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EFFECT OF WARP COUNT ON WOVEN FABRIC MECHANICAL PROPERTIES

Ethiopian Institute of Textile and Fashion

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BY

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ABSTRACT

A confident understanding of fabric behavior and characteristics are vital in the design and development of a functional garment. In textile production technology one of the objectives of the manufacturer is to produce high quality fabrics or garment which will satisfy the customers' need both in serviceability and in price.

This research focus on the effect of warp count on cotton woven fabric mechanical properties tested with three count of fabric such as 17 Ne, 22 Ne and 24 Ne to be determine their mechanical properties like tensile strength, tear strength, pilling resistance and crease resistance performance. It evident from the result obtained that the fabrics posses which result from the type of warp count used. When the result indicated the tensile strength, tear strength and crease resistance value increase for used coarser count cotton yarn, on the other hand pilling resistance value increasing for finer cotton warp count used. Beside mechanical properties test result indicated that strength properties increased with increasing the coarseness of warp count because high fiber in the cross section of the yarn to enhance the strength value and crease resistant properties. When the pilling resistance increased with finer yarn used which attributed to the fact that finer yarns have low hairiness and high twisted yarn value than coarser yarn due to that fabric pilling rate decreased when the result. Finally Fabric testing plays a crucial role in gauging product quality, assuring regulatory compliance and assessing the performance of textile materials. It provides information about the physical or mechanical properties and the performance properties of the fabrics.

Key words: Tensile strength, Tear strength, pilling resistance, crease resistance and warp count.

ADVISORS’ APPROVAL SHEET

ETHIOPIAN INSTITUTE OF TEXTILE AND FASHION TECHNOLOGY (EiTEX)
POST GRADUATE OFFICE

This is to certify that the thesis **title “Effect of warp count on woven fabric mechanical properties”** Submitted in partial fulfillment of the requirements for the degree of masters with specialization in Textile Education the postgraduate program of the Ethiopian institute of textile and fashion technology and has been carried out by BELAY ABEBAW ID. No. MTT/S/004/07 under my/our supervision, therefore, I/we recommend that the student fulfilled the requirements and hence hereby can submit the thesis to the institute.

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APPROVAL PAGE

I certify that I have supervised /read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in quality and scope, as a thesis for the fulfillment of the requirements for the degree of masters of Textile Education.

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(Examination Committee Member)

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DECLARATION

I hereby declare that the thesis is submitted in the fulfillment of the Master's degree is my own work and that all contributions from any other persons or sources are properly and duly cited. I further declare that the material has not been submitted either in whole or in part, for a degree at this or any other university in making this declaration, I understand and acknowledge any breaches in this declaration constitute academic misconducts, which may result in my expulsion from the program me and/or exclusion from the award of degree.

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Signature: _____________

Date:

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LIST OF ABBREVIATIONS

EiTEX	: Ethiopian institute of textile and fashion technology
Bdu	: Bahir Dar University
KTSC	: Kombolcha Textile Share Company
Tex	: direct cotton count numbering system
Nm	: Metric count
Ne	: English count
Yd	: pound
C V	: Count Variation
e.p.i	: Ends per inch
p.p.i	: Picks per inch
GSM	: gram square meter
N	: Newton
o	: degree
%	: percent
CVM	: co efficient variation in mass
STD	: standard count
Rpm	: revolution per minute
CRA	: crease recovery angle
Fig	: figure
Act	: actual count
U%	: Mass variation
TIP	: trash in perfection percent
TPM	: twist per minute
ASTM	: American society for testing material
M/n	: Machine

CHAPTER ONE

INTRODUCTION

1.1. Background

Humans have dressed, since before the old historical ages. The basic reason of the need for clothing were protecting and covering their bodies from external effects, such as hot and cold weather. They used animal skins for this purpose at first, but by the developing of agriculture and stockbreeding, people have formed new structures called ‘fabrics’ as clothing materials. Fabrics are defined as the structure of assembling of the textile fibers in a smooth surface with a thin layer and sufficient strength. This definition includes the fabric’s geometrical and mechanical properties. In terms of geometrical property point of view, a fabric is a structure which has a covering property, and in terms of mechanical property point of view, a fabric is an elastic material. The fabrics, especially used as clothing materials, should be fit for body, and have sufficient smooth surface that enables stretchiness and fineness. (Kawabata, S. and Niwa, M. 1999)

The mechanical properties are important for all textile users including fabric processors, garment manufacturers, designers and customers. (B P Saville, 2000) With mechanical properties, the phenomenon on textile material is described which a result of the material resistance on the activity of external forces is causing the change of shape. The response of the textile material depends on the material properties, the way of load and its tension. With regard to the direction of the applied force, deformations at stretch and compression are known. To the mechanical properties of fabrics uniaxial or biaxial tensile properties, compression, shearing properties, bending rigidity, bursting and tear resistance can be listed. (Geršak, 2006).

Numerous parameters influence the mechanical properties of woven fabrics. Firstly, there are fiber properties, and their molecular properties and structure.

The mechanical properties of fibers depend on their molecular structure, where macromolecules can be arranged in (Unique arrangements of molecules) or amorphous (coincidental arrangements of molecules) structure. The macromolecules are orientated mostly along the fiber axis and are connected to each other with intermolecular bonds. When a force is applied, the Super a molecular structure starts changing (Geršak, 2006).

The fiber properties and the type of spinning influence the yarn properties, while the fabric properties are also influenced by warp and weft density of the woven fabrics, and weave.

The mechanical properties are also influenced by the weaving conditions, e.g. speed of weaving, warp insertion rate, weft beat-up force, the way of shed opening, warp preparation for weaving, warp and weft tension, number of threads in reed dent etc.

The properties of raw fabrics consequently depend on the construction and technological parameters. For the final use, raw fabrics have to be post-treated to add different functional properties. In most cases, these post-treatments worsen some mechanical properties, while again some other mechanical properties improve (Praburaj Venkatraman).

1.2. Statement of the problem

Plain fabric is the main product in Kombolcha Textile Share Company. In the company, ruminant yarn package or different yarn count around the warping machine are used without checking the warp count when there is lack of yarn packages for the specified products. This thesis work has focused to identify the problem in kombolcha textile share company related effect of warp yarn count on woven fabric mechanical properties and to find out the better solution to increase the quality of woven fabric. During my survey the factory operator do not have full understanding of effect of warp count they used and do not know to what extent this warp count variation affect the woven fabric wear serviceability of product by affecting mechanical properties like tensile strength, tear strength, crease recovery and pilling resistance. This thesis work has aimed to carry out a detailed investigation of effect of warp yarn count on cotton fabric mechanical properties during the production stage and after production of textile material from various kinds of warp count testes are applied to the production of fabric. These materials are being tested to control the properties based on the end use properties of fabric and apparel. The warp count test is necessary to provide feedback to assure quality and to be sure that the system of production material work correctly. Finally the aim of this study is to analyze overall diverse problem on the mechanical characteristics of cotton woven fabrics with different testing evaluation systems, and to search for a reliable relationship between warp yarn count impacts on fabric quality performance and give better recommendation for the solution. Based on the above the following basic research question also drawn:

- To what extent warp count will affect the mechanical properties (tensile strength, tear strength, pilling resistance; and crease recovery on cotton woven fabric?
- Is warp count affecting the final garment performance properties?

1.3. Objective and purpose of the study

1.3.1. The main purpose of the thesis

To describe the effect of warp count on cotton woven fabric mechanical properties such as tensile strength ,tear strength ,crease recovery and pilling resistance and analysis using different fabric mechanical properties laboratory tester to give remedial solution based on the result.

To explain the impact and side effect of warp count on woven fabric mechanical properties taken from kombolcha textile share company different warp count sample fabric test or analysis create awareness for the factory operators or owners the final result with the solution to increase the fabric quality and performance to satisfy customers needs.

1.3.2. Objectives of the study

1.3.2.1. General objective

- Effects of warp count on woven fabric mechanical properties

1.3.2.2. Specific objective

- To create awareness and give knowledge to weaving factory owners about warp count effect.

- To explore the influence of yarn material, warp count on woven fabric mechanical properties
- To establish a relationship between tensile strength, pilling resistance, crease resistance of yarn and fabric with in warp direction.
- To determine the mechanical properties woven fabric samples with different specifications made from cotton yarns.

1.4. Justification

The various factors cause the woven fabric mechanical properties are fiber properties, yarn properties and machine causes. Fibers cause are depend on the molecular structure unique arrangement of molecules, or amorphous, yarn cause the type of spinning influence the yarn properties and fabric properties influence by warp and weft count and weave. Woven fabric properties such as mechanical properties and physical properties affected by warp count. The mechanical properties like tensile strength tear strength pilling resistance, crease resistance and physical properties such as warp and weft density, warp and weft count, weave crimp, weight, thickness, cover and factor width and length and sensory properties such as drape and handle are highly affected or influenced by yarn count (warp and weft).

With this research work identity and proper testing and analysis from the produce different count of woven sample fabric, finally to know the benefit of warp count different better to improve the woven fabric mechanical properties become a good performance.

1.5. Significance of the study

To study the effects of warp count on woven fabric mechanical properties like tensile strength, tear strength, crease recovery and pilling resistance to maintain the basic quality and serviceability in textile fabric product. Here is some significance of the study of research.

