Thesis

On

Study on Warp and Weft Crimp in Denim Fabrics

Course Title: Project (Thesis)
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Supervised By

Professor Dr. Md. Mahbubul Haque
Head
Department of Textile Engineering
Faculty of Engineering
Daffodil International University

Submitted By

Md. Sakhawat Hossain Rizvi
ID: 153-32-301

Department of TE
Faculty of Engineering
Daffodil International University

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled, **"Study on Warp and Weft Crimp in Denim Fabrics"** has been done by m under the supervision of **Professor Dr. Md. Mahbubul Haque.** It has not been presented for a degree of any other university and all the resource of materials uses for this thesis has been duly acknowledged.

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

Supervised By

Professor Dr. Md. Mahbubul Haque
Head
Department of TE
Faculty of Engineering
Daffodil International University

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Md. Sakhawat Hossain Rizvi
ID: 153-32-301
Department of TE
Faculty of Engineering
Daffodil International University

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At First I express my heartiest thanks and gratefulness to almighty Allah for His divine blessing makes us possible to complete this project successfully.

I fell grateful to and wish to our Supervising teacher **Professor Dr. Md. Mahbubul Haque, Department of TE**, Faculty of Engineering, Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field development of influenced us to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project. We would like to express our heartiest gratitude to other faculty member of TE department of Daffodil International University. Especially thanks goes to Textile engineers of various industries from whom I collect the sample and data. I would like to thank our entire course mate in Daffodil International University. Who took part in this discuss while completing the course work.

Finally, I must acknowledge with due respect to our parents.

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ABSTRACT

At first I visit some of denim fabric industries. I observed the denim production from the warping to weaving very carefully. I needed to commence our project work with effective analysis. In every steps of production I collect data and also analyze that. I tried to find out the crimp percentage of denim fabric of denim fabric by using various methods. I measure the warp crimp percentage and weft crimp percentage of denim fabric. I tried to find crimp percentage by using set loom method and by using crimp tester. Moreover that I tried to find weft crimp percentage at fell of the cloth position, after 10 inches production on loom, after relaxation of fabric and finished situation by using both set loom and using crimp tester. The result of various method of crimp percentage at same situation is little difference which can be ignore.

During my project work we manage to watch carefully and effectively. The product specification in every section along with machine specification and the major factors. My effort was to develop a dependable way so that I can easily visualize or can forecast the result. I have tried my best to emphasize on the adjustable points. The theoretical as well as the practical knowledge that we gathered from our classes and in the industry, help us to perform our project with credit and for this we specially convey thanks to our honorable teachers.

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CONTENTS

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CHAPTER-1
INTRODUCTION

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1.1 Introduction

Warp and weft crimp are the two fundamental parameters of woven fabric. Factors like abrasion, shrinkage, elongation, fashion designing and yarn consumption are directly related to crimp of warp and weft. It was found that if the crimp is higher, then abrasion, shrinkage and yarn consumption will be higher. The fashion designers find more comfort to design with fabric having higher warp and weft crimp. Experience show that the crimp is highly variable and lies between 2/3 to as high as 30%. This poses a challenge for the weaving industries to estimate the actual amount of warp and weft to manufacture certain amount of woven fabric. Lack of proper idea about crimp% will lead wrong estimation warp and weft yarn. To avoid this, weaving industries always weave extra fabric to compensate any shortage. As a result at the end of the year factories ended with huge amount of left over fabrics, which are normally sold at nominal price. At present, crimp% is calculated using a widely practiced method suggested by British Standard Institute (BSI). However the system was reported to have some drawbacks e.g. it uses same pretension to straighten a crimped yarn having varying types of crimps. Thus if the crimp cannot be estimated properly, it will not be possible to predict crimp of yarn properly leading to wrong estimation of yarn required to make certain length of fabric.

The present study has been designed to

Tension of the yarn is one of the important parameters which significantly affect weaving and fabric quality. For the tension of warp and weft yarn in a fabric a wavy appearance is found in the yarn which is widely known as crimp of the yarn.

“Crimp can be defined as the compression of something into small folds or ridges”. It can be done intentionally or by the adverse effect of something.

According to the English dictionary of Oxford, crimp is to press something into small folds.

In case of textile and apparel it is defined more specifically. “When warp and weft yarns interlace in fabric, they follow a wavy path. This waviness of yarn is called crimp”.

According to pierce, “Crimp, geometrically considered, is the percentage excess of length of the yarn axis over the cloth length”. And Crimp percentage is defined as the mean difference between the straightened thread length and the distance between the ends of the thread while in cloth, expressed as a percentage”.

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This crimp percentage of woven fabric has great influence on the woven fabric properties that's why it is necessary to measure the crimp percentage properly. The Following are the crimp influences:

I) For instance, if there is more crimp it will increase the amount of total yarn consumption along with more shrinkage in the fabric.

II) The variation in the crimp in a fabric also results in some fault like Diamond bar, bright picks.

III) This variation of crimp also reduce the fabric strength albeit increase the abrasion resistance of the fabric.

IV) The dimensional stability of fabric largely depends on the crimp percentage and it decrease with the more crimp in the yarn in a fabric.

For determining this crimp% Shirley crimp tester is widely is used in different textile industries.

1.2 Aim of the study

The aim of this thesis work is to determine an effective and accurate way of determining crimp% of woven fabric.

1.3 Objects of the study

- To initiate different way of identifying crimp%
- To compare the result of crimp% which has been determined in various way
- To suggest the effect measurement techniques of crimp% determination.

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CHAPTER-2

LITERATURE REVIEW

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2.1 Literature Review:

The crimp of warp and weft yarn of woven fabric depends on several factor like type of the raw materials, yarn criteria and structure, fabric structure and geometry, conditions during the weaving along with fabric finishing process [1]. Several researchers has done their through work in this area of crimp percentage. Accordingly, some mathematical equation between yarn crimp and other yarn and fabric parameters has been derived by the researches. Peirce, F. T [2]postulated the following formula to relateother fabric and yarn parameter with the yarn crimp.

$$4/3\{P_2(C_1)^{1/2}+P_1(C_2)^{1/2}\}=36e\{I/N_1)^{1/2}+I/M_2)^{1/2}\}$$

Where P_1 and P_2 is spacing of warp and weft in mills,

C_1 and C_2 is warp and weft crimp as fractions.

N_1 and N_2 is linear density of warp and weft, e is flattening co-efficient of threads. Researchers have found some correlation between crimp of yarn and mechanical properties of fabric. Md. Mahbubul Haque [3] mentioned that the existing method of measuring crimp may have some inaccuracy as same pretension is used to test crimp of a yarn having same tex but different amount of crimp. He thought that if a yarn forms different amount of crimp in two fabric say 5% and 15% then the separate pretension will be required to get the straightened length. [4]. According to Garcia et al. fabric extensibility, shear and hygral expansion, bending properties are explicitly related to the yarn crimp%

[5]. Dusenbury and Dansizer stated that, fiber with higher crimp have lower elastic moduli and breaking stresses and extensions. They mentioned that, yarn made from these fiber exhibit same kind of mechanical properties in the fabric

[6]. Tan et al. claims that, crimp of yarn in woven fabric give rise to excessive transverse deflection

[7]. Jeon et al. stated that, mechanical properties of the fabric can be analyzed by the term of yarn crimp properties and fabric structure

[8]. Though there are some researches on the effect of crimp in the different properties of fabric, there is currently no research about the crimp percentage determination techniques in woven fabric especially on denim fabric except by crimp tester. The present thesis was

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therefore undertaken to find out new techniques of crimp percentage determination keeping in mind the different aspect like preparatory and finishing process of the woven fabric.

2.2 Denim Fabric

Denim is a strong, durable fabric constructed in a twill weave with indigo and white yarns. The blue/indigo yarns are the lengthwise or "warp" threads (parallel to the selvage). The white yarns run across the fabric width (the weft threads). Denim is traditionally woven with 100%-cotton yarn; however, today it's blended with polyester, to control shrinkage and wrinkles, and Lycra to add stretch. Today, denim has many faces. It can be printed, striped, brushed, napped and stonewashed, and the indigo. In this work we have determined the crimp percentage of yarn.

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CHAPTER-3

MATERIAL AND METHODS

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3.1 Fabric Specification:

For the present study fabric samples of various contractions were woven. Table-1 shows the details of various fabric samples. Attempt has been made to determine crimp of yarn taken out of the woven fabric at grey and finished state.

Table 1**: Details of the fabric samples**

S/L NO	Fabric Construction			
	Warp		Weft	
	EPI	Count	PPI	Count
1	66	7.5 RS	40	6 OE
2	66	7.5 RS	40	6 OE
3	64	7.2 RS	42	6 OE
4	64	7.2 RS	42	6 OE
5	65	7.5RS+ 8R+11R	44	8 RS + 10L-40D
6	65	7.5RS+ 8R+11R	44	8 RS + 10L-40D

R= Ring Yarn; RS= Ring Slub; OE= Open End

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3.2 Machine Specification:

For production purpose along with preparatory and finishing purpose, we have used the following machines in our thesis.

