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Vpliv materiala na kakovost šiva

Izvirni znanstveni članek

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Izvleček

Za raziskavo vpliva materiala na kakovost šiva so bile izbrane tkanina iz bombažnih vlaken, tkanina iz poliestrnih vlaken in tkanina iz regeneriranih celuloznih vlaken (viskoznih vlaken) v vezavi platno. Izmerjene so bile mehanske lastnosti tkanine, med drugim tudi dimenzijska stabilnost. Tkanine smo šivali s spojnim šivom, enkrat in dvakrat pošitim spojnim šivom s sukancem iz 100-odstotne poliestrne oplaščene preje. Po šivanju, likanju, enkratnem, trikratnem, petkratnem in desetkratnem pranju z vmesnimi likanji sta bili izmerjeni pretržna sila šiva in dolžina konture šiva, ki je bila pred šivanjem 50 cm. Raziskava je pokazala, da ima največjo pretržno silo šiva poliestrna tkanina, in sicer po šivanju in posameznih pranjih, najnižjo pretržno silo šiva pa ima tkanina iz regeneriranih celuloznih vlaken. Statistična analiza je pokazala, da število pranj nima pomembnega vpliva na pretržno silo šiva in da so razlike med vrednostmi pretržne sile po posameznih pranjih zgolj naključne. Nasprotno pa je statistična analiza pokazala, da ima vrsta izbranega šiva pomemben vpliv na pretržno silo šiva. Rezultati so pokazali, da je prišlo do največje spremembe dolžine konture šiva pri tkanini iz regeneriranih celuloznih vlaken, ki ima najmanjšo dimenzijsko stabilnost in zato največje krčenje. Statistična analiza je potrdila, da ima število pranj pomemben vpliv na spremembo dolžine konture šiva. Prav tako na spremembo dolžine konture šiva po posameznih pranjih pomembno vpliva vrsta izbranega šiva.

Ključne besede: tkanina, šiv, pretržna sila, dimenzijska stabilnost, kontura šiva

Influence of the material on the seam quality

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Abstract

To explore the influence of material on seam quality, the fabric from cotton yarn, polyester yarn and viscose yarn were chosen for canvas weave. The mechanical properties of fabric and dimensional stability were measured. Fabrics were sewn with superimposed seam 1.01.01 and two types of lapped seams 2.02.03 and 2.02.05 with the polyester sewing thread from core spun yarn. After sewing and ironing and 1-, 3-, 5- and 10-times machine washings with ironings between, the breaking force of the seam and length of the seam were measured. The length of the seam was amounted before sewing 50 cm. The results of the research showed that the highest breaking force of the seam contained fabric from polyester yarn after sewing and after ten washings; meanwhile, the lowest breaking force contained fabric from viscose yarn. Statistical analysis demonstrated that the number of washes did not influence seam strength, which suggests that the differences between the values of breaking force of the seams after more washings occurred by chance. In contrast, the statistical analysis demonstrated that the seam sort significantly influences the breaking force of

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the seam. The greatest changes in seam length were observed in the viscose fabric. Also, viscose fabric has the lowest dimensional stability and greatest shrinkage. Statistical analysis confirmed that the number of washings influences changes in seam length. Additionally, an important influence on changes in seam length after washings was seam sort and type.

Key words: fabric, seam, breaking force, dimensional stability, the seam length

1 Introduction

Aside from its basic function of protecting environmental (weather) influences, garments should also compliment the aesthetical and fashion image of the person wearing the item. With respect to the look and shape of the garments, the fabric is influenced by its mechanical properties.

The quality of the garment is chosen based on the quality of the seam, specifically the seam sort and type, seam strength and behavior while wearing. The seam must have suitable strength and elasticity to sustain loading during wearing and prevent seam breakage or visible damage to the fabric in the seam region. [1]

Based on the extensive nature of these issues, this paper examines the influence of textile material on seam quality.

In this study, the breaking force of three different seams (superimposed and two types of lapped seams), the length of the seam, the dimensional stability of the seam after sewing, machine washings, and with ironings between separate washings on the hand press steam machine, was analyzed .

2 Seam quality

The seam appearance is closely associated with the quality demands of the seam. Seam quality depends on the adjustment of a sewing needle and sewing thread during sewing. The selection of a sewing needle depends on the material type, thickness, mass and textile material weave. A suitable sewing needle and a sewing thread are selected based on the material, which must have an appropriate fineness corresponding to 80-per-

1 Uvod

Oblačilo mora poleg osnovne funkcije, tj. zaščite telesa pred vremenskimi vplivi, zagotoviti estetski in modni videz osebe, ki ga nosi. Na videz in obliko oblačil vplivajo mehanske lastnosti tkanin. Kakovost oblačila se poleg izbrane tkanine kaže tudi preko kakovosti šiva, kar pomeni njegovega videza, trdnosti in obnašanja šiva pri nošenju.

Izdelan šiv mora imeti takšno trdnost in elastičnost, da lahko vzdrži obremenitve in ne pride do pretrga šiva ali vidnih poškodb šivanca v predelu šiva. [1]

Glede na obsežnost problematike proučevanja kakovosti šiva je v okviru prispevka raziskan vpliv vrste materiala na kakovost šiva. Za ta namen so določene pretržna sila treh različnih šivov (spojni šiv, enkrat in dvakrat pošit spojni šiv) in dolžina konture šiva oz. dimenzijska stabilnost šiva po šivanju, enkratnem, trikratnem, petkratnem in desetkratnem pranju z vmesnimi likanji na parni likalni stiskalnici.

2 Kakovost šiva

Videz šiva je tesno povezan s kakovostnimi zahtevami šiva. Kakovost šiva je odvisna od usklajenosti šivalne igle in sukanca ter parametrov šivanja. Izbira šivalne igle je odvisna od vrste, debeline, mase in vezave tekstilnega materiala. Na podlagi vrste materiala, ki ga šivamo, se izbere primerna šivalna igla in nato sukanec takšne finoče, da ustreza 80 odstotkom širine ušesa šivalne igle. Poleg navedenih parametrov mora imeti kakovostno izdelan šiv: [2]

- ustrezne mehanske lastnosti (trdnost šiva, zanesljivost šiva, dimenzijska stabilnost) in
- karakteristične kakovostne zahteve (linija šiva, nabiranje šiva, zdrs niti v šivu).

2.1 Vpliv sukanca in šivanca na kakovost šiva

Kakovost šiva je odvisna od vrste sukanca, njegove surovinske sestave, končne obdelave, konstrukcije in od vrste materiala, ki ga šivamo. Ker gre za širši problem medsebojnega odnosa sukanca in šivanca v procesu šivanja, so v nadaljevanju predstavljene zahteve sukanca in vpliv mehanskih lastnosti šivanca na kakovost izdelanega šiva. [3]

Sukanec kot vezni element med dvema ali več tekstilnimi površinami ima v procesu šivanja pomembno vlogo, ki se nanaša na kakovost sešitega oblačilnega predmeta. Sukanci so glede na svojo surovinsko sestavo, konstrukcijo, finočo različno odporni na obremenitve, ki se razvijejo pri procesu šivanja. Pri tem ima pomembno vlogo površinska obdelava sukanca. Poleg končnih vrednosti, kot sta pretržna sila in pretržni raztezek, so pomembnejše vrednosti pri manjših obremenitvah (viskoelastično področje), ki so značilne za tehnološke procese v tekstilni industriji. [4]

cent of the sewing needle eye width. The following are seam quality parameters: [2]

- *suitable mechanical properties (seam strength, seam security, dimensional stability) and*
- *characteristic quality demands (seam appearance, seam puckering, and slipped yarn on the seam region).*

2.1 Influence of the sewing thread and material on the seam quality

Seam quality depends on the type of sewing thread, its end treatment, construction and material type. Because of the extensive nature of problems associated with sewing thread and material during the sewing process, this paper intended to study the influence of mechanical properties of material on seam quality. [3]

Sewing thread connects elements between two or more plies of the textile material during the sewing process and significantly influences garment quality.

