Moderate Thermal Treated Norway Spruce (*Picea abies* (L.) [Karst.]) Exposed to Ground Contact in Austria for Five Years

Robert Stingl[1], Martin Weigl[2],
Alfred Teischinger[1,2] and Christian Hansmann[2]

[1]Institute of Wood Science and Technology, Department of Material Sciences and Process Engineering, University of Natural Resources and Applied Life Sciences, Vienna, (BOKU Vienna) Peter Jordan Straße 82, 1190 Vienna, Austria [email: robert.stingl@boku.ac.at]

[2]Wood *K plus* - Competence Centre for Wood Composites and Wood Chemistry, St.-Peter-Straße 25, 4021 Linz, Austria [email: c.hansmann@kplus-wood.at]

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ABSTRACT

Norway Spruce is the most dominant wood species in Austria; it is also the most used construction timber. But the durability – especially in ground contact - is dissatisfying. This study based on the field test method for determining the relative protective effectiveness of a wood preservative in ground contact (ÖNORM EN 252) and showed that even a moderate thermal treatment results in a distinct increase of the durability. Stakes of modified and untreated (to act as a reference) wood were inserted vertically to half their length in the soil in rows. Installations were done in the spring-time of the year 2001 and the inspections were done every two years during the same season as installation. At the test field near Vienna the soil is a sandy loam. The samples were treated in nitrogen atmosphere at 165 °C, for 24 hours at a pressure of about 0.6 MPa. The analyses according to ÖNORM EN 252 of the treated samples showed no or only very slight attack (rating 0.4 in mean) while the references showed moderate attack for both, spruce (rating 2.2 in mean) and pine (rating 2.1 in mean). Additional mechanical testing showed significant differences regarding impact bending strength due to the exposure. The treated Spruce samples revealed a loss of impact bending strength of only 3 % after the whole testing period (references up to circa 25 %).

INTRODUCTION

Most of the native European wood species are not applicable in ground contact. It is known that thermal treated wood performs well in the outside. But there are also problems, when heat treated wood has direct contact with soil (Edlund et al. 2006). Burmester (1973) and Giebeler (1983) describe a method of a moderate modification of wood. Based on this knowledge the Institute of Wood Science and Technology (BOKU Vienna) realised the project "Modified Wood – Properties and Markets", which showed positive results concerning heat treated wood in direct ground contact (Patzelt et al. 2002, 2003). By means of a quinquennial ground contact investigation and following mechanical and chemical tests it was possible to prove, that moderate thermal treatment spruce wood can be used for outdoor applications in ground contact. The reduction of the impact bending values as a result of the thermal modification (Leijten 2004) and the subsequent fungal infestation was analysed.

MATERIAL AND METHODS

Material

Norway spruce (*Picea abies* (L.) [Karst.]) was used for the investigation. The samples (500 mm x 50 mm x 25 mm) were treated in nitrogen atmosphere at 165 °C, for 24 hours at a pressure of about 0.6 MPa.

Methods

This study based on the field test method for determining the relative protective effectiveness of a wood preservative in ground contact (ÖNORM EN 252). Stakes of modified spruce and untreated spruce and pine wood (to act as a reference) were inserted vertically to half their length in the soil in rows (Figure 1).

Location of the field test and characterisation of the soil

The testing field of the BOKU-University is located in Essling, an outlying district of Vienna. The soil consists of a calcareous grey floodplain ground of grit deposit material (from clayey to arenaceous silt). The soil reaction was alkaline.

Figure 1: Testing field in Essling (Vienna)

Trial period and the meteorological data during this time

Installations were done in the spring-time of the year 2001 (1. April 01) and the inspections (rating system – Table 1) were done every two years during the same season as installation (last and end inspection 4. April 06). The following meteorological data are average values: air temperature: ~ 10 °C; soil temperature: ~ 8 °C; global radiation: 1.050 kWh/m²/year; precipitation: 500 mm/year.

