SEAM RESISTANCE ANALYSIS: COMPARING SEAMS MADE BY THE DCSS MACHINE AND IS MACHINE

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ABSTRACT
The textile manufacturing industry is quite traditional and therefore maintains a certain level of production based on empiricism. Research on textile materials and production processes has been gaining strength mainly motivated by professional sport. However, with regard to the most common processes, there are few studies that serve to demystify some information that is transferred over time. The present work performs a resistance analysis of the seams applied in flat fabrics commonly used in the making of uniform trousers. The purpose is to identify whether the Double Chain Stitch Sewing Machine is stronger than that of the Interlock Sewing Machine with rebound stitch in the Twin Needle Lockstitch Sewing Machines. For this purpose, tensile tests were carried out, where the sample tested was the twill, 3x1 frame with 100% cotton composition tested in the different directions of the fabric (weft, warp and bias). The results show that the Interlock Sewing Machine is stronger than Double Chain Stitch Sewing Machine. The results indicate that the strongest seam is necessarily the one that uses the least needles and this goes against the information that the manufacturers thought as well as spending less resources to perform.

KEY WORDS: *Technology applied to Design, Tensile test in seams, Sewing machines.*

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1. INTRODUCTION

The textile and clothing industry is growing every year, but it is a subject little explored by the researchers. Currently, technical studies are being developed in Asian countries, where abundant labor and easy access to machinery are one of the competitive advantages in the industry.

Guo et al. (2011) claim that the clothing industry is one of the major economic sectors, which plays an important role in everyday life and global economy.

In this context, the present work intends to analyze the seams used in trousers of uniforms, because according to Namiranian et al. (2014), seams on garments are constantly subjected to repetitive loads and movements during everyday use, such as walking, sitting, squatting, etc. This repeated loading causes various seam defects, such as tearing of the stitches or tearing of the fabric.

In this way, tensile tests will be carried out in which the samples will present two types of seam processes, the first performed in the Double Chain Stitch Sewing Machine and the second will be performed in the Interlock Sewing Machine with rebound stitch in the Twin Needle Lockstitch Sewing Machines. The objective is to analyze which type is more resistant to tissue orientation, since both processes are commonly used in the garment industry and there are no studies that did these analyzes. The seams reproduced on the samples are the same as those used for sewing parts of the pants, such as flap, side and crotch, but the machine usage and sewing type vary according to each company. These variables are related to the cost of each machinery, skilled labor and sometimes the final aesthetics of the product, since the seams present different results in relation to the user's comfort. The raw material used in this experiment will be the 100% cotton twill and will be tested on three different fabric orientations, considering straight yarn, thread through and bias.

Sülar et al (2014) indicate that there are few work done in this area. They performed a study whose purpose was to analyze the performance of seams in flat fabrics. In this work, the researchers analyzed two types of seam lines, applied in 20 samples. The forces of the seams were analyzed in the tensile test. However, the seams were made in the straight seam industrial machine, that is, only one type of seam was analyzed.

Namiranian et al. (2014) analyzed the density of the stitches and the strength of the fabrics in the weft and warp direction. The tensile properties of the fabric and seam strength were measured and analyzed in the yarn direction and traversed. As previously mentioned, in this study the authors only analyzed the seams made with the regular stitch industrial sewing machine. The results showed that, in general, the increase of elasticity of the fabric leads to a decrease in the slip load of the seam.

The work developed by Ferdous et al. (2014) presents the proposal of stress analysis in the different types of flat fabric structures, such as taffeta, twill and satin, with mixed compositions of cotton and polyester. The weights of the fabrics tested ranged from 152, 154, 156 and 162 g/m2. Among some of the data obtained, they concluded that the satin tensile strength is lower than the twill, this is because the number of threads used in the manufacture of twill is different from that used to make the satin. The warp yarn has more force than the weft yarn. In summary, it can be said that, the weft yarn has less tensile strength than the warp yarn. However, the technical standards for tensile stresses already establish that the direction of the thread must be respected at the time of the test.

Pasayev et al. (2012) published a study on seams in Chenille, a common fabric used for the manufacture of upholstery. The objective of this study was to analyze the effects of sewing direction when made in the warp and woven fabric, since in some cases the fabric tends to tear. In this case, the type of machine was not take into account, only the direction of the thread that has the greatest resistance.

The objective of this study is to make a comparison between the sewing machine of the Double Chain Stitch Sewing Machine and the one of the Interlock Sewing Machine with rebound stitch in the Twin Needle Lockstitch Sewing Machines and verify which of the machines generate more resistances in the seams. The initial hypothesis is that the first machine generates a more resistant seam since it uses 3 seam lines compared to the second machine that generates 2 seam lines.

