NATURAL DURABILITY OF WOOD IN NORWAY – RESULTS AFTER EIGHT YEARS ABOVE GROUND EXPOSURE

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ABSTRACT

Some of the most common Norwegian wood species were tested in a Double layer test in South East Norway. After eight years of exposure the highest decay rating (≥3) was found in Scots pine sapwood, Norway spruce, alder, birch and aspen. Two wood types had decay rate ≤1: Scots pine heartwood and cedar. Wood moisture was logged and compared with precipitation during a two month period the second year of exposure. Scots pine sapwood had higher wood moisture content than Norway spruce, and a good correlation was found between precipitation and wood moisture content. When comparing similar materials exposed at three different geographical locations in Southern Norway, the samples exposed in Bergen had higher decay rating than samples exposed at Ås and Oslo.

Key words: Norway, natural durability, geographical variation, above ground testing

INTRODUCTION

In Norway exterior wood structures have traditionally nearly exclusively been made of treated or untreated Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*). In recent years there has been a tendency that other tree species, like various domestic hardwoods and imported species have been used in exterior above ground applications - use class 3 (EN 335-1, 2006), often without any surface treatment. One of the principal reasons for the increased interest in using "new" species is that the different visual appearances of different species of wood offer a broader range of aesthetical elements in architecture, and thereby enable customised solutions in house building. Another aspect is the increased focus on utilising natural durability as an alternative to traditional wood preservation.

Natural durability of wood is determined by the European standard EN 252 (1989) for specimens in ground contact and EN 113 (1996) for basidiomycetes in the laboratory, but no standard test are included for above ground conditions. For above ground conditions, the European technical standard CEN/TS 12037 (2003) and EN 330 (1993)

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are used to determine the durability of treated wood. In addition, a range of non-standard tests are used, among them are the Double layer test (Rapp and Augusta 2004). An overview of testing and evaluation of natural durability of wood in above ground conditions in Europe is published by Råberg et al. (2005). Among their conclusions are that the most important factors for fungal establishment on the surface and within wood are the moisture content, the surrounding temperature, and the relative humidity.
The aim of this paper was to evaluate the natural durability of Norwegian wood species in above ground exposure.

MATERIAL AND METHODS

Wood material

The wood species used in this project are the most common Norwegian wood species able to give sufficient dimensions for sawn wood. In addition two imported reference species were included: Siberian larch and Spanish cedar. All wood materials are listed in Table 1, 20 test specimens were used for each wood species.

Table 1. Wood species used in the project: abbreviation, Latin name and common name.

Abbreviation	Latin name	Common name
	Hardwoods	
Alder	*Alnus glutinosa*/*Alnus incana*	Alder/ Grey alder
Birch	*Betula pendula*/*Betula pubescens*	Silver birch/Downy birch
Aspen	*Populus tremula*	Aspen
Oak	*Quercus petraea*/*Quercus robur*	Sessile oak/Pedunculate oak
	Softwoods	
Spruce	*Picea abies*	Norway spruce
Pine s	Scots pine sapwood	
Pine h	*Pinus sylvestris*	Scots pine heartwood
Pine h-n	*Pinus sylvestris*	Scots pine heartwood (narrow annual year rings)
Sitka	*Picea sitchensis*	Sitka spruce
	Imported species	
Cedar	*Cedrela* spp.	Spanish cedar
Larch	*Larix sibirica*	Siberian larch

Test methods

The Double layer test (Rapp and Augusta 2004) was used for above ground exposure. The samples rested on inert aluminium frames. The test site was the roof of the Norwegian Institute of Wood Technology's 8 floor building at Blindern, Oslo. The test started in 2002 and has been evaluated annually (with the exception of 2006). For the comparison between test sites, evaluation data after six years were compared with six year double layer data from field tests established in Ås and Bergen in 2004 (Flæte et al. 2008, 2011). The samples in Ås and Bergen are from the same batch of materials. Decay was evaluated according to the rating system of EN 252 (0 = no decay, 4 = failure). Wood moisture content was logged in a two month period the second year of exposure in three Scots pine sapwood and three Norway spruce specimens.

