UNDERGRADUATE FINAL YEAR PROJECT REPORT

Faculty of Engineering

Department of Textile Engineering

Analyzing GSM Variation: How Fabrication Type, yarn count, and Stitch Length Affect Fabric Weight

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Submitted by:

Md. Rezwan Ahmed ID: 193-23-759

Md. Jahid Hasan ID: 193-23-5750

Advised by:

Md. Farhad Hossain

Lecturer

Department of Textile Engineering (DIU)

A thesis submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Textile Engineering

Advance in Fabric Manufacturing Technology

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DECLARATION

We hereby declare that, this thesis paper has been done under the supervision of **Md. Farhad Hossain**, Lecturer, Department of Textile Engineering, Faculty of Engineering, Daffodil International University. We further declare that no portion of this thesis or any other portion of this paper has ever been submitted elsewhere for the purpose of receiving a degree or diploma.

Rezwan

Md. Rezwan Ahmed
ID: 193-23-759
Dept. of Textile Engineering
Daffodil International University

Jahid

Md. Jahid Hasan
ID: 193-23-5750
Dept. of Textile Engineering
Daffodil International University

LETTER OF APPROVAL

December 14,

2024 To

The Head

Department of Textile Engineering

Daffodil International University

Daffodil Smart City (DSC) Birulia,

Savar, Dhaka-1216.

Subject: Approval of Thesis Report of B.Sc. in Textile Engineering

Program Dear Sir,

We are writing to inform you that this project report titled as **" Analyzing GSM Variation: How Fabrication Type, yarn count, and Stitch Length Affect Fabric Weight"** has been prepared by us, **Md. Jahid Hasan, ID: 193-23-5750 & Md. Rezwan Ahmed, ID: 193-23-759** for the final assessment. The entire report has been prepared on the basis of appropriate research and relevant data on knitted items. I delivered a lot of effort to compile this report.

May I therefore pray and hope that you would be kind enough to grant and kindly accept this project report and consider it for final assessment.

Yours Sincerely,

Md. Farhad Hossain
Lecturer
Department of Textile Engineering
Daffodil International University

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ABSTRACT

The textile industry continually strives for advancements in fabric quality and performance. A critical aspect of fabric assessment is the measurement of its weight, commonly referred to as grams per square meter (GSM). This thesis investigates how fabrication type, yarn count, and stitch length influence the GSM of fabrics, providing a comprehensive analysis of these key variables. This study begins with a detailed review of existing literature on fabric weight and its determinants. The primary objective is to identify how different fabrication techniques (such as woven, knitted, and non-woven), variations in yarn count (which denotes the thickness of the yarn), and alterations in stitch length (the distance between two consecutive needle penetrations in knitting) impact the overall weight of the fabric. Experimental procedures were conducted using various samples prepared under controlled conditions to isolate the effects of each variable. The yarn counts ranged from fine to coarse, and the stitch lengths were varied systematically to observe their influence on fabric weight. Both qualitative and quantitative analyses were employed to ensure a robust evaluation of the data.

The results indicate significant variations in GSM across different fabrication types, with woven fabrics generally exhibiting higher GSM values compared to knitted and non-woven fabrics. Furthermore, the study reveals that an increase in yarn count (finer yarns) tends to decrease the GSM, whereas a decrease in yarn count (coarser yarns) increases it. Stitch length also plays a crucial role, with longer stitch lengths typically resulting in lighter fabrics due to the lower density of stitches per unit area. This research contributes valuable insights to the textile manufacturing industry, aiding in the optimization of fabric production processes to achieve desired weight characteristics.

In conclusion, this thesis underscores the importance of fabrication type, yarn count, and stitch length as pivotal factors affecting fabric weight. The findings offer practical applications for textile engineers and manufacturers aiming to tailor fabric properties to specific end-use requirements.

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Chapter 1: Introduction

1.1 Introduction

Fabric weight, commonly measured in grams per square meter (GSM), is a critical parameter influencing the performance, quality, and application of textile products. In the textile industry, understanding the factors that affect fabric weight is essential for optimizing product characteristics and production efficiency. This study aims to investigate how fabrication type, yarn count, and stitch length impact the GSM of fabrics, providing valuable insights for textile engineers and manufacturers.

Fabrication type significantly determines fabric properties, including weight. The primary fabrication methods—woven, knitted, and non-woven—each produce fabrics with unique structural characteristics and performance attributes. Woven fabrics, created by interlacing warp and weft yarns, vary in weight depending on weave density and type. Knitted fabrics, formed by inter looping yarns, are known for their flexibility and stretch ability, with weight influenced by the type of knit and stitch density. Non-woven fabrics, made by bonding or felting fibers together, exhibit diverse weights based on the manufacturing process and materials used. Understanding how each fabrication type affects GSM is crucial for selecting the appropriate method for specific textile applications.

Yarn count, indicating yarn thickness or fineness, also critically influences fabric weight. Typically expressed in terms of weight per unit length (e.g., tex, denier) or length per unit weight (e.g., cotton count), thicker yarns generally produce heavier fabrics, while finer yarns result in lighter fabrics. Investigating the relationship between yarn count and GSM helps in optimizing yarn selection to achieve desired fabric weight and properties.

Stitch length, the length of yarn in a single stitch, directly impacts the density and weight of knitted fabrics. Longer stitch lengths create looser, lighter fabrics, while shorter stitch lengths produce denser, heavier fabrics. Similar concepts apply to woven fabrics, where yarn spacing and tightness affect weight. Understanding how stitch length influences fabric weight allows for precise control over fabric density and mechanical properties.

