AD 0605
d.d. 20-06-2018

ASSESSMENT DIRECTIVE

FOR THE

KOMO® PRODUCT CERTIFICATE

FOR

MODIFIED TIMBER

Authorized by the Board of Experts of SKH dated 14-05-2018

Accepted by the KOMO® Quality and Assessment Committee dated 20-06-2018

Published by: Certification Body SKH

GENERAL INFORMATION CONCERNING THIS

This Assessment Directive 0605 was declared binding on 20-06-2018 by the Certification Body SKH in accordance with the SKH Regulations for Certification, and shall, as from 20-06-2018 be used for the issuing of a KOMO® Quality Declaration for “Modified Timber”.

This revised Assessment Directive replaces Assessment Directive 0601 “Modified Timber dated 31-03-2003.

In case of arguments the Dutch version shall be consulted.

Published by:

Certification Body SKH
P.O. Box 159
6700 AD Wageningen
The Netherlands
Telephone + 31 (0)317 - 453425
E-mail mail@skh.nl
Website http://www.skh.nl

When a construction product is covered by a harmonized European standard, the KOMO® Product Certificate can not be used to replace the CE-marking on this construction product or to replace the accompanying mandatory Declaration of Performance.

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1 INTRODUCTION

1.1 General

The requirements laid down in the assessment directive are used by the certification bodies and attestation bodies, accredited by the Council of Accreditation, and having a license agreement, during the application and the continuous surveillance of the KOMO® quality system for product certification.

Additional requirements, as general procedure requirements, of certification and attestation are laid down in the certification and/or attestation regulations of the relevant body.

The technical field according to KOMO of this AD is E5: Houtverduurzamingstechnologie houtmodificatie (Wood preservation technology Timber modification).

This assessment directive replaces AD 0605 “Modified Timber” 31-01-2003

1.2 Scope and area of application

This assessment directive and the product certificate is applicable on the production of modified timber, as defined in “definitions” (3), and the half product and includes the half product and production of as well thermally modified as chemically modified timber.
Biological and enzymatic treatments or processes including the end product are part of this assessment directive.

Timber species treated with the same modification process can result in different Use Classes.
A treated timber specie can result in different Use Classes as result of different process parameters in different treatments.
It is possible to extend the quality declaration with an annex in which specific Use Classes and areas of application are defined combined with requirements (durability, colour, dimension stability) and the performance of the modified timber.

1.3 Validation

From the moment of acceptance of this assessment onwards, SKH can issue KOMO® a product certificate based on this assessment.

This assessment directive replaces AD 0605 “Modified Timber” 31-01-2003

Product certificate based on this assessment directive will lose their validity on 20-01-2019.

1.4 Relation with the European Construction Products Regulation (CPR, EU 305/2011)

There is no European harmonised standard applicable on the products in the area of application of this assessment directive.

1.5 Requirements regarding research and testing laboratories

An applicant (producer or supplier) can submit reports of research and testing laboratories to show conformity to the assessment directive. These institutes has to be accredited for the subject according to:

- NEN-EN-ISO/IEC 17020 for inspection bodies;
- NEN-EN-ISO/IEC 17021-1 for certification bodies concerning system certification;
- NEN-EN-ISO/IEC 17025 for laboratories;
- NEN-EN-ISO/IEC 17065 for certification bodies concerning product certification.

A body is expected to fulfil these requirements with a valid accreditation certificate concerning testing linked to the subject. This certificate can be issued by the Council of Accreditation (RvA) or any other Accreditation body with mutual recognition.
When no accreditation certificate is available, the certification body shall verify themselves if the requirements for accreditation are fulfilled.

1.6 Product certificate

Based on the KOMO®-system applicable on this assessment directive, the following quality declaration is issued:
• KOMO® product certificate; for private requirements.

On the website of KOMO® (www.komo.nl) the model quality declaration of this assessment directive is published. The issued quality declaration has to be issued according to this model.

2 TERMS ANS DEFINITIONS

Modified timber:
Timber that has endured a treatment during which the cell wall material has changed at molecular level, in such a way that, dependent on the modification technology applied, properties of the timber, such as durability and dimension stability, are improved.

Timber modification / wood modification:
Timber modification is a collective term for technologies directed at the changing of physical and chemical properties of cell wall material in timber, different from technologies making use of biocides. The manner in which the cell wall material is modified, depends on the method applied. At the present state of the technique the methods can be subdivided into thermal, chemical, biological and enzymatic treatments.

Area of application:
The area of application of modified timber is defined as Use Classes according to NEN-EN 335.

EMC, Equilibrium Moisture Content:
Moisture content at a certain climate (temperature and relative humidity).

ASE, Anti Shrink Efficiency:
Degree of decrease of shrinkage due to the modification process.

3 INITIAL APPROVAL

3.1 Start of the approval research

The applicant of the product certificate provides the technical specifications of the modified timber. Information is provided regarding the Use Classes and applications and which performances has to be mentioned in the product certificate. The applicant provides foundation of these performances. In chapter 5 all the product certificate's performances, mandatory and facultative, are mentioned.

3.2 Initial inspection for the KOMO® product certificate

Before issuing the KOMO® product certificate an initial inspection is performed by the certification body:

- Conformity of the information provided by the applicant with the requirements in the assessment directive;
- Assessment of additional product performances or properties.

The certification body controls the provided performances and properties according to the requirements mentioned in chapter 4 and 5 of this assessment directive.

3.3 Assessment of quality system of the applicant

To obtain the product certificate an initial inspection on the quality system is performed;

- Assessment of the production process (chapter 4);
- Assessment of the quality system and the Internal Quality Scheme (IQS) (chapter 6);
- Assessment of additional procedures.

3.4 Issuing the KOMO® product certificate

The results of the initial inspection for the KOMO® quality declaration are reported and presented to the decider maker. The decider evaluates the results and decides whether a KOMO® product certificate can be issued or supplementary data or tests are required before a KOMO® product certificate have to be provided.

By issuing the product certificate the certification body declares that:

- The internal quality system of the certificate holder:
  - Complies to the requirements as mentioned in this assessment directive;
  - Is controlled by a independed third party on a regular basis;
- The certified product specifications comply to the requirements of this assessment directive.

3.5 External quality control

Once the KOMO® product certificate is issued the certification body carries out controls and inspections according to the requirements mentioned in chapter 8.

3.6 Validity of the KOMO® product certificate

The validity of the KOMO® product certificate is unlimited. The validity can be limited (terminated) by:

- Alterations of this assessment directive;
- Failure to comply with the commitments of this assessment directive

Valid certificates are listed on the website of KOMO (www.KOMO.nl).

In case of a temporary production stop, longer than 6 months, with the commitments of this assessment directive the certification body can suspend the validity temporary. A suspension can be in the first place of a maximum of 1 year. The certification body can expand the suspension with a total not more than 2 years.

In case of ending a suspension, the certifying body must be informed that production is again started. The certification body can then decide to end the suspension.
When the suspension period exceeds 1 year there must be a mandatory inspection control wheather the certificate can be revalidated.

When the duration of the suspension exceed the total of 2 years, the certification body must end the certificate.

4 DEMANDS REGARDING THE PRODUCTION PROCESS

4.1 General

The certificate holder should have an installation at its disposal to produce products of constant quality. The requirements regarding the product properties are described in chapter 5.

4.2 Raw materials

The producer records the demands regarding the raw materials. Aspects of the raw material that influence the process parameters or the properties of the final product shall be stated. The influence of these variables should be recorded in order to set the process conditions.

4.3 Registration

All relevant information concerning the production process (type of modification) should be recorded automatically on paper or digitally.

For purposes of trace-ability, each treatment charge should have an unique identification number. Each pack or bundle should be numbered and traceable until the pack or bundle is discontinued..

4.4 Uniformity and reproducibility of the production process

The producer shall ensure the uniformity (within a batch) and reproducibility (between batches) by demonstrating that the process conditions within the complete production installation are uniform.

The reproducibility of the process is preferably demonstrated based on the durability against basidiomycetes (NEN-EN 350:2016).
In case the durability of the modified timber is a minor property and of minor risk, the producer can request the durability to be omitted from the quality declaration. In that case, establishment of the durability class is not required. The reproducibility can be established based on another parameter (colour, shrinking and swelling etc).

4.4.1 Uniformity and reproducibility production process base on durability

The reproducibility base on durability is established on the properties of at least one wood species. The modified timber is tested conform the demands stated in NEN-EN 350 according the description in chapter 5.1 of this assessment directive.

NEN-EN 350 is approved in August 2016. Data according to NEN-EN 350-1 stay valid and are also accepted.

For purpose of the investigation 45 test pieces are tested per fungus. The test pieces originate form 45 boards or beams treated in 3 production batches (15 per batch).

The 45 treated boards will be used to determine the bending strength (5.8.2.1) and elasticity (5.8.2.1), density and equilibrium moisture content (5.7) and shrinking and swelling (5.3.1).

Remark 1: These properties are mandatory for each wood specie to characterise the influence of the process on several parameters of the final product (wood specie). Each additional wood specie can be characterised from samples of a single charge instead of three charges.

