

Investigating the Effect of Different Weft Densities and Draw in Plan on Physical Properties and Seam Strength of Woven Plain Fabrics

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ABSTRACT

Weft density and draw in plan play an important role since they affect physical properties such as fabric weight, cloth cover factor as well as seam strength. Weft density refers to the amount of weft yarn in one inch. Meanwhile, draw in plan refers to the amount of heald shaft used and the order of warp yarn through the heald. In this study, plain woven fabrics were produced by using Sulzer Rapier Loom Machine. There were two different types of weft density used which were 15 and 20 weft per centimeter (wpcm) and four draws in plan: pointed, straight, broken and broken mirror. Seams were constructed by using plain seam of Ssa-1, four stitches of stitch density and 301 lockstitches for stitch type. Subsequently, the fabric samples were tested on seam strength by using Testometric tester. As a result of this study, it is proven that weft density and draw in plan of woven plain fabric are parameters that affect the seam strength and seam efficiency. The highest increase in percentage of seam strength was obtained from straight draw in plan which increases up to 17.19% from 15wpcm to 20wpcm. Meanwhile, broken draw in plan has the lowest increase percentage for seam strength which is 6.46%. Furthermore, seam efficiency also shows straight draw in plan gives good fabric durability compared to others. Lastly, it also shows broken draw in plan has no significant effect on fabric tensile strength and seam strength.

Keywords: Draw in plan, seam efficiency, seam strength, stitch density, weft density

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INTRODUCTION

In the apparel industry, in order to determine the quality and productivity of finished garments, the sewing process is one of the most critical processes (Sarhan, 2011; Bharani & Mahendra, 2012). The sewing process is important to produce a good functional end use, such as good seam strength and good durability of garments. Nowadays, seam

strength, seam puckering and seam efficiency have become more important to the appearance and performance of garments (Anon, 1977). In order to produce good quality of sewn product, seam strength is one of the most important indicators which must be considered (Paul, Sanyal, Chowdhury, Mukhopadhyay, & Das, 2015). In addition, good quality garments must have good seam strength in order to meet customer satisfaction.

Seam strength is one of the alternative methods of measuring strength in which the material is stressed in warp or weft direction or both at the same time. In addition, seam strength also refers to the required force to break open the seam, either by breaking the sewn material or breaking the thread. There are two components in seam strength which are sewing thread and fabric. Therefore, seam strength will break either of fabric or thread or in other cases, it breaks simultaneously. It was found that the load required to break the unsewn material is more than to break the seam (Behera & Sharma, 1998; Choudhury, 2000).

From the previous studies (Behera & Chand, 1977; Behera & Shakun, 2000; Behera, Shakun & Snrabhi, 2000; Bhalariao, Budke, & Borkar, 1997; Midha, Mukhopadhyay, Chattopadhyay, & Kothari, 2010), it is confirmed that there are many factors that affect the seam strength and seam appearance which include fabric parameters as well as sewing parameters. The examples of fabric parameters are type of fabric used and fabric properties which include fabric weight, fabric density and fabric structures. Meanwhile, the type of thread, seam type and stitch density are examples of sewing parameters. These parameters give effect to the seam strength as well as to the quality of end product (Megeid, Ezzat, & Ali, 2016; Paul et al., 2015). Fabric density can be divided into two groups which are warp density and weft density. Warp density is the amount of warp yarn in one inch square. Meanwhile, weft density refers to the amount of weft yarns in one inch square. From another previous study (Sarhan, 2011), it is known that there are significant effects between seam strength and fabric weft density. Fabric weft density also gives positive correlation to seam strength. According to research conducted by Sarhan (2011), seam strength increases when weft density increases. This shows that the amount of fabric weft density used in garments is important to produce good seam strength.

In addition, fabric structure also plays an important role in fabric strength which affects seam strength performance. Based on the study by Gurarda (2008), plain fabric has lower breaking strength when compared to twill fabric. These different structures give effect to seam strength based on their fabric strength. Twill fabric has higher floating yarn compared to plain yarn. So, it makes twill fabric not to easily break when exposed to stress. Moreover, from the research by Sarhan (2011), seam strength is also influenced by stitch density that was used. It means when stitch density increases, seam strength also increases. This may be due to the increase at the joining part between the sewing thread and fabric.

