Special Examination for the Durability of Text Books

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Abstract

Although nowadays the use of the devices of electronic communication as an option is more and more frequently considered, school books have still remained the fundamental learning aids. But what is a durable school book like? The article describes the test methods that the authors have determined for the description of the structural durability of school books. There were seven types of school books differing from each other in format and/or binding technology tested, and applied to model the book-using "'habits" of students; the results have been systematically arranged, and options have been determined for the improvement of durability properties. In summary of the test results, it can be claimed that with respect to durability school books are made ideal when they are designed in smaller dimensions and with the smallest possible weight. It is better to have paperback covers, because during the performed tests hardcover books reflected more serious damage.

Keywords: textbooks, durability, bookbinding, universal book tester

1. Introduction

Today, during the production of books nearly all the binding operations are performed with machines. These technologies have developed a lot in the past 5–6 decades, especially the so-called perfect binding techniques. They properly satisfy the demands relating to the general use of books (ACTS, 2012).

It is primarily libraries that have had demands for so-called durable books, while this need has become increasingly stressed in the production of school books, too. In recent years, Hungary has particularly seen this issue associated with the quality properties of the so-called durable school books coming to the focus of attention. The fact that the need for durable school books has become important has been largely fostered by the government's effort launched in 2014 for the provision and distribution of durable school books. Requirements relating to school books (especially durable school books) are stipulated in Ministerial Decree 17/2014 (March 12) of the Ministry of Human Capacities. In terms of structural considerations and book binding, from among the provisions set out in the Decree it is only the so-called technological requirements that bring about harder tasks and challenges than before:

"**§ 38.** Technological requirements pertaining to durable books:

a) assembling the sheets of the school book with the use of thread-stitching or backlash lining,
b) durable and at the same time light form of binding: reinforced paperback (cover: at least 260 grams/square meter, cellulose-containing cardboard four times grooved), or hard-covered, or flexible binding,
c) B/5 or A/4 sized book block,
d) use of light inner paper,
e) surface finishing of the cover (thermofoil)."

Based on the Decree, from a technological (binding) perspective books are evaluated with the respect to the following criteria.

"A) Criteria of evaluation for school books of general subjects
II. Technological (binding) criteria
1. Dimensions of the book block, number of pages, mass and weight with respect to the age of the student
2. Quality of the used paper and other materials, durability of the book
3. Typography, fonts types, font sizes, system of highlights and displays
4. Page-setting, ratio and harmony of texts to images, typography of highlights and displays
5. Quality and legibility of printing, application of colours.**"**

It is apparent that the above-quoted Decree does not set out specific criteria, requirements in relation to the structural, mechanical properties of school books (durable books), the concept of durability.

Although the printing industry and the various research institutions associated with the printing industry apply well-known test techniques, methods and devices that are useful for determining the mechanical properties of a given book (mostly constituents) with respect to a specific requirements or even set of criteria, at the same time the methods for the evaluation of these test methods and the obtained results are not covered in any standardized, broadly accepted system. It means that generally accepted, objective methods and standards that would determine the mechanical and technological durability of bound books, and in particular the so-called durable books (library books and school books), on the level of definitions and substances are not available.

To promote the resolution of the issues listed above, our study has had the goal to elaborate quality indicators for durable school books, as well as define and model the properties of their durability.

2. Methods of the research

On the one hand, as it has been mentioned above, currently there is no uniform, generally accepted test method or standard that would specify the requirements in association with the examination and review of the binding quality of bound books, their durability, or the evaluation of the obtained results.

On the other hand, we are able to summarize the known test methods that are currently used for the verification of the binding quality of new, completed and bound books (Rebsamen, 2002; 2003a; 2009). Nevertheless, these test methods are not suitable for shedding light to information in relation to expected lifetime, its resistance to the mechanical and other impacts that affect the book during use. There are different devices from various manufacturers to examine the binding strength of books made with perfect binding. Examples include the Smithers' Pira Book tester or the Moffett Page Pull tester-80 (Figure 1).

In the absence of appropriate standards, it is a difficult challenge to accurately adjust binding strength tests, as with the different device types the same results can be achieved with dissimilar settings. With the given equipment, such "online" (i.e. in the process of manufacturing) quality control actions may as well be carried out to help to reduce the number of defective products. Testing yields quick and prompt results, which allows machine operators to correct/adjust production lines in the course of manufacturing. If the problem with inadequate binding strength is caused by the defect of the glue, then it can be promptly detected with the help of the mechanical test.