Sewing thread properties are based on their construction, fineness, and loading resistance that occurs during the sewing process. As a result, the end treatment of the sewing thread is extremely important. In addition to the end values, such as breaking force and breaking extension, more important values with lower loads (viscoelastic region) are characteristic of technological processes in the textile industry. [4]

Despite the important influence of mechanical properties of sewing that influence its deformation and seam quality, this paper examines the influence of mechanical properties of material because the sewing process was performed using a minimal sewing velocity (1000 stitches per minute).

Textile materials are an important aspect of making quality garments. Because of the wide selection of fabrics in today's market, the selection of appropriate materials is a difficult task. Knowing the mechanical properties of fabrics is important and enables one to predict possible problems associated with the production process of making garments. [5, 6]

Mechanical properties of the seam and material

Important mechanical properties of the seams are: [2]

Kljub pomembnemu vplivu mehanskih lastnosti sukanca pri šivanju, ki vplivajo na deformacijo sukanca in naprej na kakovost šiva, se bomo v prispevku omejili le na vpliv mehanskih lastnosti šivanca, saj je bilo šivanje izvedeno pri minimalni vbodni hitrosti šivanja (1000 vb/min).

Šivanec ima poleg sukanca pomembno vlogo pri izdelavi kakovostnega oblačila. Izbira ustreznega šivanca je pri širokem izboru materialov (tkanin) v današnjem času pogosto težavna naloga. Zato je pomembno poznavanje mehanskih lastnosti tkanin, na podlagi katerih lahko napovemo vpliv le-teh na kakovost šiva in morebitne težave pri izdelavi oblačil. [5, 6]

Mehanske lastnosti šiva in šivanca

Med pomembnejše mehanske lastnosti šivov sodijo: [2]

- trdnost in elastičnost šiva,
- pretržna napetost in pretržni raztezek,
- odpornost robov proti cefranju,
- odpornost proti zdrsu niti,
- odpornost proti drgnjenju, obrabi in vremenskim vplivom in
- odpornost pri pranju in kemičnem čiščenju.

Trdnost šiva je odvisna od vrste in tipa vboda, vrste in tipa šiva, finoče sukanca, gostote vboda ter padca pretržne napetosti šivanca v predelu šiva, medtem ko je elastičnost šiva odvisna od vrste in tipa vboda, gostote vboda in elastičnosti sukanca, ki mora biti usklajena z elastičnostjo materiala, ki ga šivamo.

Padec pretržne napetosti šivanca v predelu šiva je povezan z velikostjo vbodnih odprtin, ki nastanejo pri šivanju, in s poškodbami šivanca zaradi prebadanja šivalne igle.

Šiv mora biti dovolj trden, da nastale napetosti med nošenjem ne povzročijo deformacij na oblačilnem predmetu. Izdelan šiv mora imeti takšno trdnost in elastičnost, da lahko vzdrži določene obremenitve in se ne pretrga ali da v predelu šiva ne nastanejo vidne poškodbe. [3]

Določanje trdnosti šiva, [7] ki je opredeljena kot pretržna sila šiva, smo izvedli na dinamometru, pri čemer dinamometer zazna pretržno silo, ki je potrebna za pretrg sukanca v najšibkejšem vbodu.

Mehanske lastnosti šivanca smo določali z merilnim sistemom FAST (Fabric Assurance by Simple Testing), s katerim merimo in določamo: [8]

- kompresijske lastnosti ali stisljivosti,
- upogibne lastnosti,
- natezno-elastične in strižne lastnosti in
- dimenzijsko stabilnost tkanin.

Z vidika zagotavljanja kakovosti šiva so pomembne naslednje lastnosti tkanin: [6, 9]

- Natezno-elastične lastnosti, ki vplivajo na obnašanje tkanin pri izdelavi oblačil. Visoka razteznost tkanine privede do težav pri šivanju vzorčastih materialov, nizka razteznost pa se kaže v slabi sposobnosti prilagajanja ukrivljenih oblik šiva in v obliki nabiranja šiva.

- *seam strength and seam elasticity,*
- *breaking force and breaking extension,*
- *resistance of seam edges to unraveling ,*
- *resistance to seam slippage,*
- *resistance to rubbing, wearing out and weather influences and*
- *resistance to the washing and chemical cleaning.*

Seam strength depends on seam and stitch sort and type, fineness of the sewing thread, stitch density, breaking stress decreases the seam region material. Meanwhile, seam elasticity depends on the seam and stitch sort and type, stitch density and sewing thread elasticity, which corresponds to the elasticity of the material during the sewing process.

The decrease in breaking stress in the seam region is dependent on the expansion of stitch holes that appear after sewing because of the sewing needle, which disrupts the yarn of the fabric weave during sewing.

Seam strength must be sufficient, such that stresses accumulated during wearing do not affect deformation of the garment. The seam must sustain loadings that could break the seam or visible damages of fabric near the seam region. [3]

To determine seam strength, which is presented as a breaking force of the seam [7], the CRE (Constant Rate of Extension) dynamometer was used, where the sensor on the dynamometer (upper clamp) perceives the value of breaking force, which is necessary to break the sewing thread at the weakest stitch.

The following mechanical properties of the seam were determined using the FAST measuring system (Fabric Assurance by Simple Testing), which is designed for measuring: [8]

- *compression properties,*
- *bending properties,*
- *extension and shear properties and*
- *dimensional stability of the fabric.*

The important fabric properties are: [6, 9]

- *Extension properties, which influence fabric behavior while making the garment. High values of extension present problems when lying up and such fabrics are easily stretched during lying up. After cutting, relaxation of the cut pieces of fabric results in shrinkage to a smaller size. Low values of extension present problems with molding, produce*

- Upogibna togost je merilo sposobnosti tkanine pri njenem nabiranju v gube in vpliva na videz, pad in obliko načrtovanega oblačila. Togost oz. ohlapnost tkanine vpliva na kakovost izdelanega šiva. Tkanine z nizko upogibno togostjo so nagnjene h gubanju pri šivanju, saj takšna tkanina ni sposobna slediti napetostim, ki nastajajo zaradi všitega sukanca v šivu.
- Strižna togost vpliva na krojenje in šivanje. Tkanine z nizko strižno togostjo so izpostavljene nabiranju šiva pri šivanju, medtem ko se tkanine z visoko strižno togostjo težje preoblikujejo v tridimenzionalno obliko.
- Dimenzijska stabilnost tkanin, ki vpliva na potek tehnoloških procesov izdelave oblačila. Oblačilni deli so med izdelavo izpostavljeni različnim toplotnim učinkom in pogojem vlažnosti, kar se kaže v obliki dimenzijskih sprememb oblačilnih delov. Toplotni učinek lahko povzroči manjše krčenje oblačilnih delov pri fiksiranju ali plisiranju. Kombinacijski učinek toplote in vodne pare pri likanju lahko privede do večjih dimenzijskih sprememb. Pri neusklajenem krčenju tkanine iz šiva (sprememba dolžine konture šiva) prihaja do valovite oblike šiva, nabiranja šiva.
- Debelina tkanine vpliva na nabiranje šiva, še posebno če gre za tanke in fine tkanine.
- Sposobnost oblikovanja je lastnost, ki je ni mogoče neposredno izmeriti, ampak se izračuna na podlagi izmerjenih vrednosti raztezka tkanine in upogibne togosti. Zaradi majhne sposobnosti oblikovanja prihaja do nabiranja šiva, ker se tkanina ni zmožna prilagoditi silam v tkanini, nastalih zaradi sukanca.

