

AD 0812
dated 18-12-2012

KOMO® ASSESSMENT DIRECTIVE
FOR THE
KOMO® PRODUCT CERTIFICATE
FOR
PROFILED COMPONENTS
FOR JOINERY

Adopted by the Board of Timber Experts (CvD) dated 12-10-2012

Approved dated 18-12-2012

Issued by: Certification and attestation body SKH

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GENERAL INFORMATION RELATING TO THIS PUBLICATION

This KOMO® assessment directive was declared binding by the certification and attestation body SKH in accordance with the SKH Regulations for Certification and shall apply to the issue of a KOMO® product certificate “Profiled components for joinery” as from 18 December 2012.

This KOMO® assessment directive replaces assessment directive AD 0812 “Wooden glazing beads, nose-shaped mouldings and threshold coverings for wooden façade elements”, dated 06-02-2004.



Publisher:

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1 GENERAL

1.1 Introduction

The requirements laid down in this assessment directive are used by the certification bodies accredited for NEN-EN 45011 and authorised by the Council of Accreditation during the handling of an application for, or the maintenance of, a KOMO® product certificate for 'Profiled components for joinery'. The quality declarations to be issued are referred to as a KOMO® product certificate.

In addition to the requirements laid down in this assessment directive, the certification bodies will formulate additional requirements, in the sense of general procedural requirements for certification, as stipulated in the certification regulations of the relevant body.

This KOMO® assessment directive replaces assessment directive AD 0812 "Wooden glazing beads, nose-shaped mouldings and threshold coverings for wooden façade elements", dated 06-02-2004.

The quality declarations issued on the basis of this superseded assessment directive remain valid until *6 months after the acceptance of the AD*.

The technical field of the AD 0812 is E6: doors, windows, shutters, blinds, gates with window frames for all applications and all wooden constructions.

1.2 Area of application

The KOMO® product certificate applies to the 4 areas of application listed below:

- 1) the manufacture and supply of glazing beads and nose-shaped mouldings (with the exception of ventilated glazing beads) for the affixing of glass, panels, grids, etc. and/or wooden threshold coverings for the protection of the horizontal water drainage components in wooden façade elements;
- 2) the manufacture of wooden profiles for stiles and thresholds for wooden façade elements (frames and windows);
- 3) the manufacture of wooden profiles for use on wooden exterior doors (such as nosing sills, meeting stiles and ornamental battens);
- 4) the manufacture of wooden components for staircases (such as banisters, spindles, handrails, balusters, risers and covering strips).

Extruded and/or cast profiles do not fall within the scope of this assessment directive. These are covered by AD 0810 'Aluminium profiles for façade elements'.

1.3 Requirements regarding the certification body

The certification body must be accredited by the Council for Accreditation for the subject of this AD on the basis of NEN-EN 45011.

1.4 CE marking

Relationship between the Dutch Buildings Decree and the European Construction Products Directive (CPD 89/016/EEC):
products for which a harmonised standard (hEN) has been published, or for which an ETA is available, must be provided with CE marking as prescribed by the relevant hEN or ETAG/CUAP. No hEN or ETAG/CUAP is applicable for profiled components for joinery.

2 PROCEDURE FOR OBTAINING A PRODUCT CERTIFICATE

2.1 Start

The applicant for the quality declaration indicates which applications of the profiled elements he manufactures are to be covered by the quality declaration. He indicates which statements are to be included in the quality declaration and supplies the evidence for these statements. He also supplies the data needed for the drafting of the technical specification. The statements that must or could be included are indicated in chapters 3 and 4.

2.2 Initial inspection

The attestation body checks whether the statements included in the product certificate comply with the requirements laid down in chapters 3 and 4 of this assessment directive.

2.3 Assessment of the certificate holder's quality system

The attestation and certification body checks whether the applicant's quality system complies with chapter 5.

2.4 Issue of the product certificate

The product certificate shall be issued in accordance with the specimens established by the Building Harmonisation Committee and in accordance with the general regulations of the certification body, when the initial inspection (2.2) and the assessment of the applicant's quality system (2.3) have been positively concluded. The product certificate declares that profiled wood for joinery complies with chapters 3 and 4.

2.5 External quality assurance

Once the product certificate has been issued, the checks as described in chapter 7 are conducted by the certification body and attestation body.