This study systematically examines the combined effects of fabrication type, yarn count, and stitch length on GSM. By providing empirical data and analysis, it aims to fill gaps in existing literature and offer practical guidelines for textile manufacturers. These insights will help optimize fabric production parameters, ensuring that final products meet desired weight specifications and perform effectively in their intended applications.

1.2 Objectives

- To analyze the impact of different fabrication types on the fabric weight (GSM).
- To examine the relationship between yarn count and fabric weight.
- To assess the effect of stitch length on fabric weight.
- To establish a comprehensive understanding of the combined effects of fabrication type, yarn count, and stitch length on GSM.
- To develop practical guidelines for textile manufacturers.

1.3 Outcomes

- Identification of Optimal Fabrication Methods.
- Correlation between Yarn Count and Fabric Weight.
- Impact of Stitch Length on Fabric Density and Weight.

1.4 Limitations

- Scope of Fabrication Types: The study focuses primarily on woven, knitted, and non-woven fabrics, which may limit the applicability of the findings to other less common or emerging fabrication methods.
- Controlled Experimental Conditions: The research is conducted under controlled laboratory conditions, which might not fully replicate the variability and complexities encountered in industrial production environments.
- Material Variability: Variations in raw material properties such as fiber type blend ratios, and finishing treatments are not extensively covered, which could affect the generalizability of the results across different textile materials and applications.

Chapter 2: Literature Review

2.1 About Yarn

Yarn: A textile yarn is relatively small Cross section of fibers and/or filament's with or without twist. Yarn is a long, continuous length of interlocked fibers, suitable for use in the production of textiles, sewing, crocheting, knitting, weaving, embroidery, and rope making. It is made from both natural and synthetic fibers, and can be spun in various ways to create different textures and strengths

2.2 Characteristics of yarn

i) A number of fibers twisted together.

ii) A number of filaments lay together without twist (a zero-twist yarn)

iii) A number of filaments lay together with a degree of twist

iv) A single filament with or without twist. (Mono filament)

v) A narrow stripe at material such as paper, plastic film, metal bail, with or without twist, intended for use in a textile Construction. (Kiron, 2013)

2.3 Importance of yarn for Knitting

One of the most common methods for producing cloth is knitting. Yarns are blended together in this method to create a thick, elastic fabric that is still flexible. In order to knit the highest- quality fabric or defect-free fabric, we must select the best yarn or ideal yarn. So, we must be careful to choose yarn with the right characteristics.

2.4 Yarn Count

Yarn count is a numerical expression that defines the fineness or coarseness of the yarn. It indicates the thickness of the yarn and is used to categorize and compare different yarns. There are several systems used to define yarn count, which can vary by region and the type of fiber.

2.5 Classifications of Yarn Count

2.5.1 Direct System (Weight-based):

- **Tex:** The weight in grams of 1,000 meters of yarn. For example, if 1,000 meters of yarn weighs 20 grams, its count is 20 tex.
- **Denier:** The weight in grams of 9,000 meters of yarn. Commonly used for silk, nylon, and synthetic fibers. For example, if 9,000 meters of yarn weighs 10 grams, its count is 10 denier.

2.5.2 Indirect System (Length-based):

- **Cotton Count (Ne):** The number of 840-yard lengths of yarn in one pound. For example, if one pound of yarn contains 30 such lengths, its count is 30 Ne.
- **Worsted Count (Nc or Nek):** The number of 560-yard lengths of worsted yarn in one pound. For example, if one pound of yarn contains 16 such lengths, its count is 16 Ne.
- **Linen Count (NeL):** The number of 300-yard lengths of linen yarn in one pound.
- **Metric Count (Nm):** The number of meters of yarn per gram. For example, if one gram of yarn is 100 meters long, its count is 100 Nm.

2.6 Converting Systems of Yarn Count

Different industries and regions use different systems, so converting between them is often necessary.

Conversion Formulas:

1. **Direct to Direct:**

- **Tex to Denier:** Denier=Tex×9\text{Denier} = \text{Tex} \times 9Denier=Tex×9
- **Denier to Tex:** Tex=Denier9\text{Tex} = \frac{\text{Denier}}{9}Tex=9Denier

2. **Indirect to Indirect:**

- **Cotton Count (Ne) to Metric Count (Nm):** Nm=Ne×1.693\text{Nm} = \text{Ne} \times 1.693Nm=Ne×1.693
- **Metric Count (Nm) to Cotton Count (Ne):** Ne=Nm1.693\text{Ne} = \frac{\text{Nm}}{1.693}Ne=1.693Nm

3. **Direct to Indirect:**

- **Tex to Metric Count (Nm):** Nm=1000Tex\text{Nm} = \frac{1000}{\text{Tex}}Nm=Tex1000
- **Metric Count (Nm) to Tex:** Tex=1000Nm\text{Tex} = \frac{1000}{\text{Nm}}Tex=Nm1000
- **Denier to Metric Count (Nm):** Nm=9000Denier\text{Nm} = \frac{9000}{\text{Denier}}Nm=Denier9000
- **Metric Count (Nm) to Denier:** Denier=9000Nm\text{Denier} = \frac{9000}{\text{Nm}}Denier=Nm9000

2.7 Knit Fabric GSM

GSM is short for grams per square meter. GSM is a unit of fabric weight. It has no restrictions but does influence several fabric qualities. In order to prevent financial loss throughout the manufacturing process, fabric weight must be regulated. For instance, ordering heavier fabric than is required for the product being created. GSM is a significant knitted fabric metric that is crucial for a textile engineer to comprehend and produce fabric. Engineers must manage fabric GSM in order to meet consumer quality expectations. The yarn count is a highly important component for GSM variation. This allows us to examine which textiles are heavier and lighter per unit area.