Dimenzijska stabilnost šiva in šivanca

Dimenzijska stabilnost tekstilij je definirana kot stabilnost dimenzij pri pranju, likanju in kemičnem čiščenju, tj. stabilnost dimenzij pri delovanju toplote in vlage.

Vlaga oz. voda povzroča relaksacijo, kar pomeni, da se vlakna v preji vrnejo v energijsko ugodnejšo lego. Z odstranitvijo vode (sušenjem) med vlakni v preji ponovno nastanejo torne sile, kar pomeni, da se vlakna vnovič povežejo, kar se kaže v spremembi dimenzij. [10]

V šivu je sprememba dimenzij vezana na spremembo dimenzije sukanca kot veznega elementa in oblike slojev šivanca v šivu. Šivi, ki nastanejo v več fazah, imajo več slojev in so sestavljeni z večjo količino sukanca, so bolj izpostavljeni dimenzijskim spremembam, saj se pri pranju sprostijo napetosti in pride do relaksacije sukanca in v šiv povezanih slojev, ki se kaže v spremembi dimenzije šiva.

Sprememba dimenzij šivanca je odvisna od surovinske sestave, veza ve in napetosti, ki jim je bil izpostavljen šivanec v procesu izdelave.

Dimenzijska nestabilnost se lahko kaže v obliki:

- krčenja in
- raztezanja.

Krčenje tekstilij je zmanjšanje dimenzije pri pranju, likanju in kemičnem čiščenju glede na prvotno dolžino; označuje se z znakom (+) in ga podajamo v odstotkih glede na začetno dolžino preizkušanca.

seam pucker and give difficulties in producing overfed seams.

- *Bending rigidity is the measure of ability the fabric to drape and significantly influence the end look of the made garment. Fabrics with low bending rigidity may exhibit seam pucker and problems during cutting could appear. Also, difficulties in handling fabric on the automated production line occur.*
- *Shear rigidity influences the cutting and sewing process. Fabrics with low shear rigidity may exhibit seam pucker, meanwhile fabrics with high shear rigidity are harder to transform to a three-dimensional shape.*
- *Dimensional stability influences the production process of the garment but primarily the quality of garment after wet processing (washing, ironing, and chemical cleaning). High shrinkage values of the fabric produce problems with garment sizing due to panel shrinking. A high value of hygral expansion can lead to loss of appearance in humid conditions as the fabric increases in dimensions under these conditions. Additionally, seams can also pucker in these conditions, as the sewing thread prevents relative fabric movement.*
- *Fabric thickness influences seam puckering, especially with the use of fine, light and thin fabrics.*
- *Shaping ability is a difficult to measure prop-*

Razteznost oz. podaljšanje tekstilij pri pranju, likanju in kemičnem čiščenju je povečanje prvotne dolžine in se označuje z znakom (–) ter se podaja v odstotkih glede na prvotno dolžino. [11]
Krčenje oz. raztezanje se določi po izrazu:

$$S = \frac{L_0 - L_1}{L_0} \cdot 100\ \% \qquad (1)$$

kjer je:
L_0 – prvotna ali začetna dolžina, v cm,
L_1 – končna dolžina, v cm.
Pri pogoju $L_1 > L_0$ dobimo negativno krčenje oziroma raztezanje.
Dimenzijsko stabilnost šiva sledimo ravno tako z merjenjem šiva pred pranjem in likanjem, kar označimo z L_0, in z vnovičnim merjenjem po pranju in likanju, kar označimo kot L_1. Iz enačbe (1) izračunamo krčenje oz. raztezanje šiva.

3 Statistična analiza

Z analizo sipanja primerjamo sipanje med skupinami in v skupinah ter jo uporabimo, ko želimo primerjati več sipanj hkrati.
Pri analizi sipanja proučujemo vedno le eno lastnost ali pokazatelj lastnosti (pretržno silo šiva), če pa imamo dvojno ali večkratno analizo, pa to isto lastnost ali pokazatelj lastnosti opazujemo po več dejavnikih (na treh tkaninah po več pranjih). S F-porazdelitvijo ugotavljamo, ali sta sipanji med skupinami in v njih (med tkaninami po več pranjih) naključni ali statistično različni.
Proučevali smo vplive naslednjih dejavnikov:
– vpliv izbranih tkanin in števila pranj na pretržno silo šiva,
– vpliv vrste šiva in tkanine na pretržno silo šiva,

Table 1: Table of the two-way analysis of variance

Variability	Degree of freedom	Sum of squares	Mean of the sum of squares	F-distribution
Between groups	$n_{MS} = i - 1$	$A_{MS} = j \sum_{j=1}^{MS} (\bar{x}_{MS_i} - \bar{x})^2$	$s^2_{MS} = \frac{A_{MS}}{i-1}$	$F_{MS} = \frac{s^2_{MS}}{s^2_0}$
Inside groups	$n_{VS} = j - 1$	$A_{VS} = i \sum_{j=1}^{MS} (\bar{x}_{VS_j} - \bar{x})^2$	$s^2_{VS} = \frac{A_{VS}}{j-1}$	$F_{VS} = \frac{s^2_{VS}}{s^2_0}$
Residue	$n_0 = (i-1)(j-1) = N - i - j + 1$	$A_0 = \sum_{j=1}^{n} \sum_{i=1}^{n} (x_{MS_i VS_j} - \bar{x}_{MS_i} - \bar{x}_{VS_j} - \bar{x})$	$s^2_o = \frac{A_o}{N-j+1}$ $N = i \cdot j$	
Sum	$n_S = N - 1$	$A_S = \sum_{j=1}^{n} \sum_{i=1}^{n} (x_{MS_i VS_j} - \bar{x})$	$s^2 = \frac{A_s}{N-1}$	

erty, but it can be calculated from the values of fabric extension and bending rigidity. The low value of shaping ability contributes to seam puckering and the fabric cannot adapt to fabric forces, in which the sewing thread appears in the seam.

Dimensional stability of the seam and sewing material

The dimensional stability of fabrics is defined by the stability of dimensions of fabric with washing, ironing and chemical cleaning.

Humidity or water relaxes the fibers in the yarn causing them to return to the more advantageous energy position. As a result of drying among fibers in the yarn, torsion forces appear, which suggest that the fibers are connected once again, which is observed with the changing dimensions. [10]

In the seam, the changes in dimension are associated with changes in sewing thread dimensions and the shape of fabric plies in the seam region. Seams that appear in more phases, have more plies and are sewn with the higher quality sewing thread are subjected to greater dimensional changes. With the process, the stresses that accumulate during the sewing process result in relaxation of the sewing thread and in the seam connected to fabric plies, which reflect changes in the seam dimensions.

The change in dimension of the fabric depends upon the fabric type, fabric weave and the magnitude of stresses exposed to the fabric during the production process.

Dimension instability could reflect:

- *shrinkage or*
- *stretching.*

The shrinkage of fabric and seams decreases the fabric dimensions with washing, ironing and chemical cleaning based on the prior fabric di-

– vpliv izbranih tkanin in števila pranj na dolžino konture šiva oz. dimenzijsko stabilnost tkanine v šivu,
– vpliv vrste šiva in števila pranj na dolžino konture izdelanega šiva.

Rezultate dvojne analize sipanja zberemo v shemi in s F-testom ugotavljamo pomembnost vpliva posameznih faktorjev na analizirano lastnost (preglednica 1). [12]

Izračunano F-vrednost (F_{izr}) primerjamo s F-vrednostjo (F_{tab}) teoretične porazdelitve v preglednici za statistično zaupanje S = 95 % in za proste stopnje n_{MS}, n_o ter n_{VS}, n_o in preverimo, ali velja ničelna H_0 ali alternativna hipoteza H_1.

