

Investigation of the effect of sewing parameters on the bursting strength of knitted fabrics

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ABSTRACT – REZUMAT

Investigation of the effect of sewing parameters on the bursting strength of knitted fabrics

Knitted fabrics are extensively employed in the textile and apparel industries due to their structural adaptability, favourable mechanical behaviour, and cost-efficient production. Nevertheless, their inherent loop-based architecture renders them susceptible to complex, multidirectional loading conditions, including tensile, compressive, and shear stresses. Bursting strength is considered a more representative mechanical property for evaluating the multidirectional load-bearing capacity of knitted fabrics than the uniaxial tensile strength, which is limited to wale and course directions. Moreover, seam performance under such stresses is influenced by the intricate interaction of fabric structure, stitch configuration, and sewing parameters. This study is a continuation of the previous research. The findings of this study aim to enhance the understanding of seam-fabric interactions and contribute to the optimisation of knitted garment durability and performance. The results indicated that optimal bursting resistance varied depending on fabric type and sewing configuration. Specifically, Interlock fabrics achieved superior bursting strength with chain stitch, 5-step stitch density, Nm 70 needle thickness, and sewing in the loop bar direction. For Lacoste fabrics, the optimal configuration involved lock stitch, 5-step stitch density, Nm 70 needle thickness, and sewing in the seam bar direction. For Single Jersey fabrics, chain stitch, Nm 70 needle thickness, and loop bar direction yielded the most favourable results. Statistical analysis using regression models confirmed that sewing direction, stitch type, and needle thickness statistically significantly affected bursting pressure across all fabric types.

Keywords: knitted fabrics, bursting strength, multiaxial loading, sewing parameters, textile

Analiza efectului parametrilor de coasere asupra rezistenței la rupere a tricotelor

Tricoturile sunt utilizate pe scară largă în industria textilă și de îmbrăcăminte datorită adaptabilității lor structurale, comportamentului mecanic favorabil și producției eficiente din punct de vedere al costurilor. Cu toate acestea, arhitectura lor inerentă bazată pe ochiuri le face susceptibile la condiții de încărcare complexe, multidirecționale, inclusiv solicitări de tracțiune, compresiune și forfecare. Rezistența la rupere este considerată o proprietate mecanică mai reprezentativă pentru evaluarea capacității portante multidirecționale a materialelor tricotate decât rezistența la tracțiune uniaxială, care este limitată la direcția rândului de ochiuri. Mai mult, performanța îmbinării sub astfel de solicitări este influențată de interacțiunea complexă dintre structura tricotelui, configurația cusăturii și parametrii de coasere. Acest studiu este o continuare a cercetării anterioare. Rezultatele acestui studiu își propun să îmbunătățească înțelegerea interacțiunilor cusătură-tricot și să contribuie la optimizarea durabilității și performanței articolelor de îmbrăcăminte tricotate. Rezultatele au indicat că rezistența optimă la rupere a variat în funcție de tipul de tricot și configurația cusăturii. Mai exact, tricotelor Interlock au atins o rezistență superioară la rupere cu cusătura în punct de lăntșor, desimea cusăturii de 5 pași, grosimea acului Nm 70 și coaserea în direcția rândului de ochiuri. Pentru tricotul Lacoste, configurația optimă a implicat cusătura de acoperire, desimea cusăturii în 5 pași, grosimea acului Nm 70 și coaserea în direcția șirului de ochiuri. Pentru tricotelor glat, cusătura în punct de lăntșor, grosimea acului Nm 70 și direcția rândului de ochiuri au dat cele mai favorabile rezultate. Analiza statistică utilizând modele de regresie a confirmat că direcția cusăturii, tipul cusăturii și grosimea acului au afectat semnificativ statistic presiunea de rupere la toate tipurile de tricoteuri.

