State of the art summary on industrial strength grading, including standards

Anders Lycken, Rune Ziethén, Dan Olofsson, Magnus Fredriksson, Franka Brüchert, Andreas Wei-denhiller, Olof Broman

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Preface

The European research project READiStrength addresses the identified research gaps in strength grading. It has been initiated in 2019 and will finish in 2022.

The five project partners are Luleå University of Technology, RISE Research Institutes of Sweden, Norra Timber, Forest Research Institute Baden-Württemberg and Holzforschung Austria. Together they focus on log and board machine strength grading for four European softwood species: Norway spruce, Scots pine, silver fir and Douglas fir.

The project READiStrength is supported under the umbrella of the ERA-NET Cofund ForestValue by the national funding agencies Vinnova (SE), Fachagentur Nachwachsende Rohstoffe e.V. (DE) and the Austrian Federal Ministry for Agriculture, Regions and Tourism (AT). ForestValue has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773324.

We thank for the generous support by Microtec Srl GmbH, RemaSawco AB, Schilliger Bois SAS, Wiehag GmbH, Österreichische Bundesforste AG and the Austrian Chamber of Agriculture.
Summary

This report is a state-of-the-art summary on industrial strength grading of wood. Some used methods for grading of wood, both logs and boards, are presented, as well as some new concepts. European standards for strength grading of wood are presented, as well as some national standards and regulations for Austria, Germany and Sweden.
1 Background

In the last two decades, knowledge has been accumulated with respect to raw material characterisation of wood, from the standing tree to the end product. A summary is given in Table 1, with focus on scanning technologies at sawmills. The table entries are roughly ordered according to the processing sequence and quality of scanner information. It is known that log pre-grading (topic 1 in Table 1) has the potential to improve significantly raw material utilisation, because at that stage one is still free to choose the cutting pattern (sawn product dimensions). Log scanning immediately before sawing allows improving log rotation and positioning for cutting optimisation to maximise volume yield, which is already widely used in sawmills (topic 2). This is usually done using 3D optical scanners (topic 3). Discrete X-ray scanning (topic 4) provides interior log information, which allows significantly better prediction of sawn timber quality than 3D scanning and is already implemented in sawmills, especially in Sweden. A new promising option is based on log computed tomography (CT, see topic 5 below).

One of the major technological breakthroughs of the last years is the development of industrial computed tomography log scanning (topic 5), which provides a much more detailed insight into each individual log than 3D outer shape log scanning and discrete X-ray scanning. Studies have shown that it is possible to increase the value of visually strength graded sawn timber from Norway spruce logs by 5%-20% when using log positioning optimisation based on CT scanning, see e.g. Lundahl, C.G., Grönlund, A. (2010), Berglund et al. (2013), Berglund (2014), Fredriksson (2014). Similar improvements can be expected if rotation optimisation is used to maximise timber strength (Berglund et al. 2014), even more so if combined with log pre-grading, both of which still have to be developed.

Table 1. Current (2019) state of the art on log scanning and grading technology and concepts.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Theoretical knowledge</th>
<th>Implementation in sawmills</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-log pre-grading</td>
<td>+ benefits are known in theory</td>
<td>+ log segregation based on scanner data implemented in some Swedish sawmills</td>
</tr>
<tr>
<td></td>
<td>+ models exist</td>
<td>- not widely used due to increased log yard size requirements</td>
</tr>
<tr>
<td>2- sawing optimisation</td>
<td>+ volume yield optimisation available based on log surface shape</td>
<td>+ volume yield optimisation widely used</td>
</tr>
<tr>
<td></td>
<td>+ first results for optimisation w.r.t. visual timber quality based on CT scanning</td>
<td>- optimisation w.r.t. visual quality not yet validated</td>
</tr>
<tr>
<td></td>
<td>- little knowledge on optimisation w.r.t. timber strength</td>
<td></td>
</tr>
<tr>
<td>3- 3D optical scanner</td>
<td>+ knowledge and data available</td>
<td>+ used for log pricing and log pre-grading by sawmills in Scandinavia</td>
</tr>
<tr>
<td></td>
<td>- limited correlations with sawn timber quality</td>
<td>+ used for volume yield optimisation</td>
</tr>
<tr>
<td>4- discrete log X-ray</td>
<td>+ knowledge and data available for spruce and pine</td>
<td>+ used for log pricing and log pre-grading by sawmills in Scandinavia</td>
</tr>
<tr>
<td></td>
<td>+ good correlations with sawn timber</td>
<td></td>
</tr>
<tr>
<td>5- CT log scanning</td>
<td>+ knowledge available for visual grading for spruce and pine</td>
<td>+ first scanners installed in European sawmills (for sawing optimisation)</td>
</tr>
<tr>
<td></td>
<td>- little knowledge for strength grading</td>
<td>- optimisation not yet validated</td>
</tr>
</tbody>
</table>
For combining log and board scanning (topic 7) in the production of strength graded timber, there are basically three possible options (Figure 1).

