

EVALUATING THE IMPACT OF MAINTENANCE TO ABRASION RESISTANCE AND TEAR STRENGTH OF COATED FABRICS

Ārgērību materiālu nodilumizturības un pārraušanas slodzes novērtēšana

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Abstract. *The purpose of this paper was to evaluate the impact of maintenance to some mechanical properties of coated fabrics. Polyester is often used for outerwear because of its high durability. Coating application enhances several physical – mechanical properties of fabric. The reverse side of the test fabrics were laminated with a thin layer of the membrane to ensure complete water resistance. Since the micro-pores are sufficiently small, they will not let water through, but they let vapour through from inside to outside. It makes these kind fabrics vapour-permeable and therefore very comfortable for wearing. Although we can damage the micro-pores in the fabric very quickly whether by false maintenance mode at home for washing or drying. Test fabrics of this study were chosen from kid's outerwear collection. Kids are good for testing of ready to wear garments but this time, the emphasis was on laboratory tests of basic fabrics. The aim of this study was to test the outer fabric under the conditions of domestic care and thereafter to carry out tests on abrasion resistance and tearing of cared fabrics.*

Keywords: *coated fabrics, kids' outerwear, abrasion resistance, tearing strength, home maintenance of garments.*

Introduction

Nowadays, woven fabrics have a very wide range of applications. Textile industry is in the transition zone between a traditional textile production and the realisation of highly focused design and production of added values textiles (Hu & Babu, 2008). Depending on the application of fabrics, a variety of factors are used, such as the type of fibre, dimensions of fibres, the structure of yarns, type and amount of finishing agents added to fibres, yarns or fabrics. Polyester is a widely known durable fibre. It is also a cheap fibre but this knowledge has changed after the emergence of polyester micro fibres that are more luxurious and expensive.

Polyester fabrics have many uses since they are strong, easily washed and quick drying and are resistant to most chemicals and abrasion. Its hydrophobic property makes it ideal for garments that are used to be in wet or damp environments- coating fabric with water-resistant or stain-resistant finishes intensifies this effect.

Consumer's launder and maintenance of textile garments has important impact in the lifespan of textiles (Hurren, 2008). The most common is machine washing and dehumidification in the dryer. Because children play outside whether in rain or sunshine, their clothes may need machine wash routinely. Nowadays, kindergartens use drying boxes to get dry clothes fast before going home. But we do not have the information about what kind of conditions of machine wash and dry they use. It was also important to investigate whether domestic care affects properties of outerwear fabrics and their lifespan. Some mechanical and chemical properties of fabrics can disappear when the wearer does not follow the garment care procedures correctly. Usually, the

maintenance information is marked on the care label of each garment but sometimes consumers do not pay attention to this or they are aware of the infringement. For example, using higher temperature than allowed in order to get dry clothes faster.

Aim

The aim of this study was to investigate the fabrics of children`s outerwear. According to the information above there was important to evaluate the impact of maintenance to abrasion resistance and tear strength of test fabrics. Four different articles of coated fabrics were chosen with different weave and densities (Tab. 1).

On the basis of above, two different domestic maintenances carried out. One of them was according to care label information and for the second, higher temperature of 65°C was selected for the drying. The washing temperature was kept according to the information on the care label, at 40°C.

Materials and methods

Test materials were selected from fall/winter and spring/summer collections, two different from each. Material composition was 100 % polyester (PES) coated with polyurethane (PU). Test materials were plain-weave fabrics and one of them was additionally printed. Data of test materials are presented in Tab. 1.

Table 1

Properties of test fabrics

Article	Density, (g/cm ²)	Laminate composition/ thickness, mm	Weave structure	Composition
PB1215	180	PU/0,22	150D*300D	100% PES
PB04	95	PU	75D*75D*240T	100% PES
PB04PR	95	PU	75D*75D*240T	100% PES
Q2366	180	PU/0,22	150D*300D	100% PES

The fibre itself is woven into a yarn. There are two types of polyester yarns: filament and spun. The selected test fabrics were woven from continuous multi-filament yarns. According to manufacturer`s information two test fabrics art. PB1215 and art. Q2366 have same density and same lamination on the reverse side of fabric. A digital microscope MiScope with the magnification of 135 times was used for figures 1-4.



Figure 1. The right side of article PB1215.

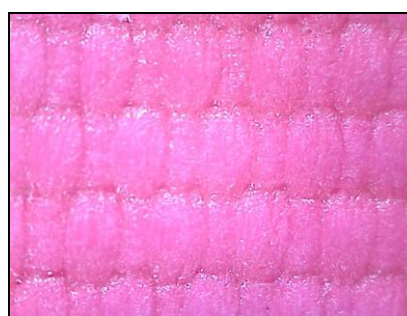


Figure 2. The reverse side of article PB1215.

