1st Edition, rev. 4, February

Certification of laminated scantlings (blanks) for use in door and window production

Technical requirements and manufacturing procedures for process and production control

Nordic Certified SCANTLINGS
WINDOWS & DOORS

RI.SE Research Institutes of Sweden

DANSK VINDUES VERIFIKATION

NDVK NORSK DØR- OG VINDUSKONTROLL SERTIFISERT

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Introduction

This certification system is based on existing procedures used in Sweden, Denmark and Norway and has been prepared by a technical group set up by the door and window control bodies and the industry in the mentioned three countries. This document will be a supplement to the certification schemes in the countries for the production of windows and doors.

Products certified according to this document comply with the requirements set by Dansk Vindues Verifikation (DVV), Norsk Dør- og Vinduskontroll (NDVK) and Research Institutes of Sweden (RISE).

Technical and inspection requirements are, to a certain extent, based on EN standards. A list of the standards used in these guidelines can be found in Section 7.

The system can be revised, when necessary, for example to harmonise with European or international standards. Updating may also be necessary if new regulations are introduced or as a result of experience from applying the guidelines. If clarification or expansion is necessary, a Technical Committee appointed by the Scandinavian industry and control bodies will revise the guidelines. The Committee will meet at least once a year.

Membership conditions

- The factory has to pay an introduction fee to the control scheme
- A yearly membership fee applies
- The certified factories must take out product liability insurance for at least 1 million EUR
- The fees will be set by the Technical Committee and adjusted when necessary

Authority of the Technical Committee

The committee:

- Approves national control bodies in Denmark, Norway, Sweden or other countries
- Assigns certificate numbers
- Decides whether to cancel or to suspend a certificate. A suspension can be granted for a maximum period of 2 years, when re-applying after 1 year. This decision must be based on advice from the national control body

1 Scope

This certification system describes the conditions for certification of laminated scantlings and finger jointed massive wood for use in door and window production in Scandinavia, where the glue lines are subject to specific requirements. The system covers the laminating and finger jointing process in finger jointed timber and in glued laminated products as well as an internal quality control system at the factory. The internal quality control system must be adapted to the products produced in question.

The wood species to be used are given in EN 14080:2013 or in other well-founded documents, e.g. European Assessment Documents (EAD).

This certification system does not apply to modified and stabilised wood with strongly reduced swelling and shrinkage properties, such as acetylated wood, heat-treated wood and polymer impregnated wood unless

documentation of gluing properties and long-term properties have been approved by the Technical Committee mentioned in the “Introduction” chapter.

Special instructions for the species of hardwood in question must be considered regarding surface preparation, open and closing time, pressure time, etc.

2 Definitions

2.1 Density

Density must be given as m_{12}/v_{12} (mass and volume at 12% moisture content).

2.2 Wood failure

Massive wood failure where the glue line cannot be seen or detected with iodine when PVAc adhesives are used. A thin fibre layer on top of the adhesive will not be regarded as wood failure.

2.3 Adhesive Class 1 (C1)

The glue lines will not be exposed to weather. Only for short periods, the moisture content may be higher than 20% close to the glue lines. The temperature will rarely, and only for short periods of time, exceed 50°C.

2.4 Adhesive Class 2 (C2)

The glue lines may be exposed to weather. For longer periods of time, the moisture content may be higher than 20% close to the glue lines. Glue lines in weather-exposed areas as defined in EN 14220 will belong to adhesive Class 2.

<u>Note:</u> Glue lines perpendicular to the window glass or to the door plan which can be seen on the surface belongs to Adhesive Class 2 even if the window is painted.
If the glue lines are protected from the weather using plastic, aluminium or similar, the glue lines will belong to Adhesive Class 1.

2.5 Finger Joints, Test Level 1 (FL1)

Test Level 1 – General performance. Is valid for finger joints with nominal finger length usually shorter than 10 mm. Requirements are given in Table 4 and 5.

2.6 Finger joints, Test Level 2 (FL2)

Test Level 2 – High performance. Is valid for finger joints with nominal finger length usually 10 mm. and longer. Requirements are given in Table 4 and 5.

3 Technical requirements and manufacturing procedures

3.1 General

The purpose of the tests and requirements included in these guidelines is to ensure that the adhesive bonding process for the components results in tight and strong joints. The requirements applicable to the timber raw material and to the adhesives system are based on specified routines and materials classes. Scantlings (pieces) of adhesively bonded timber components taken for tests must be withdrawn from normal production and in a way ensuring that they can be regarded as representative of all the products to be approved.

For hardwood glued according to adhesive Class 1 (glue lines not exposed to weather), product testing must include a shear test according to EN 14080, Annex D and a delamination test according to EN 14080, Annex C - method C.

For hardwood glued according to adhesive Class 2 (glue lines may be exposed to weather), product testing must include shear testing according to EN 14080, Annex D and a delamination test according to EN 14080, Annex C - method B.

3.2 Manufacturing inspection and requirements

These certification guidelines specify special requirements applicable to processes and conditions in order to ensure that the product can be approved, and consequently be marked as described in Section 5 of this document. Certain processes and conditions can be tested by various methods and against different requirements:

Table 1. General requirements

Category	**Reference**	**Requirement**
Moisture content * and	Appendices 1 - 3 Measuring moisture contents - methods	According to required specification, 95% of the measured test values must be within the target value ± 2%.
Timber quality *	Nordisk kvalitetsspråk for trebransjen - nåletre ISBN 87-7756-568-1	According to the required specification.
Width of annual rings *	Appendix 4 Measuring annual ring width	According to the required specification.
Heartwood *	3.3.5 Determination of heartwood proportion in the cross section	According to the required specification.
Density *	Appendix 5 Determination of material density	According to the required specification.
Temperature at the production site	Appendix 6 Climate control	Air temperature minimum 15°C.
Temperature in the wood at gluing	Technical data sheet from the adhesive supplier	According to the adhesive supplier’s technical data sheet.

Climate for storing raw material and finished products	Appendix 6 Climate control	The climate in the production and storing areas must cause an equilibrium moisture content for wood within the given target moisture range for the product. If the climate does not meet the requirements, the material must be covered.
Adhesive *	Section 3.4.2 Emission of formaldehyde	According to the required specification.

* These properties must be covered by a documented specification. EN 942 can be used to define timber quality.

Table 2. Materials reception control

Category	Reference	Requirements
Timber	Appendices 1, 2 and Section 3.3 - Timber raw material	According to required specification. The factories must have routines which safely deal with the different properties.
Adhesive	Appendix 7 Reception inspection of adhesives	
Heartwood	3.3.5 Determination of heartwood proportion in the cross section	
Annual rings	Appendix 4	
Material density	Appendix 5	

Table 3. Process inspection

Process categories	Reference	Requirements
Planing	Appendix 8 Planing quality	Clean, smooth surfaces without large cutter marks or torn grain, depending on the requirements of the type of adhesive and the manufacturer's specification. The thickness variation along the board and the deviation in parallelism between the two surfaces must comply with the requirements listed in the appendix.
Lamella moisture control just before adhesive application	Appendix 1 or Appendix 3 Using an electrical moisture meter or an inline meter.	The target moisture content is set by the manufacturer. The measured moisture content must be within the target moisture content ± 2%.
Finger jointing	Appendix 11 Control of pressure and pressing times	Apply sufficient end pressure to secure a tight joint without any cracks or openings.
	Appendix 12 Control of finger joint profile	Control of finger geometry to secure a correct fit. The joints must be tight without any openings and fulfil the requirement for bending strength. Min. nominal length of finger is 6.0 mm.
	Appendix 9 Mixing ratio	As specified by the supplier.
	Appendix 13a Adhesive application control in finger joints using iodine.	The glue line must appear as a continuous brownish coloured string along all the finger flanges. The method only applies to PVAc adhesives.
	Appendix13b Adhesive application control on the finger profile before pressing.	The application system must apply enough adhesive over all finger flanges to a depth of min. 75% of the finger length.

	Appendix 14 Tightness control of finger joints using a liquid penetrant.	Less than 2.5 mm penetration.
Lamination - gluing and pressing	Appendix 9 Mixing ratio and applied amount of adhesive.	As specified by the supplier.
	Visual control of adhesive application on the lamella surface.	A procedure must exist which describes visual frequent monitoring of the application. Observations must be filed.
	Appendix 10 Bond line temperature when HF is used.	As specified by the supplier.
	Appendix 11 Control of pressure and pressing duration.	According to specifications given by the adhesive manufacturer. Apply sufficient end pressure to secure a tight joint without any cracks or openings.
	Appendix 16 Bond line quality check after pressing - split test.	Wood failure percentage: Mean value ≥ 90% Single value ≥ 70%
Final control of finished products	Visual control of end products.	• No openings (delaminations) in the glue lines. • No knots in the finger joints in solid wood components or in outer lamellae in blanks. • Tight finger joints. • Wood quality according to specifications. • Correct dimensions. The inspection results must be filed.

Table 4. Product inspection and testing

Category	References	Requirements
Bending test of finger joints	Appendix 15 Bending test of finger joints. Performance according to EN 408.	**Test level 1 (FL1) - General performance** ***When the finger length used is usually shorter than 10 mm*** Type 1 failure No requirement. If the bending strength is lower than 40 N/mm², a new test sample must be taken. Type 2 failure Equal to or higher than 40 N/mm² Type 3 failure Equal to or higher than 50 N/mm² **Test level 2 (FL2) - High performance** ***When the finger length used is usually equal to or longer than 10 mm*** Type 1 failure No requirement. If the bending strength is lower than 45 N/mm², a new test sample must be withdrawn. Type 2 failure Equal to or higher than 45 N/mm² Type 3 failure Equal to or higher than 60 N/mm² *Note* *Example: Requirements given for "High performance" can be used if high resistance to burglary is requested.*
Moisture content in test samples for bending	Measurements are performed in bending test specimens as specified in Appendix 1 or 3.	Moisture content at testing: Product target value ± 2%.
Delamination of glue lines in lamination and in finger joints.	Laminations - Appendix 17 According to EN 14080:2013, Annex C. Finger joints - Appendix 19 Water soak delamination test of finger joints when a 2-component adhesive system is used.	Laminations The requirements apply to the mean value of 3 test samples taken from the same scantling. The maximum delamination in one single glue line must not exceed 30%. **Class 1 adhesives, minimum requirements:** Thermoplastic adhesives according to EN 204-D3 and D4 and thermosetting adhesives according to EN 12765-C3 and C4: Delamination method C: ≤ 20% after 1 cycle. *Note* *For types D3 and C3, method C can be replaced by a shear test according to EN 14080, annex D.*

		Class 2 adhesives, minimum requirements: Type I adhesives according to EN 301, EN 15425 and EN 16254: Delamination method B (A). Method B is recommended. Method B: ≤ 4% after cycle 1, ≤ 8% after cycle 2. Method A: ≤ 5% after cycle 2, ≤ 10% after cycle 3. Thermosetting adhesives according to EN 12765-C4 which pass delamination test B (A) in EN 14080, Annex C. If hardwood is glued to be used in non weather-exposed area method C can be used in delamination test. <u>Finger joints</u> No openings along the finger flanges are allowed.
Shear test of glue lines for adhesive types C3 and D3.	<u>Appendix 18</u> Test method according to EN 14080, Appendix D.	The requirements are set by the committee responsible for this certification system. A shear strength between 4 and 6 N/mm² according to EN 14080 requires 100% wood failure. This has been reduced to 90% by the committee. Shear strengths equal to or higher than 6 N/mm² have no requirement to the % wood failure.

Table 5. External testing (performed by inspection body)

Category	References	Requirement
Tightness testing of finger joints	Appendix 14 Tightness control of finger joints using a liquid penetrant.	Less than 2.5 mm penetration.
Bending test of finger joints	Appendix 15 Bending tests of finger joints. Reference to EN 14080:2013, Annex E - Test with laminations with or without finger joints. E.2.3 Additionally for factory production control.	**Test level 1 (FL1) - General performance** ***When the finger length used is usually shorter than 10 mm*** Type 1 failure No requirement. If the bending strength is lower than 40 N/mm², a new test sample must be taken. Type 2 failure Equal to or higher than 40 N/mm² Type 3 failure Equal to or higher than 50 N/mm² **Test level 2 (FL2) - High performance** ***When the finger length used is usually equal to or longer than 10 mm*** Type 1 failure No requirement. If the bending strength is lower than 45 N/mm², a new test sample must be taken. Type 2 failure Equal to or higher than 45 N/mm² Type 3 failure Equal to or higher than 60 N/mm² *Note* *Example: Requirements given for "High performance" can be used if high resistance to burglary is requested.*
Delamination of glue lines in lamination and in finger joints.	Laminations - Appendix 17 According to EN 14080:2013, Annex C. Finger joints - Appendix 19 Water soak delamination test of finger joints when a 2-component adhesive system is used.	Laminations The requirements apply to the mean value of 3 test samples taken from the same scantling. The maximum delamination in one single glue line must not exceed 30%. **Class 1 adhesives, minimum requirements**: Thermoplastic adhesives according to EN 204-D3 and D4 and thermosetting adhesives according to EN 12765-C3 and C4: Delamination method C: ≤ 20% after 1 cycle. *Note* *For type D3 and C3, method C can be replaced by a shear test according to EN 14080, Annex D.*

		Class 2 adhesives, minimum requirements: Type I adhesives according to EN 301, EN 15425 and EN 16254: Delamination method B (A). Method B is recommended. Method B: ≤ 4% after cycle 1, ≤ 8% after cycle 2. Method A: ≤ 5% after cycle 2, ≤ 10% after cycle 3. Thermosetting adhesives according to EN 12765-C4 which pass delamination test B (A) in EN 14080, Annex C. If hardwood is glued to be used in non weather-exposed area method C can be used in delamination test. Finger joints No openings along the finger flanges are allowed. Water soak delamination test must only be performed for 2-component glue.
Shear test of glue lines for adhesive types C3 and D3.	Appendix 18 Test method according to EN 14080, Appendix D	The requirements are set by the committee responsible for this certification system. A shear strength between 4 and 6 N/mm² according to EN 14080 requires 100% wood failure. This has been reduced to 90% by the committee. Shear strengths equal to or higher than 6 N/mm² have no requirement to the % wood failure.

3.3 Timber raw material

Relevant documents and standards are listed below.

- Nordisk kvalitetsspråk for trebransjen - nåletre ISBN 87-7756-568-1
- EN 844
- EN 942

The quality of the timber raw material must meet the requirements of the agreed and approved specification according to the specific use, and the specification must always be available for inspection. The properties and condition of the timber raw material must be measured according to specified routines and standards.

3.3.1 Type of timber

This certifying rule applies to the wood species mentioned in EN 14080:2013, paragraph 5.5.2, pine and spruce species.

