# Service life prediction of low build paint systems for tongue and groove cladding

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SHR

# Outline

- Introduction
- Test setup for accelerated and natural weathering
- Results
- Two step process for high performance medium build coating system
- Outlook

# Hydrophobation

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# Coloured cladding

Concerning the service life life of tongue and groove cladding there is a lack of knowledge about the available (low build) paint systems in the market, the durability thereof and the maintenance needs.

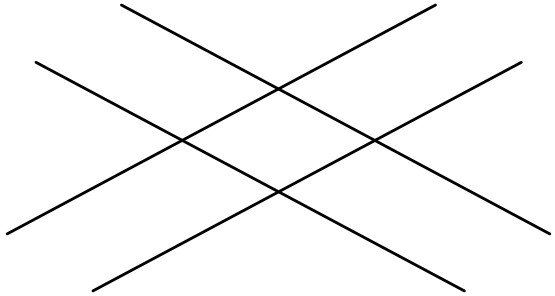
What factors are of importance?

# Test setup

- Seven low and medium build paint systems
- Three different wood species:
  WRC, Spruce and modified Spruce
- Two different qualities: planed and structured
- 12 weeks of artificial weathering EN927-6
- 2 years of natural weathering Southwest orientation
- Tape test derived from SKH publication 05-01
- Visuall assessment for cracking and flaking

# Tape test

According to SKH Publication 05-01, adhesion is tested directly after weighing and on a clean (dried with a tissue) surface. Four cuts are made in the paint systems with the following pattern:



The distances between the cuts is about 1 cm and the angle between the cuts is about 30°. A tape (bond strength of 10N / 25mm) is placed over the cuts, pressed firmly and pulled off after one minute in an angle of 180° in about 1 second time. Adhesion is evaluated according to SKH Publication 05-01. An evaluation of 5 means no adhesion and 0 means excellent adhesion.
With this method it is assumed that the adhesion between the tape and the coating is of such quality that a viable assessment can be made of the adhesion of the coating to the wood.

# Natural weathering (09/2006)

# EN 927-6 for 12 weeks

# 2 years natural weathering

Paint 1
WRC

Paint 1
Impregnated Spruce

Paint 1
Modified Spruce

Paint 2
WRC

Paint 2
Impregnated Spruce

Paint 2
Modified Spruce

# 2 years natural weathering

Paint 3
WRC

Paint 3
Impregnated Spruce

Paint 3
Modified Spruce

Paint 4
WRC

Paint 4
Impregnated Spruce

Paint 4
Modified Spruce

# 2 years natural weathering

Paint 5
WRC

Paint 5
Impregnated Spruce

Paint 5
Modified Spruce

Paint 6
WRC

Paint 6
Impregnated Spruce

Paint 6
Modified Spruce

# 2 years natural weathering

Paint 7
WRC

Paint 7
Impregnated Spruce

Paint 7
Modified Spruce

Reference
WRC

Reference
Impregnated Spruce

Reference
Modified Spruce

# Results for chalking

**Table 1**. Average value for chalking for all samples per paint system after accelerated weathering and natural weathering.

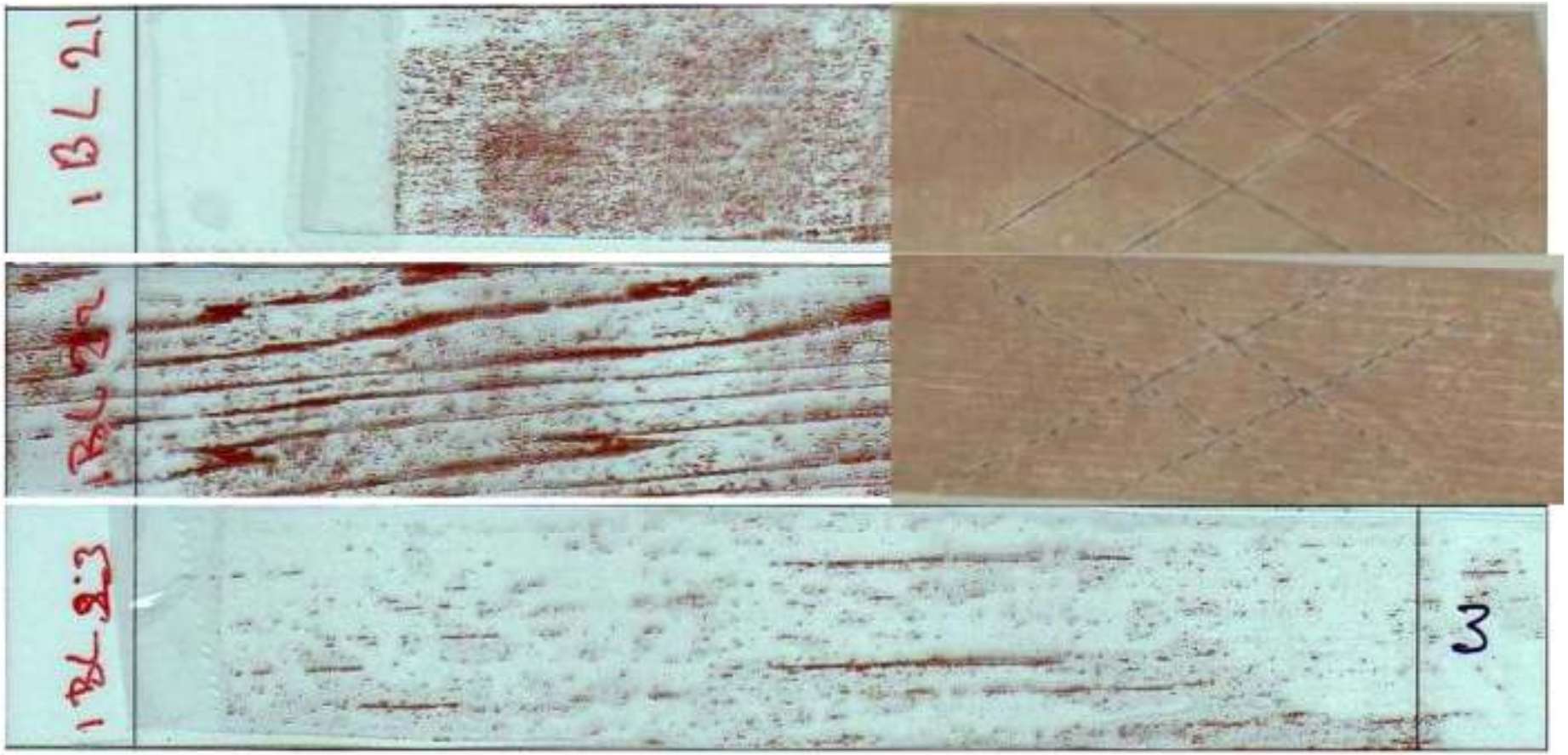
| Paint | Chalking [average value for all samples] Accelerated weathering (12 weeks) | Natural weathering (2 years) |
|---|---|---|
| 1 | 0,0 | 0,5 |
| 2 | 5,0 | 4,6 |
| 3 | 5,0 | 4,9 |
| 4 | 2,3 | 4,3 |
| 5 | 4,3 | 4,3 |
| 6 | 0,0 | 0,2 |
| 7 | 5,0 | 5,0 |

