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The Effect of Warp and Weft Variables on Fabric's Shrinkage Ratio

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Abstract

This research deals with the fabric's shrinkage ratio in both directions (warp and weft), by studying the effect of each of the warp and weft variables on the shrinkage ratio. These variables are the type, density, Yarn tension and the count of both warp and weft yarns in addition to the weave structure.

After test different types of these variables and found that weft density relationship and weft count with shrinkage ratio toward warp is a positive relationship, while the relationship shows the amount of weave float and Yarn tension of both warp and weft thread with shrinkage ratio towards warp is an inverse relationship. The warp density and warp count with shrinkage ratio towards weft relationship is a positive relationship, while the relationship shows the amount of weave float and Yarn tension of both warp and weft thread with the shrinkage ratio towards weft is an inverse relationship. Finally, there is no effect to the type of weave as if it was a satin or twill on the proportion of fabric shrinkage in both directions.

Using the SPSS statistical software solutions have been modeling the previous results and get the formula to calculate the fabric shrinkage ratio that takes into account all previous variables.

Keywords: Fabric's shrinkage ratio; Fabric's actual length; Warp and weft variables

Introduction

Warp thread is exposed during the course of the formation of fabric for a number of tensile forces resulting from (the position of a backrest roll, open the shed, move the comb to insert a weft), as the weft yarn is exposed also to the tensile forces due to (pull of the weft regulator in order to store it, pull of the rapier for publication within the shed) [1].

Researcher Watson [2] found that fabric shrinkage ratio affected by the following variables:

1. The type, count and density of the warp yarns.
2. The type, count and density of the weft yarns.
3. Weave structure

But the warp and weft tension fixed at a certain value, but the researcher Nisbet [3] found that the effect of warp and weft tension is opposite effect on shrinkage ratio.

The researcher Moghe [4] calculates the percentage of fabric shrinkage towards the warp only when using wefts yarn of polyester and weft density of 28 to 44 (pick/inch) and so for plain weave 1/1, and found that when weft density increases the shrinkage ratio increases.

The researcher Edita [5] studied the relationship between weft density and shrinkage ratio for weft densities between 21 and 27 pick/cm, but passed the low densities, and concluded that the weft density relationship with the shrinkage ratio is a direct correlation.

The researchers Çeven and Özdemir [6] have calculated the shrinkage ratio towards the weft thread, used Chenille yarn following count (4, 4.5, 5, 5.5, 6) Nm on plain weave 1/1 and warp density of 10 to 30 thread/cm. The result of their research that a positive relationship between the warp density and the percentage of shrinkage towards the weft. The relationship between the weft count and the shrinkage ratio is opposite relationship, where the yarn count is metric (indirect count).

The study of the cross-section of the relationship of overlap between the warp and weft entrance to determine the shrinkage ratio, where researchers Vyšanská and Sirková [7] study conducted on one type of yarn and one density and plain weave 1/1, and reached the following equation:

$$warp\ distance = \frac{\left(\frac{100}{D0}.n1\right).\sqrt{4.(ds)^2-(ds)^2}}{p2.\sqrt{4.(ds)^2-(ds)^2}+d1.(n1-p2)}$$

n1: distance between the center of warp thread and weaving axis
ds: the average diameter of warp and weft

p2: inverted weft density

The same of the previous principle, researchers Milašius and Vytautas [8] finding of what is known as a factor of weaving (F), which is a summary of the study of Interference warp and weft yarns, and which can predict the desired length to Interference between the yarns, also this study were the richest because of inclusion of a set of weaves are (1/1 plain, 1/2 twill, 3/1 twill, 2/2 twill, 2/2 ribes) and four types of weft yarn, however, that all these weaves used just for clothes do not include the curtains and furnishings weaves, where the amount of weave floating in this fabrics larger.

The researcher Černoša [9] and his research team have studied the effect of warp and weft tension on warp to weft variables and shrinkage ratio in both directions warp and weft, and They concluded that the increase in yarn tension lead to a decrease shrinkage ratio within the limits of elasticity of the thread, this search based on five types of weaves but on one type and one count of the warp and weft yarns.

Percentage of shrinkage have studied and calculate in two stages after the weaving and the second after immersion cloth in pure water

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by researcher Rukuižienė [10] and his research team, studied has based on a Honeycomb weave and cotton weft and warp yarns, researcher concluded during the study that shrinkage relationship with the density and count is a positive relationship.

The researchers Rukuižienė and Milašius [11] calculates the percentage of shrinkage toward warp through three stages, the first stage is between warp width and comb width, and the second stage between comb width and woven point width, and the third stage between the fabric width during weaving and cloth after weaving stage and free it from the forces of tensile applied it in loom. But just for plain weave 1/1 and polyester yarn from count 70- 100- 150 den. They concluded that the fabric shrinks three phases in addition to that the increasing count direct thread increases the shrinkage ratio.

