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Investigation of geometrical and physical – mechanical parameters of Braille by assessing the different types of cardboard materials

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1. Introduction

Since 2005 in many countries, including Lithuania, it has been a legal requirement to incorporate legible Braille onto pharmaceutical packaging. This enables the blind to easily integrate into society.

Braille is a system of raised dots which can be read by touch. Braille can be formed in three ways: by using screen or digital printing and embossing. Embossing is most common in the production of pharmaceutical packages. Pharmaceutical packages, like many other packages, undergo handling and transportation during their life cycle, therefore they may be damaged by various mechanical factors. As Braille is read by touching the dots and the package is exposed to different mechanical factors, deformation properties of paperboard are extremely important; they may vary depending on parameters, such as type of material, composition etc. It is essential to make the right choice from a large variety of paperboard types, and to form appropriate parameters of Braille. Besides, during the process of formation, values of the parameters can be affected by pressure which may cause cracks in the material [1].

The key parameters of Braille are height and distance between the dots as well as their diameter. Both a separate parameter and a set of them are very important for the readability of Braille as the absence of just one dot or incorrect formation of it could change the meaning of a word. Thus, the right choice and proper formation of geometrical parameters of Braille is of key importance. For this purpose, extensive experimental investigations were performed [2] and from the obtained results the European standard EN 15823:2010 was developed, which was later adapted as the Lithuanian standard [3]. The basic parameters (Fig. 1) and their values specified in the standard are given in Table 1.

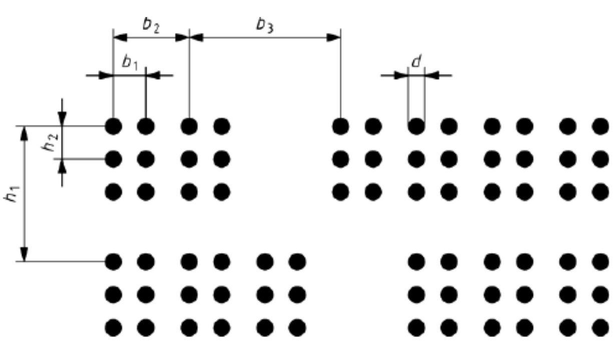


Fig. 1 Key parameters of Braille [3]

Table 1

The values of Braille parameters [3]

Parameter	Notation	Size, mm
Horizontal distance between centers of the dots	b_1	2.5
Distance between two letters of the same word	b_2	6.0
Distance between words	b_3	12.0
Dot diameter	d	1.6
Distance between lines	h_1	10.0
Vertical gap between centers of the dots	h_2	2.5
Dot height	H	0.2
Distance from package folding line	L	8.0

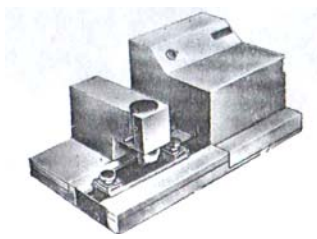
One of the basic parameters of Braille is the height of Braille dots. Although the results of the studies showed that some of the respondents were able to read the presented information in relatively low-height symbols (0.18 or 0.12 mm) [2, 4], it is recommended to form higher dots of Braille (up to 0.45 mm), so that older people, whose finger sensitivity is reduced, could also read the Braille [1]. The results of the studies that were carried out to investigate the impact of Braille parameters on readability have revealed that the Braille with a larger dot diameter and a narrower interdot space takes a longer time to read and more mistakes are made in the evaluation [5]. As with many other kinds of packaging, pharmaceutical packages undergo rigours of transportation and handling. Besides, during the reading process, when the reading finger moves along the reading surface, the vibrations dominate. The influence of oscillation on legibility and reading speed has been analyzed [6]. As Braille is read by touching, the package is constantly affected by mechanical friction, i.e. by the friction between a finger and surface of the package material. A study has set up a coefficient of friction depending on material and human fingertip skin [5], but no papers have been found on the impact of mechanical factors on the change of height of Braille dots, Braille being formed on different paperboard materials. The effect of friction body curvature to coefficient of friction was investigated in paper [7]. Cardboard types differ in their chemical composition, physical, mechanical properties and characteristics. These parameters influence the different resistance to deformations, permanent stresses and mechanical strength to friction.