Nowadays, garments easily break especially at the joining part of the fabric. They easily break especially when a small amount of stress is applied to it especially during daily activities such as walking, sitting and squatting down. These activities can contribute to seam breakages. Therefore, seam strength is an important property to be considered when producing good quality garments. Therefore, it is important to study the seam strength with some fabric parameters in order to produce good quality garment and fulfill customer satisfaction.

MATERIALS AND METHOD

Plain woven fabric with two different weft densities of 15 and 20 weft per centimeter (wpcm) and four different draw in plan - pointed, broken, broken mirror and straight were used as shown in Figure 1. These draw in plan was used to produce a plain woven fabric as the fabric sample. These woven fabric samples were produced on Sulzer Rapier Loom Machine with 1000rpm by using polyester yarn. Each fabric sample was sewn with Ssa⁻¹ seam type. Sewing thread of 100 percent spun polyester with ticket number of 120 was used. The Lockstitch 301 was used for the type of stitch and for stitch density, 4 stitches cm⁻¹ was used.

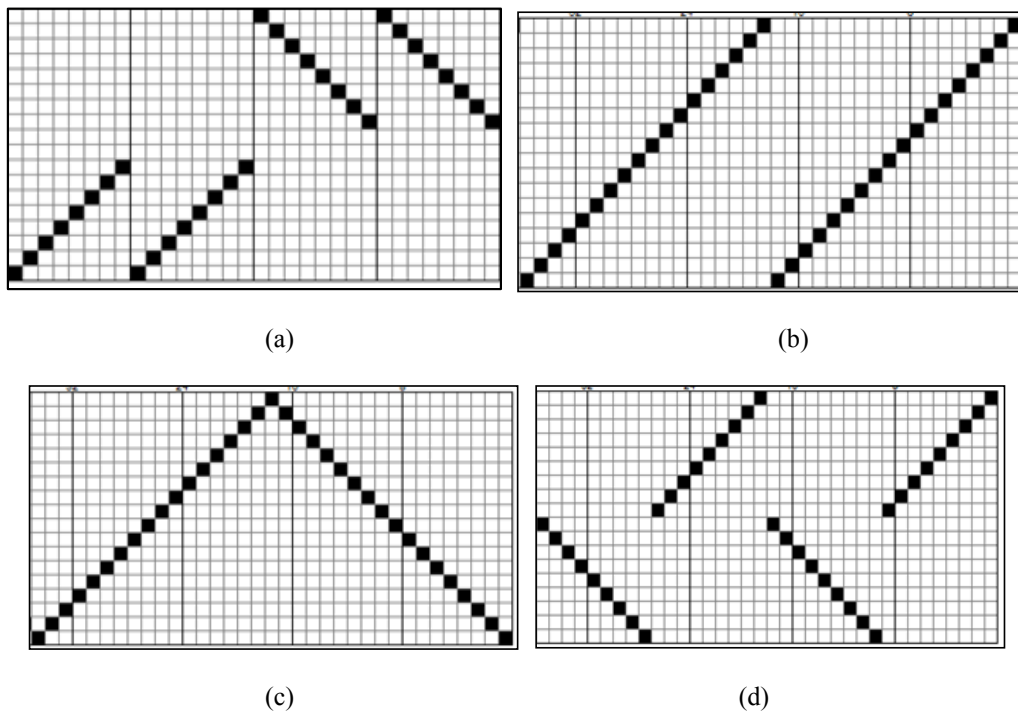


Figure 1. Structures of draw in plan: (a) broken mirror; (b) straight; (c) pointed; and (d) broken

Physical test and mechanical test of tensile strength were carried out in both warp and weft direction. Meanwhile, another mechanical test of seam strength was focused only on weft direction. This is because the amount of warp yarn was constant for this study. The fabric samples were tested for the following physical test - weight, thickness and cloth cover factor.

