forests

MDPI

Article

Durability of Wood Exposed above Ground—Experience with the Bundle Test Method

Christian Brischke [1,*], Gry Alfredsen [2], Lukas Emmerich [3], Miha Humar [4] and Linda Meyer-Veltrup [5]

1 Thuenen Institute of Wood Research, Leuschnerstraße 91d, D-21031 Hamburg, Germany
2 Norwegian Institute of Bioeconomy Research (NIBIO), Høgskoleveien 8, NO-1433 Ås, Norway; gry.alfredsen@nibio.no
3 Wood Biology and Wood Products, Faculty of Forest Sciences and Forest Ecology, University of Goettingen, Büsgenweg 4, D-37077 Goettingen, Germany; lukas.emmerich@uni-goettingen.de
4 Department of Wood Science and Technology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia; miha.humar@bf.uni-lj.si
5 Heinz-Piest Institute for Skilled Crafts, Wilhelm-Busch-Straße 18, D-30167 Hanover, Germany; meyer@hpi-hannover.de
* Correspondence: christian.brischke@thuenen.de; Tel.: +49-40-73962-411

Abstract: The durability against decay organisms is an essential material property for wood in outdoor use. A jack of all trades method for above-ground wood durability testing has been sought for decades, but until now no method has found its way into European standardization. The method of choice shall be applicable for untreated and treated wood—ideally also for wood composites. It shall further be reproducible, objective, fast, easy, and inexpensive. Finally, it shall provide high predictive power. This study was aimed at a review of results and practical experience with the Bundle test method which could serve as a standard procedure for above-ground field tests of wood-based materials. The method allows for water-trapping, creates a moderate moisture-induced decay risk typical for UC 3 situations, and was found applicable for a wide range of wood materials. The method allows for rapid infestation and failure of non-durable reference species within five years in Central Europe. Based on results from Bundle tests with different modifications and performed at different locations, a guideline has been developed. The method is recommended as a suitable tool for determining the durability of various wood-based materials including modified and preservative-treated wood and can provide data for durability classification.

Keywords: above-ground; durability classes; field test; fungal decay; use class 3 (UC 3); wood durability

check for updates

Citation: Brischke, C.; Alfredsen, G.; Emmerich, L.; Humar, M.; Meyer-Veltrup, L. Durability of Wood Exposed above Ground—Experience with the Bundle Test Method. *Forests* **2023**, *14*, 1460. https://doi.org/10.3390/f14071460

Academic Editor: Luigi Todaro

Received: 17 June 2023
Revised: 11 July 2023
Accepted: 14 July 2023
Published: 17 July 2023

1. Introduction

The biological durability of wood is usually determined in laboratory tests against monocultures of wood-destroying fungi or in the field with soil contact using so-called graveyard tests. In contrast, the majority of wooden products in outdoor use is exposed above ground. Consequently, an above-ground field test method would be highly beneficial to generate meaningful wood durability data, but is lacking within the portfolio of European test standards among CEN/TC 38 'Durability of wood and derived materials'.

Currently, the only standardised above-ground test methods in Europe are meant to be used for determining the efficacy of wood preservatives such as the Lap-joint method according to prEN 12037 [1] and the L-joint method according to EN 330 [2]. The US American pendants are AWPA E16 [3] and AWPA E9 [4]. The latter are complemented with further above-ground methods such as the Decking test method [5], the Accelerated horizontal lap-joint method [6], and the Ground proximity test method [7]. Still, they all address the evaluation of wood preservatives, not the biological durability of wood.

In contrast to the low number of standardised above-ground field test methods, numerous non-standardised methods are described in international papers and reports.

Meyer et al. [8] evaluated more than 60 different methods according to different criteria such as the principal set-up and design, severity of exposure, and distance to ground. Furthermore, the suitability to reflect a certain exposure under real-life conditions and practical aspects regarding acceleration measures, decay assessment, practicability, costs and time efforts were evaluated as well. Several methods were identified as promising candidates for a standard method.

Based on systematic literature reviews [8], comparative experimental studies [9], and the own experience of the author team, the requirements below shall be met by a suitable above-ground field test method.

(1) Natural exposure to precipitation and solar radiation, but without soil contact
(2) Low risk of accumulation of biomass, e.g., pollen and litter, in and on the test specimens
(3) Accelerated decay progress (i.e., median lifetime of the non-durable reference specimens < 5 years in Central Europe) through moisture trapping
(4) Rapid natural infestation of wood specimens by decay fungi without the use of feeder elements or external infestation
(5) Applicability for testing untreated, treated, and modified wood as well as wood composites
(6) Test design representing in-service conditions (e.g., a poorly designed wooden deck)
(7) Objective, easy, rapid, and a minimum of destructive sampling for decay assessment
(8) Use of a specimen size which can be manufactured from Scots pine (*Pinus sylvestris*) sapwood portions of a commonly available width
(9) Simple and inexpensive manufacturing of specimens with the same cross-section as specimens according to EN 252 [10] used for durability field tests in ground contact
(10) Low costs and effort for assembling and replacing specimens or their parts
(11) Low liability to wind loads and damages by animals

In a comprehensive and comparative experimental study, Meyer-Veltrup et al. [9] evaluated 24 different test methods and concluded that at least three different methods are needed to fully represent the moisture-induced risk for fungal decay covered by the use classes 2 and 3 (UC 2 and 3), i.e., wood used outdoors above ground [11]. The main outcome of this study was a recommendation of candidate methods for three levels of moisture loads within UC 2/3, where the Bundle test method shall be considered for moderate moisture risks. Moisture risk likely influences the microbiological community that colonizes and decays the wood. Thus it is of great importance to simulate various use scenarios during testing.

