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Parametri zbitega levo-desnega pletiva (2. del): moduli zanke in Mundenove konstante – zbita in superzbita struktura

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Parameters of Compact Single Weft Knitted Structure (Part 2): Loop Modules and Munden Constants – Compact and Supercompact Structure

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Abstract

The principal objective of the research was to comparatively analyse loop modules and Munden constants of single weft knitted fabrics made from core-spun yarns with elastane and those made from conventional yarns without elastane. An additional objective was to experimentally define loop modules and Munden constants for compact knitted structures. The investigated knitted structures were made from viscose and polyacrylonitrile yarns with incorporated elastane and without elastane, respectively. The samples were knitted in two densities, and dry, or dry and wet relaxed (consolidated). The values of the parameters of an open, normal and compact knitted structure were analysed. The supercompact knitted structure was defined.

Keywords: knitting, knitted structure, loop modules, Munden constants, cover factor

1 Introduction

Aesthetic, quality and performance properties of knitted fabrics/knitwear are influenced by the parameters of yarn, knitting machine and

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Izvleček

Temeljni cilj raziskave je bil primerjalno analizirati module zanke in Mundenove konstante levo-desnih pletiv iz oplaščenih prej z elastanskim jedrom ter iz konvencionalnih prej brez elastanskega jedra. Cilj je bil tudi eksperimentalno definirati module zanke in Mundenove konstante za pletiva zbite strukture. Preiskovana pletiva so bila izdelana iz viskoznih in poliakrilonitrilnih prej z vgrajenim elastanom in brez elastana. Napletena so bila v dveh gostotah ter suho oz. suho in mokro relaksirana (konsolidirana). Analizirane so bile vrednosti parametrov ohlapne, normalne in zbite strukture. Definirana je bila superzbita struktura pletiva.

Ključne besede: pletenje, pletena struktura, moduli zanke, Mundenove konstante, faktor kritja

1 Uvod

Na estetske, kakovostne in uporabne lastnosti pletiv/pletenin vplivajo parametri preje, parametri stroja in parametri okolja. Kakovost in izbira optimalnih surovin ter načrtovanje strukturnih in procesnih parametrov pletiva so ključnega pomena za sodobno pletilsko proizvodnjo.

Pletenje je zahteven dinamični proces, zato sta za kakovosten izdelek nujna natančno projektiranje pletene strukture ter stalna kontrola parametrov pletenja. Optimalna zbita/porozna struktura pomembno vpliva na dimenzijske in udobnostne lastnosti pletene strukture ter s tem tudi na njeno kakovost.

the environment. The quality and the optimal raw material selection along with the planning of the structural and process parameters of the knitted structure are of key importance for the contemporary knitting production.

Knitting is a complex dynamic process, therefore, an accurate planning of the knitted structure and a constant control of knitting parameters are essential for a quality knitted product. An optimal compact/porous knitted structure significantly influences the dimensional and comfort properties of knitted fabrics and in consequence, has an important impact on its quality.

2 Knitted fabric parameters

Numerous authors [1–22] have studied geometrical loop models and analysed the structural parameters of the knitted structure. The examination of knitted fabrics made from yarns of different material composition knitted under different process conditions and relaxed with different methods resulted in a wide range of values of individual structural parameters and loop modules. Similar to the authors of geometrical loop models, some researchers have described and/or mathematically defined an open, normal (ideal) and compact knitted structure. They mainly examined knitted fabrics made from conventional yarns without the elastane core.

The compactness/porosity of the knitted structure was most often evaluated on the basis of the length module, Munden constants, loop shape factor or density coefficient, respectively, and cover factor value. Rarely, it was evaluated on the basis of the surface and volume loop module values [1–34]. There is no trace in the scientific literature of the horizontal and the vertical compactness of the real fabric evaluation on the basis of the width and the height loop module, and the width and the length interlacing factor.

3 Experimental: sample preparation and research methods

For the preparation of knitted samples, ring-spun yarns were used. They were made to or-

2 Parametri pletiva

Številni avtorji [1–22] so študirali geometrijske modele zanke ter analizirali strukturne parametre pletiva. Preskušanje pletiv iz prej različne surovinske sestave, pletenih pod različnimi procesnimi pogoji in relaksiranih na različne načine, se je izrazilo v širokih mejah eksperimentalnih vrednosti posameznih strukturnih parametrov pletiva in modulov zanke. Nekateri avtorji so, podobno kot avtorji geometrijskih modelov zanke, opisno in/ali matematično ločili ohlapno, normalno (idealno) in zbito strukturo pletiva. Večinoma so preskušali pletivo iz konvencionalnih prej brez elastanskega jedra.

Zbitost/poroznost strukture je bila najpogosteje ocenjevana na podlagi vrednosti dolžinskega modula zanke, Mundenovih konstant, faktorja oblike zanke oz. koeficienta gostote pletiva ter faktorja kritja pletiva. Redkeje je bila ocenjevana na podlagi izračunanih vrednosti ploščinskega in prostorninskega modula zanke [1–34]. Ocenjevanja horizontalne in vertikalne zbitosti realnega pletiva na podlagi širinskega in višinskega modula zanke ter širinskega in višinskega faktorja vpletanja niti v znanstveni literaturi ni zaslediti.

3 Eksperimentalni del: priprava vzorcev in metode preiskav

Za pripravo vzorcev pletiv so bile uporabljene prstanske preje, izdelane po naročilu iz dveh vrst predivnih vlaken: viskoznih (CV) in poliakrilonitrilnih (PAN). Viskozna in poliakrilonitrilna vlakna so bila izbrana zaradi različnega izvora (naravni, sintetični polimer) ter s tem povezane različne hidrofilnosti in krčenja pri mokrih obdelavah ter obsežnih preteklih raziskav dimenzijske stabilnosti pletiv takšne surovinske sestave [29, 30, 9, 10, 35]. Iz vsake surovine so bile po naročilu izdelane preje z elastanskim jedrom enake nazivne dolžinske mase po treh različnih predilnih/sukalnih postopkih: *muliné sukana preja* (iz oplaščene preje z elastanskim jedrom in predivne preje brez elastanskega jedra, obe izdelani na prstanskem predilniku), *obsukana preja* (elastanska filamentna preja, obsukana z dvema predivnima prejama) in *oplaščena preja* (preja z elastanskim jedrom, oplaščenim s predivom). Za primerjavo sta bili iz 100-odstotnega viskoznega oz. 100-odstotnega poliakrilonitrilnega prediva izdelani tudi prstanski *predivni preji* brez elastanskega jedra enake nazivne dolžinske mase kot preje z elastanskim jedrom.