3 PRODUCT/PRODUCTION REQUIREMENTS

3.1 Planing, milling and sandpapering

The surface shall be moulded sanded and repaired, or levelled in such a way that the complete surface (including around knots and other defects) is smooth (grit 150) so that a closed layer of paint can be applied.

Imperfections caused by machining shall not be in view on the visible faces. Please refer to SKH publication 06-02 for the definition of a closed layer of paint.

3.2 Tolerances

The maximum allowable dimensional deviation for commercially available lengths shall not exceed ± 50 mm. The maximum allowable dimensional deviation for cut lengths shall not exceed ± 0.5 mm.

The maximum allowable dimensional deviation in the profile shall not exceed ± 0.2 mm. The spring and twist of profiled components may not exceed 0.5% of the shortest length. The spring and twist of glazing beads, nose-shaped mouldings and profiles rebate laths may not exceed 5 mm per metre.

3.3 Nominal dimensions

The nominal dimensions shall comply with the requirements set down by the client. The height of the glazing beads, nose-shaped mouldings and threshold coverings at the position of their connection to the glass shall be adjusted to match the height of the rebate on the other side of the glass or to the required "protection height" of the edge of the glass.

The width of the glazing beads and nose-shaped mouldings at the position of the connection shall be as follows:

- at least 14 mm for single-layer glass;
- at least 15 mm for double-layer glass;
- at least 15 mm for triple-layer glass.

3.4 Chamfers, rounding off and V-joints

All visible free exterior corners of profiles for frames, windows and doors, such as glazing beads, nose-shaped mouldings, threshold coverings and profiles rebate laths that are exposed to the exterior climate during use, shall be provided with rounded off edges with a radius of at least 3 mm, provided that the top of frame thresholds and transoms have a radius greater than or equal to 4 mm. The enclosed exterior corners (in rebates) must be broken with slanting edges or provided with a radius greater than or equal to 1.5 mm.

Furthermore, where profiles meet wooden components (joints, etc.) the profiles must be provided with rounded off edges with a radius of 3 and/or 4 mm or with v-joints.

3.5 Application of a coating system (finishing system), optional

Profiled components can be provided with one or more primer layers or undercoat and topcoat layers all over. The cross-cut ends of custom-supplied and treated glazing beads, nose-shaped mouldings, threshold coverings and profiles rebate laths must be sealed using a sealant that complies with the SKH publication 04-01 'Basis for the assessment of sealants for the joinery industry'. The scope of this product certificate includes the possibility of supplying profiled components with the following finishing classes:

- a. Provided with an undercoat or topcoat system that complies with the requirements of:
 - AD 0817 'Film-forming undercoat and topcoat systems on wood'. The coating is applied all over in accordance with the instructions of the paint supplier. If this is not possible the system may be applied in accordance with SKH publication 06-03 'Protocol for the finishing of wooden façade elements and wooden exterior doors on the basis of performance requirements'.
- b. Provided with a total primer system that complies with the requirements of:
 - AD 0814 'Film forming coatings on timber'. The coating is applied all over in two uniform layers with a total dry layer thickness of 100 µm.
- c. Components may be supplied untreated.

3.6 Storage and transport

Unless the 'profiled components' have been provided with the paint system required for delivery, they must be kept in a dry area for storage and transport. This area shall be air conditioned such that it has a relative air humidity between 50 and 80% and a required application moisture content that complies with SKH publication 99-05 'List of approved timber species for application in façade joinery'.

Production, internal transport, storage and transport to the consumer shall take place in such a way that the properties provided are retained. Transport shall be performed in such a way that no damage or permanent changes in shape can occur. Profiled components that have been protected with the aforementioned surface treatment may be stored outside under cover with the underside of the elements being kept clear of the ground so that no contact is possible with water (about 0.1 m in the case of paved surfaces and 0.3 m in the case of unimproved ground). The sides of profiled components shall also be protected against the sun, rain and snow. If profiled components are stored under tarpaulins, sufficient space shall be left between the tarpaulins and the profiled components to permit the natural drying of the components.

4 REQUIREMENTS WITH REGARD TO MATERIALS

Materials not included in this chapter shall comply with the relevant standards or AD based upon their field of application.