Če je sipanje med skupinami približno enako sipanju ostanka ali sipanje v skupinah približno enako sipanju ostanka, potem velja ničelna hipoteza H_0: $s^2_{MS} \equiv s^2_0$ *ali* $s^2_{VS} \equiv s^2_0$.

Če je $F_{izr} \leq F_{tab}$ pri statističnem zaupanju S = 95 % in prostih stopnjah n_{MS}, n_o ali n_{VS}, n_o, pomeni, da velja ničelna hipoteza H_0 (razlike so naključne).

Če je $F_{izr} \geq F_{tab}$ pri statističnem zaupanju S = 95 % in prostih stopnjah n_{MS}, n_o ali n_{VS}, n_o, pomeni, da velja alternativna hipoteza H_1 (razlike so statistično dokazane). [12, 13]

4 Eksperimentalni del

Za raziskave vpliva vrste materiala na kakovost šiva so bile izbrane tri vrste finejših tkanin v vezavi platno, ki se med seboj razlikujejo po surovinski sestavi. To so:

– tkanina z oznako TK1, ki je izdelana iz 100 % bombažnih vlaken,
– tkanina z oznako TK2, ki je izdelana iz 100 % poliestrnih vlaken, in
– tkanina z oznako TK3, ki je izdelana iz 100 % regeneriranih celuloznih vlaken (viskoznih vlaken).

Splošne lastnosti uporabljenih tkanin so podane v preglednici 2, medtem ko je dimenzijska stabilnost tkanin po 1-, 3-, 5- in 10-kratnem pranju in likanju podana v preglednici 3.

V preglednici 4 so podane fizikalne lastnosti analiziranih tkanin po sistemu FAST. [5]

Za šivanje izbranih tkanin je bil izbran sukanec iz 100 % oplaščene preje PES. Lastnosti uporabljenega sukanca so podane v preglednici 5.

Table 2: Basic properties of analysed fabrics

Fabric mark	Mass (gm^{-2})	Fabric density (*yarn/cm*)		Average breaking force (*N*)		Average breaking extension (%)	
		Warp	Weft	Warp	Weft	Warp	Weft
TK1	126	46	37	358.8	349.7	15.7	10.5
TK2	131	66	44	458.4	641.9	37.9	47.8
TK3	121	40	26	328.7	348.8	23.6	19.1

Table 3: Dimensional stability of analysed fabrics after 1-, 3-, 5- and 10-times washings and ironing

Fabric mark	Dimensional stability (%)							
	1-time washing		3-time washing		5-time washing		10-time washing	
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
TK1	–1.4	0.2	–0.8	0.2	–0.5	0.2	–0.5	0.2
TK2	0.4	0.4	0.8	0.4	1.0	0.4	1.6	0.4
TK3	2.6	1.0	5.0	1.0	6.4	2.4	6.0	2.4

Table 4: Physical properties of analysed fabrics

Mechanical properties	Mark	Unit	Direction of testing	Fabric mark		
				TK1	TK2	TK3
Fabric thickness	T2	mm	-	0.377	0.293	0.260
	T1	mm	-	0.218	0.215	0.189
Fabric surface thickness	ST	mm	-	0.159	0.078	0.072
Released surface thickness	STR	mm	-	0.176	0.035	0.090
Bending length	c_1	mm	warp	15.5	8.7	14.2
	c_2	mm	weft	16.4	16.1	13.7
Bending rigidity	B_1	μNm	warp	4.8	0.9	3.3
	B_2	μNm	weft	5.7	5.5	3.0
Extension	ε_5–1	%	warp	0.2	0.9	0.1
	ε_5–2	%	weft	0.2	0.1	0.1
	ε_{20}–1	%	warp	1.0	1.6	0.5
	ε_{20}–2	%	weft	0.6	0.2	0.5
	ε_1–1	%	warp	3.5	3.0	1.8
	ε_1–2	%	weft	2.0	0.6	1.7
	ε_{B5}	%	-	3.3	7.0	6.0
Shaping ability	F_1	mm^2	warp	0.26	0.04	0.09
	F_2	mm^2	weft	0.14	0.05	0.07
Shear rigidity	G	Nm^{-1}	-	38	17	21
Relaxation shrinkage	RS–1	%	warp	0.0	0.1	3.9
	RS–2	%	weft	–2.4	0.0	0.1
Hygral expansion	HE–1	%	warp	4.0	0.1	4.3
	HE–2	%	weft	0.2	0.0	4.1
Weight	W	gm^{-2}	-	132	135	119

mensions. Shrinkage is marked with the sign (+) and is given in percents based on the prior length or dimension of the measured fabric.

Stretching or prolongation of the fabric with washing, ironing and chemical cleaning represents increases relative to prior dimensions and is marked with the sign (–) and given in percents based on the prior length or dimension of the measured fabric. [11]

Shrinkage or stretching is determined with equation 1.

Where is: L_0 – prior length, cm and L_1 – end length, cm. With condition $L_1 > L_0$, the negative shrinkage or stretching is obtained.

Dimensional stability of the seam is assessed by measuring the seam length before washing and ironing, L_0 and once again by measuring the seam length after washing and ironing. From equation (1), the shrinkage or stretching is calculated.

3 Statistical analysis

For statistical analysis, the analysis of variance (ANOVA) was performed. With ANOVA, the variation between groups and variation within groups are compared and used to compare variations

With a one-way ANOVA, one parameter (breaking force) is studied and with two-way analysis of variance, two parameters are followed (breaking force of fabrics after more washings). With F-distribution, the equality of variations between groups and inside the group is calculated.

With statistical analysis, the followed parameters were studied:

- *the influence of chosen fabrics and the number of washings on the breaking force of the seam,*
- *influence of the seam sort and fabric on the breaking force of the seam,*
- *influence of the chosen fabrics and the number of washings on the length of the seam and dimensional stability of fabric in the seam region,*
- *influence of the seam sort and the number of washings on seam length.*

The results of two-way analysis of variance are listed in the scheme. With F-distribution, the significance of influence of parameters on analyzed property is determined (Table 1). [12]

Table 5: Properties of the used sewing thread

Mark		S1
Linear density (*tex*)	Defined	14.7 × 2
	Actual	27.4
Turns per meter (m^{-1})		986
Coefficient of friction (μ)		0.33
Breaking stress ($cNtex^{-1}$)		43.2
Standard deviation ($cNtex^{-1}$)		0.55
Coefficient of variation (%)		5.10
Breaking extension (%)		14.41
Standard deviation (%)		0.61
Coefficient of variation (%)		5.60
Dimensional stability (%)		0.3

Za opredelitev vpliva materiala na kakovost šiva sta bili izbrani dve vrsti oz. trije tipi šivov [14], in sicer:
- spojni šiv, tip šiva 1.01.01,
- enkrat pošit spojni šiv, tip šiva 2.02.03, in
- dvakrat pošit spojni šiv, tip šiva 2.02.05.

Za šivanje je bil uporabljen bazni šivalni stroj BROTHER EXEDRA DB2-B737-913, ki šiva z dvojnim prešivnim vbodom (tip vboda 301) in je opremljen z mehanizmom za spodnji pomik šivanca.

Pogonski del šivalnega stroja je elektromotor z elektronsko regulacijo, ki omogoča nastavitev šivalne igle, avtomatsko zatrjevanje šiva, dviganje in spuščanje šivalne tačke in avtomatski odrez sukanca.

Šivanje je bilo izvedeno pri vbodni hitrosti šivanja 1000 vb/min in dolžini vboda L_V = 2,5 mm s šivalno iglo finosti Nm 70. Pred šivanjem je bila določena optimalna napetost igelnega in lovilčevega sukanca, in sicer za vsako tkanino posebej.