RESULTS AND DISCUSSION

In Fi.1 mean decay ratings after eight years is presented. Within this period none of the wood species reached failure (rating 4) for all test specimens. A mean decay rate of ≥3

after eight years was found in Scots pine sapwood, Norway spruce, alder, birch and aspen. Two wood materials had ≤1 decay rate: Scots pine heartwood and cedar. The remaining species/wood types had a rating between 1 and 2.

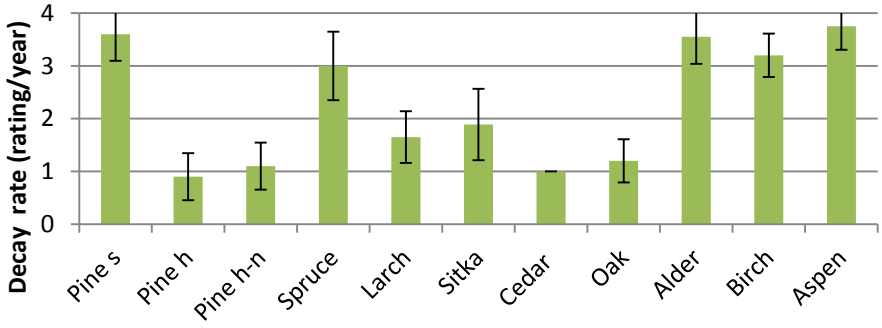
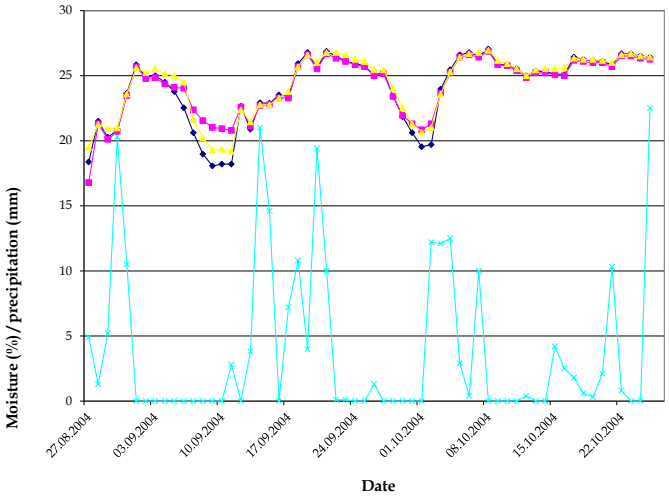


Fig. 1. Mean decay ratings (0 = no decay, 4 = failure) after eight years of exposure above ground (Double layer test) at Blindern, Oslo. Variation is given as standard deviation.

a



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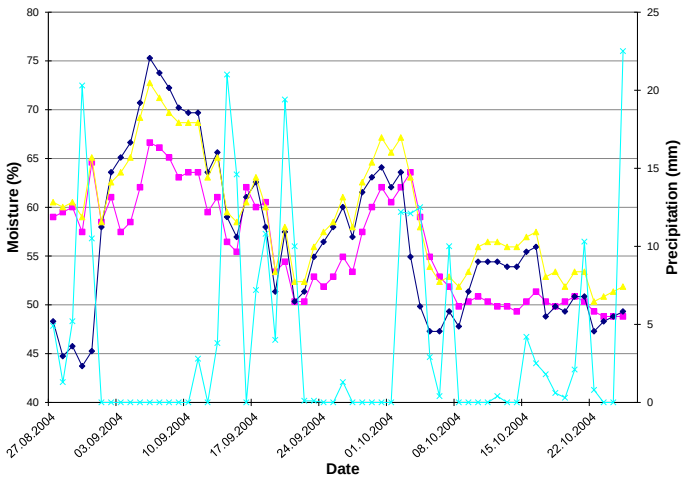

Fig. 2. Wood moisture measurements in (a) Norway spruce and (b) Scots pine specimens (yellow, pink and blue) comapred with precipitation (light blue) measurements.