# Results for adhesion

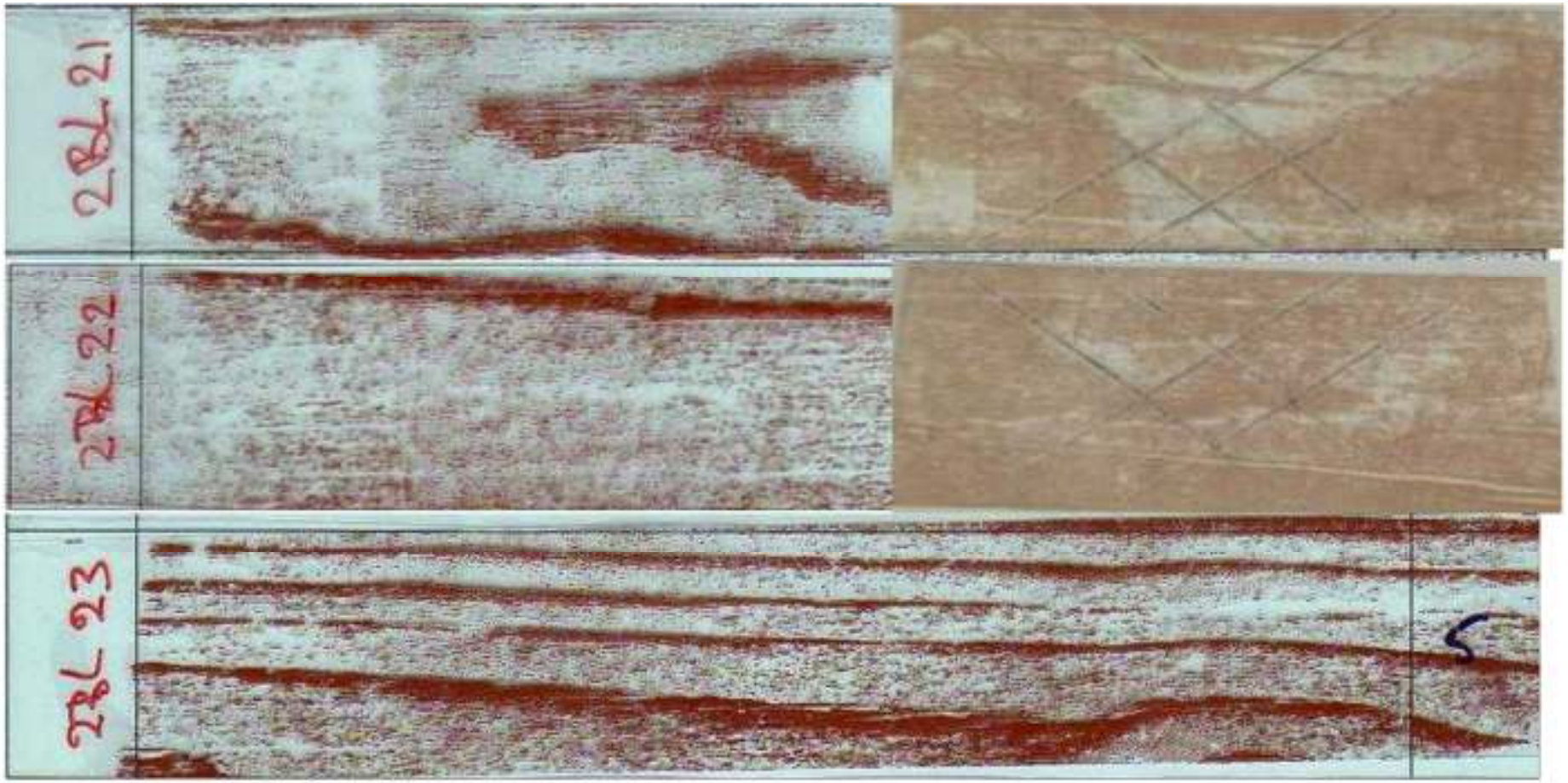
**Table 2**. Average value for adhesion for all samples per paint system after accelerated weathering and natural weathering.

| Paint | Adhesion [average value for all samples] Accelerated weathering (12 weeks) | Natural weathering (2 years) |
|---|---|---|
| 1 | 2,8 | 0,7 |
| 2 | 0,0 | 3,2 |
| 3 | 4,0 | 2,8 |
| 4 | 1,5 | 3,6 |
| 5 | 3,0 | 3,2 |
| 6 | 1,7 | 0,7 |
| 7 | 4,0 | 5,0 |

