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Section 2 **Test methodology and assessment**

Comparative studies on the moisture performance and durability of wooden facades

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ABSTRACT

Wooden claddings are traditionally used in many parts of the world. Also modern structures are frequently made from timber and timber engineering panel products. However, wood has to compete with other cladding materials and its durability needs to assure sufficient functional and aesthetic service life. Besides many other factors the durability of a wooden facade is dominated by its moisture performance on the one hand and the occurring moisture loads on the other hand.

Within this study continuous wood moisture content measurements were conducted on three different test objects: 1. Combined facade-decking elements made from eleven different wood species relevant for the European market were exposed to the South and to the North in Hannover, Germany. Material-specific moisture performance was evaluated and compared with climatic parameters. 2. Three-years of measurements were carried out on the walls of a timber-made test house at the same test site. Measurements were made in different wood species, at different distances to the ground and in all four compass directions. 3. The effect of different roof overhangs on the moisture load of a wooden facade made from Norway spruce was studied on a test assembly in Tåstrup, Denmark. In addition to the moisture content measurements, wood temperature was recorded daily and relevant weather parameters were collected from meteorological stations nearby. To assess the respective moisture performance of the various materials and construction related parameters, the number of wet days was determined and a performance model was applied to all data sets. Based on a model for above ground decay the expected service life was calculated for different exposures, materials and design details.

The highest moisture loads were found on the West facade, which is the weather side in Central Europe, followed by the North facade, where re-drying was inhibited due to limited solar irradiation. Furthermore the splash water zone was clearly identified, where moisture loads were increased and re-drying reduced due to lower wind speeds close to the ground. Finally, the moisture performance of the various timber species differed significantly. Thus, a wide range of service life estimates was deviated from the data sets.

Keywords: Eave, facade-decking element, moisture monitoring, roof overhang, service life prediction

1. INTRODUCTION

Wood as a natural, renewable resource is used as building material for many indoor and outdoor applications. Compared to other building materials, wood has a number of advantages. It has high strength related to its own weight, is good to handle and to process (Rüther 2005).

Therefore wood is increasingly used also in outdoor applications. Well known examples are wooden facade claddings which are traditionally used in many parts of the world. Also modern structures are frequently made from timber and timber engineering panel products. However the constructive and technical use of wood in exterior applications is particularly restricted by its organic degradation. In outdoor usage wood is exposed to a variety of influences, which reduce its durability against wood degrading organisms (Erler 2002). Long-term increased moisture content in combination with temperatures favourable for decay fungi increase the risk of infection and colonisation and can decrease the structural performance, in terms of stability, security and mechanical strength of wood (Rüther 2005, Brischke 2007). Therefore testing the natural durability of wood under in-situ conditions gains more and more importance. The meaning of service life prediction of wooden components increases both in public tendering and in the private sector. For the design process, calculation and realisation of construction projects a precise knowledge of the expected service life is essential (Gobakken *et al.* 2008). Norris (2011) stated that the economic service life of building materials, which he defined as 'Life Cycle Cost', is a key factor in the decision process for or against a specific nutrient. In this study the term service life is used with respect to the natural durability as defined in EN 350-1 (1994). However, service life is going to be characterised by means of the unit [years].

A wide range of factors, which have an impact on the durability of wood, needs to be taken into consideration for service life prediction. In principal, the natural durability can be determined either in the field or in laboratory decay tests (Brischke *et al.* 2012b). While laboratory tests allow clearly defined conditions and a high level of reproducibility, it is usually impossible to fully imitate real life conditions (Brischke *et al.* 2011). Further parameters having an important impact on the degradation of timber cannot be considered adequately, for instance the detoxification through so-called 'non-target-organisms' or the limited number of available test organisms, which are not necessarily responsible for decay under real life situations (Brischke *et al.* 2012b).

In contrast, it is generally accepted that field tests provide more realistic test conditions, but often suffer from unacceptably long test durations. The onset of decay in above ground trials will often take place significantly later than 5 years, and service lives cannot be calculated before decades have passed (Wang *et al.* 2008, Brischke *et al.* 2012a). For these reasons results from laboratory decay tests as well as field test data from in-ground graveyard tests can be found quite frequently, but natural durability studies with respect to above-ground exposures are rare, although they play the more important role in timber engineering.

A further distinction of fungal hazard regarding the respective moisture conditions and corresponding potential decay organisms is made with the use classes (UC) according to EN 335 (2006). However, the variety of existing above ground test methods – representing very different moisture regimes - is also linked to limited comparability of the obtained results. Moisture content measurements could therefore serve as cross linking element between test methods, test sites and other boundary conditions for comparative studies (Meyer *et.al.* 2012). However, they are still sparsely used, and especially for real assemblies and commodities moisture data are rare (Brischke *et al.* 2012b).

A second aspect of wood moisture content and its dynamics is its contribution to wood resistance. Besides biocidal or inhibiting ingredients of wood, hydrophobic substances and anatomic peculiarities have a significant impact on the moisture dynamics of timber and thus on its durability (Hedley *et al.* 2004). The capability of a wooden material to take up moisture must therefore be seen as the second component of wood resistance. At least for the less severe use classes UC 2 and UC 3.1 (EN 335 2006) moisture performance tests in the field might be seen as appropriate and time-saving alternative to long-term decay tests.

This study focuses on the moisture performance of facades. Continuous wood moisture content measurements were conducted on different test objects and wood species and the moisture performance of the various materials and construction related parameters was evaluated. Different moisture performance indicators will be applied to the various data sets. Their suitability to estimate the expected service life will be discussed.

