



Faculty of Engineering

Department of Textile Engineering

REPORT ON

Analysis of Impact of Warp Yarn Variation on the Physical Properties of Woven Fabrics.

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Supervised By

Mr. Md. Farhad Hossian

Lecturer

Department of Textile Engineering

Faculty of Engineering

Daffodil International University

Submitted By

<u>Name</u>	<u>ID</u>
Shahin Khan Amit	181-23-416
Zonayed	181-23-5314
Shakil Anower	201-23-883
Asiful Islam Sazid	201-23-873

Department of Textile Engineering

Faculty of Engineering

Daffodil International University

This project presented in partial fulfillment of requirement for the degree of Bachelor of Science in Textile Engineering.

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Letter of Approval

December 15, 2024

To

The Head

Department of Textile Engineering

Daffodil Smart City, Savar, Dhaka – 1207

Subject: Approval of Thesis Report of B.Sc. in TE Program.

Dear Sir,

We are just waiting to let you know that this thesis '**Analysis of Impact of Warp Yarn Variation on the Physical Properties of Woven Fabrics**' has been prepared bearing ID (181-23-416, 181-23-5314, 201-23-883 & 201-23-873) are completed for final evaluation. The whole report is prepared based on proper assessment and investigation. We were directlyinvolved with our work.

Therefore, it will be highly appreciated if you kindly accept the Thesis report and considered for final evaluation.

Your Sincerely.



Mr. Tanvir Ahmed Choudhury

Assistant Professor & Head

Department of Textile Engineering

Daffodil International University

Declaration

We hereby declare that the work which is presented in this thesis entitled “**Analysis of Impact of Warp Yarn Variation on the Physical Properties of Woven Fabrics**” has been done under the supervision of Mr. Md. Farhad Hossain, Lecturer TE, Daffodil International University. We also state that this project has not been presented in any other universities and all the resources of information are totally acknowledged.

Supervised By



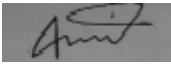
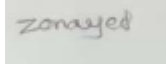

Mr. Md. Farhad Hossain

Lecturer

Department of Textile Engineering

Daffodil International University

Submitted By

<u>Name of Student</u>	<u>ID</u>	<u>Signature</u>
Shahin Khan Amit	181-23-416	
Zonayed	181-23-5314	
Shakil Anower	201-23-883	SHAKIL ANOWER
Asiful Islam Sazid	201-23-873	

Department of Textile Engineering

Faculty of Engineering

Daffodil International University

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Dedication

The study is earnestly committed to our folks, who have been our wellspring of motivation and invigorated us when we considered surrendering, who consistently give their ethical, otherworldly, close to home and monetary help.

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Abstract

The durability and performance of denim fabrics are integral to their widespread use in various applications, ranging from casual wear to heavy-duty garments. This study explores the impact of warp yarn variation on the physical properties of woven denim fabrics, focusing on tensile strength, tear strength, abrasion resistance, pilling resistance, and fabric weight (GSM). Five denim fabric samples, each featuring different warp yarn constructions, were evaluated using standardized testing methods to assess their performance under conditions simulating real-world usage. The tests included tensile and tear strength assessments to determine the fabrics' resistance to stretching and rupture, abrasion resistance to evaluate their durability under friction, and pilling resistance to analyze their surface integrity after wear. Fabric weight was measured to gauge density and potential durability.

The results revealed significant differences in the performance of the samples. Among them, Sample-2 emerged as the best-performing fabric, with the highest tensile strength in the warp direction (928.79 N), superior tear resistance (71.73 N), the highest GSM value (390), and excellent pilling resistance (rated 4-5). These findings indicate that Sample-2 offers enhanced durability, strength, and surface quality, making it a suitable choice for applications requiring high performance and long-term wearability. Other samples demonstrated varying degrees of robustness, with Sample-3 exhibiting the lowest tensile and tear strength and GSM, indicating its limitations for heavy-duty use.

This study underscores the importance of warp yarn variation in influencing the mechanical and physical properties of denim fabrics. The insights gained can guide manufacturers in optimizing fabric construction to meet specific performance demands. Moreover, the research contributes to the advancement of durable and sustainable denim products, aligning with the growing emphasis on quality and eco-friendly practices in the textile industry.

Keywords: Tensile strength, Tear strength, Fabric weight (GSM), Pilling resistance, Abrasion resistance, Fabric durability.

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CHAPTER-01

INTRODUCTION

1.1 Introduction:

One of the world's biggest producers of denim, Bangladesh is renowned for its superior denim goods. The nation's denim sector has expanded quickly, with numerous plants producing denim for international markets utilizing cutting-edge technologies. The cotton used to make Bangladeshi denim comes in a variety of weights, washes, and finishes, making it appropriate for a wide range of garments, particularly jeans. The nation's denim producers prioritize environmentally friendly dyes and water conservation in their manufacturing processes. Bangladesh is a competitive supplier of reasonably priced yet superior denim items because of its cheap production costs.

Bangladesh is the source of denim used by both domestic and foreign firms to make a variety of goods, ranging from trendy jackets and skirts to everyday jeans. Bangladesh's geographical location, production capacity, and skilled labor force have made it a major player in the global denim market.

1.2 Background of this Study:

The textile industry is constantly evolving, driven by the need for fabrics that meet the diverse demands of consumers and industries. As global fashion trends shift toward sustainability and performance-driven textiles, understanding the mechanical and physical properties of fabrics is essential for manufacturers. These properties determine the fabric's performance in terms of durability, comfort, and suitability for various end-use applications. For example, in apparel, especially in products like denim, consumers expect fabrics that offer both aesthetic appeal and high durability. The mechanical properties of fabrics—such as tensile strength, tear strength, abrasion resistance, and pilling resistance—are key to understanding their longevity and usability.

Denim, one of the most popular fabrics worldwide, is primarily known for its robustness and heavy-duty nature. However, the rise of alternative fabrics, combined with innovations in textile technology, has prompted the need to re-assess denim's position in the marketplace. As denim garments are subjected to various stresses such as pulling, tearing, abrasion, and friction during daily wear, it is important to evaluate how well different denim fabrics perform under these conditions. Evaluating these properties ensures the fabric's ability to withstand wear and maintain its quality over time.

The tensile strength of denim, which measures how much force the fabric can withstand before breaking, is crucial for determining its strength and durability. Tear strength, on the other hand, refers to the fabric's ability to resist rupture or tearing when subjected to stress. Additionally, fabric weight, pilling, and abrasion resistance are important indicators of the fabric's overall quality and longevity. These properties influence the appearance and functionality of the fabric, especially after repeated use.

Given the variation in fabric construction and finish, comparing these key physical properties across different denim samples can provide valuable insights into the factors that contribute to their performance. By systematically testing and comparing multiple denim fabrics, this study aims to offer a deeper understanding of how these properties impact fabric suitability for various applications, thus helping manufacturers select the best materials for specific needs.

1.3 Objective of the Study:

The primary objective of this study is to evaluate and compare the physical properties of five different denim fabric samples in terms of their tensile strength, tear strength, fabric weight (GSM), pilling resistance, and abrasion resistance. Specifically, this research aims to:

- Determine and compare the tensile strength of the selected denim fabrics to assess their ability to withstand force before breaking.
- Evaluate the tear strength of each fabric sample to understand their resistance to rupture under stress.
- Measure the fabric weight (GSM) of the samples to identify the thickness and density of the denim fabrics.
- Assess pilling resistance to understand how each fabric performs in terms of surface degradation after repeated rubbing.
- Evaluate abrasion resistance to determine how well the fabrics withstand friction and wear over time.

