Outdoor weathering of impregnated and steamed black locust

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ABSTRACT

The effect of outdoor weathering has been studied on treated and untreated black locust with colorimetry and the results have been given in CIELAB colour co-ordinate system. A part of the samples were impregnated with water born CONSOLAN and solvent born SANDOLIN dispersion for outdoor use. While some of samples were finished by BIRDY natural wax plus UV filter for outdoor finishing and this coating was applied with the combination of BIRDY natural oil for impregnation, and steamed black locust was also chosen. For comparison nontreated black locust and oak samples were used. All of samples were exposed to natural weather in Sopron (Hungary) from August 1997 to October 1998.
All of specimens changed their colour in the sunny August towards red considerably and the nonfinished ones towards yellow as well. During the rainy autumn the samples lost their yellow and red colours considerably. The rain leached out the cromophore degradation products. The colour points shifted towards grey. This tendency continued during the whole treating period. In winter time the velocity of change was slow. The visible colour of nonfinished samples (oak, black locust and steamed black locust) became equal grey during the year of exposure. The steamed black locust suffered the greatest colour change. The only exception was the SANDOLIN coating its colour was stable against weathering.

Keywords: black locust, weathering, colour change, robinetin, steaming

INTRODUCTION

For maintaining and extending the important role that black locust (Robinia pseudoacacia) can play as a construction material more knowledge is required about type and magnitude of changes in surface quality under outdoor weathering exposure. In order to preserve surface quality over longer periods of time it is to protect wooden substrates against the influence of sunlight and rain by structural design and/or surface finishing by coating. For this purpose an international COPERNICUS Project* was designed. In this INCO-COPERNICUS Project the changes of surface roughness and of colour were determined under continental climate conditions in Sopron (Hungary) and in Hamburg under maritime climate. In this report the results of colour changes measured in Sopron are presented.
The widely used outdoor construction material the oak wood was chosen as a standard. The excellent resistance properties of oak wood against weathering are well known. So we were able to estimate the durability of black locust wood compared to the oak wood.
The water permeability of black locust wood is very low. Its lumens are full with tyloses blocking the liquid movement. So the penetration of coatings into wood is very limited. That is why the effectiveness of the outdoor widely used surface treatment finishes is questionable in the case of black locust. In this study four selected finishes for outdoor use were tested.

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MATERIALS AND METHODS

The test specimens of black locust (natural and steamed) and of oak were cut to the dimensions of 1015x135x25 mm^3. The surfaces were planned by a machine planner. One part of natural black locust samples were coated by the outdoor used finishes listed in Table 1.

Table 1: Data of the applied surface treatments.

Name	Layers	Code (in Figures)	Colour
CONSOLAN (water-born dispersion)	2	cons	Oak 510
SANDOLIN (solvent-born dispersion)	2	sand	Cherry wood 88
BIRDY Natural wax +UV filter	2	bird	Oak (light)
BIRDY Natural oil for impregnation +BIRDY wax with UV filter	1+2	o+b	Colourless+Oak(light)

The exposure test specimens were put in outdoor racks facing towards south with the angle of 30^o to the vertical direction. The exposure was interrupted monthly to determine the colour change. Before colour measurement the specimens were stored in laboratory temperature and humid condition for two days. This drying process was enough to produce measurable dry surface.

The colour measurements were conducted with a MINOLTA 2002 colorimeter. the reflection spectrum was measured in the 400-700 nm region. From these data the L*, a*, b* colour co-ordinates were calculated based on the D65 light source. Colour measurements were taken at 10 randomly chosen spots for each specimen and the results were used for further analyses.

RESULTS

During the natural weathering the change of the CIE-L*a*b* colour co-ordinates were determined to describe the colour changes for untreated block locust, oak, steamed black locust and coated black locust. The actual colour of the samples was measured monthly beginning August, 1997 for a year followed by 2-months period of measuring. In this report the data of 14 month exposure are presented.

The colour changes (changes in house) are plotted in Figure 1 and in Figure 2. During the first month of exposure, the untreated and the vax treated black locust specimens suffered considerable colour changes towards red (increasing a* values). During this period the steamed black locust and the oak samples had moderate colour changes. The consolan coated specimens partly lost their yellow colour and gained red colour.

The sadolin surface treatment was stable against both sunlight and rain. There was no considerable colour change during the whole treating period. Thus the statements below are not relevant to sadolin treated samples.

