Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 86, 2014:231-234
(Ann. WULS - SGGW, For. and Wood Technol. 86, 2014)

Weathering resistance of fire-retardant coatings on façade claddings made of selected exotic wood species. Part 2: Fire performance

ANDRZEJ KOLBRECKI[1)], EWA SUDOŁ[2)]

[1)] Building Research Institute, Fire Department
[2)] Building Research Institute, Building Structures Department

Abstract: *Weathering resistance of fire-retardant coatings on façade claddings made of selected exotic wood species. Part 2. Fire performance.* This paper presents results of reaction to fire performance of solid wood after fire retardant treatment using two different surface active products. Also durability of fire performance after weathering is assessed.

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

INTRODUCTION

The loss of fire performance under the influence of environmental conditions is an issue raised by a number of research teams. According to Őstman i Tsandaridis [4] deterioration in fire performance of protective coatings for wood and woodbased products takes place in two ways. The first consists in the migration of the fire-retardant substance inside the wood and salt crystallization on the wood surface. Such behaviour may be caused by high moisture content in the wood subject to high relative humidity. The second mechanism by which the wood loses fire-retardant properties consists in flushing out the retardant from the secured product. As demonstrated, action of high relative humidity results in reduced product mass and deteriorated fire-protection properties. Consequently, loss of mass of protected wood during exposure to environmental conditions may be a factor describing the sustainability of properties when it comes to reaction to fire. Samples for testing were subject to environmental conditions, both with the use of selected accelerated weathering methods in accordance with ASTM D 2898-94 [6], Nordtest Method NT Fire 053 [7], as well as natural action. Finding the correlation between the accelerated weathering and natural action requires, however, a high number of tests to be carried out.

Mehaffey et al. [1] demonstrated that the tests of reaction to fire carried out by existing methods may not be fully comparable. For this reason, the correlation tests between the results from different test methods are necessary. Such correlations have been presented by Papis [3] and Steen-Hansen and Kristoffersen team [5]. The Hakkarainen and Mikkola team [1] optimized the models stipulating the fire reaction class as per PN-EN 13501−1 [9] based on the data from the fire reaction tests with the use of a cone calorimeter for wood products. Thus, small-scale tests can be used to anticipate the reaction of fireproofed wood to fire, i.e. potential application.

In this study, durability of fireproofing coatings, taking into account environmental conditions, has been determined by comparing fire reaction tests as per ISO 5660-1 [8] for a series of weathered and non-weathered samples.

The fireproofing may be considered durable if the test results for weathered samples meet the criteria set out in table 1.

Table 1. Fireproofing durability criteria for construction products (except floors)

Property	Criterion
Heat release rate	HRR ≤ 60 kW/m^2
THR_{1200s}	Not more than 20% higher than the results before weathering cycles

TESTED MATERIAL

The tests were conducted for three species of wood selected from the facade cladding materials currently available on the market: Red Cedar (*Thuja plicata* Donn. ex D. Don), Siberian Larch (*Larix sibirica*) and Okoume (*Aucoumea klaineana* Pierre). Façade cladding planks were bought and cut into samples sized 15÷19×300×75 mm. The wood was selected based on its quality properties. Only the elements without defects were selected. The average wood density was 380 kg/m^3 – Red Cedar, 640 kg/m^3 − Siberian Larch and 390 kg/m^3 – Okoume and the humidity was 12±2 %.

The tests covered two fireproofing coating compounds intended for fireproofing and decorative finishing of wood for outdoor applications. For the purpose of this study, the compounds were identified as K and S. Compound K is a single-component water-soluble veneer based on polyurethane and acrylic resins. Compound S is a single-component, transparent veneer soluble in organic solvents, based on alkyl resins.

