



## **Report**

# **GUIDELINES FOR CE MARKING OF SUGI SOLID TIMBER PRODUCTS**

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## GUIDELINES FOR CE MARKING OF SUGI SOLID TIMBER PRODUCTS

### Abstract

The use of sugi timber in construction products presents difficulties due to the obligation of CE marking (e.g. solid timber or glued laminated timber) and from the fact that it possesses low mechanical properties as a result of its low density. Therefore, this report aims to indicate some innovative solutions for the use of sugi timber for construction by briefly describing which are the normative documents available and those needed to be developed to support the CE marking of these products.

At LNEC and SerQ the products are in the process of the assessment of their technical feasibility. However, the need to find and establish a reliable and efficient strength grading process that supports the development of these products is underlined.

Keywords: Alternative products / Sugi / Região Autónoma dos Açores / CE marking

## ORIENTAÇÕES PARA MARCAÇÃO CE DE PRODUTOS DE MADEIRA MACIÇA DE CRIPTOMÉRIA

### Resumo

A madeira de criptoméria apresenta dificuldades de incorporação em produtos para a construção, decorrentes da obrigatoriedade de marcação CE (e.g. madeira maciça ou lamelados colados) e do facto de possuir baixas propriedades mecânicas em consequência da sua baixa massa volúmica. Neste sentido, o presente relatório pretende indicar algumas soluções inovadoras para a utilização de madeira de criptoméria para a construção, descrevendo de forma sumária quais os documentos normativos de suporte à marcação CE, existentes ou a desenvolver para esses produtos.

Os produtos encontram-se em processo de estudo da sua viabilidade técnica no LNEC e no SerQ, sendo, no entanto, salientada a necessidade de encontrar e estabelecer um processo de classificação para fins estruturais, fiável e eficiente, que suporte o desenvolvimento dos referidos produtos.

Palavras-chave: Produtos alternativos / Criptoméria / Região Autónoma dos Açores / Marcação CE

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# 1. Introduction

## 1.1. Definitions

The use of timber for structural applications includes a set of concepts introduced by the European standardization, being mentioned below the more relevant<sup>1</sup> :

**Strength grade** – Cluster made of a wood species or group of species (considered as alike) fulfilling a set of limits imposed on the presence of features (knots, slope of the grain, etc.) required by a specific standard for timber visual strength grading for structural applications.

**Service class**: Classes established in order to define the effect of the exposure conditions on timber member's design strength values or for the calculation of final deformations.

**Strength class**: Set of visual strength grades come out from the application of visual strength grading standards. Set considered to possess the same physical and mechanical properties for design purposes. The different strength classes are described in EN 338, establishing NP EN 1912 the correspondence, validate by CEN/TC 124/WG2/TG1, between visual strength grades (visual strength grading standard) and strength classes.

**Use class**: Classes based on different environment exposures prone to make timber products susceptible to biological deterioration (i.e. fungi, beetles and termites).

**Kit** – Construction systems made from a set of parts to be pre-assembled at the factory or assembled on site, produced by the same or by different companies.

**Finger joint** – Interlocking end joint formed by machining a number of similar, tapered, symmetrical fingers in the ends of boards, using a finger joint cutter and then bonded together, figure 1.1.

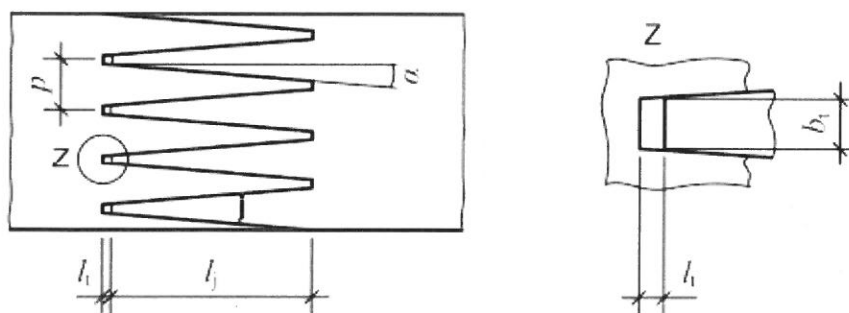


Figure 1.1 – Finger joint

<sup>1</sup> Other definitions can be found in part 1 to 12 of EN 488.



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## 1.2. CE marking – timber products - generalities

CE marking of products intended to be placed in the construction market become mandatory after the 1<sup>st</sup> of July 2013 under the Construction Products Regulation (CPR). This obligation includes all products covered by a harmonized standard cited on the official journal of the European Union (EU). A manufacturer willing to place a product in the market should verify if the marking is mandatory or, if not, decide to place a voluntary CE marking based on the European Technical Evaluation (ETA), figure 1.2.

After CE marking (e.g. label on the batch or on the product itself) the product is placed in the market accompanied by a declaration of performance (DOP), this document is solely of the responsibility of the manufacturer and where he declares the performance characteristics (being able to choose which to declare, but with the obligation to declare at least one).