Table 1: Definition of the rating system for ÖNORM EN 252

Rating	Classification	Definition of condition
0	no attack	No change perceptible by the means at the disposal of the inspector in the field
1	slight attack	Perceptible changes, but very limited in their intensity and their positional or distribution: changes which only reveal themselves externally by a change in colour or by very superficial degradation , softening of the wood being the most common symptom, to an apparent depth of 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 2 -3 mm over all or part of the test piece from the ground level zone and below
3	severe attack	Severe changes: marked decay in the wood to a depth of 3 – 5 mm over a wide surface (for example soft rot or other type of decay over all the surface of the specimen at the ground line zone or below) or by softening to a greater depth (10 – 15 mm) over a more limited surface area e.g. white rot over a few mm^2.
4	failure	Impact failure of the stake in field

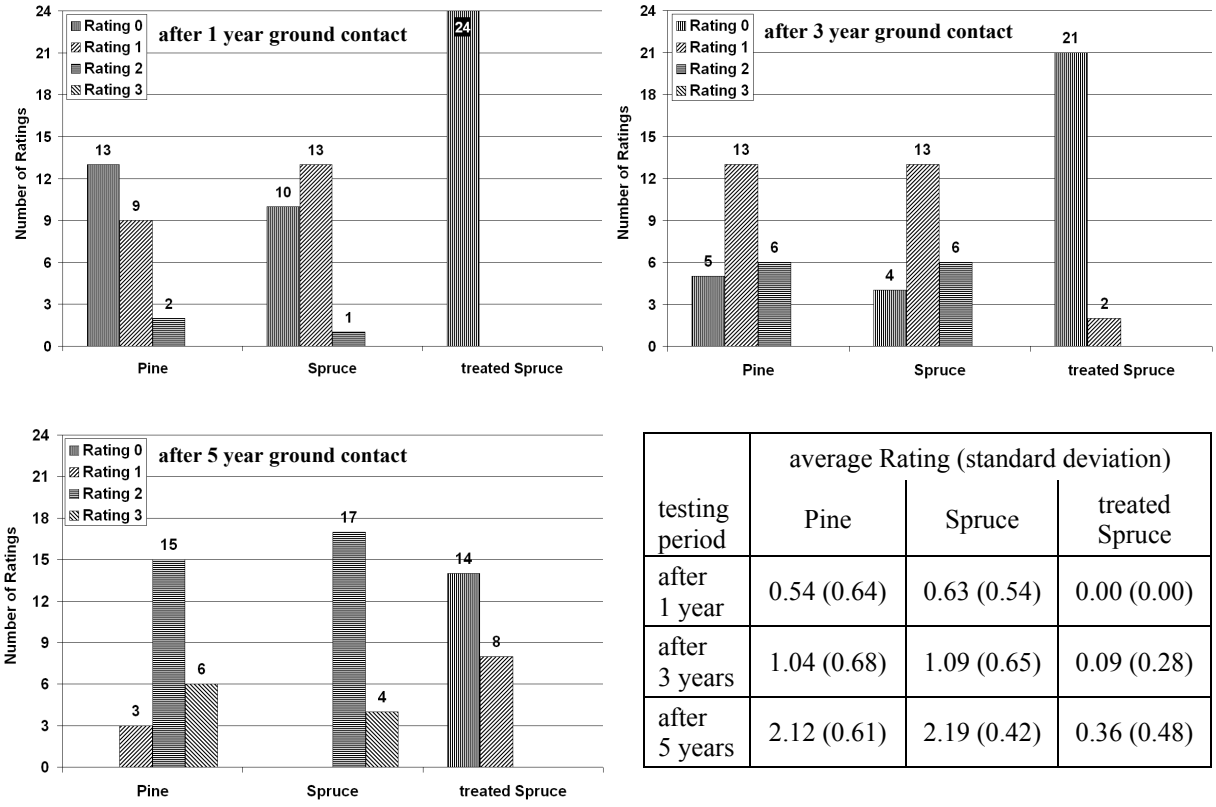
Impact bending test

Impact bending tests were done according to the standard DIN 52189 (sample size 300 mm x 20 mm x 20 mm).