In addition, for hardwood:

For hardwood glued according to adhesive Class 1 (glue lines not exposed to weather), product testing must include a shear test according to EN 14080, Annex D and a delamination test according to EN 14080, Annex C - method C.

For hardwood glued according to adhesive Class 2 (glue lines may be exposed to weather), product testing must include shear testing according to EN 14080, Annex D and a delamination test according to EN 14080, Annex C - method B.
This certification system does not apply to modified and stabilised wood with strongly reduced swelling and shrinkage properties, such as acetylated wood, heat-treated wood and polymer impregnated wood unless documentation of gluing properties and long-term properties have been approved by the Technical Committee mentioned in the “Introduction” Chapter.

3.3.2 Moisture content and temperature

The moisture content is critical for a good quality product. Three different test methods are approved for measuring it:

1. The resistance method (described in Appendix 1)
2. In-line measurements (described in Appendix 2)
3. The oven-dry weight method (described in Appendix 3)

Use methods 1 and 2 for reception inspection of timber and for measurements during the manufacturing process, and method 3 (reference method) for calibrating the first two, inspections or explanation of defects etc.

3.3.3 Density

The density of incoming timber raw material may be measured in four alternative ways:

1. By measuring and weighing planks or boards
2. By measuring an entire timber package
3. By measuring with the oven-dry method as given in Appendix 3
4. By using a density-measuring instrument or by radiography

Methods 1, 2 and 3 are described in Appendix 5. Unless no agreement is made with a window manufacturer, method 2 is used as a standard.

3.3.4 Width of annual rings

Measure the width of annual rings on the end surfaces of timber in the timber packages. Measure the ring widths on the planks or boards compared to material specification.

The method is described in Annex 4.

3.3.5 Determination of heartwood proportion in the cross section

The proportion of heartwood is customer related. The factory must have written procedures, which meet the customer's requirements for the proportion of heartwood and its location in the cross section.
The procedures must describe control of received wood as well as control of the finished product.

3.4 The adhesive system

The adhesive system must make tight and strong joints that are reliable for use in timber components and their incorporation in timber products throughout their lives.

3.4.1 Selection of adhesive

The adhesive must meet the customers' requirements and be approved for each area. When changing to a different adhesive, test samples must always be sent to a relevant test body for inspection and approval.

3.4.1.1 Required test setup for production approval according to adhesive Class 1 (C1)

Thermoplastic adhesives
Types D3 and D4 according to EN 204.

- **D3:** Interior with frequent short-term exposure to running or condensed water and/or heavy exposure to high humidity. Exterior not exposed to weather.
- **D4**: Interior with frequent long-term exposure to running or condensed water. Exterior exposed to weather but with protection by an adequate surface coating.

Note
This Nordic guideline system states that an "adequate surface coating" for type D4 does not include any painting systems applied by the window manufacturer or by the house owner (normal maintenance).

Thermosetting adhesives
Types C3 and C4 according to EN 12765.

- **C3**: As for D3 regarding definitions and product test setup.
- **C4**: As for D4 regarding definitions and product test setup.

Additional test setup for adhesives approved according to "C" and "D" classes

- **C3**: Delamination test according to EN 14080:2013, Annex C, method C (total delamination max 20%).
- **D3 and D4**: EN 14257 (testing at 80°C - former WATT 91). Delamination test according to EN 14080:2013, Annex C, method C (total delamination max 20%).

Note: For types D3 and C3, the delamination test can be replaced by a shear test according to EN 14080:2013, Annex D.

3.4.1.2 Required test setup for production approval according to adhesive Class 2 (C2) (Class 2 may substitute Class 1)

Type C4 (thermosetting adhesives) according to EN 12765.

- EN 14080:2013, Annex C, delamination test, method B (or A).

Phenolic and aminoplastic adhesives: Type I according to EN 301 (structural adhesives).

- EN 14080:2013, Annex C, delamination test, method B (or A).

EPI (emulsion-polymerised isocyanate): According to EN 16254 (structural adhesives).

- EN 14080:2013, Annex C, delamination test, method B (or A).

One-component PUR (polyurethane): According to EN 15425 (structural adhesives).

- EN 14080:2013, Annex C, delamination test, method B (or A).

Two-component PUR: No existing test standard for approval. Testing according to EN 15425 will be enough.

3.4.1.3 Adhesives for finger jointing according to Class 1 (C1) and Class 2 (C2)

Minimum requirement is type D4 according to EN 204. In addition, testing according to EN 14257 (former WATT 91 - 80°C) is needed.

3.4.2 Declaration and information

The manufacturer of the adhesive must provide a description of the adhesives system supplied, including the following information:

A description of the system, with details of the composition of the product, according to the requirements of Regulation (EC) 1272/2008 on its classification, labelling and packaging.

The class of formaldehyde emission must be declared by the adhesive supplier for the fully hardened glue line.

3.4.3 Handling and use

The Material Safety Data Sheet and Technical Data Sheet for the adhesive system in question must be present and must be followed. The adhesive supplier must clarify any deviations from the given gluing conditions in the data sheet.

The adhesive system must be handled and stored according to the supplier's instructions.
Storage areas for adhesives must be arranged so that the 'first-in-first-out' principle can be operated and monitored.

3.5 The adhesive bonding process

The adhesive bonding process must comply with the requirements of these certification guidelines, which are mostly based on EN standards.

3.5.1 Application of adhesive

3.5.1.2 Lamella gluing

The spread rate of adhesive depends on the type of adhesive and on the intended use of the component in the product, all according to the adhesive supplier's instructions and descriptions. Application of the adhesive must be uniform, uninterrupted and in sufficient quantity according to the supplier's specification. The adhesive can be applied to the lamellae as described in the Technical Data Sheet for the system.

3.5.1.3 Finger jointing

One-sided application is allowed if sufficient control is implemented (visually or by an automated system). The application system must ensure that all the fingers are covered on up to 75% of the finger length (from the fingertips and backward).
If glue and hardener are applied separately, only adhesives approved for this can be used. The application of each component must be done by two independent devices, e.g. by two combs with one nozzle or one comb with two nozzles per finger flange.

For systems approved for contact-free application (applied on the profile front as strings 90 degrees to the fingertips), the following applies:

- The amount of adhesive must be monitored by an automated system

- The application process must be continuously monitored by an automated system for one-sided application, and an automated or visual system if applied two-sided
- All results obtained must be recorded

In production control, the following tests must be performed:

Option 1:
An arbitrarily chosen finger joint must be taken just after adhesive application and cut next to the slot base. All finger surfaces must be separated by manual breaking. The adhesive coverage of all surfaces must be inspected visually, and the result must be documented.

Option 2:
An arbitrarily chosen finger joint must be taken just after pressing and cut next to both slot bases. All finger surfaces must be separated by manual breaking. The adhesive coverage of all surfaces must be inspected visually, and the result must be documented.
NB! This test is mandatory for contact-free application.

3.5.2 Application of pressure to bonded joints

Pressure must be applied uniformly over the entire bonded area. Examples of recommended pressure are given in Tables 6 and 7 below. Higher pressures must be used for curved scantlings, applied in such a way that the parts can slide over each other in the longitudinal direction in order to prevent gaps occurring in the glue line. Pressure must be maintained for the time specified by the adhesive's supplier.

3.5.2.1 Lamella bonding

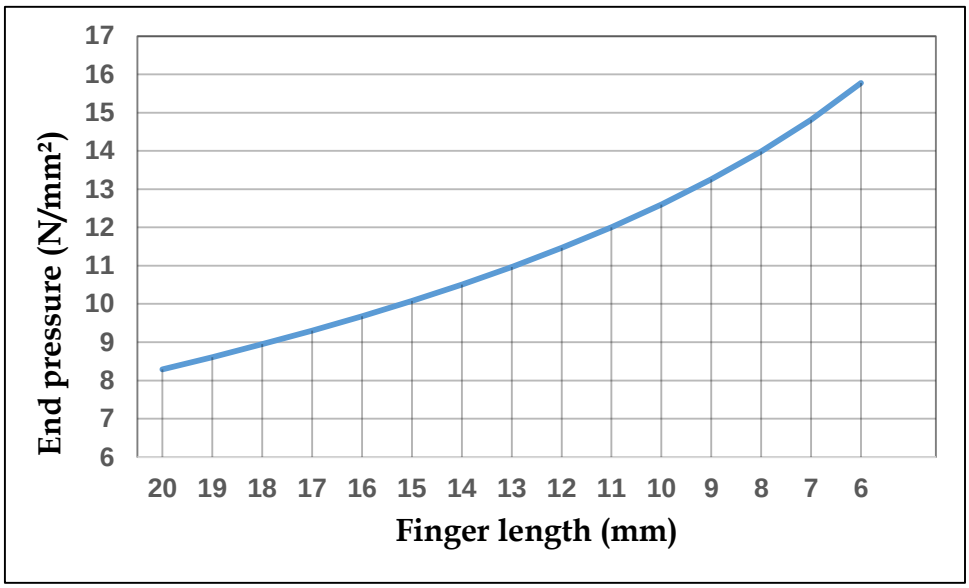
Table 6. Recommended pressure for lamella bonding of softwood (partly taken from EN 14080:2013)

Lamella thickness (t)	t ≤ 35 mm	35 mm < t ≤ 45 mm	45 mm < t ≤ 75 mm
Pressure	0.6 - 0.8 N/mm^2	0.8 - 1.0 N/mm^2	1.0 - 1.2 N/mm^2

3.5.2.2 Finger jointing

The recommended pressures are calculated on the cross section of active fingers (excluding “shoulders”, if any) and linked to jointing of construction wood. For other species, the supplier’s instructions apply. The elapsed running time for the cutters, moisture content and material density may influence the correct pressure setting.

Diagram 1: Recommended pressure for finger jointing of softwood at 20°C (EN 14080:2013, 1.4.7).



3.5.3 Finger jointing

- No knots are allowed in the finger joints in solid wood products or in the outer lamellae in blanks. The fibres must be straight when entering the jointed area.
- Gaps between the fingertips and finger bottoms are not allowed.
- Cracks coming from the finger bottoms are not allowed.

3.5.4 Lamination

- Unless otherwise accepted by the customer, the lamellae must be planed as soon as possible before bonding:
- Normal requirement is less than 24 hours before bonding.
- If the lamellae have a high resin content, planing must have been carried out less than 6 hours before bonding.
- The temperature on site must not be less than 15°C.
- The minimum thickness of the outermost lamella, which will be exposed to outdoor climate, must not be less than 6 mm after profiling.

4 Internal Quality System

4.1 General requirements

The manufacturer must establish, document and maintain a factory production control system to ensure that the products placed on the marked comply with agreed quality, and that the minimum product provisions are fulfilled.
The quality system must provide traceability backwards from the customer to the scantling producer in such a way that production parameters, test results and raw material can be identified.

The control system must at least cover the following:

- An organisation diagram must be present where all key personnel are identified, and their responsibilities are described. At least one person in the organisation must be appointed Quality Manager.
- The manufacturer must have production facilities suitable for wood processing.
- Established system for handling external claims.
- The factory production control system must consist of regular inspections, production procedures, internal test procedures and a system for maintenance and control of test and production equipment. How to handle non-confirming products and test results must be included.
- A list over production and test equipment must be available, describing the plan for calibration with tolerances included.
- An education plan for the operators must be developed and continuously be updated.
  The personnel must have adequate training in production of laminated scantlings and have sufficient knowledge about the production quality system in general. In addition, it is required that the quality routines linked to their own process areas/workstations must be well known.

4.2 Document management

Procedures must be established for the management of quality documents. The system must ensure that the correct editions of all applicable documents are available for the operators in the production areas where the described processes are performed.
In addition, it must prevent the unintentional use of outdated documents. Externally sourced documents must be identified and included.

All quality documents must be clearly written and be linked to appropriate/relevant products or orders. They must always be available for inspection by the relevant control body and be stored in such a way to ensure that they can easily be located when asked for.

4.3 Control of production

Manufacturing must be performed under controlled, planned and traceable conditions. Production must be carried out according to documented working instructions and procedures.
Procedures and actions for dealing with non-conforming products must be developed.

4.4 Inspection and testing

In order to secure correct quality of the final product, inspection routines according to Tables 7 and 8 must be established.

Each checkpoint must include clear and written procedures regarding inspection, monitoring of limit values and how to keep records. Procedures for actions to be taken in case of non-conforming products or processes must be present.

Table 7. Minimum frequency of inspection methods

Inspection		**Frequency**
Timber (reception inspection) The factories must have routines which deal with the different properties in a safe way	Temperature	As needed (at winter)
	Heartwood [2]	Each timber package, or continuously
	Moisture content [2]	Each timber package, or continuously
	Timber quality [1]	Visually, continuously
	Annual rings [2]	Each timber package
	Density [2]	Each timber package, or continuously
Adhesive (reception inspection)		Each delivery
Ambient conditions (storing of material)	Temperature and relative humidity	Continuously
Planning	Control of dimensions	Change of settings, when necessary
Bonding	Mixing glue and hardener	<u>Mixing by hand</u> Control every batch mixed <u>Automatically mixed</u> Physical control once per shift per production line Continuous supervision of glue and hardener consumption given by the application machine
	Adhesive quantity	Once per shift and at change of settings
	Glue line temperature, HF	Twice per shift. In addition: if a production stop of more than 15 minutes occurs and at change of settings
	Applied adhesive - finger joints	Frequently supervision (visual control). Inspection at least once per hour. Physical inspection of adhesive distribution on the finger flanges by opening a joint before or just after pressing. Check one joint every second hour
	Applied adhesive - lamellae	Frequently supervision (visual control). At least one inspection per hour
	Pressure, pressing duration	Twice per shift, and at change of settings
Finger joint profiles		When tools are replaced

Final control of finished products	Visual inspections according to accepted quality	Frequently, at least once pr. 30 minutes.

[1] No record-keeping necessary.

[2] If required in the material specification.

Table 8. Minimum frequency of sampling pr. production shift

Testing	**Production volume (linear meters)**	**Frequency**
Bending testing Delamination testing Shear testing [1]	< 6000	Once
	6000 - 12000	Twice
	> 12000	Three times
Tightness testing Iodine testing Chisel testing	< 6000	Twice, or at change of settings
	6000 - 12000	Three times, or at change of settings
	> 12000	Four times, or at change of settings
Water soak delamination test of finger joints when a 2-component adhesive system is used	-	Weekly testing: three jointed lamellae must be taken from each production line and shift three times during a week. From each lamella, 3 joints must be tested.

[1] If Class 1 adhesive, shear tests can replace delamination test type C.

4.5 Calibration and control of equipment

Equipment for monitoring, testing and measuring must be calibrated according to written procedures and instructions.

The company must establish an appropriate care and maintenance plan together with documentation to show that the calibration/control has been performed. Calibration reports must be stored and be available for inspection.