3.2.1 Direct Warping Machine Specification:

Brand Name	Suker Muller
Model	2005
Machine Serial No.	100040161
Origin	Germany
Working Width	71″
Manufacturing Year	2005
Max Beam Diameter	140.9cm
Max Warping Speed	850Mtr/min
Creel Type	H
Creel Capacity	432
Reed to Reed Distance	0.8cm
Max Warping Capacity	20000Mtr
Stop Motion	Auto

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3.2.2. Ball Warping Machine Specification:

Brand Name	West Point
Machine Serial No	WO#173725
Origin	America
Working Width	46″
Manufacturing Year	2005
Max Beam Disc Diameter	15″
Max Warping Speed	500Mtr/min
Creel Type	H
Creel Capacity	448
Stop Motion	Auto
Max Warping Length	18500Mtr(Depends on count)
Ball Width	53″

3.2.3. Slasher Dyeing Machine Specification:

Machine Name	Slasher Dyeing Machine
Brand Name	Sucker Muller
Origin	Germany
Manufacturing Year	1995
Creel Capacity	16
No. of Dye Bath	8
Total No. Of Box	14
Production Capacity	Continuous Dyeing Method
Dye bath's Capacity	1400Ltr
Stop Motion	Auto

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3.2.4 Rope Dyeing Machine Specification:

Machine Name	Rope Dyeing M/C
Brand Name	Morrison
Origin	America
Dryer	36
Air Consumption	60-70Kn
Model	2007
Manufacturing Year	2007
Creel Capacity	32
No. of Dye Bath	10
Total No of Box	18
Steam Supply	5000-6000lb/hr.
Water Supply	500-600lb/h
Machine Speed	35Mtr/min (Max)
Production Capacity	Continuous Dyeing Method
Storage Capacity	3000 ltr
Stop Motion	Auto

3.2.5: Long Chain Beamer Machine Specification:

Brand Name	West Point
Serial No.	WO#173733
Origin	America
Max. Speed	500 m/min
Max. Yarn Tension	450 N
Working Width	1,800 mm
Max. Beam Flange Diameter	1000 mm

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Stop Motion	Auto/Manual

3.2.6: Sizing Machine Specification:

Brand Name	Jupiter
Serial No.	17480/7/2007
Origin	India
Machine Speed	40-80Mtr/min
No. of Squeeze Roller	2 Pairs
No. of Size Dryer	14
Creel Capacity	12
Preparation Tank Temperature	100°C
Cooking Time	25-40 Minute

3.2.7: Weaving Machine Specification:

Brand Name	Picanol
Model	PICANOL OMNI Plus 800
Origin	Belgium
Machine Speed	850 rpm
Reed	Profile Reed
Shedding	Cam Shedding Mechanism
Air Pressure	6.5bar
Total Relay Valve	14
Number of Heald Shaft	6
Number of cutter	2
Let Off Motion	Electrical
Take Up Motion	Electrical

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3.2.8: Finishing Machine Specification:

Brand Name	Morrison
Serial No.	T98
Origin	America
Model	M80SF
Manufacturing Year	2006
Power	65.5KW
Machine Length × Width	105m × 1.83m
Shrinkage Control Warp/Weft/ Lycra	10-15/5-7/20-25%
Machine Capacity	80Mtr/min

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3.3 Finishing Process:

Flow Chart of Flat (Mercerizing) Finishing

Fabric Unwinding

(By Motor Speed 25-80m/Min)

⇩

J-Box

(Fabric Store Unit)

⇩

Tension Roller

(Maintain Tension)

⇩

Brusher

(Protruding Fiber Are Removed By Brushing)

⇩

Singeing

(By Gas Burner)

⇩

Mercerizing

(Caustic Treatment)

⇩

Wash Box 1

(Temperature 75-85°c)

⇩

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Wash Box 2

(Temperature 65-75°c)

⇩

Wash Box 3

(Temperature 55-65°c)

⇩

Wash Box 4

(Temperature 45-55°c)

⇩

Wash Box 5

(Temperature 35-45°c)

⇩

Softener

(Used for Softening the Fabric)

⇩

Padder

(Remove Excess Water)

⇩

Skew Roller

(Properly Maintain the Twill Line Direction)

⇩

Steam Dryer

(Temperature 120-130^{0}C)

⇩

Rubber Belt

(Pressure 2.5-3 Bar)

⇩

Palmer/Calendaring

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(Make the Fabric Surface Uniform)

⇩

Folding

(Prepare For Next Step: Inspection)

Flow Chart of Regular Finishing

Fabric Unwinding

(By Motor Speed 25-80m/Min)

⇩

J-Box

(Fabric Store Unit)

⇩

Tension Roller

(Maintain Tension)

⇩

Brusher

(Protruding Fiber Are Removed By Brushing)

⇩

Singeing

(By Gas Burner)

⇩

Wash Box

(Room Temperature)

⇩

Softener

(For Softening the Fabric)

⇩

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Padder

(Remove Excess Water)

⇩

Skew Roller

(Properly Maintain the Twill Line Direction)

⇩

Steam Dryer

(Temperature 120-130^{0}C)

⇩

Rubber Belt

(Pressure 2.5-3 Bar)

⇩

Palmer/Calendaring

(Make the Fabric Surface Uniform)

⇩

Folding

(Prepare For Next Step: Inspection)

3.4 Chemical Specification:

The following chemicals were used during the finishing of produced sample of the denim fabric.

Primasol/ Kiralon [wetting agent]: 4 g/L

Velustrol [Softening aget]: 5 g/L

Interpol Buffer [Controller]:1.5 g/L

3.5. Measurement of Crimp Percentage:

Crimp% is calculated using the following formula;

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Let the straightened thread length = l

The length of thread in fabric, crimped length = p.

$$\text{Crimp \%} = \frac{l - p}{p} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots \text{(I)}$$

3.6. Measurement of Warp Crimp Percentage:

As was mentioned, warp crimp was determined using three different techniques e.g.

i) Marking method,

ii) Set length method and

iii) Crimp tester method. The three methods have been described in detail below;

3.6.1. Measurement of warp yarn crimp percentage on marking method

This measurement has been done on the loom. In this regards warp on the loom has been marked one meter apart by marker pen. The location of the two marks A & B have been shown in figure 1. After that the referred length of warp have been woven and after certain extent the distance between the two marks was again measured and then crimp% was calculated using the formula shown in equation (i). The crimp results are shown in the tables 3 - 8

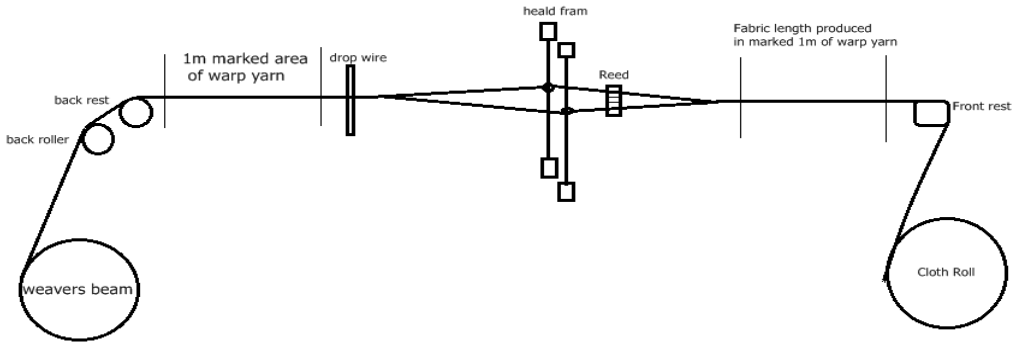

Figure-1: Warp crimp measurement by marking method

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3.6.2. Measurement of Warp Yarn Crimp Percentage on Set Length Method

According to the methods the warp crimp% was calculated indirectly from length of warp yarn wound in the weaver's beam and corresponding fabric produced from that length. The free length of warp that was not possible to weave e.g. few yards have been wasted at the beginning of weaving a new beam and few yards left unwoven at the end of weaving of that beam. Thus we got two lengths; one is length of exact length of warp that has been woven into fabric and the corresponding length of woven fabric. The two length was then used to calculate crimp% using the formula shown in equation (i). The results have been shown on table 3- 8

3.6.3. Measurement of Warp Crimp % by Using Crimp Tester

This has been done by following the BSI method of crimp test [8]. According to this method, the fabric was mark 30 cm fabric sample in warp direction. Then removed a warp yarn from the fabric (In case of multi count warp yarn in the fabric, we removed more than one yarn).After that, straightened length of this yarn was taken by using crimp tester. A prescribed yarn tension was maintained which is shown below [8].

Yarn type	Linear density	Tension (cN)
Woollen and worsted	15 to 60 tex	(0.2 × tex) + 4
	61 to 300 tex	(0.07 × tex) + 12
Cotton	7 tex or finer	0.75 × tex
	coarser than 7 tex	(0.2 × tex) + 4
All man-made continuous filament yarn	All	0.5 × tex

Then crimp percentage was calculated by using same formula as above. Thus, data was taken from five different looms and average crimp percentage was calculated. The data is shown on table 9-15.

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3.7. Measurement of Weft Yarn Crimp Percentage

As was mentioned, warp crimp was determined using three different techniques-

i. Measurement of Weft Yarn Crimp Percentage by crimp tester

ii. Measurement of Weft Yarn Crimp Percentage by on Loom Method

iii. Measurement of Weft Yarn Crimp Percentage by off loom (Relaxed Method)

3.7.1. Measurement of Weft Yarn Crimp Percentage by crimp tester

At first, we took 30 cm fabric sample in weft direction. Then removed a weft yarn from the fabric (In case of multi count warp yarn in the fabric, we removed more than one yarn).After that, straightened length of this yarn was taken by using crimp tester. Then crimp percentage was calculated by using formula. On the same way crimp percentage was calculated from the finished fabric. Thus, took reading from five different looms and average crimp percentage was calculated. The data is shown on table 16-22.

3.7.2. Measurement of Weft Yarn Crimp Percentage by on Loom Method

At first we stopped a running machine. Then fabric width in cm was taken by measuring tape from selvedge to selvedge at fell of the cloth position from set loom. Then from loom, the last weft yarn from selvedge to selvedge was removed. The straight length of this weft yarn was measured. Then we calculated the crimp percentage by using formula. At second step, we marked this measured position and let the loom run for weaving 10 inch of fabric. After production of 10 inch of the fabric, the fabric width was taken in cm by measuring tape from selvedge to selvedge in that marking point. Then calculated crimp percentage by

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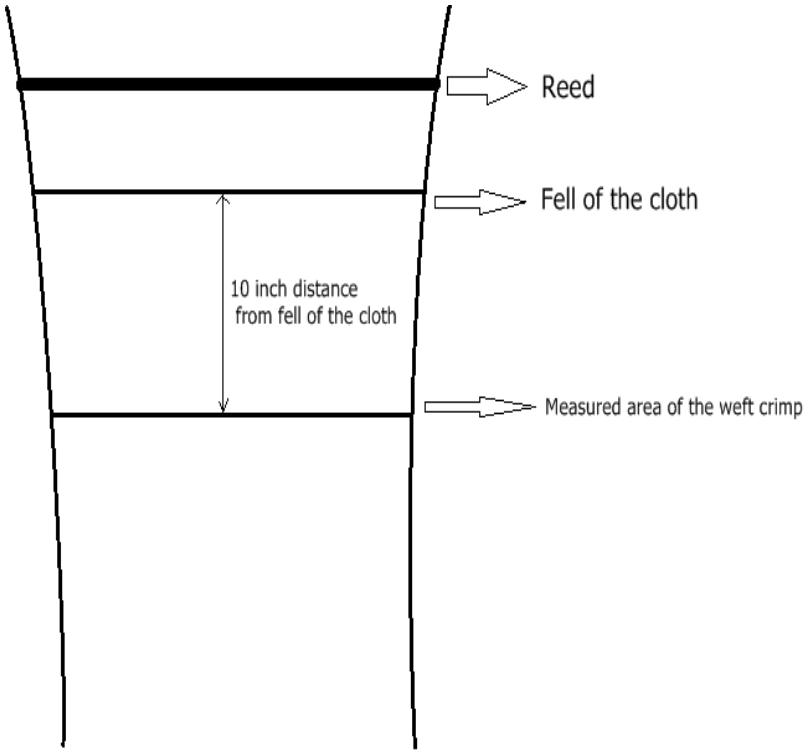
using formula. Thus, take reading from five different looms and calculate average crimp percentage. The data is shown on table 24 to 29.



