

## Research Article

# Characterization of Elastic Properties Accountable to Three Thread Fleece Fabrics

Islam S\*, Akter S and Islam S

Department of Fabric Engineering, Bangladesh University of Textiles, Tejgaon, Dhaka 1208, Bangladesh

\*Corresponding author: Shariful Islam, Department of Fabric Engineering, Bangladesh University of Textiles, Tejgaon, Dhaka 1208, Bangladesh; Email: "Sharifultext51@yahoo.com". Contact: 8801713178659

Received: September 21, 2020; Accepted: November 01, 2020; Published: November 20, 2020

## Abstract

The aim of this paper is to investigate the elastic properties of three thread fleece fabrics. Investigation was carried out on the physical properties on weft knitted single jersey fabrics where the influence of washing cycle and fabric type on stretching (%) and unrecovered elongation (%) properties of the elastane knitted fabrics were shown. Here five different types of plain weft knitted fabrics were used to investigate the result. They showed how washing cycle and fabrics type influenced on physical properties i.e GSM, elongation, unrecovered elongation, stretching. They used different type of ground yarn and composition for this investigation. Knitting structure influenced on mechanical properties of weft knitted fabrics. Knitted fabrics with various knitting structure are characterized with various extensibility and maximum force to rupture. Knit loop of various types can also give different width and length of knit. Extensibility and strength of the knitted fabrics are concerned with knitting structure. This research opens possible ways for the scholars to further study in this field.

**Keywords:** Fleece fabric; Stretch ability; Elasticity; Growth; Elongation

## Introduction

Single jersey knitted fabrics is generally used to make underwear and outerwear such as T-shirts. Knit fabric can more easily deform stretch by compressing or elongating the individual stitches that form the fabric. There has been an investigation about the knitwear industry in Bangladesh and reported that there were not large volume of asset in the garments industry in the beginning of 18<sup>th</sup> century. There were not measured sustainable and accepted minor government courtesy at that time. However, there also mentioned that by the early 19<sup>th</sup> century the RMG sector had expanded drastically. The association for textile industry also founded i.e BGMEA, BKMEA, BTMA [1].

In an another survey of competitiveness of the knitwear in Bangladesh: A study of industrial development amide global competition reported that woven garments development in Bangladesh is on the basis of upstream process which is consist of spinning and weaving [2].

The RMG industry is the heart of Bangladesh economy which sharing a major part of the country export earnings. RGM sector is playing role to contribute in economy of Bangladesh since its start journey in the late 70's and has position the largest export earning sector [3].

Knitting is the widely second mostly used method to produce the fabric. The term "Knit-ting" describes the process of constructing the fabrics by interlooping the continuous strand of yarn through different guide and device to knit the fabrics. There are two different direction for knit the fabrics i.e wales direction which is called vertical and another one is course direction which is called horizontal direction. Knitting is divided in two different sector i.e warp knitting and weft knitting. And the production process is different for both knitting types. For weft knitting loops are form across the width of fabrics and

in warp knitting process loops are form across the length of fabrics [4].

There are lots of advantages of knitting due to its economical and relatively faster process along with comfort ability of the final product. Knitted fabrics is stretchable, permeable, and moisture absorbent which concentrates some reasonable performance properties. Sportswear, lingerie, T-shirts, summer vests, swimwear, skimming wear, and hosiery garments like socks and gloves all are the products of knitting due their comfortability, elasticity and performance characteristics [5].

Consumer looks for durability and comfort in the textile used for everyday wear. With comfort and stretch of knits, they have gained popularity over the woven fabrics. Professional garments require use of support fabrics such as interlinings and linings as quality indicators of an apparel item. They provide smooth appearance [6].

It gives a better performance by providing freedom of body movement. It is very important to study the elastic behavior of knitted fabrics in order to produce body fitted comfortable garments [7]. The researcher shows here to study the effect of spandex yarn input tension, yarn loop length and spandex yarn linear density on the elastic properties of spandex knitted fabrics [8]. The fabric direction of loading plays a significant role on the elastic properties of knitted fabrics [9].

A study investigates the reliability of elongation measurement of conductive yarn, which contains stainless steel fiber [10]. Fabrics knitted with different knitting structure where reliability measure by examine the elongation dependence and time dependence of the resistance [11].

