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Weathering resistance of fire-retardant coatings on façade claddings made of selected exotic wood species. Part 3: Aesthetic-decorative features and adhesion

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Abstract: *Weathering resistance of fire-retardant coatings on façade claddings made of selected exotic wood species. Part 3: Aesthetic-decorative features and adhesion.* This article presents the results of research on weathering changes of external appearance, gloss, colour and adhesion of fire-resistant coatings applied on selected species of exotic wood used in façade claddings. The tested solutions have shown significant variations, strictly associated with the wood species, among the permanent aesthetic-decorative features and adhesion.

Key words: *weathering resistance, fire-retardant coatings, exterior conditions, exotic wood species, artificial weathering, natural weathering, aesthetic-decorative features*

INTRODUCTION

Temperate climate poses a significant challenge in ensuring the proper life of wood façade claddings directly exposed to weathering [3, 4]. This is due to incomparably higher frequency of weather changes, as compared to other geographic zones. Additionally, it must be emphasised that resistance to weathering should not only be considered in the aspect of the long-term fire protection, but also in the context of maintaining high aesthetics of the façade finish.

The aspect of losing the fire-retardant qualities by the wood fire-retardant treatment is an issue raised by many research teams [1, 2]. At the same time, the accompanying changes of the aesthetic-decorative features are rarely considered in the research works.

RESEARCH MATERIAL

Tests covered three species of wood from façade claddings currently available on the market: red cedar (*Thuja plicata* Donn. ex D. Don), Siberian larch (*Larix sibirica*) and okoume (*Aucoumea klaineana* Pierre).

The tests were made using two fire-retardant coatings designed for fire-retardant treatment and decorative finish of wood used in outdoor applications. For the research needs they were marked with the symbols K and S. The K coating is a one-component, water-soluble varnish based on polyurethane and acrylic resins. The S coating is a one-component, colourless, solvent-based varnish, made of alkyd resins.

6 test series were prepared: KC and SC – K and S varnishes, respectively, applied onto the red cedar wood, KM and SM – K and S varnishes applied onto the Siberian larch wood, KO and SO – K and S varnishes on the okoume wood. Detailed information on preparation of the research materials is provided in part 2 of the article.

The K varnish created a coating in the declared pine colour, semi-transparent, partially revealing the wood pattern. The S varnish gave a colourless, fully transparent coating.

TEST METHODS AND RESULTS

The research materials were exposed to weathering processes in artificial and natural conditions, acc. to PN-EN 927-6. Detailed information on the exposures is provided in part 2 of the article. Evaluation of the aesthetic-decorative qualities of the coatings was made according to the results of the external look verification (cracking acc. to PN-EN ISO 4626-2, flaking acc. to PN-EN ISO 4626-4, and blistering acc. to PN-EN ISO 4626-5), gloss acc. to PN-EN ISO 2813 (at 60°) and colour acc. to PN ISO 7724−1, −2, and −3 (using the measurement geometry: d/8, 10°, D65, without gloss trap). Also adhesion of the wood coatings was tested acc. to PN-EN ISO 2409.

Results of the external look verification are presented in table 1. Appearance of the selected samples is shown in photographs 1a÷1d.

Table 1. Changes in appearance

Series	Exposure	Defects		
		degree of blistering	degree of cracking	degree of flaking
KC	–	0(S0)	0(S0)	0(S0)
	natural weathering	0(S0)	0(S0)	0(S0)
	artificial weathering	0(S0)	4(S3)c	0(S0)
SC	–	0(S0)	0(S0)	0(S0)
	natural weathering	0(S0)	0(S0)	0(S0)
	artificial weathering	0(S0)	3(S5)b	5(S5)b
KM	–	0(S0)	0(S0)	0(S0)
	natural weathering	0(S0)	0(S0)	0(S0)
	artificial weathering	3(S3)	3(S4)c	0(S0)
SM	–	0(S0)	0(S0)	0(S0)
	natural weathering	0(S0)	0(S0)	0(S0)
	artificial weathering	0(S0)	2(S5)c	4(S5)b
KO	–	0(S0)	0(S0)	0(S0)
	natural weathering	0(S0)	0(S0)	0(S0)
	artificial weathering	0(S0)	0(S0)	0(S0)
SO	–	0(S0)	0(S0)	0(S0)
	natural weathering	0(S0)	0(S0)	0(S0)
	artificial weathering	0(S0)	0(S0)	0(S0)

