

Research Article

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Structural Analysis of Cotton/Lycra Corespun Single Jersey Knitted Fabrics

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Abstract

An attempt has been made to analyze the effect and as well as to gain an insight of changing the loop length of the knitted fabric against non-dimensional parameters such as the loop shape factor during different stages of relaxation using corespun cotton/lycra yarn. The yarn count, machine gauge and machine diameter are kept constant but the loop length is varied. Three different structures (Popcorn, Double Airtex and Honeycomb) at 0.106, 0.118 and 0.129 inches loop length for each structure are produced. This study will help to analyze the relationship between loop length and the non-dimensional parameters like K_c , K_w , S, K_c/K_w .

Statistical analysis is done to analyze if there is any significant change in loop shape factor between different relaxed stages and between different loop lengths in a particular fabric structure.

Keywords: Loop length; Loop shape factor; Core spun yarn; Dry relaxed state; Wet relaxed state; Fully relaxed state

Introduction

Lycra/Cotton garments find numerous applications in knitwear industry and in this study the corespun yarn is used with Lycra in the core and Cotton forming the sheath. The advantage of using corespun (core cover) instead of plaiting technique where cotton and lycra are fed separately is that the loop formation of corespun yarn is better than plaited yarn [1]. The ability of the corespun knitted fabric to maintain the dimensional stability and loop shape factor is studied for three different structures with 3 different loop length and the results are discussed in this study [2-5]. In accordance to Munden [6] the dimensions of the relaxed fabrics in most of the simple weft knitted fabrics are solely determined by the length of yarn in the knitted loop. Munden recognized two relaxed states, namely a Dry relaxed state, taken up after some day's exposure to air and a wet relaxed state, taken up after soaking in water. Nutting [7] has shown that the wet relaxation process is irreversible, but the fabric dimensions depend upon water temperature used for relaxation and the regain of the fabrics when they are measured. The use of single dry or wet relaxed state is not only convenient but a necessary simplification.

As the determination of loop length and dimensional parameters are of prime importance in defining the end use of the knitted fabrics, the present study is the continuation of the earlier studies in this field. So the objective of this research work is to establish the dimensional constants of three samples and to investigate the effect of loop length on non-dimensional parameters in different relaxed states.

Materials and Methods

The experimental part of this study involves corespun yarn having lycra in the core and cotton in the sheath of 30's Ne was purchased from M/s.Arunachala Gounder Textiles, Pallipalayam, Erode district. The yarn count was measured in indirect system and the test results are shown in table 1.

The yarn samples are tested to find unevenness and imperfections on an Uster–UT3 evenness tester using testing speed of 100m/min and time 3 min. The results are shown in table 2.

Preparation of fabric samples

The fabric was knitted on PAI LUNG circular knitting machine. The

machine specifications are given below.

Number of needles: 1800, Machine speed: 15 rpm, Gauge: 24, Cylinder Dia: 24 inches Number of feeders: 72, Model and Make: FS3B and PAI LUNG, Needle type: Latch.

Three types of weft knit structures with three different loop lengths each were produced (Figure 1).

Methodology

Knitted fabrics are similar to woven fabrics in that they are subject to relaxation shrinkage. However, it has been found difficult experimentally to determine when a fabric has reached a totally relaxed

NOMINAL COUNT	Ne 30/1
ACTUAL COUNT	29.98
COUNT CV%	1.07
BLEND	COMBED COTTON/LYCRA
SPANDEX DENIER	40 D
TWIST DIRECTION	Z
COTTON%	93.5
LYCRA%	6.5
Twist Per Metre SINGLE	853

Table 1: Yarn test results.

USTER RESULT									
U%	9.31								
THIN (-50%)	0.8								
THICK (+50%)	11.8								
NEPS (+200%)	21.3								
TOTAL IMPERFECTIONS	33.9								

Table 2: Evenness test result.

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state in which it is in a stable sate with minimum energy. The fabric samples are subjected to the following relaxation treatments and the geometrical properties like wales per inch, course per inch are analyzed after each state of relaxation.

Dry Relaxed State (DRS): The fabric is relaxed in grey state under standard test conditions at 65 ± 2% RH and 27 ± 2°C for two days.

Wet Relaxed State (WRS): This is achieved by subjecting the fabric to static soak with 0.7% wetting agent for one day and the fabric is allowed to relax for at least 3 days.

Heat Setting (HS): The fabric is stretched to the required level and set permanently by passing through the heating and curing chamber at 180°C for 40 seconds.

Bleaching: The fabric is treated with 0.7% wetting agent and to avoid creasing, 0.5% lubricant is added. Stabilizer of 0.3%, Caustic Soda of 3% and Peroxide of 2.5% is added to the sample and the machine is run for one hour at 95°C. After one hour the bath is drained and the machine is run with killer of 0.7% and acetic acid of 1.0% at pH of 6.5 and a temperature of 80°C for half an hour. Killer is used to remove peroxide and acetic acid is used for neutralization.