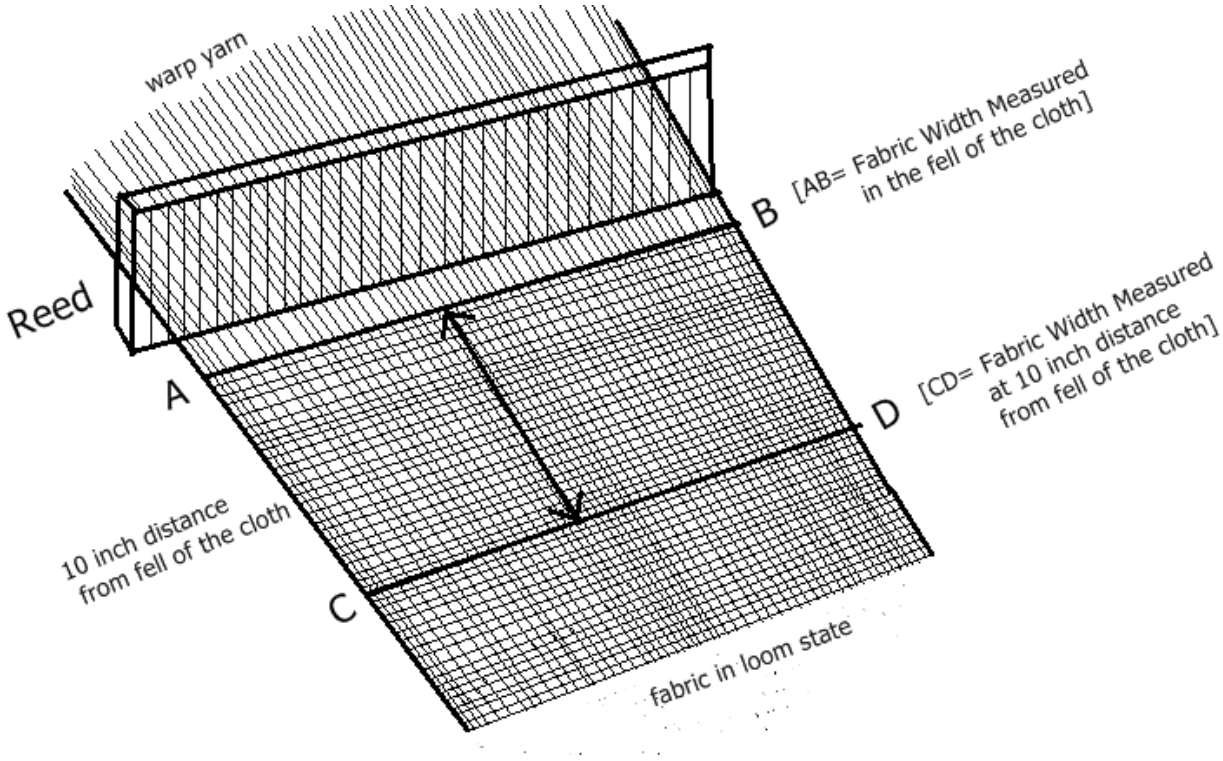


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Figure-2: Weft crimp measurement by Set Loom Method

3.7.3. Measurement of Weft Yarn Crimp Percentage by off loom (Relaxed Method)

The fabric samples are collected after two days later which were unwound from the cloth roller and relaxed for sufficient time. In this method fabric is marked on loom. Then according to this marked position, relaxed fabric width has taken. Thus, five reading was taken. From these sample fabrics a weft yarn is removed. Then measured the straightened length of these yarn. Then crimp percentage was calculated according to the formula. The data is shown on table 24-29.

Table 02: Description of the symbols used in table 3 to 8

Content	Symbol	Content	Symbol
1 meter Marked Warp Length on Loom in inch	A	Beam Length in yards	F
Length of 1 m. Marked Portion after weaving on Loom State	B	Total Fabric Length	G
Difference of A and B(A-B)	C	Finished Fabric Length	H
1 Meter Marked Relaxed Grey Fabric	D	Crimp Percentage	Cr%
1 Meter Marked Finished Fabric	E	Avg. Crimp %	A.Cr %

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Table No 3: Measurement of Warp Crimp Percentage by marking and set length Method

SL No.	Fabric Construction				A	B	C	Cr%	A.Cr %	D	Cr%	A.Cr %	E	Cr%	A.Cr %	F	G	Cr%	A.Cr %	H	Cr%	A.Cr %
	Warp Yarn		Weft Yarn																			
	EPI	Count	PPI	Count																		
1	60	7.2Ring Slub	48	16L-40D + 300L-40D	39.37	36.5	2.87	7.86	7.61	35.4	11.08	10.83	30.9	27.40	26.92	2078	1884	10.30	11.04	1626	27.80	28.02
2					39.37	36.8	2.57	6.98		35.7	10.18		31.2	26.31		1914	1727	10.83		1496	27.94	
3					39.37	36.7	2.67	7.28		35.6	10.48		31.1	26.67		1914	1716	11.54		1493	28.20	
4					39.37	36.5	2.87	7.86		35.4	11.08		30.9	27.40		1969	1761	11.81		1532	28.52	
5					39.37	36.7	2.67	7.28		35.6	10.48		31.1	26.67		1859	1686	10.26		1467	26.72	
6					39.37	36.6	2.77	7.57		35.5	10.78		31.0	27.04		1804	1638	10.13		1412	27.76	
7					39.37	36.3	3.07	8.46		35.2	11.70		30.9	27.40		1859	1654	12.39		1439	29.19	

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Table No 4: As table 3 but in different fabric constructions.

SL No.	Fabric Construction				A	B	C	Cr %	A.Cr %	D	Cr %	A.Cr %	E	Cr %	A.Cr %	F	G	Cr %	A.Cr %	H	Cr %	A.Cr %
	Warp Yarn		Weft Yarn																			
	EPI	Count	PPI	Count																		
1	66	7.2 Ring Slub	40	6 Open End	39.37	36.1	3.27	9.06	9.57	35.2	11.85	12.38	31.4	25.35	25.94	1969	1738	13.28	13.12	1545	27.42	27.25
2					39.37	36.1	3.27	9.06		35.2	11.85		31.4	25.35		1969	1753	12.34		1558	26.34	
3					39.37	36.8	2.57	6.98		35.9	9.73		32.0	22.97		1969	1767	11.41		1571	25.35	
4					39.37	35.8	3.57	9.97		34.9	12.79		31.1	26.40		1859	1635	13.73		1453	27.95	
5					39.37	36.7	2.67	7.28		35.8	10.03		31.9	23.30		1859	1664	11.73		1479	25.67	
6					39.37	35.4	3.97	11.21		34.5	14.07		30.8	27.83		1859	1614	15.15		1435	29.52	
7					39.37	35.7	3.67	10.28		34.8	13.11		31.1	26.76		1859	1646	12.95		1463	27.03	
8					39.37	36.2	3.17	8.76		35.3	11.55		31.5	25.01		1859	1636	13.65		1454	27.88	
9					39.37	36.0	3.37	9.36		35.1	12.17		31.3	25.70		1914	1694	12.97		1506	27.12	
10					39.37	35.3	4.07	11.53		34.4	14.39		30.7	28.20		1859	1622	14.59		1442	28.89	
11					39.37	35.8	3.57	9.97		34.9	12.79		34.4	14.34		1859	1653	12.49		1469	26.57	
12					39.37	35.8	3.57	9.97		34.9	12.79		34.4	14.34		1859	1636	13.65		1454	27.88	
13					39.37	36.1	3.27	9.06		35.2	11.85		34.7	13.37		1859	1634	13.80		1452	28.03	
14					39.37	36.3	3.07	8.46		35.4	11.24		35.0	12.64		1859	1668	11.43		1483	25.37	
15					39.37	36.1	3.27	9.06		35.2	11.85		34.7	13.37		1859	1663	11.80		1478	25.74	
16					39.37	35.7	4.3	11.91		34.8	13.11		34.3	14.66		1859	1620	14.75		1440	29.13	
17					39.37	35.4	3.88	12.94		34.5	14.07		34.0	15.71		1312	1157	13.45		1028	27.65	
18					39.37	35.6	4.12	12.26		34.7	13.43		34.2	15.02		1859	1636	13.65		1454	27.88	
19					39.37	36.0	3.08	10.93		35.1	12.17		34.6	13.66		1170	1027	13.91		913	28.09	
20					39.37	35.8	4.09	11.69		34.9	12.79		34.4	14.43		2133	1910	11.66		1698	25.59	

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Table No 5: As table 3 but in different fabric construction.

Sl No.	Fabric Construction				A	B	C	Cr %	A.Cr %	D	Cr %	A.Cr %	E	Cr %	A.Cr %	F	G	Cr %	A.Cr %	H	Cr %	A.Cr %
	Warp Yarn		Weft Yarn																			
	EPI	Count	PPI	Count																		
1	68	8.5 OES + 7 OE + 10 OE	39	7 Open End Slub + 10L-40D	39.37	35.8	3.57	9.97	9.74	35.0	12.45	12.21	31.0	27.14	26.87	2406	2126	13.17	12.58	1860	29.35	28.31
2					39.37	35.9	3.47	9.67		35.1	12.13		31.1	26.78		2406	2112	13.92		1859	29.42	
3					39.37	36.0	3.37	9.36		35.2	11.82		31.1	26.43		2608	2329	11.98		2037	28.03	
4					39.37	35.8	3.57	9.97		35.0	12.45		31.0	27.14		2570	2310	11.26		2033	26.41	

Table No 6: As table 3 but in different fabric construction.

