

**Timbers for window joinery – Part 4:  
Modified Timbers**

**Supplement 2: Kebony® SYP**

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## Table of Contents

1	Introduction	3
2	Scope	3
3	Product description	3
4	Testing procedures	7
	4.1 Visual Tests	7
	4.2 Quick test	7

## 1 Introduction

This supplement complements the VFF Guidance Sheet HO.06-4 “Timbers for window joinery -Part 4: Modified timbers” with proven product-specific data. This guidance sheet describes the established modification processes and specifies the property requirements for the production of dimensionally stable exterior joinery as well as suitable test methods for these properties. The properties listed hereinafter are explained by the guidance sheet which also comprises general advice. The guidance sheet also comprises a bibliography.

## 2 Scope

This supplement contains the product description of the modified timber product “Kebony® SYP“, as well as the description of a quick test method (cf. Clause 3), by the aid of which the adherence to the warranted characteristics can be checked (cf. Table B2, Clause 4, fourth line). **This supplement may only be applied in conjunction with a valid version of VFF Guidance Sheet HO.06-4 “Timbers for window joinery – Part 4: modified timbers.”**

This supplement is valid at maximum until the date stated on the cover. If the suitability has not changed, the term of validity will be prolonged correspondingly upon query at the manufacturer of “Kebony® SYP“. If the manufacturer effects any changes to a modified timber products described in a supplement to this guidance sheet, which influence the properties of the product, or should he have gathered new findings respective to individual characteristics listed in the technical description – even within the term of validity of three years – he shall submit these to the Quality Association without delay, including the appropriate proofs (test reports). Taking account of the proofs furnished by the manufacturer, the supplement will be revised accordingly and the published with a new term of validity. This also applies if the modified timber product “Kebony® SYP“ is no longer produced and this supplement has to be withdrawn.

## 3 Product description

“Kebony® SYP” is a modified wood product made from furfurylated Southern Yellow pine (the sapwood of the pine species *Pinus echinata*, *Pinus elliottii*, *Pinus palustris* and *Pinus taeda*). It is produced by the company Kebony ASA, Oslo and Skien/Norway.

The assured properties of furfurylated “Kebony® SYP” are listed in Table B2. The property performances quoted in Table B2 below are based on pertinent test reports, where products and components customarily used in window production were tested. **Where it is intended to use deviating constructions and/or components, their suitability and/or compatibility shall be proven by corresponding additional tests.**

### GENERAL NOTE:

Special care has to be taken when machining, processing and finishing “Kebony® SYP”. The specifications furnished by the suppliers for adhesives, coating systems, fittings, sealants, gaskets, and insulating glass shall be strictly observed. Different results may be obtained depending on the product used. **Therefore, only products authorized by the supplier may be used.** Due to the reduced wettability, drying and curing periods may need to be extended

Where available, the characteristics of untreated Southern Yellow Pine are quoted in comparison to “Kebony® SYP” in the table below.

According to the indices<sup>(x)</sup> the numerical values given in Table B2 are of the following types:

<sup>1</sup> Mean value, Minimum ... Maximum

<sup>2</sup> Mean value/Maximum

<sup>3</sup> Mean value/characteristic value

<sup>4</sup> Mean value/Minimum

**Table B2: Properties of furfurylated Southern Yellow Pine (“Kebony® SYP”)**

Property	Kebony® SYP		Application advice	
<b>1. General characteristics</b>				
Timber specie(s)	Kebony-Southern Yellow Pine: <i>Pinus echinata</i> (Shortleaf Pine, PNEC), <i>P. elliotii</i> (Slash Pine, PNEL), <i>P. palustris</i> (Pitch Pine, PNP), <i>P. taeda</i> (Loblolly Pine, PNTD) Origin: Southern United States			
Timber quality	For cross sections up to 25 mm x 150 mm: J10 or better. For cross sections from 25 mm x 150 mm to 42 mm x 150 mm: J10 or better on 3 faces, J30 on one face. Use quarter-sawn or semi-quarter sawn timber only.			
<b>2. Manufacturing process</b>				
Modification process	Kebony-timber materials are initially impregnated with an aqueous solution of furfuryl alcohol (complete impregnation). The furfuryl alcohol polymerizes under the influence of heat (70-120 °C) inside the cell walls. Water uptake is significantly reduced and dimensional stability and durability increased by blocking the hydroxyl groups in the cell wall.			
Structure and colour changes caused by modification	The Kebony wood produced has a higher density, hardness and mechanical resistance than the unmodified wood. It is also significantly darker in colour, which is due to the polymerization of the furfuryl alcohol. The technical properties and workability are not affected.			
Quality assurance	Kebony is submitted to an internal factory production control as well as third-party supervision by SINTEF ( <a href="#">SINTEF Technical Approval TG 2493</a> ). A sufficient treatment is ensured by controlling weight percentage gain (WPG), the residual content of furfuryl alcohol, penetration and equilibrium moisture content (EMC).			
Simple procedure for testing guaranteed properties	Determination of surface swelling on test pieces of the dimensions (20 x 20 x 8) mm after three days' submersion in water. Maximum surface swelling may not exceed 5,5 % for test piece stored under ambient conditions resp. 8 % for oven-dried test pieces.		Cf. also clause 4	
<b>3. Material properties</b>				
<b>3.1 Physical properties</b>				
Resistance against wood destroying fungi	Kebony® SYP			
	Class 1-2	Southern Yellow Pine Class 3-4		
Resistance against blue stain	Not resistant		Protection against blue stain required	
Density <sup>1</sup> (at 20 °C/65 % relative humidity)	g/cm <sup>3</sup>	Kebony® SYP	Southern Yellow Pine	Checking of density required during receiving inspection and testing
		0,7 – 0,9 g/cm <sup>3</sup>	0,5 – 0,7 g/cm <sup>3</sup>	

Property		Kebony® SYP		Application advice	
Equilibrium wood moisture <sup>2</sup> (at 20 °C/ 65 % relative humidity)	%	Kebony® SYP	Southern Yellow Pine	Estimation of moisture content with electrical resistance meters (EN 13183-2) is not possible due to the slight reduction of the pH-value. Moisture content may, however, be estimated with the capacitance method according to EN 13813-3. In this case, the meter shall be set to a density of 800 kg/m <sup>3</sup> .	
		6,6 % 6,2 ... 7,0% (Adsorption)	11,3 ... 11,8 %		
		Determination gravimetrically according to EN 13183-1			
Swelling and shrinkage properties <sup>2</sup>		Kebony® SYP	Southern Yellow Pine		
		Swelling from dry to 95 % relative humidity			
Radial	%	2,2 .. 4,4	5,4 .. 7,6		
Tangential	%	3,3 .. 4,3	6,1 .. 7,3		
Axial	%	0,2	0,3		
Max. swelling in volume	%	6,0	not specified		
Capillary water uptake <sup>2</sup>		Kebony® SYP	Southern Yellow Pine		
Radial	kg/m <sup>2</sup> .h <sup>-0,5</sup>	not specified	not specified		
Tangential	kg/m <sup>2</sup> .h <sup>-0,5</sup>	0,06 + 0,02	0,5 + 0,3		
Axial	kg/m <sup>2</sup> .h <sup>-0,5</sup>	0,5 + 0,4	2,7 + 0,7		
Resistance to fire		Euroclass D acc. EN 13501-1			
Thermal conductivity (λ <sub>D</sub> -value)	W/mK	0,17			
<b>3.2 Mechanical properties</b>					
Bending strength <sup>3</sup>	N/mm <sup>2</sup>	Kebony® SYP	Southern Yellow Pine		
		62,1 ... <b>89,4</b> ... 118,6	74 ... 105		
Modulus of elasticity in bending <sup>3</sup>	N/mm <sup>2</sup>	Kebony® SYP	Southern Yellow Pine		
		11.739 ... <b>15.598</b> ... 20.684	11.100 - 14.500 N/mm <sup>2</sup>		
Compression strength parallel and perpendicular to grain <sup>3</sup>	N/mm <sup>2</sup>	Kebony® SYP	Southern Yellow Pine		
		Axial	60,5.. <b>64,3</b> ..68,2		41 ... 58
		Radial	12,9.. <b>13,6</b> ..14,2		not specified
		Tangential	8,2.. <b>8,9</b> ..9,5	not specified	
Impact bending <sup>3</sup>	kJ/m <sup>2</sup>	Kebony® SYP	Southern Yellow Pine		
		25,1 .. <b>26,6</b> .. 28,2	60 ... 70		
Resistance to axial withdrawal of screws <sup>4</sup>	kN	3,5 mm-screw	233 + 40		
		4,2 mm-screw	259 + 26		
		Measured radially, thickness 22 mm. Values of Kebony® SYP are 17 % and 34 % higher than on unmodified timber.			
Surface hardness <sup>4</sup> (Brinell)	N/mm <sup>2</sup>	Kebony® SYP	Southern Yellow Pine		
		4,1 2,9 ... 5,3	3,1 2,1 ... 4,1		
<b>3.3 Chemical properties</b>					
Registration, evaluation and accreditation of chemicals (REACH)		Registered number of furfuryl alcohol: EC202-626-1			

