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Primerjalna študija fizikalno mehanskih lastnosti tkanin v vezavah keper in atlas

Izvirni znanstveni članek

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Comparative Analysis of Physical and Mechanical Properties of Fabrics Woven in Twill and Sateen Weaves

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Abstract

The paper deals with the analysis of physical and mechanical properties of fabrics woven in four-end twill and eight-end sateen weaves from the same materials and under the same weaving conditions. The purpose of the analysis was to give insight into these properties, which might help designers in the selection of appropriate weaves to achieve visual as well as physical and mechanical properties of end products required during the use. For the purposes of the research 12 samples of fabrics in seven weaves were designed and woven. The samples were classified into three groups in dependence of the weaving method and constructional parameters. The samples of the first and second group were made on industrial loom with the preset warp density 46 ends/cm and the linear density of the warp 17 × 2 tex. The samples of the first group were woven with the same yarn in the weft, only that the yarn was not sized, and with the weft density 26 picks/cm, whereas the samples of the second group had the linear density of the weft 25 × 2 tex and the weft density 18 picks/cm. The third group was woven on laboratory loom with the warp density 40 ends/cm and the weft density 26 picks/cm

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Izvleček

V prispevku je podana študija fizikalno-mehanskih lastnosti tkanin, izdelanih v vezavah štirivezni keper in osemvezni atlas. Namen študije je bil, da omogoči vpogled v omenjene lastnosti tkanin, izdelanih iz enakih materialov, pri enakih pogojih izdelave in bi bila pomoč pri izbiri primernih vezav za dosego tako vizualnih kot fizikalno-mehanskih značilnosti, zahtevanih pri uporabi. Za potrebe raziskave je bilo načrtovanih in izdelanih 12 vzorcev v sedmih vezavah. Vzorci so bili razdeljeni v tri različne skupine, glede na način izdelave in konstrukcijske lastnosti. Vzorci prve in druge skupine so izdelani na industrijskih statvah z nastavljeno gostoto osnove 46 niti/cm in dolžinsko maso osnove 17 × 2 tex, prva skupina je stkana z enako prejo v votku, le da ni škrobljena, in gostoto votka 26 niti/cm, druga skupina pa ima dolžinsko maso votka 25 × 2 tex in gostoto votka 18 niti/cm. Tretja skupina je stkana na laboratorijskih statvah z gostoto osnove 40 niti/cm in gostoto votka 26 votkov/cm z enako prejo v osnovi in votku 17 × 2 tex. V prvi skupini, ki obsega sedem vzorcev, so bili štirje stkani v vezavi keper (votkovni in obojestranski in njegove lomljene izpeljanke v sosledju), trije pa v vezavah osemvezni atlas (osnovni in dve izvedbi ojačenih atlasov). Tkanini druge skupine sta bili stkani v vezavah navadni in lomljeni keper, tkanine tretje skupine pa v vezavah atlas. V raziskavi so bile izvedene preiskave konstrukcijskih, fizikalnih in mehanskih lastnosti stkanih vzorcev. Ugotovljeno je bilo, da izbira vezave ob preostalih enakih konstrukcijskih parametrih in pogojih izdelave v veliki meri vpliva na fizikalno-mehanske lastnosti tkanin. Industrijsko izdelane tkanine v vezavi keper so dosegale v smeri osnove za več kot 100 N večje pretržne sile kot tkanine v vezavah atlas. V smeri votka so industrijsko izdelane tkanine v vezavi keper dosegale le 45

with the same yarn in the warp and weft 17 × 2 tex. In the first group, which comprised seven samples, four of them were woven in twill weave (weft-faced twill and double-faced twill, and its broken variants in the repeat) and three of them in eight-end sateen (weft-faced sateen and two versions of reinforced sateen). The fabrics of the second group were woven in twill and broken twill weaves, and the fabrics of the third group were woven in sateen weaves. The research included investigations of constructional, physical and mechanical properties of woven samples. It has been found that in the case of identical constructional parameters and weaving conditions the selection of weave considerably affects physical and mechanical properties of fabrics. Industrially manufactured fabrics in twill weave achieved for more than 100 N higher breaking forces in the warp direction than the fabrics woven in sateen weave. In the weft direction, industrially manufactured twill fabrics achieved only 45 N higher strength than the fabrics woven in sateen weave. The breaking elongation of fabrics woven in twill weave was two to two and a half times higher in the warp direction than in the weft direction. Breaking elongations of fabrics in sateen weave in the warp and weft direction only slightly differed; they were of the same order of magnitude. Weaving conditions as well as use of industrial or laboratory looms also affected physical and mechanical properties. Fabrics made under laboratory conditions achieved better mechanical properties than industrially manufactured fabrics, which can be attributed to lower stresses and consequently, smaller damages during the weaving process.
The research can help designers to select appropriate weaves when designing structural patterns (shaft and jacquard fabrics) which will in addition to visual characteristics and effects impart also appropriate physical and mechanical properties to the manufactured fabrics.

Keywords: fabric, twill weave, sateen weave, physical properties, tensile properties of fabrics

N večjo trdnost kot tkanine v vezavi atlas. Pretržni raztezek v smeri osnove pri tkaninah v vezavah keper je bil dva- do dvainpolkrat večji od pretržnega raztezka v smeri votka. Pri tkaninah v vezavi atlas sta se pretržna raztezka v smeri osnove in votka le malo razlikovala; bili sta enakega reda velikosti. Pogoji tkanja, industrijske in laboratorijske statve ravno tako vplivajo na fizikalno-mehanske lastnosti. Tkanine, izdelane v laboratorijih, dosegajo boljše mehanske lastnosti kot industrijsko izdelane, kar gre na račun manjših obremenitev in posledično manjših poškodb med tkanjem. Raziskava lahko pomaga oblikovalcem pri strukturnem vzorčenju (listnih in žakarskih tkanin) izbrati primerne vezave, ki bodo poleg vizualnih značilnosti in efektov omogočile tudi primerne fizikalno-mehanske lastnosti izdelanih tkanin.

Ključne besede: tkanina, vezava keper, vezava atlas, fizikalne lastnosti, natezne lastnosti tkanin

1 Uvod

Tehnologija tkanja je v zadnjem desetletju izjemno močno napredovala na področju priprave za tkanje in tkanja samega, pa tudi pri napovedovanju videza in lastnosti izdelanih tkanin. Sistemi CAD/CAM so se razvili do take stopnje, da je za določene tipe tkanin, kot so žakarske, ki so bile v preteklosti ozko grlo, priprava vzorca in njegova izdelava postala časovno nezahtevna, po kakovosti pa izjemno zanesljiva operacija, ki omogoča številne prednosti, kot so:

- izdelava vzorcev, za katere že imamo naročila, ker so jih že verificirali kupci na podlagi videza,
- olajšano shranjevanje in po potrebi popolna reprodukcija vzorcev oziroma izdelava v časovnih presledkih po željah kupcev,
- možnost tridimenzionalnega ogleda uporabe tkanine,
- hitra zamenjava vzorcev in možnost sodelovanja kupcev pri njihovem oblikovanju [1, 2, 3].

Žal takšni stopnji vizualizacije izdelkov ne sledi ustrezno napovedovanje fizikalno-mehanskih lastnosti surovih in končanih tkanin [4, 5, 6, 7, 8]. Zaradi vse bolj intenzivne, v nekaterih primerih izključne uporabe računalniško podprtih programov pri oblikovanju tkanin se znižuje raven nujno potrebnega znanja o fizikalno-mehanskih lastnostih, ki jih omogočajo posamezne vezave pri strukturnem oblikovanju vzorcev. To pride še bolj do izraza pri kombiniranju različnih vezav v strukturi listnih ali žakarskih vzorcev. Zato je bila izvedena primerjalna študija fizikalno-mehanskih lastnosti tkanin v vezavah keper in atlas z enakimi konstrukcijskimi parametri in pogoji izdelave.
Poznavanje zakonitosti posameznih vezav in s tem poznavanje vpliva na fizikalno-mehanske lastnosti ima velik pomen tudi pri načrtovanju tehničnih tekstilij.

1 Introduction

In the last decade, exceptionally great progress has been made in the weaving technology both in the area of the preparation for weaving and the weaving process itself as well as in the area of predicting visual appearance and properties of woven fabrics. CAD/CAM systems have developed to such a degree that for particular types of fabrics, such as Jacquard fabrics, which represented a bottleneck in the past, designing of patterns and their manufacture has become a time non-consuming and, in terms of quality, extremely reliable operation which offers lots of benefits such as:

- *possibility to manufacture patterns which have been ordered by customers on the basis of their visual appearance,*
- *easier storage and, if necessary, exact reproduction of the patterns, or manufacture in time intervals according to the requirements of customers,*
- *possibility of three-dimensional view of the fabric use,*
- *possibility to quickly change patterns and the possibility of cooperation of customers in the process of pattern designing. [1, 2, 3]*

Unfortunately, predicting of physical and mechanical properties of raw and finished fabrics is far below the level of such visualization [4, 5, 6, 7, 8]. As a consequence of growing and sometimes even exclusive use of computer-aided programs in designing of fabrics, the level of urgently needed knowledge about physical and mechanical properties which can be achieved by selecting particular weaves at structural patterning, has been constantly lowering. This problem is still more obvious when different weaves are combined in the structure of shaft or Jacquard patterns. For this reason a comparative analysis of physical and mechanical properties of fabrics woven in twill and sateen weaves with the same constructional parameters and under the same weaving conditions has been carried out.

