# EFFECT OF WARP YARN TENSION ON CRIMP% IN WOVEN FABRIC

***Farhana Afroz, Lecturer***
Northern University Bangladesh, Dhaka
***Ayesha Siddika, Lecturer***
Northern University Bangladesh, Dhaka

**Abstract**

Yarn tension is the most important factor that affects weaving performance and fabric property. Experimental studies were conducted by woven fabrics which are produced by rapier loom (Dobby shedding). The study shows that yarn crimp in woven fabric is affected by yarn tension. Crimp% was calculated by dividing the uncrimped length of yarn by crimped length of yarn. It was observed that crimp% of warp and weft yarn in woven fabric is affected by warp and weft yarn tension.

**Keywords:** Yarn, fabric, yarn tension, crimp, uncrimp

## Introduction

In the Little Oxford English Dictionary the first definition of crimp is: noun, ‘agent who entraps men for seamen or soldiers’. A second definition is perhaps closer to its textile meaning: verb, ‘to press into small folds, corrugate’.

When warp and weft yarns interlace in fabric they follow a wavy or corrugated path. Crimp percentage is a measure of this waviness in yarn. In his paper on cloth geometry, Pierce (*J,Text. Inst. 28, T45 (1937*)) states that ‘crimp, geometrically considered, is the percentage excess of length of the yarn axis as it lies in the cloth, therefore a definition is used which bears a close relationship to the methods used in crimp determination. ‘Percentage crimp is defined as the mean difference between the straightened thread length and the distance between the ends of the thread while in the cloth, expressed as a percentage.’ (Booth 2012)

The yarns of each family pass over and under yarns of the crossing family in a periodic fashion. Woven fabrics are referred to as “crimped fabrics” because yarns of one direction are bent around their crossing neighbor yarns. Warp yarns run parallel to the selvage (fabric edges) and are virtually unlimited in their length. The weft (or fill) yarns run across the

fabric width. The undulations, which are referred to as "crimp," are shown in Pierce's geometric fabric model[13] (figure 1) for a plain weave. Pierce's geometric model relates the fabric parameters as they are coupled among yarn families. The crimp height h is related to the crimp angle α and yarn length L as measured between yarns and the sum of yarn diameters at the crossover regions.Crimp, denoted as C, is the amount of waviness produced in a yarn when woven in fabric form; it is a geometric property of the weave because of the woven architecture used. Crimp is obtained by measuring the length of a yarn in the woven state, Lfabric, and the length of that same yarn after being extracted from the fabric and straightened, Lyarn, and then computed according to equation (1) as a percentage. (Cavallaro paul 2011)

$$C = \frac{L_{yarn} - L_{fabric}}{L_{fabric}}.$$

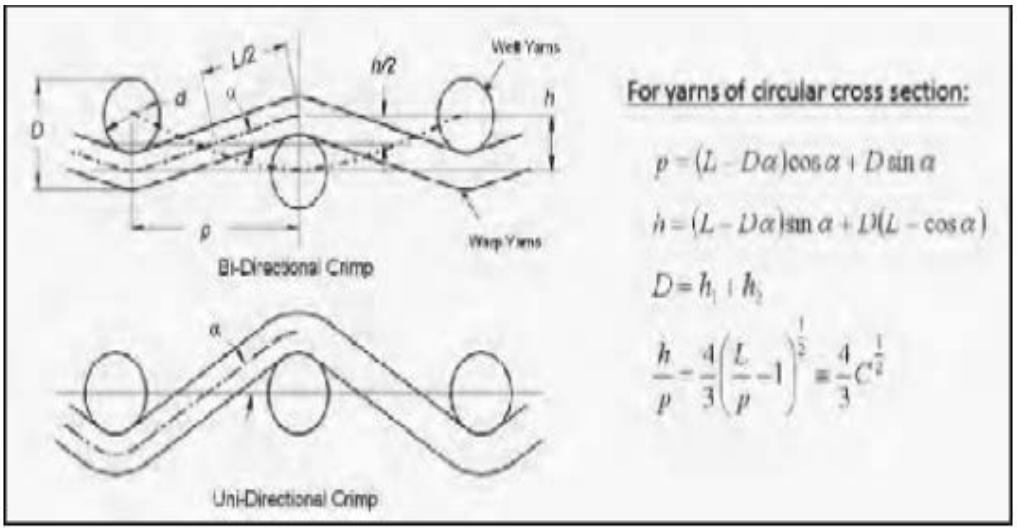


Figure 1: Examples of Pierce's Geometric Model for plain-woven fabrics with bidirectional and unidirectional crimp