After the durability test (EN 113 preceded by the EN 84) individual x-values are calculated of every individual test piece and every fungus by dividing the mass loss of each individual test piece by the average mass loss of the reverence test pieces (pine sapwood for modified softwoods and beech for modified hard woods) .

$$\mathbf{x - value_i} = \frac{\text{mass loss test piece under investigation}_{\,i}}{\text{average mass loss of reference test pieces}} \qquad \textbf{[1]}$$

With:
X-value$_i$ = x-value of an individual test piece i originating from an specific board of beam
Mass loss test piece = mass loss of an individual test piece of modified timber i.

The process can be considered reproducible if the results comply to the following criteria (figure 1):

- All individual x_i-values of the strongest fungus are < 0.15, durability class 1, or;
- When the x-value < 0.3, automatically durability class 2 can be claimed and the quotient has not the be calculated,
- At the strongest attacking fungus the quotient between the highest and lowest calculated X-value < 2, or;

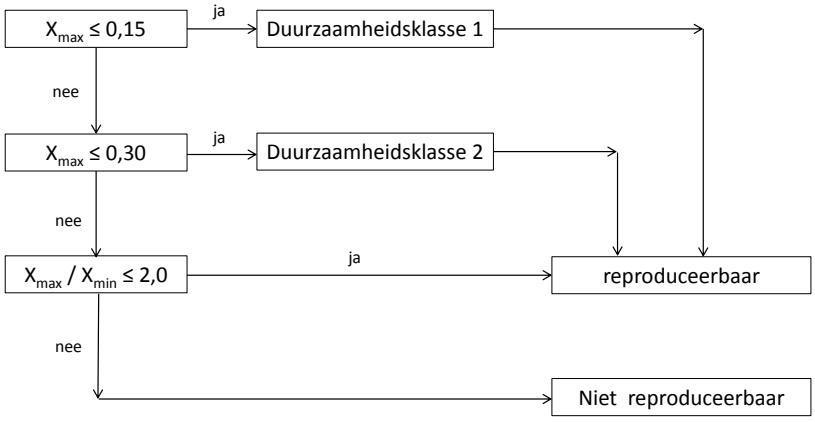

Figure 1: Acceptance of reproducibility
Duurzaamheidsklasse = Durability class
(Niet) reproduceerbaar = (Not) reproducable

4.4.2 Uniformity and reproducibility or the production process other the durability.

The uniformity and reproducibility based on another property than durability is established on at least one wood species. The typical property is investigated conform chapter 5 of this assessment directive

When the assessment directive does not give a method to determine the claimed property a validated method must be provided. This method must be performed and validated at an independent research institute.
The average value ($\overline{x}$) and standard deviation(s) per batch are determined of the property under investigation (see [2] and [3]). These formulas are based on a normal distribution. If another distribution is opportune, the proper method of determination can be decided upon in consultation with the certification body.

$$\bar{x} = \frac{\sum x_i}{n} \quad \textbf{[2]}$$

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{(n-1)}} \quad \textbf{[3]}$$

With
n = number of determinations in a batch (15)
x_i = individual determinations
$\overline{x}$ = average value of the batch
s = standard deviation of a batch

the properties must, depending on the properties, for each batch comply to the following demands:

- At a one sided acceptance level (for instance swelling) comply to the top 90% or lower 10% of the specific limit (see[4] and [5]);
- At a two sided acceptance level (for instance colour) the property should comply tot he top (95%) lowest (5%) specification limit (see [6] and [7]);
- De specification limit is the same as the declared value.

The specification limits are calculated as:

$$\boldsymbol{L_{10\%} = \bar{x} - t_n \cdot \bar{s}} \quad \textbf{[4]}$$
$$\boldsymbol{U_{90\%} = \bar{x} + t_n \cdot \bar{s}} \quad \textbf{[5]}$$

$$\boldsymbol{L_{5\%} = \bar{x} - t_n \cdot \bar{s}} \quad \textbf{[6]}$$
$$\boldsymbol{U_{95\%} = \bar{x} + t_n \cdot \bar{s}} \quad \textbf{[7]}$$

With:

$L_{10\%}$ = lower specification limit at 1 sided property
$U_{90\%}$ = top specification limit at 1 sided property
$L_{5\%}$ = lower specification limit at 2 sided property
$U_{95\%}$ = top specification limit at 2 sided property
t_n = Statistical value according to table 1 (for n = 15, $t_{15,\ 5\text{-}95\%} = 1.76$ and $t_{15,\ 10\text{-}90\%} = 1.35$)
s = Standard deviation

Table 1: Statistical values based on the number of observation

N, number of test pieces per batch										
t_n 10% and 90%										
t_n 5% and 95%										

5

5 REQUIREMENTS FOR THE PRODUCT

General
The general requirements and the possible assessment directives and normative references are laid down in chapters 5.1 to 5.9.

The product specifications shall be included in the product certificate.
The product specifications are stated as absolute or as relative values (i.e. in respect of the basic material). Within the product certificate the restrictions and intended applications of the modified wood will be stated.

The following properties are mandatory for every wood specie. The determination can be on basis of one single charge. Uniformity and reproducibility do not have to be proven for additional wood species. Hereby the specific influence of the modification process on the individual wood species is determined:

- Durability (5.1);
- Bending strength (5.8.2.1);
- Bending stiffness (5.8.2.1);
- Density (5.7);
- Equilibrium Moisture Content (5.7);
- Shrinkage behaviour (5.3.1).

In case the producer of the modified wood is not intending to make any claims within the product certificate on improved durability performance (resistance against fungal decay), this is not obligatory to test (4.4.2).

All other product properties described within this chapter (5.1 to 5.9) are optional to include in the product certificate.

For applications within joinery additional information might be required (see Appendix 1).

5.1 Performance requirement: Durability

The producer of the modified timber indicates for which applications the timber shall be produced. The durability of modified timber shall be in agreement with the circumstances in which it shall be applied, all in accordance with EN 460. The circumstances, also indicated as use classes for biological attack, are defined in EN 335. The modified timber product shall comply to the indicated use class.

For every additional wood species, testing of 15 samples from 1 batch is sufficient. If previous test results show a distinct sensitivity for a fungi species, only this species needs to be tested (after discussion with Certification Body (CB) and distinction between soft and hard wood species).

Remark 2: The samples need to be taken at a minimum 100 mm from the cross end of the modified boards. In case of testing of heart wood, the samples shall be cut near the centre of the boards.

Determination method
The test methods that can be used to classify a modified timber species as suitable for a use class by durability performance, shall be executed in accordance with EN 350-1:1994 or NEN-EN 350:201:.

- For use classes 1, 2 or 3 for:
  - NEN-EN 350-1:1994, NEN-EN 113 applies when prior to execution of the test the test pieces are leached according to NEN-EN 84. Instead of Serpula lacrymans the test fungus Coniophora puteana shall be used for all modified timber species.
  - NEN-EN 350:2016, CEN/TS 15083-1 is applicable
- For use class 4:

- NEN-EN 350-1:1994, the ENV 807 applies when prior to execution of the test the test peaces are leached according to NEN-EN 84. Classification of the x-value will be done conform NEN-EN 113 test results as described in NEN-EN 350-1.
- NEN-EN 350:2016, CEN/TS 15083-2 is applicable

In addition to ENV 807 (use class 4) an in-ground field test according to NEN-EN 252 needs to be started. The quality declaration is given provisionally on basis of the results of ENV 807.

Suitability for use class 5 (marine conditions) needs to be demonstrated according to existing standards and test results (for instance on basis of NEN-EN 275).

For application of modified wood in joinery (use classes 1, 2 and 3) additional requirements on durability testing apply. Instead of the described fungi species according to NEN-EN 350-1:1994 or NEN-EN 350:2016, the species shown in table 2 should be used for testing both modified soft and hard wood species.

Table 2: NEN-EN 113 or CEN/TS 15083-1 fungi species for use in KOMO joinery.

Soft wood species	Hard wood species
Gloeophyllum trabeum	Dokioporia expansa
Poria placenta Coniophora puteana Trametes versicolor	Poria placenta Coniophora puteana Trametes versicolor

When both modified sapwood and heartwood of a timber species is being applied in practice, the durability of the modified sapwood shall at least be determined.

Initial inspection
During the initial inspection the durability class of the product is determined.

KOMO® product certificate
The KOMO® product certificate will mention the durability class of the material.

5.2 Moisture content

5.2.1 Performance requirement: Equilibrium Moisture Content

Determination method
The equilibrium moisture content of the modified timber at 65% RH, 20 °C shall be included in the quality declaration, and is to be determined by means of the oven-dry method as laid down in EN 13183-1. The equilibrium moisture content shall be expressed as a value (%) with a tolerance of ± 2% (see also section 5.3.2).

Initial inspection
During the initial inspection the equilibrium moisture content of the material at 65% RH and 20 °C is determined.

Remark 3: At delivery the moisture content of the modified wood can deviate from the equilibrium moisture content. It is the responsibility of the producer to communicate this with the customer.

KOMO® product certificate
The KOMO® product certificate will mention the equilibrium moisture content at 65% RH and 20 °C.

5.2.2 Performance requirement: Water absorption (optional)

The water uptake is determined according to Appendix1: The suitability of modified timber for application in joinery.

Determination method
Of each wood species or type of process 15 stakes of the dimension 20 x 20 x 400 mm are cut from 15 boards out of 3 production batches. As reference 15 stakes of Scots pine sapwood of the same dimensions are used. The stakes are conditioned at 65% ± 5% RH, 20 ± 2 °C until constant mass.