**Figure 1. Different approaches to log and board strength grading:** a) log strength grading, b) integrated strength grading; c) sequential strength grading. Arrows pointing out from the material flow to the right indicate rejected logs or boards.

The first option is a pure log grading approach (Figure 1a) – the logs are segregated during log scanning. The virtual boards in the log are assigned to strength classes according to EN 338, see chapter 4.1.1. The logs are assigned “class” according to the worst board in the log. After sawing, all pieces from each log are assigned this strength class (except for visual override). This system for assigning a strength class to a virtual board has not been developed yet. One fear with this approach is that a large number of “good” boards will be graded to a lower class than they could belong to.

Figure 1b shows integrated grading – strength class assignment is done after board scanning as is the current practice, but the information from log scanning is used to improve the grading precision. For this option, theoretical results exist but there are no practical implementations yet.

The third possibility (Figure 1c) is to apply log pre-grading, possibly rejecting unsuitable logs, while the strength grade assignment is done on the sawn pieces (sequential strength grading). Limited implementations based on 3D optical scanning and discrete X-ray scanning exist but the full potential of sequential strength grading yet needs to be explored. Moreover, an effective pre-grading could significantly change the strength characteristics of the produced sawn timber. Special efforts are required to reconcile such a
change with the requirements for machine strength grading as laid down in EN 14081-2, see chapter 4.2.2.

The main open question with respect to combined log and board scanning was for a long time how to attach the material information to the material stream. Up to now, the roundwood data had largely been lost during the production in the sawmill and could not be connected to the individual pieces of sawn wood.

Recently, traceability of sawn boards to the log of origin has been developed (topic 8 in Table 1), connecting knot information from log scanning and board scanning using a fingerprint method. This opens several avenues for new applications in the field of X-ray/CT based log scanning. Since logs can be matched to corresponding boards, the results of log scanning can be used in later stages of sawmill production. Open questions are models for strength prediction of boards based on X-ray and especially CT scanning of logs as well as communicating information between log scanning and board grading stations. Moreover, sawmills which do not have an X-ray or CT log scanner cannot use this kind of traceability – an alternative, possibly not linking the data individually but on the batch level, still needs to be explored.

2 Brief description of existing methods to measure logs and boards

Log grading usually serves two purposes: determining the value of the log for payment and determining the best use of the log. Measurement and grading rules in the sawmill for payment vary strongly between the countries depending on the agreements on how to derive volume or other features which will have an effect on the sawing yield. Also depending on the country measurement errors are differently defined.

When determining the value in Sweden, it is the batch value that is in focus. This means that one error can be neutralized by another error. The mean error of the batch value set at the log sorting station must be less than 1.5% compared to the correct value and the volume error less than 1% (Anonymous 2019b). When grading for sawmill use however, all errors are costly, so in this case one error cannot be neutralized by another. In this report we only discuss the log grading for use, not for payment.

2.1 Log scanning

The automatic scanning can be made by an optical scanner, which in its simplest implementation measures the dimensions of the logs to be able to maximize the volume yield when sawing. In this case no quality grading is performed.