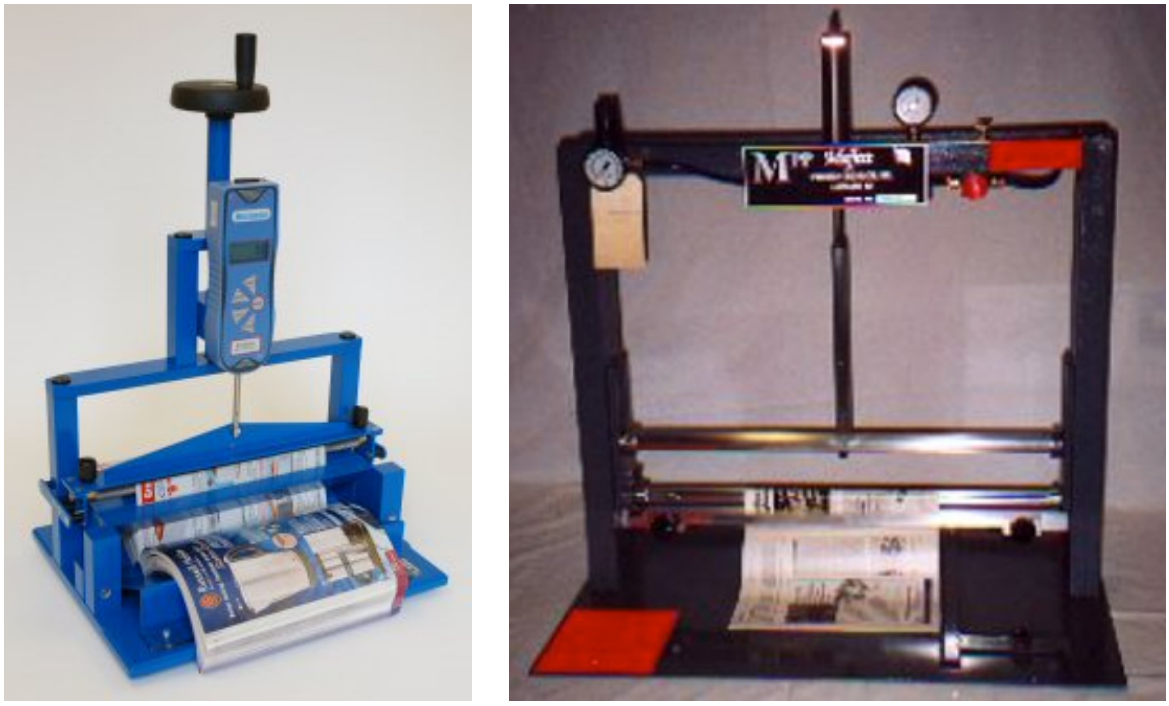

Figure 1: Smithers' Pira Book tester and Moffett Page pull tester-80

During the examination conducted with the MOFFETT Flex tester-40 equipment (Figure 2), loading is exercised on the clamped and tested book pages cyclically, in contrast with the form of loading used by the above-described binding strength testing devices (non-recurrent stress that gradually increases up to the limit of binding strength). With the equipment, the stress that imitates page turning is exercised on the tested page of the book at a 40 cycles/minute rate. Two types of loading strengths can be applied. The number of stress cycles is recorded, and the equipment automatically stops when the examined page becomes torn, or any other damage takes place. The binding strength of the given book can be described with the number of the stress cycles (and the extent of the applied loading). A main difference of this type of equipment in comparison with the previous devices is that it can be used only with perfect bound books.

Figure 2: MOFFETT Flex tester-40

Figure 3: Moffett UBT-9 Universal Book tester

The Moffett UBT-9 (Figure 3) is designed to test the durability, that is, it evaluates several aspects of a hard-cover binding; the abrasion resistance of covering materials, the integrity of the hinges, the stiffness and resistance to de-lamination of the boards, and to a limited degree, the durability of the sewn or adhesive bound book blocks (Rebsamen, 2003b; 2013; Hyatt, 1988).

The device consists essentially of a rectangular test chamber constructed of steel, lined with 50 by 50 mesh of No. 304 stainless steel wire 0.009 inch in diameter. The chamber is supported and rotated by a drive shaft attached perpendicular to the centre of its base. Viewed from the front, the drive is inclined at an angle of 20° from the horizontal, and rotates in a clockwise direction at a speed of 20 rpm. The dimensions of the test chamber vary with the size of the volume being tested (MSST, 2012).

The spine of the book is perpendicular to the squared ends of the chamber. As the chamber rotates, the book slides in a regulated manner, receiving impact stresses on the bottom, along with the abrasion of the edges and shoulder, and some flexing of the hinges. The principle actions of the UBT are pulling of the head-cap, sliding the book off the shelf, dropping the book on a book truck or a return box, and sliding the book across the table or down a chute! The capabilities of the Moffett UBT-9 are presented in Table 1.