In Fig. 2 wood moisture content and precipitation in a two month period the second year of exposure is presented. The wood moisture content correlates well with the precipitation, this includes a slight time lag. Norway spruce showed much lower wood moisture content then Scots pine sapwood.

In Fig. 3 mean decay rate (rating/year) from all eight years is presented. During the exposure period there have been no huge shifts in durability ranking between species. Scots pine sapwood has throughout the test period the highest decay. No significant differences was found between the two types of Scots pine heartwood. One should be careful to interpret too much from ratings below 2. Field evaluations are rather subjective and climate and moisture conditions might influence the evaluation results, one obvious example is the birch results after six years. In this study we have done independent evaluation, not looking at previous year's results during evaluation.

In Fig. 4 the decay rating after six years in Oslo is compared with similar materials exposed at Ås and Bergen. Oslo and Ås are located in the same region in Eastern Norway with similar climatic conditions, while Bergen is located in the humid coastal region in Western Norway. Generally, Bergen has the highest decay rating. Between Ås and Oslo there is no obvious trend, it varies between species. Norway spruce had surprisingly similar rating between the test sites. It has to be noted that the test sites in Bergen and Ås is exposed above soil, while the test setup in Oslo is located on a roof. This might cause some of the variation between Oslo and Ås.

Still knowledge is lacking, both in Norway and in general, about species diversity, colonisation and succession patterns in different wooden materials used outdoors. Identifying fungi with traditional methods, like agar plate isolation, is time consuming and not very accurate. Molecular methods, e.g. PCR and sequencing, is an objective approach for species identification, and it does not require mycological skills (Råberg et al. 2005).

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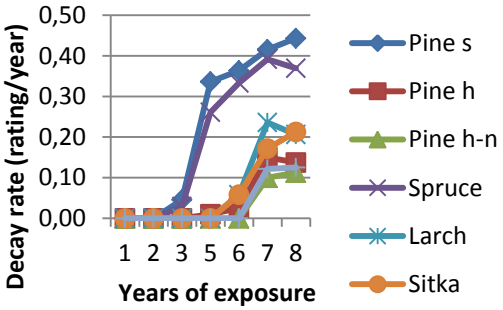

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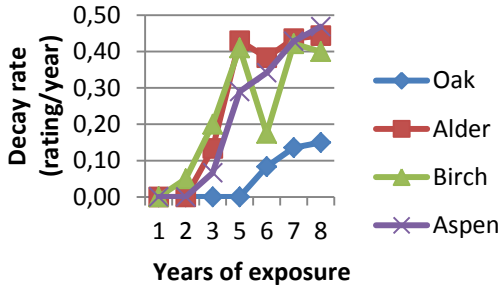

Fig. 3. Mean decay rate (rating/year) for (a) softwoods and (b) hardwoods.

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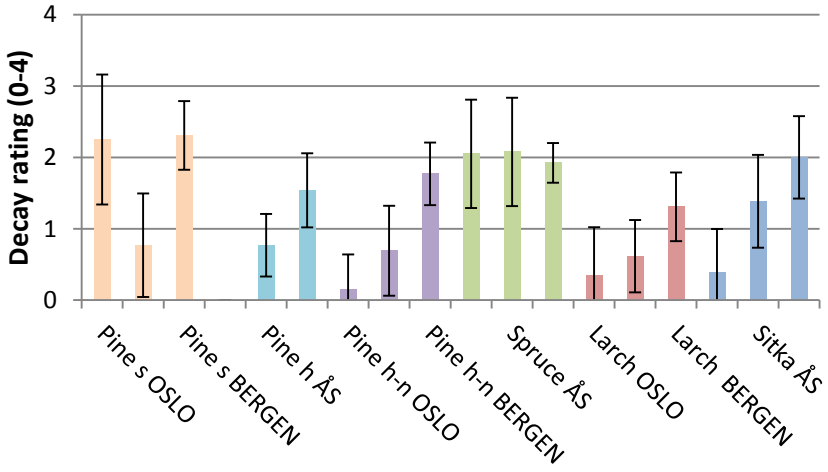