To know the principles of individual weaves and, consequently, their influence on physical and mechanical properties of fabrics is highly important also in the area of technical textiles planning.

2 Teoretični del

Vzorčenje tkanin, izdelanih z enako ali različno obarvanimi nitmi, se lahko izvaja v treh oblikah: vzorčenje z barvo, vzorčenje s strukturo in vzorčenje s strukturo in barvo hkrati. Strukturno vzorčenje je tisto, ki omogoča diskretne vizualne efekte in vzorce brez uporabe obarvanih niti [1]. Za strukturno vzorčenje se v posameznih delih vzorca uporabljajo različne vezave, ki se po svojih lastnostih ne smejo preveč razlikovati. Pri večjih razlikah v lastnostih vezav namreč prihaja do različnega stkanja in skrčenja in se bodisi oteži ali onemogoči izdelava (na eni strani pregosta, na drugi preredka tkanina, preveliko pribijanje bila, povečano število napak in pretrgov, problemi s krajci, majhna učinkovitost tkanja) bodisi uporabne lastnosti tkanine niso več primerne (drsenje niti in preveliko flotiranje, vlečenje blaga ter poslabšanje lastnosti pri negi in pranju, nezadostna pretržna sila in raztezek …). Zato se pri strukturnem vzorčenju najpogosteje uporabljajo osnovni in votkovni efekt ene in iste ali zelo podobne vezave. Ker je platno obojestranska vezava, je za strukturno vzorčenje enoslojnih tkanin redkeje primerna, če pa je, je le ob primerni gostoti niti in vdevu v greben, ki upošteva značilnosti drugih vezav, uporabljenih v kombinaciji. Najpogosteje uporabljane vezave za strukturno vzorčenje enoslojnih vezav sta vezavi keper in atlas ter njune izpeljanke.

2.1 Značilnosti keper vezav

Osnovna značilnost keper vezav je, da istovrstne točke tvorijo tako imenovane žarke, ki se lahko gibljejo od leve proti desni ali v nasprotni smeri. Lahko so lomljeni, koničasti, prepleteni ali kakor koli manipulirani. Štirivezni kepri so med kepri zagotovo najpogosteje uporabljeni, v nizu keprov so takoj za triveznim keprom, najmanjšim mogočim – laskasom. Štirivezni kepri se lahko izdelajo v votkovnem, osnovnem ali obojestranskem efektu z desnosmernimi in levosmernimi žarki, ki so lahko lomljeni tudi v sosledju, so kvadratične vezave z dvakratnim prepletanjem na štiri niti. Flotiranje niti je pri obojestranskih keprih za dve niti pri osnovnih/votkovnih pa za tri niti.

Glede na finost osnovnih niti so lahko vdete po dve ali po štiri niti v zob grebena. Zaradi omenjenih lastnosti so izjemno primerni za strukturno vzorčenje. Če naštejemo prednosti, so:

- velika pogostost prepletanja – največja za platnom in laskasom
- velika kompaktnost tkanine; dobre fizikalno-mehanske lastnosti;
- vzorčenje z osnovnim in votkovnim efektom ob enaki ali različni finosti in gostoti osnovnih in votkovnih niti – uporaba različnih prej v osnovi in votku in maksimalno produkcijsko nastavitev statev;
- vzorčenje tudi z obojestranskim videzom – različne smeri žarkov, kombinacija usmerjenega in lomljenega kepra;
- možnost kombinacije s platnom in osemveznim atlasom ob ustrezni nastavitvi, ker so sode kvadratične vezave;

2 Theoretical Part

Patterning of fabrics woven from identically or differently coloured threads can be carried out in the following three ways: by using colour, by using structure, and by using structure and colour at the same time. It is structural patterning, which produces discreet visual effects and patterns without using coloured threads. Structural patterning uses different weaves in particular parts of the pattern, the features of which should not differ considerably [1]. Higher differences in the features of weaves lead to various degree of warp and weft crimp the result of which is either difficult or even impossible manufacture (too dense fabric in one part and too thin in the other part, too high slay beat-up, increased number of defects and breaks, problems with selvedges, low production efficiency) or improper properties of a fabric (slipping of threads and too large floating, stretching of fabric, deterioration of properties during care and washing, insufficient breaking force and elongation…) [9]. This is why the warp and weft effects of one and the same or very similar weave are mostly used in structural patterning. Since plain weave is a double-faced weave, it is less convenient for structural patterning of one-ply fabrics; it is convenient only with appropriate thread count and reeding, which consider the characteristics of other weaves used in the combination. Most frequently used weaves for structural patterning of one-ply fabrics are twill and sateen weaves and their variants.

2.1 Characteristics of Twill Weaves

A basic typical feature of twill weaves is that interlacing points create the so-called rays which can run either from the right to the left or in the opposite direction, from the left to the right. These rays can be broken, conical, interlaced, or manipulated in any other way. Four-end twills are undoubtedly mostly used among twills. In the family of twills they are immediately after the three-end twill, the smallest possible twill called laskas. Four-end twills can be woven in weft-faced, warp-faced or double-faced effect with the rays running to the right or to the left, which can be broken also in the repeat. They have a checkered pattern with two interlacings

- možnost vzorčenja tudi z različno barvo niti – dodatno barvno poudarjeni vzorci ali vzorci raye [10, 11].

2.2 Značilnosti vezav atlas

Osnovna značilnost vezav atlas je, da so osnovnega/votkovnega efekta in da se vezne točke med sabo ne dotikajo. Osemvezni atlasi so takoj za petveznimi (najmanjši atlasi) druga najbolj uporabljana atlasova vezava. Šestvezne izvedenke obstajajo samo v nepravilni obliki, sedemvezni pa se težko kombinira s katero koli drugo vezavo. Pri vzorčenju se najpogosteje kombinirajo sami s sabo (osnovni in votkovni efekt), redkeje pa z drugimi vezavami, če pa se, se kombinirajo s platnom ali štiriveznimi kepri. Osemvezni atlas omogoča bodisi osnovni bodisi votkovni efekt. Težko je primerljiv s štiriveznimi kepri, predvsem zaradi velikosti sosledja (dvakrat večje) in velikosti flotiranja niti (sedem niti). Izdelava ojačenih izpeljank lahko flotiranje v eni smeri skrajšajo skoraj na flotiranje keprov, v drugi pa za eno in dve niti. Če se A 1/7 Z_3 ojači za eno točko v desno, se dobi vezava dušester, ki ima v smeri osnove pogostost prepletanja 4-krat na osem niti (enako kot kepri) in flotiranje za dve in štiri niti zaporedoma, v smeri votka se preplete le dvakrat (enako kot osnovni atlas) in flotira za šest niti. Če se osnovni osemvezni atlas ojači za eno nit k vsaki točki diagonalno, se dobi vezava soley, ki ima tako v smeri osnove kot v smeri votka pogostost prepletanja 4-krat (tako kot kepri) in flotiranje ene in petih niti zaporedoma. Omenili bi samo, da je pri določenih izdelkih, ki se pri naknadnih obdelavah kosmatijo, flotiranje niti eden pomembnejših elementov, s katerimi se uravnavajo debelina, poroznost in termoregulacijske lastnosti tkanin.

Prednosti so:

- možnost tkanja z velikimi gostotami (največjimi gostotami), doseganje največje trdnosti in pokritosti tkanin na račun največjih gostot (fizične razdalje flotiranja se zaradi tega zmanjšajo), doseganje maksimalne pokritosti površin;
- vzorčenje z osnovnim in votkovnim efektom ob enaki ali različni finosti osnovnih in votkovnih niti;
- možnost kombinacije s platnom in štiriveznimi kepri ob ustrezni nastavitvi, ker so sode kvadratične vezave;
- primernost tkanin za eno- ali obojestransko kosmatenje;
- možnost vzorčenja tudi z različno barvo niti, dodatno barvno poudarjeni vzorci ali vzorci raye, tudi majhne čiste vzdolžne ali prečne črte neenakih širin [10, 11].

3 Eksperimentalni del

3.1 Materiali za preiskavo

Za potrebe preiskave je bilo stkanih dvanajst vzorcev v sedmih različnih vezavah. Posamezni vzorci so bili po nekaterih konstrukcijskih parametrih enaki, po drugih pa različni, tako da so lahko oblikovali tri skupine primerjalnih vzorcev. V prvi skupini, ozna-

on four threads. Thread floating of double-faced twills is for two threads, and that of warp-faced and weft-faced twills for three threads.