- To enhance quality performance woven product.
- To identify the parameters focus on woven fabric mechanical properties
- To identify the role of warp count on woven fabric mechanical properties.

1.6. Benefits and Beneficiaries

1.6.1. Benefits

The benefits of this thesis work are directly related to satisfying of different people and users increasing income with proper fabric mechanical properties attainig.people increase their product and quality to ataine the warp count effect on woven fabric related with their mechanical propertis.

1.6.2. Beneficiaries

The major beneficiaries of this thesis work are the following

- People who need woven fabricproduct with better quality performances.
- Industry which produce highly mechanical force resistance materials.
- Industry to analysis properly the impact of warp count on cloth mechanical properties to produce good performance product.

1.7. Scope of the study

The project has been done for Bahir Dar University Ethiopian institute of textile and fashion technology laboratory using different warp yarn count woven fabric to test mechanical properties such as tensile strength ,tear strength ,crease recovery and pilling resistance using different fabric mechanical properties laboratory machine.

1.8. Limitation of the study

The researchers were faced some problems in conducting this thesis. From these problems, the most mentioned were the acquisition of different warp count fabric sample, financial problem and transport access. Beside the researchers was faced problem. When also faced shortage of reference materials in the library, there were no more related studies on warp count effect on mechanical properties.

1.9. Operational definitions of terms and concepts

Direct Count System: - The direct systems are based on the weight or mass per unit length of yarn.

Indirect Count System: - In an indirect system, the yarn number or count is expressed in "units of length" per "unit of weight”.

Tensile strength: - properties are the most common mechanical measurement on fabrics.

Tear strength: - Tearing occurs when stress imposed on a fabric result in a concentration of stress at a point, leading the individual to failure.

Fabric Crease Recovery: - The crease recovery is one of the elementary properties of fabrics which affect product performance.

Pilling resistance: - is a fabric defect which is observed as small fiber balls or group consisting of intervened fibers that have been attached to the fabric surface by one or more fiber

CHAPTER TWO

LITERATURE REVIEW

2.1. Spinning

Spinning in conversion of fibers into yarn. These fibers can be natural fibers (cotton) or manmade fibers (polyester).Spinning also entails production of manmade filament yarn (yarn that is not made from fibers). Final product of spinning is yarn. Cotton value chain starts from Ginning that adds value to it by separating cotton from seed and impurities.

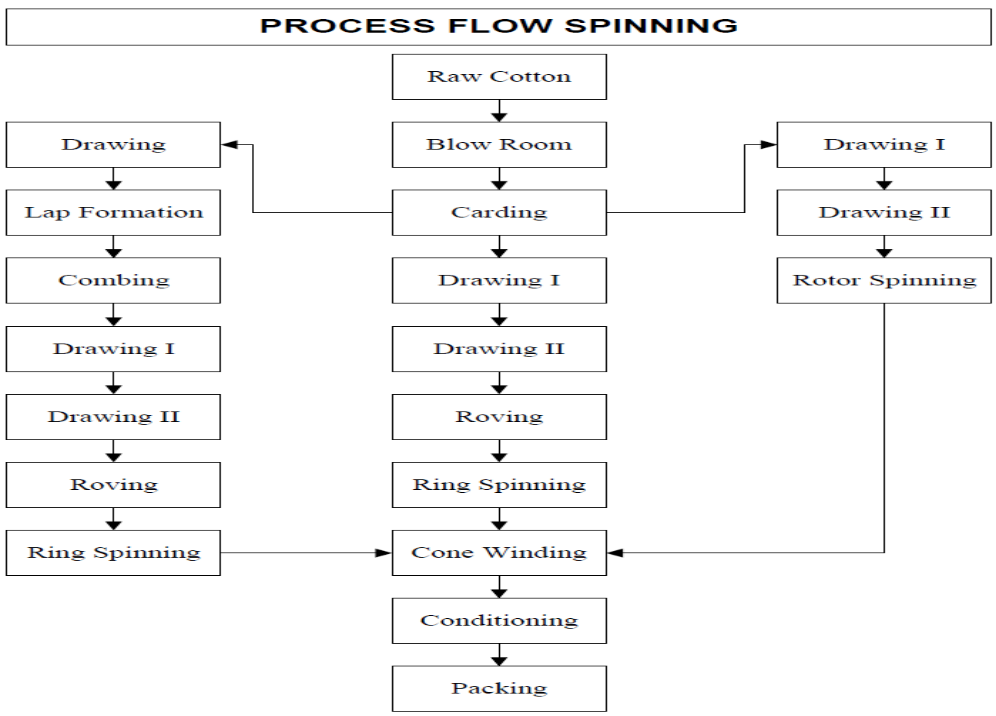

Figure 1 Process of Spinning

2.1.1. Blow Room Operations

In the first process of spinning, cotton is converted into laps. Cotton bales are opened up and fed into puckers which open up the cotton fibers through tearing action. From here, it is sent to blow room. In the Blow room, different lots of opened up cotton are mixed to achieve homogeneity and then passed through different stages of blowing and thrashing to remove trash and open it up further(usually, eight stages are used).If required, blending of fibers is also carried out in the blow room. In the end we get straightened layers of cotton wrapped in the form of rolls called Laps. In chute feed system, lap formation is eliminated and clean and blended cotton fibers pass directly to the carding machine by pneumatic controls(Pakistan's Textile Vision 2005 and William Oxenham 2003)

2.1.2. Carding

The Laps from blow room are fed into the carding machines to get uniform Slivers which are in the form of lose continuous strands of cotton staple.

Figure 2.2 Carding

Another purpose of carding is to further clean the impurities that are left during the blow room operations. Some short fibers and any other foreign matter are also in the process. The slivers are kept in specially made lightweight drums. Slivers from carding section can go either directly to Finisher drawing through breaker drawing or through UN Lap/Comber to Finisher drawing. (William Oxenham 2003).

2.1.3. Drawing

Purpose of drawing is to straighten the fibers and remove any curls. This takes place by passing the slivers through different sets of rollers that are revolving at different speeds. The speeds of the rollers increase as the sliver moves from one stage to the next.

Figure 2.3 Drawing

The progressive attenuation reduces the size and weight of single sliver that has-been fed. The final sliver that comes out of drawing is of the same weight and size as the number of slivers which are fed compensate for the attenuation of the individual slivers (textilelearner.blogspot.com).

2.1.4. Ring Spinning

Ring Spinning is the stage from which yarn is obtained in its proper count and twist. Four actions take place in this stage. First is roving delivery. Second is drafting that is process in which the linear density of the roving is decreased by controlling the surface speeds of the input and output machine components. Thirdly, twist insertion into yarn and final action is winding. All these operations take place continuously in a relative order. The product of ring spinning is the yarn of given count, twist type (S or Z), draft and (TPI) Twists per Inch (Pakistan’s Textile Vision 2005).

Figure2.4 Ring Frame

2.2. Properties of Staple Yarns

During the process of textile slashing and weaving, the yarns are subjected to a variety of both simple and complex mechanical deformations, such as tensile, bending, compression, and torsion. The ability of textile yarns to withstand such cyclic tensile, bending, compressive, and tensional stresses is of prime importance for successful slashing and subsequent weaving. An understanding of a yarn's performance during the subsequent processes is therefore never complete without taking into account the mechanical response of the yarn to such deformations. The mechanical behavior of staple fiber yarns is strongly influenced by the properties of the constituent fibers and their relative disposition in the body of the yarn [Adamec, S.; Kubicek, 1986].

2.2.1. Basic Structural Features of Spun Yarn

Before proceeding with the discussion on yarn characteristics, it will be important to discuss the basic structural features of spun yarn. Understanding these features provides an insight into the interpretation of yarn behavior during processing or in the end product. The basic structural features of spun yarn are: yarn density, bulk integrity, and surface profile (Dr. Yehia El Mogahzy elmogye@auburn.edu)

2.2.2. Yarn Density

In a yarn structure, fibers represent the main component. The other component is air pockets created by the technology forming the structure. The importance of packing fraction lies in its powerful effects on many yarn and fabric properties. It is indeed one of the major design parameters of textile fabrics. For a given fiber material, a yarn of very high packing fraction is likely to be stiff and probably weak. In relation to fabric performance, yarn density plays a major role in determining many of the performance characteristics of fabric. One of the major fabric characteristics influenced by yarn density is fabric comfort. In general, fabric comfort is viewed in terms of two main aspects [El Mogahzy, 1998].

2.2.3. Yarn Bulk Integrity

Yarn bulk integrity is determined by the fiber arrangement in the yarn structure. Fiber arrangement is expected to have significant effects on many yarn and fabric characteristics including yarn liveliness, fabric dimensional stability, yarn appearance, yarn strength, and fabric cover. The bulk integrity of a spun yarn largely reflects the impact of the spinning process on yarn structure. In general, different spinning techniques provide different forms of bulk integrity through providing different fiber arrangements.

Obviously, the simplest fiber arrangement can be found in a continuous filament yarn where fibers (or continuous filaments) are typically arranged in parallel and straight form (Dr. Yehia El Mogahzy elmogye@auburn.edu).