The results of these tests will provide insights into the relative durability and performance of the different denim fabrics, guiding fabric selection for various practical applications in the textile industry. This study also aims to identify the best-performing fabric in terms of overall strength, wear resistance, and longevity.

1.4 Importance of the Study:

This study is crucial for the textile industry, particularly in the production of durable denim fabrics. By evaluating key properties such as tensile strength, tear strength, abrasion resistance, pilling resistance, and fabric weight, the research helps manufacturers select the most suitable fabrics for various applications. The findings will guide the development of higher-quality, long-lasting denim products, meeting consumer demands for durability and sustainability. Overall, this study contributes to improving fabric performance, supporting innovation, and enhancing the quality of denim in the textile market.

1.5 Limitation of the Study:

- The study is based on only five denim fabric samples, limiting its representation of the entire market.
- It focuses on specific physical properties, excluding other factors like colorfastness and environmental impact.
- Testing is conducted under controlled conditions, which may not reflect real-world usage.
- The findings are based on specific testing methods, which may differ from other industry standards.

CHAPTER: 02

LITERATURE REVIEW

Denim fabric, a cornerstone of the global textile industry, is renowned for its durability, comfort, and versatility. With diverse applications, from casual wear to high-fashion, the quality of denim is essential [1]. This has led to a focus on laboratory testing methods that assess various physical, mechanical, and aesthetic properties of denim [2]. This literature review aims to explore the various laboratory tests employed to evaluate denim fabric, comparing different methods used to assess different types of denim items [3].

Denim is typically composed of cotton yarn, woven in a twill weave pattern [4], with varying weights, finishes, and compositions depending on the final product. The differences in denim fabric compositions [5], such as raw denim, stone-washed denim, stretch denim, and others, play a role in determining the choice of testing methods [6]. Denim quality is judged based on various properties like tensile strength [8], abrasion resistance, color fastness, shrinkage, and stretch recovery [7].

The evaluation of denim quality requires specific laboratory tests to measure its performance and durability. Common tests include:

This test measures the force required to break the denim fabric. According to previous studies [08], tensile strength is a critical parameter for assessing the durability of denim, especially for heavy-duty applications like work wear.

Abrasion tests are crucial in understanding how denim wears out with use. The Martindale abrasion test is one of the most commonly used methods [09], and it helps in predicting the longevity of denim products under repeated friction conditions.

Color retention is a major concern in denim. The ISO 105-C06 test, which measures color fastness to washing and rubbing, is used to assess whether the color of denim fabric fades over time.[13], the performance of color fastness varies depending on the dyeing techniques and finish used.[10]

Denim fabric can shrink after the first wash, which impacts the fit of the garment. The American Society for Testing and Materials (ASTM) standards provide guidelines for assessing dimensional stability through shrinkage tests [11] showed that different denim finishes influence shrinkage rates.

For stretch denim, estimating the recuperation subsequent to extending is fundamental. As indicated [16], the exhibition of stretch denim can be assessed utilizing both the "leftover stretch" and "recuperation proportion" tests, which give experiences into the texture's flexibility and long haul convenience [12].

Each kind of denim thing (like pants, coats, skirts, and so on) may go through various research facility tests in light of its expected use. Specialists have investigated how different denim gets done and loads impact the test results:

Crude denim has higher elasticity and scraped area obstruction contrasted with stone-washed denim. Stone-washing, while at the same time making a troubled look, can diminish the texture's general strength [13]

The presence of elastane or spandex in stretch denim impacts the aftereffects of elasticity and recuperation tests. Concentrates [19] have shown that stretch denim performs well in solace related tests however may show lower scraped area opposition contrasted with non-stretch denim. Denim for Fashion vs. Functional Use: Denim utilized for style things, for example, very good quality coats or thin pants, is exposed to various testing principles contrasted with denim utilized in work wear or rock solid jeans.[14] features that practical denim is ordinarily exposed to stricter tests for solidness and variety speed, while style denim zeros in additional on stylish properties like tone and surface.

While research center tests give fundamental information on denim quality, there are constraints to the momentum testing techniques. One of the difficulties is that research center outcomes may not generally connect impeccably with certifiable execution. For instance, material scraped spot tests (e.g., Martindale or Taber tests) may not totally duplicate the impacts of day to day wear. Besides, the variety in machine adjustment and test conditions can prompt irregularities in results [15].

Furthermore, fresher denim medicines, for example, eco-accommodating completing strategies, have not been generally normalized in testing methods, c

The rising spotlight on manageability in the material business has prompted the improvement of new testing strategies. Scientists are investigating elective, eco-accommodating methodologies for denim testing, including biodegradable color testing and water-saving cycles [16]. These fresher tests plan to survey the ecological effect of denim fabricating, notwithstanding conventional execution ascribes.

This literature review examines the impact of weave structure on fabric properties. Weave structure significantly influences physical, mechanical, and comfort properties of woven fabrics [17]. Fabric quality is initially judged by appearance and handle, with wear performance becoming important later. Models for changing fabric quality include adjusting sett, yarn linear density, or both while maintaining cover factor [18]. While weft-knitted fabrics generally have inferior mechanical properties for composite reinforcement, biaxial weft-knitted fabrics show promise due to improved mechanical behavior [19]. In impact resistance applications, 3D woven composites demonstrate superior performance compared to 2D woven composites, which suffer from low delamination resistance [20]. These studies highlight the crucial role of weave structure in determining fabric properties and performance, emphasizing its importance in various technical textile applications.

CHAPTER-03
METHODOLOGY

3.1 Materials:

Denim is a popular fabric used to make jeans and other clothing, and it is made from different raw materials that contribute to its unique qualities. The main raw material used to make denim is cotton. Cotton fibers are harvested from cotton plants, and these fibers are spun into yarn. The yarn is then woven into denim fabric using a technique called twill weave, which gives denim its characteristic diagonal pattern. This pattern is formed by weaving the yarn in a way that creates a visible diagonal line on the surface of the fabric. Denim can also be made with blends of other materials, like polyester or elastane. Polyester is often added to denim to improve its strength and make it more durable, while elastane (also known as spandex or Lycra) is added to make the fabric stretchy and comfortable.

3.1.1 Yarn Details:

Weft yarn: 8 OE

Supplier: Square Textile LTD

Lot:

A451DL

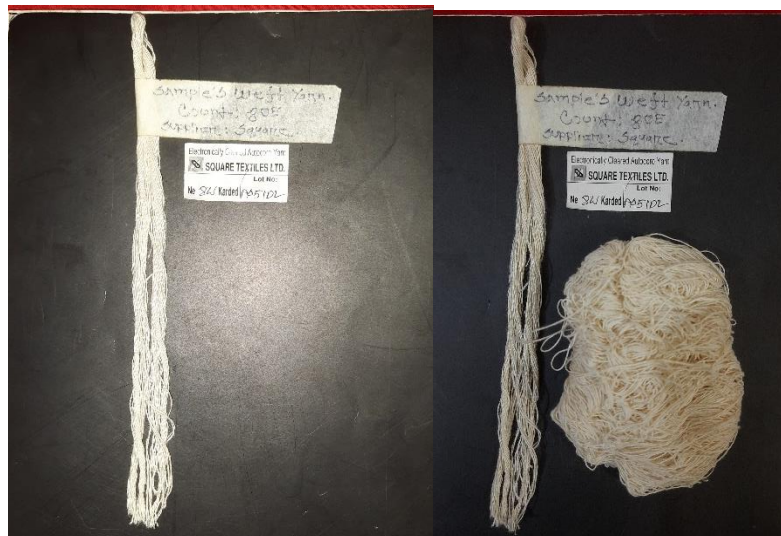


Figure 3.1: Weft Yarn

3.1.1.1 Weft yarn test report:

Count	8 0E
Supplier	Square
Lot	A451DL
Loom Picks	10000
Breakage	0
Weft cpx	-
Thick place	Not Found
Thin place	Not Found
Hairiness	Ok
Inspection yds	5
Inspection point	0
Color	Same as Standard Yarn
Comment	CAN BE USED