All stakes are weighed to 0.2 gram accuracy. Twelve stakes, four of each batch, are put into 5-10 mm water in a closed box. Three stakes, the fifth stake of each batch, are placed in the same box but above the water. All stakes most be positioned separately and should be standing free from each other and from the sides of the container. The weight of the stakes is measured at the start, after 1 and 24 hours and after 2, 3, 7, 14 and 21 days. The water uptake is caused by capillary uptake of liquid water and by adsorption of moisture from the high humidity surrounding in the closed box.

After the water uptake test the water loss is determined. The stakes are put into a climate of 65% ± 5% RH, 20 ± 2 °C and weighed after 1 and 24 hour and after 2, 3, 7 and 14 days.

The water uptake and loss are determined according to:

$$W_i = (m_{wi} - m_{w0}) - (m_{di} - m_{d0}) \quad [8]$$

with:
W_i water uptake and water loss at time i [g]
m_{wi} weight of water uptake of samples at time i [g]
m_{w0} weight water uptake of samples at time 0 [g]
m_{di} weight water vapour uptake of samples at time i [g]
m_{d0} weight of water vapour uptake of samples at time 0 [g]

Initial inspection
During the initial inspection the water uptake of the material is determined.
The following conditions describe a high water uptake and low water release:
- The maximum (average) water uptake after 21 days ≥ 0,4 x maximum average water uptake of pine sapwood;
- After 14 days water release, the (average) moisture content does not reach the starting moisture content ± 1%.

KOMO® product certificate
The KOMO® product certificate will mention if the water uptake ability of the material is high or low.

5.3 Dimensional stability

The shrinkage and swelling behaviour of modified timber will, depending on the application, be an minor of an essential property. In case the dimensional stability is of minor interest when applying modified timber, the test referred to in section 5.3.1 is sufficient
This way wood species can be compared to each other.

In case of direct water contact by exposition to weather and wind and/or direct positioning in water, section 5.3.1 applies too.

Additional requirements concerning shrinkage behaviour of (modified) timber apply for application in joinery (essential shrinkage and swelling par. 5.3.2, see also SKH Publication 99-05 and 13-02). The requirements are listed in appendix 1.

5.3.1 Performance requirement: Dimensional stability as minor property

The dimensional stability as a minor property may be determined according to Appendix1: The suitability of modified timber for application in joinery.

Determination method

The dimensional stability as a non-essential characteristic can be determined according annex 1 or according to DIN 52184 when desirable.

The dimensional stability (for joinery and other applications) is determined by conditioning perfectly radially and tangentially cut samples to different climate conditions. The samples are preferably 50 x 50 mm, but at least 20 x 20 mm cross cut dimensions, and a length of 10 mm.
A minimum of 15 test pieces cut from 15 different boards are used, preferably treated in 3 different production batches. The dimensional stability is determined between 50 and 90% RH. With respect to hysteresis effects the samples, the test pieces are conditioned initially at 30 - 35% RH, 20 °C for at least 1 week.
After 1 week at 30 – 35% RH the test pieces are conditioned at 50 ± 5% RH, 20 ± 2 °C until constant mass (maximal weight difference of 0.1% within 24 hours). The dimensions are measured with an accuracy of 0.02 mm. Subsequently the samples are conditioned at 90 ±5% RH, 20 ± 2 °C to a constant mass, and the dimensions are again measured with an accuracy of 0.02 mm.

The swelling is calculated in accordance with:

$$St_{50-90\%} = \frac{(Dt_{90} - Dt_{50})}{Dt_{50}} \times 100\% \qquad \textbf{[9]}$$

and

$$Sr_{50-90\%} = \frac{(Dr_{90} - Dr_{50})}{Dr_{50}} \times 100\% \qquad \textbf{[10]}$$

With:

$St_{50\text{-}90\%}$	tangential swelling between 50% and 90% RH [%]
$Sr_{50\text{-}90\%}$	radial swelling between 50% and 90% RH [%]
Dt_{50}	tangential dimension at 50% RH [mm]
Dt_{90}	tangential dimension at 90% RH [mm]
Dr_{50}	radial dimension at 50% RH [mm]
Dr_{90}	radial dimension at 90% RH [mm]

The dimensional stability may also be determined according to DIN 52184.

The tangential shrinkage shall be determined, as well as the difference between tangential and radial shrinkage of test samples. The swelling coefficient is the percentage of swelling of the wood per 1% change in relative humidity between 35 and 85% RH. The differential swelling is the percent of swelling per 1% change in wood moisture content between 35 and 85% RH.

Initial inspection
During the initial inspection will be controlled if the swelling and/or shrinking is determined according to to Appendix1: The suitability of modified timber for application in joinery.

KOMO® product certificate
The KOMO® product certificate will mention the swelling in the 50% RH – 90% RH range or will mention the swelling coefficient according to DIN 52184.

5.3.2 Performance requirement: Dimensional stability as an essential property (optional)

Parallel to the determination of the dimensional stability the EMC can be determined.

Determination method
A swelling and shrinkage behaviour from oven dry to water saturated should be done with the following intermediate climates (RH ± 5%, 20 °C): determined by subjecting samples to the following climates: 30% RH, 50% RH, 65% RH, 80% RH and 90% RH (in this and in reversed sequence). From the swelling and/or shrinkage coefficient ASE (anti shrink/swelling efficiency) can be calculated.

$$S\ (\%) = [(V_{ws} - V_{od}) / V_{od}] \times 100 \qquad \textbf{[11]}$$

Met
S Shrinkage or swellings coefficient
V_{ws} Volume of water saturated wood
V_{od} Volume of oven dry wood

$$ASE\ (\%) = [(S_u - S_m) / S_u] \times 100 \qquad \textbf{[12]}$$

Met:
ASE Anti Shrink Efficiency or Anti Swelling Efficiency
S_u Shrinkage or swelling coefficient van non –modified wood
S_m Shrinkage or swelling coefficient van modified wood

Initial inspection
The determination of the shrinkage and swelling data is controlled.

KOMO® product certificate
The KOMO® product certificate will mention the shrinkage or swelling data.
Also the product certificate can mention the calculated Anti Shrink or Swelling Efficiency.

5.3.3 Performance requirement: Shrinkage class

For use in joinery the shrinkage class of the modified timber is requested.

Determination method
The method is described in Appendix 1.

Initial inspection
The data to determine the shrinkage class will be evaluated.

KOMO® product certificate
The KOMO® product certificate mentions the stated shrinkage class.

5.4 Performance requirement: Glue ability (optional)

5.4.1 Non-loadbearing applications (optional)

Determination Method
The requirements as well as the required test methods in respect of the glue ability shall comply to Appendix1: The suitability of modified timber for application in joinery.

Initial Inspection
The data of the glue ability will be evaluated if they comply with the requirements

KOMO® product certificate
The KOMO® product certificate will mention if the material is suitable for use in glued non-load bearing applications.

5.4.1.1 Performance requirement: Window frame Joinery (optional)

Determination method
The method is described in Appendix 1.

Initial inspection
The compliance of the material data to the requirements is controlled.

KOMO® quality declaration
The KOMO® quality declaration will mention the suitability for use in window frame joinery.

5.4.1.2 Performance requirements: Windows and doors (optional)

Determination method
The method is described in Appendix 1: The suitability of modified timber for application in joinery.

Initial inspection
Evaluation if the material complies to the requirements.

KOMO® product certificate
The KOMO® product certificate will mention the suitability for use in windows and doors.

5.4.1.3 Performance requirement: Finger jointed timber for exterior use (optional)

Determination method
The method is described in Appendix 1: The suitability of modified timber for application in joinery.

Initial inspection
Evaluation if the material complies to the requirements.

KOMO® product certificate
The KOMO® product certificate will mention the suitability for use in finger jointed timber for external use.

5.4.1.4 Performance requirement: Laminated timber for exterior use (optional)

Determination method
The method is described in Appendix 1: The suitability of modified timber for application in joinery.

Initial inspection
Evaluation if the material complies to the requirements.

KOMO® product certificate
The KOMO® product certificate will mention the suitability for use in laminated timber for external use.

5.4.2 Performance requirement: Load bearing constructions (optional)

The requirements as described in AD 2338 apply to demonstrate the performance of the modified wood in combination with the adhesive.

Determination method
The method is described in Appendix 1: The suitability of modified timber for application in joinery.

Initial inspection
Evaluation if the material complies to the requirements.

KOMO® product certificate
The KOMO® product certificate will mention the suitability for use in loadbearing constructions.

5.5 Performance requirement: Finishing (optional)

The modified timber can be coated with a finishing product.

Determination method
The method is described in Appendix 1: The suitability of modified timber for application in joinery, B2.8).

Initial inspection
Evaluation if the material complies to the requirements.

KOMO® product certificate
The KOMO® product certificate will mention the suitability for finishing joinery.

5.6 Colour (optional)

5.6.1 Performance requirement: Sensitivity for UV radiation (optional)

The UV sensitivity may be determined when modified timber shall be used untreated or finished with transparent coating.

Determination method
The UV sensitivity is determined by colour measurements according to CIE-Lab method (ISO 7724-2) prior to and after QUV weathering described in NEN-EN 927-6 (12 weeks) on modified wood without a coating.