4.1 Timber

The quality requirements for wood for profiled components relate to the permissibility of natural imperfections. For this chapter, the definitions and determination methods shall be taken from NEN 5461, unless otherwise stated.

4.2 Timber species and durability class

The timber species shall comply with the requirements set down in SKH publication 97-04 'Timber species for application in joinery'. Timber species listed in the SKH publication 99-05 'List of approved timber species for application in wooden façade joinery (frames, windows and doors)' comply with these requirements.

The durability class is as follows for each area of application:

- 1) Timber for glazing beads and nose-shaped mouldings (with the exception of ventilated glazing beads) for the affixing of glass, panels, grids, etc. and/or threshold coverings for the protection of the horizontal water transport components in wooden façade elements shall comply with durability class 1 or 2.
- 2) Timber for 'wooden profiles' for stiles and thresholds for wooden façade elements (frames and windows) shall comply with durability class 1 to 4;
- 3) Timber for the manufacture of wooden profiles for use on wooden exterior doors (such as nosing sills, meeting stiles and ornamental battens) shall comply with durability class 1 to 4;
- 4) Timber for wooden components for staircases (such as banisters, spindles, handrails, balusters, risers and covering strips) shall comply with durability classes 1 to 4. Timber species other than those listed in SKH publication 99-05 are allowed provided the timber complies with the requirements stated in Appendix 1 of this AD.

4.3 Timber moisture content

The timber moisture content depends upon the area of application.

- 1) The timber moisture content for glazing beads and nose-shaped mouldings for the affixing of glass, panels, grids, etc. and/or threshold coverings for the protection of horizontal water drainage components in wooden façade elements shall comply with the values in SKH publication 99-05;
- 2) The timber moisture content for timber for 'wooden profiles' for stiles and thresholds for wooden façade elements (frames and windows) shall comply with the values in SKH publication 99-05;
- 3) The timber moisture content for timber for the manufacture of wooden profiles for use on wooden exterior doors (such as nosing sills, meeting stiles and ornamental battens) shall comply with the values in SKH publication 99-05;
- 4) The timber moisture content of softwood staircase components shall be $15 \pm 2\%$ (during manufacture). The timber moisture content of hardwood staircase components shall comply with the timber moisture percentages in SKH publication 99-05 (during manufacture). For timber species not included in SKH publication 99-05, the timber moisture percentage during production of wooden staircase components for staircases made of 1 timber species may not differ from one another by more than 4%, with a maximum value of 18%.

4.4 Timber quality

The timber quality depends upon the area of application.

- 1) The timber quality for glazing beads and nose-shaped mouldings for glass, panels, grids, etc. and/or threshold coverings for the protection of the horizontal water drainage components in wooden façade elements shall comply with the timber quality requirements in SKH publication 99-05. Furthermore, the timber shall be free of imperfections in the sense of NEN 5461, with the exception of some scattered sound (not chipped) pin knots and pin holes. The slope of grain may not exceed 1:10. Sapwood is not allowed.
- 2) The timber quality of 'wooden profiles' for stiles and thresholds for wooden façade elements (frames and windows) shall comply with the quality requirements in SKH publication 99-05;
- 3) The timber quality for the manufacture of wooden profiles for use on wooden exterior doors (such as nosing sills, meeting stiles and ornamental battens) shall comply with the timber quality requirements in SKH publication 99-05;
- 4) The timber quality for wooden staircase components shall comply with the timber quality requirements in SKH publication 99-05 and Appendix 1 of this AD.

4.5 Fingerjointed timber

Fingerjointed timber for glazing beads, nose-shaped mouldings, threshold coverings, profiles and staircase components, or areas of application 1, 2, 3 and 4, must comply with the requirements in AD 1704-2 "Fingerjointed timber", with the additional condition that the timber shall be free of imperfections as described in paragraph 4.1. Class BGVT applies for glazing beads, nose-shaped mouldings, threshold coverings and profiles. Class B applies, as a minimum, for components of staircases.

4.6 Optimised timber

Optimised timber must comply with the requirements in AD 2902 "Optimised timber", with the additional condition that the timber shall be free of imperfections as described in paragraph 4.1.

4.7 Modified timber

Modified timber shall comply with the requirements laid down in AD 0605 "Modified timber", with the additional condition that the timber shall be free of imperfections as described in paragraph 4.1.

