Effect of Moisture Acquired with Time-Periodic after Sizing on Yarns Abrasion Resistance

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Abstract

The weaving process is based on various factors, including the structural aspects of the yarns and the sizing process of the sizing materials, the thread is a complex structural composition with great physical characterises. The abrasion resistance properties are among the main factors that affect the performance of the warp threads during the weaving process and its processing and other mechanical properties. The sizing process is an important preparation process to increase the loom's efficiency and the fabric's quality.

The current research concerns the abrasion resistance before and after sizing the isolated threads inside the sizing hall, as it was examined in three different structural materials. Each structure is considered an independent case. Measuring and evaluating the effectiveness of the sizing to resist abrasion was based on the yarn moisture obtained with the isolation period in the sizing room (outside the sizing machine). Yarn abrasion resistance was examined before and after the sizing process.

Keywords:

sizing process, materials construction, yarn abrasion.

الملخص:

ان عملية النسيج تتم بناءً على عوامل مختلفة، بما في ذلك العوامل البنائيه للخيط، وعملية البوش وأيضا مواد البوش حيث يتميز الخيط بتركيب بنائي معقد ويتميز بخصائص فيزيائية كبيرة حيث تعتبر خصائص مقاومة التآكل من العوامل الرئيسية التي تؤثر على أداء خيوط السداة أثناء عملية النسج وتجهيزها عن الخصائص الميكانيكية الأخرى.

ان عملية البوش هي عملية تحضير مهمة لزيادة كفاءة النول وكفاءة جودة النسيج. يهتم البحث الحالي بمقاومة التآكل قبل وبعد عملية بوش الخيوط المعزولة داخل صالة البوش، كما تم فحصها في ثلاثة مواد بنائيه مختلفة. تعتبر كل عينة حالة مستقلة. اعتمد قياس وتقييم فعالية البوش لمقاومة التآكل على رطوبة الخيط المكتسبة مع فترة العزل في صالة البوش (خارج ماكينة البوش). تم إجراء مقاومة تآكل الخيط قبل وبعد عملية البوش.

الكلمات المفتاحية:

عملية البوش. التركيب البنائي للخامه. تاكل الخيوط

Introduction:

A high degree of penetration inside the yarn provides a better binding force. Poor weave-ability results when there is less penetration of the size material in the yarn core, eventually, the low binding energy of fibres. The adhesive power of a sizing agent is an important factor in assessing its suitability as much as the adhesive power of what gives the sized yarn a higher abrasion resistance.

The current decade has seen exponential growth in the interest in cellulose research. Rapid development in cellulose chemistry, processing and characterisation has led to a property scope of cellulose-based materials. There is a preference in the cellulose field to invoke H-bonding as an almost phenomenal justification (Berglund et al., 2010) [1]; Benıtez et al., 2017) [2].

The end breakages in the weaving process mostly rely on the size of pickup agents, with their share of individual components in size. Qualitatively sizing protects the warp yarns from the weaving process, enhancing the planned efficiency of the fabric quality. Qualitative sizing is applied to the yarns to preserve and strengthen weak places. Dynamic forces arise during weaving, possibly exceeding the breaking strength of weak places. By sizing, fibres are fixed together, as the yarn receives abrasion resistance during a surface film is formed on the yarn. The quantity of size pickup on yarn should be determined by the lab measuring samples of sized yarn, which makes it possible to keep the pickup size constant.

The level of twisted yarn affects the size pickup, where the lower level of twisting is an "opener", enabling a higher absorptive capacity of the size than a yarn with a higher level of twist. The size pickup will be different, resulting in a different sizing effect. The influence of the twist level on the size pickup and physical and mechanical properties of the yarn is investigated in this work (Kovačević,2000)[3].

The size must create a surface layer whose strength will take up and withstand stresses in the weaving process, and the fibres within the yarn should remain in the position assumed before sizing. Surface sizing is preferred, and today producers of sizing agents are researching it intensively, as well as sizing machine manufacturers of size boxes. The condition for this kind of sizing is new sizing agent properties with a higher capability of adhesiveness and elasticity. One problem that still needs to be solved in the sizing process is that water vaporises during the sizing process, resulting in an increase in size concentration in the size box. The consequence is that the yarn is sized with increasing size concentration, and the size penetrates the yarn increasingly harder. Thus, the yarn will be sized with a higher-size pickup. A regular-size pickup on the warp yarn is achieved by regulating the squeezing force on the last pair of rollers. The squeezing pressure is changed during the sizing process by altering the passage speed. The box entry speed is higher than the box exit speed to obtain as low tension as possible in a wet condition and, thereby, better penetration of the size into the crevices of the yarn (Schwarz 2014)[4].

Size pickup does not only depend on sizing requirements but also yarn properties. The fact is that thread of the same count, raw material composition, and fibre quality sometimes differ in the level of twist, resulting from the purchase of yarn from different spinning mills or even from the same spinning mill. Differences in twist level exist not only in production batches but also in the same yarn package.

The number of warp yarn breaks on the loom depends greatly on the percentage and quality of the size coat and the sizing process. The number of thread breaks will change, as will as the production of the looms and the quality of the end product. Keeping the size coat constant is complex and depends on various factors associated with raw materials, size and automation of the sizing machine, etc. (Sejri et al.2008)[5].

The research importance.

- Each yarn element is subjected to destructive actions such as extensions, bending and abrasion during weaving.
- Due to abrasion, the tensile deformation accelerates yarn failure.
- Due to the immersing time of the sized yarn, the yarn and the size film are supposed to react differently.
- The rubbing action will affect the size film first, and repeated extension movement will ultimately destroy both elements.
- Due to the rubbing action, the abrasion deteriorates the yarn strength.

Previous work

Kovačević et al. (2009)[6] studied the impact of the level of yarn twist on the size pickup, abrasion resistance and breaking force of yarn are analysed. A cotton yarn differing only in twist level was used for testing.

The sizing process was carried out on a laboratory sizing machine. Sizing conditions were varied, especially the squeezing force and size recipe. According to the results, the twist level affects the size pickup, abrasion resistance and breaking force. Based on the coefficient of correlation, it can be claimed that the level of twist concerning the size pickup and breaking force is very high, confirming that a very close correlation is systematically proved.

To know if it is possible to decrease the size content of the yarn with mechanical properties for good 'wearability', Sejri et al. (2011)[7] investigated the effect of adding a wetting agent to a size solution and the water operated for the pre-wetting. The consequence of adding the wetting agent's physical and mechanical differentiation was examined. As a result of adding the wetting agent to a size solution, it was found that, during the tensile test, an enlargement in Young's modulus of elasticity of the yarn sized classically was affected as a result of a decrease in a pre-wetting technique. Using the Kawabata evaluation unit illustrated the same conclusion regarding bending rigidity. These deteriorations have been demonstrated by using scanning electron microscopy. However, the micrographs show that the fibres of yarns sized with the pre-wetting technique are coated with the size film and not bridged to the size, which illustrates the decrease in the mechanical properties. Eventually, this coating is not recommended in the sizing process.