Muliné sukani preji in obsukani preji so bile izdelane z nazivnim vitjem 500S, enojne preje (oplaščeni prstanski preji z elastanskim jedrom in primerjalni prstanski preji brez elastanskega jedra) pa z vitjem 221–281Z. Takšno vitje je bilo ocenjeno kot optimalno; relativno nizko vitje prej, ki se največkrat uporabljajo za pletenje, povzroča spremenljiv premer preje [34], medtem ko visoko vitje *der from two types of staple fibres, i.e. viscose (CV) and polyacrylonitrile (PAN). The viscose and polyacrylonitrile fibres were selected due to their different origin (natural, synthetic polymer), and consecutive different hydrophility and shrinking behaviour during wet processes. Furthermore, they were selected due to the previous extensive research of the dimensional stability of knitted structures with an identical material composition [29, 30, 9, 10, 35]. From each raw material, elastomeric core-spun yarns with the same linear density were made to order by three different spinning/twisting processes, i.e. muliné twisted yarn (composed of elastomeric core-spun yarn and yarn without elastane, both ring-spun), core-twisted yarn (elastane filament yarn, core-twisted with two ring-spun yarns) and core-spun yarn (yarn with an elastane core and staple fibre sheath covering). For comparison, also ring-spun yarns without elastane from 100% viscose and 100% polyacrylonitrile fibres with equal linear density as elastane core-spun yarns were produced.*

Muliné twisted yarns and core-twisted yarns were produced with the nominal twist of 500S, while single yarns (elastane core-spun yarns and comparative ring-spun yarns without elastane) were produced with the nominal twist of 221–281Z. Such a twist was estimated as optimal. A relatively low yarn twist which is usual for knitting yarns causes a variable yarn diameter [34], while a high yarn twist increases the possibility of an undesired spirality deformation of the knitted fabric which obstructs the execution of precise measurements [36].

Knitted samples with different levels of compactness of the structure were prepared with:

- *use of yarns with different extension, elastic and relaxation properties, produced by various spinning/ twisting processes,*
- *knitting with two couliering depths, and*
- *dry and dry&wet relaxation (consolidation) of knitted fabrics.*

The knitted samples were produced on the electronic flat weft knitting machine UNIVERSAL MC 720, gauge E8. The yarn was on bobbins, not wound and not waxed. All samples were knitted with an equal yarn input tension, equal knitted fabric take-off and at identical

povečuje možnost nastanka nezaželene poševne deformacije pletiva, ki otežuje izvedbo natančnih meritev [36].

Vzorci pletiv z različno stopnjo zbitosti strukture so bili pripravljeni:

- z uporabo prej, izdelanih po različnih predilnih/sukalnih postopkih, ki imajo različne raztezne, elastične in relaksacijske lastnosti,
- s pletenjem z dvema različnima globinama kuliranja ter
- s suho oz. suho in mokro relaksacijo (konsolidacijo) pletiv.

Vzorci pletiv so bili napleteni na elektronskem ploskem kulirnem pletilniku UNIVERSAL MC 720 delitve E 8, preja je bila na predilniških navitkih, tj. neprevita in neparafinirana. Vsi vzorci so bili napleteni z enako dovajalno napetostjo preje, enakim odvlekom pletiva in pri enakih razmerah okolja. Iz vsake preje so bili napleteni vzorci dveh gostot: gostejše pletivo je bilo izdelano z nastavitvijo globine kuliranja 9, redkejše pletivo pa z nastavitvijo globine kuliranja 11.

Vsi vzorci pletiv so bili najprej suho statično relaksirani: v neobremenjenem stanju so ležali v standardnem okolju 72 ur. Polovična količina vsakega vzorca je bila po suhi relaksaciji še mokro dinamično relaksirana (konsolidirana), pri čemer je bila temperatura obdelave prilagojena šibkejšemu členu, tj. poliakrilonitrilnim vlaknom. Postopek konsolidacije je obsegal pranje v gospodinjskem pralno-sušilnem stroju ELEKTROLUX EW 1247W pri 30°C (program za občutljivo perilo), kratko centrifugiranje, sušenje 40 min (program za občutljivo perilo), štiri cikle kratkega izpiranja in 40-minutnega sušenja (program za občutljivo perilo) ter odležanje mokro relaksiranih vzorcev v standardnem okolju najmanj 24 ur po končanem sušenju.

Zaradi strukture, velike razteznosti in visoke elastične povratnosti prej z elastanskim jedrom je bilo pri mokri dinamični relaksaciji (konsolidaciji) pletiv pričakovati nezanemarljive spremembe premerov prej z elastanskim jedrom. Zato so bile za izračun parametrov zanke in pletiva v suho oz. mokro relaksiranem stanju hkrati s pletivi relaksirane tudi preje. Suho relaksirane preje so 72 ur ležale v standardnem okolju v neobremenjenem stanju, tj. odvite z navitka brez izgube zavojev. Preje so bile zaradi nevarnosti zamršenja niti med prevračanjem v bobnu pralnega stroja dinamično mokro relaksirane z dveurnim namakanjem v predenih z občasnim mešanjem v vodi pri 30 °C. Nato so se hkrati s preskušanim pletivom sušile v pralno-sušilnem stroju ELEKTROLUX EW 1247W pri programu za občutljivo perilo.

4 Rezultati preiskav z razpravo

Koeficient gostote pletiva (preglednica 3) se pri vseh pletivih, gosto in redko pletenih ter iz prej z elastanskim jedrom in brez njega, z mokro relaksacijo (konsolidacijo) zmanjša, saj se vertikalna gostota pletiv poveča bolj kot horizontalna. Pri vseh gostih pletivih

Table 1: Yarn samples description

yarn label	yarn type	material composition (%)	yarn linear density (tex)	twist (m^{-1})	br. tenacity ($cNtex^{-1}$)	br. extension (%)	Uster value (%)	no. of thin places	no. of thick places	no. of nobs
1	muliné twisted yarn with elastane	97.8 % CV 2.2% EL	100	500S	20.2	19.3	7.4	0	0	0
2		97.8 % PAN 2.2% EL	100	500S	21.5	26.9	7.3	0	2	1
3	core-twisted yarn with elastane	97.8 % CV 2.2% EL	102	500S	20.3	19.1	7.5	0	0	0
4		97.8 % PAN 2.2% EL	102	500S	21.2	26.5	7.4	0	0	0
5	core-spun yarn with elastane	97.8 % CV 2.2% EL	100	281Z	18.4	17.7	8.5	0	0	1
6		97.8 % PAN 2.2% EL	100	278Z	19.6	23.8	9.1	0	0	0
7	ring-spun yarn without elastane	100% CV	100	221Z	21.9	17.7	8.4	0	1	0
8		100% PAN	100	221Z	19.7	23.0	9.1	0	1	0

environment conditions. From each yarn, the samples were knitted in two densities. A more dense structure was produced with the couliering depth setting 9, while a looser structure was made with the couliering depth setting 11.

First, all samples were statically dry relaxed. They were placed unloaded to the standard environment for 72 hours. After the dry relaxation, a half portion of each sample was additionally dynamically wet relaxed (consolidated). The processing temperature was adjusted to the weak link, i.e. polyacrylonitrile fibres. The consolidation process comprised laundering in the household wash-dryer ELECTROLUX EW 1247W at 30 °C (delicate laundry programme), short spinning, 40-minute drying (delicate laundry programme), four cycles of short rinsing and 40-minute tumble drying (delicate laundry programme), and placing wet relaxed samples flat to the standard environment for at least 24 hours after the drying was finished.

Due to their structure, high extensibility and high elastic recovery of the elastane core yarns, significant changes of the elastane core yarn thickness were expected after the dynamic wet relaxation (consolidation) of knitted fabrics.