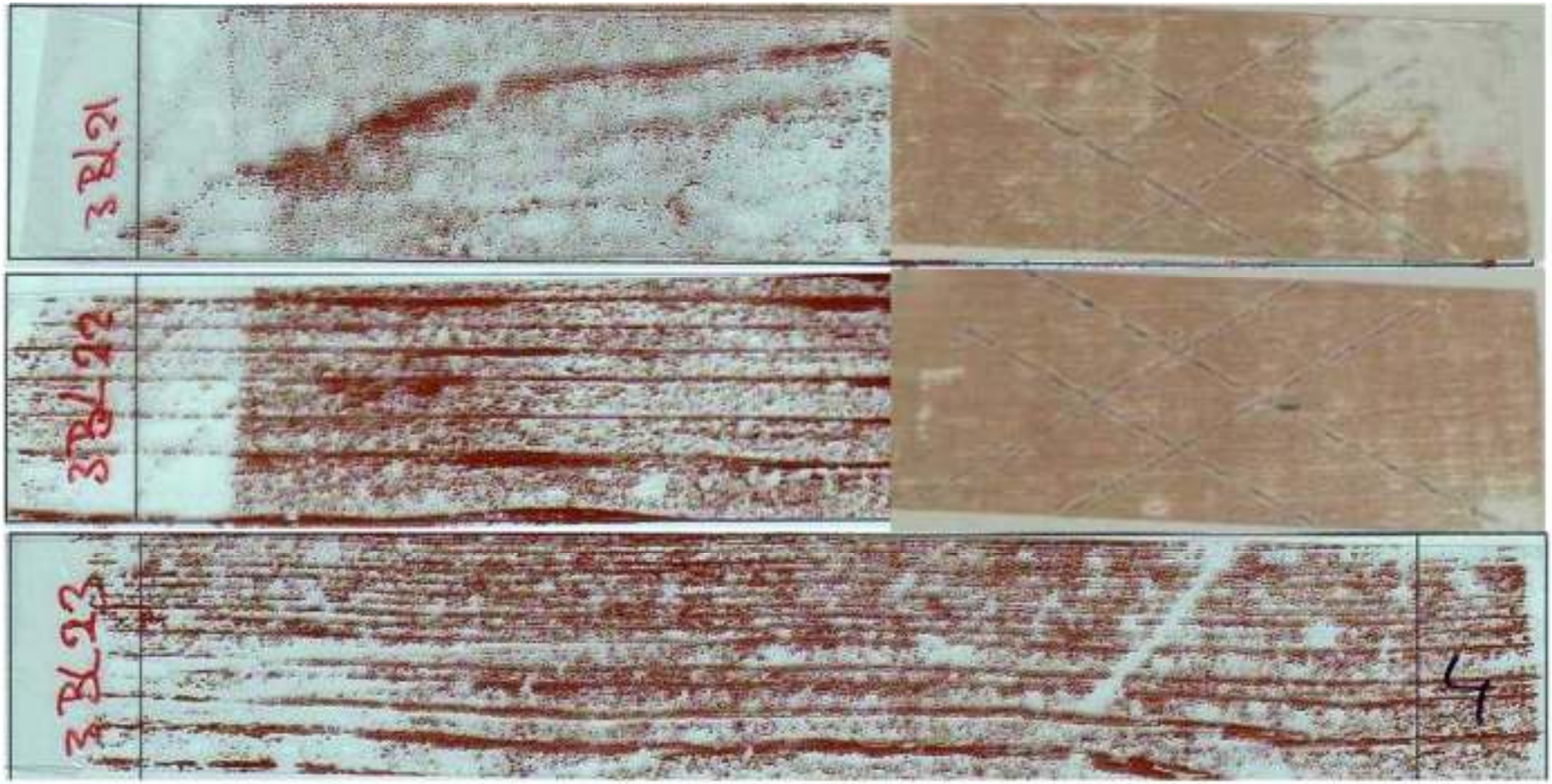
# Paint 2 WRC



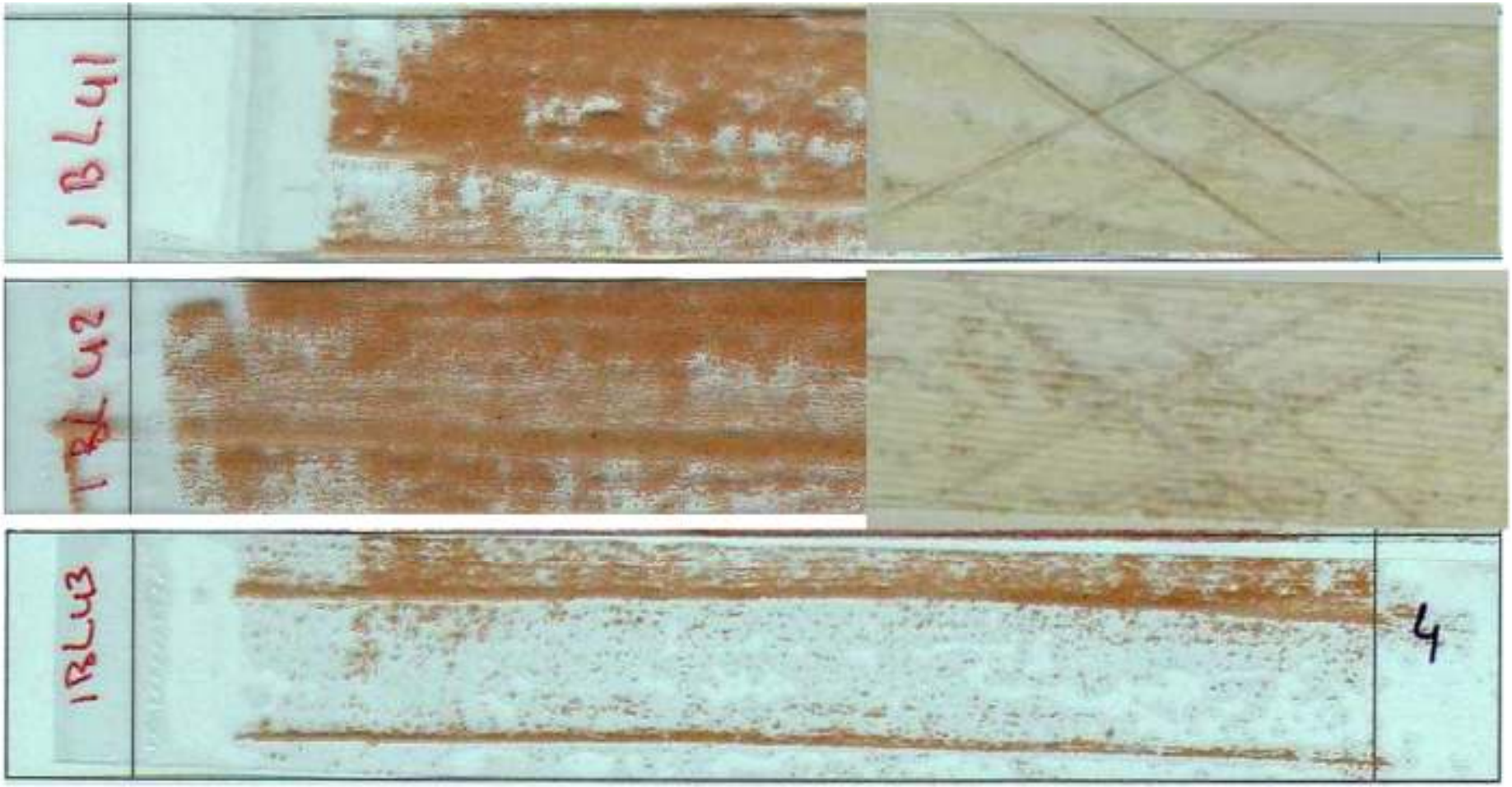
# Paint 2 Impregnated Spruce



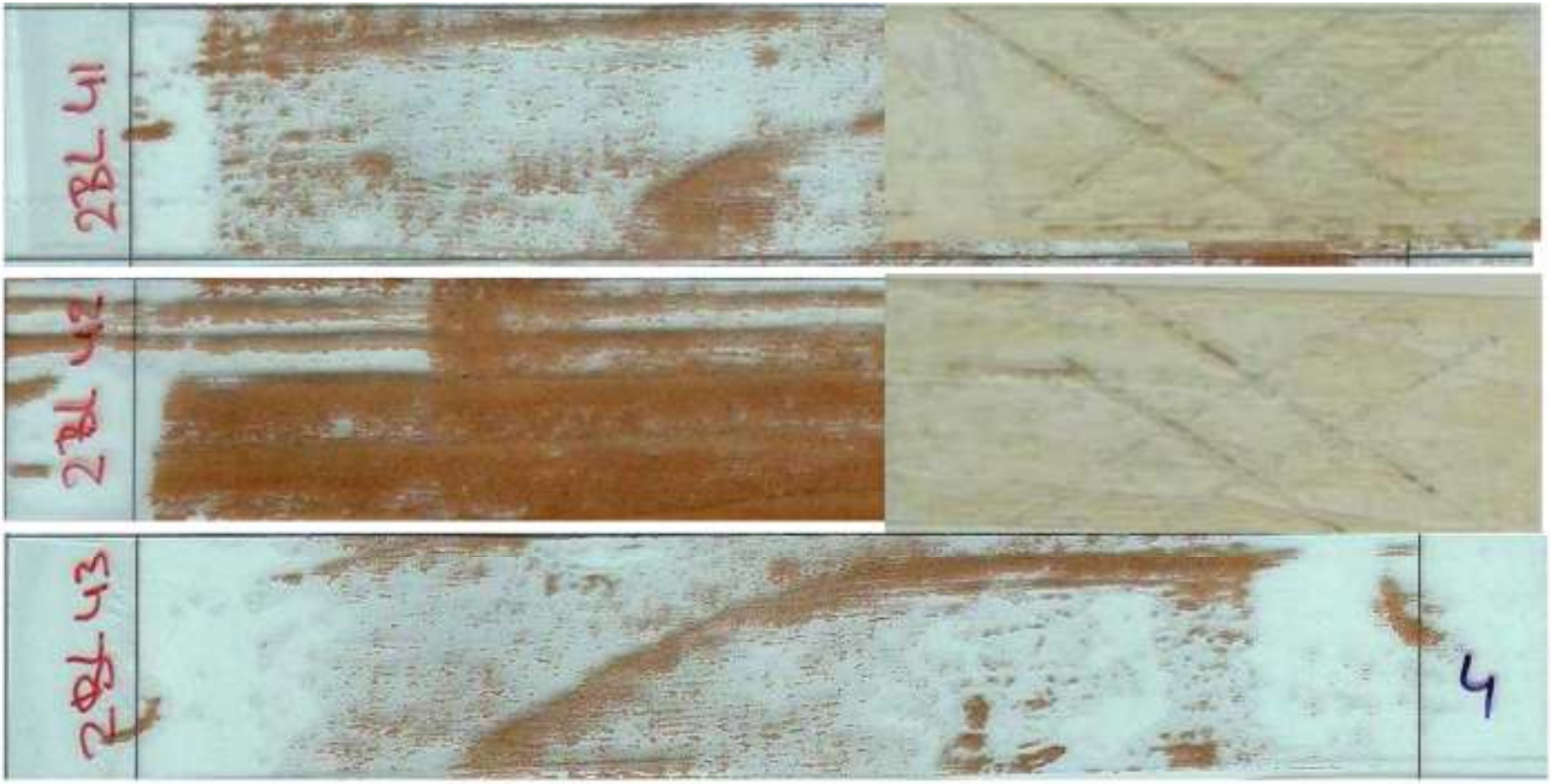
# Paint 2 modified Spruce



# Paint 4 WRC



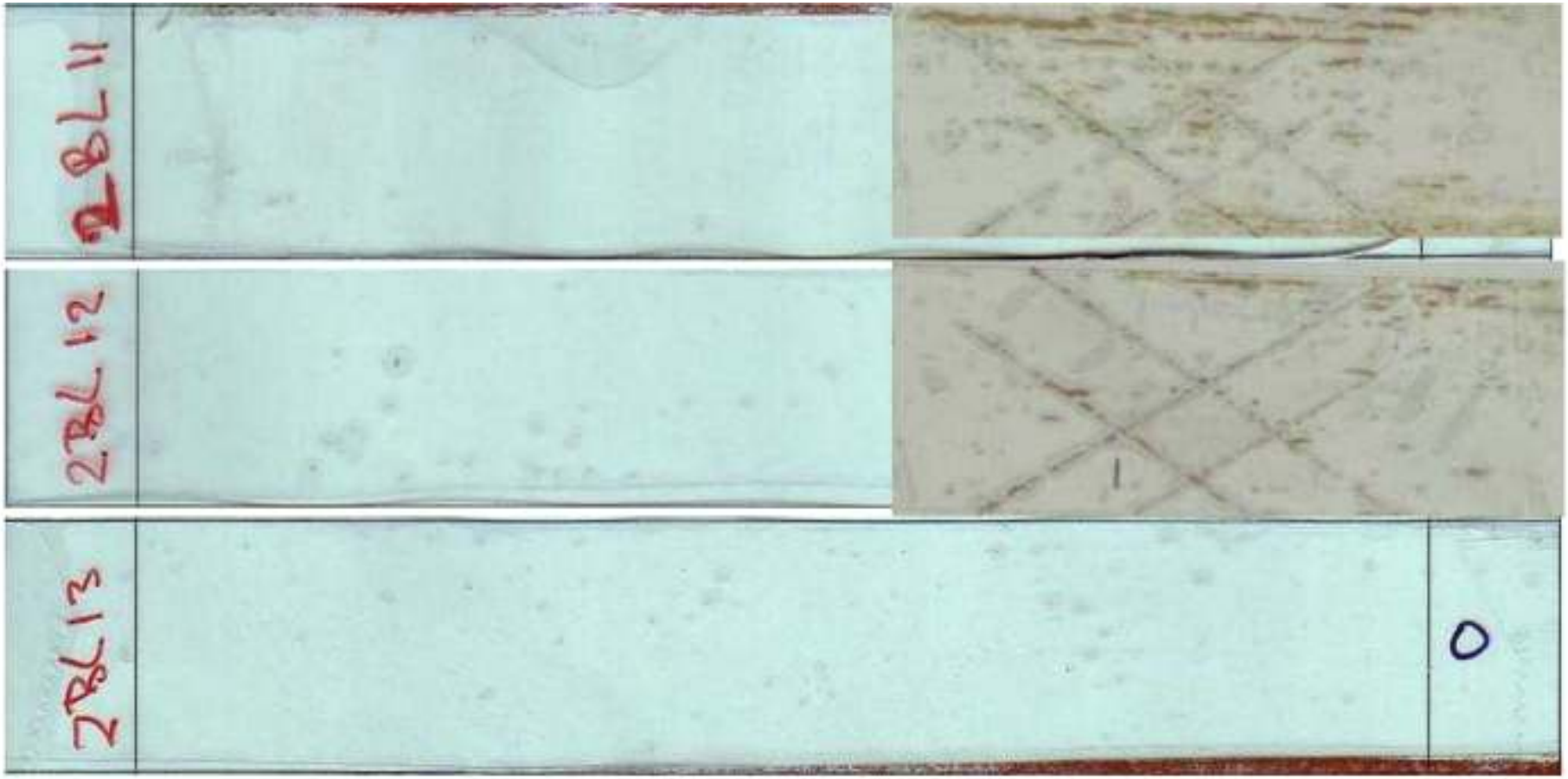
# Paint 4 impregnated Spruce



# Paint 4 modified Spruce

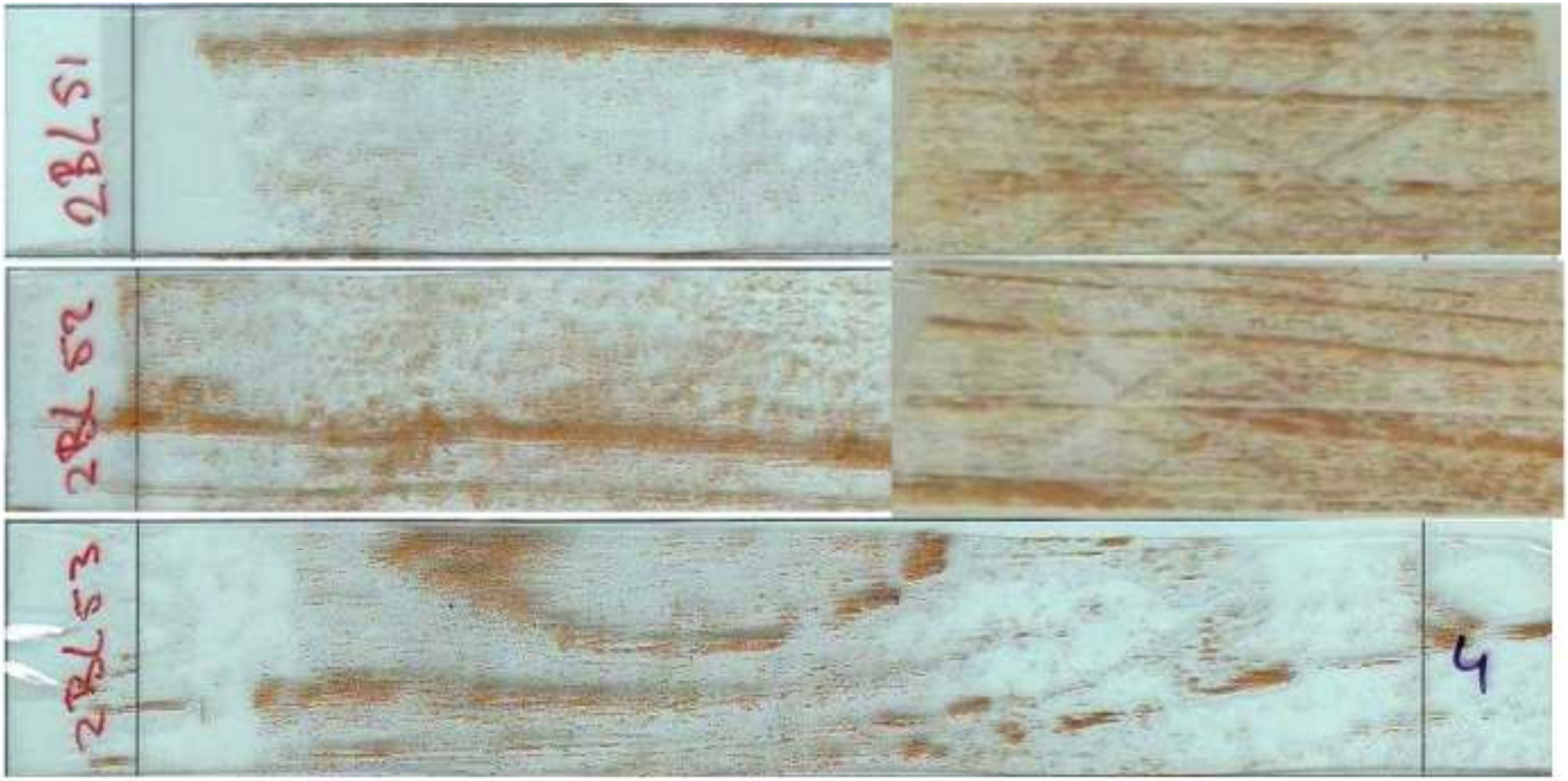
# Ref. impregnated Spruce

# Paint 1 impregnated Spruce

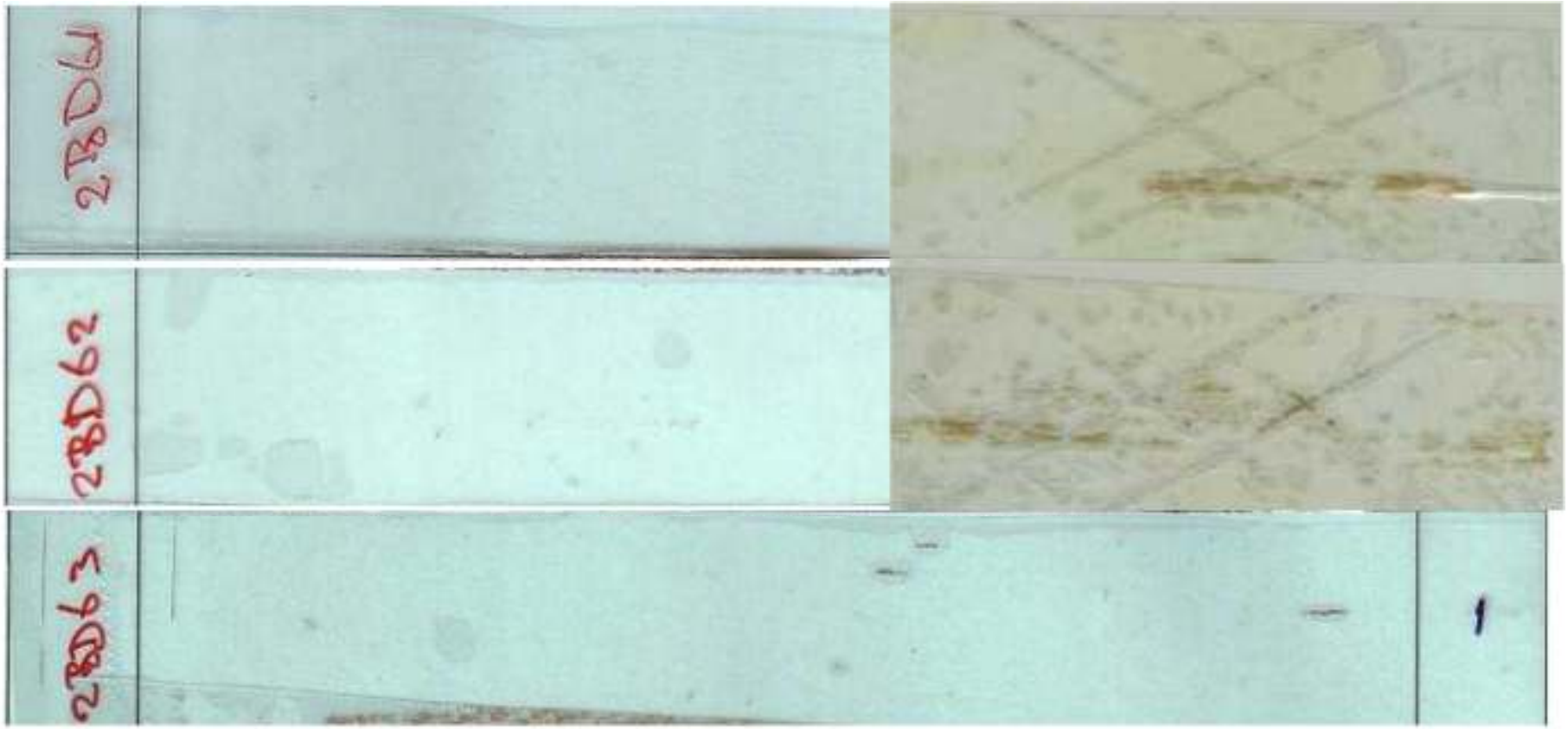