Next step in the automated/machine log grading evolution is to make a distinction between top, middle and butt logs, as they have different features and are suitable for different purposes. This is usually done by measuring the taper of the logs. If you then combine the taper with the bumpiness, you get a measure of knottiness and sizes of the knots. All this can be made by using a 2D or 3D profile scanner. This is a common Scandinavian approach.
In Germany, a discussion and work-in-progress is ongoing about how to use 3D scanning of physical features like taper and shape to define grades.

If you use an X-ray scanner it is also possible to “see” the inside of the log. Then it is possible to grade the logs by the interior quality, such as knot volume and distance between whorls. A CT-scanner, computer tomography, can make it possible to “see” even more features, and more important, their exact position in the log.

There exist also methods using vibration to determine the quality of the logs.

2.2 Log (pre-)grading

The log grading and pre-grading concepts are based on manual grading and sorting and/or automatic scanning of the logs in order to estimate the quality/grade of the planks and boards after sawing. Log grading and pre-grading serves two purposes: payment grading to regulate the price that the log supplier gets for the timber, and grading for the sawmills’ own production control.

Grading of round timber is, beside measuring dimension, the second most important part in the contracts between forest owners and wood industry. In different countries and different parts of the wood industry different grading systems are applied. In the process of harmonising grading rules some standards could be merged to create unified European standard. Nevertheless, there are still national standards in use in the different countries.

The European standard EN 1927:2008 “Qualitative classification of softwood round timber” is the main standard for classification of round timber of conifers and harmonises softwood grading throughout Europe.

On the national level in Germany, conifer roundwood in standard length or pole length is predominantly classified using the German grading system RVR (2015) or client-specific round wood specifications. The German grading system RVR (2015) ("Rahmenvereinbarung für den Rohholzhandel in Deutschland") is a voluntary agreement between the confederations of the forestry and timber industry in Germany. The RVR regulates measurement, sorting and grading of raw timber and the harmonised definition of the related terminology of wood features and grading procedures. In order to become legally binding the regulations of RVR need to be included in the private-law contracts on wood sales between roundwood supplier and customer. Further specifications can be agreed between partners in addition to the basic RVR specifications. The RVR agreement succeeded the HKS ("Gesetzliche Handelsklassensortierung für Rohholz"), which existed in several versions applying regional specifications in the various federal states of Germany.

In Austria, roundwood grading and sorting is regulated in a way similar to Germany, by the system ÖHHU (Österreichische Holzhandelsusancen, 2006) as by RVR in Germany. Further relevant documents are the standard ÖNORM L 1021:2015 which regulates measurement of length, diameter, taper and curvature both for manual and electronic measurements and the Austrian laws and regulations on official calibration. Currently, curvature has to be officially calibrated in addition to length and diameter. The calibration law supports the addition of further log features.
In Sweden, Biometria’s instructions for timber measurement (Grading of sawlogs of pine and spruce, 2019a) apply when measuring sawlogs of Scots pine and Norway spruce. These rules are only for payment. Each sawmill has their own rules for grading/sorting for different use of the logs.

### 2.3 Measuring of board features

There are a number of systems in use in sawmills and other wood working industry for measuring of board features. The systems have different complexity and capability. They are using a number of different technologies, more or less useful for the application. Many of them also have more than one type of sensor or light.

The “simplest” systems use visible light from LED lights, fluorescent lamps or similar. The sensors, cameras, can only “see” the light in the visible spectrum. These systems can “see” almost the same features and defects as a manual grader can see.

If you add laser dots to the lighting, it is also possible to “see” the fibre direction, which might help in determining the size of knots and other features where the fibre direction, or the tracheid effect, is affected.

When adding sensors with the possibility to perceive other wave lengths, e.g. NIR, near infrared, or UV, ultraviolet, it is also possible to distinguish even more wood features with the right type of lighting.

Board scanning can also, like log scanning, be improved by using x-rays, to be able to identify features hidden behind the surface.

