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Multidisciplinary Academic Journal Publisher

Interaction of the Qualities and Properties between Yarns and Fabrics

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Abstract: Bangladesh has a grand reputation for its quality textile products exportation over 148 countries throughout the world. Now, it is the second largest textiles exporting country and a competitor of China, which is the first largest country on the way. The textile sector of the country is growing very fast which 7,000 garments factories with about 4 million manpower and its current, Fiscal year 2012, exportation of about US$12 billion has proved its promising prospects. Over 78% of its foreign exchanges come from this sector and its contribution to the national GDP is about 18%. In the total apparel production knitwear has greater contribution than woven products has, esp. in the domestic uses. Knitwear share is about 53%, where woven share is 47% in the textiles production. This research work is majorly concentrated on knitted fabrics, though some experiments are taken for woven fabrics for comparative judgment. As the aim of the production of fabric is to meet the buyer's requirement and which is estimated by the consumer's serviceability. So, it is very significantly crucial to ensure the desirable properties from the early grey stage of the fabric. This is why, it is vital to select the right yarns or threads to get predetermined fabrics with desirable qualities. And, to ensure all these, it needs to know how yarn's qualities affect fabric qualities. This research shows how different properties of knitted fabrics vary with the change of yarn's count. Especially, Wales Per Inch and Courses Per Inch (WPI & CPI), Fabric weight in Grams per Square Meter (GSM), Bursting strength, Flammability, Stiffness, Perspiration, Absorbency, Shrinkage, Pilling resistance and Crease recovery etc. properties have been measured for analyses. International standard instruments and methods were used to carry out all the tests. It is discovered that fabric properties are dependant on yarn qualities and some other factors, which are related to fabric processing, e.g. chemical and mechanical processing.
[A. M. K. Bahrum Prang Rocky, Md. Tahmidul Islam Molla. **Interaction of the Qualities and Properties between Yarns and Fabrics.** *J Am Sci* 2019;15(6):69-77]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org. 10. doi:10.7537/marsjas150619.10.

Keywords: Bursting strength, Crease recovery, CSP, Flammability, GSM, Knitting & Weaving, Pilling resistance, Shrinkage, Stiffness, TPI

1 Introduction:

The core prerequisite of high quality textiles, high quality fabric is required and it can only be confirmed by high quality yarns or threads, using it in appropriate manners. The quality is mainly measured by the usefulness, serviceability in respective purposes, durability, comfortability and outward appearance etc. of the products. And to make sure all these for textiles, selection of yarns with appropriate fineness and use in a sequence of precise methods to attain the desirable fabric are very important.

When a countless number of fibers are twisted together in a form of continuous length, *yarn* is produced. The quality of yarn is massively influenced by the fiber's length, whether to form yarns from natural fibers or synthetic fibers. Yarn fineness is expressed by yarn count which is defined by weight of the yarn per length or the lengths per weight. *Count* for the yarn produced from natural fibers is mainly expressed by lengths per mass unit, especially English count, Ne, which is the number of hanks of 840 yards length of the yarn in 1lb. and count of the synthetic or artificial yarns is expressed by American count, Tex, which is the number of grams per 1 km long yarn.

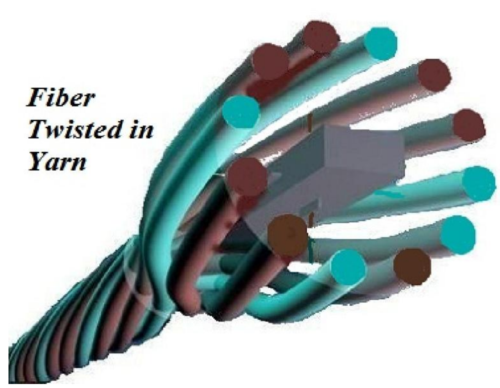

Figure 1: Yarn formation.

Though some fabrics are directly formed from fibers by fusing, bonding or interlocking, major portion of the world demand of fabrics is fulfilled by fabrics produced from yarns or threads. In the way of interweaving, interlooping or Intertwining and twisting, Fabrics are produced from yarns. Most popular worldwide methods of fabrics construction are weaving and knitting.