Table 1: Capabilities of the Moffett Universal Book Tester Model-9

Actions Produce the Following Results
1. abrasion of the shoulder of the spine
2. abrasions of the edges of the cover
3. light abrasion of the cover surface
4. distortion by impact
5. abrasion of the tail-cap and edges
6. hinge flexing action
7. breaking and tearing of the internal hinge
8. failure of sewn or adhesive bindings and splitting of the spine
9. abrasion and turning up of the edge of cover*

* We have assessed the testing of this property to be important.

The tested school books are used at primary and secondary schools. All of them have been provided by the manufacturers for testing. Their properties are specified in Table 2.

Table 2: School books subjected to testing and their properties

Book No.	Cover	Binding	Size	Tested Quantity
7–9	hard-covered	thread-stitched	A4	3 pcs
13–15	hard-covered	thread-stitched	B5	3 pcs
16–18	hard-covered	thread-sealed	B5	3 pcs
19–21, 25–27, 28–30	soft-covered	thread-stitched	A4	3 pcs
4–6	soft-covered	thread-stitched	B5	3 pcs
22–24	soft-covered	perfect bound with PUR	A4	3 pcs
1–3,10–12	soft-covered	perfect bound with PUR	B5	3 pcs

3. Results

Due to the limitations of the extended abstract, only a part of the study will be presented. For paperback school books, durability tests assessing the conditions of the spine edges and corners, as well as binding conditions have been carried out. The other tests are conducted in a similar manner, and summed up in the conclusion.

3.1 Abrasion at the spine edges

From among the B/5 sized school books with perfect PUR binding, the school book with the 250 g/m^2 cardboard cover and non-gloss foil coating (Figure 4) proved to be the best concerning the abrasion of spine edges. The abrasion is hardly visible to the naked eye. The moderate damage is also due to the light, 230 gram weight of the book, as the book smashes against the sides of the machine with less power.

Figure 4: The B5 sized book showing the least abrasion on the spine edges

Similarly, from among the B5 books the largest extent of spine abrasion has been suffered by the 496 gram school book (Figure 5) with perfect PUR binding.

Figure 5: The largest extent of spine edge abrasion has been experienced for B5 sized book No. 10–12

With respect to the properties of the cover, it has a flexible cover of small square meter weight that does not compensate for the weight of the book.

Figure 6: The A4 sized, No. 28–30 thread-stitched school book with a smaller extent of spine edge abrasion

In the A/4 format, the best final result has been achieved by the 410 gram, thread-stitched school book (Figure 5). Its cover is of 260 g/m^2 weight. During the test, abrasion apparently occurred after the 50th minute, but it did not change drastically even by the end of the 60th minute.

Figure 7: The A4 format, No. 25–27 thread-stitched school book with a considerable extent of spine edge abrasion

The thread-stitched book (Figure 3.7) proved to be the book with the worst spine edge. The weight of its cover is 260 g/m^2. It was thinner and more flexible than the most durable book, and therefore the book showed no rigidity in the test machine. It smashed against the walls of the chamber more easily, and due to their flexibility it more easily leant against the rounded corners, and therefore suffered abrasion over a larger area.

