Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 103, 2018: 202-207
(Ann. WULS - SGGW, For. and Wood Technol. 103, 2018)

Slip resistance of wood-polymer composite decking profiles

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Abstract: *Slip resistance of wood-polymer composite decking profiles.* The paper presents results of slip resistance tests of wood-polymer composite terrace deckings profiles. The tests were performed on various geometries of profile surfaces, in dry and wet conditions. The obtained results show that the surface finish has larger impact on slip resistance than fluting geometry. The impact of fluting was noticeable only in case of a surface with wide profiling. A large decrease in slip resistance was noted as a result of surface wetting. Most of the tested solutions featured pendulum test value of above 36 units, which allowed them to be classified as low slip risk surfaces.

Key words: *slip resistance, wood-polymer profiles, pendulum test value, dry and wet conditions*

INTRODUCTION

Slip resistance of decking surfaces is a performance characteristic decisive to achieve the basic safety requirement no. 4 *Safety and accessibility in use*, which together with the Appendix I to the Regulation of the European Parliament and of the Council (EU) no. 305/2011 (CPR) [10] form one of the seven basic requirements that must be met by construction products. This regulation indicates that civil structures must be designed and constructed in such a manner so that not to create an inadmissible risk of accidents or damages in use or in operation, such as the slip risk.

The issue of slip resistance of flooring surfaces in rooms designed for permanent presence of people, is regulated by the *Technical conditions that must be met by buildings and their locations* [9]. The Part VII *Safety of use* indicates that the *Building and the associated equipment shall be designed and made to prevent an inadmissible risk of accidents during use* (Art. 291). To achieve the above, the *Surfaces of access routes to buildings, stairs and external/internal ramps, traffic routes within the building, and flooring surfaces in rooms designed for presence of people, as well as garage floors, shall be made of materials that do not create the risk of slipping* (Art. 305, item 1).

The aspect of slip resistance of wood-composite profile deckings is also included in the standard PN-EN 15534-4 [7] which indicates that they shall feature a pendulum test value, in both dry and wet conditions, not lower than 36 units, alternatively the acceptable angle in bare foot test shall not be lower than 24° or the dynamic friction factor shall not be lower than 0.43.

TEST METHOD

Slip resistance can be verified using various methods [1], [2], [11]. Most of them is associated with friction force measurements. The scope of this paper covers tests of pendulum test value (PTV). This method was chosen due to its universality. A pendulum, which was used to carry out the measurements, is a mobile device that allows to perform measurements both at the laboratory, and to verify the measurements on an actual flooring surface installed in a building.

The testing technique was described in many standards, including CEN/TS 15676 [3], CEN/TS 16165 [4], and PN-EN 13036-4 [6]. The slip resistance test determines the slider rubber energy loss caused by friction on the tested surface. The tests were carried out using the slider no. 57 (CEN) with the hardness of 55-61 IRHD, with the slider surface width of 76.2mm and length of 126mm.

Before the tests the device was calibrated using reference surfaces. During the tests the slider moved over the surface of the tested profile. The friction force between the slider and the tested surface was determined by measuring the displacement of the pendulum during slider movement, by using a calibrated scale. The scale C was used.

The tests were carried out in longitudinal direction (parallel to the profile lengths) and lateral direction (perpendicularly to the profile lengths), separately for each surface (Fig. 1-4). Measurements were taken in the following conditions:

– dry, i.e. after stabilising the samples in laboratory conditions,
– wet, i.e. after applying of plenty of demineralized water on both the sample and the slider.

10 measurements were taken per each type of profile, each type of surface, and in specific conditions.

TEST MATERIAL

Tests were carried out on terrace decking profiles made of wood-polymer composites of the composition described in Table 1. The profile geometry is presented in Fig. 1-4.

Table 1. Material composition of composites

Profile type	Material composition of the composite			Shape and dimensions	Surface finish
	matrix	filler	other		
	type of material				
F1	PVC	wood flour	modifiers and additives	Fig. 1	brushing
F2				Fig. 2	
L1	HDPE	bamboo fibres	modifiers and additives	Fig. 3	polishing
L2				Fig. 4	