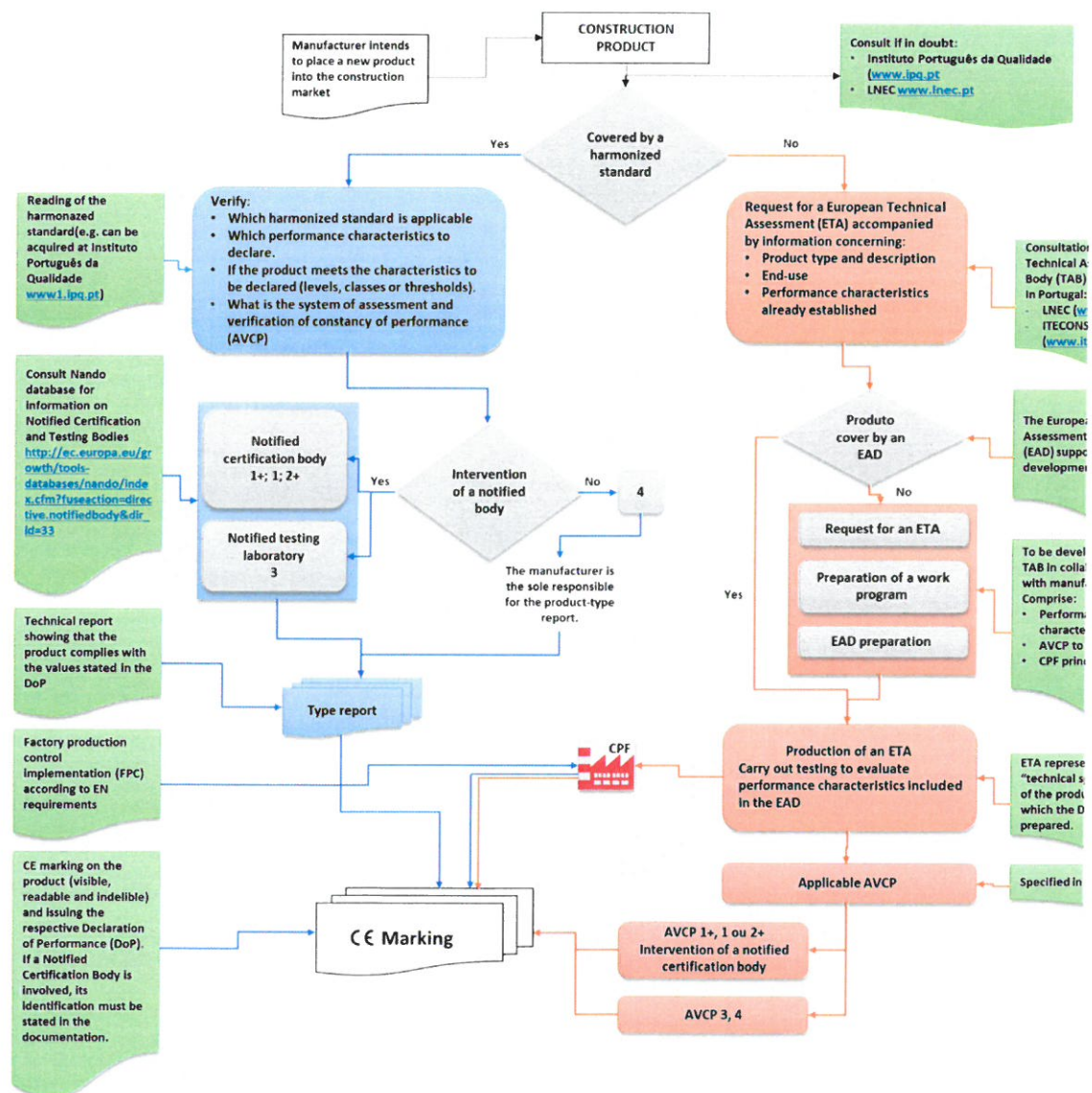


Figure 1.2 – Flowchart for obtaining CE marking

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The Declaration of Performance (DoP) facilitates transactions by presenting the relevant information, or declared, of the product in a standardized format, helping direct customers or end users to verify the product performance and compare it with other products intended for the same end use.

The CE marking also allows, to manufacturers or their agents, to circulate the product within the European Single Market and Turkey, being however the responsibility of the manufacturer to verify if there are additional regulations to which the product is subject in the intended destiny country (application). For this purpose, the local Contact Point<sup>2</sup> of the country where the product will be applied on site should be contacted.

In addition to CE marking, manufacturers can use additional product certification or quality assurance schemes to address issues relevant to service performance, such as application rules. These procedures may coexist with the CE marking provided that they do not create confusion with the CE marking, do not reduce its readability and visibility. Thus, in the case of the National Civil Engineering Laboratory (LNEC), the so-called voluntary Application Documents (DA) are made available for further evaluation of the products, meeting regulatory or relevant conditions for on-site application (and not covered by the CE marking). The DA covers CE marked products covered by Portuguese and non-harmonized European standards.

Table 1.1 presents the products based on solid timber relevant to the project and covered by a harmonized standard.

Table 1.1 – Products covered by harmonized standards relevant to this project

Harmonized European Standard	Standard title	AVCP
EN 14080	Timber structures - Glued laminated timber and glued solid timber - Requirements	1
EN 14081-1 e 2 (visual and machine strength grading)	Timber Structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements. Timber structures - Strength graded structural timber with rectangular cross section - Part 2: Machine grading - additional requirements for type testing	2+
EN 14342	Wood flooring - Characteristics, evaluation of conformity and marking	1 / 3 / 4
EN 14915	Wood flooring - Characteristics, evaluation of conformity and marking	1/3/4

Manufacturers wishing to start the CE marking process should consult the NANDO database to confirm the last version (year of publication) of the harmonized standard to be applied.<sup>3</sup>

In the CE marking process several entities could be involved, figure 1.3.