Table 3.1: Weft Yarn Test Report

3.1.1.2 Warp Yarns:

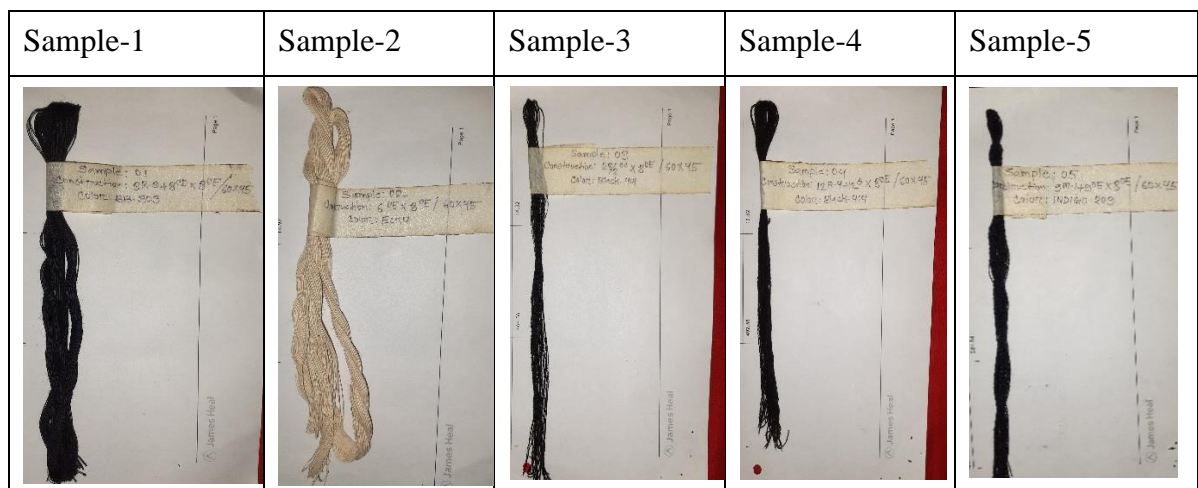


Figure 3.2: Warp Yarns

3.1.2 Weaving machine:

Name	Picanol OptiMax-i
Origin	Belgium
RPM	600-700
Reed Length	87"
Reed space	84.5"
Frame Capacity	16
Width	87"

Table 3.2: Weaving Machine Specifications

3.1.3 Parameters during weaving:

3.1.3.1 Weaving Process:



Figure 3.3: Rapier Loom

The Rapier Loom is one of the most popular weaving machines in the textile industry because of its adaptability, energy efficiency, and capacity to handle a wide range of textiles. The Rapier Loom is made to satisfy a variety of demands without compromising on speed or quality, whether you're making heavy-duty denim or delicate silks.

Individual harnesses are chosen and moved via a mechanical or electronic mechanism in dobby shedding. It is possible to weave intricate twills, satins, tiny geometric shapes, and pattern stripes with up to 16 harnesses. The weaving speed of rapier looms is 500–700 picks per minute.

Functions Name	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
Construction	$\frac{8 R3 + 8 CD \times 8 OE}{60 \times 45}$	$\frac{6 OE \times 8 OE}{60 \times 45}$	$\frac{28/2 CC \times 8 OE}{60 \times 45}$	$\frac{12 R4 + 12 S \times 8 OE}{60 \times 45}$	$\frac{9M1 + 9 OE \times 8 OE}{60 \times 45}$
Weave	3/1 R.H.T	3/1 R.H.T	3/1 R.H.T	3/1 R.H.T	3/1 R.H.T
Color	BB-303	ECRU	BLACK-401	BLACK-414	IND-203
Reed Length	75 inch	75 inch	75 inch	75 inch	75 inch
Reed count	590/4	590/4	590/4	590/4	590/4
Reed space	74 inch	74 inch	74 inch	74 inch	74 inch
Selvedge	10x5	10x5	10x5	10x5	10x5
Back rest	11/5	11/5	10/4	10/4	11/5
Contact bar	5/15	5/15	4/15	4/15	5/15
Total Ends	4440	4440	4440	4440	4440
Frame Height	172 mm	172 mm	172 mm	172 mm	172 mm
Shade Angle	26 degree	26 degree	26 degree	26 degree	26 degree

Table 3.3: All data of Weaving Machine

3.1.4 Fabric sample details:

Sample 01:



Figure: 3.4 : Sample-1

Fabric construction	$\frac{8 R3 + 8 CD \times 80E}{60 \times 45}$
GSM	342

Table 3.4: Fabric Construction of Sample-01

Sample 02:

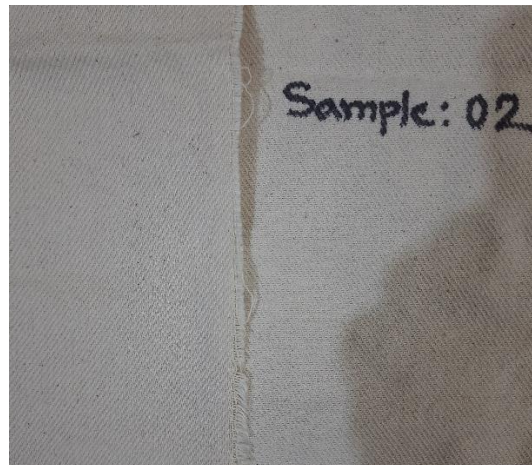


Figure: 3.5: Sample-2

Fabric construction	$\frac{6 OE \times 8 OE}{60 \times 45}$
GSM	390

Table 3.5: Fabric Construction of Sample-02

Sample 03:



Figure: 3.6: Sample-3

Fabric construction	$\frac{28/2cc \times 8 OE}{60 \times 45}$
GSM	293

Table 3.6: Fabric Construction of Sample-03

Sample 04:

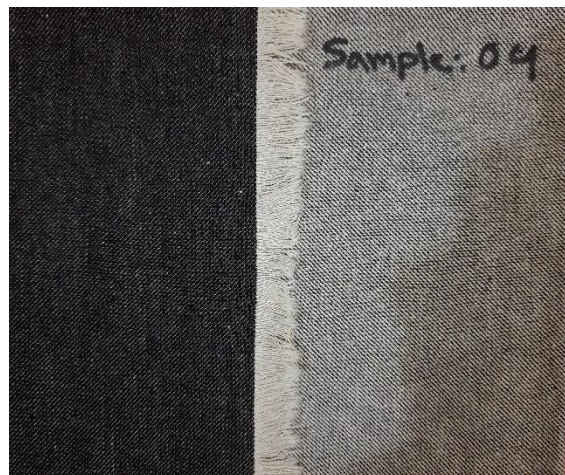


Figure: 3.7: Sample-4

Fabric construction	$\frac{12 R4 + 12S \times 8 OE}{60 \times 45}$
GSM	318

Table 3.7: Fabric Construction of Sample-04

Sample 05:



Figure: 3.8 : Sample-5

Fabric Consumption	$\frac{9M1 + 9 OE \times 8 OE}{60 \times 45}$
GSM	330

Table 3.8: Fabric Construction of Sample-05

3.2 Methods:

The quality of this study is ensured through the use of standardized testing methods for all fabric samples, which guarantees reliable and reproducible results. The tests conducted, including tensile strength, tear strength, abrasion resistance, pilling resistance, and fabric weight (GSM), and are commonly recognized in the textile industry, ensuring that the data generated is consistent with industry standards. Additionally, the study considers various fabric types, providing a comprehensive comparison of their physical properties. The controlled testing environment helps eliminate external variables, ensuring that the results are purely reflective of the fabric's inherent qualities. Furthermore, the use of precise instruments like GSM cutters and digital balances enhances the accuracy of measurements, contributing to the overall credibility and validity of the study. The findings offer valuable

insights that can aid in the selection of denim fabrics with superior durability and performance.

