

# Impact of Stitch Type and Stitch Density on Seam Properties

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**Abstract:** *Seam strength, aesthetic look and seam puckering are an important factor in determining the durability of a garment. This is carried out on blended fabric with different structures like plain, twill, satin. Samples were prepared by varying SPI and stitches type. The seam strength was determined by strength tester and carried out on different commercial fabrics for making comparison on seam strength and seam puckering based on the changing SPI values, same needle and two different sewing machine(over lock and plain). The results showed that, the overall seam performance is influenced by different factors. It was concluded from this research that, as SPI was increased, the seam strength was also increased and decreased when SPI was reduced vice-versa as well as SPI increased aesthetic look seam puckering is good.*

**Keywords:** seam strength, seam puckering, SPI, stitch type, thread.

## 1. Introduction

Seam is one of the important parameter and considered as basic requirements in the construction of apparel. Compatibility of the seam for functional and aesthetic requirement is very important for serviceability and life of apparel [1]. The serviceability of apparel can be increased by selecting the suitable type of fabric, thread and seam. Selection of type thread, fabric and seam are basic elements in garment durability, especially for the fashionable garments in terms of cost and quality. Seam quality is subjected to seam strength, seam efficiency, puckering and appearance. Consumers evaluate seam quality mainly based on the seam appearance and its durability after wear and care procedures. Various types of seams, stitches can be applied on finished fabrics (garments) with different stitch density (SPI) having diverse effect on seam strength, quality in general and performance in particular. The probability of seam performance for different garment is also different depending upon its end use. As a result, analysis of seam performance can provide a more significant study of various elements influence the seam performance. The quality of seam is generally evaluated by the manufacturers during product development and production. Further the quality level of the apparel requires the judgment of seam quality, strength and physical appearance.

The apparel industry is diversified by fashion products, types, volumes of production and manufacturing environment, therefore, increasingly demands versatility and quick response technology applied to apparel sewing. The management of apparel manufacturers is relatively precarious in respect of quality and with the presence of advanced technology; the concern between the raw material properties, performance of sewing and seam quality becomes very significant where fabric and sewing thread is the primary material of apparel industry. The primary material sewing thread, universally Tex is used to represent it [2].

Qualitative of the primary material influences the quality of seam of the Fashion dress alongside the garments. High seam quality and consumer is mainly made attention in appearance, comfort, and wears ability dress, is primarily interested by fashion designers by using raw material properties. Appropriate selection of raw material not only gives comfort to the wearer but also helps in smooth working of manufacturing process and lead to defect free garment [3].

Appropriate seams are essential factors in fashion garment quality. The characteristics of an appropriate seam are its strength, elasticity, durability, stability and appearance, which depend on the type of seam and the stitches per unit length of the seam, the thread tension and the seam efficiency of the fabric.

In common, the quality of seam mainly relies on both seam strength and appearance. A seam having no seaming defects such as puckering or skipped stitches; and the overall appearance of the seam must meet the design requirements of the apparel/fashion products, must be flexibility and strength to meet up as a good seam quality. Through various functional and aesthetic performances desired for good seam quality to apparel product during their end use. The functional performance mainly depends to the strength, tenacity, efficiency, elasticity, elongation, flexibility, bending stiffness, abrasion resistance, washing resistance and dry cleaning resistance of the seam under conditions of mechanical stress for a reasonable period of time [4-6]. Basically, seam quality may be examined from two main aspects: functional and aesthetic performance. Previous studies [7] investigated the functional performance of seam mainly in terms of the seam strength and/or seam efficiency. Some researchers stated that common apparel products, the seam are an essential part of the garment [8]. Seam damage also occurs due to between the fabric and high friction the needle. Tex is the universal system used to represent the sewing thread size [9, 10] showed the impact of sewing thread size on seam strength. Higher sewing thread size was led to

greater friction during sewing, which finally reduced its strength. Therefore it led to impoverished seam strength.

Although they represent only a very small fraction of the cost of the garment, poor sewing threads can greatly increase production costs, as they cause frequent stoppages of sewing machines<sup>[11]</sup>. Introduce textured PES threads to clothing industry are the best methods to reduce production cost and are the most economical threads today.

One of the most serious defects in garments manufacturing consider the seam puckering phenomenon which is defined as a local defect of a clothing item in form of large ridges of material beside the seam.<sup>[12]</sup> The flaw during pressing operation is almost impossible and so in practice, sometimes needs to accept a large grade as normal. Consequently, to acceptable to the client, the final product, the objective assessment of seam puckering is essential<sup>[13]</sup>.