Table 2: Yarn and knitted fabric samples labelling

yarn label	yarn labelling		knitted fabric labelling		
	relaxation type	yarn label	relaxation type	knitted fabric density	
				dense	loose
1	dry relaxation	1S	dry relaxation	1Sg	1Sr
	consolidation	1M	consolidation	1Mg	1Mr
2	dry relaxation	2S	dry relaxation	2Sg	2Sr
	consolidation	2M	consolidation	2Mg	2Mr
3	dry relaxation	3S	dry relaxation	3Sg	3Sr
	consolidation	3M	consolidation	3Mg	3Mr
4	dry relaxation	4S	dry relaxation	4Sg	4Sr
	consolidation	4M	consolidation	4Mg	4Mr
5	dry relaxation	5S	dry relaxation	5Sg	5Sr
	consolidation	5M	consolidation	5Mg	5Mr
6	dry relaxation	6S	dry relaxation	6Sg	6Sr
	consolidation	6M	consolidation	6Mg	6Mr
7	dry relaxation	7S	dry relaxation	7Sg	7Sr
	consolidation	7M	consolidation	7Mg	7Mr
8	dry relaxation	8S	dry relaxation	8Sg	8Sr
	consolidation	8M	consolidation	8Mg	8Mr

Table 3: Density coefficient C, cover factor K, width interlacing factor V_s and length interlacing factor V_d of dry and dry & wet relaxed (consolidated), dense and loose structures

knitted fabric label (relaxation type)		dense knitted fabric – g				loose knitted fabric – r			
		C	K ($\text{tex}^{1/2}\text{mm}^{-1}$)	V_s	V_d	C	K ($\text{tex}^{1/2}\text{mm}^{-1}$)	V_s	V_d
1	S	0.62	1.28	4.36	7.06	0.61	0.93	5.79	9.44
	M	0.54	1.83	5.59	10.32	0.58	1.39	5.93	10.17
2	S	0.62	1.21	4.24	6.87	0.77	0.91	5.20	6.79
	M	0.56	1.65	4.98	6.89	0.57	1.24	6.02	10.64
3	S	0.60	1.23	4.42	7.38	0.65	0.95	5.01	7.66
	M	0.54	1.79	5.31	9.90	0.55	1.36	6.13	11.24
4	S	0.64	1.15	4.25	6.69	0.80	0.87	5.46	6.85
	M	0.56	1.53	5.13	9.08	0.60	1.14	6.29	10.45
5	S	0.54	1.29	4.52	8.42	0.56	0.96	5.41	9.70
	M	0.49	1.89	5.50	11.30	0.52	1.37	6.51	12.59
6	S	0.57	1.20	4.16	7.26	0.62	0.91	4.82	7.79
	M	0.51	1.72	5.12	9.94	0.53	1.32	5.70	10.75
7	S	0.76	1.14	3.91	5.16	0.84	0.87	3.90	4.66
	M	0.55	1.22	3.18	5.80	0.66	0.92	3.43	5.23
8	S	0.75	1.12	4.00	5.36	1.08	0.85	4.37	4.04
	M	0.73	1.13	4.04	5.54	0.87	0.86	4.35	5.03

* loop length ℓ_{IN} measured with the new method [37] was applied for the calculations

Therefore, yarns were relaxed simultaneously with the knitted fabrics in order to calculate the parameters of the dry and wet relaxed (consolidated) knitted structure. The dry relaxed yarns were placed unloaded to the standard environment for 72 hours; they were unwound from the bobbins without any turns loss. To avoid the ruffling of yarns in the laundering machine drum during rotation, the yarns were dynamically wet relaxed with a 2-hour soaking of the threads in the water at 30 °C with occasional stirring. Afterwards, they were dried simultaneously with the investigated knitted fabrics in the wash-dryer ELECTROLUX EW 1247W at the delicate laundry programme.

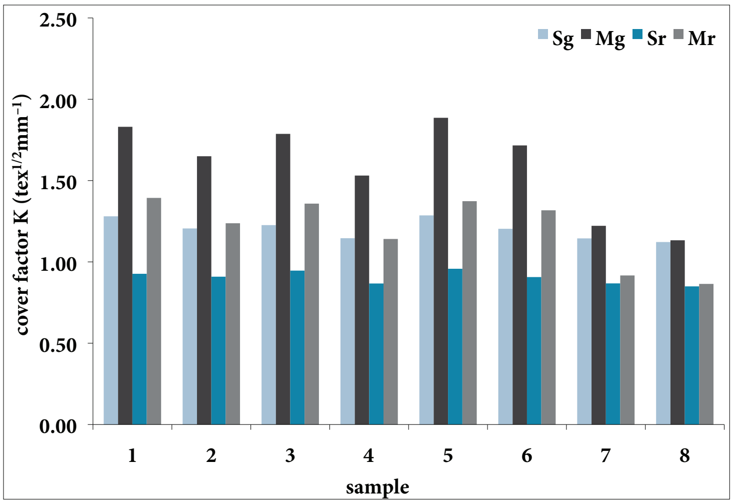

Figure 1: Cover factor of dry and dry & wet relaxed (consolidated), dense and loose knitted fabrics

4 Results and discussion

The knitted fabric density coefficient (cf. Table 3) decreases with wet relaxation with all investigated knitted fabrics, i.e. dense and loose knitted fabrics, structures with and without elastane. It occurs, since the vertical density increases more than the horizontal density. With all dense structures, the density coefficient is lower than the recommended value C = 0.866, calculated by Dalidovič [23] for the ideal, i.e. normal, structure. The closest values to the ideal structure are exhibited by the knitted fabrics made from yarns without elastane (Samples 7 and 8). The loose knitted fabrics exhibit higher density coefficients than the dense knitted fabrics. Among them, only the fabrics knitted from yarns without elastane get close to the ideal value. In most cases, the density coefficients of the

je koeficient gostote C manjši od priporočene vrednosti $C = 0{,}866$, ki jo je za idealno, tj. pletivo normalne strukture izračunal Dalidovič (23); najbližje vrednosti imata pletivi iz prej brez elastanskega jedra (vzorca 7 in 8). Redka pletiva imajo višje koeficiente gostote kot gosta; tudi med njimi se idealni vrednosti približujeta le pletivi, pleteni iz prej brez elastanskega jedra. Koeficienti gostote viskoznih prej so v večini primerov manjši od koeficientov gostote istovrstnih poliakrilonitrilnih prej. Iz preglednice 3 in slike 1 je videti, da se z mokro relaksacijo (konsolidacijo) faktor kritja K pri vseh pletivih poveča. Povečanje je večje pri pletivih iz prej z elastanskim jedrom, ker se ta pri mokri obdelavi bolj krčijo, pri čemer se poveča debelina preje in s tem dolžinska masa; povečanje dolžine zanke je majhno. Faktor kritja pletiv iz viskoznih prej je večji od faktorja kritja istovrstnih pletiv iz poliakrilonitrilnih prej.