Cuvinte-cheie: tricoteuri, rezistență la rupere, încărcare multiaxială, parametri de coasere, textil

INTRODUCTION

Knitted fabrics are widely used in the fashion industry due to their versatility in fabric, design, and production methods, supported by technological advancements. Knitted fabrics have gained popularity in the textile and fashion world due to the comfort, functionality, and style alternatives they offer to consumers. The features offered by knitted fabrics, such as drape, flexibility, wrinkle resistance, softness, comfort and ease of care, allow them to be in increas-

ing demand [1–7]. Today, consumers' increasing demand for knitted clothing attracts attention as an attractive market for manufacturers since fabric and clothing production takes place in a short time, with little labour and low production costs [6, 8].

Popular in casual and athletic wear, these garments endure various stresses and tensions during use. During wear, knitted garments are subjected to multidirectional forces, including tensile, compressive, and shear stresses, which can affect their durability

and performance. Therefore, ensuring optimal mechanical properties, elasticity, and resilience is essential to meeting the dynamic demands of body movement, garment functionality, and environmental conditions [9].

Knitted fabrics are widely used in various fields, including fashion and industrial applications, and possess critical physical and mechanical properties that directly impact their performance in these applications. The bursting strength is an essential quality parameter of knit fabric is a key parameter that evaluates the fabric's resistance to multidirectional tensile forces, providing insight into its overall strength and elasticity [10–13]. Knitted fabrics must exhibit adequate mechanical resistance during dyeing and finishing processes and throughout their use and service life, where they are subjected to various external forces [13].

The bursting strength of knitted fabrics is determined by various factors, including raw material composition, pattern configuration, elastomer ratio, and yarn count [14]. Due to knitted fabrics' unique elastic nature, their mechanical behaviour is more accurately evaluated using bursting strength tests rather than conventional tensile tests, which are limited to uniaxial directions and unsuitable for looped structures [1, 15, 16]. Bursting strength testing, involving the application of multidirectional pressure perpendicular to the fabric surface until rupture, offers a reliable assessment of the fabric's resistance to three-dimensional stress and deformation [1, 10, 12]. Stitching, as the primary method of fabric joining in garment production, is a complex process that alters textiles' structural and mechanical behaviour [17–20]. The interaction between stitch parameters and fabric structure affects not only seam integrity but also the garments' overall quality and appearance. Therefore, understanding the structural composition of fabrics is essential for optimising fabric and seam performance [21]. A product's functional performance and seam quality are evaluated based on the structural and mechanical properties of the fabric, the seam parameters reflecting its aesthetic appearance, and the

damage it sustains during use and care. Both the fabric and the seams that join it are subjected to various mechanical stresses throughout the manufacturing process and the product's lifespan, including elongation, bending, stiffness, abrasion resistance, seam shear strength, shrinkage, tightness, thickness, and resistance to washing and dry cleaning [22–26]. The ability of seams to withstand these forces and stresses determines their extensibility, security, durability, appearance, and efficiency, which collectively define seam performance [18].

Research on the bursting strength of sewn fabrics remains limited. Several studies have examined various factors influencing multiaxial seam strength. Yusof investigated the effects of different seam types, sewn with ISO 401 stitch type, on the multiaxial strength of selected woven and knitted fabrics [27]. Kovalova et al. analysed the multiaxial seam strength of automobile seat covers, sewn with a lockstitch, using a self-developed bursting apparatus [28]. Rajput et al. explored the impact of three stitch types, three fabric types, and sewing yarn fineness on the hydraulic bursting strength of knitted fabrics [29]. Yesilpinar examined how different lockstitch techniques affect fabric bursting strength [30].

Additionally, Kara evaluated the influence of various stitch types and their combinations on the seam strength and bursting strength of workwear [31].

Mousazadegan et al. investigated the effects of sewing parameters on seam strength under both unidirectional and multidirectional load conditions. They employed the bursting test to simulate multidirectional loading and compared seam efficiency under bursting force with tensile seam efficiency [32].