3.2.1 Testing:

- Fabric Weight Test.
- Tear & Tensile strength Test.
- Pilling Test.
- Abrasion Test.

3.2.2 Weight Test:

Fabric weight indicates the heaviness of a fabric and is typically expressed in ounces per square yard (oz/yd²) or grams per square meter (g/m²). It serves as a key factor in determining the fabric's performance during screen printing as well as the appearance and feel of the finished product.

Scope of this test and method of Fabric weight test:

- Its helps to find the heaviness of a fabric
- How it will perform when some process will applied for finished product

Scope for methods:

This International Standard outlines methods for determining:

- The mass per unit length, and
- The mass per unit area of woven fabrics conditioned in the standard testing atmosphere.

These methods are suitable for woven fabrics, including stretch types, whether in full width or folded down the middle. They apply to measuring the fabric mass of entire pieces as well as sample lengths.

3.2.3 Apparatus:

2.4.1 Required Equipment:

- Calibrated Steel Rule: A 3-meter-long steel rule (or at least 2 meters as an alternative), graduated in centimeters and millimeters, is needed for methods 1, 2, 3, and 4.
- Cutting Device: A tool for cutting fabric specimens at right angles to the selvedge, applicable to methods 1, 2, 3, and 4.
- Balance: A weighing scale capable of measuring the mass of fabric pieces or sample lengths with an accuracy of $\pm 0.2\%$ of the measured mass. For method 5, a higher accuracy of 0.001 g is required.
- Table: A smooth, flat-surfaced table that is wider than the fabric being tested and at least 4 meters long.
- Specimen Cutting Device: A device with 1% accuracy for cutting 10 cm x 10 cm specimens or a circular cutter with an area of 100 cm², used for method 5.
- Metal Plate: A metal plate approximately 9 cm square (or 80 cm² for a circular plate) and 1 cm thick, required for method 5.

3.2.4 Principle of Method:

3.2.4.1 Methods 1 and 3

if the fabric piece or sample length can be conditioned in the standard testing atmosphere, the mass per unit length is calculated by measuring the fabric's length and mass. Alternatively, the mass per unit area is determined by measuring the fabric's length, width, and mass, depending on the requirement.

3.2.4.2 Methods 2 and 4

If conditioning the entire fabric piece in the standard testing atmosphere is not feasible, the length (and width) and mass of the fabric are measured after relaxation in the current atmosphere. The mass per unit length or mass per unit area is then calculated and adjusted using a correction factor. This factor is determined by comparing the length, width, and mass of a specific portion cut from the fabric after relaxation, measured first in the ambient atmosphere and then in the standard testing atmosphere.

3.2.4.3 Method 5

when testing involves small samples, the mass per unit area is determined by exposing the samples to the standard testing atmosphere for textiles until they achieve equilibrium.

Specimens of known dimensions are then cut, weighed, and the mass per unit area is calculated based on these measurements.

3.2.5 Procedure:

First, we cut the fabric samples using the GSM cutter, which has a diameter of 11.2. We collect the cut swatches from each sample piece with the GSM cutter. Then, we weigh each cut swatch using the digital weight balance.

3.2.5.1 Pre-conditioning

Equilibrium should be approached from the dry side. If the fabric cannot be immediately conditioned in this way, it can be pre-conditioned by exposing it to an atmosphere with a relative humidity not exceeding 10% and a temperature not higher than 50°C. Equilibrium with the pre-conditioning atmosphere is considered reached when the difference between successive weighings, taken at least 2 hours apart, does not exceed 0.5% of the final mass of the fabric when conditioned in this atmosphere.

3.2.5.2 Selvedges

If the mass per unit length (or area) of the selvedge significantly differs from the mass of the fabric, the mass per unit area should be determined on a sample with the selvedges removed along the outermost warp threads. Calculations should be based on the mass of the trimmed sample, along with its length and width.



Figure 3.9: GSM cutter, flat surface and a weight measurement machine.

3.2.6 Tensile and Tear Test:

Tensile and tear strength are essential properties of fabrics, particularly for denim, which is valued for its durability and toughness. Tensile strength refers to the maximum force a fabric can withstand while being stretched before it breaks, and tear strength measures the resistance of fabric to tearing once it has already been cut or torn. Both properties are crucial in determining the performance of denim in various applications, especially in apparel that requires high durability. Two common tests for determining fabric and textile tensile strength.

3.2.6.1 Objective:

The objective of this study is to evaluate the tensile and tear strength of denim fabric through standardized testing methods. Specifically, the objectives are as follows:

- To assess the tensile strength of denim fabric by measuring the force required to break the fabric when subjected to tension.
- To determine the tear strength of denim fabric by measuring its resistance to tearing once a tear is initiated.

- To analyze the effect of fabric properties (such as fiber type, weave structure, and weight) on the tensile and tear strength of denim.
- To investigate the impact of finishing treatments (such as washing, dyeing, and chemical treatments) on the fabric's durability and strength.
- To compare the performance of different denim samples (such as raw vs. treated, or different fabric compositions) in terms of their tensile and tear strength.
- To provide recommendations for improving the strength and durability of denim fabrics based on the findings from the tensile and tear strength tests.

3.2.7 Procedure for Tensile and Tear Strength Tests of Denim Fabric:

3.2.7.1 Tensile Strength Test:

The Tensile Strength Test calculates the maximum amount of force that denim texture can withstand before stretching or breaking. This test is important for understanding the overall strength and durability of the texture. An example of denim is stretched till it breaks during the test, and the amount of force required to break the texture is noted. High-elasticity denim can withstand greater strain and is less likely to tear when used on a daily basis. Its rigidity depends on a number of factors, including the type of cotton, the weave pattern, and the thickness of the texture. Generally speaking, denim with more tightly woven, grounded threads will be stiffer. The test procedure is given bellow:

3.2.7.1.1 Sample Preparation:

Cut fabric swatches (5 cm x 20 cm) using a GSM cutter and align the fabric grains parallel to the test direction.

Condition fabric samples in a standard atmosphere.

3.2.7.1.2 Test Setup:

Use Grab Test or Strip Test based on fabric type.

Place the fabric in the test machine's jaws and calculate its cross-sectional area.

3.2.7.1.3 Conducting the Test:

Apply force to the fabric, recording the maximum force at break and the elongation.

3.2.7.1.4 Calculation:

Calculate tensile strength by dividing the force at break by the cross-sectional area.

3.2.7.2 Tear Strength Test:

The ability of denim fabric to withstand tearing under force is measured by the tear strength test. Tear strength is a key factor in the overall durability of denim, a fabric that is made to survive harsh conditions. A sample of denim fabric is cut into a predetermined shape for this test, and it is then forced until it tears. The fabric's tear strength is calculated by recording the force needed to tear it. Stronger textiles are more durable since it takes more force to tear them. The type of denim weave, fiber quality, and fabric weight are some examples of factors that can affect the test's outcome. The test procedures are given below:

3.2.7.2.1 Sample Preparation:

Cut fabric into standardized shapes (tongue, trapezoid, or rectangular) based on the test method.