Dyeing (DY): The recipe for dyeing is Blue EDG of 0.90%, Salt of 1.35 g/l, Soda ash of 20 gms, M:L ratio is 1:8 and the temperature is 65°C. The salt is added to obtain evenness of color throughout the fabric and soda ash is added to fix the color in the fabric.

Compacting (COM): It is done to stabilize the cotton yarn. The samples are compacted at 100°C for 30 seconds. The fabric is subjected to compressive shrinkage in the width direction.

The non directional parameters like K_c (Course constant), K_w (Wales constant), S (Stitch density), K_s (Stitch density constant) and K_c/K_w (Loop shape factor) are calculated as per the formula given below.

 K_c =Course per inch×loop length in inches.

 K_w =Wales per inch×loop length in inches.

S=Course per inch×Wales per inch.

 $K_s = S \times (\text{loop length in inches})^2$.

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Loop shape factor=K_c/K_w.

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Results and Discussions

Relationship between loop length and loop shape factor

It is established from figures 2-6 the loop shape factor (K_c/K_w) for









Figure 4: Loop Length vs Kc/Kw at Heatset Stage.







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each of the samples at different relaxed states reduces with increase in loop length which shows that loop shape is not maintained with increase in loop length. This shows that the fabric undergoes progressive length wise shrinkage, resulting in gradual decrease in course spacing. The analysis also shows that the loop shape factor for Honey comb structure is higher in all relaxed states, which is due to its stabilized structure.

Relationship between loop length and aerial density

From the test results it is observed that the aerial density increases after a sample is subjected to relaxation. This is due to the tendency of the yarn in a loop to try to regain its original shape after each relaxation stages. This is irrespective of the loop lengths and the value is higher in compacting stage because the fabric is subjected to compressive shrinkage in the lengthwise direction.

Relationship between loop length and bursting strength

From the observations it is known that the bursting strength increases after the fabric has completely relaxed because the course and wale density of the sample has increased from dry relaxed stage to compacted stage. But on comparison of the bursting strength in the same state, but with increase in loop length, it showed a reduction because of less stitch density. This trend is same on all samples.

Relationship between loop length and thickness

From the test results it is established that the thickness of the fabric reduces after different relaxation states for a particular loop length, which is due to the yarn attaining the maximum relaxed state of minimum residual energy. But as the loop length is increased the thickness is reduced which is obvious in a grey fabric. But after subsequent relaxation process the thickness is reduced.

Regression analysis

The regression analysis for the relationship between loop shape factor and loop length at different stages of relaxation are made and this is shown in each of the figures 2-6.

Statistical analysis of loop shape factor between loop length and different relaxed states using 2 WAY ANOVA (within structure) at 95% confidence level

Popcorn

Hypothesis 1: There is no significant difference in the loop shape factor between relaxed states.

Hypothesis 2: There is no significant difference in the loop shape factor between loop lengths.

F ratio between relaxed states is 6.3 and F ratio between loop lengths is 21.2 $\,$

The calculated F value for both the conditions was more than the table value and hence both the hypothesis is rejected (Table 3).

The analysis showed that there is significant difference in the loop shape factor between relaxed states and loop lengths which imply that the loop length of the fabric sample is not able maintain its shape regardless of the different relaxation stages which is confirmed by the earlier work of Nutting [8].

Double airtex

Hypothesis 1: There is no significant difference in the loop shape factor between relaxed states.

Popcorn	Popcorn 0.106 inches						0.1	18 inche	es		0.129 inches					
	DRS	WRS	HS	DY	COM	DRS	WRS	HS	DY	COM	DRS	WRS	HS	DY	СОМ	
Wales/ nch	36	38	40	44	48	34	36	38	40	44	32	33	34	36	40	
Course/Inch	62	64	68	70	74	55	56	58	60	64	48	50	52	56	60	
ĸ	3.82	4.02	4.24	4.66	5.09	4.01	4.24	4.48	4.72	5.19	4.13	4.25	4.38	4.64	5.16	
K _c	6.6	6.8	7.2	7.4	7.8	6.5	6.6	6.8	7.1	7.6	6.2	6.5	6.7	7.2	7.7	
S	2232	2432	2720	3080	3552	1870	2016	2204	2400	2816	1536	1650	1768	2016	2400	
K _s	25.1	27.25	30.52	34.48	39.91	26.02	27.98	30.64	33.41	39.18	25.56	27.41	29.34	33.5	39.94	
K _c /K _w	1.720	1.687	1.698	1.592	1.540	1.618	1.557	1.527	1.500	1.455	1.499	1.518	1.530	1.556	1.500	
Aerial density (Gms/square metre)	240	240	247	332	335	251	251	246	316	312	250	250	244	327	333	
Bursting Strength (Kg/cm ²)	6.9	-	-	-	7.0	5.6	-	-	-	6.2	4.7	-	-	-	5.7	
Thickness (mm)	0.62	0.62	0.85	0.83	0.76	0.76	0.76	0.92	0.88	0.77	0.79	0.79	0.98	0.94	0.88	

Table 3: Analysis of geometrical and non directional parameters of Popcorn Structure in different stages.