Elongation of coated knitted fabrics were investigated in one article. Where elongation properties of polyurethane coated knitted

fabrics were investigated. Test of elongation properties of knitted fabrics was core objective of this researcher [12]. Here used seven different knitted fabrics with various structures. Breaking force also investigated of PU coated fabrics [13].

Stretch is the most significant property of textiles that contribute to wearer comfort of final product. There is an investigation of stretch properties, recovered elongation and un-recovered elongation. Where researcher showed that how yarn count can play a significant role on stretch properties on woven fabrics. The influence of fabric specification on Total Hand Value (THV), stretch properties, and pressure comfort is analyzed [14].

Arnold M Hansen\* and Hazel M Fletcher, determined the elastic recovery of fabrics knit- ted from natural and mercerized carded and combed cotton yarns. Where carded, combed natural and mercerized cotton were used to find out the desired consequence [15].

There was an investigation on effect of yarn size and stitch length on elastic behavior of plain and double knit fabrics .Properties was basically on the basis of before and after laundering measured. There was different type of course per inch fabrics were used along with different yarn count. Researcher find out those Fabrics having the same cover factor but knit of different yam sizes and with different courses per inch had the same elongation and growth. Thus the elastic properties of knit cotton fabrics can be controlled by varying the ratio of diameter of yarn to stitch length [16].

This study was commenced to determine the effect of Ground and binder yarn composition, Loop yarn composition and yarn type, on Elongation, un-recovered elongation (growth), recovered elongation and elastic recovery of three thread fleece fabrics. These properties were measured in accordance with ISO 14704-1 method .Also in addition dimensional properties were measured in accordance to ISO 6330 method [17]. As per my knowledge and information from different journal there is no such kind of research work done on three thread fleece fabrics but Comprehensive research work has been published on single jersey plain knitted fabrics etc . Some article is on double jersey knit fabrics [18].

Knitted fabrics with various properties such as fiber used, yarn type, composition are influenced in different extensibility/elasticity and recovery of fabrics. Fleece fabrics is one kind of single jersey knitted fabrics and on the basis of brushing there are two type .One kind of fleece is used without brush effect (which are called T/F UB) where there is not much effect of elastic and recovery properties. But another kind of fleece is used with brush effect where elastic and recovery properties play an important role during fitting and wearing comfortability [19].

### Elongation

Elongation is the ratio of the extension of test specimen to its original length .Elongation is the most important parameter of knitted fabrics. The comfortability of fabrics depends on fabrics elongation.

For better fabric elongation it is also necessary to using good quality fiber/yarn which has also good elongation properties. There is an article on “Effect of ginning on tenacity, elongation” where focused on ginning process to show how the single and bundle fibre of short and naps are effect on elongation and tenacity of fibre. They

showed that the finer and more mature the fibre, the greater the elongation. Fibre tensile/elongation properties are very important factors in determining the amount of energy required to break either a fibre or a yarn [20].

### Elastic Recovery

Elastic recovery is a measure of the ability of a material to return to its original shape when applied load is removed.

The amount of stretch and the elastic recovery, also called ‘recoverable stretch” deter-mine the suitability of knitted fabrics for specific uses. Since stretch and elastic recovery are of such great importance in knitted fabrics, assessment of these properties for fabrics of various constructions made of different kinds of yarns is significantly needed.

## Material and Method

### Fabrics

Cotton polyester knitted three thread fleece fabrics were the fundamental raw material for this research work. Different types of composition and yarn count were used to make three thread fleece fabrics to get the anticipated properties.

Ground yarn composition were used same for all fabrics but yarn type is different for individual fabrics binder yarn composition also same for individual fabrics. On the other hand, loop yarn were used of same count of different composition and also different yarn type. The details of the sample description are listed in Table 1. Ground yarn are used 30/1 combed yarn (ring and OE) which are same for all sample but yarn type is different for individual sample. But loop yarn are different for all sample. Binder yarn 100d/34f polyester were used for 80% cotton, 20% polyester sample and loop yarn are used 20/1 card OPEN END for one sample and 20/2 card RING for another sample.