The percentage of shrinkage φ can calculate in the study of researcher Kumpikaitė [12] through a mathematical equation based on the density of warp and weft and linear distance between the warp and weft yarns and factor named Milašius's factor which expresses the inverted weave float, and the type of materials used.

$$\varphi = \sqrt{\frac{12}{\pi}} \frac{1}{p1} \sqrt{\frac{Tav}{\rho}} S2^{\frac{1}{1+2/3\sqrt{T1/T2}}} S1^{\frac{2/3\sqrt{T1/T2}}{1+2/3\sqrt{T1/T2}}}$$

T1: warp density T2: weft density

Tav: the arithmetic average of the fabric density

P1: Milašius factor for weaving

ρ: Density of raw materials

S1: warp settings in woven fabric S2: weft settings in woven fabric

The researcher Anderson [13] have presented a mathematical equation to calculate shrinkage percentage for three yarn types and three weaves are plain 1/1 and twill 1/3 and satin 1/7. This equation suggests that the shrinkage rate be greater when using plain 1/1 goes down when using twill 3/1 and be at the lowest value when using satin 1/7.

The aim of the research is that includes the effect of each warp and weft variables on the shrinkage ratio, the one hand, the weft density value range of 4 to 20 pick/cm, the warp density range is from 33 to 66 thread/cm, yarn tensile force ranges between 12 to 20 cN/Tex, weaves float from 2 to 20 and finally the types of thread for the weft yarn studied more than four types in terms of use, namely, (chenille -polypropylene with continuous filament-thread with continuous filament and amplifying by air ATY (jet)-cotton yarn turbine spinning) while the warp (mixed with a thread of cotton and viscose (trivera) -polyester DTY) with different magnitude of yarn count depends on type of yarn.

Materials and Methods of Search

The study and experiments were conducted on the loom model (GTM) from the production company (Picanol) Belgian, a loom capable of producing all type of fabrics, because it contains the Jacquard (a device to open the shed) (Figure 1).

Warp thread tension was adjusted by a device to measure yarn tension, its model (I1901) of production company (Schmidt) German.

Shrinkage rate define as the difference between length of thread before weaving and beyond, the experiments are divided into two types:

- determine the percentage of shrinkage towards the weft yarns: weft yarn identified before weaving by a device for determine certain lengths of yarn has model (L232), this device has a wheel surroundings of one meter, but it is difficult to be carried out tests on the basis of that length of the thread before weaving 1m because the entire fabric width 1.4 m, and as the wheel of the machine is divided into 6 sections by 6 beams, which means that the distance between the crossbars are 16.67 cm we will put signs on the yarns at each edge of the symptoms of the cupboard to be determining the length of a string weft before weaving.
- determine the percentage of shrinkage towards the warp yarns: warp thread identified before weaving on warp beam before backrest roll order to determine the length before being subjected to any kind of friction with the loom parts, was chosen length lab 15 cm depending on the length laboratory at researcher Anderson [13], as evident in Figure 2 order to reduce error rate measurement.

To find out the effect of each of the variables on the fabric shrinkage rate has been changing the value of the variable according to the most widely used field with fixed the rest of the variables at a specific value, note that variables has been fixed as follows:

1 warp density: 66 thread/cm

2. the type of warp yarn: thread Trivera

3. warp count: 150 den

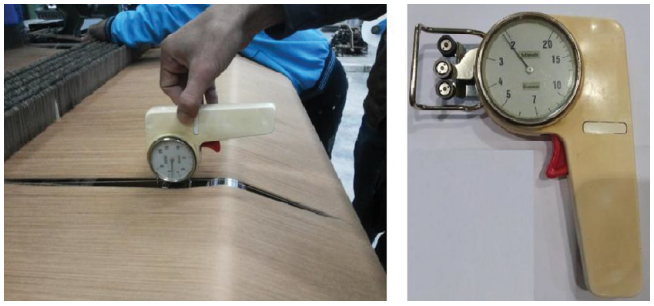

Figure 1: A device for measuring Yarn tension of thread.

Figure 2: Reference Determination of the warp yarn length.

4. weft density: 12 thread/cm
5. the type of weft yarn: Polyester DTY
6. weft count: 150 den
7. tension applied to the warp yarns: 15 cN/Tex
8. tension applied to the weft yarns: 15 cN/Tex
9. weave structure: Satin 8

Results and Discussion

Effect of weft density on fabric shrinkage ratio toward warp

Densities tested were (4, 8, 12, 16, 20) thread/cm, because this range covers weft densities in all kinds of fabrics, even consisting of more than one type of weft yarn such as the curtains and furnishings (Table 1).

In definite of the Figure 3 that increase weft density will increases fabric shrinkage and reason for this is an increase in density of the weft increases length of the warp thread which interferes with the weft thread path. Comparing this result with results of the researcher Edita M note match outcomes, but the researcher Edita M studied the densities of high field only and therefore not able to infer the equation linking weft density and the percentage of shrinkage, while our study has larger weft density field.