Ensure consistent fabric fiber orientation.

3.2.7.2.2 Test Setup:

For Tongue Tear, create a slit and propagate the tear.

For Trapezoid Tear and Elmendorf Tear, use the appropriate method to initiate and measure the tear.

3.2.7.2.3 Conducting the Test:

Measure the force required to continue tearing the fabric and record energy absorption.

3.2.7.2.4 Calculation:

Calculate tear strength by dividing the force by the initial tear size.

This procedure ensures consistent testing of tensile and tear strength in denim fabrics, providing accurate results for durability evaluation.



Figure 3.10: Tensile strength test machine.



Figure 3.11: Tear Strength test machine

3.2.8 Abrasion Test:

The Pilling Test evaluates a fabric's resistance to the formation of pills, which are small fiber balls formed on the surface due to wear, friction, or abrasion. This test is essential for maintaining the fabric's aesthetic appearance and ensuring durability.

The denim texture's capacity to endure scouring or grating prompted mileage is assessed by the scraped area test. Since denim is made out of woven cotton filaments and is habitually exposed to unforgiving conditions, its protection from scraped spot is pivotal to its life span. The test involves scouring the material for a foreordained measure of time against a grating substance or harsh surface. The better the fabric plays out, the more it can endure without showing observable crumbling. Higher scraped area opposition is regularly found in textures with more grounded strands or more tight winds around. The experimental outcomes are critical for deciding how the texture will toll over the long haul, especially in high-wear districts like the thighs, knees, and sleeves.

Denim might decay, tear, or fight all the more rapidly on the off chance that it isn't scraped area safe. This might bring about a more limited life expectancy and a more broken-down look. In the scraped spot test, textures treated with specific coatings or completions could perform better. Producers can utilize more grounded yarns or change the weave thickness

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to increment scraped spot obstruction. The scraped area test helps ensure that denim isn't just elegant yet additionally sufficiently able to persevere through normal wear and hold its structure and appearance over the long run.

3.2.8 Importance of the Pilling Test:

Aesthetic Quality: Ensures the fabric maintains its appearance during use and washing.

Durability: Indicates how well the fabric withstands wear and friction over time.

Quality Control: Helps manufacturers improve fabric finishing processes, ensuring customer satisfaction and adherence to industry standards.

3.2.9 Procedure for Pilling Test:

3.2.9.1 Sample Preparation:

Cut fabric swatches to the required dimensions (e.g., 14 cm x 14 cm). Condition the samples in a standard atmosphere (20°C temperature, 65% relative humidity) for at least 24 hours.

3.2.9.2 Test Setup:

Choose the pilling test method based on the standard:

Martindale Abrasion Tester: Simulates wear and rubbing using controlled abrasion cycles.

Random Tumble Pilling Tester: Uses a tumbling chamber to mimic real-life pilling conditions.

Mount the fabric sample securely on the testing apparatus with the surface to be tested facing outwards.

3.2.9.3 Conducting the Test:

For the Martindale Method:

Rub the fabric against a standard abrasive material under a specified pressure and cycle count (e.g., 1000 cycles).

For the Random Tumble Method:

Place the fabric in a cylindrical chamber with small abrasive particles and subject it to tumbling action for a specified duration (e.g., 15-30 minutes).

Observe how pills form on the fabric surface.

3.2.9.4 Evaluation:

Compare the tested fabric samples with standard photographic or physical pilling rating scales (e.g., ISO 12945, AATCC 179).

Ratings range from 1 (severe pilling) to 5 (no pilling).

Assess the surface visually for pill density, size, and distribution.

3.2.9.5 Reporting Results:

Record the pilling rating.

Provide observations on the fabric's resistance to pilling and any factors contributing to its performance.



Figure 3.12: Pilling testing machine

Pilling test in denim texture is a strategy used to survey how much the texture frames little balls or pills on its surface after contact or wear. These pills are little groups of strands that assemble and can influence the texture's appearance and feel. The test recreates wear by

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scouring the texture against a harsh surface or with a grating instrument. Denim, being a woven texture, is more inclined to pilling because of free weave and the presence of strands can break or release after some time. The consequences of the pilling test can be affected by the kind of denim, the sort of fiber utilized (cotton, polyester, and so on), and the texture's weight or thickness.

Denim with higher cotton content keeps an eye on pill less contrasted with mixes with engineered strands. To lessen pilling, producers might work on the texture's weave or apply hostile to pilling medicines. Pilling influences the tasteful allure of denim as well as diminish its toughness and solace. By assessing the aftereffects of the pilling test, producers can decide the nature of the denim texture and make changes in accordance with work on its presentation and life span. This is significant for guaranteeing the denim keeps a smooth, new appearance even after rehashed wear and washing.

3.3 Quality Test Result of Sample:

The quality of this study is ensured through the use of standardized testing methods for all fabric samples, which guarantees reliable and reproducible results. The tests conducted, including tensile strength, tear strength, abrasion resistance, pilling resistance, and fabric weight (GSM), and are commonly recognized in the textile industry, ensuring that the data generated is consistent with industry standards. Additionally, the study considers various fabric types, providing a comprehensive comparison of their physical properties. The controlled testing environment helps eliminate external variables, ensuring that the results are purely reflective of the fabric's inherent qualities. Furthermore, the use of precise instruments like GSM cutters and digital balances enhances the accuracy of measurements, contributing to the overall credibility and validity of the study. The findings offer valuable insights that can aid in the selection of denim fabrics with superior durability and performance.

3.3.1 Sample -1:

Abrasion: No breakdown found after 30000 cycle time.

Sample-1	Tensile Test		Tear Test		Fabric Weight (GSM)	Pilling	Abrasion
	Warp	Weft	Warp	Weft			
$\frac{8R3 + 8CD \times 8 OE}{60 \times 45}$	669.53 N	603.41 N	39.2 N	31.92 N	342	4	No thread breakage

Table 3.9: Fabric Test of Sample-01

3.3.2 Sample-2:

Sample-2	Tensile Test		Tear Test		Fabric weight (GSM)	Pilling	Abrasion
	Warp	Weft	Warp	Weft			
$\frac{60E \times 8 OE}{60 \times 45}$	928.79 N	472.76N	71.73N	31.92 N	390	4-5	No thread breakage

Table 3.10: Fabric Test of Sample-02

3.3.3 Sample- 3:

Sample-3	Tensile Test		Tear Test		Fabric weight (GSM)	Pilling	Abrasion
	Warp	Weft	Warp	Weft			
$\frac{28/2 CC \times 8 OE}{60 \times 45}$	733.95N	464.36N	64.2N	35.27N	293	4	No thread breakage

Table 3.11: Fabric Test of Sample-03

3.3.4 Sample- 4:

Sample-4	Tensile Test		Tear Test		Fabric weight (GSM)	Pilling	Abrasion
	Warp	Weft	Warp	Weft			
$\frac{12R4 + 12S \times 8 OE}{60 \times 45}$	846.48 N	492.58 N	42.85 N	30.34 N	318	4-5	No thread breakage

Table 3.12: Fabric Test of Sample-04

3.3.5 Sample- 5:

Sample-5	Tensile Test		Tear Test		Fabric weight (GSM)	Pilling	Abrasion
	Warp	Weft	Warp	Weft			
$\frac{9M1 + 9 OE \times 8 OE}{60 \times 45}$	666.84 N	584.54 N	52.16 N	29.46 N	330	4	No thread breakage