In total, Meyer-Veltrup et al. [9] compared 22 above-ground methods and two methods including soil contact with respect to the moisture-induced risk for fungal decay, and different operability aspects were evaluated. The time of wetness (ToW) and decay rates of the following five European wood species were monitored over a period of three years: Scots pine sapwood and heartwood (*Pinus sylvestris*), Norway spruce (*Picea abies*), European beech (*Fagus sylvatica*), and English oak (*Quercus robur*). The wood moisture content (MC) of the specimens was measured daily based on electrical resistance measurements and the ToW was expressed as the number of days with MC $\geq$ 25%.

The ToW for the five wood species under test is shown in Table 1 as well as the mean of all five species. Considering the latter mean, the Bundle test specimens were wet during 58% of the exposure time. Significantly higher ToW had been determined for Sandwich specimens, i.e., 69 and 73% respectively. However, the difference between Sandwich specimens exposed close to the ground was less increased than expected when compared with those exposed 1 m above the ground. An even higher moisture-induced risk for decay was found for Horizontal double-layer specimens (75% ToW) and In-ground test specimens (91% ToW). Significantly lower ToW was determined for Decking test specimens; they were only wet during 34% of the exposure time. Thus, the moisture load in Bundle tests shall be considered 'medium' [9]. In contrast, Sandwich tests, Horizontal double-layer tests, and In-ground tests provide 'high' moisture loads, and only the Decking test represents a 'low' moisture load.

Table 1. Number of days with MC ≥ 25% and mean decay rate v% [%/year] for selected above-ground field tests (based on a total of 1156 days of exposure in Hanover, Germany) [9].

Test	Measure	Beech	English Oak	Norway Spruce	Scots Pine		Mean
					Heartwood	Sapwood	
In-ground test [10]	ToW (%)	93	97	79	94	94	91
Horizontal double-layer [a]		86	84	67	44	95	75
Sandwich test, 20 cm [b]		97	85	88	2	96	73
Sandwich test, 1 m [b]		96	73	68	20	89	69
Bundle test		81	67	58	9	74	58
Decking test [c]		72	44	5	1	47	34
In-ground test [10]	v% (%/year)	137	30	63	39	55	65
Horizontal double-layer [a]		38	16	34	20	33	28
Sandwich test, 20 cm [b]		27	13	23	7	3	15
Sandwich test, 1 m [b]		25	10	21	0	3	12
Bundle test		25	0	23	0	0	10
Decking test [c]		25	34	8	0	3	14

[a] Horizontal double-layer test modified after Augusta [12], 20 cm above ground, [b] Sandwich test modified after Zahora [13], 'close to ground' 20 cm above ground, 'far above ground 1 m above ground, [c] Decking test according to Laks et al. [14], dimension of the decking boards: 500 × 100 × 20 mm^3, 20 cm above ground.

As expected from the different severity of moisture-induced risks, the decay rates of the five wood species under test differed and correlated well with the ToW (Table 1). The Bundle method revealed mean decay rates of 10%/year. The highest mean decay rate was found in In-ground tests (65%/year) followed by Horizontal double-layers (28%/year), and the Sandwich tests (15 and 12%/year). Surprisingly, also the Decking test led to a mean decay rate of 14%/year, which was not expected due to the lowest moisture-induced decay risk determined for this method.

In summary, the Bundle test method revealed a moderate decay risk based on medium moisture loads due to simply designed water traps formed by the three specimen members, and represents a typical use class 3.2 (UC 3.2) scenario. According to EN 335 [11], UC 3.2 refers to exterior above-ground applications with extended wetting. The German standard DIN 68 800-1 [15] further specifies that wood in UC 3.2 is often wet (>20%) and that spatially limited water ingress into wood shall be expected. The findings from this study appear to match both definitions.

Surprisingly, Sandwich tests close to ground and far from ground did neither differ significantly in moisture load nor in resulting decay rates. The effect of splash water and hindered ventilation and re-drying when wood is exposed close to ground was less prominent than expected. However, in this study this potential impact factor was addressed again for Bundle tests.

This study aimed at reviewing previous and current studies using the Bundle test method for determining the biological durability of wood to evaluate the following. Different specimen configurations should be compared and assessed with respect to decay rates, handling, and decay assessment. The effect of different distances between the test specimens and the ground on decay rates should be investigated. Furthermore, the minimum exposure time (test duration) needed to obtain sufficiently high decay ratings of the specimens should be estimated, the most promising test parameters and details identified, and recommendations for a draft standard should be developed.