Property	Kebony® SYP	Application advice
<b>4. Suitability for window construction</b>		
4.1 Suitability as a component for windows		
Suitability for laminated and/or finger-jointed constructions	A proof of suitability of the system used is required. Testing of three-layer scantlings made from Kebony® SYP and spruce according to the ift-guideline fulfilled the admittance requirements. It is recommended to use EPI or PUR-adhesives.	
Bonding strength of adhesives	In general, no differences with untreated softwoods.	Use products authorized by the manufacturer only.
Compatibility with surface coatings	Acrylic-based paints generally show good adhesion on Kebony® SYP. Alkyd-based paints may need longer curing times on Kebony wood than on unmodified wood. It is therefore recommended to use acrylic-based paints.	The test only concerns wet adhesive strength according to VdL-Guideline 14 (tearing strength). If alkyd-based opaque white coatings are used, there is a risk of yellowing.
Compatibility with fittings and fasteners	Where corrodible metals are used, discolouration of the surfaces may occur. It is therefore recommended to use stainless-steel fittings and fasteners.	
Compatibility with sealants (adhesion)	WG 1: Neutral silicone: no interference observed WG 2: Alkoxy silicone: no interference observed WG 3: MS sealant: <b>restricted suitability!</b>	No difference in comparison to unmodified spruce.
Compatibility with gaskets (sealing profiles)	WG 1: Polyethylene, polypropylene: no tests carried out WG 2: Silicone rubber: no interference observed WG 3, WG 4: Thermoplastic elastomers: no interference observed WG 5: Soft PVC: <b>unsuitable</b>	
Compatibility in contact with the insulating glass seal	Polyisobutylene: restricted suitability Polysulfide: restricted suitability Polyurethane: restricted suitability Silicone rubber: no interference observed	Independent on species and modification, the following interferences were observed: Polyisobutylene: interlocking/difficult release between test piece and sealing Polysulfide, Polyurethane: Softening of the coating (opaque/ translucent)
Tips on processing Sawing, moulding, cutting drilling, torque for screwing, etc.	Due to the increase in density, the machining of Kebony wood materials is comparable to that of high-density hardwoods (e.g. oak, black locust (Robinia)).	
Development of dust	Due to the brittleness of the material, the amount of dust fines is significantly increased in comparison to non-modified timber.	During comparative measurements of the Timber Employers liability insurance association (Holz-Berufsgenossenschaft) in a manufacturing plant, the maximum workplace concentrations (MAK-values) were not exceeded.

