International Journal of Advance Industrial Engineering

E-ISSN 2320 –5539
Available at http://inpressco.com/category/ijaie/

Research Article

Performance Analysis of Stitch and Turn Fabricated Leather Seam: Relevance to Diverse SPC and SC

Muhammad Naimul Hasan * , Md. Imrul Kayes Limon and Md. Samsul Arefin

Department of Leather Engineering, Khulna University of Engineering & Technology, Khulna 9203 Bangladesh

Received 01 Sept, Accepted 28 Nov 2017, Available online 12 Dec 2017, **Vol.5, No.4 (Dec 2017)**

Abstract

In this article multiple pieces of chromed tanned leather with a thickness of 1.00 mm were used to sew together by the utilization of a selected cutting needle count (LR90) to assemble stitch and turn seam with a definite dimension for the study. The seam was assembled with different SPC (stitches per cm) (3, 4, 5 and 6) with specific four types of SC (stitch construction) i.e. lock (301), chain (401), zig-zag (304) and also combination of 401 and 304 to observe the results and other parameters like material, machine, thread were kept unchanged which may influence the strength of seam. The objective assessment was to find out the best combination of SPC (stitches per cm) and class of stitch construction (SC) that presented the best seam performance or seam quality in terms of seam strength, seam efficiency and thickness strain. Here, ASTM D 1683 method was followed to determine the seam strength and it was revealed that seam strength amplified with the increase of SPC up to certain level. The seam with 301 SC at 3 SPC provided the best seam performance whereas seam with combination (401 and 304) at 3 SPC shown significant seam strength as well.

Keywords: *SC, SPC, seam, seam strength, seam efficiency, thickness strain.*

1. Introduction

Leather apparel is a combination of multiple seaming lines (zones) with specific structure and a seam is the successive joining of two materials (leather/synthetic) either by cementing, stitching, riveting, stapling or applying more than one technique among the four. The durability, wear-ability or the performance of the apparel is directly related with the seam quality. In case of leather apparel choice, the customer satisfaction largely depends on many factors; assembly quality is the most important parameter after the leather quality whereas quality seams in sewn apparel contribute to the overall performance of the apparel in use. Poor quality seam construction makes apparel unusable even though the leather may be in good condition.

For common garments, the seam is an essential part of the garment (Jebali, *et al*, 2016), (Lindberg, *et al*, 1960). A seam is manufactured employing sewing methods, with the idea that the seam should satisfy all the requirements imposed by a number of end-users of garments (Rosenblad and Cednas, 1973). For any garment, it is essential to have clear understanding of the basic parameters of seam as the ultimate element of cloth. Seam quality has great significance in the production of quality apparel. Consumers evaluate seam quality mainly based on seam appearance and its durability after wear and care procedures. The probability of seam performance for different garments is also different depending upon its end use.

For some functional garments such as sportswear, the requirements of seam strength is higher than that of the seam appearance, while for some apparel products such as night gowns, the appearance of the seam is of higher importance. Seam appearance and performance depends on the type of materials, threads, stitch type, type of seam, sewing parameters/conditions, which include the needle size, stitch density, the appropriate operation and maintenance of the sewing machines (Nazakat, *et al*, 2014), (Rengasamy, *et al*, 2003), (Salhotra, *et al*, 1994), (Krasteva, *et al*, 2008), (Gribba, *et al*, 2006). Basically, the quality of seam can be examined from two aspects: functional and aesthetic (Bhalerao, *et al*, 1997), (Behera, *et al*, 1998), (Bahera, 1997b). The functional performance mainly refers to the strength, tenacity, efficiency, elasticity, elongation, flexibility, abrasion and washing resistance (both dry and wet) of the seam under certain condition of mechanical stress for a reasonable period of time (Carr, *et al*, 1995), (Mehta, 1985), (Solinger, 1989), (Glock and Knuz, 1995), (Sandow and Hixon, 1999).