In *weaving*, at least two (one set is called warp and other is called weft yarns) or more sets of yarns are used to interlace at about 90^0 angle to each other to produce different types of fabrics. Three major types weaving methods are Plain, twill and satin weave. Moreover, basket, leno, mock leno, Honey comb, distorted thread effect, crepe styles are also used.

The most difficult weaving methods is *plain weave* which is formed by alternative ups and downs of warp yarns through weft yarns with symmetrical appearance to both face and back sides of the fabric.

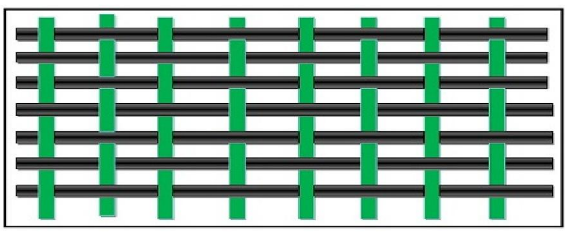

Figure 2: Plain weave (1X1)

Twill weave is the definite types of the order of interlacing method in which one or more warp yarns pass over and under two or more weft and causes diagonal straight or broken line appearance to the fabric.

Satin weave is formed by only one interlacement between one warp and one weft yarn and the interlacement point is covered with long float yarn. Satin fabrics are very smooth and lustrous with loose structure.

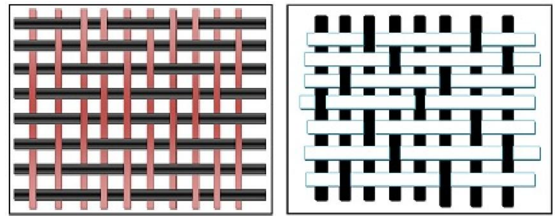

Figure 3: Twill weave (2X2) and Satin weave (2X2)

Knitting is a process of producing textile fabrics. In this method, a series of loops are formed from continuous length of yarn and interlocked loops by means of needles with preceding row or column and thus formed elastic, smooth and porous structure of knitted fabrics. It is a quicker and cheaper method of fabric preparation than weaving. But knitted fabric has high tendency of wrinkling. Fabrics produced by knitting method are of two kinds- 1) Weft, and 2) Warp knitted fabric.

In *weft knitting*, a horizontal row of loops is made using a horizontally running yarn and then each loop is interlocked with the row latter. Weft knitted fabric is mainly produced in tubular form. It has higher shrinkage and elasticity.

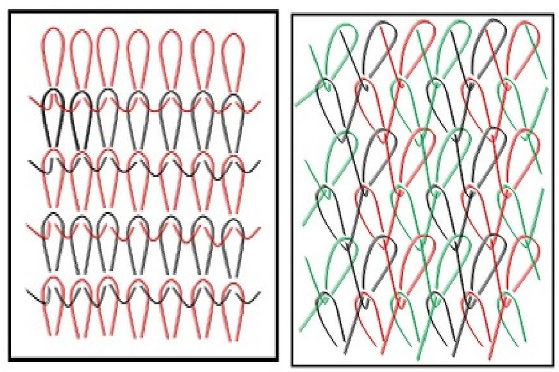

Figure 4: Basic Weft knit and Basic Warp knit fabric

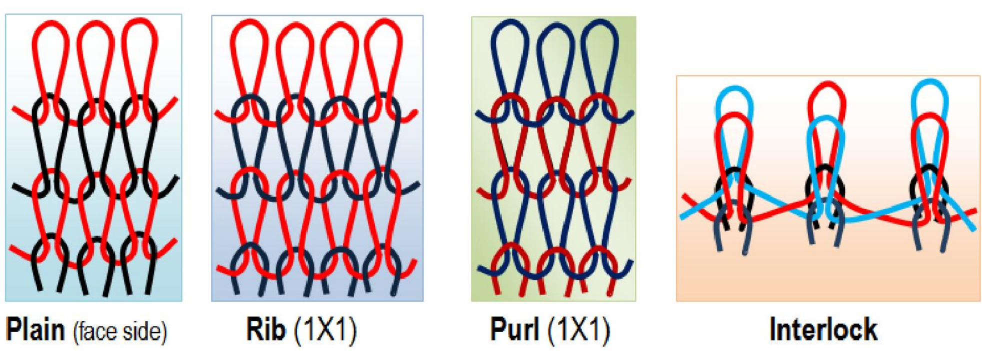

Figure 5: Yarn interlace in Plain, Rib, Purl and Unterlock Fabric

In *warp knitting*, each loop in the horizontal direction is made from different yarn and each loop is also made by distinct needle. Warp knitted fabric is mainly produced in flat form and has high compactness. So, this is less elastic and less shrinkable.

