# The Effect of Surface Finishes on Rising Damp in Oriented Strand Board

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**Abstract**. It is known that oriented strand board (OSB) is prone to water absorption. This characteristic of OSB is undesirable, it can have a negative impact on the physical and mechanical properties of the material and it can also make it prone to attack from wood-destroying insects, rot or mould. The research follows previous work of the authors related to optimisation of surface finishes for OSB in order to increase its moisture resistance. The aim of the research is to compare the rise of dampness in test specimens with different types of coating, spray, primer and waterproofing under predefined conditions. The paper contains a definition of the basic material, test specimens and test methods, and covers 8 different types of surface finish materials selected for application to the test specimens. The results include graphs showing rise of dampness in the test specimens for each day of observation. The results are also discussed and in the conclusion the results are evaluated. The results of the experiments confirm the assumption that the choice of surface finish has a significant effect on slowing down the rise of dampness in OSB.

## 1. Introduction

OSB is a wood-based building material that sees very widespread use. This popularity is related to the several advantages it offers, such as its high dimensional stability, its availability in large sizes, and the fact that it can be used as a load-bearing material. [1]. OSB is employed for the cladding of walls and roofs, and can also be incorporated in floor or ceiling structures. It is the most frequently used material in structural insulated panels (SIPs), where panels clad with OSB are used for the foundation of buildings on foundation strips instead of base concrete [1].

One of the disadvantages of OSB is that it is prone to water absorption. During the construction process before the building shell is sealed, sometimes the exposure of OSB to water from precipitation is unavoidable [2, 3]. As a result, it swells up, which impairs its dimensional stability. This is a serious problem especially in the case of floor panels [3]. If a large amount of rainwater accumulates, there is a risk that the water may rise into vertical structures.

The authors of the article focus on the possibility of increasing the resistance of OSB to water absorption and ensuring its dimensional stability using a suitable surface finish. The use of a surface finish has the potential to reduce the swelling of the OSB. For example, the application of a highly elastic polyurethane coating [4], the treatment of the surface of the OSB with sprayed melted wax [3], a coating with a UV-cured surface finish [5] or the application of a nanotechnological compound [6] have all proved successful in the past. One of the authors' criteria for the selection of surface finishes for testing was that their application should be as easy as possible and not require prior mechanical surface treatments such as grinding [5]. Furthermore, an effort was made to choose products which are readily available on the market and relatively cheap [7].

The research builds on previous work by the authors [7], within which the results of applying the selected surface finishes were tested in terms of the swelling up of OSBs after their placement in water [8], and also through the determination of their resistance to moisture via a cycling test [9]. In the current article, the effect of surface finishes is evaluated by measuring the rise of dampness through the OSB. Two alternative test methods (one destructive, one non-destructive) were designed in order to allow the progress of moisture rising through the moisture to be observed.

## 2. Materials and methods

### *2.1. OSB specification*

OSB/4 was selected for the purposes of this research. It is classified in the relevant standard as a heavy-duty load-bearing board for use in humid conditions [10]. The investigated OSB (thickness 15 mm) was a commercial product from one of the main distributors on the Czech market. The manufacturer declares the following composition: 85-92 % absolutely dry wood weight (mainly softwood of the pine and spruce type, hardwood content up to max. 30 %), 4-6 % water (wood moisture), 3-6 % PMDI glue in the surface and core layers, ≤1 % paraffin wax emulsion. The guaranteed characteristic bulk density of the boards is greater than 600 kg/m$^3$.

### *2.2. Test specimens*

All specimens are cut from 15 mm thick OSB panels from the same manufacturer, with the same production batch number. For the destructive method, samples measuring 15 x 200 mm were used, while 30 x 200 mm samples were employed for the non-destructive method. The choice of sample size was made with regard to the technical capabilities of the selected measuring instruments (for example, the spacing of the measuring electrodes of the external moisture meter), and in the case of the destructive test, the option of cutting the samples with a hand saw was also taken into account. As with the detection of swelling after storage in water, the samples were first conditioned to a constant weight at a mean relative humidity of 65 % and a temperature of 21 °C [7, 8].

### *2.3. Specification of surface finishes*

8 types of surface finish suitable for OSB were selected for application to OSB test specimens. Each of them is supposed to increase the resistance of OSB against the effects of moisture. Surface finishes which are freely available on the market were selected. In the case of some of the selected surface finishes, the manufacturer´s instructions required their application in several layers or in combination with another product. The selected finishes do not require any special treatments to be applied to the surface of the OSB itself, only the removal of any impurities or grease. Except for the cork mixture intended for spraying, all finishes can be applied with a brush. A list of the surface finishes used and their compositions, including their more detailed specification, is shown in table below (Table 1).