Širinski faktor vpletanja niti v_s opisuje razmerje med dolžino ℓ in širino zanke A. Pri normalnem pletivu po Dalidoviču [23], kjer je dolžina zanke $\ell = 16{,}64\ d_{pr}$, širina zanke pa $A = 4\ d_{pr}$, je $v_s = 4{,}16$. Iz preglednice 3 je videti, da imajo najnižji širinski faktor vpletanja niti v_s pletiva iz prstanskih prej brez elastanskega jedra. Vrednosti

Table 4: Width α, height β, linear δ, area δ_{pl} and volume loop module δ_v of dry and dry & wet relaxed (consolidated), dense and loose knitted fabrics

knitted fabric label (relaxation type)		dense knitted fabric – g					loose knitted fabric – r				
		α	β	δ	δ_{pl}	δ_v	α	β	δ	δ_{pl}	δ_v
1	S	2.27	1.40	9.90	0.32	0.80	2.36	1.45	13.68	0.25	0.75
	M	1.35	0.73	7.55	0.13	0.28	1.67	0.98	9.92	0.16	0.38
2	S	2.33	1.44	9.89	0.34	0.80	2.52	1.93	13.12	0.37	1.04
	M	1.38	0.87	6.89	0.16	0.36	1.53	0.86	9.18	0.14	0.38
3	S	2.79	1.67	12.35	0.38	1.08	3.19	2.09	16.00	0.42	1.41
	M	1.75	0.94	9.28	0.18	0.49	1.99	1.09	12.21	0.18	0.58
4	S	2.77	1.76	11.79	0.41	1.17	2.85	2.27	15.58	0.42	1.42
	M	1.50	0.85	7.69	0.16	0.38	1.64	0.99	10.31	0.16	0.39
5	S	2.44	1.31	11.00	0.29	0.90	2.73	1.52	14.77	0.28	1.09
	M	1.18	0.57	6.49	0.10	0.22	1.37	0.71	8.92	0.11	0.26
6	S	2.79	1.60	11.62	0.38	1.18	3.20	1.98	15.43	0.41	1.59
	M	1.39	0.71	7.10	0.14	0.36	1.62	0.86	9.52	0.15	0.43
7	S	3.45	2.62	13.51	0.67	1.46	4.57	3.83	17.81	0.98	1.96
	M	3.75	2.06	11.93	0.65	1.52	4.63	3.04	15.90	0.89	1.97
8	S	3.65	2.72	14.60	0.68	1.83	4.42	4.77	19.29	1.09	2.94
	M	3.39	2.47	13.67	0.61	1.76	4.11	3.56	17.91	0.82	2.34

* yarn thickness d_{prS} measured with Sadikov method [38] and loop length ℓ_{IN} measured with the new method [37] were applied for the calculations

knitted fabrics from viscose yarns are lower than the density coefficients of the knitted fabrics from polyacrylonitrile yarns.

From Table 3 and Figure 1, it can be seen that the cover factor K increases with the wet relaxation (consolidation) at all knitted fabrics. The increase is higher with the structures from the elastane core yarns, since they shrink more during wet processes, which leads to the yarn thickness increase and consequently to the yarn linear density increase. The loop length increase is low. The cover factor of knitted fabrics made from viscose yarns is higher than the cover factor of adequate knitted fabrics made from polyacrylonitrile yarns.

The width interlacing factor V_s *describes the ratio between the loop length* ℓ *and the loop width A. According to Dalidovič [23], the loop length is* $\ell = 16.64\ d_{pr}$*, the loop width is* $A = 4d_{pr}$ *and therefore, the width interlacing factor is* $V_s = 4.16$ *in the case of a normal knitted structure. From Table 3, it can be seen that the knitted fabrics from the ring-spun yarns without elastane core exhibit the lowest width interlacing factor. The knitted fabrics without the elastane core and the dry relaxed compact structures from the elastane core yarns get the closest to the value of the ideal width interlacing factor for the normal knitted structure* $V_s = 4.16$*.*

The height interlacing factor V_d *describes the ratio between the loop length* ℓ *and the loop height B. With the normal knitted structure according to Dalidovič [23], the loop length is* $\ell = 16.64\ d_{pr}$*, the loop height is* $B = 2\sqrt{3}\ d_{pr}$ *and consequently, the height interlacing factor* $V_d = 4.81$*. Table 3 shows that the knitted structures made from yarns without the elastane core exhibit the lowest length interlacing factor* V_d*. The knitted structures made from yarns without the elastane core get the closest to the value of the ideal length interlacing factor for the normal knitted structure* $v_d = 4.81$*.*

The width loop module α is the ratio between the loop width A and the yarn thickness d_{pr}*. It shows to which extent the loop is filled with yarn in the width direction, i.e. the widthwise compactness of the loop. With a normal knitted structure, where the needle and sinker arcs are in contact [23], the loop width is* $A = 4d_{pr}$*, therefore, in this*

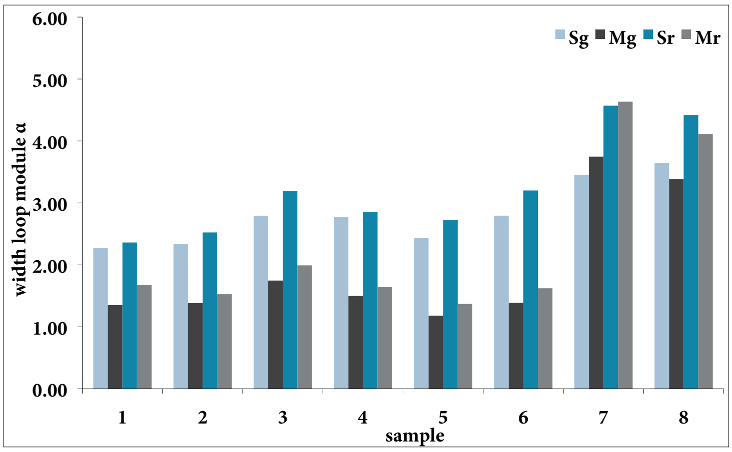

Figure 2: Width loop module of dry and dry & wet relaxed (consolidated), dense and loose knitted fabrics

idealnega širinskega faktorja za normalno pletivo $V_s = 4{,}16$ se najbolj približajo pletiva iz prej brez elastanskega jedra ter suho relaksirana gosta pletiva iz prej z elastanskim jedrom.

Višinski faktor vpletanja niti V_d opisuje razmerje med dolžino ℓ in višino zanke B. Pri normalnem pletivu po Dalidoviču [23], kjer je dolžina zanke $\ell = 16{,}64\ d_{pr}$, višina zanke pa $B = 2\sqrt{3}\ d_{pr}$, je $V_d = 4{,}81$. Preglednica 3 kaže, da imajo najnižji dolžinski faktor vpletanja niti V_d pletiva iz prej brez elastanskega jedra. Vrednosti idealnega dolžinskega faktorja za normalno pletivo $V_d = 4{,}81$ se najbolj približajo pletiva iz prej brez elastanskega jedra.

