotton count.

Average float:

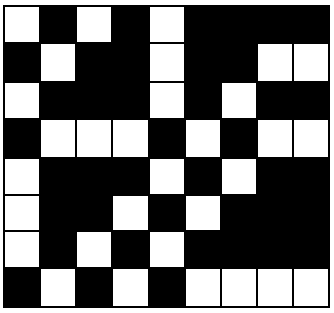
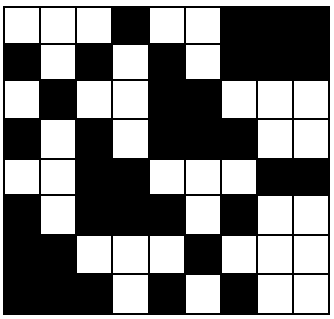
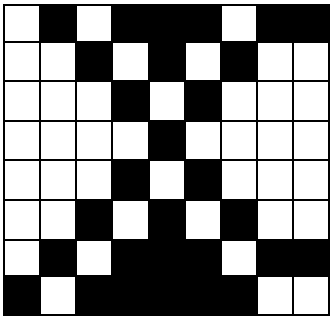
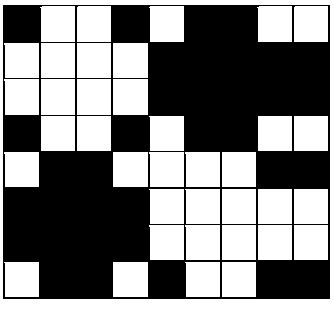
The average float was calculated by using the following formula[9]:

M=E/I, where *"E"* is number of threads per repeat, and *"I"* is number of intersections per repeat. Table 2 shows the calculated average floats for the weave structures under study.

Table (1) Fabric Specifications

	Fabric A		**Fabric B**	
Fabric Specifications	**Warp**	**Weft**	**Warp**	**Weft**
Raw Material	Linen 100%	Linen 100%	Linen 100%	Polyester 100%
Yarn count, Ne	30/2	30/2	30/2	35.4/1
Density yarns/ cm	12	10 &12	12	25 & 30
Cover factor	11 &13		11 &13	

Table (2) Weave Structures

Weave	Structure	Average float
Fancy Twill Weave		1.33
Crepe Weave		1.60
Honey Comb Weave		1.62
Mock Leno Weave		2.00

Seams preparation:

The fabrics under study were used to make sewn seams for measuring the seam strength rather than the fabric strength to calculate the seam efficiency. Table 3 shows the seam specifications for the sewn seams.

Table (3) Seam Specifications

Sewing thread used	
Raw material	100% polyester, spun
Count, Ne	40/2
tenacity, cN/tex	18.5
Breaking elongation %	20.4
Sewing operation	
Machine	Lock stitch (Pfaf)
Stitch type	301
Stitch density, S/cm	3

2. Testing procedure:

Sewn seam strength measurement:

INSTRON tensile testing machine was used to measure the fabric and seam tensile strength after conditioning samples in the standard testing atmosphere. The fabric and seam tensile strength were measured according to the ASTM D 1683-4.

Results and discussion:

Table (4) summarizes the experimental design and results of seam efficiency for the seams made of the two fabrics under study.

