

Sewing Performance of Stretch Denim

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ABSTRACT

The elastic yarns and fabrics are gaining popularity in last few years all over the world because of their wearing comfort and functionality. The elastane ratio and the subsequent finishing processes influence the fabric mechanical properties and hence performance during sewing. In this paper an attempt has been made to investigate the effect of Lycra percentage, type of sewing thread and silicone finish on sewability of denim fabrics. The seam efficiency was found to be increased with Lycra percentage, while the seam pucker and needle damage were affected by the weights of the fabric rather than the Lycra percentage. The seam slippage does not show any trend with either of the Lycra percentage or fabric weight. The use of silicone finish reduces the seam efficiency, seam pucker and needle damage while the seam slippage is increased. The use of corespun thread though helps to achieve higher seam efficiency; the seam pucker, seam slippage and needle damage is increased.

Keywords: Sewability, Seam efficiency, Seam slippage, Seam pucker, Needle cutting index

Introduction

Denim, the favorite fabric of the youngsters has indeed come a long way. The scope for denim wear is increasing tremendously every year and its worldwide market share has increased unpredictably in the last few decades. Recently the fashion trend is moving from denim to stretch denim (denim with Lycra). Just a little amount of Lycra

(about 1-5%) in denim adds freedom of movement and greater elasticity to the denim. The new generation stretch denim is paving the way due to its softness, ease of body movement and comfort. Totally invisible, comprising only up to 5% of the fabric content, Lycra respects the authentic look and feel of denim.

Only the production or procurement of good quality fabric for denim doesn't guarantee good quality garment, as many parameters play role from the cutting table till the packing. The most important is the fabric selected for garment should have good sewability. The term sewability can be defined as the ability and the ease with which the 2-D fabric components can be qualitatively and quantitatively be seamed together to 3-D garment [1]. Good sewability of a fabric indicated the ease of formation of shell structures on the surface of the fabric producing pucker-free garments. The integration of various parameters related to sewing thread, fabric and sewing machine settings at their optimum level results in good sewability [2]. The sewability of various types of fabrics has been studied by several researchers [3,4,5,6].

The quality and performance of a sewn garment depends on various factors such as seam strength, seam slippage, seam pucker and yarn severance [2]. In sewn garments, sewing damage is a constantly recurring phenomenon and is the major cause of customer complaint. The sewing needle penetration force and the elastane fibre damage were studied by Gurarda and Mrick [7]. In the present paper, the sewability of stretch denim has been analyzed.

Materials

Two different types of sewing threads commonly used for stitching denim fabrics were selected for the investigation. The sewing thread dimensional properties are given in Table 1. The stretch denims were manufactured by using the cotton/elastane corespun yarn in the weft direction. Cotton/elastane yarns were produced by core spinning method where an extended core of elastane was introduced to the front drafting roller of a ring frame spinning staple yarns from cotton. Thus the resultant yarn contains the elastane core and cotton sheath. The elastane fibre used was produced by DuPont (Lycra®). The amount of Lycra in the yarn was varied by varying the stretch of Lycra between the Lycra feed

roller and the ring frame front roller. Four types of denims containing different proportions (0%, 1%, 3% and 5%) of Lycra were prepared by suitable combination of the number of corespun threads in the weft and the amount of Lycra in the weft yarn. All the four denim fabrics were prepared on Picanol air-jet weaving machine with 3/1 twill structure, having same number of end and pick spacing. Out of these four samples, three samples contain varying proportions of Lycra are known as stretch denim and one sample without Lycra (0% Lycra) is known as basic denim. The fabric constructional parameters are given in Table 2.

Methods

Testing of Sewing Thread Properties: The diameter of sewing thread was measured by using a projection microscope. The ticket number of sewing threads was determined according to ASTM-D 3823. The tensile tests for measurement of breaking strength & elongation and loop strength & elongation were carried out according to ASTM-D 204 test method, on Instron tensile tester (model 4411). The gauge length was kept at 500 mm and a jaw separation rate of 300 mm/min was used.

Testing of Fabric Samples: The warp and weft counts were measured by using the beesley balance as per ASTM-D 1059 method. The warp and weft densities were measured by an ordinary counting glass according to ASTM-D 3775 method. The warp and weft crimps were measured by Shirley crimp tester according to ASTM-D 3883 test method. Fabric aerial density was measured by a round cutter and a digital weighing balance as per ASTM-D 3776.