5 Marking, labelling and tracing

Manufactured components produced under these guidelines must be marked clearly with an approved label on each package. The delivery to the customer must be carried out in such a way that the product characteristics will not be changed, and to avoid moisture changes, dust/dirt and bleaching of the wood.

The producer must have a tracking system for their products. It must be possible for at window/door factory to trace the laminated blank producer and at least the production week of the actual scantlings.

The following information regarding the product shall be given to the customer:

1. The logo of this Certification System with reference to the control body responsible for the factory inspections
2. The name and certification number of the company

3. The batch number, order number or other means of package identification
4. The name of the profile/item no.
5. Dimensions in mm (thickness, width, length)
6. Volume/Weight
7. Date of production
8. Adhesive type and class (example: MUF-class 2 (C2) or PVAc-class 1 (C1))
9. Bending strength of finger joints. Test Level 1 (FL1) - General performance or Test Level 2 (FL2) - High performance

Note 1: The information mentioned above can be split between a label attached to the package, in the delivery documents or in a separate written agreement between the factory and the client. This agreement shall be accepted by the control body and be included in the quality system.

Note2: Information to the customer regarding Profile name, adhesive type, adhesive class and test level for the finger joints can be given as follows:
Example: The factory makes "Profile X" and use MUF in Class 2 for the lamella gluing and PVAc in Class 1 in the finger joints. The test level for the joints is Level 2 – High performance.
This can be marked as "Profile X/C2-MUF/FL2-C1-PVAc".

6 Surveillance inspection

6.1 Inspection visits

Surveillance inspection will be carried out twice a year by the inspection body by means of inspection visits to the place of manufacture. If serious non-compliances are found, additional visits may be required.

Surveillance inspection will cover:

- Inspection to ensure that the company's material specifications are followed.
- Inspection of the manufacturer's quality procedures and to check if internal inspection procedures are followed.
- Inspection of measuring instruments and test equipment used by the manufacturer for internal inspection work.
- Sampling for external testing.

When the Technical Committee has sufficient experience with the control scheme, it will be considered whether the visit frequency may be reduced, from two to one visit, under certain conditions.

6.2 Samples for external testing

Samples will be taken, and tests performed, at each visit as follows:

Table 9. Sampling frequency

Category	Samples
Tightness testing of finger joints	6 items /line and visit

Bending test of finger joints	6 items /line
Delamination of bond lines	6 items /line
Shear test of bond lines [1)]	6 items /line
Delamination of finger joints	6 items /line

[1)] If Class 1 types C3 and D3 adhesives, shear testing can replace delamination type C.

6.3 Actions if products or inspection results are not approved

If results from testing and/or inspection of manufacturing control are not satisfactory according to Appendices 20 or 21, the reason for non-conformity must be investigated. If the samples taken for external testing do not pass requirements, further samples must be taken and tested. If these additional samples do not fulfil requirements, it will be necessary to decide on what action is needed. If the manufacturing process is unsatisfactory, a date must be set by which this deviation must be corrected. In case of more serious deviations, it may be necessary to make an additional visit to the plant.

6.4 Reporting

The results of surveillance inspection must be documented in the form of an inspection report and delivered to the manufacturer and to the holder of the certificate, if the holder of the certificate is some other entity than the manufacturer.

7. References

References given in this document are listed in Table 10

Table 10. References

Standard	Description
EN 844 Round and sawn timber - Terminology	Terms, concepts and definitions
13307-1 Timber blanks and semi-finished profiles for non-structural uses	Growth ring directions; Service classes
EN 942 Timber in joinery - General requirements	Classification of joinery timber and assessment of timber quality
EN 14220 Timber and wood-based materials in external windows, external door leaves and external door frames - Requirements and specifications	Classification of joinery timber for windows and external doors
EN 14221 Timber and wood-based materials in internal windows, internal door leaves and internal door frames - Requirements and specifications	Classification of joinery timber for internal windows and internal doors
EN 1309-1 Round and sawn timber - Method of measurement of dimensions	Measurement of length, width and thickness
EN 1309-3:2018 Round and sawn timber - Method of measurement - Features and biological degradations	Measurement of special features
Trätek book, Trätorkning 1a Grunder i trätorkning [Timber drying 1a, Foundations of timber drying], Björn Esping	Recommended relative humidity and equilibrium moisture contents at different temperatures
CEN/TS 12169 Criteria for the assessment of conformity for a lot of sawn timber	Measurement of moisture contents in timber
EN 14298 Sawn timber - Assessment of drying quality	Moisture content requirements for incoming raw material and scantlings in the process.
COST E53 Quality control for wood and wood products - How to specify correctly (work document). European Drying Group (EDG). Version 1.0	Moisture content difference between two bonded pieces Moisture contents - geographical application Suggested moisture contents - Europe Special drying - moisture content precision
EN 13183-1, -2 and -3 Moisture content of a piece of sawn timber - Determination of moisture content by the resistance method, dry weight method and estimation by capacitance method	For reception inspection and production inspection
Trätek report L 9006029 Resistance curves for electrical moisture content meters	To ensure the use of correct resistance curves and temperature compensation
EN 1312 Round and sawn timber - Determination of the batch volume of sawn timber	Used for density determination
EN 14080 Timber structures - Glued laminated timber and solid timber - Requirements	Manufacturing inspection: Bending strength of finger joints Delamination test methods

Standard	Description
	Shear test method
CEN/TS 13307-2:2010, Laminated and finger jointed timber blanks and semi-finished profiles for non-structural uses	Manufacturing inspection: Tightness testing, iodine testing and chisel testing
EN 408 Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties	Test method for bend testing
EN 204 Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties	Classification of thermoplastic adhesives
EN 12765 Classification of thermosetting wood adhesives for non-structural applications	Classification of thermosetting adhesives
EN 301 EN 301 Adhesives, phenolic and aminoplastic, for load-bearing timber structures	Classification of phenolic and aminoplastic adhesives
EN 14257 Adhesives - Wood adhesives. Determination of tensile strength of lap joints at elevated temperature (WATT 91)	Classification of the tensile strength of Type D4 adhesives at elevated temperature
Nordisk Kvalitetsspråk for trebransjen (Nordic quality language for the wood industry)	

Appendix 1 - Measuring moisture content by the resistance method

1. General

These instructions describe how to measure the moisture content of timber as part of a reception inspection and as a part of a manufacturing inspection, according to the procedure described in EN 13183-2.

The instructions can be used for moisture measurement of timber having a moisture content between 7% and fibre saturation point.

When a new timber package is to go into production, it needs to be inspected against its work order documents as follows:

- When unloading the timber into the manufacturing site, measure the moisture content and check the material quality in at least every third package.
- If necessary, measure the temperatures in the timber packages during unloading or when entering the production line.
- Check the moisture content before starting the production process.

If the timber don`t meet the requirements above, it must be recalled from the production line. The factory must have procedures for handling recalled material.

2. Equipment

Moisture meters must enable to measure the moisture content of timber with an accuracy of ± 2%. The accuracy of a moisture meter according to EN 13183-2 or -3, must be checked by comparison with results from measurements with the oven dry method according to EN 13183-1. Documentation from such a test must be available.

The following equipment is necessary for correct measurement of the moisture content:

- A resistance moisture meter, having insulated test probes at least 35 mm long, with a scale graduation up to 30% and a resolution of at least 0.1%.
- A thermometer with a thin external sensor. An IR sensor can be used for a quick overview and when temperature conditions are stable.
- A calibration block with several calibration points.

3. Method

3.1 Reception inspection

<u>If the timber is bought dried, a minimum number of measurements are:</u>

- 5 measurements at the top end of the lamellae on each side of the package (risk of low moisture content, normally over dried).
- 5 measurements at the root end of the lamellae on each side of the package (risk of high moisture content).

<u>If the factory dries the timber by their own:</u>

- Documentation of moisture content from every timber package coming from the driers must be available.
- Measure according to alt. 1.

If the average value is outside the requirements, check the timber as follows:

Measure twenty randomly selected planks in the package, ten on each side. If the result is on the borderline for approval, measure a further ten planks and then evaluate the result.

Calculate the average value and lowest, highest and standard deviations from the measurements of each individual timber package and file them.

It is up to the manufacturer to decide if a routine control of moisture gradients in the cross section of incoming material is required. If so, it is recommended to check cross sections where either the thickness or the width of a plank is ≥ 50 mm. Use an electrical moisture meter and measure 5 mm down from the surface and in the middle point of the material thickness.
The difference between the two values must not exceed the requirement given for the target moisture content ± 2% (see Table 1).

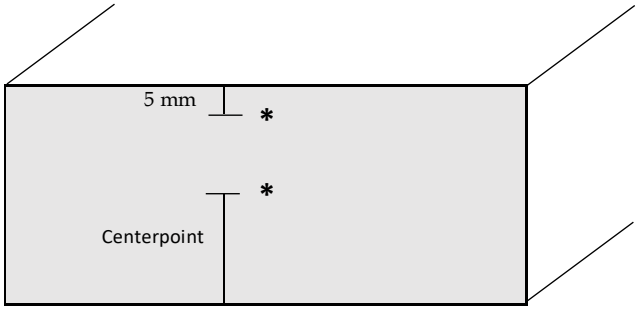


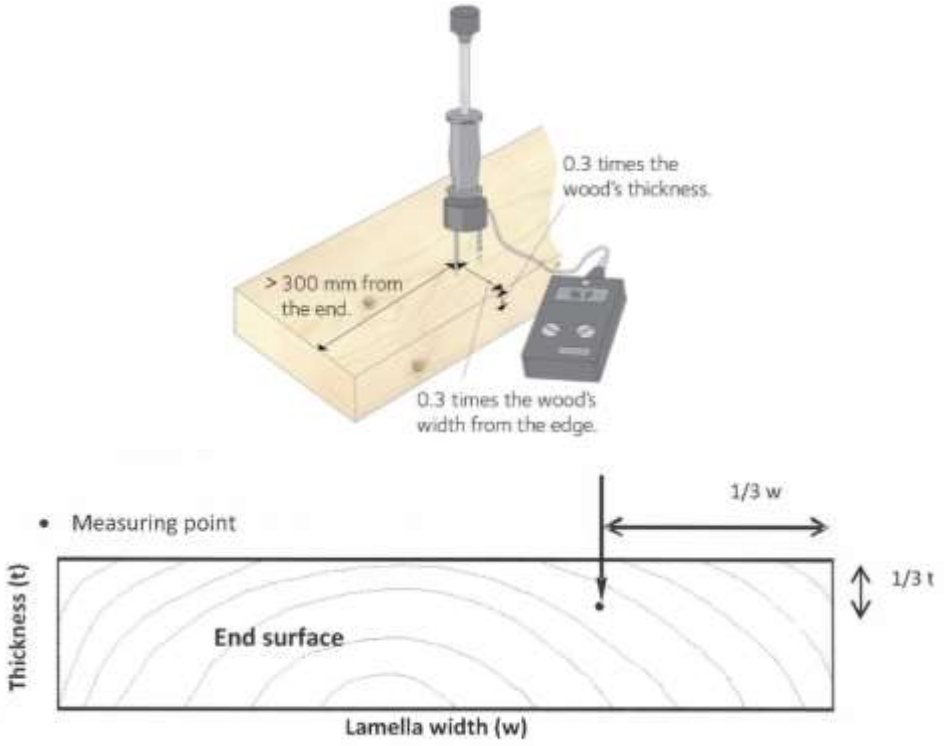
Figure 1 - Measurement of moisture gradient in the cross section

4. Performance

Before measuring the moisture content, check that the moisture meter is set for the correct wood species and wood temperature. Use the holes made in the wood by the meter's probes for measurement of the temperature of the timber. Measuring the temperature is important, especially in the cold season.

- Measure the moisture content in the fibre direction.
- Preferably, measure the moisture content on the flat side of the plank. However, measurement on the edge is also acceptable. The measurement area must be free of knots, bark, resin pockets or resinous wood.
- At reception inspection, measurements must be made at least 300 mm from the end of the piece: see Figure 1.
- Note the measured value after 2-3 seconds, when it has stabilised.

Surface measurement



Edge measurement

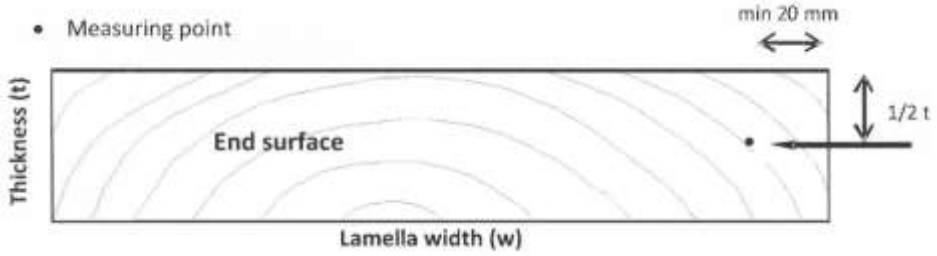


Figure 2 - Measurement of moisture content

5. Results

- The limit values of moisture contents depend on the material specification.
- Actions: note the deviation from applicable limit values in the logs and report them to the person responsible for quality deviations.

6. Report and documentation

All measurement results must be recorded, and the following details should be recorded for each inspection. The limit values used must be clearly noted in the log, and any actions taken in case of non-approved results.

- Date
- Identity
- Wood species
- Wood temperature
- Average moisture content
- Initials of the person who performed the testing

Appendix 2 - Measuring moisture content by the capacitance method

1. General

These instructions describe how to measure the moisture content of timber as part of processing control, using an in-line moisture meter according to the procedure described in EN 13183-3.

The instructions can be used for moisture measurement of timber having moisture content between 7% and 30%. This method of measurement measures the moisture content of all pieces. Note that it is necessary also to measure the temperature of the timber if there is a risk of too cold timber.

This measurement is carried out to ensure that timber not having the correct moisture content or not being of the correct quality do not enter the production process. Such defective pieces can be used for other products or can be conditioned or, in the case of serious deviation from the required values, be the subject of a claim or reject it.

2. Equipment

The following equipment is required in order to be able to measure the moisture content:

- Inline equipment with automatic reject of timber with the wrong moisture content.

3. Method

Measurements are carried out on all the pieces passing through the production process. The equipment must be set to operate with relevant limit values. Measured moisture values (accepted and rejected) must be documented. It's important to observe the calibration interval, at least 1 - 2 times per year.
Calculate the average value of the measurements from each plank and record them in the files.

4. Performance

Instructions for operating the equipment must be available and be used. The latest calibration protocol for the meter must be available.

5. Results

- The limit values of the moisture content depend on the material specification.
- Actions: note the deviation from applicable limit values in the logs and report them to the person responsible for quality control.

6. Report and documentation

Save the recorded results and keep them available for inspection.

Appendix 3 - Measuring moisture content by the oven dry method

1. General

These instructions describe how to measure the moisture content of the timber according to EN 13183-1.