Fabrics of outerwear are usually developed waterproof, breathable and laminated. The back side of the fabric is coated with a thin microporous layer. These kind fabrics are called microporous fabrics. The membranes stretch in both directions, and there are micro-pores small enough to allow the vapour but not the water flow through the pores. The simplest form is a two-

layered fabric in which the outer layer is typically composed of polyester. The inner membrane layer is made of polyurethane.

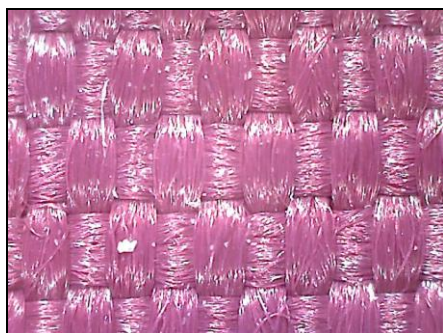


Figure 3. The right side of article Q2366.

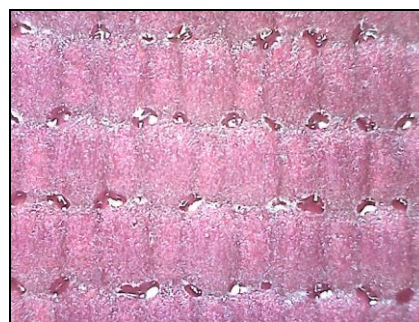


Figure 4. The reverse side of article Q2366.

There are seen holes in the laminated reverse side of fabric which enable fabric to breathe (Fig. 4). To looking in the table of test fabrics properties there were given data of coating type. For art. PB1215 and art. Q2366 these are same, but pictures of microscope didn't confirm it. There are totally different laminate type of reverse side as we can see on Fig. 2 and Fig. 4.

Previous studies have shown that changes in type of coating and in warp density provide significant influence to physical-mechanical properties of fabrics and multi-component materials (Kos, Gudlin Schwarz & Suton, 2014).

Moisture has a big impact on thermal comfort, but also on sensory comfort. This sensory comfort may change with different activity rates and environmental conditions. Moisture from external sources (e.g. rain) will impact both the micro- and macro-environments, which in turn impacts the comfort perception of both hot and cold conditions (Bishop, 2008).

Two different coating types from our fabrics have been used based on the manufacturer's information. One of them is called Milky laminate, for which the coating paste is placed on the back of the fabric and after that, it is scrubbed into the fabric. The other method, the most common one, is lamination in which the prepared polymer layer is attached to the fabric by using an adhesive or by heating lightly the inner side of the polymer before the layers are joined. The main deficiency is that the microporous fabrics are then soiled, after that the micro-pores may open up and are filled with dirt.

Since the test materials are used for the production of children's wear, it was important to carry out tests on fabric abrasion resistance. Additionally, a tearing test of the same materials was conducted using the Elmendorf method. Kids are good for testing garment wear but this time, the emphasis was on laboratory tests of basic fabrics.

The aim of this study was to test the outer fabric in the conditions of home care and thereafter to carry out tests on the abrasion resistance and the tearing of cared fabrics. One washing and two different drying conditions were selected to simulate a home care regime, see in Tab. 2. The quantity of the gel detergent in millilitres (ml) was chosen according to medium water hardness/ softness 4-14 dH (Degrees of Hardness). The recommended amount of gel detergent for the average dirty laundry was taken from the manufacturer's data sheet, see in Tab. 2. The washing gel does not contain odorants or colorants. The chemical composition is suitable for washing the laundry of small children and allergy-prone persons (Mayeri, 2011). Wash tests were carried out in the domestic washing machine with the custom wash program for sportswear and the spin speed to remove the water from the fabric's tests at the end of a cycle was 800 rpm (revolutions per minutes).

Table 2

Washing and drying conditions for test materials

Maintenance	Detergent, ml	Conditions of washing		Conditions of drying	
		Temp, t°	Term, in min	Place	Temp, t°
Correct (C)	75	40	44	In the air	20-22
Incorrect (IC)	75	40	44	In the drying box	60

The correct maintenance was carried out according to the care label instructions of the fabric manufacturer, see in Tab. 2. During the incorrect maintenance, the temperature of the dryer was changed to higher than allowed, to 60° C.