Effect of weave type on fabric shrinkage ratio toward warp

Due to plain is one of the twill weaves, the comparison here will be between twills and satins, and will test two amount of floating for each of the two weaves (1/7, 1/15) (Figures 4 and 5).

Note match in the percentage of shrinkage towards warp yarns between each of the weave satin and twill for two tested float

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Weft density (pick/cm)
A 001	3.33	14.1	51	4
A 002	4.67	14.3	51	8
A 003	6	14.1	51	12
A 004	7.33	13.9	51	16
A 005	8.67	13.7	51	20

Table 1: Shrinkage ratios toward warp for each of weft densities.

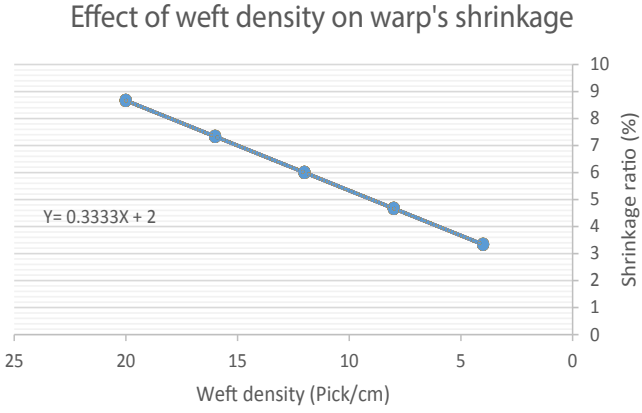

Figure 3: Relationship of weft density and shrinkage ratio towards warp.

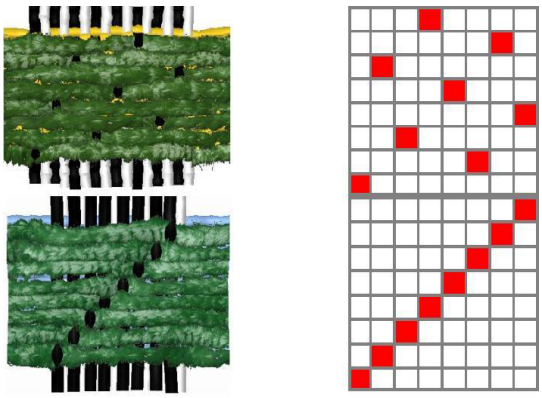

Figure 4: Comparison between satin and twill.

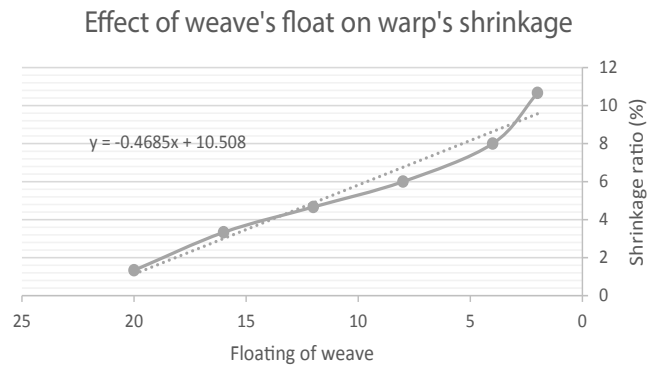

Figure 5: Relationship of the amount float with fabric shrinkage toward warp.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Type of weave
B 001	6	14.1	51	Satin
B 002	6	14.1	51	Twill

Table 2: Shrinkage ratios toward the warp yarns for satin and twill 7/1.

sample	Length lost (%)	Length after test (mm)	Length before test (mm)	Type of weave
B 003	3.33	14.5	51	Satin
B 004	3.33	14.5	51	Twill

Table 3: Shrinkage ratios toward the warp yarns for satin and twill 15/1.

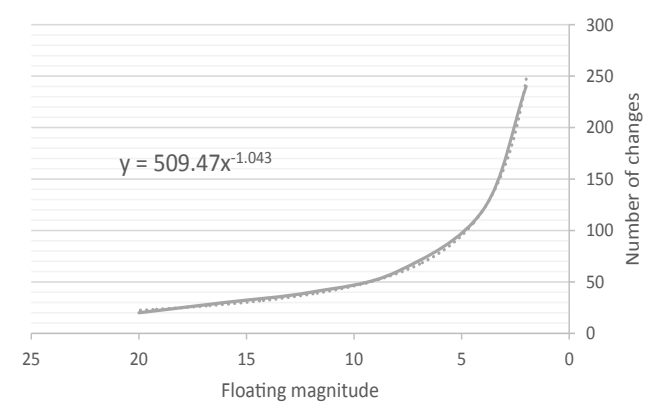

Figure 6: Relationship between the amount float with intersections.

(1/7 - 1/15), which shows that there is no effect of the type of weave whether twill or satin on the fabric shrinkage ratio (Tables 2 and 3).

On the other hand, and for Explanation of the previous result, we must study the number of intersections in a pair of weave satin and twill to one of the previous float (1-7) (Figure 6).