2. MATERIALS AND METHODS

In this experiment, the fabric used was twill, 3x1 frame, 100% cotton and 10 oz. The choice of this type of frame, composition and weight was due to the fact that it is a type of fabric used for making trousers in general, because it is a thicker fabric whose weight is 10 oz, it is also used in the manufacture of various uniforms, besides the use in sofa coverings.

The seams were made in accordance with the Brazilian Association of Technical Standards for Textile Materials, NBR 13483/1995, which determines the types of stitches. The sewing machines used in this work are industrial, previously adapted and regulated to make seams in flat fabrics, as well as the type of needle used, which is appropriate for the most robust type of fabric. The sewing thread chosen was polyester, because according to Prendergast (2014), it is the most resistant.

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The first sample was sewn into the Double Chain Stitch Sewing Machine which will be renamed to DCS. The model of the machine is SC 8200 J / 01, brand SUNSTAR (figure 1). It should be noted that this machine does the process once, it attaches one fabric to the other by sewing the edge inward as there is a mechanism that enables the fabric to be sewn with the edge of one side superimposed with the other edge of the fabric shape simultaneously. However, this operation depends on the correct handling of the operator.

Figure 01 – Development of the first seam – Double Chain Stitch Sewing Machine
Fonte: Author.

The DCS machine operates with the lupper mechanism, ie there is no coil. In this way three line wires are used at the top and three line wires at the bottom. In the manufacture of pants, they usually use a thinner line on the inside (title 120) and thicker on the upper (title 80), since it is the line that appears in the piece and is also used for stitches.

The second sample was first sewn on the IS machine, model ZJ32-86A, of the ZOJE brand (figure 2). The seam of this machine joins the two fabrics by the edges, making two types of seams and sealing the edges.

Figure02 – Desenvolvimento da segunda costura – Interlock Sewing Machine
Fonte: Author.

The seam made in the IS machine was rebounded in the SUNSTAR brand model KM-797BL-7S (figure 3).

Figure 03 – Finishing of the second seam – Twin Needle Lockstitch Sewing Machines
Fonte: Author.

Figure 4 illustrates the layout of the cut of the fabric and the making of the samples that have been cut in the straight, cross and bias directions. In the figure, it is also possible to observe the seams according to the type of process.

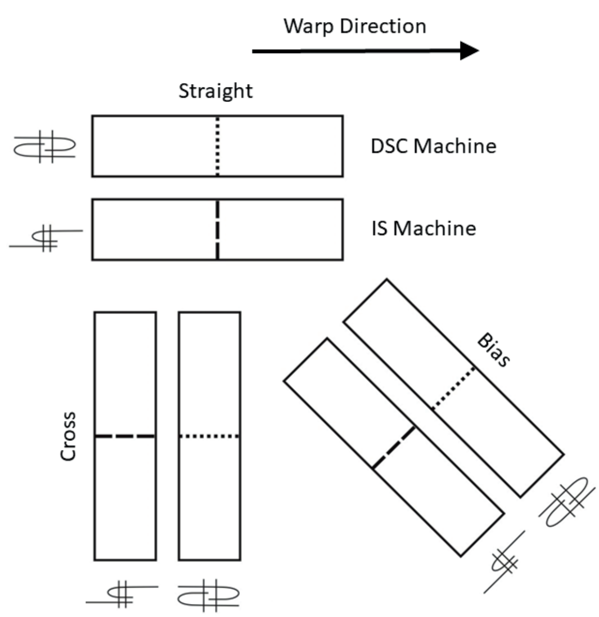

Figure 04 – Types of seams and positioning in the fabric
Fonte: Author.

The samples were prepared according to the NBR ISO 139: 2008 standard. This standard defines the characteristics and use of a standard conditioning atmosphere to determine the physical and mechanical properties of textiles and an alternative standard atmosphere that can be used by agreement between the parties.

According to the standard, the samples must be 300 mm x 60 mm in the warp and weft direction such that the largest dimension side is parallel to the yarns being tested. The two sides of the samples should be shredded towards the largest dimension until a width of 50 mm is obtained. In difficult-to-shred fabrics, samples should be cut to exactly 50 mm width.

For the tensile test, the Brazilian Association of Technical Standards for Textile Materials NBR 11912 2001 was used to determine the tensile strength and flat tissue elongation by the strip method. After the prepared samples, they were taken to the traction equipment, which was regulated as to the distance of the claws and the tension that would be applied to them. Each sample was placed in the equipment and the same placement and fixation in the jaws were observed for all the tests, being always well centralized to guarantee valid results.