MATERIALS AND METHODS

Material

The properties of the 100% cotton knitted fabrics – single jersey, pique, and interlock – used in this study, sourced from Ares Örme, Türkiye, are provided in table 1. Before the sewing process, all fabric samples

Table 1

KNITTED FABRIC CHARACTERISTICS						
Knit face structure	Colour	Fibre content	Knit density		Weight (g/m ²)	Yarn Count (Ne)
			Wales (no./cm)	Courses (rows/cm)		
Single jersey	White	100% Cotton	15	20	150	30/1
	Red	100% Cotton	15	21	150	30/1
	Black	100% Cotton	15	20	150	30/1
Pique	White	100% Cotton	12	18	200	30/1
	Red	100% Cotton	11	18	200	30/1
	Black	100% Cotton	12	18	200	30/1
Interlock	White	100% Cotton	14	16	250	30/1
	Red	100% Cotton	14	16	250	30/1
	Black	100% Cotton	14	16	250	30/1

were conditioned for 24 hours under standard atmospheric conditions, maintaining a temperature of $20 \pm 2^{\circ}\text{C}$ and a relative humidity of $65 \pm 4\%$, to ensure consistency and reliability in testing.

Due to variations in the structural properties of the tested fabrics, such as loop formation, thickness, and weight, the selection of sewing threads and needle sizes was adjusted accordingly to match each fabric's specific characteristics. Sewing machine needles exhibit specific characteristics based on their size and point type. The machine needles used in the study were obtained from Groz-Beckert. The needle sizes used in this research range from Nm 60 to Nm 90, each featuring an FFG/SES (Fine Fabric Gauge / Small Embroidery Scarf) point type. This point type is designed for delicate and lightweight fabrics, ensuring precise stitching and minimal fabric damage. These sizes include Nm 60, Nm 65, Nm 70, Nm 75, Nm 80, and Nm 90, catering to various sewing applications that require accuracy and fabric protection. The sewing threads exhibit specific properties based on their number, tex value, length, strength, and stretch percentage. The sewing threads used in the study were procured from Coats.

The available thread numbers are 150 and 120, with tex values of 24 and 21, respectively. Regarding tensile strength, the 150 thread has an average strength of 980 cN, while the 120 thread possesses a higher strength of 1,190 cN. Additionally, both thread types demonstrate an elongation range between 17% and 22%, ensuring flexibility and durability in various sewing applications. The sewing machines used in this study vary in type and operational speed. All machines belong to the JUKI brand and include three different types: lockstitch, 3-4 thread overlock, and chainstitch. The lockstitch machine operates at a speed range of 1,000 to 4,500 RPM, offering high

precision for straight stitching. The 3-4 thread overlock machine and the chainstitch machine both function within a speed range of 2,860 to 3,450 RPM, ensuring efficiency in seam formation and fabric edge finishing.

METHOD

Sample preparation

For the seam bursting test, fabric samples measuring 15×15 cm were sewn along row and bar lines using two stitch pitch spacings, four needle thicknesses, and four stitch types. The bursting strength tests were conducted using the SDL Atlas M229 Autoburst Bursting Strength Tester by the ISO 13938-1 standard. Single jersey, pique, and interlock fabrics were cut into 15×15 cm swatches to carry out the bursting strength tests. For each fabric, two sets of samples were prepared: one along the lengthwise direction and the other along the widthwise direction. The first set of samples was sewn parallel to the loop bar for each stitch type to assess lengthwise bursting, while the second set was sewn parallel to the loop line for each stitch type to evaluate widthwise bursting. In subsequent analyses, the sample groups are referred to as lengthwise and widthwise for the bursting evaluations. Detailed information regarding the samples is provided in table 2.

