



THE EFFECT OF MULTIPLE LAYERS OF WOVEN FABRICS ON TENSILE STRENGTH AND ELONGATION

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Abstract

The tensile strength of woven fabrics is influenced by several factors, the most important of which are the type of material, the nature of the composition of the warps and wefts, the number of twists, the density of the warps and wefts per measurement unit and the weave construction. There is number of studies that dealt with these factors either separately or in combination and their effect on the tensile strength and elongation of woven fabrics.

The present study deals with the effect of the multiple layers of woven fabrics and the interlining ratio of these layers on tensile strength and elongation of these fabrics. Fifteen research experiments were conducted with three different weave constructions and three differences in the layers and the interlining ratio. The experiments proved that there is a statistical relationship between the effect of the interlining ratio and the multiple layers on both tensile strength and elongation.

I INTRODUCTION

The tensile strength of woven fabrics is influenced by several factors, the most important of which are the type of material, the nature of the composition of the warps and wefts, the number of twists, the density of the warps and wefts per measurement unit and the weave construction. There is number of studies that dealt with these factors either separately or in combination and their effect on the tensile strength and elongation of woven fabrics.

The present study deals with the effect of the multiple layers of woven fabrics and the interlining ratio of these layers on tensile strength and elongation of these fabrics.

Key words: (*Fabrics tensile strength - Elongation - Double fabrics - Three-layer fabrics - Cohesion of multi-layer fabrics*).

II TENSILE STRENGTH AND ELONGATION OF FABRICS

The tensile strength of woven fabrics is one of tests which has great importance due to what it indicates of the durability and strength of the fabrics to withstand stresses, and this test is a routine test carried out on many fabrics of different uses when determining the efficiency of performance for fabrics in general. The tensile strength is estimated at breaking by the force applied to a centimeter of cloth or in



some cases on the sample width causing rupture, using a piece of cloth with a specific size, which is exposed to a certain force or gradually increasing load to the point of rupture⁽¹⁾.

Studies show that the fabric tensile strength is affected by several factors, including the pull strength of yarns and the number of twists, yarn count, yarn bending behavior and friction and flexibility coefficient. Cloth structure, density of warps and wefts and weave construction also have their effect. ^(2, 3, 4, 5)

Studies also indicate that tensile strength can be predicted for cotton fabrics by linear and regression analysis by finding out the strength of warps and wefts, yarn density and float length. ⁽⁶⁾

2.1 The Double Fabrics

They are one of the weave constructions that produce two layers of cloth on top of each other either separate or attached according to the weave constructions and the method of interlining between the layers.

The layers can also be exchanged so that the front threads appear in the back and vice versa. ⁽⁷⁾

In addition, the cloth can be produced so that it is double the width of the cloth on the loom. The double construction marks are indicated as follows:

- 1 - The auxiliary marks are placed at the convergence of all warps of the front layer with the back layer wefts (i.e. all warps of the front layer are lifted when back layer wefts are inserted).
- 2 - The marking of the weave construction of the front layer are placed at the convergence of front warp and front weft.
- 3 - The marking of the weave construction of the back layer are placed at the convergence of the back warps with the back wefts.
- 4 - Adding bonding or interlining marks between the layers.

If the layers are to be kept separate, the interlining methods are eliminated and the layers can be interlined in the following ways:

- 1 - Warp casting off by lifting a thread from the back warp above a weft of the front layer.
- 2 - Weft casting off by lowering a thread from the front warps under a back weft (removing the auxiliary mark).
- 3 - Warp and weft casting off together by combining methods 1, 2 in the same cloth.
- 4 - Additional threads can be used to connect the layers of fabrics.
- 5 - The use of special warps and wefts to make an intersection in the cloth in the direction of warp and weft.
- 6 - The exchange of yarns and the wefts of the front and back together to replace each other and this method is used in striped, or checked or patterned fabrics. ⁽⁸⁾

2.2 The Three-layer Fabrics

This type of fabrics has three layers either separate or integrated according to the ultimate purpose of use. The middle layer yarns can be used from cheaper materials when the middle layer does not exchange with the front and back layers. If separate layers of fabric are required to be completely

separated or the three layers are to be exchanged, in that case all threads and wefts are carefully selected.