### *2.4. Rising damp in OSB*

The essence of this test is to determine how high the water rises in a test specimen standing in a container of water with a water level of 10 mm above the bottom of the container. The container with the test specimens is placed in the same room and under the same conditions as in the previous step, where the samples were brought to a constant weight. Two variants of these tests were designed: destructive and non-destructive.

**Table 1.** Specification of tested surface finishes.

| Number of composition | Specification of the composition of the surface finish | Use |
|---|---|---|
| 1 | Silicone waterproofing coating – 1 layer | Exterior |
| 2 | One-component polymer-based waterproofing screed – 1 layer | Exterior |
| 3 | Acrylic copolymer water emulsion penetration primer – 1 layer<br>Cork mixture for application by spraying (organic mixture of crushed cork, acrylate emulsion in a water dispersion, pigments and water) – 2 layers | Exterior |
| 4 | Wood treatment lacquer suitable for primers (composition: acrylate, TiO2, BaSO4, white spirit, Na-phosphate, water, conservation additive) – 2 layers | Exterior and interior |
| 5 | Acrylate wood colour (composition: acrylate, TiO2, Fe2O3, silicate, white spirit, glycol, preservatives, water) – 2 layers | Exterior and interior |
| 6 | Protective water-based agent for end grain wood (composition: a mixture of 5-chlor-2-methyl-2H-isothiazol-3-on and 2-methyl-2H-isothiazol-3-on (3:1), 1,2-benzisothiazol-3(2H)-on) – 1 layer | Exterior |
| 7 | Adhesive bridge (one-component solvent-free coating, mixture of fillers and aggregates in a water styrene-acrylate dispersion) – 1 layer | Exterior and interior |
| 8 | Polyurethane-based wood strengthening agent (composition: diphenylmethan-4,4´-diisocyanat, range of aromas hydrocarbons C9-C11, diphenylmethan-2,4´-diisocyanat, hexamethylen-1,6-diisocyanat homopolymer) – 1 layer<br>Wood treatment lacquer suitable for primers – 2 layers | Exterior and interior |

### *2.5. The destructive test*

The gravimetric method was used for the destructive test. For this purpose, a total of 15 samples with the given finish applied to their whole surface and one set of samples without any surface finish are prepared for each surface finish. The samples are placed in water with their shorter edge downwards, with the water level reaching 10 mm of the total height of the sample. Measurements are taken for a total of 5 days. At 24-hour intervals, 3 samples are taken out of the water and placed in a protective container to prevent the water from evaporating. Smaller parts are gradually cut from them at every 10 mm of height. These are weighed with an accuracy of 0.001 g immediately after collection. Afterwards, they are dried at a temperature of 105 °C to a constant weight [11] and re-weighed with an accuracy of 0.001g. The moisture content of the successively cut off individual parts of test specimen H is given as a percentage by mass and is calculated according to the following formula (Equation 1), which is based on standard EN 322 [11]:

$$H = [(m_H - m_o)/m_o] \times 100 \quad (1)$$

where $m_H$ is the mass in grams of the test specimen during the first weighing after sample collection and $m_o$ is the mass in grams at the last weighing after drying.

### *2.6. The non-destructive test*

Each surface finish is tested on a set of 3 specimens treated with a surface finish across their whole surface. A set of 3 specimens without a surface finish is also tested. The specimens are placed in water in such a way that the bottom part of the specimen is immersed in water up to a height of 10 mm. The specimens are taken out of the water every 24 hours. The % H2O is measured on both sides of the specimen using an external moisture meter at levels located at an increasing distance from the edge of the specimen that is immersed in water: this distance increases by 10 mm per measurement. Throughout the measurements, care is taken to always place the electrodes in the same place symmetrically with respect to the centre of the specimen. The measured percentages refer to the absolute moisture content of wood, as there are no external hygrometers available specifically for OSB. The measuring range of the external hygrometer is 6 to 30 %: a moisture content ranging from 6 to 12 % means a dry specimen, 13 to 19 % are limit values, and 20 to 30 % is a high moisture content. These measurements are repeated for 5 consecutive days.

## 3. Results and discussions

The EN 300 standard specifies a moisture content requirement for OSB in the range of 2 to 12 % when shipped from the manufacturer [10]. It is generally true of wood used in buildings that the moisture content should not exceed 20 %, while wood with a permanent moisture content of up to 12 % does not need to be further protected against attack by biotic pests [12].