In this study, plain single jersey, Rib and interlock knitted fabrics have been used. These are weft knitted fabrics. There are mainly four basic types of weft knitting style – 1) Plain, 2) Rib, 3) Purl and 4) Interlock. All four types of structures are shown.

2 Working Principle & Procedure

2.1 TPI

Twist is necessary in yarn or rope construction to hold the fibers or yarns together in a continuous extent, and is added in both the spinning and plying processes. The amount of twist may vary on the type of the fiber, thickness of yarn, fiber processing, spinning system, and the desired result. The direction of the twist may be to the clockwise (right), known as Z twist, or to the anti-clockwise (left), known as S twist. Twist imparts desirable strength to the yarn for fabric preparation. Sometimes, two or more single yarns are twisted together to get desirable strength called ply yarn. Generally, warp yarn needs more twists than weft yarns in weaving. Yarns with low twists are used in knitting, moderate twisted are used for weaving and high twisted are used for crepe.

TPI is a term used in the textile sector and its full name is Twists Per Inch or Turns Per Inch. It is defined by the number of twists in one inch length of yarn. TPI is an important measure to recreate a yarn. Strength of a yarn increases with increase of TPI up to a certain time but, at the higher twist, strength decreases with the increase of TPI value. Yarns that have relatively fewer Twists Per Inch tend to have a softer hand but are not as strong as yarns with more twists per inch, such as medium twist or hard twist yarns. TPI of single yarn can directly be counted by using counting glass and needle, and TPI of plied yarns are determined by counting the number of bumps in one inch, and divide by the number of singles (the strands plied together to make the yarn). Another method is to measure an inch of yarn, and untwist it, counting how many full revolutions it takes until there is no twist left. Following formula is also used to find TPI of double plied yarn-

$$\textbf{TPI of double yarn} = \mathbf{0.7} \times \textbf{ Single yarn TPI}$$

The Twist Multiplier, TM, or the Twist Factor, K, may also be used to calculate TPI. This is an empirical parameter that has been established by experiments and practice that the maximum strength of a yarn is obtained for a definite value of K. The formula is-

$$\mathbf{TPI} = \mathbf{TM} \times \sqrt{\mathbf{count}}$$

TM should not exceed 3.7 for combed yarn and 3.9 for carded yarn of knotted fabrics.

2.2 Strength of Yarn

Strength of yarn is the force required to break a yarn. It is generally expressed in terms of lea strength or Count Strength Product (CSP) in textile sector. Yarn strength may differ with the variation of fiber strength, yarn count, yarn twist (TPI), yarn evenness, test speed, test specimen length and air humidity.

To test Lea strength, a lea of 120 yards was wound by 80 wraps with a wrap reel, having 1.5 yard circumference and is fitted with a traversing mechanism that minimizes the bunching of yarn on the reel. Then breaking load was tested with a lea strength tester which gives the breaking load and is a pendulum type with constant rate of traverse, the moving clam operating at a uniform speed of 12 inches/minute. It gives lea strength in pounds (lb).

After the strength was tested the same lea was taken and tested for cotton count (Ne) to calculate CSP. CSP is the product of yarn count in cotton count system (Ne) and lea strength in lb of the yarn, i.e.

$$\mathbf{C.S.P} = \textbf{Count in Ne} \times \textbf{Lea strength in lb}$$

The higher the CSP value, the better the yarn. Generally, Yarns having less than 1800 CSPs are weak, 1800-2200s are moderate and above 2200s are considered as strong.

2.3 Stitch Density (WPI and CPI)

WPI is the number of Wales Per Inch and wale is a mainly vertical column of needle loops produced by the same needle knitting at successive knitting cycles and thus intermeshing each new loop through the previous loop. In warp knitted fabrics, a wale can be produced from the same yarn.