4.8 Other materials

If materials other than timber are used as components for joinery, the following additional conditions, as described in paragraphs 4.8.1 to 4.8.4, shall apply.

4.8.1 Hygroscopic properties

Materials may not exhibit swelling of more than 4% in thickness and width or more than 0.1% in length. The materials are measured at an ambient air humidity of 50% and a temperature of 20 degrees Celsius, and at an ambient air humidity of 95% and a temperature of 20 degrees Celsius. The materials are conditioned for 72 hours.

4.8.2 Thermal properties

Materials may not exhibit more than 0.1% expansion and contraction in thickness and width. The materials are measured at a temperature of -10 degrees Celsius and an air humidity of

65%, and at a temperature of +60 degrees Celsius and an air humidity of 65%. The materials are conditioned for 72 hours.

4.8.3 Bending strength

The material shall withstand a minimum comparable moment equal to that of timber with a strength class C24. The moment capacity is calculated according to the formula below:

$$M_x = \sigma \times W = \sigma \times 1/6 \times b \times h^2 = 24 \times 1/6 \times a \times b^2 = \dots \text{ Nmm}$$

$$M_y = \sigma \times W = \sigma \times 1/6 \times h \times b^2 = 24 \times 1/6 \times b \times a^2 = \dots \text{ Nmm}$$

The alternative material shall be able to withstand a minimum equivalent moment.

4.8.4 Finishing of materials

If materials are to be finished, the materials shall be paintable using systems such as those mentioned in 4.6 and 4.7 of this AD. The adhesion of the coating to the materials shall comply with Class 0-1 of SKH publication 05-01 'Determination of the adhesion of paint onto wood'.

4.9 Coatings

All coatings must comply with AD 0814 'Film forming coatings for application to timber' or AD 0817 'Film forming undercoat and topcoat systems used in the timber industry'.

4.10 Sealants

Sealants must comply with the requirements as laid down in SKH publication 04-01. The products in the SKH publication 07-01 meet these requirements.

4.11 Processing instructions

Processing instructions must be supplied with profiled components for joinery. These processing instructions must cover topics including dimensional tolerances, the risk of mechanical damage and coatings. If treated profiled components are supplied, a painting recommendation shall be given.

5 REQUIREMENTS REGARDING THE QUALITY SYSTEM

5.1 General

This chapter includes the requirements with which the producer's quality system must comply.

5.2 Responsibility

The responsibility for the manufacturing process of the product and for internal quality monitoring and for the finished product lies with the producer.

5.3 Manager of the quality system

Within the organisational structure, an official must be appointed who is charged with the management of the quality system.

5.4 Quality system

5.4.1 Document control

The written procedures for inspection and testing must be assessed and approved for suitability and effectiveness by authorised persons in the company before they are issued. Document control must ensure that only valid documents are available for inspection and testing. The documents must be in Dutch, English or German.

5.5 Inspection and testing

5.5.1 Internal quality control

The manufacturer shall implement an internal quality control; the following minimum components shall be included in this and laid down in writing:

- incoming inspection of raw material;
- workplace instructions (including inspection of the production process);
- inspection of paint coating(s) (SKH publication 98-04);
- end product inspection;
- inspection of measuring equipment;
- complaints recording system.

5.5.2 Registration

Records must be kept of the inspections and tests as described in the IQC scheme. Registered data must be kept for at least 10 years.

5.5.3 Calibration

Inspection, measuring and test equipment must be calibrated at least once a year. Records must be kept of this calibration.

5.5.4 Supplies

Raw materials, semi-manufactured products, etc., in regard to which reference is made to another assessment directive, must meet the requirements of the relevant assessment directive. The goods received must be inspected according to the IQC plan.

5.5.5 Non-conformities in products

Products or parts of products found to be non-compliant with requirements during the production process must be clearly recognisable as such. If necessary, corrective measures must be taken.

5.5.6 Handling complaints

The producer (holder of the product certificate) must demonstrably maintain a record of complaints and how they are handled for the product to which the product certificate and its application relates. There must be a statement regarding every complaint describing how the complaint was analysed and dealt with and any appropriate corrective measures subsequently taken.