Schwarz(2013)[8] examines the influence of the sizing process on the multi-coloured warp, an investigation consisting of two stages of sample treatment and testing. The first stage was dyeing cotton yarns (counts of 20tex and 30tex) using reactive dyes and investigating the Differences in physical and mechanical properties between yarns of different colours. In the second stage, all samples were sized using the standard sizing process as pre-wetting sizing, with two different size concentrations. Moreover, it investigated the impact of dyeing on size bonding to the yarn and the physical-mechanical properties of sized yarns.

Sizing is an important step to increase the efficiency of weaving production to produce a woven fabric. Taosif et al.(2021)[9] investigated various sizing agents such as starch, carboxymethyl cellulose (CMC) and polyvinylalcohol (PVA); they evaluated this sizing agent as one of the parameters using a modified sizing agent. The recipes mix various sizing chemicals for modification of the sizing agent. Then the modified sizing agents are applied to the cotton fabric. After sizing, the yarns and fabrics are liable to assess the performance of sizing parameters. Eventually, the modified sizing agent showed a higher tenacity (Djordjevic et al.2014)[10].

The modified agent has an acceptable range of sizing parameters; even in some cases, the performances are higher than the frequently used sizing agent. Most importantly, the modified sizing agent reduces chemical consumption and makes weaving production cost-effective. The modified sizing became an economically sustainable development in the textile industry(Djordjevic et al.2019)[11].

Kovaˇcevi et al., 2004)[12] reported that sizing is how an adhesive is applied to the yarn predominantly to improve the weaving capacity of twist yarn by making it more impervious to weaving activities such as tension, fixation, absorption and flexing. It likewise keeps up great texture quality by decreasing hairiness and expanding the perfect absorbency of yarn. The most different highlights of the sizing are changes in other actual properties. Sizing is applied to the yarn surface by different cycles and plans as indicated by the prerequisites; sizing is termed "Heart of Weaving".

Rozelle (2001) [13]reported that during various processing methods (winding, weaving, knitting) when yarns pass through multiple guides, it becomes subjected to friction when passing over surfaces made from different materials of various smoothness or when they rub against each other. Depending on its frictional properties and abrasion resistance, as well as on the surface characteristics of rubbing elements; the yarn to a greater or lesser degree, wears out, deforms, and changes its surface, causing difficulties and standstills during production respectively. When testing the abrasion resistance, the number of yarns passing over the abrading element is used to measure the resistance, whereby the yarn is broken.

To better understand the possible comparability of the results of the different tests, Textor et al. (2019)[14]investigated three established test methods(Martindale, Schopper, and Einlehner) for evaluating the abrasion or wear resistance, they were compared to gain deeper insight into the specific damaging mechanisms. The knowledge of these mechanisms is necessary for the systematic development of finishing agents improving the wear resistance of textiles. Tests analysed two natural (cotton) fabrics and synthetic (polyethene terephthalate) fibres. Samples were investigated by digital microscopy and scanning electron microscopy to visualise the damage. Damage symptoms are compared and discussed concerning differences in the damaging mechanisms.

Sizing plays a very important role as one of the considerably complex steps in the weaving process. The primary purpose of the sizing is to obtain the warp threads that can successfully be woven without major damages which occur during the yarn passage through sliding metal parts of the weaving machine (Maatoug,2007b)[15]. It applies to improving the physical and mechanical parameters of warp threads, primarily to increase strength and abrasion resistance and thus to reduce the number of warp breaks to a minimum to achieve the maximum efficiency of weaving looms and energy savings. Also, the goal of sizing is to keep the fibres in the yarn in a position where they were before sizing, with minimal yarn deformations during weaving(Kovacevic et al.2006)[16].

The success of the weaving process depends on the complexity of several factors, including the characteristics of the desired material, the sizing process, the sizing ingredients and yarn properties. Moreover, the extensive knowledge of a textile technologist makes this process more difficult and more important for the overall operation of woven fabric (Maatoug et al., 2007)[17].

The aim of the present work

The present research is to compare and understand differences in industrially yarn components sustained on the sizing room for a periodic time. This study investigated the time-periodic sustainability at the sizing room condition (not in the sizing box) performance by measuring the physical properties of cotton in different sample sized at the state of the sizing room. Every sample is considered an independent case concerning the abrasion resistance tests.

The present work investigates the effect of adding a sizing period to know if it can increase the yarn's mechanical properties allowing good 'wearability'. The impact on the physical and mechanical characteristics of increasing the sustained time of warp threads up to 10 days was examined by measuring the mechanical properties every two days.

Precaution of the sizing process.

One of the basic tasks is to keep the size coat fast, accurate, and constant during the sizing process (Kovačević 2002)[18]. One of the basic prerequisites for obtaining good and economical sizing is that the size coat in the warp is uniform while sizing the batch.

It is necessary, therefore, to keep some influencing factors constant such as:

- Concentration, viscosity and temperature in the size box.
- The speed of the warp through the size box.
- The inlet moisture of the warp before sizing.
- The outlet moisture of the warp after sizing.
- The squeezing force.
- The tension of the warp threads through the size box, etc…

The present research is considerably concerned with the following parameters:

- The raw material of the yarn.
- Materials characteristics include yarn count, yarn twist, yarn type and quality.
- The time-periodic in the sizing room.

Yarn Materials and methods.

Three types of yarns in <u>three independent cases</u> have been used as shown in table(1):

Table(1): Types of yarns under testing

no	Composition (Cotton Giza 86)	Count E	Twist factor
1	Combed cotton yarn	40 S.twist Single	4.2
2	Combed cotton yarn	80/2. S.twist Doubled	
3	Blended cotton50% /polyester 50%	40. S.twist Single	

The experiment was conducted on a sizing machine equipped with a dry mechanism. Sufficient beams were prepared from the same creel. The other sizing variable that could influence yarns' weave-ability, like size liquor concentration, viscosity and temperature, size add and machine speed, were kept constant.

Sizing materials

Textile finishing and surface modification can improve the abrasion resistance of given yarns by changing the slip resistance by applying hard coatings (Brzeziński 2011)[19]; otherwise, by lowering the frictional resistance(Li,2017)[20].