<sup>2</sup> <https://ec.europa.eu/docsroom/documents/30102>

<sup>3</sup> <http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=cp.hs&cpr=Y#hs>



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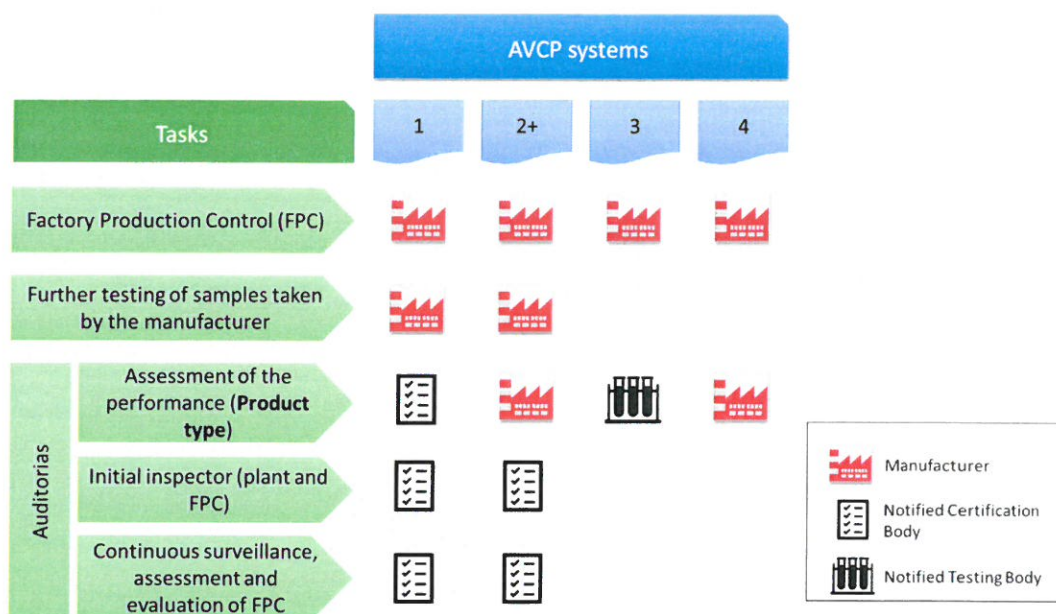


Figure 1.3 – Entities involved in the various AVCP systems

This report is part of the project “Modification of sugi wood by densification” and intends to identify some construction products in which sugi may be incorporated, either in its natural or modified state (i.e. densification).

Therefore, in the following chapters the essential steps of the CE marking associated with each product-type are briefly presented. A more detailed explanation can be found in the guide “CE marking of construction products step by step”<sup>4</sup>. It should also be noted that in CE marking processes covered by an AVCP 1 and 2+ the manufacturer shall involve a Notified Certification Body in order to ensure the conformity of its factory production control manual (CPF).

The product standards or of CE marking (European or Portuguese standards if translated) must be obtained from the Portuguese Quality Institute ([www.ipq.pt](http://www.ipq.pt)). For European Assessment Documents (EADs), these can be consulted on the EOTA portal ([www.eota.eu](http://www.eota.eu)).

<sup>4</sup> <https://ec.europa.eu/docsroom/documents/12318?locale=en>

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## 2. Strategic products

The project assumes the development of construction product prototypes incorporating sugi timber, with innovative characteristics against current end uses for this timber, through the analysis of its technical viability and possible CE marking. Therefore this report addresses the following products:

- Glued laminated timber.
- Slab type elements.
- I beams.
- Non-structural products (flooring) using the potential of densified wood

### 2.1 Structural products

The structural use of sugi timber implies the ability to grade it (visual or machine grading) dividing timber elements into more homogeneous batches (grades), with specific characteristic mechanical strength values. A set of grades approved by the Technical Committee 124 Timber Structures can be consulted in the standard EN 1912.

The development of CE marking of sugi timber for construction through machine grading is underway, within the scope of this project, at the Innovation and Competence Forest Centre (SerQ). From this study, SerQ will provide LNEC with data that will serve as complementary information to support the revision of the Portuguese standard for visual strength grading of sugi timber for structural purposes (NP 4544).