Correct selection of sewing thread requires consideration of its properties in the completed garment under conditions of wear and cleaning<sup>[14]</sup>. Three factors are influenced sew ability and seam quality<sup>[15]</sup>: (i) the material to be sewn, (ii) The sewing technique and (iii) The end use or the application of the sewn material. Seam pucker is influenced by different factors, as properties of sewing threads and fabrics, processes of needle penetration, stitch formation, sewing thread tension and fabric feeding, seam construction and various technological parameters, and other. Great attention is paid to fabric properties and factors of a sewing machine as well as to their compatibility in the process of sewing<sup>[16-21]</sup>. On occurrence of this defect, the shrinkage of threads after sewing may have not inconsiderable influence. The changes of mechanical properties after sewing were analyzed in most cases<sup>[22-27]</sup>.

The limited amount of researches analyzing the influence of sewing thread properties on seam pucker have been reported<sup>[28-31]</sup>. To evaluate process of sewing garment fabric, after the sewing process or shortly after it, seam pucker often is assess without delay.

The aforementioned discussion, seam strength and seam puckering play a vital role to ensure the garments quality acceptable to the consumer which also depends on it sewing quality how it is sewn and which parameters are used.

Constantly changing trends in fashion and the development of production tools, the quality requirement from customer are also changing constantly in this dynamic and traditional sector known as apparel industry. To fill up to satisfy client's demands, the variables must be kept under control that affects product quality.

The perspective of including both fabrics and sewing threads assessment depends to evaluate the process of sewn product which is relating to performance and appearance and also considering sewing, clothing and maintenance of the product. A good congruence between sewing thread and materials will influence the product quality and productivity, or during the sewing process, the fabric is damaged or the machine stops at unanticipated time intervals<sup>[32]</sup>.

Seam strength is an important factor in determining the durability of a garment. Seam strength, seam slippage, seam puckering, seam appearance and yarn severance are important factor to maintain seam performance and quality and cost problem may appear as serious level for seam damage, often it can be seen, only after the garment has been worn. Fabric construction, chemical treatments of the fabric, needle thickness and sewing machine settings with sewing thread is influenced on seam damage tendency, so those are the important parameter.

For any apparel product, it is necessary to clearly understand the seam, as it is the basic element of an article of clothing. A large number of studies<sup>[33-39]</sup> have determined the seam strength according to ASTM 1683-04 standards, which express the value of seam strength in terms of maximum force (in Newton (N)) to cause a seam specimen to rupture.

This is measured by using the

Following equation:  $S_s = K \times S_b$

Where:  $S_s$  = sewn seam strength (N);  $K$  = a constant equal to 1000 for SI units;  $S_b$  = observed seam breaking force (N).

Leaving the Fabric intact or fabric rupture during sewing and leaving the Sean intact or both breaking at the same can seam failure occurring in garments. Fabric breaking and strength as same as the manner as seam strength. To have balanced construction of material is equal of seam strength or stitch which will resist the force face with in the garment of which the seam in a part.

The seam strength are affecting on some element which rely on thread strength type, stitch type, thread strength stitches per Inch, thread tension, seam type, seam efficiency of the material. Usually the chain stitch seam is stronger than lock stitch seam.

The seam opening load is mainly dependent on:

- The rate of stitch
- The fabric weaves structure
- Allowance of the width of the seam

### Seam

A crease is the utilization of a progression of fastens or line composes to one or a few thickness of material applying by a series of stitches or stitch types. Stitch line of a seam is seam line. Overall attractiveness of a garment is always a appearance which is affected by seam and is usually parallel.

### Classification of Seams

- 1 Class 1-The Super Imposed Seam
- 2 Class 2-Lapped Seam
- 3 Class 3-Bound Seam
- 4 Class 4-Flat Seam
- 5 Class 5-Decorative Stitching Seam
- 6 Class 6-Edge Neatening Seam
- 7 Class 7-Edge Stitched Seam
- 8 Class 8-Enclosed Seam

### Stitch

The term stitches refers both to the thread interloping or Interlocking used to make seams-the joints between two pieces of fabric that are sewn together. Stitches help

determine the functional aesthetic performance of a garment. Their durability comfort and attractiveness are important performance considerations determined by the end use and design of the garment, the type of fabric used, and the location and purpose of the stitches. Cost considerations also affect the choice of stitches. Loop or loops of one or more threads when bounds with each other, either by interlacing, interloping, interlooping or combination of those when sewing fabric, each unit of such configuration is called stitch. Interlacing: During stitching when one loop of one thread passes over another loop of another thread is called interlacing. Interlooping: When loop of one thread passes through the loop of another thread is called interlooping.