Table 3.13: Fabric Test of Sample-05

CHAPTER -4

RESULT & DISCUSSION

4.1 Results:

Comparison between all fabric with different fabrication and tests:

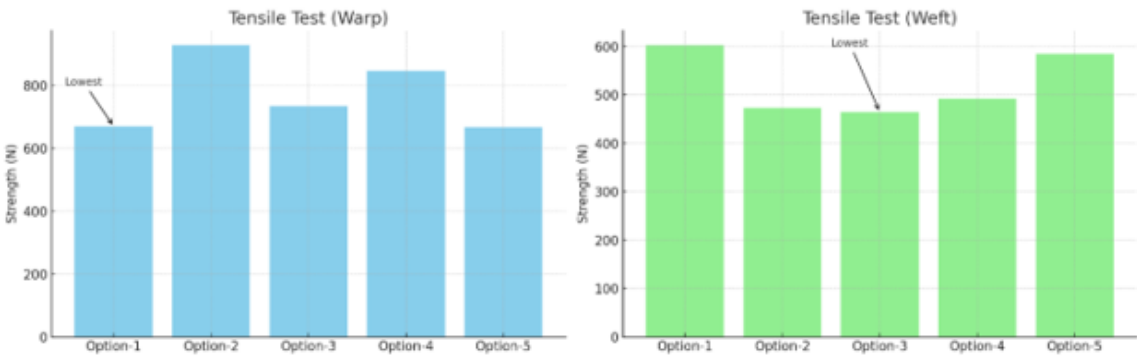
Test type	sample-1	sample-2	sample 3	sample 4	sample 5
	8R3 + 8CD × 8 OE 60 × 45	60E × 8 OE 60 × 45	28/2 CC × 8 OE 60 × 45	12R4 + 12S × 8 OE 60 × 45	9M1 + 90E × 8 OE 60 × 45
Tensile Test (Warp)	669.53N	928.79N	733.95N	846.48N	666.84N
Tensile Test (Weft)	603.41N	472.76N	464.36N	492.58N	584.54N
Tear Test (Weft)	39.2N	71.73N	64.27N	42.85N	52.16N
Tear Test (Weft)	31.92N	31.92N	35.27N	30.34N	29.46N
Fabric Weight Test (GSM)	342	390	293	318	330
Pilling Test	4	4-5	4	4-5	4
Abrasion Test	No thread breakage	No thread breakage	No thread breakage	No thread breakage	No thread breakage

Table 4.1: Comparison Between all Samples

4.2 Description of Results and Analysis:

In this study, five fabric samples were tested for various physical properties, including tensile strength, tear strength, fabric weight (GSM), pilling resistance, and abrasion resistance. The following section provides a detailed analysis and comparison of the test results to determine the most suitable fabric.

4.2.1 Tensile Strength Test:

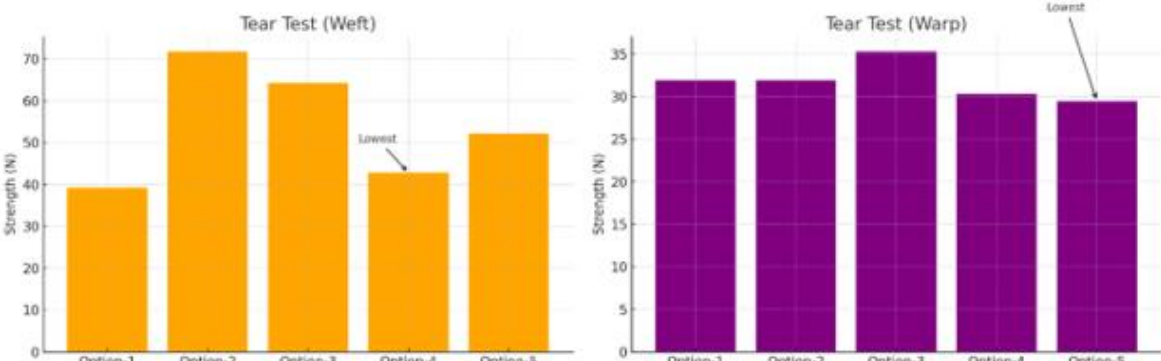


Graph 4.1: Tensile Strength Test

Tensile strength was measured in both warp and weft directions. Among the five samples, sample-2 Fabric exhibited the highest warp tensile strength, with a value of 928.79N, indicating its superior resistance to stretching along the warp direction. In contrast, sample-3 Fabric showed the lowest warp tensile strength at 733.95N.

For the weft direction, sample-1 Fabric achieved the highest tensile strength of 603.41N, while sample-3 Fabric recorded the lowest value at 464.36N. Overall, sample-2 Fabric demonstrated consistently high tensile strength, particularly in the warp direction, which is critical for fabrics requiring durability under longitudinal stress.

4.2.2 Tear Strength Test

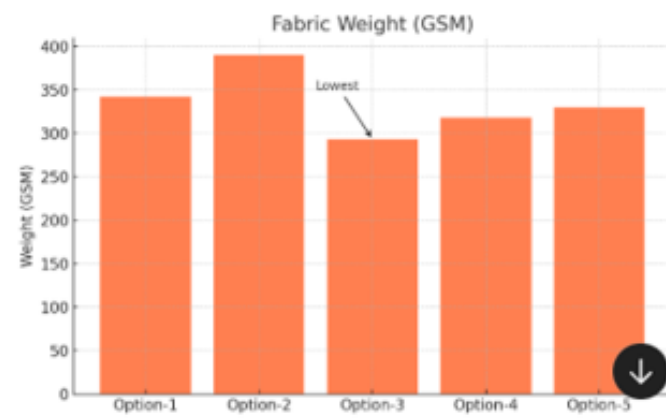


Graph 4.2: Tear Strength Test

Tear strength was evaluated in the weft direction to assess the fabric's resistance to tearing. The results revealed that sample-2 Fabric had the highest tear strength at 71.73N, demonstrating its ability to resist tearing forces effectively. Conversely, sample-5 Fabric showed the weakest performance, with a tear strength of only 29.46N.

These findings suggest that sample-2 Fabric would perform better under conditions where tear resistance is crucial, whereas fabrics with lower tear strength, like Option-5, may be more prone to damage under stress.

4.2.3 Fabric Weight (GSM)

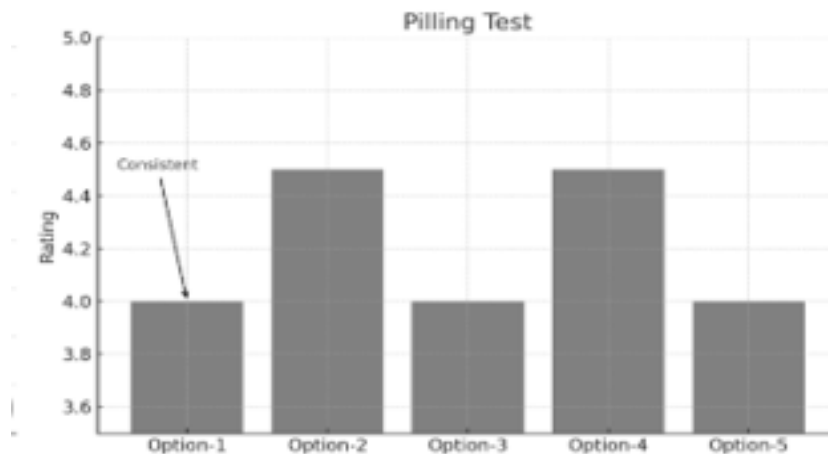


Graph 4.3: GSM Test

The fabric weight test, expressed in grams per square meter (GSM), showed significant variation among the samples. sample-2 Fabric recorded the highest GSM value of 390, indicating a denser and potentially more durable structure. On the other hand, sample-3 Fabric had the lowest GSM at 293, suggesting a lighter and less robust composition.