The sizing process

All the conditions necessary to achieve maximum sizing results were held constant. The conditions of the sizing process were not varied by changing the recipe or size concentrations. The size temperature in the size box was 90° C, the sizing speed was 40-50 m/min.

Sizing agent

The following agents were used for preparing the size:

- Polyvinyl alcohol (PVA) type Vinerol STH tt. Hoechst (now Clariant).
- Carboxymethyl cellulose (CMC) type Tylose C30 by Hoechst.

CMC has an extremely high grip on cellulose filaments and is joined with PVA to help their productivity (Xiao et al., 2009)[21].

The size preparation recipe

The size parameters and the sizing conditions were the same for all the samples:

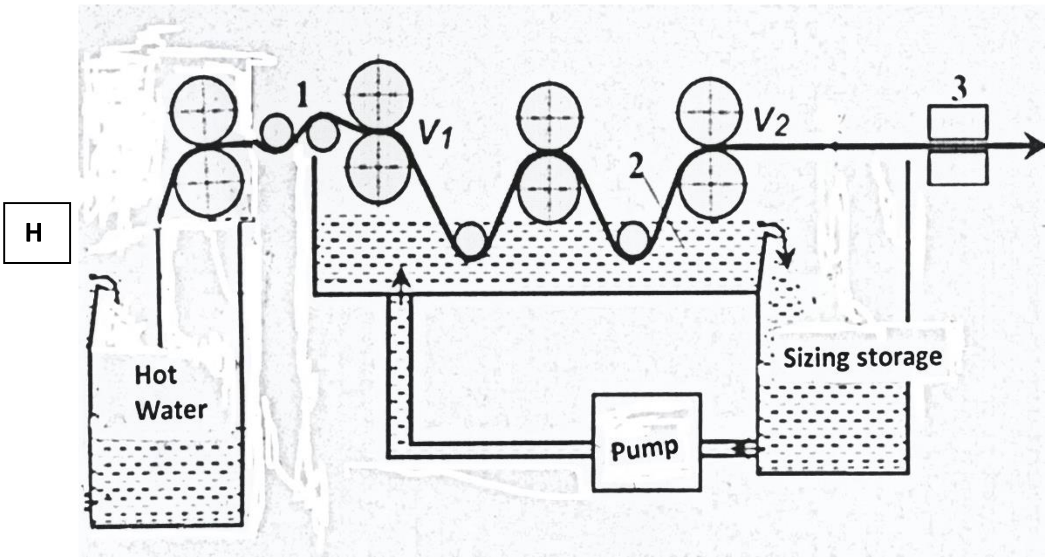
- Composition: 3.5 kg PVA + 3.5 kg CMC + 100 L water.
- Concentration 6.5%
- Sizing rate - from 4 to 6 m/min.
- Temperature 90°C.
- Squeezing constant at a pressure of (100 N).

The sizing device

The yarn sizing operation was carried out using an experimental laboratory device using a specific sizing device and its essential components, as shown in the schematic diagram (1).

The yarn bobbins are placed in fixed support to avoid the yarn tangle and to keep the same tension. The raw yarns are passed through the first container with hot water and squeezing rollers. A temperature as high as 90°C ensures an adequate wetting process. This container is placed on a hotplate to keep the same temperature. Then the yarns are immersed in the second container of size solution maintained at 90 C. The yarns with the wet size box are passed through a pair of squeezing rollers to remove the excess size liquid from the yarn before reaching the drying zone. Finally, the yarns are rolled up on a new bobbin.

The entry moisture corresponded to a moisture regain of 8%. The exit moisture was kept constant by regulating the sizing speed, ranging from 6 to 7.5 % moisture regain. A tensiometer made by Rothchild was used to measure and sustain tension values. The size concentration was measured using a Carl Zeiss Jena refractometer.



Schematic diagram(1) of yarn sizing operation

1 - Measuring the warp moisture point before sizing.
2 - Taking samples storage for concentration measurement.
3 - Point of Warp moisture measuring after sizing.
v1 - Measuring the speed of the warp at the entrance of the size box, in m/min.
v2 - Measuring the speed of the warp outlet from the size box in m/min,
P- pump.
H- Hot water storage.

Preparation of yarn sample

The present study obtains the yarn materials from Misser Spinning & Textile public sector (MST) Mills. The sizing process was carried out at the laboratory of the same Mill.

All the conditions mentioned are necessary to achieve maximum sizing results in the sizing process. They were held constant for each case; therefore, it can be safely claimed that each yarn sample is sized under the same conditions.

- The testing process was carried out as the sizing sample was dried, weighed, and sized, then dried again and weighed.
- The amount of size picked up is calculated as percentage values.
- The sample was sustained in the sizing room(out of the size box) five times-periodic,2,4,6,8,10 days.
- This period is possible because the Mill has more than 36000 weaving looms, and the sized beams are supposed to be ready whenever the looming machine is prepared.

Process of testing :

Method of testing the samples

Yarn abrasion resistance methodologies used for testing could be divided into two categories:

1.The first category utilises a specified abrasion material (Oxenham et al.). A typical example of this instrument is Zweigle G 552 tester (Goswami 2004)[22] and the Wira tester (Zweigle .2007)[23].
2.The second category is the CTT yarn abrasion tester, and the representative instrument is the Reutlinger tester; measurement can be realised in normal or wet conditions (Reutlingen,2007)[24].
Where the loom specification, speed, and all interactions rely on yarns, the guiding places, however, they are different for various looms, where mechanical simulation conducted on a laboratory loom or its position parts can simulate results close to the actual weaving process. Emulation of "yarn on the yarn" abrasion can assist us in understanding the mechanism of yarn deterioration during yarn-on-yarn contact. According to the model of the Zweigle tester, the yarns have been tested.

Abrasion resistance is usually expressed as several strokes to yarn destruction. A criterion based on weight reduction is problematic because limited yarn length can be weighed. A weight decrease due to abrasion can be easily expressed as the yarn diameter changes. According to methodology IN 32-102-01/01, at 50% of the number of strokes, the diameters of the initial and deteriorated-sized yarn samples were observed. Zweigle G 552 instrument was used by counting the number of stokes up to destruction (pretension 20g, emery paper P 800 with abrasive grain alpha Al2O3 and loom reed, 60 measurements. (Technical Notes .2005;2007) [25,26] & (Mayer et al., 2018)[27].

Testing process.

The process was as follows: The sample was weighed and then sized before sizing. The size picked up was calculated every time-periodic, and then the abrasion resistance was measured.

Case 1

Material:

Combed cotton with a yarn count of 40 E. Giza 86

S twist, twist factor 4.2.