This type of weave structure is carried out according to the same rules of the double fabric in terms of the interlining and the structure of each layer. The three layers can be exchanged with each other, where the threads and wefts of the middle layer can be used in the front or back layers. The front layers can also be used in the back or used as a middle layer as well as a back layer. ^(9, 10)

III THE RESEARCH EXPERIMENTS

The idea of the research depends on several experiments to measure fabric tensile strength and elongation in both the direction of the warp and weft using the same specification of each but only changing the number of layers of fabrics and the interlining structure between the layers. The executive specifications of these experiments are as follows:

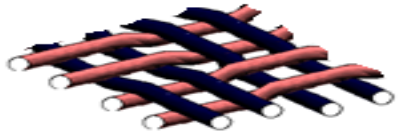
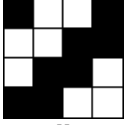
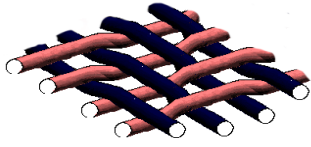
1. Warp no 150/1 textured spotted dull polyester and the number of dent threads is 72 on the loom, reed 9 and 8 per dent.
2. Weft no 40/2 cotton and the number of wefts 32 picks /dent on the loom (35 wefts / dent after descending from the loom).

The Structures in which Samples Were Implemented:

Five types of experiments were carried out with three basic structures: plain 1/1 and hopsack weave 2/2, and twill 2/2 as follows:

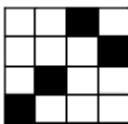
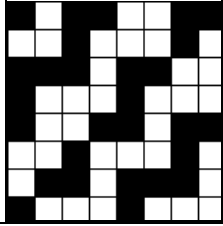
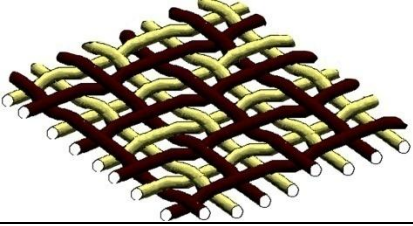
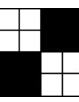
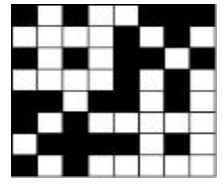
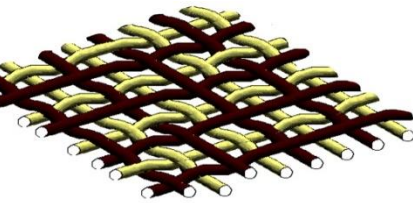
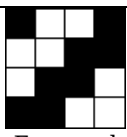
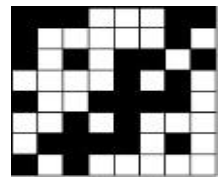
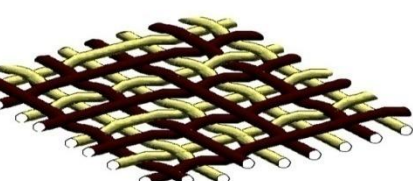
(1) Samples of one layer: are illustrated by the following table no. (1)

Table (1)

Sample Number	Weave Structure	Diagram Showing (Surface)
1	 Plain 1/1	 This sample was not implemented on the same specification because the plain weave has the highest rates of intersection between the warps and the wefts and therefore the number of cotton wefts per dent did not exceed 40/2 only, 24 picks /dent.
2	 Hopsack 2/2	
3	 Twill 2/2	

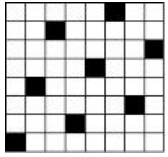
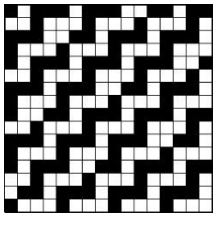
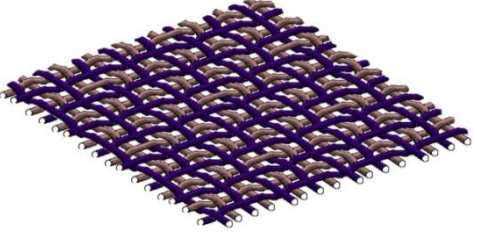
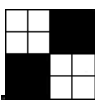
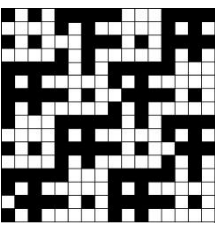
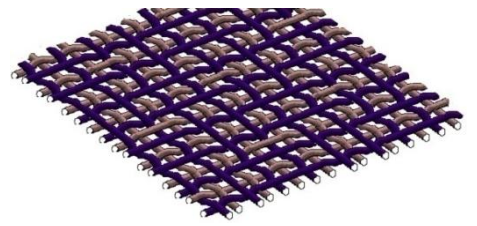
(2) **Double-layer samples:** arrangement of warps and the wefts 1 thread in each side: 1 thread back and interlining of the two layers of the weft on satin weave 4 as illustrated in Table 2.

