Evaluation of Seam Pucker of Woven cotton Fabrics Using Two Different Methods

Najwa Ali Abou Nassif

Fashion Design Department, Design and Art College, King Abdul Aziz University, Jeddah, kingdom of Saudi
dr.ngaa@hotmail.com

Abstract : This study is aimed to determine the influence of sewing machine parameters on seam pucker. The paper provides an experimental investigation of the impact of sewing needle size, sewing thread tension, stitch density and sewing direction on the seam pucker of cotton woven fabrics. In this study, fabric samples were sewn at 0, 45, and 90 degrees. The zero degree signifies that the fabrics were sewn in the weft direction, whereas the 90 degree means the fabrics were sewn in the warp direction. The seam pucker of woven fabrics was evaluated objectively and subjectively using two different measuring techniques. The correlation between the two measuring methods was examined. One –Way ANOVA statistical analysis was used to examine the significance of the effects of independent variables on the seam pucker. The findings of this study revealed that most of sewing machine parameters have a significant influence on woven fabric in relation to seam pucker. The study also revealed that a good correlation between the subjective and objective measuring methods of seam pucker, especially in the case of the effects of needle size and sewing thread tension. This study also will aid the producers of ready made garment to minimize the seam pucker and improve the seam quality of their products.
[Najwa Ali Abou Nassif. **Evaluation of Seam Pucker of Woven cotton Fabrics Using Two Different Methods .** *J Am Sci* 2013;9(4):205-210]. (ISSN: 1545-1003). http://www.americanscience.org. 29

Key Words: Seam pucker, sewing machine, stitch density, needle count, sewing direction, sewing thread tension.

Introduction

Recently, as interest in the quality of clothing production has risen, the performance and appearance of garments and sewing techniques especially seam pucker problems have become important **[1-3].** Seam pucker is defined in the **Oxford English Dictionary [4]** as "a ridge, wrinkle or corrugation of the material or a number of small wrinkles running across and into one another, which appear in sewing together two pieces of cloth". It has been regarded as one of the most serious faults in garment manufacturing, reducing the aesthetic value of garments **[5]**

Seam pucker appears along the seam line of garment when sewing parameters and material properties are not properly selected, and the aesthetic value of garments then deteriorates **[6].** For several decades, many different ways to define and control seam pucker have been introduced. **Dorkin and Chamberlain [7]** identified five primary causes of puckered seams, and classified seam pucker into four groups: Inherent pucker, feeding pucker, tension pucker, and thread shrinkage pucker **[8-10].**

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. Particular great attention is paid to fabric properties and factors of a sewing machine as well as to their compatibility in the process of sewing **[11-16].**

Many re-searches have also been working on the relationships between fabric properties and seam pucker in clothing production in order to predict seam pucker on the basis of fabric properties, especially structure and mechanical properties under low stress. Several charts and equation have also been developed for the determination of seam pucker grade, but they can only provide guidelines and cannot offer specific predictions of how the seam pucker might perform in garment manufacturing **[17-19].**

The object of this study is to evaluate of fabric seam pucker objectively by two different techniques. The effects of sewing machine parameters such as, needle count, stitch density, sewing thread tension, and sewing direction on seam puckers were studied. The correlation between two measuring methods of seam pucker was also evaluated.

2. Materials

In the course of this study, 100% cotton fabric samples were used. All fabric samples were woven on Rapier weaving machine with the following particulars:
Weave structure: plain 1/1.
Warp yarn count: 16/1 Ne.
Weft yarn count: 16/1 Ne.
Warp yarn density: 66 ppi
Weft yarn density: 58 ppi
No. of harness frames: 6
Machine speed: 420 ppm

Sewing Machine Parameters

To study the effects of sewing machine variables on seam pucker of the cotton woven fabrics,

the studied samples were sewn with super imposed seam type, SSa-1, on high speed sewing machine with different sewing parameters. Figure 1 shows the seam type used to sew the cotton fabric samples.

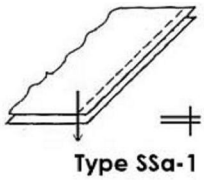

Fig 1: seam of type SSa-1 used in this study

The sewing thread used in this study was made from 100% cotton with linear density 14.8 tex, breaking tenacity 42.9 cN/ tex and 6% breaking elongation.

