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SIMULTAN EVALUATION OF WOOD AND COATINGS PERFORMANCE IN OUTDOOR EXPOSURE

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ABSTRACT
The paper refers to the possibility of employing a modified L-joint test to evaluate both the natural durability of wood and the performance of some coating materials in outdoors, above ground applications. Experiments were carried out comparatively on beech (Fagus sylvatica) and fir (Abies alba) wood, untreated and finished with two types of coating materials. The periodical evaluation of the test samples looked at the forms and intensity of biological attack, wood cracking, and coatings performance (adherence, exfoliation, blistering, cracking, mould growing).
The results from 3 successive evaluations, covering a total exposure time of 27 months, allowed a study of the evolution of wood and coatings degradation phenomena, revealed behaviour differences between beech and fir wood and the influence of finishing on wood durability in the conditions of biological hazard class 3.
Wood cracking and discoloration evolved somehow differently for the two wood species. Wood coating with opaque or semi-opaque alkyd based finishing materials reduced wood cracking and staining, but is not sufficient for an efficient wood protection for outdoors exposure
Keywords: L-joint field test, beech, fir, coatings, durability, performance.

1. INTRODUCTION
As a natural, ecological, renewable, relatively low-cost and available, easy to process, strong and low-density, wood continues to be a modern, valuable and extensively used material for constructions. Its utilisation in this field, strongly related to tradition in many parts of the world, comprises structural, non-structural and decorative applications. Maintaining its aesthetical appearance and mechanical strengths are basic quality requirements for wood in these applications. Wood species are different as structure, chemical composition, dimensional stability and natural durability. Consequently, a correct choice of wooden material and application of adequate treatments are very important. Field tests are often employed to offer the necessary data and assist this choice. The paper outlines the possibility of employing a modified L-joint test to evaluate both the natural durability of wood and the influence of finishing on its behaviour outdoors, out of ground contact, under the direct action of climatic factors, conditions corresponding to the biological hazard class 3 (HC 3).

2. MATERIALS AND METHODS
The L-joint test (SR EN 330) is the field test designed to evaluate the performance of wood preservatives to be used with further coating to protect wood in hazard class 3. The L-joint test piece is designed and exposed so that to reproduce the extreme conditions to which exterior joinery may be exposed. L-joints (tenon-mortise joints) actually simulate the bottom corners of a joinery unit with a

low joint quality. They are exposed outdoors, above ground, uncovered (no roof) so that a complex of biotic (bacteria, fungi, insects) and non-biotic factors (UV light, rainwater, humidity and temperature variation) are active as in real service-life. Accordingly, this test also allows determination of natural durability of wood in the conditions of HC 3 and evaluation of coatings performance. A modified L-joint test was employed in this research. Tenon members, representing the actual test samples, were fixed in longer mortise members made of the reference non-durable wood species (beech and pine sapwood) in order to accelerate biodegradation [1]. The assemblies were exposed to the action of climatic factors on a special experimental stand.