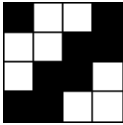
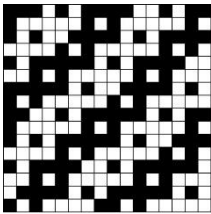
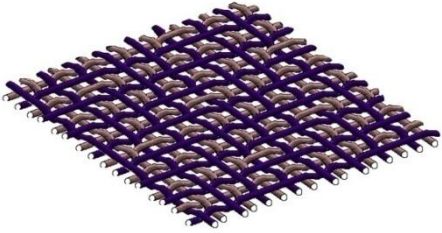
Table (2)

Sample No.	Front , Back Weave	Weave Structure for interlining	Double Weave	Diagram Showing (Surface)
4	 Front and Back Plain 1/1	 structure for interlining of weft satinweave 4		
5	 Front and Back Hopsack 2/2			
6	 Front and Back Twill 2/2			

(3) **Double-layer samples:** arrangement of warps and the wefts 1 thread in each side: 1 thread back and interlining of the two layers of the weft on satin weave 8 as shown in Table (3)

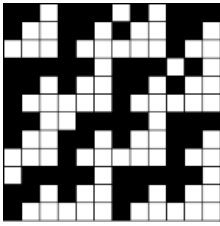
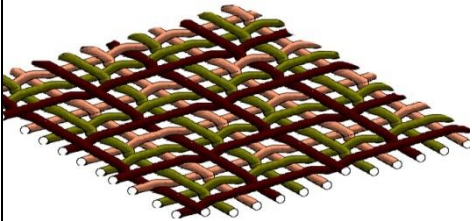
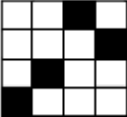
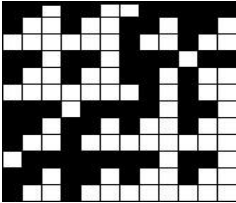
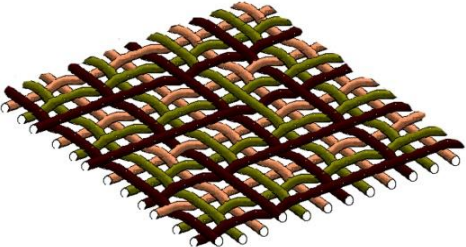
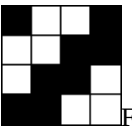
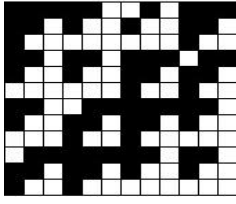
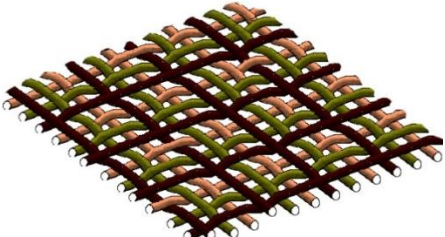
Table (3)

Sample No.	Front , Back weave	Weave structure for interlining	Double weave	Diagram Showing (Surface)
7	 Front , Back Plain 1/1	 structure for interlining of weft satin weave 8		
8	 Front , Back Hopsack 2/2			

9	 Front , Back Twill 2/2		
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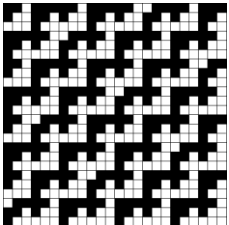
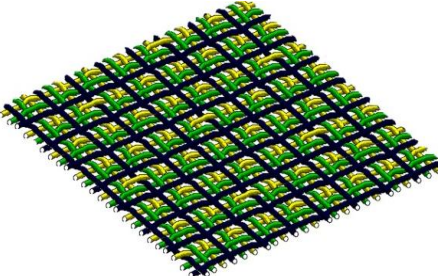
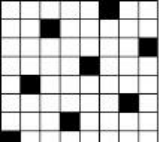
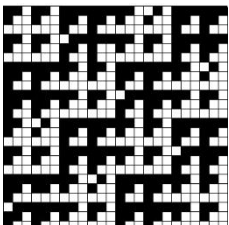
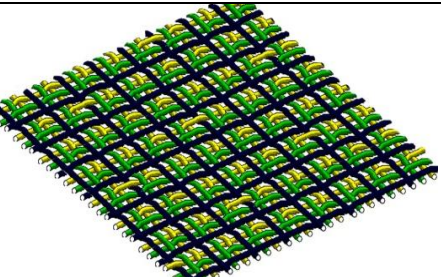
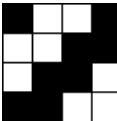
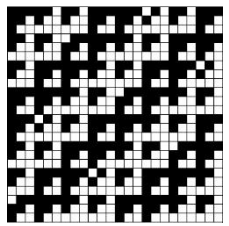
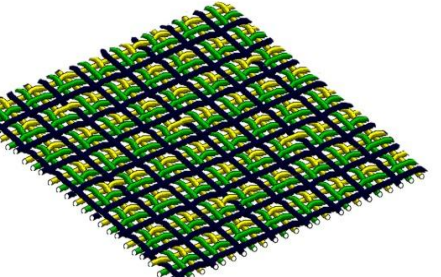
(4) **Double three-layer samples:**arrangement of warps and the wefts 1 thread in each side: 1 thread front:1thread middle:1 thread back;interlining of the three layers (front, back and middle) of the weft on satin weave4 as illustrated in Table (4).