### Stitch types

Stitch definition: Loop or loops of one or more threads when bounds with each other, either by interlacing, interloping or combination of those when sewing fabric, each unit of such configuration is called stitch.

Stitches are of 70 types:

All these types of stitches are grouped in 6 classes. According to British standard-

- 1) Stitch class – 100 (Single Thread Chain Stitch).
- 2) Stitch class – 200 (Hand Stitch).
- 3) Stitch class – 300 (Lock Stitch).
- 4) Stitch class – 400 (Multi Thread Chain Stitch).
- 5) Stitch class – 500 (Over Edge Stitch).
- 6) Stitch class – 600 (Covering Chain Stitch).

Incorrect tension settings, fabric and / or thread instability, structural jamming and poorly controlled fabric feed are the most common problem which is encountered by a combination of those major causes of seam puckering. Seam pucker problems in lightweight fabrics are reducing the aesthetic value and degrading quality of garment <sup>[40]</sup>.

The principle factor to decide its value is depended on its visual appeal of garments. Crease pucker is a wrinkled appearance along the crease, impacts the appearance to an operative degree.

Differential shrinkage that emerges all through the crease line and is caused by the impermanence of crease, may describe seam pucker. Usually, wrinkling appears due to not proper selection of stitching parameters and also material properties are sewn together and affecting the appearance characteristics leading to an unevenness of fabrics lengths that.

In a later stage, as the stitches shrink, crease appear in the material and cannot be detected immediately and seam product must have a good durability to washing and ironing, as differential shrinkage may cause puckering which is happened between sewing thread and fabrics.

For satisfactory seam quality depends on the prime subject on sewing thread. Hence, in the present study, an attempt has been made to study on Assessment of seam strength and seam puckering on different types of fabric based on different SPI (Stitch per inch.) and stitch types(lockstitch and over edge stitch).

## 2. Material and Methods

### Material

The major portion of the experimental work was carried out in sewing lab. However the remaining work and test analysis was conducted in testing lab. Materials and methods for measuring the seam strength and measurement of puckering are experimental. The detailed Experimental Procedure involved in carrying out this project work is described below:

### Sewing Thread details

50/2, 100% spun polyester thread in both needle and bobbin  
Composition: - 100% spun Polyester Sewing Thread  
Count: - 50/2  
Cone Length: - 4000 Meter

### Stitch type

#### 1) Lock Stitch

This type of stitch is constructed by using two threads with the help of interlacing. One thread is coming from needle so it is called needle threads and the others is coming from bobbin so it is called bobbin threads. The other name of this stitch is stitch class – 100. This stitch is done by plain m/c.

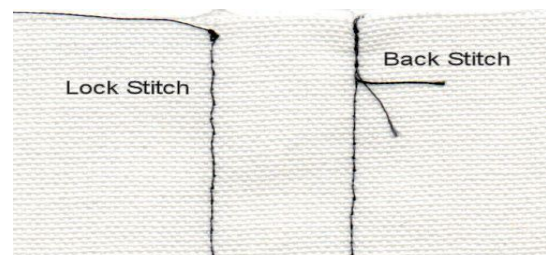


Figure 1: Lock stitch Picture

#### 2) Overlock

Two or more superimposed plies of material, aligned along their edges, are joined together, edge-trimmed and oversewn in one operation, with overedge stitches having two or more threads.

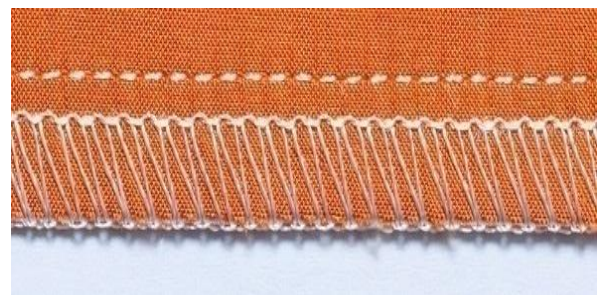


Figure 2: 5 Thread Overlock Stitch Picture

### Sample size

Sample dimension is required for folding along with its middle, after that folding fabrics length 06cm and wide 04 cm. Stitch was towards to this folded middle line of the sample fabric as if it had folded by the distance from folded edge 1.5 cm.