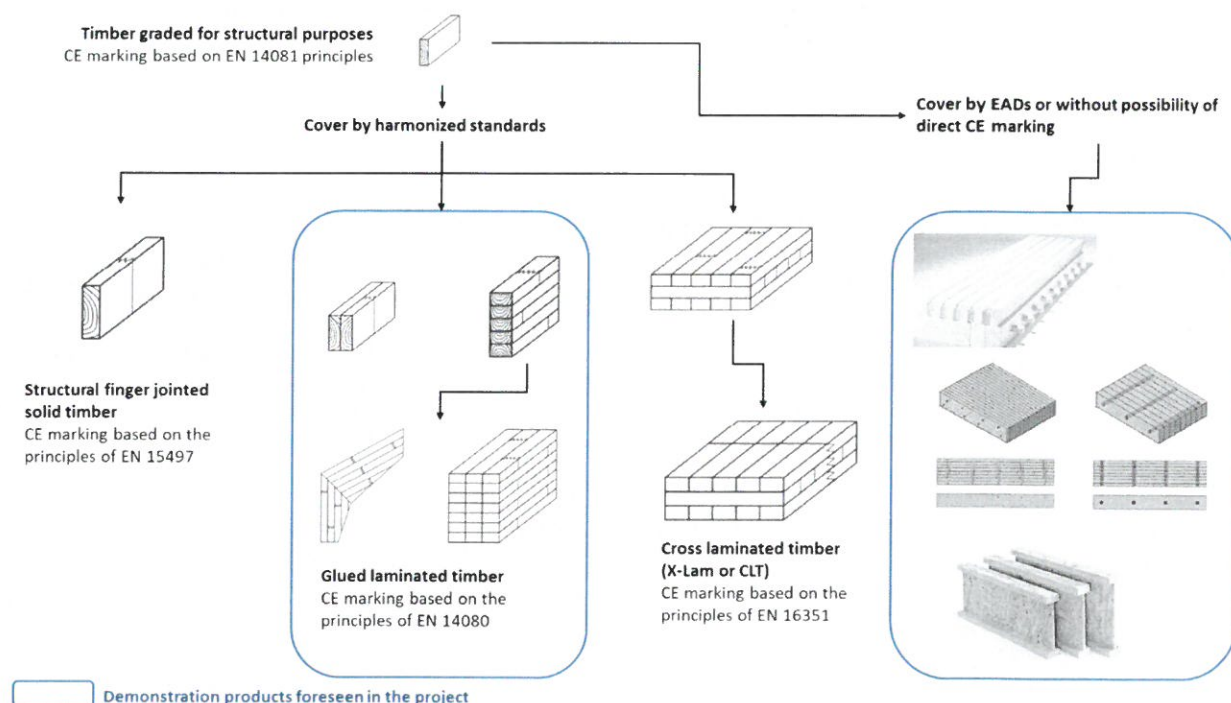
For both grading options, reports will be submitted to CEN/TC 124/WG2/TG1 that allow the allocation of strength classes to visual grades (visual strength grading) or the implementation of machine grading, filling the current void, figure 2.1. Thus, it is intended that at the end of the project a manufacturer using sugi wood will have at its disposal grading technology for structural purposes, similar to that existing for central and northern European timbers.

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Maritime pine scenario ( <i>Pinus pinaster</i> Aiton)				
Grading option	Grading standard	Grades	European recognition process	Strength class
Visual	NP 4305	E	Included in EN 1912	C18
		EE	Not included in EN 1912	—
Machine	EN 14081 parts 1 a 3	NA	Report accepted by CEN/TC124	C24/Reject C35/C24/C18/Reject C40/C24/C18/Reject
Sugi scenario ( <i>Cryptomeria japonica</i> Thunberg ex Linnaeus)				
Grading option	Grading standard	Grades	European recognition process	Strength class
Visual	NP 4544	CYS I	Not included in EN 1912	—
		CYS II	Not included in EN 1912	—
Machine	EN 14081 part 1 a 3	NA	No report exists	—

**Figure 2.1 – Current status of structural qualification of home-grown timber taking into account the applicable European framework**

The products described below and developed on a prototype basis are based on the assumption of the possibility of machine grading, figure 2.2.



**Figure 2.2 – Identification of product-type to be developed using sugi for structural purposes**



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### 2.1.1. Support basis for product-type - MTG machine grading

The ongoing process of sugi machine grading (report to be published) uses the user-friendly Machine Timber Grader (MTG) portable device, figure 2.3 a), which only requires a Bluetooth connection to a computer. This equipment uses the longitudinal vibration method to determine the dynamic modulus of elasticity - indicator property (IP), figure 2.3 b). The equipment consists of a ball coupled to a spring and a vibration sensor. The impact of the sphere on the wood element translates into a free vibrating movement of the element that is captured by the sensor resulting in the dynamic module evaluation and consequent strength.

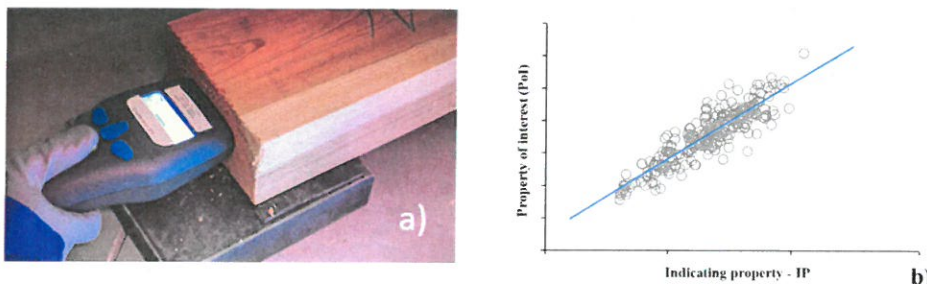


Figure 2.3 – Machine grading based on MTG equipment

### 2.1.2. Product-type – Glued laminated timber

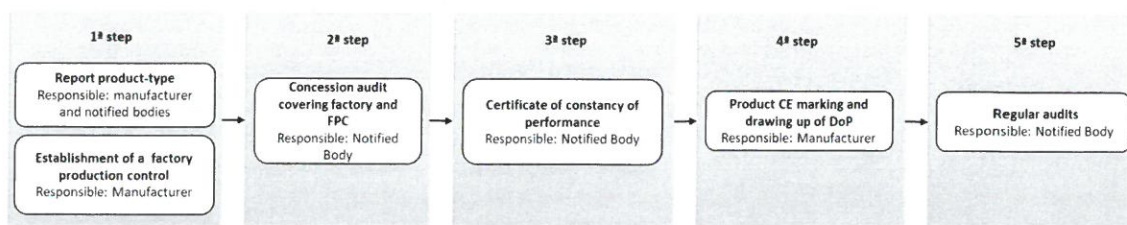
#### 2.1.2.1 Marking in the scope of harmonized standard