Also for boards, as for logs, are vibration methods used. In these cases, a longitudinal wave is induced and the vibrations are measured, either by using microphone or laser interferometer.

The vibration methods are based on the fact that the E-module is correlated to the boards eigenfrequency

$$E = 4 \times f^2 \times l^2 \times \rho$$

where

$E$ is the board’s E-module

$f$ is the board’s eigenfrequency

$l$ is the board’s length

$\rho$ is the board’s density

As the vibration methods cannot “see” e.g. top rupture or large knots in dangerous positions, it is necessary to have a visual override to remove boards that do not fit the grade.

In the visual and the x-ray grading the knots, fibre distortions and other strength affecting features are measured on the boards. Grading rules are applied to the features and a strength class is determined.

Also, in this case, if the grading is done before the kiln, it is necessary to have a complimentary procedure to ensure that any board damaged by the drying or handling processes are sorted out.
3 Strength grading of sawn timber

3.1 General

Strength grading of structural timber has so far exclusively been made on sawn or planed boards. It can be divided into two major systems, visual strength grading and machine strength grading. The difference between these methods is more a question of the system for attestation of conformity than depending on the grading technique used. Strength grading of structural timber based on log grading has until now not been utilized. Neither the equipment used for measuring and scanning logs has nor the system for traceability from log to board have been accurate enough.

3.2 Visual strength grading

Visual strength grading of structural timber has a long tradition. In Sweden the first national grading rules were established in 1951. They have later been revised and are now common rules for the Nordic countries (INSTA 142) published as national standards. Other grading rules have been developed in the other parts of Europe. In Central Europe visual strength grading specific rules were published and has been revised since the late 1930s. The widely used standard (ÖNORM) DIN 4074 is shared in Germany and Austria as national standard. Traditionally the visual strength grading has been made manual with a personal approval for each grader. In later years board-scanners have been approved to perform visual strength grading. They are then using the national standards for visual grading.

No common European standard is developed for visual strength grading, local variation within both climate and forestial methods made it difficult to find grading parameters that were comparable between different part of Europe. Instead a system was created were national methods were used to grade the timber and the resulting grading classes were then approved to fit into a strength grade according to European standard. The approved relationships were published in a standard EN 1912. In the period between revisions of EN 1912 the strength grades corresponding to grading classes can be published in an AGR, Approved Grading Report).

3.3 Machine strength grading

Structural timber in Europe is CE-marked under the CPR (construction products regulation) using the harmonised CEN-standard EN 14081-1. It is divided into two major procedures: machine control systems and output control systems.

The machine control system is made initially and need, once a grading machine is examined, not be verified in use. The system requires a substantial amount of testing, minimum 450 pieces for each species and timber origin where settings are to be determined. One major prerequisite for the sampling is that it is representative for the timber to be graded in production. Representative in terms of forestial conditions, origins, dimensions, and pregrading. To be able to fulfill these conditions it may be necessary to extend
the sampling. Based on the results from machine readings and testing of the grade determining properties (strength, MOE and density) the settings are determined and then verified according to the procedures given in standard EN 14082-2. Once the report and the settings are approved by the standardization group CEN/TC124/WG2/TG1 the settings can be used in production.

The settings according to the machine control system is fix and must not be changed unless they are verified and approved again. However, in the latest version there is a possibility to adjust the settings due to minor changes of the incoming material. A higher quality of the ungraded source material allows you to adjust the settings into a less strict value and vice versa in the quality is going down. Normally no factory production control is verifying the quality of the graded material. Only grades with grade determining properties higher than C30 is subject to testing.

Output control systems are unlike the machine control system not approved in advance. Instead it is after each day of production tested and the compliance with the requirements are verified. The amount of testing required is depending on species, origin, dimensions and grades and may if several of the variables are changed be quite extensive. The output control system is not common in Europe, but more frequently used in North America and Australia. The system has been debated. Due to the large variation of quality for timber is the procedure not effective to determine if the settings used are correct or if they need to be changed.