2. EXPERIMENTAL METHODS

2.1 Moisture and temperature recording

The measurement system applied in this study was described in an earlier publication (Brischke *et al.* 2008a) and can be summarized in brief as follows: electrodes of polyamide coated stainless steel cables were conductively glued in the specimens. The electrodes were connected to small data loggers (Materialfox Mini, Scanntronik Mugrauer GmbH, Zorneding, Germany) that recorded the electrical resistance of the wood. The data loggers were calibrated in a range between 12 and 50 % moisture content (MC) and species-specific resistance characteristics were developed (Brischke *et al.* 2008a, Lampen 2010). Measurements above fibre saturation were increasingly inaccurate, but still indicated a tendency within the calibration range. Minimum and maximum temperatures were recorded daily using Thermofox Mini data logger (Scanntronik Mugrauer GmbH, Zorneding, Germany) and used to calculate the average daily temperature. Unless otherwise indicated, the measurement points were placed in the centre of the specimens. Measurements close to supporting beams were avoided.

2.2 Combined facade-decking element

Combined facade-decking elements, which had been designed as a reference object for UC 3.1 (EN 335 2006), had been equipped with samples made from in total eleven different wood species (Table 1). According to Figure 1 board-like specimens were submitted to the following three exposure situations:

South oriented, vertical cladding:
Boards (25 x 100 x 500 mm^3) were mounted horizontally on a combined facade-decking element (Figure 1a/b) and carried out as board-on-board cladding.

North oriented, vertical cladding:
Boards (25 x 100 x 500 mm^3) were mounted horizontally on a combined facade-decking element (Figure 1a/b) and carried out as board-on-board cladding.

Horizontal single layer (decking):
Boards (25 x 100 x 500 mm^3) were exposed vertically on two bearings of a combined facade-decking element.

For each exposure type three replicate specimens were provided with electrodes for daily moisture content and temperature recordings. Specimens of European larch sapwood (*Larix decidua* L.) and Douglas fir sapwood (*Pseudotsuga menziesii* Franco) contained heartwood portions, which were not considered for the measurements. The facade-decking elements started in November 2009. All test rigs were exposed in Hannover-Herrenhausen, Germany.

Table 1: Wood species used for moisture content monitoring field trials

Wood species	Botanical name
Black locust	*Robinia pseudoacacia* L.
English oak	*Quercus robur* L.
Beech	*Fagus sylvatica* L.
Norway spruce	*Picea abies* Karst.
Douglas fir heartwood	*Pseudotsuga menziesii* Franco.
Douglas fir sapwood	*Pseudotsuga menziesii* Franco.
Larch heartwood	*Larix decidua* L.
Larch sapwood	*Larix decidua* L.
Scots pine heartwood	*Pinus sylvestris* L.
Scots pine sapwood	*Pinus sylvestris* L.
Western Red Cedar	*Thuja plicata* L.

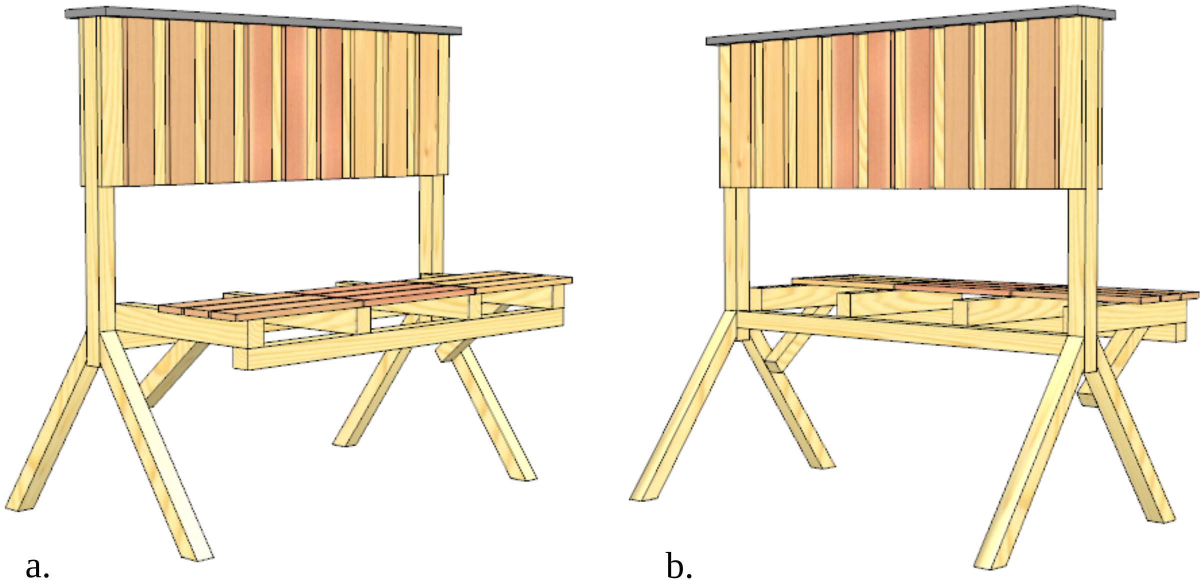

Figure 1: Test set up for moisture monitoring. a. Front side of facade-decking element, South oriented, b. Back side of facade-decking element, North oriented

2.3 Test house in Hannover, Germany

The impact of wall orientation and distance to the ground on the moisture induced decay risk was studied on the claddings of a test house, which was built in Hannover-Herrenhausen in December 2008 (Figure 2). The house had a quadratic floor plan of 3 x 3 m² and a total height of 3.18 m. The four facades were exactly aligned to the cardinal points of the compass. The stud frame, which was made from Norway spruce, carried a board-on-board cladding and a pyramidal broach roof. The roof overhang was minimized to a width of 7.5 cm including the gutter. Five test boards of Norway spruce (*Picea abies* Karst.), Scots pine sapwood (*Pinus sylvestris* L.) and Douglas fir were mounted on each side of the building (Figure 3). The spaces in between were filled with so-called blind boards made from Norway spruce.