The aim of this paper is to determine the change of geometrical parameters of Braille dots under the cyclic mechanical influence (cyclic wearing), when Braille is embossed on the different types of cardboard materials.

2. Experiment equipment and method

Experimental tests were carried out using different pharmaceutical packages made from different type and grammage paperboard: cellulose-pulp and recycled pulp. Alaska 200 g/m^2, Alaska 250 g/m^2, Alaska 275 g/m^2, Arktika 200 g/m^2, Arktika 230 g/m^2, Arktika 250 g/m^2, SBS 200 g/m^2 (cellulose-pulp) and Obuhiv 180 g/m^2, Chromerzats MM 235 g/m^2, Umka Color, Hansol HI-Q, Exprint 225 g/m^2, Mirabell 320g/m^2 (recycled pulp). For the evaluation of dispersion of the parameters of Braille on pharmaceutical packages, measurements of Braille dot height and other parameters were made using the "BRAI³ Braille Dot Checker" device (Fig. 2, a).

a



b

Fig. 2 Equipment used for the experimental tests: a - BRAI³ Braille Dot Checker; b - ИМР-1

When reading Braille elements, fingers touch relief-dot images and the wear resistance of Braille elements to their actions is important. To simulate the effects of reading fingers of the blind, studies of wear resistance of Braille elements have been conducted applying specially developed techniques.

The experiment of Braille resistance to wear was carried out using the device ИМР-1 whose working run is 50 mm (Fig. 2, b). The conditions of the tests were close to the performance conditions of reading with fingers imitation. The experiment was carried out applying the excursion motion in horizontal position at the regular speed of 60 cycles/min. During the experiment, the samples were affected by the mechanical force and after 50, 100 and 150 cycles measurements of Braille dot height were made.

The visual typical digital images captured by using a microscope and a computer with the integrated DN-CAM camera are provided (Figs. 3-5).

3. Results and discussion

The results of dispersion of the measurement of Braille font geometrical parameters before mechanical effect indicate that the deviation of the dot height from the average value is 0.01-0.04 mm, so the scatter of height values is not of great significant. As a paper suggests [5], another important parameter is the diameter d of a Braille dot. From the obtained measurements of geometrical parameters, it was determined that the value of a Braille dot diameter has direct effect on other values of geometrical parameters, namely b_1, b_2, b_3, h_1, h_2 (Table 2).

When forming the Braille fonts onto packages, it is necessary to leave a safe gap between the edge of the package and the folding line. The value of this safe gap should be 5-10 mm, thus, as can be seen from the results

Table 2

The values of Braille font geometrical parameters formed on the packages till mechanical effect

No.	Material type	Grammage, g/m^2	Average of dot height, mm	Deviation of dot height, mm	Dot diameter, mm	Horizontal distance between centers of the dots, mm	Horizontal distance between letters, mm	Distance between words, mm	Distance between lines, mm	Vertical distance between centers of two dots, mm	Min. distance from the horizontal package side, mm	Min. distance from the vertical package side, mm
			H_v	H_s	d	b_1	b_2	b_3	h_1	h_2	L_h	L_v
1.	Alaska	275	0.11	0.03	1.85	2.66	7.06	-	-	2.67	5.50	9.50
2.	Alaska	275	0.09	0.02	1.80	2.59	6.78	-	10.00	2.48	10.00	9.00
3.	Alaska	275	0.11	0.04	1.60	2.41	4.38	-	-	2.37	11.00	9.00
4.	Alaska	275	0.11	0.02	1.61	2.50	5.96	-	-	2.49	5.00	21.00
5.	Alaska	275	0.10	0.01	1.58	2.49	6.04	-	9.96	2.61	5.00	14.50
6.	Alaska	275	0.10	0.01	1.61	2.31	6.13	9.70	-	2.31	6.50	5.00
7.	Alaska	275	0.10	0.01	1.60	2.56	6.05	-	-	2.54	7.00	21.00
8.	Mirabell	320	0.16	0.01	1.63	2.29	6.12	-	-	2.13	9.00	5.00
9.	Mirabell	320	0.18	0.01	1.60	2.51	3.54	-	-	2.57	7.00	22.00
10.	Alaska	275	0.11	0.01	2.17	3.27	8.74		13.16	3.24	9.00	8.50
11.	Alaska	275	0.07	0.01	1.36	1.89	5.10	-	7.67	1.92	5.00	7.00