Table (4)

Sample No.	Front , Back and middle weave	Weave structure for interlining	Weave three layers	Diagram Showing (Surface)
10	 Front , Back and middle Plain 1/1			
11	 Front , Back and middle Hopsack 2/2	 structure for interlining of weftsatin weave 4		
12	 ront , Back Twill 2/2			

(5) **Double three-layer samples:**arrangement of warps and the wefts 1 thread in each side: 1thread front:1thread middle:1 thread back;interlining of the three layers (front, back and middle) of the weft on satin weave8as illustrated in Table (5).

Table (5)

Sample No.	Front , Back and middle weave	Weave structure for interlining	Weave three layers	Diagram Showing (Surface)
13	 Front , Back and Middle Plain 1/1			
14	 Front , Back and Middle Hopsack 2/2	 structure for interlining of weft satin weave 8		
15	 Front , Back and Middle Twill 2/2			

Tensile Strength and Elongation Test on Research Samples¹:

The tensile strength test of the samples of fabrics was carried out in both the direction of the warp and weft using Grab test. The results were grouped as follows in Tables (6&7).

1- Warp Tensile strength and elongation of samples Table (6):

Table (6)

	One layer		Two layers interlining stain 4			Two layers interlining stain 8			three layers interlining stain 4			Three layers interlining stain 8		
Sample No.	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Warp Breaking Force	1449	1525	1400	1403	1358	1406	1311	1342	1326	1177	1308	1266	1233	1229
Warp Apparent Elongation	38.9	42.5	36.5	36.4	33.2	35	29.6	32.8	31.7	28.6	31.3	28.8	27.2	28.5

1.The experiments were carried out at The Textile Technology Centre, Faculty of Applied Arts, Helwan University.

2- Weft Tensile strength and elongation of samples (7):

Table (7)

	One layer		Two layers interlining stain 4			Two layers interlining stain 8			three layers interlining stain 4			Three layers interlining stain 8		
Sample No.	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weft Breaking Force	331	359	326	339	318	327	312	295	295	294	293	271	281	283
Weft Apparent Elongation	7.9	9.5	10	13.4	11.7	9.8	12.9	11.1	11.6	13.7	13.7	11.1	15.4	14

IV ANALYSIS OF TEST RESULTS

4.1 Tensile Strength of Fabrics

1- Warp Tensile Strength of Fabrics:

The results of the tensile strength test in the warp direction proved that the simple weave structures (single layer) were higher in the tensile strength than the double weave structure and the double weave structure is higher in tensile strength than the three-layer weave structure when all variables, except the layers of cloth, are constant. The results also show the effect of the interlining ratio of the layers on the tensile strength in the direction of the warp. The higher the interlining ratio, the stronger the tensile strength, figures (1-2-3-4).

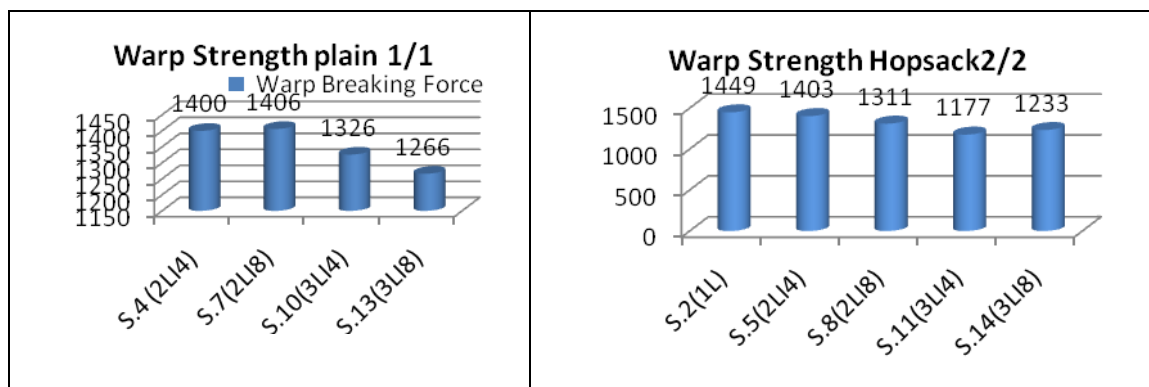


Figure (1)