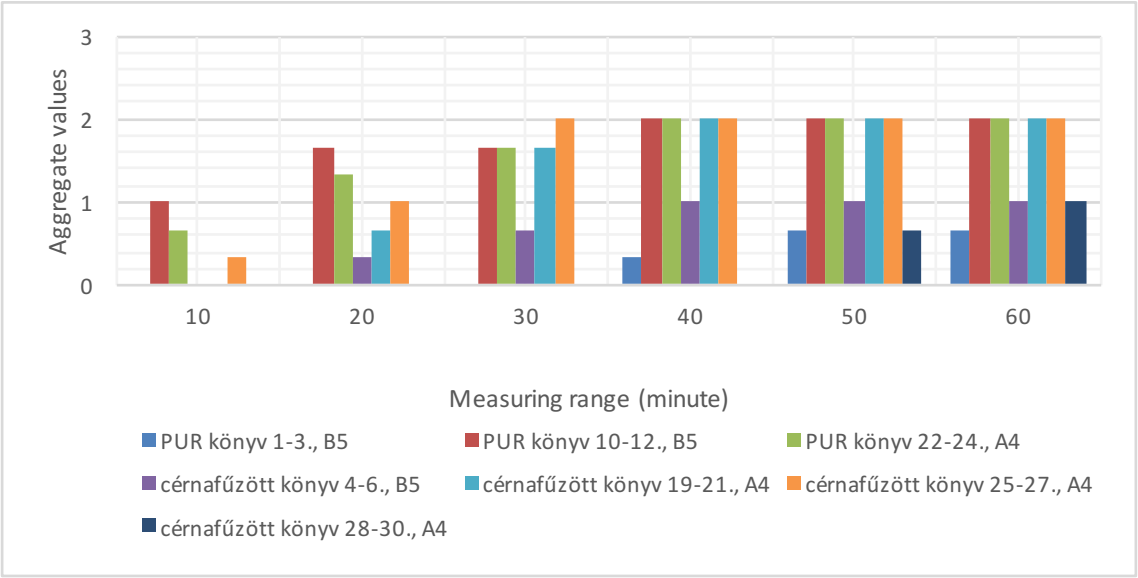

Figure 8: Spine edge abrasion for paperback books

In the light of the aggregated evaluation (Figure 8), it can be claimed that while initially the B5 school book with perfect PUR binding showed strong abrasion, the spine edge abrasion of A4 school books surpassed this extent of abrasion, and eventually even worse statistics could be obtained. It is also dependent on the type of the cover material and the weight of the book. In general, the worst type was the Aurocard paper type in the case of large-format books. With respect to spine edge abrasion, smaller format books achieved better results.

3.2 Abrasion at the spine corners

For the study of spine corners, the smallest extent of abrasion has been experienced for the same book where the least spine edge abrasion has been seen (Figure 2). No signs of impacts can be detected at the corners. The upper part of the spine edge can be regarded to belong to the corner section. This part – extending 10 mm along the spine edge towards the middle of the book block – has not become considerably worn, either (Figure 9). In the opening of the book, it can be observed that along this line the cover has not become worn so that any tear could be observed when pages are turned.

Figure 9: Slight spine corner abrasion on the No. 28-30 thread-stitched school book

By the end of the measurement, more serious corner damage has been detected in the case of three books. Two types of school books (Figure 10) that have the same type of covers and inner sheets – their corner damage has been also similar. On the other hand, in the measuring range it can be seen that over time book No. 19–21 and No. 25–27 have not suffered comparable abrasion even with similar base materials. The abrasion has been the most significant in the head section, as in both cases the covers have been worn down to the adhesive layers, and therefore they have become detached and torn down to a depth of 5 mm together with the end papers, along the spine edges.

Figure 10: Spine corner abrasion of the No. 25–27 and No. 19–21 school books

In B5 size, the 570 gram No. 10–12 school book with perfect PUR binding (Figure 11) proved to be the least durable at the edges. Because of its weight, the flexible block and thin cover made the book rub along the rounded sides of the chambers, and smash against the spines. For this book type, the cover has become worn down to the adhesive layer along the spine edge, while in the head the extent of abrasion was even more serious. It means that the cover material has become so much worn that together with the end paper the spine has torn up to 5 mm along the spine.

Figure 11: Strongly worn spine corners in the No. 10–12 school books with perfect PUR binding

According the summary shown in the graph (Figure 12), paperback school books have been given evaluation over value 2 on the aggregate. All of them have been considerably changed, damaged.

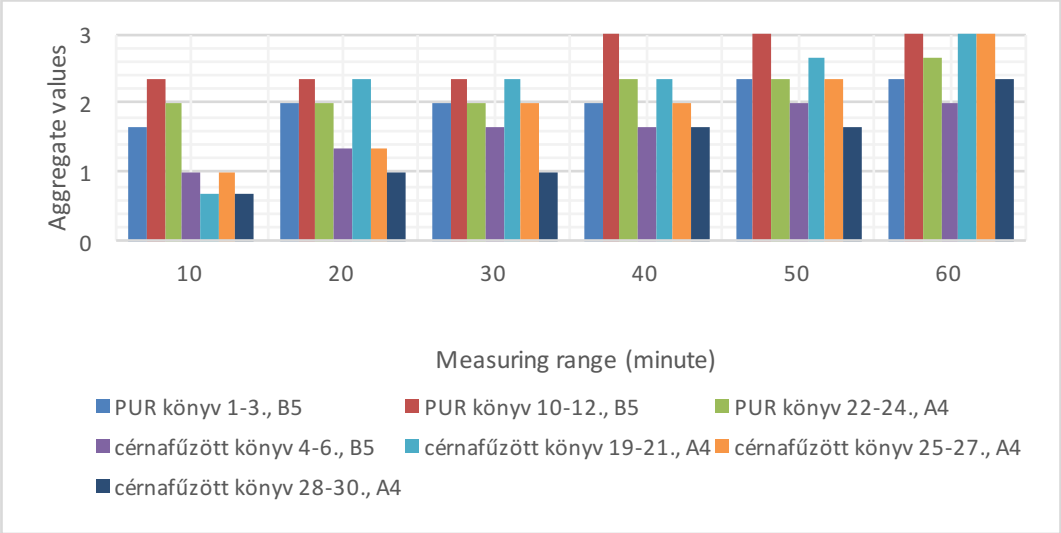

Figure 12: Spine corner abrasion for paperback books

This change has not caused damage to the spine binding. Better results in the abrasion of spine corners have been achieved for B5 format books.