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SL No.	Fabric Construction				A	B	C	Cr %	A.Cr %	D	Cr %	A. Cr %	E	Cr %	A.Cr %	F	G	Cr %	A.Cr %	H	Cr %	A.Cr %
	Warp Yarn		Weft Yarn																			
	EPI	Count	PPI	Count																		
1	54	7 Ring Slub	44	10L-40D	39.37	35.8	3.57	9.97	9.99	35.0	12.56	13.20	31.0	27.14	27.65	2242	2022	10.88	13.49	1759	27.46	28.01
2					39.37	35.7	3.67	10.28		34.9	12.88		30.9	27.49		2242	1999	12.16		1739	28.92	
3					39.37	35.5	3.87	10.90		34.7	13.51		30.7	28.21		2242	1976	13.46		1747	28.33	
4					39.37	35.4	3.97	11.21		34.6	13.83		30.6	28.57		2242	1953	14.80		1754	27.82	
5					39.37	35.6	3.77	10.59		34.8	13.19		31.0	26.82		2242	1930	16.17		1758	27.53	

Table No 7: As table 3 but in different fabric constructions.

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SL No.	Fabric Construction				A	B	C	Cr %	A.Cr %	D	Cr %	A.Cr %	E			F	G	Cr %	A.Cr %	H	Cr %	A.Cr %
	Warp Yarn		Weft Yarn																			
	EPI	Count	PPI	Count																		
01	65	7.5 Ring Slub + 8 Ring + 11 Ring	45	8 Ring Slub + 10L-40D	39.37	35.7	3.67	10.28	10.85	35.2	11.78	12.11	30.7	28.20	28.57	2187	1960	11.58	13.38	1685	29.79	30.90
02					39.37	35.6	3.77	10.59		35.1	12.10		30.6	28.57		1969	1761	11.81		1620	21.54	
03					39.37	35.4	3.97	11.21		34.9	12.76		30.4	29.32		2187	1921	13.85		1660	31.75	
04					39.37	35.4	3.97	11.21		34.9	12.76		30.4	29.32		2242	1971	13.75		1710	31.11	
05					39.37	35.7	3.67	10.28		35.3	11.46		30.8	27.83		2187	1934	13.08		1669	31.04	
06					39.37	35.6	3.77	10.59		35.2	11.78		30.7	28.20		2187	1925	13.61		1665	31.35	
07					39.37	35.4	3.97	11.21		35.1	12.10		30.6	28.57		1979	1774	11.56		1533	29.09	
08					39.37	35.5	3.87	10.90		35.1	12.10		30.6	28.57		2242	1897	18.19		1710	31.11	
09					39.37	35.3	4.07	11.53		35.0	12.43		30.5	28.94		2242	1969	13.86		1710	31.11	
10					39.37	35.5	3.87	10.90		35.1	12.10		30.6	28.57		2187	1912	14.38		1590	37.55	
11					39.37	35.6	3.77	10.59		35.2	11.78		30.7	28.20		2242	1960	14.39		1690	32.66	
12					39.37	35.5	3.87	10.90		35.1	12.10		30.6	28.57		2242	2030	10.44		1690	32.66	

Table No 8: As table 3 but in different fabric constructions.

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SL No.	Fabric Construction				A	B	C	Cr %	A.Cr %	D	Cr %	A. Cr %	E	Cr %	A.Cr %	F	G	Cr %	A.Cr %	H	Cr %	A.Cr %
	Warp Yarn		Weft Yarn																			
	EPI	Count	PPI	Count																		
01	62	7 Ring Slub	40	10L-40D	39.37	35.9	3.47	9.67	10.33	34.8	13.06	13.69	30.7	28.26	28.98	1750	1562	12.04	13.32	1346	30.01	30.14
02					39.37	35.8	3.57	9.97		34.7	13.37		30.6	28.62		1750	1555	12.54		1334	31.18	
03					39.37	35.6	3.77	10.59		34.5	14.01		30.4	29.34		2242	1980	13.23		1749	28.19	
04					39.37	35.7	3.67	10.28		34.6	13.69		30.5	28.98		2242	1986	12.89		1738	29.00	
05					39.37	35.5	3.87	10.90		34.4	14.33		30.4	29.71		2242	1931	16.11		1711	31.03	
06					39.37	35.7	3.67	10.28		34.8	13.06		30.7	28.26		2242	1986	12.89		1710	31.11	
07					39.37	35.6	3.77	10.59		34.7	13.37		30.6	28.62		2209	1946	13.51		1693	30.48	

Table No 9: Measurement of Warp Percentage using Crimp Tester

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No. of Obs.	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
01	66	7.2 Ring Slub	40	6 Open End	34.2	30	13.85	13.52	38.1	30	27.08	26.71
02					34.0	30	13.19		37.9	30	26.34	
03					34.1	30	13.52		38.0	30	26.71	
04					34.0	30	13.19		37.9	30	26.34	
05					34.2	30	13.85		38.1	30	27.08	

Table No 10: As table 9 but in different fabric constructions.

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No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (l) cm	Crimped Length (p) cm	Crimp%	Avg. Crimp %	Straightened Length (l) cm	Crimped Length (p) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
01	60	7 Ring Slub	48	16L-40D + 300L-40D	33.5	30	11.64	11.50	38.4	30	28.13	27.47
02					33.7	30	12.32		38.3	30	27.76	
03					33.4	30	11.30		38.1	30	27.04	
04					33.4	30	11.30		38.0	30	26.67	
05					33.3	30	10.96		38.3	30	27.76	

Table No 11: As table 9 but in different fabric constructions.

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No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
01	62	7 Ring Slub	43	7 open ends	34.9	30	14.04	14.1	39.2	30	30.50	30.36
02					35.1	30	14.52		39.2	30	30.50	
03					34.9	30	14.04		39.3	30	30.86	
04					34.8	30	13.79		39.0	30	30.15	
05					34.9	30	14.04		38.9	30	29.80	

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Table No 12: As table 9 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
01	62	7 Ring Slub	40	8L - 40D	34.0	30	13.31	13.37	38.9	30	29.72	29.79
02					34.2	30	13.93		39.1	30	30.43	
03					34.1	30	13.62		39.0	30	30.08	
04					33.9	30	12.99		38.8	30	29.36	
05					33.9	30	12.99		38.8	30	29.36	

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Table No 13: As table 9 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
1	68	8.5 OESL	39	7 Open Ends Slub + 10 L-40D	34	30	11.76	8.5 OESL = 11.92	38.2	30	27.42	8.5 OESL = 27.79
		7 OE			34.1	30	12.02		38.6	30	28.54	
		10 OE			33.9	30	11.50		38.1	30	27.05	
2		8.5 OESL			34.1	30	12.02		38.3	30	27.79	
		7 OE			34.3	30	12.54		38.5	30	28.17	
		10 OE			34.0	30	11.76	7 OE = 12.38	38.0	30	26.67	7 OE = 28.92
3		8.5 OESL			34.1	30	12.02		38.3	30	27.79	
		7 OE			34.4	30	12.79		38.8	30	29.29	
		10 OE			34	30	11.76		38.2	30	27.42	
4		8.5 OESL			34	30	11.76		38.3	30	27.79	
		7 OE			34.2	30	12.28	10 OE = 12.01	38.7	30	28.92	10 OE = 27.20
		10 OE			33.8	30	11.24		38.1	30	27.05	
5		8.5 OESL			34.1	30	12.02		38.5	30	28.17	
		7 OE			34.2	30	12.28		38.9	30	29.66	
		10 OE			34.8	30	13.79		38.3	30	27.79	

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Table No 14: As table 9 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
1	65	7.5 RSL	45	8 RSL + 10 L-40D	33.5	30	11.67	7.5 RSL = 12.13	38.1	30	27.05	7.5 RSL = 28.62
		8R			33.6	30	12.00		38.5	30	28.17	
		11R			33.7	30	12.33		38.2	30	27.42	
2		7.5 RSL			33.3	30	11.00		38.6	30	28.54	
		8R			33.3	30	11.00		38.0	30	26.67	
		11R			33.4	30	11.33	8R = 11.87	38.5	30	28.17	8R = 28.32
3		7.5 RSL			33.9	30	13.00		38.7	30	28.92	
		8R			33.7	30	12.33		39.0	30	30.04	
		11R			33.5	30	11.67		38.5	30	28.17	
4		7.5 RSL			33.8	30	12.67		38.6	30	28.54	
		8R			33.7	30	12.33	11R = 11.60	38.3	30	27.79	11R = 28.39
		11R			33.6	30	12.00		38.7	30	28.92	
5		7.5 RSL			33.7	30	12.33		39.0	30	30.04	
		8R			33.5	30	11.67		38.7	30	28.92	
		11R			33.2	30	10.67		38.8	30	29.29	

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Table No 15: As table 9 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
01	54	7 Ring Slub	44	10L-40D	34.0	30	13.33	13.26	38.5	30	28.17	27.72
02					33.9	30	12.99		38.2	30	27.42	
03					34.0	30	13.33		38.3	30	27.79	
04					34.1	30	13.67		38.3	30	27.79	
05					33.9	30	12.99		38.2	30	27.42	

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Table No 16: Measurement of Weft Yarn Crimp Percentage by crimp tester

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg. Crimp %
	EPI	Count	PPI	Count								
01	66	7.2 Ring Slub	40	6 Open End	31.1	30	3.67	3.93	31.9	30	6.3	6.18
02					31.2	30	4.0		31.7	30	5.67	
03					31.2	30	4.0		32.0	30	6.67	
04					31.3	30	4.33		31.9	30	6.3	
05					31.1	30	3.67		31.8	30	6.0	

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Table No 17: As table 16 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.
	EPI	Count	PPI	Count								
01	64	7.2 Ring Slub	42	6 Open End	31.0	30	3.33	3.27	32.4	30	8.00	7.53
02					31.0	30	3.33		32.1	30	7.00	
03					30.9	30	3.00		32.3	30	7.67	
04					30.8	30	2.67		32.3	30	7.67	
05					31.2	30	4.00		32.2	30	7.33	

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Table No 18: As table 16 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.
	EPI	Count	PPI	Count								
01	60	7.2 Ring Slub	48	16L-40D	32.6	30	8.67	16L-40D = 8.8	35.2	30	17.33	16L-40D = 17.67
				300L-40D	32.0	30	6.67		34.2	30	14.00	
02				16L-40D	32.5	30	8.33		35.1	30	17.00	
				300L-40D	32.1	30	7.00		34.4	30	14.67	
03				16L-40D	32.7	30	9.00		35.1	30	17.00	
				300L-40D	31.9	30	6.33	300L-40D = 6.53	33.9	30	13.00	300L-40D = 14.027
04				16L-40D	32.6	30	8.67		35.6	30	18.67	
				300L-40D	31.8	30	6.00		34.4	30	14.67	
05				16L-40D	32.8	30	9.33		35.5	30	18.33	
				300L-40D	32.0	30	6.67		34.5	30	15.00	

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Table No 19: As table 16 but in different fabric constructions.