RESULTS

Results of the field test with ground contact

The analyses (according to ÖNORM EN 252) of the treated samples showed no or only very slight attack (rating 0.4 in mean) while the references showed moderate attack for both, spruce (rating 2.2 in mean) and pine (rating 2.1 in mean). After 5 years most of the untreated samples had softenings caused by the fungal attack. Treated wood showed only small discoloured stains, but no palpable fungal decay (Figure2).



testing period	average Rating (standard deviation) Pine	Spruce	treated Spruce
after 1 year	0.54 (0.64)	0.63 (0.54)	0.00 (0.00)
after 3 years	1.04 (0.68)	1.09 (0.65)	0.09 (0.28)
after 5 years	2.12 (0.61)	2.19 (0.42)	0.36 (0.48)

Figure 2: Results of the field test with ground contact after 1, 3 and 5 years according to EN 252

Impact bending test

The heat treated spruce samples revealed a loss of impact bending strength of only 3 % after the whole testing period. However, the references (untreated spruce and pine) showed a reduction of the strength value of 18.9 % and 23.7 % respectively (Table 2). Several untreated samples with massive fungal decay observed a loss of strength up to 50 %.

Table 2: Results of impact bending test

Material	before ground contact		after five years ground contact		
	Impact bending value [kJ/m²]	standard deviation	Impact bending value [kJ/m²]	standard deviation	Reduction of the impact bending value [%]
Pine	43.5	11.1	35.3	7.9	18.9
untreated Spruce	45.2	11.5	34.5	8.3	23.7
heat treated Spruce	6.7	1.4	6.5	0.9	3.0

CONCLUSIONS

The analyses of the heat treated and untreated wood samples showed big differences regarding the vulnerability by microorganisms. The quinquennial field test with ground contact (according to ÖNORM EN 252) proved that heat treated spruce showed no or only very slight fungal attack. However, the references (untreated pine und spruce) showed moderate attack. An additional mechanical testing (impact bending) emphasized the statement, that moderate modified wood is resistant to microorganisms. Due to the strong fungus decay the untreated samples lost a lot of their impact bending strength (several samples up to 50 %). The heat treated wood lost strength due to the modification process, but revealed only a slight strength reduction during the testing period in the ground.
The investigations of moderate heat treated spruce wood showed that it is possible to use spruce wood in ground contact. As a next step, chemical analyses will be performed in order to clarify the chemical background of the protective effect due to the moderate thermal treatment.

REFERENCES

Burmester, A. (1973) Einfluß einer Wärme-Druck-Behandlung halbtrockenen Holzes auf seine Formstabilität. *Holz als Roh- und Werkstoff*, **31**, 237-243

DIN 52 189-1 (12. 1981) Prüfung von Holz - Schlagbiegeversuch - Bestimmung der Bruchschlagarbeit (Testing of wood – determination of impact bending strength)

Edlund, M-L., Evans, F., Henriksen, K. (2006) Testing durability of treated wood according to EN 252 – Interpretation of data from Nordic test fields. In: NT Techn Report 591, ISSN: 0283-7234, approved 03. 2006, Oslo, Norway

Giebeler, E. (1983) Dimensionsstabilisierung von Holz durch eine Feuchte/Wärme/ Druck-Behandlung. *Holz als Roh- und Werkstoff*, **41**, 87-94

Leijten A.J.M. (2004) Heat treated wood and the influence on the impact bending strength. *HERON*, Volume 49 (2004), issue 4, Special issue: Wood, ISSN 0046-7316, Delft, Netherlands

ÖNORM EN 252 (11. 1989) Holzschutzmittel; Freiland-Prüfverfahren zur Bestimmung der relativen Schutzwirkung eines Holzschutzmittels im Erdkontakt (Field test method for determining the relative protective effectiveness of a wood preservative in ground contact)

Patzelt, M., Stingl, R., Teischinger, A. (2002) Thermische Modifikation von Holz und deren Einfluss auf ausgewählte Holzeigenschaften. In: *LIGNOVISIONEN*, issue 3 „Modified Wood – Properties und Markets“, ISSN 1681 – 2808, Vienna, Austria, pp 101-147

Patzelt, M., Emsenhuber, G., Stingl, R. (2003) Colour Measurement as means of Quality Control of Thermally Treated Wood. In: *Proceedings of the First European Conference on Wood Modification*. Ghent, Belgium, pp 213–218