provided in Table 2, the distances from the package horizontal side partly meet the requirements, but from the vertical side, 37% of samples exceed the default values.

From the obtained experimental tests of mechanical effect, it can be seen that, depending on paperboard type, composition and properties of paperboard surface, packages wear differently. The digital images show the obvious surface wear difference between different paperboard types (Figs. 3-5). It can be noticed that the surface of cellulose pulp paperboard wears gradually under mechanical effect (Figs. 3 and 5, d), while on the surface of recycled pulp paperboard tears (Figs. 4 and 5, b) which can affect the readability of Braille font elements can be seen.

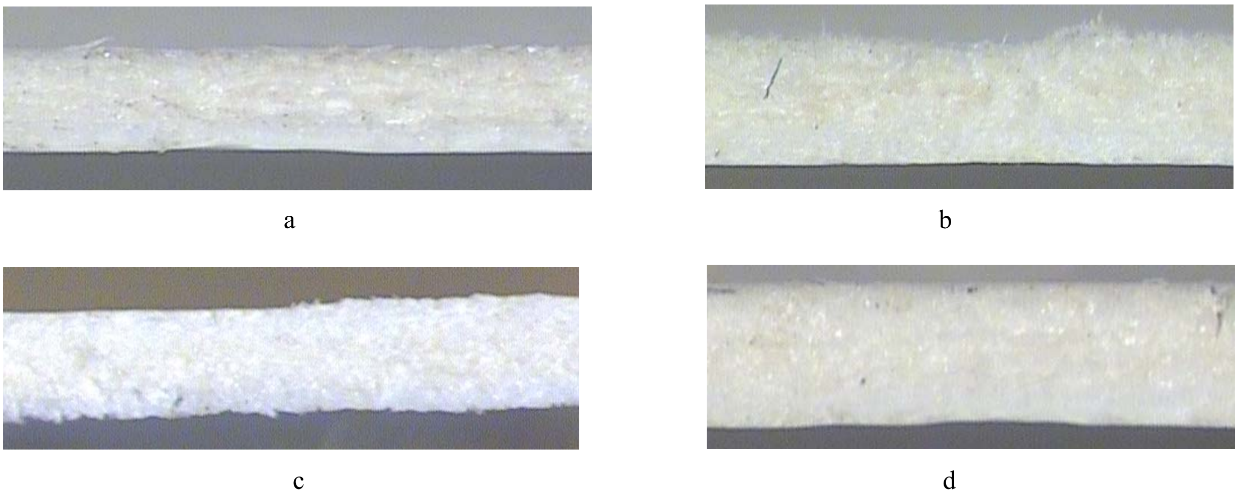


Fig. 3 Digital images of cellulose pulp paperboard surface after mechanical wearing (enlarged 80 times): a – Alaska 200 g/m^2, b – Arktika 200 g/m^2, c – Arktika 230 g/m^2, d – SBS 200 g/m^2