No. of Obs	Fabric Construction					Grey Fabric					Finished Fabric			
	Warp Yarn		Weft Yarn			Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.
	EPI	Count	PPI	Count										
01	72	10 Ring Slub	50	12L-40D		32.0	30	6.67	6.534		34.6	30	15.33	15.27
02						32.1	30	7.00			34.5	30	15.00	
03						32.0	30	6.67			34.7	30	15.67	
04						31.9	30	6.33			34.7	30	15.67	
05						31.8	30	6.00			34.4	30	14.67	

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Table No 20: As table 16 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.
	EPI	Count	PPI	Count								
01	60	7 Ring Slub	40	8L-40D	31.9	30	6.33	6.27	33.5	30	11.67	11.67
02					32.0	30	6.67		33.4	30	11.33	
03					31.8	30	6.00		33.4	30	11.33	
04					31.8	30	6.00		33.6	30	12.00	
05					31.9	30	6.33		33.6	30	12.00	

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Table No 21: As table 16 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp %	Avg.	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.
	EPI	Count	PPI	Count								
01	68	8.5 OESL + 7 Open End + 10 Open End	39	7OESL	31.1	30	4.33	7OESL = 4.20%	33.1	30	10.33	7OESL = 10.60%
				10L-40D	31.7	30	5.67		33.6	30	12.00	
02				7OESL	31.4	30	4.67		33.2	30	10.67	
				10L-40D	31.6	30	5.33		33.5	30	11.67	
03				7OESL	31.2	30	4.00		33.1	30	10.33	
				10L-40D	31.7	30	5.67	10L-40D = 5.868%	33.4	30	11.33	10L-40D = 11.666 %
04				7OESL	31.3	30	4.33		33.2	30	10.67	
				10L-40D	32.0	30	6.67		33.6	30	12.00	
05				7OESL	31.1	30	3.67		33.3	30	11.00	
				10L-40D	31.8	30	6.00		33.4	30	11.33	

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Table No 22: As table 16 but in different fabric constructions.

No. of Obs	Fabric Construction				Grey Fabric				Finished Fabric			
	Warp Yarn		Weft Yarn		Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.	Straightened Length (L) cm	Crimped Length (P) cm	Crimp%	Avg.
	EPI	Count	PPI	Count								
01	62	7.2 Ring Slub + 7 Ring	44	6.25 Open End	31.8	30	5.84	6.12	32.5	30	8.22	8.11
02					31.9	30	6.18		32.6	30	8.55	
03					31.9	30	6.18		32.4	30	8.00	
04					32.0	30	6.52		32.5	30	8.22	
05					31.8	30	5.84		32.3	30	7.58	

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Table No 23: Description of the symbols used in table 24 to 29

Content	Symbol
Length h of the weft yarn(cm)	X
Fabric width of the cloth position(cm)	Y
Crimp%	Cr%
Average Crimp%	A.Cr%
Fabric width 10 inch distance from fell of the cloth	P
Relaxed Fabric width(cm)	Q
Finished Fabric width (cm)	R

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Table No 24: Measurement of Weft Yarn Crimp Percentage on the loom and off the loom (i.e. Relaxed) Method

No. of Obs	Fabric Construction					X	Y	Cr%	A.Cr %	P	Cr%	A.Cr %	Q	Cr%	A.Cr %	R	Cr%	A.Cr %
	Warp Yarn		Weft Yarn															
	EPI	Count	PPI	Count														
01	64	7.2 Ring Slub	42	6 open End		176.6	173.8	1.63	1.58	171.8	2.79	2.76	171.01	3.27	3.22	164.3	7.48	7.39
02						176.7	173.8	1.67		171.8	2.852		171.31	3.14		164.6	7.35	
03						175.7	173.4	1.50		171.1	2.68		170.37	3.13		163.8	7.26	
04						175.8	173.1	1.55		171.2	2.686		170.16	3.31		163.7	7.39	
05						176.2	173.2	1.55		171.4	2.80		171.01	3.27		164.3	7.48	

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Table No 25: As table 24 but in different fabric constructions

No. of Obs	Fabric Construction					X	Y	Cr%	A.Cr %	P	Cr%	A.Cr %	Q	Cr%	A.Cr %	R	Cr%	A.Cr %
	Warp Yarn		Weft Yarn															
	EPI	Count	PPI	Count														
01	72	10 Ring Slub	50	12L-40D		170.1	167.8	1.37	1.47	164.4	3.467	3.12	159.8	6.44	6.34	147.9	15.01	14.77
02						169.8	167.4	1.433		165.0	2.90		159.7	6.32		147.5	15.11	
03						168.3	165.7	1.569		163.2	3.125		158.4	6.25		147.2	14.33	
04						168.9	166.3	1.563		163.8	3.11		158.9	6.29		147.3	14.66	
05						169.1	166.7	1.439		164.1	3.04		158.9	6.41		147.4	14.72	

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Table No 26: As table 24 but in different fabric constructions.

No. of Obs	Fabric Construction					X	Y	Cr%	A.Cr %	P	Cr%	A.Cr %	Q	Cr%	A.Cr %	R	Cr%	A.Cr %
	Warp Yarn		Weft Yarn															
	EPI	Count	PPI	Count														
01	62	7Ring Slub + 7 Ring	44	6.25 open End		180.1	177.6	1.40	1.43	176.2	2.17	2.26	174.2	3.78	3.65	168.3	7.01	7.16
02						180.3	177.4	1.48		175.8	2.50		174.7	3.66		168.7	6.71	
03						179.8	177.6	1.238		175.9	2.17		174.3	3.61		168.2	6.896	
04						179.6	176.9	1.52		175.9	2.06		174.1	3.61		167.9	6.96	
05						180.3	177.6	1.520		176.0	2.38		17408	3.60		168.5	7.00	

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Table No 27: As table 24 but in different fabric constructions

No. of Obs	Fabric Construction					X	Y	Cr%	A.Cr %	P	Cr%	A.Cr %	Q	Cr%	A.Cr%	R	Cr%	A.Cr%
	Warp Yarn		Weft Yarn															
	EPI	Count	PPI	Count														
01	62	7Ring Slub	40	8L-40D		169.2	165.2	2.42	2.34	163.8	3.29	3.48	159.2	6.28	6.2	152.01	11.30	11.52
02						169.5	165.7	2.29		163.9	3.41		159.6	6.20		152.2	11.35	
03						169.7	165.8	2.35		164	3.47		159.8	6.19		151.9	11.52	
04						169.9	166	2.34		164.0	3.57		160.1	6.12		152.0	11.71	
05						168.9	165.1	2.30		163.9	3.66		159.02	6.21		151.0	11.70	

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Table No 28: As table 24 but in different fabric constructions

No. of Obs	Fabric Construction					X	Y	Cr%	A.Cr %	P	Cr%	A.Cr %	Q	Cr%	A.Cr%	R	Cr%	A.Cr%
	Warp Yarn		Weft Yarn															
	EPI	Count	PPI	Count														
01	68	8.5O ESL + 7 OE + 10 OE	39	7OES		158.7	156.8	1.21	7OES = 1.25	155.2	2.26	7OES = 2.08	152.5	4.07	7OES = 3.98	144.3	9.98	7OES = 9.68
				10L-40D		161.6	156.8	3.06		155.2	4.12		152.5	5.97		144.3	11.99	
02				7OES		158.3	156.5	1.15		155.4	1.87		152.6	3.74		144.7	9.40	
				10L-40D		161.4	156.5	3.13		155.4	3.86		152.6	5.77		144.7	11.54	
03				7OES		158.4	156.5	1.21		155.3	2.00		152.4	3.94		144.4	9.70	
				10L-40D		161.6	156.5	3.26	10L-40D = 3.19	155.3	4.06	10L-40D = 4.06	152.4	6.04	10L-40D = 5.98	144.4	11.91	10L-40D = 11.81
04				7OES		158.5	156.7	1.15		155.4	1.99		152.5	3.93		144.8	9.46	
				10L-40D		161.8	156.7	3.25		155.4	4.12		152.5	6.10		144.8	11.74	
05				7OES		158.5	156.3	1.41		155.0	2.26		152.1	4.21		144.3	9.84	
				10L-40D		161.4	156.3	3.26		155.0	4.13		152.1	6.11		144.3	11.85	

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Table No 29: As table 24 but in different fabric constructions

No. of Obs	Fabric Construction					X	Y	Cr%	A.Cr%	P	Cr%	A.Cr%	Q	Cr%	A.Cr%	R	Cr%	A.Cr%
	Warp Yarn		Weft Yarn															
	EPI	Count	PPI	Count														
01	60	7.2 Ring Slub	48	16L-40D		179.8	177.2	1.47	16L-40D = 1.54	175.6	2.39	16L-40D = 2.41	164.3	9.43	16L-40D = 9.31	156.8	14.69	16L-40D = 14.75
				300L-40D		178.4	177.2	0.68		175.6	1.59		164.3	8.58		156.8	13.80	
02				16L-40D		179.9	177.3	1.47		175.7	2.39		165.4	8.77		157.0	14.60	
				300L-40D		178.6	177.3	0.73		175.7	1.65		165.4	7.98		157.0	13.78	
03				16L-40D		179.9	177.1	1.58		175.6	2.45		164.3	9.49		156.7	14.83	
				300L-40D		178.5	177.1	0.79	300L-40D = 0.76	175.6	1.65	300L-40D = 1.63	164.3	8.64	300L-40D = 8.47	156.7	13.94	300L-40D = 13.86
04				16L-40D		180.0	177.2	1.58		175.7	2.45		164.6	9.36		156.9	14.74	
				300L-40D		178.4	177.2	0.68		175.7	1.54		164.6	8.38		156.9	13.72	
05				16L-40D		179.8	177.0	1.58		175.6	2.39		164.2	9.50		156.6	14.85	
				300L-40D		178.6	177.0	0.90		175.6	1.71		164.2	8.77		156.6	14.08	

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CHAPTER- 4

RESULT AND DISCUSSION

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Table No 30: Summery of warp crimp percentages obtained by various methods