The harmonized standard EN 14080 covers the products shown in figure 2.2 as glued laminated timber. In the case of these products the AVCP System is 1. Prior to the application of this standard it is recommended to carefully read its scope to confirm that the product to be produced meets the requirements. These include:

- a) Softwood and poplar timber, but **not applicable** to sugi since this species is not included in the list present in section 5.5.2 of EN 14080.
- b) Members with two or more layers, presenting lamellas with thickness between 6mm and 45mm.
- c) Applicable to products treated or not with preservative substances against biological attack.
- d) **Not applicable** to products treated with flame retardants, thermally and/or chemically modified timber and structural finger jointed timber.

The CE marking of sugi glued laminated timber, given the condition a), would require a change in the list of species possible to occur in the revision of the European standard every 5 years. This review is currently ongoing under CEN / TC 124.

The path to CE marking goes through the steps shown in figure 2.4. The manufacturer's tasks start by defining the performance characteristics to be declared, table 2.1 of EN 14080.



**Figure 2.4 – Different stages in the CE marking process of glued laminated timber according to EN 14080**

Given the importance of the product-type report for a precise definition of product performance characteristics, table 2.1 indicates the tasks and responsible of the entities involved. In the case of the use of components (e.g. strength graded timber according to EN 14081-1 or 2) with CE marking, the manufacturer shall have in his records the DoP of the product supplied by the manufacturer of that component.

In the production of glued laminated timber, the need to achieve a GL20h class or greater for homogeneous laminates (100% sugi) requires the machine grading of lamellae as the sole resource, since visual grading of sugi does not allow to attain strength classes higher than C18. This issue reinforces the importance of the ongoing study under this project dedicated to study machine grading by means of MTG.

**Table 2.1 – Procedures and responsibility in drafting product-type Report**

Task	Responsible	Description
Type testing	Manufacturer	<b>Characterization of the mechanical behaviour of GLT</b> Option A: Testing of final product Option B: Declaration based on geometrical data and material properties
		<b>Adhesives characterization</b> Documentation containing test report and relation to end use service class – EN301 or EN 15425
		<b>Durability</b> Durability class (EN 350)
		<b>Preservative treatment</b> Declaration on the effect on properties, if it occurs (EN 15228)
		<b>Reaction to fire</b> If declared according to table 11 of EN 14080
		<b>Formaldehyde emission</b> Testing or declared according to EN 14080
	Notified Testing Body	<b>Durability of bonding strength</b> Testing of end joints and glue lines
	Notified Certification Body	<b>Reaction to fire</b> If declared a higher class than the one defined in EN 14080
		<b>Responsible for collecting the manufacturer's and Notified Testing Body's information and preparing the product-type Report</b>



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In factory production control, figure 2.4, external entities may be involved performing routine (less than 24 hours) or verification (more than 24 hours) tests. These entities shall be accredited or, alternatively, also audited in the framework of a concession or surveillance audit carried out by the Notified Certification Body.

Factory production control shall also take into account the following points:

- a) Information (documental) about the origin of timber;
- b) Visual criteria supporting the acceptance/rejection of timber;
- c) Evidence regarding the competence of MTG operators or visual graders - in both cases when there is no external grading entity;
- d) Composition of the glued laminated timber (species, dimensions, tolerances);
- e) Procedure / work instruction related to the lamella classification system implemented (visual / machine and strength classes);
- f) Product's characteristics (GL – strength class of GLT, service class);
- g) Certificates for possible preservative or fire-retardant treatments.
- h) Calibration/verification of moisture meters to validate the grading for a given moisture content. Subsequent changes in moisture content, in the sawmill, the transport or onsite may cause or worsen existing defects such as warping and cracking.

Considering the mechanical characteristics of sugi (low density and low resistance to localized crushing), several studies have been performed on solutions based on heterogeneous glued laminated timber (using in outer lamellae resistant wood species). It should be stress that different configurations of heterogeneous glued laminated timber covered by EN 14080 were studied within a doctoral dissertation (Martins, 2019).

#### 2.1.2.2. Marking under a European Technical Assessment

The present project proposes a type of heterogeneous glued laminated timber in which the distribution of the lamellae meets two criteria, figure 2.5: 1) the need to increase the overall strength of the beams by introducing outer lamellae made of more resistant wood species; 2) the need for increased strength capacity in areas subjected to stress due to structural connections using fasteners or metal plates by changing the composition of the laminate in those areas.

This type of glued laminated timber does not fit the solutions described in harmonized standard EN 14080, and so the CE marking must follow the ETA path supported by an EAD.