Can enumerate the number of intersections occurring within a weave by Ned Graphics program and note that number of intersections between each of the twill and satin is the same in one repeat.

We conclude from the foregoing that if the number of weave intersections similar must have the same effect on the percentage of shrinkage towards the warp yarns [14]. The only difference between satin and twill is a difference in the distribution of the intersection between the warp and weft yarns points.

Effect of weave floating on fabric shrinkage ratio toward warp

Amounts of floats were tested covering more weaves traded in the practical field, namely (2, 4, 8, 12, 16, 20).

The figure shown that the relationship between the percentage of shrinkage towards warp yarns and the amount of float is inverse (Table 4).

This result did not match with the result of the researcher Milašius and Vytautas in the relationship between the type of weave and the fabric shrinkage, so the reason for this is that weaves tested by the researcher is of derivatives plain, this weaves don't effect on float amount, while the method of studying the effect of the amount of float on the shrinkage ratio is comprehensive.

To explain the previous result we must enumerate the number of intersections between the warp and weft in every pick in one repeat, as the woven fabric caused by friction between the warp and weft yarns linked directly with the number of intersections, and you have to enumerate the number of intersections occurring in each of the previous weaves within a unified measure paper squares, the suitable measurements for (2, 4, 8, 12, 16, 20) weaves is 240×240, results of the number of intersections shown in Table 5.

The relationship between the intersections and the amount of float in weaves is an inverse relationship, which means that by increasing the float amount will decrease the number of intersections so would weaken the fabric structure woven due to lack of friction between the warp and weft yarns, but when increasing the number of intersections amount required from the warp yarn length will increase in order to achieve the thread intersections required of it, and this explains the results obtained, that the greater amount of float in weave gives larger shrinkage ratio.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Length of floating (pick)
C 001	10.67	13.4	51	2
C 002	8	13.8	51	4
C 003	6	14.5	15	8
C 004	4.67	14.3	15	12
C 005	3.33	14.5	15	16
C 006	1.33	14.8	15	20

Table 4: Shrinkage ratios for each of the amounts floats tested.

Intersections	Floats
240	2
120	4
60	8
40	12
30	16
20	20

Table 5: Intersections for each amount float.

Effect of warp's yarn tension on fabric shrinkage toward warp

The range of warp's yarn tension tested followed to the range of tensile could be applied on warp yarns, depends on the allowable area of warps is (120 - 200) Kg and due to that the total number of warps are 10000 thread, the range of study is (12 - 20) cN/Tex, it divided into five sections (20, 18, 16, 14, 12) cN/Tex (Table 6).

In definite from the Figure 7 that the inverse relationship between the percentage of shrink warp direction and value of warp's yarn tension.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
D 001	8	13.8	51	12
D 002	6.67	14	51	14
D 003	5.33	14.2	15	16
D 004	4.67	14.3	15	18
D 005	4	14.4	15	20

Table 6: Shrinkage ratios toward warp according to warp's Yarn tension.

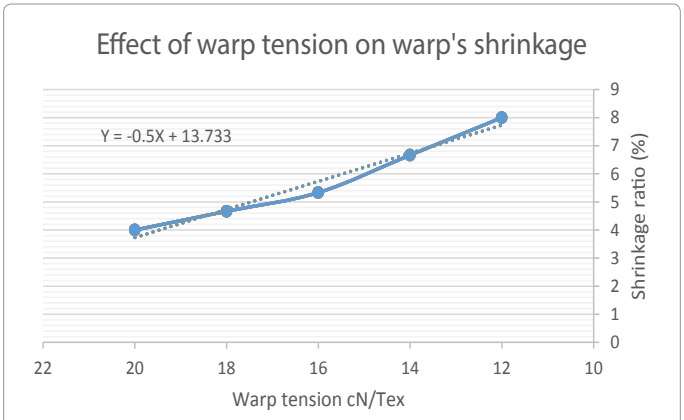

Figure 7: Relationship between warp's tension with shrinkage toward warp.

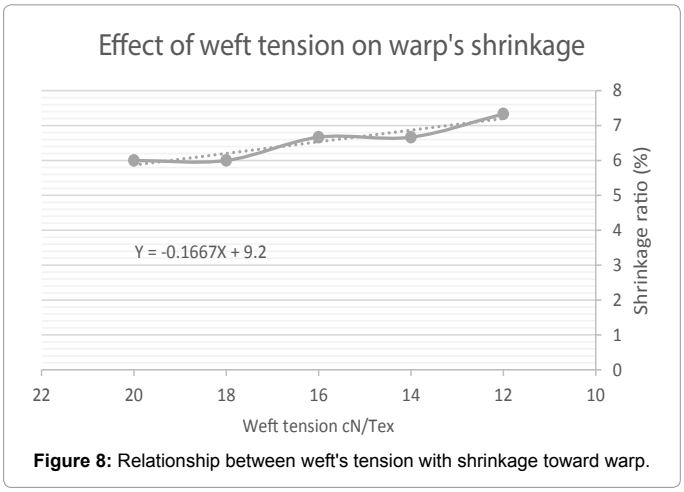

Figure 8: Relationship between weft's tension with shrinkage toward warp.

