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INVESTIGATION OF SEWING PARAMETERS CAUSED FABRIC DAMAGES

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ABSTRACT

In this study, it was determined the factors that affect the needle damage, which occurs during the sewing process. In this context, three knitted fabrics (single jersey, 1×1 Rib and pique), sewing direction, needle point form, needle number and sewing speed parameters were determined as variables and the effect of the sewing thread was excluded. The sewability properties were evaluated by using L&M Sewability tester and the fabric damages occurred during sewing process were evaluated by visual evaluation. Regarding the obtained data, the most important factor causing needle damage during sewing was the needle number. In order to achieve a high quality of stitch and minimize the formation of needle damage, determining the appropriate needle number and needle point form comes forward. This study also reveals the effect of the parameters which should be taken into account during the needle selection such as the fabric type, the knit structure as well as the loop density.

KEYWORDS

Sewing needle, Sewability, Needle penetration force, Needle damage.

INTRODUCTION

Quality in apparel products is very important however when high speed sewing machines started to use, the stitch and sewing problems during the sewing process has occurred. The seam quality has significant effect on the overall performance of the apparel in use [1]. In this regard, the needle penetration force, which depends the spaces in the fabric, needle profile, needle size, sewing machine setting and sewing material, comes forefront on seam quality [2]. High needle penetration forces values can cause seam and fabrics damages [3].

Recent studies have been made to improve sewing performance as well as the sewing quality. The effects of different sewing threads and densities on seam strength and needle penetration forces [4] and the fabric ply numbers [5] to the seam performance. Carvalho et al. [6], presented a system which allows the measurement of parameters of needle penetration during high-speed sewing. Çitoğlu and Kaya [7], were studied the effects of different sewing threads properties and stitch densities on the seam strength and seam extension in different sewing angles. Pamuk et al. [8], were researched the effect of sewing thread count and fabric density on needle penetration force.

MATERIALS AND METHODS

In this study, it was determined the factors affecting the formation of fabric damage arising from the needle during the sewing process. The experimental design of the study was prepared including the parameters such as the fabric knit structure, sewing direction, needle point form, needle number and sewing speed, the effect of sewing thread was excluded from the study. The sewability properties of the fabrics were evaluated using the L&M sewability tester, and the needle damage was evaluated visually and subjectively. In this context, fabrics knitted with 30/1 Ne yarns, 50% Co-50% PES composition were determined and the knit structures were single jersey (149.8 gr/m^2), 1×1 rib (190.4 gr/m^2) and pique (207.1 gr/m^2). During the sewing and sewability tests of the samples, 4 different needles were used in 2 different needle point forms, SUK (middle ball) and SES (light ball), and 2 different needle numbers, 80 Nm and 110 Nm.

Visual evaluation

The visual evaluation of fabric damage for each needle penetration was carried out in the laboratory using a lighted desktop magnifier. The visual evaluation tests were carried out using 4 different needle forms described in the material for comparison in both loop course and wale direction. The experimental design is presented in Table 1.

Table 1. Experimental plan.

Sample Code	Needle point type	Needle number (Nm)	Test Equipment	Sewing speed (rpm)
1	SES	80	Lock Stitch M.	2000
2	SES	80	Lock Stitch M.	4000
3	SES	110	Lock Stitch M.	2000
4	SES	110	Lock Stitch M.	4000
5	SUK	80	Lock Stitch M.	2000
6	SUK	80	Lock Stitch M.	4000
7	SUK	110	Lock Stitch M.	2000
8	SUK	110	Lock Stitch M.	4000
9	SES	80	Sewability T.	100
10	SES	110	Sewability T.	100
11	SUK	80	Sewability T.	100
12	SUK	110	Sewability T.	100

In total, 144 visual evaluation test samples and 72 sewability test samples were prepared. For each fabric structure, the samples were prepared in 3 repetitions in the loop course and loop wale directions.

The visual evaluation samples, were subjected to needle penetrations 100 times by using a lock stitch machine, with 4 different needles, SES and SUK needle points and 80 and 110 needle numbers without using sewing thread. The effect of the sewing speed factor on the formation of fabric damage arising from the needle was also investigated by operating the machine at two constant sewing speeds.

In the visual evaluation of needle damage in fabrics, the damage caused by the needle in the knitting loops as well as in the yarns were taken into account. In some samples pinholes were clearly visible, while in others no hole formation was observed. The visual evaluation was carried out in only two cases, with and without damage to the fabric by the needle.

Sewability tests

The sewability properties of the samples were evaluated using the L&M sewability tester. A total of 100 needle penetrations were performed in this test device, which gives the force applied to the fabric in grams in each needle penetration. 4 different needle forms described in the material were also used in sewability tests. The threshold value for each fabric structure was determined according to the recommended values of the L&M sewability tester catalogue. Accordingly, the threshold value was determined as 50 gf for single jersey fabric and 100 gf for 1×1 rib and pique fabrics. At the end of the tests, the average needle penetration forces calculated after 100 needle penetrations and the number of needle penetrations exceeding the determined threshold force were obtained.

RESULTS AND DISCUSSION

In visual evaluations, the pinholes, which caused by the damage in the knitting loops, in the yarns as well as in the fibres were taken into count. Figure 1 shows examples of needle penetrations considered as needle damage.