In dependence of the fineness of warp threads, it is possible to draw-in two or four threads in the reed dent. Due to the mentioned properties, twill weaves are exceptionally suitable for structural patterning. Their advantages are the following:

- *high frequency of interlacing – the highest after plain and laskas weaves – high compactness of fabric – good physical and mechanical properties;*
- *patterning with warp-faced and weft-faced effect with the same or different fineness and densities of the warp and weft threads – use of different yarns in the warp and weft and maximum output setting of loom;*
- *patterning also with a double-faced look – different directions of rays, combination of oriented and broken twill;*
- *possibility of combination with plain weave and eight-end sateen by using proper setting as they have even checkered pattern;*
- *possibility of patterning also with differently coloured yarn – patterns made still more dis-*

čeni kot T1 (tkanine prve skupine), so vzorci pod zaporednimi številkami od 1 do 7, ki so bili stkani v širini 1,6 m na industrijskih statvah Wamatex v tovarni Tekstina Ajdovščina s hitrostjo vnašanja votka 500 v/min. Osnovne niti pri teh vzorcih so bile iz škrobljenega sukanca 17 × 2 tex. Votkovne niti so bile iz enake, vendar neškrobljene preje. Nastavljena gostota osnovnih niti je bila 46 niti/cm, votkovnih pa 26 votkov/cm. Vzorci so se razlikovali samo v vezavi, in sicer so bili prvi štirje stkani v štiriveznih keprih (votkovni/osnovni in obojestranski ter njihova lomljena izvedenka v sosledju), vzorci od 5 do 7 so bili stkani v osemveznem atlasu, osemveznem atlasu, ojačenem za eno nit v desno (dušester) in diagonalno (soley). V drugi skupini, označeni z oznako T2 (tkanine druge skupine), sta samo dva vzorca pod številkama 8 in 9, ki sta konstrukcijsko in izvedbeno enaka vzorcema 1 in 2 iz prve skupine in se od njiju razlikujeta samo v finosti in gostoti votka, ki sta 25 × 2 tex in 18 votkov/cm. Vzorca 8 in 9 sta namenjena za primerjavo z vzorcema 1 in 2 in oceno vpliva spremenjenih konstrukcijskih parametrov v votku na fizikalno-mehanske lastnosti tkanine. V skupino vzorcev T3 (tkanine tretje skupine) smo uvrstili vzorce 10, 11 in 12, ki so stkani v enakih vezavah kot vzorci 5, 6 in 7, le da so izdelani pri gostoti osnove 40 niti/cm, osnovne niti niso škrobljene; izdelani pa so bili v širini 60 cm na laboratorijskih statvah s hitrostjo vnašanja votka 100 v /min. Namen tretje skupine vzorcev je bil, da se primerjalno oceni vpliv spremenjenih konstrukcijskih parametrov (gostota osnove) in škrobljenja ter pogo-

Table 1: Classification of individual fabrics into groups, their numbers and abbreviated marks

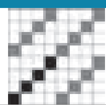
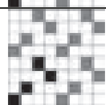
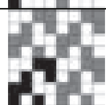
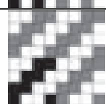
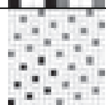
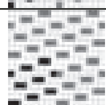
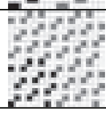
	Group	Weave	Mark			Group	Weave	Mark
1	T1	TWILL 1/3	K 1/3		8	T2	TWILL 1/3	K 1/3
2		BROKEN TWILL 1/3	LK 1/3		9		BROKEN TWILL 1/3	LK 1/3
3		BROKEN TWILL 2/2	LK 2/2					
4		TWILL2/2	K 2/2					
5		SATEEN 1/7	A 1/7		10	T3	SATEEN 1/7	A 1/7
6		DOUCHESTER	OA 1		11		DUCHESTER	OA 1
7		SOLEY	OA 2		12		SOLEY	OA 2

Table 2: Constructional parameters and weaving conditions of investigated samples

	Weave	Mark	Group	d1	d2	Tt 1	Tt 2	Loom	Sizing	Material
				(threads/cm)		(tex)				
1	TWILL 1/3	K 1/3								
2	BROKEN TWILL 1/3	LK 1/3								
3	BROKEN TWILL 2/2	LK 2/2								
4	TWILL2/2	K 2/2	T1		26		17 × 2			
5	SATEEN 1/7	A 1/7		46				industrial	yes	
6	DOUCHESTER	OA 1								100% cotton
7	SOLEY	OA 2				17 × 2				
8	TWILL 1/3	K 1/3	T2		18		25 × 2			
9	BROKEN TWILL 1/3	LK 1/3								
10	SATEEN 1/7	A 1/7								
11	DOUCHESTER	OA 1	T3	40	26		17 × 2	laboratory	no	
12	SOLEY	OA 2								

tinctive by means of colour or raye patterns [10, 11].

2.2 Characteristics of Sateen Weaves

A basic typical feature of sateen weaves is that they have warp-faced/weft-faced effect and that interlacing points do not touch one another. Eight-end sateen is the second most used sateen weave, immediately after five-end sateen (the smallest possible sateen). Six-end variants exist only in irregular form, whereas seven-end sateen can hardly be combined with any oth-

jev izdelave (hitrost vnašanja votka) na lastnosti stkanih surovih tkanin.

Oznake vzorcev in konstrukcijske značilnosti so podane v preglednicah 1 in 2.

3.2 Preiskovalne metode

Na tkaninah so bile izmerjene fizikalne lastnosti, dejanska dolžinska masa preje v tkanini, stkanje in skrčenje, ploščinska masa in debelina tkanine. Vse meritve so bile izvedene skladno s standardom. Izmerjene so bile natezne lastnosti, pretržna sila (Fp) in pretržni raztezek (Ep) prej, izvlečenih iz tkanine, ter pretržna sila (Ft) in pretržni raztezek (Et) tkanin v smeri osnove in votka. Meritve

Table 3: Measured values of constructional and physical properties

		d1	d2	Tt_1	Tt_2	Warp crimp	Weft crimp	Mass	Thickness
		(threads/cm)		(tex)		(%)		(g/m^2)	(mm)
1	TWILL 1/3	47.2	26.4	38.2	32.6	9.9	2.8	282.9	0.512
2	BROKEN TWILL 1/3	47.4	26.5	37.2	32.5	11.9	2.5	287.0	0.532
3	BROKEN TWILL 2/2	47	26	36.6	32.4	9.8	3	284.6	0.497
4	TWILL2/2	47.5	25.8	36.2	33.1	9.1	3.5	278.2	0.508
5	SATEEN 1/7	48	25.3	36.9	32.1	3.2	4	267.4	0.602
6	DOUCHESTER	50.1	26	36.9	32.5	5.3	5.5	282.0	0.557
7	SOLEY	49	24.1	36.7	33.7	5	6.2	275.0	0.612
8	TWILL 1/3	45.9	19.1	36.9	50.3	8.9	1.8	285.0	0.561
9	BROKEN TWILL 1/3	47	19	37.3	48.8	9.1	2.3	285.2	0.559
10	SATEEN 1/7	40.4	26	33.9	33.5	5.8	5.4	250.5	0.703
11	DOUCHESTER	42	26	34.1	34.1	6.8	7.6	258.3	0.706
12	SOLEY	42.4	26	34.3	34.9	5.2	7.6	252.4	0.600

er weave. When designing patterns, one sateen weave is usually combined with another sateen weave (warp-faced and weft-faced effect) and very rarely with other weaves. The only possible combination is with plain and four-end twills. Eight-end sateen can have either warp-faced or weft-faced effect. It can be hardly compared with four-end twills, particularly due the size of repeat (two times higher) and the size of thread floating (7 threads). Reinforced variants can reduce floating in one direction almost to that of twills and for one or two threads in the other direction. By reinforcing A 1/7 Z_3 for

nateznih lastnosti prej in tkanin so bile narejene na dinamometru Instron 5567 po standardu SIST EN ISO 13934.

4 Rezultati

Rezultati meritev dejanskih vrednosti konstrukcijskih (gostota osnove (d1) in votka (d2) ter dolžinska masa osnove (Tt_1) in votka (Tt_2)) in fizikalnih lastnosti (stkanje, skrčenje, ploščinska masa in debelina) so prikazani v preglednici 3. Natezne lastnosti (pretržna sila in pretržni raztezek) prej, izvlečenih iz tkanin ter natezne lastnosti tkanin (pretržna sila in pretržni raztezek) so prikazane v preglednici 4.

Table 4: Tensile properties of threads extracted from fabrics and of fabrics

		Yarn				Fabric			
		Warp		Weft		Warp		Weft	
		Fp1 (cN)	Ep1 (%)	Fp2 (cN)	Ep2 (%)	Ft1 (N)	Et1 (%)	Ft2 (N)	Ft2 (%)
1	TWILL 1/3	817.96	5.54	755.1	4.32	2098	20.58	1076	8.18
2	BROKEN TWILL 1/3	833.38	5.28	754.3	4.24	2166.7	22.85	1111.7	8.08
3	BROKEN TWILL 2/2	812.37	5.18	769.32	4.29	2179.6	19.23	1091.7	8.18
4	TWILL2/2	808.04	5.33	746.12	4.41	2187.3	20.89	1068.3	8.84
5	SATEEN 1/7	851.03	4.41	737.24	4.56	2092.6	10.34	989.48	9.99
6	DOUCHESTER	800.47	5.42	748.7	4.36	1974.5	13.7	1092.8	12.35
7	SOLEY	799.45	5.55	768.54	4.37	2016.9	11.95	1049.9	12.1
8	TWILL 1/3	844.5	5.8	1102.3	4.97	2146	17.77	1111.2	7.78
9	BROKEN TWILL 1/3	836.6	5.67	1089.9	4.88	1935.1	16.07	1083.4	7.93
10	SATEEN 1/7	812.84	5.52	803.43	5.31	1750.3	13.51	1011.5	11.3
11	DOUCHESTER	828.98	5.67	803.82	4.42	1915.6	16.27	1122.8	14.46
12	SOLEY	812.1	5.62	793.91	4.7	1724.4	13.55	1107.9	14.86

one point to the right, Douchester weave is obtained which has the frequency of interlacing in the warp direction four times on eight threads (same as twills) and floating for two and four threads successively. In the weft direction, it interlaces only two times (same as the warp sateen) and floats for six threads. By reinforcing the warp sateen for one thread to each point diagonally, Soley weave is obtained which interlaces four times in both the warp and weft direction (same as twills) and floats for one and five threads successively. It should be mentioned that in the case of certain products, which are raised during subsequent finishing processes, threads floating is one of the most important factors which regulate thickness, porosity and thermoregulation properties of fabrics.