When warp's yarn tension increase will lead to increase pressure on the warp thread not to allow it to form excess pile during interlace with the weft thread, and thus decrease the length of the consumer warp thread, this explains the previous result.

Effect of weft's yarn tension on fabric shrinkage toward warp

Range of weft's tension tested are (20, 18, 16, 14, 12) cN/Tex. Definite from the Figure 8 that the inverse relationship between percentage of shrinkage towards warp and weft's tension. However, the effect of weft's tension on the fabric shrinkage toward the warp is a slight effect, where the difference between the highest percentage of shrinkage and the lowest is up 1%, and the reason that the increased weft's tension will press the warp thread just in weave point, on the other hand weft's tension does not effect on the amount of used warp thread (Table 7).

Effect of weft's type and count on fabric shrinkage toward warp

Types of weft yarn tested are (Chenille, Poly Propylene with continuous filaments, spinning turbine cotton, threaded inflated by air ATY), and because of the large difference in thread count tested it is difficult to compare, so it will be compared to each type of weft yarn (Tables 8 and 9).

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
E 001	7.33	13.9	51	12
E 002	6.67	14	51	14
E 003	6.67	14	15	16
E 004	6	14.1	15	18
E 005	6	14.1	15	20

Table 7: Shrinkage ratios toward warp according to weft's Yarn tension.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
F 001	14.67	12.8	51	5512
F 002	12.67	13.1	51	1500
F 003	10.67	13.4	15	1125

Table 8: Shrinkage ratios toward the warp for each weft count (Chenille).

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
F 004	6	14.1	51	150
F 005	7.33	13.9	51	300
F 006	8.67	13.7	15	500
F 007	10.67	13.4	15	1000

Table 9: Shrinkage ratios toward warp for each weft count (Poly Propylene).

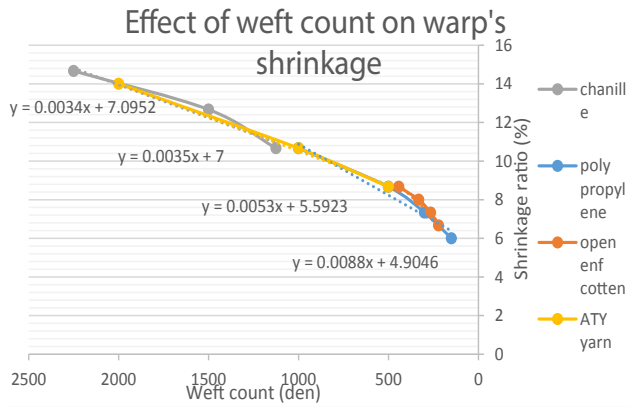

Figure 9: Relationship between weft count with fabric shrinkage toward warp yarns for all tested weft types.

By studying the charts in Figure 9 it is clear that a positive relationship between fabric shrinkage towards warp and weft count when count are directly (den). When thread diameter increases the fabric shrinkage will increase thereby increasing the length of thread required to complete the interlacement between warp and weft (weave structure), as shown in the Figure 10, which is a fabric cross section showing the three weft count for same weave, figure shows that warp length needed for complete the weaving increases when weft diameter increased, on other hand when weft count decreases in metric system [15] (Tables 10 and 11).

Effect of warp density on fabric shrinkage toward weft

Warp densities are selected (66, 45, 33) end/cm, because the warp density related to harness density, because of the tested fabrics are upholstery fabrics and curtains, harness density are (66, 45, 33) end/cm.

Definite from the Figure 11 that when warp density increases fabric shrinkage toward weft increases, the reason for this result is when the number of warp yarns per length unit increases the number of weft intersections increases, thus the shrinkage ratio towards weft increases (Table 12).

Effect of weave type on fabric shrinkage ratio toward weft

Chosen weaves are more useful in the practical field, namely: (a Satin 7/1, (b twill 7/1, (c Satin 15/1, d twill 15/1).

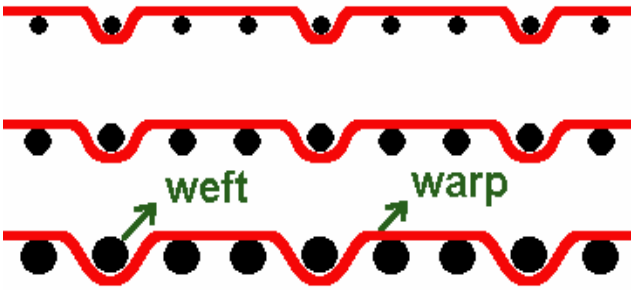

Figure 10: A comparison between the length of the warp thread required to implement the weave for several weft count.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
F 008	8.666667	13.7	51	442.5
F 009	8	13.8	51	331.87
F 010	7.333333	13.9	15	265.5
F 011	6.666667	14	15	221.25

Table 10: Shrinkage ratios toward the warp for each weft count (spinning turbine cotton).

