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Effects of Various Fabric Structures and GSM on Bursting Strength of Single Jersey Weft Knit Derivatives Fabric

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Abstract
According to Bangladesh Export Promotion Bureau (EPB) statistics in the last fiscal year (2019-2020) is that nearly $16.88 billion knitwear products were exported from Bangladesh, which is 11.19 % more than last year. A huge number of varieties of knit fabrics were produced by Bangladeshi knit manufacturers, among them most of products are single jersey plain or single jersey derivatives structure such as single lacoste, double lacoste, polo pique, fleece etc. Grams per Square meter, is commonly known as GSM is one of the most important parameters for the knit fabric manufacturing process. The strength of the knit fabric is also an important consideration from the buyer's aspects. In this present study, authors found out how various weft knit fabric structures and their GSM effect on the knit fabric bursting strength. We produce plain, polo pique, cross miss, double lacoste, fleece, single lacoste weft knit fabric using 30/1 Ne yarn with four stitch lengths i.e. 2.55, 2.60, 2.65 and 2.70 mm respectively and measured their GSM values. On the other hand, 30/1 Ne is also used for producing two thread terry and three thread fleece fabric and measure GSM. After that, we analysed how fabric structure as well as fabric GSM affect bursting strength of common weft knit fabric and found that higher GSM fabric shows higher bursting strength and vice versa.

Keywords: Knit Fabric, Fabric Structure, Stitch Length, GSM, Bursting Strength.

1. Introduction
The knit fabrics are more comfortable than woven fabric, so productivity of knit goods are increasing day by day. A wide range of diversified knit fabric production has also increased its new export market in all around the world. A wide range of knitwear can be found using various types of yarn, different types of fabric structures design and varying stitch lengths. Knit fabrics produced from different parameters also show various dimensional properties. About 90% of knit fabric is produced by plain knitting [1]. A large number of knit goods are produced in our country such as T-shirt, underwear, stockings, socks, sweater etc. Moreover, knit fabric is widely over woven fabric due to its lower manufacturing cost, comfortable property and easy manufacturing process. For producing different types of knit fabric patterns there are the usage of different machinery arrangements with different loop stitches. Both the Physical and mechanical properties of weft knit fabrics are influenced by the fabric structure as well as their knitting parameters [2]. In most of the cases of the dimensional properties of weft knit depends on yarn count, machine gauge and stitch length etc. [3]. On the other hand, different loop arrangements, yarn twist direction, GSM, tightness factor also influenced knit fabric dimensional properties [4-5]. Some other special properties such as rigidity, air permeability, bursting strength and gram per square meter (GSM) of the fabric are changed with change in loop length [6]. Bursting strength is an important parameter for fabric manufacturing process. Most of the buyers prefer knit fabrics having a good bursting strength for making ready-made garments. Various fabric structures have a positive effect on their corresponding bursting strengths [7]. In some studies authors found that strength and knit fabric extension are inversely co-related [8-9]. Some other researcher showed that various fibres have a direct

influence on bursting strength of knit fabric [10]. Gram per Square meter commonly known as GSM is one of the most important parameters from buyer aspects. According to various studies it is very difficult to predict the bursting strength of knitted fabrics before performing strength tests [4]. In this study, we tried to produce various weft knit fabric such as plain, single lacoste, double lacoste, polo pique, cross miss, terry using same count with different stitch length and then measured GSM and eventually examined how GSM effects on knit fabric bursting strength.

2. Materials and Methods

2.1 Raw materials and equipment used

For producing single jersey derivatives such as double lacoste, cross miss, single lacoste, plain, polo pique weft knit fabric, we used 30/1 Ne 100% cotton yarn. Each of the samples was made with four different stitch lengths i.e. 2.55 mm, 2.60 mm, 2.65 mm. 2.70 mm respectively. On the other hand, we produced two thread terry and three thread fleece knit fabrics using (30Ne + 20Ne) yarn with 3.85 mm and 4 mm stitch lengths respectively. All polo pique, cross miss, single lacoste, plain and double lacoste weft knit fabric samples were produced by JIUNN LONG, machine specification is given below.

Table 1. Machine specification used for producing plain, cross miss, double and single lacoste, polo pique knit fabric.