The results indicate that the amount of size absorption and distribution determined many features of yarn properties. The difference between the yarns sized with samples of the sizing process is easily calculated as follows:

$$\%\text{Miosture Difference} = \frac{\text{PoMS} - \text{PrMS}}{\text{PrMS}} \text{x100}$$

PrMS= pre-moisture content outside the sizing room.
PoMS= Post- moisture content at zero-day inside the sizing room after sizing.
MS= Material sized outside the sized box.
MA=Abrasion resistance at every time-periodic.
PoMA= Post- moisture abrasion resistance.
DS= % Moisture difference content at the sizing room outside the sizing box.

$$= \frac{MS-PoMS}{PoMS} \times 100$$

DA= % abrasion resistance.

$$= \frac{MA - PoMA}{PoMA} \times 100$$

TP= Time-Periodic inside the sizing room(outside the sizing box).

Σ=Mean value

The measurements of the sizing process for the yarn materials are first taken outside the sizing room (PrM) and inside the sizing room(PoM), and the abrasion resistance testing. The differences are reported as % values in table (2).

Table (2) The measurements of the sizing process

%Abrasion resistance of the sized yarns			% Moisture absorption				
DA	**MA**	**PoMA**	**DS**	**MS**	**PoMS**	**PrMS**	**PT**
202.6	90.8	30	11.6	4.6	4.3	5.2	2
213	93.9		25.5	6.7			4
222	96.6		37.2	15.6			6
228.6	98.6		46.5	19.6			8
236.6	101.0		55.8	23.6			10
220.6	96.18		35.2	14.02			Σ

Measuring the Yarn abrasion resistance

A size yarn extensively has high abrasion resistance. This property is reflected by its increased tensile strength with minimum loss of elasticity and required moisture for looming. The weaving beam should not have more missing ends, cross ends, lappers and taped ends to unwind smoothly in the weaving loom. Increasing the strength in abrasion resistance of yarn after sizing depends on several factors, namely the recipe of the size mixing, size preparation, level of size pickup and its degree of penetration into the yarn, as well as on the sizing condition. (Behera, et al. 2006)[28].

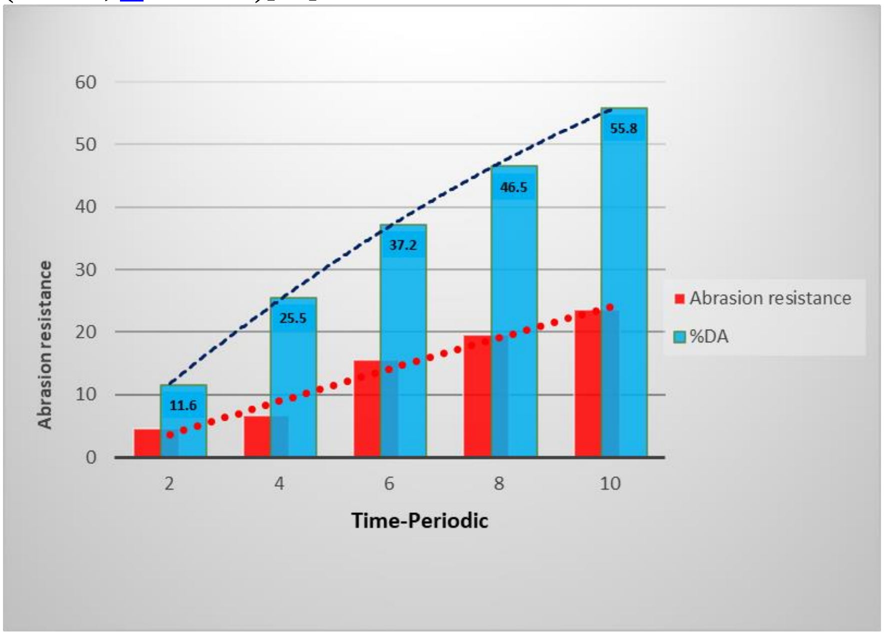


Figure (1) Time-periodic VS Abrasion resistance and % Moisture difference content(%DA)

Table (1) and Figure (1) show the abrasion resistance at different time-periodic. The sizing materials add film coating onto the fibre surface, which resists destroying the yarn fibre. It increases from one time-periodic to other, representing the following graph of abrasion resistance against the number of times-periodic. The higher value after the fifth period gives a better result of the abrasion cycle to resist at the break. It could be postulated that this mechanism is attributed to forming of hydrogen bonds (H bonds) between the sizing agent and the yarn surfaces (Wang. et al.,2020)[29]. The test results for combed cotton yarn abrasion resistance were found to vary depending on the yarn's time-periodic inside the sized room. Absolutely Yarns, with higher abrasion resistance had a higher breaking force.

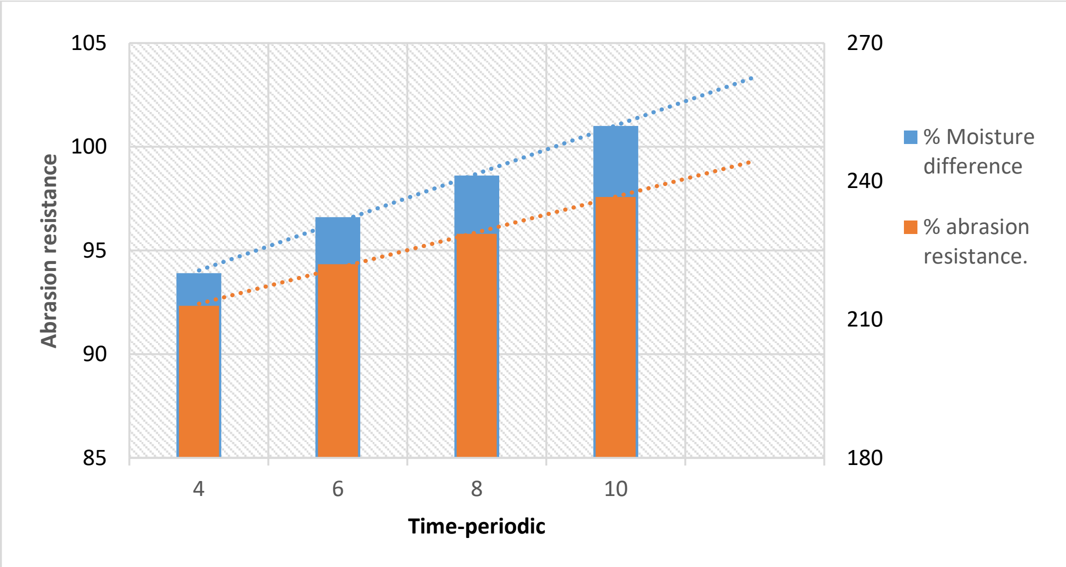


Figure (2): Time-periodic VS Abrasion resistance and % abrasion resistance.