# Paint 3 impregnated Spruce

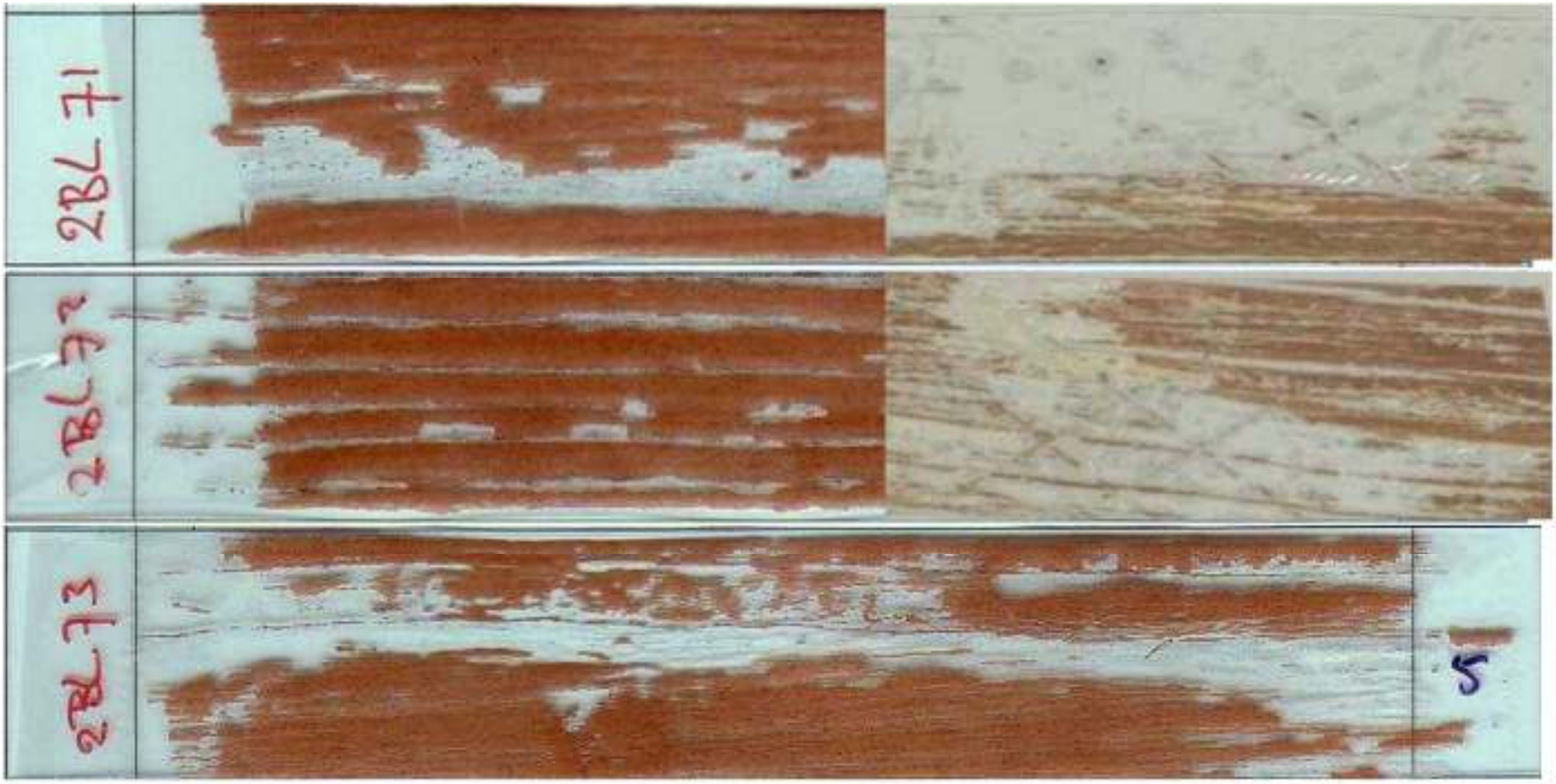
# Paint 5 impregnated Spruce



# Paint 6 impregnated Spruce



# Paint 7 impregnated Spruce



# Conclusions on Tape test

- In general there is a good correlation between the results after artificial and natural weathering
- The results match with the tendency of the paint system to flake around woodcracks, defects and critical areas