FINDINGS

The statistical evaluation of the test results was conducted using the SPSS 26.0 software. Analyses were interpreted within 95% and 99% confidence intervals, considering significance levels of $p < 0.05$ and $p < 0.01$. To assess the bursting strength test data, the Shapiro-Wilk test was applied to examine univariate normality, along with assessments for the distribution

Table 2

STITCHING PARAMETERS FOR FABRIC SAMPLES							
Fabric type	Colour	Width-wise samples pcs.	Length-wise samples pcs.	Needle sizes	Thread number	Stitch classes	Stitch Density (stitch/cm)
Single Jersey	White	32	32	60-65-70-75	150	301-401-504-514	3-5
	Red	32	32	60-65-70-75	150	301-401-504-514	3-5
	Black	32	32	60-65-70-75	150	301-401-504-514	3-5
	Total	192 pieces					
Pique	White	32	32	65-70-75-80	120	301-401-504-514	3-5
	Red	32	32	65-70-75-80	120	301-401-504-514	3-5
	Black	32	32	65-70-75-80	120	301-401-504-514	3-5
	Total	192 pieces					
Interlock	White	32	32	70-75-80-90	120	301-401-504-514	3-5
	Red	32	32	70-75-80-90	120	301-401-504-514	3-5
	Black	32	32	70-75-80-90	120	301-401-504-514	3-5
	Total	192 pieces					
Grand Total		576 pieces					

Note: * Width-wise samples pcs.: Number of samples sewn in parallel to the loop line; ** Length-wise samples pcs.: Number of samples sewn in parallel to the loop bar.

of quantitative variables. Based on the outcomes of these normality tests, non-parametric methods- specifically the Mann-Whitney U test and Kruskal-Wallis test-were employed for variables that did not follow a normal distribution. Furthermore, regression analysis was utilised to investigate causal relationships among the variables. Table 3 presents the descriptive statistical parameters for the fabric types used in the study, providing a comprehensive overview of their structural characteristics.

Table 3 shows that the tested samples' bursting pressure values ranged from 102.5 to 867.8 kPa. The mean bursting pressure was calculated as 335.4±144.7 kPa, with a median value of 303.7 kPa.

Table 4 presents the statistical evaluation of bursting pressure in single jersey fabrics under experimental parameters. Based on fabric colour, no statistically significant difference was observed in bursting pressure ($p>0.05$). Bursting pressure ($p<0.01$) varied significantly according to stitching direction. Samples stitched length-wise exhibited a more significant bursting pressure ($M=362.0$) than those stitched width-wise ($M=20.9$ and $M=203.2$, respectively). This finding implies that the orientation of stitching relative to the fabric's structural axis plays a critical role in its mechanical response under stress, possibly due to fibre alignment and tension distribution. Regarding Stitch Density, bursting pressure showed a statistically significant difference ($p<0.05$). Fabrics sewn with a 5-stitch density demonstrated higher bursting pressure ($M=256.7$) than those with a 3-stitch density ($M=218.6$). Additionally, bursting pressure ($p<0.01$) was significantly influenced by stitch type. Among the stitch types tested, the 4-thread overlock stitch yielded the highest values for bursting pressure ($M=305.5$). This outcome suggests that the structural reinforcement provided by overlock stitching improves single jersey fabric stability under

Table 3		
DESCRIPTIVE STATISTICS ON FABRICS		
Variables	Frequency (N = 576)	Percentage (%)
Knit face structure		
Interlock	192	33.3
Pique	192	33.3
Single jersey	192	33.3
Colour		
White	192	33.3
Red	192	33.3
Black	192	33.3
Knit density		
Wales	288	50
Courses	288	50
Stitch density		
3	288	50
5	288	50
Stitch Classes		
3 Thread Overlock	144	25
4 Thread Overlock	144	25
Chainstitch	144	25
Lockstitch	144	25
Needle sizes		
60	48	8,3
65	96	16.7
70	144	25
75	144	25
80	96	16.7
90	48	8.3
	Avrg.±S.S	Median (Min.-Max.)
Pressure (Kpa)	335.4±144.7	303.7 (102.5-867.8)