5 Razprava o rezultatih

5.1 Analiza sprememb konstrukcijskih in fizikalnih lastnosti

Iz preglednice 3 in slike 1 je razvidno, da je bila finost osnovnih škrobljenih niti (prvih devet vzorcev) okrog 37 tex, kar pomeni, da se je masa niti zaradi nanosa škroba v povprečju povečala za malo manj kot 10 odstotkov. Pri neškrobljeni osnovi v vzorcih 10, 11 in 12 je bila zelo blizu deklariranim vrednostim 34 tex, kar pomeni, da se zaradi laboratorijskih pogojev tkanja (minimalne napetosti) ni raztegnila in ni spremenila svoje finosti. Enako velja za finost votka iz laboratorijsko stkanih vzorcev. Ne velja pa za finost votka pri industrijsko stkanih vzorcih, kjer se je finost zaradi velikih napetosti in deformacij pri vnašanju votka zmanjšala z deklariranih 34 tex na okrog 32,5 tex.

Gostota osnovnih niti se je v vseh primerih povečala glede na nastavljeno gostoto, kot je bilo pričakovati, največ pri vzorcih 5, 6 in

The advantages of sateen weaves are the following:

- possibility of weaving with high densities (the highest possible densities), maximum fabric strength and coverage due to the highest densities (as a result, physical distances of floating become shorter), maximum surface coverage;
- patterning with warp-faced and weft-faced effect with the same or different fineness of the warp and weft threads;
- possibility of combinations with plain and four-end twills by using a suitable setting because they have even checkered patterns;
- suitability of fabrics for one-sided or double-sided raising;
- possibility of patterning with a different thread colour to achieve more distinctive patterns by means of colour or raye patterns, and also small, clear longitudinal or transversal stripes of unequal width [10, 11].

3 Experimental Part

3.1 Materials

Twelve samples in seven different weaves were woven for the purposes of the research. As individual samples were identical in some constructional parameters but different in others, they were classified into three comparative groups. The first group marked T1 (fabrics of the first group) contained samples No. 1 to 7 which were woven in the width of 1.6 m on industrial looms Wamatex in the factory Tekstina Ajdovščina with the weft insertion rate 500 p/min. Warp threads used in these samples were made of sized yarn 17 × 2 tex. Weft threads were of the same, but unsized yarn. The warp threads density was preset to 46 ends/cm and that of the weft threads to 26 picks/cm. The only difference between samples was the weave. The first four samples were woven in four-end twills (weft-faced/warp-faced and double-faced twills and their broken variant in repeat), samples 5, 6 and 7 were woven in eight-end sateen, eight-end sateen reinforced for one thread to the right (Douchester) and diagonally (Soley). The second group marked T2 (fabrics of the second group) contained only two samples, i.e. No. 8 and 9, which had the same construc-

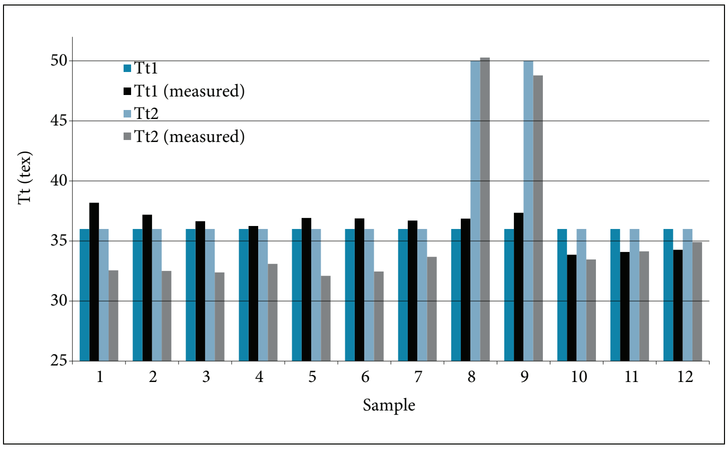
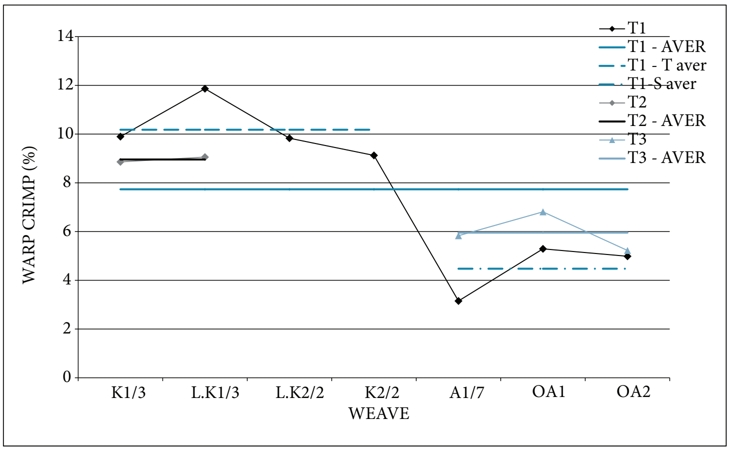


Figure 1: Graphical presentation of the change of warp (Tt1) and weft (Tt2) threads fineness



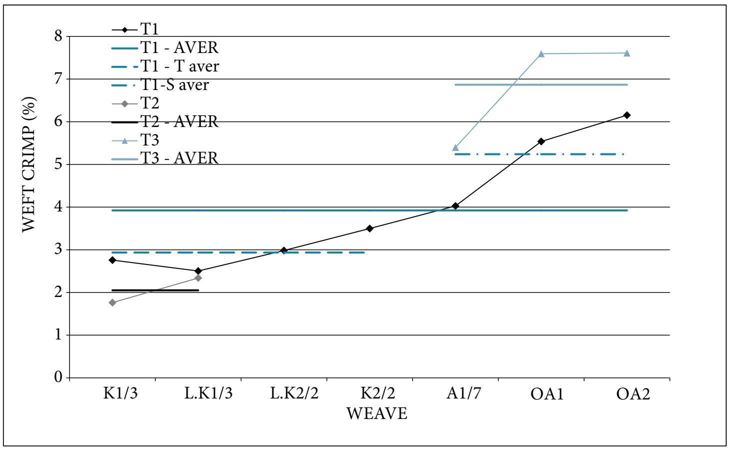


Figure 2: Warp and weft crimp of investigated samples, where T1-AVER, T2-AVER, T3-AVER means average value of all samples in group, T1-T aver means average value of twill woven fabrics and T1-S aver means average value of sateen woven fabrics

tional parameters and were manufactured under the same conditions as samples No. 1 and 2 from the first group; the only difference was the fineness and density of the weft which was 25 × 2 tex and 18 picks/cm, respectively. Samples No. 8 in 9 served for comparison with samples No. 1 and 2 and for estimation of how the changed constructional parameters in the weft affected physical and mechanical properties of a fabric. The third group marked T3 (fabrics of the third group) contained samples No. 10, 11 and 12 which were woven in the same weaves as samples No. 5, 6 and 7 only that they were woven with the warp density 40 ends/cm, that warp threads were not sized and that they were woven in the width 60 cm on laboratory looms with the weft insertion rate 100 p/min. The purpose of the third group of samples was to evaluate comparatively the effect of changed constructional parameters (warp density) and sizing as well as of weaving conditions (weft insertion rate) on the properties of woven raw fabrics. Marks and constructional parameters of samples are presented in Tables 1 and 2.

3.2 Research Methods

Physical properties, real linear density of yarn in the fabric, warp and weft crimp, mass per square meter and thickness of the fabric were measured. All measurements were carried out in compliance with the standard. Tensile properties such as breaking force (Fp) and breaking elongation (Ep) of threads extracted from the fabric as well as breaking force (Ft) and breaking elongation (Et) of fabrics in the warp and weft direction were measured. The measurements of tensile properties of yarns and fabrics were made on Instron 5567 dynamometer in compliance with SIST EN ISO 13934 standard.