Independent of control system chosen the grading machine must be approved. At present stage 37 different grading machines are approved.

4 Existing standards for strength grading of wood

4.1 General

In order to make wood an engineering material for construction, it is necessary to have knowledge about the strength and elasticity of the boards and other building components. There are several standards and regulations that regulate how to grade the boards, depending on the intended use. The following chapters describe some of the standards, both international and national.

4.1.1 EN 338 Structural timber – Strength classes

The latest revision of EN 338 is published in 2016. EN 338 is one of the central standards for structural timber. It is not dealing specifically with grading but is giving the design values for structural timber in standardised grades. Three tables with design values are published in the standard:

- C-grades; grades based on bending adapted for softwood species
- T-grades; grades based on tension adapted for softwood species
• D-grades; grades based on bending adapted for hardwood species

In these tables three properties, bending/tension strength, modulus of elasticity and density, are denoted as grade determining properties. Thus, they are also the requirements to fulfil in the case of testing.

Important to notice is that besides these standardised grades the CE-marking is open for “user-defined grades”. A producer or a group of producers or of users can define a grade more suitable for a specific use. The grade determining properties of this grade must be given but there might not be a complete table with design values. An example of this is the British grade TR 26.

4.1.2 EN 1912 Structural Timber – Strength classes – Assignment of visual grades and species

Visual strength grading has a long tradition in most countries. Grading has been made according to national standards that has a long history and is well established in each country. For this reason and because there is a significant difference between the relation of the grade determining properties and the visual appearance it has been considered as very difficult to create a common European standard for visual strength grading. To consider local deviations it would be far too conservative. Instead the chosen approach has been to create a standard listing the visual strength grades, species and sources of timber, and specify the strength classes from EN 338 to which they are assigned. For many of the grades, species and sources included, there is a long history of use, the strength grades are then determined by existing practice. For other grades the strength grades are based on new or historical test data.

4.1.3 EN 408 Timber structures – Structural timber and glued laminated timber – Determination of some physical and mechanical properties

EN 408 is a pure testing standard. It is giving the prerequisites and requirements on equipment and procedures for the testing of several different properties of timber. Among the things are conditioning climate, load configurations, and the tested volume of a specimen.

4.1.4 EN 384:2016 Structural timber – Determination of characteristic values of mechanical properties and density

EN 384 is a support standard to EN 408. It gives equations for adjustment of test values when it is not done strictly to standard. Adjustments are made with respect to deviations from reference conditions for moisture content, tested cross-section, test length and number of sub-samples. It also contains additional requirements for testing concerning
number of specimens and specimen size. Further on, the standard contains guidance on the calculation of characteristic values connected to grading, when results from testing of small clear specimens are available and for other properties than bending strength, MoE and density. For the equations and coefficients used in the determination of characteristic values EN 384 references to EN 14 358.

4.1.5 EN 14358:2016 Timber structures - Calculation and verification of characteristic values

This standard gives statistical methods for the determination of characteristic values from test results on a sample of solid wood, fasteners, connectors and wood-based products. The characteristic value is an estimate of the property for the population and can be based on a 5-percentile value of strength, resistance or density as well as on a mean value for stiffness.

Methods are given for percentile as well as for mean values for both normal and log-normal distribution with recommendation for use, log-normal for strength and normal distribution for MOE and density.

The standard also provides the acceptance procedure for verification of a lot. The procedure is based on statistical theory and assumes a consumer’s risk of 10% and a producer’s risk of 5%.

4.2 Machine strength grading

4.2.1 EN 14081-1:2016 Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements

The Standard specifies requirements for strength graded structural timber with rectangular cross-sections either visual or machine graded. It is intended to be the harmonised standard for CE-marking of structural timber. At present state it is not published in the official journal and therefore not accepted by the notified bodies as the valid version. Still CE-marking is based on the 2005 version of the standard. It includes the essential requirements and the test methods to determine them including the requirements for the visual override of machine graded structural timber. Also, it contains requirements on the FPC (factory production control), Assessment and Verification of Constancy of Performance and marking of structural timber.
4.2.2 EN 14081-2:2018 Timber structures - Strength graded structural timber with rectangular cross section - Part 2: Machine grading; additional requirements for type testing

EN 14081 part 2 contains the basic requirements for a grading machine such as range of environmental conditions for the machine to operate, repeatability, maximum grading speed and calibration process for the machine.