Evaluation of Fabric Sewability: Fabric sewability was investigated by measuring the seam efficiency, seam pucker, seam slippage and needle cutting index of the fabrics. A high-speed industrial lockstitch machine (Juki) was selected for sewing the samples with the following specifications:

Type of stitch :Lockstitch type 301
Stitch density :8 stitches per inch
Machine speed :2000 stitches per minute

Needle size :16 (Singer system)
 Seam allowance:1 inch

Seam efficiency

Seam efficiency was measured according to ASTM-D 1683 method on the Instron tensile tester. Seam efficiency was calculated as the percent seam strength over fabric strength by using the following formula:

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

Seam slippage

The seam slippage test was done as per ASTM-D 1683 on the SDL tensile tester. The load-elongation curve of fabric was superimposed over the load-elongation curve of the same fabric with a standard seam sewn parallel to the yarns being tested. The force at which the load-elongation curve of the fabric with the seam is a predetermined distance greater than the load elongation of the fabric without a seam is reported as resistance to yarn slippage. The above test was carried out using following test parameters:

Gauge length : 75 mm
 Test speed : 300 mm/min
 Seam opening : 6 mm

Seam pucker

Seam pucker is the distortion in the surface of sewn fabric which appears as a swollen effect along the line of seam. Both subjective and objective test methods exist for measuring pucker. In this study it was objectively determined by measuring the percentage increase in the thickness of the seam over the fabric under a constant compressive load on the SDL tensile tester. The seam thickness strain which is the indicative of seam pucker was calculated using the following formula:

$$\text{Thickness strain}(\%) = \frac{F - 2S}{2S} \times 100$$

Where F = Seam thickness, and S = Fabric thickness.

Needle cutting index

The seam damage by the needle action was measured according to ASTM-D 1908 test method on Mitsubishi Micro Watcher. For each sample, needle-cutting index was determined using the following formula:

$$\text{Needle cutting index}(\%) = \frac{\text{Number of yarns cut/inch}}{\text{Number of yarns in fabric/inch}} \times 100$$

Table 1: Properties of sewing threads

Sample Code	Type	No. of Plies	Ticket number	Diameter (mm)	Breaking strength (Kg)		Breaking extension (%)	
					Single strand	loop	Single strand	loop
T1	Spun polyester	3	50	0.25	1.63	1.94	18.30	16.75
T2	Corespun	2	50	0.32	3.51	4.29	23.81	18.68

Table 2: Constructional parameters of denim

Sample Code	Lycra Percentage	Yarn count (Ne)		Thread density		Crimp (%)		Fabric weight (oz/yd ²)
		Warp	Weft	EPI	PPI	Warp	Weft	
D1	0	9	10.4	70	42	11.8	6.1	11.67
D2	1	9	10.4	69	42	12.4	5.7	9.82
D3	3	9	10.4	71	43	11.9	6.4	10.35
D4	5	9	10.4	70	41	12.5	6.0	10.81

Results and Discussion

Sewing Thread Properties

The dimensional properties, tensile strength and elongation (both single strand and loop method) of the sewing threads are shown in Table 1. It can be observed that the diameter of the corespun thread is higher than the spun polyester thread which is because of the bulkier core sheath structure of the former. The breaking strength of corespun sewing thread both in single strand and loop method is found to be higher than the spun polyester thread. This can be attributed to the presence of stronger filament as a core in the corespun thread. Also the breaking extension of the corespun thread is higher because of the high extensibility of Lycra present in the core. The loop strength of both the threads are higher as compared to their single counterpart because of two threads are present in loop method.

Fabric Constructional Properties and Sewability

The fabric constructional properties are shown in Table 2. The warp and weft count was found to be invariably the same. The slight change in the end and pick spacing from the nominal is because of the differential relaxation behavior of the denims with varying Lycra percentage. The

warp crimps for all the denims were higher than the weft crimps which is because of the more relaxation of the warp threads during the finishing process. The fabric weights lie in a very close range and do not show any specific trend with the Lycra percentage. The sewability parameters of stretch denim such as seam efficiency, seam pucker, seam slippage and needle cutting index; before and after the silicone finish are shown in Table 3.

