Performance of Fence Posts Treated with CCB and Creosote After 18 Years Exposure in Greece

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ABSTRACT: The effect of 18 years exposure on toughness of CCB and creosote combination treated pine was examined. Vacuum CCB treated fence posts were subsequently treated at their lowest part (ground contact) with creosote using the open hot and cold tank process. After 18 years exposure under warm dry temperate climatic conditions in Greece, samples were taken from the above ground contact, top, middle and ground contact and tested for toughness using a Denison single blow impact bending test machine. There was no significant reduction of toughness in any of these zones. Chemical analysis of the residual CCB of unexposed and exprasedi samples, by ICP showed that copper and chromium losses were insignificant but boron losses were significant but was- more than 50% of the initial. This was attributed to an effect of creosote treatment.

1. INTRODUCTION

Solid wood production in Greece is relatively low and wood consumption has steadily increased for the last 10 years. Expanding the service life of wood in its end uses as well as enhancing the production and proper utilisation of wood for all forest species growing becomes increasingly necessary. Particularly, the demand for preservative treated wood has rapidly increased in past years due to expanding demands of wood for electricity and telecommunication poles, construction of wooden houses and other buildings, green houses, fish-cultivation platforms, fences, railroad sleepers, etc. Forest areas cover 49.3% of the total country area but only about 25.4% are characterised as industrial forests. The annual production of wood from state forests is 2,707,000 nr\ which corresponds to 786,000 m^3 wood for technical use and to 1,921,000 m^3 firewood (Kakaras, 1993). The existing impregnation units m Greece include three creosote plants and thirteen small-scale units treating by full cell vacuum pressure with water-soluble preservatives (CCA-Copper/Chromium/Arsenic, CCB- Copper/Chromium/Boron). About 70,000 m^3 of timber per year are treated with creosote for ground contact applications (electricity and telecommunication poles, railway sleepers, bridges) while about 15,000 m^3 of timber per year are treated with waterbornes for use in ground contact (greenhouses, poles, fences) or above ground (wooden houses, shelters, props) (Kakaras, 1993). It has been estimated that in Greece a total of 4.6 million poles have been impregnated. The annual consumption of electricity and telecommunication poles is about 100,000 poles, treated mainly with creosote although about 2,000-3,000 are treated with waterborne preservatives every year. About 20% of this is imported as untreated timber from Finland, USA, Germany, Russia, and Spain which is treated in Greece.

CCA is the main waterborne preservative in use. However several other formulations including CCB are applied. Although CCB is regarded by some as less eco-toxic than CCA because of the absence of arsenic, it is less effective than CCA because boron leaches to a higher extent than chromium (Homan and Militz, 1993). CCB preservatives have long been considered alternatives to CCA preservatives and are used commercially in Scandinavia and some parts of Western Europe (Tillot and Coggins, 1981; NWPC, 2001)

Several workers have studied the performance of CCB against decay compared with CCA preservatives- It has been reported that in New Zealand at some sites CCB preservatives (pine sapwood) showed good performance, similar to CCA, but at sites where there is a prevalence of copper-tolerant brown rot fungi CCB failed to achieve protection (Wakeling, 1991). Similar results have been presented from a comparative study between CCB and CCA preservatives in Malaysia (Salamah, 1993). Hedley (1992) showed that CCB preservative formulations performed as well as CCA at sites where soft rot predominated or where no particular decay type was dominant. However, CCB is less effective than CCA at sites where copper tolerant brown rot fungi comprise the fungal flora (Gray and Dickinson, 1982; Tamblyn and Levy, 1981). Additionally it seems that wood species play an important role for the performance of CCB in soft rot decay sites. Hedley (1992) showed that in sites where no particular type of decay dominates the performance of CCB in beech is superior to CCA. Gray and Dickinson (1983) concluded that CCB shows better performance than CCA against soft rot decay fungi because greater amounts of copper are absorbed during treatment. Koch *et al* (1991) suggested that CCB preservatives should be used only in applications that there is not very high risk of leaching.

From the literature review is apparent that CCB may be used as an alternative to CCA if its effectiveness against copper tolerant brown rot fungi and boron resistance to leaching were improved. Climatic conditions have a significant impact on the performance of CCB. In addition it is generally accepted that soil type and other physical factors, such as climate, affect the decay hazard to preservative treated wood in ground contact (Wakeling, 1991). In sites were temperate climatic conditions with long "dry season" are predominant preservative chemicals such as CCA may be replaced by CCB. In this study the performance of a preservative combination of CCB and creosote after 18 years of exposure was examined.

2. EXPERIMENTAL

2.1. Wood impregnation

Impregnation of wood full cell impregnation of Scots pine *{Pinus sylvestris)* posts was carried out with the water soluble preservative CCB (Copper/Chromium/Boron) to achieve final retention of 2% m/m (i.e about 9 kg $m^{"1}$) at the State Wood Industry facility at Kalambaka, Greece. After treatment the samples were allowed to dry slowly to achieve preservative fixation. Posts were then treated with creosote at their lowest part (ground contact zone) using the open hot and cold tank method.