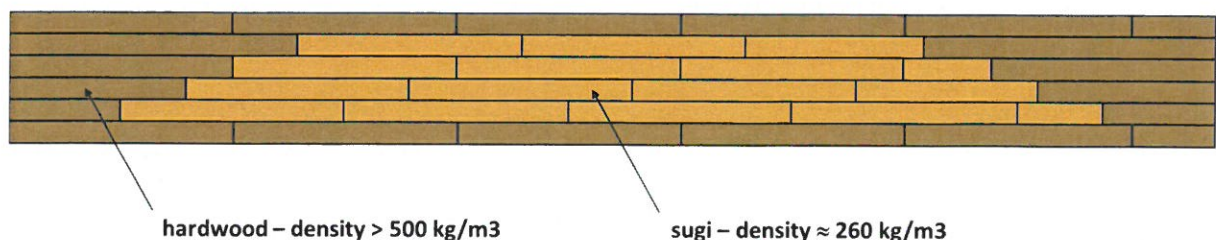


Figure 2.5 – Illustration of the composition of the proposed mixed glued laminated proposed in the project

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At the present moment two European Evaluation Documents (EAD) are published showing deviations to EN 14080:

- Glued laminated timber made of hardwood – Structural laminated veneer lumber made of beech (EAD n° 130010-01-0304)
- Glued laminated timber made of steam-cured solid timber with rectangular cross section – Softwood (EAD n° 130197-00-0304).

The prototype under study considering the type of lamella (species) and the beam lay-up (distribution of lamellas along the length) is not included in these two documents. Therefore, a manufacturer who wants the CE marking should apply to a Notified Certification Body for draft an EAD for their product. The overall performance characteristics to be included in the EAD will be similar to those given in Table 2.2.

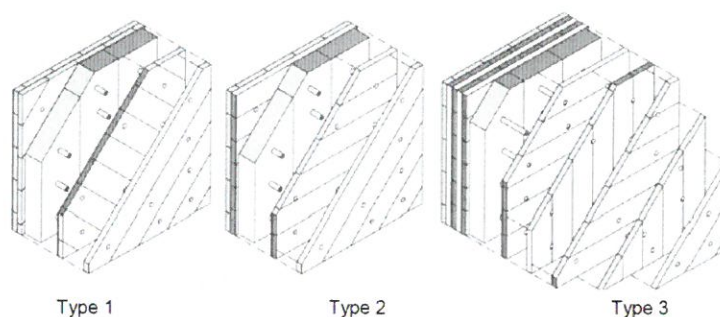
**Table 2.2 – Performance characteristics possible to be included in a EAD**

Performance characteristics
Mechanical resistance and stability Bending, compression, tensile and shear strength and modulus of elasticity Creep and duration of load Bonding quality Resistant capacity of fasteners Dimensional stability
<b>Safety in case of fire</b> Reaction to fire Resistance to fire (charring rate)
<b>Hygiene, Health and the environment</b> Emission of formaldehyde
<b>Safety and accessibility in use</b> Same as those considered in <u>mechanical resistance and stability</u> (see above)
<b>Energy economy and heat retention</b> Thermal conductivity Thermal inertia

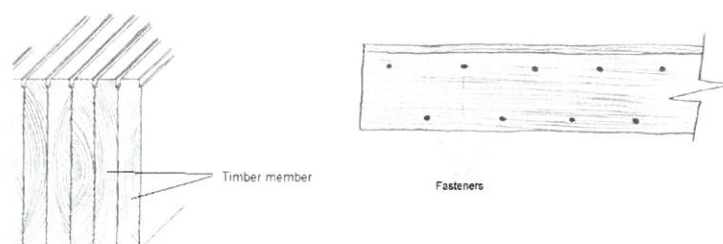
### 2.1.3. Product-type wood slab

Wood slab products cover several types, some already targeted by EADs, figures 2.6 to 2.8.

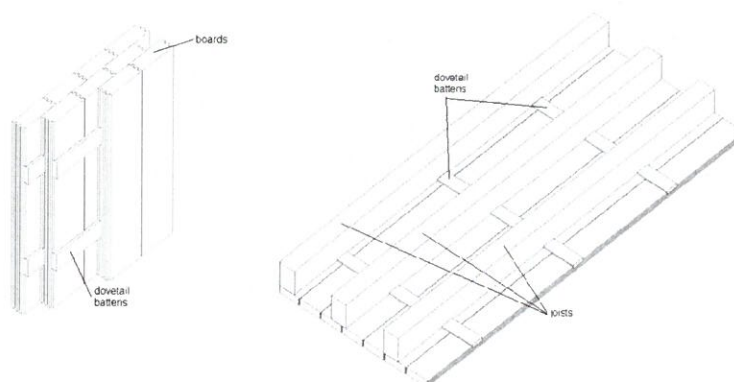
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**Figure 2.6 – Solid wood slab element - element of dowel jointed timber boards to be used as a structural element in buildings - EAD n° 130002-00-0304**

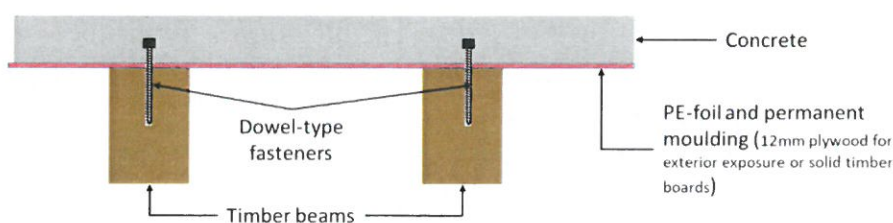


**Figure 2.7 – Prefabricated wood slab element made of mechanically jointed square-sawn timber members to be used as a structural element in buildings – EAD n° 130011-00-0304**



**Figure 2.8 – Solid wood slab element to be used as a structural element in buildings — element of timber boards jointed by dovetail connections – EAD n° 130013-00-0304**

Other wooden slab elements are supported by wood-concrete type typologies, as described in EAD 130090-00-0303, figure 2.9.