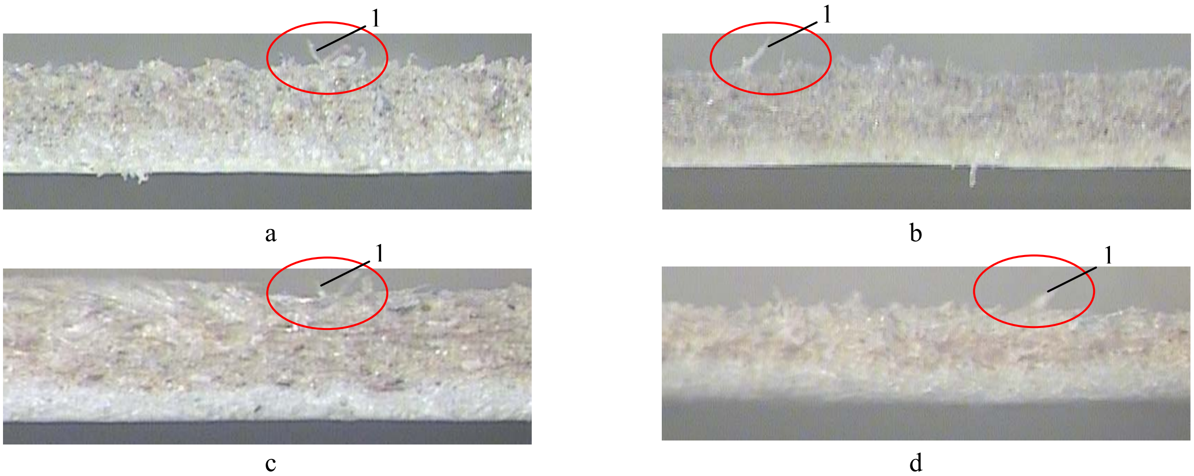


Fig. 4 Digital images of recycled pulp paperboard surface after mechanical wearing (enlarged 80 times): a – Obuhiv 180 g/m^2, b – Chrom-erzats MM 235 g/m^2, c – Umka Color, d – Exprint 225 g/m^2; *1* - tears

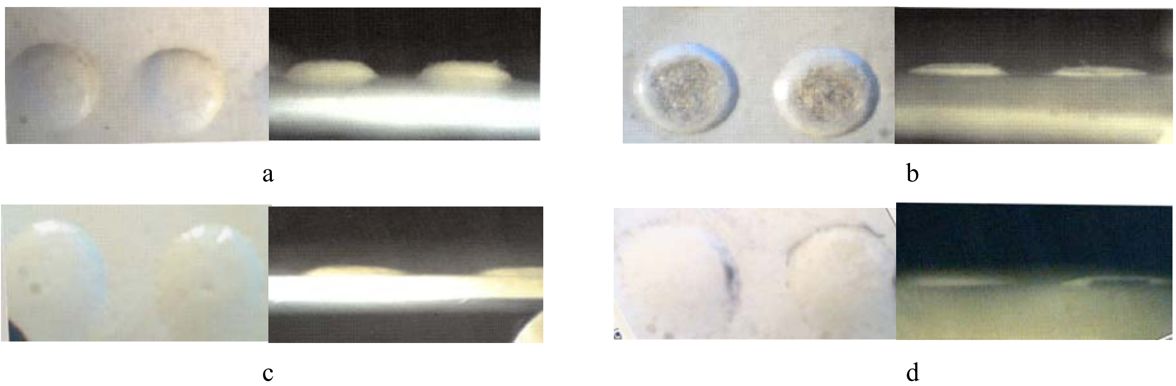


Fig. 5 Digital images of Braille font dots before and after mechanical wearing: paperboard Mirabell 320 g/m^2 (recycled cardboard) in the beginning of the experiment (a) and after 80 min (b); paperboard Alaska 275 g/m^2 (cellulose cardboard) in the beginning of the experiment (c) and in the end (d) (enlarged 10 times)

In digital images (Fig. 5), after some time of wearing large local areas of tearing and cracks in the Braille fonts formed on the packages from recycled pulp paperboard can clearly be seen (Fig. 5, b), while in the case of cellulose pulp packages, the fonts are only compressed and the changes are insignificant (Fig. 5, d). It is determined by different paperboard properties.

The results of the experimental tests suggest that the most stable Braille dots are the ones formed on the cellulose pulp paperboard with double-layer coating. As it is seen from the graphical dependency (Fig. 6), the height of Braille elements on cellulose cardboard with double-layer coating GC2 at 50 cycles of wear decreases in cardboard Alaska (200 g/m²) by 13%, Alaska (250 g/m²) by 21% of initial height, at 100 cycles – Alaska (200 g/m²) by 20% and in cardboard Alaska (250 g/m ²) by 39%.