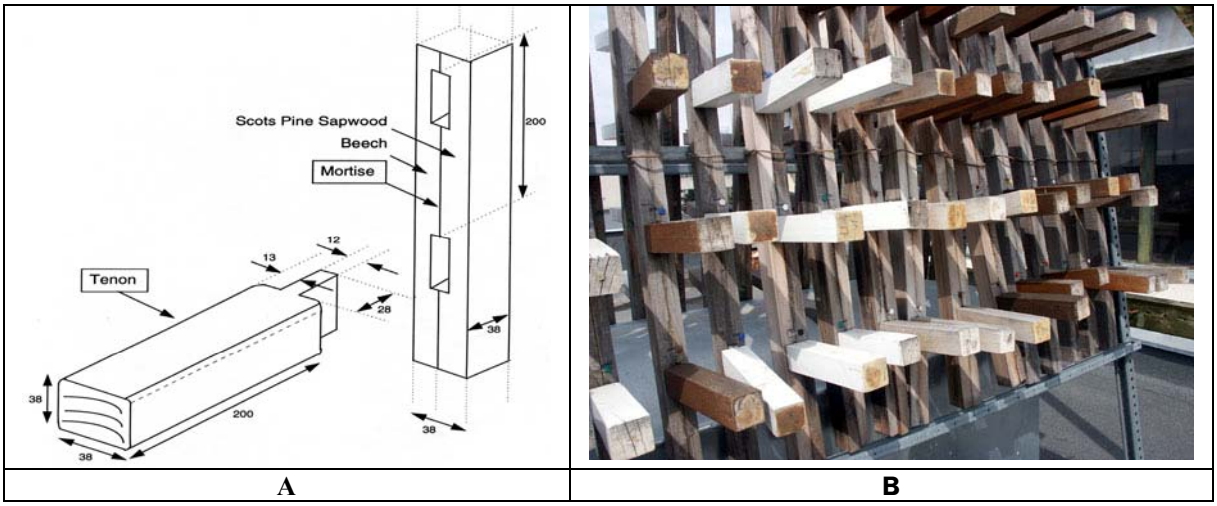

Figure 1 L-joint test specimens according to a modified EN 330 procedure: A. form and dimension of tenon and mortise members; B. exposure in the experimental stand

Experiments were carried out comparatively on beech (Fagus sylvatica) and fir (Abies alba) wood, untreated and finished with two types of coating materials: a dark-brown, semi-transparent alkyd lazure containing biocides (coded S1) and a white opaque alkyd paint (coded S2). The periodical evaluation of the test samples looked at the forms and intensity of biological attack (discolouration, mould growth, decay), wood cracking, and coatings performance (adherence, exfoliation, blistering, cracking, mould growing).
The degree of biological degradation, consisting mostly in discolouration due to mould fungi and blue stain, was appreciated, when detected, on a scale from 1 to 3 (according to prCEN/TS 12037: 2002E, whilst original marking schemes were employed for wood cracking (grades from 0 to 4) and coatings adhesion (grading from 0 to 3), as presented in previous publications [2].

3. RESEARCH RESULTS

Exposure of wood under the conditions of biological hazard class 3 lead to the apparition and evolution of complex degradation phenomena. Degradation evolved in time, so that if only surface cracking and some discolouration were present after 9 months, this situation was completely changed after 27 months when deep wood cracking, extensive discolouration, mould growth and even incipient rot was detected, as exemplified in Figure 2.
Beech and fir wood samples showed some behaviour differences, illustrated in Figure 3. However, these differences were not always in accordance to the theoretical assumptions. For instance, even if fir wood is characterised by a lower density and lower swelling and shrinking coefficients compared to beech wood, the fir samples presented generally more cracks. In contrast, discolouration was more accentuated for beech, as expectable due to its lower natural durability to fungi.
Wood coating improved both cracking resistance and biological resistance, so that less cracking and discolouration characterised all the finished samples. It seems that the two types of finishing materials had the same effect on cracks reduction, though they proved different influence on the discolouration resistance. The experimental data show that the coating material S1 (with biocides) offered a better protection, though no definite conclusion can be drawn taking into consideration the evaluation

difficulties due to the dark colour of this product. However, wood finishing could not offer a full protection of wood in hazard class 3 and could not eliminate the differences between the two species.