Zašiti preizkušanci dimenzij 700 mm × 350 mm, krojeni v smeri osnove, so bili pri nadaljnji raziskavi uporabljeni za določanje pretržne sile (trdnosti) [7] in dolžine konture šiva po šivanju, likanju, 1-kratnem, 3-kratnem, 5-kratnem in 10-kratnem pranju z vmesnimi sušenji in likanji na parni likalni stiskalnici.

Dolžina konture šiva zašitega preizkušanca je pred likanjem in pranji znašala 50 cm in se je po likanjih in 1-, 3-, 5- in 10-kratnem pranju vnovič izmerila.

Pranje je bilo izvedeno po standardu za postopek pranja in sušenja za preizkušanje tekstilij. [15]

Meritve pretržne sile šiva so bile izvedene na univerzalnem elek-

Calculated F-value (F_{izr}) is compared with the F-value (F_{tab}) of theoretical distribution in the table for statistical confidence S = 95 % and degrees of freedom n_{MS}, n_O and n_{VS}, n_O and the validation of null hypothesis H_0 or alternative hypothesis H_1 have to be confirmed.

If the variations between groups MS (between analyzed fabrics) and within groups VS (each of fabric after more washings) is almost equal to residue variation, O, then the null hypothesis is valid $H_0 : s^2_{MS} \equiv s^2_0$ ali $s^2_{VS} \equiv s^2_0$.

If $F_{izr} \leq F_{tab}$ with statistical confidence S = 95 % and degrees of freedom n_{MS}, n_O or n_{VS}, n_O, the null hypothesis H_0 is valid (differences are coincidental).

If $F_{izr} \geq F_{tab}$ with statistical confidence S = 95 % and degrees of freedom n_{MS}, n_O or n_{VS}, n_O, that alternative hypothesis H_1 is valid (differences are statistical proved). [12, 13]

4 Experimental

Research of the influence of material type on seam quality includes three kinds of thin fabrics in the canvas weave.

The chosen fabrics are:

- *fabric with mark TK1, made from 100 % cotton yarn,*
- *fabric with mark TK2, made from 100 % polyester yarn and*
- *fabric with mark TK3, made from 100 % viscose yarn.*

The basic properties of analyzed fabrics are listed in Table 2 and the dimensional stability of fabrics after machine washings (1-, 3-, 5- and 10-times) and ironings is listed in Table 3.

In Table 4, the physical properties of analyzed fabrics determined with FAST system are listed. [7]

The sewing thread from 100 % PES core-spun yarn was chosen. Properties of chosen sewing thread are listed in Table 5.

To determine the influence of material on seam quality, two sorts and three types of seams were chosen [14]:

- *superimposed seam, sort of the seam 1.01.01,*
- *lapped seam, sort and type of the seam 2.02.03 and*
- *lapped seam, sort and type of the seam 2.02.05.*

tronskem dinamometru INSTRON 6022 pri vpenjalni dolžini preizkušanca 200 mm in hitrosti raztezanja 100 mm/min.
Dobljeni rezultati meritev pretržne sile šiva in dolžine konture šiva so podani kot srednje vrednosti petih meritev.

5 Rezultati

Rezultati raziskave vpliva vrste materiala in vrste šiva na kakovost šiva, tj. pretržne sile šiva in dolžine konture šiva po šivanju, likanju, 1-kratnem, 3-kratnem, 5-kratnem in 10-kratnem pranju z vmesnimi sušenji in likanji, so podani v obliki:

- rezultatov meritev povprečne pretržne sile šiva,
- rezultatov meritev povprečne dolžine konture šiva in
- rezultatov statistične analize.

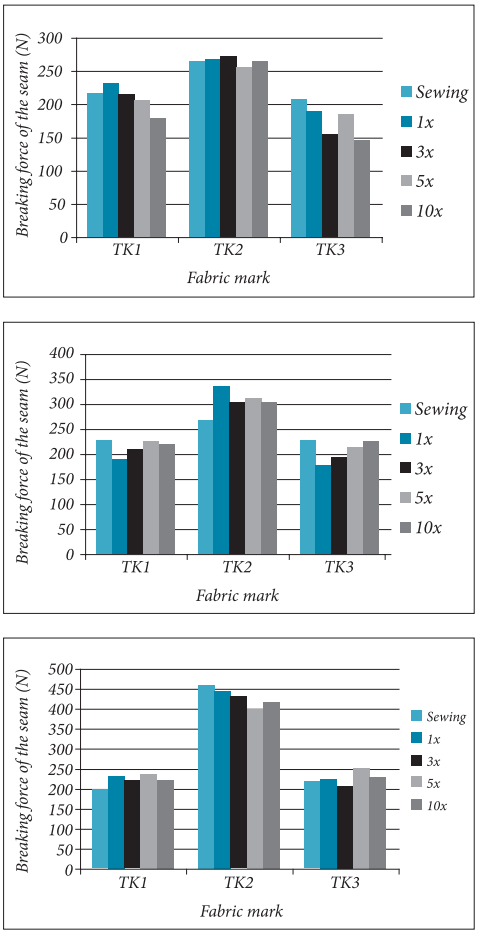

Figure 1: Breaking force of the superimposed seam-1.01.01 (a) lapped seam-2.02.03 (b) lapped seam-2.02.05 (c), produced on the analysed fabrics after sewing, 1-time (1×), 3-times (3×), 5-times (5×), 10-times washings (10×)

Table 6: Results of seam length after sewing, ironing, after 1-, 3-, 5- and 10-times washings and ironings between washings and after 24-hours relaxation

Mark		Stitch length (*mm*)	Seam length before sewing (L_0/*cm*)	Average seam length after ironings and moretimes washings (*cm*)						
Fabric	Seam			After ironing	24-h relaks.	1-time wash.	After ironing	24-h relaks.	3-time wash.	After ironing
TK1	1.01.01	2.5	50	50.1	50.1	48.7	49.1	49.0	49.0	49.4
	2.02.03	2.5	50	50.2	50.0	48.5	49.1	49.0	48.0	49.1
	2.02.05	2.5	50	50.2	50.1	48.5	49.1	49.0	48.0	49.0
TK2	1.01.01	2.5	50	49.8	49.8	49.0	49.1	48.9	49.0	49.4
	2.02.03	2.5	50	50.2	50.1	48.5	49.0	49.2	49.5	49.5
	2.02.05	2.5	50	50.3	50.2	48.7	49.0	48.5	48.0	49.0
TK3	1.01.01	2.5	50	49.9	49.8	47.0	46.0	46.3	48.0	46.5
	2.02.03	2.5	50	49.0	49.1	47.0	48.0	48.0	48.0	46.5
	2.02.05	2.5	50	49.5	49.6	46.0	45.0	45.0	47.5	46.0

Mark		Stitch length (*mm*)	Seam length before sewing (L_0/*cm*)	Average seam length after ironings and moretimes washings (*cm*)						
Fabric	Seam			24-h relaks.	5-time wash.	After ironing	24-h relaks.	10-time wash.	After ironing	24-h relaks.
TK1	1.01.01	2.5	50	49.2	48.7	49.2	49.0	48.7	49.3	49.1
	2.02.03	2.5	50	49.0	48.0	48.5	48.5	48.0	49.1	48.9
	2.02.05	2.5	50	48.8	47.8	49.0	48.6	47.7	48.8	48.5
TK2	1.01.01	2.5	50	49.3	49.2	49.5	49.4	48.8	49.2	49.3
	2.02.03	2.5	50	49.2	47.8	49.2	49.1	47.5	49.0	49.0
	2.02.05	2.5	50	49.0	48.0	49.3	49.2	47.8	49.2	49.0
TK3	1.01.01	2.5	50	46.2	46.0	45.0	45.5	45.0	45.5	45.3
	2.02.03	2.5	50	46.4	45.2	45.3	45.0	45.8	45.7	45.5
	2.02.05	2.5	50	46.0	45.9	45.9	45.7	45.7	45.5	45.5

Basic lock stitch (stitch type 301) sewing machine BROTHER EXEDRA DB2-B737-913 was used for sewing, which is equipped with the bottom feed mechanism.