A higher GSM value often correlates with better durability and strength, which reinforces the superior performance of sample-2 Fabric in this study.

4.2.4 Pilling Resistance Test:



Graph 4.3: Pilling Resistance Test

Pilling resistance was assessed for all fabric samples, and results were rated on a scale from 1 (severe pilling) to 5 (no pilling). sample-2 Fabric and sample-4 Fabric performed the best, both achieving a rating of 4-5, indicating minimal pilling tendency. The remaining samples, including sample-1, sample-3, and sample-5, received a rating of 4, showing slightly lower resistance to pilling.

The superior pilling performance of sample-2 and sample-4 fabrics makes them more suitable for applications where surface appearance and durability are important

4.2.5 Abrasion Resistance Test

All fabric samples recorded a value of 0 in the abrasion test, indicating no significant resistance to abrasion. This result highlights a common limitation among the tested fabrics, which may restrict their use in high-friction applications.

Based on the comparative analysis of the test results, sample-2 Fabric emerged as the best-performing sample. This fabric demonstrated:

- Highest tensile strength in the warp direction (928.79N).
- Superior tear strength (71.73N).
- Highest fabric weight (GSM) (390), which suggests increased durability.
- Excellent pilling resistance with a rating of 4-5.

While other fabrics showed strengths in individual tests, Option-2 consistently outperformed the rest across multiple parameters, making it the most suitable choice for applications requiring high strength, durability, and surface performance.

In comparison, sample-3 Fabric exhibited the lowest results in tensile strength, tear strength, and GSM, indicating its limitations in terms of robustness and durability. sample-5 Fabric also displayed poor tear strength, further reducing its suitability for heavy-duty use.

Therefore, the findings clearly demonstrate that sample-2 Fabric provides the best combination of strength, durability, and overall performance among the tested samples.

CHAPTER- 5

CONCLUSION

5.1 Conclusion

This study investigated the impact of warp yarn variation on the physical properties of woven denim fabrics, focusing on tensile strength, tear strength, abrasion resistance, pilling resistance, and fabric weight (GSM). Five denim fabric samples with varying warp yarn compositions and constructions were subjected to standardized testing methods to evaluate their performance. The results highlighted significant variations among the samples, with Sample-2 demonstrating exceptional performance across all key parameters. It exhibited the highest tensile strength in the warp direction (928.79N) and substantial tear strength (71.73N), making it highly resistant to stretching and tearing. Additionally, Sample-2 had the greatest fabric weight (390 GSM), indicating a denser and more durable structure, along with superior pilling resistance (rating of 4-5), which minimizes surface degradation during use. In contrast, other samples such as Sample-3 and Sample-5 showed comparatively lower values in tensile strength, tear strength, and GSM, limiting their suitability for heavy-duty applications.

The findings emphasize the critical role of warp yarn composition and fabric construction in determining the mechanical and physical properties of denim fabrics. They provide valuable insights for manufacturers aiming to optimize fabric performance and durability for specific applications, such as heavy-duty work wear or high-performance garments. Moreover, this study contributes to advancing the understanding of denim fabric properties, guiding the development of high-quality, durable, and sustainable textile products. Future research could expand on these findings by investigating additional properties, such as colorfastness, stretch recovery, and environmental impact, to further refine the selection and optimization of denim fabrics for diverse industrial and consumer needs.

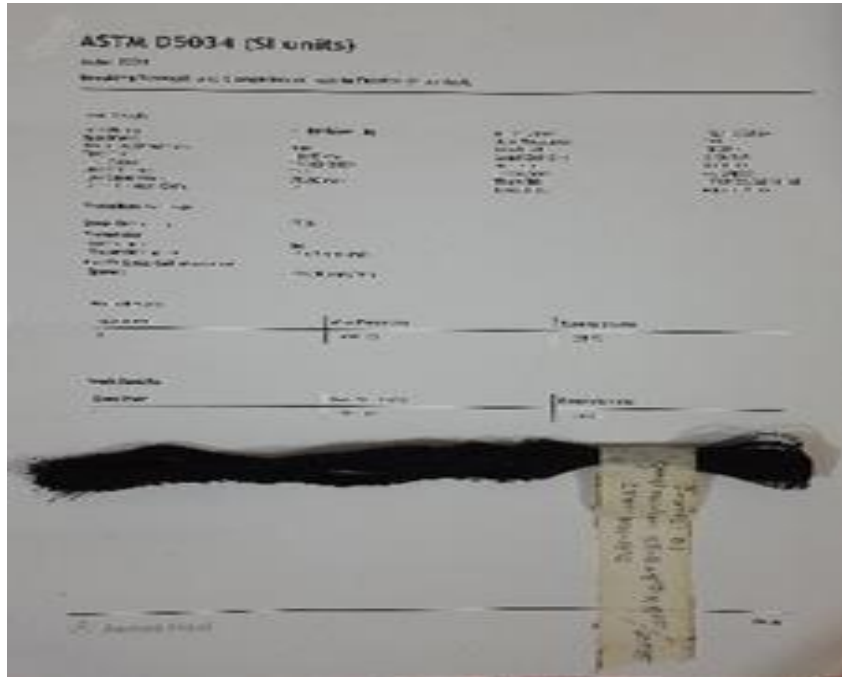
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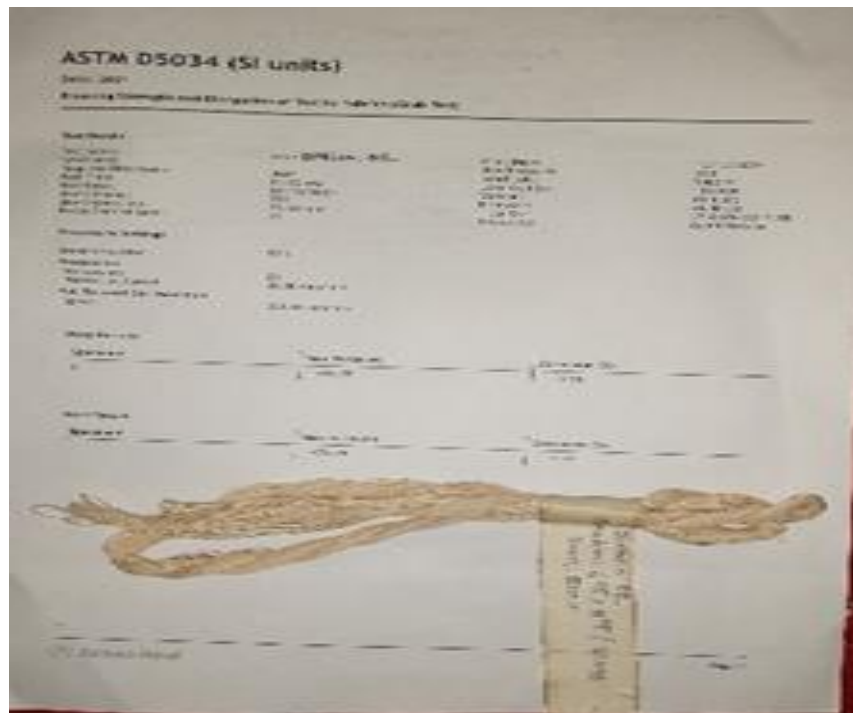
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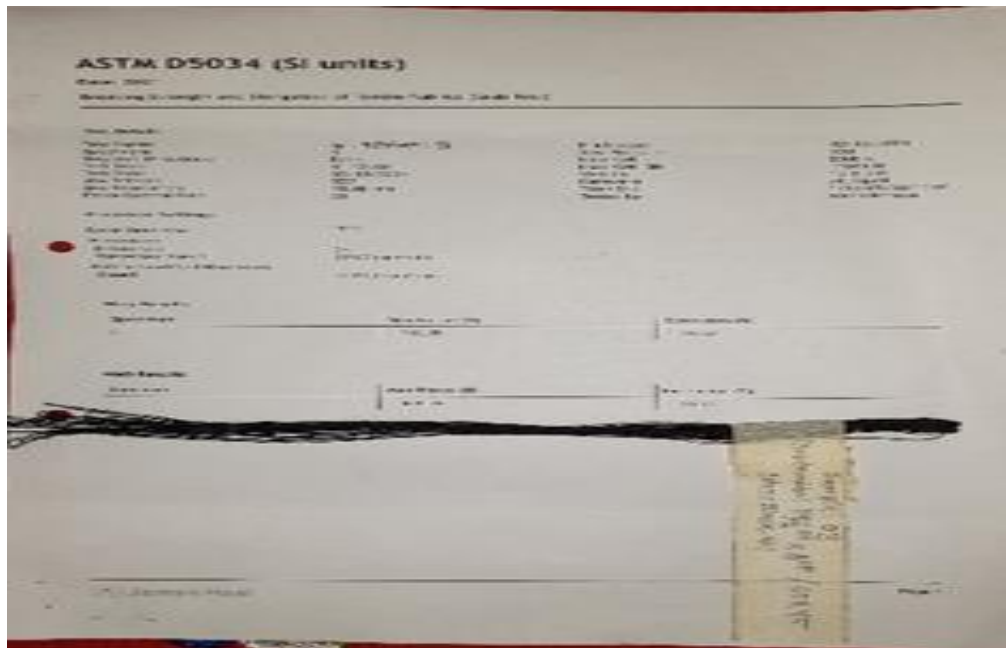
Appendix A