Whereas for composition 70% cotton, 30% polyester, ground yarn were used 30/1 combed (ring & OE) but binder yarn were used 100d/34f poly for both sample. Loop yarn are used 20/1 ring CVC and 20/1 OE CVC respectively.

For composition 60% cotton, 40% polyester, ground yarn were used 30/1 combed (ring & OE) but binder yarn were used 100d/34f poly whereas loop yarn were used 20/1 PC of Ring and Open end respectively.

The structure of three thread fleece fabric is formed from back fleecy yarn, binding yarn and face yarn and is shown in figures.

Furthermore figures shows the needle arrangement and Figures shows the cam arrangement of three thread fleece fabrics production after completion of knitting, grey fabrics are process as per figure. Flow process chart. When all the process is completed then fabrics wash tested to anticipating desired properties. Table 1 shows three thread fleece fabrics of different composition, yarn count & yarn type.

### Manufacturing Process flow

Different count and type of yarn with various compositions were collected. Then knitting action was done with keeping sample knitting parameter. After knitting, sample was transferred to scouring section. Dyeing action was done after scouring then sample passed through

a machine for squeezing. After squeezing fabrics were proceed for drying. Then fabrics were transferred to raising section. Sample were then possessed for brushing, reversing and finally compacting. Then sample were ready for testing to do further procedure. Below is the process flow of sample processing.

### Knitting structure of three thread fleece fabrics

Three thread fleece fabrics are consist of three type of yarn which are face yarn (ground yarn), fleecy/loop yarn and binding yarn. Fleece/loop yarn are knitted by tuck cam and miss cam which are converted into fleecy look after brushing. Figure 1 shows Three thread fleece fabrics knitting structure.

### Needle arrangement of three threads fleece fabrics

Four but needle were used to produce sample fabrics for this research work. The needle arrangement of four but needles are illustrated below with practical view. Figure 2 shows Practical view of four-butt needle.

### Cam arrangement of three thread fleece fabrics

Cam arrangement of three thread fleece fabrics are represented below where drawn cam arrangement of loop, knit and binder yarn are clearly illustrated and also additionally inserted practical picture of cam arrangement from machine setting are illustrated.

## Machine and Instrument

### Knitting machine

Knitting machine was manufactured by Fukuhama, origin Taiwan. The fabrics sample was manufactured in this special single-jersey circular knitting machine.

### Dyeing machine

Sample fabrics were dyed with this dyeing machine. Machine Brand name is Thies, Origin: Germany, Model- D-4420. Normally two types of dyeing can perform which are Disperse and reactive but sometimes fluorescent dyeing also can be performed. Figure 3 shows dyeing machine.

### Brushing/Raising machine- GRI228

Brushing was done with this machine. This is lafer brand machine and originated from Italy. Figure 4 shows brushing machine.

Raising is not exact science, it could also be defined as art; some modern machine can, without any doubt, help the operators to obtain the consistency and a high standard production, more and more precise and efficient, but it is the experience, the know-how and savoir fair of the most skillful finishes to confer the final touch to a product of excellence.

The function of raising machine is to produce hairy surface on a fabrics, this effect is made through a series of needle that, with a mechanism are penetrating the fibers, breaking and lifting them [20].

### Stretch and Recovery tester

This machine consist of several parts. There is a computer with installed software of ISO 14704-1 method .There are two clamping jaw where one jaw is fixed at bottom clamping and another one is moveable at top clamping. Clamping is operated with air pressure. There is an emergency switch to stop machine if it is uncontrollable.

### Dimensional stability tester

Dimensional stability is very much important properties of any kind of fabrics. Especially for knitted fabrics dimensional stability play an important role to make final product more comfortable. DS is called two categories. When fabrics shrink then it is called shrinkage which is expressed as minus sign (-) and when extend than original area then it is called extension which is expressed as plus sign (+).

## Method

### Fabric (sample) production

First of all, yarn count and composition of ground, binding and loop yarn were selected .Then needle and cam arrangement was set up in the machine. Gauge length and dia of knitting machine are remaining same. Then setting of stich length, which is most important part of knitting to keep constant GSM. The machine was computerized and auto stopped system. So that fabrics fault was minor. Six different types of fabrics were produced with different yarn count, composition and yarn type with keeping same machine dia and gauge.