Figure 2: Test house in Hannover-Herrenhausen

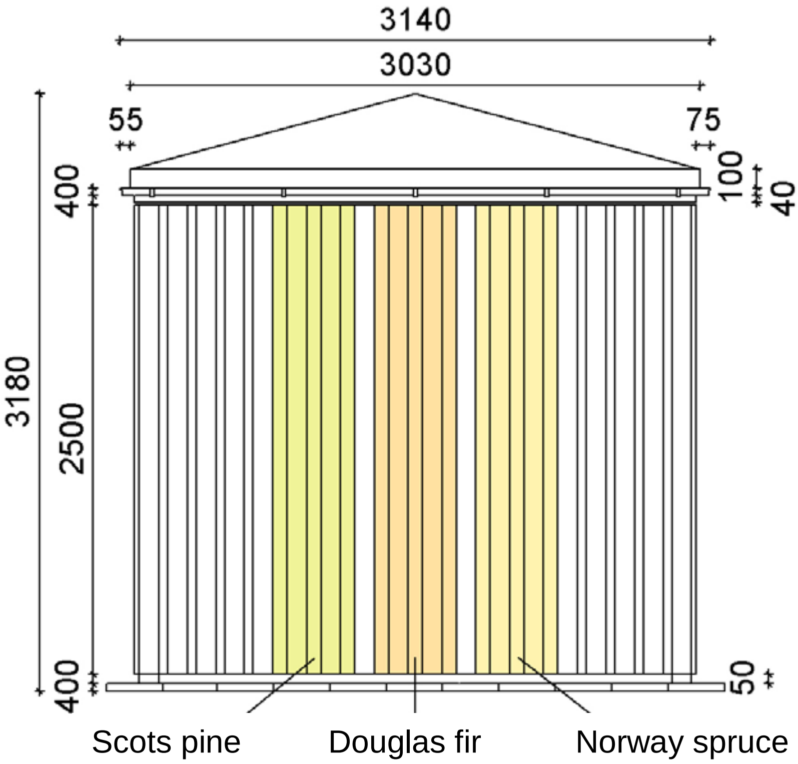

Figure 3: Position of test boards from different wood species in the board-on-board cladding of the test house (dimensions in mm)

For measuring the wood moisture content electrodes were installed at seven different heights: 5, 10, 20, 40, 80, 160, and 240 cm from the bottom end of the boards. Three measurement points per wood species, height and wall orientation were set, which means in total 252 pairs of electrodes. The electrodes were glued in from the back side of the cladding, two pairs in the central cover boards, and one pair in the central base board (Fig. 4). In addition, 84 temperature sensors were installed, one for each parameter combination. Temperature and wood moisture content were recorded daily.

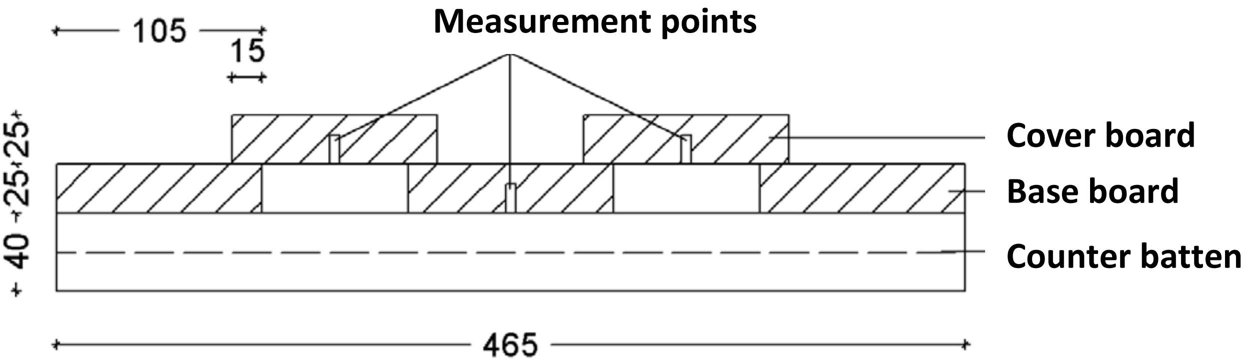

Figure 4: Position of measurement points in the board-on-board cladding of the test house (dimensions in mm)

2.4 Cladding in Tåstrup, Denmark

The aim of this study was to examine the influence of a roof overhang on the moisture conditions within a cladding (Brischke *et al.* 2008b). Therefore moisture measurements were conducted on a cladding (15 m long, 2.5 m high) with three different roof overhangs (12 cm, 62 cm, 112 cm) on the test site of the Danish Technological Institute (DTI) in Tåstrup, Denmark (Figure 5). The cladding was made from un-machined Norway spruce boards of 1170 x 105 x 25 mm³, faced to the North, and carried out as a vertical, rear ventilated board-on-board cladding (Figure 6). The cladding was split into an upper and a bottom part, each with a height of 117 cm, separated from each other by a horizontal board, acting as a small roof overhang of 4.5 cm width. The distance between the boards of the bottom cladding and the ground was 15 cm. Electrodes for MC measurements were glued in from the back of the cladding at two different heights, 65 cm and 170 cm. In total 18 pairs of electrodes were installed, three for each roof overhang/height combination (Fig. 5).