Figure (2)

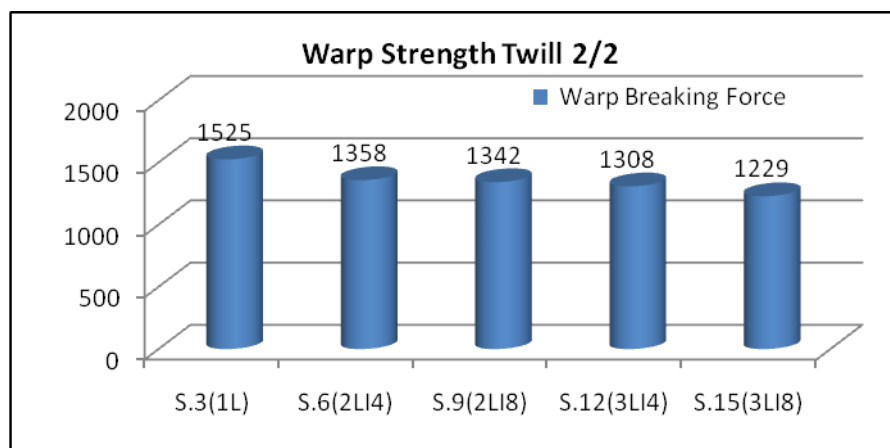


Figure (3)

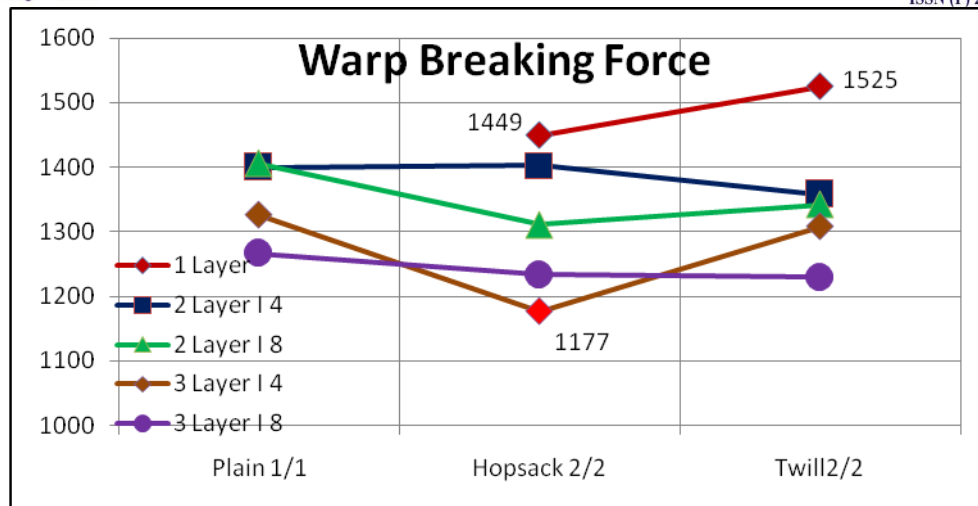


Figure (4)

2- WeftTensile Strength of Fabrics

The results of tensile strength in the direction of the weft indicate that the single-layer weave structures are higher in tensile strength than of the two layers and the two-layer fabrics are higher than the three-layer fabrics. The interlining ratio also affects the tensile strength in the direction of the weft. The higher the interlining ratio, the stronger the tensile strength in the direction of the weft. Figures (5-6-7-8).

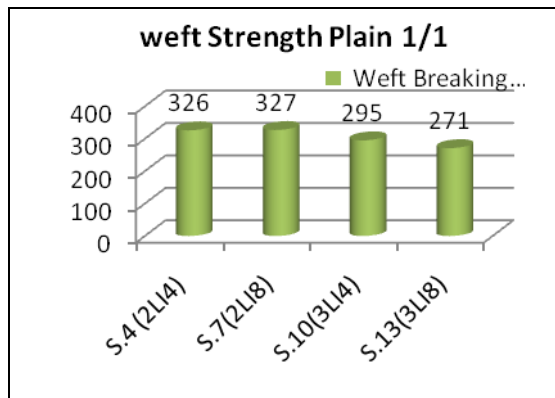


Figure (5)