### Elongation, un-recovered elongation, recovered elongation and recovery test

The measurement of Stretch, recovery and growth of three thread fleece fabrics were conducted in accordance with the procedure of BS EN 14704-1:2005. There are different standard to measure of stretch and recovery i.e. ASTM, GB, MS. NEXT etc. But BS EN method is mostly used to determine elastic and recovery properties of knitted fabrics internationally. There are different options in BS EN 14704-1 method. Strip Test (method A) was used to conduct stretch and recovery test for this research. The sample size was 300mmX50mm. No of sample were 5 set for both wales and course direction. There

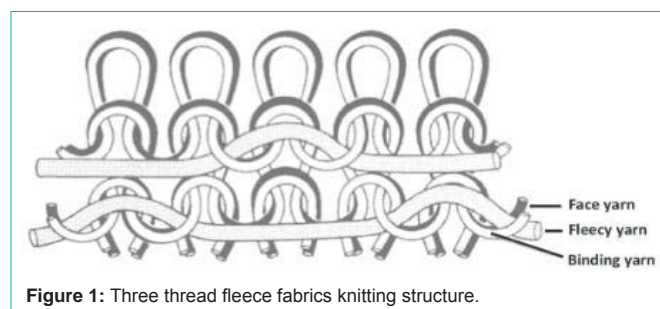


Figure 1: Three thread fleece fabrics knitting structure.



Figure 2: Practical view of four-butt needle.



Figure 3: Dyeing Machine.



Figure 4: Brushing Machine.

were two set of jaws. One jaw is fixed which is located at bottom and another one is moveable which is located at top between clamping. The sample was clapping between these two jaws. Now the machine started to elongate the specimen. When the specimen is reached up to the setting load or break the yarn then it come downwards and record the breaking point.

Five set of wales and course direction were tested for all six types of fabrics. Requirement of recovery is depending on buyer requirement. Generally, 95% recovery is standard of different buyer.

### Experiment of elastic performance

To conduct the required test six different type of three thread fleece fabrics were used as mention in tables. Different types of composition used in six different types of fabrics of loop yarn and different types of yarn used for six different fabrics, GSM, Machine dia, Machine gauge were remained constant for all fabrics manufacturing process.

### Preparation of sample

Before testing sample were conditioned according to ISO 139. After completing condition process, the sample is ready to preparation i.e cutting the specimen. Firstly, sample were laid on the table then marked with calibrated roller. Sample is marked 150mm inside from the edge of sample. Sample were cut at 90-degree angle so that there were not repetition occurred of same yarn among the sample as illustrated in picture below.

### Terms and definition

**Elasticity:** Properties of a material by virtue of which it tends to recover its original size and shape immediately after the removal of the force causing deformation.

**CRE (Constant rate of extension):** Testing machine provided with one clap, which is stationary and another clamp, which moves with a constant speed throughout the test, the entire testing system being virtually free from deflection.

**Strip Test Specimen:** Test sample in which the full width is absorbed in the mouths of the analysis mechanism.

**Extension:** Increase in length of a test specimen produce by a force because of testing, expressed in unit length millimeters.

**Elongation:** Ration of the extension of the test specimen to its initial length, expressed as a percentage.

**Maximum force:** Force recorded in newton at the position when a test specimen is taken to a fixed extension.

**Recovered elongation:** Un-recovered elongation, expressed as a percentage, subtracted from 100 %.

**Elastic Recovery:** Recovered elongation expressed as a percentage of the total elongation.

**Fibre Composition:** Fibre composition test is carried out in accordance with ISO 1833 (Quantitative chemical analysis).

## Result and Discussion

### Elastic, growth and recovery test result

The table specifies that sample 2 (Ring yarn) shows higher elongation than sample 1 (OE yarn). Composition of both sample are same (80% cotton, 20% polyester). Elongation is found same for sample 3 & 4 though yarn type is different but loop yarn is used CVC for both sample. On the other hand comparing sample 5 & 6, it is found that elongation result is higher for sample 5 than sample 6. Table 2 shows Wales's way elongation of different samples.