The manufacturer of the investigated OSB states a moisture content of 4-6 %. Based on this data, it can be assumed that the parts of a sample with a measured moisture content of ≤6 % lie at a height to which the water in the test apparatus has not risen. In the case of values above 20 %, we can speak about a high moisture content, which can also be seen from the division of the measuring scale of the external hygrometer.

The OSB samples without any surface finish and the samples provided with 8 types of surface finish across their whole surface were subjected to a destructive test in which the height of the rising damp was determined for 5 consecutive days. A total of 9 sets of 15 samples (3 samples for each day) were subjected to the test. The results obtained with the arithmetic mean were plotted in 5 graphs showing the dependence between the calculated moisture content and the height of the tested OSB material above the submerged base over time, as shown in the following figures (Figure 1 – Figure 5).

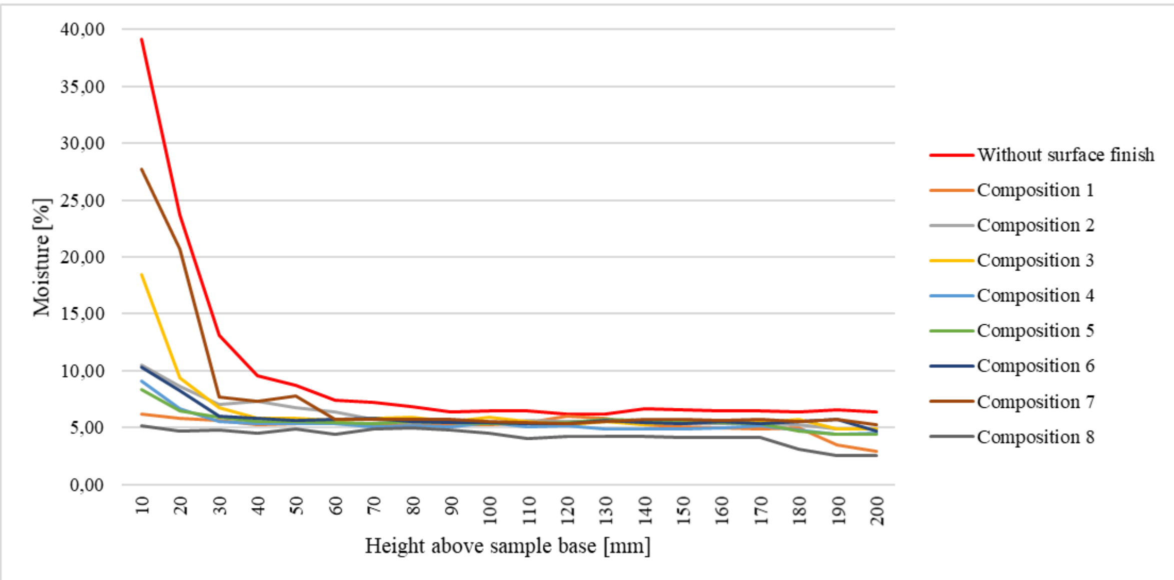


**Figure 1.** Results of destructive testing – day 1

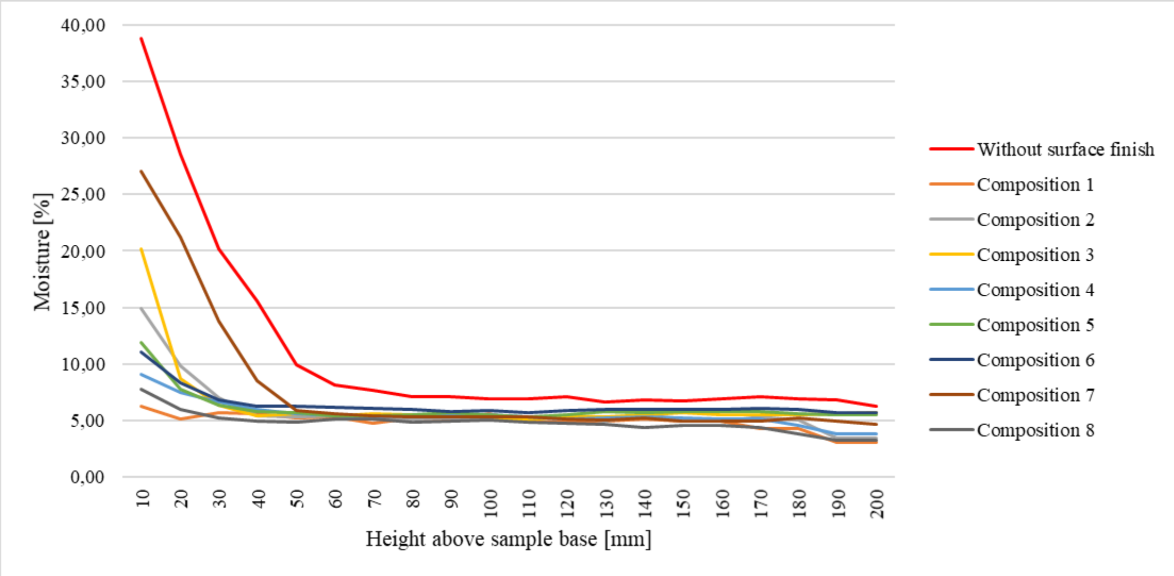


**Figure 2.** Results of destructive testing – day 2

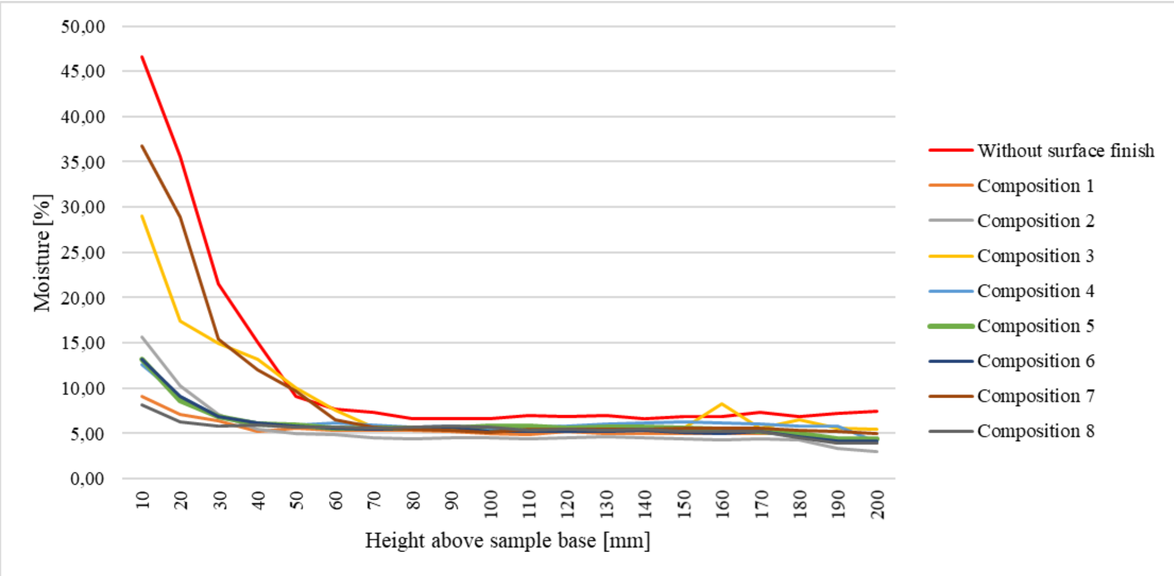


**Figure 3.** Results of destructive testing – day 3

Apart from the sprayed cork mixture – composition 3 (Table 1) and the adhesive bridge – composition 7 (Table 1), all surface finishes were able to keep the moisture content below the critical limit of 20 % for the entire 5 days of measurement. Composition 3 had significantly worse results in comparison with those from the previous stage of the research when surface finishes were evaluated on the basis of swelling [7]. This is because the crushed cork grains contained in the mixture tend to soak up water themselves and it isn´t possible to determine the difference between the amount of water absorbed by the board and that absorbed by the surface finish, as the surface finish wasn´t separated from the OSB before the weighing of the individual parts of the test specimens. For the same reason, there are also fluctuations in this composition at greater heights above the base of the specimen on the third day of measurement (Figure 3). The increased moisture content which appears here is probably not contained in the OSB but only in the surface finish. Composition 2 – one-component waterproofing screed (Table 1) – also achieved worse results in comparison with the previous stage of the research, where it performed the best [7]. As with the previous case (composition 7), the surface finish itself has a tendency to soak up water.