SL. No	Construction				Crimp% of Marking Method			Crimp % Set Length Method		Crimp % by Using Crimp Tester	
	EPI	Count	PPI	Count	On loom state	Relaxed Grey	Finished	Grey	Finished	Grey	Finished
A	60	7.2 RS	48	16L-40D + 300L-40D	7.61	10.38	26.92	11.04	28.02	11.50	27.47
B	66	7.5 RS	40	6 OE	9.57	12.38	25.94	13.12	27.25	13.52	26.71
C	62	7RS	40	10L-40D	10.38	12.69	28.98	13.32	30.14	13.37	27.79
D	68	8.5 OESL + 7OE + 10 OE	39	7OESL + 10L-40D	9.74	12.21	26.87	12.58	28.31	8.50ESL: 11.92	8.50ESL: 27.89
										7OE: 12.38	7OE: 28.92
										10OE: 12.01	10OE: 27.20
E	54	7 RS	44	10L-40D	9.99	13.20	27.65	13.49	28.01	13.26	27.72
F	65	7.5RSL + 8 R + 11 R	45	8 RS + 10L-40D	10.85	12.21	28.57	13.38	30.90	7.5 RS: 12.13	7.5 RS: 28.62
										8R: 11.87	8R: 28.32
										11R: 11.60	11R: 28.39

Here,R= Ring OE= Open End, RS= Ring Slub, OESL= Open End Slub

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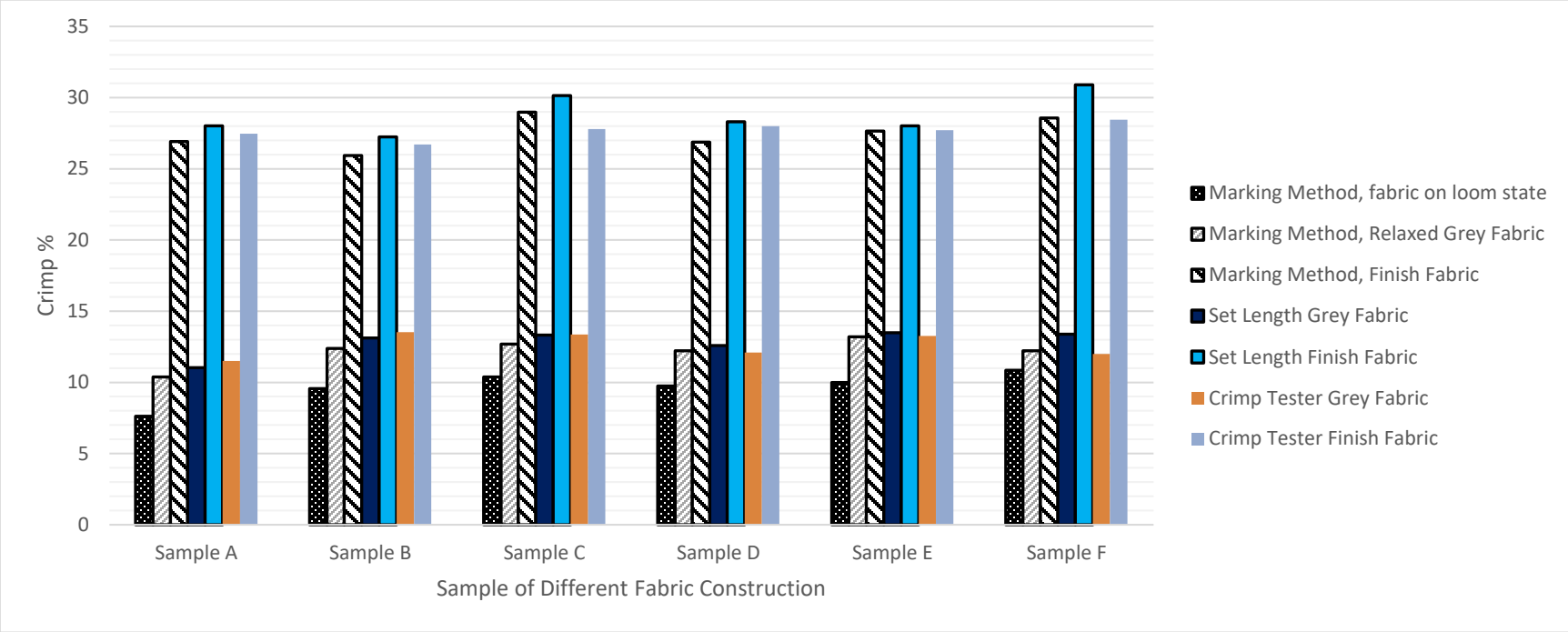

Figure-3: Warp crimp% vs different fabric samples obtained by various methods.

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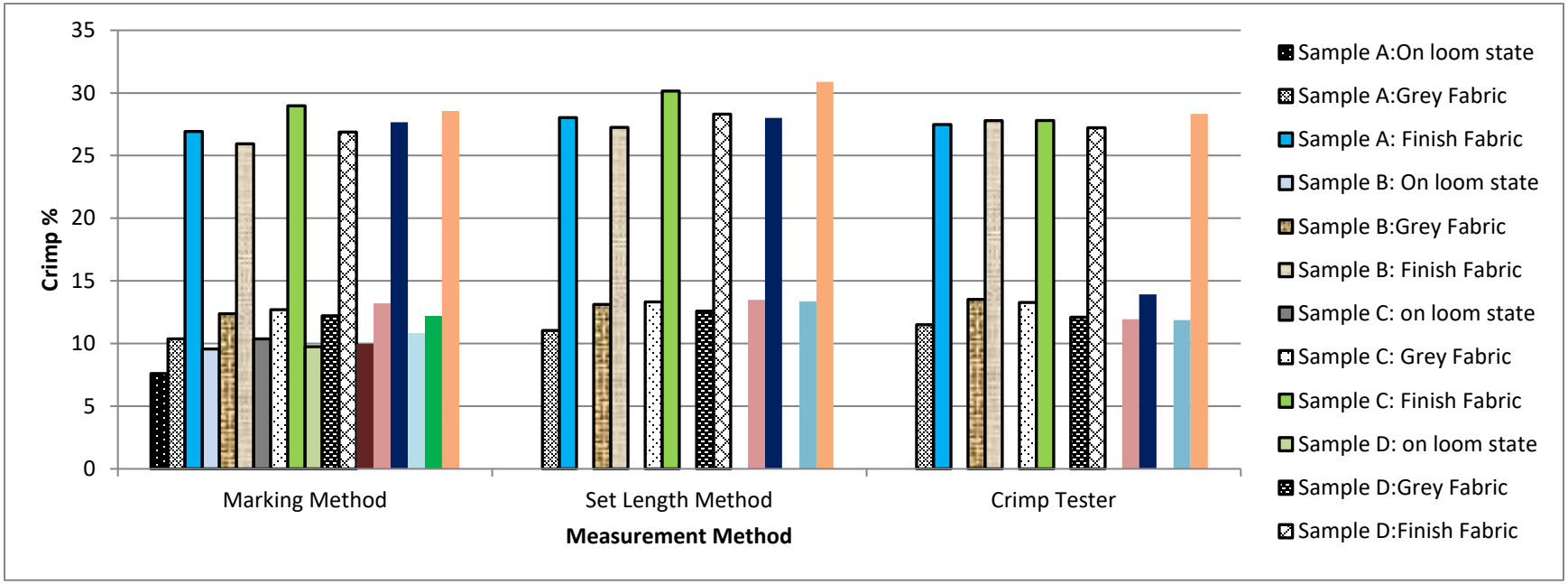

Figure-4: Summary of warp crimp% obtained by various methods for different fabric constructions

For different methods

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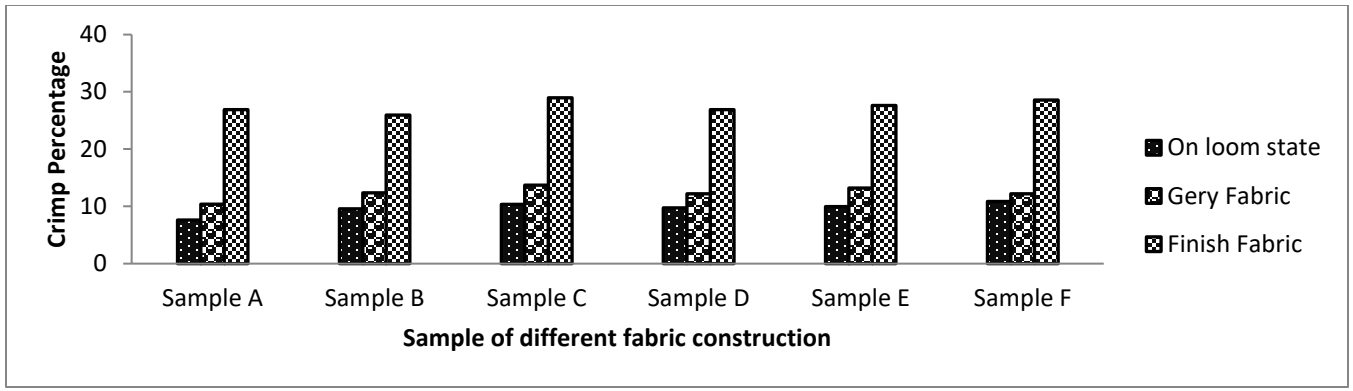

Figure-5: Measurement of warp crimp% in marking method for different fabric constructions

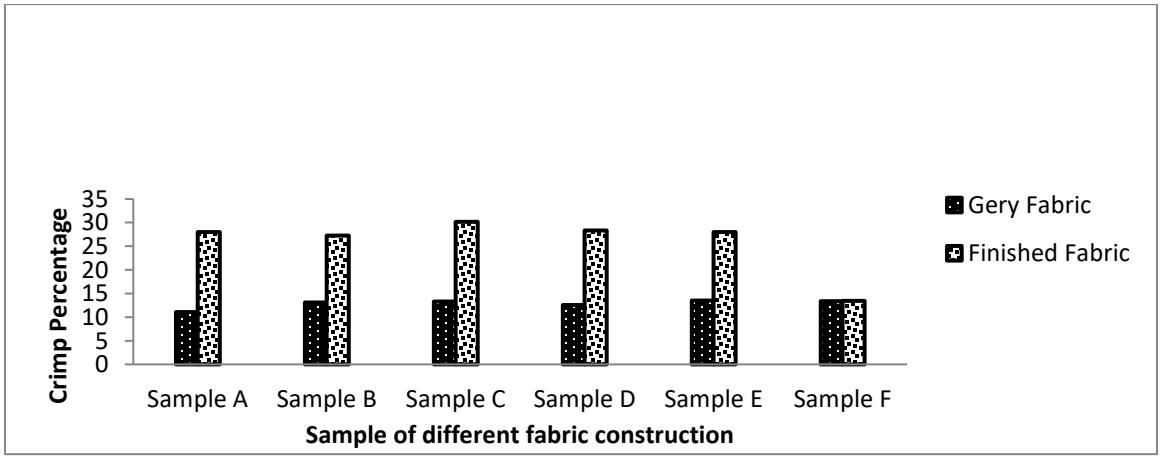

Figure-6: Measurement of warp crimp% in set loom method for different fabric constructions