**Preparation of sample**

Select samples either in accordance with the procedure laid down in the material specification for the fabric or as agreed between the interested parties. Avoid test specimens with folded or creased areas, selvages, and areas not representative of the fabric.

**3) Preparation of sample for lock stitch**



**Figure 3:** Lock stitch Sample picture

**4) Preparation of sample for 5 threads over lock**



**Figure 4:** 5 Thread Overlock stitch picture

**Table 1:** Different types of different fabric construction are used. Properties of fabrics:

Serial No.	Weave	Thread Density (per inch)		Fabric Count		Fabric width	Fabric G.S.M
		EPI	PPI	Warp count (Ne)	Weft count (Ne)		
<b>Fabric 1</b>	Plain (Poplin)	101	54	50s/1	43s/1	34	96
<b>Fabric 2</b>	Plain( KT/K2 (60/40))	90	72	40s/1	40s/1	42	94
<b>Fabric 3</b>	plain (2/1, irregular –warp rib)	60	72	46s/1	white - 25s Green - 28s	42	93
<b>Fabric 4</b>	Satin	202	67	90s/1	60s/1	42	76
<b>Fabric 5</b>	Plain (Boil)	90	63	50s/1	45s/1	34	77
<b>Fabric 6</b>	Plain(Toray)	104	76	65s/1	65s/1	41	68
<b>Fabric 7</b>	Plain(Toray)	110	80	46s/1	56s/1	45	90
<b>Fabric 8</b>	Twill	58	127	34s/1	36s/1	55	143

Here, the table shows the properties of fabric details: EPI, PPI, fabric width, warp count, weft count and fabric G.S.M

**Table 2:** According to fabric serial no. described in table 1, code no. express which fabric which SPI use either plain stitch machine or over lock stitch machine.


Fabric	Plain stitch for SPI-8	Plain stitch for SPI-10	Plain stitch for SPI-12	Plain stitch for SPI-14	Over lock Stitch for SPI-8	Over lock Stitch for SPI-10	Over lock Stitch for SPI-12	Over lock Stitch for SPI-14
Fabric No.-01	F1-P8	F1-P10	F1-P12	F1-P14	F1-V8	F1-V10	F1-V12	F1-V14
Fabric No.-02	F2-P8	F2-P10	F2-P12	F2-P14	F2-V8	F2-V10	F2-V12	F2-V14
Fabric No.-03	F3-P8	F3-P10	F3-P12	F3-P14	F3-V8	F3-V10	F3-V12	F3-V14
Fabric No.-04	F4-P8	F4-P10	F4-P12	F4-P14	F4-V8	F4-V10	F4-V12	F4-V14
Fabric No.-05	F5-P8	F5-P10	F5-P12	F5-P14	F5-V8	F5-V10	F5-V12	F5-V14
Fabric No.-06	F6-P8	F6-P10	F6-P12	F6-P14	F6-V8	F6-V10	F6-V12	F6-V14
Fabric No.-07	F7-P8	F7-P10	F7-P12	F7-P14	F7-V8	F7-V10	F7-V12	F7-V14
Fabric No.-08	F8-P8	F8-P10	F8-P12	F8-P14	F8-V8	F8-V10	F8-V12	F8-V14

Here, F = represent the number and the number with “F” stands for fabric number as in Table 2

P = represent to mean plain stitch and the number stands for stitch per inch

V = represent to mean overlock stitch and the number stands for stitch per inch.

**Table 3:** Details of sewing machine, sewing thread and stitch per minute are given below.

Serial no.	Machine details	Machine Picture	Needle Details	Stitch per minute (SPM)
<b>01</b>	Single Needle Lock Stitch Machine- 301 Brand: - Typical Origin: - Chine Model no.:- GC6150H Serial no. :- No. 480102289 Company Name:- Typical Sewing m/c Wanping Machinery Co. Ltd.		Needle: - DP×5-14 Brand: - ORGAN Company: - Organ Needle Co. Ltd.	4000-4500

02	Five Thread Overlock Machine Brand: - Juki Origin: - China Model no.:- MO 6716S Serial no. :- 8MOBM11430 Company Name:- Juki		Needle: - DC×1-14 Brand: - ORGAN Company:- Organ Needle Co. Ltd	3500-4000
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**Seam Strength Machine, and Method**