2.2.4. Yarn Surface Profile

The surface profile of a spun yarn may be described by three basic parameters: - the overall surface appearance of yarn, surface integrity, and surface irregularities. The importance of yarn surface profile lies in the fact that a yarn is initially judged by its surface appearance. As the yarn goes through the weaving or the knitting process, surface integrity (abrasion resistance and hairiness) becomes the most critical factor determining yarn performance. As the yarn is finally woven or knitted into a fabric, Surface irregularities (thick and thin places, and yarn neaps) are typically the most noticeable defects in the fabric (textilelearner.blogspot.com).

2.2.5. Yarn Fineness or Count

In practice, yarn fineness is typically described by terms such as yarn count, yarn number, or yarn size. The subject of yarn fineness can be treated in a similar manner to that of fiber fineness in the sense that both the fiber and the yarn may not have perfectly circular cross sections and they both exit thickness variability. Therefore, the linear density or mass per unit length is commonly used as an alternative measure of actual fineness or thickness. In general, two yarn count systems are commonly used: (I) the direct system, and (ii) the indirect system. (Website at: (www.cottoninc.com)

2.2.6. Direct Count System

In a direct system, yarn count is the mass of a unit length of yarn. One of the universally used direct systems is known as the "tex". This is defined by the mass in grams of 1 km of yarn. Both the mille tex and the decitex mentioned earlier for fibers are extensions of the tex system. For intermediate heavy products such as slivers, the "kilotex" is commonly used. This is the mass in kilograms per kilometer (or equivalently, grams per meter). A more common direct system for slivers is the grains/yd, where a grain is1/7000lb. For continuous filament yarns, the denier system is used; this is the weight in grams. (Website at: www.cottoninc.com)

2.2.7. Indirect Count System

. According to Xungai Wang (2009), indirect system, the yarn number or count is expressed in "units of length" per "unit of weight”. Several indirect systems are used in practice depending on the type of yarn produced, and the spinning system. For cotton yarns, the “English” or “cotton” count is used to express yarn fineness. The unit of length in an “English” count system is the hank, 840 yd, and the unit of weight is 1 lb. normally, yarn count is determined by determining the mass of 120 yd of yarn. For example, if the weight of a 120 yd yarn is 0.004 lb, the English or cotton count will be 120/(840x0.004), or 35.7. In symbols, this is commonly written as Ne = 35.7's. The cotton count may also be used for heavier products such as slivers. For wool yarns, two indirect systems are commonly used: (i) the Woolen system, and (ii) the Worsted system. Within the Woolen system, several sub-systems are utilized. These include: (a) the Woolen (American cut) with a unit length of 300 yards cut, and the unit of weight is pound, and (b) the Woolen (American run) with a unit length of 100 yards and the unit of weight is ounce. In the Worsted system, the unit length (or the hank) is 560 yards, and the unit of weight is pound. Another indirect system is the "metric" system commonly used in Europe. In this system, the unit length is kilometer, and the unit of mass is kg.

Conversion Factors of Count

From	To	Formula
Tex	Denier	9xTex = Denier
Tex	English or Cotton Count(Ne)	590.5/Tex = Ne
Tex	Metric (Nm)	1000/Tex = Nm
Ne	Denier	5315/Ne = Denier
Ne	Metric(Nm)	Ne / 0.59 = Nm
Ne	Grains/yd	8.33/Ne = grains/yd

2.2.8. Yarn Twist

Twisting is the primary binding mechanism of spun yarns. In general, twist is defined as a measure of spiral turns given to a yarn in order to hold the constituent fibers together. (Hong, B.T., Bin, G.X. and Xiao, M.T).

2.2.9. The Importance of Yarn Twist

In practice, the importance of twist direction is realized when two single yarns are twisted to form a ply yarn. Ply twist may be Z on Z, or S on Z depending on appearance and strength requirements of the ply yarn. Recall that in determining the yarn count of a plied yarn, we had to account for the possible contraction or increase in length resulting from twisting. Normally, the Z on Z twist will result in a contraction of the plied yarn, while the S on Z twist will result in an increase in length. This amount of contraction or expansion will depend on the amount of twist inserted. (Dr. Yehia El Mogahzy elmogye@auburn.edu).Twist direction will also have a great influence on fabric stability, which may be described by the amount of skew or "torque" in the fabric. This problem often exists in cotton single jersey knit where knitted wale sand courses are angularly displaced from the ideal perpendicular angle. One of the solutions to solve this problem is to coordinate the direction of twist with the direction of machine rotation. With other factors being similar, yarn of Z twist is found to give less skew with machines rotating counterclockwise. Fabrics coming off the needles of a counterclockwise rotating machine have courses with left-hand skew, and yarns with Z twist yield right-hand wale skew. Thus, the two effects offset each other to yield less net skew (Journal of American Science, 2012 and (http://www.americanscience.org) Many investigators made various attempts to explain the strength-twist relationship (e.g. Hearle et al, 1969, and Lord, 1981). In practical terms, the strength-twist relationship may be explained on the ground that at zero twist, fibers are more or less oriented along the yarn axis but without any binding forces (except their interfacial contact). As twist slightly increases, the contact between fibers will increase due to the increase in traverse pressure, and the force required to stretch the yarn must first overcome the inter-fiber friction. Further increase in twist will result in further binding between fibers and an increase in the number of cross-linking points between fibers. This provides an opportunity for many fibers to be held at some points along their axis by other fibers. When this happens, the fiber strength begins to play a role in resisting the force required to stretch or rupture the yarn. Eventually, fiber strength will play a greater role than inter fiber friction in tensile resistance. However, the discrete nature of fibers will always necessitate inter-fiber cohesion. The trend of increasing strength with twist will continue until some points where the fibers become so inclined away from the yarn axis that the contribution of fiber strength will decrease. This will result in a reduction of yarn strength with the increase in twist (Hearle et al, 1969, and Lord, 1981).

2.2.10. Yarn Strength

Yarn strength is considered as one of the main criteria characterizing yarn quality. Indeed, no other yarn characteristic has received more investigative attention than yarn strength. Most of the studies dealing with yarn strength focused on developing models characterizing yarn strength as a function of structural parameters and fiber attributes. Many of these models revealed a great deal of information about the complex nature of yarn strength. In recent years, interest in modeling yarn strength with respect to relevant fiber attributes has increased as a result of the revolutionary development of fiber testing and information technology, and the introduction of new spinning technologies (B P Saville, 2000).

2.2.11. Importance of Yarn Strength

The importance of yarn strength can be realized in all stages of processing from spinning to finish fabric manufacturing. In any spinning technique, yarn strength represents a crucial parameter, which determines the performance of spinning. For instance, an ends down in ring spinning is often a result of the failure of the yarn to withstand a high peak of spinning tension. This failure results from a weak portion of the yarn (Dr.Yehia El Mogahzy, 20011).

The strength-twist relationship is considered to be a characteristic curve of the spinning performance that must be established to produce a high strength yarn. As indicated earlier, fiber properties such as strength, length, fineness, and friction play a vital role in determining this relationship.

During yarn preparation for weaving, the yarn is subject to continuous tension as a result of the repeated winding and unwinding necessary for weaving preparation. This tension should be within the elastic boundaries of the yarn to avoid permanent deformation..

During the weaving process, thousands of yarns are simultaneously subject to continuous cyclic loading, which is a basic necessity for the interlacing actions required to make cloth. Weaving peak tension may reach levels exceeding 35% of the average breaking force of the yarn. Both tension variation and yarn strength variation are expected. A single yarn may break when it exhibits a level of strength that is lower than the weaving tension at some points of the yarn. When a maximum tension coincides with a minimum strength point of the yarn, failure of yarn to withstand the tension will occur. This failure may result in an end breakage and a complete stop of the weaving process. During weaving, the yarn is subject to tension, which may reach levels of more than 30% of the average breaking force of the yarn. The stress-strain behavior of yarn is a critical factor in determining the mechanical behavior of fabric under different modes of deformation (e.g. tension, bending, and shear). (DeLuca L B and Thibodeaux D P, 1992)

2.3. Weaving

In textiles, fabrics are manufactured in wide varieties and designs. And different designs and effects are produced on fabric with various mechanisms which are helpful to form different weaves and lots of design which enhances the look of apparels. Tortora and Merkel (2005) define weaving as the method or process of interlacing two or more sets of yarns or similar materials so that they cross each other at usually right angles to produce woven fabric. It further explains it is the act of causing two systems of yarn, warp and filling, to interlace. Weaving is the textile art in which two distinct sets of yarns or threads, called the warp and the filling or weft (older woof), are interlaced with each other to form a fabric or cloth. The warp threads run lengthways of the piece of cloth, and the weft runs across from side to side.

2.3.1. The process of weaving

A woven fabric is produced on a machine called a loom. The starting point for making a fabric is to get the warp beam (which is a sheet-like assembly of parallel yarns wound on a roll) ready for transfer to the loom. The path of the warp sheet on the loom is worth noting. The actual yarn interlacement goes on in the front part of the loom and the woven cloth is then wound on the cloth roll. At this stage it would be instructive to understand how the warp beam is filled with yarn. To do this the dimensions of the cloth to be made must be known (Wynne, A. (1997).