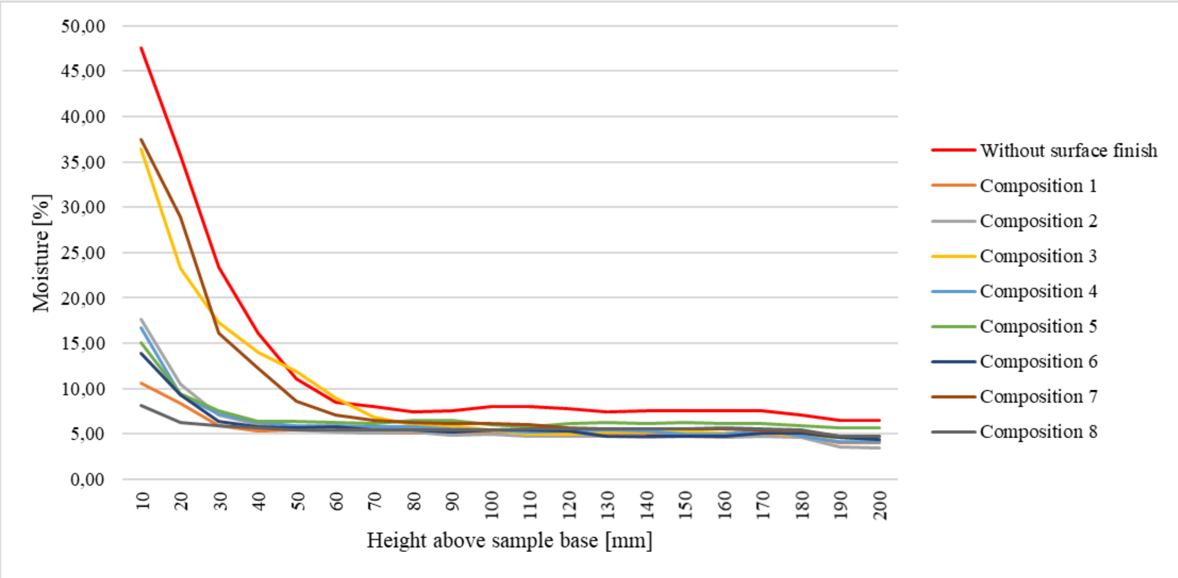


**Figure 4.** Results of destructive testing – day 4

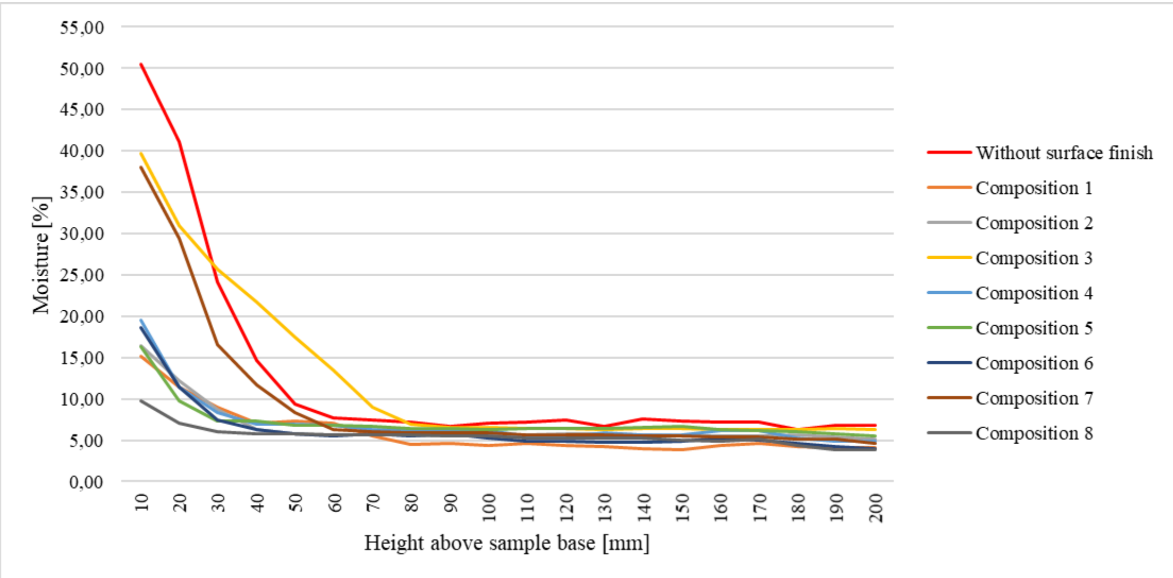


**Figure 5.** Results of destructive testing – day 5

OSB specimens without a surface finish and specimens provided with 8 types of surface finish across their whole surface were subjected to a non-destructive test during which the upward progression of rising damp was determined for 5 consecutive days using an external hygrometer. A total of 9 sets of 3 specimens were subjected to the test and the moisture content was always measured on both sides of the specimen. The results obtained by arithmetic mean were plotted in 5 graphs showing the dependence between the calculated % moisture content and the height of the OSB material above the submerged base over time, as shown in the following figures (Figure 6 – Figure 10).