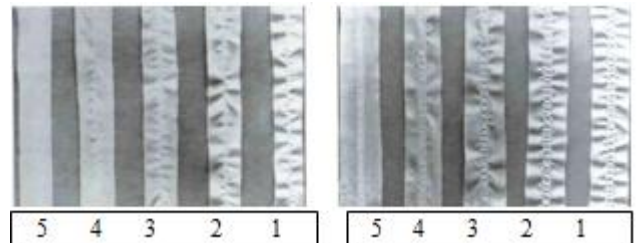
Method: - ISO 13935-2  
 Sample Size: - 15×10 cm  
 Unit: - Newton  
 Machine: - Electromechanical Testing Machine  
 M/C Model: - 5ST  
 Original: - U.S.A



**Figure 5:** Seam Strength Testing Machine Picture

**Method for Measuring Seam Puckering**

In subjective evaluation method, experts or experienced judges grade the fabric seam appearance according to certain standers, Variety of standards has been proposed and AATCC standard 88B is the most commonly practiced today. According to AATCC method, seam appearance is classified into five grades: grade 1 refers to worst fabric which heavily puckered and grade 5 refers to smooth fabric with little puckering or no pucker at all. Figure 3.6, illustrates the photographs of reference seam specimens from AATCC (American Association of Chemists and Colorist).



**Figure 6:** AATCC Photographic seam puckering replicas

**3. Method**

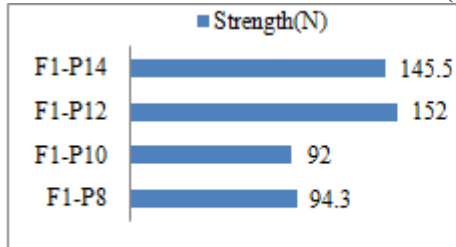
**Method for Measuring Seam Strength**

Seam strength is measured through ISO 13935-2 method by electromechanical testing machine.