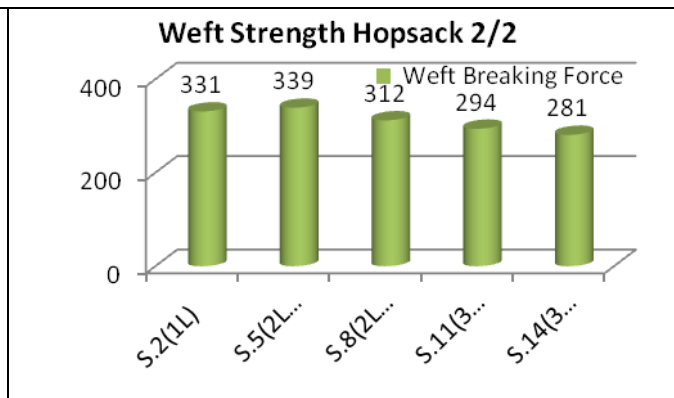


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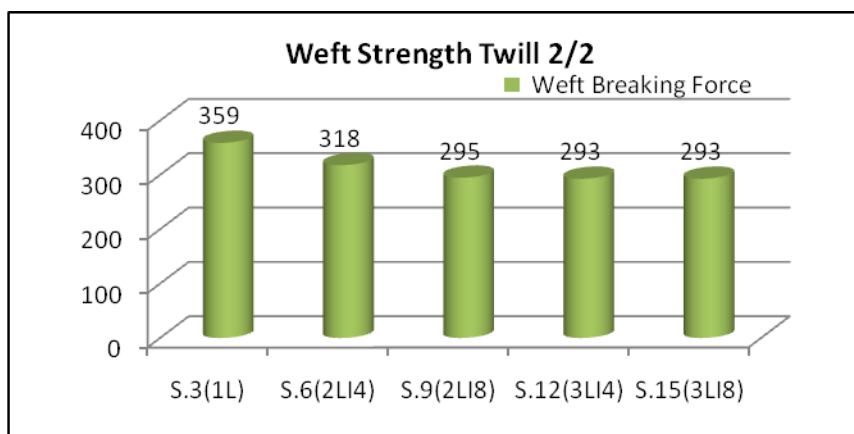


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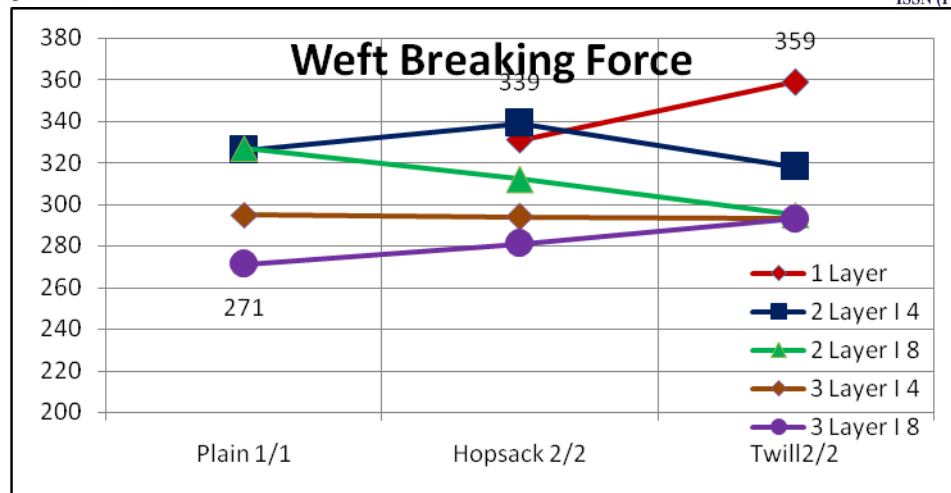


Figure (8)

4.2 Elongation of Fabrics

1-Warp Elongation of Fabrics:

By analyzing the results of elongation ratio in the direction of warp, the results showed that the elongation ratio of the single-layer fabrics was higher than double cloth and three-layer fabrics. The percentage of interlining affects the elongation rate. The greater the interlining, the greater the elongation (9-10-11-12).

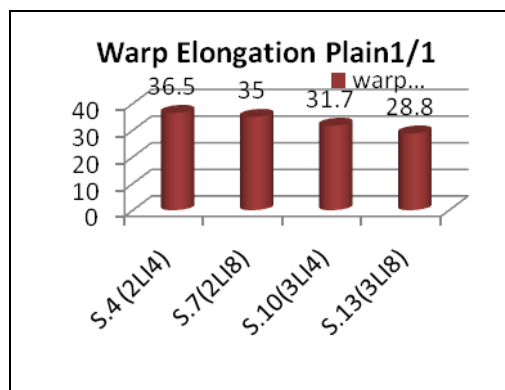


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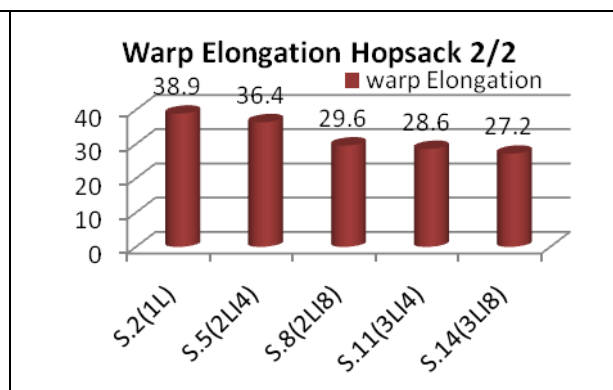