2. Materials and Methods

2.1. Comparative Above-Ground Field Tests

Three different above-ground field test methods were compared at the North campus test site of the University of Goettingen, Germany. Therefore, specimens made from German-grown kiln-dried Scots pine sapwood and heartwood (*Pinus sylvestris*), Norway spruce (*Picea abies*), Douglas fir (*Pseudotsuga menziesii*), European beech (*Fagus sylvatica*), Silver birch (*Betula pendula*), Norway maple (*Acer pseudoplatanus*), European ash (*Fraxinus excelsior*), and English oak (*Quercus robur*) were submitted to three different test set-ups (Figures 1–3):

(1) Bundle tests, 1 m above ground
(2) Bundle tests, 20 cm above ground
(3) Segmented horizontal double-layer tests, 20 cm above ground [9]

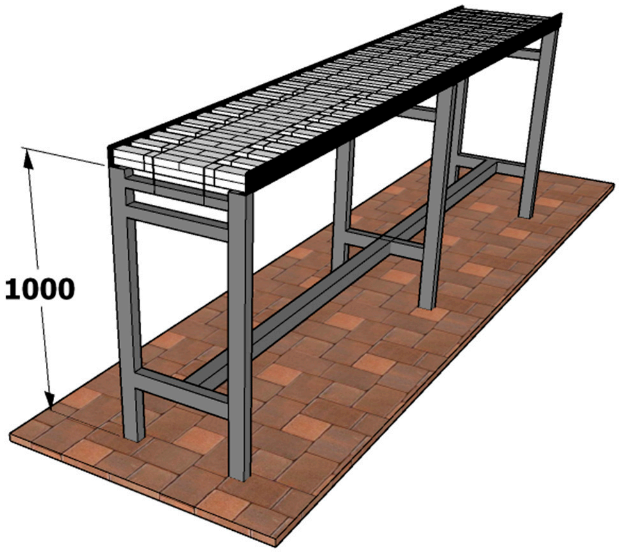
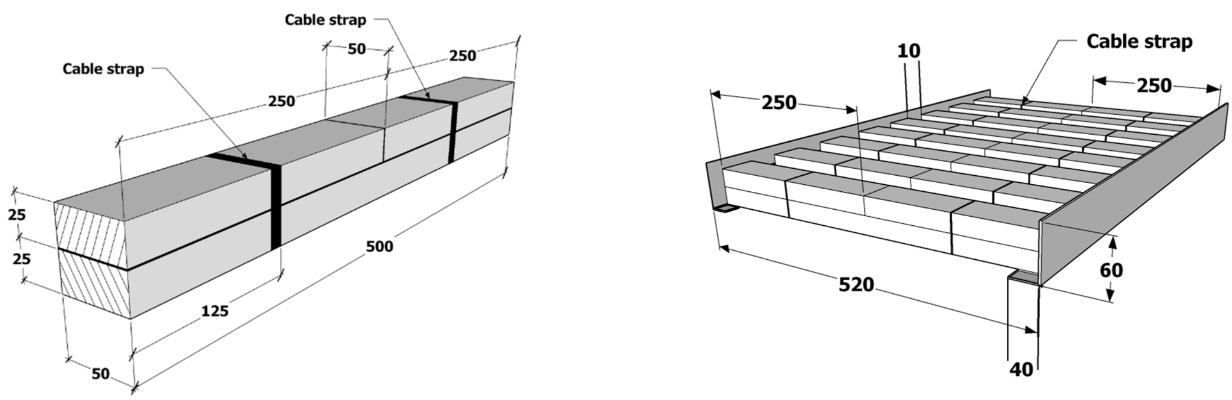


Figure 1. Test rack—sub-construction for exposure of Bundle test specimens 1 m above ground (alternatively racks with a height of 20 cm were used).



(**a**) (**b**)

Figure 2. Configuration of Bundle test specimens: (**a**) Specimen consisting of three members held together by cable straps; (**b**) Exposure of bundle test specimens on aluminium L-profiles.

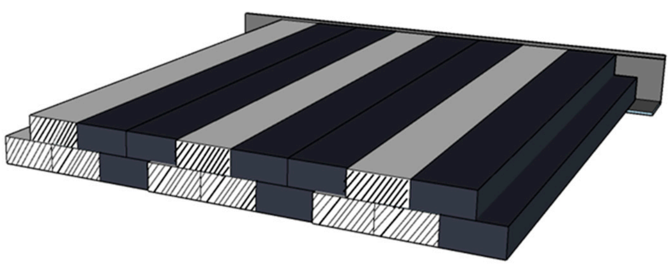


Figure 3. Segmented horizontal double layer tests.

The specimens were from defect such as decay, insect damage, resin pockets and larger checks.

The primary objectives of this part of the study were (1) to enlarge the database for Bundle test results, (2) to detect differences in decay risk between Bundle test setups at different distance to the ground, and (3) to check whether Bundle tests can substitute Horizontal double-layer tests when performed at similarly low distance to the ground (here: 20 cm).

2.2. Bundle Tests with Different Wood-Based Materials

Comparative Bundle tests were performed in Ljubljana, Slovenia, and Hannover, Germany [16]. The latter specimens were moved to Göttingen, Germany, after the 1st year of exposure. In total, 13 different materials were exposed in 2015 (Ljubljana) and 2016 (Hanover) respectively.

Norway spruce, Scots pine sapwood, and beech served as reference species. At both test locations, beech showed the highest decay rate and was therefore used to calculate durability factors f (see Section 3.3, Equation (1)). The latter were used to assign durability classes (DC) based on the classification scheme described in EN 350 [17] using x-values.

The primary objectives of this part of the study were to investigate the suitability of the Bundle method for (1) durability classification, and (2) for testing differently treated wood.