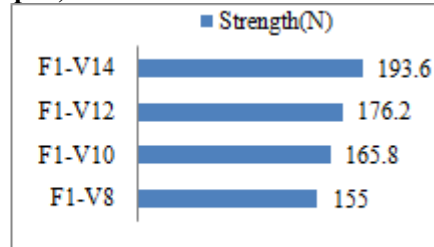
**4. Results and Discussion**

**4.1.1 Data Analysis**

**Plain (Poplin)**

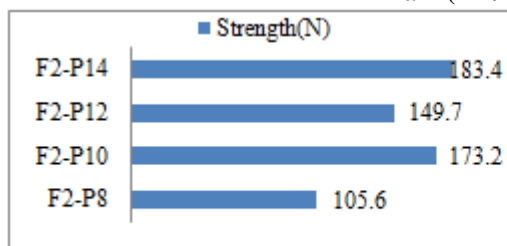


**Figure 7:** Plain

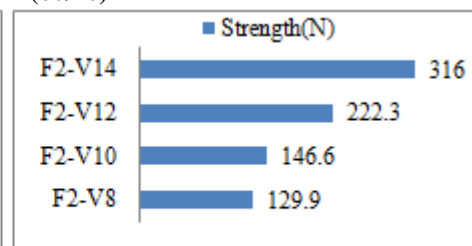


**Figure 8:** Overlock

**Plain (KT/K2 (60/40))**

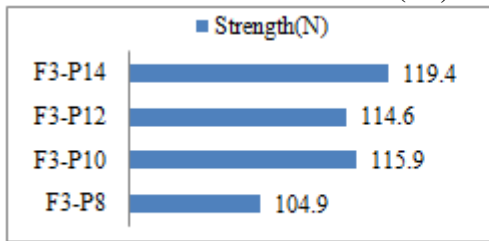


**Figure 9:** Plain

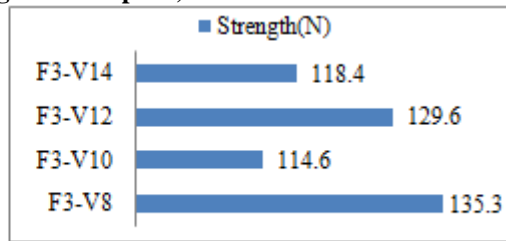


**Figure 10:** Overlock

**Plain (2/1, irregular –warp rib)**

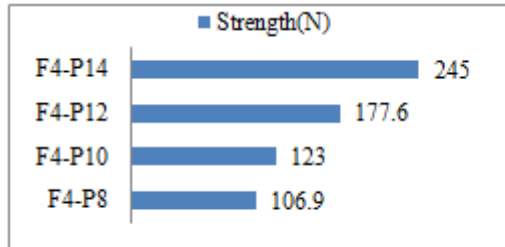


**Figure 11: Plain**

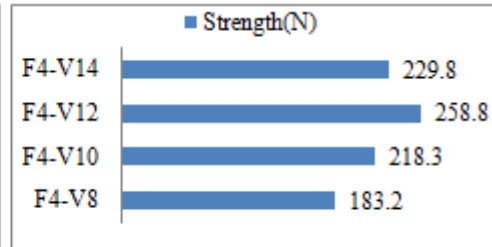


**Figure 12: Overlock**

**Satin**

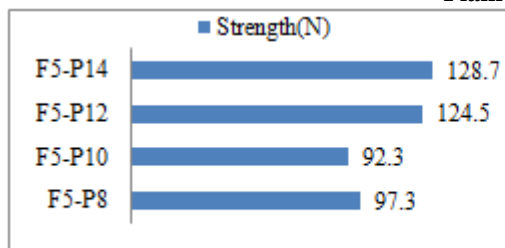


**Figure 13: Plain**

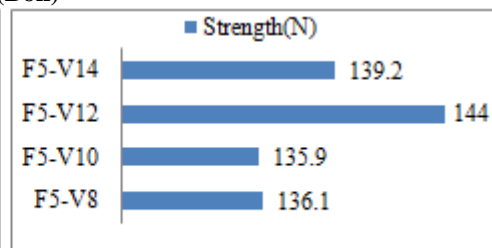


**Figure 14: Overlock**

**Plain (Boil)**

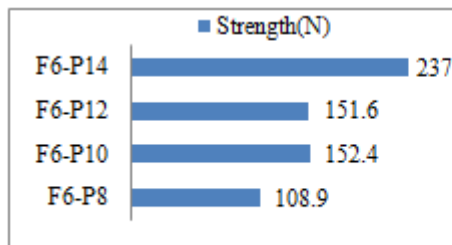


**Figure 15: Plain**

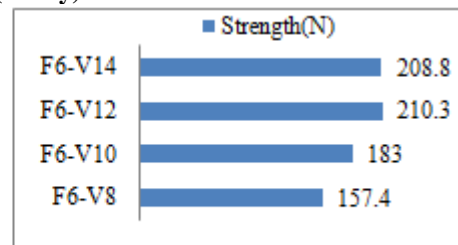


**Figure 16: Overlock**

**Plain (Toray)**

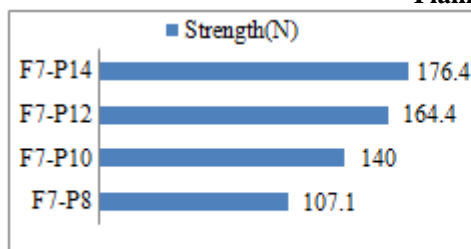


**Figure 17: Plain**

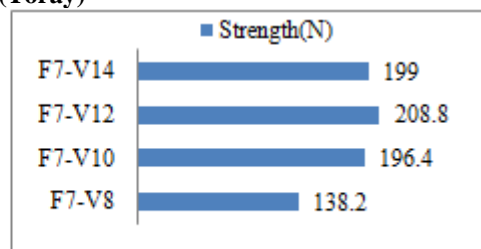


**Figure 18: Overlock**

**Plain (Toray)**

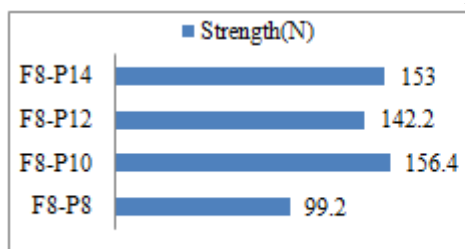


**Figure 19: Plain**

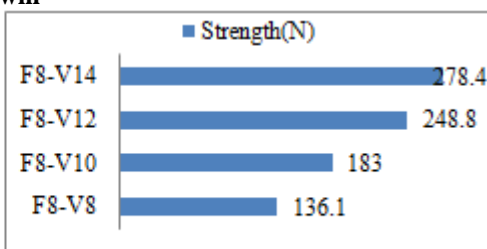


**Figure 20: Overlock**

**Twill**



**Figure 21: Plain**



**Figure 22: Overlock**

**Seam Strength Data Analysis**

According to the above figures, strength of seam is increased, when SPI is increased. Because the unit of seam, increasing within an inch. For this the force of strength shared in large amount of stitch. But in plain stitch, when

SPI increase 10 to 12, the strength of seam decreases (e.g. fig: 9,11,17,21) and overlock stitch, SPI 12 is more convenient than SPI 14 (e.g. fig: 14, 16, 18, 20). So it can say the seam strength, not only depends on SPI but also depends on fabric construction.