3.3 Conditions of spine binding

The most durable binding has belonged to the B5 sized No. 10–12 school book with perfect PUR binding. The graph reflects that no values have been given to it. The perfect PUR binding has proved to be strong enough in for the 496 gram weight. The sheets have remained stable.

Figure 13: Conditions of binding on the A4 format, No. 25–27 thread-stitched school book

The A4 format, No. 25–27 thread-stitched school book has proved to have the weakest binding (Figure 13). It has the largest weight among paperback school books. As a result of the large format and 570 gram weight, the thread-stitched spine edge has suffered larger impacts, and therefore this binding has weakened more significantly and sooner than the others. The stability of sheets has changed only to a smaller extent. Impacts have concentrated along the spine edge, and therefore this part has demonstrated stronger abrasion, as a result of which the first sheet has become torn in the head.

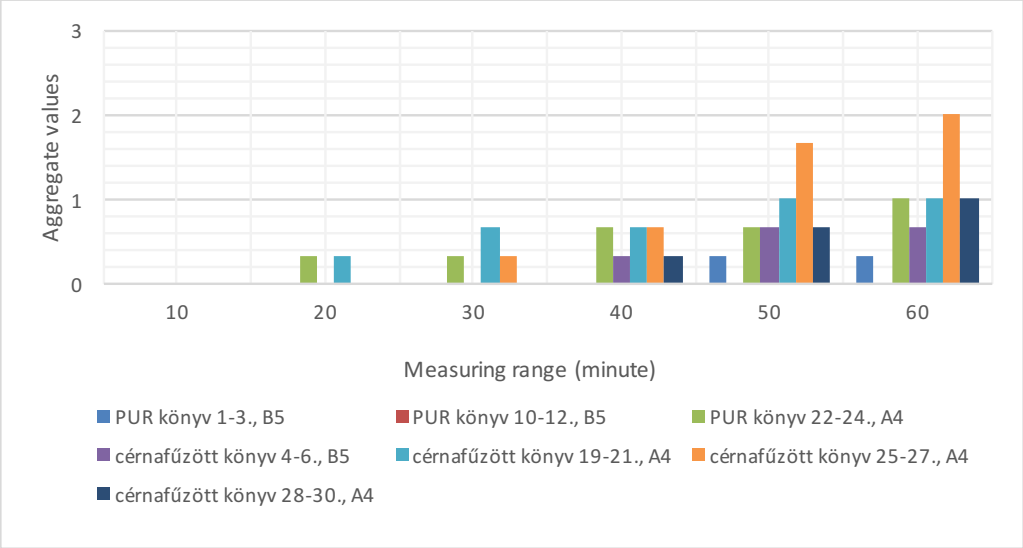

Figure 14: Conditions of spine binding for paperback books

By the end of the 60th minute, the binding has fallen into pieces in nine of the cases (Figure 14). The quality of the received school books can be regarded as appropriate. According to the summary tables, minor changes have occurred only at the end of the 50th minute.

4. Conclusion

In summary of the test results, it can be claimed that with respect to durability school books are made ideal when they are designed in smaller dimensions and with the smallest possible weight. It is better to have paperback covers, because during the performed tests hardcover books reflected more serious damage.

It has also been proved that it is reasonable to modify the test methods described in the referenced technical literature, because the recommended full testing time (60 minutes) that we have also applied is insufficient. In our experience – and it is also reflected in the results –, it is too short. Outcomes showing serious or total damage have occurred less frequently than expected.

Obviously, another conclusion that can be potentially drawn in view of the measured results, that the examined test books have had better than average quality in view of durability. Still, it can be true. Nonetheless, based on our studies this assumption cannot be scientifically confirmed.

The test method has to be refined in two respects. On the one hand, the damage time or intensity should be increased until total destruction so that clean-cut quality-related findings could be made in connection with the individual binding technologies. On the other hand, it is important to compare the accelerated destructive study with real-life use to see at what intensity the model examination can lead to the accessibility of the expected durability requirements. In this context, tests have already been conducted, and the associated results are still under processing.

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