Seam efficiency

Seam efficiency mainly depends upon the dimensional & surface characteristics of the sewing thread, the tensile behavior of fabrics & sewing thread, the combination of fabric & sewing thread and the machine & process parameters. It can be observed from Table 3 and Fig. 1 that with the increase in Lycra percentage the seam efficiency increases. The increase in seam efficiency with Lycra percentage is because of the higher elasticity and better compatibility of the sewing thread with the denim, which subsequently increases the seam efficiency. This is in accordance with the earlier result (i.e. The higher percentage of Lycra in the denim increases the fabric elasticity and seam performance) obtained by Gurarda and Meric [7].

Table 3: Sewability parameters of stretch denim

Sewing thread type/ property	Denim Fabric							
	Without silicone				With silicone			
T1	D1	D2	D3	D4	D1	D2	D3	D4
Seam efficiency (%)	54.6	59.0	68.3	72.5	48.4	57.2	58.3	66.1
Seam pucker (%)	32.30	18.56	26.91	29.32	27.51	15.39	21.54	25.32
Seam slippage force (Kgf)	~*	8.65	30.12	40.63	12.59	7.05	15.13	22.50
Needle cutting index (%)	6.91	2.73	5.31	6.25	5.21	2.49	4.73	4.99
T2	Without silicone				With silicone			
Seam efficiency (%)	60.8	63.2	75.4	77.9	54.3	61.2	57.5	71.3
Seam pucker (%)	39.23	22.20	28.35	31.33	30.13	17.21	22.17	25.76
Seam slippage force (Kgf)	27.53	6.25	20.15	21.2	11.17	5.14	10.69	9.25
Needle cutting index (%)	7.45	3.19	5.68	7.11	6.93	2.92	4.88	5.75

* indicates no seam slippage at maximum load.

The denim fabrics sewn with corespun sewing threads show higher seam efficiency. This is because of more elastic nature and higher breaking strength of corespun thread

helps in improving the seam efficiency. The silicone finish has a positive effect in the seam efficiency. Fig.1 shows that the seam efficiency of all the denim decreased after

the silicone finish irrespective of the type of sewing thread.