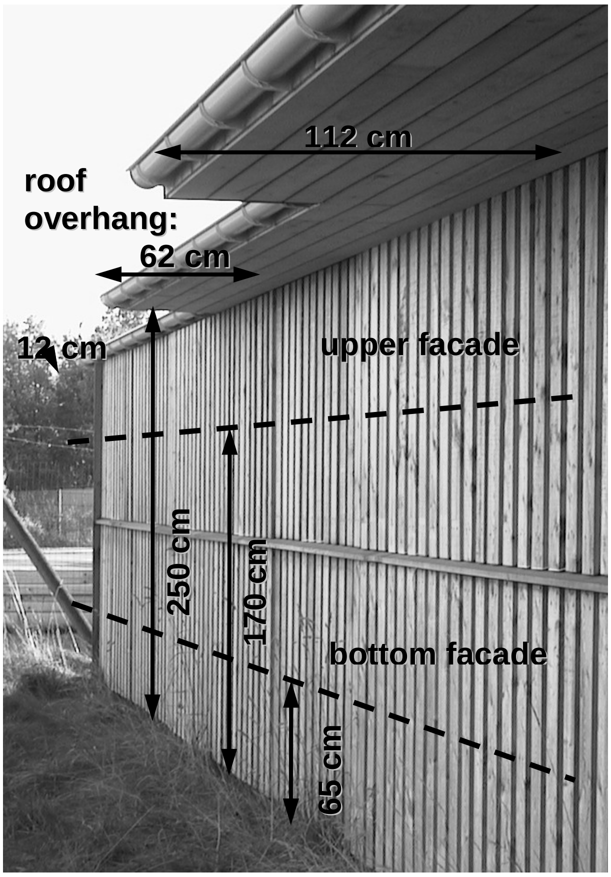

Figure 5: Board-on-board cladding with different roof overhangs in Tåstrup, Denmark. Dashed lines mark the heights of measurement points on the upper and bottom parts of the facade

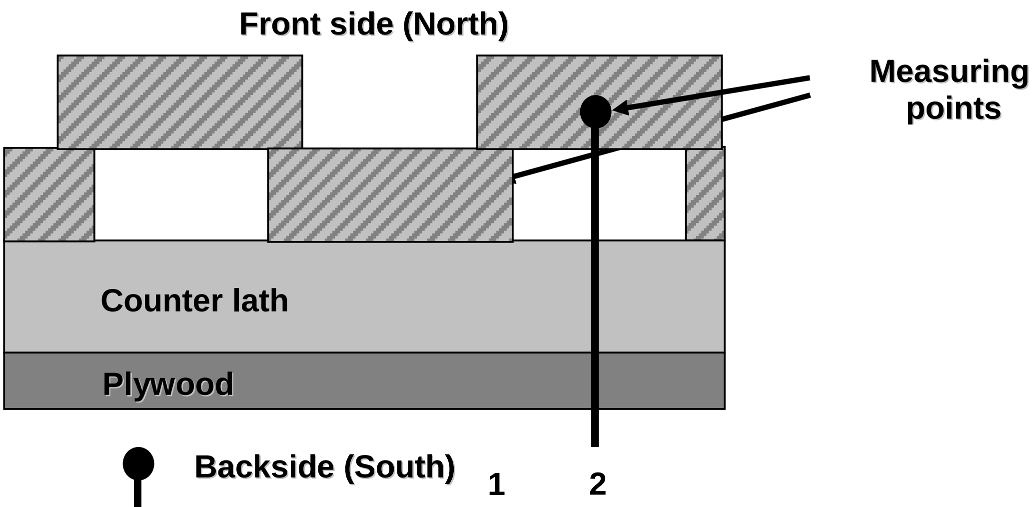

Figure 6: Cross cut through the cladding and schematic arrangement of the measurement points. Measuring point 1 installed in the overlapping zone of a base board; measuring point 2 installed centrally in a cover board

2.5 Moisture performance indicators

The number of wet days has been considered to estimate the durability of the wood species in terms of its moisture performance. Therefore the number of days with MCs above 25 %, which were considered as lower threshold for fungal activity, was determined.

Furthermore, a dose-response performance model for above ground decay as described by Brischke and Rapp (2010) and shown in Figure 7 was applied to the recorded MC and temperature data from the selected test sites. For comparative analysis the total daily dose D (= cumulated daily dose over time) was determined. Therefore the moisture induced dose component d_{MC} (Eq. 1) and the temperature induced dose component d_T (Eq. 2) were calculated according to the following equations:

$$d_{MC} = 6.75 \bullet 10^{-10}\, MC^5 - 3.50 \bullet 10^{-7}\, MC^4 + 7.18 \bullet 10^{-5}\, MC^3 - 7.22 \bullet 10^{-3}\, MC^2 + 0.34MC - 4.98 \quad ; \text{if } MC \geq 25\ \% \qquad (1)$$

$$d_T = 1.8 \bullet 10^{-6}\, T^4 + 9.57 \bullet 10^{-5}\, T^3 - 1.55 \bullet 10^{-3}\, T^2 + 4.17 \bullet 10^{-2}\, T \quad ; \text{if } T_{min} > -1\ °C \text{ and } T_{max} < 40\ °C \qquad (2)$$

d_{MC} MC induced daily dose
d_T temperature induced daily dose
MC daily moisture content
T daily average wood temperature
T_{min} daily minimum temperature
T_{max} daily maximum temperature

To consider the differently severe impact of MC and temperature on decay the weighting factor *a* was added to calculate the daily dose as follows (Eq. 3):

$$d = ((a \bullet d_T) + d_{MC}) / (a + 1) \quad ; \text{if } d_T > 0 \text{ and } d_{MC} > 0 \qquad (3)$$

d daily dose
a = 3,2 weighting factor of temperature induced daily dose component d_T

Thereby the dose is defined as material-climate-index and the response according to the mean decay rating according to EN 252 (1989).