Table (4) Experimental results for seams stiffness properties

Sample #	Weave structure	Weft material	Cover factor	Fabric Strength; kgf		Seam Strength; kgf		Seam Efficiency %	
				Warp	Weft	Warp	Weft	Warp	Weft
1	Honeycomb	PES	13	16.77	28.50	12.55	19.95	74.8%	70.0%
2	Fancy Twill	PES	13	15.60	28.01	11.05	18.85	70.8%	67.3%
3	Mock Leno	PES	13	19.54	28.45	14.90	20.60	76.3%	72.4%
4	Crepe	PES	13	17.91	27.70	13.58	19.80	75.8%	71.5%
5	Honeycomb	PES	11	16.30	26.90	11.80	18.90	72.4%	70.3%
6	Fancy Twill	PES	11	17.46	22.70	11.95	15.30	68.5%	67.4%
7	Mock Leno	PES	11	16.51	25.65	11.70	18.22	70.9%	71.0%
8	Crepe	PES	11	15.75	20.60	10.95	14.61	69.5%	70.9%
9	Honeycomb	Linen	13	22.80	25.25	16.70	18.35	73.2%	72.7%
10	Fancy Twill	Linen	13	23.80	22.70	15.60	16.40	65.5%	72.2%
11	Mock Leno	Linen	13	24.80	25.20	18.85	18.84	76.0%	74.8%
12	Crepe	Linen	13	19.35	22.65	14.55	16.25	75.2%	71.7%
13	Honeycomb	Linen	11	19.70	28.25	14.15	19.80	71.8%	70.1%
14	Fancy Twill	Linen	11	17.90	29.15	12.15	19.55	67.9%	67.1%
15	Mock Leno	Linen	11	18.93	24.65	13.80	17.75	72.9%	72.0%
16	Crepe	Linen	11	21.12	25.10	15.05	17.95	71.3%	71.5%

1. Effect of weave structure and cover factor on the seam efficiency of 100% Linen fabric:

The influence of weave structure and cover factor on the seam efficiency of 100% linen fabric in both warp and weft direction are shown in fig. 1 and fig. 2 resp. From the figure one can see a direct relationship with the cover factor; CF as the higher the CF the higher the seam efficiency will be. Also the weave structure with higher average float; AF has higher seam efficiency than that of lower AF. Analysis of variance; ANOVA is a tool of capturing significance and by applying it we found that p-values of 0.012 and 0.005, for the CF and AF parameters resp. This may be due to an increase of fabric cohesion achieved by higher cover factor and the more straightening of the yarns happened with the higher level of float ratio for weave structures.

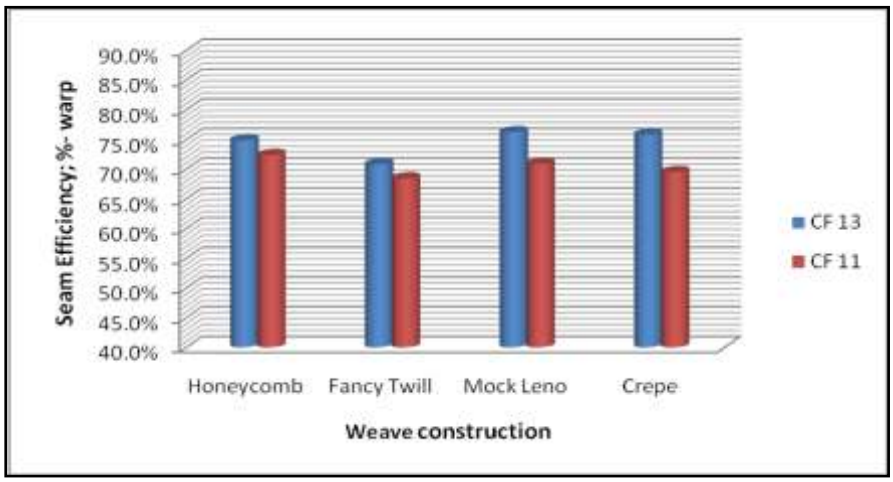


Figure (1) Effect of weave structure and cover factor on the seam efficiency of 100% Linen fabric in warp direction.

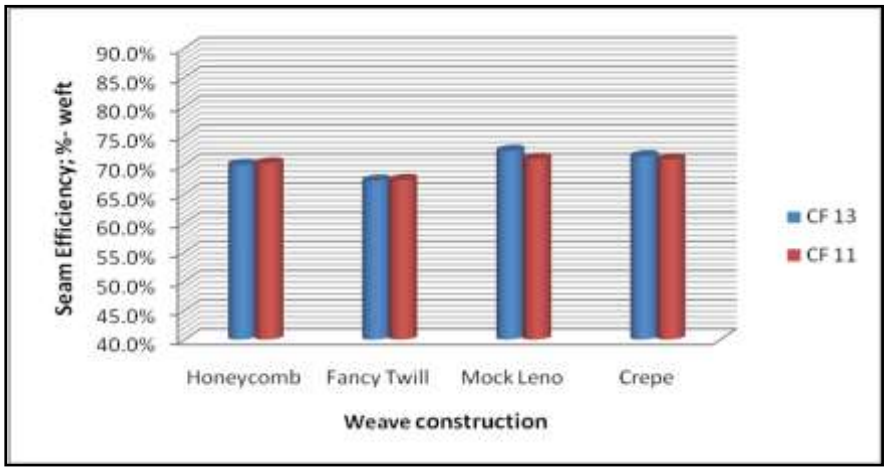


Figure (2) Effect of weave structure and cover factor on the seam efficiency of 100% Linen fabric in weft direction.