4 Results

The results of measurements of real values of constructional parameters (warp and weft density, linear density of the warp and weft) and physical properties (warp and weft crimp, mass per square meter and thickness) are presented in Table 3. Tensile properties (breaking force and breaking elongation) of threads extracted from the fabrics and tensile properties of fabrics

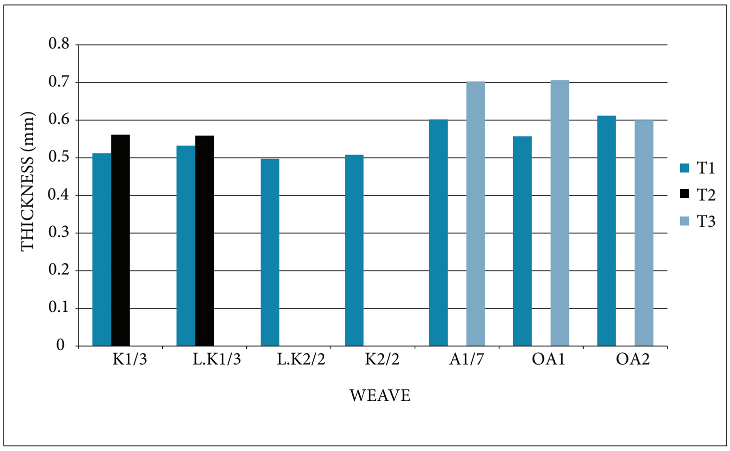


Figure 3: Thickness of investigated samples

7, ki so stkani v vezavi atlas, saj le-ta omogoča večje zgoščanje niti, kot pri tkaninah, stkanih v vezavah keper. Enak trend je opaziti tudi pri primerljivih vzorcih 10,11 in 12, stkanih na laboratorijskih statvah. Zanimivo je, da se gostota votka pri laboratorijsko stka-

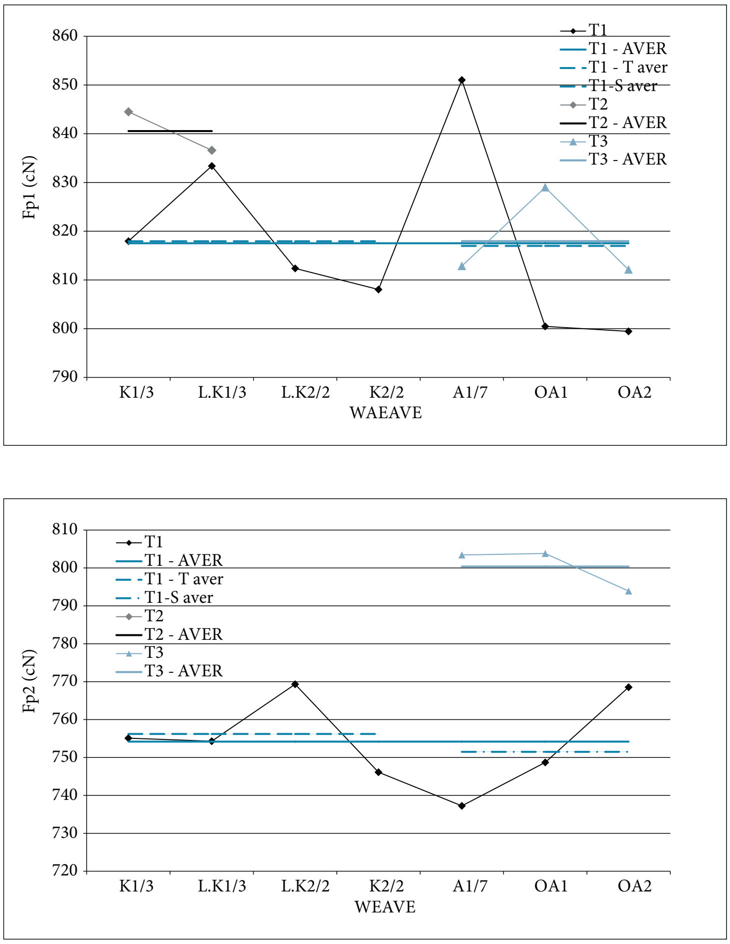


Figure 4: Breaking force of warp (Fp1) and weft (Fp2) threads extracted from fabrics

(breaking force and breaking elongation) are presented in Table 4.

5 Discussion

5.1 Analysis of Constructional and Physical Properties

It is evident in Table 3 and Figure 1 that the linear density of sized threads (first nine samples) was approximately 37 tex, which means that the linear density increased by slightly less than 10% on average due to applied starch. In the case of unsized warp of samples No. 10, 11 and 12, the linear density of the warp threads was very close to the declared values, i.e. 34 tex, which means that due to laboratory weaving conditions (minimum stresses), the threads did not stretch and change their linear density. The same applied for the linear density of the weft threads of laboratory woven samples. However, in the case of industrially woven samples, the fineness of the weft threads decreased from the declared 34 tex to about 32.5 tex due to high stresses and deformations occurred during weft insertion.

In all cases the warp density increased in comparison with the preset value. As expected, the increase was the highest in samples No. 5, 6 and 7 woven in sateen weave as this weave enables higher thickening of threads than twill weaves. The same trend could be noticed in samples No. 10, 11 and 12 woven on laboratory looms. It is interesting, however, that the weft density of laboratory woven samples did not change at all in comparison with the preset value; in industrially woven samples No. 5 and 7 it was even lower than the preset value. This was not the case with the fabrics woven in twill weaves with the exception of the weft density of sample No. 4. As a rule, both densities increased and deviated only to a smaller extent.

The warp crimp of all industrially woven fabrics in twill weave was much higher than the crimp. On average, the percentage of warp crimp was about 10% and the percentage of weft crimp about 3%. This can be attributed to high weft insertion rate due to which the weft tension was considerably higher than the warp tension (this is proved by the change of the weft threads fineness). At the same time, all fabrics

nih vzorcih ni nič spremenila glede na nastavljeno gostoto, pri industrijsko stkanih vzorcih je bila pri vzorcih 5 in 7 celo manjša od nastavljene. Pri tkaninah, stkanih v vezavah keper, se z izjemo gostote votka pri vzorcu 4 to ni dogajalo; praviloma sta se povečevali obe gostoti, vendar odstopata v manjšem intervalu.

Stkanje je pri vseh industrijsko stkanih tkaninah v vezavah keper izrazito večje kot skrčenje. V povprečju se odstotek stkanja giblje okrog 10 odstotkov, skrčenje pa okrog treh odstotkov. To si razlagamo tako, da je zaradi velike hitrosti vnašanja votka napetost votka bistveno večja od napetosti osnove (to dokazuje tudi sprememba finosti votkovnih niti). Hkrati vse tkanine v vezavi keper prepletajo dvakrat pogosteje kot osemvezni atlas. Stkanje in skrčenje tkanin v vezavi atlas je po osnovi in votku približno enako, skrčenje je za približno pol odstotka večje kot stkanje (stkanje = 5 %, skrčenje = 5,5 %). Enako se dogaja pri tkaninah, stkanih v laboratorijskih razmerah, kjer sta tako stkanje kot skrčenje za približno en odstotek večja (stkanje = 5,5 % skrčenje = 6,5 %).

Na debelino po pričakovanjih vpliva velikost flotiranja posameznih niti v vezavi. Štirivezni obojestranski keper (cirkas) in njegova

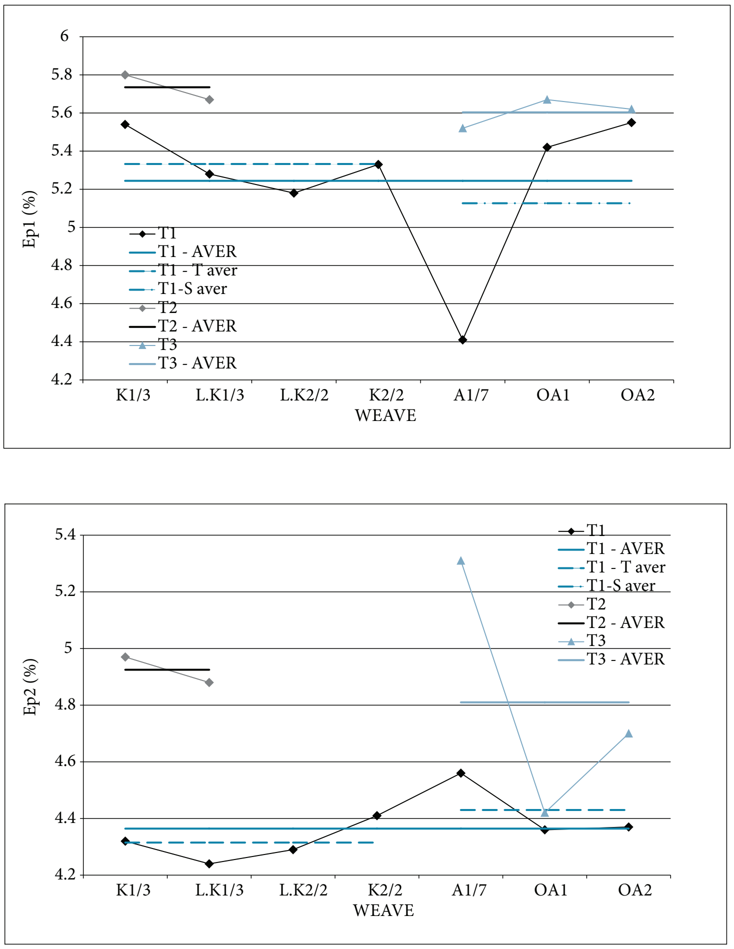


Figure 5: Breaking elongation of warp (Ep1) and weft (Ep2) threads extracted from fabrics

in twill weave interlaced two times more frequently than the fabrics in eight-end sateen. The warp crimp and weft crimp of the fabrics in sateen weave were approximately equal in the warp and weft direction; the crimp was by a half percent approximately higher than the warp crimp (warp crimp = 5%, weft crimp = 5.5%). The same occurred in the fabrics woven under laboratory conditions where both the warp and weft crimp were by approximately one percent higher (warp crimp = 5.5%, weft crimp = 6.5%).