Seam strength was measured using Testometric Tensile machine with speed of 100mm/min for three repeated readings in Newton ASTM D1683 standard. In the apparel industry, this method is widely used in order to evaluate the seam strength (Murugesu, Gowda, Rajashree, & Sarumathy, 2012). Several journals were referred to for this study, which used the same method to identify seam performance (Murugesu et al., 2012; Ali, Rehan, Ahmed, Memon, &

Hussain, 2014; Sular, Kefsiz, & Seki 2014). Seam efficiency was also measured using formula as shown below. The samples were sewn in warp direction as shown in Figure 2 below.

$$\text{Seam Efficiency (\%)} = \frac{\text{Seam Tensile strength}}{\text{Fabric tensile strength}} \times 100$$

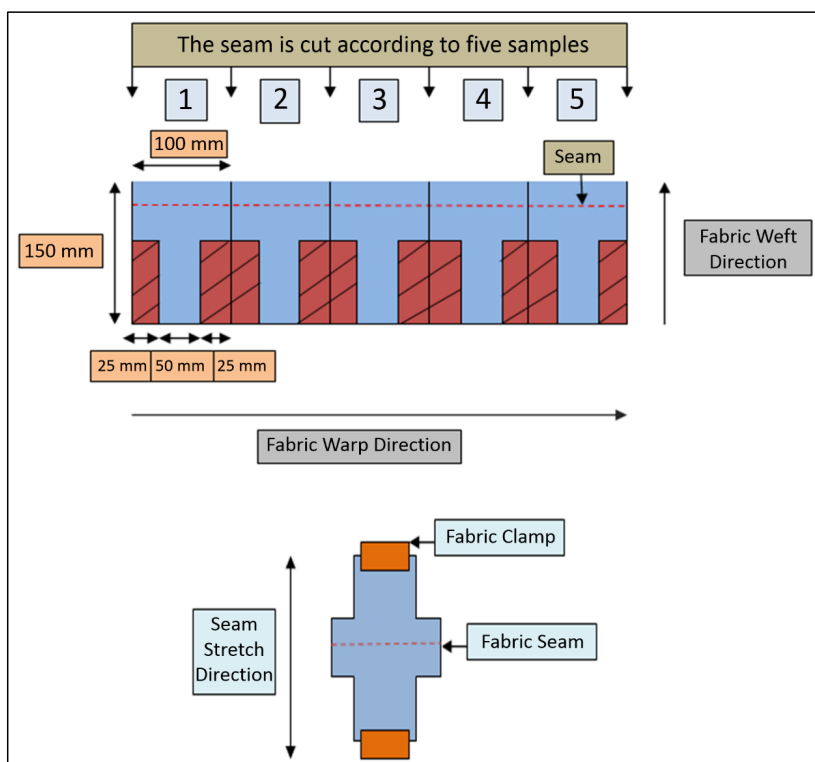


Figure 2. Preparation of sample for seam strength test

RESULTS AND DISCUSSION

Physical Testing

Table 1
Results for fabric testing of 15wpcm and 20wpcm

Fabric Weft Density	Draw in Plan Physical Testing	Pointed	Broken Mirror	Broken	Straight
15	Fabric Weight (g/m ²)	153.1	152.1	152.6	154.6
	Fabric Thickness (mm)	0.46	0.46	0.49	0.49
	Cloth Cover Factor	17.74	17.58	18.00	18.04
	Warp per inch	81	83	83	84
20	Fabric Weight (g/m ²)	174.7	171.4	171.7	176.0
	Fabric Thickness (mm)	0.449	0.451	0.470	0.462
	Cloth Cover Factor	18.33	18.68	18.66	18.42
	Warp per inch	75	78	77	78

Table 1 shows the results for woven plain fabric testing of 15wpcm and 20wpcm with different draw in plan. Based on the results, fabrics of 20wpcm have higher weight compared to 15wpcm, whereby the readings are between 171 g/m² to 176 g/m². Meanwhile, fabric of 15wpcm has lower weight compared to 20wpcm, whereby the readings are between 152 g/m² to 154 g/m². This is due to the higher amount of yarn per inch square in 20wpcm fabric compared to 15wpcm. Thus, it increases the fabric weight on 20wpcm. In addition, the amount of warp per inch for 15wpcm and 20wpcm also shows different readings. This is because the amount of warp yarn used in production was the same but it gives different amount per inch, due to the different draw in plan used.

