INVESTIGATING THE SEAM SLIPPAGE OF SATIN FABRICS

MANAL A. SEIF

Associate Professor, Department of Apparel Design & Technology, Faculty of Applied Arts, Helwan University, Egypt

ABSTRACT

Different fabrics are sewn into garments in the apparel industry. The performance and appearance of seams form an important component of the quality of the finished product. The quality and performance of a sewn garment depends on various factors such as seam strength, seam slippage, seam grin, seam pucker, seam appearance and yarn severance. Seam slippage may be due to improper woven construction or finish, or may also be caused by stitching that does not have proper holding power. Satin fabrics are known to be critical for seam slippage due to the weave construction likewise chiffon fabrics. In this study it will be investigated the defect of seam slippage in satin fabrics and factors cause minimizing of this problem. For experimental work, three satin materials are sewn in warp, weft and Bias’s direction with three stitch types in three levels of stitch length by 2 needle sizes, are chosen. Results of each factor are separately presented and analysed.

KEYWORDS: Satin Fabric, Seam Slippage, Seam Opening, Seam Strength, Seam Elongation, Sewing Factors, Fabric’s Direction.

INTRODUCTION

Woven fabric is a sophisticated structure material and its characteristics and quality influenced closely by its structure. There are seven parameters influencing woven fabric structure: the raw material of the warp and the weft, the linear density of warp and weft, the warp and weft setting and the weave of the fabric [1].

Satin was the first choice for fabric in the royal courts of 14th century in England, and it is considered just as luxurious today. It is not the name of a raw material; it refers to the weave of the fabric. It is made from a low-twist yarn which is like a filament and is constructed using a process similar to a twill weave. It is glossy, smooth and sleek and has one shiny side and one dull side. A satin fabric tends to have a high lustre due to the high number of floats on the fabric. Silk, cotton, wool and polyester are all fibres that are commonly woven into satin. High grade silk is the preferred choice, but polyester is a common, less expensive imitation that can be woven to appear as the silk. If a fabric is formed with a satin weave using filament fibres such as silk, nylon, or polyester, the corresponding fabric is termed a satin. If the yarns used are short-staple yarns such as cotton, the fabric formed is considered a sateen [2]. Otherwise satin weaves have a surface of nearly unbroken warp; their opposite, fabrics woven with a nearly unbroken weft surface, are called sateen [3].

The cut sewn apparel industry converts a two-dimensional fabric into three-dimensional apparel. Many processes are involved during apparel production, till reaching the finished garment. While there are other methods of shaping fabrics into garment, stitch seaming is by far the most common method used worldwide. A seam is manufactured employment sewing methods, with the idea that the seam should satisfy all the requirements imposed by the end-users of apparel products [4].
Stitches and seams are two important elements of apparel construction. Stitches are used to join the materials and hold the apparel together, and seams give the shape/contour and detail of the apparel. These two elements together with the material properties contribute to the quality of the seam (datastream.pdf). The quality of apparel depends on two factors: physical features and performance features. Physical features depend on the materials and methods used to assemble the apparel. Types of fibre (natural or synthetic), properties of the fabric, stitch and seam types are some factors that should be considered when dealing with physical features of the apparel. Performance features define the visual and functional requirements of the apparel. Visual requirements are based on colours, patterns, design, trends and accessories, and functional requirements are more related to the stability of the apparel during wear and care [5]. The quality and performance of a sewn garment depends on various factors such as seam strength, slippage, grinning, puckering, appearance and yarn severance. Nowadays, apparel plants decrease their quality defect rates, therefore they can become more advantageous in the conditions of competition [6]. Therefore, overall quality of seam depends on the requirements imposed by the consumers. Good overall seam is essential for the longevity of an apparel product, which together with consumer satisfaction during wear and care procedures affects its saleability. The apparel industry uses different dimensions for the evaluation of seam quality on the basis of requirements of seam from the point of view of consumer. The requirements of a seam quality are clearly illustrated in figure 1.