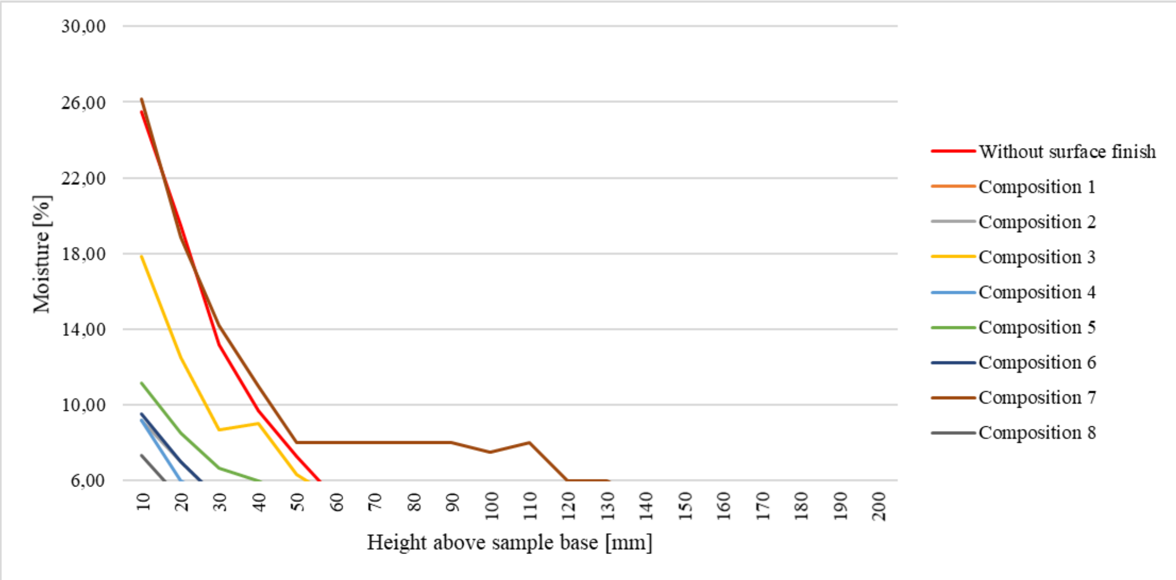


**Figure 6.** Results of non-destructive testing – day 1

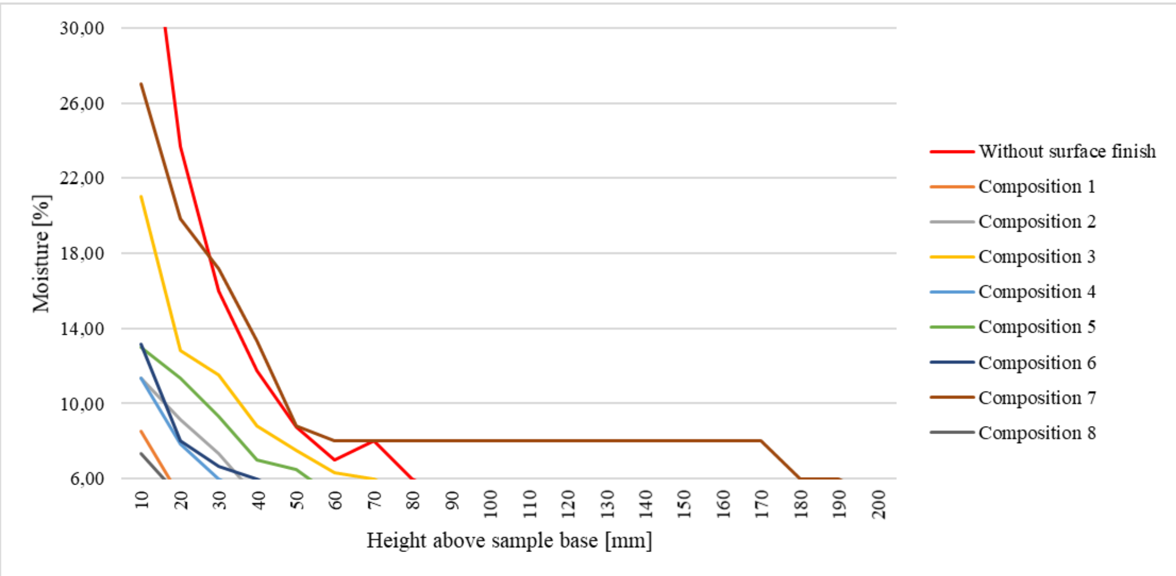


**Figure 7.** Results of non-destructive testing – day 2

The results obtained with the external hygrometer essentially confirm the results obtained with the destructive test. Composition 7 – adhesive bridge (Table 1) performed even worse in this case. Just like composition 3 (the composition with the cork mixture for application via spraying), this surface finish has a tendency to soak up water by itself. However, unlike sprayed cork, the thickness of this surface finish after application is much smaller. This explains the difference in the measured values, as if both surface finishes have a tendency to soak up water, the samples with a surface finish that is applied in a thicker layer must logically exhibit a higher moisture content.

In the graphs obtained via non-destructive testing (Figure 6 – Figure 10), there are more obvious fluctuations in moisture content along the height of the specimen. The transport of water in the OSB takes place irregularly [13, 14], and the external hygrometer is more sensitive to this fact.