Due to using PC ring yarn in loop yarn, elongation is increased then OE yarn of sample 6. Therefore, it is summarize that elongation is decreasing with the percentage of polyester fibre increasing in composition except sample 1. On the other side it is observed that elongation is higher of cotton yarn than CVC and PC yarn using in loop yarn. Table 3 shows Course way elongation of different sample.

The table indicates that, sample 2 (ring yarn) shows higher value than sample 1 (OE yarn) between sample 1 & 2 though composition is same but yarn type is different. Same type of result found among sample 3, 4, 5 & 6. Result of Ring yarn sample shows higher value of all composition among all sample stated above. Ring yarn of sample 4 & 5 shows value 88.4 and 87.1 consecutively whereas OE yarn sample 3 & 6 shows value 77.2 & 86.6 consecutively. On the other hand if we consider composition than we found that, sample 4 (70/30, CVC, ring) shows the higher elongation (88.4) whereas sample 3 (70/30, CVC, OE) shows lower elongation (77.2) among all sample. So it is summarize that 70/30 with using ring yarn showed higher elongation. Table 4 shows Wales way Unrecovered elongation.

### Un-recovered elongation for wales and course

The table specifies that, sample 2 (ring yarn) shows higher un-recovered elongation than sample 1 (OE). Sample 4 (ring yarn) shows higher un-recovered elongation than sample 3 (OE yarn). Similarly sample 5 (Ring yarn) shows higher unrecovered elongation than sample 6 (OE yarn).

**Table 1:** Three Thread Fleece fabrics of different composition, yarn count & yarn type.

Type	Composition	Yarn count	M/C DIA & Gauge	GSM
Sample 1	80% cotton, 20% polyester	30/1 com+100d/34f poly+20/1 OE	30X20 G	270
Sample 2	80% cotton, 20% polyester	30/1 com+100d/34f poly+20/1 Ring	30X20 G	270
Sample 3	70% cotton, 30% polyester	30/1 com+100d/34f poly+20/1 CVC(60c+40p) Ring	30X20 G	270
Sample 4	70% cotton, 30% polyester	30/1 com+100d/34f poly+20/1 CVC(60c+40p) OE	30X20 G	270
Sample 5	60% cotton, 40% polyester	30/1 com+100d/34f poly+20/1 PC(65c+35p) Ring	30X20 G	270
Sample 6	60% cotton, 40% polyester	30/1 com+100d/34f poly+20/1 PC(65c+35p) OE	30X20 G	270

Calculation of fabrics composition from yarn composition:

Sample1: 30/1 com+100d/34f poly+20/1 OE

The stitch length is 4.4/3.05/1.6

$$32/1 \text{ Cotton} = \frac{SL}{\text{Count}} = \frac{4.4}{30} = 0.146$$

$$100D \text{ polyester} = \frac{SL}{\text{Count}} = \frac{3.05}{53.15} = 53.15$$

$$20/1 \text{ cotton} = \frac{SL}{\text{Count}} = \frac{1.6}{31.15} = 0.057$$

$$20/1 \text{ cotton} = \frac{SL}{\text{Count}} = \frac{1.6}{20} = 0.08$$

$$\text{Total} = 0.146 + 0.057 + 0.08 = 0.283$$

Now, we will find the yarn percentage-

$$32/1 \text{ cotton \%} = \frac{0.146 \times 100}{0.283} = 51.6 \%$$

$$100 \text{ D polyester \%} = \frac{0.057 \times 100}{0.283} = 20.1 \%$$

$$20/1 \text{ Cotton \%} = \frac{0.08 \times 100}{0.283} = 28.3 \%$$

Hence,

$$\text{Cotton \%} = 51.6 + 28.3 = 79.9 \% \cong 80 \%$$

$$\text{Polyester \%} = 20.1 \% \cong 20 \%$$

Therefore, Fabrics composition is 80% cotton, 20% polyester

By the same process all sample fabrics composition can be calculated and proved.