2.3. Decay Assessment and Durability Classification

In each test n = 10 replicate specimens were exposed and assessed using a pick test according to EN 252 [10] every six months during the first two years of exposure and every year afterwards. Therefore, the EN 252 [10] rating scheme was slightly modified as shown in Table 2 with respect to the criteria for failure of the specimens, which is either achieved when more than 50% of its cross-sectional area is decayed or the specimens breaks during impact bending. The tests are still ongoing.

Table 2. Rating system for decay.

Rating	Description	Definition
0	Sound	No evidence of decay. Any change of colour without softening has to be rated as 0.
1	Slight attack	Visible signs of decay, but of very limited intensity or distribution: changes which only reveal themselves externally by very superficial degradation, softening of the wood being the most common symptom, to an apparent depth in the order of one millimetre.
2	Moderate attack	Clear changes to a moderate extent according to the apparent symptoms: changes which reveal themselves by softening of the wood to a depth of approximately 1 to 3 millimetres over more than 1 cm^2 per segment
3	Severe attack	Severe changes: marked decay in the wood to a depth of more than 3 millimetres over a wide surface (more than 20 cm^2) or by softening deeper than 10 mm over more than 1 cm^2 per segment.
4	Failure	Impact failure of the segment or more than 50% of the cross-sectional area shows clear signs of decay.

Note: The grading system has been modified from the system described in EN 252 [10]. Changes were made where needed due to the deviating specimen dimensions.

At each assessment, the decay ratings for each test specimen segment and each reference specimen segment were recorded. Nominal mean decay ratings and nominal median decay ratings were determined for all specimens of each test wood material and for all reference specimens of each reference species. Therefore, the highest decay rating of the three segments of one specimen was considered.

If one or more segments of one specimen had failed (decay rating 4), it was considered in following calculations by its rating 4. The decay rate (Equation (1)) was calculated after each inspection for each test wood specimen and each reference specimen as follows:

$$v = \frac{d}{t} \cdot 25\% \quad (1)$$

where:
v is the percentage decay rate (%/year);
d is the decay rating (0–4);
t is the time of exposure (years).

Durability classes (DC) according to EN 350 [17] were assigned to the different test materials using either x-values or durability factors f (Equation (2)). The x-values, i.e., the relative lifetimes of test specimens, could not be determined until all specimens had failed. To allow for a durability classification at an earlier time point, durability factors were used and calculated as follows:

$$f = \frac{v_{median,ref}}{v_{median,test}} \quad (2)$$

where:
f is the durability factor (-);
$v_{median,ref}$ is the highest median decay rate of the reference species under test (%/year);
$v_{median,test}$ is the median decay rate of test wood material (%/year).

The durability factor, derived from the median decay rate was used as a preliminary statement to assess the durability of the test wood material until the x-value, derived by the median life was available. The closer a set of replicates approaches its median time to failure, the closer comes the durability factor (which is a preliminary value) to the x-value (which is the final basis for classifying the biological durability of the test wood material).

If more than 50% of the test wood material specimens had failed (rating 4) the median life of the respective test wood material was available and the x-value (Equation (3)) was calculated as follows:

$$x = \frac{L_{median,test}}{L_{median,ref}} \quad (3)$$

where:
x is the x-value according to EN 350 [17] (-);
$L_{median,ref}$ is the median life of test wood material (years);
$L_{median,test}$ is the median life of the reference wood species which failed first (years).

3. Results and Discussion

3.1. Decay Rates in Different Test Set-Ups

The mean decay ratings for all three test methods are shown for the first 5.5 years of exposure in Figure 4. Please note that only seven out of nine wood species had been included in all three tests.

Unexpectedly, the decay rates were on average higher in both Bundle test set ups compared to the Horizontal double layer tests. The decay rates between the two Bundle test configurations differed only marginally, and not consistently among the different wood species under test. The relationship between the decay rates obtained with the help of the three different test methods is shown in Figure 5.

The effect of reducing the distance between test specimens and the ground on the decay rate was negligibly small. Hence, further tests shall be performed on test racks with a height of 1 m, which is beneficial from an ergonomic viewpoint and may generally increase the ease of performing the test. Furthermore, future test data could be compared better with data from other tests which are also using specimens exposed 1 m above ground such as in Lap-joint and L-joint tests [8,18].