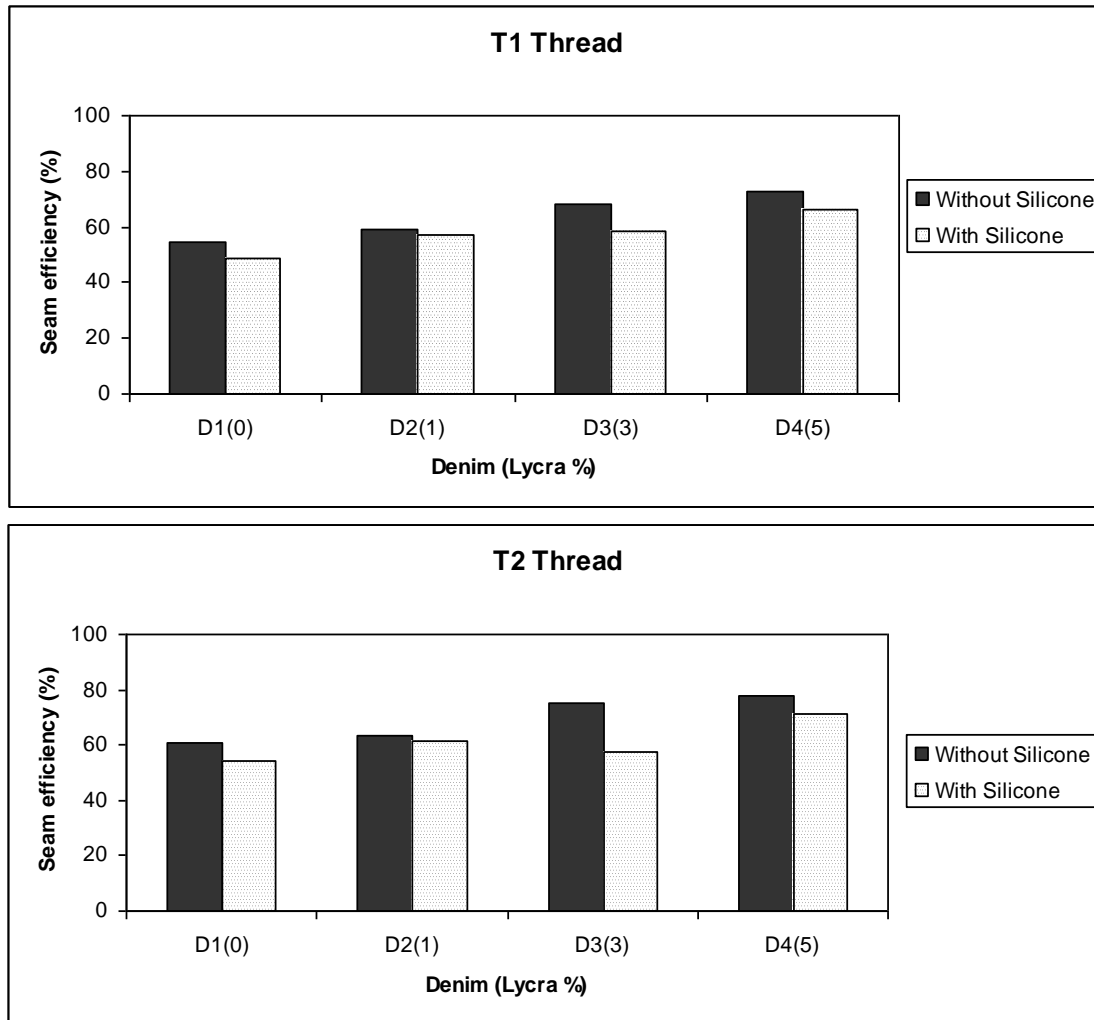


Fig. 1: Effects of Lycra percentage and type of sewing thread on seam efficiency

Seam pucker

Seam pucker refers to the gathering of the seam either just after sewing or after finishing/ laundering causing an unacceptable seam appearance. It can be observed from Table 3 and Fig. 2 that seam pucker shows an increasing trend with the increase in the weight of the fabric rather than Lycra percentage irrespective of the type of sewing thread. The seam pucker is caused by the contractive forces introduced in the seam during stitching [1]. The seam pucker along a seam line starts when these contractive forces exceed the buckling resistance of a fabric at a stitch. The high puckering in case of heavier denim can be attributed to the high contractive force.

It can also be observed that seam pucker is higher when the denims are stitched by corespun sewing thread. This is because of the higher diameter of the corespun thread causes more mechanical restraint and deformation of the yarns in the fabric, when inserted by the needle. The seam pucker decreased in all the fabrics after treated with the silicone. This can be attributed to the reduction in the mechanical restraint in the denim due to silicone finish. The silicone acts as a plasticizer and helps in reducing the differential shrinkage between the fabric and the sewing thread.