Table 4								
COMPARISON OF SINGLE JERSEY FABRICS' BURSTING PRESSURE WITH SEWING PARAMETERS								
Variables	N	Avrg.	Median	S.s	Min.	Max.	H/Z	p
Colour	White	64	261.5	219.7	107.7	111.0	1.892 ^a	0.388
	Red	64	279.6	260.2	107.2	102.5		
	Black	64	260.6	222.8	91.7	114.2		
Stitch type	3 Thread Overlock	48	273.9	260.2	77.9	131.5	61.19 ^a	0.000 ^{**}
	4 Thread Overlock	48	296.8	305.5	98.6	155.0		
	Lockstitch	48	178.2	169.1	58.1	102.5		
	Chainstitch	48	320.0	301.7	107.2	118.0		
Needle Sizes	60	48	247.304	213.4	94.6844	111.8	61.19 ^a	0.000 ^{**}
	65	48	272.79	230.3	113.5544	102.5		
	70	48	290.573	265.35	91.8097	159		
	75	48	258.217	225.55	105.8389	111		
Stitching direction	Length	96	332.7	362.0	99.5	128.6	-8.207 ^b	0.000 ^{**}
	Width	96	201.7	203.2	49.8	102.5		
Stitch density	3	96	253.6	218.6	99.7	102.5	-2.095 ^b	0.036 [*]
	5	96	280.8	256.7	103.7	108.9		

Note: ^a Kruskal-Wallis H, ^b Z; ^{**} $p<0.01$; ^{*} $p<0.05$

Table 5

COMPARISON OF PIQUE FABRICS' BURSTING PRESSURE WITH SEWING PARAMETERS									
Variables		N	Avrg.	Median	S.s	Min.	Max.	H/Z	p
Colour	White	64	267.8	241.9	70.3	178.7	458.2	17.849 ^a	0.000**
	Red	64	316.5	308.1	74.5	138.8	537.1		
	Black	64	290.9	271.0	70.2	203.4	484.9		
Stitch type	3 Thread Overlock	48	235.9	228.0	41.9	178.7	374.4	117.702 ^a	0.000**
	4 Thread Overlock	48	246.9	243.4	29.4	199.2	323.2		
	Lockstitch	48	382.6	379.2	59.1	278.5	537.1		
	Chainstitch	48	301.5	309.5	49.1	138.8	381.6		
Needle Sizes	65	48	303.3	277.2	77.6	210.3	537.1	4.946 ^a	0.176
	70	48	303.6	289.2	74.4	186.1	484.9		
	75	48	282.2	269.9	72.6	138.8	435.6		
	80	48	277.8	257.6	70.0	178.7	464.1		
Stitching direction	Length	96	309.9	297.2	78.3	178.7	537.1	-3.266 ^b	0.001**
	Width	96	273.6	256.0	65.1	138.8	432.1		
Stitch density	3	96	284.1	266.9	62.7	138.8	459.6	-0.652 ^b	0.514
	5	96	299.4	277.2	83.5	184.5	537.1		

Note: ^a Kruskal-Wallis H, ^b Z; ** p<0.01; * p<0.05

multidirectional force. Finally, needle size did not show any statistically significant effect on bursting strength ($p>0.05$), indicating that within the range tested, needle thickness did not substantially affect the bursting behaviour of single jersey fabrics.

Table 5 summarises the statistical analysis results for bursting pressure in piqué fabrics. Bursting pressure ($p<0.01$) was found to vary significantly according to the fabric colour. Among the colour variants tested, red fabrics exhibited the highest bursting pressure ($M=308.1$). In the stitch direction, bursting pressure showed a statistically significant difference ($p<0.01$). Length-wise sewn samples recorded higher bursting pressure ($M=297.2$) than width-wise sewn samples

($M=256.0$). This indicates that the seam orientation of the fabric's structural alignment plays a more critical role in pressure resistance than vertical deformation. Bursting pressure did not exhibit a statistically significant difference based on stitch density ($p>0.05$). Stitch type had a highly significant effect on bursting pressure ($p<0.01$). Fabrics constructed using lock stitch types demonstrated the highest performance, with bursting pressure ($M=379.2$) exceeding those observed in other stitch types. These results emphasise the mechanical advantage of lock stitches in distributing stress across the fabric plane. Finally, no statistically significant difference was observed in bursting pressure based on needle size ($p>0.05$).