GSM= (CPI×WPI×0.9158)/Ne

2.8 Stitch Length

Stitch length or loop length is the amount of yarn needed to create a finished knitted loop. A stitch length is the length of yarn that includes the needle loop and each side's half of the sinker loop.

Chapter 3: Methodology

3.1 Materials:

3.1.1 Knitting Machine

Knitting machines are essential tools in the textile industry, used to produce a variety of knitted fabrics and garments. These machines range from simple manual models to complex, fully automated industrial machines capable of producing intricate patterns and high-quality fabrics at high speed.

Figure 1 (3.1.1): Circular Knitting Machine

3.1.2 Main machine parts

1. Needles
2. Needle Bed
3. Cam System
4. Yarn Feeders
5. Sinker
6. Fabric Take-up Roller
7. Tensioner
8. Stitch cam
9. Lubrication system

3.2 Yarn Description

Sl No	Yarn composition	Lot/Batch	Brand	Count	Sample
01	Cotton Melange	33	TCCL	34 Ne	
02	Recycle Cotton	328872348	TQM	30 Ne	
03	BCI CT/Combed Yarn	24164620101	Onetex	30/30 Ne	
04	Grey Melange	(50/50)BCI CT/MM	DCM	34 Ne	

05	100% KH Slub	298C/93	Fariba	28 Ne	
06	100% Viscose	Q4NC116P03	SQR	24 Ne	

Table 1 (3.2): Yarn Description

3.3 Fabric Description

3.3.1 Sample Work 01:

Fabrication : (2×1) RIB

Lycra/ % (cm) : Half feeder Lycra (184)

Yarn Count 34

Stitch Length : 2.85

GSM 220

Figure 2 (3.3.1): (2×1) RIB

The (2×1) half feeder Lycra RIB fabrication type refers to a specific knitting technique used in the production of stretchable fabrics, commonly seen in textiles that require elasticity and recovery, such as sportswear, underwear, and other form-fitting garments. Let's break down the components of this fabrication type:

- **RIB Fabric:** This is a type of knitted fabric characterized by its ribbed texture, created by alternating knit and purl stitches in a vertical alignment. RIB fabrics are known for their stretch ability and recovery, making them suitable for cuffs, neckbands, and other areas requiring elasticity.

- **(2×1) Structure:** This denotes the pattern of the knit. In a (2×1) RIB, there are two knit stitches followed by one purl stitch. This pattern repeats across the width of the fabric, giving it a distinctive ribbed appearance and texture. The (2×1) structure provides a balance between elasticity and firmness.

3.3.2 Sample Work 02:

Fabrication : Variegated RIB

Lycra/% (cm) : Full feeder Lycra (248)

Yarn Count : 30

Stitch Length : 2.80

GSM 240

Color : (Black/White) Stripe RIB

Figure 3 (3.3.2): Variegated RIB

Variegated RIB fabrication refers to a type of rib knit fabric that features a pattern of alternating colors or yarns, creating a multicolored or textured appearance. This variation in color or texture can be achieved through different knitting techniques and the use of varied yarns. Let's delve deeper into the components and characteristics of variegated rib fabrication:

Variegated Pattern: The term "variegated" refers to the use of different colors or textures within the same fabric. In variegated rib fabrication, this effect is achieved by alternating different colored yarns or using yarns with varying textures in a specific pattern. This can create stripes, marled effects, or other decorative patterns.

3.3.3 Sample Work 03:

Fabrication : (2×2) RIB

Lycra/% (cm) : Full feeder lycra (210)

Yarn Count : 40

Stitch Length : 2.25

GSM 200

Figure 4 (3.3.3): (2×2) RIB

The (2×2) RIB fabrication type refers to a specific knit pattern used in creating ribbed fabrics. This type of rib knit is characterized by its structure and the way the stitches are arranged, providing a balanced combination of stretch, elasticity, and texture. Let's break down the components and characteristics of (2×2) RIB fabrication:

(2×2) Pattern: The (2×2) designation indicates that there are two knit stitches followed by two purl stitches, which repeats across the width of the fabric. This pattern creates pronounced ribs that are visible and tactile.

3.3.4 Sample Work 04:

Fabrication : (2×1) RIB

Lycra/% (cm) : Half feeder lycra (205)

Yarn Count : 26

Stitch Length : 2.90

GSM 300

Figure 5 (3.3.4): (2×1) RIB

3 3.5 Sample Work 05:

Fabrication : (4×4) RIB

Lycra/% (cm) : Full feeder lycra (250)

Yarn Count 34

Stitch Length : 2.70

GSM 220

Figure 6 (3.3.5): (4×4) RIB

The (4×4) RIB fabrication type refers to a specific knitting pattern used in creating ribbed fabrics. This pattern is characterized by its distinctive structure, which provides a unique combination of stretch, elasticity, and texture. Let's break down the components and characteristics of (4×4) RIB fabrication:

(4×4) Pattern: The (4×4) designation means there are four knit stitches followed by four purl stitches, repeating across the fabric's width. This pattern results in well-defined, wider ribs compared to (2×2) or (1×1) rib knits

3.3.6 Sample Work 06:

Fabrication : (5×3) RIB

Lycra/ % (cm) : N/A

Yarn Count : 36

Stitch Length : 2.70

GSM 200

Figure 7 (3.3.6): (5×3) RIB

The (5×3) RIB fabrication type refers to a specific knitting pattern used to create ribbed fabrics. This pattern is characterized by the arrangement of knit and purl stitches, providing a unique combination of stretch, texture, and durability. Here's a detailed look at the components and characteristics of (5×3) RIB fabrication:

(5×3) Pattern: The (5×3) designation indicates a sequence of five knit stitches followed by three purl stitches. This pattern repeats across the width of the fabric, producing prominent ribs.