3. RESULTS AND DISCUSSIONS

Before analyzing the seams themselves, it is important to compare the strength and elasticity of the fabric in the three main directions, straight, bias, and cross directions. The graph of Figure 5 shows the relationship of these three directions. The mean representative curves of the test set were obtained. As expected in the straight direction, the fabric has greater strength and in the direction of bias greater elasticity. In the cross direction the resistance is lower than in other directions and this is due to the fact the fabric twist when pulled, creating multidirectional stresses that weaken it. Regarding elasticity, the cross direction was in an intermediate value in relation to the other directions.

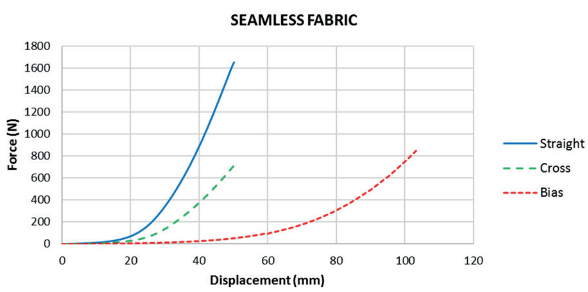

Figure 05 – Test results for seamless fabric
Fonte: Author.

The first tests were done with the seams without any transverse finish, that is, only the fabric was sewn. However, it was noted that the seams began to break during the test. For this reason a seam called a bartack was made, which is a type of reinforcement, used in strategic points of the clothes to improve the strength of the seam. Figure 6 shows the seams with and without bartack, where it can be seen that, when performing the test, the reinforced seam does not peel, making the test more realistic.

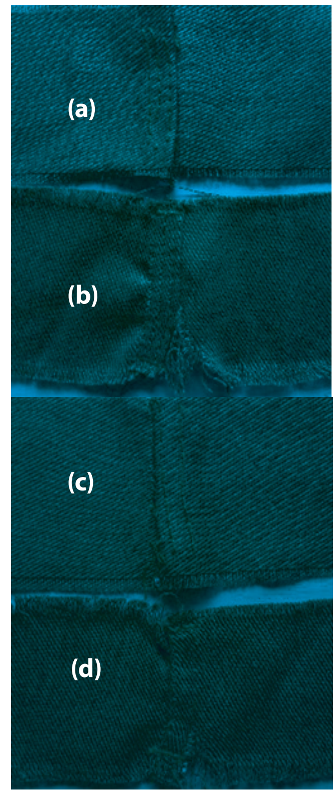

Figure 06 – Seams made in the DCS machine without reinforcement (a) and with reinforcement (b) and in IS machine without reinforcement (c) and with reinforcement (d)
Fonte: Author.

The graphs of the tests with and without bartack were also obtained to verify if there was a change in the behavior of the seam. Figures 7, 8 and 9 show the results for the DCS machine in the direction of straight, bias and cross. For these seams, the curves without bartack were slightly below the curves with bartack and broke earlier also because of the seam seals before the fabric rupture. This demonstrates that the insertion of the bartack improves the strength of the seam. The bartack also did not change the shape of the curve and this shows that this element does not change the behavior of the seam.

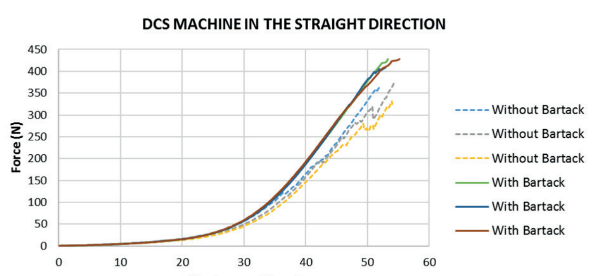

Figure 07 – Results of the tests for the DSC machine in the straight direction with and without bartack
Fonte: Author.

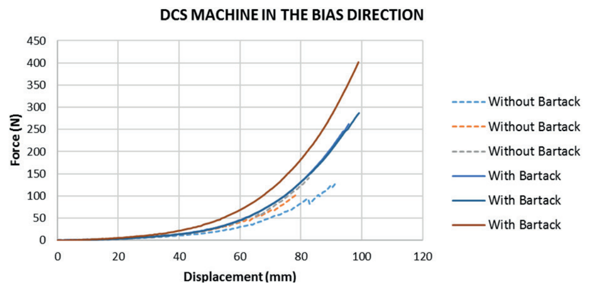

Figure 08 –Results of the tests for the DSC machine in bias direction with and without bartack
Fonte: Author.