Figure (2) shows the abrasion resistance (DA) of all the five time-periodic ranges from % 202.6 up to % 236.6, with a mean value of % 220.6. The Combed Cotton Yarn Abrasion resistance was higher after ten days by almost 10%. The minimum values of abrasion cycles to the break of sized yarn at the first time-periodic was nearly three times. The maximum was almost 200 % difference (DA), as shown in Figure (2). The average number of abrasion cycles (PoMA) yarn is 30, and the minimum and maximum values (MA) reached 90.8 and 101.%, respectively. Yarn properties after sizing time-periodic have largely influenced the properties before yarns in the sizing room. The relationship of abrasion resistance in the samples ranges from 30 (PoMA) to 96 (MA), whilst there are no great differences among the samples through the all-time-periodic (MA) itself; it was about 11% (Figure 2).

Case II

Blended Cotton (Giza 86 cotton / 50% polyester 50%) yarn count 40 E, S twist,4.2 twist factor.

Yarn abrasion resistance

No doubt that, during various production methods, yarns are subjected to friction when passing over machine surfaces made from different materials of various smoothness. Due to its excellent wearability, superior wearing comfort, good moisture permeability and outstanding breathability, blended cotton polyester is widely used (Joshi .,2003)[30].

When testing the abrasion resistance of blended cotton polyester yarn, the number of yarns passing over the abrading element is broken. Wear or abrasion resistance, therefore, it has been the focus of numerous investigations(Can et al. 2013)[31], especially for fabrics woven from staple fibre yarns. Abrasive stress can also result in destruction, which means tearing the yarn. No matter if it is a filament or staple fibre yarn. For the yarns based on synthetic fibres, an abrasive material removal will yield an increasing weakening of the fibres, and, finally, a complete rub-through or rupture will occur.

Table (2) shows the testing measurements for both the % Moisture absorption(MS) and % differences of moisture absorption(DS) as a reference to the PoMS. Also, referring to PoMA, it shows the result of testing the % Abrasion resistance of the sized yarn(MA) and the % differences of Abrasion resistance(DA).

Table(2) the testing measurements

Abrasion resistance of the sized yarn			Moisture absorption				
DA	**MA**	**PoMA**	**DS**	**MS**	**PoMS**	**PrMS**	**TP**
44.5	107		٧,١	٣.0			٢
45.9	108		١٤,٢	٣,٢			٤
63.5	121		٢١,٤	٣,٤			٦
72.9	128	74	٣٥,٧	٣,٨	٢,٨	٣	٨
75.5	129.9		٤٢,٧	٤.0			١٠
60.46	118.7		24.22	3.48			Σ

It is clear that (MS) is getting higher than the value of (PoMS) as the time-periodic increased with a mean value of 3.48, whilst the (DS), the % moisture absorption difference increased with a mean value of 24.22. That means the time-periodic has a crucial effect on the size properties of the yarn almost eight times.

Figure(2) demonstrates the behaviour of sizing materials versus the abrasion properties under the circumcise of time-periodic (TP).

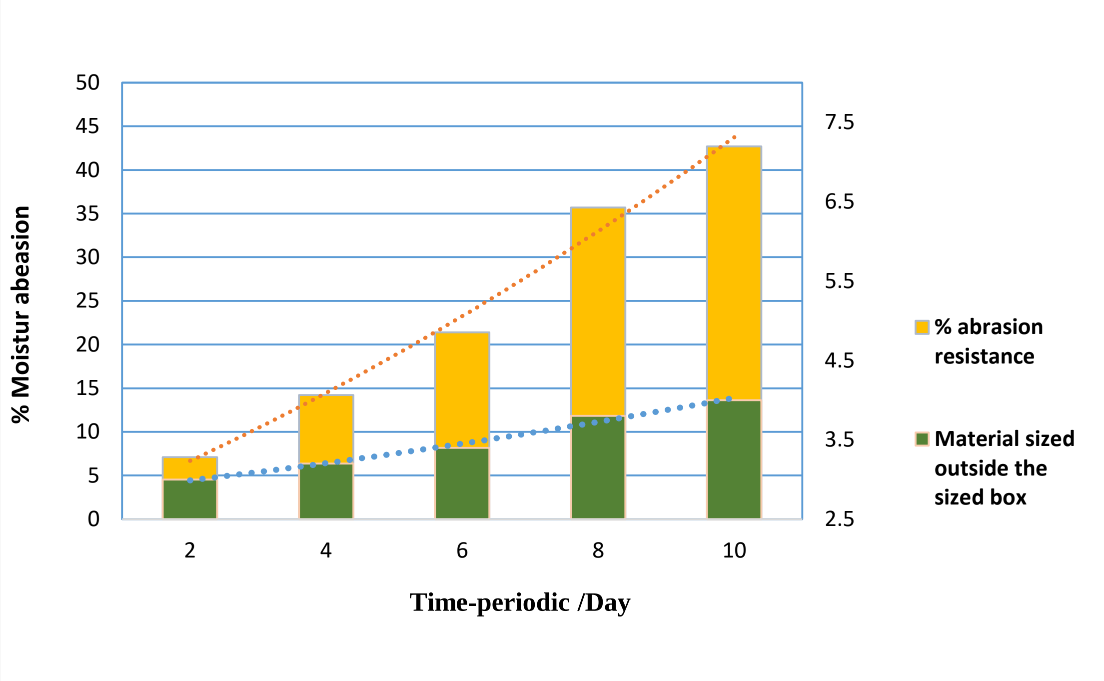
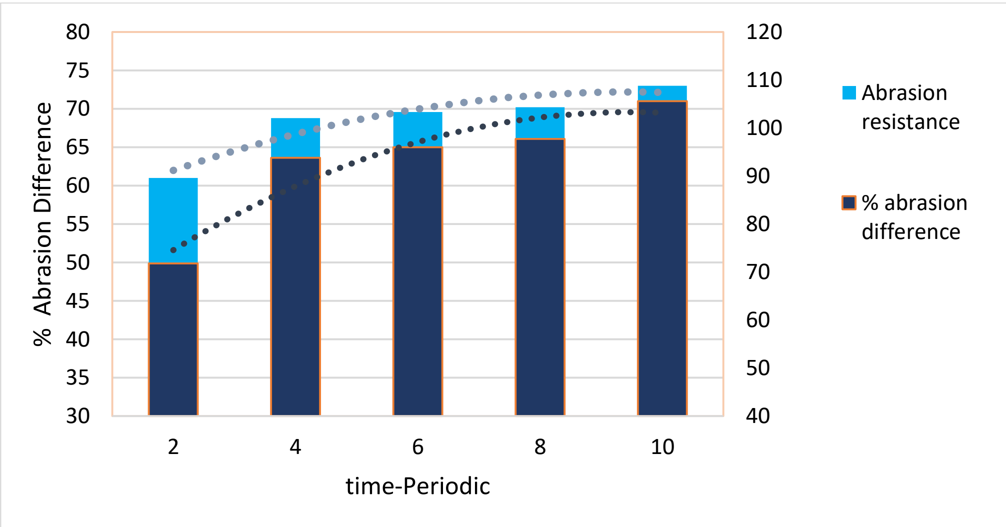