3.4 Needle Selection:

3.4.1 Needle Selection Procedure for Sample 01:

Creating a (2×1) rib fabric on a rib interlock circular knitting machine requires specific needle selection and machine setup. Here is a step-by-step guide for selecting needles and setting up Rib Interlock circular knitting machine:

Needle Selection Procedure for (2×1) Rib on Rib Interlock Circular Knitting Machine

1. Understand the Rib Pattern: A (2×1) rib pattern involves knitting two stitches and then purling one stitch repeatedly.

2. Preparation:

- ✓ Ensure the machine is clean and well-lubricated.
- ✓ Check the yarn tension and ensure it matches the requirements of the yarn being used.

3. Insert Needles:

- ✓ **Cylinder**: Insert needles into the cylinder according to the (2×1) pattern. For every set of three needles, two will be active (knitting) and one will be inactive (non-knitting).
- ✓ **Dial**: Insert needles into the dial so that for every set of three needles, one will be active (knitting) and two will be inactive (non-knitting).

4. Set the Feeder: Adjust the yarn feeder to ensure smooth feeding of the yarn to the active needles.

5. Adjust Machine Settings:

- ✓ **Stitch Length**: Adjust the stitch length on 2.85 according to the desired fabric tightness.
- ✓ **Tension**: Set the machine tension appropriately to avoid loose or overly tight stitches.

6. Test Run:

- ✓ Perform a test run with a small amount of yarn to ensure the needles are correctly arranged and the fabric is forming the (2×1) rib pattern.

- ✓ Check for any dropped stitches or other issues and adjust the needle setup or tension as needed.

Carefully selected and arranged the needles on both the cylinder and dial beds, and makes the necessary machine adjustments, We produced a well-formed (2×1) rib fabric on rib interlock circular knitting machine.

3.4.2 Needle Selection Procedure for Sample 03:

Creating a (2×2) rib fabric on a rib interlock circular knitting machine involves specific steps for needle selection and machine setup. Here is a detailed procedure for achieving this:

Needle Selection Procedure for (2×2) Rib on Rib Interlock Circular Knitting Machine:

1. Understand the Rib Pattern:

A (2×2) rib pattern involves knitting two stitches followed by purling two stitches repeatedly.

2. Preparation:

- ✓ Ensure the machine is clean and well-lubricated.
- ✓ Check the yarn tension and ensure it matches the requirements of the yarn being used.

3. Insert Needles:

- ✓ **Cylinder**: Insert needles into the cylinder according to the (2×2) pattern. For every set of four needles, two will be active (knitting) and two will be inactive (non-knitting).
- ✓ **Dial**: Insert needles into the dial so that for every set of four needles, two will be active (knitting) and two will be inactive (non-knitting).

4. Set the Feeder:

Adjust the yarn feeder to ensure smooth feeding of the yarn to the active needles.

5. Adjust Machine Settings:

- ✓ **Stitch Length**: Adjust the stitch length on 2.25 according to the desired fabric tightness.

- ✓ **Tension**: Set the machine tension appropriately to avoid loose or overly tight stitches.

6. Test Run:

- ✓ Perform a test run with a small amount of yarn to ensure the needles are correctly arranged and the fabric is forming the (2×2) rib pattern.
- ✓ Check for any dropped stitches or other issues and adjust the needle setup or tension as needed.

Carefully selected and arranged the needles on both the cylinder and dial beds, and making the necessary machine adjustments, you will produce a well-formed (2×2) rib fabric on your rib interlock circular knitting machine.

3.4.3 Needle Selection Procedure for Sample 05:

Creating a (4×4) rib fabric on a rib interlock circular knitting machine involves specific needle selection and setup procedures. Here's a detailed step-by-step guide to achieve this:

Needle Selection Procedure for (4×4) Rib on Rib Interlock Circular Knitting Machine

1. **Understand the Rib Pattern**: A (4×4) rib pattern involves knitting four stitches followed by purling four stitches repeatedly.
2. **Preparation**:

   - ✓ Ensure the machine is clean and well-lubricated.
   - ✓ Check the yarn tension and ensure it matches the requirements of the yarn being used.

3. **Insert Needles**:

   - ✓ **Cylinder**: Insert needles into the cylinder according to the (4×4) pattern. For every set of eight needles, four will be active (knitting) and four will be inactive (non- knitting).

- ✓ **Dial**: Insert needles into the dial so that for every set of eight needles, four will be active (knitting) and four will be inactive (non-knitting).

4. **Set the Feeder**: Adjust the yarn feeder to ensure smooth feeding of the yarn to the active needles.
5. **Adjust Machine Settings**:

   - ✓ **Stitch Length**: Adjust the stitch length on 2.70 according to the desired fabric tightness.
   - ✓ **Tension**: Set the machine tension appropriately to avoid loose or overly tight stitches.

6. **Test Run**:

   - ✓ Perform a test run with a small amount of yarn to ensure the needles are correctly arranged and the fabric is forming the (4×4) rib pattern.
   - ✓ Check for any dropped stitches or other issues and adjust the needle setup or tension as needed.