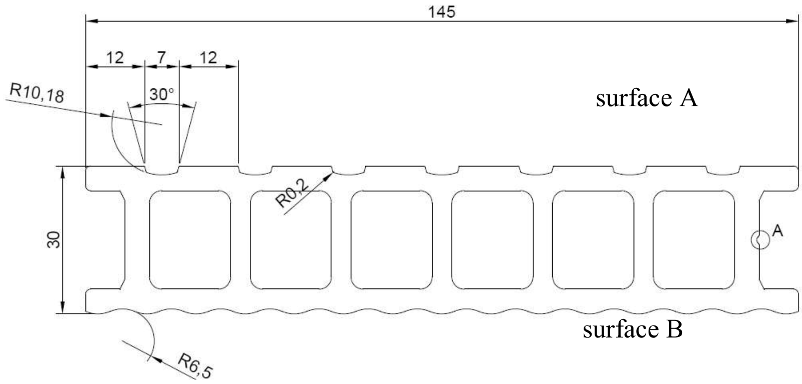

Figure 1. Profile geometry type F1

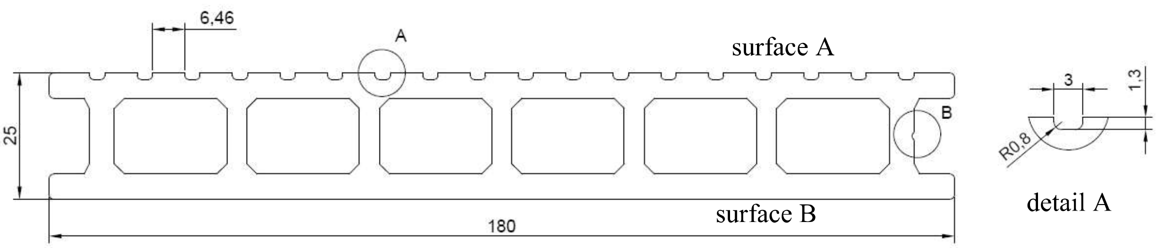

Figure 2. Profile geometry type F2

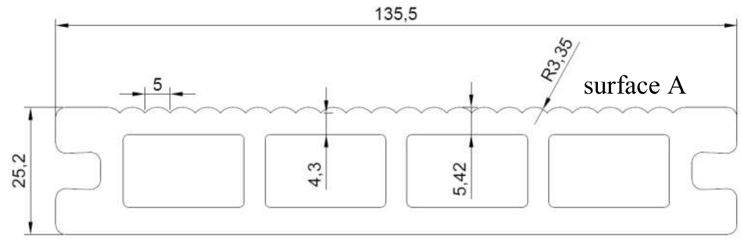

Figure 3. Profile geometry type L1 surface B

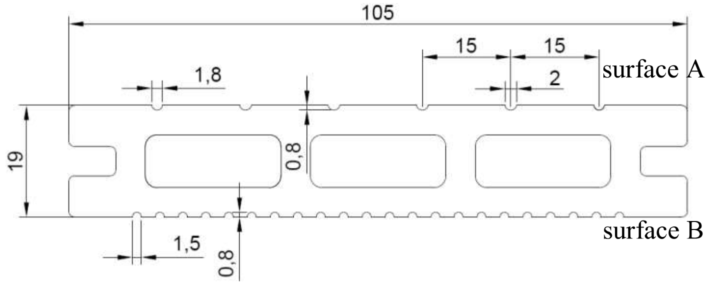

Figure 4. Profile geometry type L2

TEST RESULTS

Results of pendulum tests in longitudinal direction are shown in Fig. 5, and in lateral direction in Fig. 6. In both cases the presented results include measurements for both dry and wet profiles. Analysis of the obtained test results indicates a significant influence of profile surface condition on their slip resistance. The pendulum test value in dry condition covered the range from 46 to 87 units in longitudinal direction, and 73 to 101 units in lateral direction, whereas in wet condition the readings were 32 to 77 units, and 38 to 86 units, respectively. The highest decrease caused by water was observed in the case of L1 and L2 profiles in lateral direction. They were from 43% to 49% of the value in dry condition.

When analysing the test results in terms of the slider direction action, a higher slip resistance was observed in the lateral than in longitudinal direction, as it was expected. The difference was from 3 (F2A) to 27 (L2B) units in dry condition, and from 1 (L2A) to 15 (F2B) in wet condition. Larger differences were observed in the case of L1 and L2 profiles than for F1 and F2 profiles.

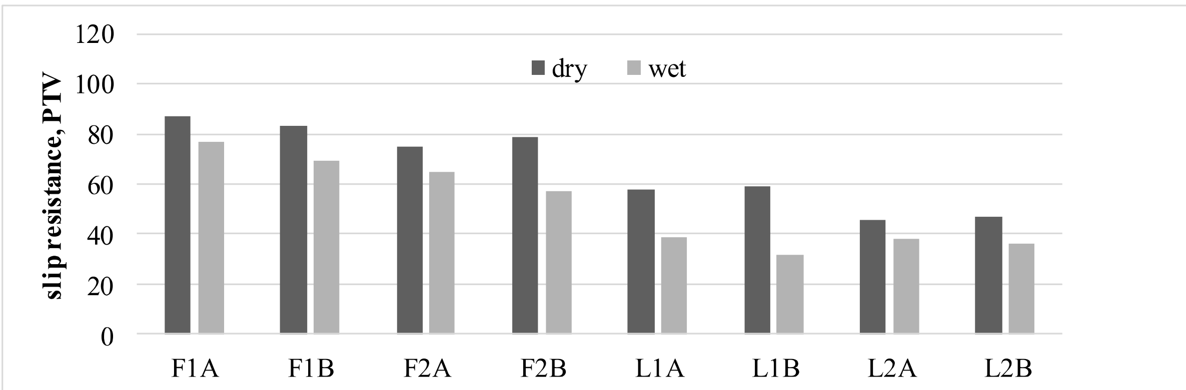

Figure 5. Pendulum test value of profiles in dry and wet condition, in longitudinal direction