Širinski modul zanke α je razmerje med širino zanke A in debelino preje d_{pr} in kaže, kako je zanka po širini izpolnjena s prejo oz. opisuje širinsko zbitost pletiva. Pri pletivu z normalno strukturo, kjer se igelni in platinski loki zanke dotikajo [23], je $A = 4\ d_{pr}$, torej je v tem primeru širinski modul zanke $\alpha = 4$. Manjši širinski modul zanke $\alpha < 4$ pomeni prečno zbito, večji širinski modul

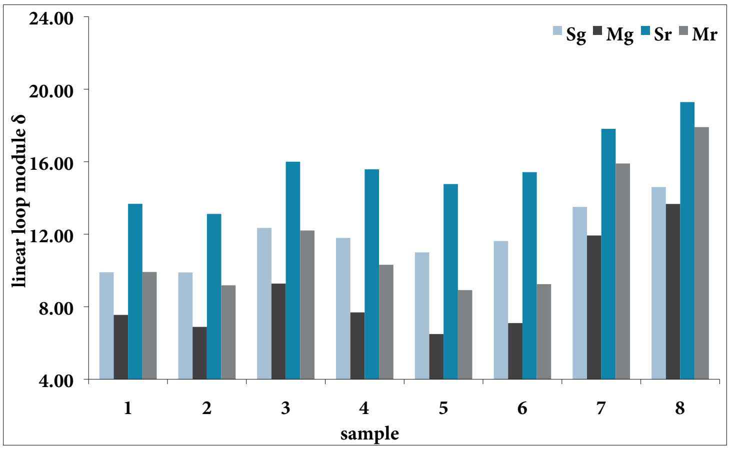

Figure 3: Linear loop module of dry and dry & wet relaxed (consolidated), dense and loose knitted fabrics

Table 5: Munden constants of dry and dry & wet relaxed (consolidated), dense and loose knitted fabrics

knitted fabric label (relaxation type)		dense knitted fabric – g				loose knitted fabric – r			
		K_1	K_2	K_3	K_4	K_1	K_2	K_3	K_4
1	S	30.79	7.06	4.36	1.62	54.67	9.44	5.79	1.63
	M	57.73	10.32	5.59	1.85	60.32	10.17	5.93	1.71
2	S	29.11	6.87	4.24	1.62	35.30	6.79	5.20	1.31
	M	44.28	8.89	4.98	1.78	64.01	10.64	6.02	1.77
3	S	32.62	7.38	4.42	1.67	38.38	7.66	5.01	1.53
	M	52.57	9.90	5.31	1.86	68.86	11.24	6.13	1.83
4	S	28.46	6.69	4.25	1.57	37.59	6.85	5.46	1.25
	M	46.59	9.08	5.13	1.77	65.70	10.45	6.29	1.66
5	S	38.00	8.42	4.52	1.86	52.53	9.70	5.41	1.79
	M	62.15	11.30	5.50	2.05	81.99	12.59	6.51	1.93
6	S	30.22	7.26	4.16	1.75	37.53	7.79	4.82	1.62
	M	50.88	9.94	5.12	1.94	61.30	10.75	5.70	1.89
7	S	20.18	5.16	3.91	1.32	18.15	4.66	3.90	1.19
	M	18.48	5.80	3.18	1.82	17.94	5.23	3.43	1.52
8	S	21.48	5.36	4.00	1.34	17.65	4.04	4.36	0.93
	M	22.36	5.54	4.04	1.37	21.90	5.03	4.35	1.16

* loop length ℓ_{IN} measured with the new method [37] was applied for the calculations

case, the width loop module is $\alpha = 4$. A lower value of the width loop module $\alpha < 4$ indicates the widthwise compact structure, while the higher value of the width loop module $\alpha > 4$ indicates the widthwise open structure. From Table 4 and Figure 2, it can be seen that all dense knitted structures are widthwise compact. Loose knitted fabrics exhibit a widthwise compact structure when made from elastane core yarns, while the loose knitted fabrics made from yarns without elastane exhibit a widthwise open structure. The widthwise compactness indicates that the yarn is compressed within the interlacing points.

The height loop module β is the ratio between the loop height B and the yarn thickness d_{pr}. It shows to which extent the loop is filled with yarn in the height direction, i.e. the lengthwise compactness of the loop. With the normal knitted structure, where the needle and the sinker arcs are in contact [23], the loop height is $B = 2\sqrt{3}\, d_{pr}$; therefore, in this case, the height loop

$\alpha > 4$ pa prečno ohlapno pletivo. Iz preglednice 4 in slike 2 je videti, da so vsa gosto pletena pletiva prečno zbita, pri redko pletenih pa so prečno zbita vsa pletiva iz prej z elastanskim jedrom, medtem ko so redka pletiva iz prej brez elastanskega jedra prečno ohlapna. Prečna zbitost pletiva pomeni, da je preja v stičnih točkah stisnjena.

Višinski modul zanke β je razmerje med višino zanke B in debelino preje d_{pr} in kaže, kako je zanka po višini izpolnjena s prejo oz. opisuje vzdolžno zbitost pletiva. Pri pletivu z normalno strukturo, kjer se igelni in platinski loki zanke dotikajo [23], je $B = 2\sqrt{3}\, d_{pr}$, torej je v tem primeru višinski modul zanke $\beta = 3{,}46$. Manjši višinski modul zanke $\beta < 3{,}46$ pomeni vzdolžno zbito, večji višinski modul $\beta > 3{,}46$ pa vzdolžno ohlapno pletivo. Iz preglednice 4 je videti, da so vsa gosto pletena pletiva vzdolžno zbita, pri redko pletenih pa so vzdolžno zbita vsa pletiva iz prej z elastanskim jedrom, medtem ko so redka pletiva iz prej brez elastanskega jedra vzdolžno ohlapna, razen redko pletenega in mokro relaksiranega (konsolidiranega) pletiva iz viskozne preje, ki ima zaradi nestabilnosti in deformacije pri dinamični mokri relaksaciji izrazito zmanjšano višino zanke, predvidoma na račun povečanja širine zanke.

module is $\beta = 3.46$ [23]. A lower value of the height loop module $\beta < 3.46$ indicates a lengthwise compact structure while a higher value of the height loop module $\beta > 3.46$ indicates a lengthwise open knitted structure. From Table 4, it can be seen that all dense knitted structures when made from elastane core yarns are lengthwise compact. The loose knitted fabrics made from yarns without elastane exhibit a lengthwise open structure with an exception of the loose wet relaxed viscose knitted structure. The latter has a distinctly lower loop height, presumably on account of the increased loop width, all due to the instability and deformation of the structure after a dynamic wet relaxation.

The linear loop module δ is the ratio between the loop length ℓ and the yarn thickness d_{pr}. It is one of the basic knitted fabric parameters, which describes the compactness of a structure. For a normal knitted structure, Peirce [4] defined $\delta = 16.66$, Vekassy [39] defined $\delta = 17.33$ and Dalidovič [23] determined $\delta = 16.64$. For a vertically compact structure, Vekassy [39] defined $\delta = 13.85$.

From Table 4 and Figure 3, it can be seen that according to Dalidovič's criteria, all dense knitted fabrics are compact while according to Vekassy, all dense knitted fabrics are lengthwise compact except for the dry relaxed fabric made from polyacrylonitrile yarn which only slightly exceeds the limit value. All loose knitted fabrics made from elastane core yarns are also compact according to Dalidovič's criteria and all wet relaxed fabrics among them are simultaneously also lengthwise compact according to Vekassy's criteria. The linear loop module δ decreases in all cases with wet relaxation due to the yarn thickness increase and the knitted structure becomes even more compact.

The area loop module δ_{pl} is the ratio between the rectangle that limits the loop area and the area of yarn forming the loop. It describes the filling of the loop area unit with yarn. From Table 4, it can be seen that all dense knitted fabrics have the loop area completely filled with yarn. The yarn is compressed as in all cases and the area loop module is $\delta_{pl} < 1$. Therefore, all dense fabrics are compact. The dense knitted fabrics made from yarns without the elastane core have a significantly higher area loop module

Dolžinski modul zanke δ je razmerje med dolžino zanke ℓ in premerom preje d_{pr} in je eden temeljnih parametrov pletiva, ki opisuje zbitost strukture. Za normalno strukturo pletiva je Peirce [4] definiral δ = 16,66, Vekassy [39] δ = 17,33, Dalidovič [23] pa δ = 16,64. Za vertikalno zbito strukturo je Vekassy [39] definiral δ = 13,85.