By carefully selecting and arranging the needles on both the cylinder and dial beds, and making the necessary machine adjustments, we have produced a well-formed (4×4) rib fabric on rib interlock circular knitting machine.

3.4.3 Needle Selection Procedure for Sample 06:

Creating a (5×3) rib fabric on a rib interlock circular knitting machine involves specific needle selection and setup procedures. Here's a detailed step-by-step guide to achieve this:

Needle Selection Procedure for (5×3) Rib on Rib Interlock Circular Knitting Machine

1. **Understand the Rib Pattern**: A (5×3) rib pattern involves knitting five stitches followed by purling three stitches repeatedly.
2. **Preparation**:

   - ✓ Ensure the machine is clean and well-lubricated.

- ✓ Check the yarn tension and ensure it matches the requirements of the yarn being used.

3. **Insert Needles**:

- ✓ **Cylinder**: Insert needles into the cylinder according to the (5×3) pattern. For every set of eight needles, five will be active (knitting) and three will be inactive (non- knitting).
- ✓ **Dial**: Insert needles into the dial so that for every set of eight needles, three will be active (knitting) and five will be inactive (non-knitting).

4. **Set the Feeder**: Adjust the yarn feeder to ensure smooth feeding of the yarn to the active needles.
5. **Adjust Machine Settings**:

- ✓ **Stitch Length**: Adjust the stitch length on 2.70 according to the desired fabric tightness.
- ✓ **Tension**: Set the machine tension appropriately to avoid loose or overly tight stitches.

6. **Test Run**:

- ✓ Perform a test run with a small amount of yarn to ensure the needles are correctly arranged and the fabric is forming the (5×3) rib pattern.
- ✓ Check for any dropped stitches or other issues and adjust the needle setup or tension as needed.

By carefully selecting and arranging the needles on both the cylinder and dial beds, and making the necessary machine adjustments, we have produced a well-formed (5×3) rib fabric on rib interlock circular knitting machine.

3.5 Test Methods and Testing Machines:

The followings are applied test procedure and machines used on whole sample making process

1. GSM cutter
2. Digital balance
3. Thread counting glass

3.5.1 GSM cutter

A GSM (Grams per Square Meter) cutter is a device used to determine the weight per unit area of fabric or other sheet materials. This measurement is essential in the textile industry to ensure consistent quality and performance of fabrics. The GSM cutter helps in accurately cutting a circular sample of fabric which is then weighed to calculate the GSM.

Components of a GSM Cutter

1. **Cutting Pad:** A base on which the fabric is placed for cutting.
2. **Blade Mechanism:** Typically consists of a sharp, circular blade that cuts the fabric.
3. **Sample Cutter:** A cylindrical tool with a handle and a circular cutting edge.
4. **Weights (Optional):** Some GSM cutters come with weights to ensure consistent pressure during cutting.
5. **Balance/Scale:** A precision weighing scale to measure the weight of the fabric sample.

Working Procedure of GSM test- Ensure the fabric or paper is flat and free of wrinkles. Place the GSM cutter on the sample. Rotate the cutter to cut a circular piece. Place the cut sample on a precision scale and record its weight in grams.

Calculate the GSM using the formula:

GSM= (Weight of the sample in grams ÷ Area of the sample in m2)

3.5.2 Digital balance

A digital balance is an electronic weighing device that provides precise measurements of weight. It is commonly used in laboratories, industries, and other settings where accurate weight measurements are essential. The digital balance utilizes modern electronic components and technology to convert a measured weight into a digital reading displayed on an LCD screen.

Components of a Digital Balance

1. **Load Cell:** The primary sensor that converts the weight into an electrical signal.
2. **Digital Display:** An LCD or LED screen that shows the weight measurement.
3. **Control Panel:** Buttons for tare, calibration, unit selection, and other functions.
4. **Platform:** The surface on which the object to be weighed is placed.
5. **Power Supply:** Can be batteries, an AC adapter, or a rechargeable battery pack.

Working Method of a Digital Balance

1. **Powering On:** Turn on the digital balance using the power button. The balance will perform a self-check and calibration process to ensure accuracy.
2. **Zeroing/Tarring:** Ensure the balance is on a stable and level surface. Press the tare button to zero the balance. This step is crucial to eliminate any residual weight on the platform.
3. **Placing the Object:** Gently place the object to be weighed in the center of the platform. Avoid any vibrations or drafts that could affect the measurement.
4. **Reading the Measurement:** The digital display will show the weight of the object. Wait for the reading to stabilize before recording the weight.

3.5.3 Thread counting glass

A thread counting glass, also known as a pick glass or linen tester, is a magnifying device used to count the number of threads per inch (TPI) or per centimeter in woven fabrics. This tool is essential in the textile industry to determine the fabric's thread density, which impacts its quality, texture, and performance.

Components of a Thread Counting Glass

1. **Magnifying Lens**: Provides magnification to clearly see the threads in the fabric. The magnification power can vary, commonly around 5x to 10x.
2. **Base with Grid**: A small, clear base often marked with a grid pattern (usually 1 cm^2 or 1 $inch^2$) to help count the threads accurately.
3. **Frame**: Holds the lens and base together. The frame is usually foldable for easy storage and portability.
4. **Measurement Scale**: Some models have a built-in scale for additional measurement functions.