The standard also contains rules for sampling materials used for determination of settings and the requirements for determination and verification of settings for machine control systems. Settings can be determined for a part of a country, one country or several countries. The sampling shall be representative for the area covered by the settings and normally each country within the covered area shall be represented in the sampling. In the standard some standardized areas are defined, these areas consist of countries that can be treated as one unit and a sample from one country can be considered representative for the other countries in the same standardized area. The calculation of settings has in the present version of the standard become open to any method. It is the verification of the settings that is mandatory in the standard. Requirements are given for the whole sample, for each country or part of a country within the desired area and for the cost matrix (the correlation between strength and IP-value).

A feature in the 2018 version of the standard is fixed settings. Those are settings valid for spruce and fir from all countries in Europe. The settings are conservative but does not need to be further verified.

Another new feature in the standard is the adaptive settings. These are settings that can be adjusted during the grading procedure due to the relation between the IP-values for the initial testing and the IP-values for the present grading. The adjustments are minor but can have a positive effect on the yield if the quality of the incoming material is increased.

Output control system is an alternative to the machine control system. The output control system offers a simpler way to determine settings but has a mandatory testing of the grading results. This testing can be extensive since it is based on both grades and dimensions. Therefore, the output control system is suitable mainly for plants grading only few grades and dimensions. It is not commonly used in Europe. EN 14081-2 contains methods to verify the initial settings for output control.

4.2.3 EN 14081-3:2012+A1:2018 Timber structures - Strength graded structural timber with rectangular cross section - Part 3: Machine grading; additional requirements for factory production control

The standard contains information about special requirements on the factory production control such as requirement for internal bending test for grades with a strength higher
than C30 and the use of control planks to check installation and calibration daily. It also contains information on the continuous use of an output control system for the grading.

4.3 Visual strength grading

Visual strength grading has a long tradition in Europe. Many of the countries within Europe have their own grading standards based on visual grading. Depending on geography, climate and silvicultural differences these standards are different. Because of this, it has been regarded as counterproductive to try to create a common European standard for visual grading of any species. Instead, the national standards have been accepted and a standard EN 1912 has been created to assign the national grading classes into strength grades according to EN 338.

4.3.1 SS-230120 Nordic visual strength grading rules for timber (INSTA 142)

The Nordic visual strength grading rules for timber (INSTA 142) is a grading rule common for Denmark, Finland, Iceland, Norway and Sweden. It is valid for coniferous woods, Norway spruce (Picea abies), Sitka spruce (Picea sitchensis), Scots pine (Pinus sylvestris), Silver fir (Abies alba), Douglas fir (Pseudotsuga menziesii) and Larch (Larix decidua, Larix x eurolepis, Larix kaempferi). The grading rules can be applied to timber from north and north-eastern Europe. The standard is noted in EN1912 but not in its full content; some species in the INSTA grading rules (Sitka Spruce and Douglas Fir) are only partly assigned to strength classes in EN 1912.

Grading in the standard is based on three major types of observations:

- Strength reducing features
- Size and shape
- Biological attack

The main strength reducing features are different types of knots, cracks and year ring width with requirements given as ratios of the cross-section or length of the graded board or plank. Other types of grading parameters are usually given without reference to the cross section of the timber.