Iz preglednice 4 in slike 3 je videti, da so glede na Dalidovičeva merila vsa gosta pletiva zbita, glede na Vekassyjeva merila pa so vzdolžno zbita vsa gosta pletiva, razen suho relaksiranega iz poliakrilonitrilne preje, ki le malo presega mejno vrednost. Tudi vsa redka pletiva iz prej z elastanskim jedrom so po Dalidovičevih merilih zbita, vsa mokro relaksirana (konsolidirana) med njimi pa so tudi vzdolžno zbita po Vekassyjevih merilih. Dolžinski modul zanke δ se v vseh primerih z mokro relaksacijo (konsolidacijo) zmanjša, saj se pri tem poveča debelina preje, pletivo pa postane (še) bolj zbito.

Ploščinski modul zanke δ_{pl} je razmerje med površino pravokotnika, ki omejuje zanko, in površino niti, ki oblikuje zanko; opisuje zapolnjenost enote zanke s prejo. Iz preglednice 4 je videti, da imajo vsa gosta pletiva površino popolnoma zapolnjeno s prejo, pri čemer je preja stisnjena, saj je v vseh primerih $\delta_{pl} < 1$. Vsa gosta pletiva so torej zbita. Gosta pletiva iz prej brez elastanskega jedra imajo pomembno višji ploščinski modul zanke δ_{pl} kot enaka pletiva iz prej z elastanskim jedrom. Ploščinski moduli zanke δ_{pl} redkih in gostih pletiv iz prej z elastanskim jedrom (vzorci 1–6) se ne razlikujejo pomembno, so pa δ_{pl} redkih pletiv iz prej brez elastanskega jedra (vzorca 7 in 8) pomembno višji od δ_{pl} istovrstnih gostih pletiv. V vseh primerih se ploščinski modul zanke δ_{pl} z mokro relaksacijo (konsolidacijo) zmanjša.

Prostorninski modul zanke δ_v je razmerje med prostornino kvadra, ki omejuje zanko ter prostornino niti, ki oblikuje zanko. Večji prostorninski modul pomeni ohlapnejšo strukturo pletiva. Iz preglednice 4 je vidno, da se prostorninski modul zanke z mokro relaksacijo (konsolidacijo) zmanjša. Zmanjšanje je posebno očitno pri pletivih iz prej z elastanskim jedrom, ki se pri mokri obdelavi zelo krčijo, hkrati pa se močno poveča debelina preje. Prostorninski moduli zanke pletiv δ_v iz prej brez elastanskega jedra so pomembno večji od tistih iz prej z elastanskim jedrom; pletiva iz prej brez elastanskega jedra so ohlapnejša.

Munden je svoje konstante definiral na podlagi obširnega eksperimentalnega dela za suho in mokro relaksirana pletiva, ni pa določil njihovih vrednosti za normalno, ohlapno in zbito strukturo. Ker je konstante določil na podlagi analize realnega uporabnega pletiva iz prej brez elastanskega jedra, verjetno opisujejo normalno do rahlo zbito strukturo pletiva, ki se najpogosteje proizvaja.

K_1 opisuje produkt med ploskovno gostoto pletiva D in kvadratom dolžine zanke ℓ^2. Ker se z relaksacijo dolžina zanke pri prejah brez elastanskega jedra le malo spremeni, povečanje konstante K_1 pomeni povečanje ploskovne gostote pletiva. Iz preglednice 5 izhaja, da imajo le pletiva iz prej brez elastanskega jedra ustrezno *compared to the equivalent knitted fabrics made from elastane core yarns. The area loop modules* δ_{pl} *of dense knitted and loose knitted fabrics made from elastane core yarns (Samples 1–6) do not differ significantly. Yet, the area loop modules* δ_{pl} *of the loose knitted fabrics made from yarns without the elastane core (Samples 7 and 8) are significantly higher than the area loop modules of equivalently dense knitted fabrics. In all cases, the area loop module* δ_{pl} *decreases with wet relaxation.*

The volume loop module is the ratio between the rectangular solid that limits the loop volume and the volume of the yarn forming the knitted loop within the fabric. It describes the voluminosity of the knitted structure. A higher value of the volume loop module indicates a more open knitted structure. From Table 4, it can be seen that the volume loop module decreases with wet relaxation. The decrease is especially evident with fabrics made from elastane core yarns which shrink considerably during the wet after-treatment and at the same time, their yarn diameter (thickness) increases considerably. The volume loop modules δ_v *of the knitted fabrics made from yarns without elastane are considerably higher than those of the knitted fabrics made from elastane core yarns. The knitted fabrics made from yarns without the elastane core are more open.*

Munden defined his constants for the dry and wet relaxed knitted fabrics on the basis of extensive experimental work; however, he did not determine their values for an open, normal and compact knitted structure. As he defined his constants on the basis of real applicable knitted fabrics made from yarns without the elastane core, they presumably describe normal to slightly compact knitted structure which is produced most commonly.

K_1 *represents a product between the area density of the knitted fabric D and the square of the loop length* ℓ^2*. As the loop length of the fabrics made from yarns without the elastane core changes only slightly with relaxation, the* K_1 *increase signifies the area density increase. From Table 5, it follows that only the knitted fabrics made from yarns without the elastane core exhibit an adequate value of the constant* K_1*, which is* K_1 *= 19.0 for the dry relaxed fabrics*

vrednost konstante K_1, ki za suho relaksirano pletivo znaša K_1 = 19,0, za mokro relaksirano pa K_1 = 21,6. Konstante K_1 pri vseh pletivih iz prej z elastanskim jedrom močno odstopajo od priporočene vrednosti. Z mokro relaksacijo (konsolidacijo) se odstopanje še poveča zaradi pomembnega povečanja ploskovne gostote pletiva D.

Konstanta K_2 je produkt vertikalne gostote pletiva D_v in dolžine zanke ℓ. Povečanje konstante K_2 pri enaki dolžini zanke pomeni večjo vzdolžno zbitost pletiva. Iz preglednice 5 je vidno, da imajo le pletiva iz prej brez elastanskega jedra ustrezno vrednost konstante K_2, ki za suho relaksirano pletivo znaša K_2 = 5,0, za mokro relaksirano pa K_2 = 5,3. Konstante K_2 pri vseh pletivih iz prej z elastanskim jedrom močno odstopajo od priporočene vrednosti. Z mokro relaksacijo (konsolidacijo) se odstopanje še poveča zaradi velikega povečanja vertikalne gostote pletiva D_v.

Konstanta K_3 je produkt horizontalne gostote pletiva D_h in dolžine zanke ℓ. Povečanje konstante K_3 pri enaki dolžini zanke pomeni večjo prečno zbitost pletiva. Preglednica 5 kaže, da se le pletiva iz prej brez elastanskega jedra približujejo priporočeni vrednosti konstante K_3, ki za suho relaksirano pletivo znaša K_3 = 3,8, za mokro relaksirano pa K_3 = 4,1. Konstante K_3 pri vseh pletivih iz prej z elastanskim jedrom odstopajo od priporočene vrednosti, vendar je odstopanje manjše kot pri K_2. Z mokro relaksacijo (konsolidacijo) se odstopanje poveča zaradi povečanja horizontalne gostote pletiva D_h. Odstopanje od priporočene vrednosti Mundenove konstante in povečanje vrednosti konstante z mokro relaksacijo (konsolidacijo) je za pletiva iz prej z elastanskim jedrom bolj izrazito pri K_2 kot pri K_3, kar pomeni, da je pletivo iz teh prej bolj vzdolžno kot prečno zbito.