2.2. Exposure and mechanical testing

Exposure and mechanical testing of wood treated posts were exposed in ground contact under warm temperate climatic conditions in Greece. After 18 years' exposure, posts were removed and samples (300 x 20 x 20 mm) were taken from three different zones of the posts: the top, mid-way between the ground contact line and the top and from the ground contact line, both from the surfaces and from the sample cores, i.e. six samples were taken from each post. Six exposed and six unexposed posts were used giving a total of 72 samples. Samples were then tested for toughness using a Denison single blow impact bending test machine and mean values were calculated and compared with the unexposed. Analysis of Variance ($p=0.05$) and Tukey's pairwise comparisons were applied to identify variances.

2.3. Residual preservative analysis

After mechanical testing samples were analysed for their residual CCB contents. Cross sections 20 mm thick were cut from the ground contact zone ana the mid-post out of ground contact zone used above for mechanical testing. Weighed wood blocks were then ground and chemical analysis was performed to evaluated the preservative losses. Wood digestion was performed according to AWPA A 7-93 method 5 (nitric acid and hydrogen peroxide) and solutions were analysed for Cu, Cr and B by inductively coupled plasma (ICP).

2 4 Climatic conditions

The average monthly temperature and rain precipitation were recorded for 18 years and an ombrotherrmc diagram showing the period of the dry season in the exposure site (Figure 1) was drawn.

3. RESULTS AND DISCUSSION

3.1. Climatic conditions

The dry period at the exposure site was about 5 months (May-October), as depicted in Figure 1. The long dry period resulted in reduction of fungal activity.

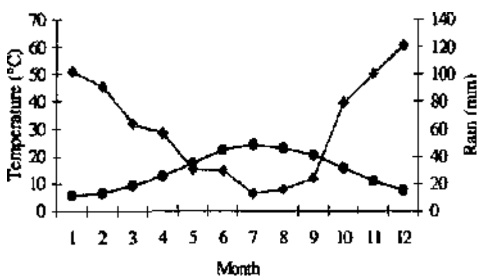

Figure 1. Ombrotherrmc diagram: Mean temperature of air (•), Mean annual precipitation (•). The period that the latter is below the former denotes the dry season

3.2. Exposure and mechanical testing

Visual examination of the external and internal condition of the treated samples showed that the samples were apparently internally sound. The effect of 18 years exposure on toughness is shown in Figure 2, where the core values are compared to the surface values. It is apparent that there was no significant reduction of toughness between the exposed and unexposed samples for all zones tested. This was possibly attnbuted to the fortification effect of creosote treatment.

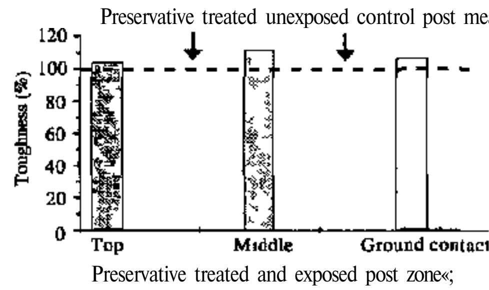

Figure 2. The effect of 18 years exposure on toughness of treated pine fence posts.

3.3. Residual preservative analysis

Analytical results of the residual loadings of CCB (Table 1) show minor apparent gains m copper and chromium in both zones analysed with less apparent gain at the ground-line. The minor gain is probably a result of sample treatment differences. For example the differences between the ground -line and mid zones are as much as 9% even in the unexposed samples. The major effect noticeable is the loss of Boron, about half of which has been lost This is somewhat less than that reported for a similar period (18 years) in New Zealand by Hedley (1992) for single treatments of waterbornes. It is likely that this is due to combination of the drier exposure environment and the creosote dip treatment.

Table 1. Analytical values of CCB components at different zones of exposed and unexposed wood samples. (Standard deviations in parentheses)

Treatment	Post zone	Cu (m/m)	B (m/m)	Cr (m/m)
Exposed	Ground-line	0 188 (004)	0 014 (0005)	0 258 (0 06)
	Middle	0 185 (0 05)	0021 (0 008)	0 250 (0 04)
Unexpose 11	Ground-line	0 175 (004)	0029 (0007)	0 21T (005)
	Middle	0 162 (005)	0 017 (0011)	02H (0 06)
Element Loss	G round-line	*-1*	51.7	-107
	Middle	14	43.2	148

4. CONCLUSIONS

Posts dual-treated with CCB and creosote showed excellent performance after 18 years exposure Very little work has been done on the fungi causing wood decay under Greek and other Mediterranean countries climatic conditions and there is very little information referring to the natural durability of Greek wood species In addition European standards based on Northern European conditions ol wet conditions may overestimate the amount ot preservative required for adequate performance under these drier conditions European standards referring to wood preservation should take into account the local climatic conditions in the south Mediterranean zone because the dry period is very long and this itself has an inhibitory effect on fungal growth Therefore hazard class 3 and hazard class 4 might require lower amount of preservative than this used for the same hazard classes m the North Europe, at least for control against fungal attack

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