**Table 2:** Wales's way elongation of different samples.

Sample	Specification of sample	Elongation
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	40.3
Sample 2	80% cotton, 20% polyester; 30/1 com+20/1 Ring	41.4
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	40.5
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	40.5
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	39.9
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	36.6

**Table 3:** Course way elongation of different sample.

Sample	Specification of sample	Elongation
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	77.8
Sample 2	80% cotton, 20% polyester; 30/1 com+20/1 Ring	81.3
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	77.2
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	88.4
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	87.1
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	86.6

**Table 4:** Wales way Un-recovered elongation.

Sample	Specification of sample	Un - recovered elongation
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	3.0
Sample 2	80% cotton, 20% polyester; 30/1 com+20/1 Ring	3.8
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	3.4
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	4.6
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	3.6
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	2.0

Among all the sample it is observed that, ring yarn shows higher un-recovered elongation with different fabrication than OE yarn. Table 5 shows Course way Un-recovered elongation.

The table indicates that, sample 2 (ring yarn) shows higher un-recovered elongation than sample 1 (OE) though composition are same (80/20) whereas we can see different figure in between sample

**Table 5:** Course way Un-recovered elongation.

Data of Un-Recovered Elongation		
Sample	Specification of sample	Un - Recovered Elongation
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	20.4
Sample 2	80% cotton, 20% polyester; 30/1 com+20/1 Ring	22.0
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	26.6
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	23.0
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	26.8
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	24.8

**Table 6:** Wales way Recovered elongation.

Data for Recovered Elongation		
Sample	Specification of sample	Recovered Elongation
Sample 1	80% cotton, 20 % polyester; 30/1 com+20/1 OE	97.0
Sample 2	80% cotton, 20 % polyester;30/1 com+20/1 Ring	96.2
Sample 3	70% cotton, 30 % polyester; 30/1 com+20/1 CVC(60c+40p) OE	96.6
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	95.4
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	96.4
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	98.0

**Table 7:** Recovered Elongation.

Data for Recovered Elongation		
Sample	Specification of sample	Recovered Elongation
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	79.6
Sample 2	80% cotton, 20 % polyester; 30/1 com+20/1 Ring	78.0
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	73.4
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	77.0
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	73.2
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	75.2

**Table 8:** Wales way elastic recovery of six different samples.

Wales way data for Elastic Recovery		
Sample	Specification of sample	Elastic Recovery
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	227.0
Sample 2	80% cotton, 20% polyester;30/1 com+20/1 Ring	218.6
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	225.1
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	221.1
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	226.6
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	251.1

3 & 4. Sample (OE yarn) shows higher un-recovered elongation than sample 4 (Ring yarn) though composition are same (70/30). On the other hand, it is observed that ring yarn of sample 5 shows higher un-recovered elongation than sample 6 of OE yarn though composition are same (60/40). So, ring yarn un-recovered elongation is higher than OE yarn though same type of composition except sample 4. Here un-recovered elongation is lower than OE due to fabrication type (70/30). So, highest value found (26.8) on sample 5 of composition 60/40 where loop yarn used PC with OE. In contrast, lowest value found (20.4) on sample 1 of composition 80/20 where loop yarn used cotton with OE. Table 6 shows Wales way Recovered elongation.

The table indicates that, sample 2 (ring yarn) of 80/20 shows higher recovered elongation than sample 1(OE) of 80/20. Similarly sample 4 (ring yarn) of 70/30 and sample 5(ring yarn) of 60/40 shows higher recovered elongation than sample 3(OE yarn) of 70/30 and sample 6 (OE yarn) of 60/40. So, it is summarized that same composition of ring yarn shows higher recovered elongation than OE yarn. On the other hand, it is observed that highest value (98.0) found on sample 6 of 60/40 where in loop yarn used PC with OE yarn .In contrast , lowest value found (95.4) on sample 4 of 70/30 where loop yarn used CVC. Table 7 shows Recovered Elongation.