Konstanta K_4 je razmerje med K_2 in K_3 in hkrati nasprotna vrednost koeficienta gostote pletiva C, katerega vrednosti v odvisnosti od vrste preje, pletiva in relaksacije so podane v preglednici 3. Priporočena vrednost K_4 za suho relaksirano pletivo je K_4 = 1,32, za mokro relaksirano pa K_4 = 1,29. Tem vrednostim najbolj ustrezajo izračunane vrednosti K_4 za pletiva iz prej brez elastanskega jedra, pletiva iz prej z elastanskim jedrom pa, razen nekaterih redko pletenih in suho relaksiranih iz poliakrilonitrilnih prej, od priporočene vrednosti pomembno odstopajo.

5 Sklepi

Krčenje pletiv iz visokoelastičnih prej z elastanskim jedrom po pletenju in predvsem po mokri relaksaciji (konsolidaciji) je pomembno večje od krčenja pletiv iz prej brez elastanskega jedra. Posledica je pričakovano pomembno odstopanje parametrov zanke in pletiva iz prej z elastanskim jedrom od parametrov zanke in pletiva iz prej brez elastanskega jedra. Normalna do ohlapna struktura se s suho oz. suho in mokro relaksacijo (konsolidacijo) spremeni v zbito in zelo zbito. Zelo zbito strukturo pletiva je mogoče definirati kot superzbito strukturo.

Table 6: Definition of parameters of supercompact, compact, normal and open structure

		structure			
		supercompact	compact	normal	open
knitted fabric parameter	K (tex$^{1/2}$mm^{-1})	$K > 1.5$	$K \geq 1.4$	$K = 1.4$	$K < 1.4$
	α	$\alpha < 2$	$2 \leq \alpha \leq 4$	$\alpha = 4$	$\alpha > 4$
	β	$1 \leq \beta \leq 3$	$3 < \beta < 3.46$	$\beta = 3.46$	$\beta > 3.46$
	δ	$\delta < 9.5$	$9.5 \leq \delta < 16.6$	$16.6 \leq \delta \leq 17.3$	$\delta > 17.3$
	δ_{pl}	$\delta_{pl} < 0.2$	$0.2 \leq \delta_{pl} < 1$	$\delta_{pl} = 1$	$\delta_{pl} > 1$
	δ_v	$\delta_v < 0.5$	$0.5 \leq \delta_v < 1$	$\delta_v = 1$	$\delta_v > 1$

and $K_1 = 21.6$ for the wet relaxed (consolidated) knitted fabrics. The constants K_1 of all knitted fabrics made from elastane core yarns exceedingly differ from the recommended value. The difference even increases with wet relaxation (consolidation), due to a significant increase in the area density D.

The constant K_2 is a product of the vertical density of the knitted fabric D_v and the loop length ℓ. The K_2 increase at the unchanged loop length value signifies a more lengthwise compact knitted structure. From Table 5, it can be seen that only the knitted fabrics made from yarns without the elastane core exhibit an adequate value of the constant K_2, which is $K_2 = 5.0$ for the dry relaxed knitted fabrics and $K_2 = 5.3$ for the wet relaxed (consolidated) knitted fabrics. The constants K_2 of all knitted fabrics made from elastane core yarns exceedingly differ from the recommended value. The difference even increases with wet relaxation (consolidation), due to a significant increase in the vertical density D_v.

The constant K_3 is a product of the horizontal density of the knitted fabric D_h and the loop length ℓ. The K_3 increase at the unchanged loop length value signifies a more widthwise compact knitted structure. From Table 5, it can be seen that only the knitted fabrics made from yarns without the elastane core exhibit the value of the constant K_3 which is close to the recommended value $K_3 = 5.0$ for the dry relaxed knitted fabrics and $K_3 = 5.3$ for the wet relaxed (consolidated) knitted fabrics. The constants K_3 of all knitted fabrics made from elastane core yarns exceedingly differ from the recommended

Na podlagi pregleda zbranih vrednosti parametrov pletiva (preglednice 3–5) je mogoče definirati parametre pletiva za superzbito, zbito, normalno in ohlapno strukturo pletiva. Podani so v preglednici 6.

Širinski modul zanke α opisuje prečno zbitost pletiva, če je $\alpha < 4$. Vsa preskušana pletiva iz prej z elastanskim jedrom, gosta in redka, suho ter suho in mokro relaksirana (konsolidirana), imajo širino zanke $A < 4d_{pr}$. Gosta in redka suho relaksirana pletiva iz prej z elastanskim jedrom imajo $2 \leq \alpha \leq 4$, kar je mogoče označiti za prečno zbito strukturo, gosta in redka suho in mokro relaksirana (konsolidirana) pletiva iz prej z elastanskim jedrom pa imajo $\alpha < 2$, kar je mogoče označiti za prečno superzbito strukturo. Gosta pletiva iz prstanskih prej brez elastanskega jedra se približujejo idealni prečno normalni strukturi ($\alpha = 4$), medtem ko so redka pletiva iz prstanskih prej brez elastanskega jedra prečno ohlapna, saj je $\alpha > 4$.

Višinski modul zanke β opisuje vzdolžno zbitost pletiva, če je $\beta < 3{,}46$. Vsa pletiva iz prej z elastanskim jedrom, gosta in redka ter suho in mokro relaksirana (konsolidirana), imajo višino zanke $B < 3{,}46\ d_{pr}$. Gosta in redka suho relaksirana pletiva iz prej z elastanskim jedrom imajo $1 \leq \beta \leq 3$, kar je mogoče označiti za vzdolžno zbito strukturo, gosta in redka mokro relaksirana (konsolidirana) pletiva iz prej z elastanskim jedrom pa imajo $\beta < 1$, kar je mogoče označiti za vzdolžno superzbito strukturo. Gosta pletiva iz prstanskih prej brez elastanskega jedra so vzdolžno zbita, a se bližajo idealni vzdolžno normalni strukturi ($\beta = 3{,}46$), medtem ko so redka pletiva iz prstanskih prej brez elastanskega jedra vzdolžno ohlapna, saj je v večini primerov $\beta > 3{,}46$.

Idealni dolžinski modul zanke je glede na modele zanke Peircea [4], Dalidoviča [6, 23] in Vekassyja [39] $\delta = 16{,}6–17{,}3$, dolžinski modul zanke zbitega pletiva pa je po Vekassyju $\delta = 13{,}4$ [39]. Dolžinski modul zanke δ za vsa gosta in redka, suho in mokro relaksirana (konsolidirana) pletiva iz prej z elastanskim jedrom je $\delta < 16{,}6$. Kot superzbita je mogoče definirati pletiva, pri katerih je $\delta < 9{,}5$; superzbita so torej mokro relaksirana (konsolidirana) gosta pletiva iz prej z elastanskim jedrom. Zbita so gosta suho re-

value; nevertheless, the difference is smaller than with K_2. The difference even increases with wet relaxation, due to a significant increase in the horizontal density D_h. The deviation from the recommended value of the Munden constant and the increase in the constant value with wet relaxation (consolidation) is more distinctive for the constant K_2 than for the constant K_3 with the knitted fabrics made from elastane core yarns. This signifies that the knitted fabrics made from these yarns are more compact lengthwise than widthwise.