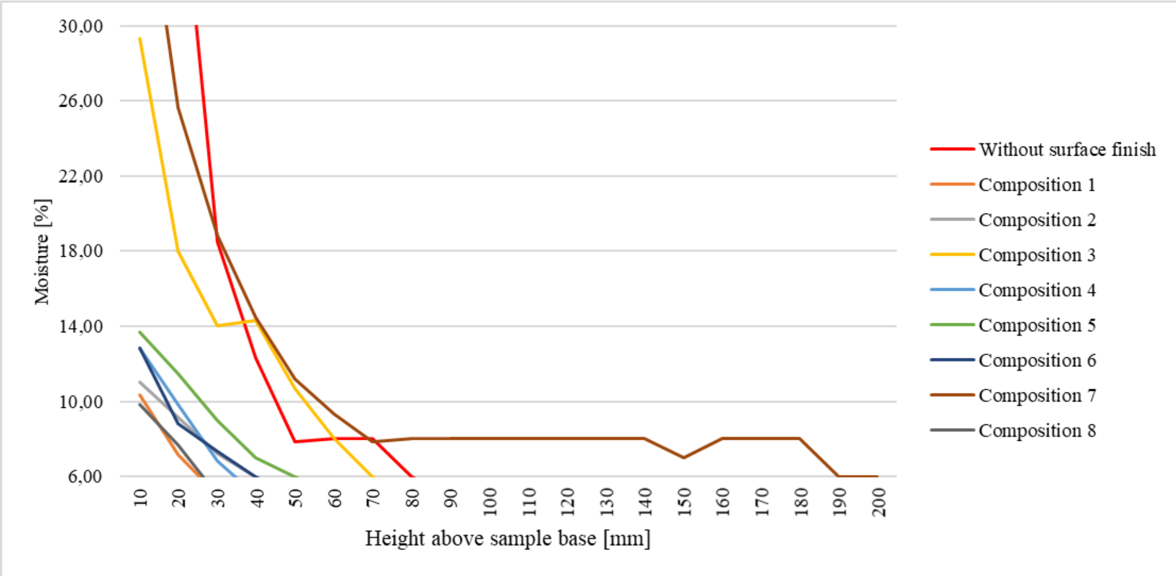


**Figure 8.** Results of non-destructive testing – day 3

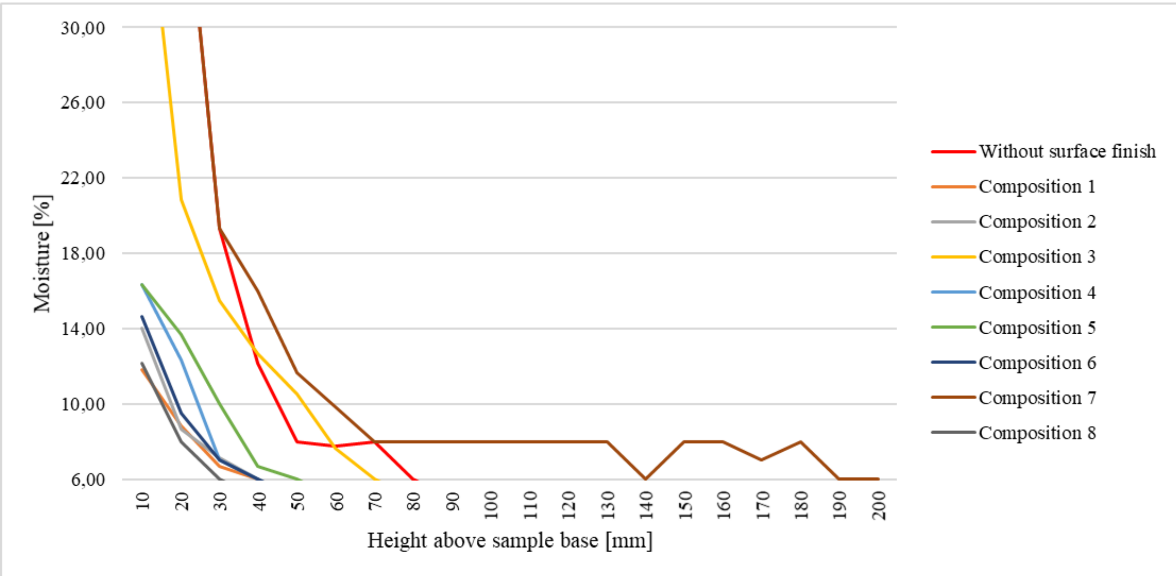


**Figure 9.** Results of non-destructive testing – day 4

## 4. Conclusions

The results of the experiments confirmed that a suitably selected surface finish can slow the progress of rising damp in OSB, and also that it can prevent the accumulation of a high moisture content in OSB that is directly exposed to the effects of water for at least 5 days. It was also discovered that after 5 days of exposure to the direct effects of water, the water level in the OSB rises to a max. height of 80 mm, which is also true for a board without any surface finish. On the other hand, an unsuitable surface finish could cause the water to rise even higher