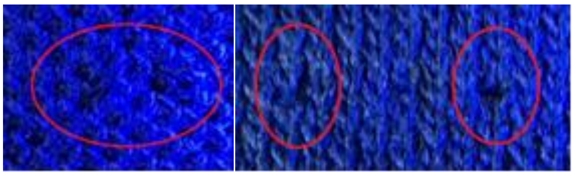

Figure 1. Examples of needle damage.

In Table 2, the average values of the visual evaluation results of the tests performed as three repetitions were given. The average values in the table indicate how many needle damage occurred in 100 needle penetrations in the samples.

Table 2. Visual evaluation results: Number of fabric damages per 100 penetrations (C: course; W: wale).

Sample Code	1C	1W	2C	2W	3C	3W	4C	4W	5C	5W	6C	6W	7C	7W	8C	8W
Single Jersey	1	4	3	7	89	98	92	98	2	4	2	2	95	95	87	95
1×1 Rib	0	0	0	0	97	89	95	93	0	1	0	1	96	94	97	94
Pique	9	1	13	3	83	68	55	77	2	2	3	3	75	83	65	82

Regarding the obtained results, the most important factor causing needle damage during the sewing process was the needle number. While the needle damages were observed in insignificant amount in the samples sewn with 80 Nm needle, a 98% of needle damages occurred in the samples sewn with 110 Nm needle.

The least needle damage occurrence was observed in the 1×1 Rib fabric tests carried out with 80 Nm needle in both fabric directions (loop course and loop wale), both needle point form (SES and SUK) and both sewing speed (2000 rpm and 4000 rpm). It is thought that this was due to the fact that the fabric in the 1×1 rib knit structure stretches more during sewing compared to single jersey and pique fabrics, and the stretch rate of the rib can withstand the impact of the use of 80 Nm needles.

Considering the cutting direction of the fabrics, it was seen that the needle damage occurrence was higher in the pique knit fabric in the samples cut in the loop course in the samples sewn with 80 Nm needle, while the needle damage formation in the single jersey fabric was higher in the samples cut in the loop wale direction. This may be due to the less stretching feature of the single jersey fabric in the samples cut in the loop wale direction.

Regarding the tests performed with 110 Nm needle, the least needle damage occurrence was observed in the pique fabric. The honeycomb structure of pique fabric generates gaps between the loops. This allows the needle to pass through the fabric more easily, reducing the occurrence of needle damage compared to other rib and single jersey knit structures. However, in the samples sewn with 110 Nm needle, the maximal needle damage occurred in 1×1 Rib fabric with 98%. The reason for this is that the gaps between the loops that the needle can pass through were insufficient when considering the needle thickness.

Table 3 shows the average penetration force obtained because of 100 needle penetrations and the data on the number of needle penetrations exceeding the threshold value in the tests carried out on the sewability test device of the fabrics.

Table 3. Sewability test results (C: course; W: wale).

	Single Jersey		1×1 Rib		Pique	
Sample Code	**Average Needle Penetration Force (gf)**	**Number of Threshold Exceeds**	**Average Needle Penetration Force (gf)**	**Number of Threshold Exceeds**	**Average Needle Penetration Force (gf)**	**Number of Threshold Exceeds**
9C	23.67	6	38.33	3	25.67	1
9W	17.67	2	39.33	6	25	0
10C	53.33	52	94	32	29.33	4
10W	67.67	89	81	42	57.67	8
11C	24.67	2	38.67	1	26	0
11W	19.33	2	43	3	26.67	1
12C	61.67	67	64.67	5	44.67	7
12W	84.67	77	89.33	23	68.67	20

Regarding the obtained data, the needle penetration force increased as the needle number increased for all fabrics in both directions (loop course and loop wale). In the tests performed with an 80 Nm needle, it was observed that needle penetrations took place in the spaces between the loops. Therefore, the force required for needle penetration was lower. However, in the case of using a thicker needle, that was, in the tests performed using a 110 Nm needle, the needle penetrations did not pass through the gap between the loops, but at the junction of the threads forming the loop or directly on these threads. Here, the needle performed its penetration by damaging the threads. Therefore, the needle penetration force required for the needle to pierce through the threads was higher.

The highest number of needle penetrations exceeding the determined threshold value was observed in the tests performed with 110 Nm needle in single jersey fabric. In the tests performed with Rib fabric, the test performed with the sample prepared toward the loop wale with the SES needle point form gave the highest number of crossing the threshold value with 42%. In the tests carried out using pique fabric and a 110 Nm needle, the lowest threshold values were obtained. It is thought that this situation was caused by the honeycomb texture in the knit structure.

CONCLUSION

When the test results using the L&M sewability tester were examined, it was seen that the number of crossing the threshold value was higher in the tests performed with 110 Nm. Thus, the necessity of comes to the forefront on choosing the right sewing needle to be used by considering the values such as the fabric type, the knit structure as well as the loop density.

We observed that the most important factor causing needle damage during the sewing process was the needle number. While the formation of needle damage was minimum in the Rib fabric samples sewn with 80 Nm, it was minimum in the pique fabric samples sewn with 110 Nm. It is thought that the pique knit structure allows the needle to pass through the fabric more easily, reducing the occurrence of needle damage more than other knit structures.

This study reveals the importance of determining the appropriate needle number and needle point form to be used in sewing a product in terms of minimizing the occurrence of needle damage. Consequently, at the needle selection stage, the thickness and hardness of the fabric as well as the number of fabric layers should be taken into account in the sewing process.

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