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WATER UPTAKE AND FREEZE STABILITY TEST



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1. INTRODUCTION

This work instruction describes the activities for the performance of a water uptake and freeze stability test..

1.1 Scope

The scope of this work instruction is the correct performance of the water uptake and freeze stability test to determine resistance to alternating stress due to moisture and frost, as described in AD 0814 and AD 0817, and the correct performance of the associated assessments for adhesion, blistering and flaking. The timber specie sapele, at least, must be tested according to AD 0814 and AD 0817. The testing of other timber species is optional.

1.2 Principle

The water uptake and freeze stability test is used to determine the resistance to moisture and frost of water-soluble paint systems immediately after critical drying, and to assess the robustness of the paint coat under these circumstances.

1.3 Safety

Always read the safety data sheet for the product in question before using paint products.

1.4 Definitions

Water absorption:

water absorption is defined as the number of grams of water absorbed via the test surface of the test panel after 72 hours of floating on water

Water permeability:

water permeability is the quantity of water expressed in grams per square metre that has passed through the test surface during 72 hours of floating on water.

2. REAGENTS AND AIDS

The following materials are required to carry out this test:

- the paint to be tested;
- five straight grained, free of defects, sapele test panels, for each colour to be tested and type of determination, with dimensions: 150 mm x 70 mm x 20 mm (length x width x thickness) and a growth-ring orientation of approximately 45° with the surface;
- sealant with a maximum water permeability of 30 g/m² according to EN 927-5;
- tray with fresh demineralised water⁽¹⁾, placed at 20°C

¹⁾ *All water referred to in this publication has to meet the requirement of conductivity of 20 µSiemens/cm, e.g. demineralised or distilled water.*

3. EQUIPMENT AND GLASS

The following equipment is required to carry out this test:

- brush;
- airless high-pressure spraying installation or airmix spraying installation;
- climate cabinet/room with adjustable RH, temperature, and an adjustable laminar air flow;
- calibrated balance with an accuracy of 0.01 g.

4. PROCEDURE

4.1 Production of test pieces

The test pieces are produced as follow.

- from straight-grained and free of defects sapele, planks are sawn and planed with a cross-cut dimensions of 70 ± 1 mm x 20 ± 1 mm. Hierbij moet de hoek tussen de jaarringen en het testoppervlak $45 + 10$ °. Panels with a length of 150 ± 1 mm are then sawn from this. The test pieces are then stored for at least one week at 20° C and 65% RH, but in any case until they reach a constant weight. The mass per unit volume is then determined by weighing and dividing the weight by the volume. At the reached equilibrium moisture content, the mass per unit volume should lie between 650 and 800 kg/m³ based upon a timber moisture percentage as referred to in SKH Publication 99-05.

COMMENT: In addition to sapele, the standard timber species for this test method, this test method is also applicable to other timber species and timber-like substrates.

- The test panels (150 mm x 70 mm x 20 mm) will be sealed using a sealant (SKH Publication 04-01) on the cross-cut edges, the longitudinal sides and the heart side. Ensure that no sealant gets onto the surface to be tested.
- After sealing, the test pieces are stored for at least one week at 20° C and 65% RH, but in any case until a constant weight is reached.
- For each opaque paint system to be tested, five panels are finished on the bark side in colour RAL 1013 (white) and five in the colour RAL 7026 (dark grey).
- For each transparent paint system to be tested, five panels are finished on the bark side in the “critical” colour (the colour that is regarded as the most critical by the manufacturer).
- The paint system is applied in one or more coats according to the supplier’s instructions, within the provisions of AD 0801 and AD 0803.
- The quantity of paint to be applied is calculated according to Formula 1 below. During application, the quantity of paint applied is recorded by weighing.

Formula (1)

$$LD = \frac{m_1 - m_0}{A * \left(\frac{\rho_v}{VS} \right)}$$

LD: coat thickness to be applied [μ m]

m_1 : weight of panel with wet paint [g]

m_0 : weight of panel before the application of paint [g]

VS: percentage of solid substance by volume according to manufacturer’s data

ρ_v : density of the wet paint, according to manufacturer’s data [g/cm^3]

A: area of surface onto which paint is applied [cm^2] for standard panel dimensions this is 105 cm^2

After critical drying of the test panels a check should be made for a closed paint coat according to SKH publication 06-02. If the paint coat is not closed on more than one panel, the test series must be re-applied. One panel may be left out of the assessment.