**Puckering Result for Plain Stitch**

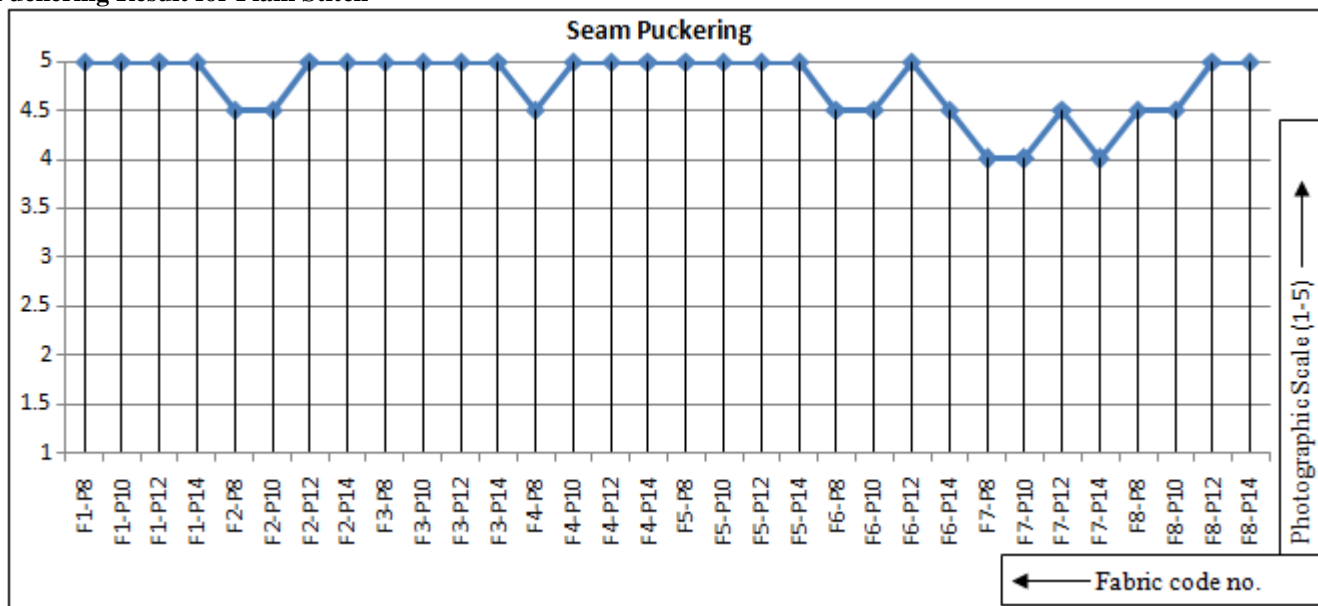


Figure 23: Puckering Result for Plain Stitch

**Puckering Result for Over Lock Stitch**

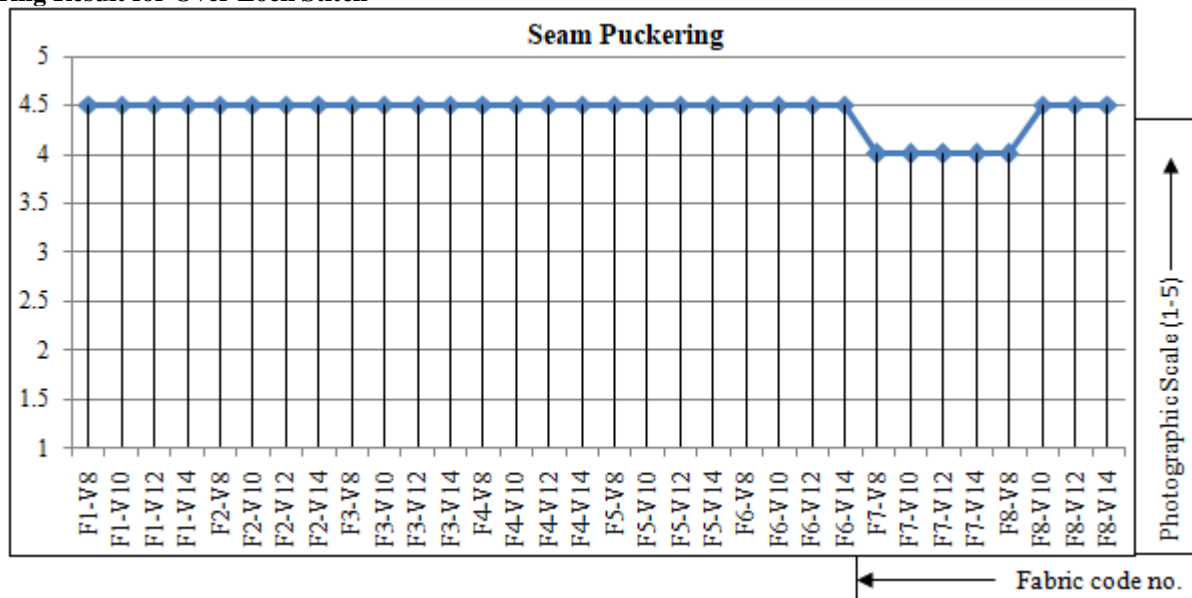


Figure 24: Puckering Result for Over Lock Stitch

**4.1.2 Seam Puckering Data Analysis**

According to AATC method, seam appearance is classified into five grades. Grade 1 refers to worst fabric which is heavily puckered and grade 5 refers to smooth with little pucker or no pucker at all. By seam puckering measurement, aesthetic look, it seam for plain stitch when SPI increase, the smoothness of fabrics looks little pucker or no pucker at all. Sometimes SPI-12 is preferable then SPI-14 (Fig: 23, Fabric code: F6-P12, F6-P14 and F7-P12, F7P14) though they are different fabric with different fabric construction. In overlock stitch, the smoothness of fabric don't so smoothness on fabric by either SPI increases or decreases.

**5. Conclusion**

It was found from experimental results that with increase in the stitch density the strength of the seam was also increase but up to some extent, after that the strength of seam decreased, because increase in the stitch density after certain level may rupture the fabric. Further it was also found that different seams impact in a different way on the strength under different SPI. Seam quality is subjected to seam strength, strength efficiency, puckering and appearance. Consumers evaluate seam quality mainly based on the seam appearance and its durability after wear and care procedures.

Various types of seams, stitches can be applied on finished Fabrics (garments) with different stitch density (SPI) having diverse effects on seam strength, quality in general and performance in particular. The probability of seam performance for different fabrics is also different. As a result, analysis of seam performance can provide a more significant study of various elements influence the seam performance. The study was carried out on