MECHANICAL TESTING

Tensile Strength

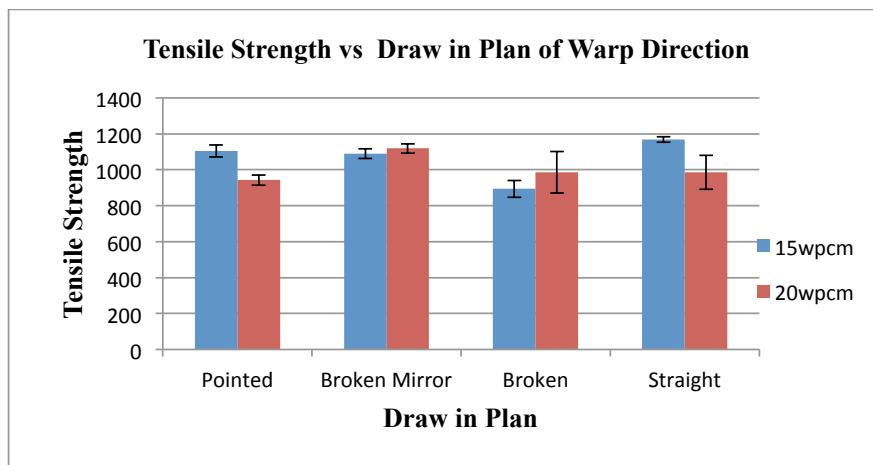


Figure 3. Tensile strength and draw in plan of warp direction for 15wpcm and 20wpcm

Figure 3 shows the bar chart of relationship between tensile strength and draw in plan of warp direction for 15wpcm and 20wpcm. According to the results, tensile strength for 15wpcm broken mirror and broken draw in plan shows an increased percentage to 1.30% and 4.88% respectively. Meanwhile, pointed and straight draw in plan have a decreased percentage for tensile strength from 15wpcm to 20wpcm which are 7.89% and 8.48% respectively. This means the highest increase in percentage are straight draw in plan. This may be due to the highest amount of warp per inch for straight draw in plan. Furthermore, there are statistically significant results for pointed and straight draw in plan based on the error bar shown in the graph.

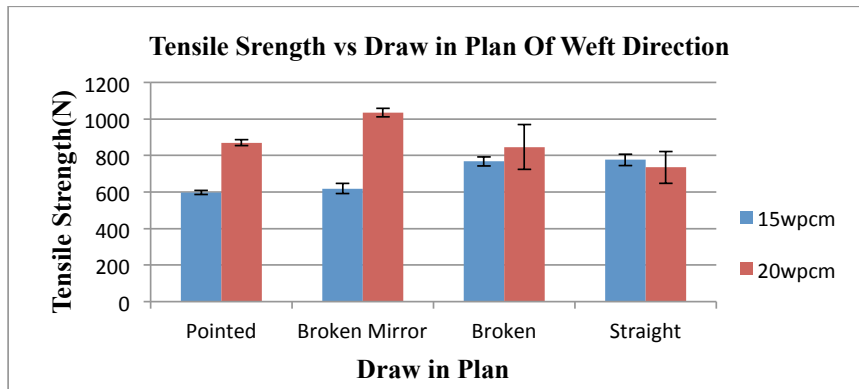


Figure 4. Tensile strength and draw in plan of warp direction for 15wpcm and 20wpcm

Figure 4 shows the bar chart of relationship between tensile strength and draw in plan of weft direction for 15wpcm and 20wpcm. According to the results of tensile strength on weft direction, broken mirror shows the highest percentage of increase, from 15wpcm to 20wpcm, which is up to 25%. Furthermore, only straight draw in plan shows decreased percentage from 15wpcm to 20wpcm, which is 2.7%. Meanwhile, for broken and straight draw in plan, the results are not significant for 15wpcm and 20wpcm. These different results may due to the different tension on the fabric during fabric production which gives effect to the performance tensile strength.