4.2 Application and drying of paint systems according to the paint supplier's process parameters

- The paint is checked for the presence of microfoam. If this is found, the paint is stored for one week before being processed.
- The paint is stirred for two minutes with a spatula and vented for 15 minutes (left to stand with the lid off).
- The panels are taken out of the climatized room (20° C and 65% RH) and the first coat of paint is applied immediately.
- The coats of paint can be applied in the following ways:
 - In accordance with the paint supplier's process parameters;
 - In accordance with Appendix 5A and/or Appendix 6A of AD 0801;
 - In accordance with Appendix 6a and/or Appendix 7a of AD 0803;
- The precise amount of wet paint calculated to achieve the dry coat thickness prescribed by the paint manufacturer (opaque and transparent systems) is applied; this is ensured by weighing.
- On spruce an over dosage of 10% is used for the first coat only. On other timber species an overdosage of 15% to 25% is used for the first coat only to achieve a closed coat of paint.
Each panel is separately weighed before and after application.
- In the laboratory a flow coat is applied by a flat brush (45 mm).
Spray coats are sprayed.
- Conditions under which spray application must take place:
 - type of spray gun: Airless or Airmix;
 - type of nozzle: opening 0.009-0.13 inch, spraying angle 30° - 40°, replaced after a maximum of 1000 litres;
 - adjust spraying pressure until a good spray pattern is achieved (80-120 bar, depending upon nozzle and paint);
 - preferably do not circulate the paint due to air inclusion;
 - conditions during application: 20° C and 65% RH;
 - distance between nozzle and object: approx. 300 mm;
 - coat thickness to be achieved: by weighing;
 - cleaning and maintenance protocol: Good housekeeping.

5. METHOD

5.1 Resistance against alternating stress due to moisture and frost

The resistance against alternating stress due to moisture and frost is measured on defect free panels in the colours RAL 1013 and RAL 7026, or as specified by the client. The paint system is applied by means of airless/air mix spraying. The dry coat thickness of the paint system is built up as specified by the principal. The paint system is dried under at least QS conditions or as specified by the principal. After critical drying the panels are exposed to alternate moisture and frost for a minimum of 6 cycles.

Table 1 shows the progression of the water uptake and freeze stability test. The panels are weighed at the start and after every water uptake stage. After every third cycle the panels are visually inspected for defects. The assessment is performed with and without 10x magnification. Any paint damage in the form of blistering, flaking and cracking is determined in accordance with ISO 4628-2, -4 and -5.

After the end of the last cycle, once the panels have returned to room temperature, the adhesion is determined in accordance with SKH Publication 05-01, two hours after the end of the last test cycle (after the freezing step). The dry layer thickness of the coating is also checked by a suitable microscopic investigation like the method described ISO 2808..

Table 1: Water uptake and freeze stability test, performed after application and critical drying in accordance with the minimum process conditions from AD 0801 and/or AD 0803.

Step	Operation	Stress	Temperature	Duration	Assessment
Cycli 1 to 3					
1A	Weighing	Water uptake	20 ± 2° C	72 hours	
1B	Weighing	Freezing	-18 ± 4° C	≥ 24 hours	
2A		Water uptake	20 ± 2° C	72 hours	
2B	Weighing	Freezing	-18 ± 4° C	≥ 24 hours	
3A		Water uptake	20 ± 2° C	72 hours	
3B	Weighing	Freezing	-18 ± 4° C	≥ 24 hours	ISO 4628-2, -4 and -5
Cycli 4 to 6					
4A		Water uptake	20 ± 2° C	72 hours	
4B	Weighing	Freezing	-18 ± 4° C	≥ 24 hours	
5A		Water uptake	20 ± 2° C	72 hours	
5B	Weighing	Freezing	-18 ± 4° C	≥ 24 hours	
6A		Water uptake	20 ± 2° C	72 hours	
6B	Weighing	Freezing	-18 ± 4° C	≥ 24 hours	ISO 4628-2, -4 and -5 SKH-Publication 05-01

5.2 Performance of the substeps

Before starting the first water uptake step the test panels are weighed, after which they are placed in fresh demineralised water at a temperature of 20°C with the coating to be tested facing down..

- 1A After 72 hours the test panels are taken out of the water, patted dry with a new tissue, immediately weighed and then immediately placed in the freezer on a plastic grille on their sides with a space of at least 10 mm between them.
- 1B After at least 24 hours the panels are taken from the freezer and placed in fresh demineralised water at a temperature of 20° C with the coating to be tested facing down.

- 2A After 72 hours the test panels are taken out of the water, patted dry with a new tissue, immediately weighed and then immediately placed in the freezer on a plastic grille on their sides with a space of at least 10 mm between them.
- 2B After at least 24 hours the panels are taken from the freezer and placed in fresh demineralised water at a temperature of 20° C with the coating to be tested facing down.