- Therefore an indication of the expected maintenance efforts to be made can be derived from the results from EN 927-6

# Conclusions on Tape test

- Application of the double cross pattern before starting the artificial weathering might give better compensation for woodcracks and defects in natural weathering
- For better service life expectations combinations of paint systems and woodspecies can be pre-screened by EN 927-6 testing in combination with proper evaluation of the Tape test

## Problem identification

Blistering and flaking due to adhesion failure of paint

## Aim

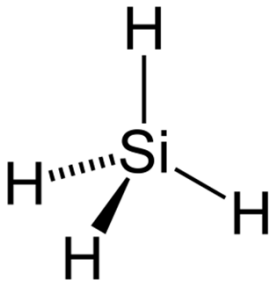
Develop a wood treatment based on silane sol-gel technology to:

- improve hydrophobicity of wood
- achieve persistent wet adhesion

# Chemical Background

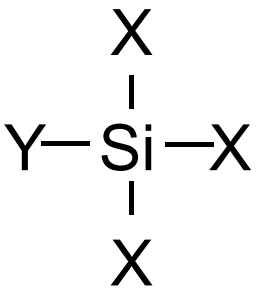
## Silanes

Chemical compounds consisting of a central silicon atom with 4 constituent groups




## Organofunctional silanes

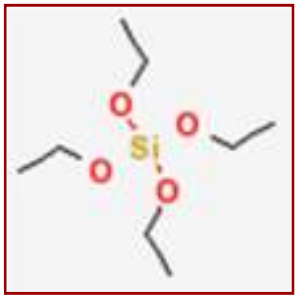
Silanes having both inorganic and organic groups



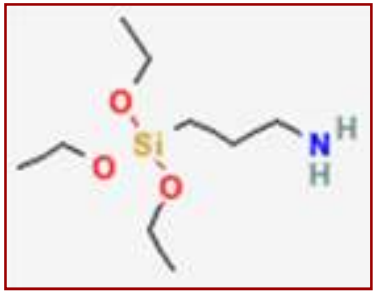

Where X = inorganic hydrolyzable group
and Y = organofunctional group

# Chemical Background

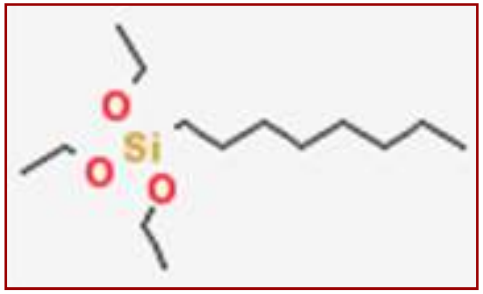
Silane compounds used during experimentation include:




Tetraethylorthosilicate (TEOS)