Driving part of the sewing machine presents an electromotor with electronic regulation, which enables sewing needle placement, automatic backtacking, lifting and leaving the sewing foot and is equipped with automatic thread trimmer.

5.1 Rezultati meritev pretržne sile šiva in dolžine konture šiva

Rezultati meritev pretržne sile šivov, izdelanih na bombažni tkanini (TK1), PES-tkanini (TK2) in tkanini iz regeneriranih celuloznih vlaken (TK3) s sukancem iz oplaščene preje PES, po šivanju, likanju, 1-kratnem, 3-kratnem, 5-kratnem in 10-kratnem pranju so prikazani na sliki 1.

Rezultati meritev dolžine konture šiva po šivanju, likanju, 1-kratnem, 3-kratnem, 5-kratnem in 10-kratnem pranju in vmesnih likanjih so prikazani v preglednici 6 in na sliki 2.

The sewing velocity 1000 stitches per minute was chosen with a stitch length of 2.5 mm and a sewing needle with fineness Nm 70. Before sewing, the optimal tension of the needle and hook thread was chosen for each of the fabrics.

Two plies of the tested material (dimensions 700 mm × 350 mm) were joined together with different seams and cut in the warp direction to determine seam strength [7] and the length of the seam after sewing, ironing, after 1-, 3-, 5-times and 10-times machine washings with drying and ironing on the hand press steam machine between washings.

The seam length of the tested material before ironing and washings was 50 cm and was measured once again after ironing and washing (1-, 3-, 5-, 10-times).

The washing process was performed in agreement with the standard for washing and drying during textile testing. [15]

Measuring the breaking force of the seam was performed using a universal electronic dynamometer INSTRON 6022, with the maximal distance between upper and lower clamp at 200 mm and velocity of the moving of upper clamp at 100 mm/min.

The results obtained from the breaking force of the seam and seam length are depicted as the arithmetical average of five measurements.

Na sliki 2 je podrobneje prikazana sprememba dolžine konture šiva za dvakrat pošit spojni šiv, tip šiva 2.02.05, po likanju, 1-, 3-, 5- in 10-kratnem pranju z vmesnimi likanji na analiziranih tkaninah.

5.2 Rezultati statistične analize

Rezultati statistične analize vpliva vrste tkanine na kakovost šiva, tj. na pretržno silo šiva in dolžino konture šiva, po 1-kratnem, 3-kratnem, 5-kratnem in 10-kratnem pranju in likanju so prikazani v preglednicah od 7 do 12.

6 Razprava

Analiza vpliva vrste tkanine na pretržno silo šiva kaže, da fizikalne lastnosti tkanine pomembno vplivajo na pretržno silo šiva, kar je pokazala tudi statistična analiza (preglednica 7).

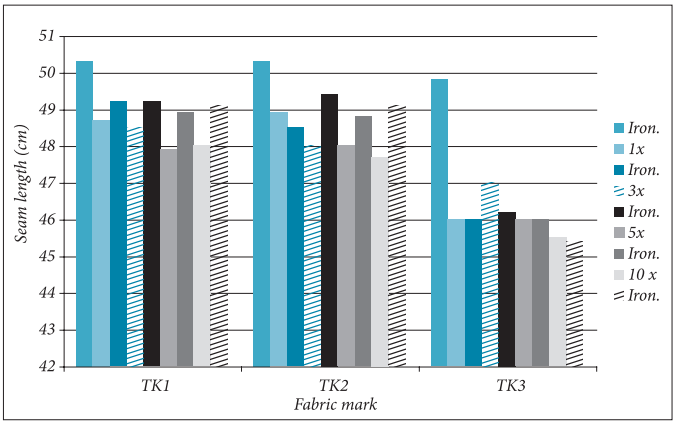

Figure 2: The change of the seam length of the lapped seam, type of the seam 2.02.05, after ironing, 1-, 3-, 5- and 10-times washings with ironings between washings of analysed fabrics

Table 7: Results of the average values for the influence of the fabric and the number of washings on the breaking force of the seam

Number of washings	Fabric sign			Average between fabrics $\bar{x}_{MS_i}$
	TK1	TK2	TK3	
	Breaking force of the seam (N)			
1-time	190.1	335.3	201.2	242.2
3-times	207.9	301.9	192.7	234.2
5-times	225.3	310.7	212.1	249.3
10-times	220.0	301.5	213.8	245.1
Average between washings, $\bar{x}_{VS_j}$	210.8	312.3	204.9	

5 Results

Results examining the influence of material on seam quality were assessed by analyzing the breaking force of the seam and determining the seam length after sewing, ironing, washing (1-, 3-, 5- and 10-times) with drying and ironing between washings are described by:

- *average breaking force of the seam,*
- *measurements of average seam length,*
- *statistical analysis.*

Najvišja pretržna sila je bila izmerjena na poliestrni tkanini (preglednica 2) v smeri osnove (458,4 N) in votka (641,9 N), kar posledično vpliva na pretržno silo izdelanih šivov, ki je na polestrni tkanini (TK2) najvišja po šivanju, likanju in po 1-, 3-, 5- in 10-kratnem pranju z vmesnimi likanji (slika 1).
Statistična analiza je potrdila, da ima vrsta izbranega šiva pomemben vpliv na pretržno silo šiva (preglednica 12), saj je bila pri dvakrat pošitem spojnem šivu 2.02.05 izmerjena najvišja pretržna šiva po šivanju in likanju (458,8 N), po 1-kratnem pranju (443 N), po 3-kratnem pranju (428 N), po 10-kratnem pranju (416 N). Tak šiv vsebuje večjo količino sukanca in ima tako tudi najvišjo pretržno silo, saj nudi večji odpor pri nateznem obremenjevanju kot spojni šiv in enkrat pošit spojni šiv.

Table 8: Sheme of two-way analysis of variance for the influence of fabric (x_{MS}) and the number of washings (x_{VS}) on the breaking force of the seam 2.02.03

Variability	Degree of freedom	Sum of squares	Mean of the sum of squared	F-distribition		Validity of H_0. H_1
				F_{izr}	F_{tab}	
Between fabrics (i = 3)	$n_{MS} = 2$	$A_{VS} = 29163.4$	$s^2_{VS} = 14581.7$	$F_{VS} = \frac{14581.7}{236} = 61.8$	5.1	$F_{izr} \geq F_{tab}$ Valid H_1*
Between number of washings (j = 4)	$n_{VS} = 3$	$A_{MS} = 368.2$	$s^2_{MS} = 122.7$	$F_{MS} = \frac{122.7}{236} = 0.5$	4.8	$F_{izr} \leq F_{tab}$ Valid H_0**
Residue	$n_0 = 6$	$A_0 = 1415.8$	$s^2_0 = 236$			
Sum	$n_S = 11$	$A_S = 30947.4$	$s^2 = 28314$			

** Answer 1: Alternative hypothesis is valid H_1: the differences in the breaking force of the seam between fabrics are statistical proved.*
*** Answer 2: Null hypothesis is valid H_0: the differences in the breaking force of the seam between the number of washings are coincidental.*
**** Influence of the sort of fabric and the number of washings on the breaking force of the seam is shown only for the seam sort 2.02.03, the same validity of the hypothesis is calculated also for the seam sorts 1.01.01 and 2.02.05.*

Table 9: Results of the average values for the influence of the fabric and the seam sort on the breaking force of the seam after 5-times washing

Mark of the seam	Fabric sign			Average between the fabrics. $\bar{x}_{MS_i}$
	TK1	TK2	TK3	
	Breaking force of the seam (N)			
1.01.01 (superimposed seam)	205.2	255.0	184.6	215.0
2.02.03 (lapped seam)	225.3	310.7	212.1	252.7
2.02.05 (lapped seam)	340.4	425.0	258.4	341.1
Average between the seams, $\bar{x}_{VS_j}$	260.0	330.3	218.5	

5.1 Results of measurements of breaking force of the seam and the length of the seam

The measurements of the breaking force of the seam are listed in Figure 1.