CPI is the number of Courses Per Inch and course is a horizontal row of loops, in an upright fabric, produced by adjacent needles during the same knitting cycle. In weft knitted fabrics, a course is composed of yarn from a single supply. In warp knitted fabrics, each loop in a course is normally composed of a separate yarn.

Only measurement of number of loops lengthwise (Wales) or widthwise (Courses) does not give accurate result._Because, tension acting in one direction may produce a low reading for the Courses and a high reading for the Wales. But when their product is calculated this effect is cancelled out. Therefore, Stitch density should be measured which is defined as the product of Wales Per Inch, WPI, and Courses Per Inch, CPI. In this experiment, Counting glass and needle were used to count number of loops. Here, $\textbf{Stitch density} = \textbf{ WPI} \times \textbf{CPI}$

2.4 GSM

The weight of a fabric can be expressed in two ways- 1) weight per unit area, such as Grams per Square Meter, *GSM*, and 2) weight per unit length but it requires information about the width of the fabric. Thus, GSM is the best way to explain the weight of the fabric. If GSM value is higher, it can be easily deduced that fabric is heavier. To measure GSM, GSM cutter is widely used which is a very reliable instrument and can be used both for woven and knitted fabrics. It is circular fabric sample cutter which uniformly cut 100 cm^2 fabrics in circular form and weight is measured by balance. The instrument is equipped with a set of four replaceable circular blades and two special grade cutting pads. It consists of Sample cutter with safety catch lock.

Conditioning should be done with special care before measuring GSM of fabric. Standard atmosphere for GSM measurement is 20°C temperature and 65% relative humidity. The fabric to be measured GSM is placed between the sample cutter and cutting board. When the safety lock is released, light downward pressure on the hand wheel is applied to bring the multiple blades into contact with the fabric. Specimens are cut by rotating the hand wheel under a light and even pressure. To get precise results, specimens should be perfectly circular and of smooth edges and weight should be measured with great care. In this experiment, 10 readings of each type of fabric were taken and then average was calculated to get accurate result. In calculation GSM following, formulas are used-

1) Specimen from GSM cutter,

$$\textbf{Grams per Square Meter},\ \textbf{GSM} = \textbf{Specimen Weight in Grams} \times \textbf{100}$$

2) For knitted fabric, by using WPI, CPI and stitch length (SL),

$$\textbf{GSM} = \frac{\textbf{WPI} \times \textbf{CPI} \times \textbf{SL in mm}}{\textbf{count in Ne}} \times \textbf{0.9155}$$

3) For woven fabric, by using Ends Per Inch (EPI) and Picks Per Inch (PPI),

$$\textbf{GSM} = \left[\left(\frac{\textbf{EPI}}{\textbf{warp count in Ne}} + \textbf{warp crimp}\ \%\right) + \left(\frac{\textbf{PPI}}{\textbf{weft count in Ne}} + \textbf{weft crimp}\ \%\right) \times \textbf{25.6}\right]$$

2.5 Bursting Strength

Bursting strength is defined as the distending force, which is applied at right angles to the plane of the fabric, under specified conditions, which will result in the rupture of a textile.

The bursting strength of fabric materials is measured by an increasing hydrostatic pressure to a circular region of the specimen through an elastic diaphragm. The specimen is firmly held round the edge of the circular region by a pneumatic clamping device. When the pressure is applied, the specimen deforms together with the diaphragm. The bursting strength corresponds to the maximum pressure supported by the specimen before failure.