4.3.2 DIN 4074 Sortierung von Holz nach Tragfähigkeit - Sortierkriterien für Nadelholz und Laubholz (Strength grading of wood part 1-5 for softwood and hardwood)

The standard contains procedures and classification criteria for visual grades of timber for construction purposes for softwood (DIN 4074-1:2008) and hardwood (DIN 4074-5: 2008). The visual grading classes can be converted to strength classes when applying EN 1912.
4.3.3  DIN 68365:2008-12 Schnittholz für Zimmererarbeiten – Sortierung nach dem Aussehen – Nadelholz (Sawn timber for carpentry – Appearance grading – Softwood)

The standard contains procedures and classification criteria for visual grades of timber for construction purposes for softwood. The standard does not apply to finger-jointed sawn timber. It has no reference to EN 1912, thus its grading classes cannot be assigned to strength classes according to EN 338.

4.3.4  EN 12246 Quality classification of timber used in pallets and packaging

The standard contains procedures for visual grading of timber to packaging. Grading requirements are similar to EN 14081-1 but the grading results cannot be used for classification according to EN 14081-1 to 3.

4.3.5  EN 14081-1:2016 Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements

The standard contains the basic requirement for the CE-marking. It contains also requirements on the factory production control and the principal requirements on the accepted national standards for visual strength grading (for more information about EN 14081-2, see also section 4.2.2).
5 Standards for some products using strength graded timber

5.1 EN 15497:2014 Finger jointed solid timber

The standard for finger-jointed solid timber EN 15497:2014 Structural finger jointed solid timber – performance requirements and minimum production requirements sets out provisions regarding the performance characteristics for structural finger jointed timber with rectangular cross section. It also lays down minimum requirements for material, such as species and moisture content and size deviations for the wood and type of glue, and the production such as press and curing facilities. The standard also contains requirements for factory production control and marking of the product.

On the national basis in Germany, the contractual agreements „Vereinbarung über KVH (Konstruktionsvollholz)“ (last updated 2015) and „Vereinbarung über Duobalken/Triobalken“ (last updated 2015) regulated the requirements on finger jointed solid timber, glulam and CLT cross-referencing to EN 1597 and EN 14080.

5.2 EN 14080:2013 Glulam

The standard EN 14080:2013 Timber structures – Glued laminated timber and glued solid timber – Requirements cover the performance requirements of the following glued laminated products: - Glued laminated timber (glulam); - Glued solid timber; - Glulam with large finger joints; - Block glued glulam for use in buildings and bridges. It lays down minimum production requirements, provisions for evaluation and attestation of conformity and marking of glued laminated products. The standard is applicable for glued laminated timber made of coniferous species or poplar, as listed in the standard, consisting of two or more laminations having a thickness from 6 mm up to 45 mm. It also gives the relation between the characteristic values for timber, finger-joints and glue and the properties of the finalized glulam beam.

5.3 EN 16351:2015, Cross laminated timber, CLT

The Standard EN 16351:2015, Timber structures - Cross laminated timber - Requirements sets out provisions regarding the performance characteristics for structural cross laminated timber as a material for the manufacture of structural elements to be used in buildings and bridges.

the Standard applies to cross laminated timber:

- to be used in service class 1 or 2 according to EN 1995 -1-1
• made of coniferous species and poplar
• built up of at least three orthogonally bonded layers
• having thicknesses between 6 mm and 60 mm and made of strength graded timber according to EN 14081-1
• bonded with adhesives, fulfilling the requirements given in the European standard
• having overall thicknesses up to 500 mm.

It also lays down minimum production requirements, provisions for evaluation and attestation of conformity and marking of Cross laminated timber.
6 Literature


7 Standards and regulations


DIN 4074 Teile 1-5 Sortierung von Schnittholz nach der Tragfähigkeit (Strength grading of wood, parts 1-5). DIN. 2008.


EN 338 Structural timber – Strength classes. CEN. 2016.


EN 1927:2008 Qualitative classification of softwood round timber. CEN. 2008

EN 12246 Quality classification of timber used in pallets and packaging. CEN. 1999.


EN 14081 Timber structures - Strength graded structural timber with rectangular cross section, Parts 1 to 3. CEN. 2016-2018.

EN 14358:2016 Timber structures - Calculation and verification of characteristic values. CEN. 2016.

EN 15497 Structural finger jointed solid timber – performance requirements and minimum production requirements. CEN. 2014.


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