Double Airtex		0.	106 inch	nes		0.118 inches						0.129 inches					
	DRS	WRS	HS	DY	COM	DRS	WRS	HS	DY	COM	DRS	WRS	HS	DY	COM		
Wales/Inch	32	33	34	36	38	30	31	32	34	36	28	29	30	32	35		
Course/Inch	70	71	72	76	80	60	62	64	68	72	50	51	53	59	65		
ĸ"	3.39	3.49	3.60	3.81	4.03	3.54	3.65	3.77	4.01	4.25	3.61	3.75	3.87	4.12	4.52		
K _c	7.4	7.5	7.6	8.1	8.5	7.1	7.3	7.6	8.0	8.5	6.5	6.6	6.8	7.6	8.4		
S	2240	2343	2448	2736	3040	1800	1922	2048	2312	2592	1400	1479	1590	1888	2275		
K _s	25.15	26.24	27.46	30.63	34.17	25.06	26.68	28.46	32.16	36.13	23.28	24.63	26.43	31.41	37.88		
K _c /K _w	2.189	2.155	2.119	2.113	2.104	1.994	2.003	2.003	2.000	2.000	1.787	1.752	1.765	1.847	1.854		
Aerial density (Gms/square metre	295	295	280	357	348	292	292	279	361	377	288	288	272	321	374		
Bursting Strength (Kg/cm ²)	6.2	-	-	-	7.1	5.0	-	-	-	6.2	4.3	-	-	-	5.4		
Thickness (mm)	1.8	0.98	0.95	0.91	0.9	1.9	1.89	0.97	0.93	0.91	1.96	1.96	1.9	1	0.94		

Table 4: Analysis of geometrical and non directional parameters of Double Airtex structure in different stages.

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Honey Comb		0.1	06 inch	es			0.	118 inch	es		0.129 inches					
	DRS	WRS	HS	DY	COM	DRS	WRS	HS	DY	COM	DRS	WRS	HS	DY	COM	
Wales/Inch	35	36	37	40	44	32	33	34	36	39	28	29	30	32	34	
Coarse/Inch	87	88	89	91	92	75	76	78	81	84	63	65	67	71	75	
ĸ"	3.71	3.81	3.92	4.24	4.66	3.78	3.89	4.01	4.24	4.6	3.61	3.74	3.87	4.12	4.39	
κ _c	9.22	9.32	9.43	9.64	9.75	8.85	8.96	9.2	9.55	9.91	8.13	8.38	8.64	9.15	9.68	
S	3045	3168	3293	3640	4048	2400	2508	2652	2916	3276	1764	1885	2010	2272	2550	
K _s	34.21	35.5	36.96	40.87	45.43	33.45	34.85	36.89	40.49	45.59	29.35	31.34	33.43	37.69	42.5	
K _c /K _w	2.485	2.446	2.406	2.274	2.092	2.341	2.303	2.294	2.252	2.154	2.252	2.241	2.233	2.221	2.205	
Aerial density (Gms/square metre	286	286	295	381	372	290	290	291	391	389	297	297	275	363	393	
Bursting Strength (Kg/cm ²)	6.2	-	-	-	7.1	5.1	-	-	-	6.25	4.3	-	-	-	5.45	
Thickness (mm)	1.87	1.87	1.09	1.07	0.98	1.92	1.92	1.1	1.08	1.04	1.97	1.97	1.11	1.02	1.09	

Table 5: Analysis of geometrical and non directional parameters of Honeycomb structure in different stages.

Hypothesis 2: There is no significant difference in the loop shape factor between loop lengths.

F ratio between relaxed states is 0.45 and F ratio between loop lengths is 99.6

The calculated F value between relaxed state was less than the table value and hence hypothesis 1 is accepted and the calculated F value between loop length was more than the table value and hence hypothesis 2 is rejected. The possibility of significant difference between loop shape factor and relaxed states is due to its complexity of the structure of the sample which is reflected in the increase in loop length against loop shape factor (Table 4).

Honeycomb

Hypothesis 1: There is no significant difference in the loop shape factor between relaxed states.

Hypothesis 2: There is no significant difference in the loop shape factor between loop lengths.

F ratio between relaxed states is 0.19 and F ratio between loop lengths is 1.02

The calculated F value between relaxed state and between loop

lengths was less than the table value and hence both the Hypothesis is accepted. This result shows that there is no significant difference in the loop shape factor between loop lengths and different relaxed states (Table 5). This is due to torsional resistance of the yarn and more balanced structure of the sample.

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