A high speed industrial lockstitch machine – Juki- was selected for sewing samples with the following specifications:
Type of stitch: Lockstitch type 301
Machine speed: 2000 stitches per minute
Seam allowance: 1 inch

The sewing machine parameters were varied to study its effects on seam pucker of sewn cotton woven fabrics. Needle size was used with three counts, and stitch densities were with three different values. The tension of sewing thread was at low, medium and high levels. Cotton woven fabrics were sewn in three directions according to the weft direction. Table 1 lists the levels of the parameters varied on sewing machine.

Table 1: Levels of the parameters used on sewing machine

Needle size, Singer system	Stitch density, Stitches/cm	Sewing thread tension	Sewing direction, degrees
12	3	Low	0
14	5	Medium	45
16	7	High	90

Statistical Analysis

One-Way ANOVA statistical technique was used to analyze the significant effects of needle size, stitch density, sewing thread tension, and sewing direction of seam pucker of woven fabrics. The statistical analysis was performed using SPSS statistical package. A regression analysis was also used to explore the correlation coefficient between subjective and objective measuring methods of seam pucker in relation to all independent variables.

Rating of Seam Pucker

In this study, seam pucker of sewn woven fabrics was assessed subjectively and objectively by two different techniques. A test procedure for a subjective evaluation of the seam pucker has been proposed by the American Association of Textile Chemists and Colorists **AATCC, test methods** 8831-1992 **[20].** The evaluation of seam pucker is done by three observers; each one compares three specimens at a time with photographs. Each seam is marked as equivalent in appearance to one photographic standard, where 5 indicates the best, non-puckered seam, and 1 is the worst. Average values are then calculated from the nine determinations **[21].** Fig.2 shows a rating system for seam puckering from 1 to 5 with 5 being pucker-free. This AATCC seam smoothness analysis is used by many major manufacturers to rate their seam performance.

Fig 2: AATCC Photographic of Seam puckering rating

In this study seam pucker was objectively determined by measuring the percentage increase in the thickness of the seam over the fabric under a constant compressive load. The seam thickness strain which is the indicative of seam pucker was calculated using the following formula **[22-24]:**

Thickness strain % = F-2S / 2S *100

Where,

F= seam thickness, and S= Fabric thickness

3. Results and Discussion

Seam pucker is a result of fabric yarns displacement, when a needle penetrates the fabric and the upper and the lower threads loop insert within fabric. The fabric yarns are bent, stressed, and attempting to return to their original positions, but are prevented by the sewing threads. In this portion of the study the effects of sewing needle count, stitch density, sewing thread tension and sewing direction on seam pucker will be discussed in details.

Effect of needle size

Figures 3 and 4 show the effects of sewing thread tension on the AATCC grade of seam pucker and thickness strain. For seam thickness strain, an increasing trend is detected, confirming that as the needle size increases the seam thickness strain increases. This means that increasing sewing needle size will lead to an increase of fabric seam pucker. For AATCC grade of seam pucker, figure 4, a decreasing trend is detected, assuring that as the needle size increases the grade of seam pucker decreases. This means that lower needle sizes will enhance the seam pucker of woven fabrics.

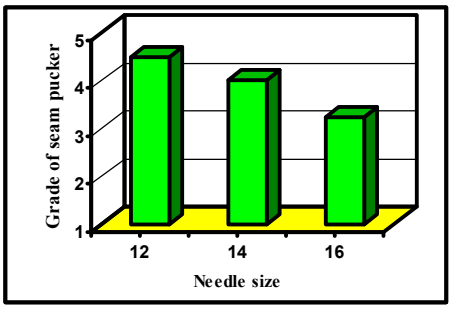

Figure 3: Objective evaluation – Thickness strain- of seam pucker at different levels of needle size

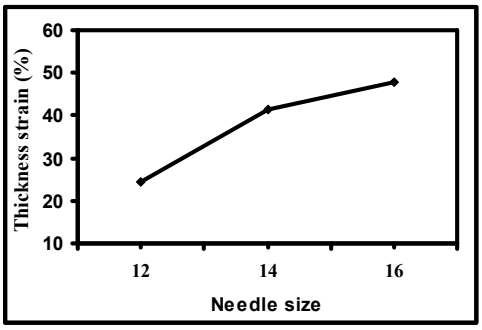

Figure 4: Subjective evaluation – AATCC grade - of seam Pucker at different levels of needle size

Figure 5 shows the correlation between subjective evaluation, AATCC grade, of seam pucker and objective evaluation of seam pucker which assessed using seam thickness strain of the woven fabric samples. From this figure it is shown that a negative correlation between two techniques was found. The correlation coefficient between two methods is very high and significant with a value of –0.97, which means that we can use any technique in place of the other to determine seam pucker with relation to the effect of needle size.