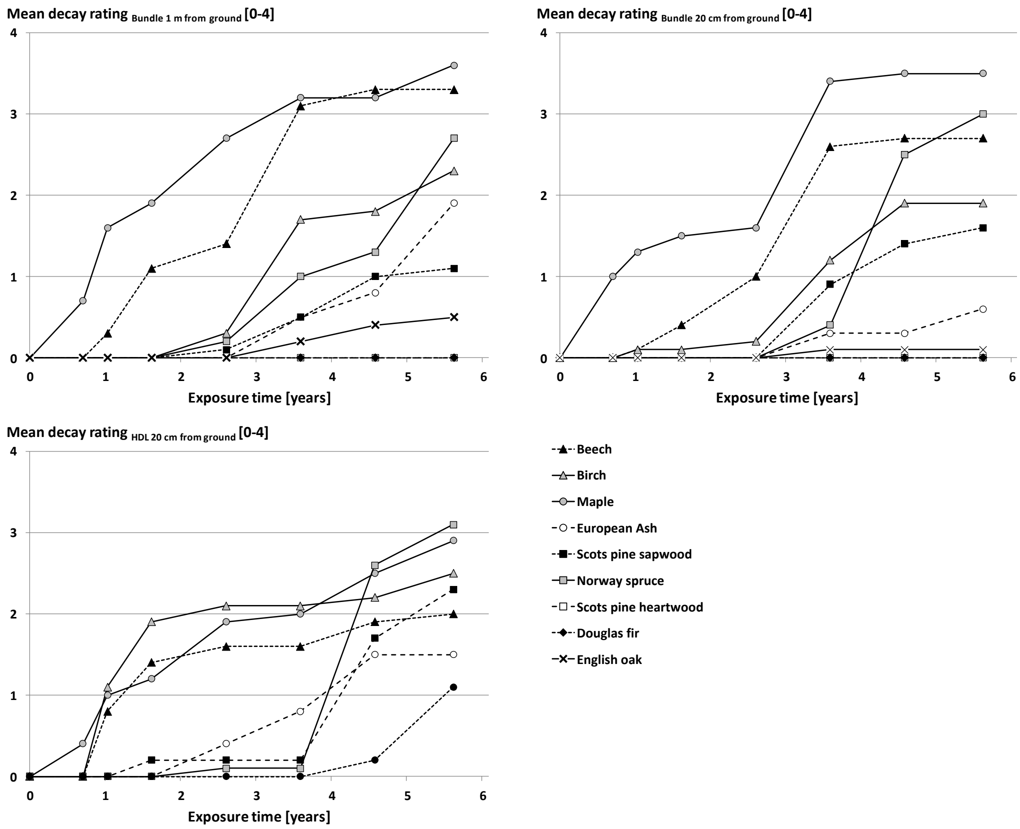
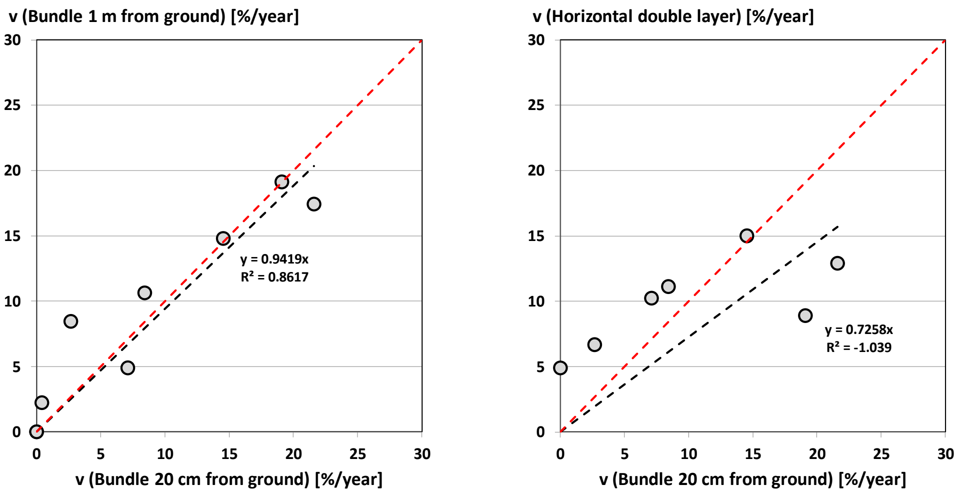


Figure 4. Mean decay ratings of specimens made from different European-grown wood species exposed in Bundle tests 1 m above ground (**top left**), Bundle tests 20 cm above ground (**top right**), and in horizontal double layer (HDL) tests 20 cm above ground (**bottom left**) at Goettingen University.



(**a**) (**b**)

Figure 5. Relationship between decay rates in Bundle tests exposed 20 cm above ground ('close-to-ground') and Bundle tests exposed 1 m above ground (**a**) and segmented horizontal double-layer tests (**b**), respectively. Black dashed line: linear regression. Red dashed line: ideal line.

An advantage of the Bundle test compared to other above-ground test methods from a methodological and statistical point of view is that each bundle represents only one replicate. For instance, for the horizontal double-layer test [19] and the block test [20], one could argue that the entire sample set only represents one replicate [13,21] since they mainly have been placed in direct contact with each other without any spacers (i.e., hyphae can easily grow between the stakes).

3.2. Durability Classification of Different Wood-Based Materials Based on Bundle Tests

The decay rates of the Bundle test specimens differed remarkably both between materials and test locations (Figure 6 and Table 3). While the decay rate of Norway spruce and beech in Hanover/Goettingen was approximately two times the decay rate in Ljubljana, Scots pine sapwood decayed surprisingly slow in Hanover/Goettingen, i.e., three times slower compared to Ljubljana. Similar differences were found between the two Norway spruce TMT materials and European larch heartwood. In summary, the results pointed to the need to consider more than one test location for a meaningful durability classification. Similarly, several reference wood species should be used to minimize the risk that one reference material decays untypically slow (see e.g., [22]) and thus affects the resulting durability classification which is either based on the durability factors or the x-values.