Initial inspection
There will be controlled what the UV sensitivity of the modified timber is according the test method.

KOMO® product certificate
The KOMO® product certificate will mention the UV-sensitivity after QUV-weathering of the material according to the CIE-lab method.

5.6.2 Performance requirement: Colour value (optional)

Determination method
In situations where the colour of the modified timber is important, the colour value can be determined by means of a colorimeter according to the CIE-Lab method (ISO 7724-2), and colour changes are measured according to ISO 7724-3.
The colour value needs to be determined on 45 samples, 15 samples from 3 batches.

Initial inspection
There will be controlled what the colour value after the modification treatment will be..

KOMO® product certificate
The KOMO® product certificate will mention the colour value of the material after the modification treatment.

5.7 Performance requirement: Density

Determination method
The density is determined in accordance with ISO 13061-2 at an equilibrium moisture content at 65% RH, 20 °C, with a minimum of 15 samples.

Initial inspection
Evaluation of the density at the prescribed climate conditions (20 °C, 65% RH).

KOMO® product certificate
The KOMO® product certificate will mention the density of the modified material at an equilibrium moisture content at 20 °C, 65% RH.

5.8 Mechanical properties

If the mechanical properties of the modified timber deviate from the properties of the untreated timber, the mechanical properties shall be determined and stated in the product certificate.

Statements on mechanical properties such as bending strength (MOR), bending stiffness (MOE), impact bending strength and shear strength, can be added to the quality declaration, if tests have been performed according to the appropriate standards as shown in chapter 10.

5.8.1 Non-loadbearing, non-structural applications

No requirements in respect of bending strength and stiffness have been laid down for modified timber. Possible changes of the mechanical properties as a result of the modification treatment shall be included in the product certificate.

Except for mid stiles and sills, where strength requirements are described in the KVT, no requirements are laid down for (modified) wood in joinery.

5.8.2 Structural applications (optional)

5.8.2.1 Performance requirement: structural use in joinery (optional)

Determination method
By means of laboratory tests it shall be demonstrated that the mechanical properties of modified timber comply with SKH-Publication 97 04:

- *bending strength (N/mm^2)*, determined in accordance with NEN EN 408 (four-point bending test);
- *hardness*, determined according to Janka (N) (ASTM D 143) or according to Brinell (NEN-EN-ISO 6506-1);
- *bending stiffness (N/mm^2),* determined in accordance with NEN EN 408;
- *cleaving resistance and screw holding capacity* in accordance with ASTM D143 and SKH-BGS 002 respectively.

Initial Inspection
The bending strength, elasticity, hardness and cleavage strength and screw holding capacity of the material will be evaluated.

KOMO® product certificate
The KOMO® product certificate will mention the bending strength, elasticity, hardness and cleavage strength and/or screw holding capacity of the material.

5.8.2.2 Performance requirement: Loadbearing and structural application (optional)

Determination method
For load bearing applications the bending strength and stiffness should be determined with a 4-point bending test according to NEN-EN 408 and determination of characteristics values according to Eurocode NEN-EN 1990. Classification in strength class (NEN-EN 338) is not possible. However, the determined characteristic values can be used to perform structural calculations.

Initial inspection
The data on bending strength and stiffness are controlled.

KOMO® product certificate
The KOMO® product certificate mentions the (characteristic values) of bending strength and stiffness that have been determined.

5.8.2.3 Performance requirement: Intermittent load, impact bending strength (optional)

Determination method
When modified timber has been applied in situations where intermittent load could be important, the impact bending strength shall be determined in accordance with DIN 52 189-1.

Initial inspection
The results of the test will be evaluated.

KOMO® product certificate
The KOMO® product certificate mentions the determined impact bending strength of the material.

5.9 Fire behaviour (optional)

Reference is made to the Building Act, in which functional and performance requirements are laid down for requirements to be set for the fire behaviour of modified timber.

Determination method
The classification of the performance of reaction of fire should be determined according to NEN-EN 13501-1.

Initial inspection
The results will be evaluated according NEN-EN 13501-1

KOMO® product certificate
The KOMO® product certificate mentions the reaction to fire performance of the material.

6 REQUIREMENTS REGARDING THE QUALITY SYSTEM

6.1 General

The following sections mention the requirements to which the producer's quality system has to comply with.

6.2 Responsibility

The owner of the certificate will be always responsible for the quality of the fabrication process, the internal quality control and the quality of the product. The internal quality control has to comply with the requirements in this chapter. The certificate owner shall maintain a quality scheme with at least the requirements as described.

Initial inspection
The certification body will control:
- The compliance of the quality scheme with the requirements of this assessment directive;
- The competition of the personnel involved;
- Weather the quality control scheme is implemented correctly.

KOMO® product certificate
The product certificate to be issued will mention that the internal quality system of the company is controlled periodically and therefore:
- The internal quality control scheme complies with the requirements;
- The certificate holder is able to assure the compliance of his product;
- The product meets the technical requirements.

The producer is responsible for the product, the production process of the product and the internal quality system.

6.3 Quality System manager

Within the company, an official must be appointed who is responsible for maintaining the Internal Quality Control Scheme. This will be the contact person for the certification body.

6.4 Quality System

6.4.1 Control of documents

The written procedures for inspection and testing shall be assessed and approved for suitability and effectiveness by the authorised persons within the company. This has to be done before distribution of the procedures within the company.
Document control must ensure that only valid documents are available for inspection and testing of the product. The documents shall be (also) in Dutch, English or German.

6.4.2 Inspection and testing

6.4.2.1 Internal Quality Control Scheme

The producer shall keep an Internal Quality Control Scheme. At least the following aspects and procedures should be included in writing:
- Control of incoming raw materials;
- Workplace instructions (control of the production process);
- Control of the end product;
- Control of measuring equipment;
- Registration of complaints;
- Handling non-conformity products.

6.4.2.2 Registration

A registration shall be kept of the inspections and tests described in the Internal Quality Control Scheme. Registered data need to be kept for a period of at least 10 years.
The producer should have an appropriate and accessible registration or inspections and tests carried out and keep these up to date in order to be able to show that the requirements have been complied with.

6.4.2.3 Calibration

When applicable, measuring and testing equipment shall be controlled at least once a year. A registration shall be kept of this control. The producer may perform these controls by themselves. In case of doubt the Certification body can ask for calibration by an accredited Calibration Body.

6.4.2.4 Supply

Raw materials shall be controlled upon receipt in accordance with the Internal Quality Control Scheme. The results of this raw material inspection shall be registered.

6.4.2.5 Laboratory

For the internal execution of laboratory tests the producer shall have (a separate) space equipped with the prescribed measuring and test equipment.
In case of using an external laboratory, the laboratory shall be approved by the certification body.

Samples used for measuring and testing shall by clearly identified.

The producer shall have at least the following equipment (general):
- Oven (103 ±1 °C)
- Scale (±0,1 g)
- Wood moisture meter (calibrated)
- Calibrated thermometer (control of the oven)
- Equipment for controlling the end product. The equipment is to be defined by the certification body depending on the type of modification.

6.4.2.6 Non-conformity products

Products or parts of products that during the production process do not comply with the requirements shall be set aside and clearly marked.
In case of an accidental shortcoming, it is sufficient to perform a correction on the production (disposal of the products or re-treatment).
In case of a structural shortcoming, restart of production can only begin after retrieving the cause, and implementation of corrective measures and after re-control by the Certified Body.

6.4.2.7 Retaining product characteristics

Production, internal transport and storage of end products shall be done in such way that product properties are maintained. External transport shall be performed in such way that damaging and permanent deformation can not occur.

6.4.3 Handling of complaints

The producer (the owner of the product certificate) shall maintain a register of complaints related to the treated product and the application there of.
For every complaint it has to be clear how the complaint is analysed and is dealt with and any corrections and corrective measures taken.

7 MARKING

The KOMO® modified timber shall be supplied marked per bundle or packaging unit:

The KOMO® mark and/or logo, minimum size 5 mm. Besides KOMO® mark also the QR code can be used as it appears on the KOMO® website for the relevant certificate;
2. The quality declaration number and/or the name of the producer of the modified timber;
3. The production date and/or batch number.

When packaging units are split, the date and batch number do not have to be present on each part;
The area of application of the product, at least by mentioning the Use Class according to NEN-EN 335-1, or another code according to table 3.
The original wood species of which the modified timber is produced of.

The certification mark has to be fixed separate from any other quality marking to prevent any confusion.

Table 3: Use Classes according to NEN-EN 335-1

Use Class	Description	Colour code	Letter code
1	Above ground, inside	Black	L
2	Above ground, inside with risk of wetting	Orange	
3	Above ground, outside, periodic rain contact	Blue	
4	In ground contact, permanent water contact and ground-water contact	White	G
5	Permanent contact with brackish and salt water	Red	Z

8 REQUIREMENTS REGARDING EXTERNAL CONTROL

8.1 General

External quality control is specified by the certification body in accordance with the Regulations for Product Certification of the certification body.

8.2 Initial Inspection

The certification body controls during the initial inspection whether the relevant company/producer complies with the requirements as given in this Assessment Directive. A report of the initial inspection shall be made as a basis on which the KOMO® product certificate is issued.