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
F 012	8.67	13.7	51	500
F 013	10.67	13.4	51	1000
F 014	14	12.9	15	2000

Table 11: Shrinkage ratios toward the warp for each weft count (ATY).

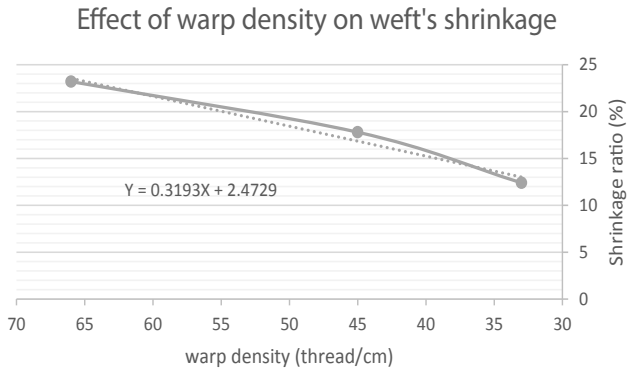

Figure 11: Relationship between warp density and shrinkage ratio towards weft yarn.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
G 001	12.40	14.6	16.667	33
G 002	17.80	13.7	16.667	45
G 003	23.20	12.8	16.667	66

Table 12: Shrinkage ratios toward weft for each warp density.

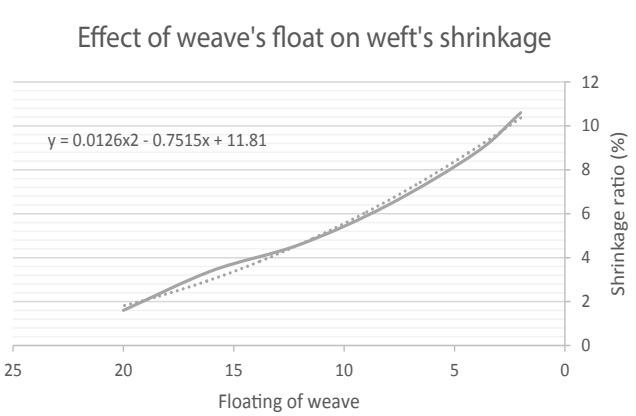

Figure 12: Relationship of amount float with fabric shrinkage ratio toward weft.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
H 001	6.40	15.6	16.667	Satin
H 002	6.40	15.6	16.667	Twill

Table 13: Shrinkage ratios toward weft for each of weave satin and twill 7/1.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
H 003	3.40	16.1	16.667	Satin
H 004	3.40	16.1	16.667	Twill

Table 14: Shrinkage ratios toward weft for each of weave satin and twill 15/1.

As the only difference between satin and twill is the method of point distribution of weave Figure 12, because that there isn't any difference between fabric shrinkage towards weft for each of satin twill and this explains that there is no effect on the weave type whether satin or twill (Tables 13 and 14).

Effect of weave floating on fabric shrinkage ratio toward weft

Amount of weave float has been selected are (2, 4, 8, 12, 16, 20).

Equation shows that the inverse relationship between the percentage of shrinkage towards weft and the amount of float, as the number of intersections increases the required weft length increases, thus the shrinkage ratio increases (Table 15).

Effect of weft's tension on fabric shrinkage toward weft

Definite from Figure 13 that inverse relationship between fabric shrinkage towards weft and value of weft's tension, it explains that when weft's tension increases it will prevent the shrinkage of fabric

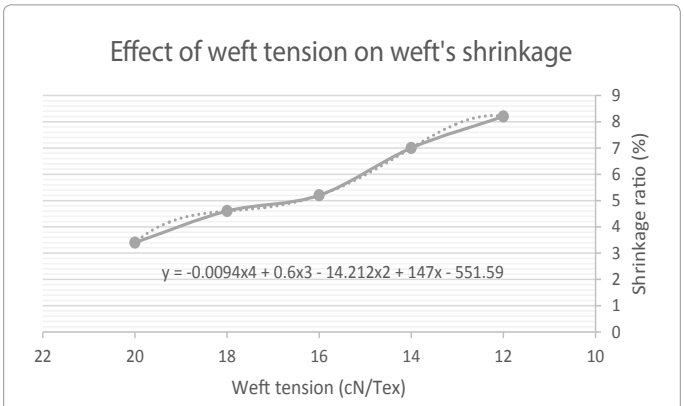

Figure 13: Relationship between weft's tension with shrinkage toward weft.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
I 001	10.60	14.9	16.667	2
I 002	8.80	15.2	16.667	4
I 003	6.40	15.6	16.667	8
I 004	4.60	15.9	16.667	12
I 005	3.40	16.1	16.667	16
I 006	1.60	16.4	16.667	20

Table 15: Shrinkage ratios for each of the tested amounts float.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
J 001	8.20	15.3	16.667	12
J 002	7.	15.5	16.667	14
J 003	5.20	15.8	16.667	16
J 004	4.60	15.9	16.667	18
J 005	3.40	16.1	16.667	20

Table 16: Shrinkage ratios toward the weft for each of tested weft's tension.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
K 001	7.33	13.9	51	12
K 002	6.67	14	51	14
K 003	6.67	14	15	16
K 004	6	14.1	15	18
K 005	6	14.1	15	20

Table 17: Shrinkage ratios toward the weft for each of tested warp's tension.

towards weft depends on the friction between the warp and weft (Table 16).