Table 6

COMPARISON OF INTERLOCK FABRICS' BURSTING PRESSURE WITH SEWING PARAMETERS									
Variables		N	Avrg.	Median	S.s	Min.	Max.	H/Z	p
Colour	White	64	438.3	381.3	166.1	162.7	841.9	1.233 ^a	0.540
	Red	64	464.1	423.5	174.5	192	867.8		
	Black	64	439.5	376.1	161.1	134.2	758.3		
Stitch type	3 Thread Overlock	48	374.4	328.5	135.4	134.2	646.2	18.060 ^a	0.000**
	4 Thread Overlock	48	446.7	389.2	161.4	232.7	738.6		
	Lockstitch	48	455.2	423.5	146.7	276.4	741		
	Chainstitch	48	512.9	438.3	193.4	246	867.8		
Needle Sizes	70	48	496.5	448.2	176.1	242.0	841.9	23.507 ^a	0.000**
	75	48	473.5	458.0	170.1	236.2	832.3		
	80	48	465.7	429.3	166.1	201.6	867.8		
	90	48	353.8	307.7	115.2	134.2	559.7		
Stitching direction	Length	96	574.8	589.7	136.1	266	867.8	-10.423 ^b	0.000**
	Width	96	319.8	309.9	68.1	134.2	570.6		
Stitch density	3	96	429.313	352.4	160.5418	201.6	786.3	-1.944 ^b	0.052
	5	96	465.404	403.15	172.0303	134.2	867.8		

Note: ^a Kruskal-Wallis H, ^b Z; ** p<0.01; * p<0.05

This indicates that, unlike in interlock fabrics, needle size did not notably impact the structural behaviour of piqué knits under multidirectional stress conditions. Table 6 presents the statistical analysis results for bursting pressure in interlock fabrics. The findings reveal several significant patterns. Firstly, bursting pressure did not exhibit a statistically significant difference based on fabric colour ($p > 0.05$). Colour does not influence the resistance of the fabric to pressure. Concerning stitching direction, bursting pressure demonstrated statistically significant differences ($p < 0.01$). Specifically, length-wise samples recorded higher bursting pressure ($M = 589.7$) than width-wise samples ($M = 24.2$ and $M = 309.9$, respectively). In terms of stitch density, bursting pressure did not differ significantly ($p > 0.05$). The variable of stitch type also showed a statistically significant effect on bursting pressure ($p < 0.01$). Among the stitch types, the chain stitch yielded the highest bursting pressure ($M = 438.3$). These results underline the importance of stitch type selection in optimising fabric performance under multidirectional stress. Finally, needle size had a significant effect on bursting parameters. Bursting pressure ($p < 0.01$) was highest in samples sewn with a size 75 needle, showing values of $M = 25.3$ and $M = 458$, respectively. It suggests that finer needles reduce fabric damage during stitching, enhancing structural durability.

REGRESSION ANALYSIS AND MODEL EVALUATION

Regression analyses were conducted based on the bursting strength data to determine the influence of sewing parameters and optimise them. The regression models were constructed using sewing-related predictors, including needle size, fabric orientation, stitch density, and stitch type. The resulting models for single jersey, pique, and interlock knit fabrics are presented in table 7.

According to the ANOVA test, the regression model developed for single jersey fabric was statistically significant ($F = 76.207$, $p < 0.01$). Examination of the t-test results for model coefficients revealed several significant predictors. Sewing direction significantly affected bursting pressure ($\beta = -131.027$, $p < 0.01$). β values mean that the bursting test of the width-wise fabric samples resulted in 131.027 units of lower bursting pressure compared to length-wise oriented samples. The stitch density was also a significant predictor ($\beta = 27.231$, $p < 0.01$), sewing with a 5 stitch density increased bursting pressure by 27.231 units compared to 3 stitch density. Regarding stitch type, 3-thread overlock stitches significantly reduced bursting pressure compared to 4-thread overlock stitches ($\beta = -22.908$, $p < 0.05$). Lock stitch type also resulted in significantly lower bursting pressure than the 4-thread overlock ($\beta = -118.644$, $p < 0.01$), while chain stitch type contributed to an increase in bursting pressure ($\beta = 23.194$, $p < 0.05$). Needle size, however, was not found to have a statistically significant effect on bursting pressure ($p > 0.05$). The coefficient of