It is possible to detect that fabric crimp (warp and weft) depends on type of raw materials, yarn structure and properties, fabric geometry, weaving conditions (such as temperature, humidity and yarn tensions during weaving) as well as fabric finishing treatments. Researchers in the last years in an attempt to obtain effective relations on fabric crimp behavior include as factors yarn diameter, no. of interlacements warp and fabric tension beat-up force etc. The term "crimp" has become a very familiar term to Alpaca breeders. Crimp is defined as the natural wave formation of the fiber, expressed as waves or crimps per unit of length. Visually, crimp is most notable in the well-organized staples found in the fleece. Crimp also occurs

along the shaft of a single fiber. This has been defined by Cameron Holt, of the Melbourne College of Textiles, as crinkle.(Safely n.d.)

Warp Crimp describes the observation that the fabric is produced significantly shorter than the length of warp consumed. This is because the warp's path in the fabric is not straight. The degree of warp crimp depends strongly on the weaves being used - a plain weave causes many more wiggles, hence more crimp than would a Satin weave. It is also affected by the size and nature of the wefts - a softer weft compresses more easily thus allowing the warp to lie straighter while a hard weft forces the warp to deflect around it and take a longer path. Higher warp tensions will tend to reduce crimp by squashing the wefts more. As with Sett, PPI, and coverage, the best that can be done is to estimate the effects; the only true test is to weave a sample.

Warp crimp is an important parameter because it directly affects the fabric's cost (amount of warp consumed per square yard of fabric) and the fabric's weight.(A discussion of yarn measures 2014)

## Experimental

### The experimental crimp tester

Crimp of the samples was measured by W.I.R.A. crimp tester and the test method was carried at 69% RH and 28$^{o}$C.

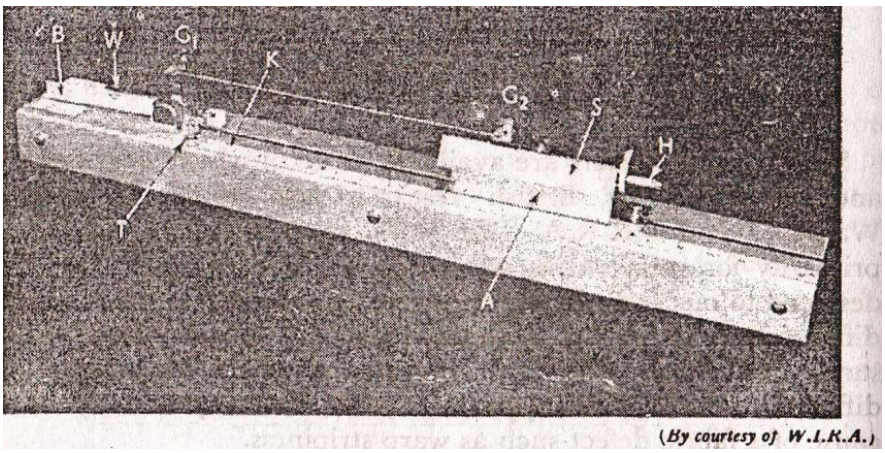


Figure 2: W.I.R.A crimp tester

In W.I.R.A. crimp tester test length up to 16 inch can be handled . In figure $G_1$ is a grip on the vertical arm of the pivoted beam B. When the beam is horizontal it just touches a contact and the torch bulb T tights up. On the long arm of the beam a sliding weight W can be set by means of a scale marked on the on the beam to the recommended tension in grams. The other grip $G_2$ is carried on a plate which is in turn mounted on a screwed rod in the assembly A. When $G_2$ is as its extreme position to the left a pointer is at 0 on

the scale s. By turning the hand wheel H, $G_2$ has a maximum movement to the right of 5 inch.