Use this method of measurement when performing re-tests due to production faults, calibration of in-line moisture meter, investigating problems or in connection with disputes.

This test method provides an accurate measurement of average moisture content in a blank.

2. Equipment

The following equipment is necessary for correct measurement of the moisture content:

- An oven with forced air circulation and exhaust air ventilation, temperature 103°C.
- A weighing instrument, with 0.1 g resolution if the weight exceeds 120 g.
- A weighing instrument, with 0.01 g resolution if the weight is between 12 and 120 g.

3. Performance

- Cut out a cross section, with a length of more than 20 mm in the grain direction, weight according to above.
- The cuts should be done at least 300 mm from the end of the piece, or in the centre if the piece is less than 600 mm long.
- The test piece must be free from resin pockets, knots or other defects.
- Weigh the test piece immediately and write the result on the piece.
- Dry the test piece at 103°C ± 2°C. Weigh it at two-hourly intervals and continue drying until the change in mass between two weighings is less than 0.1% (normally 8 - 20 hours).

Calculate the moisture content from: $\omega = \frac{m_1 - m_o}{m_o} \text{ x } 100$

where: ω = the moisture content in %
m_1 = the mass in gram before drying
m_o = the mass in gram after drying

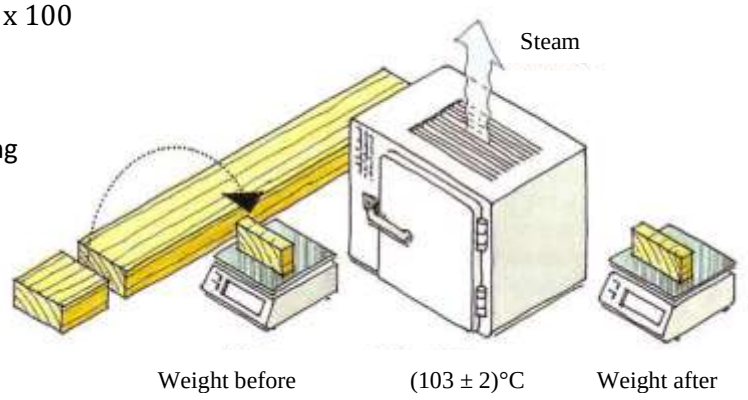


Figure 3: Measuring moisture content

4. Results

- The limit values of the moisture content depending on the material specification.
- Actions: note the deviation from applicable limit values in the logs and report them to the responsible person.

5. Report and documentation

- Date

- Identity
- Wood species
- Moisture content (rounded to the nearest integer)
- Initials of the person who performed the testing

Appendix 4 - Measuring annual ring width

1. General

These instructions describe how to measure the width of annual rings during reception inspection from the sawmill and in finished scantlings according to EN 1309-3:2018.

Perform this inspection before the scantlings are released for production in order to ensure that the timber with correct annual ring width according to the material specification is used. Scantlings that fail this inspection can be used for other products or, in the case of serious deviations, be the subject of claims to the supplier.

2. Equipment

The following equipment is required in order to measure the annual ring width correctly:

- A measuring tape or rule or calliper gauge
- A loupe (*magnifying glass*)

3. Method

Note the average value of the measurements from each timber package in the logs.

4. Performance

Calculate the average width of the annual rings in mm as follows:

- On the end surface of the piece to be measured, mark out the longest straight line that can be drawn perpendicular to the rings. (See Figure 4.)
- Measure the length of the line, disregarding the 25 mm closest to the pith.
- Count the number of annual rings.
- Divide the length of the line by the number of annual rings.
- Calculate the mean and the maximum values.

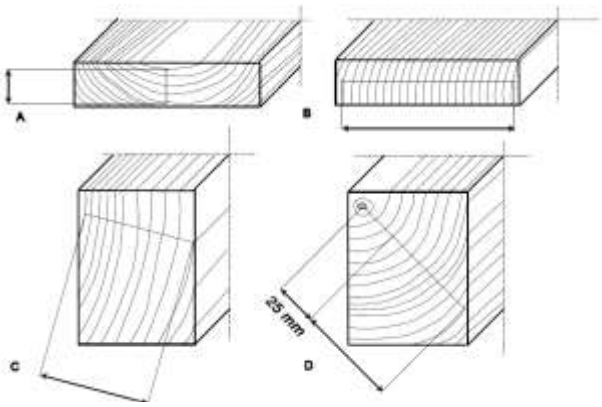


Figure 4. Measuring annual rings

5. Results

- The limit of annual ring width in the material is indicated in the material specification.
- Actions: note the deviation from applicable limit values in the logs, and report them to the responsible person.

6. Report and documentation

- Date
- Identity
- Average and maximum annual ring width
- Initials of the person who performed the testing

Appendix 5 - Determination of material density

1. General

These instructions describe how to measure the density of the timber as part of the work of reception inspection or during production.

Perform this inspection in order to ensure the correct density of the material, as specified in the material specification, before it is released for production. The density of incoming raw material can be measured in three normal ways: either by measuring an individual plank or board, by measuring an entire batch or timber package or by the weight and drying method.
Furthermore, the measurement can also be performed by using a density meter.

Defect scantlings can be used for other products or, in the case of serious defects, be the subject of claims to the supplier.

Density must be given as m_{12}/v_{12} (mass and volume at 12% moisture content).

2. Equipment

The following equipment is needed in order correctly to measure the density:

- Measuring tape or a calliper
- Scale with sufficient accuracy for the actual method
- Density meter
- Drying chamber which can reach at least 110°C

3. Performance

3.1 Individual board measurement

- Measure the moisture content of the board (u)
- Measure the length (l), the width (w) and the thickness (t) of the board in meters, to three decimal places. Calculate the volume (v_u)
- Weigh the board (m_u) with an accuracy of ± 0.5%
- Calculate the density kg/m^3: (m_u/v_u)

3.2 Entire package measurement

- Measure the moisture content (u) and estimate a mean value for the package
- Estimate the volume (v_u) in m^3 of the package from length (l) x width (w) x thickness (t)
- Weigh the timber package (m_u) with an accuracy of ± 0.5%
- Calculate the density in kg/m^3 at u% moisture content: (m_u/v_u)

3.3 Calculation by using small test pieces

1. Cut out a test piece from the board with a length of about 50 mm, free from knots and other material defects
2. Measure the weight (m_u) to the nearest gram and give the value in kilos. Measure the length (l_u), width (w_u) and thickness (t_u) and give the values in meters
3. Calculate the volume v_u in m^3
4. Calculate the density in kg/m^3: (m_u/v_u)

4. Calculation to a density (m_{12}/v_{12})

Density must be given as (m_{12}/v_{12}, mass and volume at 12% moisture content. The formula for transfer (m_u/v_u) to (m_{12}/v_{12}) is given below.

$\rho_{12.12}$ = (m_{12}/v_{12})
$\rho_{u,u}$ = (m_u/v_u)
β = Total volume shrinkage from fibre saturation point and down to 0% moisture content
FMP = Fibre saturation point

$$\rho_{12.12} = \frac{(100 - \frac{12\beta}{FMP}) \cdot 1.12}{100} \cdot \frac{100}{(100 - \frac{u \cdot \beta}{FMP}) \cdot (\frac{u}{100} + 1)} \cdot \rho_{u,u} \quad [kg/m^3]$$

Pine (*Pinus sylvestris*)
The total volume shrinkage: 12.1%
FMP: 30%

$$\rho_{12.12} = 1.0658 \cdot \frac{100}{(100 - U \cdot 0.4033) \cdot (\frac{U}{100} + 1)} \cdot \rho_{u,u} \quad [kg/m^3]$$

Spruce (*Picea abies*)
The total volume shrinkage: 11.7%
FMP: 30%

$$\rho_{12.12} = 1.0676 \cdot \frac{100}{(100 - U \cdot 0.39) \cdot \left(\frac{U}{100} + 1\right)} \cdot \rho_{u,u} \quad [kg/m^3]$$

Example
A measured density at 9% moisture content is calculated to be 475 kg/m³ (pine).

$$\rho_{12.12} = 1.0658 \cdot \frac{100}{(100 - 9 \cdot 0.4033) \cdot \left(\frac{9}{100} + 1\right)} \cdot 475 \quad [kg/m^3]$$

$$\rho_{12.12} = 1.0658 \cdot \frac{100}{105.044} \cdot 475 = 482 \quad [kg/m^3]$$

5. Results

- The limit values of density depend on the material specification.
- Actions: note the deviation from applicable limit values in the logs and report them to the person responsible for action.

6. Report and documentation

- Date
- Identity
- Density (mass and volume at 12% moisture content)
- Initials of the person who performed the testing

Appendix 6 - Climate control

1. General

These instructions describe how to control the climate conditions in the production and storage rooms.

The temperature at the production site and in storage rooms used for adhesive curing of bonded scantlings should not be lower than 15°C. Control the humidity so that the desired equilibrium moisture content of the wood material can be achieved and maintained during manufacture and storage. Processed material must be covered by plastic sheeting if stored in production site where the relative humidity departs from the specified limit values.

Below are some examples of equilibrium climate at 20°C:

- For a moisture content of 8%, the equilibrium climate is 45% Rh
- For a moisture content of 12%, the equilibrium climate is 65% Rh

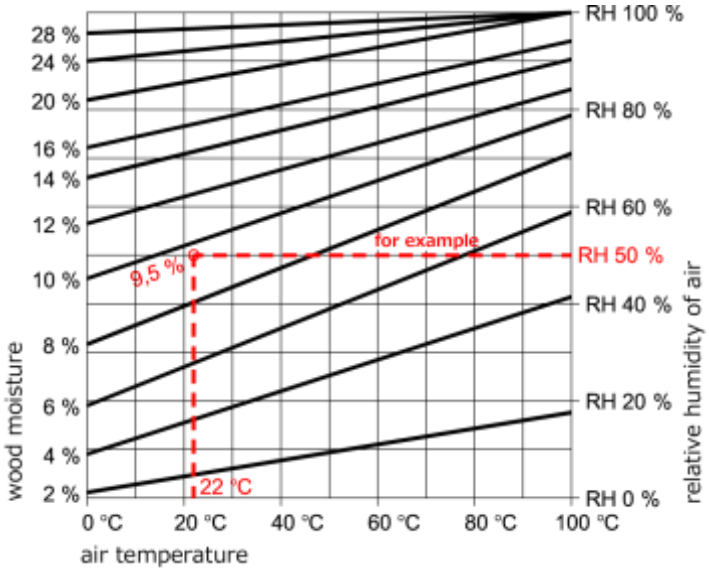
The temperature at the production site and in storage rooms used for adhesive curing of bonded scantlings should not be lower than 15°C. Control the humidity so that the desired equilibrium moisture content of the wood material can be achieved and maintained during manufacture and storage. Below are some examples.

Examples

- Target value 12 ± 2% moisture content
  At 18°C, a relative air humidity of approx. 55% to 73% will be safe.
- Target value 10 ± 2% moisture content
  At 18°C, a relative air humidity of approx. 42% to 65% will be safe.

The table below shoves the relationship between air temperature, air moisture content and the equilibrium moisture content for wood.

Diagram 2: Relationship between air temperature, air moisture content and the equilibrium moisture content for wood



2. Equipment

The following equipment is needed in order correctly to monitor these conditions:

- A thermo hygrometer or Temperature/RH logger

3. Performance

Measure and record conditions in all premises in which raw materials, semi-finished products or finished products are stored. Measurements must be made continuously, with the results being noted and summarised weekly.

4. Report and documentation

Note and record all measurements, together with the following information from each inspection. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Temperature and relative humidity
- Initials of the person who performed the testing

Appendix 7 - Reception inspection of adhesives

1. General

These instructions describe how to inspect a new delivery of adhesives.

2. Equipment

Measure the temperature of the adhesive by using an IR temperature sensor or a sensor with a measurement probe. Measure directly on the surface of the adhesive in its container. The adhesives supplier must include sensors or equivalent in the consignment that show the lowest temperature of the consignment during its transport.

3. Performance

For each new delivery of adhesives, note the batch number, the date of production and the last date of use in the process records. Register the temperature of the adhesive and check it against the adhesive manufacturer's specified critical usage temperatures. The lowest temperature of the consignment during transport shall be filed (see section 3).

4. Documentation

Check/measure the following points, and note the details, for every inspection. Applicable limit values must be clearly noted in the logs, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Name / type number of the adhesive
- Batch number
- Date of production
- Last date of use
- Adhesive temperature
- Lowest temperature during transport
- Initials of the person who performed the inspection

Appendix 8 - Planing quality

1. General

These instructions describe how to inspect the quality of the planed surface before application of adhesive.

- The thickness of any cross section of the planed lamellae must not differ by more than ± 0.2 mm from the average thickness at any point on the same lamella. This applies to phenolic and aminoplastic adhesives (PRF, RF, MUF and MF types) applied in mixed state. If hardener and glue are applied separately, the maximum deviation from the mean value is ± 0.1 mm, the same as for PVAc, EPI and PUR adhesives.
- Any systematic difference in thickness between the upper and lower edges (resulting from planning) must not exceed 0.10% of the lamella width for PVAc, EPI and PUR adhesives and 0.15% of the width for the phenolic and aminoplastics.
- A systematic difference in thickness would mean that the adhesive-coated surfaces of the pieces would not be parallel, and that the same edge would always be thicker when adhesive was applied. See Figure 5. This requirement can be disregarded if only a few pieces are bonded and pressed, and if the press face adjusts to the edge surfaces. Note, however, that the ± 0.2 mm requirement must be met.

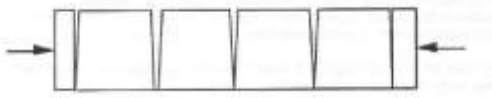


Figure 5. Systematic difference in thickness

2. Equipment

- A digital calliper gauge, or dial gauge with 0.01 mm resolution.

3. Performance

Inspect the pieces involved in order to ensure that the dimensions are as shown in the instructions, and that there is sufficient thickness of material to allow for planing.

When changing settings in the machine, and/or adjusting or installing a new cutter, check the measurements of at least three successive scantlings at three points along the two edges, at about 100 mm from each. Calculate the total mean thickness and the difference in the mean thicknesses measured along the edges. The results must fulfil the requirements given above.

To meet the requirements for the wood surface to be glued, the planer blade must be sharp and undamaged. Fault at planing such as large torn grain nearby sections of knots, or cutter marks deeper than 0.025 mm, cannot be accepted (although it may be permissible for this depth to be greater, depending on the type of adhesive to be used).

4. Report and documentation

The results of all measurements must be logged, dated and signed by the operator performing the control. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of non-conforming result.

Appendix 9 - Control of mixing ratio and amount of adhesive application

9.1. Mixing ratio between glue and hardener

9.1.1 General

These instructions describe how to check that the correct quantity of hardener has been mixed with the glue.