Machine Type	S/J Circular Knitting Machine
Brand Name	JIUNN LONG
Gauge	24
Diameter	24”
Origin	MADE IN TAIWAN

On the other hand, terry and fleece fabric were produced.

Table 2. Machine specification used for producing terry and fleece knit fabric.

Machine Type	S/J Circular Knitting Machine
Brand Name	Lisky
Gauge	24
Diameter	24”
Origin	MADE IN TAIWAN

To measure GSM, we used GSM cutter and weight balance and for measuring bursting strength we used hydraulic bursting strength tester. Specification of bursting strength tester and GSM cutter are given below,

Table 3. Machine specification of Hydraulic bursting strength tester.
Machine Type Hydraulic bursting strength tester

Machine Type	Hydraulic bursting strength tester
Brand Name	TESTEX
Model	TF142A/B
Power	220/110 V 50/60 Hz
Origin	MADE IN CHINA

Table 4. Specification GSM cutter.

Machine Type	GSM cutter
Brand Name	Schroder
Model	GSM100
Cutting area-	100 cm^2 of fabric sample
Origin	MADE IN Germany

2.2 Testing method for measuring GSM

2.2.1 Principle

The mass per unit area was determined by maintaining standard testing atmosphere to reach the equilibrium atmospheric condition. The sample specimens were cut according to dimension and then weighed After that, the sample mass per unit length was calculated.

2.2.2 Test standard

B.S. 1051, 1981 and ISO 139, 1973 methods were followed.

2.2.3 Test samples and methods

At first took enough large swatch, so that we got five samples easily. All sample specimens were 100 cm2. During the sample preparation we avoided selvedge portion and creases portion of the sample. With a view to measure fabric GSM we followed simple steps i.e., we removed the crease or wrinkle portion of the fabric by conditioning all the fabric samples for a day with maintaining standard temperature 27±2 ºC and 65±2% RH. After that we used GSM cutter to cut the sample according to specimen size. Then fabric samples were weighted by an electric balance tester. Lastly multiplied the weight of the cut sample by 100. The result was the GSM of the fabric [11].

2.3 Testing method for measuring bursting strength

2.3.1 Principle

Bursting strength is a process to identify the strength of the material which is stressed in all directions. Normally the readings were noted in KPa.

2.3.2 Test standard

ISO 13938-2 method was followed.

2.4 Test samples and methods

ISO 13938-2 method used for the determination of bursting strength with a TESTEX tester. Standard temperature and relative humidity (20 ± 2 °C, 65 ± 2%) were maintained during the data collection. Before data collection, all the samples were conditioned according to the ASTM D1776-08 (2009) method for 24h. Then the sample was placed in the specimen plate and put into the clamp very carefully. When the machine was started its diaphragm was raising and it created pressure on the specimen sample. While the pressure reached up to the rupture point the specimen sample was bursted. Immediately after the rupture, and in rapid succession, released the clamping lever over the specimen. That data was taken as a bursting strength in the Kpa unit.

3. Results and Discussion

3.1 Determination of Knit Fabric GSM

Table 5. Determination of GSM for plain knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Plain Fabric	30/1	2.55	138	140
			143	
			142	
			138	
			139	
		2.60	125	125
			127	
			125	
			122	
			126	
		2.65	117	118
			119	
			118	
			116	
			120	

Table 6. Determination of GSM for Single lacoste knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Single lacoste	30/1	2.55	154	155
			153	
			155	
			155	
			158	
		2.60	152	153
			152	
			154	
			153	
			154	
		2.65	151	151
			152	
			152	
			150	
			150	
		2.70	149	149
			149	
			150	
			149	
			148	

Table 7. Determination of GSM for double lacoste knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Double lacoste	30/1	2.55	159	159
			158	
			158	
			160	
			160	
		2.60	154	153
			155	
			153	
			152	
			151	
		2.65	151	151
			152	
			150	
			151	
			151	
		2.70	151	150
			150	
			151	
			149	
			149	

Table 8. Determination of GSM for cross miss knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Cross miss	30/1	2.55	115	115
			113	
			117	
			115	
			115	
		2.60	114	113
			114	
			112	
			113	
			112	
		2.65	111	111
			111	
			110	
			113	
			110	
		2.70	111	110
			109	
			112	
			111	
			107	