From each of the four fabric articles, test specimens were collected, where the first test specimen was taken from the brand-new fabric. The second and the third test specimens were collected in accordance with the maintenance mode, correct and incorrect. The home maintenance cycle was carried out five times before the testing.

An air-conditioned laboratory shall provide and maintain a standard atmosphere. Standard atmosphere shall have a temperature of 20° C and relative humidity of 65.0 %. The tolerance for temperature is allowed $\pm 2.0^{\circ}$ C and ± 4.0 % for relative humidity.

Variations in temperature and relative humidity are likely to exist throughout the working space. Our laboratory indoor climatic conditions were at the time of the testing the following: the temperature was 25° C and relative humidity 32 %.

The specific condition of temperature and relative humidity are considered attained when the following requirements have been satisfied. The mean temperature and relative humidity over any continuous 1h period shall conform to the tolerance zone at the standard atmosphere conditions. The spatial variation of the standard atmosphere shall comply with the specified tolerance zone. (EVS-EN ISO 139, 2005).

To assign the abrasion resistance of fabrics there are possible to choose three different types of Martindale method according to ISO 12947:1998. Part 2 is Determination of specimen breakdown and Part 3 is Determination of mass loss. The third possibility is to make the visual examination for a test specimen according to Part 4” Assessment of appearance change“. Tests of this study were carried out according to part 2, where the evaluation of the abrasion resistance of woven fabric is determined from the inspection interval to breakdown of the specimens. The Martindale abrasion tester subjects a circular specimen to a defined load and rubs it against an abrasive medium (i.e standard fabric) in a translational movement tracing a Lissajous figure. The specimen is subjected to abrasive wear for a predetermined number of rubs. (ISO 12497, 1998)

The test apparatus, a 4-head Martindale abrasion tester, consists of a baseplate on which the abrading tables and a drive mechanism are mounted. The abradant was woven wool mounted over felt. The small test specimen is placed on the large abradant and then cycled backwards and forwards in a Lissajous motion producing even wear. To the top of specimen a force of 9 kPa was applied to hold it against the abradant.

For the test fabrics of this study, the number of rubs according to the relevant test series given in Tab. 3 have been selected. For diagnostic purposes, the test interval for each test series may be reduced as the end point is approached.

Table 3

Test intervals of abrasion test

Test series	Number of rubs	Test interval (rubs)
a	5000	0
b	25 000	0
c	50 000	after 50 000
d	100 000	to the end

Different fabric structures will require different inspection intervals. Alternative test intervals have been chosen as you can see in Tab. 3, which was agreed upon by the interested parties of this study. After 50 000 rubs, the abradant was replaced.

The measurements of tear strength were carried out according to the international standard EN ISO 13937:2000. This standard specifies the methods for the determination of tear force of fabrics. Part 1 describes a ballistic pendulum method (Elmendorf) for the determination of tear force of textile fabrics. The method describes the measurement of the tear force required to propagate a single-rip tear of defined length from a cut in a fabric when a sudden force is applied. Tests are mainly applicable to woven textile fabrics. (EN ISO 13937, 2000)

The falling (ballistic) pendulum (Elmendorf) method is used for the determination of the average force required to single-rip-tear of a fabric specimen by the force of a falling pendulum. Each test specimen has a notch in the long side. For test specimens, where the short side is parallel to the warp, the direction of the tear is qualified as across weft and where the short side is parallel to the weft, the tear is qualified as across warp (EN ISO 13937, 2000).

The ballistic pendulum measures energy directly. In current practice, it is preferred to express tear resistance as a force which is usually indicated directly in newton (N). To describe the results, the arithmetic mean of the tear force is calculated in newton and at least five specimens tested for each directions. (EN ISO 13937, 2000).

Results

A fabric's resistance to abrasion and tear strength are affected by many factors, such as fibre type, the inherent mechanical properties of the fibres, the structure of yarns, the construction and thickness of the fabrics, and the type and amount of finishing material added to the fibres, yarns or fabrics. (Wang, Liu & Hurren, 2008).

Analysing the results of fabric abrasion resistance, it was concluded that for each test series, the end point/breakdown was not approached. Also the pilling could not be observed from the specimens.

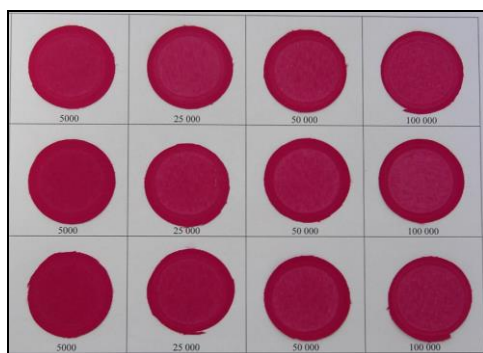


Figure 5. Determination of fabric resistance art. PB1215.