As expected, the thickness of a fabric depended on the length of floating of individual threads in the weave. Four-end twill (cirkas) and its broken variant (tiefel) with floating over two threads had the lowest thickness, i.e. about 0.5 mm. The thickness of warp-faced/weft-faced four-end twill and its broken variant with the float over three threads was about 0.52 mm. The thickness of industrially woven sateens with floats over seven, six or five threads was about 0.55mm, same as that of broken twills, which had coarser weft threads. Laboratory woven fabrics in sateen weave were about 0.65mm thick despite of having lower warp count than industrially woven fabrics.

The mass per square meter of industrially woven samples did not differ considerably as the sums of the warp and weft crimp percentages were almost the same, i.e. about 13% in twills and 10%–11% in sateens. It is logical that the mass per square meter of fabrics in sateen weaves was lower, namely, due to lower warp densities, their mass per square meter was also accordingly lower.

5.2 Analysis and Comparison of Changes of Tensile Properties of Yarns Extracted from Fabrics

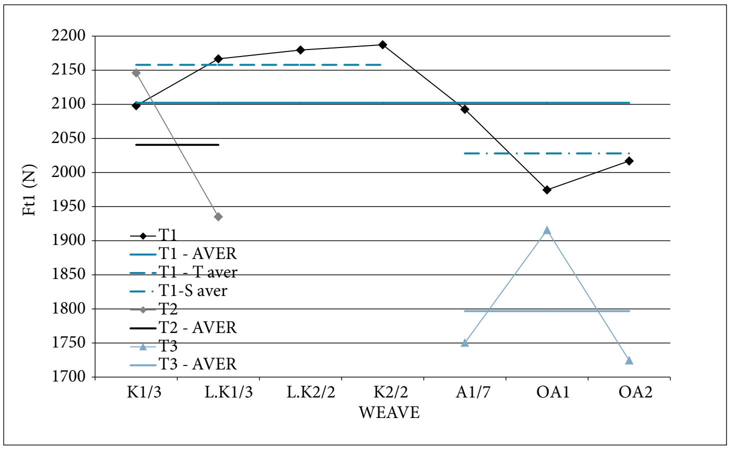
It is evident in Table 4 and Figure 4 a) that among industrially woven samples the warp threads extracted from fabric No. 5 (eight-end sateen) achieved the highest residual tensile force and the lowest residual breaking elongation at the same time (probably due to weft beat-up at open shed and minimum thread change in the shed). Lower residual force was achieved by the warp threads extracted from samples No. 8 and 9 (the second group), which

lomljena varianta (tiefel) s flotiranjem čez dve niti imata najmanjšo debelino okrog 0,5 mm. Osnovni/votkovni štirivezni keper in lomljena izpeljanka s flotiranjem čez tri niti imata debelino okrog 0,52 mm. Industrijsko stkani atlasi, ki flotirajo sedem, šest oziroma pet niti, imajo vrednosti debeline okrog 0,55 mm, enako kot lomljena kepra iz bolj grobih votkov. Laboratorijsko stkane tkanine v vezavi atlas pa imajo vrednosti debeline okrog 0,65 mm, čeprav je gostota osnove v primerjavi z industrijsko stkanimi manjša.

Površinska masa industrijsko stkanih vzorcev se ni razlikovala veliko, saj sta bili vsoti odstotka stkanja in skrčenja približno enaki, in sicer okrog 13 odstotkov pri keprih in 10–11 odstotkov pri atlasih. Logično je, da je površinska masa tkanin v vezavah atlas ustrezno manjša, laboratorijsko stkane tkanine imajo zaradi manjše gostote osnovnih niti tudi primerno manjšo ploščinsko maso.

5.2 Analiza in primerjava sprememb nateznih lastnost prej, izvlečenih iz tkanin

Iz preglednice 4 in slike 4a) je razvidno, da so največjo preostalo pretržno silo med industrijsko stkanimi vzorci dosegale osnov-



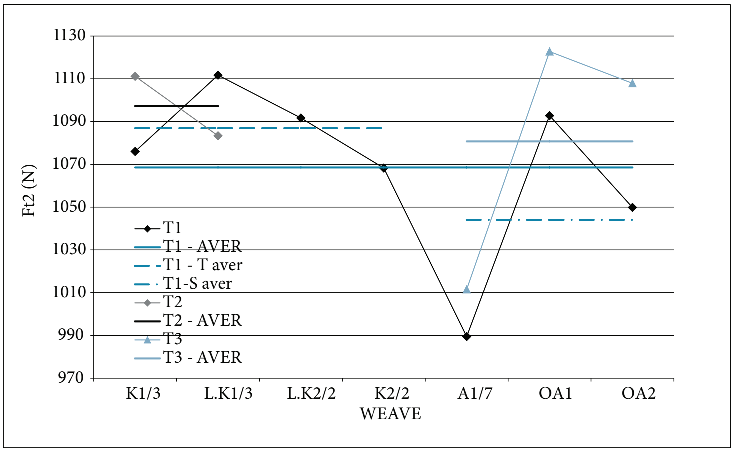


Figure 6: Breaking force of fabrics in warp (Ft1) and weft (Ft2) direction

had lower number of cycles (the lowest weft beat-up) due to lower weft density.

Still lower residual force was achieved by the threads extracted from samples No. 2, 1, 3 and 4 woven in twill and broken twill weaves which were followed by samples No. 6 and 7 woven in sateen weaves which had the same number of interlacings in the warp direction as twills.

Despite of lower number of warp threads the residual breaking force of the warp threads of laboratory woven fabrics in sateen weaves was higher for about 20 cN in comparison with samples No. 6 and 7 because the threads were less stressed on laboratory looms, weaving process was slower and as a result, the threads were less damaged.

The residual breaking elongation of the warp threads of all samples (with the exception of sample No. 5) exceeded the value of 5%. All threads extracted from laboratory woven fabrics had the breaking elongation above 5.5% (Figure 5 a)).

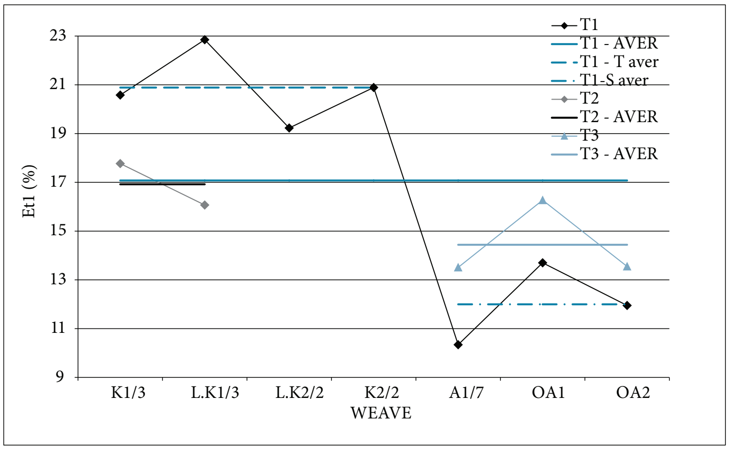
The residual breaking force of the weft threads of industrially woven fabrics was for about 50 cN lower than that of the warp threads (about 755 cN). It is understandable if we know that the warp was not sized and the weft insertion rate was high, the result of which was decreased breaking force of threads. It is also proved by the fact that the residual breaking force of the weft threads of laboratory woven fabrics was approximately the same as the breaking force of the warp threads extracted from fabrics and for about 40 cN higher than the residual breaking force of the weft threads of industrially woven fabrics.

Breaking forces of the threads extracted from fabrics of the second group were higher, i.e. about 1100 cN due to higher linear density of their weft, i.e. 50 tex (Figure 4 b)).

Residual breaking elongations of the weft threads of all samples were lower than those of the warp threads which is seen in Figure 5 b), and achieved the value under 5%; the exception was sample No. 10 with the value higher than 5%, i.e. 5.3%, and samples No. 8 and 9 with the value very close to 5% (about 4.9%).

5.3 Analysis and Comparison of Tensile Properties of Fabrics

It is evident in Table 4 and Figure 6 a) that among industrially woven fabrics the high-



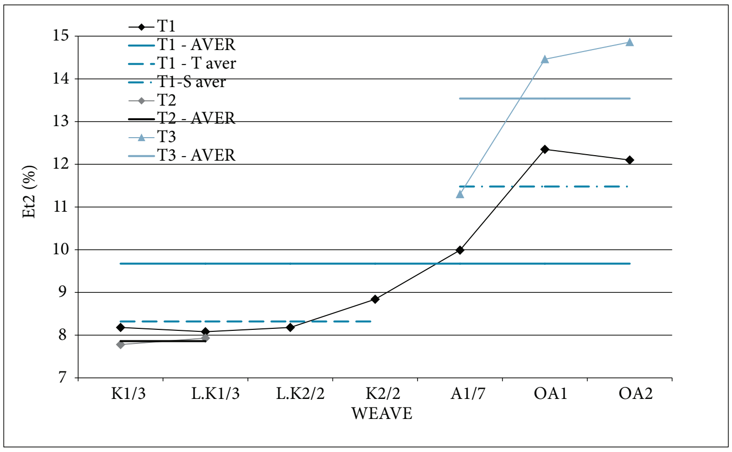


Figure 7: Breaking elongation of fabrics in warp (Et1) and weft (Et2) direction

ne niti iz tkanine 5 (osemvezni atlas), hkrati pa najmanjši preostali pretržni raztezek (verjetno zaradi pribijanja votka pri odprtem zevu in minimalne zamenjave niti v zevu). Sledijo osnovne niti iz vzorcev 8 in 9 (druga skupina), ki so imeli manj ciklusov (najmanj pribijanja votkov) zaradi manjše gostote votka.