In this experiment, Hydraulic Diaphragm Bursting Tester was used which is hand driven model testing machine. There is also a motor driven tester which can be used in case of heavyweight fabrics. The machine consists of several parts, such as- clamps, Diaphragm, Pressure Gage and Hydraulic Pressure System. There are two clamping (upper and lower) surfaces- annular, plane and parallel- are made of stainless steel to hold the specimen firmly and uniformly without causing any slippage during test. A 48 mm diaphragm of molded synthetic rubber, 1.80 ±0.05 mm in thickness with reinforced center, clamped between the lower clamping plate and the rest of the apparatus so that before the diaphragm is stretched by pressure underneath it, the center of its upper surface is below the plane of the clamping surface. The pressure required to raise the free surface of the diaphragm plane shall be 30 ±5 KPa. There is a pressure gauge to measure the pressure throughout the entire range of its scale to within a value of 1 % of its maximum capacity. And Hydraulic Pressure System, a system of applying increasingly controlled hydrostatic pressure to the underside of the diaphragm until the specimen bursts through a fluid displaced at the rate of 95 ±5 ml/min. The fluid is displaced by a piston in the pressure chamber of the apparatus. 96% pure glycerine or Ethylene glycol is used as fluid. Specimen is clamped over the expandable diaphragm and fluid pressure expands the diaphragm to the point of specimen rupture. The difference between the total pressure required to rupture the specimen and the pressure required to inflate the diaphragm is reported as the bursting strength.

2.6 Flammability

Flammability is defined as the propagation of flame on the fabric or how easily fabric will burn or ignite or how easily fabric will catch on fire. A flammable fabric is one which propagates flame, i.e. it continues to burn after the igniting flame has been removed. It is important to know both whether a fabric will bum or not, and, if it does, how quickly the flame will spread through it. The flammability testing procedure therefore determines both whether a fabric will ignite and the time that it takes to burn. Standardized conditions are applied including the size of the sample, the flame length used, and the timing of the test. There are some factors that affect the fabrics, such as- fiber content, yarn structure, fabric construction, fabric weight and fabric finishes etc. There are different methods of Flammability test, e.g. - the vertical strip test, the visual timing test, the hoop test and the 45° test etc.

International standardized A.S.T.M-D1054 for the vertical strip test principle was employed in this work. The test fabric was cut to a dimension of 30cm×5cm and was suspended in a drought free cabinet and held at the top end over the top most wire by clips. The flame from a candle stick was put below the lower end of the fabric. Then, by using a stop watch, the time in seconds it took the flame to consume the fabric from its lower to top end was recorded. The results for the five fabric samples for each type of fabric were taken by averaging.

2.7 Stiffness

Stiffness is a fabric property to describe its resistance against deformation. Stiffness means resistance to bending. Stiffness is a special property of fabric. It is the tendency of fabric to keep standing without any support. It is a key factor in the study of handle and drape of fabric. It can be measured by finding out the bending length or bending modulus or flexural rigidity. To determine the stiffness of the fabrics, Shirley Stiffness Tester was used in this work. It works according to cantilever principle as recommended by ASTM-D1388. Standard atmospheric weather condition was maintained during the experiment and the specimens were kept exposed to the standard atmosphere for conditioning for 24 hours.

Bending length of a fabric can directly be measured by the Shirley Stiffness Tester from the scale reading. For the test, a **6"×1"** (25±1mm×200±1mm**)** rectangular strip of fabric was needed to be supported on a horizontal platform of the stiffness tester and extended in the direction of its length, so that an increasing part overhung and bent under its own mass as shown in the figure below-

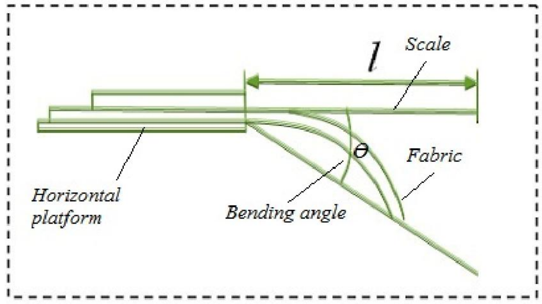

Figure 6: Cantilever Principle for Stiffness test

When the tip of the specimen reached a plane passing through the edge of the platform and inclined at an angle of 41.5° below the horizontal, the bending length was read off the scale of the apparatus. Thus, reading was taken The mean of the face up, face down, and results from both ends of the specimen and towards lengthwise and widthwise direction separately.

1. Bending length can be determined by the formula given below,

Bending length, $\boldsymbol{C = lf_1(\Theta)}$

Where, l = Unsupported fabric length,

$$f_1(\Theta) = \left(\frac{\cos\frac{1}{2}\Theta}{8\tan\Theta}\right)^{\frac{1}{3}}$$

And Θ = Bending angle.