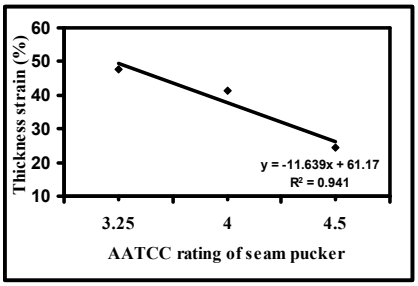

Figure 5: Correlation between subjective and objective evaluation of seam pucker with respect to the effect of needle size.

Effect of stitch density

The effects of stitch density on seam pucker of woven fabrics were illustrated in figures 6 and 7. The statistical analysis proved that stitch density has a profound impact on fabric seam pucker. Figure 6 shows the objective evaluation, seam thickness strain, of seam pucker at different stitch densities. From this figure, it is noticed that as the stitch density increases the seam thickness strain will decreases. Seam thickness strain lowered from 39.6% to 36.7% with increased stitch density from 3 to 5 and then increases to 37.4% with the increase of stitch density to 7. In general, increasing stitch density enhanced the seam pucker of the woven fabric samples.

Figure 7 depicts the grade of seam pucker according to AATCC at different levels of stitch density. An increasing trend is detected assuring that as the sitch density increases the grade of seam pucker acccording to AATCC also increases, which means that increasing stitch density enhances the seam pucker of the woven fabrics.

The correlation between two measuring methods of seam pucker according to the variations of stitch density was depicted in figure 8. From this figure it is shown that there is a low negative

correlation between subjective and objective evaluation of seam pucker in relation to the effects of stitch density. The statistical analysis proved that the correlation coefficient between the two measuring methods is -0.73.

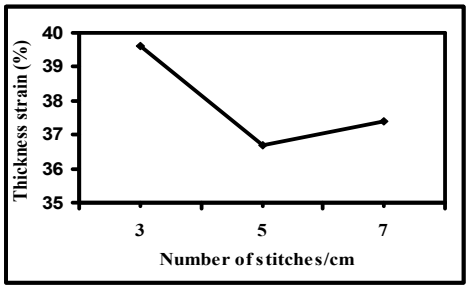

Figure 6: Objective evaluation – Thickness strain- of seam Pucker at different levels of stitch densities.

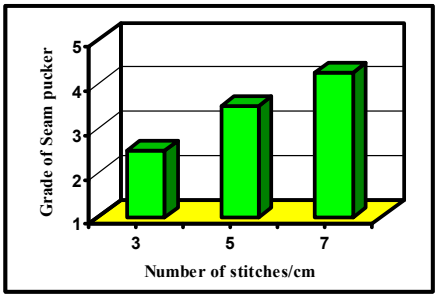

Figure 7: Subjective evaluation – AATCC grade - of seam Pucker at different levels of stitch densities.

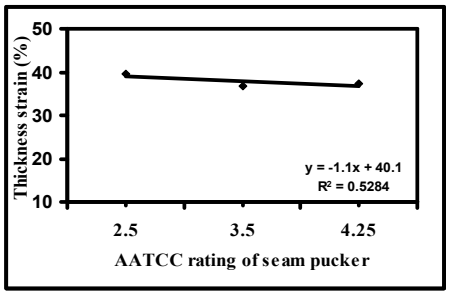

Figure 8: Correlation between subjective and objective evaluation of seam pucker with respect to the effect of stitch density.

Effect of sewing thread tension

The tension of sewing thread on sewing machine was set at low, medium and high tension. The effects of sewing thread tension levels on seam pucker of woven fabrics was plotted in figures 9 and 10. The seam pucker was evaluated subjectively using AATCC rating method and objectivelty by the seam thickness strain of seamed fabric samples. The statistical analysis proved that sewing thread tension has a significant influence on fabric seam pucker whether the measured objectively or subjectively. From figure 9, a decreasing trend is deteced confirming that as sewing thread tension increases, the seam thickness strain decreases. This means that high tension of sewing thread enhances the seam pucker of sewn woven fabrics. The average values of thickness strain were 54%, 34% and 18% at low, medium and high sewing thread tensions.