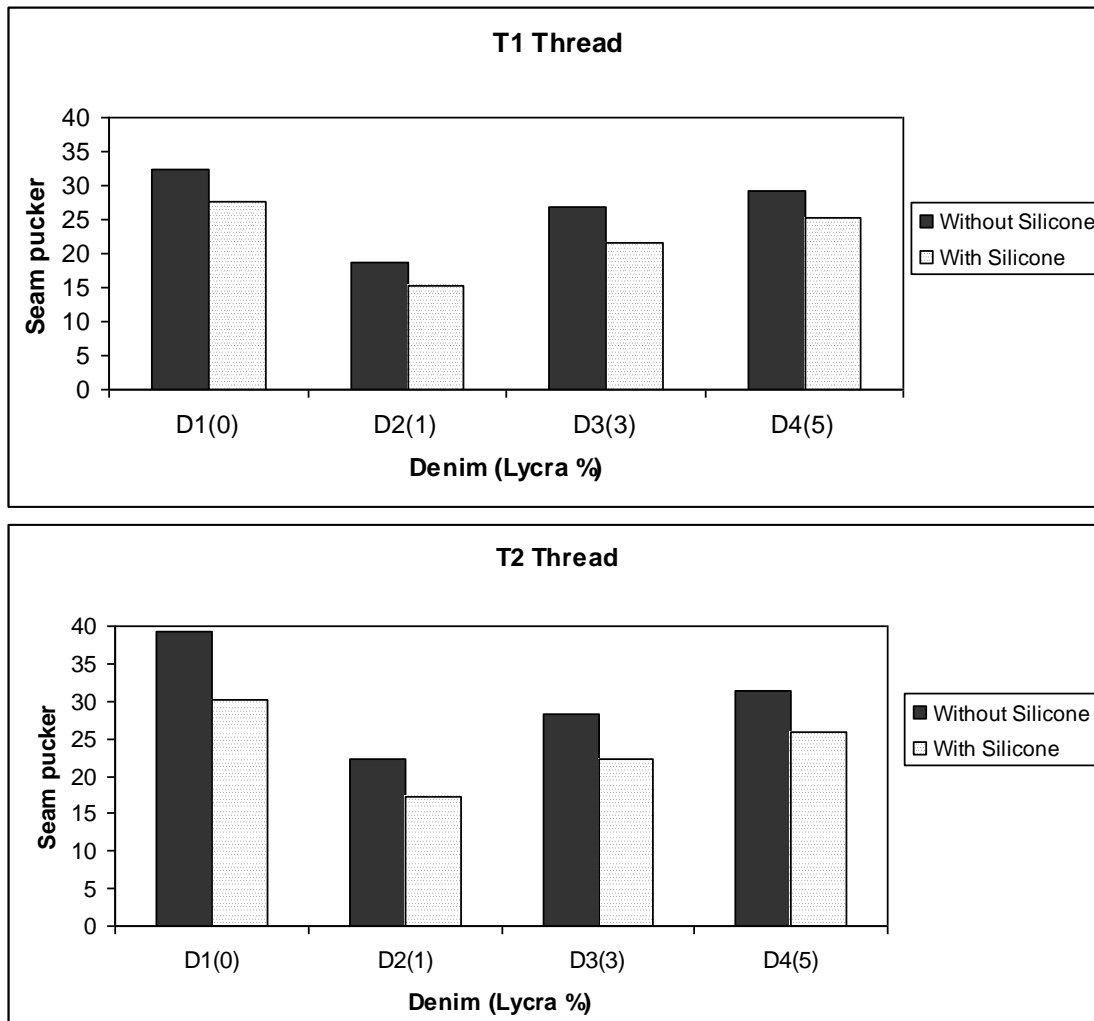


Fig. 2: Effect of Lycra percentage and type of sewing thread on seam pucker

Seam slippage

The seam slippage behavior of denim is shown in Fig. 3. It is indicated by the load required to separate the seam by a certain distance. Higher load indicates the fabric is more resistant to seam slippage or the seam slippage is less. It can be observed that the seam slippage does not follow any specific trend with Lycra percentage or fabric weight. In case of the denim D1 (basic denim) stitched with spun polyester and without silicone finish the seam slippage force is not present (Fig. 3). This indicates there is no slippage at maximum load which may be because of the higher weight of the fabric sample.

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The fabrics sewn with corespun thread showed higher slippage (less force) which can be attributed to the high extensibility of the corespun thread. Also with the spun polyester thread, the seam slippage is lower because of less extensibility and compact structure of the polyester thread. It has also been observed that the application of silicone finish increases the seam slippage which is indicated by lower force. This is because silicone helps in mobilizing the threads and the desired seam opening is achieved at a very less force.