determination for the model was $R^2 = 0.712$, indicating that sewing direction, stitch density, and stitch type can explain approximately 71.2% of the variance in bursting pressure for single jersey fabric.

The model developed for pique fabric was also statistically significant ($F = 75.705$, $p < 0.01$). Key findings from the regression analysis are as follows: Needle size significantly negatively affected bursting pressure ($\beta = -1.959$, $p < 0.01$), suggesting that a 1-unit increase in needle thickness resulted in a 1.959-unit decrease in bursting pressure. Sewing direction was also a significant factor ($\beta = -36.244$, $p < 0.01$), where width-wise fabrics led to 36.244 units lower bursting pressure than length-wise fabrics. Stitch density positively influenced ($\beta = 15.340$, $p < 0.01$); sewing with a 5 stitch density increased bursting pressure by 15.340 units compared to 3 stitch density. Among stitch types, the lock stitch had the most significant positive effect ($\beta = 135.717$, $p < 0.01$), followed by the chain stitch ($\beta = 54.544$, $p < 0.01$), both yielding higher bursting pressures than the 4-thread overlock stitch. In contrast, the 3-thread overlock stitch did not exhibit a statistically significant effect ($p > 0.05$). The model's explanatory power was confirmed with $R^2 = 0.711$, indicating that needle size, fabric orientation, stitch density, and stitch type collectively explained 71.1% of the variation in bursting pressure for pique fabric.

The interlock fabric regression model was highly significant ($F = 112.706$, $p < 0.01$), with more substantial explanatory capability than the previous two fabric types. Needle size had a statistically significant negative effect ($\beta = -7.122$, $p < 0.01$), where an increase in needle size corresponded to a 7.122-unit decrease in bursting pressure. Sewing direction was again a significant determinant ($\beta = -254.935$, $p < 0.01$), with width-wise fabric samples leading to substantially lower bursting pressures than length-wise samples. Stitch density also positively and significantly impacted ($\beta = 36.092$, $p < 0.01$), confirming that a high stitch density contributed to increased bursting strength. The 3-thread overlock stitch was associated with a significant decrease in bursting pressure ($\beta = -72.290$, $p < 0.01$), while the chain stitch significantly increased bursting pressure ($\beta = 66.192$, $p < 0.01$). Interestingly, the lock stitch type did not substantially affect bursting pressure in interlock fabrics ($p > 0.05$). The coefficient of determination for this model was $R^2 = 0.785$, suggesting that the combined predictors explained 78.5% of the variance in bursting pressure, making this the most robust model among the three fabric types.

Optimal seam parameters for 3 fabric types are given in table 8 according to the bursting test results.

CONCLUSION

This study comprehensively investigated the effects of key stitch parameters, including sewing direction, needle size, stitch density, and stitch type, on the bursting strength of single jersey, pique, and interlock