2. Effect of weave structure and cover factor on the seam efficiency of polyester/linen blended fabric:

The influence of weave structure and cover factor on the seam efficiency of the polyester/linen blended fabric in both warp and weft direction are shown in fig. 3 and fig. 4 resp. From the figures we can deduct a direct relationship with the cover factor; CF as the higher the CF the higher the seam efficiency will be. Also the weave structure with higher average float; AF has higher seam efficiency than that of lower average floats AF.

By comparing the two figures 2 and 4 for the two fabrics used we can notice that the seam efficiencies of linen fabric are relatively higher than that of polyester/linen blended fabric (p-values = 0.03).

Significance test shows that p-values of 0.027 and 0.005, for the CF and AF parameters resp. This may be due to the same reason mentioned in item 1.

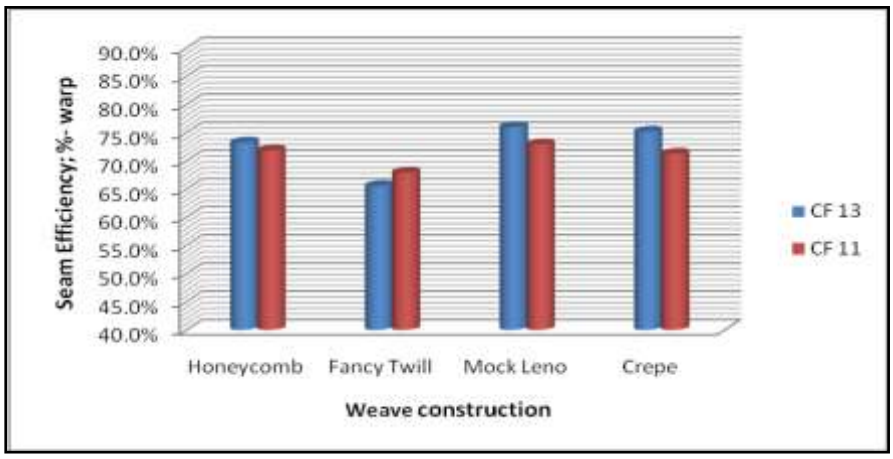


Figure (3) Effect of weave structure and cover factor on the seam efficiency of polyester/linen blended fabric in warp direction.

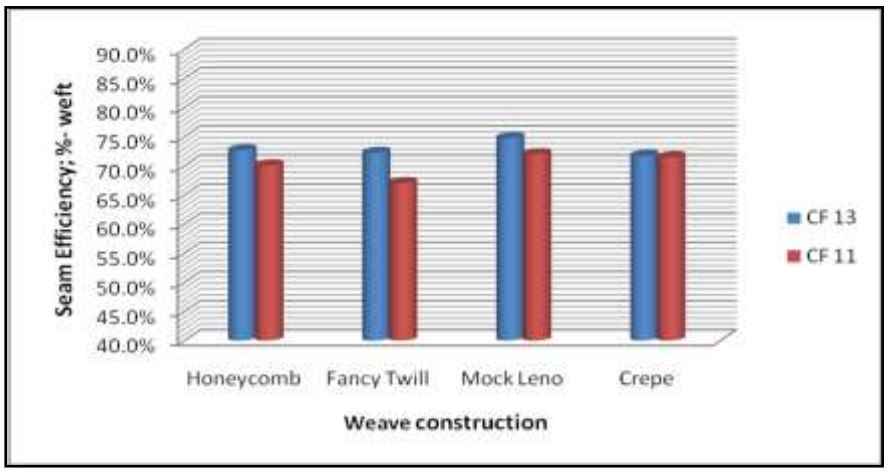


Figure (4) Effect of weave structure and cover factor on the seam efficiency of polyester/linen blended fabric in weft direction.