The initial inspection report shall:
- Be complete: all requirements has to be mentioned;
- Trace-ability: all data shall be recorded.

The decider shall base the decision on the data put in the report. The decision to issue the certificate will not be the same person as who has done the initial inspection.

8.3 Annual Controls

The certification body controls 3 x per annum whether the product complies with the technical specifications as mentioned in sections 4, 6 and 7 of this Assessment Directive and whether the internal quality control system complies.

A written report is made of these controls.
On recommendation of the Board of Experts of SKH, the frequency of controls mentioned above can be adjusted.

The country in which the controls has to be performed must be safe for the control visits.
In case of negative travel advisory issued by the Ministry of Foreign Affairs, products will be inspected upon arrival in the Netherlands. In that case the producer is obliged to notify the certification body. In good time and writing, o the deliveries, including the time and location of receipt.

8.3.1 Periodic control on reproducibility

Periodic the reproducibility of the production process will be controlled. Therefor the durability will be checked in correlation with the treatment process.

In case the producer of the modified wood is not intending to make any claims within the product certificate on improved durability performance (resistance against fungal decay), this is not obligatory to test, but shall the test be done according to the reproducibility test done during initial intake.

8.3.1.1 Reproducibility in respect of durability tests

For every production location additional research of performance of durability in relation with the treatment method shall be done yearly. A minimum of 15 samples will be taken by the certification body and will be sent to an (accredited) laboratory for testing according to NEN-EN 113 or CEN-TS 15083-1 on leached samples according to EN 84. These samples will be taken out of production or from batch found in the market.

For every location a minimum of at least one modified product (wood specie) will be tested, to be determined by the certification body. These test shall be performed with the most aggressive fungus for that product (modified wood specie).
When multiple modified products are certified will be sought variation in product testing, so that all products be tested over the years.
If it is required, extra samples can be taken.

The cost for the execution of these yearly tests (with or without extra sampling), shall be financed by the producer.

9 REQUIREMENTS REGARDING THE CERTIFICATION BODY

9.1 General

The certification body shall comply with the requirements according to NEN-EN-ISO/IEC 17065 and must be accredited by the Raad voor Accreditie (RvA, Dutch Accreditation Council), and having a license agreement, or have initiated the application procedure for this.

The certification body shall have regulations, or an equivalent document, in which the general rules are mentioned to comply with for certification. In particular, these are:

- General rules for performing the initial inspection:
  - Procedure to inform the applicant about the administrative process of an application;
  - Procedure for the execution of an initial inspection;
  - Procedure about the decision of acceptation based on the initial inspection;
- General rules with respect to perform controls and inspections and the controlled aspects of the controls and inspections;
- Procedure of taking measures by the certification body in case of non-conformities;
- Procedures about the termination of the quality declaration;
- Procedure of the option of making appeal against decisions or measures imposed by the certification body.

The board of experts of SKH (CvD, College van Deskundigen) is able to make an interpretation document of this Assessment Directive. The use of this document is mandatory for every certification body using this Assessment Directive.

9.2 Certification Staff

The staff involved in the certification process is defined as followed:
- Controller, inspector: performing external controls;
- Initial inspector: performing the initial inspection and assessing reports of test and laboratories.
- Assessor: assessing results of the initial approval research inspection and external controls; decisions needed for taking corrective measures;
- Decision-maker: taking decisions based on the initial inspections and continuation of the quality declaration based on controls..

9.3 Qualification

Staff involved in the certification process shall be tangibly demonstrably qualified for the performance of the required activities. The following requirements apply in respect of education, training expertise and experience:

Certification Staff	education	Expertise and experience
Controller Initial inspector	Intermediate Vocational Training level	- Production and application of modified timber or similar; - Training ISO 9001 auditor; - Minimum of 2 year experience in timber industry or similar.
Assessor	Higher Vocational Training level	- Timber and/or construction education or similar; - Production and application of modified timber or similar; - Minimum of 2 year experience on management level within the timber industry or similar.
Decision-maker	Higher Vocational Training level	- Management experience or similar; - Certification experience or similar; - Accreditation experience or similar; - Knowledge of relevant certification schemes and systems.

Certification staff has to be qualified by means of assessment of training and assessment of experience of the above mentioned requirements. In case of qualification on other criteria than mentioned, it should be documented.

Qualification of personnel will be done by:
- Decision-takers for the qualification of controllers, inspectors and other auditors;
- Management for qualification of decision-takers.

9.3 Reporting to the Board of Experts (CvD)

The certification body reports at least annually about the work done for the specific field of certification. In this report the following aspects must be mentioned:
• Mutations in the number of certificates (new, ended);
• Number of controls performed in relation to the prescribed control frequency;
• Results of these controls.

9.4 Sanctions procedure

Sanctions procedure (sanctions to be taken by the certification body in case of non-conformities) shall be laid down in the Regulations for Product Certification of the certification body or in a separate document.

10 REFERENCE DOCUMENTS

ASTM D143-14	Standard Test Methods for Small Clear Specimens of Timber. Sections 95-99 – Cleavage;
ASTM D3359-09e2	Standard Test Methods for Measuring Adhesion by Tape Test;
AD 0801:20011+WB2016	Houten gevelelementen, uitgave SKH;
AD 0803:2013+WB2016	Houten buitendeuren, uitgave SKH;
AD 0814:2016	Film forming coatings for application on timber;
AD 0817:2008+WB2009	Film forming mid- and top coat systems on timber;
AD 0819:2010	Joining techniques in wooden façade elements;
AD 2338:1998 + WB:2007	Adhesives for load bearing wooden building constructions;
AD 2339:2012	Adhesives for non-load bearing applications
CEN/TS 15083-1:2005	Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 1: Basidiomycetes;
CEN/TS 15083-2:2005	Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 2: Soft rotting micro-fungi;
CPR	Regulation (EU) No 305/2011 - Construction products;
DIN 52184:1979	Prüfung von Holz; Bestimmung der Quellung und Schwindung;
DIN 52189 Part 1:1981	Prüfung von Holz; Schlagbiegeversuch - Bestimming der Bruchschlagarbeit;
ISO 7724-2:1984 en	Paints and varnishes - Colorimetry - Part 2: Colour measurement;
ISO 7724-3:1984 en	Paints and varnishes - Colorimetry - Part 3: Calculation of colour differences;
ISO 13061-2:2014	Physical and mechanical properties of wood - Test methods for small clear wood specimens - Part 2: Determination of density for physical and mechanical tests
KVT	Kwaliteit van houten gevelelementen, uitgave NBvT
NEN 1068:2012+C2:2016	Thermal insulation of buildings - Calculation methods;
NEN-EN 84: 1997	Wood preservatives - Accelerated ageing of treated wood prior to biological testing - Leaching procedure;
NEN-EN 113:1996/A1:2004	Wood preservatives - Test method for determining the protective effectiveness against wood destroying basidiomycetes - Determination of the toxic values;
NEN-EN 252:2014	Field test method for determining the relative protective effectiveness of a wood preservative in ground contact;
NEN-EN 275:1993	Wood preservatives - Test method for determining the protective effectiveness against marine borers;
NEN-EN 335:2013	Durability of wood and wood-based products - Use classes: definitions, application to solid wood and wood-based products;
NEN-EN 335-1:2006	Durability of wood and wood-based products - Definition of use classes - Part 1: General;
NEN-EN 338:2016	Structural timber - Strength classes;
NEN-EN 350-1:1994	Durability of wood and wood-based products - Natural durability of solid wood - Part 1: Guide to the principles of testing and classification of the natural durability of wood;

NEN-EN 350:2016	Durability of wood and wood-based products - Testing and classification of the durability to biological agents of wood and wood-based materials
NEN-EN 408:2010/A1:2012	Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties;
NEN-EN 460:1994	Durability of wood and wood based products - Natural durability of solid wood - Guide to the durability requirements for wood to be used in hazard classes;
NEN-EN 927-6:2006	Paints and varnishes - Coating materials and coating systems for exterior wood - Part 6: Exposure of wood coatings to artificial weathering using fluorescent UV lamps and water;
NEN-EN 1990+A1+A1/ C2:2011/NB:2011	National Annex to NEN-EN 1990+A1+A1/C2: Eurocode: Basis of structural design;
NEN-EN 12664:2001	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Dry and moist products of medium and low thermal resistance;
NEN-EN 13183-1:2002	Moisture content of a piece of sawn timber - Part 1: Determination by oven dry method;
NEN-EN 13501-1:2007 +A1:2009	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests;
NEN-EN-ISO 4628-2:2016	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;
NEN-EN-ISO 4628-4:2016	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;
NEN-EN-ISO 4628-5:2016	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;
NEN-EN-ISO 6506-1:2014	Metallic materials - Brinell hardness test - Part 1: Test method;
NEN-EN-ISO 9001:2015	Quality management systems – Requirements;
NEN-EN-ISO 10456:2008 +C1:2009	Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values;
NEN-EN-ISO/IEC 17020:2012	Conformity assessment - General criteria for the operation of various types of bodies performing inspection;
NEN-EN-ISO/IEC 17021:2011	Conformity assessment – Requirements for bodies providing audit and certification of management systems;
NEN-EN-ISO/IEC 17025:2005 +C1:2007	General requirements for the competence of testing and calibration laboratories;
NEN-EN-ISO/IEC 17065:2012	Conformity assessment - Requirements for bodies certifying products, processes and services;
NVN-ENV 807: 2001	Wood preservatives - Determination of the effectiveness against soft rotting micro-fungi and other soil inhabiting micro-organisms;
SKH-BGS 002:2017	SKH-Publicatie Beoordelingsgrondslag – BGS voor schroeven geschikt voor hout- en houtachtige plaatmaterialen.
SKH Publ. 05-01:2018	SKH-Publication - Determination of the adhesion of paint on wood.
SKH-Publ. 06-02:2011	Assessment of the closeness of a paint film on timber;
SKH-Publ. 08-02:2015	Determination of the water permeability after critical drying and complete drying of coating systems on timber;
SKH-Publ. 10-01:2015	Water uptake and freeze stability test;