Fig (2) The time-periodical VS %Moistur abrasion

Referring to post moisture (PoMA), Figure(3) shows the relationship between % abrasion (MA) and % difference of abrasion (DA) with the time-periodic. It is clearly demonstrated that time-periodic influences the abrasion resistance(MA) and % abrasion resistance difference(DA).
The difference reached about 60%, whilst the abrasion (MA), referring to the post moisture(PoMA), got a value of 129.9 with a mean value of 118.7. On the other hand, the mean value of (DA) reached % 60.46.



Figure(3) Time-periodical vs Abrasion resistans & % Difference Abrasion resistance

Case III

100% combed cotton, played yarn 80/2, (Giza 86) S twist with 4.2 twist factor.

As reported in table (3), considering the level of sizing intake at the time of sustained in the sizing room(PoMS), the moisture intake shows lower values(PoMS=4.8 than PrMS =5.9), as explained earlier. As the time-periodic increased, the moisture intake decreased and started to grow again.

Table(3)the measurement of % Moisture absorption and
Abrasion resistance of the sized yarns

Abrasion resistance of the sized yarns			**% Moisture absorption**				**Time-Periodic**
DA	**MA**	**PoMA**	**DS**	**MS**	**PoMS**	**PrMS**	**TP**
71.8	61		18.75	5.7			٢
93.8	68.8		22.9	٥,٩			٤
96	69.6		٣١,٢٥	٦,٣			٦
97.7	70.2	٣٥,٥	٣٩,٥	٦,٧	٤,٨	5.9	٨
105.6	73		٤١,٦	٦,٨			١٠
92.98	68.52		30.8	6.28			Σ

It means that the effect of the time-periodic on the sizing agent improves the cohesion force between the cellulosic fibres, as shown in Figure (4).

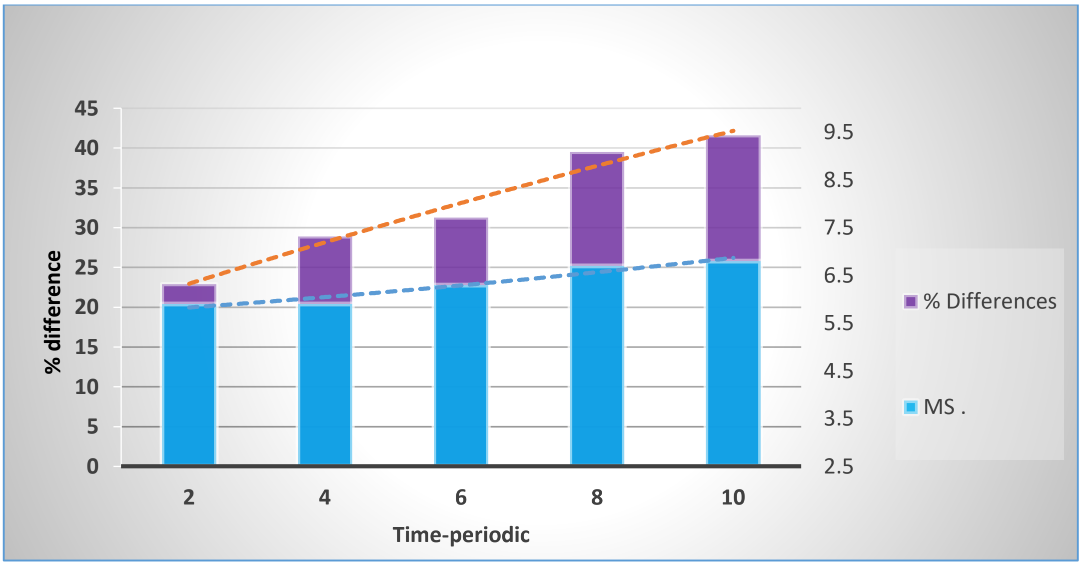
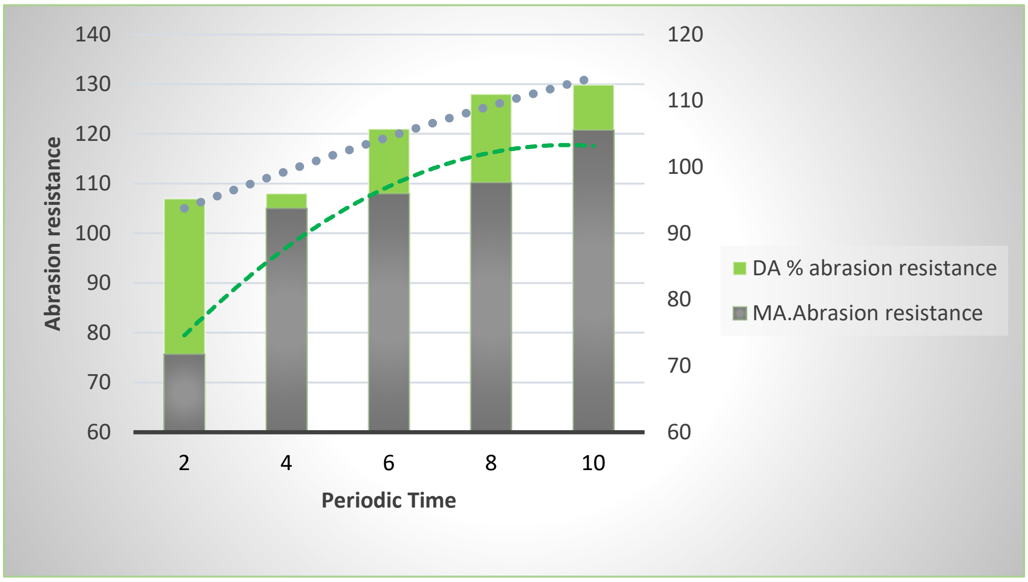


Figure (4) the % size intake &% differences of Abrasion resistanceVS Time-periodic

The % size (MS)and the % size differences(DS) increased as the time-periodic increased, whilst the mean value was 6.28, equal to %, 30.8, i.e. representing five times.