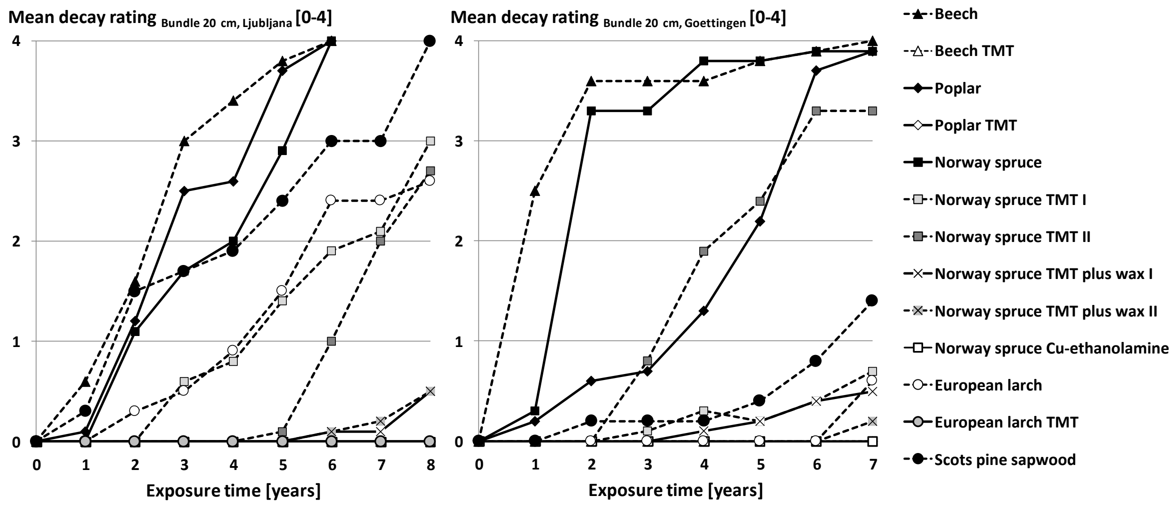


Figure 6. Mean decay ratings of specimens made from untreated and differently treated wood species exposed in Bundle tests 20 cm above ground in Ljubljana, Slovenia, and Hanover/Goettingen, Germany.

Table 3. Mean decay ratings d_{mean}, median decay rates v_{median} (%/year), durability factors f, and durability classes (DC) based on the durability factors of different materials after seven and eight years of exposure in Hanover/Goettingen, Germany, and Ljubljana, Slovenia, respectively. n.a. = not available.

Material	Ljubljana					Hanover/Goettingen				
	d_{mean} (0–4)	v_{median} (%/year)	f (-)	x (-)	DC	d_{mean} (0–4)	v_{median} (%/year)	f (-)	x (-)	DC
Norway spruce	4.0	16.7	1.47	1.25	4	3.9	30.2	1.33	n.a.	4
Scots pine sapwood	4.0	12.5	1.34	1.67	4	1.4	5.0	8.02	n.a.	1
European larch	2.6	8.1	2.06	n.a.	3	0.6	2.1	19.10	n.a.	1
Beech	4.0	21.3	1.00	1.00	5	4.0	40.1	1.00	1.00	5
Poplar	4.0	19.0	1.12	n.a.	5	3.9	15.6	2.57	n.a.	3
Norway spruceTMT I	3.0	9.4	2.27	n.a.	3	0.7	2.5	16.04	n.a.	1
Norway spruceTMT II	2.7	8.5	2.51	n.a.	3	3.3	14.0	2.86	n.a.	3
Norway spruceTMT plus wax I	0.5	1.6	13.31	n.a.	1	0.5	1.8	22.28	n.a.	1
Norway spruceTMT plus wax II	0.5	1.6	13.31	n.a.	1	0.2	0.7	57.29	n.a.	1
Norway spruceCu-ethanolamine	0.0	0.0	∞	n.a.	1	0.0	0.0	∞	n.a.	1
European larch TMT	0.0	0.0	∞	n.a.	1	-	-	-	-	-
Poplar TMT	0.0	0.0	∞	n.a.	1	0.0	0.0	∞		1
Beech TMT	0.0	0.0	∞	n.a.	1	0.0	0.0	∞		1

As expected, all replicate specimens had failed only for very few materials, i.e., beech at both sites, and Scots pine sapwood and Norway spruce in Ljubljana. Hence, x-values could be calculated only for those, and f-values served as alternative measure for all other materials. Since at least one reference material was rated '3 or worse' on average, the tests were considered valid at both locations. Larsson Brelid et al. [23] re-evaluated data from Nordic in-ground field trials with more than 20,000 stakes of untreated and preservative-treated wood. Their evaluation showed that the average life of stakes in test can be predicted with high precision by using the median time to rating of 4 (failure) as the basis for the determination. By this method, a value of the average life will be obtained in a shorter time than if one must wait until the last stake in a series has failed. Their results clearly showed that the early stages of decay were reflected in the long-term performance of the stakes. However, the overall conclusion was that the reliability of predicting the long term performance of wood is lower the earlier in the test the information is extracted. Thus, in this study we used the decay rate instead of the time till a certain decay rating, but we defined a median decay rating of 3.0 of the reference species as the validity criterion.

3.3. Field Observations

In the frame of different research projects numerous materials were tested using the Bundle method in different modifications and at different locations [9,16]. Some observations with respect to operability and the test procedure are reported below.