Figure 1: Seam Quality Criteria [7]

Seams on garments are subjected to repeated loading during daily use, such as walking, sitting, squatting down, etc. This repeated loading causes several seam defects, such as slippage for woven fabrics and seam grinning. Seam slippage (opening) is a mode of failure evidenced by yarn movement at either side of the seam creating a gap or opening. Seam grinning may be described as the separation of the interface line between two sewn fabrics. Elastic fabrics have more tendency to seam slippage as the seams at elastic fabrics do not have enough elasticity like the elastic fabric [8]. When a seam is stretched at right angles to its direction, seam slippage normally occurs. If the slippage is conspicuous, it is regarded as a sewing defect. The former is connected with seam slippage and has been reported to be influenced mainly by fabric characteristics such as weave, type of weaving yarn, coefficient of friction between yarns, fabric density, and so on [6]. Both of seam strength and seam slippage are parameters measure the performance of seam. Seam strength refers to the strength when seam finally ruptures or when the fabric breaks. However before rupturing there is an unacceptable opening in the seam which makes the seam 'failed' commercially even when there is no visible rupture and this case is called seam slippage. Seam strength depends upon stitch type, thread strength, stitches per inch, thread tension, seam type and seam width.
Investigating the Seam Slippage of Satin Fabrics

efficiency of the material. Seam slippage depends upon the stitch rate, the weave structure of the fabric and the width of the seam allowance [9].

Seam slippage is expressed as the transverse ratio of seam strength to fabric strength including the ratio of elongation of fabric to the ratio of elongation at the seam. Any movement of the warp and weft yarns away from a seam line under transverse stresses exacerbate the potential slippage [4].

Description of Seam Slippage

Seam slippage is defined as: a defect consisting of separated yarns occurring when sewn fabrics pull apart at the seams. Seam slippage is more prone to occur in smooth-yarn fabrics produced from manufactured filament yarns.

There are two major types of seam slippage:

- **Seam Slippage**: When stress is applied to a seam, the yarns in the fabric slip out of the stitching causing an open seam;
- **Yarn Slippage**: When stress is applied to a seam, the yarns in the fabric shift of slide in the weave construction causing seam grinning and fabric distortion [9].

Causes for Seam Slippage

Seam slippage is a type of yarn slippage that appears where fabric sections are joined with a stitching line. A fabric’s susceptibility to yarn slippage is determined by the fibre type, yarn structure, weave, and finishes applied to the fabric. Smooth, long filament silk or synthetic yarns (including metallic yarns) or mercerized cotton yarns can easily shift in a loosely woven fabric. Satin weave fabrics have long sections of yarns floating on the surface that can shift and slip with minimal rubbing and abrasion. Fabrics with a low thread count, which is the combination of a slippery yarn and a loose weave caused yarn slippage to occur on this dress, creating thin areas on the fabric. When tension is placed on the seam of a fabric, yarns can separate, resulting in a form of yarn slippage known as seam slippage. Numbers of yarns per inch in the lengthwise and crosswise direction, are susceptible to yarn slippage. Fabrics that have thick yarns in one direction and thin yarns in the opposite direction, forming an imbalanced weave, are susceptible to yarn slippage. Seam slippage may be due to an insufficient number of stitches per inch, poorly constructed seams, or excessive tension and stress in areas. In many cases, seam slippage may appear on a snug or poorly fitted garment [10]. It is known, that seam slippage depends upon the fabric fibre content, the structure, the width of seam allowances, the garment’s fit to human figure, the seam construction, the number of weft yarns per unit length, the stitch density, the fabric’s direction, the yarn linear density, the sewing-thread tension, the yarn-to-yarn friction, the textile finishing, the yarn flexural rigidity, the contact angle between threads [11].

There are numerous studies [5, 12] on the seam quality based on the aesthetic performance. However, these studies focus mainly on the seam defects such as the seam puckering, seam damage. Furthermore, few studies had been evaluated the seam quality from both aspects of seam: the functional and the aesthetic. Very limited work [4,13] has been done to study analyse the seam quality on functional and aesthetic performance together, and study the effect of thread size, fabric properties and stitch density on seam quality in various types of fabric materials. Many studies on the problem of yarn and seam slippage and their relationship with the weave structure and finish [1, 6, 10, 13, 14, 15, 16] have been done, however this question is still open. In all previously studies concerned the researchers in their experimental works on...
the plain and twill weave structure. Satin weave structure has a very limited interest, although Satin fabrics are known to be critical for seam slippage due to the weave construction likewise chiffon fabrics.