1a) KM2/6 sample

1b) SC2/8 sample

1c) SM3/9 sample

1d) SO3/10 sample

Photo 1. Appearance of the coatings on selected samples after 6 weeks of artificial weathering

Analysis of the above data shows that 6 weeks of exposure to artificial weathering caused significant changes in the external look of the fire-retardant coatings, both in the K and S varnishes, especially on the red cedar and Siberian larch woods. Numerous and extensive cracks were observed. In the case of

the S varnish coatings, these were accompanied by flaking, while in the KM series also blistering was visible. The same treatment exposed to weathering in natural conditions did not show any signs of change in appearance. The coatings on the okoume wood were not damaged, regardless of the type of exposure.

Diagram 1 shows results of adhesion of coatings to wood. Analysing the data allows to conclude that changes in appearance were accompanied by reduction of adhesion, from the highest degree of 0 to the degrees from 3 to 5 in the case of artificial exposure, and from 1 to 3 in natural exposure. The lowest adhesion, corresponding to degree 5, characterises the S varnish coatings applied onto the red cedar and Siberian larch woods, exposed to accelerated weathering.

Diagram 2 shows the coating gloss values. The degree of gloss of the coatings, which had been matt before the exposure, was only slightly affected.

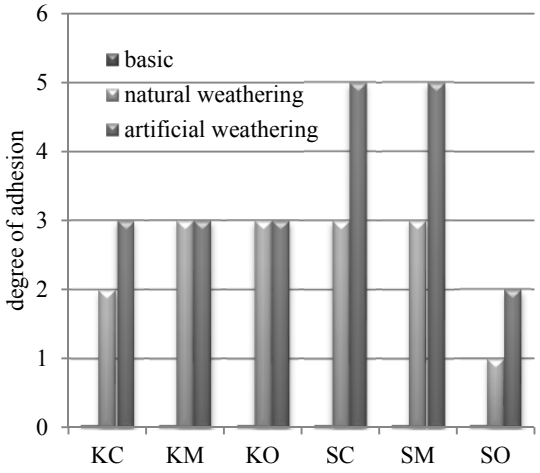

Diagram 1. Change of coating adhesion

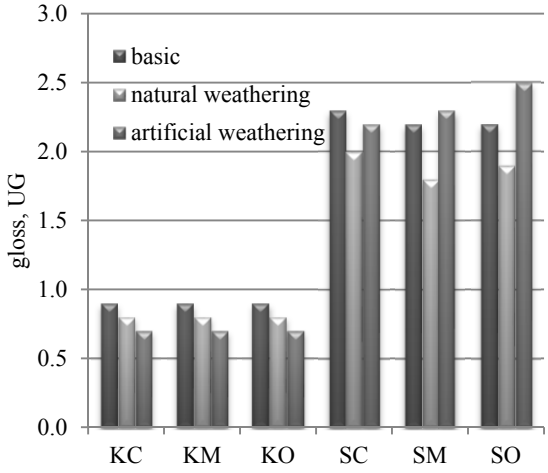

Diagram 2. Change of coating gloss

Results of measurements of the coating colour coordinates L*, a*, b* are shown in diagrams 3-5. Values of colour change calculated based on the coordinates are shown in diagram 6.