Property	Kebony® SYP	Application advice
Emissions during woodwork- ing (volatile organic com- pounds for which MAK-values are in force)	During machining of unfinished Kebony® SYP acetic acid and furfural may be emit- ted.	During comparative measurements of the Timber Employers liability insurance association (Holz- Berufsgenossenschaft) in a manu- facturing plant, the maximum workplace concentrations (MAK- values) were not exceeded. .
Recycling of product residues, ordinance on used wood	Untreated Kebony wood: Used wood cate- gory A I Glued and/or coated Kebony wood (without halogenated organic compounds): Used wood category A II.	Kebony is exempt from the Euro- pean Biocide Ordinance and may therefore be treated as untreated wood.
Substances of high concern acc. REACH (“candidate list”) hazardous substances acc. TRGS 900	Registration for furfuryl alcohol fulfilled.	
<b>4.2 Suitability as end product (wood window)</b>		
Glueing and corner strength	Tests were carried out on corner joints glued with PVAc glue, based on DIN 68121. On a mortice-and-tenon joint, the weight class 180 kg (casement weight) was achieved. When using a Kontec-corner joint (Leitz Co.) the weight class 130 kg (casement weight) was achieved.	
Natural weathering of win- dows (vertical position)	After 12 months natural weathering, tests according to ISO 4628 showed no damages on the coating systems tested.	
<b>5. Final product</b>		
Emission testing (chamber testing)	Chamber tests carried out on window scant- lings made from Kebony® SYP showed increased emissions of furfural and acetic acid. Expected indoor air concentrations are, however, very low.	Residual emissions of acetic acid from surface-coated Kebony® SYP are in general lower than the odour detection threshold.

## 4 Testing procedures

### 4.1 Visual Tests

E.g. specifications on the delivery note, marking of the products/packages (batch no.), date of treatment, etc.

### 4.2 Quick test

#### 4.2.1 Introduction

Procedure for the determination of surface swelling of furfurylated wood in order to determine material quality.

#### 4.2.2 Testing apparatus

- Dial gauge or sliding calliper with a measuring range of 25 mm, a graduation of 0,01 mm, an accuracy of  $\pm 0,03$  mm and a reproducibility of 0,01 mm.
- Cutting saw
- Sanding machine
- Permanent marker
- Water tank with cold water ( $20 \pm 2$  °C)

#### 4.2.3 Sampling and dimensions of test pieces

For the purposes of this test, a piece of 8 mm thickness is cut from the cross-section of a Kebony board. In order to achieve a valid result, 20 test pieces have to be prepared.

Test pieces of about 25 x 25 mm are cut from the 8mm thickness board. The test pieces shall be cut from the board in such a way, that the growth rings are parallel to one edge of the 25 x 25 mm test piece, as on the example in the middle of figure B2.



**Figure B2:** Test pieces with parallel growth rings

The selected test pieces are sanded down to a dimension of 20 x 20 mm on a sanding machine. The measuring points for the measurements of radial and tangential length are marked on the edges of the test pieces. The measuring points must be visible after immersion in water, therefore they have to be permanently marked.

#### 4.2.4 Execution of the test

The test pieces are immersed in the water tank, where they are left for three days. Care has to be taken that the test pieces are completely immersed in water.

#### 4.2.5 Measurements and records

Each test piece is measured before and after immersion with the dial gauge or the sliding calliper. The following measurements shall be recorded:

- Radial length before ( $L_r$ ) and after water immersion ( $L_{wr}$ )
- Tangential length before ( $L_t$ ) and after water immersion ( $L_{wt}$ )

#### 4.2.6 Calculations

By multiplication of the respective dimensions ( $L_r \times L_t$ , resp.  $L_{wr} \times L_{wt}$ ), the surface before ( $A_i$ ) and after ( $A_w$ ) water immersion is calculated for each test piece in  $\text{mm}^2$ .

Subsequently, relative surface swelling is calculated in percent for each test piece according to the following equation:

$$\text{Swelling (\%)} = 100 \times ((A_w - A_i) / A_i)$$

Finally, the average relative swelling of all 20 test pieces is calculated according to the following equation:

$$\text{Average swelling (\%)} = \text{sum (individual swelling values (\%))} / 20$$

#### 4.2.7 Requirements

The average swelling determined by this procedure may not exceed 5,5 %. If a value > 5,5 is obtained, this indicates that the product tested does not fulfil the requirements of Kebony.

NOTE: If there are any doubts about the results of this test or the validity of the procedure, the complete testing procedure may be repeated on oven-dry test pieces. In this case, average swelling may not exceed 8 %.

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