As the adhesives used consist of at least two components, they must be measured out accurately according to their manufacturers' instructions. The calculated ratio must meet the target value ± 2%.

9.1.2. Equipment

- A weighing instrument with a maximum inaccuracy not exceeding 0.5% of reading weight.

9.1.3. Performance

Mixing by hand

- Weigh the container before starting the mixing.
- Measure out and weigh the hardener and glue and calculate the quantity of hardener as a percentage: Quantity of hardener x 100 / quantity of glue.
- Weigh the container again as a final check for the total amount of components.

Mixing automatically by machine

- Collect adhesive and hardener in two different containers and weigh them out. Calculate the mixing ratio as described under "Mixing by hand".
- At regularly intervals, a manually control should be performed for safety reasons.

9.1.4. Results

The adhesives manufacturer normally states limit values for the amounts of hardener and resin to be used for different applications.

9.2. Control of applied adhesive amount on the lamella surface

9.2.1. General

These instructions describe how to check that the correct quantity/spread rate of adhesive is used before bonding.

The adhesives manufacturer states the spread rate of adhesive to be used for specific applications. The adhesive must be applied evenly over the entire surface, avoiding the formation of any surplus amount. The presence and even distribution of adhesive on the glued surface must be checked visually.

9.2.2. Equipment

The following equipment is required for this inspection:

- A weighing instrument with a resolution of 1 g.
- A calliper gauge with a resolution of 0.1 mm.

9.2.3. Performance

One-component adhesives or adhesives mixed before application

- Take a test piece from production. To simplify the calculation, use one meters specimens
- Calculate the area (A) of the surface to which the adhesive is applied in m^2

- Place the test piece on the weighing instrument and zero the reading
- Feed the test piece through the adhesive spreader and then re-weigh it. The weighing instrument is now displaying the amount of adhesive applied (m)

Applied amount of adhesive in g/m²: (m) / (A)

Separate string application of glue and hardener

- Collect the amount of glue (m_g) and hardener (m_h) in separate containers over a certain time (t) in grams
- Measure the length of the nozzle tube (l_{tube}) in meters
- Note the planer velocity (v) in meters pr. minute

Applied adhesive (glue + hardener)
Area covered (m²) in time (t): $[(v) \times (t) \times (l_{tube})]/60$
Applied amount (g/m²): $[(m_g) + (m_h)] / [((v) \times (t) \times (l_{tube})) / 60]$

9.2.4. Results

The adhesives supplier specifies the quantity of adhesive to be used for each specific case.
A normal amount is in the range 150-200 g/m^2.

9.3. Report and documentation

Note and record all measurements, together with the following information from each inspection.
Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Type of adhesive
- Batch number
- Mixing ratio (%)
- Spread rate (g/m²)
- Initials of the person who performed the control

Appendix 10 - Bond line temperature when High frequency (HF) is used in the hardening process

1. General

These instructions describe how to measure the temperature of the adhesive bond at gluing in an HF press.

Limit values for the adhesive bond temperature are specified by the adhesives manufacturer and must be the minimum target value at the time the batch is free from the press.

2. Equipment

The following equipment is required in order to perform this inspection:

- A thermometer with a sensor probe less than 2 mm in diameter. The meter must have a quick response time to make it stable within a few seconds.
- A drilling machine with a drill stop and a drill size suitable for the temperature sensor.
- A drill for working in wood.

Note. Twinned and soldered wires have been used with good results and can be an alternative to solid metal probes.

3. Performance

Option 1:
Measure the temperature by drilling a hole in the centre of the bond line, making one or two holes per blank. Position these holes in the scantlings so that they are at least 100 mm from the ends of the press. Set the drill stop to a depth of half the width of the bond. Use a drill of such a diameter that the temperature sensor precisely fits the hole without creating unnecessary friction heat which can give a rather high impact on the measuring results.
Measure the temperature immediately after the blank is removed from the press.
The temperature across the entire width of the press needs to be measured. Since the bonds cool relatively quickly, it can be difficult to measure more than two bond lines per pressing batch. Note the results in the log.

Option 2:
Measure the surface temperature with an IR meter just after the scantlings have left the press zone. To allow this, a documented context to the real temperature in the middle of the glue line must exist.

4. Results

The adhesives manufacturer specifies the bond line temperature to be used for each case.
The measured temperature will be lower than this caused by a certain cooling time (normally 10 to 20 seconds) from HF shut down and until the charge has left the press.
The target value at this stage can be found from experiments, and it is not unnormal with a lowering of 10 to 15°C. Target values need to be confirmed by the adhesive supplier.

5. Documentation

Note and record all measurements, together with the following information from each inspection. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- Adhesive
- HF power
- Temperature of each tested blank
- Initials of the person who performed the testing.

Appendix 11 - Control of pressure and pressing times in the finger jointing and lamination process

1. General

These instructions describe how to document the press force when bonding lamellae and finger joints and the pressing time for the lamination process.

Values for the pressure can be given by the adhesive manufacturer or be taken from the tables in Section 3.5.2. The press duration must be given by the adhesive manufacturer.

2. Performance

Adjust the pressure and its duration to the values given in the instructions. Written instructions for setting the pressure and pressing duration must be available for all products made by the company. Check the pressure and pressing duration and note their values when each work order batch starts or when tests show unacceptable results. For the following time, monitor and control the values as a supervisory measure.

Laminations: Adhesive must be seen pressed out from the glue lines continuously along the blank

Finger joints: Adhesives must be pressed out continuously from all the finger bottoms. The profile must be completely tight between fingertips and finger bottoms and between the “shoulders” of the profile. Appendices 14 and 15 describe how to control adhesive application and tightness.

3. Report and documentation

Note and record all measurements, together with the following information from each inspection. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

Lamella joints:

- Date
- Identity
- Pressure
- Pressing duration
- Initials of the person who performed the inspection

Finger joints:

- Date
- Identity
- Pressure
- Pressing duration
- Initials of the person who performed the inspection

Appendix 12 - Control of finger profile

1. General

These instructions describe how to inspect the finger profile. The control must be performed on the two wood parts making a joint. The following must be measured:

- Finger length
- Width of fingertip

2. Equipment

The following equipment is recommended to perform this inspection:

- A digital length-measuring gauge with a resolution of at least 0.01 mm.
- An angle support
- Magnifying glass with scale (at least 10 times enlargement)

Figure 6: Finger depth device from RISE

3. Performance

Measure at least two points on each side of the finger joint. Check that the joint is at right angles to the blank direction. The profile fitness and bottom clearance can be checked when the two profile parts are brought together.

4. Report and documentation

Record the results of all measurements and note the following points for each inspection. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Time
- Initials of the person who performed the tests

Appendix 13a - Adhesive application control in finger joints with iodine when a PVAc adhesive is used

1. General

These instructions describe how to inspect the application of adhesive in a joint. The method is not working on every type of adhesive, it works fin on PVAc.

2. Equipment

The following equipment is required in order to perform this inspection:

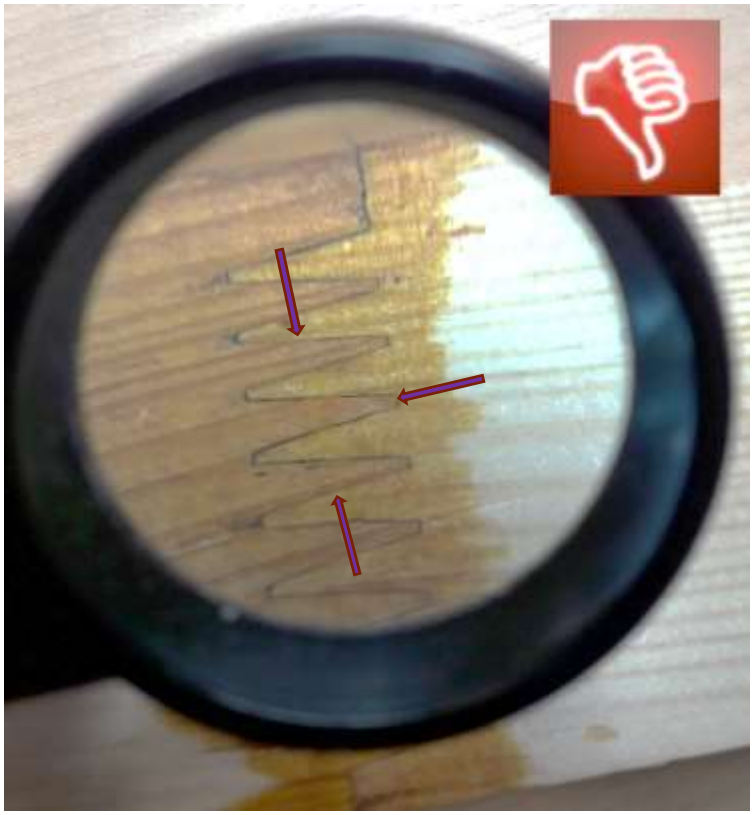
- Iodine solution. Mix 20 g KI, 6.5 g I and 50 ml water to make a “mother solution”. For use, dilute the solution with water 1:20.
- A planer
- A brush or spray bottle
- A magnifying glass

3. Performance

- Perform this inspection as quickly as possible after making a joint (i.e. within about 10-15 minutes).
- Plane the joint lightly on both sides (not deeper than the thickness of the final product) in order to remove any adhesive residues and to expose clean finger joints.
- Brush the joint with iodine solution and wait for five minutes.
- Inspect the joint: there should be an even, coloured line along the joint. If there are any breaks in the line, the joint has failed the inspection.

Picture 1: Dark/black glue line

Picture 2: Partly dark / black glue line



4. Report and documentation

Record the results of all measurements and note the following points for each inspection. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- Finger profile/line
- Results
- Initials of the person who performed the inspection

Appendix 13b - Adhesive application control on finger flanges

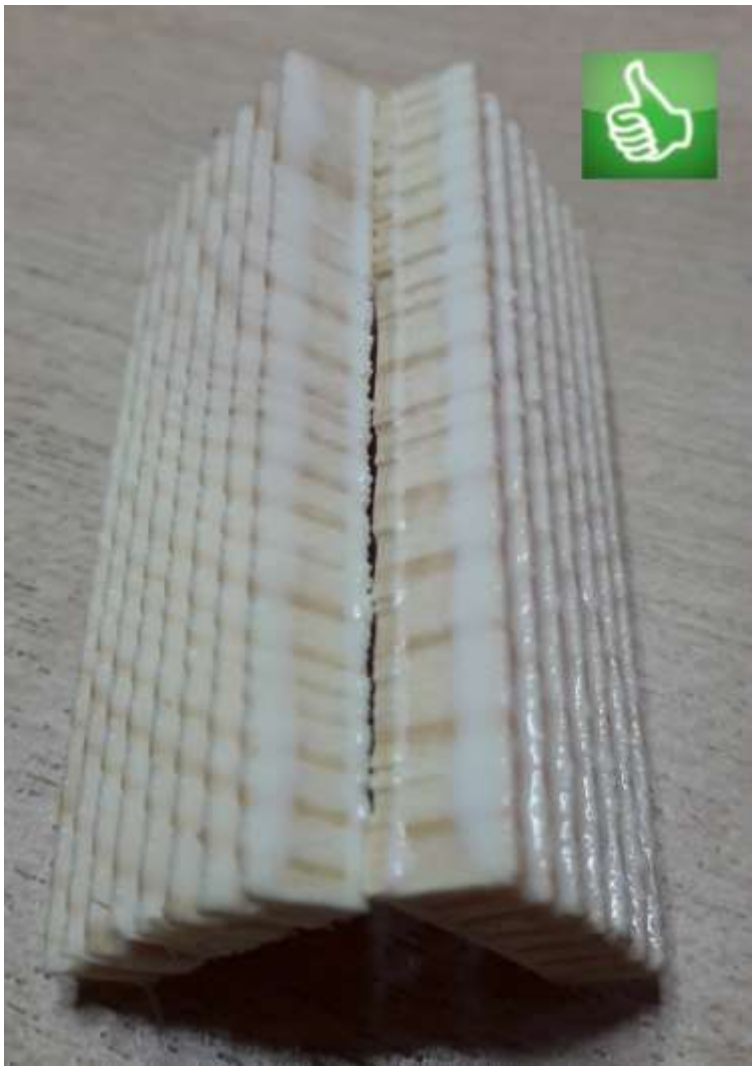
1. General

These instructions describe how to control the adhesive distribution on the finger flanges by open up the profile before pressing.

2. Performance

Take a lamella from the production line between the adhesive applicator and the press. Cut off the profiled end close to the slot base. Break loose the individual fingers and look at the adhesive distribution on the surfaces as shown in Pictures 3 and 4. An appearance which can be seen in the pictures will be accepted.

Picture 3: Example of approved adhesive application.



Picture 4: Example of adhesive application.

3. Report and documentation

The chosen method and the result of the evaluation must be recorded in a log as “Accepted” or “Not accepted”. In the actual procedure, it must be described how to act if the evaluation is negative.

- Date
- Identity
- Finger profile/line
- Evaluation method
- Evaluation result
- Initials of the person who performed the inspection

Appendix 14 - Tightness control of finger joints by the use of a liquid penetrant

1. General

These instructions describe how to check the tightness of finger joints.

2. Equipment

The following equipment is required in order to perform this inspection:

- Liquid penetrant: dark-coloured spirit-based bets, blue or black
- A planer
- A brush

3. Preparing the liquid penetrant

The following components must be mixed:

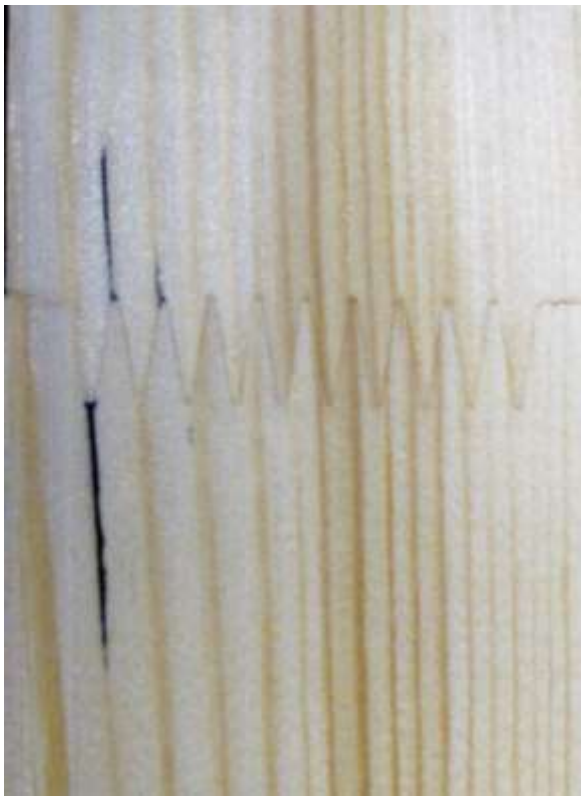
- 50% distilled water
- 50% antibacterial (95% solution)
- 3 drops of washing-up liquid
- 3-5% ink (black or blue colour is preferable)

4. Performance

- Perform this inspection as quickly as possible after making a joint (i.e., within about 10-15 minutes).
- Plane the joint approx. 1 mm on both sides in order to remove any adhesive residues and to expose clean finger joints.
- Brush the joint surface with excessive penetrant and leave it for 2-5 minutes.
- Plane the joint down a further (2 ± 0.5) mm.
- If coloured penetrant can be seen anywhere in the joint, the joint has failed
  (The contact areas between fingertips and finger bottoms are included).
- Colouring made by natural defects in the wood must be disregarded.