Nato sledijo pretržne sile niti, izvlečene iz vzorcev 2, 1, 3 in 4, stkane v vezavah keper in lomljeni keper, ter nato vzorci 6 in 7 v vezavah atlas, vendar z enakim številom prepletov v smeri osnove kakor kepri.

Preostala pretržna sila osnovnih niti laboratorijsko stkanih tkanin v vezavah atlas je bila kljub manjšemu številu osnovnih niti večja za okrog 20 cN kot pri vzorcih 6 in 7, saj so niti na laboratorijskih statvah manj napete, samo tkanje poteka počasneje in zato se niti tudi manj poškodujejo. Preostali pretržni raztezek osnovnih niti je povsod (razen izjeme, to je vzorec 5) presegel vrednost 5 odstotkov. Pretržni raztezek nad 5,5 odstotka so imele vse preje, izvlečene iz laboratorijsko stkanih tkanin (slika 5a).

Preostala pretržna sila votkov industrijsko stkanih tkanin je bila za dobrih 50 cN manjša kot osnove (okrog 755 cN), kar je tudi razu-

Table 5: Visual appearance of fabric and its tensile properties (breaking force and breaking elongation)

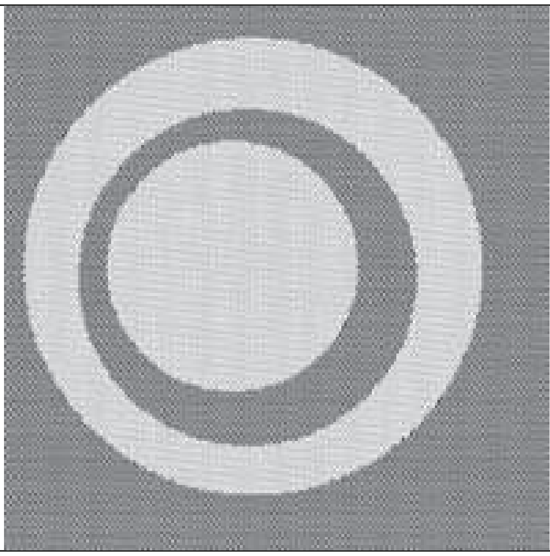
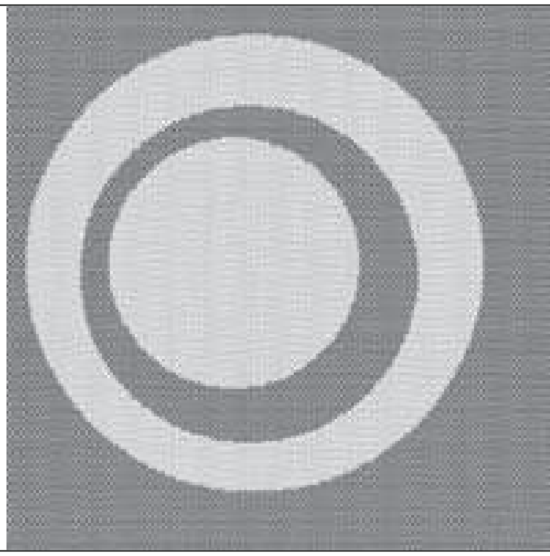
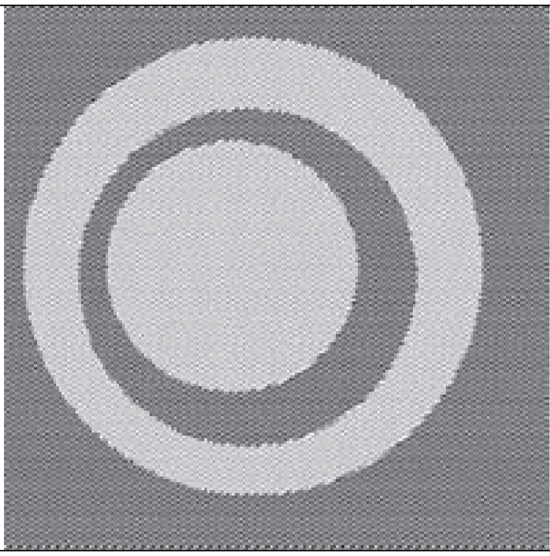
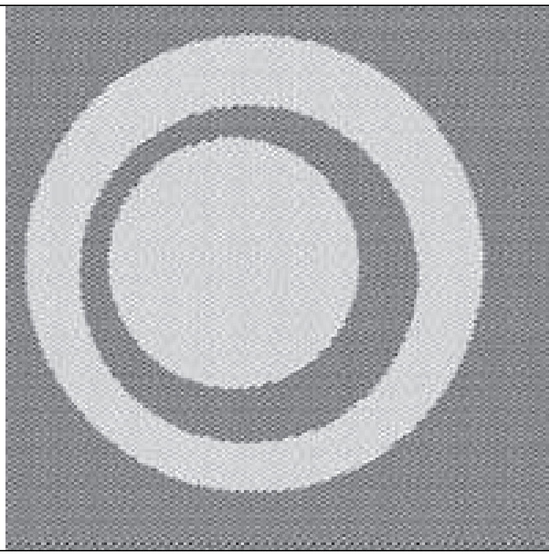
	
Weaves: warp-faced and weft-faced four-end twill Industrially woven samples – mechanical properties Ft1 = 2097.97 N; Ft2 = 1076.03 N Et1 = 20.58%; Et2 = 8.18%	Weaves: warp-faced and weft-faced four-end twill broken in repeat Industrially woven samples – mechanical properties Ft1 = 2166.67 N; Ft2 = 1111.71 N Et1 = 22.85%; Et2 = 8.08%
	
Weaves: warp-faced and weft-faced Duchester Industrially woven samples – mechanical properties Ft1 = 1974.54 N; Ft2 = 1092.77 N Et1 = 13.7%; Et2 = 12.35% Laboratory woven samples – mechanical properties Ft1 = 1915.55 N; Ft2 = 1122.75 N Et1 = 16.27%; Et2 = 14.46%	Weaves: warp-faced and weft-faced Soley Industrially woven samples – mechanical properties Ft1 = 2016.93 N; Ft2 = 1049.85 N Et1 = 11.95%; Et2 = 12.1% Laboratory woven samples – mechanical properties Ft1 = 1724.4 N; Ft2 = 1107.91 N Et1 = 13.55%; Et2 = 14.86%

Table 5: Visual appearance of fabric and its tensile properties (breaking force and breaking elongation)

	All simulations have been made on the basis of the following parameters: Fineness of warp and weft threads: 17 × 2 tex; Warp count: Go = 46 ends/cm; Weft count: Gv = 26 picks/cm Note: Warp count of laboratory woven fabrics is 40 ends/cm.
Weaves: warp-faces and weft-faced eight-end sateen Industrially woven samples – mechanical properties: Ft1 = 2092.64 N; Ft2 = 989.48 N Et1 = 10.34%; Et2 = 10.34% Laboratory woven samples – mechanical properties: Ft1 = 1750.31 N; Ft2 = 1011.52 N Et1 = 13.51%; Et2 = 11.3%	

est breaking forces were achieved by the fabrics woven in double-faced twill weave and double-faced broken twill (LK2/2 and K2/2). The explanation lies in the shortest and constant floating over two threads as well as in the most frequent and regular interlacing with weft threads. The breaking forces in the warp direction of fabrics woven in twills (K1/3) and broken twill1/3 (LK1/3) weaves were only slightly lower than those achieved by broken twill 2/2 and twill 2/2.

The breaking force of fabrics in sateen weave was for more than 100 N lower than the breaking force of fabrics woven in twill weave, and that of laboratory woven samples was even lower for additional 200 N due to lower warp density.

The most distinguishable among fabrics woven in sateen weaves (samples No. 6 and 12) was Douchester which achieved the highest breaking elongations in the warp and weft direction (by approximately 2% higher than other fabrics in

mljivo, saj je bila osnova škrobljena in tudi hitrosti vnašanja votka so velike, kar vpliva na zmanjšanje pretržne sile prej. To se vidi tudi iz dejstva, da je preostala pretržna sila votkov pri laboratorijsko stkanih tkaninah približno enaka pretržni sili osnovnih niti, izvlečenih iz tkanine, ter za okrog 40 cN večja od tistih, ki jo dosegajo votki industrijsko stkanih tkanin.

Pretržne sile niti, izvlečene iz tkanin druge skupine, so toliko večje okrog 1100 cN, saj ima uporabljen votek večjo dolžinsko maso 50 tex (slika 4b).

