END-OF-LIFE WOOD QUALITY OF MOORING POLES.

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ABSTRACT: The wood quality of an out-of-service timber mooring pole (wood species *Dicorynia guianensis)* has been assessed after 40 years having been in service. The resistance level of wood species against fungi determines predominantly the propagation of degradation of timber in hydraulic structures in the critical area around the water-line. Several tests have been performed in order to determine the residual strength and the natural durability. Results of the tests showed that the natural durability of the timber was still comparable with fresh timber. Also the test results show that the mechanical properties have most probably not changed over time and are comparable with new basralocus. The results of this investigation can be used for decision making regarding possible re-use of structures in the same condition or increase the service life of same timber structure.

KEYWORDS: natural durability, decay tests, hydraulic structure, residual strength, basralocus

1 INTRODUCTION

The use of timber in marine structures gives satisfactory performance both in sea- and brackish water environments, particularly in construction elements continuously submerged below the lowest water level.
In the Netherlands, hydraulic structures are often from tropical hardwoods. They are normally used for fenders, sheet pile walls, lock gates, mooring poles, etc. The most widely wood species used are azobe (*Lophira alata*), basralocus (*Dicorynia guianensis*) and demerara greenheart (*Chlorocardium rodiei*).
Due to economic and ecological reasons the service life of these marine structures has to be maximised by reliable assessment methods in order to predict residual strength and biological durability.
For example several thousand mooring poles (ca. 20 meter in length) have been replaced based on visual inspection every year just in the Netherlands [1]. The visual inspection criteria are not distinctive enough in order to predict the residual strength of the mooring poles. The responsible Dutch ministry (RWS) assumed that the residual wood quality of the replaced mooring poles are still sufficient for a second service period.

***Figure 1**: Mooring pole Zwartsluis/Netherlands*

Because strength properties of the wood can be seriously affected by biological degradation of the wood, therefore in this investigation the wood quality has been assessed with respect to biological durability and mechanical properties.

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2 MATERIAL AND METHOD

2.1 MATERIAL

The mooring pole be investigated, had been in service for 40 years, exposed to harsh conditions in Dutch waters. That pole was considered for replacement. The wood basralocus (*Dicorynia guianensis*) originated from Suriname is assigned to durability class 2 according to EN 350-2 [2]. The pole had a cross section of 0.32×0.32 m^2 and a length of 18 m. For investigation the pole had been cut into sections considering the air, water and soil zone. Visually most decayed zone was the water-air line. Furthermore the cross section of the pole had been divided in different zones of heart- and sapwood along the radial direction, because after the service period a wider spread of wood quality was expected.

2.2 METHODS

The natural durability of the pole has been assessed by 2 different tests, a standard method according the Technical Specification CEN/TS 15083-1 [3] and an accelerated method, originally developed by Bravery [4]. The first test method was used to determine the durability class of the basralocus pole. The second one was used to investigate the 'resistance behaviour' of the test specimens over a longer period up to 41 weeks of exposure to fungi. The basralocus test samples and the reference samples were exposed to two different fungi: the brown rot fungus Coniophora puteana (Schumacher ex Fries) Karsten (BAM Ebw. 15) and the white rot fungus Coriolus versicolor (Linnaeus) Quélet (CTB 863A).

Compression specimens with dimensions 44×44×260 mm^3 were cut from sections of the pole located at different heights, so that they covered all different zones of conditions (air, water, soil). The tests to determine the compression strength ($f_{c,0}$) and the modulus of elasticity in compression parallel to the grain ($E_{c,0}$) have been performed according to the European Standard EN 408 [5]. About 600 samples were prepared for the durability test and 74 for compression tests.

3 RESULTS

3.1 BIOLOGICAL DURABILITY

The highest mass loss registered was 0.9% for the inner heartwood zone, for all the 3 sections, when the samples were subjected to the attack of Coniophora puteana. Also the median mass loss for the heartwood of the whole pole does not exceed 0.9% of mass loss for both fungi. Therefore, the durability class of the timber tested can be assigned to durability class 1 (very durable), according to CEN/TS 15083-1.

During the extended accelerated decay test, the median mass loss of the basralocus test specimens slowly increases up to 1.9% and 3.6% for the brown rot and white rot fungus respectively. Even prolonging the test duration for a remarkably longer period than that commonly used in fungal decay tests, the mass loss recorded was still low enough to classify the tested timber as durability class 1.

3.2 COMPRESSION STRENGTH

The mean values and the standard deviations of the compression strength ($f_{c,0}$) were calculated for the different characteristic zones of the pole. They were found to be (62±5) N/mm^2, (55±8) N/mm^2 and (59±3) N/mm^2, for the air zone, the water-line and the soil-line respectively. The lowest value of $f_{c,0}$ was recorded for a specimen cut from the water-line zone.

The mean strength for the whole pole was 61 N/mm^2 with a standard deviation of 4 N/mm^2. The mean MOE for all specimens was 18 kN/mm^2 with a standard deviation of 1.6 kN/mm^2.

4 CONCLUSION

The results of the decay tests, , showed that the durability class of the pole is 1. Therefore The wood of the pole can still be classified as very durable according to CEN/TS 15083-1, even after 40 years of service as a mooring pole. Relative long exposure of the miniblocks [4] to 2 fungi (up to 41 weeks) revealed that even under optimal conditions for fungal growth, very durable timber species undergo only very slow mass loss, compared with less durable timbers such as beech.

The results of the mechanical tests indicate that the timber after 40 years of service shows no significant strength reduction compared to new material. The results of the compression tests indicate mechanical properties equivalent to at least strength class D60. In comparison to this, the density seems relatively low according to the prEN 338 [6].

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