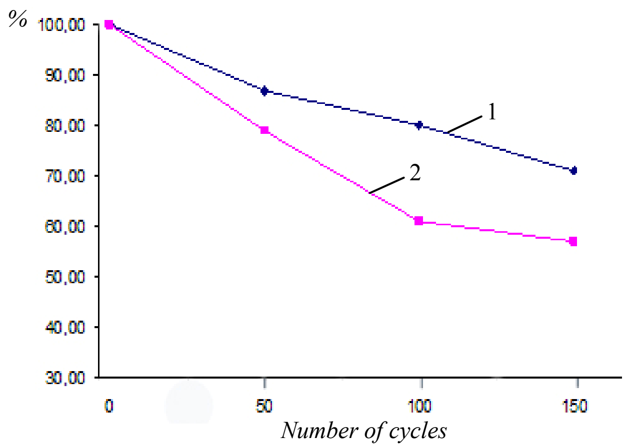


Fig. 6 The change of dot height of Braille font formed on the cellulose pulp paperboard after different number of cycles of mechanical wearing: *1* – Alaska 200 g/m^2; *2* – Alaska 250 g/m^2

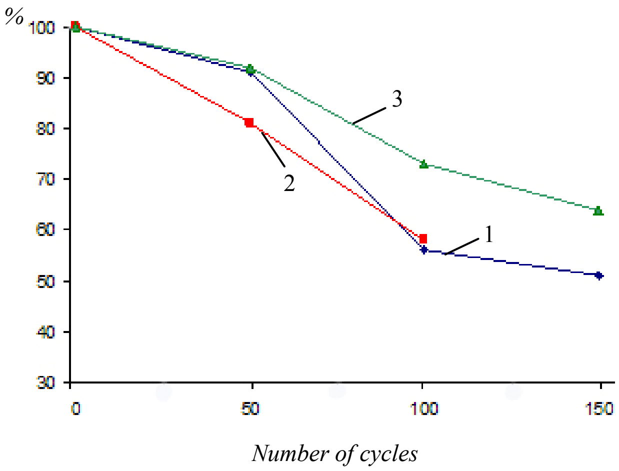


Fig. 7 The change of dot height of Braille font formed on the cellulose pulp paperboard after different number of cycles of mechanical wearing: *1* – Arktika 200 g/m^2; *2* – Arktika 230 g/m^2; *3* – Arktika 250 g/m^2

Fig. 7 presents the similar change of Braille dot height on cellulose pulp paperboard with double-layer coating GC1: after 50 cycles the Braille dot height of the paperboard Arktika 200 g/m^2 decreased by 9%, for Arktika 230 g/m^2 – 19%, for Arktika 250 g/m^2 – 8% from the original dot height, and after 100 cycles for Arktika 200 g/m^2 from the original dot height – 44%, for Arktika 230 g/m^2 – 42% and for Arktika 250 g/m^2 – 27%. Upon further wear, there appear naps on the cardboard surface that will likely interfere with the perception of Braille elements by blind people. Thus further deterioration of relief-dot image was suspended.

The results of dot height change of Braille formed on the packages of recycled pulp paperboard are presented in Fig. 8. The research of wear resistance of Braille dots on recycled paperboard revealed that the height of Braille dot on the recycled paperboard type GT2, GD2, with the double-layer surface at 50 cycles of wear decreases for paperboard Hansol Hi-Q by 33%, for paperboard Exprint by 30% from the original height of the dot, at 100 cycles – Hansol Hi-Q by 45%, paperboard Exprint by 39%.