Scope of the Study

The main concerns of this study are:

- Investigating the seam slippage of different satin fabrics and make a focus on the cases, when this problem occurred.
- Determining the best sewing conditions to minimize the defect of seam slippage of satin fabrics.

EXPERIMENTAL WORK

Materials

Tests were performed with three satin fabrics varying in their fabric contents, weight per unit area, thickness and fabric density. In table 1 states the description of investigated materials.

<table>
<thead>
<tr>
<th>Fabric Code</th>
<th>Fabric Contents</th>
<th>Weave Structure</th>
<th>Weight per Unit Area [g/m²]</th>
<th>Thickness [mm]</th>
<th>Warps/cm</th>
<th>Picks/cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 1</td>
<td>96% PES, 4% LYC</td>
<td>Satin (Atlas 5)</td>
<td>92</td>
<td>0.22</td>
<td>87</td>
<td>32</td>
</tr>
<tr>
<td>M 2</td>
<td>96% PES, 4% LYC</td>
<td>Satin (Atlas 5)</td>
<td>147</td>
<td>0.29</td>
<td>76</td>
<td>26</td>
</tr>
<tr>
<td>M 3</td>
<td>35% CO, 65% PES</td>
<td>Sateen (Atlas 5)</td>
<td>163.5</td>
<td>0.33</td>
<td>66</td>
<td>33</td>
</tr>
</tbody>
</table>

Methods

Three types of stitches are chosen for the experimental work, (lockstitch 301, multi-chain over lock stitch 504 and Safety stitch 515) because of their difference in fabric layers number and sewing thread consumption. Table 2 gives the summary of factors designing the experimental work.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Variation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Material</td>
<td>3 types, Two satin fabrics, one sateen fabric</td>
</tr>
<tr>
<td>2</td>
<td>Fabric’s direction</td>
<td>3 direction, Warp (90), Weft (0), Bias (45)</td>
</tr>
<tr>
<td>3</td>
<td>Stitch type</td>
<td>3 types, Stitch 301, Stitch 504, Stitch 515</td>
</tr>
<tr>
<td>4</td>
<td>Stitch length</td>
<td>3 levels, 1 mm, 2 mm, 3 mm</td>
</tr>
<tr>
<td>5</td>
<td>Sewing needle size</td>
<td>2 sizes, 14 (90 Nm) and 16 (100 Nm) for Stitch 301</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 (100 Nm) only for stitch 504 and stitch 515</td>
</tr>
<tr>
<td>6</td>
<td>Sewing thread</td>
<td>One type, Spun polyester 40/2</td>
</tr>
</tbody>
</table>

Sewing was done on the industrial sewing machine under particular sewing conditions that are commercially adopted by apparel manufacturers in apparel manufacturing. The most famous in apparel industry, superimposed seam (ISO 1.01.01), was selected for all tests. Sewing thread spun polyester 40/2 was used for sewing all specimens. Materials were tested in warp’s, weft’s and bias’s direction. Seam slippage in satin fabrics was measured with tensile testing machine.
Intron, according to the international standard BS EN ISO 13936-1:2004 “Textiles: Determination of the slippage resistance of yarns at a seam in woven fabrics: Fixed seam opening method” [17].

Procedure of the Method to Calculate the Seam Slippage

- Clamp the specimen without seam in the jaws and produce a force/extension curve on the chart until a force of 200 N (approx. 20 kgf) is achieved.
- Clamp the specimen with seam in the jaws and produce another force/extension curve from the zero point on the same previous chart.
- For this pair of curves, measure the distance L (see figure 2) to the nearest 0.5 mm between the curve without a seam and the curve with a seam at a force of 5N. This is to compensate for initial straightening of the seamed test specimen.
- Add the distance L to 30 mm or 15 mm (equivalent to the seam opening of 6 mm or 3 mm).
- Read off the force on each pair of curves where the separation between them parallel to the extension axis (seam opening plus compensation).
- Record the Force F to the nearest Newton at this separation.
- If the required separation between the curves is not achieved at or below 200N report the result as “more than 200N”.
- If the fabric tears at a force of 200N or less and the required separation cannot be found, report the result as “fabric breakdown” and quote the force at which this occurred [17].