When Θ=41.5^0, $f_1(\Theta) = \left(\frac{\cos\frac{41.5^0}{2}}{8\tan 41.5^0}\right)^{\frac{1}{3}}$

= 0.509321 ≈ 0.5

In case of the Shirley Stiffness Tester, C can directly be read visually.

2. Flexural rigidity can be calculated from GSM and bending length which is also measure of stiffness associated with handle. The formula is,

Flexural rigidity, $\boldsymbol{G = 0.1MC^3}$

Where, G is in mg.cm,

M = GSM i.e. the mass per unit area of the fabric in g/m^2,

And C = the bending length in cm.

3. Bending modulus is independent of the strip tested and may be defined as the intrinsic stiffness of the fabric. The thickness of the specimen needs to be calculated at a pressure of 1lb/in^{2}to find it. The bending modulus in kg/c m^2 is then given by the following formula-

$$\text{Bending modulus, } \mathbf{q} = \frac{\mathbf{12G \times 10^{-6}}}{\mathbf{g^3}}$$

Where, g = the cloth thickness in centimeters.

G = the flexural rigidity in mg.cm.

2.8 Absorbency

Absorbency is the capability of a material to take in water or any other liquid. And that extracts a fluid (gas or liquid) from a medium or surface on contact, and changes physically or chemically during the process is absorbent material.

High absorbent fabric is the one which has a lot of air holes (or pores) in it. The spray Test, as described by ASTM-D1005, was employed in this effort. In this test, a small scale mock rain shower was produced by pouring water through a spray nozzle. The water was sprayed on to specimen that was mounted an angle of 45^0 over a 6 inch diameter embroidery hoop. At about 25^0C, 250 ml water was steadily poured into the funnel for 25-30 sec. When spraying was finished, the sample holder was taken away and the additional water was removed by tapping the frame six times against a solid object. Then the fabric surface was examined visually and compared to the spray rating recommended by The American Association of Textile Chemists and colorists (AATCC) as follows-

2.9 Shrinkage

Shrinkage of textiles is defined as a change in the dimensions of a fabric or garment. This dimensional change may be in a positive (growth) or negative (shrinkage) direction for fabric length, width, and thickness. In other words, shrinkage is reduction or increase in length or width of a fiber, yarn or fabric, induced by conditioning, wetting, steaming, chemical treatment, wet processing as in laundering, dry heat or mechanical action. The greater the dimensional stability, the greater the technical merit of a fabric.

Table 1: Standard spray ratings

Spray rating	Visual observation
0	Complete wetting of whole of upper and lower surface
50	Complete wetting of whole of upper surface
70	Partial wetting of water of upper surface
80	Wetting of upper surface at spray point
90	Slight random sticking or wetting of the upper surface
100	No sticking or wetting or wetting of the upper surface

In this experiment, ASTM-D505 was followed with sample sizes 30cm×30cm of interlock and 20cm×20cm of rib and single jersey fabrics were taken. The procedures were done in four stages for each sample. Firstly, sample were prepared by conditioning in standard testing atmosphere and marked of 30cm×30cm or 20cm×20cm dimensions with the help of irremovable ink. Though, the marking out might be done with sewing thread. Secondly, washing solutions were prepared in washing machine with washing agent and wetting agent. After the specified time had elapsed the samples were rinsed. Thirdly, the surplus water was removed by centrifuge or by hand squeezing or rolling in toweling of the rinsed samples. Drying was completed by means of a flat-heated press or a heated flat iron. Finally, samples were re-conditioned and re-measured.

Then percentage shrinkage was measured by the formula below-

$$\textbf{Percentage shrinkage, S} = \frac{\mathbf{A - B}}{\mathbf{A}} \times \mathbf{100}$$

Where, A = distance between gauge marks before washing, and

B = distance between gauge marks after washing and drying.

2.10 Pilling Test

Pilling is one kind of fabric surface fault illustrated by little pills of entangled fibers clinging to the fabric surface giving an unlikely appearance. A pill is known as a bobble, a small ball of fibers that forms on a piece of cloth. Pill is also a verb for the formation of such balls. The pills are formed during wear and washing by the entanglement of loose fibers which protrude from the fabric surface. Pilling is a tendency of fibers to come loose from a fabric surface and balled particles of fibers.