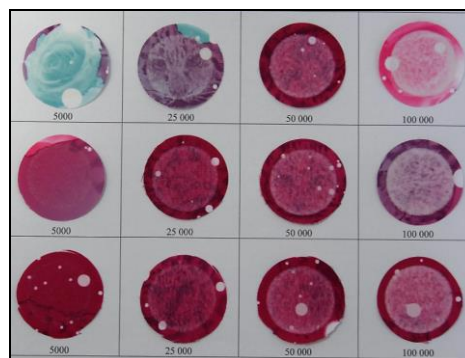


Figure 6. Test specimens of art. PB04PR in different rubs.

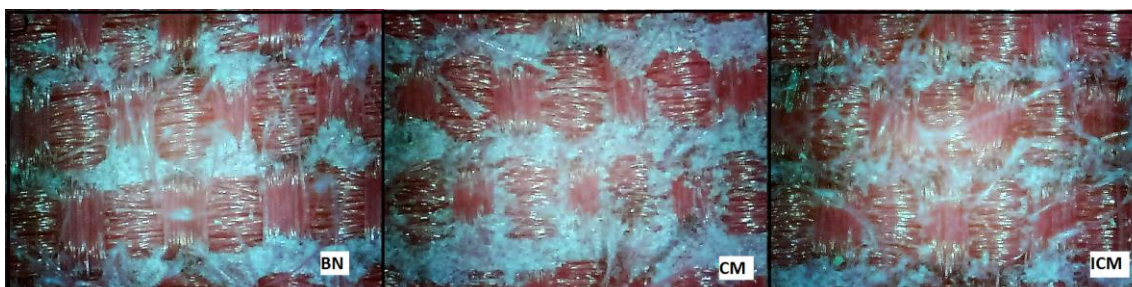
For each fabric article, tests of abrasion resistance were provided by the same system as you can see on Fig. 5. In the first row, there are test specimens of a brand-new (BN) fabric. In the second row, there are test specimens of correct (C) maintenance and in the third row, of incorrect (IC) maintenance (see in Tab. 2). Outcomes are visually the same and the abrasion resistance results do not differ for cared and brand-new test specimens. Only a change in shade can be detected. As one of four fabrics, article PB04PR, was printed, the print quality of the three test specimens is rather abraded on rubs 100 000, see on Fig. 6.

Similar visual results, as you can see on Fig. 5 and Fig. 6 were observed for all four fabric articles. Our test material composition was 100 % polyester (PES) and plain-weave fabrics. The filament fibres are long and strong, therefore do not get tangled with each other during the

friction. Therefore, the surface of the fabric is not hairy. The surface of the test material is homogeneously worn out, but appearance is unharmed and smooth.

Based on the earlier scientific results, it can be concluded that polyester is generally considered to have auspicious abrasion resistance. Longer filament fibres incorporated into a fabric show better abrasion resistance than short fibres because it is harder to extract them from the fabric structure. Flat plane-weave fabrics are more tightly locked in a plain weave structure. (Wang, Liu, Hurren, 2008).

If you compare three types of test specimens whose number of rubs is finally 100 000 rubs then they are not different as you can see on Fig 7. A digital microscope MiScope with the magnification of 130 times was used on Fig. 7.



* BN- brand new fabric; CM- correct maintenance; ICM- incorrect maintenance

Figure 7. Three different test specimens of art. PB1215 on rubs 100 000.

For the measurements of tear strength, the appropriate measurement methods were chosen by taking into account the fabric’s destination, the kind of tear performance and also the parameters and criteria which are in the form of normative documents.

Previous tests have shown that filament yarn has higher tear strength compared to staple yarn. An increase in yarn density in woven fabrics will decrease the tear strength of a fabric. (Wang, Liu, Hurren, 2008).

For representing the results, the arithmetic mean of the tear force in newton (N) has been calculated, see in Tab. 4.

Table 4

Result of tear strength

Article	Brand-new (BN) fabric, N		Correct (C) maintenance, N		Incorrect (IC) maintenance, N	
	Weft	Warp	Weft	Warp	Weft	Warp
PB1215	36.01	16.95	40.75	18.20	39.41	18.27
PB04	6.34	8.41	6.10	8.31	5.99	8.12
PB04PR	6.86	5.37	6.04	6.89	5.56	6.94
Q2366	27.32	16.31	30.33	17.44	30.04	17.08

On the following Figures 8 results of tear strength for weft and warp per different test specimens has been given.