Service lives were estimated using a mean decay rating 2 (=moderate decay) as limit state corresponding to a critical dose d_{crit} = 670 according to Eq. 4 and Figure 7.

$$\text{Estimated service life ESL} = \frac{\text{critical dose}}{\text{mean annual dose}} \quad [a] \qquad (4)$$

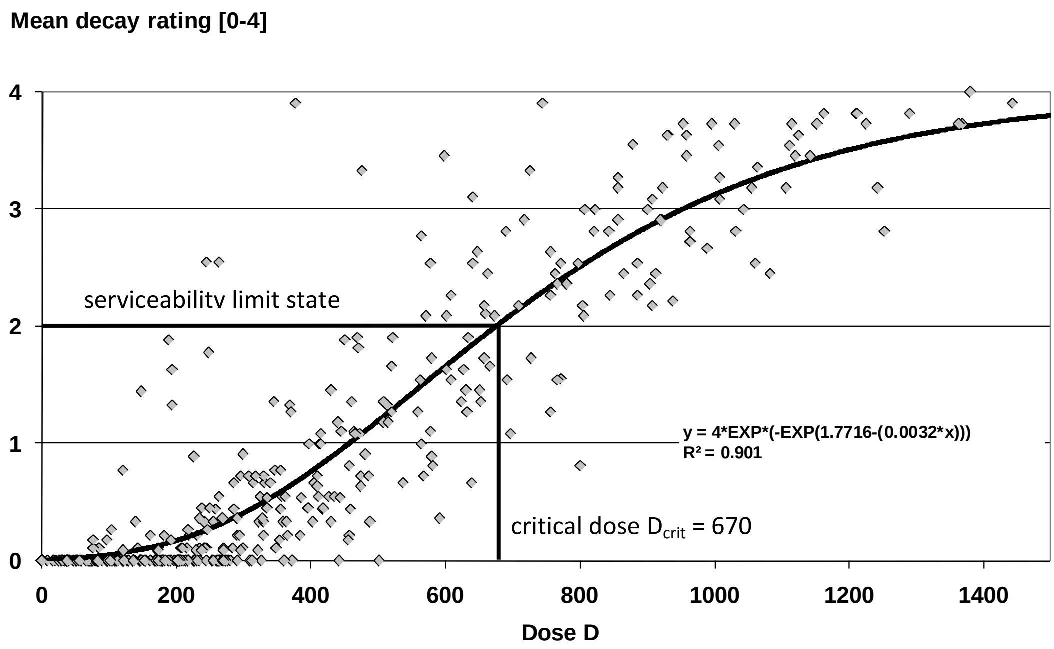

Figure 7: Relationship between the dose D and the mean decay rating according to EN 252 (1989) of Scots pine sapwood and Douglas fir heartwood specimens exposed at 23 different field test sites (each dot represents the mean decay rating for one wood species at one exposure site at a certain time of exposure; black line: Gompertz smoothing function), from: Brischke and Rapp 2010

3. RESULTS AND DISCUSSION

3.1 Impact of wood species

Schmidt (1994) defined the number of ‘critical days’ as a period of time which has to be seen as crucial for the affliction through wood destroying fungi. According to Brischke (2007) days with moisture content above 25 % have to be seen as ‘critical days’.

For the combined-facade-decking-element significant differences between the various wood species and their orientation with respect to the ‘critical days’ were determined. Further the dose values differed regarding wood species and orientation and therefore also varying service life was estimated (Table 2).

Table 2: Number of days with a wood moisture content MC ≥ 25 % # (d), mean annual dose D and estimated service life ESL (a) for the different wood species (material climatic related measures are based on the year 2010 corresponding to a total of 365 days)

Wood species	**North oriented facade**			**South oriented facade**		
	#	**D**	**ESL**	**#**	**D**	**ESL**
	[d]	**[-]**	**[a]**	**[d]**	**[-]**	**[a]**
Black locust	0	0.0	∞	0	0.0	∞
English oak	41	1.7	394	78	4.3	156
Beech	0	0.0	∞	0	0.0	∞
Norway spruce	14	0.9	744	14	1.1	607
Larch heartwood	49	0.3	2233	12	0.1	6700
Larch sapwood	73	0.3	2233	49	0.1	6700
Scots pine heartwood	0	0.0	∞	0	0.0	∞
Scots pine sapwood	44	2.0	335	100	11.2	60
Western Red Cedar	0	0.0	∞	0	0.0	∞

A clear relationship between moisture load and orientation of the facade elements could not be verified. As exemplarily shown for Scots pine sapwood and heartwood in Fig. 8 all wood species experienced slightly higher moisture loads at the South oriented facade though the amplitudes of the moisture curves of the South oriented claddings were higher compared to those exposed to the North. It was expected that all wood species at the South oriented facade received higher moisture loads due to driving rain, because South-West is the weather side in central Europe. This phenomenon was also described by Lauenstein (2010) and Nore *et al*. (2007) who reported that test elements showed higher moisture contents in terms of high wind-driven rain loads and high relative humidity. On the other hand solar irradiation and higher wind loads on the South oriented facade fostered re-drying. Therefore permeable wood species like Scots pine sapwood had most likely more ‘critical days’ on the South oriented facade whereby more refractory wood species, like Larch, showed more ‘critical days’ at the North orientation where re-drying was inhibited by less wind loads and less solar irradiation.