Figure 2 Examples of degradation phenomena observed after 27 months exposure

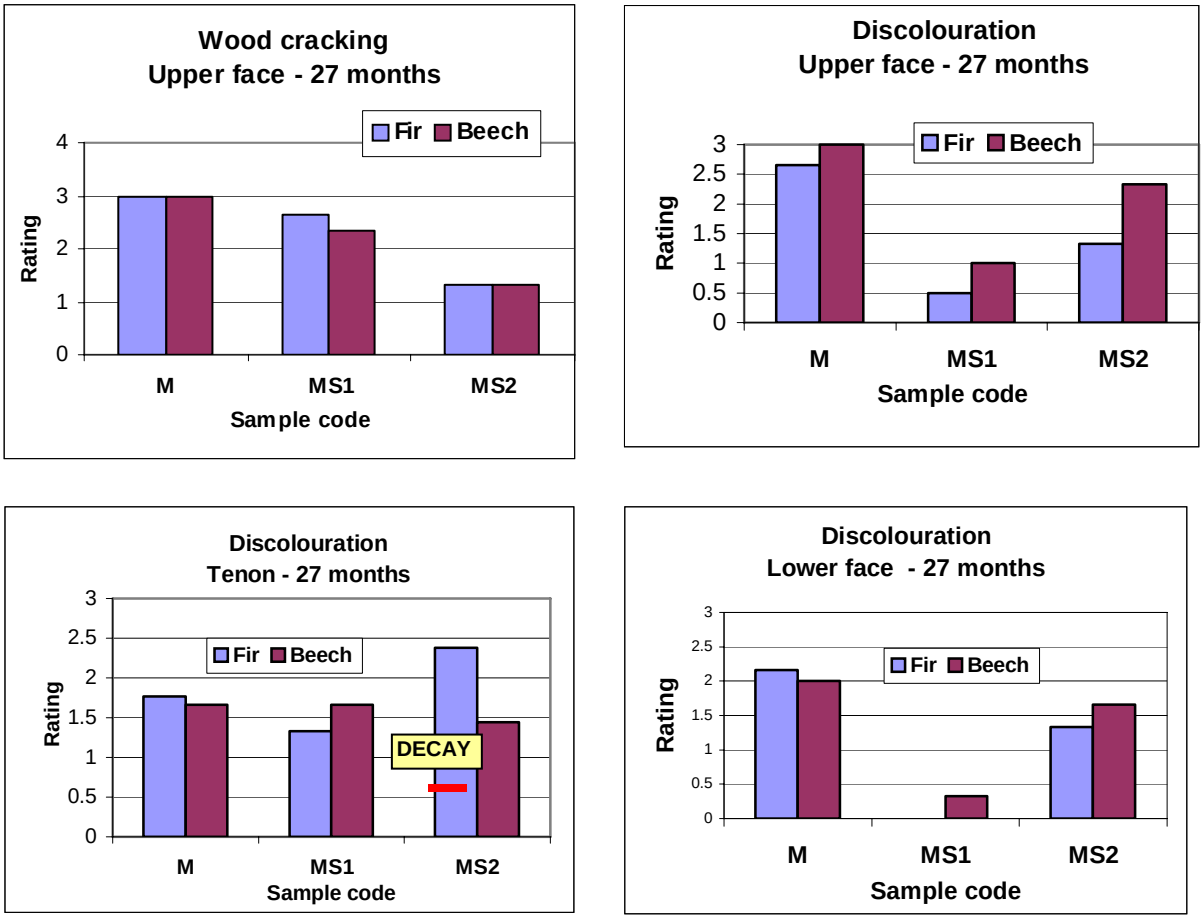

Figure 3 Differences in the behaviour of beech and fir wood after 27 months exposure in HC 3

The evolution of degradation phenomena in time is illustrated by the histograms in Figure 4, referring to cracking and discolouration of the upper faces of test samples after three periods of exposure; 9 months, 16 months and 27 months. It seems that the S1 finishing reduced and slowed down considerably the apparition of discolouration, whilst the S2 finishing was more effective in cracking reduction. None of these finishes presented serious degradation phenomena (adhesion loss, blistering, other degradations) after the 27 months exposure period.