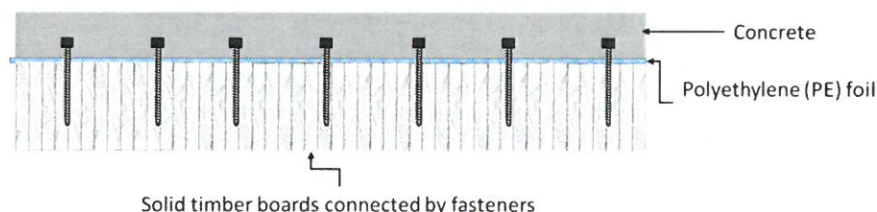


**Figure 2.9 – Wood-concrete composite slab with dowel-type fasteners – EAD n° 130090-00-0303**



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The present study aims to verify the possibility of a wood-concrete composite structural element, composed of wooden pieces of rectangular section connected by pegs, figure 2.10. This product would be placed in the market as a kit. This product does not fall within the scope of EAD No. 130090-00-0303 as it has the deviation regarding the type of wood element provided for in the EAD (beam, glued laminate, LVL<sup>5</sup> or cross-laminated timber). However, given the type deviation the solution may be amended to the EAD upon request by a notified body to EOTA.



**Figure 2.10 – Wood-concrete composite structural element**

This product is intended to be developed on a kit basis where all components apart from sugi wood (dowels, concrete, PE film) can be purchased by the customer according to ETA specifications. Such a product is generally covered by an AVCP system 1 or 2+. Production control should consider the grading (visual or machine) of the wood elements, the assessment of the quality of the connectors, including possible end connections between elements (if finger joints exist). Table 2.3 shows the performance characteristics that may be included in an EAD applicable to this type of product. The drafting of the ETA (document similar to a type-product report under harmonized standards) is the responsibility of European Technical Assessment (OAT) bodies authorized to issue ETA<sup>6</sup>.

<sup>5</sup> Laminated veneer lumber

<sup>6</sup> <https://www.eota.eu/en-GB/content/how-to-find-a-tab/55/>

**Table 2.3 – Performance characteristics possible to be included in a EAD**

**Performance characteristics**

---

**Mechanical resistance and stability**  
Bending, compression, tensile and shear behaviour  
Resistant capacity of fasteners  
Dimensional stability  
Creep and duration of load  
Bonding quality

**Safety in case of fire**  
Reaction to fire  
Resistance to fire

**Hygiene, health and the environment**  
Vapour permeability  
Dangerous substances

**Safety and accessibility in use**  
Same as those included in mechanical resistance and stability  
(see above)

**Protection against noise**  
Airborne sound insulation  
Sound absorption

**Energy economy and heat retention**  
Thermal conductivity

In an indicative way, factory production control may be expected to include:

- a) Clear designation and identification of product, raw materials and components.
- b) Procedures and work instructions concerning control of raw materials and components and tests carried out at the factory or subcontracted to others.
- c) Date of manufacture of the product and guarantee of traceability.
- d) Control results (routine and verification tests) and comparison with requirements if available.

#### 2.1.4. Type I-beams

Timber I-beams are not covered by European standardization and have until recently been included in ETAG 011 “Light Composite Wood-based Beams and Columns”. However, currently the CE marking of this type of products will have to go through the request for drafting and subsequent publication of an EAD, which will be used as support of an ETA.

In the present case, the proposed solution will go through composite I-beams (using wood species existing in the Região Autónoma dos Açores), figure 2.11.

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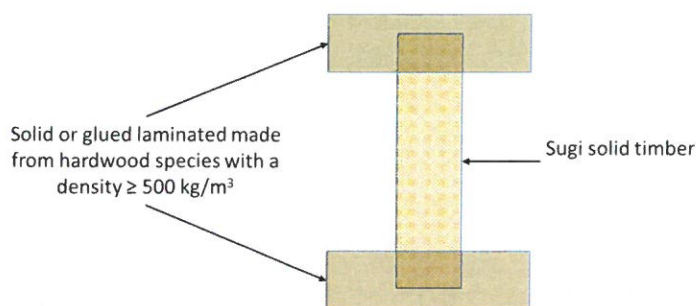


Figure 2.11 – Structural element I-beam

Having in mind the draft of a product-type report the assessment should be carried out considering that:

- The manufacturer should define the end use application for the I-beam.
- The decision on the suitable tests should ensure a fully characterization of the product, including components (e.g. strength grading of the timber used in web and flange and suitability of the glue, if used, having in mind the service class conditions), the connection web-flange and the overall behavior of the final element.

Table 2.4 indicates some performance characteristics that could be declared in a future EAD.