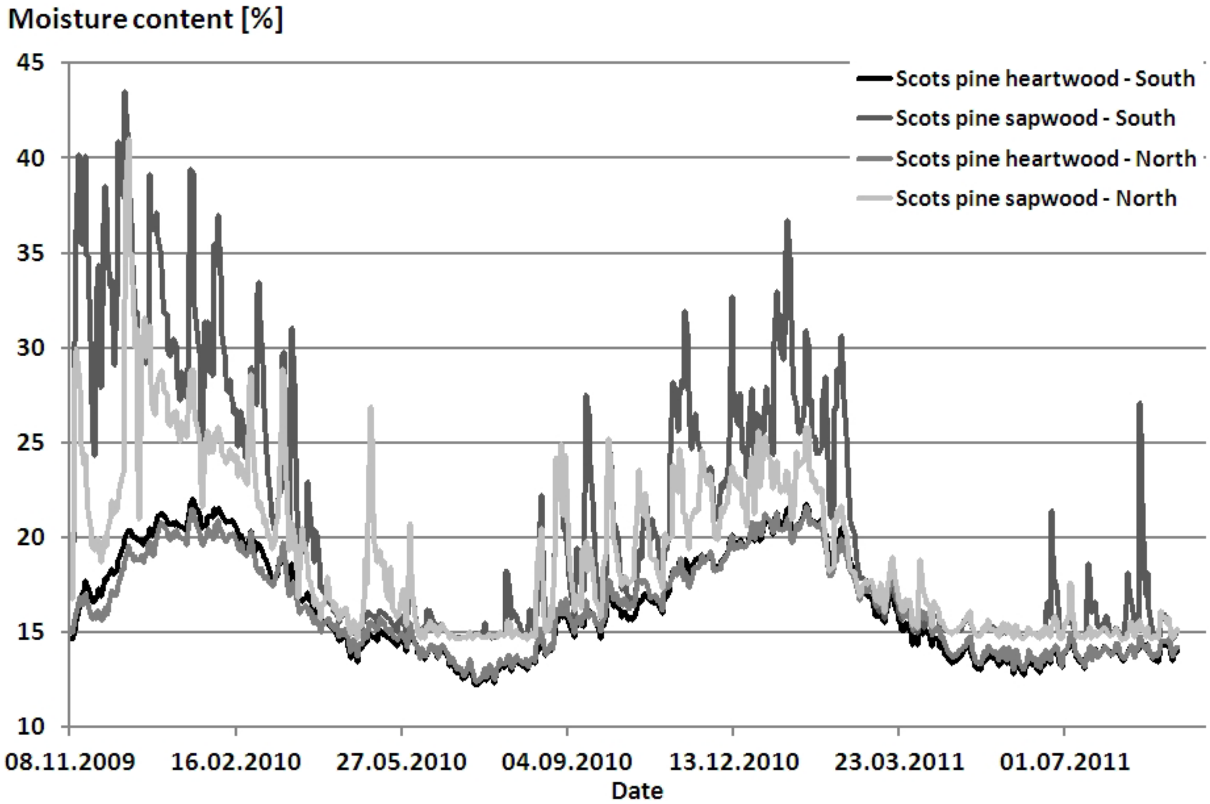

Figure 8: Wood moisture content of Scots pine sapwood and Scots pine heartwood on the North and South oriented facade from 09. 11. 2009 to 05. 09. 2011

As can be seen in Table 2 only for wood species with moisture content above 25 % a dose was determined because at this moisture content a risk of fungal degradation of wood is given. Secondly, a dose was induced only at temperatures above 0 °C. Below the freezing point no liquid water is available and no enzymatic metabolism of wood substance by fungi occur (Schmidt 1994). Therefore moisture content has to be related to the wood temperature. The highest dose of 11.2 was determined for Scots pine sapwood on the South facade and with 2.0 for the North facade which indicates a difference regarding dose values between the North and South orientation. Although the number of ‘critical days’ was nearly the same for larch heartwood, larch sapwood and Scots pine sapwood on the North facade, significantly lower doses were determined for larch. This was due to low temperatures during the winter period where no risk of fungal decay had to be expected. In this period larch sapwood and heartwood had their highest number of ‘critical days’. In contrast Scots pine sapwood showed most ‘critical days’ during warmer periods.

Due to the overall low dose values realistic service life was only estimated for Scots pine sapwood with 60 years and English oak with 156 years on the South oriented facade. For all other wood species the ESL was more than 300 years or even endless. Since a dose value of 0 leads to a service life of ∞, which appears to be ‘unrealistic’ but still indicates a negligibly small risk of fungal degradation. Furthermore after one year of exposure the results need to be seen as preliminary, for more reliable service life estimations longer periods (e.g. as mean over a three years’ period) will be considered.

3.2 Impact of wall orientation and distance to ground

Moisture monitoring on the test house in Hannover-Herrenhausen revealed significantly different moisture loads between compass directions, heights above ground and wood species (Table 3). As already indicated through the highest number of critical days, also highest dose values and consequently shortest service lives were estimated for the West facade, which coincides with wind most often blowing from South-west in Central Europe.

A close relationship between relative humidity and MC needs to be considered as well as the effect of solar irradiation, which became again apparent on the South oriented facades, where the number of critical days was comparatively little. In contrast, the North facade suffered from high moisture loads because of less solar irradiation. Compared to the other orientations the wood could not dry up properly, which increased the possibility of an MC induced dose. Norway spruce did not show such distinct tendencies.