The veneers were applied in laboratory conditions, in three layers, with a brush. The total application rate was 210 g/m^2. 6 testing series were prepared: KC and SC – veneers K and S on Red Cedar wood respectively, KM and SM – veneers K and S on Siberian Larch wood respectively and KO and SO – veneers K and S on Okoume wood respectively. Veneer K formed a coat of the declared pine colour, partially showing the wood texture. Veneer S formed a transparent coat. The thickness of the coats obtained was determined as per PN−EN ISO 2808 with the use of an ultrasound meter and equaled, on average 71 μm − KC, 57 μm – KM, 61 μm – KO, 72 μm – SC, 73 μm – SM i 73 μm – SO.

TEST METHODS

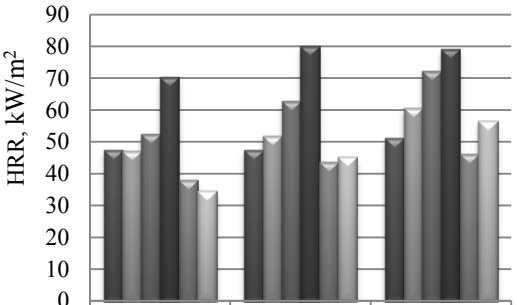
The tested material was exposed to weathering conditions in artificial and natural conditions. The accelerated weathering was carried out in accordance with PN-EN 927-6, with the use of UV Test apparatus equipped with fluorescent lamps as the light source. Six uninterrupted cycles lasting a total of 1008 h were carried out. Each cycle included 24 h of dampening by condensation, at BST of 45±3°C and 168 h of conditions planned as follows: 2.5 h illumination − UVA 340 lamps, light intensity of 0.89 W/m^2 (340 nm), BST 60±3°C and 0.5 h sprinkling with demineralised water, without UV. The weathering in natural conditions was applied in a field location in Warsaw. The samples were arranged horizontally on racks at an angle of 45° with the exposed surface facing the equator. The exposure lasted 6 months, from May to November.

The parameters adopted for analysing fireproofing coating resistance to environmental factors are as follows: heat release rate HRR, total heat release THR_{1200}, time until ignition, effective combustion heat and mass losses.

The tests were carried out in accordance with ISO 5660 - 1. All samples were weathered until constant was achieved in accordance with PN-EN 13238. The samples were placed in a special clamp, directly on the insulation layer made of ceramic fibre. Cone heater power of 50 kW/m^2 was applied. The test took 22 minutes and the average values were calculated for the period of 20 minutes.

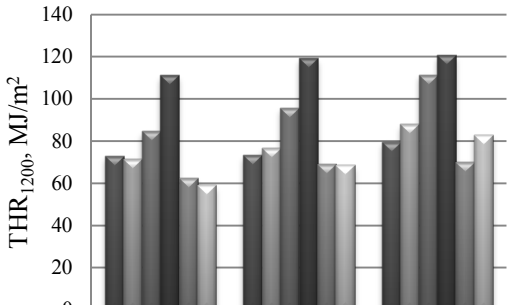
TEST RESULTS

The test results are provided in Charts 1÷5.



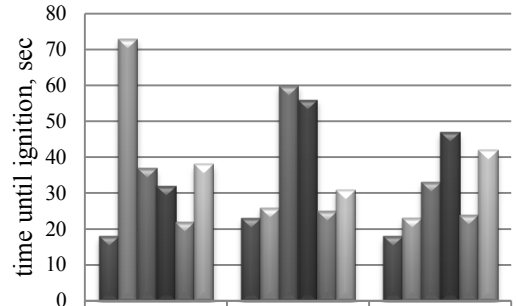
	basic	natural weathering	artificial weathering
KC	47.52	47.58	51.15
SC	47.20	51.92	60.52
KM	52.43	62.83	72.35
SM	70.46	80.16	79.05
KO	37.86	43.64	46.27
SO	34.44	45.21	56.48