Fig(5) Periodical Time vs abrasion resistance and the % differences of abrasion resistace

As illustrated in Figure (5), the analysis of the results shows the technical characteristics of the sized yarns as exposed to a more time-periodic, where the abrasion resistance (MA) and the % differences (DA) increase as the time-periodic increases.

A comparison measurement between the three cases for the abrasion resistance:

As explained before, in this methodology, the conditioning of the yarn pre-sizing(PrMS) and post-sizing (PoMS) yarns outside the sizing room were in an open atmosphere. In a different meaning, at the normal RH, the temperature was lower, but when the yarn was transferred to the closed sizing room where the temperature was higher, the yarn lost some moisture, as reported in table (1,2,3). However, in the table, according to the sample structure, the comparison of the behaviour of the three samples shows different abrasion resistance values.

Table (4) A comparison measurement between the three cases for the abrasion resistance

Single yarn combed cotton,		Played yarn, combed cotton,		Blended cotton polyester		Time - Periodic
%D.II	S.II	% D.III	S.III	%D.I	S.I	TP.
11.6	4.6	18.75	5.7	7.1	3.0	2
25.5	6.7	22.9	5.9	14.2	3.2	4
37.2	15.6	31.25	6.3	21.4	3.4	6
46.5	19.6	39.5	6.7	35.7	3.8	8
55.8	23.6	41.6	6.8	42.7	4.0	10
35.2	14.02	30.8	6.28	24.22	3.48	Σ

As demonstrated in fig(4), the higher abrasion resistance is by the combed cotton(DII), followed by the double yarn cotton(DIII), whilst the lower one is the blended cotton/polyester yarn(DI).

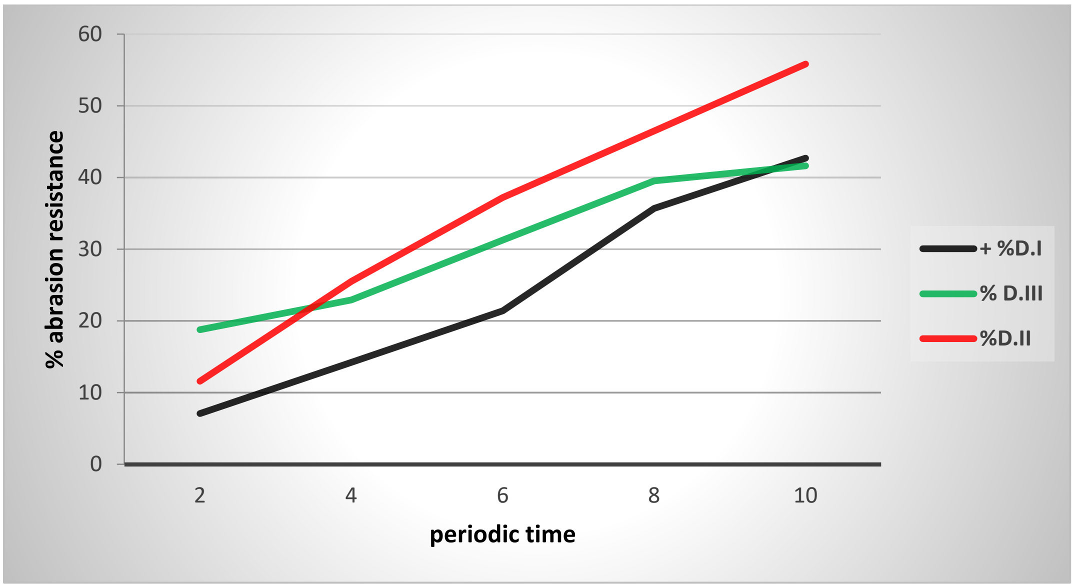


Figure (4) the relationship between theTime-Periodical VS % Abrasion Difference of the three Cases

This behaviour is unsurprising and depends on the wetting and wicking mechanism. The more cellulosic fibre, the more wetting mechanism rather than the wicking mechanism. Due to the 50% polyester, the wicking mechanism takes the share of the possibility of absorbing moisture, the bonding of the cellulosic materials, therefore, got less effect.

Bayer et al.(2017)[32] have reported four categories of the mechanism of wetting (the mechanism of adhesion matrix reinforcement) are:

1.The Interdiffusion adhesion.

2.Electrostatic attraction.

3.Mechanical adhesion depends on the fibre's roughness, which may affect the bonding capacity.

4.Chemical bonding where the hydroxyl groups in cellulose fibres confer a hydrophilic nature, while the hydrocarbon structure confers hydrophobicity.

Conclusion

The results deducted from this research, in which the effect of the moisture levels gained for the post-moisture(PoM) exposure to pre-moisture (PrM), are the following:

1.The absorptive capacity of the yarn's size depends not only on the type of sizing agents, size viscosity, temperature, and concentration but also on the yarn structure and time-periodic in the sizing room.

2.In the present technique, at different time-periodic, the sizing agent dissolved better more to the intramolecular structure of the yarn.

3.A significant improvement and increase in the percentage of moisture absorption had been gained for all the sized yarns, whether 100% cotton or 50% cotton/polyester blended and 100% combed twisted cotton yarns according to their capacity.

4.Due to the time-periodic abrasion resistance, the H-pond reaction was improved.

From the perspective of viewing chemical interpretation, in the cellulose scientific community, Relative Humidity(RH) has a hydrogen molecular bonding often used to explain many phenomena and properties related to cellulose and cellulose-based materials. Nevertheless,

hydrogen bonding is just one of several molecular interactions and is relatively weak and sensitive to the environment. The high axial modulus and strength of cellulosic fibrils and fibre-fibre bonding are commonly explained based on "hydrogen bonding effects".
Cellulose significantly has hydrophilic groups with a pronounced hygroscopic character and wetting. This phenomenon has been attributed to forming H-bonds between the cellulose molecules, leading to large and readily precipitating aggregates(Wohlert, 2022)[33].
Synthetic fibres, however, have hydrophobic groups and wicking results from spontaneous wetting in a capillary system. Nevertheless, at different molecules (blended cotton/polyester)at the ambient conditions, the simultaneous capillary penetration and imbibing by the fibres (diffusion of the liquid into the fibres' intermolecular structure) will occur simultaneously.

Recommendations

The present research recommends not sending the product of the sized beams immediately after the sizing process to the looming except in extreme necessity to avoid malfunction in the looming process.
It is preferable to leave the sized beams on their holders exposed to surrounding moisture at the sized room temperature, preventing them from contamination to benefit from restoring the absorption and gaining the H-bonding required for the weaving (Rutenburg1984)[34].