The majority of specimens showed decay in the central part of the specimens, where the two upper segments form an end-grain/end-grain contact face. Both the end-grain area of the latter and the side-grain area of the bottom segment beneath are infested (Figure 7). Thus, decay develops where it is supposed to. In contrast, it has been frequently reported that interior rot occurs in specimens with end-grain sealants such as Lap-joint specimens [9,24]. End-grain sealants serve as a moisture barrier and avoid re-drying of specimens. Consequently, moisture accumulates close to the sealed surface, and decay develops but cannot be detected in its early stages. From this perspective, end-grain sealing of specimens can neither be recommended in general nor for Bundle test specimens in particular.

(**a**) (**b**)

Figure 7. Moisture trapping and decay development in Bundle test specimens: (**a**) Scots pine sapwood modified with polysiloxane after a few weeks of exposure in Goettingen, Germany. (**b**) Decay on end-grain faces of upper specimen segments and below the contact face in the bottom segment.

The use of upper segments with only 25 cm length for Bundle test specimens is advantageous since it saves material and allows for the formation of the above described water trap. In contrast, the short specimens do not allow for impact bending testing to detect specimens' failures. Alternatively, the decayed cross-section can be considered for decay assessment. As soon as more than 50% of the cross-section of any of the three specimen segments is decayed the entire specimen shows 'failure', which is in line with the American rating scheme for decay [22].

The segments of the Bundle test specimens are held together with cable straps, which should be UV-stable. Cable straps are not reusable and could be replaced by stainless steel clamps. However, such clamps are forming additional water traps, where decay can develop [9], and can therefore only be recommended when they are thin enough to avoid water trapping. Also, the label on the specimens needs to be of an inert material and should not cause water traps.

It has proven useful to secure the test specimens at wind-exposed locations by tying them down with cords. The cord should be thin enough to avoid forming additional water traps. Furthermore, the support of the test racks should be made only of anodized aluminium to avoid reaction between wood preservatives or other ingredients with the aluminium.

4. Conclusions

During the last 15 years, Bundle tests were performed with untreated timbers of varying biological durability including seven softwood and 14 hardwood species. In addition, approximately 25 different modified and preservative treated timbers were tested or are still under test. Bundle tests ran with different modifications, e.g., different distance to the ground, and at different locations such as Hamburg, Hannover, Göttingen, and Dresden in Germany as well as Ljubljana and Bilje in Slovenia, Borås in Sweden, and in Hilo, Hawaii, and Corvallis, Oregon, in the United States. Based on the reported experience from these tests and to the best knowledge of the authors the Bundle test method appears promising and is worth considering as a candidate for a standard method for above-ground durability testing of wood. The Bundle test represents a moderate decay risk typical for UC 3 situations and allows for rapid infestation and failure of non-durable reference species within five years in Central Europe. The method is applicable for untreated, treated, and modified wood as well as wood composites. It allows for objective, easy, rapid, and less destructive decay assessment using the pick test, and it uses specimens which can be easily and inexpensively manufactured from commonly available Scots pine sapwood. Furthermore, the method requires only low cost and effort for assembling, reassembling, and maintenance, and it can be easily protected from wind loads and other hazards.

The experience of the author team made with the Bundle test had been introduced in a draft standard [25]. To enhance the knowledge about the Bundle test method including a wider range of tested materials and test locations is needed and will increase acceptance of the method. In this respect a round-robin test with partners from climatically different regions should be given high priority.