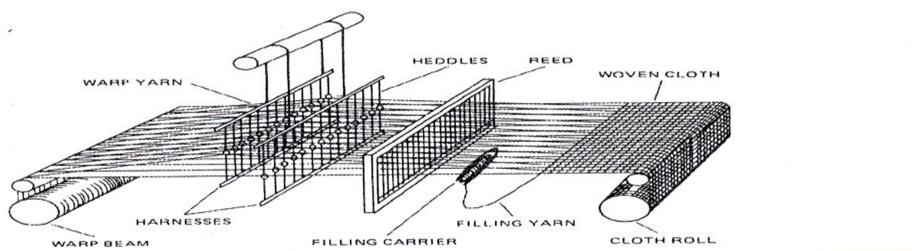

Figure 2.5 Process of Interlacement or weaving

2.3.2. Types of Weave

Woven fabrics are produced as result of interlacing two sets of yarns, warp and weft which runs lengthwise and crosswise respectively in the fabric. The order of successive movements between these two sets of yarns determines the physical appearance of the fabric identified as the weave or the structure. Furthermore, fabric weaves are regarded as the structural pattern of different fabrics. Without the fabric weave, fabric may never be constructed. How loose, decorative, tight, nubby or soft a certain fabric is, depends largely on the fabric weave. They can also cause a huge variance regarding the fabrics durability or strength.

Luther (2010) states that, there are many kinds of fabric weave. The most common ones are Twill; Rib, Plain, Oxford, Basket, Satin, Uncut Pile, Chenille Weave, Dobby, Cut Pile, Double Knit, Leno, and Jacquard. Furthermore, fabric weaves are different methods wherein the various types of fabric are manufactured. There are actually a lot of different fabric weaves that are initially made due to various purposes.

2.3.3. Plain weave

Merkel (2005) the plain weave is variously known as “calico” or “tabby” weaves. It is the simplest of all weaves having a repeat size of 2. The plain weave characteristics are: (*i*) It has the maximum number of binding points

- The threads interlace on alternate order of 1 up and 1 down.
- The thread density is limited
- Cloth thickness and mass per unit area are limited.

The principle involved in the construction of plain cloth is the interlacement of any two continuous threads either warps or weft in an exactly contrary manner to each other (Luther, 2010).

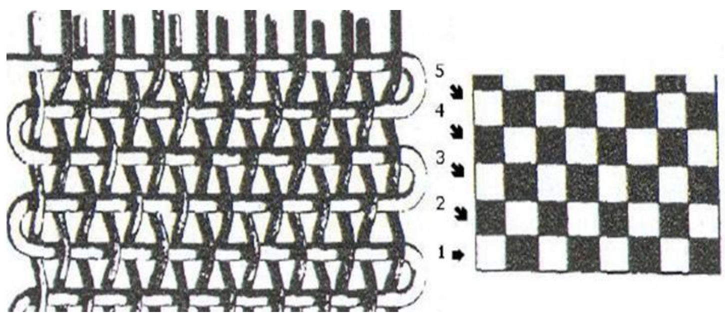

Fig. 2.6 Plain weave

2.3.4. Twill weaves

Twill weaves are the weaves that find a wide range of application. They can be constructed in a variety type of ways. The main feature of these weaves that distinguishes from other types is the presence of pronounced diagonal lines that run along the width of the fabric. (V. Subramaniam, 2004)

The basic characteristics of twill weaves are:

- They form diagonal lines from one selvedge to another.
- More ends per unit area and picks per unit area than plain cloth.

- Less binding points than plain cloth
- Better cover than plain weave
- More cloth thickness and mass per unit area. (V. Subramaniam, 2004)

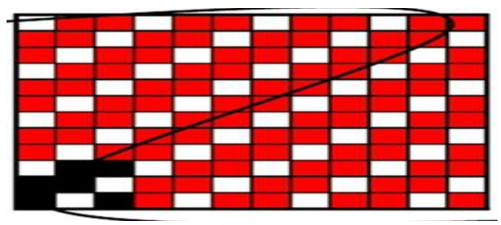

Fig. 2.7 Twill weave

2.4. Fabric Properties and Their Characteristics

While the fabric properties are also influenced by warp and weft density of the woven fabrics, and weave. The mechanical properties are also influenced by the weaving conditions, e.g. speed of weaving, warp insertion rate, weft beat-up force, the way of shed opening, warp preparation for weaving, warp and weft tension, number of threads in reed dent etc. The properties of raw fabrics consequently depend on the construction and technological parameters. For the final use, raw fabrics have to be post-treated to add different functional properties. In most cases, these post-treatments worsen some mechanical properties, while again some other mechanical properties improve (Emel Önder, weaving technology II, 2008).

2.4.1. Mechanical properties of woven fabrics

The mechanical properties, the phenomenon on textile material is described which a result of the material resistance on the activity of external forces is causing the change of shape. The response of the textile material depends on the material properties, the way of load and its tension. With regard to the direction of the applied force, deformations at stretch and compression are known. Fabric properties are generally divided in three important parameters; Chemical Properties of Fabrics Physical Properties of Fabrics Appearance Properties of Fabrics (Kawabata, S. and Niwa, M., 1989.)

2.4.2. Tensile Strength of Yarn and Woven Fabric

According to Realff et al (1997), tensile strength is defined as a maximum load that a yarn or fabric specimen will endure when subjected to uni-axial tensile loading (in this report, all the analyses are based on the absolute values as measured from yarn and fabric samples throughout the work). Taylor (1959) stated that tensile strength is the most important property of a woven fabric. It differentiates a woven fabric from anon-woven and a knitted fabric. It provides a comprehensive check on most of the features of cloth construction. Thus in order to ensure the quality of fabric, yarn as well as fiber, a demand for minimum fabric strength is added to the usual structural particulars of a fabric(Nikolic et al (2000) reported that tensile strength of a woven fabric is a function of thread strength, fabric density and thread strength coefficients.

In the modern era, when a buyer wishes to put an order in bulk for woven fabric, the order is placed to the fabric manufacturer or supplier with some required specifications such as yarn linear density and material (cotton, polyester or blend etc) in warp and weft direction, warp and filling count (ends and picks per 25 mm), weave design, tensile strength, width and weight per square meter of the fabric etc. In such cases, buyer asks the supplier to submit fabric sample and confirms the order after getting an acceptable fabric sample. To ensure consistent quality of fabric, buyer keeps this accepted sample as reference and raises the claim in case of any deviation from required specifications specially the tensile strength which is a comprehensive check on quality of fiber, yarn, fabric as well as their processing.

Thus, a manufacturer has to send a sample to buyer for acceptance. For this, the yarn of required linear density and material is purchased from the market. Then it is processed through warping, sizing, drawing-in as per weave design, warp and filling count and width of fabric. Then this sample is tested in the laboratory for the predefined specifications. Mostly the test results remain in the required range for all specifications except the tensile strength. It is because; tensile strength of yarn cannot be calculated from the predefined tensile strength of required fabric and thus sample is rejected even if all other specifications are according to the requirement.

2.4.3. Factors Affecting Woven Fabric Tensile Strength

- ✓ **Yarn material**

According to Celanese Acetate (2001), yarn occurs in the following forms

- A number of fibers twisted together (spun yarn).
- A number of filaments laid together without twist (a zero-twist yarn).
- A number of filaments laid together with a degree of twist.
- A single filament with or without twist (a monofilament).
- A narrow strip of material, such as paper, plastic film.

Tensile strength of yarn and fabric is affected by different characteristics of yarn material. Logically, a strong fiber produces a strong yarn and consequently a strong fabric than a weak fiber. However, Taylor (1959) stated that strength of cloth is much less than that of the integral strength of fibers in a cross section of cloth. Fiber friction is the key force that produces strength by holding staple fiber together.

- ✓ **Yarn linear density**

Weight per unit length of yarn is called linear density. A yarn with higher linear density has more number of fibers per cross section and large diameter. Large numbers of fibers enhance the inter-fiber cohesion and consequently improve the tensile strength of yarn and fabric. Booth (1982) stated that yarn count (linear density) is one of the variables related to yarn, which has influence on fabric strength. Similarly Dastoor et al (1994) reported that yarn size is one of the yarn variables which have influence on the structural properties of woven fabric.

- ✓ **Yarn tensile strength**

According to Ping and Greenwood (1986), tensile strength of a fabric in either the warp or weft direction is the function of yarn strength. Taylor (1959) stated that strength of woven cloths of common constructions usually remained between 85 %and 125% of the integral strength of all the yarns in the direction tested. Nikolic concluded that woven fabric strength increases with the increase of thread strength.

- ✓ **Warp and filling count**

Warp and filling count can be described as number of warp yarns (ends) per unit distance and filling yarns (picks) per unit distance which are determined using suitable magnifying and counting devices or by raveling yarns from fabrics. According to Taylor (1959), strength of a fabric is increased with increase in the warp and filling count by improving fiber binding relative to the yarn strength. However, if the yarns are already very well bound, the effect may be small, and it may be offset by the increase of yarn crimp. Similarly, Seo et al (1993) reported that a dense fabric shows high strength since yarn failure is initiated at the bending point where the highest local strain occurs.