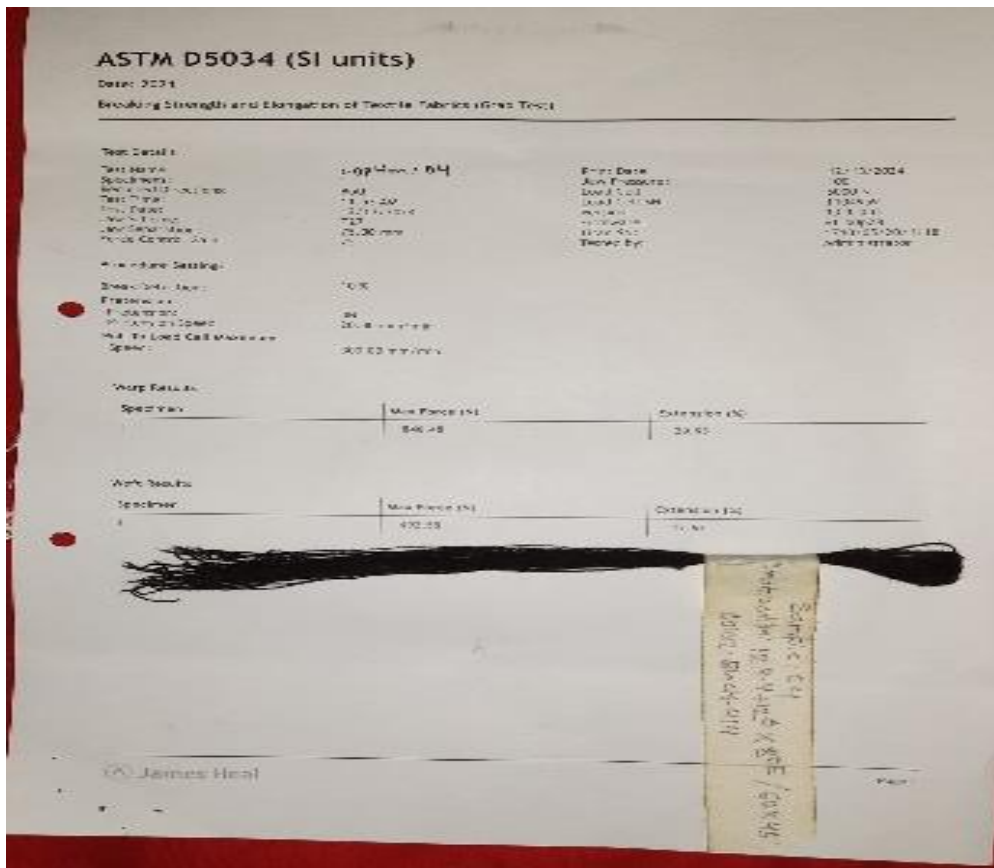
Picture A.1: Test report of sample 01



Picture A.2: Test report of sample 02



Picture A.3: Test report of sample 03



Picture A.4: Test report of sample 04

ASTM D5034 (SI units)
 Date: 2021
 Breaking Strength and Elongation of Textile Fabrics (Grab Test)

Test Details

Test Name:	4 - PHION / 05	Test Date:	12/11/2021
Specimens:	5	Low Pressure:	100
Required Direction:	000	Load Cell:	5000 N
Test Time:	1:50 AM	Load Cell 5:	1304909
Test Date:	07/11/2024	Version:	13.1.6.3
Job Scheme:	1LF	Program:	16.06.28
Low Speed Rate:	75.00 mm	Issue No:	1713/05/23/1118
Force Control Gain:	25	Driver by:	Admin/17482

Procedure Settings

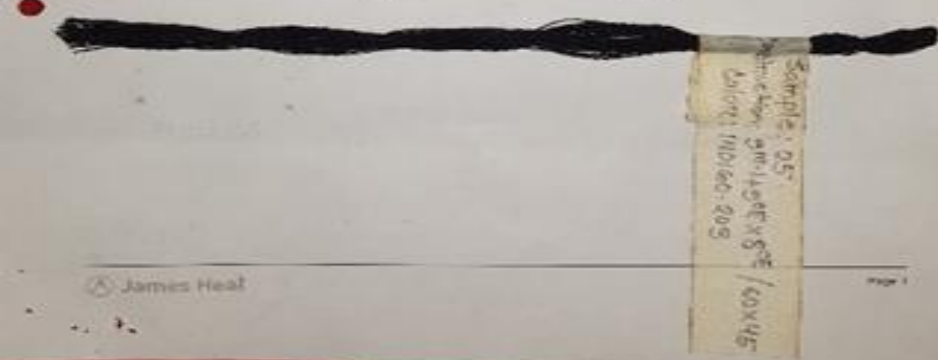
Break Detection:	NO
Pre-tension:	ON
Pre-tension Speed:	30.30 mm/min
Full To Load Cells Maximum Speed:	303.03 mm/min

Warp Results

Specimen	Max Force (N)	Elongation (%)
	166.94	21.28

Welt Results

Specimen	Max Force (N)	Elongation (%)
	156.54	14.29



James Heald Page 1

Picture A.5: Test report of sample 05

Analysis of Impact of Warp Yarn Variation on the Physical Properties of Woven Fabrics.

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