Table 9. Determination of GSM for polo pique knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Polo pique	30/1	2.55	139	139
			139	
			138	
			139	
			140	
		2.60	133	135
			135	
			132	
			137	
			138	
		2.65	131	133
			134	
			135	
			134	
			131	
		2.70	129	131
			130	
			132	
			132	
			132	

Table 10. Determination of GSM for terry knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Terry	(30Ne+20Ne)	3.84	245	245
			248	
			249	
			241	
			242	
		3.93	228	227
			226	
			227	
			228	
			226	

Table 11. Determination of GSM for fleece knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Average GSM(Gm/m^2)
Fleece	(30Ne+20Ne)	4.00	237	238
			239	
			238	
			238	
			238	
		4.10	226	224
			228	
			222	
			221	
			223	

3.2 Determination of fabric bursting strength

Table 12. Determination of bursting strength for plain knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength (Kpa)
		2.55	140	480.7
plain	30/1	2.60	125	471.1
		2.65	118	448.6
		2.70	116	393.3

Table 13. Determination of bursting strength for single lacoste knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength
		2.55	155	540.4
single lacoste	30/1	2.60	153	512.8
		2.65	151	501.5
		2.70	149	478.7

Table 14. Determination of bursting strength for double lacoste knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength
		2.55	159	548.2
Double lacoste	30/1	2.60	153	525.5
		2.65	151	512.2
		2.70	148	499.5

Table 15. Determination of bursting strength for cross miss knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength
		2.55	115	380.4
Cross miss	30/1	2.60	113	363.3
		2.65	111	344
		2.70	110	342

Table 16. Determination of bursting strength for polo pique knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength
		2.55	139	464
Polo pique	30/1	2.60	135	457.2
		2.65	133	428.7
		2.70	131	421

Table 17. Determination of bursting strength for Terry knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength
Terry	30Ne+20Ne	3.84	245	594.3
		3.93	227	573.2

Table 18. Determination of bursting strength for fleece knit fabric.

Type of Fabric	Yarn Count in Ne	Stitch Length in mm	GSM (Gm/m^2)	Bursting Strength
Fleece	30Ne+20Ne	4.00	238	579.7
		4.10	224	567.3

3.3 Effect of stitch length on fabric GSM

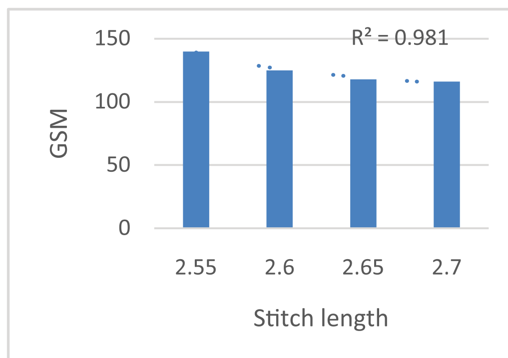

Figure 1. Stitch length's effect on plain fabric GSM.

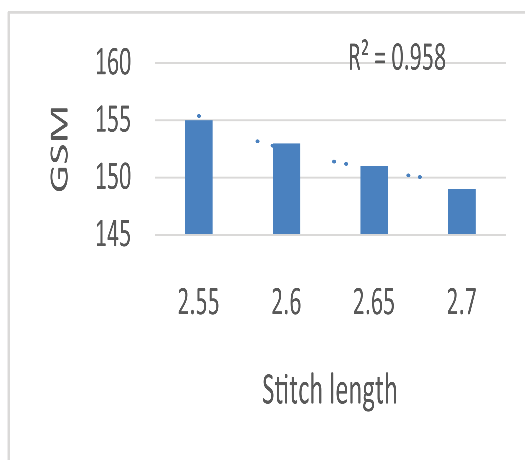

Figure 2. Stitch length's effect on single lacoste fabric GSM.

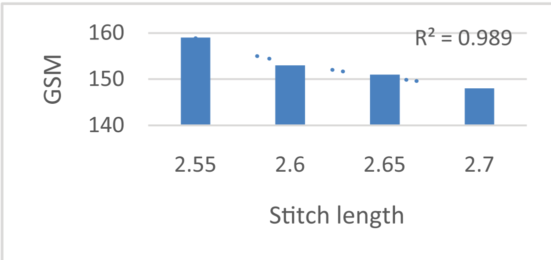

Figure 3. Stitch length's effect ondouble lacoste fabric GSM.