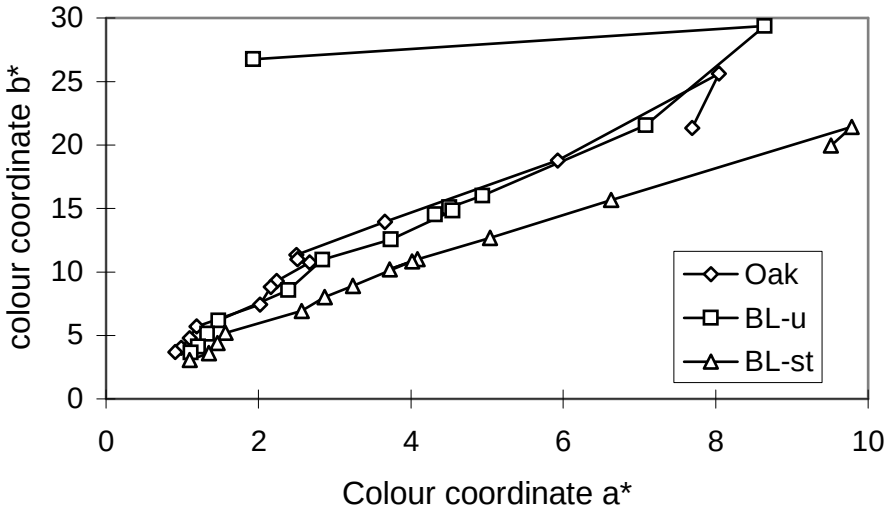

Figure 1:.Colour changes of specimens exposed to natural weathering during 14 month period (BL-u = black locust untreated, BL-st = black locust steamed)

After the first month of exposure the hue of the samples decreased continuously. This tendency was interrupted only at the middle of winter. At the end of the 14 months period, the untreated samples lost they hue completely and became grey. These specimens were equal grey for necked eyes. The outcoming fibres from the surface of the boards were liberated by the degradation and these parts were bitten by wasps and used for making their nests.
At the end of the 14 months period the surface of the treated samples (except sadolin treatment) was stained. From these areas the coating was partly or completely missing.

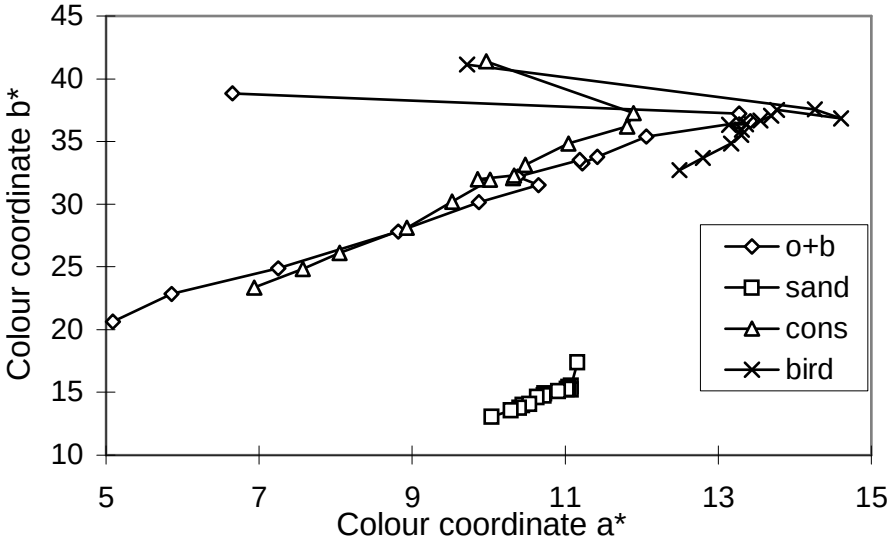

Figure 2:.Colour changes of coated black locust specimens exposed to natural metering during 14 month period (for abbreviations see Table 1)

DISCUSSION

During the first month of exposure a more or less step increase of yellow (b*) component was observed in the case of nontreated samples and in contrast there was a decrease of b* of treated samples. This change was accompanied by an intensification of the red (a*) component. There was sunshine but no rain in this period. The yellowing tendency (increasing b* value) of natural wood surfaces is well known result of sunshine irradiation. Our applied surface treatments were able to prevent the wood surface against this yellowing effect.

In the case of natural black locust and treated black locust surfaces the shift towards red was much greater than in the case of other specimens such as oak and steamed black locust. This is due to the high robinetin content of black locust wood. Robinetin is sensitive both to UV light and heat as well. For steamed black locust, the change of cromofore robinetin has already occurred during steaming, that is why the colour of this samples hardly altered during UV irradiation. The intensive colour change of treated samples towards red confirm the applied surface treatments were not able to prevent the degradation of robinetin.

In autumn the specimens started to turn grey. The rain continuously leached all the coloured degradation product regardless of how they were formed. The oil + vax and the consolan surface treatments were not able to impede the leaching process at all. The surface treatments have also suffered degradation. At the end of 14 months exposure, the rain washed out not only the UV degradation products of lignin but all of the coloured water-soluble extractives from the surface layer. Practically only the pure colourless cellulose, represented by grey colour, remained in the outermost layers regardless of the type of wood species (Figure 1.). The steamed samples have also lost their brown colour during the weathering period. So the steaming is not an effective colour modification process for outdoor use. The other disadvantage of steaming is that the excellent resistance of black locust wood against fungi decreases considerably during steaming.

During the exposure the colour of the surface of the treated specimens became inhomogeneous, some areas became lighter so the treating material has also suffered degradation. The BIRDY Natural oil prevented the BIRDY wax from penetrating into wood, so the rain leached out it. This combination was not effective for preservation of black locust wood

For conclusion, in terms of colour changes, the degradation of natural or steamed black locust during an outdoor exposure were similar to the degradation of oak. It means that the outdoor weathering properties of black locust wood are similar to the properties of oak. So the black locust wood can be a material which substitutes the oak wood in outdoor use. Beside of the applied treatments only the sadolin was effective to protect the wood against natural weathering.