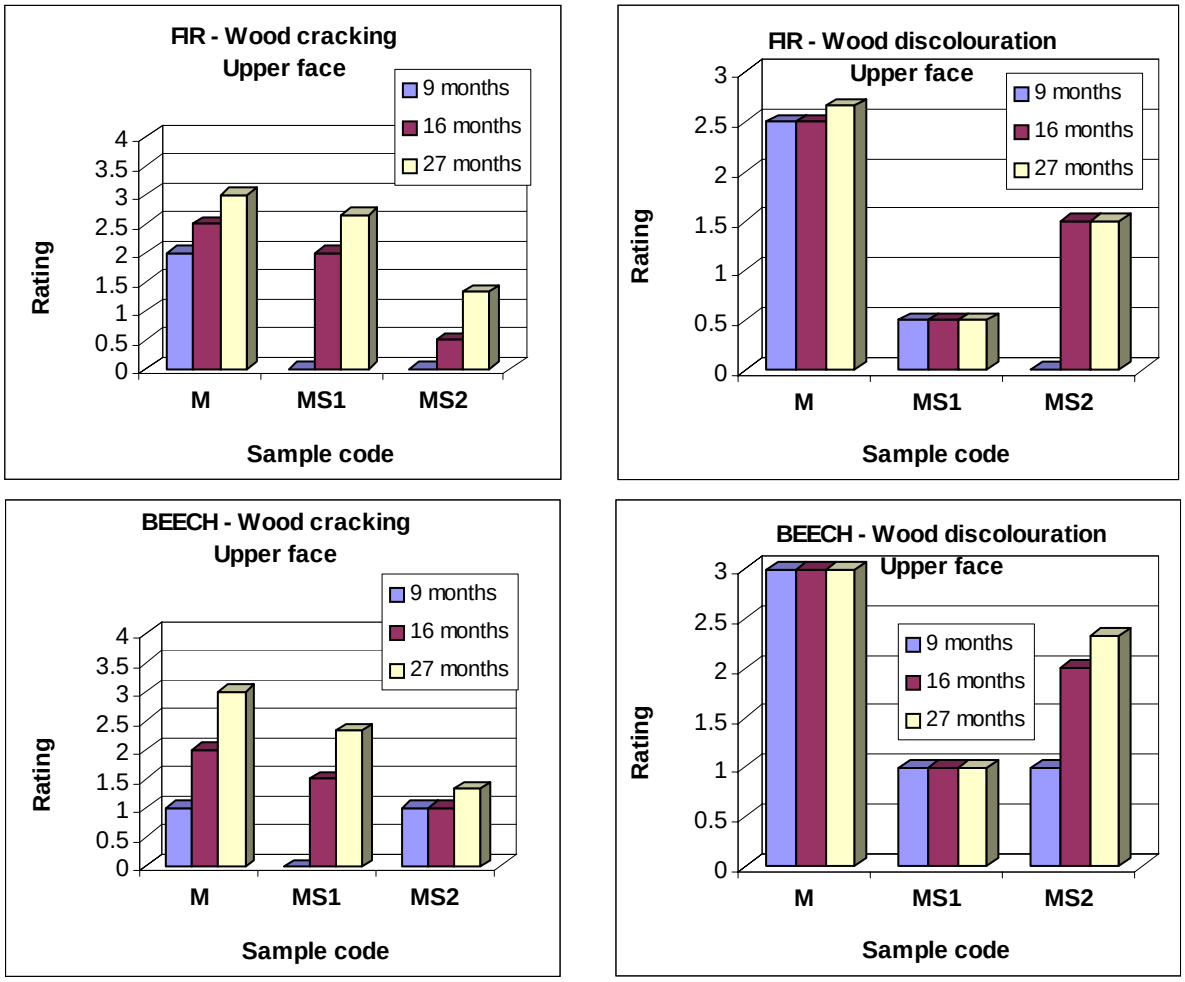

Figure 4 Evolution in time of the wood degradation phenomena

4. CONCLUSIONS

The experimental research in this field clearly highlighted the utility of the employed L-joint test that offered complex information on the wood degradation phenomena in the conditions of HC 3, the influence of wood species and the importance of surface treating procedures. Wood cracking and discoloration evolved somehow differently for the two wood species. Wood coating with opaque or semi-opaque alkyd based finishing materials reduced wood cracking and staining, but is not sufficient for an efficient wood protection for outdoors exposure. Both finishes proved a good performance so far in terms of adhesion to the substrate, integrity of the film and resistance to blistering, though some cracks were present. No definite conclusions can be, however, drown until ending the test after a period of exposure of at least 5 years

5. REFERENCES

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