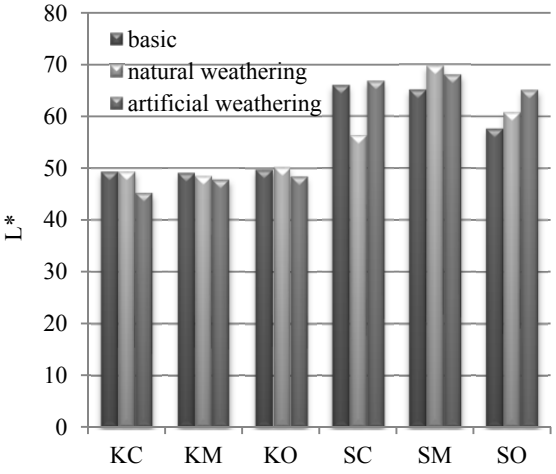

Diagram 3. Change of colour coordinate L*

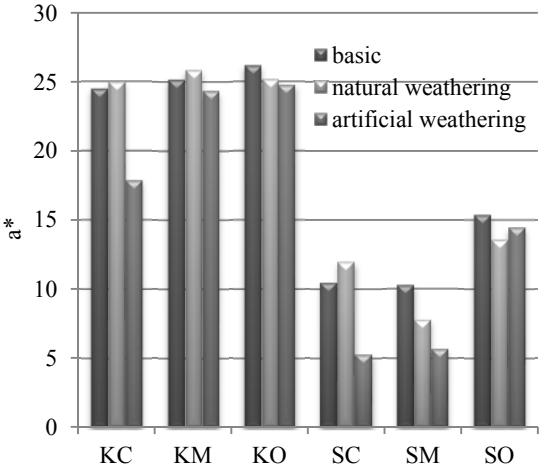

Diagram 4. Change of colour coordinate a*

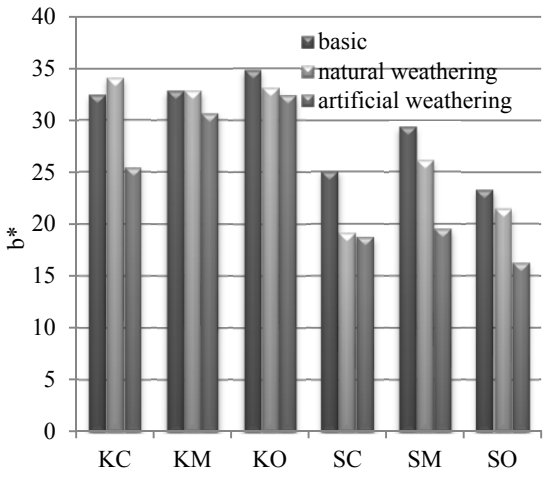

Diagram 5. Change of colour coordinate b*

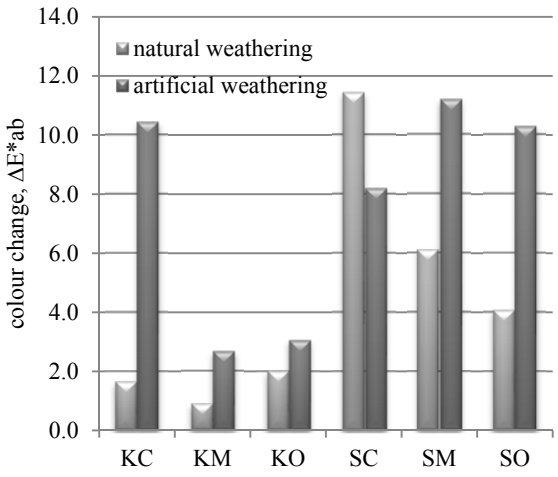

Diagram 5. Change of coating colour

Colour of the semi-transparent coatings made of K varnish changed slightly, towards darker shades. Much more significant was the change of the S varnish protective coating colour, which became lighter. Also a reduction of the colour coordinate a*, which is responsible for the contribution of the red colour, was observed. Values of the coordinate b* were also reduced, indicating a reduced index of the yellow colour. Generally, larger changes of colour were observed in the case of exposure to artificial weathering. The sole exception was the S coating on cedar wood.

CONCLUSIONS

Results of the completed tests indicate significant variation, strictly associated with the wood species, of durability of the aesthetic-decorative qualities of fire-retardant coatings. Exposures to artificial weathering conditions, in the case of the solvent based varnish coating on red cedar wood and coatings made of both the tested types of varnish applied onto the Siberian larch, caused a loss of adhesion and deterioration of aesthetic-decorative qualities. Exposure to natural conditions did not have such a strong impact on the qualities of the fire-retardant coatings, however, it must be noted that the results covered the initial, six-month period of exposure. The fire-retardant coatings on okoume wood maintained their properties.

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Streszczenie: *Odporność powłok ogniochronnych na drewnie wybranych gatunków egzotycznych, stosowanym w elewacjach, na wpływ czynników środowiskowych. Cz. 3. Cechy estetyczno-dekoracyjne i adhezja.* W artykule zaprezentowano rezultaty badań nad zmianami, pod wpływem czynników środowiskowych, wyglądu zewnętrznego, połysku, barwy i adhezji powłok z lakierów ogniochronnych aplikowanych na wybranych gatunkach drewna egzotycznego, stosowanego do wykonywania okładzin elewacyjnych. Testowane rozwiązania wykazały istotnie zróżnicowaną, ściśle związaną z gatunkiem drewna, stałość cech estetyczno-dekoracyjnych i przyczepność.

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