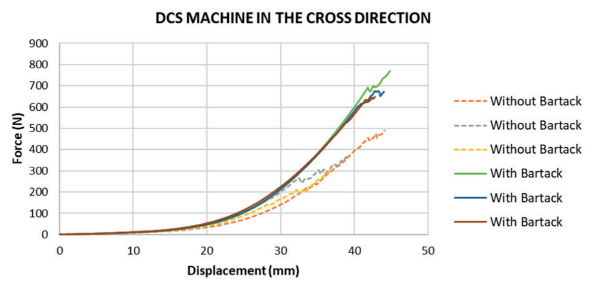

Figure 09 –Results of the tests for the DSC machine in the cross direction with and without bartack
Fonte: Author.

The same was done for the tests with the IS machine, where through the graphs of figures 10, 11 and 12 the behavior was the same as for the DSC machine. Just in the bias direction (figure 10) there was a reversal of the curve, ie with bartack the curve was below the unbartack. However, the tissue rupture remained earlier as in the other graphs showing that there was an improvement in the elasticity given by the bartack.

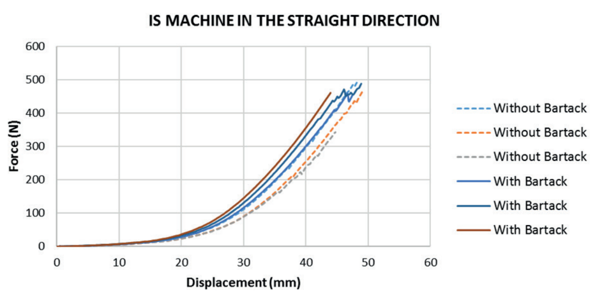

Figure 10 – Results of the tests for the IS machine in the straight direction with and without bartack
Fonte: Author.

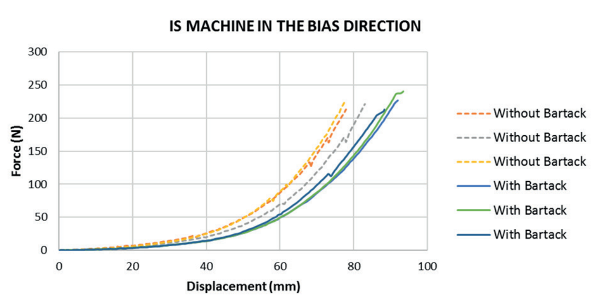

Figure 11 –Test results for the IS machine in bias direction with and without bartack
Fonte: Author.

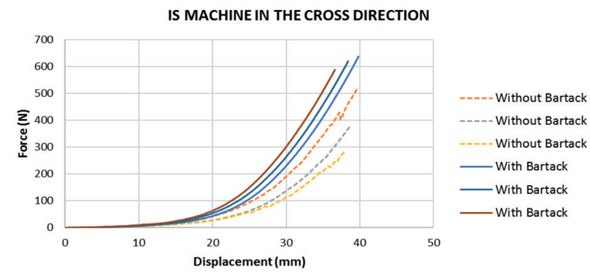

Figure 12 –Test results for the IS machine in cross direction with and without bartack
Fonte: Author.

After adjusting the seams to receive the reinforcement, the strengths of the seams made for the DCS machine and IS machine in the three directions of the fabric (straight, bias and cross) were analyzed. Figures 13, 14 and 15 illustrate the results. The first observation is that sewing, in the straight and bias direction, always weakens the fabric. This information was already well known to the garment industry, however, it was not known that in the cross direction the seam improves the strength of the fabric. This is probably due to the fact that the seam is a twist limiter that the fabric suffers when being pulled, since the seam is a union of the fabric that has been folded, giving more rigidity in the cross direction. For the bias direction the seams had practically similar behavior, however, for the straight direction, sewing with the DCS machine decreased to 3.24 times the resistance of the garment in relation to a not stitched region. This value is calculated by setting a displacement plateau (elasticity generated by the fabric) and finding the force values. For IS sewing, clothing is 220% less rigid than non-sewn fabric.

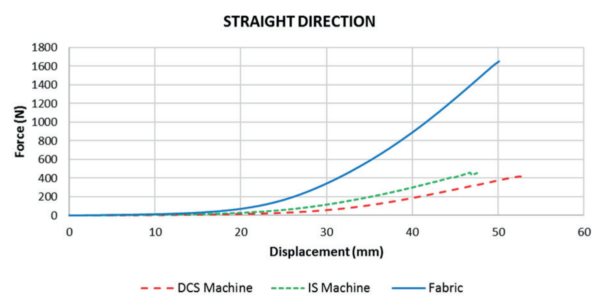

Figure 13 – Comparison of the tests for the seams of the DCS machine, IS machine and the seamless fabric in the straight direction
Fonte: Author.