different commercial fabrics for making comparison on seam strength and seam puckering based on changing SPI values. Different commercial fabrics were used under four different SPI (SPI-8, SPI-10, SPI-12, and SPI-14). In this study seam puckering is determined through AATCC method and seam strength is measured through ISO 13935-2 method by Electromechanical Testing Machine. The results showed that, the overall seam performance is influenced by different factors. It was concluded from this research that, as SPI was increased, the seam strength was also increased and decreased when SPI was reduced vice-versa as well as SPI increased aesthetic look seam puckering is good.

## 1) Recommendation

Best thread and SPI can use in garments product to reduce its cost in overlock and plain stitch to get better strength and less puckering and make garments product acceptable to customers to gain satisfactory desire from it.

### 5.1 Recommendation for further research

- 1) Measuring seam strength and puckering on basis of same construction of fabric and different SPI for both plain and overlock stitch.
- 2) Determination of seam strength and puckering on basis of same construction and same yarn count of fabric both plain and overlock stitch.
- 3) Determination of seam strength and puckering on basis of same construction and various yarn count of fabric both plain and overlock stitch.
- 4) Cost reducing factor depends on choosing which count sewing thread that gives better strength and less puckering.

## 2) Limitation

- 1) Not to make a conclusion by applying theoretical formula for plain stitch by which gives a similarity to the researcher work getting the best sewing thread that is better for good strength and less puckering.
- 2) No theoretical formula for overlock stitch by which it can easily reach a conclusion stands for measuring to choose the perfect material to stitch getting better strength and less seam puckering.

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