SKH-Publ.13-02:2018	SKH-Publication - Approved modified timber species to be used in wooden facade elements (window frames, windows and doors);
SKH-Publ. 97-04:2014	SKH-Publicatie Beoordelingsgrondslag - Houtsoorten voor toepassing in timmerwerk; eisen en bepalingsmethode;
SKH-Publ. 98-04:2017	Conditions and internal controls for the industrial finishing of joinery with water-diluted paints;
SKH-Publ. 99-05:2017	SKH Publication - Approved timber species to be used in wooden facade elements (window frames, windows and doors);

APPENDIX 1: SKH PROTOCOL

The suitability of modified timber for application in joinery
(interpretation document AD 0605)

B1. Principle

AD 0605 “modified timber” mentions in chapter 4 that “depending on the application of modified timber the certification organisation will determine which properties that need to be determined and tested”. This protocol has been prepared to give an overview of the properties that need to be established for application of modified timber in joinery in conjunction with **AD 0801** and de **AD 0803**. This protocol gives also additional instructions about the execution of tests if the text in AD 0605 is not clear.

B2. Reference point

AD 0801 and AD 0803 define the following properties to be established for joinery:

B2.1 Performance requirement: Wood Quality, basic material

The quality of modified timber depends both on the process and on the quality of the basic material input. Analogue to untreated timber, the requirement regarding sorting classes and less admissible defects as stated in SKH-publication 99-05, apply to modified timber. When sorting classes with less admissible defects as described in SKH-publication 99-05 are generally used in the modified timber this should be stated in the KOMO-attest-with product certificate[1].

[1] In order to obtain improved product properties (for instance strength properties) it is possible to allow only timber with less defects.

B2.2 Performance requirement: Durability, resistance to fungal decay

Complimentary to chapter 5.1 of AD 0605, the durability of the modified timber should be determined on 45 test pieces per fungus originating from 15 boards of each of 3 independent production batches. Once the uniformity and reproducibility of the process has been established as described in chapter 4.4. of AD 0605, the durability of other wood species can be determined on 15 test pieces per fungus. Distinction is made between hardwoods and softwoods. If the durability of softwoods has been established base on 3 production batches, the durability for hardwoods needs to be established on 3 production batches as well. The same is valid for the reverse.
The following fungi need at least to be included in the test:

- Poria placenta, Coniophora puteana and Trametes versicolor;
  - For soft wood species *Gloeophyllum trabeum*;
  - For hard wodd species *Donkioporia expansa*.

<u>Requirements regarding durability</u>

For application in frames, windows and doors, the durability of the modified timber must be class 1 or 2. Modified timber falling in durability class 3 may be used in frames, windows and doors provided the water absorption is low (see water absorption requirements 2.5).

B2.3 Performance requirement: Dimensional stability

The dimensional stability of façade joinery is determined based on test pieces that are sawn at right angles to the longitudinal direction of the material and by conditioning them at different climates conditions until an equilibrium is reached. The test pieces are preferably 50 x 50 mm in size, but at least 20 x 20 mm with a length of 10 mm. at least 15 test pieces are used cut out of 15 boards or beams, preferably originating from 3 independent production batches.

The dimensional stability is determined over a range from 50% RH to 90% RH. Due to hysteresis effects, the test pieces will initially be conditioned at 30 - 35% RH, 20 °C, during at least 1 week . For the determination of the dimensions at 50% RH, the test pieces are conditioned at 50 ± 5% RH, 20 ± 2 °C. After reaching the equilibrium (maximum weight change 0.1% in 24 hours), the dimensions will be determined with a minimum accuracy 0.02 mm. The test pieces will then be conditioned at 90 ± 5% RH, 20 ± 2 °C until an equilibrium is reached. The dimensions will be determined once more with minimum accuracy 0.02 mm

Additionally, the test pieces must be conditioned at 100% water saturation followed by 65% RH, 20 °C to determine the shrinkage class (chapter B3.2.1 of this annex). the 10 mm thick test pieces are saturated with water by pulling a vacuum with the samples submerged in water. After 30 minutes the vacuum is released and the test pieces remain submerged for at least 16 h. the wet dimensions are determined. Consecutively the samples are conditioned at 65% ± 5% RH, 20 ± 2 °C. till equilibrium. The conditioned dimensions are determined. The radial and tangential shrinkage is calculated

The swelling is calculated as:

$$St_{50-90\%} = \frac{(Dt_{90} - Dt_{50})}{Dt_{50}} \times 100\% \qquad \textbf{[B1]}$$

and

$$Sr_{50-90\%} = \frac{(Dr_{90} - Dr_{50})}{Dr_{50}} \times 100\% \qquad \textbf{[B2]}$$

With:

$St_{50\text{-}90\%}$	tangential swelling form 50% to 90% RH	[%]
$Sr_{50\text{-}90\%}$	radial swelling from 50% to 90% RH	[%]
Dt_{50}	tangential dimensions at 50% RH	[mm]
Dt_{90}	tangential dimensions at 90% RH	[mm]
Dr_{50}	radial dimensions at 50% RH	[mm]
Dr_{90}	radial dimensions at 90% RH	[mm]

De shrinkage is determined as:

$$St_{nat-65\%} = \frac{(Dt_{nat} - Dt_{65})}{Dt_{nat}} \times 100\% \qquad \textbf{[B3]}$$

and

$$Sr_{nat-65\%} = \frac{(Dr_{nat} - Dr_{65})}{Dr_{nat}} \times 100\% \qquad \textbf{[B4]}$$

with:

$St_{nat\text{-}65\%}$	tangential shrinkage form saturated to 65% RH	[%]
$Sr_{nat\text{-}65\%}$	radial swelling over from saturated to 65% RH	[%]
Dt_{nat}	tangential dimensions at saturation	[mm]
Dt_{65}	tangential dimensions at 65% RH	[mm]
Dr_{nat}	radial dimensions at saturation	[mm]
Dr_{65}	radial dimensions at 65% RH	[mm]

Requirements regarding swelling
Table B1 shows the requirements regarding the swelling of modified timber for application in joinery.

Table B1: Requirements regarding swelling of modified wood.

Orientation	Requirement
Average tangential swelling	Average ≤ 4%, standard deviation ≤ 1%
Average tangential swelling / average radial swelling	≤ 2,3

B2.3.1 Performance requirement: Shrinkage classes for SKH-Publication 13-02
Within one product ((window, frame or door) the elements of different wood species can be combined only is the shrinkage and swelling does not variate too much. To evaluate the differences in shrinking and swelling the Shrinkage classes are used. Wood species with the same or subsequent shrinkage classes can be combined.

The classification of modified wood into shrinkage classes is based on the tangential shrinkage from water saturation to equilibrium moisture content at 65% RH, 20 °C based on literature data or research data (for instance ASE). The shrinkage classes are determined or confirmed by SKH based on literature data or research data.

The average value and the variation will considered in the classification
Four shrinkage classes are defined:: 1 = < 2%; 2 = 1.5 - 3.5%; 3 = 2.5 - 4.5%; 4 = > 4%.
Overlap of the classes are a result of the natural variation in a wood species.

B2.4 Performance requirement: Equilibrium moisture content
The equilibrium moisture content is determined using test pieces conditioned 65% RH, 20 °C till equilibrium is reached. The samples have dimension s between 50 x 50 mm and 20 x 20 mm and a length of 10 mm. the orientation of the annual rings id not important. A minimum of 15 test pieces is used originating from 15 different boards or beams, preferably treated in 3 different production batches (5 per batch). To determine the equilibrium moisture content the test pieces are conditioned at 65 ± 5% RH and 20 ±2 °C till equilibrium is reached the equilibrium is reached and the weight does not change more than 0.1 % in 24 hours. After conditioning and weighing the test pieces are dried in an ventilated oven at 103 ±2 °C. the dry weight is determined after cooling in a desiccator. The weight of the test pieces is determined with a minimal accuracy of 0.02 g.

The equilibrium moisture content is calculated as

$$EMC_{i\%} = \frac{(m_i - m_{od})}{m_{od}} \times 100\% \qquad \textbf{[B5]}$$

with:

$EMC_{i\%}$	Equilibrium moisture content at i% RH	[%]
m_i	Weight after conditioning at i% RH	[g]
m_{od}	Dry weight	[g]

<u>Requirements regarding the equilibrium moisture content</u>
In compliance with chapter 5.2.1 of AD 605 the quality declaration will state the equilibrium moisture content of the modified timber at 65% RH, 20 °C. the equilibrium moisture content is expressed in percentages with a tolerance of ± 2%.