To make a test assembly A is set to a scale K on the base of the tester to a length equal to the strip length, the pointer of grip $G_2$being at 0. The weight W is set to the required tension.

One end of the thread is then clamped in the grip $G_1$ with its extreme tip in line with a datum line marked in the transparent upper face of the grip. The other end is then clamped in grip $G_2$ in a similar manner. At this stage the thread will usually sag & the beam will be tilted. The hand wheel H is turned, grip $G_2$ moves to the right. The thread straightens up, & eventually the beam touches the contact.

As soon as the bulb lights, the movement of $G_2$ is noted. This value is the increase in length due to the crimp removal. Then crimp% is calculated by the help of previous equation.

## Fabrics used

The samples used in this experiment are of 100% cotton fabric having same EPI, PPI, and weave type. These samples are produced from same yarn type. Rapier loom (Dobby shedding) was used for this purpose. Machine rpm was constant at 450 in all cases .

| **Fabric type** | **Plain** |
|---|---|
| EPI | 110 |
| PPI | 90 |
| Warp yarn count | 40 Ne |
| Weft yarn count | 40 Ne |

Table1 : Fabric specification

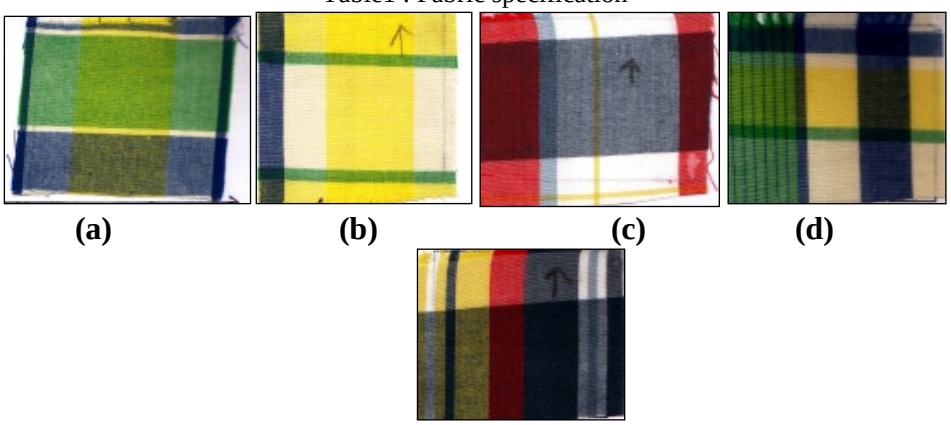


Figure 3: Woven fabric produced at different warp tension a) 2100N b) 2150N c) 2200N d) 2250N e) 2300N

## Experimental Data

### Measure of warp yarn crimp%

The crimp% of warp yarn in fabric were obtained and shown in Table 2.

| Sample no. | Warp tension in newton | Crimp% |
|---|---|---|
| 1 | 2100 | 13.8 |
| 2 | 2150 | 13.5 |
| 3 | 2200 | 13 |
| 4 | 2250 | 12.6 |
| 5 | 2300 | 12.0 |

Table 2:Data for Warp way crimp% due to warp tension

### Measure of weft yarn crimp%

The crimp% of weft yarn in fabric were obtained and shown in Table 3.

| Sample no. | Warp tension in newton | Crimp% |
|---|---|---|
| 1 | 2100 | 15.6 |
| 2 | 2150 | 16.0 |
| 3 | 2200 | 16.4 |
| 4 | 2250 | 16.9 |
| 5 | 2300 | 17.4 |

Table 3: Data for Weft way crimp% due to warp tension .