Figure 2.8 universal tensile strength tester

2.4.4. Pilling resistance

According to Kumaşlarda Boncuklanma (1994, Vol. 45-46)Pilling resistance is a fabric defect which is observed as small fiber balls or group consisting of intervened fibers that have been attached to the fabric surface by one or more fibers. Pilling in general, is a self-limiting process which emerges at three consumptive different stages. According to B P Saville, (1999), Formation of surface fuzz, entanglement, and transformation into pills. Subsequently, pills are broken off the fabric surface when by excessive frictions, the anchor fibers are broken. The pills are formed during wear and washing, which means that fabrics are affected by friction forces during usage. Friction forces results in the abrasion and pilling of fabric. Consequently there are some relationships between abrasion resistances and pilling .The construction of the fabric is also important in determining its susceptibility to pilling. A very tight, compact construction, such as denim, usually pills very little. However, a loosely knitted or woven fabric will show more pilling with both wear and cleaning. Pills do not interfere with the functionality of the textile, unless a spot with a lot of pills turns into a hole in the fabric. This is because both pills and holes are caused by the fabric wearing. According to Lee, W. and Dhingra, Vol. 3, pp. 50-58. According to Ahmed, M., Vol.80, pp. 279-284 Many textile scientists have studied the factors that generally affect pilling performance. According to Gintis, and E. J. Mead, (1959) Pilling attitude is prejudiced by not only the structure of the yarn and fabric but also by the fiber properties, e.g. tensile strength, percent elongation, flex abrasion, bending rigidity, fiber titer, shape officer cross-section and friction. According to R. Campos, A mathematical model was established to evaluate fiber–fiber friction and that gave an indication of the pilling properties of man-made cellulosic knitted fabrics. In another work, fabric pilling was evaluated with light-projected image analysis. It was found that the method could eliminate interference with pilling information from the fabric color and pattern. Different pilling testers may give different pilling results for the same fabric, and it has different sensitivities for various yarn fiber and fabric parameters.

2.4.5. Methods for fabric pilling measurement

The traditional wrinkling and pilling measurements are both based on the visual examination which compares fabric samples with different levels of standard replicas. Pilling conditions are quantified by a standard set of photographic pilling standards supplied by ASTM, as seen in Figure 2.6.Five grades from most severe pilling, grade 1, to no pilling, grade 5, were defined to describe fabric pilling condition (Wenbin Ouyang, M.S.T.A.T2013)

Figure 2.9 ASTM standard replicas for pilling assessment

Figure 2.6 Marking system Mark 5 = no or very little pilling, Mark 4 = light pilling formation, Mark 3 = moderate pilling formation, Mark 2 = distinct pilling formation, Mark 1 = strong pilling formation, (Half marks are allowed).

2.4.6. Tear strength

Tearing occurs when stress imposed on a fabric result in a concentration of stress at a point, leading the individual to failure (Brody H, U.K 1994). The main factors that affect tear strength are yarn properties and fabric structure. The mechanism of fabric tearing is different from linear tensile failure and relates to the ability of individual yarns to slide, pack together or 'jam' as bundle, increasing the tearing force. Thus an open fabric structure contributes to more yarn sliding and jamming, and higher tear strength. An increase in yarn density in a woven fabric will decrease the tear strength of a fabric as yarns are broken individually as they have more restriction, preventing yarn slide. A tightly mounted fabric is easier to tear than a slackly mounted fabric because the tear force propagates from yarn to yarn as the linear force in the yarn restricts yarn slide. Staple yarn has a lower tear strength compared to filament yarn. In a trapezoid tear test, an increase in ends and picks increases tear strength. Tear resistance can also be affected considerably by the speed of the test. [B P Saville, 2000].

2.4.7. Effect of Number of Warp and Filling Yarns on Tear Strength

The tear resistance depends upon the freedom of movement of the warp and filling yarns and upon the elongation and breaking strength of the yarns. The number of warp and filling yarns appear to have little effect on the tear resistance. The tear resistance is greater for the basket weave, which is more open and contains fewer yarns interlacing than the plain weave, which is in agreement with the results noted in Research Paper RP600. The tear resistance of the warp is greater than that of the filling. This difference is attributable to the fact that the elongation and breaking strength are greater for the warp yarns than for the filling yarns (Herbert F. Schieler and Daniel H237 (1998).

2.4.8. Effect of the ground weave

The main factors that affect tear strength are yarn properties and fabric structure. The mechanism of fabric tearing is different from linear tensile failure and relates to the ability of individual yarns to slide, pack together or 'jam' bundle, increasing the tearing force. Thus an open fabric structure contributes to more yarn sliding and jamming, and higher tear strength. An increase in yarn density in a woven fabric will decrease the tear strength of a fabric as yarns are broken individually as they have more restriction, preventing yarn slide. A tightly mounted fabric is easier to tear than a slackly mounted fabric because the tear force propagates from yarn to yarn as the linear force in the yarn restricts yarn slide. Staple yarn has a lower tear strength compared to filament yarn. In a trapezoid tear test, an increase in ends and picks increases tear strength. [B P Saville, 2000].

2.4.9. Fabric Crease Recovery

Crease recovery The ability of fabrics to resist the formation of crease or wrinkle when lightly squeezed is termed as crease resistance of the fabric and is associated with the fabric stiffness (Dr. V. A. Shenai and Dr. N. M. Saraf, Second edition 1995) Cotton though is comfortable to wear; its Crease recover angle is very poor and hence is aesthetically unappealing. Cotton fabrics are most prone to crease formation since their ability to recover from the applied deformation is the least and has been explained in the mechanism of crease formation [Dr. V. A. Shenai and Dr. N. M. Saraf, Second edition 1995]. It is known that the synthetic yarns/fibers have greater resilience and are springy in nature, obviously resulting in greater Crease recover angle up to 150-155°. Wool is the most resilient natural fiber and its expected Crease recover angle is around 140-145°. Various methods are available to improve the dry and wet crease recovery of cotton fabrics. Several researchers have reported the influence of different treatments on fabric and many other have studied the recovery property in wet as well as dry conditions along with mathematical models.

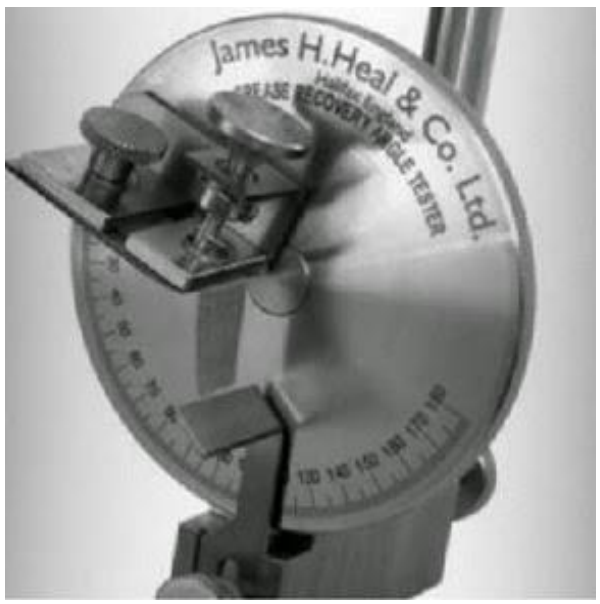

Figure 2.10 Shirley crease recovery tester

CHAPTER THREE

MATERIAL AND METHODS

3.1. Materials

This thesis is concerned with Effect of warp count on woven fabric mechanical properties (tensile strength, tear strength, pilling resistance and crease recovery) to enrich it and also improving its properties, meeting the functional purpose it is produced for in this thesis 3 fabrics were produced. Table 3.1 includes warp and weft count, yarn material specification and table 3.2 indicate lab taste equipment.

Table 3.1 Specifications Fabrics produced three warp count fabric sample

Fabric type cotton	Warp count (Ne)	Weft count (Ne)	Material of warp	Material of weft	end/ cm	pick/ cm	m/n type Picanol, G 6300	m/n speed 400 rpm
1	17	34	Awash Cotton	Awash Cotton	20	13	Picanol	400 rpm
2	22	34	Awash Cotton	Awash Cotton	20	13	Picanol	400 rpm
3	24	34	Awash Cotton	Awash Cotton	20	13	Picanol	400 rpm

Table 3.2 Laboratory Test Equipments used

No	Name of equipment	Test	Located in	Specification
.1	Universal pilling tester	fabric pilling resistance	/ EITEX	Mesdan Italy
2	Tear strength tester	Fabric tearing strength	EITEX	SDL atlas
3	Fabric cutter for Gsm	Fabric weight	EITEX	SDL Italy
4	tensile strength tester	Fabric strength tester	EITEX	Mesdan Italy
5	Crease recovery tester	Crease recovery	EITEX	Mesdan Italy

3.2. Methods

This thesis is designed to study the effect of warp yarn count on woven fabric mechanical properties by collecting different data and samples. The fabric properties are identified for the study depending on the availability of equipments for the test and by selecting the most Pikanol weaving fabrics. For this study three different warp yarn count fabric are selected and other yarn properties and weaving machine setting and parameters are controlled with constant value. The methods for this thesis work are:-

- Produce fabric with different warp count and constant other parameters.
- Study the effect of warp count on woven fabric mechanical properties by carrying out proper testing.
- Produce woven fabrics from the three different warp count levels of yarn.
- Study the fabric mechanical properties by carrying out proper testing.