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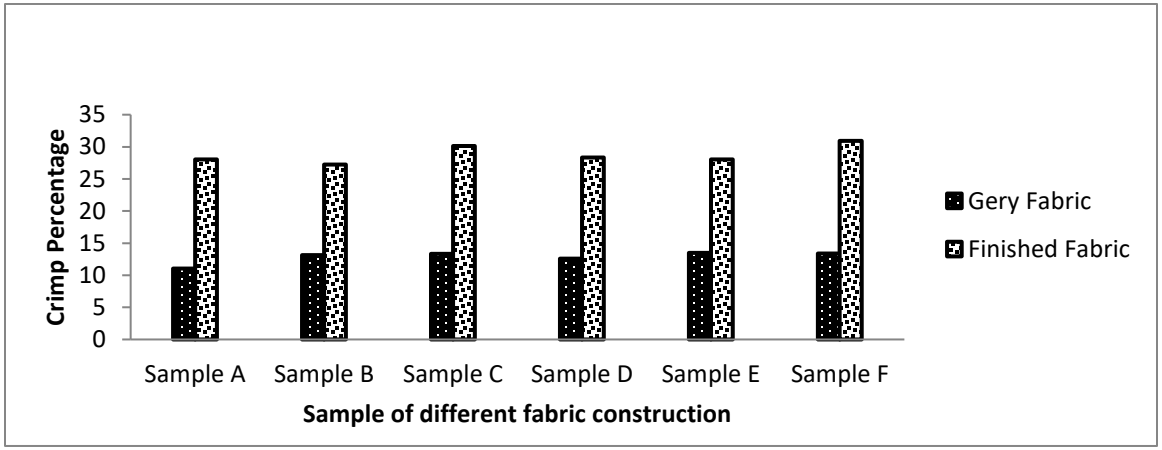

Figure-7: Measurement of warp crimp% by crimp tester for different fabric constructions

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Table No 31: Summery of weft crimp% obtained by various methods

Sample no	Fabric Construction				Crimp% at fell of the cloth position	Crimp% at 10 inches production on loom	Crimp% at relaxed Width	Crimp% Finished Width	Crimp % by Using Crimp Tester	
	EPI	Count	PPI	Count					Grey	Finished
A	66	7.5 RS	40	6 OE	1.31	2.34	3.93	6.34	3.93	6.18
B	64	7.2 RS	42	6 OE	1.58	2.76	3.22	7.39	3.27	7.53
C	72	10 RS	50	12L-40D	1.47	3.12	6.34	14.77	6.54	15.27
D	62	7RS + 7R	44	6.25 OE	1.43	2.26	6.5	7.16	6.12	8.11
E	62	7RSL	40	8L-40D	2.34	3.48	6.2	11.52	6.27	11.67
F	60	7.2 RSL	48	16L-40D	1.54	2.41	9.31	14.74	8.8	17.67
				300L-40D	0.76	1.63	8.47	13.86	6.5	14.027
G	68	8.5 OESL + 7OE + 10 OE	39	7OESL	1.25	2.08	3.98	9.68	4.20	10.60
				10L-40D	3.19	4.06	5.98	11.81	5.86	11.66

Here, R= Ring, RS= Ring Slub, OE= Open End, OESL= Open End Slub

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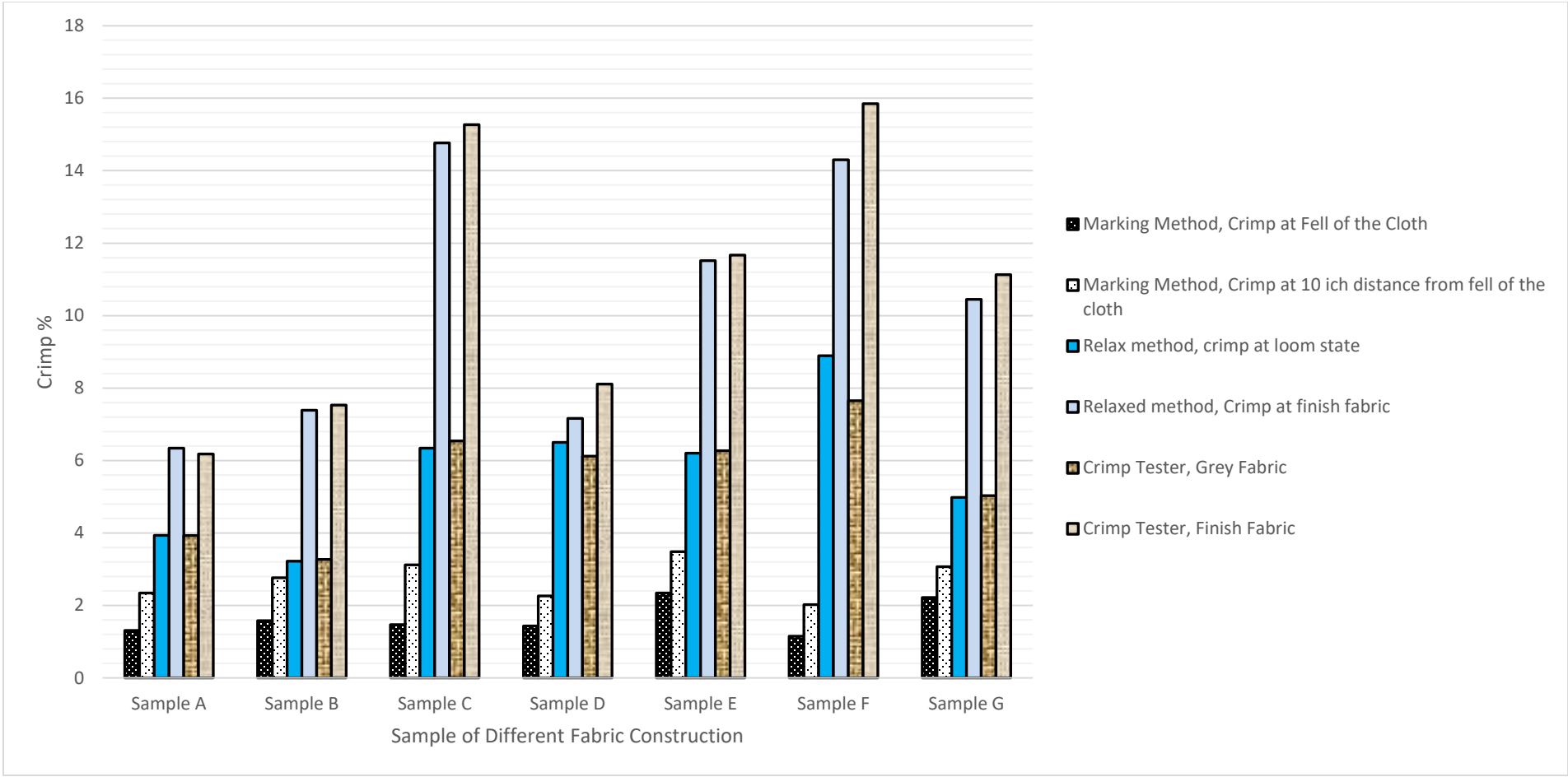

Figure-8: Weft crimp percentage for different fabric constructions in different method

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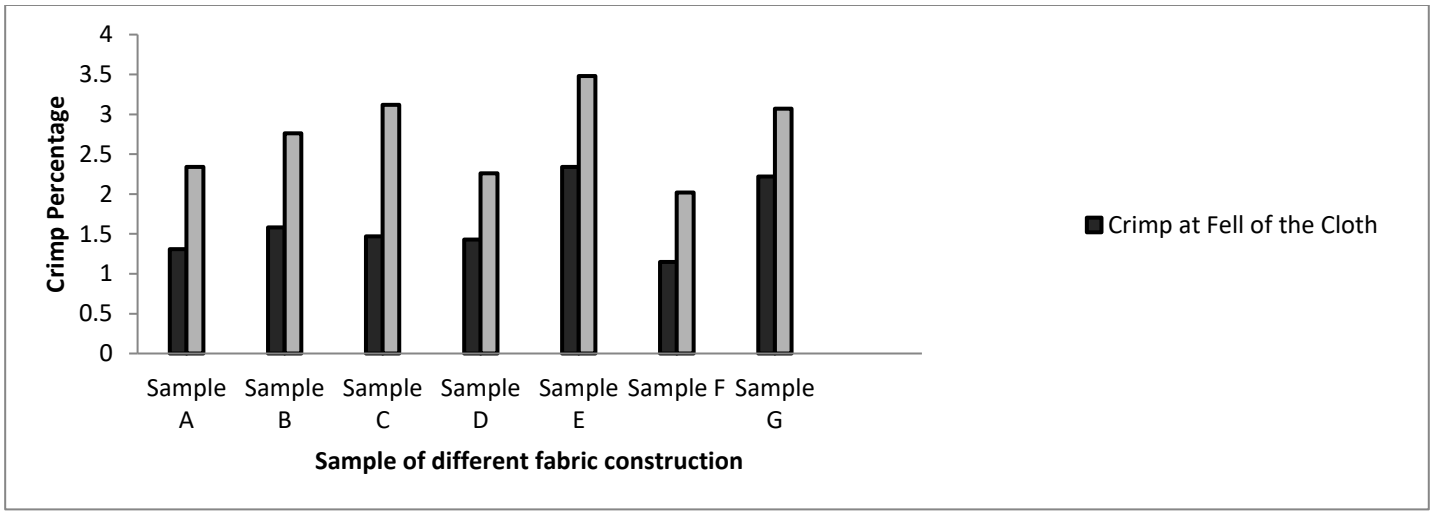

Figure-9: Weft Crimp percentage measured in set length method for different fabric constructions