Results of the measured length of the seam after sewing, ironing washings (1-, 3-, 5- and 10-

Statistična analiza je pokazala, da so po 1-, 3-, 5- in 10-kratnem pranju razlike v pretržni sili šiva med analiziranimi tkaninami zgolj naključne, to pomeni, da do deset pranj nima pomembnega vpliva na vrednosti pretržne sile šiva (preglednica 8). Obstojnost pri pranju mora biti ena od lastnosti kakovostno izdelanega šiva, ne glede na vrsto in tip šiva.

Table 10: Sheme of two-way analysis of variance for the influence of the fabric (x_{MS}) and seam sort (x_{VS}) on the breaking force of the seam after 5-times washing

Variability	Degree of freedom	Sum of squares	Mean of the sum of squared	F-distribition		Validity of H_0. H_1
				F_{izr}	F_{tab}	
Between fabrics (i = 3)	$n_{MS} = 2$	$A_{VS} = 19185.9$	$s^2_{VS} = 9592.9$	$F_{VS} = \frac{9592.9}{665.6} = 14.4$	6.9	$F_{izr} \geq F_{tab}$ Valid H_1*
Between seams (j = 3)	$n_{VS} = 2$	$A_{MS} = 25154.7$	$s^2_{MS} = 12577.4$	$F_{MS} = \frac{12577.4}{665.6} = 18.9$	6.9	$F_{izr} \geq F_{tab}$ Valid H_1**
Residue	$n_0 = 4$	$A_0 = 2662.4$	$s^2_0 = 665.6$			
Sum	$n_S = 8$	$A_S = 47003$	$s^2 = 5875.4$			

* *Answer 1: Alternative hypothesis is valid H1: the differences in the breaking force of the seam between fabrics after 5-times washing are statistical proved.*

** *Answer 2: Alternative hypothesis is valid H1: the differences in the breaking force of the seam between seams after 5-times washing are statistical proved.*

*** *Influence of the sort of fabric and the seam sort on the breaking force of the seam is shown only for 5-times washing, the same validity of the hypothesis is calculated also for the 1-, 3- and 10-times washing.*

Table 11: Sheme of two-way analysis of variance for the influence of the number of washings and ironings (x_{MS}) and fabric (x_{VS}) on the seam length of the seam 1.01.01

Variability (data from the Table 6)	Degree of freedom	Sum of squares	Mean of the sum of squared	F-distribition		Validity of H_0. H_1
				F_{izr}	F_{tab}	
Between number of washings and ironings (i = 15)	$n_{MS} = 14$	$A_{VS} = 27.9$	$s^2_{VS} = 2.0$	$F_{VS} = \frac{2.0}{0.8} = 2.6$	2.1	$F_{izr} \geq F_{tab}$ Valid H_1*
Between fabrics (j = 3)	$n_{VS} = 2$	$A_{MS} = 61.4$	$s^2_{MS} = 30.7$	$F_{MS} = \frac{30.7}{0.8} = 38.4$	3.9	$F_{izr} \geq F_{tab}$ Valid H_1**
Ostanek	$n_0 = 28$	$A_0 = 21.3$	$s^2_0 = 0.8$			
Sum	$n_S = 44$	$A_S = 110.7$	$s^2 = 2.5$			

* *Answer 1: Alternative hypothesis is valid H1: the differences in the seam length of the seam sort 1.01.01 between washings are statistical proved.*

** *Answer 2: Alternative hypothesis is valid H1: the differences in the seam length of the seam sort 1.01.01 between fabrics are statistical proved.*

*** *Influence of the number of washings and ironings and the sort of fabric on the seam length is shown only for seam sort 1.01.01, the same validity of the hypothesis is calculated also for the seam sorts 2.02.03 and 2.02.05.*

Table 12: Sheme of two-way analysis of variance for the influence of the number of washings and ironings (x_{MS}) and the seam sort (x_{VS}) on the seam length of fabric TK1

Variability (data from the Table 6)	Degree of freedom	Sum of squares	Mean of the sum of squared	F-distribition		Validity of H_0, H_1
				F_{izr}	F_{tab}	
Between number of washings and ironings (i = 15)	$n_{MS} = 14$	$A_{MS} = 17.2$	$s^2_{MS} = 1.2$	$F_{MS} = \frac{1.2}{0.05} = 24.0$	2.1	$F_{izr} \geq F_{tab}$ Valid H_1*
Between seams (j = 3)	$n_{VS} = 2$	$A_{VS} = 1.2$	$s^2_{VS} = 0.6$	$F_{VS} = \frac{0.6}{0.05} = 12.0$	3.3	$F_{izr} \geq F_{tab}$ Valid H_1**
Residue	$n_0 = 28$	$A_0 = 1.4$	$s^2_0 = 0.05$			
Sum	$n_S = 44$	$A_S = 19.8$	$s^2 = 0.5$			

** Answer 1: Alternative hypothesis is valid H1: the differences in the seam length of fabric TK1 between number of washings are statistical proved.*

*** Answer 2: Alternative hypothesis is valid H1: the differences in the seam length of fabric TK1 between the seams are statistical proved.*

**** Influence of the number of washings and ironings and the sort of seam on the seam length is shown only for fabric TK1, the same validity of the hypothesis is calculated also for the fabrics TK2 and TK3.*

times) with ironings between are listed in Tables 6 and Figure 2.

5.2 Statistical analysis

Analysis of the influence of material on seam quality, average breaking force of the seam and seam length after sewing, ironing, and washing (1-, 3-, 5- and 10-times) with ironings between is listed in Tables 7 to 12.

6 Discussion

Analysis of the influence of chosen fabrics on breaking force of the seam demonstrates that the physical properties of fabric significantly affect the breaking force of the seam. This was confirmed by statistical analysis (Table 7).

The highest breaking force was measured on polyester fabric (Figure 1) in the warp (458.4 N) and weft (641.9 N) directions. Breaking force of the seam is consequently the highest on polyester fabric after sewing, ironing and after washing 10-times with ironings between (Figure 1).

Statistical analysis confirmed that the seam sort significantly influences the breaking force of the seam (Table 12). With the lapped seam, with sign 2.02.05, the highest breaking force of the seam was measured after sewing and ironing

Rezultati meritev dolžine konture šiva so pokazali, da je sprememba dolžine konture šiva odvisna od dimenzijske stabilnosti analiziranih tkanin, saj je bila največja sprememba dolžine konture šiva izmerjena pri tkanini TK3, pri kateri znaša dolžina konture po šivanju spojnega šiva 1.01.01 49,9 cm, po 1-kratnem pranju 47 cm, po 3-kratnem pranju 48 cm, po 5-kratnem pranju 46 cm in po 10-kratnem pranju 45 cm (slika 2, preglednica 6). Pri tkanini TK3 je bilo izmerjeno tudi najvišje krčenje, ki je po 1-kratnem pranju v smeri osnove 2,6 % in po desetih pranjih 6 % (preglednica 3).