This thesis work the data is collected from weaving and quality control department of kombolcha textile Share Company. The data is targeted to weaving section to collect three type warp count (17 Ne, 22 Ne 24 Ne) sample cotton fabric and from quality control section to collect different mechanical properties of warp yarn count according to the standard sample fabric taste. When taken three plain fabric sample have the same structure kombolcha textile share company to check and analysis using Eitex laboratory machine the fabric sample properties related to the problem with warp count effect on woven fabric mechanical properties to increase the fabric quality deeply emphasis for the solution. Here all the data collected and tested exclusive of warp yarn properties except warp yarn count (keeping yarn properties constant other than warp yarn count). The quantitative approach was employed as a design for the study because it is intended to make detailed analysis of the effect of warp count on cotton woven fabric mechanical properties such as tensile strength tear strength pilling resistance and crease recovery. Finally conclude and report the study.

CHAPTER FOUR

RESULT AND DISCUSSION

The thesis work is mainly focus on the effect of warp count on cotton fabric mechanical properties such as tensile strength, tear strength, pilling resistance and crease recovery. The study is done using three different warp counts such as 17 Ne, 22 Ne and 24 Ne each average specimen sampling in the laboratory tested. The test was done as (ASTM) and the test results are recorded along with each property studied. With this standard, many of the tests were done for three specimens in the standard atmospheric condition at 21 ± 1^{o}c and 65±2% at EiTEX laboratory. When the tested properties of fabric are tensile tear strength, pilling resistance and crease recovery.

4.1. Tensile strength test

Tensile strength test was carried out according to American standard specifications of (ASTM-D-5034-90) Five samples each with their lengths parallel to the warp are prepared in the laboratory test.

Table 4.1 Plain fabric tensile strength made from 17 Ne, 22 Ne and 24 Ne cotton yarn in warp direction.

Number of tested fabric	Warp wise Tensile strength (N) **17** (Ne)	Elongation %	Warp wise tensile strength (N) **22** (Ne)	Elongation %	Warp wise tensile strength (N) **24** warp (Ne)	Elongation %
1	639	11.25	385	8.40	402	10.80
2	631	12.15	587	13.95	324	14.70
3	510	15.00	482	17.40	335	13.48
4	611	15.25	494	10.25	478	11.10
5	625	13.8	506	11.55	244	9.15
Average	603	13.49	490.8	12.31	356.6	11.846

As above indicate table 4.1 the tensile strength value of the fabric count 17 Ne, 22 Ne and 24 Ne was made by using 17 Ne, 22 Ne and 24 Ne cotton yarn in warp direction, it has been observed that the tensile strength of fabric 17 Ne cotton fabric is greater than that of fabric count 22 Ne and fabric 24 Ne respectively. This difference is fabric tensile (17 Ne) is only due to change of yarn count because all other construction parameters are the same. So warp wise tensile strength is higher in case of 17 Ne cotton fabrics in warp direction. Consequently it used 17 Ne coarser count yarn to contribute for tensile strength of fabric which has larger yarn diameter and more number of fiber in the yarn layer and more fiber present with the same time better yarn elongation properties of 17 Ne cotton fabrics. The tensile strength values of 24 Ne plain cotton fabrics in warp direction are less than fabric 22 Ne plain cotton fabric. When using finer cotton yarn count (24 Ne) in case of 24 Ne plain cotton fabric breaking elongations of fabric lower value. The reason for finer yarn cotton count low yarn diameter and less number of fibers in the yarn cross-section area that reduction cotton fabric elongation and strength properties. For a better comparison and understanding how three warp yarn count influence tensile strength, fabrics in warp direction indicated in figure 4.1

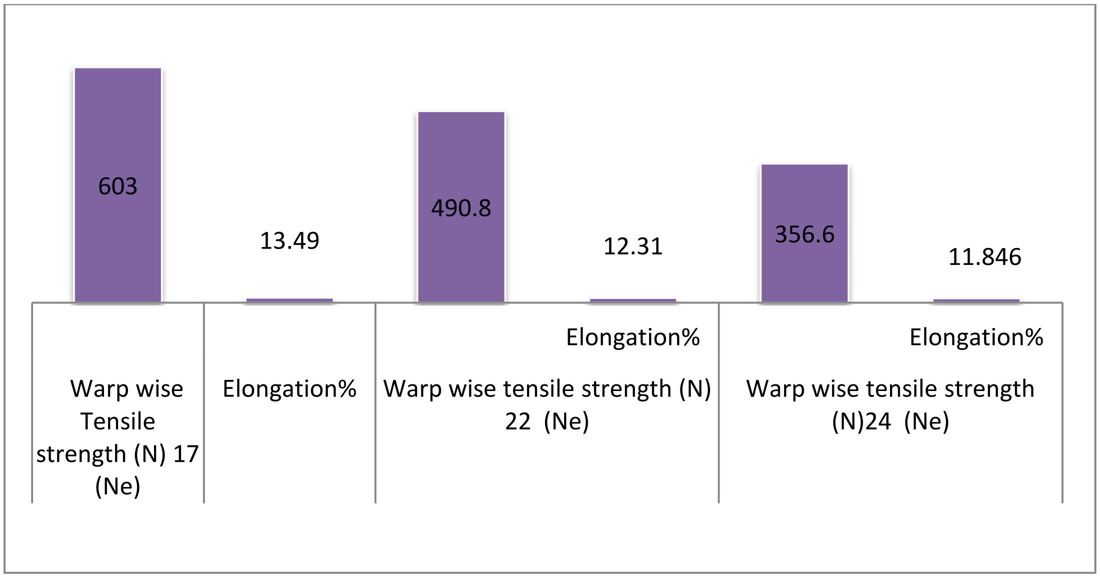

Fig 4.2 Effect of warp count on fabric tensile Strength in warp direction

Whereas other researches (Armitage, Law, Brierley, Seyam and El-Shiekh (2008) related to the yarn count were carried out with relation to tensile strength and elongation to finer count of weft yarns that to less tensile strength in the weft direction of the fabrics, that is an inverse relationship, while coarser the linear density of wefts increases the tensile strength in the weft direction. This is due to that finer counts of weft thread, reduced the strength of yarn in addition to low elongation ratio is even lower accordingly, tensile strength. While it is coarser the linear density of wefts that growing number of threads exposed to the tensile strength are increased accordingly tensile strength in the direction of the weft.

4.2. Tear Strength Test

The mechanism of fabric tearing is different from linear tensile failure and relates to the ability of individual yarns to slide, pack together or 'jam' into a bundle, increasing the tearing force. The test was carried out according to American standard specifications of (ASTM-D-2661-98).The average tear strength of the specimens from each laboratory sampling unit, and the average are reported in Table 4.2 below.

Table 4.2: Tear strength of plain fabrics made from 17 Ne 22 Ne and 24 Ne cotton yarn in warp way.

Number of tested fabric	Warp wise Tear resistance (N) **17** warp count (Ne)	Warp wise Tear resistance (N) **22** warp count (Ne)	Warp wise Tear resistance(N) **24** warp count (Ne)
1	46.9	41.2	40.06
2	46.6	40.5	40.93
3	47.57	42.2	39.5
4	48.4	42.12	40.44
5	47.8	42.8	38.3
Average	47.454	41.764	39.84

From the Tables 4.2: It can be observed that 17 Ne plain cotton fabrics has scoured the highest rate for warp tear strength followed by 22 Ne plain cotton fabric and 24 Ne plain fabric respectively. Because as indicated in the result the tear strength of 17 Ne plain cotton fabric is higher in warp direction as the fabric was made by using coarser or 17 Ne cotton yarn. Thus it can be using coarser or high count cotton yarn utilization of fabric tear strength because coarser count has greater number of fiber in the cross section of the yarn, due to that tear breaking strength are higher. When 22 Ne (warp count) plain cotton fabrics made from 22 Ne cotton yarn medium resistance tear force compares to 17 Ne cotton fabrics. The tear strength of 24 Ne (count) plain cotton fabrics made from 24 Ne finer cotton yarn score slow result of tear strength value. Tear strength of fabric low result value for uses finer yarn count because finer yarn are low diameter, thin structure and low number of fiber in the yarn layer during yarn production in this contributes lowering of tear strength value of the plain cotton fabric. Recently, many simulation studies (*ElSayed A. ElNashar 2017*) related to the yarn count on tear strength, to use fine count of weft for less resistant fabrics producing rupture in the direction of the warp, This is due to that finer count of yarns of the weft in Ne System, decreasing the thickness which increases the porosity between the interlaying of warp threads which less the resistance to tearing.