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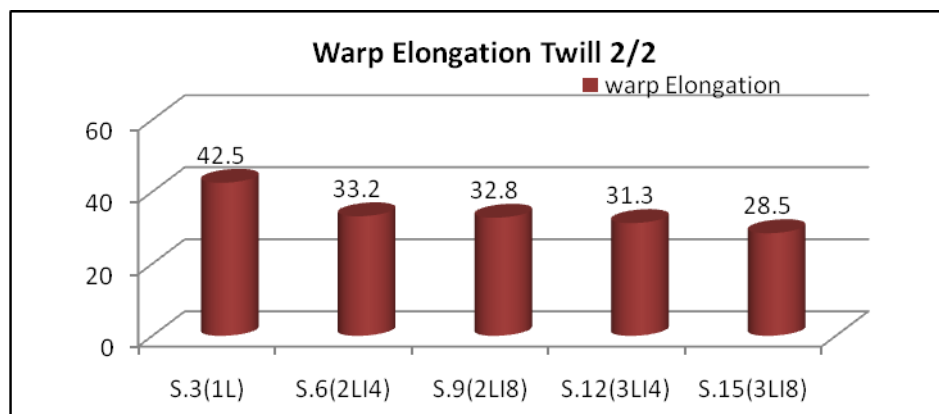


Figure (11)

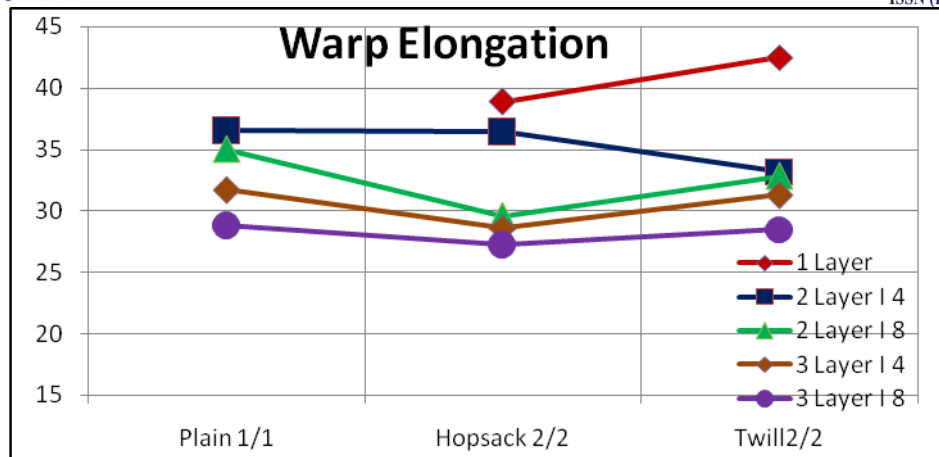


Figure (12)

2-WeftElongation of Fabrics:

From the study of elongation results in the weft direction, the results indicate that the elongation rate for single-layer fabrics is lower than the two-layer fabrics, and the elongation of the double fabrics is less than the elongation of the three-layer fabrics. The ratio of interlining between the layers also affects the elongationrate in the direction of the weft; the greater the interlining, the longer the elongation in the weft direction. Figures (13-14-15-16).