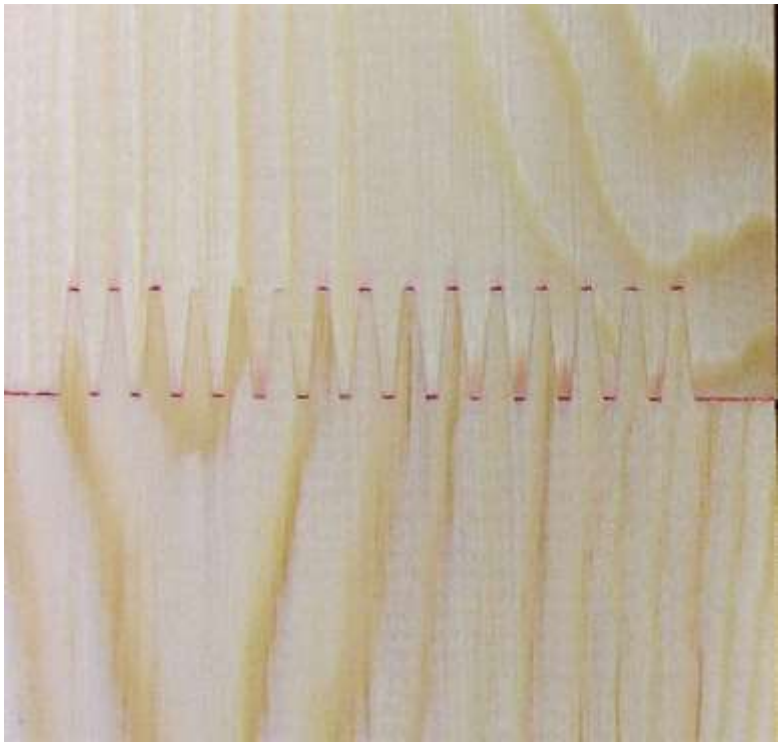
Customer related requirements could lead to other test depths. The pictures below show different appearance after testing.

Picture 1: Cracks formed from finger bottoms - not accepted

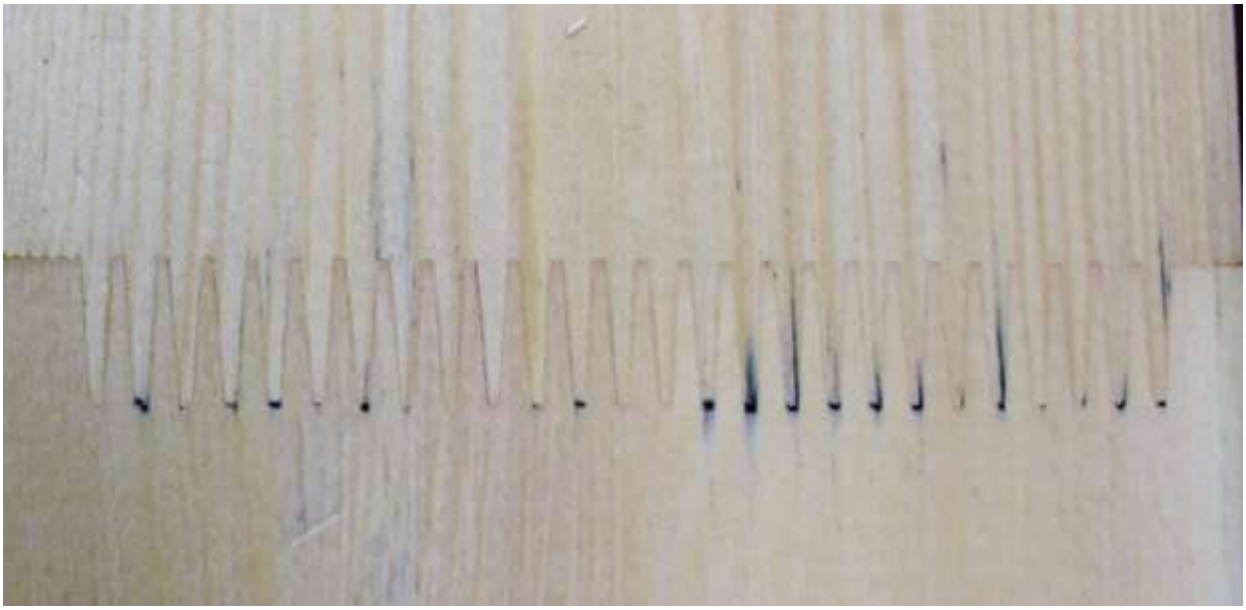


Picture 2: Test accepted

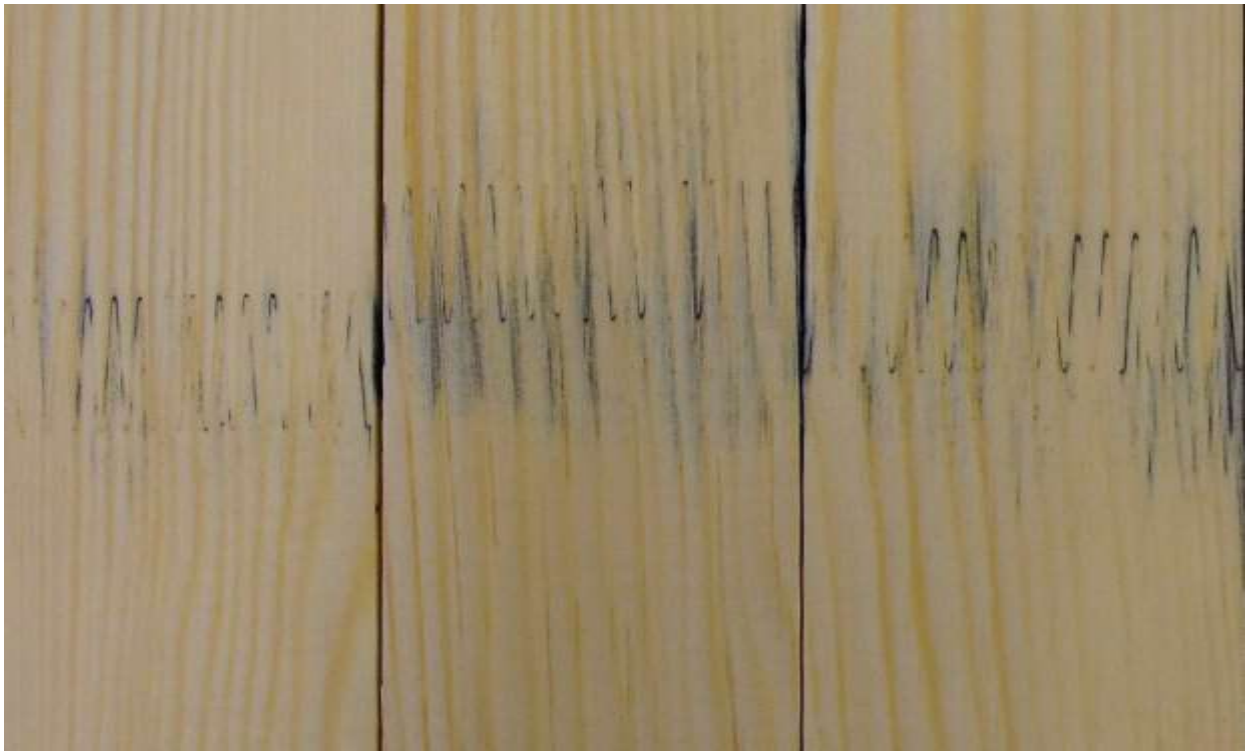
Picture 3: Too big bottom clearance - not accepted



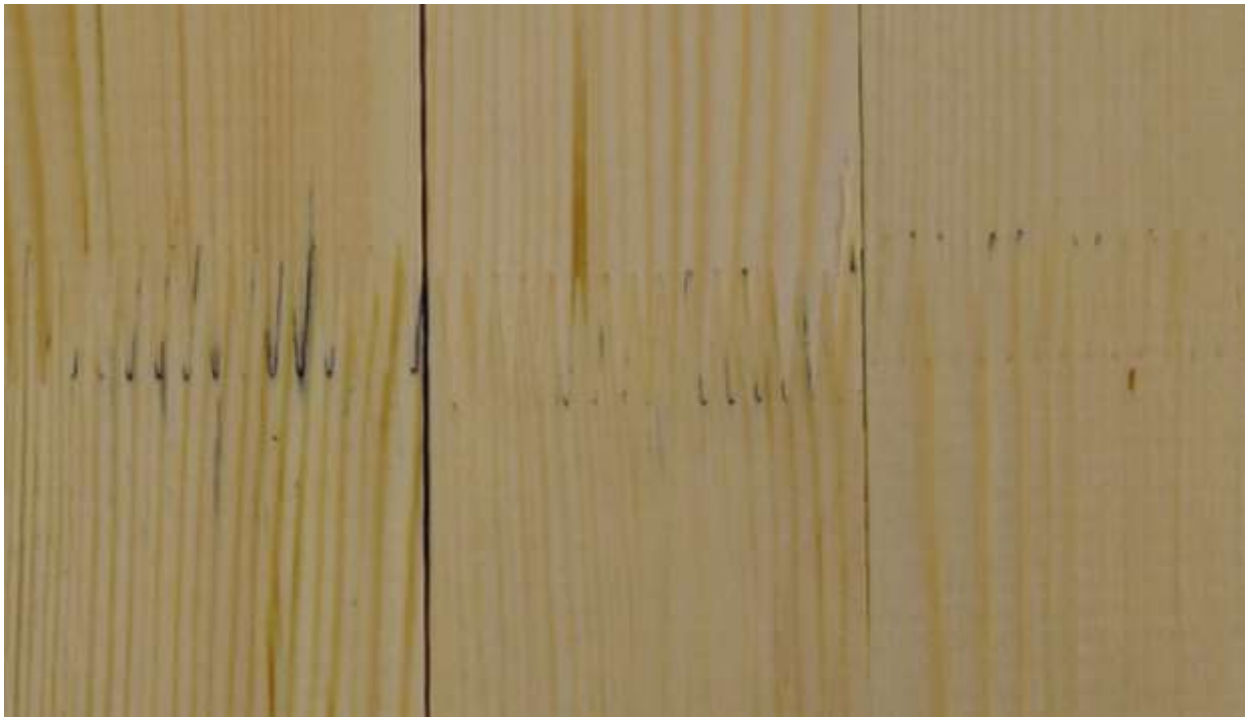
Picture 4: Too short fingers on one side - not accepted



Picture 5: Not accepted



Picture 6: Not accepted



In Table 8, the frequency for sampling is given as ”one, two, three or four times”. Each ”time” is defined as enough lamellae to give 10 subsequent finger joints. All the 10 joints must be tested by colouring all the 4 sides. Three types of failure may occur, the first one is open areas along the finger flanges, the second one is missing contact between fingertip and finger bottom, and the third one is cracks introduced in finger bottoms when pressing.

If one out of the 10 tested joints fail to meet the requirement, it is defined as a random failure and the test lot will be approved.
If two or more joints fails, it will be defined as a systematic failure. Consider corrective actions before a new test batch of 10 joints will be taken. All of the 10 must now be accepted. If not, the actual test has failed, and the internal deviation system must be used for further action. The results from all the tested joints must be filed.

5. Report and documentation

Record the results of all inspections and note the following points for each of them. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- Finger profile / line
- Results
- Initials of the person who performed the inspection

Appendix 15 -Bending tests of finger joints

1. General

These instructions describe how to perform bending tests on finger joints according to EN 408, in order to be able to evaluate the quality in the finger joint.

The bending tests are performed in order easily to be able to distinguish a good joint from a bad joint. To simplify the evaluation, the thickness of the tested piece should not exceed 35 - 40 mm: if it is greater than this, the contribution of the wood becomes more significant, it is the finger joint that must be evaluated. If larger pieces are glued, the test pieces should be split, and both the outside pieces should be tested. In addition, with large test pieces, do not test the centre section.

2. Equipment

The following equipment is required in order to perform this test:

- A 4-point bending test machine with a load cell for measuring the maximum load at failure.
- A calliper gauge and measuring tape.
- A table saw
- A planer

3. Performance

A bending test must be performed as soon as possible after bonding, but not earlier than stated by the glue manufacturer.

Cut a sample from a finger jointed component, with the finger joint in the centre. The sample must be 100 mm longer than the support points.
Arrange the bending test equipment as shown in Figure 7 below with the finger joint placed in the middle span.
Small steel plates can be inserted between the test piece and the load support in order to prevent local indentation in the wood.

The test pieces must be stored in such a way that drying is prevented, preferably in a conditioned area or under cover of plastic sheeting or some similar arrangement. Small steel plates can be inserted between the test piece and the load support in order to prevent local indentation in the wood.

- Cut a sample from a finger jointed component, with the finger joint in the centre. The sample must be 100 mm longer than the support points and be planed on both sides before testing
- Before testing, the jointed samples must be stored in such a way that drying is prevented, preferably in a conditioned area or under cover of plastic sheeting or a similar arrangement
- Arrange the bending test equipment as shown in Figure 7 below, with the finger joint placed in the middle of the span.
- Before testing, remove the shoulders on the sides of the finger joint.

  Option: If it can be proved by testing that the shoulders will not improve the bending strength, the samples can be tested in full width by using the reduced cross section in the calculation (original width minus shoulders).