The dose decreased from the lower measurement points to the upper ones. The cumulated annual dose values for 10 cm were always higher compared to 5 cm measuring height (Lück 2011), (*cf.* Table 3). The high dose values at a height of 10 cm were due to high levels of MC. Between the facades and the ground was a distance of 5 cm (Figure 3). The lower MC in the height of 5 cm, compared to 10 cm measuring height, was probably due to a stronger airstream compared to the 10 cm height, which promoted a re-drying. It could be shown that the highest moisture loads and consequently the highest risk of decay were in heights of 5 – 10 cm, where splash water led to an increased ingress of moisture. Additionally, lower wind speed at the ground hindered re-drying.

Generally, the moisture load decreased with ascending distance to the ground, although this trend was not steadily observed for all four walls and all three wood species. Surprisingly, the number of ‘critical days’ was extremely little for Scots pine sapwood on the East and South facade, which might be explained by its high permeability leading to high moisture uptakes, but also easy re-drying at the same time.

Partly, the estimated service life varied strongly in terms of absolute values (in extreme between 65 years and endless). However, the critical details of wooden facade became apparent and were quantifiable in terms of service life values. Besides moisture ingress in terms of splash water and wind-driven rain, hindered re-drying turned out to be most crucial and can be the consequence of low solar irradiation in combination with insufficient ventilation. The impact of roof overhangs as design measure to prevent driving rain loads has been quantified on a third test assembly.

Table 3: Number of days with a wood moisture content MC ≥ 25 % # [d], mean annual dose D and estimated service life ESL [a] for different wood species for a measuring period of 3 years (2009-2011)

		Douglas fir			**Norway spruce**			**Scots pine sapwood**		
		#	**D**	**ESL**	**#**	**D**	**ESL**	**#**	**D**	**ESL**
Measuring height		**[d]**	**[-]**	**[a]**	**[d]**	**[-]**	**[a]**	**[d]**	**[-]**	**[a]**
240 cm	North	0	0.00	∞	3	0.07	9571	0	0.00	∞
	East	0	0.00	∞	2	0.00	∞	0	0.00	∞
	South	0	0.00	∞	0	0.00	∞	12	1.01	663
	West	54	2.29	293	11	0.50	1340	28	1.52	441
160 cm	North	0	0.00	∞	22	0.67	1000	7	0.27	2482
	East	0	0.00	∞	34	0.30	2233	3	0.00	∞
	South	40	3.22	208	3	0.20	3350	2	0.12	5583
	West	128	3.67	183	25	1.15	583	54	2.05	327
80cm	North	0	0.00	∞	78	1.70	394	41	1.29	519
	East	0	0.00	∞	26	0.16	4188	8	0.06	11167
	South	1	0.06	11167	5	0.27	2482	0	0.00	∞
	West	160	3.92	171	128	3.92	171	130	3.74	179
40cm	North	1	0.04	1675	56	1.27	528	30	0.77	870
	East	0	0.00	∞	98	1.88	356	3	0.05	13400
	South	2	0.12	5583	3	0.16	4188	0	0.00	∞
	West	193	5.12	131	103	3.18	211	151	4.51	149
20cm	North	0	0.00	∞	7	0.09	7444	49	1.34	500
	East	0	0.00	∞	131	2.33	288	0	0.00	∞
	South	7	0.20	3350	16	0.61	1098	0	0.00	∞
	West	109	1.79	374	169	4.52	148	163	5.72	117
10 cm	North	0	0.00	∞	46	0.96	698	63	1.50	447
	East	0	0.00	∞	114	1.86	360	18	0.31	2161
	South	89	2.43	276	38	1.51	444	0	0.00	∞
	West	149	3.48	193	208	5.09	132	231	6.95	96
5 cm	North	0	0.00	∞	70	1.35	496	126	3.60	186
	East	0	0.00	∞	102	1.44	465	0	0.00	∞
	South	17	0.59	1136	154	4.87	138	2	0.02	33500
	West	107	2.38	282	208	5.05	133	166	5.87	114

3.3 Impact of roof overhangs

Differently wide roof overhangs influenced the moisture load of the board-on-board cladding of the facade in Tåstrup, Denmark, significantly. Table 4 contains the number of days with a MC ≥ 25 % for the cladding made from Norway spruce with different roof overhangs and measuring heights above ground. Claddings with a larger roof overhang showed the fewest count of ‘critical days’ followed by the roof overhang of 62 cm. The count for the smaller roof overhang was increased by a factor of 6. Differences between the upper and lower facade were only determined for a roof overhang of 112 cm (30 days to 252 days) and for 62 cm (194 days to 286 days). These findings support the assertion that wide roof overhangs inhibit high moisture loads due to precipitation and particular driven rain. As Lauenstein (2010) and Lück (2011) stated, wind-driven rain events led to temporal increase of MC due to the hygroscopic characteristics of wood. Fig. 9 also supports these findings. The MC from claddings of the bottom wall was 5 times higher compared to the upper wall for the wide roof overhang and nearly as high as for the small roof overhang. This supports the findings of Lauenstein (2010) and Lück (2011).