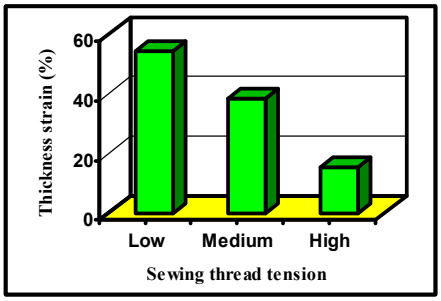

Figure 9: Subjective evaluation – AATCC grade - of seam Pucker at different levels of sewing thread tension.

Subjective evaluation of seam pucker of sewn woven fabrics at different levels of sewing thread tension was illustrated in figure 10. It is shown that as the sewing thread tension increases, the grade of seam pucker according to AATCC increases. This means that increasing sewing thread tension enhanced seam pucker of seamed fabrics. The statistical analysis proved that the average values of seam pucker grade are 2, 4, and 5 at low, medium and high tension of sewing thread tension. The correlation between objective and subjective evaluation of seam pucker was plotted in figure 11. The statistical analysis proved the presence of strong negative correlation between the two measuring techniques. Tit was found that the correlation coefficient between the subjective and objective evaluation of seam pucker is about -0.99. This high correlation means that we can use one of the measuring techniques in place of the other to judge the grade of seam pucker.

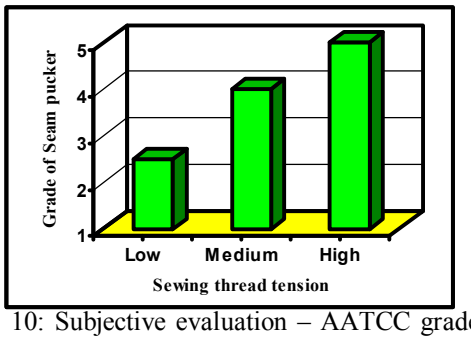

Figure 10: Subjective evaluation – AATCC grade - of seam Pucker at different levels of sewing thread tension.

Effect of sewing direction

In this study, the woven fabric samples were sewn in different directions according to the weft direction. The fabric samples were sewn at 0, 45, and 90 degrees. The zero degree signifies that the fabrics were sewn in the weft direction, whereas the 90 degree means the fabrics were sewn in the warp direction. The effects of sewing direction on seam pucker of woven fabrics are shown in figures 12 and 13. The statistical analysis showed that the sewing direction has a significant effect on seam pucker, whether measured subjectively or objectively.

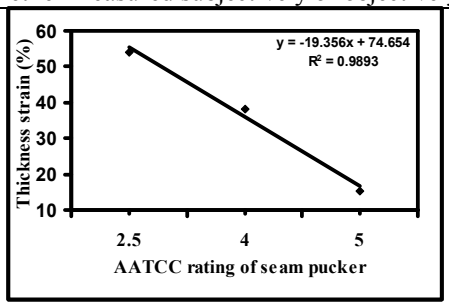

Figure 10: Subjective evaluation – AATCC grade - of seam Pucker at different levels of sewing thread tension.

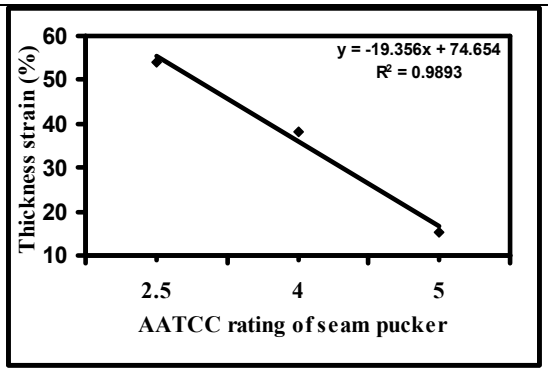

Figure 11: Correlation between subjective and objective evaluation of seam pucker with respect to the effect of sewing thread tension.

Figure 12 plotted the relationship between sewing direction and thickness strain of woven fabrics as indicative of seam pucker. From this figure an increasing trend is detected, assuring that as sewing direction increases, the thickness strain increases. This means that the increase of sewing direction will deteriorates the fabric appearance by increasing seam pucker. Thickness strain of woven fabrics increased from 30.7% to 43% with the increase in sewing direction from 0 to 45 degree and then lowered to 39% with increased sewing direction to 90 degree.