The functional quality of seam is directed by the seam efficiency, seam strength, thickness strain which are related to stitch type, thread type, thread tension, seam type, stitches per inch, seam puckering that have connection to the technological parameters of the

*Corresponding author: **Muhammad Naimul Hasan**

machine and leather (material) specifications (Salhotra, *et al*, 1994), (Krasteva, *et al*, 2008), (Gribba, *et al*, 2006). The leather quality plays a significant role for the assembly of a good quality seam in leather apparel fabrication. However, only the material (leather) inherent quality alone does not fulfill all the criteria for the production of high quality leather garments. The transformation of two-dimensional leather into three-dimensional garment involves many other interactions such as selection of suitable sewing threads, optimization of sewing parameters, ease of conversion of leather to garment and actual performance of sewn leather during wear of the garment (Bahera, 1997b).

Up to now, very limited work has been done to observe the quality of stitch and turn constructed leather made seam on functional aspect. Throughout the recent decades a lot of works have been done on seam quality but the base material was different types of fabric and seam construction was also different but in this study the base material was selected as garment leather and stitch and turn seam construction was followed to carry out the analysis. Important and main focusing side of this study was to analysis the compatibility of material with thread, thread with needle size and point, standard SPC (stitches per centimeter) in case of seam fabrication.

In this article, an experimental attempt was made to evaluate and observe the seam performance of stitch and turn constructed leather seam based on diverse SC (stitch construction) and SPC (stitches per centimeters). For this work, multiple seam were prepared based on stitch and turn construction using chromed tanned garment leather as basic material and lock (301), chain (401), zig-zag (304) and also combination of chain (401) and zig-zag (304) stitch formation were applied during joining multiple pieces of leather for the seam assembly. Manifold seam were prepared by maintaining different stitch densities per cm (3, 4, 5 and 6) with needle system i.e. needle size 14, 16 and 18. Finally, seam breaking load, % of elongation were recorded by following ASTM D1683 for the determination of seam strength, seam efficiency, thickness strain to evaluate the functional performance of leather seam in the end product. The success of this study could help leather garment fabricators to show a proper guide line and instructions for the evaluation of seam quality more efficaciously in the department of production planning and control.

2. Materials and methods

2.1 Materials

Table 1 Base material specification

Material	color	Thickness(mm)	Texture	Tanning
Leather	Black	1.0	Soft &smooth	Chrome

Table 2 Sewing Machines and tools specification

S.N	Name	Brand	Speed(rpm)	Needle No.
1	Lock (301) stitch m/c	DURKOPP ADLER AG, Eco 0669, Czech Republic	3200	14(lock)
2	Chain stitch (401) m/c			16(chain)
3	Zigzag (304) m/c			18(zigzag)

Table 3 Thread and needle specification

S.N	Type	Brand	Point	Number	Color
1	Needle	Pfaff	Cutting (LR 90)	14, 16,18	-
2	Nylon Thread	Pfaff	-	60/3	Black

The material used for this research work was chrome tanned leather (origin: cow hide) with a thickness of 1.0 mm which is very common in leather garments manufacturing and nylon thread with a ticket number 60/3 was used for sewing purpose. Seam allowance kept as 1.2 cm in each sample. Since the stitch and turn constructed seam is more imperative to entire garment performance, only this construction seam is investigated.

The industrial scale chain, lock and zigzag stitch sewing machines are used for joining the leather pieces. The detailed specification of the materials, sewing machines and tools used in this experiment are given in the Table 1, 2 and 3.

2.2 Methodology

The tensile properties of the stitch and turn constructed seam were evaluated using Instron Tensile Tester (model 4411) following the international testing standard method ASTM D1683. Triplet test was done for each sample. The applied load on the test specimen was perpendicular to the direction of seam line. During the test, the preload was maintained 200 cN at constant rate of expansion and jaw speed was 50 mm/min and it was gradually increased up to the breaking point of the specimen.

A rectangular test specimen was (14 x 4) inch dimension was prepared for each test which is shown in fig.1, and each sample was clamped in between the jaws. Therefore, in each time load at rapture, percentage of elongation was noted. Seam strength, % of elongation, seam efficiency, thickness strain were also determined in accordance with the following equations- (1), (2) and (3).

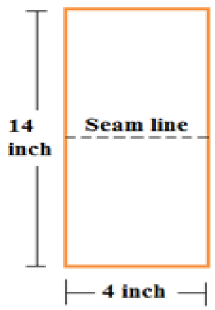

Fig.1 Specimen dimension

$$S_E = \frac{S_T}{M_T} X100 \quad (1)$$

$$T_S = \frac{t_S - 2t_L}{2t_L} X100 \quad (2)$$

$$E_S = \frac{E_L}{O_L} X100 \quad (3)$$

Where, $S_E, S_T, M_T, T_S, t_S, t_L, E_S, E_L$ and O_L indicate seam efficiency, seam tensile strength, material tensile strength, thickness strain, seam thickness, material thickness, seam elongation, extended length and original length respectively.