The constant K_4 is the ratio between K_2 and K_3, and simultaneously the inverse value of the knitted fabric density coefficient C. Its values in dependence on the yarn type, knitted fabric structure and the relaxation process are shown in Table 3. The recommended value of K_4 is $K_4 = 1.32$ for the dry relaxed fabric and $K_4 = 1.29$ for the wet relaxed (consolidated) fabric. The calculated values of K_4 for the knitted fabrics made from yarns without elastane correspond the most to these recommended values. The constants K_4 of the knitted fabrics made from elastane core yarns deviate significantly from the recommended values except for some loose knitted and dry relaxed knitted fabrics made from polyacrylonitrile yarns.

5 Conclusions

The shrinkage of knitted fabrics made from highly elastic yarns with the elastane core after the knitting and above all, after the wet relaxation (consolidation) is significantly higher than the shrinkage of the knitted fabric made from yarns without the elastane core. The consequence is the anticipated significant deviation of the loop parameters and structural parameters of knitted fabrics made from elastane core yarns from the loop and structural parameters of knitted fabrics made from yarns without the elastane core. A normal to open structure converts to a compact or a very compact structure after the dry or dry and wet relaxation. A very compact knitted structure can be defined as a supercompact structure.

On the basis of the gathered values of the knitted fabric parameters (Tables 3–5), the parameters for a supercompact, compact, normal and laksirana pletiva iz prej z elastanskim jedrom ter redka suho in mokro relaksirana (konsolidirana) pletiva iz prej z elastanskim jedrom. Normalno do ohlapno strukturo imajo redka pletiva iz prstanskih prej brez elastanskega jedra, zbito do normalno pa gosta pletiva iz prstanskih prej brez elastanskega jedra.

Ploščinski modul zanke opisuje zbito strukturo, če velja $\delta_{pl} < 1$. Približno normalno strukturo, za katero velja $\delta_{pl} = 1$, imajo redka pletiva iz prstanskih prej brez elastanskega jedra. Normalno do zbito strukturo imajo gosta pletiva iz prstanskih prej brez elastanskega jedra. Mokro relaksirana (konsolidirana) pletiva iz prej z elastanskim jedrom imajo $\delta_{pl} < 0{,}2$ in jih je mogoče označiti za superzbita.

Prostorninski modul zanke opisuje zbito strukturo, če velja $\delta_v < 1$. Ohlapno strukturo, za katero velja $\delta_v > 1$, imajo gosta in redka, suho in mokro relaksirana (konsolidirana) pletiva iz prstanskih prej brez elastanskega jedra. Pletiva, ki imajo $\delta_v < 0{,}5$, je mogoče označiti za superzbita; v to skupino spadajo gosta in redka mokro relaksirana (konsolidirana) pletiva iz prej z elastanskim jedrom. Zbito do normalno strukturo imajo gosta in redka suho relaksirana pletiva iz prej z elastanskim jedrom.

Faktor kritja pletiva $K = T_t^{1/2} / \ell$. $K > 1{,}4$ označuje zbito pletivo. Glede na ostale parametre je mogoče določiti, da je faktor kritja K za superzbito pletivo $K > 1{,}5$.

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open knitted structure can be determined. They are presented in Table 6.

The width loop module α *denotes the widthwise compactness of the knitted fabric if* $\alpha < 4$. *All the investigated knitted fabrics made from elastane core yarns, dense and loose, dry and dry & wet relaxed (consolidated) exhibit the loop width* $A < 4d_{pr}$. *The dense and loose dry relaxed knitted fabrics made from elastane core yarns have* $2 \leq \alpha \leq 4$, *which can be indicated as a widthwise compact structure. The dense and loose dry & wet relaxed (consolidated) knitted fabrics made from elastane core yarns exhibit* $\alpha < 2$ *which can be denoted as a widthwise supercompact structure. The dense knitted fabrics made from yarns without the elastane core approach the ideal widthwise-normal structure* ($\alpha = 4$), *while the loose knitted fabrics made from yarns without the elastane core are widthwise open, as* $\alpha > 4$.

The height loop module β *denotes a lengthwise compactness of the knitted fabric if* $\beta < 3.46$. *All the investigated knitted fabrics made from elastane core yarns, dense and loose, dry and dry & wet relaxed (consolidated) exhibit the loop height* $B < 3.46\ d_{pr}$. *The dense and loose dry relaxed knitted fabrics made from elastane core yarns have* $1 \leq \beta \leq 3$, *which can be indicated as a lengthwise compact structure. The dense and loose dry & wet relaxed (consolidated) knitted fabrics from elastane core yarns have* $\beta < 1$, *which can be denoted as a lengthwise supercompact structure. The dense knitted fabrics made from yarns without the elastane core are lengthwise compact, however, they approach the ideal lengthwise-normal structure* ($\beta = 3.46$). *The loose knitted fabrics made from yarns without the elastane core are lengthwise loose, as in most cases* $\beta > 3.46$.

The ideal linear loop module is $\delta = 16.6$–17.3 *according to the loop models of Peirce [4], Dalidovič [6, 23] and Vekassy [39], while according to Vekassy, the compact knitted fabric linear loop module is* $\delta = 13.4$ *[39]. The linear loop module* δ *of all knitted fabrics made from elastane core yarns, dense and loose, dry and dry & wet relaxed (consolidated) is* $\delta < 16.6$. *The knitted fabrics with* $\delta < 9.5$ *can be denoted as supercompact. Therefore, the wet relaxed (consolidated) dense knitted fabrics made*

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from elastane core yarns exhibit a supercompact structure. The dry relaxed dense knitted fabrics made from elastane core yarns, and the dry & wet relaxed (consolidated) loose knitted fabrics made from elastane core yarns exhibit a compact structure. A normal to open structure is exhibited by loose knitted fabrics made from yarns without the elastane core, while a compact to normal structure is exhibited by dense knitted fabrics made from yarns without the elastane core.

The area loop module denotes a compact knitted structure if $\delta_{pl} < 1$*. An approximately normal structure for which* $\delta_{pl} = 1$ *is exhibited by loose knitted fabrics made from yarns without the elastane core. A normal to compact structure is exhibited by dense knitted fabrics made from yarns without the elastane core. The wet relaxed (consolidated) knitted fabrics made from elastane core yarns have* $\delta_{pl} < 0.2$ *and can be denoted as supercompact structures.*

The volume loop module denotes a compact structure if $\delta_v < 1$*. An open structure for which* $\delta_v > 1$ *is exhibited by dense and loose, dry & wet relaxed (consolidated) knitted fabrics made from yarns without the elastane core. Knitted fabrics that have* $\delta_v < 0.5$ *can be denoted as supercompact – dense and loose wet relaxed (consolidated) knitted fabrics made from elastane core yarns can be classified into this group. A compact to normal structure is exhibited by dense and loose knitted dry relaxed knitted fabrics made from elastane core yarns.*

The knitted fabric cover factor is $K = T_t^{1/2} / \ell$*.* $K > 1.4$ *denotes a compact structure. According to other examined knitted fabric structural parameters, it can be defined that the cover factor for a supercompact structure is* $K > 1.5$*.*

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