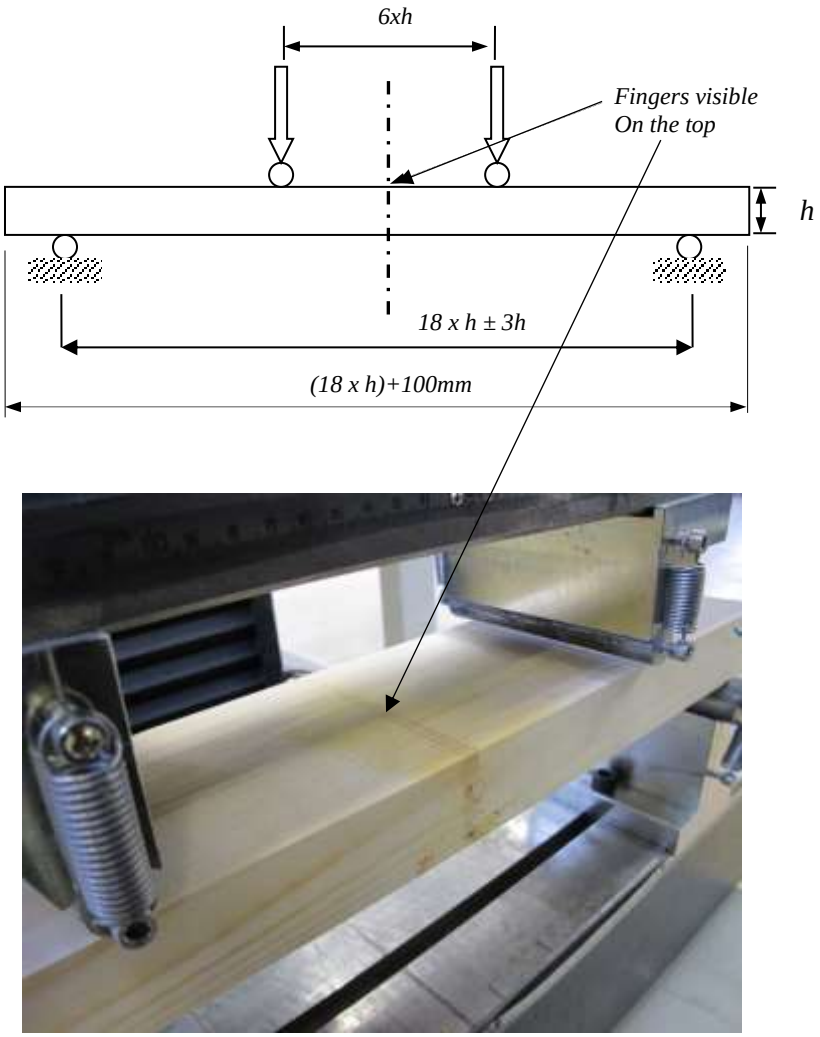


Figure 7: Schematic figure of the test arrangement and a picture from test rig

Use a moisture meter to measure the moisture content on both sides of the finger joint. Measure the dimensions of the cross-section of the test piece as close to the finger joint as possible.
The ultimate load must be reached within 30 to 60 seconds.

If the load is applied by a hand pump, the force increase must take place evenly.

Calculate the bending strength from the formula:

$f_m = \frac{3Fa}{bh^2}$ where:

f_m = bending strength (N/mm²)
F = maximum load at fracture (N)
a = distance between the support and nearest load points (mm)
b = cross section width (mm)
h = cross section thickness (mm)
Inspect the fracture surface. To determine glue failures, use iodine to help (if PVAc based adhesives are used). The different failure modes are illustrated below.

Figure 8. Different failure modes after bending test of finger jointed components

- Type 1
  This failure mode has occurred in the material itself. None or only a few fingers are exposed. The weaker structure or allowed defect of the wood has been the main cause of failure in this case. If there is any doubt in deciding between Type 1 and Type 2,
  choose Type 2.
- Type 2
  Mostly wood failure in the finger joint where the profile itself can be identified to a rather high extent. This failure mode is a combination of wood density, used profile and the jointing process itself (machining, fitness and glue application). This mode is rather normal when finger joints are tested in bending.

  Type 3
  This failure mode leaves most of the finger profile intact and will mainly occur in the glue line itself or in the adhesion zone (between the glue line and the wood). This failure mode can be seen if high density wood is used, the adhesive is not correctly applied or if the finger profile, for one reason or another, will not appear as self-locking

4. Report and documentation

Record the results of all measurements and note the following points for each inspection. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- Moisture content
- Bending strength in N/mm²
- Failure mode/failure type
- Initials of the person who performed the testing

Appendix 16 - Split testing of adhesively bonded lamella joints

1. General

The object is to get an impression of the gluing quality of the bond line just after pressing. The test can be combined with the use of a liquid penetrant to check the tightness of the glue line at the lamella edges. See Appendix 14.

2. Equipment

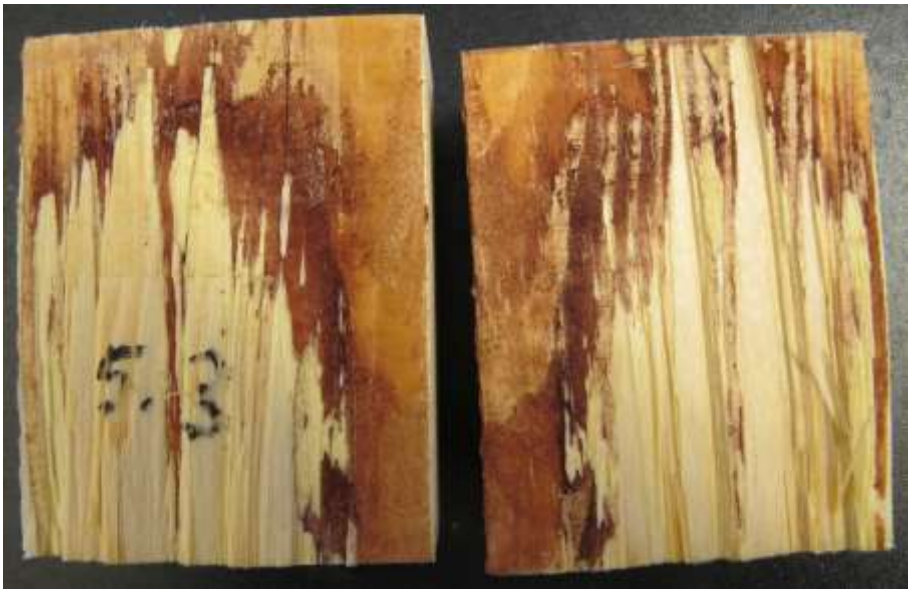
The following equipment is required in order to perform this test:

- A wide chisel or a knife.
- Hammer.
- Iodine solution for detection of PVAc adhesive.
- Microscope, magnifying glass or camera (evaluation of delamination, especially when hardwood is glued).

3. Performance

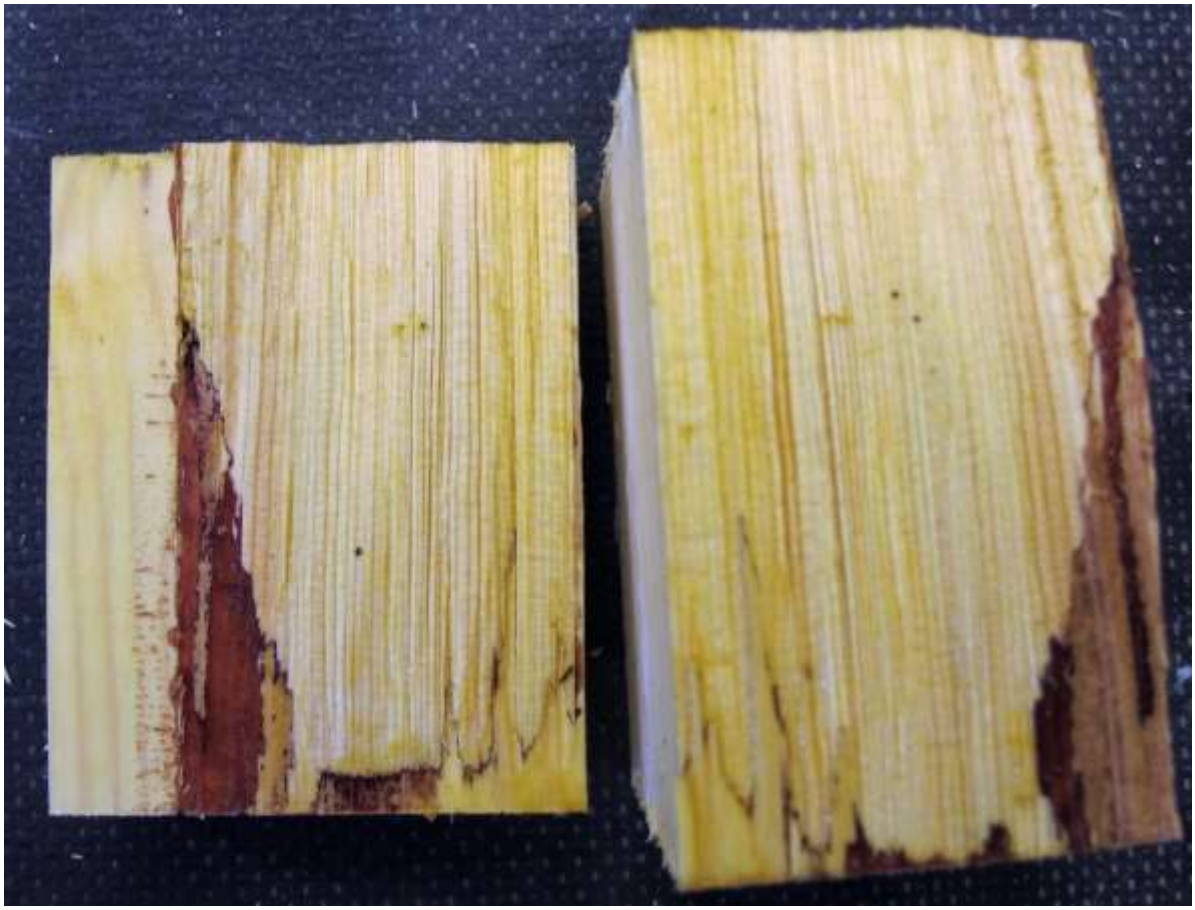
- The time between press ending and test performance must be stated in the quality handbook, which will be dependent of press- and adhesive type.
- The quality handbook must describe how an acceptable split-surface must appear.
- The test can most easily be performed by forcing the joint apart using a chisel and hammer.
- Sample dimension: Original cross section of the scantling and (75 ± 5) mm in length.
- The requirement for a good quality bond is that the failure must occur mainly in the wood itself and not in the glue line. For mean values, the acceptance criteria is at least 90% of massive wood failure in the glued area, and at least 70% massive wood failure for single values.

Picture 1: Surface after splitting and treated with iodine (PVAc adhesive). Wood and adhesive failure



Picture 2: Surface after splitting and treated with iodine. Wood failure

Picture 3: Surface after splitting - mostly wood failure



Picture 4: Surface after splitting - adhesive failure

Iodine solution can be sprayed on the split surface in order to identify adhesive failures if PVAc based glues are used. The iodine solution will stain the adhesive dark red to black, but not colour the wood itself.

4. Report and documentation

Record the results of all measurements and note the following points for each test. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- Adhesive
- Wood Failure Percentage, %
- Initials of the person who performed the testing

Appendix 17 - EN 14080 delamination test

1. General

These instructions describe how to perform a delamination test according to EN 14080:2013, Annex C. Three methods can be used which are denoted A, B and C, with the choice being determined by the type and class of adhesive used in the product. Where method B is required, method A can be used.

The requirements for the different methods are given in Table 4. The values here are based on the mean delamination achieved for 3 test specimens taken from the same laminated blank. See figure 10.

2. Equipment

The following equipment is needed in order to perform the tests:

- An autoclave, for both positive and negative pressures
- A drying cabinet, with thermostat, fan and mechanical exhaust air ventilation
- A thermometer
- A measuring scale
- A calliper
- Microscope, magnifying glass or camera (evaluation of delamination, especially when hardwood is glued)

3. Performance

Cut three test pieces, (75 ± 5) mm along the grain from each blank (See Figure 9). The outermost pieces must be at least 100 mm from the ends of the scantlings.

- Mark each test piece with its number.
- The test pieces must be free from knots or other defects.

Figure *9. Positions of samples from a blank. Each blank is about 1 m long.*

3.1 Impregnation cycle

Weigh all the test samples before loading them into the autoclave and cover them with water. It is important that they are kept under the water during the impregnation process.

Method A

- Place the test samples in the autoclave and weigh them down.
- Add cold water (temperature 10 - 20°C) until the samples are fully submerged.
- Draw a vacuum of 70 - 85 kPa leading to an absolute pressure of 15 to 30 kPa for 5 minutes.

- Release the vacuum and apply a pressure of 500 to 600 kPa leading to an absolute pressure of 600 to 700 kPa for 60 minutes.
- Repeat the vacuum and pressure cycle to give a total impregnation time of 130 minutes.

Method B

- Place the samples in the autoclave and weigh them down.
- Add cold water (temperature 10 - 20°C) until the samples are fully submerged.
- Draw a vacuum of 70 - 85 kPa leading to an absolute pressure of 15 to 30 kPa for 30 minutes.
- Release the vacuum and apply a pressure of 500 to 600 kPa leading to an absolute pressure of 600 to 700 kPa for 120 minutes.
- The vacuum and pressure cycle must not be repeated.

Method C

- Place the samples in the autoclave and weigh them down.
- Add cold water (temperature 10 - 20°C) until the samples are fully submerged.
- Draw a vacuum of 70-85 kPa leading to an absolute pressure of 15 to 30 kPa for 30 minutes.
- Release the vacuum and apply a pressure of 500 to 600 kPa leading to an absolute pressure of 600 to 700 kPa for 120 minutes.
- Repeat the vacuum and pressure cycle to give a total impregnation time of 300 minutes.

3.2 Drying cycle

Place the test pieces in a drying chamber after water impregnation. The drying time will be determined by a weight control of the test piece, which means that the sample weight after drying must be within the initial sample weight + 10% of it.

Since the test pieces from laminated scantlings will be smaller than those for structural glulam (which the standard is meant for), the drying times given for Method A and Method C can lead to an over-drying. If this happens, the delaminated areas can close in again because of the missing moisture gradient.

Method A

- Temperature: 60 - 70°C
- Air humidity: < 15% RH
- Air velocity: 2 - 3 m/s

Immediately after drying, the test pieces must return to the autoclave for a further full test sequence before inspection.

Method B

- Temperature: 65 - 75°C
- Air humidity: 8 - 10% RH
- Air velocity: 2 - 3 m/s

Method C

- Temperature: 25 - 30°C
- Air humidity: 25 - 35% RH
- Air velocity: 2 - 3 m/s

3.3 Calculation of delamination

The following glue line openings must be considered as being valid delaminations:

- a cohesive crack within the adhesive layer.
- a failure of the glue line precisely between the adhesive layer and the wood substrate. No wood fibres are left attached to the adhesive layer.
- a wood failure which is invariable within the first one or two layers of cells beyond the adhesive layer in which the fracture path is not influenced by the grain angle and the growth-ring structure. It is characterised by a fine, woolly appearance of the wood fibres, which border the interface between the wood surface and the adhesive layer.