Seam Strength

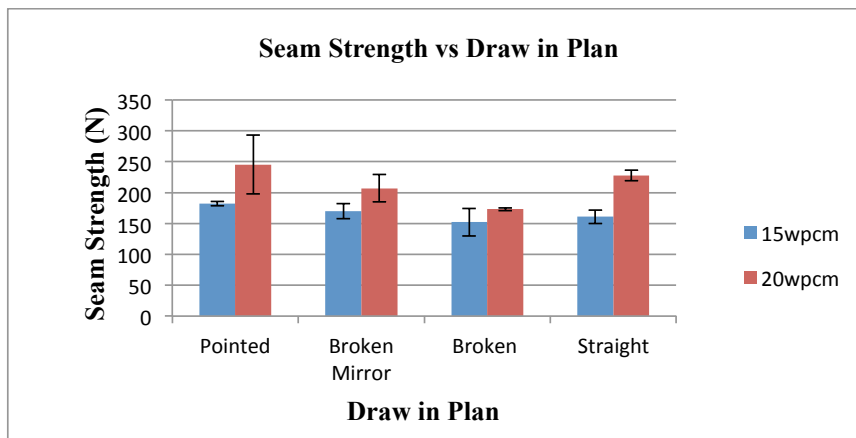


Figure 5. Seam strength and draw in plan of weft direction for 15wpcm and 20wpcm

Figure 5 indicates the bar chart of relationship between seam strength and draw in plan of 15wpcm and 20wpcm. The results show that all draw in plan have an increasing value of seam strength from 15wpcm to 20wpcm. The highest increase in percentage is from pointed draw in plan which increases until 17.19%. It means the increasing degree of weft density will increase

the seam strength. This is because fabric of 20wpcm have higher amount of weft yarn in one inch. So, it has good resistance to stress and does not easily break when stress is applied to it. Furthermore, from the error bar on the bar chart, it can be seen that the results are statistically significant for pointed and straight draw in plans. However, for broken draw in plan, it is not statistically significant between 15wpcm and 20wpcm.

Seam Efficiency

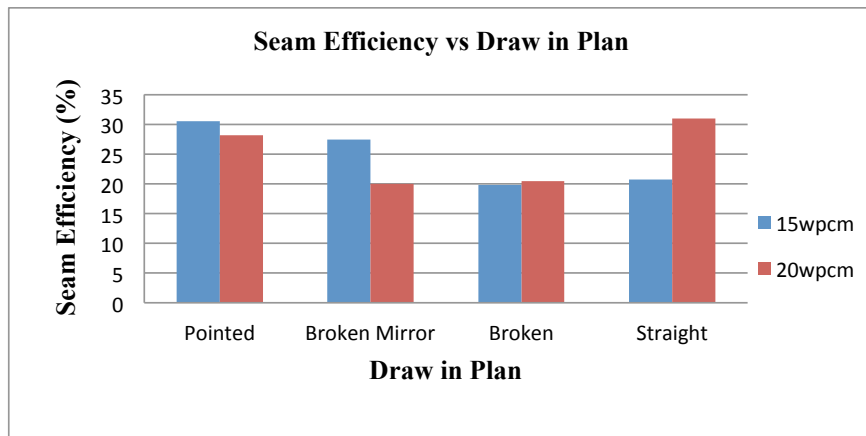


Figure 6. Seam efficiency and draw in plan of weft direction for 15wpcm and 20wpcm

Figure 6 shows the percentage of seam efficiency of different draw in plan for 15wpcm and 20wpcm. From the results obtained, it can be seen that the highest seam efficiency is from straight draw in plan on 20wpcm. Meanwhile, the lowest is from broken draw in plan on 15wpcm. These differences may be affected by the strength of the thread itself on different fabric samples. In addition, straight draw in plan has the highest percentage increase of seam efficiency which increases up to 19.8% from 15wpcm to 20wpcm, compared to other draw in plan. This means that straight draw in plan has good durability compared to others.

CONCLUSION

It can be concluded that fabric weft density and draw in plan play an important role in order to produce good seam strength of garments. It is also a priority to ensure that garments do not easily tear, particularly at the joining part of the fabric when they are exposed to stress, especially during daily activities such as walking and sitting. The results confirm that there is a causal relationship between fabric parameters and seam strength performance. Furthermore, when the degree of weft density increases, the seam strength also increases the same way. However, the same cannot be applied for seam efficiency. Finally, the highest fabric durability is found to be from straight draw in plan which has the highest percentage of 30.96% of seam efficiency.

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