Table 2.4 – Performance characteristics possible to be included in a future EAD

Performance characteristics
<b>Mechanical resistance and stability</b> Bending, compression, tensile and shear behaviour (web and flanges or member) Resistant capacity of connections Dimensional stability Creep and duration of load Behaviour of "finger joints" (if existent)
<b>Safety in case of fire</b> Reaction to fire Resistance to fire
<b>Hygiene, health and the environment</b> --
<b>Safety and accessibility in use</b> Same as those included in <u>mechanical resistance and stability</u> (see above)
<b>Protection against noise</b> --
<b>Energy economy and heat retention</b> --

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In an indicative way, factory production control may be expected to include:

- a) Name and full identification of the product, raw materials and components.
- b) Procedures and work instructions related to the control of raw materials and components.
- c) Tests performed at the factory or subcontracted to exterior laboratories.
- d) Date of manufacture of the product and guarantee of traceability of factory production control data.
- e) Production controls (routine and verification tests) and comparison with requirements if available when existent. The type of connection (glued or mechanical) between components influences the factory production control to be implemented.

Figure 2.12 presents one example already in the market using wood-based I-beams for floor.

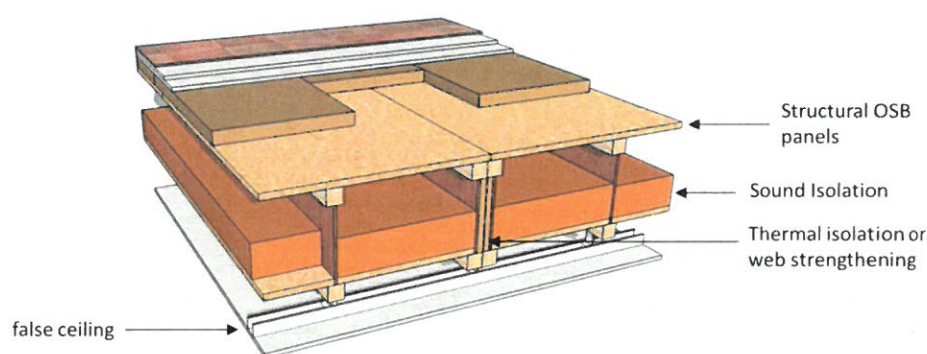


Figure 2.12 – Example of I Beams use in floor solutions (system STEICOjoist)

## 2.2. Non-structural products (coverings) based on densified wood potential

Non-structural use of sugi wood may include floor and interior or exterior wall cladding or panelling products. These two types of application are covered by harmonized standards: flooring - EN 14342; interior or exterior cladding or panelling walls - EN 14915.

For use as an indoor floor covering, sugi wood presents a low average density (between 280kg/m<sup>3</sup> and 400kg/m<sup>3</sup>) corresponding to a hardness inferior to 10N/mm<sup>2</sup>, which is the indicative minimum value for an adequate performance as a floor covering. The use in floors thus necessarily involves the development of technology (treatments or modification of wood) that allows to achieve a hardness greater than or equal to the reference value of 10N/mm<sup>2</sup>. A preliminary study on the feasibility of achieving an acceptable performance through wood densification is under way in the present project.

In the case of the solution under evaluation, the feasibility takes into account the appropriate product standard, EN 13489, covering floor coverings having a wood blade thickness  $\geq 2.5$ mm glued to a wood substrate or wood-based panel, figure 2.13.





Figure 2.13 – Wood flooring - multi-layer parquet elements - EN 13489

In the case of a product intended for interior or exterior wall cladding or panelling, these are covered by EN 14915. This standard does not cover a system – kit - (including fixings and performance of the cladding system), if the manufacturer wanted to place into the market a cladding system it can be done based on EAD 090062-00-0404 “Kits for external wall claddings mechanically fixed”.

Table 2.5 – Relevant performance characteristics in case of claddings subject to Assessment under EAD assessment 090062-00-0404

Performance characteristics
<b>Safety in case of fire</b> Reaction to fire Façade fire performance Propensity to undergo continuous smouldering
<b>Hygiene, Health and the environment</b> Water vapour permeability Emission of dangerous substances
<b>Safety and accessibility in use</b> Wind load resistance Impact resistance Cladding element resistance Connection resistance between cladding element and its fixings
<b>Protection against noise</b> Airborne sound insulation
<b>Energy economy and heat retention</b> Thermal resistance
<b>Durability</b> Dimensional stability Chemical and biological resistance

In an indicative way, factory production control may be expected to include:

- Name and full identification of the product, raw materials and components.
- Procedures and work instructions related to the control of raw materials and components.
- Tests performed at the factory or subcontracted to exterior laboratories.



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- d) Date of manufacture of the product and guarantee of traceability of factory production control data.
- e) Production controls (routine and verification tests) and comparison with requirements if available when existent. The type of connection (glued or mechanical) between components shapes the factory production control to be implemented.
- f) An important parameter to take into account is the bonding quality, namely durability when subjected to extreme environments (e.g.  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$  temperature and  $30\% \pm 5\%$  relative humidity and  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$  temperature and  $85\% \pm 5\%$  relative humidity).

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### 3. Final comments

This report complements the studies currently underway at LNEC and SerQ aiming to demonstrate the technical feasibility of sugi wood-based construction solutions. These solutions are in a Technology Readiness Level (TRL) level 4 to 6, being the responsible for the full experimental or numerical validation of the solutions and the implementation of the necessary conditions for their commercialization of the companies that decided to adopt them, thus achieving the TRL 9 level (actual system proven in operational environment).

The procedures and insights provided for the possible CE marking of the products should be regarded as indicative, and any manufacturer proposing to bring one of the solutions to the market should consult the applicable regulatory documents and, where required, consult a Notified Certification or Approval Body to establish the specific steps to follow to achieve that goal.

Sertã, 6 november 2019

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