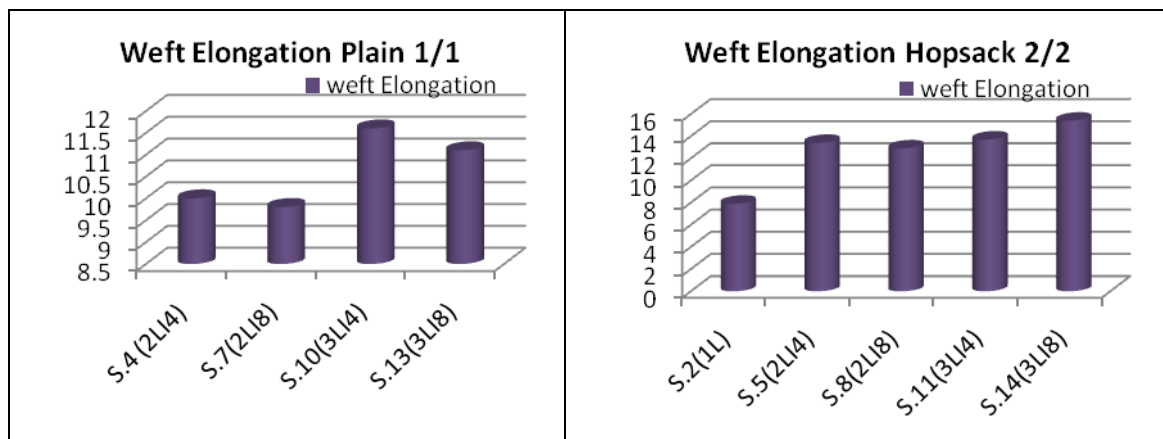


Figure (14)

Figure (13)

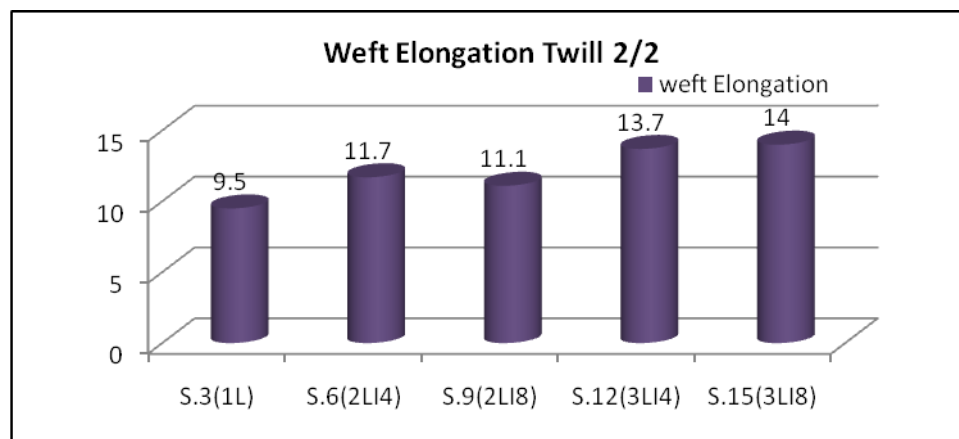


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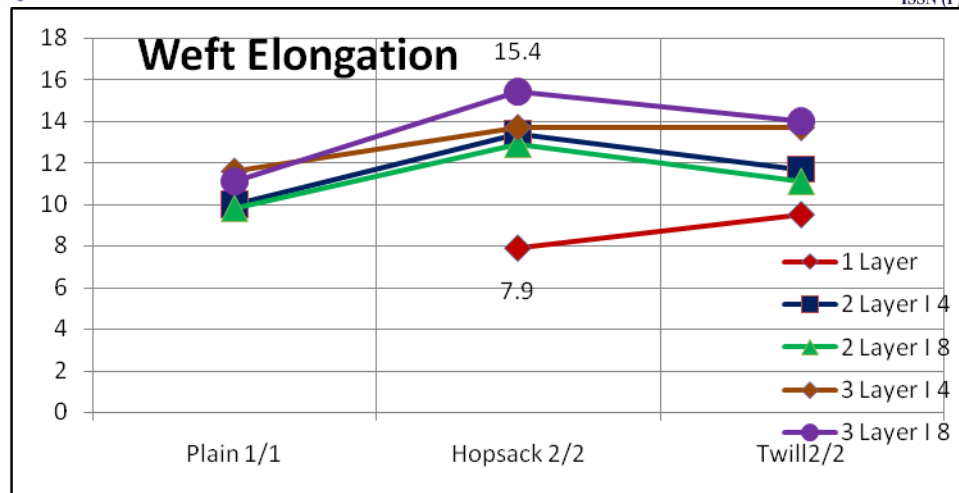


Figure (16)

V RESULTS AND DISCUSSION

1. Fabrics Tensile strength is influenced by number of layers. One-layer fabrics are higher in tensile strength than the two-layer and three-layer fabrics.
2. The higher the interlining ratios between the layers, the stronger the tensile strength.
3. The relationship between the interliningratio and elongation in the direction of warp and weft is directly proportional.
4. The relationship between the elongation ratio in the direction of warp and the increase in layers of cloth is an inverse relationship.
5. The relationship between the elongation ratio in the direction of the weft and increase of the number of fabric layers is directly proportional as three-layer fabrics are higher in elongation in the direction of the weft than the double-layer and one-layerfabrics.

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[ACCORDING TO THEIR ORDER OF APPEARANCE]

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