The relation between sewing direction of the woven fabrics and the subjective evaluation of seam pucker according to AATCC was introduced in figure 13. A decreasing trend is detected conforming that as the sewing direction increases, the rating of seam pucker decreases. This signifies that sewing of woven fabrics at lower angles according to weft direction will enhance the seam pucker. The grades of seam pucker were about 4, 3 and 3 at sewing directions 0, 45 and 90 degrees.

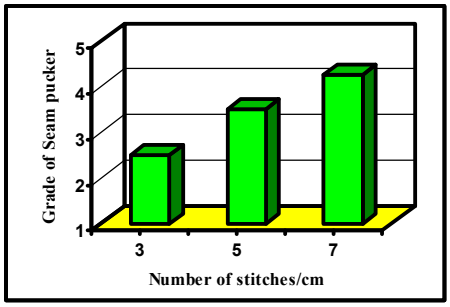

Figure 12: Subjective evaluation – AATCC grade - of seam Pucker at different levels of sewing direction.

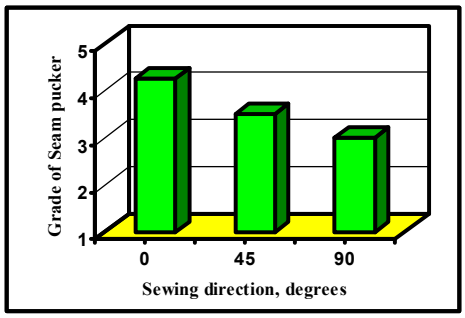

Figure 13: Subjective evaluation – AATCC grade - of seamPucker at different levels of sewing direction.

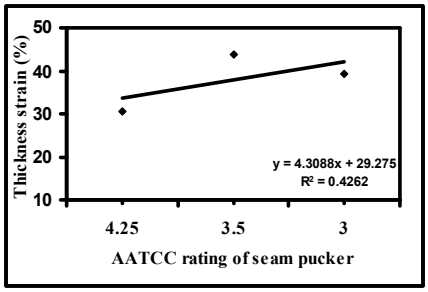

Figure 14: Correlation between subjective and objective evaluationof seam pucker with respect to the effect of sewing direction.

The correlation between subjective and objective evaluation of seam pucker according to sewing directions was depicted in figure 14. It is shown that there is a positive correlation between subjective and objective evaluation of seam pucker with respect to the effects of sewing direction. The statistical analysis proved that the correlation between the two measuring methods is approximately 0.65. This lower positive correlation between the two

measuring methods will make us not rely on one of the measuring methods instead of the other.

Conclusion

The findings of this study can be sum up as follows:

- Increasing needle size leads to the seam thickness strain to be increase. This means that increasing sewing needle size will lead to an increase of fabric seam pucker. For AATCC grade of seam pucker, a decreasing trend is detected, assuring that as the needle size increases the grade of seam pucker decreases.
- Seam thickness strain lowered from 39.6% to 36.7% with increased stitch density from 3 to 5 and then increases to 37.4% with the increase of stitch density to 7. Also as the sitch density increases the grade of seam pucker acccording to AATCC also increases
- The statistical analysis proved that sewing thread tension has a significant influence on fabric seam pucker whether the measured objectively or subjectively. This means that high tension of sewing thread enhances the seam pucker of sewn woven fabrics.
- In this study, fabric samples were sewn at 0, 45, and 90 degrees. The zero degree signifies that the fabrics were sewn in the weft direction, whereas the 90 degree means the fabrics were sewn in the warp direction. As sewing direction increases, the thickness strain increases. This means that the increase of sewing direction will deteriorate the fabric appearance by increasing seam pucker. The relation between sewing direction of the woven fabrics and the subjective evaluation of seam pucker according to AATCC was introduced. A decreasing trend is detected conforming that as the sewing direction increases the grade of seam pucker decreases.
- Finally, there was found a good correlation between subjective and objective evaluation methods of seam pucker with respect to the effects of needle size and sewing thread tension.

Corresponding author
Najwa Ali Abou Nassif
Fashion Design Department, Design and Art College, King Abdul Aziz University, Jeddah, kingdom of Saudi
dr.ngaa@hotmail.com

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