6 MARKING

Glazing beads, nose-shaped mouldings, threshold coverings, profiles and staircase components supplied under the product certificate, or the packaging of these components, must be legibly marked with the finishing classes a, b or c and the KOMO® mark including:

- the KOMO® word or logo (minimum size 5mm)
- product certificate number.

7 REQUIREMENTS REGARDING EXTERNAL INSPECTION

7.1 General

External quality control is specified by the certification body in accordance with its product certification regulations.

7.2 Initial inspection

During the initial inspection, the certification body checks whether the company in question complies with the requirements stated in this assessment directive. A report is prepared on the initial inspection. This report forms the basis for the issue of the KOMO® product certificate, to which certain conditions may be attached.

7.3 Annual inspection

The certification body will check, without prior notice and at least four times a year, whether the technical specification has been continuously satisfied, whether production meets the specifications laid down by the manufacturer and agreed upon with the certification body, and whether the manufacturer's internal quality control scheme meets the requirements laid down in Chapter 5.

A written report is prepared of these checks.

The aforementioned frequency of inspections can be adjusted on the recommendation of the Board of Experts.

Generally speaking, the certificate holder's country must be safe for the certification body's inspection visits. In case of a travel advisory issued by the Ministry of Foreign Affairs, the country will not be visited and the 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 in writing, of the deliveries, including the time and location of receipt.

8 REQUIREMENTS REGARDING THE CERTIFICATION BODY

8.1 General

The certification body must comply with the requirements specified in NEN-EN 45011. In addition, the body must be accredited by the Dutch Accreditation Council for the scope of this assessment directive, or have initiated the application procedure for this.

The certification body must have a set of regulations, or an equivalent document, in which the general rules used for certification are specified. In particular these are:

- The general rules for performing the initial inspection, split up into:
 - The procedure for informing suppliers about the administrative processing of an application;
 - The procedure for implementing the inspection;
 - The procedure for deciding about acceptance based on the initial inspection.
- The general rules concerning the performance of inspections and the inspection aspects used;
- The measures to be taken by the certification body in the event of non-conformities;
- The rules for the termination of a certificate;
- The option of lodging an appeal against decisions or measures taken by the certification body.

8.2 Certification staff

The staff members concerned with the certification process are as follows:

- Inspector: tasked with carrying out the external inspections;
- Initial inspector: tasked with carrying out the initial inspection and assessing the reports of inspectors and laboratory technicians;
- Assessor: assessment of the inspector and initial inspector; decisions on the need for taking corrective measures.
- Decision-taker: tasked with taking decisions based on the initial inspections that have been carried out, continuation of certification on the basis of the completed inspections.

8.3 Qualification requirements

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

Certification staff	Training	Expertise and Experience
Inspector Initial inspector	Senior secondary vocational education level ('MBO' level)	<ul style="list-style-type: none"> - Production and application of profiled components for joinery - Training of ISO 9001 auditor - Two years' experience in the timber industry
Assessor	Higher professional education level ('HBO' level)	<ul style="list-style-type: none"> - Architecture training or other type of training - Production and application of profiled components for joinery - At least two years' experience at management level in the timber industry
Decision maker	Higher professional education level ('HBO' level)	<ul style="list-style-type: none"> - Management experience or equivalent - Certification or equivalent - Accreditation criteria or equivalent - Knowledge of relevant certification systems

Certification staff must be demonstrably qualified by means of assessing training and experience based on the requirements mentioned above. If qualification is based on different criteria, this must be recorded in writing.

8.4 Report to the Board of Experts

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 addressed:

- Changes in the number of certificates (new/ended);
- Number of inspections performed in relation to the prescribed frequency;
- Results of the inspections.