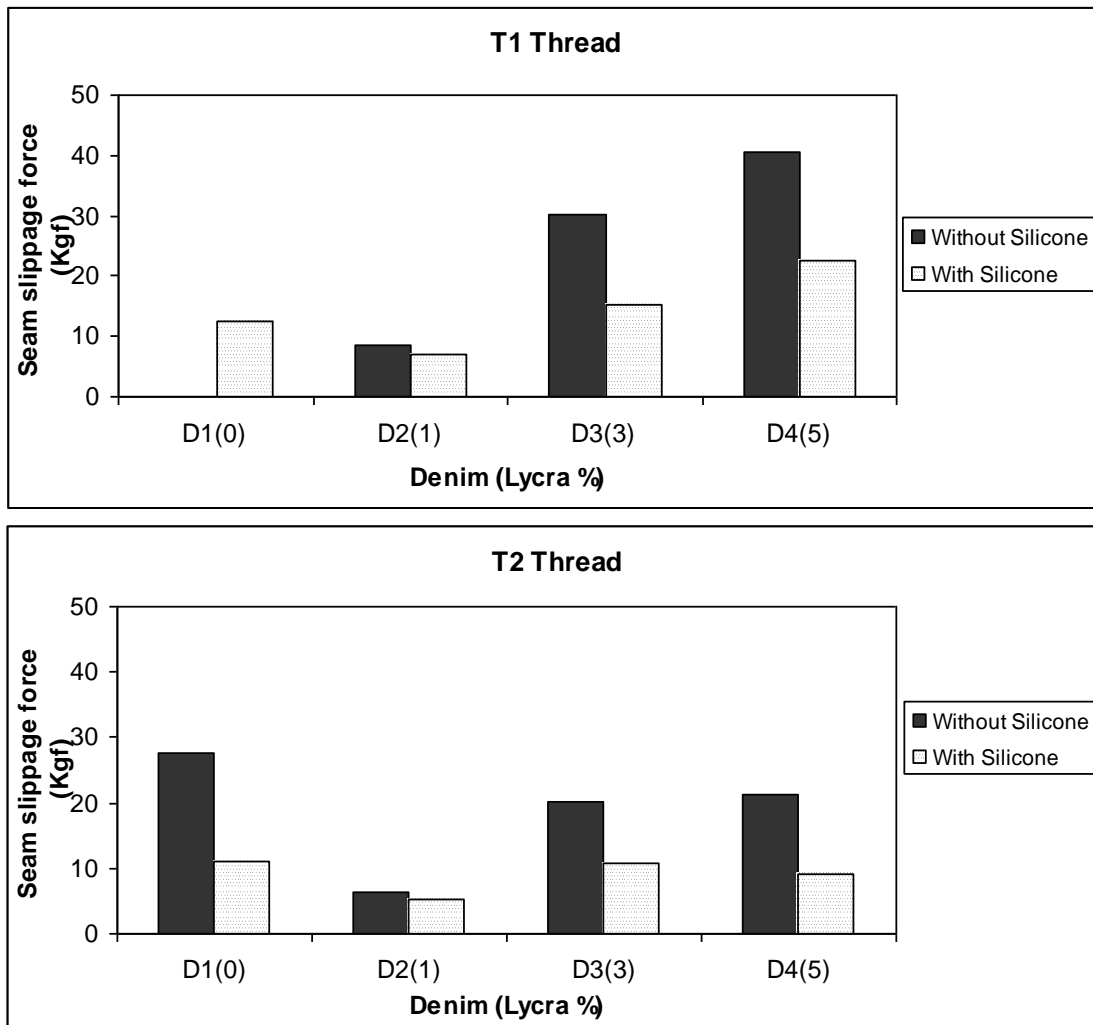


Fig. 3: Effect of Lycra percentage and type of sewing thread on seam slippage

Needle cutting index

The needle cutting index depends on the fabric weave, cover factor, stitch density, thread diameter and surface properties of the thread. Table 3 and Fig. 4 show that the needle cutting index is higher in case of the denims with higher weight. Also as the Lycra percentage increases from 1 to 5 %, the needle cutting index increases. This can be attributed to the voluminous structure of the Lycra yarn which is more complicated inside the fabric structure at interlacing points. Also the more voluminous structure leads to a higher yarn to needle surface contact area and thus a higher frictional force.

The high needle damage of the fabrics sewn

with corespun thread is because of higher thread diameter and more surface friction of corespun thread. It is also observed that silicone finish reduces the needle cutting index values as application of silicone on the denim fabric promotes the seam performance and prevents damage of the fabric by needle action. Also this can be attributed to the slippery surface produced by applying the silicone which helps the fabric threads to move apart when the needle penetrates the fabric. In addition, silicone reduces the coefficient of friction between thread-thread and thread-needle so that needle penetration force is decreased which leads to less seam damage.