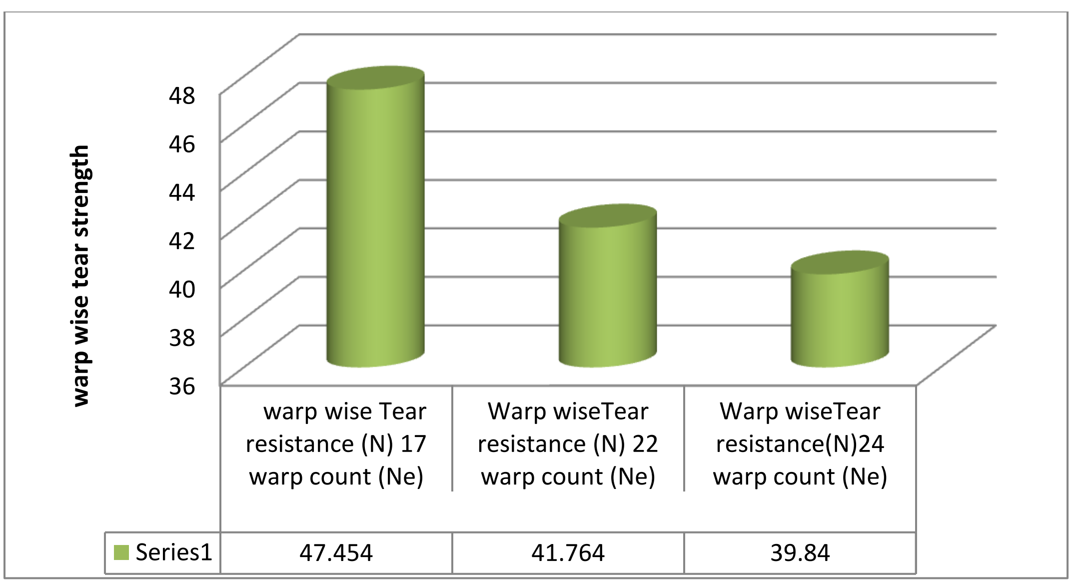

Fig 4.2 Effect of warp count on tear Strength in warp direction

4.3. Pilling Resistance of woven fabric Fabrics

The specimens were tested as directed by ASTM in Test method D4970 termed as Standard Test Method for Pilling resistance and other related Surface Changes of Textile Fabrics: Martindale Tester. The materials or products sampled are different warp count cotton fabrics and laboratory sampling method is used. The fabric is in its raw state or tested before washing subjected for 5000 movements. The rating standard is used for rating of individual specimens for pilling. Ratings of each individual specimen for pilling, the average rating of the specimens from each laboratory sampling unit, and the average are reported in Table 4.3 below.

Table 4.3 pilling resistance of plain fabrics made from 17 Ne 22 Ne and 24 Ne cotton yarn in warp way.

Number of tested fabric	warp count 17(Ne) pilling resistance rating at 5000 cycles	warp count 22 (Ne) pilling resistance rating at 5000 cycles	warp count 24 (Ne) pilling resistance rating at 5000 cycles	Remark
1	2	3	4	
2	3.5	3.5	3.5	
3	3.5	3.5	4	
4	2	3	3.5	
5	2.5	3.5	4.5	
Average	2.7	3.3	3.9	

As it can be seen from the table, the average pilling resistance of 24 Ne (warp count) plain cotton fabrics has the maximum (3.9) pilling resistance rating at 5000 cycles. This fabric is made of using finer yarn count (24 Ne) cotton yarn pilling rate reduced. When 24 Ne (warp count) cotton yarn are compact structure, low hairiness value to contribute to better for fabric pilling resistance.

Secondly as shown in the table result the pilling resistance of 17 Ne plain cotton fabric and 22 Ne (warp count) plain cotton fabrics made from 17Ne cotton yarn and 22 Ne cotton yarn are both lower pilling resistance as compared 24 Ne plain cotton fabrics. This because 17 Ne plain cotton fabric and 22 Ne plain cotton fabric are coarser structure due to that low twist structure, more hairiness structure which leads to higher exposure of fiber for protruding and pilling on the fabric.

Many researches (Wenbin Ouyang, M.S.T.A.T., 2013) related to the yarn count finer count structures, found in plain weave fabrics, and could pill less; a factor attributing to their compactness. Fabrics cannot avoid the generating of pilling, and the quantity of pilling will only increase with a longer service period.

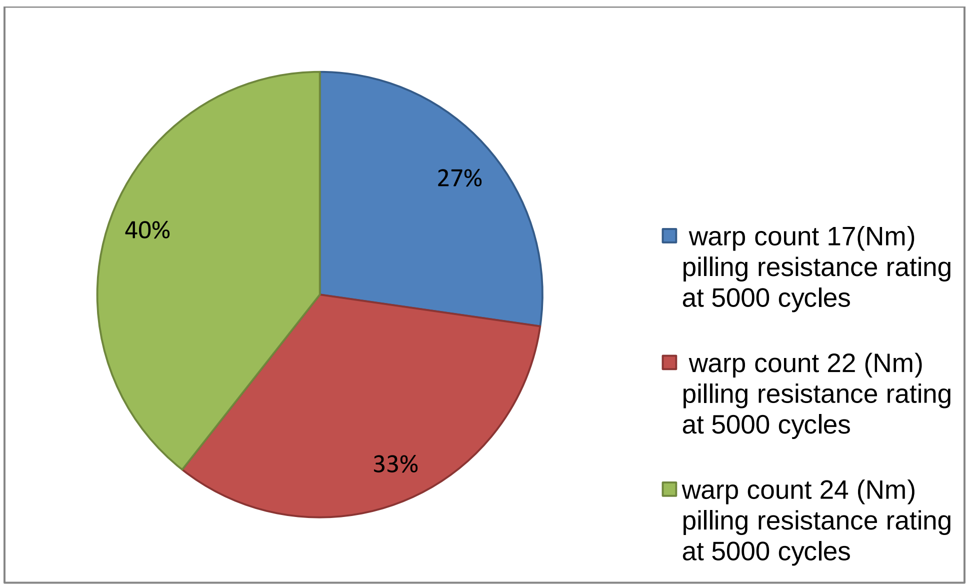

Fig 4.3 Effect of warp count on pilling resistance rating cycles in warp direction

4.4. Fabric Crease Recovery

The specimens were tested as directed by the crease recovery of the fabrics was tested using the Shirley crease recovery tester. Crease recovery angle studied in this thesis is by analyzing the effect of warp count on fabric mechanical properties. It is determined in accordance with Shirley crease recovery tester.

The materials or products fabric are 17 Ne, 22 Ne and 24 Ne warp count fabric and laboratory sampling method using Shirley crease recovery tester. The results are indicated in table 4.4.The value reported in this instrument was crease recovery angle (CRA). The testing was carried out using the standard procedure with minor changes for measuring the recovery angles at intermediate 5min time intervals.

Table 4.4 crease recovery of plain fabrics made from 17 Ne 22 Ne and 24 Ne cotton yarn in warp way.

Number of tested fabric	warp count 17(Ne) crease recovery angle	warp count 22 (Ne) crease recovery angle	warp count 24 (Ne) crease recovery angle
1	93	86	84
2	95	93	81
3	95	96	89
4	98	75	73
5	95	70	74
6	98	86	77
7	97	96	76
8	97.5	94	75.5
9	97	88	92
10	93.5	75	73
Average	95.9°	85.9°	79.45°

As it show in the Table 4.4 that the crease recover angle of 17 Ne (warp count) cotton fabric scored the highest rates crease recovery angle (95.9°) followed by fabric 22 Ne (warp count) crease recovery angle (85.9°) and fabric 24 Ne (warp count) crease recovery angle (79.45°) respectively. When the 17 Ne plain cotton fabrics have scored highest rates crease recovery tendency. Based on the result 17 Ne cotton yarn is more crease recovery angle. Because the result 17 Ne cotton yarn was coarser yarn count, low twisted and high tightness structure. So the fabric produced with coarser yarn and low twisted yarns with high tightness structure leads to higher crease recovery properties. On the other hand the test result value of 24 Ne cotton fabrics made from 24 Ne cotton yarn the crease recovery angle lower than 17 Ne plain cotton fabric crease recovery angle value. While 24 Ne plain cotton fabrics were made from 24 Ne cotton yarn reduce the fabric recovery angle because of different factors such as twist, yarn diameter elasticity of yarn. when finer yarn are high twist, low number of fiber in the yarn layer this enhance lower crease recovery properties in case of 24 Ne cotton fabric crease recovery angle result value. On the other hand finer cotton yarns less yarn diameter these does not resist applied load thus reduce fabric recovery property. Whereas, other researcher (Sutapa Chowdhur) studied if the yarn are finer the yarn diameter decrease, as twist per inch increased with the fabric have compact structure and more number of bending angle on the surface of fabric where as the yarn are coarser the diameter of the yarn increase the as twist per inch decrease fabric have less intersection open structure with high recovery angle.