Author Contributions: Conceptualization, C.B., M.H. and L.M.-V.; methodology, C.B., M.H., L.E. and L.M.-V.; validation, C.B., M.H., L.E., G.A. and L.M.-V.; formal analysis, C.B., M.H. and L.E.; investigation, C.B., M.H., L.E., G.A. and L.M.-V.; resources, C.B. and M.H.; data curation, C.B., M.H., L.E., G.A. and L.M.-V.; writing—original draft preparation, C.B.; writing—review and editing, C.B., M.H., L.E., G.A. and L.M.-V.; visualization, C.B.; supervision, C.B. and M.H.; project administration, C.B. and M.H.; funding acquisition, C.B. and M.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded from the research project DURATEST, supported by the German Ministry of Food and Agriculture (BMEL) via the Agency of Renewable Resources (FNR), grant number 2219NR372.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. *prEN 12037:2020*; Wood Preservatives—Field Test Method for Determining the Relative Protective Effectiveness of a Wood Preservative Exposed Out of Ground Contact—Horizontal Lap-Joint Method. European Committee for Standardization: Brussels, Belgium, 2020.
2. *EN 330:2015*; Wood Preservatives—Determination of the Relative Protective Effectiveness of a Wood Preservative for Use under a Coating and Exposed Out of Ground Contact—Field Test: L-Joint Method. European Committee for Standardization: Brussels, Belgium, 2015.
3. *AWPA E16*; Standard Field Test for Evaluation of Wood Preservatives to Be Used above Ground (UC3B): Horizontal Lap-Joint Test. American Wood Protection Association: Birmingham, AL, USA, 2013.
4. *AWPA E9*; Standard Field Test for the Evaluation of Wood Preservatives to Be Used above Ground (UC3A and UC3B): L-Joint Test. American Wood Protection Association: Birmingham, AL, USA, 2013.
5. *AWPA E25*; Standard Field Test for Evaluation of Wood Preservatives to Be Used above Ground (UC3B): Decking Test. American Wood Protection Association: Birmingham, AL, USA, 2013.
6. *AWPA E2*; Standard Field Test for Evaluation of Wood Preservatives to Be Used above Ground (UC3B): Accelerated Horizontal Lap-Joint Test. American Wood Protection Association: Birmingham, AL, USA, 2013.
7. *AWPA E18*; Standard Field Test for Evaluation of Wood Preservatives to Be Used above Ground (UC3B): Ground Proximity Decay Test. American Wood Protection Association: Birmingham, AL, USA, 2013.
8. Meyer, L.; Brischke, C.; Preston, A.F. Testing the natural durability of timber exposed above ground—A review on methodology. *Wood Mat. Sci. Eng.* **2016**, *11*, 283–304. [CrossRef]
9. Meyer-Veltrup, L.; Brischke, C.; Källander, B. Testing the durability of timber above ground: Evaluation of different test methods. *Eur. J. Wood Wood Prod.* **2016**, *75*, 291–304. [CrossRef]
10. *EN 252:2015*; Field Test Method for Determining the Relative Protective Effectiveness of a Wood Preservative in Ground Contact. European Committee for Standardization: Brussels, Belgium, 2015.
11. *EN 335:2013*; Durability of Wood and Wood-Based Products—Use Classes: Definitions, Application to Solid Wood and Wood-Based Products. European Committee for Standardization: Brussels, Belgium, 2013.
12. Augusta, U. Untersuchung der natürlichen Dauerhaftigkeit wirtschaftlich bedeutender Holzarten bei verschiedener Beanspruchung im Außenbereich. Doctoral Thesis, University of Hamburg, Hamburg, Germany, 2007.
13. Zahora, A. Above ground field testing—Influence of test method and location on the relative performance of various preservative systems. In Proceedings of the IRG Annual Meeting, IRG/WP 08-20393, Istanbul, Turkey, 25–29 May 2008.
14. Laks, P.E.; Morris, P.I.; Larkin, G.M.; Ingram, J.K. Field tests of naturally durable North American wood species. In Proceedings of the IRG America's Regional Meeting, IRG/WP 08-10675, Americas Regional Meeting, Playa Flamingo, Costa Rica, 30 November–2 December 2008.
15. *DIN 68800-1:2019*; Wood Preservation—Part 1: General. Beuth: Berlin, Germany, 2019.
16. Ugovšek, A.; Šubic, B.; Starman, J.; Rep, G.; Humar, M.; Lesar, B.; Thaler, N.; Brischke, C.; Meyer-Veltrup, L.; Jones, D.; et al. Short-term performance of wooden windows and facade elements made of thermally modified and non-modified Norway spruce in different natural environments. *Wood Mat. Sci. Eng.* **2019**, *14*, 42–47. [CrossRef]
17. *EN 350:2016*; Durability of Wood and Wood-Based Products—Testing and Classification of the Durability to Biological Agents of Wood and Wood-Based Materials. European Committee for Standardization: Brussels, Belgium, 2016.
18. Råberg, U.; Edlund, M.L.; Terziev, N.; Land, C.J. Testing and evaluation of natural durability of wood in above ground conditions in Europe—An overview. *J. Wood Sci.* **2005**, *51*, 429–440. [CrossRef]
19. Rapp, A.O.; Augusta, U. The full guideline for the 'double layer test method'—A field test method for determining the durability of wood out of ground. In Proceedings of the IRG Annual Meeting, IRG/WP 04-20290, Ljubljana, Slovenia, 6–10 June 2004.
20. Pfeffer, A.; Krause, A.; Militz, H. Testing modified wood and natural durability in use class 3 with the block-test approach. In Proceedings of the Cost Action E37 Final Conference, Bordeaux, France, 29–30 September 2008.
21. Brischke, C.; Welzbacher, C.R.; Meyer, L.; Bornemann, T.; Larsson-Brelid, P.; Pilgård, A.; Frühwald Hansson, E.; Westin, M.; Rapp, A.O.; Thelandersson, S.; et al. Service life prediction of wooden components—Part 3: Approaching a comprehensive test methodology. In Proceedings of the IRG Annual Meeting, IRG/WP 11-20464, Queenstown, New Zealand, 8–12 May 2011.
22. Stirling, R.; Alfredsen, G.; Brischke, C.; De Windt, I.; Francis, L.P.; Frühwald Hansson, E.; Humar, M.; Jermer, J.; Klamer, M.; Kutnik, M.; et al. Global survey on durability variation–on the effect of the reference species. In Proceedings of the IRG Annual Meeting, IRG/WP 16-20573, Lisbon, Portugal, 15–19 May 2016.
23. Larsson-Brelid, P.; Brischke, C.; Pilgård, A.; Hansson, M.; Westin, M.; Rapp, A.O.; Jermer, J. Methods of field data evaluation—time versus reliability. In Proceedings of the IRG Annual Meeting, IRG/WP 11-20466, Queenstown, New Zealand, 8–12 May 2011.

24. Brischke, C.; Melcher, E. Performance of wax-impregnated timber out of ground contact: Results from long-term field testing. *Wood Sci. Technol.* **2015**, *49*, 189–204. [CrossRef]
25. Brischke, C.; Alfredsen, G.; Emmerich, L.; Humar, M.; Meyer-Veltrup, L. Field durability testing of wood above ground—Part 2: The full guideline of the Bundle method. In Proceedings of the IRG Annual Meeting, IRG/WP 23-20696, Cairns, Australia, 28 May–1 June 2023.