## Discussion on results

### Effect of warp tension on warp yarn crimp:

Table 2 shows that yarn crimp is significantly affected by the warp tension. The Table also shows that as the warp tension increases the warp crimp decreases. This is probably due to the fact that the warp yarns become straight due to tension on them; as a result the warp yarns bend less.

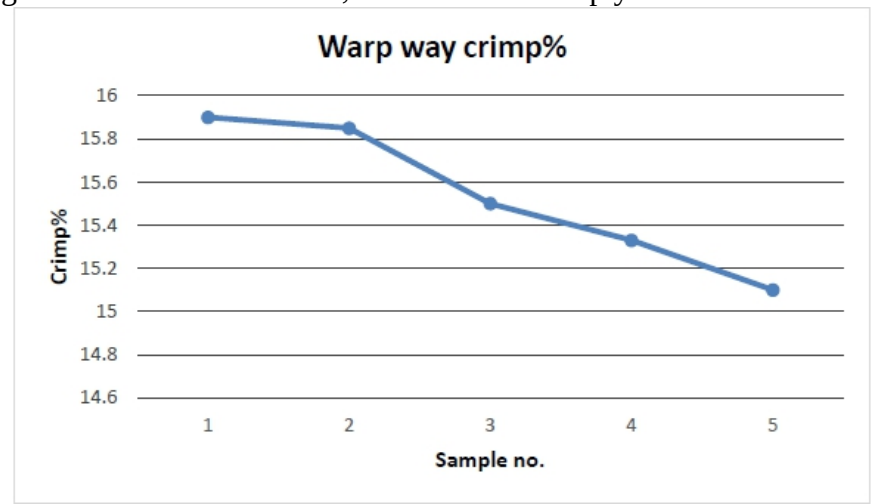


Figure 4: Effect of warp tension on warp yarn crimp%

**Effect of tension on weft yarn crimp**

Table 3 shows that with increasing warp tension, the crimp in weft yarn increases rapidly. This is because the more bending of weft yarn as warp yarn remains more straight due to tension on them.

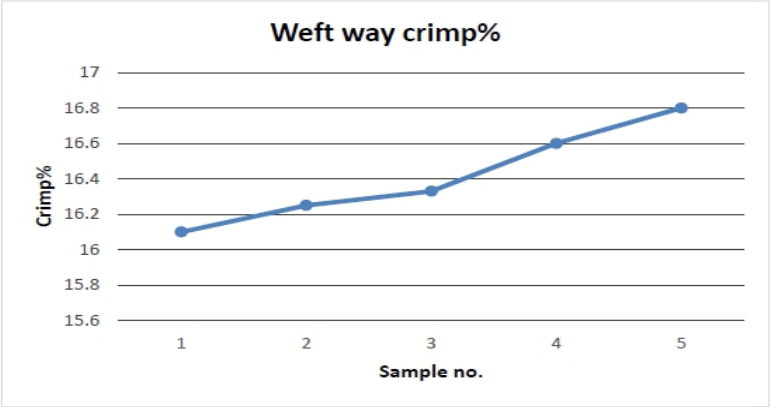


Figure 5: Effect of warp tension on weft yarn crimp%

**Conclusions**

The study leads to many questions as well as related answers. The warp tension affects both warp and weft yarn crimp% significantly. In our experiment we have seen that warp crimp% reduces with increase of warp tension. It was also observed that weft crimp% increases with the increase of warp tension. In fact a theory can be proposed that the crimp of yarn of the woven fabric is directly related to the tension which is applied during weaving. It is expected that the outcome of this study will contribute to the better understanding of the woven sector in the world**.**

**References:**

Booth,2012, Principle of textile testing

Safely, M n.d., The role of crimp in the textile process <http://www.alpacas.com>. [8July 2014]

Cavallero Paul Soft Body Armor: An Overview of Materials, Manufacturing, Testing and Ballistic Impact Dynamics 2011, NUWC – NPT.[1August 2011]

A discussion of yarn measures and how they relate to yarn diameters, Sett, EpI and Ppi, Warp crimp and fabric weight.Page = 16>.[8 July 2104]