Table 4: Number of days with a wood moisture content MC ≥ 25 % # [d], mean annual dose D and estimated service life ESL [a] for different wood species for a measuring period of 3 years (2002 – 2004)

Roof overhang	Facade	Board type	# [d]	Dose [-]	ESL [a]
112 cm	upper	cover	52	1.09	569
		base	61	1.35	497
	bottom	cover	252	6.78	99
		base	245	6.46	104
62 cm	upper	cover	197	5.04	133
		base	181	4.54	148
	bottom	cover	297	7.86	85
		base	263	6.69	100
12 cm	upper	cover	310	8.44	79
		base	289	7.51	89
	bottom	cover	314	8.88	75
		base	254	6.54	102

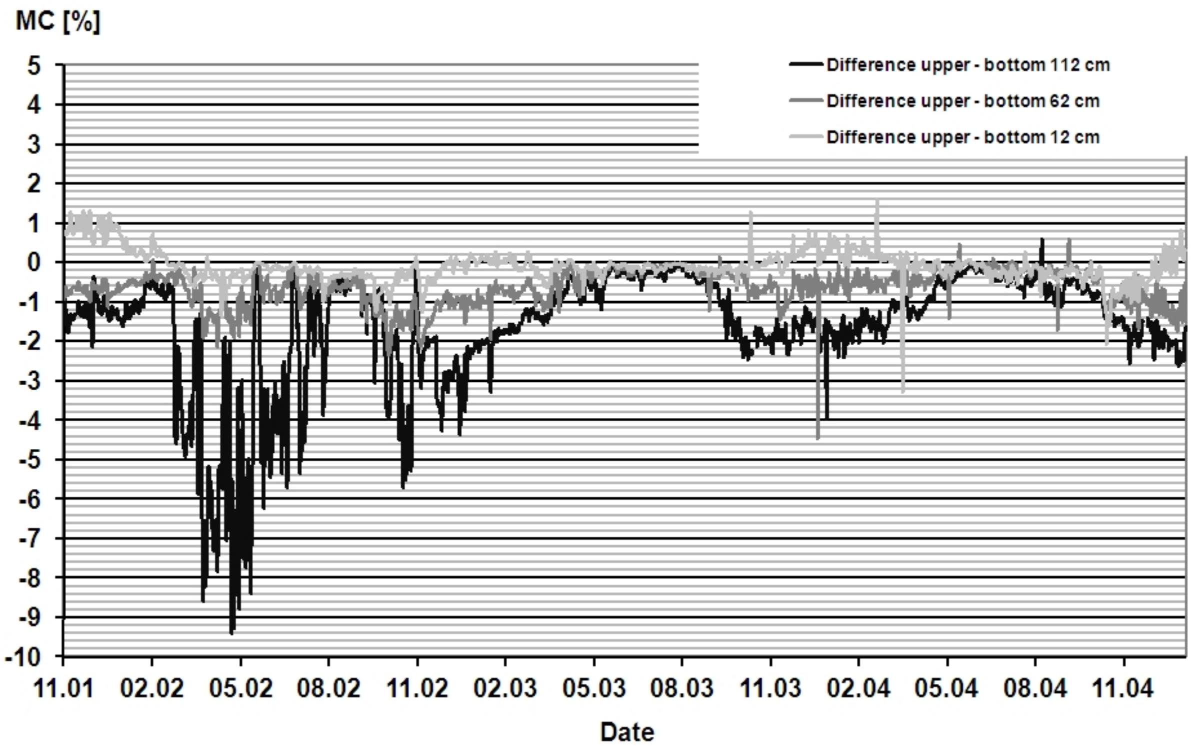

Figure 9: Difference of wood moisture content of upper and bottom wall for Norway spruce for all roof overhangs from 23.11.2001 to 10.01.2005

No significant difference regarding 'critical days' for base- and cover boards on the upper and bottom facade for each roof overhang was detectible. Obviously the contact area of the boards had no negative influence on the moisture content of the base claddings.

According to Table 4 the facade with the lowest roof overhang was the most stressed and the highest dose was measured at the bottom cover board with 10.94. Also here the emphasised differences between the roof overhangs and measuring heights were approved. Lower doses were determined for the upper facades with increasing wide roof overhangs.

Furthermore plausible service life was prognosticated (Table 4). The longest service life was estimated for the upper sections of the wide roof overhang while minimal service life was estimated for the narrow roof overhang. Further, relatively short service life, compared to the wide roof overhang, was calculated for the upper part of the roof overhang with 62 cm. Shading of the upper facade by the roof overhang caused an inhibition of re-drying due to solar irradiation. This effect was not relevant for the wide roof overhang because less moisture load was existent caused by the protection against wind driven rain.
In contrast, the facades with wider roof overhang were more efficiently protected from wind-driven rain, wherefore the negative effect of shading was superposed.

4. CONCLUSIONS

While it is common practice to determine wood MC in lab decay tests, it is neither in field trials nor in studies on whole commodities, constructions or buildings. In contrast, many studies on moisture dynamics and resulting moisture load of the respective building materials are known in the field of building physics, e.g. in-situ measurements on wall mounting, construction, or rain screen wall assemblies. The comparative study on the moisture performance and durability of wooden facades showed that plausible service life can be estimated for different exposures, materials and design details.

Moisture monitoring allows for both, characterisation of material quality in terms of moisture performance, e.g. as an alternative to long-term field testing in less severe use conditions, and secondly for quantification of various factors having an influence of service life of wooden constructions.

The results of this study recommend taking more advantage of the additional information provided by continuous MC measurements, in particular with respect for service life prediction issues. On the other hand, it became apparent that microclimatic differences can have significant impact on the test results and need to be considered carefully for interpretation.

In the context of future studies test-site comparisons with a referential test object could serve to investigate the influence of various factors in different regions with preferentially more extreme climate conditions (mountain and coastal areas, humid and arid regions, etc).

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