Table 4 Seam performance parameters for stitch and turn fabricated leather seam at different SPC and SC

S.N	Seam type	SPC	SC	Breaking Load (N)		Elongation (%)	
				Mean	SD	Mean	SD
1	Stitch and turn	3	301	93.77	2.01	27.33	0.40
			401	79.85	4.01	25.40	0.65
			304	84.53	5.01	37.30	0.57
			304 & 401	89.60	2.90	21.00	0.52
2		4	301	80.77	1.78	22.32	0.48
			401	73.20	2.01	25.53	0.52
			304	69.27	3.23	22.67	0.75
			304 & 401	72.23	2.76	28.70	0.45
3		5	301	72.33	2.80	26.7	0.34
			401	63.25	4.84	25.9	0.65
			304	57.80	3.05	26.99	0.55
			304 & 401	63.29	4.27	31.10	0.45
4		6	301	57.12	3.03	27.31	0.75
			401	46.33	4.26	26.99	0.65
			304	37.96	2.45	26.30	0.55
			304 & 401	31.97	5.01	27.79	0.69

3. Results and discussion

The seam efficiency (%), thickness strain (%), seam strength (N/cm), percentage of elongation, breaking load (N) of the stitch and turn constructed leather seam along with different SPC and SC are shown in Table 4 and 5. The relationship among seam efficiency, thickness strain, seam strength at different levels of stitch densities (SPC) and SC for 1.0 mm thickness of chromed tanned leather made seam are demonstrated in figures 2, 3 and 4 respectively. The statistical analysis tabulated in Table 4 and 5 revealed that SPC and SC have influence on elongation, breaking load and ultimately on seam tensile strength.

It is noticed from fig.2 that the seam efficiency (%) at 3 SPC is near about 82% in case of 301 SC whereas other SCs (401,304 and combination of 304 & 401) ranges from 69 to 73%. At the same time, it is also revealed from fig. 2 that seam efficiency is gradually decreased with the increase of SPC. Though it is seen a growing trend at 5 SPC for 301 and 401 stitch constructions (SC), there is a possibility of material failure due to increase in stitch densities.

Table 5 Load-elongation values of stitch and turn leather seam at different SPC and SC

S.N	Seam type	SPC	SC	Seam Strength (N/cm)		Seam Efficiency (%)		Thickness Strain (%)	
				Mean	SD	Mean	SD	Mean	SD
1	Stitch and turn	3	401	0.79	0.50	69.6	2.64	14.35	0.4
			301	0.92	0.29	81.6	2.83	9.50	0.3
			304	0.83	0.70	70.1	5.01	18.60	0.6
			304& 401	0.88	0.29	73.1	2.90	11.28	0.5
2		4	401	0.69	0.20	66.6	2.01	15.08	0.3
			301	0.79	0.02	71.4	2.45	10.34	0.2
			304	0.67	0.03	65.2	3.01	18.60	0.8
			304& 401	0.71	0.03	62.3	3.01	11.45	0.6
3		5	401	0.59	0.02	63.6	2.01	22.20	0.7
			301	0.71	0.19	65.4	2.45	16.70	0.5
			304	0.56	0.02	57.2	3.01	25.60	0.9
			304& 401	0.62	0.04	57.3	3.01	19.60	0.8
4		6	401	0.56	0.02	35.7	2.02	33.50	1.0
			301	0.56	0.19	50.4	2.45	26.91	0.7
			304	0.35	0.02	42.3	3.01	32.30	0.8
			304& 401	0.29	0.03	45.7	3.31	29.32	1.2

It has been observed from fig.3 that at 3 SPC value, 301 SC has given the maximum seam strength 0.92 ± 0.29 N/cm. As it is also understood that combination SCs (304 & 401) have provided with the acceptable seam strengths 0.88 ± 0.29 N/cm and 0.92 ± 0.29 N/cm respectively. On the contrary, it is clear that with the increase of SPC value seam strength has drastically deteriorated and this may due to increase number of stitches indicating the sign of material damage.