Remark:
In order to check the moisture content of the modified timber before or during the production of wooden elements one of two options need to be fulfilled:

- *A calibration line needs to be determined conform chapter 5.2.2.3 of SKH-Publication 97-04*
- *An alternative method needs to be established to determine the moister content corresponding to 65% RH, 20 °C.*

B2.5 Performance requirement: Water uptake and release

To determine the water uptake, 15 test pieces with dimension 20 x 20 x 400 mm are used originating from 15 boards or beams preferably treated in 3 different production batches (5 per batch). As references 15 test pieces of pine sapwood are used with the same dimensions. The test pieces are conditioned at 65 ±5% RH. 20 ±2 °C till equilibrium. Al test pieces are weighed till 0.2 g accuracy. 12 test pieces of each series, 4 of each batch, are placed vertically in a closed container in 5 – 10 mm of water. The 3 remaining test pieces of each series are placed in the same container but not in the water. Make sure the test pieces are standing free from each other and from the sides of the container. The weight of the test pieces is determined after 1 and 24 hours and after 2,3,7,14 and 21 days.

After the water uptake period, the water release is determined. Therefore, the test pieces are place in a climate of 65 ±5% RH, 20 ±2 °C and weighed after 24 hours. 2,3,7 and 14 days. After the test the test pieces are dried at 103 ±2 °C for at least 16 hours and the dry weight is determined.
The water uptake is defined by the uptake of liquid water and the hygroscopicity as a result of the high moisture content in the closed container.

Water uptake and release are calculated as

$$W_i = (m_{wi} - m_{w0}) - (m_{di} - m_{d0}) \qquad \textbf{[B6]}$$

With:

W_i	Water uptake and release at time i	[g]
m_{wi}	weight water uptake (liquid water) test pieces at time i	[g]
m_{w0}	weight water uptake (liquid water) test pieces at time 0	[g]
m_{di}	weight water vapour test pieces at time i	[g]
m_{d0}	weight water vapour test pieces at time 0	[g]

Requirements regarding water uptake and release

Modified timber with durability 3 or 4 can be applied in joinery under the condition that a high water uptake is not combined with a low water release.
The following conditions describe a high water uptake and low water release:

- The maximum (average) water uptake after 21 days ≥ 0,4 x maximum average water uptake of pine sapwood;
- After 14 days water release, the (average) moisture content does not reach the starting moisture content ± 1%.

B2.6 Performance requirement: Volumetric weight, density

Additional to the determination of the density described in chapter 5.7 of AD 0605, the density needs to be determined on an average of at least 40 elements, preferably originating from 3 independent production batches.

B2.7 Performance requirement: Strength properties for non-load bearing applications

Additional to chapter 5.8.2.1 of AD 0605 the strength properties need to be determined. The strength of modified wood is determined of selected beams or boards. The density and wood quality of these boards is defined before the modification process according to chapter 5.7 of AD 0605[1]. A sample of at least 40 boards is taken preferably from 3 different production batches. The bending strength and elasticity is determined in a 4-point bending tests according to EN 408. The dimensions of the samples are 50 x 150 x 3000 mm (width x height x length) following Eurocode EN 1990, the following properties are determined:

- The characteristic (average) modulus of elasticity ($E_{0,mean}$) in N/mm^2.
- The characteristic bending strength ($f_{m,k}$) in N/mm^2.

Requirements regarding strength properties

The strength properties are applicable only to the same tested wood species, to timber of the same starting quality as the quality of the tested, and of timber treated using the same process conditions as the tested timber. For stiles and mid sills the maximum span needs to be calculated. .

[2] The strength of modified timber depends on the quality of the starting material and on the process conditions. For joinery in is expected that the same grade of untreated timber is used of the same strength class. The modification process can influence the strength properties.
As there is not enough experience with the effect of modification on the strength properties (bending strength, shear, elasticity etc.) it is not possible to grade modified timber into strength classes. However, it is possible the determine the strength properties and use these values to determine, for instance, the maximum window dimensions, under the assumption that the same grade of starting material is used and the same process conditions.

B2.8 Performance requirement: Printability

Complementary to section 5.5 of AD 0605, modified wood coated with film forming coating systems need to be tested with 3 certified coating systems (cortication of the coating systems according to AD 0814 and BLR 0817). The choice of coating systems is determined by the organization that performs the test, if necessary in consultation with the industry (coating and wood). To test the paint ability, use is made of three normal opaque (primer) coating systems (colour RAL 9010). Wood species without bleeding extractives or three insulating covering (primer)paint systems (colour RAL 9010), wood species which have been shown to contain water-soluble and extractable components. Tests with tree transparent systems (in the most critical colour allowed) are optional.

The printability of modified wood is determined according to the test methods described in sections 2.7.1 to 2.7.6. not all these tests are always required to determine the paint ability of modified wood. The determination of bleeding, the closeness of the paint coat the adhesion of the coating and emission of extractives (sections 2.7.1 to 2.7.4) are the minimal requirements. Depending on the results of these test and the water-uptake, additional tests need to be performed.

a. If the water-uptake is low, the coating can be applied in a closed film , and the bleeding of volatile extractives is absent, no other tests need to be performed;
b. If the water-uptake is high, or an extra coating layer is necessary to obtain a closed film the blistering test (test 5) needs to be performed additionally;
c. If an extra coating layer is necessary to obtain an closed film or the wood species has a tendency to bleed, the water-uptake and freeze stability test (test 6) needs to be performed additionally.

Assessment methodology:

1. Assessment of bleeding or non-bleeding based on wetting with water (SKH Publication 05-01 section 7.4);
2. Application of coating systems and assessment of the closedness of the paint coat in accordance with SKH Publication 06-02;
3. Assessment of dry and wet adhesion after 7 days of drying accordance with SKH-Publication 05-01 (including discolouration due to wetting of the incised pattern) determination method shall be at least equivalent to the test in accordance with ASTM D 3359;
4. Assessment of emitting extractives in accordance with section 5.2.7.3 of SKH publication 05-01 (including adhesion rating);
5. Blister test in accordance with SKH-Publication 97-04 section 5.2.7.3 (determination method shall be at least equivalent to the determination in accordance with (NEN-EN-)ISO 4628-2);
6. Water uptake and freeze stability test in accordance with SKH-Publication 10-01.

Description of the test methods

B2.8.1 Assessment of bleeding or non-bleeding based on wetting with water

The assessment must be conducted to one standard opaque coating system on 15 samples, preferably from 3 modification batches. When applying the certified standard opaque primer or undercoat system in accordance with AD 0814 or AD 0817, all test pieces, with a minimum size of 12 x 70 x 300 mm, will be provided with two (primer) coats, applied by airless spray or a different application method according to the processing instructions of the supplier.
After application the finished samples are conditioned for 7 days at 65% ± 5% RH and 20 ± 2 °C. After conditioning, incisions will be made in the finish of the test pieces in accordance with SKH-Publication 05-01 section 7.4. and it is covered with wet filter paper for 1 hour. After 1 hour the discolouration outside the incised pattern is assessed.

Requirements for the bleeding of the modified timber
Modified wood is considered non-bleeding when no discolouration is visible outside the incised pattern at a magnification of 10x. If the modified timber bleeds (there is discolouration outside the incised pattern), a switch must be made to 3 isolating paint systems for the articles of section 8.2 and beyond.

B2.8.2 Application of paint systems and assessment of the sealing of the paint coat
The sealing, closed-ness, of the paint coat is tested for each finishing system on 15 test pieces with a minimum size of 12 x 70 x 300 mm. When applying an opaque system, all test pieces will be provided with two (primer) coats of a certified primer or undercoat system in accordance with AD 0814 or AD 0817, applied by airless spray or a different application method according to the processing instructions of the supplier.
When applying a transparent undercoat system, all test pieces will be provided with a certified transparent undercoat system in accordance with AD 0817, applied by airless spray or a different application method according to the processing instructions of the supplier. After application the finished samples are conditioned for 7 days at 65% ± 5% RH and 20 ± 2 °C and the sealing of the paint coat will be assessed in accordance with SKH-Publication 06-02.

Requirements for the sealing of the paint coat.
In accordance with SKH-Publication 06-02, the paint coat should be sealed, closed. If this is not the case, an additional layer of at least 140 µm total dry paint coat thickness should be applied. If it is still not possible to obtain a sealed paint coat, the modified wood will not be released for use in joinery.

B2.8.3 Assessment of dry and wet adhesion after 7 days of drying
The wet adhesion is tested for each finishing system on 15 test pieces. The dry adhesion is tested for each finishing system on 3 test pieces, unless the variation in wet adhesion requires a larger number. The minimum size of the test pieces is 12 x 70 x 300 mm. The application of the paint coat and conditioning should take place as described in section 2.7.2 of this Protocol. The determination of the wet and dry adhesion of the paint must be performed in accordance with SKH Publication 05-01.

Requirement for the wet and dry adhesion
The average of the measurements of wet and dry adhesion must meet maximum Class 1 and at least 13 of the 15 samples must meet Class 0 or 1 in accordance with SKH-Publication 05-01.