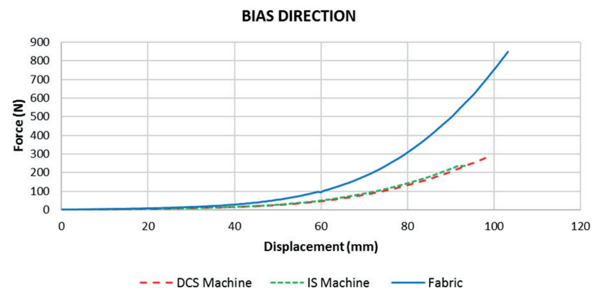

Figure 14 – Comparison of the tests for the seams of the DCS machine, IS machine and seamless fabric in the bias direction
Fonte: Author.

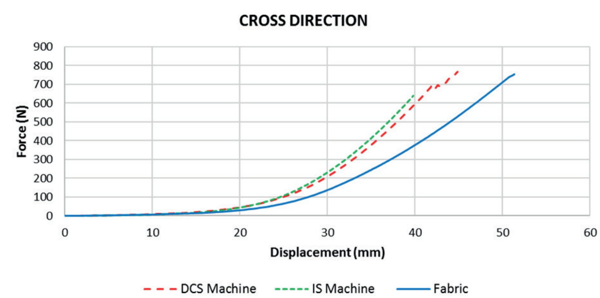

Figure 15 – Comparison of the tests for the seams of the DCS machine, IS machine and seamless fabric in the cross direction
Fonte: Author.

In the same way, the two seams can be compared to each other, shown in figure 13. For constant displacement levels the IS machine is 2.2 times stronger than the sewing with the DCS machine. If, similarly, a steady force plate is set, it is possible to observe that the IS machine is about 15% less elastic (displacement in the test) than the sewing with the DCS machine. This, however, can be compensated by the fact that the seam performed on the IS machine is more flexible than that of the DCS machine, although this is merely qualitative, that is, it has not been quantified.

Thus, by making a general analysis, contrary to what was thought, in the opinion of the industries, where the DCS machine was thought to be the most resistant, the contrary was evidenced, and in terms of cost, the two seams may arrive to a variation of only 10% of difference, which does not justify the use of the DCS machine. The above observation can be also seen from another perspective, that is, assuming that industries always want to sell more and more, a seam, as done in DCS machine, which look more visually resistant, makes the clothing lasts less, needing to be replaced more frequently, increasing sales. However, in terms of sustainability, this is not recommended as cotton production is highly environmentally impactful and generates waste after the use of clothing that usually goes to landfills.

It is also important to emphasize that it was not possible to identify the reason why the sewing in the DCS machine weakens the fabric, it would be necessary more tests and investigations to improve the understanding about this phenomenon. However, an important factor is that more sewing lines, for this study indicated a greater fragility of the fabric only in the straight direction.

4. CONCLUSIONS

Based on the tests conducted in this study, it was found that weakens the seam the fabric on the bias and straight direction. This result had already been presented by Ferdous et al. (2014), whose work also points out that the fabric in straight direction has a greater weakening the direction of bias.

In the straight direction, which simulates the friction of crotch seams, the IS machine proved to be more resistant. According to the visual analysis it was noticed that the seam of the IS machine was less fragile than the seam performed by the DCS machine.

Another factor that may justify the choice of the process performed by the IS machine is the fact that the seam performed by the DCS machine is thicker and this can generate discomfort to the user.

The seam of the IS machine is 2.2 times stronger than the seam of the DCS machine. However, from a financial and productive point of view, the DCS machine is seen as a better alternative, since time and line consumption used to sew in the DCS machine is lower than the process performed by the IS machine and with rebound stitch in the Twin Needle Lockstitch Sewing Machine. The DCS machine represents a saving of 15% of time compared to the process performed with the IS machines and Twin Needle Lockstitch Sewing Machine. This economy is not only reflected over time, because in terms of sustainability, within that time there is less energy, fewer wires and fewer human resources with the same results. That is, the DCS machine is more efficient to produce a stronger product.

This study was done with the tensile test, which is considered a static test, that is, does not evaluate situations where the load is not enough to break the tissue but there is a cycle involved, as in the case of normal use of clothing. For future work, some tests could be done, such as a dynamic test, to verify that the seams have the same behavior when subjected to a cyclic loading.

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