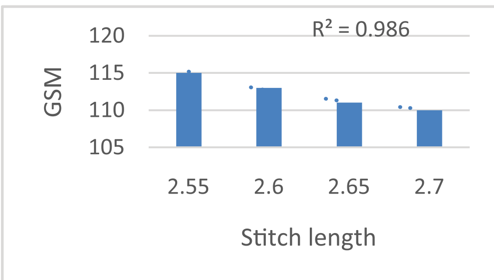

Figure 4. Stitch length's effect on cross miss fabric GSM.

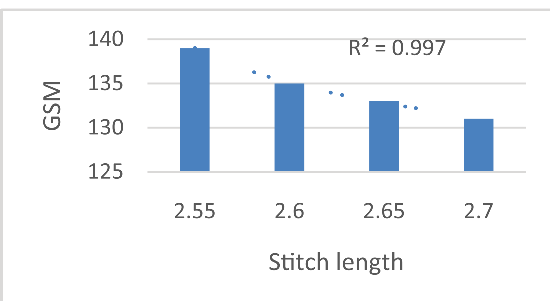

Figure 5. Stitch length's effect on polo pique fabric GSM.

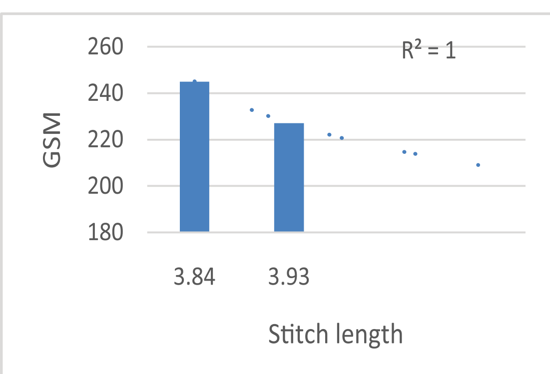

Figure 6. Stitch length's effect on terry fabric GSM.

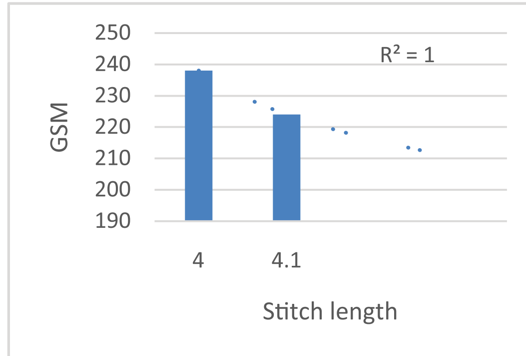

Figure 7. Stitch length's effect on fleece fabric GSM.

3.4 Effect of weft knit fabric GSM on bursting strength

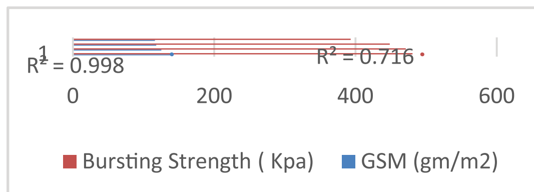

Figure 8. Effect of fabric GSM for plain fabric bursting strength.

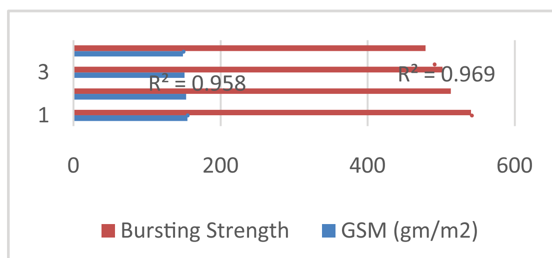

Figure 9. Effect of fabric GSM for single lacoste fabric bursting strength.

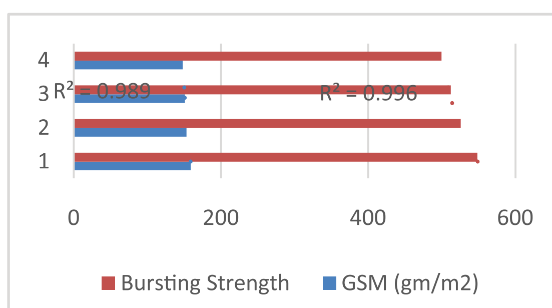

Figure 10. Effect of fabric GSM for double lacoste fabric bursting strength.