The Martindale Abrasion Tester was used to measure pilling as described by ASTM-D3511 in this work. To measure by this tester, at first, specimens were cut according to measure of the GSM cutter. Then two pieces were taken from each sample and they were placed in opposite to one another on the circular disk. There is provision of eight heads to be set on the tester. When the preset 500 cycles rotation was completed, the machine stopped automatically. Then the samples were taken out from the machine and each sample was compared with the standard ratings. The standard ratings are given in the following-

5- No pilling
4- Slight pilling
3- Moderate pilling
2- Severe pilling
1- Very severe pilling

The specimens should be observed at an angle of 45^0.

2.11 Crease Resistance & Recovery

Crease or wrinkle resistance means that the resistance of a fabric to bending twisting and other deformations. Several terms are used to describe creasing characteristics of the fabric. Crease recovery means regain original shape after removal of the force of deformation. Crease resistance and recovery depends on type of fiber, yarn structure and fabric structure etc. Wool and silk have a good resistance to creasing whereas cellulosic materials such as cotton, viscose, and linen have very poor resistance to creasing.

In this study, The Shirley crease recovery tester was used as mentioned by ASTM-D2505 for measuring Crease Recovery Angle (CRA) and Crease Recovery Percentage (CRP). For the Shirley crease recovery test specimens were cut with a template 2 inch long by 1 inch wide.

Each specimen was carefully creased by folding in half placing it between two glasses and was added a 2 kg weight (Sometimes, 1kg weight is applied). The loading device has provision for applying different loads to fulfill the requirement of both European and American standards. After one minute the weight was removed and the specimen were transferred to the fabrics clamp on the instrument. On removal of load, the sample was allowed to recover for 2 minutes before the CRA is measured. The magnitude of the CRA is an indication of the ability of fabric to recover from incidental creasing. CRAs were measured to both course wise and wale wise to the nearest degree and the mean of ten tests of each type of fabric was taken.

3 Results and analyses

All the experiments were performed in standard Atmospheric condition for testing textiles so that results do not contradict with international standard value. Conditioning was also carried out for standard moisture regain and accurate results. Worldwide popular testing instruments were attempted to use according to availability. Results are presented in the following with respective analyses.

3.1 Yarn Properties

Only some yarn properties were determined in this work. Yarn properties are influenced by a lot of factors. Further study of yarn properties determination can give more detail view about its impacts on fabrics qualities. It was observed from the data that TPIs increase with increase of count (Ne) but strengths in lb decrease and CSPs also decrease. The experimental data of TPI, actual strength, actual count and CSP of yarns are revealed below-

The relations recognized among count vs. TPI and strength from experimental data are also presented graphically in the following-

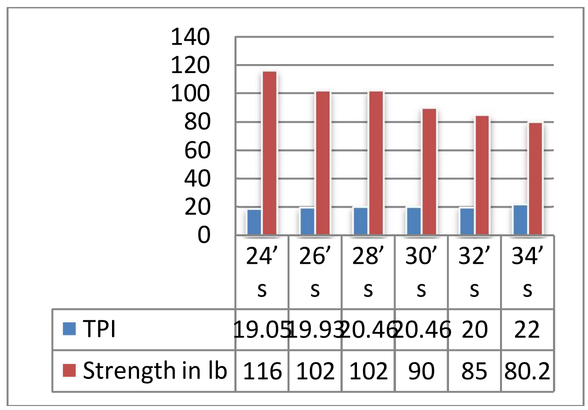

Figure 7: Yarn vs. TPI, strength and CSP

Table 2: Yarn count, TPI, strength and CSP

Yarn Count	TPI	Actual Count	Actual Strength in lb	CSP
24's	19.05	23.60	116	2737.6
26's	19.93	25.52	102	2603.04
28's	20.46	27.50	102	2805
30's	20.46	29.78	90	2680.2
32's	20	31.50	85	2677.5
34's	22	33.64	80.2	2697.928

3.2 Fabric Properties:

In every particular test, at least, ten samples were tested and averages were taken. All the tests were performed after conditioning in standard atmospheric condition for 24 hours to ensure accurate results so that they do not interfere with internationally accepted usual results. It needs to mention here that results may vary with the variation of the testing instruments, Specimen's size, testing methods, Style of fabric preparation etc. The summary of all properties tested in this effort is given in the following table-