Chart 1. HRR Heat release rate



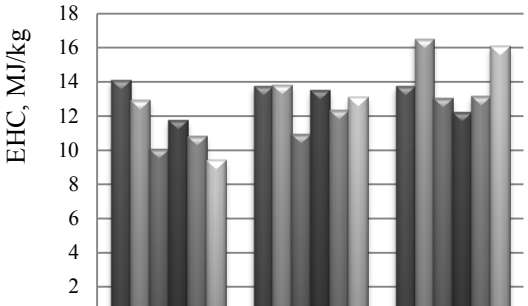
	basic	natural weathering	artificial weathering
KC	72.96	73.35	79.77
SC	71.69	76.71	88.09
KM	84.65	95.77	111.47
SM	111.21	119.19	120.72
KO	62.57	68.98	70.22
SO	58.89	68.67	82.96

Chart 2. Total heat release THR_{1200}



	basic	natural weathering	artificial weathering
KC	18	23	18
SC	73	26	23
KM	37	60	33
SM	32	56	47
KO	22	25	24
SO	38	31	42

Chart 3. Time until ignition



	basic	natural weathering	artificial weathering
KC	14.13	13.78	13.77
SC	12.95	13.85	16.50
KM	10.08	10.98	13.07
SM	11.75	13.52	12.23
KO	10.82	12.38	13.17
SO	9.43	13.10	16.10

Chart 4. Mass loss

The comparison of obtained results with the criteria set out in table 1 leads to the following conclusions:

- the Red Cedar wood does not meet the above criteria in the case of artificial weathering of samples protected with a water-based fireproofing compound,
- the Siberian Larch wood does not meet the criteria set out in table 1 for water-based fireproofing compound both before and after weathering, as well as after weathering samples protected with organic-solvent based compound,
- the Okoume wood maintains stable fire properties irrespective of the method of protection and type of weathering.

CONCLUSIONS

The results of tests conducted point to significantly differentiated durability of fireproofing coating compounds closely related to wood species. Exposure of tests solutions to accelerated weathering in artificial conditions resulted in loss of fireproofing properties for solvent-based veneer applied on Red Cedar and both types of veneer applied on Siberian Larch. Weathering in natural conditions did not significantly change the fireproofing properties in such a significant manner. However, it should be noted that the results from the period of an initial six-month exposure were analysed.

REFERENCES

[1] HAKKARAINEN T. et al: *Tools for developing. Wood based products with improved fire performance*, Interflam 2007;

[2] MEHAFFEY J.R. i et al: *Fire performance of wood-based room lining materials*, Interflam 2007;

[3] PAPIS B.: *Experimental and theoretical verification of SBI and cone calorimeter methods*, statutory study NP 55/07 of the Fire Testing Department of the Building Research Institute;

[4] ŐSTMAN B., TSANDARIDIS L. (2007): *Durability of the reaction to fire performance of FRT wood products in interior and exterior applications*, Interflam 2007;

[5] STEEN-HANSEN A., KRISTOFFERSON B.: *Assessment of fire properties for painted surfaces in escape routes*, Interflam 2007**;**

[6] ASTM D 2898-94 (1999) *Standard Test Method for Accelerated Weathering of Fire−Retardant−Treated Wood for Fire Tests*;

[7] Nordest Method NT Fire 053 (2003): *Accelerated weathering of fire-retardant treated wood for fire tests*;

[8] ISO 5660 *Reaction-to-fire tests – heat release, smoke production an mass loss rate – Part 1: Heat release rate (cone calorimeter method)*;

[9] PN-EN 13501−1 *Fire classification of construction products and building elements. Part 1: Classification based on testing the reaction to fire*;

Streszczenie: *Odporność powłok ogniochronnych na drewnie wybranych gatunków egzotycznych, stosowanym na elewacjach, na wpływ czynników środowiskowych. Cz. 2. Właściwości ogniowe.* W artykule zaprezentowano rezultaty badań właściwości ogniowych drewna zabezpieczonego ogniochronnie przed i po oddziaływaniach środowiskowych.

Corresponding authors:

Andrzej Kolbrecki, Ewa Sudoł
Building Research Institute
e-mail: a.kolbrecki@itb.pl
e-mail: e.sudol@itb.pl