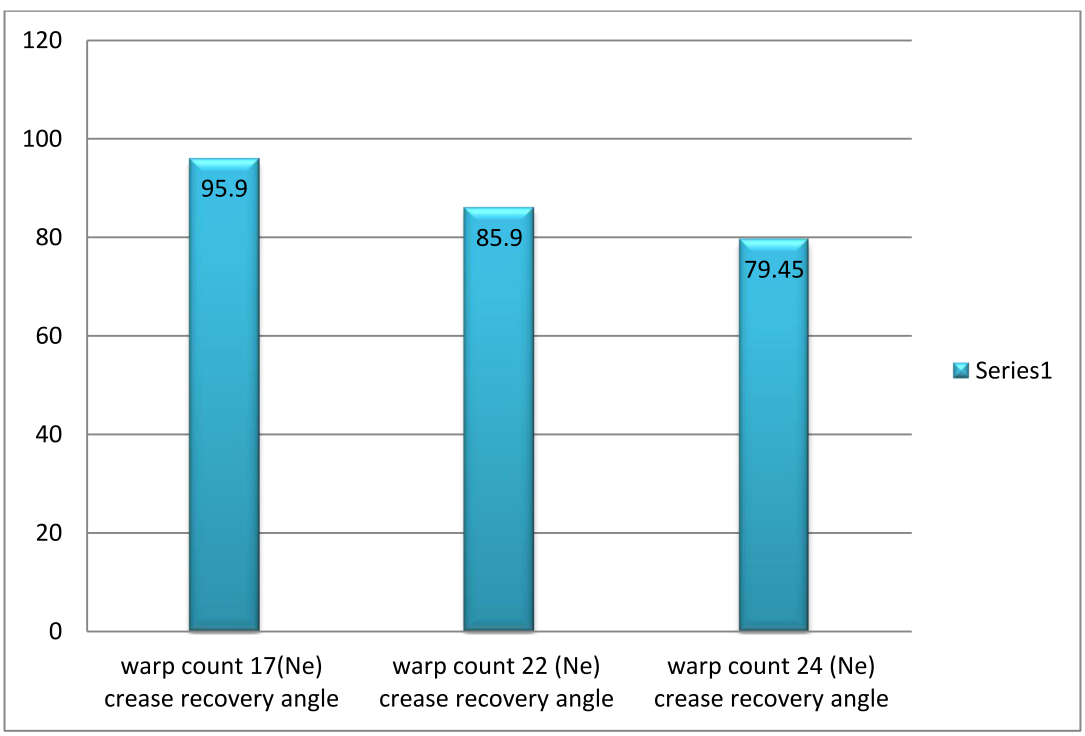

Fig 4.4 Effect of warp count on crease recovery angle in warp direction

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

This work has aimed to carry out a detailed investigation of the effect of warp count on woven fabric mechanical properties three type of cotton fabric yarn count 17 Ne, 22 Ne and 24 Ne woven from kombolcha textile Share Company. Amongst the fabric considering the tensile strength value, tear strength and the crease resistance value increase when the warp count are coarser properties on the other the warp count are finer the tensile and crease resistance value lower. While, warp count 17 Ne on the fabric shows highest tensile strength value the reason coarser warp count of cotton yarn tensile strength increase in the warp direction have more number of fibers present in the yarn layer have good elongation properties. Considering the fabric count 24 Ne and count 22 Ne made of finer warp count fabric tensile strength value decreasing with the yarn diameter of the cotton which turns the reduction of elongation of constituent yarn reflected lower fabric breaking elongation.

The tested value of tear resistance of the count 17 Ne on the fabric shows the maximum resistance. This may be fabric made of coarser count has high number fiber in cross section of the yarn. While warp count 22 Ne and count 24 Ne fabric shows lower tear strength. The reason using fine warp count (lower linear density) of cotton has less resistance tear force. The tested value of pilling resistance rate of the warp count 24 Ne on the fabric show the maximum pilling resistance. This may be finer yarn more compact (high twist), less hairiness properties. *But fabrics made from coarser yarn are less pilling resistance because lower twist yarn, more hairiness causes high pilling rate. Generally study the fabric mechanical properties are important to enhance fabric serviceability and quality product to satisfying users or customers in textile product.*

5.2. RECOMMENDATION

After conducting a careful study the effect of warp count on the woven fabric mechanical properties, the researcher forwarded the following recommendations. Warp count is the most important factor in a woven Fabric mechanical property because its influence is not only rapid but also massive. The mechanical properties such as tensile strength, tear strength are the most important durability properties on woven fabrics. Higher tensile and tear strength are preferred and these can be achieved from coarser cotton warp count. Depending on the type of woven fabrics applications, the properties to be employed in the yarns as well as in the fabrics will be different.

The kombolcha textile share company and textile factory produces woven fabrics for apparel application especially for bead sheet, grey fabric and solder cloth wears. Performances, mechanical are crucially important properties. These properties can be achieved from coarser cotton warp count yarn are used more preferable. Crease recovery also part of mechanical properties related to fabric aesthetic properties of fabric improved by medium coarser cotton warp count in fabric production. The factories try to use fine yarn in the warp direction for better utilization of fabric pilling resistance properties.

Finally it is recommended that Textile factory try to fulfill textile laboratory equipments that identify the relationship of fabric properties and yarn properties before the yarns are woven into the fabric should be investigated.

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APPENDIX

Appendix - A: yarn specification data from kombolcha K.T.S.C

Instrument			Uster tester 5														autodyne				Twist tester		Appearance board	
Production machine	Std count (Nm)	Actual count N(Nm)	U%		CVM		Neps		Thick place 50%		Thin place -50%		TIP		Hairiness		Strength		Elongation		TPM		Grade	
		Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act	Std	Act
Ring Spinning	24.5	24.5	12.24	12.96	15.3	16.7	212	308	156	420.7	8	19.8	376	749	6.9	7.4	15.9	m/p	5.8	m/p	740	760	C+	c
	22.7	22.7	11.92	11.99	14.9	15.36	138	192.4	124	246.4	5	3.37	267	442.3	7.4	8.1	16	X	6	x	646	678	C+	
	17	17	19.7	10.07	13.4	12.77	10	1.1	26	11.3	3	1.2	39	13.6	6	6.3	12.7	X	6.9	x	682	648	C+	c
Open end	33.5	33.5	12.24	13.22	15.3	17.1	212	430	156	447	8	16.2	370	893	6.9	8.3	15.9	X	6.3	x	850	820	B+	B+

Appendix - B: fabric sample production process in K.T.S.C

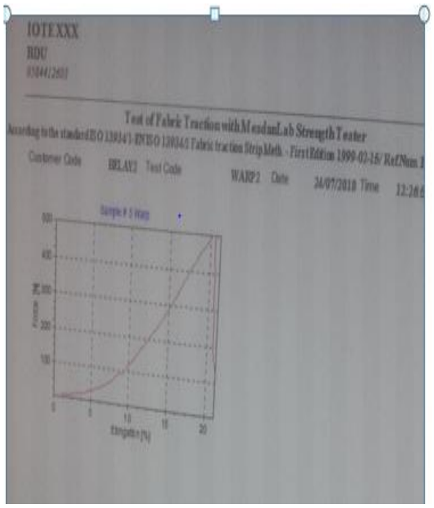
Sample one plain fabric design process in K.T.S.C

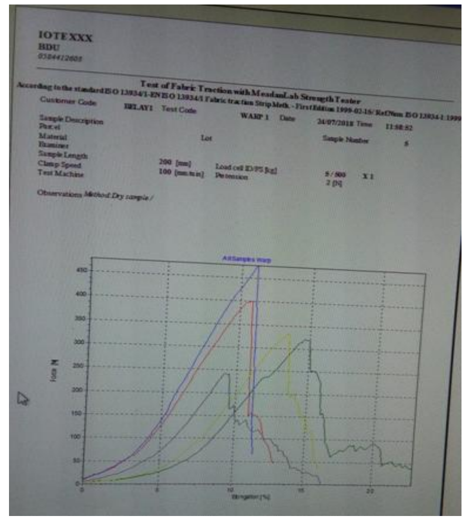
pikanol weaving machine K.T.S.C

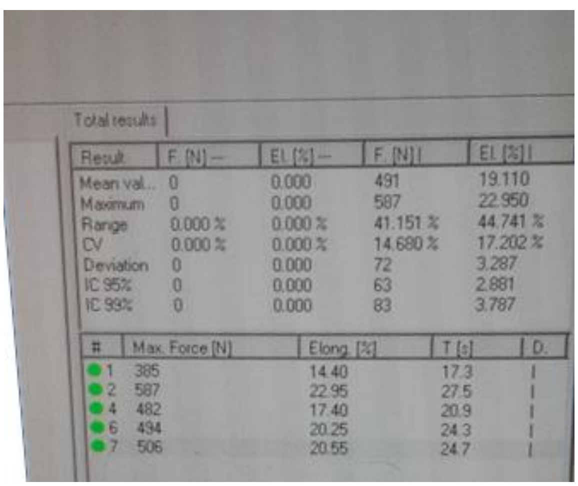
kombolcha textile share company

Laboratory Machine

Appendix – C: three warp count tensile strength result figure in Eitex laboratory.







Total results

Result	F [N] --	El [%] --	F [N] I	El [%] I
Mean val...	0	0.000	491	19.110
Maximum	0	0.000	587	22.950
Range	0.000 %	0.000 %	41.151 %	44.741 %
CV	0.000 %	0.000 %	14.680 %	17.202 %
Deviation	0	0.000	72	3.287
IC 95%	0	0.000	63	2.881
IC 99%	0	0.000	83	3.787

#	Max. Force [N]	Elong. [%]	T [s]	D.
1	385	14.40	17.3	I
2	587	22.95	27.5	I
4	482	17.40	20.9	I
6	494	20.25	24.3	I
7	506	20.55	24.7	I

Figure 4 warp count 17 Ne, 22 Ne and 24 Ne tensile strength test result graph

Appendix – D fabric mechanical properties tester machine in Eitex laboratory.

Crease recovery tester

universal pilling tester

Tear strength tester

Tensile strength tester