Effect of warp's tension on fabric shrinkage toward weft

Definite of Figure 14 that there an inverse relationship between fabric shrinkage and value of warp's tension, the reason is that increase in warp's tension would increase the pressure on the contact points between the warp and weft and reduce the shrinkage, but by light effect (Table 17).

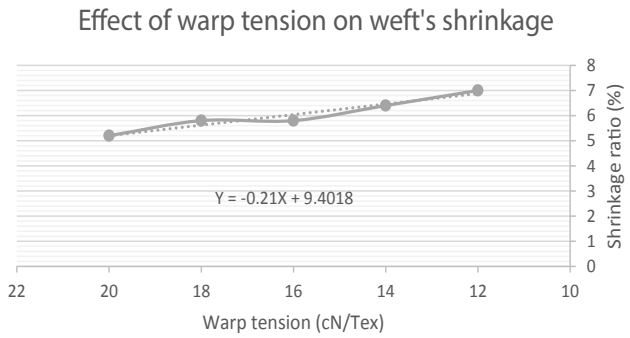

Figure 14: Relationship between warp's tension with shrinkage toward weft.

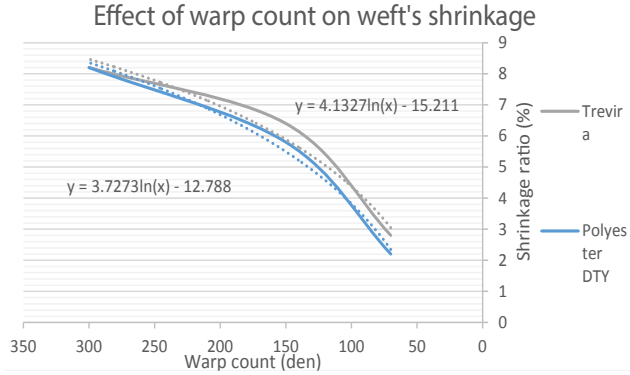

Figure 15: Relationship between warp count with fabric shrinkage toward weft yarns for Trivera warp yarn.

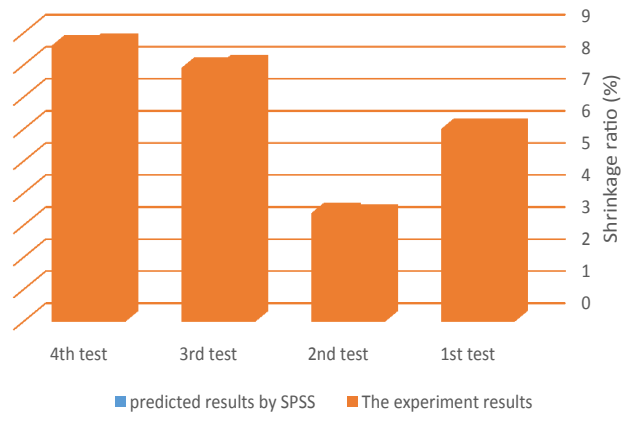

Figure 16: Relationship between warp count with fabric shrinkage toward weft yarns for Polyester DTY warp yarn.

Effect of warp's type and count on shrinkage toward weft

Figures 15 and 16 show great similarities between the planners path for each of the polyester and trivera, and both indicate that the relationship between the fabric shrinkage ratio toward weft and warp count is a positive relationship. This result does not matched with the result of researcher [11] conducted on warp count (70-100-150) den and densities (10-30) thread/cm, where the percentage of shrinkage for count 150 den is 5.80%, while a researcher [11] is greater than that where it is 9.11% and the reason for this is that researcher tested weave is plain 1/1 while our tested weave is Satin 1/7, and as we saw previously that when the amount of float less the shrinkage ratio be greater and this explains the difference between the two results (Tables 18 and 19).

Calculate fabric shrinkage ratio by deriving an equation

Using SPSS program (Statistical Package for the Social Sciences) from the IBM company to conclude the shrinkage ratio equation, we get equations one to calculate the percentage of shrinkage towards warp numbered (1) and another to calculate the percentage of shrinkage towards weft numbered (2).