3. Regression Analysis:

A regression analysis was used to get the relationship between the seam efficiency and the studied parameters (CF, AF and Fabric Material; FM).

The multiple linear regression model was used.

The equations of best linear relationship were as follow:

Seam Efficiency (warp direction)= 0.43+0.014CF+0.08AF.

Multiple R+0.79 and R2=0.625

Seam Efficiency (weft direction)= 0.499+0.008CF+0.06AF+0.14FM.

Multiple R+0.85 and R2=0.723

The predicted and observed seam strength values are shown in fig. 5 and fig.6.

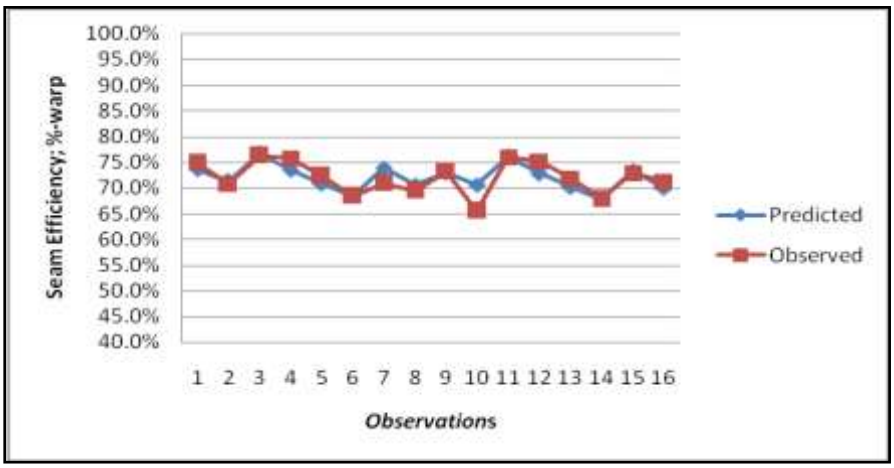


Figure (5) The predicted and observed seam strength values warp direction.

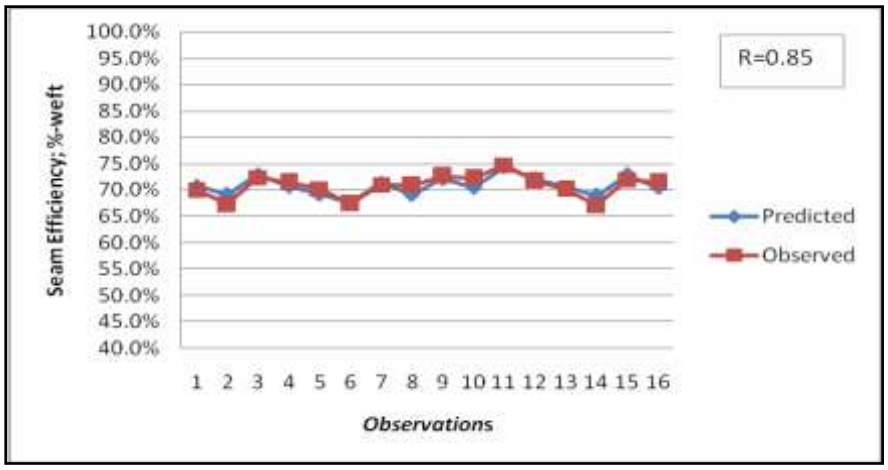


Figure (6) The predicted and observed seam strength values weft direction.

Conclusions:

In this study the effects of cover factor and weave structure expressed as average float weaving parameters for 100% linen fabric and polyester/linen blended fabric.

A direct relationship of the fabric cover factor with seam efficiency. Also the weave structure with higher average float has higher seam efficiency than that of lower AF with a significant effect. This result may be referred to the increase of fabric cohesion and compactness when cover factor is high and also the straightening of the yarns happened with the higher level of float ratio for weave structures cause the improvement of both fabric and seam strength.

A regression analysis used to get the relationship between the seam efficiency and the studied parameters was effective with strong coefficient of determination.

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