Table 7

REGRESSION ANALYSIS ON THE EFFECT OF SEAM PARAMETERS ON BURSTING PRESSURE										
Fabric type	Variables	Unstan- dardized coeffi- cients	Stan- dardized coeffi- cients	Unstan- dardized coeffi- cients	t	p	Multi- collinear- ity statis- tics	Multi- collinear- ity statis- tics	F	p
Single Jersey	Constant	280.505	49.627		5.652	0.000**			76.207	0.000**
	Needle Sizes	1.010	0.721	0.055	1.402	0.163	1	1		
	Length-wise	-131.027	8.056	-0.642	-16.265	0.000**	1	1		
	Stitch Density [5 Stitches]	27.231	8.056	0.133	3.38	0.001**	1	1		
	Stitch Type [3 Thread Overlock]	-22.908	11.393	-0.097	-2.011	0.046*	0.667	1.5		
	Stitch Type [Lockstitch]	-118.644	11.393	-0.503	-10.414	0.000**	0.667	1.5		
	Stitch Type [Chainstitch]	23.194	11.393	0.098	2.036	0.043	0.667	1.5		
Pique	Constant	399.364	38.559		10.357	0.000**			75.705	0.000**
	Needle Sizes	-1.959	0.523	-0.148	-3.748	0.000**	1	1		
	Length-wise	-36.244	5.843	-0.245	-6.203	0.000**	1	1		
	Stitch Density [5 Stitches]	15.340	5.843	0.104	2.625	0.009**	1	1		
	Stitch Type [3 Thread Overlock]	-10.977	8.263	-0.064	-1.328	0.186	0.667	1.5		
	Stitch Type [Lockstitch]	135.717	8.263	0.796	16.424	0.000**	0.667	1.5		
	Stitch Type [Chainstitch]	54.544	8.263	0.320	6.601	0.000**	0.667	1.5		
Interlock	Constant	1117.006	61.994		18.018	0.000**			112.706	0.000**
	Needle Sizes	-7.122	0.767	-0.316	-9.283	0.000**	1	1		
	Length-wise	-254.935	11.347	-0.766	-22.467	0.000**	1	1		
	Stitch Density [5 Stitches]	36.092	11.347	0.108	3.181	0.002**	1	1		
	Stitch Type [3 Thread Overlock]	-72.29	16.047	-0.188	-4.505	0.000**	0.667	1.5		
	Stitch Type [Lockstitch]	8.473	16.047	0.022	0.528	0.598	0.667	1.5		
	Stitch Type [Chainstitch]	66.192	16.047	0.172	4.125	0.000**	0.667	1.5		

Note: ** p<0.01; * p<0.05; Single Jersey Samples; R=0.844; R²=0.712; Adjusted R²=0.703; Durbin-Watson=1.713; Pique Samples; R=0.843; R²=0.711; Adjusted R²=0.701; Durbin-Watson=1.586; Interlock Samples; R=0.886; R²=0.785; Adjusted R²=0.778; Durbin-Watson=1.861.

Table 8

OPTIMAL SEAM PARAMETERS ACCORDING TO BURSTING TEST RESULTS				
Fabric type	Performance	Needle sizes	Stitch type	Stitch density
Single Jersey	Optimal	Nm 70	Chainstitch	5
Pique	Optimal	Nm 70	Lockstitch	5
Interlock	Optimal	Nm 70	Chainstitch	5

fabrics. The statistical analyses and regression models indicated that sewing direction and stitch type consistently influenced seam performance across all fabric types. In contrast, the effect of needle size varied depending on the fabric structure. Among the models developed, the interlock fabric exhibited the highest explanatory power ($R^2=0.785$). It was observed that samples stitched in the length-wise direction exhibited higher bursting strength than those sewn in the width-wise direction, suggesting that seam direction is critical for load-bearing applications. High stitch density (5 stitch) was associated

with improved seam durability, presumably due to better mechanical stress distribution. Among the stitch types tested, 4-thread overlock and chain stitch constructions provided superior resistance to bursting forces compared to straight and 3-thread overlock stitches. While thinner needles (e.g., size 75) enhanced performance in interlock fabrics, needle size had a limited effect in pique fabrics. These findings underscore the importance of tailoring stitch configurations to the specific properties of each fabric type. Incorporating such fabric-specific optimisation into the garment design and manufacturing process can significantly improve seam integrity and

enhance knitwear's overall performance and durability, particularly in applications subjected to high multidirectional stress.

The findings of this study aim to enhance the understanding of seam-fabric interactions and contribute to the optimisation of garment durability and performance within the textile industry.

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