Preostali pretržni raztezki prej po votku so pri vseh vzorcih manjši od pretržnih raztezkov osnovnih niti, kar je razvidno s slike 5b, in dosegajo vrednosti pod 5 odstotki, z izjemo vzorca 10, ki presega 5 odstotkov, in sicer 5,3 odstotka, ter vzorcev 8, 9, ki sta zelo blizu vrednosti 5 odstotkov (okrog 4,9 odstotka).

5.3 Analiza in primerjava nateznih lastnosti tkanin

Iz preglednice 4 in slike 6a, je razvidno, da med industrijsko stkanimi tkaninami največje pretržne sile dosegajo tkanine, stkane v vezavi obojestranski keper in obojestranski lomljeni keper (LK2/2 in K2/2). Razlaga tega dejstva temelji na najmanjšem in konstantnem flotiranju čez dve niti ter hkrati najpogostejšem in enako-

sateen weave) and the highest breaking force in the weft direction of both industrially and laboratory woven samples. In the case of laboratory woven samples, Douchester achieved also the highest breaking force in the warp direction, which was for 20 cN lower than that of industrially woven samples. Such properties are attributed to a special arrangement of reinforcing points in eight-sateen weave which reduces the length of float to two and six threads in the warp direction and makes the interlacing frequency equal to that of twill weaves, i.e. four interlacings on eight threads. In the weft direction, however, the number of interlacings remained two on eight threads and the floating of weft threads was uniform, i.e. six threads.

Table 5 shows how fabrics with almost identical visual appearance have different tensile properties in dependence of the weave, which justifies the purpose of the investigation.

6 Conclusions

On the basis of the results of the investigation it can be concluded that the weave and weaving conditions can considerably affect mechanical properties of fabrics. When fabrics are used for clothing purposes, the differences in mechanical properties are not so important. However, when fabrics are designed for technical purposes, such differences may be of vital importance.

Due to the high weft insertion rate, all fabrics woven on industrial looms were exposed to high stresses and deformations during weaving, which reflected in the change of the weft threads linear density and minor weft crimp. This was particularly noticeable in the fabrics woven in twill weave which had lower residual breaking elongation of the weft threads as well as lower breaking elongation in both the weft and warp direction. These differences were not so obvious in the case of fabrics woven in sateen weave, especially those woven under laboratory conditions.

The increased elongation of the weft threads due to the weft insertion rate resulted in higher warp threads density, which increased in all fabrics, while the weft threads density did not change considerably. Warp and weft crimp highly differed from one weave to another. The warp crimp of fabrics in twill weaves was sev-

mernem prepletanju z votkovnimi nitmi. Pretržni sili tkanin v smeri osnove, stkanih v vezavah cirkas (K1/3) in tiefla (LK1/3), sta bili le malo manjši od tistih, ki sta jih dosegala lomljeni keper 2/2 in keper 2/2.

Tkanine v vezavi atlas dosegajo za več kot 100 N manjšo pretržno silo kot tkanine, stkane v vezavah keper, laboratorijsko stkani vzorci pa zaradi manjše gostote v smeri osnove manjšo pretržno silo še za dodatnih 200 N.

Med tkaninami, stkanimi v vezavah atlas, po svojih značilnostih izstopa vezava dušester (vzorca 6 in 12), ki dosegata največje pretržne raztezke v smeri osnove in votka (za približno 2 odstotka glede na druge tkanine v vezavi atlas) ter največjo pretržno silo v smeri votka pri industrijsko in laboratorijsko stkanih vzorcih. Pri laboratorijsko stkanih vzorcih pa dosega tudi največjo pretržno silo v smeri osnove, ki je za 20 cN manjša kot pri industrijsko stkanih vzorcih. Tovrstne lastnosti izhajajo iz posebne razporeditve ojačitvenih točk v vezavi osemvezni atlas, ki flotiranje v smeri osnove zmanjša na dve in šest niti, ter pogostost prepletanja izenačijo s pogostostjo prepletanja keprovih vezav; štiri prepletanja na osem niti. V smeri votka pa ostane število prepletanj le dve na osem niti in je flotiranje votkovnih niti enotno ter znaša šest niti.

Preglednica 5 kaže, da imajo tkanine s skoraj enakim vizualnim videzom, v odvisnosti od vezave, različne natezne lastnosti, kar upravičuje namen opravljene študije.

6 Sklepi

Iz opravljene analize ugotovimo, da vezava in pogoji tkanja lahko pomembno vplivajo na mehanske lastnosti tkanin. V primerih, ko so tkanine uporabljene v oblačilne namene, razlike niso tako pomembne, ko pa gre za uporabo v tehnične namene, znajo omenjene razlike igrati zelo pomembno vlogo.

Pri vseh tkaninah, izdelanih v industrijskih razmerah, je zaradi velike hitrosti vnašanja votka prihajalo do velikih napetosti in deformacij, ki se odražajo v spremembi finosti votkovnih niti, manjšem skrčenju votkovnih niti. To se pokaže predvsem pri tkaninah v vezavi keper, ki imajo manjši preostali pretržni raztezek votkovnih niti in manjši pretržni raztezek tkanin v smeri votka in tudi v smeri osnove. Pri tkaninah v vezavi atlas te spremembe niso tako izrazite, še zlasti pri vzorcih, izdelanih v laboratorijskih razmerah.

Povečano raztezanje votkovnih niti zaradi hitrosti vnašanja votka je povzročilo tudi večjo gostoto osnovnih niti, ki se je povečala pri vseh tkaninah, gostota votka pa se ni bistveno spreminjala. Stkanje in skrčenje sta se v veliki meri razlikovala glede na uporabljeno vezavo. Pri tkaninah v vezavah keper je bilo stkanje nekajkrat večje od skrčenja, vsota obeh se je gibala okrog 13 odstotkov.

Hitrost vnašanja votka je vplivala tudi na pretržni raztezek tkanin v smeri osnove, ki se je gibal okrog 19 do 20 odstotkov in je bil okrog 2,5-krat večji od pretržnega raztezka v smeri votka (ki *eral times higher than the weft crimp with the sum of both being about 13%.*

Weft insertion rate influenced also the breaking elongation of fabrics in the warp direction, which ranged from 19% to 20% and was 2.5 times as high as the breaking elongation in the weft direction (which was slightly higher than 8%). The breaking elongation in the warp direction of fabrics in twill weave with coarser wefts woven on industrial looms (the second group) ranged between 13% and 16% due to lower weft density, and was the same as the breaking elongation in the warp direction of fabrics woven in sateen weave.

The breaking elongation in the warp direction of the second group fabrics was also about two times higher than the breaking elongation in the weft direction.

In the case of all fabrics in sateen weave the breaking elongation in the warp and weft directions were almost identical. On average, the breaking elongation in the weft direction was slightly higher which is in agreement with residual breaking elongation of yarns and with the percentage of the warp and weft crimp. The fabric woven in Douchester weave exhibited outstanding end properties, namely, almost all results of measurements of mechanical and physical properties were apparently better than the results of other fabrics woven in sateen weaves.

Based on the results it can be concluded that the weave containing the arrangement of warp and weft interlacing points as well as the interaction of warp and weft threads produce apparent differences in physical and mechanical properties of raw fabrics. Although the selected weaves in all cases were checkered, nevertheless, also due to non-checkered densities, such conditions were generated during the weaving process, which gave rise to different breaking forces and elongations of fabrics in the warp and weft directions. If higher breaking strength and breaking elongation in the warp direction is required, one of twill weaves will be selected, but if more equally distributed properties in both directions are required, one of sateen weaves will be selected.

je bil nekaj več kot 8 odstotkov). Tkanine, stkane v vezavi keper, z bolj grobimi votki, stkane na industrijskem stroju (druga skupina), so imele pretržni raztezek v smeri osnove od 13 do 16 odstotkov zaradi manjše gostote votka in enako kot tkanine, stkane v vezavi atlas v smeri osnove.

Tudi pri tkaninah druge skupine so pretržni raztezki v smeri osnove presegli pretržne raztezke v smeri votka za okrog dvakrat.

Pri vseh tkaninah v vezavi atlas so bili pretržni raztezki v smeri osnove in votka približno enaki. V povprečju so bili za malenkost večji pretržni raztezki v smeri votka, kar se ujema s preostalimi pretržnimi raztezki prej in z odstotkom stkanja in skrčenja osnovnih in votkovnih niti. Glede končnih lastnosti izstopa tkanina, stkana v vezavi dušester, ki dosega skoraj pri vseh meritvah mehanskih in fizikalnih lastnosti vidno boljše rezultate kot preostale tkanine v vezavi atlas.

Analiza je pokazala, da vezava, ki zajema razporeditev osnovnih in votkovnih točk, ter medsebojna interakcija osnovnih in votkovnih niti prinašata očitne razlike v fizikalno-mehanskih lastnostih surovih tkanin. Čeprav so bile vse izbrane vezave kvadratične, so se, predvsem tudi zaradi izbranih nekvadratičnih gostot, med tkanjem ustvarile razmere, ki so povzročale različne pretržne sile in raztezke tkanin v smeri osnove in votka. Če bi želeli večjo pretržno trdnost in pretržni raztezek v smeri osnove v primerjavi s smerjo votka, bi izbrali eno izmed keprovih vezav, če bi pa želeli enakomerneje porazdeljene lastnosti v obeh smereh, bi se lahko odločili za eno izmed atlasovih vezav.

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