Po posameznih pranjih prihaja zaradi relaksacije napetosti, ki so se nakopičile v materialu pri šivanju, do spremembe v dolžini konture šiva. Statistična analiza je potrdila, da ima število pranj pomemben vpliv na dolžino konture šiva pri vseh analiziranih tkaninah (preglednica 11, preglednica 12), vendar pa – kot je bilo ugotovljeno – število pranj ne vpliva na pretržno silo šiva.

Dolžina konture šiva se po likanjih, ki sledijo posameznim pranjem, na analiziranih tkaninah poveča, vendar po likanju po 10. pranju prvotne dolžine, 50 cm, pri analiziranih tkaninah ne doseže in se giblje med 45,5 cm in 49,3 cm (preglednica 6). Vzrok je v toplotni obdelavi analiziranih šivov (pranje in likanje), kjer prihaja po pranju do relaksacije in povrnitev vlaken v preji v energijsko ugodnejši položaj, po sušenju se vlakna med seboj ponovno povežejo, in sicer tako, da jih tudi po likanju ne moremo povsem povrniti v začetno dimenzijo, saj toplota in vodna para pri likanju vplivata na delno spremembo dimenzij med likanjem. Takšni rezultati so se pokazali na tkanini iz regeneriranih celuloznih vlaken (TK3) po posameznih likanjih (slika 2), kjer pride do zmanjšanja dolžine konture šiva zaradi velike stopnje krčenja tkanine tudi pri lika-

(458.8 N) and after one washing (443 N), three washings (428 N) and ten washings (416 N). The lapped seam 2.02.05 is sewn with a greater quantity of sewing thread, consequently has the highest breaking force and offers greater resistance with tension loading relative to the superimposed seam 1.01.01.

Statistical analysis has shown that the differences between breaking forces of the seam after 1-, 3-, 5- and 10 washings are random, which suggests that ten washings does not significantly influence the breaking force of the seam (Table 8). The existance with washing is an important property of the quality made seam.

Seam length analysis demonstrates that changes in seam length depend upon the dimensional stability of analyzed fabrics. The highest shrinkage of the seam was measured with fabric TK3 from viscose yarn. After using superimposed seam 1.01.01, the seam length was 49.9 cm. After the first, third, fifth and tenth washing, seam length decreased to 47 cm, 48 cm, 46 cm and 45 cm, respectively (Figure 2, Table 6). With fabric from viscose yarn TK3, the highest shrinkage was measured in the warp direction after the first washing (2.6 %) and after the tenth washing (6 %) in the weft direction (Table 3). Because of the accumulated tension in the material during sewing, relaxation appears, which is seen as the change of the seam length.

Statistical analysis confirmed that the number of washings affected seam length (Table 11, Table 12); additionally, the number of washings did not influence the breaking force of the seam.

The seam length after ironings, which follow separate washings on analyzed fabrics, is increased. After ironing which follows the tenth washing, the seam length was decreased from 50 cm to between 45.5 cm and 49.3 cm (Table 6). We believe that the warm and wet treatments (ironing and washing) of the analyzed seams returns the fibers in the yarn to a more advantageous energetic position. After drying, the fibers are connected together in a manner that would not enable them to the start position after ironing, which influences changes in seam dimensions.

Similar results were demonstrated with seam on viscose fabric (TK3) after separate ironings (Figure 2) where the fabric was unable to reach the initial seam length due to shrinkage. After the tenth washing, the length of the seam

nju, ki sledi 10. pranju. Po 10. pranju je izmerjena vrednost dolžine konture šiva 2.02.05 45,7 cm, po likanju pa je ta vrednost manjša in znaša 45,5 cm (preglednica 6).

Likalna sposobnost tkanin na povečanje dolžine konture šiva po likanju nima velikega vpliva, kajti tudi pri bombažni tkanini, ki se pri pranjih celo razteza, vrednost relaksacijskega krčenja RS-2 je –2,4 % (preglednica 4), po likanjih, ki sledijo, dolžina konture šiva ne naraste bistveno in po 10. pranju ne doseže prvotne dolžine, ki je 50 cm (preglednica 6).

Rezultati analize so pokazali, da prihaja pri dvakrat pošitem spojnem šivu 2.02.05 do večje spremembe dolžine konture šiva glede na spojni šiv 1.01.01, saj prihaja pri izdelavi dvakrat pošitega spojnega šiva do večjega kopičenja napetosti, ki se po posameznih pranjih sprostijo v obliki večje spremembe dolžine konture šiva. Statistična analiza je potrdila pomemben vpliv vrste izbranega šiva na spremembo dolžine konture šiva (preglednica 12).

7 Sklepi

Na podlagi rezultatov analize vpliva vrste tkanine na kakovost šiva, tj. pretržne sile šiva in dolžine konture šiva, lahko zaključimo naslednje:

- Vrsta izbrane tkanine ima pomemben vpliv na pretržno silo šiva, kar je sicer pričakovano.
- Vendar pa so razlike v pretržni sili šiva analiziranih tkanin do desetih pranj zgolj naključne, kar pomeni, da do deset pranj nima pomembnega vpliva na pretržno silo šiva. To velja za vse analizirane šive.
- Dimenzijska stabilnost tkanin pomembno vpliva na spremembo dolžine konture šiva, saj se dolžina konture šiva močno zmanjša po 10. pranju, zlasti pri tkanini iz regeneriranih celuloznih vlaken TK3, ki ima najmanjšo dimenzijsko stabilnost in zato največje krčenje.
- Na spremembo dolžine konture šiva pomembno vpliva tudi vrsta izbranega šiva, saj prihaja pri posameznih pranjih do sprostitve napetosti v šivu. Pri dvakrat pošitem spojnem šivu prihaja do večjega kopičenja napetosti pri izdelavi kot pri enkrat pošitem oz. spojnem šivu.
- Likalna sposobnost uporabljenih tkanin nima večjega vpliva na spremembo dolžine konture šiva po likanju. Tudi po likanjih, ki sledijo posameznim pranjem, zaradi toplotne obdelave dolžina konture šiva ne pride na prvotno vrednost, v nekaterih primerih pa prihaja celo do zmanjšanja dolžine konture šiva.

8 Viri

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2.02.05 (lapped seam) decreased to 45.7 cm and after ironing, the seam length decreased to 45.5 cm (Table 6).

The ironing ability of analyzed fabrics does not influence the growing seam length. After washing fabric from cotton yarn, the value of relaxation shrinkage RS was –2.4% (Table 4). After ironing, the seam length did not increase principally and after the tenth washing, the seam length maintained a value below the starting length of 50 cm (Table 6).

These results demonstrate that a greater change in seam length occurred with the lapped seam 2.02.05 relative to the superimposed seam 1.01.01 because a greater accumulation of stresses after washings occurs with the superimposed seam. Statistical analysis confirmed the influence of seam sort on seam length changes (Table 12).

7 Conclusions

Based on the results of the analysis of influence of the material on the seam quality, it can be concluded that :

- *the fabric type significantly influences the breaking force of the seam, as expected,*
- *the differences between the breaking forces of analyzed fabrics until ten washings only coincidental, which suggests that the ten washings do not significantly influence the breaking force of the seam. This is valid for all analyzed seams;*
- *the dimensional stability of fabrics significantly influences changes in seam length, because the seam length is much lower after the tenth washing, especially with viscose fabric TK3, where the highest shrinkage was measured. Changes in seam length significantly influence the seam type because after washings, the stresses that accumulated in the seam during production were decreased. With lapped seam 2.02.05, greater accumulation of stresses with production relative to the superimposed seam 1.01.01 occurs;*
- *the ironing ability does not influence changes in seam length after ironing, which suggests that after ironings, which follow separate washings, the seam length did not reach the started length. In similar cases, decreases in the seam length occur.*

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