ɣ-aminopropyltriethoxysilane




Octyltriethoxysilane

# Chemical Background

## Sol-gel process

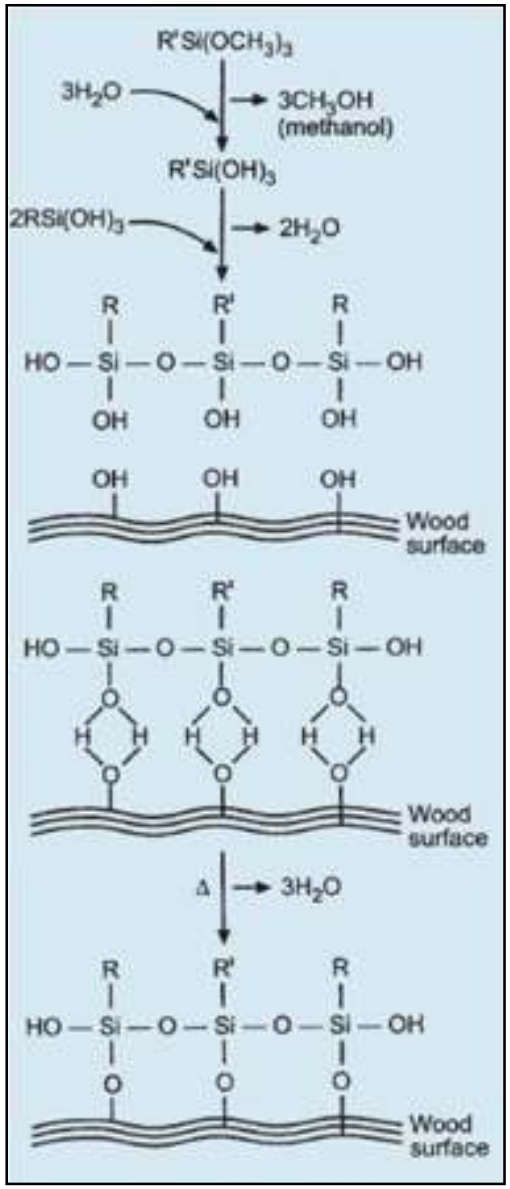
1) Hydrolysis

   • alkoxy groups are hydrolyzed to form silanols and alcohol is released

2) Condensation

   • silanol + silanol: Si-O-Si network formed

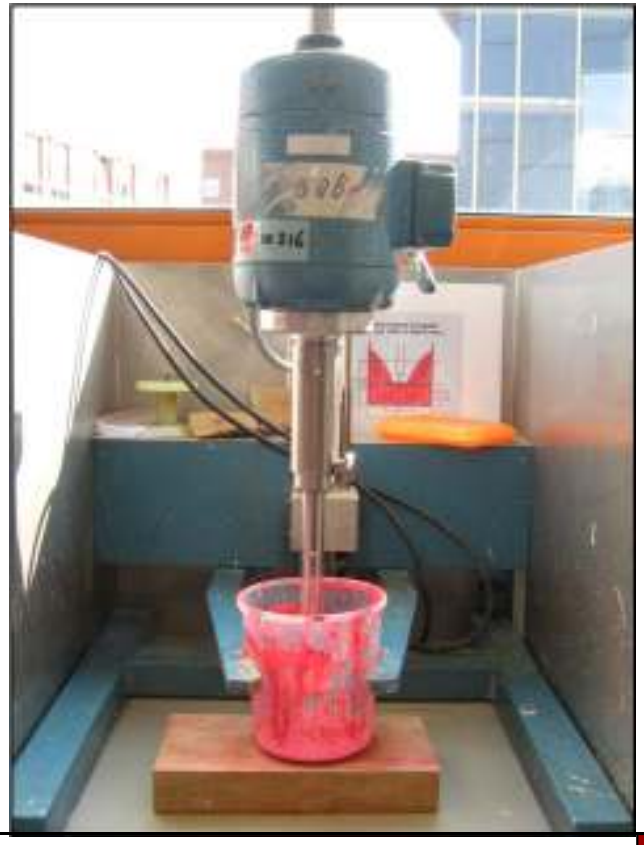
   • silanol + surface (wood): covalent bonding of silane to the wood



# Two step process

- Pretreatment by flowcoat application: TEOS, functional Silanes, ethanol, self-crosslinking binder, pH control

- Single layer coating application (brush): self-crosslinking binder, UV-titan, pigments, wetting agent, defoamers, thickeners, driers.



# Two step process

New approach to achieve covalent bonding of the finish coat to the wood by means of functional silanes in the sol-gel pretreatment formulation.

# Adhesion – Proof of concept

0% amino silane

3% amino silane

12% amino silane

# Upscaling – IR and spray cycle

Accelerated weathering by IR heating and water spray

- no cracking or flaking
- increased heat in drying = improved adhesion

# Upscaling - 8 weeks EN 927-6

Evaluation after 8 weeks of artificial weathering for planed Norway Spruce for the novel paint system:

| Paint code | Cracking [Y/N] | Flaking [Y/N] | Adhesion [0 – 5] Tape test | Chalking [0 – 5] Tape test | Remarks |
|---|---|---|---|---|---|
| 21 | N | N | 1,0 | 4,0 | |

In the figures below two individual test panels are shown after 8 weeks of artificial weathering for planed Norway Spruce along with the tape test results.

Sample code 21

# Upscaling – natural weathering

Natural weathering

- Water trap applied to panels
- Started Summer 2010

# Water uptake and freeze test

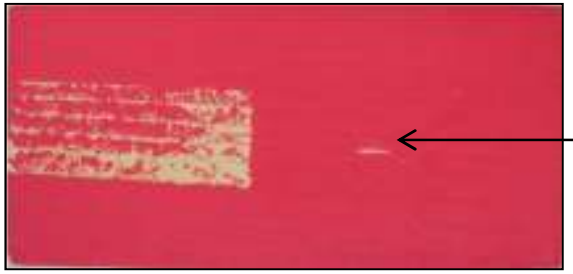
| Step | Action | Temperature |
|---|---|---|
| 1A | Water | 20 ± 2°C |
| 1B | Freezer | -18 ± 4°C |
| 2A | Water | 20 ± 2°C |
| 2B | Freezer | -18 ± 4°C |
| 3A | Water | 20 ± 2°C |
| 3B | Freezer | -18 ± 4°C |
| 4A | Water | 20 ± 2°C |
| 4B | Freezer | -18 ± 4°C |
| 5A | Water | 20 ± 2°C |
| 5B | Freezer | -18 ± 4°C |
| 6A | Water | 20 ± 2°C |
| 6B | Freezer | -18 ± 4°C |

# Results for water uptake and freeze test

Water uptake and freeze test

Adhesion

Initial drying time



Extended drying time

# Results for water uptake and freeze test

Reformulation of pretreatment mixture and optimisation of pH during application resulted in good performance.

| Water uptake [g/m2] | | | | | | | Cracking | Adhesion |
|---|---|---|---|---|---|---|---|---|
| **Code** | **Step 1** | **Step 2** | **Step 3** | **Step 4** | **Step 5** | **Step 6** | | |
| 22.3 | 390 | 602 | 741 | 845 | 907 | 925 | 1S2 | 0 |
| 22.4 | 373 | 581 | 727 | 837 | 900 | 921 | 1S1 | 0 |
| 22.5 | 346 | 532 | 668 | 770 | 835 | 853 | 1S1 | 0 |
| *Av.* | *370* | *572* | *712* | *817* | *881* | *900* | | |
| *S.d.* | *23* | *36* | *39* | *41* | *39* | *40* | | |

# Conclusions and outlook

Persistant wet adhesion achieved?

- Proof of principal was achieved that with the chosen approach good wet adhesion can be produced
- Further testing is carried out to support the previous results
- Development of a fully water based pretreatment formulation is desirable as well as optimisation of the finish coat formulation

# Questions

Thank you for your attention!