![Figure 2: Determination of Seam Slippage According to BS EN ISO 13936-1:2004 [17]](image)

RESULTS AND DISCUSSIONS

From the results obtained, the causes of seam failure included the thread breakage, the fabric breakage and seam slippage. Generally, the following discussion would concentrate on the effects of stitch type, stitch length, sewing needle size, Fabric’s direction on minimizing the seam slippage. A comparison of seam slippage by the two different seam opening will also presented.
Effect of Stitch Type on Seam Slippage

Investigated samples in warp’s, weft’s and bias’s directions are sewn with three different stitch types (stitch 301 (2 threads), stitch 504 (3 threads) and stitch 515 (4 threads)). Results of the forces, within the seam slippage occurred by warp direction of material 3 is shown in figure 3.

![Figure 3: Influence of Stitch Type on the Seam Slippage by Warp’s Direction of Material 3](image)

It can be seen, that the stitch type 515 has a better resistant effect against seam slippage rather than the other stitch types. This stitch consists of 2 stitches (401 and 503). However the stitch type 301 has also an acceptable resistant effect against slippage. Stitch type 504 considered to be the worst of all stitch types and causes a seam slippage at a low load. Actually this stitch is usually used in knit wear, but in woven garment it can be used for cleaning and decorating the fabric rather than assembling.

Effect of Stitch Length on Seam Slippage

In order to investigate the influence of stitch length on the seam slippage, three levels of stitch length (L1 (1 mm), L2 (2 mm) and L3 (3 mm)) are used. Results of seam slippage in warp’s direction of fabric is presented in figure 4.

![Figure 4: Influence of Stitch Length on the Seam Slippage in for Material 3 in Warp’s Direction](image)
Investigating the Seam Slippage of Satin Fabrics

It is observed, that the level 3 of stitch length (3 mm) recorded the higher force of seam slippage, however sometimes recorded stitch length at level 1 (1 mm) higher force than level 2 and level 3. It can be said, that the often used level 2 of stitch length (2 mm), stitch density is 5 stitch/cm, caused a seam slippage. This case of slippage could be changed with 2 solutions: increasing the stitch length (decreasing the stitch density) or decreasing the stitch length (increasing the stitch density). Results of the seam slippage indicates, that the stitch length has a significant effect on the force caused seam slippage. The correlation factor for stitch 301 in warp’s direction for all tested materials is (1.00) and the regression equations (1, 2 and 3) confirm this result.

Regression equations of effect of stitch length on the seam slippage by different stitches for material 3 in warp’s direction are:

\[
y_{301} = 2.5x^2 - 2.5x + 25 \quad \text{for stitch type 301} \quad (1)
\]
\[
y_{504} = -1.5x^2 + 12.5x + 6 \quad \text{for stitch type 504} \quad (2)
\]
\[
y_{515} = -15x^2 + 55x - 9E-13 \quad \text{for stitch type 515} \quad (3)
\]

Where:

- \(y\) is the force for seam slippage and \(x\) is the stitch length.

Results indicated also, that material 3 (sateen fabric) shows a different influence than material 1 and material 2 (satin fabrics), which means that the fibre contents of the woven fabric has also a significant effect on the seam slippage. It is recommended that this point should next investigated.

Effect of Sewing Needle Size on Seam Slippage

To determine the influence of sewing needle size, two sizes were chosen for sewing the tested fabrics: Needle size 14 (90 Nm) and needle size 16 (100 Nm). Figure 5 shows the effect of different needle size on the seam slippage by using stitch type 301 in warp’s direction.