B2.8.4 Assessment of the emission of extractives (IR radiation)
The emission of components is determined for each finishing system on 15 test pieces with a minimum size of 12 x 70 x 150 mm. The application of the paint coat and conditioning should take place as described in section 2 of this Protocol. After conditioning, the surface of the test pieces is irradiated with an infrared lamp for 8 hours in such a way that a one-sided surface temperature of 70 °C is reached. After this, the samples are visually assessed on the emission of components (e.g. resin), cracking, blistering and flaking. The test is concluded with an assessment of the adhesion of the paint.

Requirements for the emission of components and the adhesion
The requirements the paint coat must meet after irradiation of the surface are shown in table B2 below.

Table B2: Requirements for the emission of components

Property	Method	Requirement
Emission of components	**-**	**Not allowed**
Cracking	**NEN-ISO 4628-4**	**Maximum 1S1**
Blistering	**NEN-ISO 4628-2**	**0**
Flaking	**NEN-ISO 4628-5**	**0**
Adhesion	**SKH Publication 05-01**	**The average of the measurements must meet maximum Class 1 and at least 13 of the 15 samples must meet Class 0 or 1**

B2.3.5 Blister test

Unilateral moisture load of the modified may cause any water-soluble components or unreacted components in the wood to migrate to one of the surfaces in an accelerated manner. The possible consequences, such as blistering, detachment or discolouration, are studied.
The blistering is determined on 10 test pieces per finishing system. The test pieces with dimensions of 12 x 70 x 150 mm must be finished on three sides and both cross cut des are sealed with an appropriate agent (SKH Publication 08-02). The test pieces are placed in the blister box with the non-finished side to the interior. The water temperature in the blister box is set to 40 ± 1 °C. The blister box must be placed in an environment of 50 ± 5% RH and 23 ± 2 °C. The test will take 10 days. The samples are weighed before and after the test. After the test, the samples are assessed visually for blistering, discolouration and flaking. The test is concluded with an assessment of the adhesion of the paint.

Requirements for the blister test
The requirements for the blister test are shown in the table below.

Table B3: Requirements for the blister test

Property	Method	Requirement
Blistering	**NEN-ISO 4628-2**	**0**
Flaking	**NEN-ISO 4628-5**	**0**
Discolouration	**-**	**no visible discolouration**
Adhesion	**SKH-Publication 05-01**	**The average of the measurements must meet maximum Class 1 and at least 13 of the 15 samples must meet Class 0 or 1 (wet and dry)**

B2.8.6 Moisture/freeze test

The moisture/freeze test must be performed on test pieces with dimensions of 12 x 70 x 150 mm in accordance with SKH Publication 10-01 taking into account the following deviations (simplified procedure):

1. The test pieces must be conditioned during 1 week
2. 10 test pieces will be tested in RAL 9010 per paint system
3. The test pieces are weighed before the initial water absorption, before the fourth water absorption and after completion of the last step.
4. The test pieces will only be assessed visually for cracking, blistering and flaking after the last step. The test is concluded with an assessment of the adhesion of the paint.

Requirements for the moisture/frost test
The requirements the paint coat must meet after the moisture/frost test are described in section 4.1.5 of AD 0817

Requirements for the paintability of the modified wood
The outcome of the tests described in sections 1 to 6 will be converted into the paint ability of the modified timber as follows.

1. All the tested systems have been assessed as satisfactory.
   The modified wood is released for general paint ability . The company processing the modified wood is required to test the tolerance of the wood to a specific coating in accordance with the instructions in SKH Publication 98-04 before processing the selected coating system and to repeat this with the frequency described therein.
2. Not all the tested systems have been assessed as satisfactory.
   The modified wood is released for paintable under certain conditions. The paint supplier has the obligation to substantiate its paint advice by performing independent adhesion tests on the relevant material. The company applying the coating is required to test the tolerance of the material in accordance with the instructions in SKH Publication 98-04 before processing the selected coating system and to repeat this with the frequency described therein.
3. None of the tested systems have been assessed as satisfactory.
   In this case the modified timber material is not suitable to be released for general paint ability .
   COMMENT: The company applying the coating is required to demonstrate the paint ability in accordance with the paint ability test described in this publication before processing with a selected coating system.

B2.9 Glue ability

The glue ability of modified wood must be demonstrated. Depending on the intended use, the following must be demonstrated:

- Window frame joinery; per glue system and/or joining product in accordance with AD 0819.
- Windows and doors; per glue system in accordance with section 4.1.4 (exterior façade joinery) of AD 2339.
- Finger joints (exterior); per glue system in accordance with section 4.1.3 (exterior façade joinery) of AD 2339.
- Laminating; per glue system in accordance with section 4.1.2 (exterior façade joinery) of AD 2339.

In addition to the requirements after ageing as described in AD 0819 and AD 2339, severe cracking in the modified timber after ageing is not allowed. Severe cracking shall be understood to mean: cracks of over 2 mm wide and 100 mm long.
If the tests are conducted on glued sample material manufactured by a manufacturer (for instance frame joints made by a joinery factory), the results are applicable only for the production process of the joinery factory.

B2.10 Burglary resistance.

Modified wood may be used for burglary-resistant windows, window frames and doors provided that the following requirements are met:

- The extraction resistance of the screws must at least be equivalent to that of spruce or Meranti. The equivalence of the extraction resistance must be determined in accordance with section 3.2 of SKH-AD 002.
  It is possible that the required extraction resistance can be reached only by using longer screws. This can be included in the processing instructions.
- The splitting strength in both the direction of pressing and perpendicular to the direction of pressing must be at least equivalent to that of pine. Testing of the splitting strength must be determined in accordance with ASTM D143.

If the modified timber does not comply with the above requirements, the burglary resistance of the entire façade element must be tested or a series of test can be performed showing that the force necessary to remove different types of ironware from the modified wood is equals or surpasses the force necessary to remove the same types of iron ware from spruce.

B2.11 Performance requirement: Thermal conductivity

The thermal conductivity of modified timber, especially thermal modified timber, can change (decrease) due to the treatment.

The thermal conductivity (λ) shall be determined according to NEN-EN 12664. To determine the design value, NEN 1068 / NEN-EN-ISO 10456 will be used.

In case there is no thermal conductivity (λ) determined, the design value for modified timber can be given by using tabulated values related to density (NEN 1068 / EN-NEN-ISI 10456). The following values can be used for purpose in SKH-Publication 13-02:

- Hardwood/modified hardwood: λ = 0,18 W/(m * K) (700 kg/m^3)
- Softwood/modified softwood: λ = 0,13 W/(m * K) (500 kg/m^3)

Or use table B4 of NEN-EN-ISO 10456: the thermal conductivity (λ) may be determined by interpolation.

Table B4: Design thermal conductivity values (λ) (according to NEN-EN-ISO 10456)

Wood type	Density (mean) at 12% mc (kg/m^3)	Thermal conductivity (λ) W/(m * K)
Solid wood	**300**	**0,09**
	400	**0,11**
	500	**0,13**
	600	**0,15**
	700	**0,18**
	1000	**0,24**

B 3 Literature

ASTM D143-14	Standard Test Methods for Small Clear Specimens of Timber. Sections 95-99 – Cleavage;
ASTM D3359-09e2	Standard Test Methods for Measuring Adhesion by Tape Test;
AD 0605:20-06-2018	Modified timber;
AD 0801:20011+WB2016	Houten gevelelementen, uitgave SKH;
AD 0803:2013+WB2016	Houten buitendeuren, uitgave SKH;
AD 0814:2016	Film forming coatings for application on timber;
AD 0817:2008+WB2009	Film forming mid- and top coat systems on timber;
AD 0819:2010	Joining techniques in wooden façade elements;
AD 2338:1998	Adhesives for load bearing wooden building constructions;
AD 2339:2012	Adhesives for non-load bearing applications
NEN 1068:2012+C2:2016	Thermal insulation of buildings - Calculation methods;
NEN-EN 408:2010/A1:2012	Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties;
NEN-EN 1990+A1+A1/ C2:2011	Eurocode: Basis of structural design
NEN-EN 12664:2001	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Dry and moist products of medium and low thermal resistance;
NEN-EN-ISO 4628-2:2016	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;
NEN-EN-ISO 4628-4:2016	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;
NEN-EN-ISO 4628-5:2016	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;
NEN-EN-ISO 10456:2008 +C1:2009	Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values;
SKH Publ. 05-01:2018	SKH-Publication - Determination of the adhesion of paint on wood.
SKH-Publ. 06-02:2011	Assessment of the closeness of a paint film on timber;
SKH-Publ. 08-02:2015	Determination of the water permeability after critical drying and complete drying of coating systems on timber;
SKH-Publ. 10-01:2015	Water uptake and freeze stability test;
SKH-Publ. 13-02:2018	SKH-Publication - Approved modified timber species to be used in wooden facade elements (window frames, windows and doors).
SKH-Publ. 97-04-2014	Beoordelingsgrondslag Houtsoorten voor toepassing in timmerwerk; eisen en bepalingsmethoden
SKH-Publ. 98-04:2017	Conditions and internal controls for the industrial finishing of joinery with water-diluted paints;
SKH-Publ. 99-05:2017	SKH-Publication - Approved timber species to be used in wooden facade elements (window frames, windows and doors);
SKH-BGS 002:2017	Beoordelingsgrondslag voor schroeven geschikt voor hout en houtachtige plaatmaterialen.