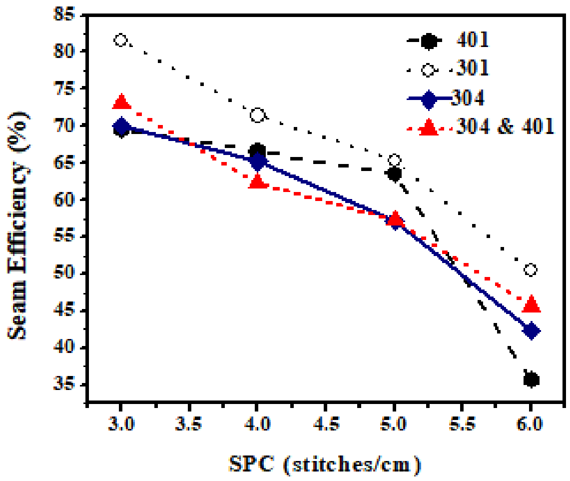

Fig.2 Effect of SPC and SC on seam efficiency

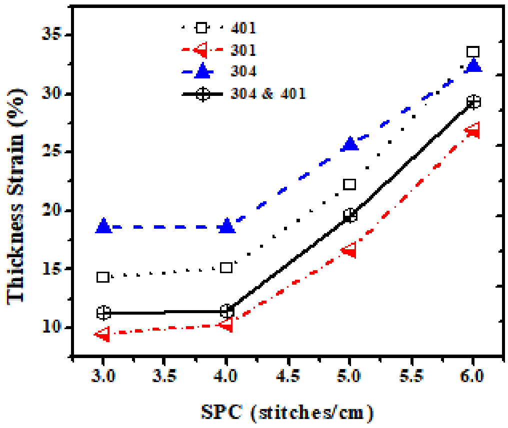

Fig.4 Effect of SPC and SC on seam thickness strain

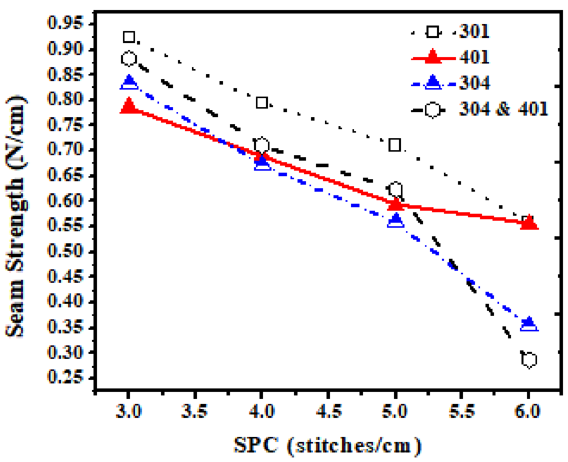

Fig.3 Effect of SPC and SC on seam strength

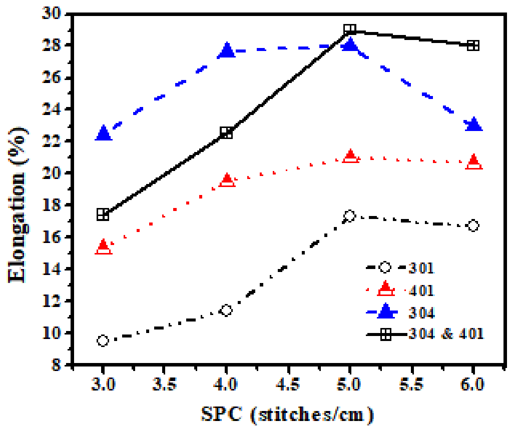

Fig.5 Effect of SPC and SC on seam elongation

Fig.4 and fig.5 illustrate the correlation among stitches per Centimeter (SPC), stitch construction (SC) and thickness strain as well as SPC, SC and percentage of elongation respectively. It has been analyzed that there is a gradual increase of thickness strain with the increase of SPC value from 3 to 6 (Fig. 4) for every stitch construction. At 3 SPC, 301 SC has given the least thickness strain (9.50%) and in contrast, 304 has provided with (18.60%) the utmost. Lesser values of thickness strain indicates fewer seam puckering which are always greeted by the apparel engineers.