Working Procedure of a Thread Counting Glass

1. **Preparation**: Lay the fabric flat on a clean, stable surface. Ensure the fabric is not stretched or wrinkled, as this can affect the accuracy of the count.
2. **Positioning the Thread Counting Glass**: Place the thread counting glass on the fabric so that the area to be counted is directly under the magnifying lens. Ensure the grid is clearly visible through the lens.
3. **Focusing**: Adjust the position of the magnifying lens to get a clear view of the threads. Some thread counting glasses have adjustable lenses for better focus.
4. **Counting the Threads**: Count the number of threads within the marked grid area (typically 1 cm^2 or 1 $inch^2$).

- **Warp Threads**: These are the vertical threads in the fabric.
- **Weft Threads**: These are the horizontal threads in the fabric.

Use a needle or a fine-pointed tool to help keep track of the threads as you count.

5. **Calculating Thread Density**:

- If your grid is 1 cm^2, multiply the counted number by 10 to get the threads per inch (since 1 inch ≈ 2.54 cm, and 1 $inch^2 \approx 6.45\ cm^2$).
- If your grid is 1 $inch^2$, the counted number directly gives the threads per inch (TPI).

Chapter 4: Result & Discussion

4.1 Test and Analysis:

On this comprehensive analysis of how stitch length, yarn count, and fabrication type collectively influence GSM in rib fabrics. The findings contribute to a deeper understanding of fabric weight variations and provide valuable insights for textile engineers, manufacturers, and designers aiming to optimize fabric properties for specific applications, tested on multiple rib fabrics, separately for all parameter which affect fabric weight and achieved clear knowledge about the changing sequence of GSM.

4.1.1 Discussion on analysis:

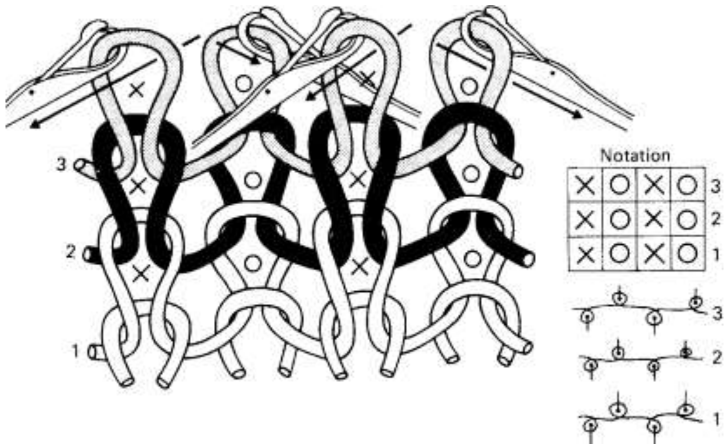
1. Analysis of results indicates a clear trend between stitch length and GSM.
2. Higher stitch lengths generally resulted in higher GSM due to increased thread density.
3. Statistical analysis confirms the significance of the relationship.
4. Comparison with literature findings and practical implications for fabric production

4.2 Analysis about impact of stitch length on rib fabric GSM:

We have knitted 6 different rib fabrics on different stitch length and measured GSM value on laboratory, results has given on table 4.2.3. This helps for finding those factors which are responsible for GSM variation and actual way of affecting GSM. Here we works on various rib fabrics including (2×1) RIB, variegated RIB, (2×2) RIB, (2×1) RIB, (4×4) RIB and so on.

Rib fabrics were tested across different types of rib fabrics with varying stitch lengths (e.g., 2 mm, 3 mm, or 2.5mm etc).The stitch length in sewing can indeed affect the fabric GSM (grams per square meter), which is a measure of the fabric's weight and density. To determine how different stitch lengths can influence GSM and the overall characteristics of the fabric

Stitch Length: In knitting, stitch length refers to the length of yarn that forms each stitch. Longer stitch lengths mean fewer stitches per unit length, which can reduce the overall density of the fabric.



GSM: GSM stands for Grams per Square Meter. It is a metric measurement used to quantify the weight or density of fabrics and other materials per unit area. GSM indicates how many grams a fabric weighs per square meter of area.

4.2.1 Graphical representation Table:

GSM values for different stitch lengths and different fabric type for different rib fabrics:

SL No	Stitch Length	Fabric Type	GSM
Sample 03	2.25	(2×2) RIB	200
Sample 05	2.70	(4×4) RIB	220
Sample 06	2.70	(5×3) RIB	200
Sample 02	2.80	variegated RIB	240
Sample 01	2.85	(2×1) RIB	220
Sample 04	2.90	(2×1) RIB	300

Table 2 (4.2.1): Graphical representation Table

4.2.2 Test Result:

Sample 01 and sample 04 has same fabric construction but GSM and stitch length is different. On this 2 sample only stitch length is responsible for GSM variation. Here for 2.85 mm stitch length GSM is 220 and for 2.90mm stitch length GSM is 300.For sample 03 stitch lengths is