The table specifies that, sample 1 (OE) shows higher recovered

**Table 9:** Course way Elastic recovery of six different samples.

Course way Data for Elastic Recovery		
Sample	Specification of sample	Elastic Recovery
Sample 1	80% cotton, 20% polyester; 30/1 com+20/1 OE	88.7
Sample 2	80% cotton, 20% polyester; 30/1 com+20/1 Ring	83.9
Sample 3	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) OE	74.7
Sample 4	70% cotton, 30% polyester; 30/1 com+20/1 CVC(60c+40p) Ring	78.7
Sample 5	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) Ring	74.5
Sample 6	60% cotton, 40% polyester; 30/1 com+20/1 PC(65c+35p) OE	76.1

**Table 10:** Comparative analysis of various parameter among different composition of ring yarn (Wales direction).

Sample Description	Elongation	Un recovered elongation	Recovered elongation	Elastic recovery
Sample 2	41.4	3.8	96.2	218.6
Sample 4	40.5	4.6	95.4	221.1
Sample 5	39.9	3.6	96.4	226.6

**Table 11:** Comparative analysis of wales direction among different composition of OE yarn.

Sample Description	Elongation	Un recovered elongation	Recovered elongation	Elastic recovery
Sample 1	40.3	3.0	97.0	227.0
Sample 3	40.5	3.4	96.6	225.1
Sample 6	36.6	2.0	98.0	251.1

**Table 12:** Comparative analysis of Course direction among different composition of Ring yarn.

Sample Description	Elongation	Un recovered elongation	Recovered elongation	Elastic recovery
Sample 2	81.3	22.0	78.0	83.9
Sample 4	88.4	23.0	77.0	78.7
Sample 5	87.1	26.8	73.2	74.5

**Table 13:** Comparative analysis of various parameters among different composition of OE yarn (Course direction).

Sample Description	Elongation	Un recovered elongation	Recovered elongation	Elastic recovery
Sample 1	77.8	20.4	79.6	88.7
Sample 3	77.2	26.6	73.4	74.7
Sample 6	86.6	24.8	75.2	76.1

elongation than sample 2 (Ring) whereas composition is same for both sample (80/20). Between sample 3 & 4, higher recovered elongation found (77.0) on sample 4 (ring) whereas sample 3 found lower recovered elongation (73.4). On the other hand, between sample 5 & 6, it is observed that higher recovered elongation found on sample 6 (OE) than sample 5 (ring) where composition are same but yarn type is different. SO, it is summarized that OE yarn sample found higher recovered elongation than ring yarn except sample 3 due to its fabrication nature. Where CVC yarn used in loop yarn. Highest value (79.6) found on sample 1 which composition is 80/20 and loop yarn used 100% cotton OE. In contrast, lowest value found (73.2) on sample 5 which composition is 60/40 and loop yarn used PC Ring yarn. Lowest recovered elongation found due to using PC in loop yarn and ground yarn composition polyester portion is higher than any other sample. Table 8 shows Wales way elastic recovery of six different samples.

The table indicates that, between sample 1 & 2, recovery found (227.0) higher in sample 1(OE) than sample 2. Similarly, in between sample 3 & 4, recovery value found higher in sample 3 (OE) than

sample 4(ring). And between sample 5 & 6, recovery value found higher in sample 6 (OE) than sample 5 (ring). To summarized, it is observed that among all sample ring yarn recovery is higher that OE yarn. Highest value found on sample 6 which composition is 60/40 and PC used in loop yarn whereas lowest value found on sample 2 which composition is 80/20 and loop yarn used 100 % cotton. Table 9 shows Course way Elastic recovery of six different samples.

The table indicates that, between sample 1 & 2, higher recovery shows than sample 1 (OE) than sample 2 (OE). On the other hand between sample 3 & 4, higher value shows on sample 4 (ring) than sample 3. And between last two sample (5 & 6), higher value shows in sample 6 (OE) than sample 5. It is observed that OE yarn recovery is higher than ring yarn except sample 3. Where value is found lowest than ring yarn due to its fabrication (70/30) and loop yarn used CVC. Table 10 shows Comparative analysis of various parameter among different composition of ring yarn (Wales direction). Table 11 shows Comparative analysis of wales direction among different composition of OE yarn. Table 12 shows Comparative analysis of Course direction among different composition of Ring yarn. Table 13

shows Comparative analysis of various parameters among different com-position of OE yarn (Course direction).