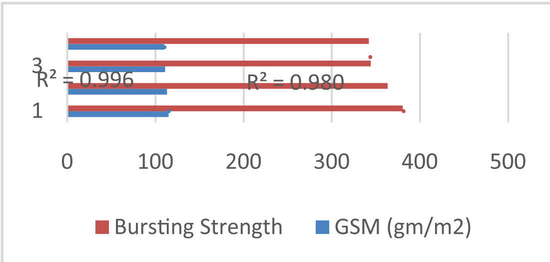

Figure 11. Effect of fabric GSM for cross miss fabric bursting strength.

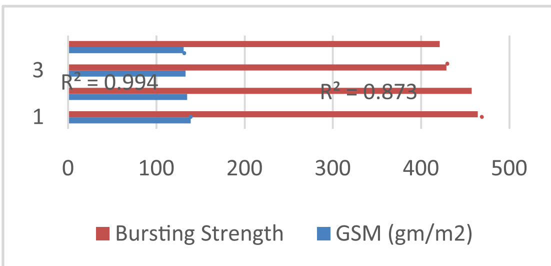

Figure 12. Effect of fabric GSM for polo pique fabric bursting strength.

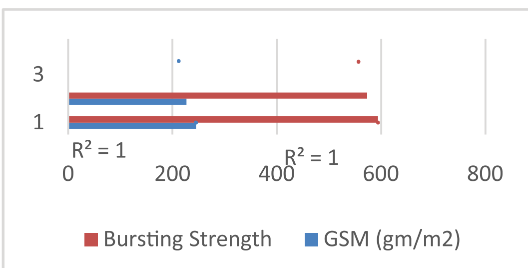

Figure 13. Effect of fabric GSM for terry fabric bursting strength.

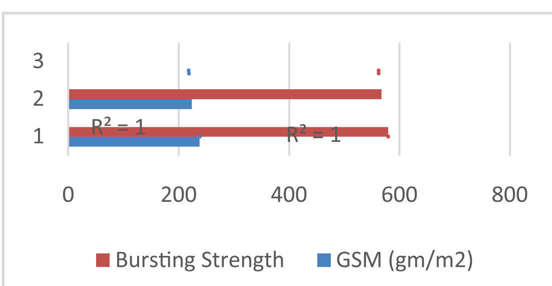

Figure 14. Effect of fabric GSM for fleece fabric bursting strength.

Fabric GSM is one of the important considerations from a buyer's end. Stitch length, yarn count, machine gauge, fabric structure are the prime parameters that are considered for maintaining fabric GSM. In this study, authors produced seven different types of fabric structures using the same machine gauge and more or less the same stitch length with a view to determine how stitch length affects fabric GSM and how knit fabric GSM may effect on their bursting strength respectively. From experimental data analysis it can be shown that terry fabric shows maximum GSM then fleece, double lacoste, single lacoste, plain, polo pique, and lastly the lowest GSM found in cross miss weft knit fabric structure. On the other hand, from the bursting strength data analysis, it can be clearly understood that terry fabric showed maximum bursting strength as it had maximum GSM, then sequentially lowered GSM fabric needed less bursting strength for burst. As cross miss weft knit has minimum GSM so, it needs minimum bursting strength for the rapture. For plain, single lacoste, double lacoste, polo pique, cross miss, terry, and fleece weft knit fabric it can be found that increasing the stitch length causes the decrement of fabric GSM and vice versa [1]. On the other hand, higher GSM fabric is literally heavyweight fabric which may need more strength for bursting, that is why higher GSM fabric needs more strength for burst and vice versa [4- 5].

4. Conclusion

Bursting can be varied for several reasons. According to these studies, it can be easily concluded that GSM is inversely proportional to the stich length. Plain fabric is less heavier then terry and fleece due to structure variation. Single lacoste, double lacoste, polo pique structures are medium heavy fabrics which may need moderate amount of strength for burst. This study easily concludes that higher GSM fabric requires higher strength for burst.

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