9 LIST OF DOCUMENTS REFERRED TO

Check that these are complete and up to date

NEN 45011: 1998	General requirements for bodies operating product certification systems
NEN 5461:1999/A1:2004	Quality requirements for timber (KVH 2000) - Sawn timber and round wood - General part
NEN 5466:2010	Quality requirements for timber (KVH 2000) - European softwood sorted according to external characteristics
NEN-EN 338: 2009	Structural timber - Strength classes
ISO 9001:2008-11	Quality management systems – Requirements
AD 0605:2003	Modified timber
AD 0810:2004	Aluminium profiles for façade elements
AD 0814: 2005	Film forming coatings on timber
AD 0817:2010	Film forming undercoat and topcoat systems on wood
AD 1704-2: 2004	Fingerjointed timber for non-load bearing applications
AD 2902:2008	Optimised timber for non-load bearing applications
SKH publication 97-04: 2009	Basis for assessment 'Timber species for use in façade joinery; requirements and methods of determination'
SKH publication 98-04: 2011	Conditions and internal checks for the finishing of façade joinery with water-soluble paints in the joinery industry
SKH publication 99-05: 2011	List of approved timber species for application in wooden façade elements (frames, windows and doors)
SKH publication 04-01:2011	Basis for the assessment of sealants for the joinery industry
SKH publication 05-01:2005	Determination of the adhesion of paint onto wood
SKH publication 06-02: 2011	Assessment of the quality of the encapsulation of a paint film on wood
SKH publication 06-03: 2011	Protocol for the finishing of wooden façade elements and wooden exterior doors on the basis of performance requirements
SKH publication 07-01: 2012	Overview of permitted sealants for the joinery industry

**) For the correct publication date of this SKH publication, please consult the SKH website.

APPENDIX 1: Timber quality of softwood and hardwood for staircase components of staircases and corncing

For reasons of strength, at least timber quality class C according to NEN 5466, heart-free, with a timber moisture content of 15 +/- 2% and strength class **C18** in accordance with NEN-EN 338 must be used for steps, stringers en spindles of wooden staircases and corncing. For deformations, a minimum timber quality of class B according to NEN 6068 applies.

Any defects not specifically mentioned are not allowed. This table applies for softwood with a covering finish.

Requirements for softwood C (C18) in the finished product (max. allowed)		
Grub holes		
- No chance of propagation		Allowed
Maximum slope of grain		1 : 7
Growth ring width		6
Number of resin pockets per m		0
Heart		
- heart free		Allowed
- virtually heart free		Allowed
- sawn through the heart		Not allowed
- boxed heart		Not allowed
Knots		
- hard and solid		Allowed
- centre line	wood width ≤ 190 mm	45 mm
	wood width > 190 mm	60 mm
Maximum		
Reaction wood		Max. 10% of the surface
Cracks	Hairline cracks	Allowed
	Contraction (drying) cracks	Allowed to a limited degree. Max. ≤ 2 mm wide and 100 mm long
Fungal attack		
- Blue to grey		Max. 10% of the surface
Sapwood		Allowed
Discolouration due to weathering		Allowed to a limited degree
Deformation:		
- bend per 2 m wood length		8 mm
- curvature per 2 m wood length		4 mm
- warp per 2 m wood length		4 mm
- hollow per 100 mm wood length		2 mm

Timber quality of hardwood

Hardwood to be used for the manufacture of hardwood components of staircases and accessories shall at least be free of defects that have a severe detrimental effect upon the structural loading and/or wear resistance, such as spiral grain, blisters, voids, large longitudinal and drying cracks, upset shake (felling shake), reaction wood, brittle or spongy heart and boxed heart.

Aesthetic imperfections such as a limited number of pinholes/shotholes and contraction cracks/hairline cracks which are inherent to the wood type used are allowed. Other aesthetic imperfections expressly accepted by the client are also allowed.

Requirements of hardwood (general) in the end product	
Spiral growth, blisters, voids	Not allowed
Growth of longitudinal and drying cracks	Not allowed
Upset shake (felling shake)	Not allowed
Reaction wood	Not allowed
Brittle heart	Not allowed
Boxed heart	Not allowed
Pinholes/shotholes	Allowed to a limited degree
Contraction cracks / hairline cracks	Allowed to a limited degree
Maximum slope of grain	1 : 7
Deformation:	
- bend per 2 m wood length	8 mm
- curvature per 2 m wood length	4 mm
- warp per 2 m wood length	4 mm
- hollow per 100 mm wood length	2 mm

1. TECHNICAL SPECIFICATION
 - 1.1 Subject
Profiled components for joinery.
 - 1.2 Marks
Profiled components for joinery are marked with
 - 1.3 Product specification
 - 1.3.1 Timber
.....
 - 1.3.2 Coatings
.....
 - 1.3.3 Models and dimensions
2. PROCESSING INSTRUCTIONS
 - 2.1 Transport and storage
.....