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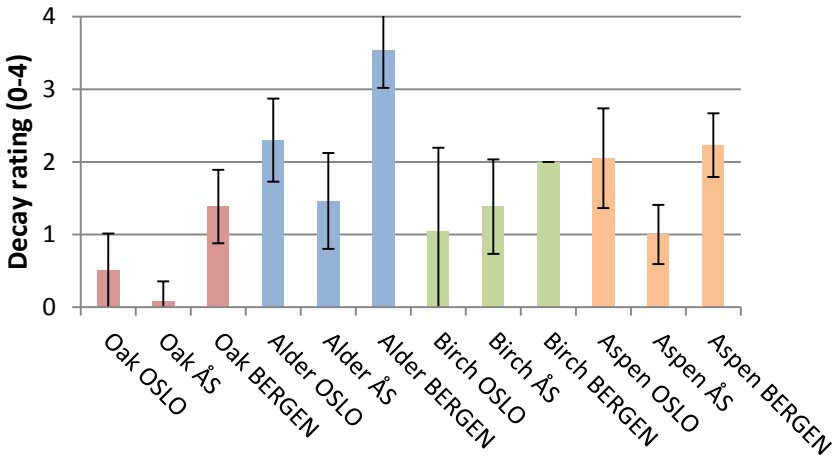

Fig. 4. Mean decay rating after six years of exposure in Double layer test showing geographical variation between three different localities in Norway: Bergen, Oslo and Ås. Softwoods are illustrated in (a), hardwoods in (b). Variation is given as standard deviation.

To improve our knowledge about wood protection and to utilize wooden materials in an optimal way we need to improve our utilization and evaluation of field trials. Logging temperature and moisture will provide important information about how climate affects the service life of outdoor wooden constructions. Evaluation should also be taken one step further, not only using the traditional decay rating system. Råberg et al. (2005) concluded that strength tests are the most sensitive for decay detection, but neither strength tests nor identification of fungi responsible for the decay are included in the standards of above ground durability in field tests.

CONCLUSIONS

- After eight years of exposure Scots pine sapwood had the highest decay rating, Scots pine heartwood and cedar the lowest decay rating.
- Wood moisture content was higher during the measuring period in Scots pine sapwood than in Norway spruce.
- When comparing similar materials exposed at three different locations in Southern Norway, the samples exposed in Bergen had the highest decay ratings.

ACKNOWLEDGMENT

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REFERENCES

EN 113 1996. Wood preservatives - Test method for determining the protective effectiveness against wood destroying basidiomycetes - Determination of toxic values. European Committee for Standardization (CEN), Brussels, Belgium, 31 p.

EN 252, 1989. Field test method for determining the relative protective effectiveness of a wood preservative in ground contact. European Committee for Standardization (CEN), Brussels, Belgium, 12 p.

EN 330, 1993. Wood preservatives. Field test method for determining the relative protective effectiveness of a wood preservative for use under a coating and exposed out-of-ground contact. L-joint method. European Committee for Standardization (CEN), Brussels, Belgium, 14 p.

EN 335-1, 1992. Durability of wood and wood-based products. Definition of hazard classes of biological attack - Part 1: General. European Committee for Standardization (CEN), Brussels, Belgium, 9 p.

CEN/TS 12037, 2003. 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 (CEN), Brussels, Belgium, 34 p.

Flæte, P.O., Alfredsen, G. & Evans, F.G. 2008. Comparison of four methods for natural durability classification after 2.5 years exposure. ProLigno 4(3): 15-24.

- 2011. Natural durability of wood tested in different environments in Northern Europe. International Research Group on Wood Protection. Doc. No. IRG/WP 11-10747: 9 p.

Rapp, A.O. & Augusta, U. 2004. The full guideline for the "double layer test method" - A field test method for determining the durability of wood out of ground. The International Research Group of Wood Preservation, IRG/WP 04-20290: 24 p.

Råberg, U., Edlund, M.-L., Terziev, N. & Land, C.J. 2005. Testing and evaluation of natural durability of wood in above ground conditions in Europe – an overview. Journal of Wood Science 51: 429-440.