- 3A After 72 hours the test panels are taken out of the water, patted dry with a new tissue, immediately weighed and then immediately placed in the freezer on a plastic grille on their sides with a space of at least 10 mm between them.
- 3B After at least 24 hours the panels are taken from the freezer and stored at 20° C and 65% RH, for 2 hours. After these two hours the panels are checked for defects and placed in fresh demineralised water at a temperature of 20° C with the coating to be tested facing down.

- 4A After 72 hours the test panels are taken out of the water, patted dry with a new tissue, immediately weighed and then immediately placed in the freezer on a plastic grille on their sides with a space of at least 10 mm between them.
- 4B After at least 24 hours the panels are taken from the freezer and placed in fresh demineralised water at a temperature of 20° C with the coating to be tested facing down.

- 5A After 72 hours the test panels are taken out of the water, patted dry with a new tissue, immediately weighed and then immediately placed in the freezer on a plastic grille on their sides with a space of at least 10 mm between them.
- 5B After at least 24 hours the panels are taken from the freezer and placed in fresh demineralised water at a temperature of 20° C with the coating to be tested facing down.

- 6A After 72 hours the test panels are taken out of the water, patted dry with a new tissue, immediately weighed and then immediately placed in the freezer on a plastic grille on their sides with a space of at least 10 mm between them.
- 6B After at least 24 hours the panels are taken from the freezer and stored at 20° C and 65% RH, for 2 hours. After these 2 hours the panels are checked for defects and the final assessment is made.

6. SCHEDULE

Table 2 shows an example schedule

Table 2: Example schedule for the water uptake and freeze stability test

Step	Operation	Stress (start)	Schedule example 1	Schedule example 2	Run time
Application and critical drying					
1 ^e coat	Application	15° C / 60% RV Circulation 0,2 m/s	Thursday 16:00	Thursday 16:00	Week 1
2 ^e coat	Application	15° C / 60% RV Circulation 0,2 m/s	Friday 08:00	Friday 08:00	Week 1
3 ^e coat	Application	15° C / 60% RV Circulation 0,2 m/s	Friday 12:00	Friday 12:00	Week 1
	Through drying	15° C / 60% RV Circulation 0 m/s	Friday 16:00	Friday 16:00	Week 1
Cycli 1 to 3					
1A	Weighing	Water uptake	Monday 08:00	Tuesday 15:00	Week 2
1B	Weighing	Freezing	Thursday 08:00	Friday 15:00	Week 2
2A		Water uptake	Friday 10:00	Monday 08:00	Week 2
2B	Weighing	Freezing	Monday 10:00	Thursday 08:00	Week 3
3A		Water uptake	Tuesday 13:00	Friday 10:00	Week 3
3B	Weighing	Freezing	Friday 13:00	Monday 10:00	Week 3
	Removal for assessment		Monday 09:00	Tuesday 13:00	Week 4
	Interim assessment		Monday 11:00	Tuesday 15:00	Week 4
Cycli 4 to 6					
4A		Water uptake	Monday 11:00	Tuesday 15:00	Week 4
4B	Weighing	Freezing	Thursday 11:00	Friday 15:00	Week 4
5A		Water uptake	Friday 13:00	Monday 08:00	Week 4
5B	Weighing	Freezing	Monday 13:00	Thursday 08:00	Week 5
6A		Water uptake	Tuesday 15:00	Friday 10:00	Week 5
6B	Weighing	Freezing	Friday 15:00	Monday 10:00	Week 5
	Removal for assessment		Monday 09:00	Tuesday 13:00	Week 6
	Final assessment		Monday 11:00	Tuesday 15:00	Week 6

Processing time at least 6 weeks.

7. DOCUMENTLIST

AD 0801	Wooden façade elements SKH, Wageningen.
AD 0803	Wooden exterior doors SKH, Wageningen
AD 0814	Film forming coatings for application on wood. SKH, Wageningen.
AD 0817	Undercoat and topcoat systems for timber. SKH, Wageningen.
SKH Publication 04-01	Assessment of sealants for the timber industry
SKH Publication 05-01	Determination of the adhesion of paint on timber. SKH, Wageningen
SKH Publication 06-02	Assessment of the closedness of a paint film on timber, SKH, Wageningen
SKH Publication 08-02	Determination of water permeability after critical drying and complete drying of undercoat and topcoat systems on timber
SKH Publication 99-05	List of approved timber species to be used in wooden façade elements (window frames, windows and doors)
ISO 2808	Paints and varnishes - Determination of film thickness.
ISO 4628-2	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance Part 2: Assessment of degree of blistering.
ISO 4628-4	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance Part 4: Assessment of degree of cracking.
ISO 4628-5	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance Part 5: Assessment of degree of flaking. (ISO 4628-5:2003, IDT).