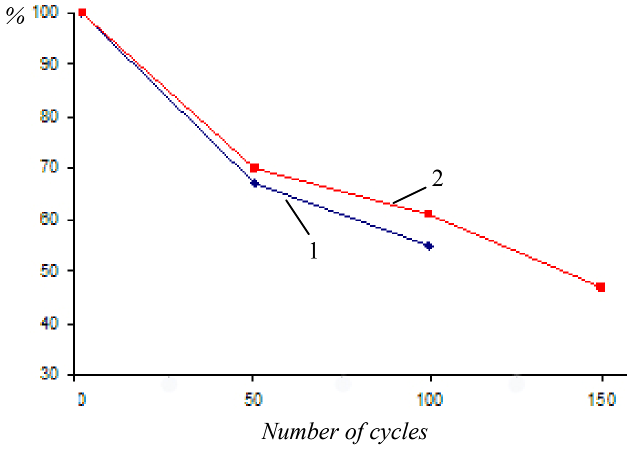


Fig. 8 The change of dot height of Braille font formed on the recycled pulp paperboard after different number of cycles of mechanical effect: *1*– Hansol HI-Q; *2* – Exprint

The analysis of the received results has shown that in the initial stage of abrasion – at 50 cycles, Braille elements created on recycled pulp paperboard wear out faster in comparison with cellulose pulp paperboard, and the studied paperboards have double-layer coating of the front side. At 100 cycles, the wear of decreasing Braille elements height on recycled pulp paperboard slows down and the process of wear is almost as fast as on cellulose paperboard.

4. Conclusions

1. The results of the tests show that for packages with Braille, cellulose pulp paperboard is most commonly used.

2. The measurements of dispersion of Braille geometrical parameters before mechanical effect have shown that the change of dot height is insignificant and the deviation from the average value is 0.01-0.04 mm.

3. It was determined that the surface of a package wears differently depending on the paperboard type, composition and properties of the paperboard surface.

4. Braille dots formed on the packages of recycled pulp paperboard wear faster than the ones on the packages produced from cellulose pulp paperboard.

5. After more than 100 mechanical effect cycles, on the surface of paperboard picking of fibers was formed which caused trouble in the readability of Braille.

6. It was determined that the Braille formed on the packages produced from cellulose pulp paperboard manifest greater resistance to mechanical effect: after 50 mechanical effect cycles the greatest change of Braille dot height is 21% and after 100 cycles – 44%.

7. Braille dots formed on the packages from recycled pulp paperboard are less durable: after 50 mechanical effect cycles the greatest change of dot height is 33% and after 100 cycles – 45%.

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BRAILIO RAŠTO GEOMETRINIŲ IR FIZIKINIŲ-MECHANINIŲ PARAMETRŲ TYRIMAI, ĮVERTINANT SKIRTINGO TIPO KARTONO MEDŽIAGAS

R e z i u m ė

Žmonių, turinčių regos negalią, viena iš integravimo į visavertį visuomeninį gyvenimą priemonių yra Brailio rašto naudojimas juos supančioje aplinkoje, taip pat ir ant įvairios paskirties pakuočių. Brailio rašto skaitymui labai svarbūs yra tinkamai suformuoti elementai, kurie ir po ilgalaikio naudojimo turėtų išlikti lengvai skaitomi aklųjų.

Straipsnyje atlikti kelių tipų kartono, kaip medžiagos, naudojamos farmacijos pramonės pakuotėms, taip pat Brailio rašto paviršiaus atsparumo mechaniniams veiksniams tyrimai. Ištirta Brailio rašto, suformuoto ant kartono pakuočių, geometrinių parametrų sklaida. Pateiktos tyrimų išvados.

E. Kibirkštis, I. Venytė, V. Mayik, D. Vakulich

INVESTIGATION OF GEOMETRICAL AND PHYSICAL – MECHANICAL PARAMETERS OF BRAILLE BY ASSESSING THE DIFFERENT TYPES OF CARDBOARD MATERIALS

S u m m a r y

For people with visual impairment, one of the means of full integration into society is provision of Braille in their environment, including information on multipurpose packages. Properly formed elements are very important for the readability of Braille font, which after some handling should remain easy readable by the blinds.

In this paper, investigations of different types cardboard which is mainly used as a packing material in pharmaceutical industry as well as resistance of Braille surface to mechanical factors were carried out. Dispersion of geometrical parameters of Braille formed onto paperboard packages is analyzed. Conclusions based on the performed investigations are provided.

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