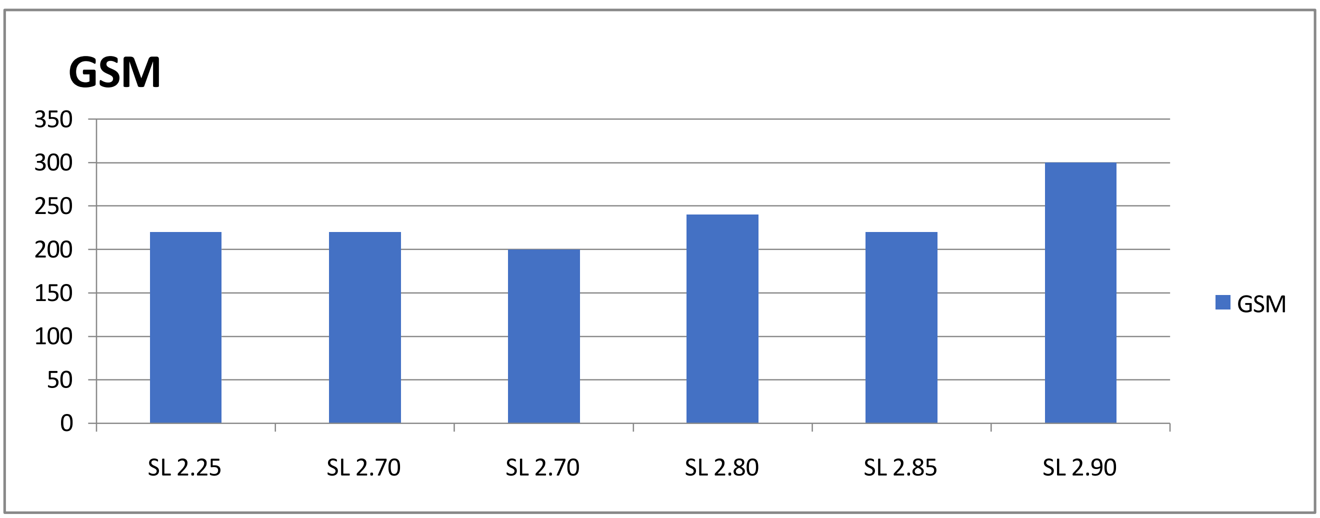
2.25mm with light GSM 200.For 2.80mm stitch length GSM is found 240 on variegated rib. On sample 05 and 6 we can see the stitch length value is same 2.70mm but fabrication type is different for (4×4) RIB GSM value is 220 and for (5×3) RIB GSM value is 200.

We explored all information about stitch length and GSM on basis of sample work here are final decision about the impact of stitch length on GSM for given fabric types:

- When we decrease stitch length on same type fabric with same yarn count enlarges GSM value.
- By expanding stitch length we will get lower GSM value.

4.2.3 Discussion on stitch length:

Stitch length refers to the distance between successive stitches in a knitted fabric. It is usually measured in millimeters or number of stitches per inch (SPI).In rib and interlock knits, stitch length affects not only the aesthetic appearance but also the structural integrity and weight (GSM) of the fabric. Clear inspection appears to this following graph chart:



The given chart shows the ratio between stitch length and fabric weight (GSM).For variation of stitch length GSM changes for each sample on the following way here on sample 01 stitch length has been fixed on 2.85 then fabric weight has been found 220 gram per square meter. On the next sample we reduce the stitch length by 0.05 as a result GSM rise up to 240 gram per meter square. For 2.25mm stitch length GSM found 200 and for 2.90 GSM boost up on 300 gram per meter square. Last two samples have same stitch length but difference of GSM value is 20.

GSM in knit fabrics is influenced by the density of stitches per square meter. A higher stitch density generally results in a higher GSM because more yarn is used per unit area.

4.3 Analysis about impact of yarn count on rib fabric GSM:

Rib fabrics are commonly used in knitwear due to their elasticity and structural properties. GSM (grams per square meter) is a critical parameter in fabric production, as it indicates the weight and thickness of the fabric. Yarn count, which refers to the thickness of the yarn, significantly influences the GSM of rib fabrics. Understanding this relationship is essential for manufacturers aiming to produce fabrics with specific characteristics.

Yarn Count: Yarn count is a numerical expression that indicates the fineness or coarseness of the yarn. It is defined as the length of the yarn per unit weight. There are various systems to measure yarn count, including:

- **Tex**: The mass in grams per 1,000 meters of yarn.
- **Denier**: The mass in grams per 9,000 meters of yarn.
- **Cotton Count (Ne)**: The number of 840-yard lengths of yarn per pound.

In general, a higher yarn count indicates a finer yarn, and a lower yarn count indicates a coarser yarn.

4.3.1 Graphical representation Table:

Yarn count significantly affects the weight of a fabric. Here are some examples of how this works:

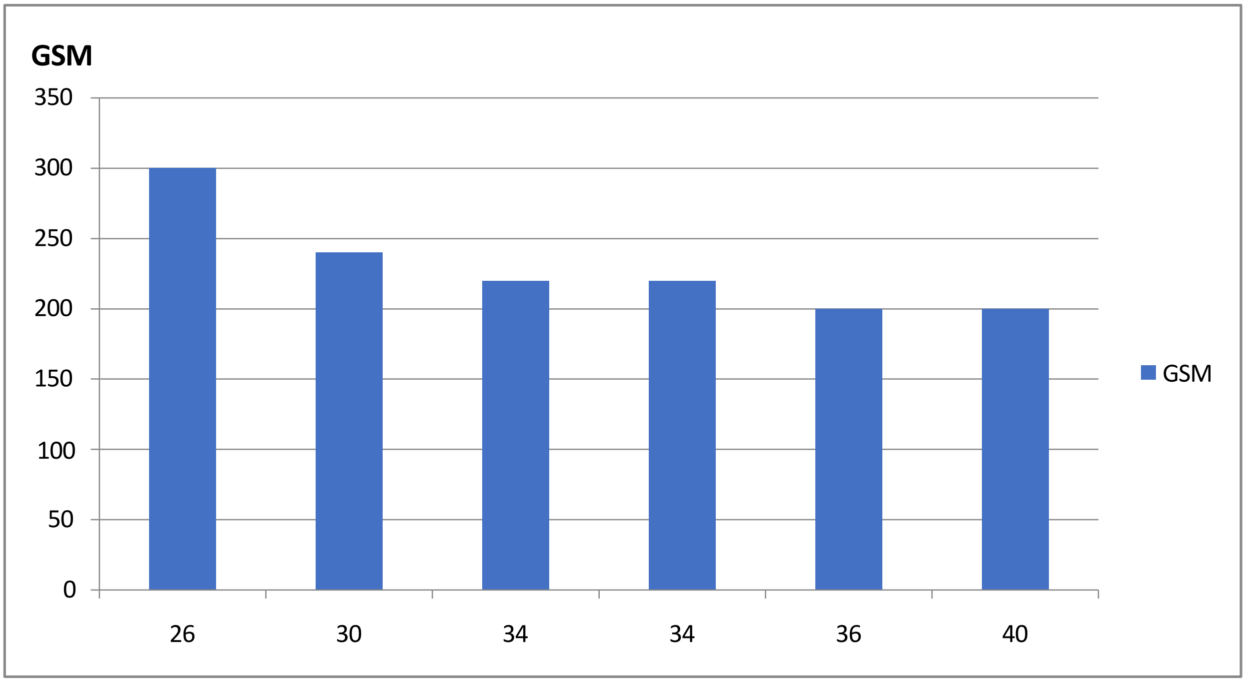
SL No	Yarn count	Fabric Type	GSM
Sample 04	26	(2×1) RIB	300
Sample 02	30	variegated RIB	240
Sample 01	34	(2×1) RIB	220
Sample 05	34	(4×4) RIB	220
Sample 06	36	(5×3) RIB	200
Sample 03	40	(2×2) RIB	200

Table 3 (4.3.1): Graphical representation Table

We examines 06 RIB samples considering different yarn count to know how it affect the GSM value and got this given result. We got 220 GSM for 34 yarn count and 240 for 30 yarn count. Using finer yarns decreases the overall mass of the fabric, leading to a lower GSM. Then we improves yarn count to 40 on sample 03 where final GSM was 200.But on sample 04 yarn count was 26, less then sample 01, 02 and 03 so higher GSM seems here it was 300 gram per meter^2.On sample 05 we used same yarn count as sample 01 and got same GSM value for sample 05.Finally on sample 06 36 yarn count makes fabric weight 200 gram per meter^2.

4.3.2 Discussion on yarn count impaction to GSM:

The yarn count has a significant impact on the GSM of rib fabrics, influencing their weight, feel, and applicability. Understanding this relationship allows manufacturers to produce fabrics tailored to specific requirements, ensuring the right balance of comfort, durability, and functionality. By controlling yarn count, manufacturers can achieve consistent GSM values, maintaining product quality and meeting market demands.



This graph has been shown the influencing ratio between yarn Count and fabric weight (GSM)

Here on sample 01 yarn count was taken 26 and GSM was 300 and on sample 02 for 30 yarn count GSM was 240. Thicker yarns occupy more space and increase the fabric's packing density. We used 34 yarn counts on sample 03 then GMS was 220. Using finer yarns decreases the overall mass of the fabric, leading to a lower GSM. Similarly on sample 04, 05, and 06 yarn count was taken 34, 36, and 40 causes GSM to 220, 200, and 200.

GSM ∝ 1/Yarn Count

4.4 Analysis about impact of rib fabric construction on rib fabric GSM:

The way yarns are knitted or woven also affects weight. Rib fabrics, for instance, have a specific structure that can be made heavier or lighter fabric weight. Tighter weaves or knits increase the fabric's density and weight. For example (2×2) RIB consist tighter weaves then (2×1) RIB.

4.4.1 Graphical representation Table:

This analysis highlights how fabric construction, specifically rib patterns, affects fabric weight (GSM), providing insights into fabric density and thickness variations based on weave or knit structures.

SL No	Fabric Type	GSM
Sample 01	(2×1) RIB	220
Sample 02	variegated RIB	240
Sample 03	(2×2) RIB	200
Sample 04	(2×1) RIB	300
Sample 05	(4×4) RIB	220
Sample 06	(5×3) RIB	200

Table 4 (4.4.1): Impact of rib fabric construction on rib fabric GSM

Chapter 5: Conclusion

We have done the thesis successfully. In this study the effect of knitted structure with different yarn count and stitch length on the fabric weight of knitted fabrics were investigated. The research conducted on analyzing GSM (Grams per Square Meter) variation in fabrics provides crucial insights into how fabrication type, yarn count, and stitch length collectively influence fabric weight. Understanding these relationships is essential for textile manufacturers aiming to produce fabrics that meet specific quality standards and performance requirements.

The yarn count, defined as the thickness of the yarn, is inversely proportional to the GSM of the fabric. Thicker yarns (lower yarn count in the indirect system) result in heavier fabrics with higher GSM. Conversely, finer yarns (higher yarn count) produce lighter fabrics with lower GSM. This relationship is critical for tailoring fabric properties to specific applications, such as lightweight garments for summer or heavier fabrics for winter wear.

Stitch length directly affects the density and weight of knitted fabrics. Longer stitches reduce fabric density and GSM, creating lighter and more breathable fabrics. Shorter stitches increase density and GSM, yielding heavier and more robust fabrics. Controlling stitch length allows manufacturers to fine-tune the balance between fabric weight and other properties like elasticity and durability.

Different fabrication types, such as woven, knitted, and non-woven, exhibit distinct characteristics that impact GSM. Woven fabrics generally display higher GSM due to their tighter structure, while knitted fabrics vary significantly based on stitch patterns and densities.

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