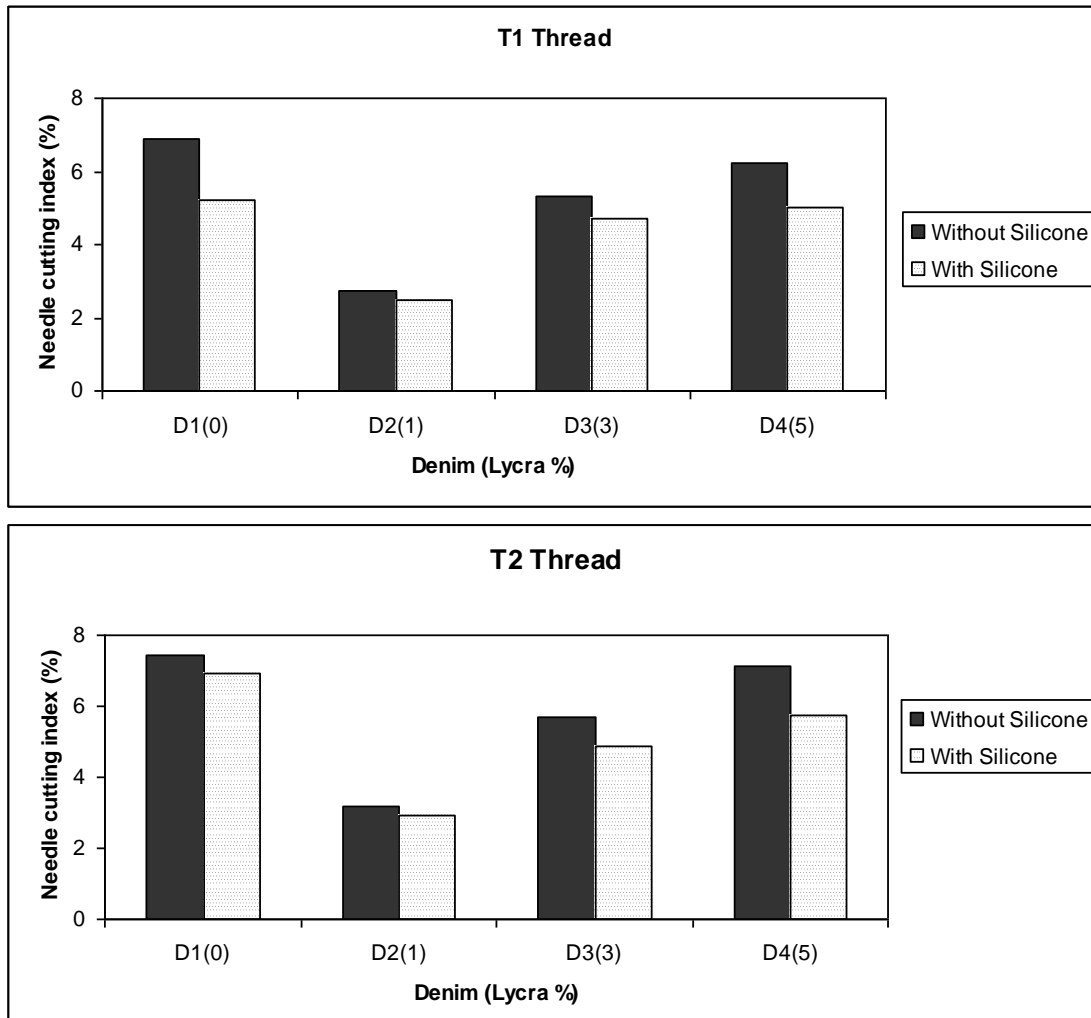


Fig. 4: Effect of Lycra percentage and type of sewing thread on needle cutting index

Conclusions

The effect of Lycra percentage, fabric weight, type of sewing thread and silicone finish on the fabric sewability is very significant. While the seam efficiency increases with Lycra percentage, the seam pucker and needle cutting index increases with the weights of the fabric rather than the Lycra percentage. The seam slippage does not show any specific trend with either of the Lycra percentage or fabric weight. The

Core-spun thread increases the seam efficiency but the seam pucker, seam slippage and needle cutting index are increased. This indicates that the denims should be stitched with coarser spun polyester thread or bit finer corespun thread to achieve good result. The use of silicone finish reduces the seam efficiency, seam pucker and needle cutting index while the seam slippage is increased.

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