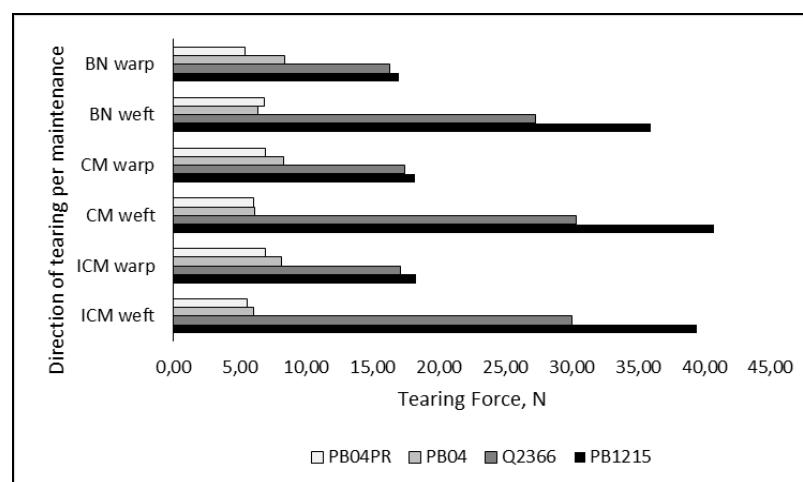


Figure 8. Tear strength results of test specimen.

The relationships between the mean tear strength and the density of fabric are direct (Fig.8). For thicker fabrics like art. PB1215 and art. Q2366 at the density 180 g/m² is needed to implement the bigger tearing force.

The maintenance of thicker fabrics do not degrade the tear strength, but will make it even better, up to 10 %, as we can see on Fig. 8. There is no difference in tearing strength between correct and incorrect maintenance for all four test fabrics.

Nevertheless, upon analysing the results for four fabrics, we cannot state unequivocally whether such an interpretation would be useful for a bigger sample population, nor whether any kind of ‘anomaly’ (e.g. for the same fabric, the result for the warp direction can be once higher and once lower than for the weft direction) is due to the yarn strength uniformity, or whether it is a regularity, which can occur for some fabrics of given technological parameters. (Witkowska & Frydrych, 2004).

Summary

Based on the results, the following conclusions can be made:

- abrasion resistance does not degrade after five home care procedures;
- tear strength does not degrade after several home care procedures and even after false maintenance;
- there is a linear correlation between the density of fabrics and tear strength;
- the maintenance does not degrade the tear strength of fabrics.

On the basis of the results above, it can be concluded that the domestic care of children’s outerwear fabrics does not make the mechanical properties, like abrasion resistance and tear strength, worse. There is even no difference between incorrect and correct maintenance. It is important to investigate next properties of fabrics like tensile strength, water resistance and breathability. The data of fabrics need to be checked carefully beforehand because type of coating can significantly affect the permeability of the water or tearing strength.

It is also necessary to further test fabrics under the conditions of home care. It is possible that children’s clothes that are really dirty, are washed at much higher temperatures and, in order to get clothes dry in the shortest possible time, elevated temperatures are used in a dryer as well.

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Kopsavilkums. Pētījuma mērķis bija novērtēt mehānisko īpašību ietekmi uz pārklājuma audumu uzturēšanu. Poliēsters bieži tiek izmantots virsdrēbēm, tāpēc ka tam ir augsta izturība. Aizsargpārklājuma uzklāšana uzlabo vairākas fiziski mehāniskas audumu īpašības. Testējamo audumu otra puse tika nolaminēta ar plānu membrānas slāni, lai nodrošinātu pilnīgu ūdens necaurīdību. Tā kā mikro poras ir pietiekami mazas, tās nēlaiž cauri ūdeni, toties tās laiž tvaiku no iekšpusēs uz ārpusi. Tas audumiem nodrošina tvaika caurlaidību, tādejādi tie ir ērti

valkāšanai. Taču mēs arī varam noārdīt mikro poras audumos diezgan ātri, mājās piemērojot neatbilstošu mazgāšanas vai žāvēšanas režīmu. Šajā pētījumā testējamie audumi tika izvēlēti no bērnu virsdrēbju kolekcijas. Bērni ir labi pārbaudei gatavo audumu valkāšanai, bet šoreiz uzmanība tika vērsta pamatmateriālu laboratorijas testiem. Šī pētījuma mērķis bija pārbaudīt virsējos audumus saskaņā ar aprūpi mājas apstākļos un veikt pārklājuma audumu nodiluma un drēbes izturības testus.

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