![Figure 5: Influence of Sewing Needle Size on the Seam Slippage by Stitch Type 301](image)

Results confirmed, that the needle size has a significant influence on the seam slippage. It is found, that the lower the size of the needle is, the higher the required force for seam slippage is. It is known that the needle size 14 is thinner.
than needle size 16. So it is recommended, that for sewing satin fabrics, it is better to use low needle size to avoid the big holes, which can be done by high needle size.

**Effect of Fabric’s Direction on Seam Slippage**

To answer the question, if the fabric’s direction has an influence of the seam slippage or not, all specimens have been sewn with different stitch types in the warp’s (90), weft’s (0) and bias’s (45) directions. The results presented in figure 6 indicate a significant effect for this factor.

![Figure 6: Influence of Fabric’s Direction on the Seam Slippage](image)

It is obviously, that most slippage occurs in the seam that run parallel to the warp’s direction. It can be referred to the high tension of the warp yarns because of the weave process and finishing. In weft’s direction occurs seam slippage also, but the required force for seam slippage is higher than in warp’s direction. Due to the elasticity in weft’s direction, extend the seam with the fabric first (according to the stitch type), then occurs the slippage in seam or yarn. It should be mentioned, that a few specimen in this direction are broken down and the results are disallowed. Sewing in bias’s direction (45) records the best results of all. During making the calculation of the seam slippage, it has been found, that the curves of samples with seam run parallel to the curves of sample without seams. This case make the calculation of the seam slippage according to procedure of the method, which described before, is incredible. According to BS EN ISO 13936-1:2004 results should be recorded as (More than 200 N). In our analysing we mentioned most of these results as 0 force.

**Seam Slippage by Different Seam Opening**

Seam slippage has been described before as, when stress is applied to a seam, the yarns in the fabric slip out of the stitching causing an open seam. Seam opening according to BS EN ISO 13936-1:2004 is considered as 6 mm, but for some fabrics a seam opening of 3 mm would produce an unsatisfactory appearance. For satin fabrics, it has been found, that it is better to make the calculation with the seam opening of 3 mm. In this research all the discussions and conclusion are done with calculating the seam slippage with the seam opening of 3 mm. In this research all the discussions and conclusion are done with calculating the seam slippage with the seam opening of 3 mm. However we recorded the results with the seam opening 6 mm to make a comparison between the two recorded forces (F1 and F2). So for seam opening 6 mm, we added a distance of 30 mm to the compensation (distance between the curve of sample without seam and curve of sample with seam). For the seam opening 3 mm, we added a distance of 15 mm to the compensation. In figure 7 states the comparison
of the two cases. It is obviously, that the force for seam slippage is higher by the seam opening 6 mm (F2) than the seam opening 3 mm (F1) for all fabric’s directions. This result is logic, due to the calculation method, which mentioned before.

Figure 7: Seam Slippage by Stitch Type 301 with Different Seam Opening

In figure 8 some of optical pictures of the investigated material 3 during carrying out the test are presented. Pictures show, that the damage form of seam slippage is not constant. The behaviour of the sewn fabric vary completely. Sometimes occurred seam grin in different level, sometimes occurred seam slippage and sometimes occurred fabric breakdown.

Figure 8: Kinds of Seam Damage of Tested Material 3

CONCLUSIONS

Results indicated, that sewing factors (stitch type, stitch length, sewing needle size) have significant effects on the seam slippage. Stitch type 515 is considered as the best stitch type for minimizing the seam slippage. For the effect of stitch length, showed the results that increasing or decreasing the stitch length could solve the problem of seam slippage. Results indicated also, that sewing with needle size 14 is better than sewing with needle 16.

The influence of the fabric’s direction on the seam slippage was also investigated. Seam slippage occurred by warp’s direction rather than the other direction. Sewing in bias’s direction (45) avoided the failure of the seam slippage generally. A comparison between the seam slippage by seam opening of 6 mm and seam opening 3 mm was done. Force for seam slippage by seam opening 6 mm is higher than the seam slippage by seam opening 3 mm.

REFERENCES


7. AMANN Group: No Quality Product without Quality Seams, Service and Technology, AMANN & Soehne GmbH & Co. KG.