## Conclusion

It is seen from the research that the Characterization of elastic properties accountable to three thread fleece fabrics were investigated. Knitted fabrics and products are exposed to a variety of stresses and loads/deformation during their usage. The loads are unlike by value, by direction, and by duration. The alternations of loading and unloading or resting processes affect the knitted structure and could bring about changes in the linear dimensions of the fabric or result in the distortion of the knitted items and finally the loss of product appearance or its useful properties. A wide range of textile materials resistant to multiply loads was produced by using elastomeric yarn that has an elongation of more than 95% and is able to attain full recovery after relaxation due to its chemical composition. Knitted fabrics of Single jersey fabrics are normally used to create underwear and ie T-shirts. Knitted fabrics or product can easily be distort or elastic comparing to outerwear woven fabrics or product. The Influence of Knitting Structure on Mechanical Properties of Weft Knitted Fabrics is investigated. Hence an investigation carried out on different types of rib knitted fabrics to establish that elasticity and strength of the knitted fabrics are immediately concerned with knitting structure.

## References

- Mohammad Y. Knitwear Industry in Bangladesh: A Case Study of Firms in Narayanganj. Delhi: Institute of Human Development. Delhi. 2010.
- Zaid B. Competitiveness of the knitwear industry in Bangladesh: a study of industrial.. CHIBA 261-8545. Japan: Researchgate. October. 2008.
- Islam MS, Rakib MA, Adnan ATM. Ready-Made Garments Sector of Bangladesh: Its Contribution and Challenges towards Development. Dhaka: Researchate. 2016; 5.
- Kothari VR. Basics of KNITTING. Knitting Views. 2010.
- Hussain U, Younis FB, Usman F, Hussain T, Ahmed F. Comfort and Mechanical Properties of Polyester/Bamboo and Polyester/Cotton Blended. Pakistan: Journal of Engineered Fibers and Fabrics. 2015; 10.
- Kyzymchuk MO, Liudmyla. Stretch properties of elastic knitted fabric with pillar stitch. Ukraine: Journal of Engineered Fibers and Fabrics. 2018.
- Sadek R, El-Hossini AM, Eldeeb AS, Yassen AA. Effect of Lycra Extension Percent on Single Jersey Knitted Fabric Properties. Egypt: Journal of Engineered Fibers and Fabrics. 2019; 7.
- Usha C. Impact of Interfacings and Lining on Breaking Strength, Elongation and Duration of the Test for Knitted Wool. USA: International Journal of Textile Science and Engineering. 2019.
- Senthilkumar M. Elastic Properties of Spandex Plated Cotton Knitted Fabric. India: 2011; 92.
- Senthilkumar M. Dynamics of Elastic Knitted Fabrics for Sports Wear. India: Journal of Industrial Textiles. 2010.
- Eltahan E. Effect of Lycra Percentages and Loop Length on the Physical and Mechanical Properties of Single Jersey Knitted Fabrics. Article ID 3846936, Egypt: Hindawi Publishing Corporation. 2016.
- Çeven EK, Eren HA, Günaydin GK. Comparison of the Selected Physical Properties of Elastane Weft Knitted Fabrics Before and After Repeated Launderings. No 1. SL: Reserchgate. 2019; 24.
- Mikučionienė D, Čiukas R, Mickevičienė A. The Influence of Knitting Structure on Mechanical Properties of Weft Knitted Fabrics. Lithuania. Materials Science. 2010; 15; 16.
- Ehrmann A, Heimlich F, Brućken A, Weber M, Haug R. Suitability of knitted fabrics as elongation sensors subject to structure, stitch dimension and elongation direction. Germany: Textile Research Journal. 2007; 84.
- Marija V, Matković P, Skenderi Z. Mechanical Properties of Polyurethane Coated Knitted Fabrics. No 4 (100), Croatia: Fibres & Textiles in Eastern Europe. 2013; 21.
- Varghesea N, Thilagavathi G. Development of woven stretch fabrics and analysis on handle, stretch, and pressure comfort. India: The Journal of the Textile Institute. 2014.
- Elastic Recovery in Cotton Knitted Fabrics. Textile Research Journal. Nov 1. 1946.
- Hazel MR, Fletcher, Helen S. Washington DC: Elastic Properties of Plain and Double Knit Cotton Fabric. Textile research journal. 1965.
- GB Tesemaa, Axel D. Effect of ginning on tenacity, elongation and other fibre quality properties. 10 June 2019. Germany: The Journal of the Textile Institute. 2019.
- Mominul ASM. Raising, Shearing & Seeding Machine. Dhaka. 2014.