thanks to its use. Nevertheless, based on experiments performed in the previous stage of the research when the effects of surface finishes were assessed on the basis of the swelling of OSB boards, it can be concluded that in such a case, most of the moisture is retained by the surface finish itself and does not enter the OSB.

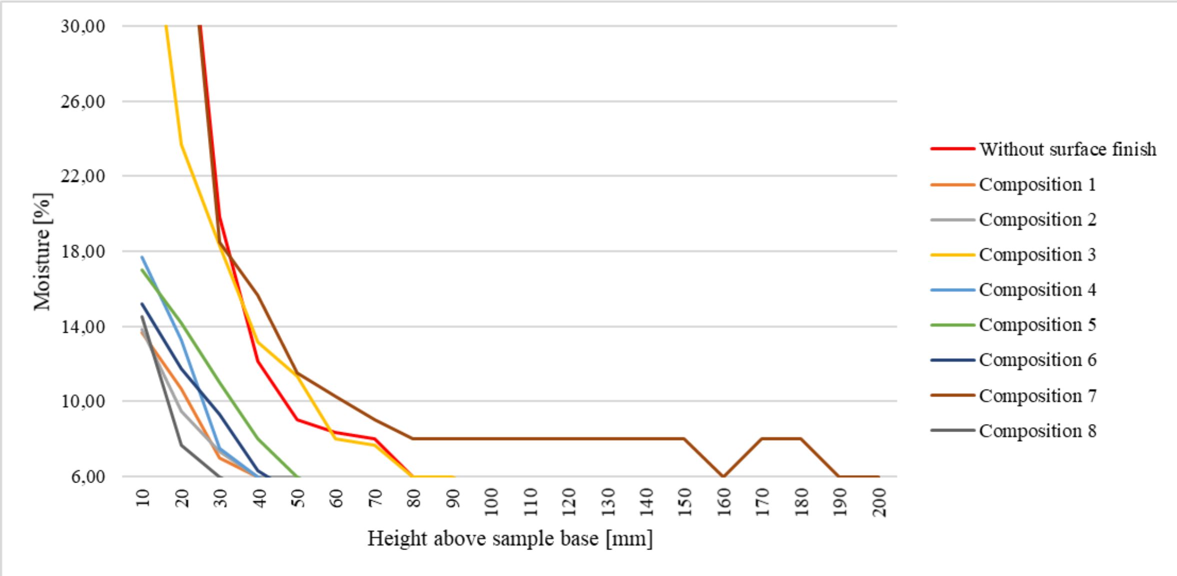


**Figure 10.** Results of non-destructive testing – day 5

In conclusion, it can be stated that the results from the measurements taken using an external hygrometer correspond very well with the results from the destructive test, and are both easier and faster to obtain. However, it should be noted that the measurements were always taken on both sides of the board.

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