- Shwr: shrinkage ratio towards warp (%)
- Shwf: shrinkage ratio towards weft (%)
- Dwf: weft density (pick/cm)
- Dwr: warp density (thread/cm)
- Fl: weave float
- Twr: warp's Yarn tension (cN/Tex)
- Twf: weft's Yarn tension (cN/Tex)
- Cwf: weft count (den)
- Cwr: warp count (den)

To ensure the validity of equations (1) and (2), four experiments are performed on random values of variables of fabric samples and

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
L 001	2.80	16.2	16.667	70
L 002	6.40	15.6	16.667	150
L 003	8.20	15.3	16.667	300

Table 18: Shrinkage ratios toward weft for each weft yarn (Trivera) count.

sample	Length lost (%)	Length after test (cm)	Length before test (cm)	Warp tension (cN/Tex)
L 004	2.20	16.3	16.667	70
L 005	5.80	15.7	16.667	150
L 006	8.20	15.3	16.667	300

Table 19: Shrinkage ratios toward weft for each weft count (Polyester DTY).

Weft type	α	β	ξ	η	φ	λ
Chenille	+0.191	-0.017	-0.104	-0.018	+0.001	6.187
Poly propylene	+0.168	-0.040	-0.151	-0.023	+0.001	7.387
Turbine spinning cotton	+0.194	-0.016	-0.143	-0.018	+0.006	6.777
ATY yarn	+0.184	-0.024	-0.093	-0.016	+0.003	6.011

Table 20: Constants of the equation (1).

Warp type	α	β	ξ	η	φ	
polyester	+0.291	-0.008	-0.050	-0.008	+0.001	3.324
trivera	+0.257	-0.006	-0.077	-0.014	+0.001	3.109

Table 21: Constants of the equation (2).

sample	Dwf	Fl	Twr	Twf	Cwf	Actual Shwr	Predict Shwr
1st test	12	8	15	15	150	6	6.002
2nd test	12	16	15	15	150	3.33	3.38
3rd test	12	8	12	15	150	8	7.93
4th test	12	8	15	15	500	8.66	8.6

Table 22: A comparison of the actual samples results and predictive results.

compare it with the theory of equations results, and found that the error rate does not exceed 0.006 (Tables 19-22).

Results

- Variables that effect on fabric shrinkage ratio towards warp are: weft density, weft count, weft type, weft's Yarn tension, warp's Yarn tension and weave float.
- Variables that effect on fabric shrinkage ratio towards weft are: warp density, warp count, warp type, weft's Yarn tension, warp's Yarn tension and weave float.
- Relationship between weft density with fabric shrinkage ratio toward warp is a positive correlation. It matches with the result of the researcher Edita M.
- Relationship between weft count with fabric shrinkage ratio toward warp is a positive correlation.
- Relationship between weave float with fabric shrinkage ratio toward warp is an inverse correlation. This result does not matches with the result of the researcher Milašius and Vytautas.
- Relationship of each warp and weft Yarn tension with fabric shrinkage ratio toward warp is an inverse correlation.
- Relationship between warp density with fabric shrinkage ratio toward weft is a positive relationship.
- Relationship between warp count with fabric shrinkage ratio toward weft is a positive relationship. This result does not matches with the result of the researcher Rukuižienė and Milašius.
- Relationship of each warp and weft Yarn tension with fabric shrinkage ratio toward weft is an inverse correlation.
- There isn't effect of weave type whether Satin or Twill on fabric shrinkage ratio toward both warp and weft direction.

References

1. Lord M (1982) Weaving conversion of yarn to fabric.
2. Watson W (1955) Advanced textile design.
3. Nisbet H (1980) Grammar of textile design.
4. Moghe A (2002) Study and characterization of small diameter woven tubular fabrics.
5. Edita M (2008) Investigation of Linen Honeycomb Weave Fabric Shrinkage After Laundering in Pure Water, Kaunas.
6. Çeven E, Özdemir Ö (2006) Using Fuzzy Logic to Evaluate and Predict Chenille Yarn's Shrinkage Behavior, Bursa.
7. Sirková B, Vyšanská M (2012) Methodology for Evaluation of Fabric Geometry on the Basis of the Fabric Cross-Section, Liberec.
8. Milašius A, Milašius V (2008) New Representation of the Fabric Weave Factor, Kaunas.
9. Gabrijelčič H, Černoša E, Dimitrovski K (2007) Influence of Weave and Weft Characteristics on Tensile Properties of Fabrics, Ljubljana.
10. Malčiauskienė E, Rukuižienė Z, Milašius R (2008) Investigation of Linen Honeycomb Weave Fabric Shrinkage After Laundering in Pure Water, Kaunas.
11. Rukuižienė Z, Milašius R (2006) Influence of Reed on Fabric Inequality in Width, Kaunas.
12. Kumpikaitė E (2007) Influence of Fabric Structure on the Character of Fabric Breakage, Kaunas.
13. Anderson K (2004) Seamless textiles with inherent shape.
14. Alderman S (2004) Mastering weave structures.
15. Vander H (1993) The complete book of drafting for handweavers.