References

1. Berglund LA, Peijs T (2010) Cellulose biocomposites—from bulk mouldings to nanostructured systems. M.R.S. Bull 35:201–207
2. Benı´tez AJ, Walther A (2017) Cellulose nanofibril, nano papers and bioinspired nanocomposites: a review to understand the mechanical property space. J Mater Chem A 5:16003–16024
3.Kovačević S. et al.,(2000). Optimising Size Layer As Related to Input Humidity, Tekstil, 49 (12, pp. 689-697 .
4.Schwarz I. G. & Kovačević S. A New Pre-Wet Sizing Process (2014).Cutting Edge Research in New Technologies.
5.Sejri N., Harzallah O., Viallier P., Amar S.B. & Nasrallah S.B. (2008). Influence of Pre-wetting on the Characteristics of a Sized Yarn, Textile Research Journal, 78, 326-335.
6. Kovačević S., Gordoš D.; Impact of the Level of Yarn Twist on Sized Yarn Properties. FIBRES & TEXTILES in Eastern Europe 2009, Vol. 17, No. 6 (77) pp. 44-49.
7. Sejri N.; Harzallah O.; & Nasrallah S. (2011) Influence of wetting phenomenon on the characteristics of a sized yarn..81(3) 280–289.Volume 81, Issue 3. Textile Research Journal.
8.Schwarz, S. Kovačević K. Dimitrovski I. Schwarz, S. Kovačević,K. Dimitrovski(2013) .Materials Science .Fibres & Textiles in Eastern Europ.
9.Taosif A.;Rony M. ;Gazi F. ;Ishraque T. ;Jarin J. ;Mahamudul H. et al .(2021).Evaluation of sizing parameters on cotton using the modified sizing agent. Cleaner Engineering And Technology Vol. 5.
10.Djordjevic, S., Kovacevic, S., Djordjevic, D., Konstantinovic, S., 2019. Sizing process of cotton yarn by size from a copolymer of methacrylic acid and hydrolysed potato starch. Textil. Res. J. 89 (17), 3457–3465. https://doi.org/10.1177/ 0040517518813628.

11.Djordjevic, S., Kovacevic, S., Nikolic, L., Miljkovic, M., Djordjevic, D., 2014. Cotton yarn sizing by acrylamide grafted starch copolymer. J. Nat. Fibers 11 (3), 212–224. https://doi.org/10.1080/15440478.2013.874963.

12.Kovaˇcevi´c, S., Penava, Z., ˇ 2004. Impact of sizing on physicomechanical properties of yarn. Fibres Text. East. Eur. 48 (4), 32–36 .

13.Rozelle W.N. (2001). Pre-wet Sizing System Bases on Water Atomization, Textile World, 151, 3, March 28-30.

14.Textor T., Derksen L., Bahners T., Jochen; Gutmann S , and Mayer-Gall T. .(2019). Abrasion resistance of textiles: Gaining insight into the damaging mechanisms of different test procedures. Journal of Engineered Fibers and Fabrics Volume 14.

15.Maatoug, S., Ladhari, N., Sakli, F., 2007b. Fatigue behavior of sized cotton warps. J. Appl. Sci. 7 (18), 2706–2709. https://doi.org/10.3923/jas.2007.2706.2709.

16.Kovacevic S. ; Penava Z. & Oljača M. (2006).OTPimisation of production costs and fabric quality.Fibres and Textiles in Eastern Europe 14(2):79-84.

17.Maatoug, S., Ladhari, N., Sakli, F., (2007). Evaluation of the weavability of sized cotton warps. Autex Res. J. 8 (4), 239–244.

18. Kovačević S., (2002) Determination of the Size Coat, Fibers & Textiles in Eastern Europe, 10, 7/8, pp. 63-67.

19.Brzeziński S, kowalczyk D, borak B, et al. (2011).Nanocoat finishing of polyester/cotton fabrics by the sol-gel method to improve their wear resistance. Fibres Text East Eur; 89: 83–88.

20. Li G, Joo Lee H, Michielsen S. (2017) Design of abrasion resistant super-anti wetting nylon surfaces. New J Chem; 5: 13593–13599. Crossref.

21. Xiao, H., Zhang, W., (2009). Current situation of environment protection sizing agent and paste. J. Sustain. Dev. 2 (3), 172–175. https://doi.org/10.5539/jsd.v2n3p172 .

22. Goswami, B., C., Anandjiwala, R., D. and Hall, D. M.(2004).Textile Sizing. Marcel Dekker, Inc., ISBN 0 8247-5053-5, USA - New York – Basel.

23.Zweigle .(2007).Operating instructions Zweigle G 567. Retrieved from feb-2(2022).www.zweigle.com. Last Update 20.10.

24.Reutlingen W, Denkendorf ITV. (2007).www.itvdenkendorf.de. Last Update 20.10 .

25.Technical Notes .(2005).Yarn on yarn abrasion test. Quantitative Measure of yarn durability.

26. Technical Notes 18. (2007). Tension Technology International www.vectranfiber.com. Last Update 20.10.

27.Mayer-Gall T, Gutmann JS, Textor T.(2018) New method for damage assessment in Martindale abrasion testing. Melliand Int ;1:36.38.

28.Behera, V.,Joshi K. B. (2006). Effect of sizing on the weavability of Dref yarns.AUTEX Research Journal, Vol. 6, No 3, © AUTE

29. Wang X, Pang Z, Chen C, Xia Q, Zhou Y, Jing S, Wang R, Ray U, Gan W, LI C, Chen G, Foster B,Li T, Hu L (2020) All natural, degradable, rolled-up straws based on cellulose micro- and nano-hybrid fibres. Adv Funct Mater 30:1910417..

30. Joshi V.K., Weavability of Dref spun yarns, Ph. D. Thesis, IIT Delhi, 2003.

31.Can Y. & Akaydin M. (2013).Effects of laundering process on abrasion and wrinkle resistance of plain cotton fabric. Tekst Konfeksiyon; 23: 49–54.

32. Bayer J. & Mutjé P.,(2017) Advanced High Strength Natural Fibre Composites in

Construction, Cellulose polymer composites (WPC).
33. Wohlert M., Benselfelt T., Wågberg L., Furó I., Lars A. Berglund & Wohlert J.. (2022) Cellulose and the role of hydrogen bonds: not in charge of everything. Cellulose 29:1–23 https://doi.org/10.1007/s10570-021-04325-4. 22.Oxenham, W., Brzan, E. and Yu, C.(2004). The abrasive properties of the yarn. Department of Textile and Apparel, Technology and Management, College of Textiles, North Carolina State University website.
34.Rutenburg M.W and solarek d. (1984). starch derivatives: production and uses, in starch, chemistry and technology Eds.R.L.whistler, J.N.BeMiller and E.F.paschal, Academic press, inc, London,311.