Table 3: Different properties of knit fabric

Properties			Single jersey			Rib			Interlock		
Yarn count			24	28	32	26	28	30	30	32	34
Wales Per Inch (WPI)			28	28	30	24	25	26	30	30	31
Courses Per Inch (CPI)			55	58	60	42	44	45	39	40	40
Stitch density			1540	1624	1800	1008	1100	1170	1170	1200	1240
Gram Per Square Meter (GSM)			155	146	121	214	195	187	235	215	210
Bursting strength	Pressure in KPa		320.7	255.4	242.3	297.6	256.2	250.3	453.4	369.8	342.4
	Time (s)		41	36	33	39	35	33	53	48	45
Flammability	Time (s)		19	18	17	22	21	20	41	39	38
Absorbency (Spray rating)			80	80	80	90	90	90	90	90	90
Stiffness	Bending Length (cm)	walewise	Not determined			0.75	1.01	0.95	0.97	1.09	1.10
		coursewise				0.40	0.43	0.39	0.95	1.06	1.06
	Flexural Rigidity	walewise				16.05	19.70	17.77	22.80	23.44	23.10
		coursewise				8.56	8.39	7.30	22.33	22.80	22.26
Shrinkage (%)	walewise		21.1	22.3	23.3	15.5	9.1	9.5	13.7	12.5	11.9
	coursewise		6.6	6.4	5.1	16.7	10.4	13.3	12.2	13.1	13.6
Pilling resistance			2-3	2-3	2-3	2-3	2-3	2-3	2-3	2-3	2-3
Crease resistance	CRA (degree)		Not determined			131	145	162	165	168	171
	CRP (%)					72.8	80.6	90	91.7	93.3	95

Different properties of Single Jersey, Rib and Interlock Knit Fabrics:

3.2.1 WPI and CPI- two are higher in respective fabric for finer counts. WPIs are nearly same for certain count in single jersey, rib and interlock fabrics CPIs are comparatively higher in single jersey as course's loops are tightly and closely attached in it. Stitch density is also greater for higher Ne in particular fabrics.

3.2.2 GSM- it decreases for finer count in individual fabrics. But single jersey has lowest GSM where interlock and rib has higher for same count and stitch density.

3.2.3 Bursting strength- Breaking loads were tested for both face side and back side of all types of fabrics and average were taken. It can be seen here that the bursting strength and time to break the specimens are lower for higher count (Ne) but, for same count, rib and interlock have higher value.

3.2.4 Flammability- time to completely burn a certain fabric is higher for coarser/ lower count. Since interlock and rib are heavier, they need more time than lighter single jersey.

3.2.5 Absorbency- Since untreated (grey) 100% cotton fabrics were used, single jerseys were wet on upper surface at spray point, 80 ratings and ribs and interlocks were slight random sticking at spray point, 90 ratings.

3.2.6 Stiffness- Single jersey fabric has too high curling tendency to determine Bending length and Flexural rigidity. Bending length and Flexural rigidity were calculated walewise and coursewise and both are higher for finer count. Walewise stiffness value is greater than coursewise.

3.2.7 Shrinkage- percentages of shrinkage are higher for finer count in particular fabric, but for a certain count single jersey has very higher percentage for its curling tendency due to lighter thickness.

3.2.8 Pilling- pilling resistances are same, because all fabrics were produced from same cotton fibers.

3.2.9 Creasing- CRA and CRP of ribs and interlocks are greater for higher count. Crease resistance of single jerseys were not determined due to it high curling tendency.

4 Conclusion

In this research, it is learned that desired fabric production can only be ensured by proper yarn selection. Only yarn with proper and desired characteristics can give aspired fabric, though some chemical and physical treatment can improve fabrics quality. Fabrics' qualities and properties are hugely influenced by yarn qualities and properties. So, every manufacturer should take yarn into great consideration so that desirable can be produced without counting any loss for taking a weak appalling decision. But this is only a primary and limited research. Further study can give us more detailed idea about interaction between yarns and fabrics.

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6/21/2019