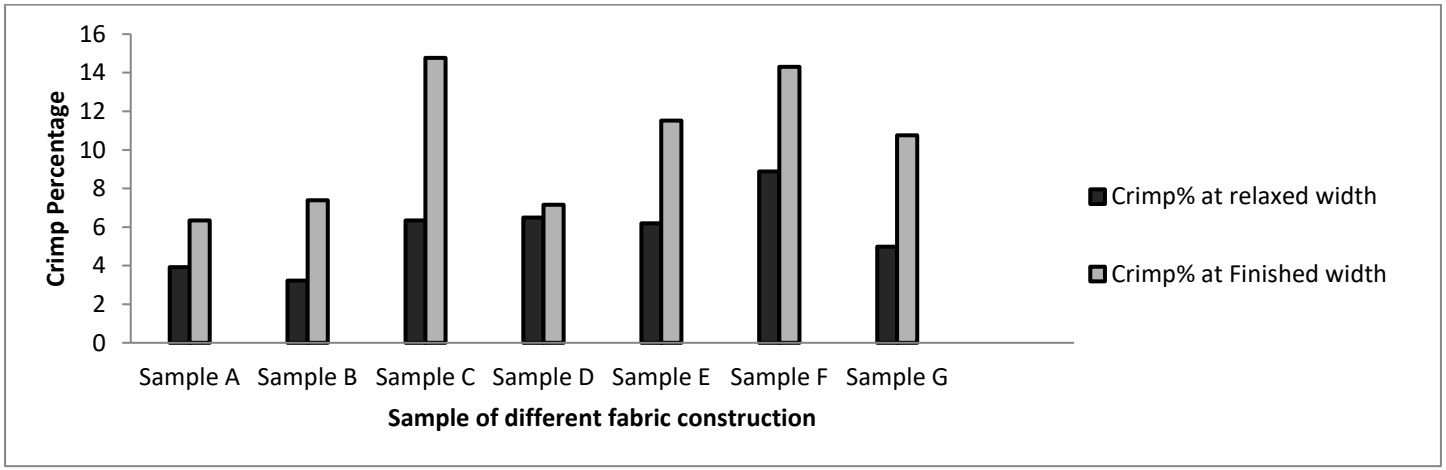

Figure-10: Weft Crimp percentage measured in relax method for different fabric constructions

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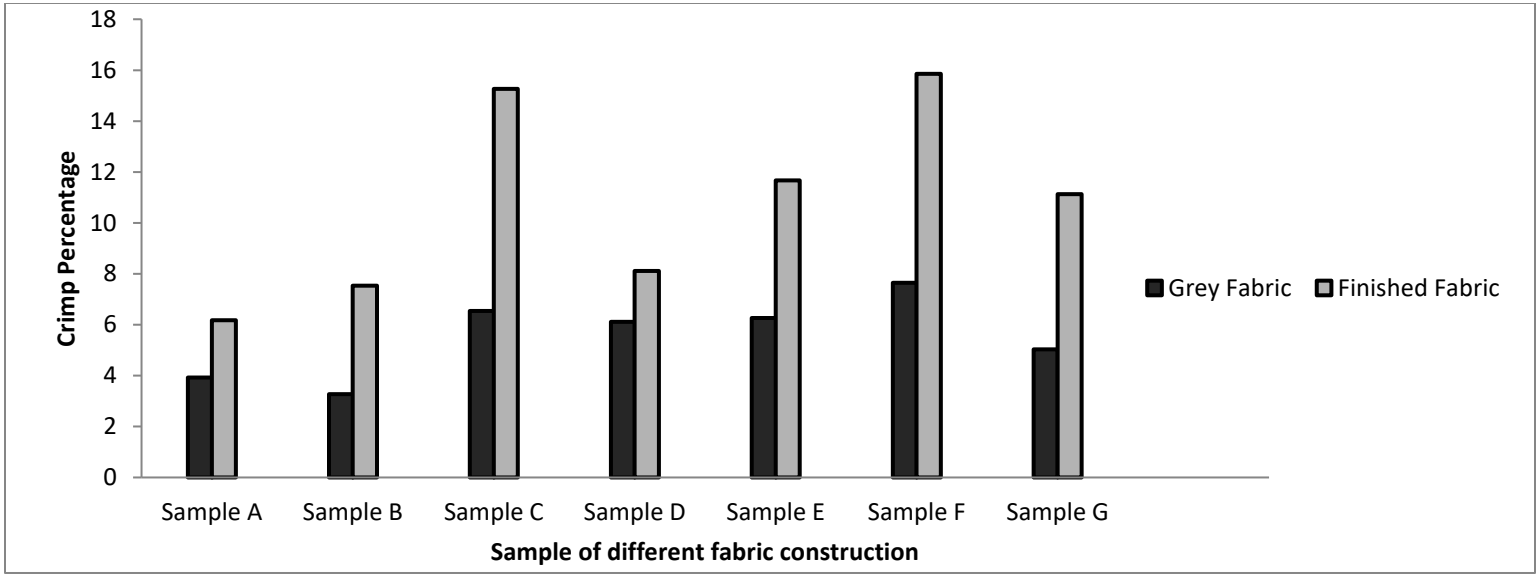

Figure-11: Crimp percentage measured by crimp tester for different fabric construction

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4.1 Warp Crimp

Tables 3 to 15and 30, and figures 3-4 show the warp crimp results obtained by various methods. The crimp results obtained by various methods have been discussed below.

4.1.1 Evaluation of warp crimp by marking method

Tables 3-8 and 30and figures 3-4shows the crimp percentages obtained by marking method. It was mentioned in 3.6.1 and shown in figure 1 that two lines were drawn on the warp yarns one meter apart after weaving to some extent the distance between the lines were measured and crimp measured from the change in distance between the lines. Similarly, warp crimp percentages were measured after relaxation and final finishing. The results show quiet significant change at the three stages. It is seen the table 30 that the crimping of the warp yarns on the loom are in the range of 7.61 to 10.85. The grey crimp percentages were in between 10.38 and 13.69 and the finished crimp percentages were in between 25.94 and 28.98. An important point need to be noted is that the warp yarns were under relatively heavily stretched on the loom. Therefore the crimp percentages on the loon and relaxed fabric was somewhat higher. The reason that the final crimp% are much higher than usual crimp percentages is that during finishing stage a process is carries out called compressive shrinkage where the fabric is allowed to shrink warp way deliberately. This is done to avoid any shrinkage after making garment i.e. during use. It seems that the marking method is the most authentic method than the other two method.

For the following reasons crimp% will be different:

i) Crimp depends on the elongation during sizing.
ii) Crimp depends on the tension in warp yarn on loom.
iii) Crimp depends on the warp and weft interlacement. For war crimp when no of picks increases the interlacement increases and crimp % increases.
iv) In different construction fabrics structure are different. In different structure crimp% varies. Like in plain weave interlacement are higher than 2/1 or 3/1 twill and crimp% are higher in plain weave.

4.1.2 Evaluation of warp crimp by set length method

Tables 3-8 and 29 and figures 3-4 shows the crimp percentages obtained by set length method. As was mentioned, this technique lies in the fact that the length of warp wound on the experimental weaver's beams were recorded, during and after weaving certain length of warp is wasted as yarn form, this length has been deducted from the initial length and after deduction the length was used as actual length of warp yarns used in the fabric. The lengths fabric obtained from each beams (after taken out and relaxed stage and also after finishing) were also recorded and these two fabric lengths and previously determined warp yarn lengths were used to calculate the crimp percentages at relaxed and finished stages.

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The tables show that both the grey and finished crimp percentages were almost same as were obtained from the marking method, however the crimp percentages obtained from the set length methods were slightly higher in all cases of both grey and finished stage. This may had happened due to the fact that in case of marking method the warp yarns were under stretch so that the length before weaving were actually less than that were used for set length method, because the set length were taken with nominal stretch used in the sizing machine.

i) In different construction fabrics structure are different. In different structure crimp% varies. Like in plain weave interlacement are higher than 2/1 or 3/1 twill and crimp% are higher in plain weave.
ii) In different construction i.e. different count and different no of total ends elongation are different during sizing
iii) Crimp depends on the tension in warp on loom.
v) Crimp depends on size materials picked up on warp yarn.
vi) Crimp also depends on shed geometry also.

4.1.3 Evaluation of warp crimp by crimp tester

Tables 9-15 and 30 shows the crimp results obtained by Shirley crimp tester. The tables 30 and figures show that crimp percentages obtained by various methods are slightly different from those obtained by set length method. It was observed that in most cases the grey crimp results obtained by the crimp tester are slightly higher than those obtained from the set length method while the finished crimp obtained from the crimp tester is slightly lower than those obtained from the set length method. It was not possible to comment about the differences but the differences are insignificant.

For the following reasons different construction crimp are different:

i) Crimp depends on the no of ends on fabrics. Higher no of ends per inch higher interlacement in weft and increases the weft crimp and vise-versa.
ii) Increases the warp tension then increases the weft crimp.
iii) Weft Crimp depends on the count of warp threads also. If warp thread are coarser the weft crimp% will be higher.
iv) Crimp depends on warp yarn sizing materials picked up.
v) Weft crimp depends on no of ends/inch and picks/inch also.
vi) Crimp depends on fabric design and pattern.
vii) Crimp can depends on shed geometry also.

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4.2 Weft Crimp

4.2.1 Evaluation of weft crimp by the crimp tester.

Tables 16-22 and 31, and figures 5 show that the grey weft crimp percentage obtained by the crimp tester lies between 3.27% and 8.8%. The finished crimp% lies between 6.18 and 17.67.

4.2.2. Evaluation of weft crimp by measuring fabric width

Table's 23-29and 31, and figures 5 show that the weft crimp percentage at the cloth fell position on the loom was between 0.76 to 3.19%, and the crimp% at 10 inch distance was between 1.63 to 4.06%. When taken of the loom and relaxed, the weft crimp% was found to be in the range of 3.98 to 9.31. The crimp% of the finished fabric was found to be in the range of 6.34 to as high as 14.77.

Crimp depends on the warp and weft interlacement. Different construction different no of ends and picks per inch. For warp crimp it depends on picks. Higher the picks then higher the interlacement and warp crimp will be higher.

In different construction fabrics structure are different and warp and weft tension will be different for different no of warp ends and weft ends/ inch and crimp% will be different. i.e.: in plain weave crimp are higher than 2/1 and 3/1 respectively.

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CHAPTER-5

CONCLUSION

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Conclusion:

Crimp percentages of warp and weft of various types' denim fabrics have been determined using three different techniques e.g. marking method, set length method and traditional crimp tester method. It seems that the marking method is most authentic methods but as the length before weaving was measured under tension therefore the crimp percentage is thought to be somewhat lower than actual crimp. After marking methods the, set length method was also found to be quite accurate. Crimp tester method also not very different from the marking and set length method. It was observed that depending on the construction 10-13% crimp is produced at grey stage but after finishing the crimp % becomes as high as 27-30%. It seems that deliberate shrinkage during finishing (after weaving) is responsible for this high crimp% of the finished denim fabrics.

Regarding the weft crimp%, it can be said that grey crimp is around 3-5 but for fabrics where lycra was used as weft, crimp was between 6-8 and the finished crimp was found to be between 6-8 (without lycra) but with fabrics the crimp% was as high as 15%. Weft crimp was also measured using a new technique as well as crimp tester but the difference between the two methods were not much.

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