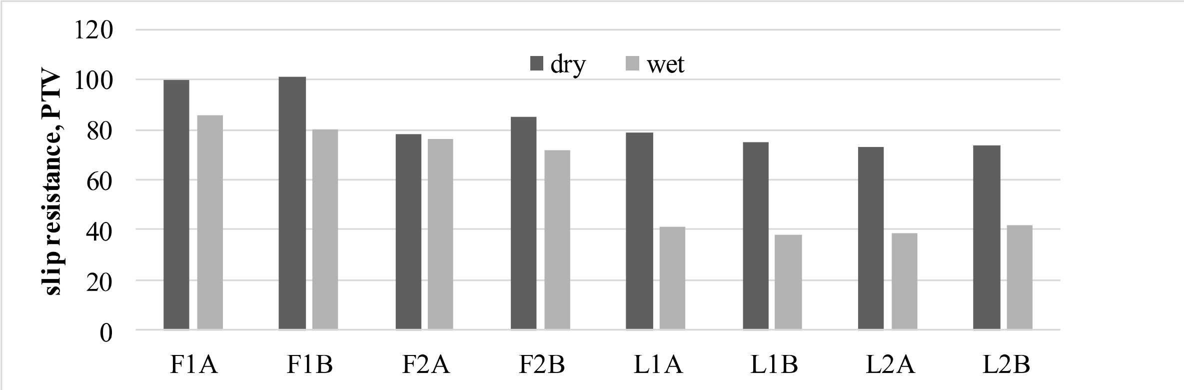

Figure 6. Pendulum test value of profiles in dry and wet condition, in lateral direction

It was also noticed that the surface finish has larger impact on the slip resistance than the profile geometry. The lowest pendulum test values were expected for the non-fluted surfaces (F2B and L2A). However, the test results show no significant difference of slip resistance between the non-fluted and finely fluted surfaces, with groove width up to 5mm, especially in dry condition. For both F2 profile surfaces (side A with fine fluting, plain side B), and L1 profiles (side A with fine fluting, plain side B) similar PTV values were obtained, both in longitudinal and lateral directions. Larger differences were observed in wet condition, but not higher than 7 units. Whereas the larger influence of fluting was observed in the case of fluting with 7/12mm groove width (F1A) or 13mm (F1B). They achieved the higher PTV values at the levels of above 83 units in dry condition, and above 69 units in wet condition.

The profiles with brushed surface finish (F1 and F2), regardless of the surface geometry, achieved noticeably higher pendulum test values than profiles with polished surface (L1 and L2). Especially the differences between the PTV for non-fluted surfaces are observed. For F2B in dry condition, the PTV result in longitudinal direction was 79 units, and for the L1B – 59 units, which is 25% less. In wet condition, the difference in longitudinal direction was even higher. For F2B the PTV result was 57, and for the L1B – 32, which is 43% less.

It must also be noticed that all the tested products, except the L1B profiles, achieved the pendulum test value the level not lower than 36 units, in both dry and wet conditions. When the obtained results are compared to the criteria developed by the UK Slip Resistance Group [5], [12] specified in Table 2, the floorings made of these profiles can be classified as low slip resistance solution. It is assumed that the slip probability at PTV≥36 is at the level of 1:1,000,000, whereas for the products with PTV at the level of 24 it rises up to 1:20 [8].

Table 2. Flooring slip resistance classification

Pendulum test value (PTV)	Classification
0 – 24	high probability of slipping
25 – 35	medium probability of slipping
> 36	low probability of slipping

CONCLUSIONS

The results of the terrace decking profiles made of wood-polymer composite are showing a significant impact of the profile surface finish on the slip resistance. Brushed surfaces achieved distinctly higher pendulum test values than polished. Whereas fluting brought noticeable results only in case of wide groove finishes. Significant decrease of slip resistance was noticed in case of wetted products. The impact of water was especially noticeable in case of polished surfaces, in lateral direction. Most of the tested solutions featured pendulum test value of above 36 units, which allowed them to be classified as low slip risk floorings.

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Streszczenie: *Odporność na poślizg desek z kompozytów drewno-polimerowych.* Artykuł przedstawia wyniki badań oporu poślizgu desek tarasowych wykonanych z kompozytów drewno-polimerowych. Badania przeprowadzono dla różnej geometrii powierzchni licowej, w stanie suchym i mokrym. Uzyskane wyniki wskazały, że istotniejszy wpływ na opór poślizgu ma sposób obróbki powierzchni niż geometria ryflowań. Wpływ ryflowania zaznaczył się jedynie w przypadku powierzchni z szerokim profilowaniem. Odnotowano istotny spadek oporu poślizgu wskutek zawilgocenia powierzchni. Większość badanych rozwiązań cechował opór poślizgu powyżej 36 jednostek, co pozwoliło je sklasyfikować, jako odpowiadające niskiemu ryzyku poślizgnięcia.

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