In case of stitch and turn leather seam, it is assessed from fig. 5 that there is a regular growth of elongation with the stitch densities up to 5 SPC and there is sharp decrease has been observed at the end of 6 SPC.

It is also evident from table 5 that 301 SC with 3 SPC exerted the uppermost breaking load (93.77 ± 2.01 N)) and combination construction (304 & 401) has shown the bottommost breaking load (31.97 ± 5.01 N) at 6 SPC. It is strongly concluded from figures 2, 3 and 4 that maximum seam efficiency, seam strength have been recorded for 301 category SC with 3 SPC and on the other hand, lesser thickness strain is also shown at this SPC. So, there is a vice versa relationship in between seam efficiency and thickness strain indeed. A high percentage of seam efficiency and lesser percentage of thickness strain always represent good seam quality and it has a positive influence on the end products.

Conclusion

In this study, it is revealed that the resistance to breakage at the application load is the most for the 301 stitch construction with 3 SPC value and at the same time, higher seam efficiency, seam strength and the least thickness strain are observed for the combination SCs. Moreover, it is distinct from this work that for the similar type of leather material and thickness with the increase of SPC, all the four category stitch constructions (SCs) exposed decreasing trend in the mentioned seam quality parameters except strain at rupture. So, it can be concluded from the present research, this guidance of seam quality parameters definitely will add a benefit for proper planning and control of seam quality during leather apparel fabrication.

Acknowledgements

The author would like to express gratitude and thank to the concerned people of the institutes and industries who were supportive during this work.

References

Bahera, BK., (1997b), Evaluation and Selection of sewing Thread, *Textile Trends*, Vol. 39(12), pp. 33-42.

Behera, BK., Sharma S., (1998), Low stress behavior and sewability of suiting and shirting fabrics, *Indian Journal of Fibre and Textile Research*, Vol. 23(4), pp. 223-241.

Bhalerao, S., Budke, AS., Borkar, SP., (1997), Seam performance in suitings, *Indian Textile Journal*, Vol. 107(11), pp. 78-81.

Carr, H., Latham, B., (1995), The technology of Clothing Manufacture, *Blackwell Scientific Publications*, Oxford.

Glock, RE., Knuz, GI., (1995), Apparel Manufacturing: Sewn Product Analysis. *New Jersey: Englewood Cliffs.*

Gribba, S., Amar, SB., Dogui, A., (2006), Influence of sewing parameters, upon the tensile behavior of textile assembly, *International Journal of Textile and Clothing Technology*, Vol. 18(3), pp. 235-246.

Jebali, N., Babay Dhouib A., Ben Hassen, M., (2016), Modeling the overall Seam Quality of Woven Cotton Fabric, *International Journal of Applied Research on Textile*, Vol. 4, pp. 47-61.

Krasteva, DG., Petrov, H., (2008), Investigation on the seam's quality by sewing on light fabrics, *International Journal of Clothing Science and Technology*, Vol. 20, pp. 57-64.

Lindberg, J., Westerberg, L., Svenson, R., (1960), Wool fabrics as garment construction material, *Journal of the Textile Institute*, Vol. 51, pp. 1475-1492.

Mehta, P.V., (1985), An introduction to quality control for apparel industry, *ISN international, Japan.*

Nazakat, A., Abdul, MR., Zamir, A., Hafeezullah, M., Ahmer, H., (2014), Effects of different Types of seam, stitch class and stitch density on seam performance, *App Em Sc*, Vol. 5(1), pp. 32-43.

Rengasamy, RS., Kothari, VK., Alagirusamy, R., Modi, S., (2003), Studies on air-jet textured sewing threads, *Indian Journal of Fiber and Textile Research* Vol. 28(3), pp. 281-287.

Rosenblad, WE., Cednas, M., (1973), The influence of fabric properties on seam puckering, *Clothing Research Journal,* Vol. 1, pp. 20-26.

Salhotra, KR., Hari, PK., Sundaresan, G., (1994), Sewing thread properties, *Textile Asia,* Vol. 25, pp. 46-49.

Sandow, K., Hixon, D., (1999), Thread Selection made simple, Bobbin. pp. 46-49.

Solinger.J., (1989), Apparel Manufacturing Hand Book, *Bobbin Blenheim, Columbia*.