The following glue line openings must not be considered as being valid delaminations:

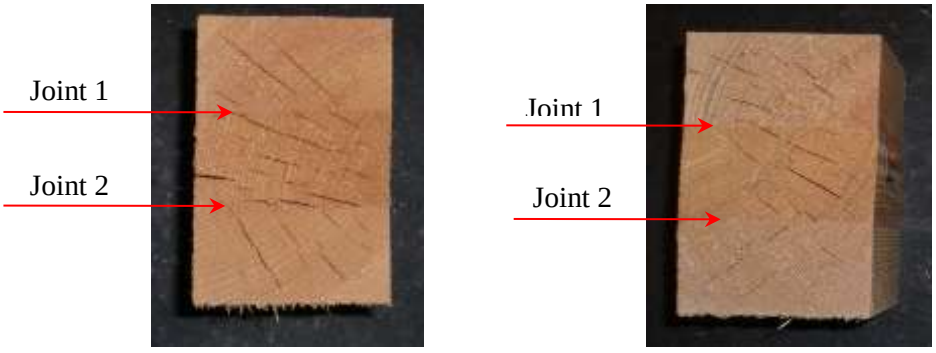
- a solid wood failure which is invariably more than two cell layers away from the adhesive layer, in which the fracture path is strongly influenced by the grain angle and the growth-ring structure. The fracture path is significantly influenced by the grain angle and the structure of short fibers. If there are any doubts, the glue line shall be opened with a wedge and a hammer and be examine under a microscope, magnifying glass or a camera. This evaluation helps determine if the failure is linked to any of these characteristics, which is particularly beneficial when assessing hardwood species.
- isolated openings in the glue line which are less than 2.5 mm long and more than 5 mm away from the nearest delamination.
- openings in the glue line which are found along knots or resin pockets which border the glue line, or openings in the glue line which are caused by hidden knots in the glue line. When the cause of an opening in the glue line due to the presence of a knot is suspected, the glue line must be opened with a wedge and a hammer and be inspected for the presence of a concealed knot. Should the cause of a glue line opening be due to a concealed knot, the opening must not be considered as a delamination.

Measure the total length of the glue line at both ends of the test piece.
The total glue line length of each glued joint in the test piece shown below is 122 mm.

Measure any openings (delamination's) in the glue line at both ends of the test piece.
The total delamination lengths in the glue lines shown below are 12 mm in Joint 1 and 18 mm in Joint 2.

Calculate the total length of any delamination/gaps in the glue line as a percentage of the total length of the glue line.

Using the three test pieces, calculate the average delamination of the entire tested blank.



Test piece no. 1
End surface no. 1

Test piece no. 1
End surface no. 2

Piece Nr:	Test sample 1.1				Test sample 1.2				Test sample 1.3				Sum delam.	
	Joint:	Delamination:			Joint:	Delamination:			Joint:	Delamination:			1-3	
1	mm	mm	%	Not.	mm	mm	%	Not.	mm	mm	%	Not.	mm	%
Joint 1	122	12	**9,8**		122	0	**0,0**		122	10	**8,2**		22	**6,0**
2	122	18	**14,8**		122	0	**0,0**		122	32	**26,2**		50	**13,7**
3													0	
4													0	
Total	244	30	**12,3**		244	0	**0,0**		244	42	**17,2**		72	**9,8**
Test result:			**Delam. OK**											

Average, joint 1
Average, joint 2

Average for entire blank

Figure 10. Calculation of delamination for method C

4. Report and documentation

Record the results of all measurements and note the following points for each test. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- Type of adhesive
- Test method
- Results
- Initials of the person who performed the testing

Appendix 18 - EN 14080 shear test

1. General

These instructions describe how to perform an EN 14080 shear test which will only apply if an adhesive in class C3 or D3 is used.

2. Equipment

The following equipment is needed in order to perform this test:

- Test machine with load cell, for measuring the maximum load at fracture
- A calliper and a measuring tape
- A band saw

3. Performance

Cut three test bars from a blank (1 m), width and thickness is both 50 mm (see Figures 11 and 12). The outermost bar must be at least 100 mm from the ends of the scantlings.

- The moisture content of the wood must be between 8% and 13%.
- The test pieces must be free from knots or other defects.
- Mark each bar piece with its number.

Figure *11. Positions of samples from a blank. Each blank is about 1 m long.*

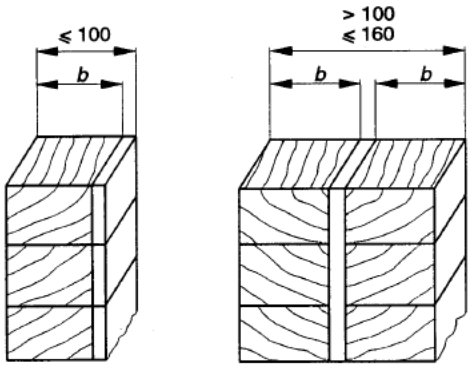


Figure *12. Test bars to be cut from a full cross-sectional specimen.*

- Measure the moisture content to see that it is between 8% and 13%.
- Measure the dimensions near the shear area, both width and thickness.
- Place the test piece in the shearing tool so that it is loaded in the direction of the grain.
- The load must be applied at a constant rate so that failure occurs no earlier than after 20 s.
- **Important!** The load must be applied in the middle of the bond line, both on the top and bottom side on the test piece.

3.1 Calculation of shear strength

Calculate the shear strength from $f_v = k\frac{F}{bt}$

f_v = shear strength (N/mm²)
F = max load at failure, (N).
b = the width of test piece (mm)
t = the thickness of test piece (mm)
k = correction factor = 0.78 + 0.0044 x t (for deviating dimension from 50 mm in the fibre direction)

4. Report and documentation

Record the results of all measurements and note the following points for each test. Applicable limit values must be clearly noted in the log, together with a description of any actions taken in the event of any non-conforming results.

- Date
- Identity
- The shear strength in N/mm²
- % massive wood failure
- Initials of the person who performed the testing

Appendix 19 - Water soak delamination test of finger joints

1. General

These instructions describe how to perform a water soak delamination test. The test is only mandatory for 2-component adhesive systems.

2. Equipment

The following equipment is needed in order to perform this test:

- Heat regulated water bath
- Drying facility which can hold 20°C and 50% relative moisture content in the air
- Magnifying glass or/and a feeler gauge.

3. Performance

From a jointed lamella, take a test sample as shown in Figure 1 leaving a length of 100 mm from the fingertips on each side of the profile.

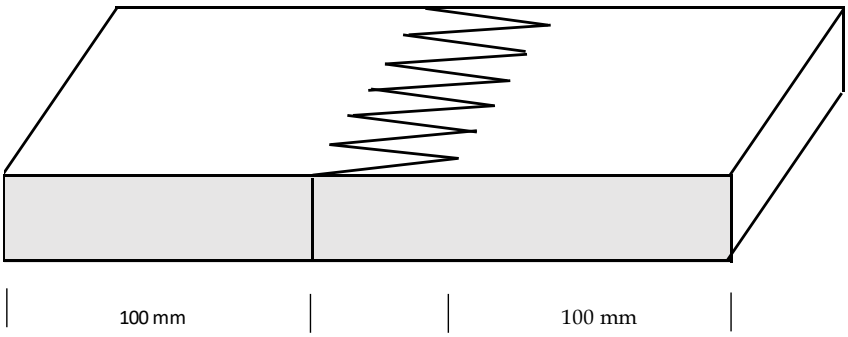


Figure *13: Jointed lamellae for water soak delamination test*

The following test cycles must be performed:

- 3 hours immersed in water at 20°C
  followed by
- 3 hours immersed in water at 60°C
  followed by
- 18 hours immersed in water at 20°C

Immediately after ending this cycle, dry the sample out for 72 hours under a stable climate of 20°C and 50% relative humidity.

Use a magnifying glass and check the glue lines in the finger profile for openings.
Requirement: No delaminations in the glue line must appear.

4. Report and documentation

Record the following data:

- Date
- Identity
- File the result (passed or failed)
- Initials of the person who performed the testing
- A description of any actions taken in the event of any non-conforming results

Appendix 20 - Internal Quality System - Checklist for Initial Certification

Evaluation by Inspection body:
Approved: **Ap**
Approved, but correction needed according to note **AP+C**
Not approved: **NAp**
Relevant section in the Technical requirements: **Ref.**

Description of defects		Evaluation			Ref.
		Ap	AP+C	NAp	
Internal Quality System					**4.0**
General requirements					**4.1**
1	Organisation diagram				4.1
2	Training of personnel				4.1
3	Production facilities suitable for wood processing				4.1
4	Factory production control system				4.1
5	Handling external claims				4.1
6	List over production and testing equipment				4.1
7	List with calibration interval for equipment				4.1
	Document management				**4.2**
8	Working instructions				4.2
9	Products descriptions and drawings				4.2
10	Documentation for materials used				4.2
11	Documents for materials specification				4.2
12	Contract documents and manufacturing instruction				4.2
13	Documents for service reports and claims				4.2
14	Documents for inspection visits and for product testing				4.2
15	System for handling of outdated documents				4.2
16	Traceability and saving documents				4.2
	Control of production				**4.3**
17	Appropriate supervision of production				4.3
18	Working instructions, instructions, procedures and methods				4.3
19	Description of procedures for non-conforming results or products				4.3
	Inspection and testing				**4.4**

20	Sufficient working, inspection and monitoring stations				4.4
21	Testing properties, according to Table 7				4.4
22	Test frequency, according to Table 8				4.4
23	Action described in case of non-conforming products				4.4
24	Keeping records				4.4
	Calibration and control of equipment				**4.5**
25	Instructions and records				4.5
26	Maintenance and calibration				4.5
27	Equipment not listed in quality manual				4.5
	Marking, labelling and tracing				**5**
28	Labelling according to requirement in Section 5				5.0
29	Registration no. assigned by Nordic Certified Scantling				5.0
30	Agreement with an approved control body, cf. NCS rules § 3				NCS
31	Traceability to product.				5.0

	Comments

Signed by:

Quality manager: Inspection body:

Appendix 21 - Factory inspection

Factory inspection will normally be carried out twice a year. Each item in the checklist given below will be evaluated, and any remarks will be categorised as Critical errors, Significant errors, and Minor errors defined as:

Critical error: 3 points - Will have a direct impact on product quality
Significant error: 2 points - Can affect process security and product quality
Minor error: 1 point - Does not affect product quality

- All critical errors must be documented as closed to the control body within 2 weeks from the inspection date. If not, an extra control will be imposed.
- All significant errors must be documented as closed to the control body within 3 weeks from the inspection date. If not, an extra control will be imposed.
- All the minor error needs to be closed within the next visit.

In special cases, the control body may provide longer deadlines than indicated.

If the sum of critical and significant errors will exceed 10 points, an extra control will be imposed directly after the necessary documentation has been received.

Example: 2 critical and 3 Significant errors will give the value 12 points.

Samples will be withdrawn for external testing according to Table 9 - Frequency of testing. If the result does not pass the requirements, a new test batch will be asked for. If these additional test samples also fail, the control body in question will decide on further actions.

Evaluation:
No.: For use in the list of Comments
Ap: Approved
CE: Critical error
SE: Significant error
ME: Minor error
Ref.: Relevant section in the Technical requirements

	Factory inspection	Category				Ref.
		Ap	CE	SE	ME	
No.	**General Requirements**					**4.0**
1	Organisation					4.1
2	Training personnel					4.1
3	Document management					4.2
4	Self-monitoring					4.3
5	Record keeping					4.3
6	Calibration and control of equipment					4.5
7	Marking and labelling					5.0
8	Handling material safety/technical data sheets for adhesives					App.7

	Material reception control					**3.2**
9	Moisture content and temperature					App.1-3
10	Timber quality (required spec. by client) - Moisture, Dimensions, Twist, Bowing.					App.1-5
11	Width of grow rings					App. 4
12	Density as required in specification					By spec.
13	Heartwood as required in specification					By spec.
14	Adhesive - Temperature and expiration day					App.7
	Process inspection					
14	Production facility - RH/Temp.					App.6
15	Lamination - Moisture content					Ap.1-3
16	Lamination - Dimension/planed surface of lamellae					App.8
17	Lamination - Cuttermarks					App.8
18	Finger joint - Profile					App.12
19	Finger joint - Pressure and time					App.11
20	Finger joint - Tightness (Ink test)					App.14
21	Temperature in the wood at gluing (as required by glue supplier.)					By spec.
22	Glue - Storage and expiration date					By spec.
23	Glue - Dosing and mixing					App.9
24	Application/distributed evenly on all fingers (Iodine)					App.13a
25	Application/distributed evenly on all fingers (Gruber)					App.13b
26	Mixing ratio/applied amount of adhesive					App.9
27	Frequency of visual control of glue applications					By spec.
28	Bond line temperature (HF)					App.16
29	Pressure and time					By spec.
30	Bond line quality check after pressing - Split test					App.16
31	Visual control of end products					3.5.3
32	Climate for storing of raw material and finished products (Equilibrium moisture content for wood within the given target moisture range for the product)					App.6
33	Frequency of various test					Client spec

	Product testing and inspection					
	Internal:					
34	Log - Moisture content					App.1-3
35	Log - Finger joint - Bending Test					Appg.15
36	Log - Finger Joint - Delamination of glue lines					App.19
37	Log - Lamination - Delamination of glue lines					App.17
38	Log - Shear test of glue lines for adhesive types C3 and D3					App.18
	External:					
39	Tightness testing of finger joint					App.14
40	Bending test of finger joint					App.15
41	Finger joint - Delamination of glue lines					App.19
42	Lamination - Delamination of glue lines					App.17
43	Shear test of glue lines for adhesive types C3 and D3					App.18

Comments	
No.	

Inspection results

Category	**Number of errors**	**Points**	**Closing date**
Critical			

Significant			
Minor			
Extra control (Yes / No)			

Signatures		**Date**
Quality manager:		
Inspection body:		

CERTIFICATE OF APPROVAL

No. NCS-101

In compliance with the rules of Nordic Certified Scantlings (NCS), Windows and Doors, this certificate applies to the products

Laminated scantlings and finger jointed massive wood

for use in door and window production in the Scandinavian countries produced by

Company AB
Company street 11, SE-111-11 Company town, Sweden
VAT: SE 1111111111

This certificate attests full compliance with all regulations given in the document “Certification of laminated scantlings (blanks) for use in door and window production - Technical requirements for processing and production control”, and that the products fulfil the prescribed requirements given by NCS.

The certificate allows **Company AB** to mark their products according to NCS rules.

This certificate is only valid if the factory has an agreement with an authorised control body for the given products regarding inspection and testing. It will be valid from the date of approval and five years ahead, but can be recalled if the requirements of NCS Nordic Certified Scantlings are not fulfilled.

Place and date
Control body - NCS number

Signature **Logo - control body**