



SLOVENSKI STANDARD SIST EN 17121:2019

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Ohranjanje kulturne dediščine - Zgodovinske lesene konstrukcije - Smernice za ocenjevanje nosilnih lesenih konstrukcij na kraju samem

Conservation of cultural heritage - Historic timber structures - Guidelines for the on-site assessment of load-bearing timber structures

Erhaltung des kulturellen Erbes - Historische Holzkonstruktionen - Leitlinien für die Bewertung vor Ort von tragenden Holzkonstruktionen

Conservation du patrimoine culturel - Structures en bois du patrimoine - Lignes directrices relatives à l'évaluation sur site des stuctures porteuses en bois

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EUROPEAN STANDARD

EN 17121

NORME EUROPÉENNE

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September 2019

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English Version

Conservation of cultural heritage - Historic timber structures - Guidelines for the on-site assessment of load-bearing timber structures

Conservation du patrimoine culturel - Structures en bois du patrimoine - Lignes directrices relatives à l'évaluation sur site des structures porteuses en bois

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Contents	Page
European foreword.....	3
Introduction	4
1 Scope.....	5
2 Normative references.....	5
3 Terms and definitions	5
4 Assessment procedure	8
4.1 General.....	8
4.2 Preliminary assessment	9
4.3 Desk study.....	11
4.4 Historical analysis.....	11
4.5 Preliminary visual survey.....	12
4.6 Measured survey	12
4.7 Structural analysis.....	13
4.8 Preliminary report	14
5 Detailed survey.....	15
5.1 Overview	15
5.2 General.....	15
5.3 Identification of wood species.....	16
5.4 Estimating wood moisture content and moisture gradients.....	16
5.5 Characterization of biological damage.....	16
5.6 Strength assessment of timber.....	17
5.7 Wood dating.....	18
5.8 Detailed survey of timber joints	19
5.9 Detailed structural analysis	20
Annex A (informative) Tools for non-destructive analyses on timber structures	21
Bibliography.....	27

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SIST EN 17121:2019

<https://standards.iteh.ai/catalog/standards/sist/0bc96a9c-716e-4c26-8dba-1a77011191d/sist-en-17121-2019>

European foreword

This document (EN 17121:2019) has been prepared by Technical Committee CEN/TC 346 “Conservation of Cultural Heritage”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2020, and conflicting national standards shall be withdrawn at the latest by March 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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Introduction

The purpose of the present document is to consider condition survey and diagnostic methods for assessing heritage load-bearing timber structures with a view to establishing safe working loads or determining the need for strengthening or repair in order to ensure their continuing use.

Heritage structures are important historic artefacts, which differ from other existing structures in that a greater value is placed on their fabric because of their historical significance. It is necessary to gather data in order to be able to assess the ability of such a structure to carry the required loads and continue to be in use both now and for the foreseeable future, and to identify those areas of the structure that require repair or strengthening. Both the conduct of the survey, assessment and any subsequent repair or strengthening that could be necessary should involve minimum intervention. This could justify greater expense both in the survey, diagnosis and assessment of the structure and in the consideration of the repair methods that might be employed. The assessment of their condition and of their existing structural characteristics is expected to be state of the art, which might require the use of more precise methods than those that are used for other existing structures, with a cost that could not otherwise be justified. Moreover intervention works (repair or strengthening) should only be carried out to a heritage structure as a last resort and should have minimal impact on the building fabric (the original materials, structural systems and techniques).

An important part of the work involves the documentation and understanding of the history of a structure: loads, construction technology, and the period's aesthetic details in order to be able to assess the historical significance of either the overall structure or of any of its components. Historical significance of a structure could relate to the history of the structure itself or that of the building of which it is a part. Such understanding requires an interdisciplinary approach with any other profession that can be helpful to the assessment procedure. (standards.iteh.ai)

In some cases, where the problems are simple and obvious, the preliminary, visual survey might be all that is required but in general a more detailed survey will be needed ¹.

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¹ The survey of existing buildings to determine their suitability for continuing use or for a change of use has been considered by ISO 13822. Annex I of that standard considers heritage structures.

1 Scope

This document gives guidelines on the criteria to be used for the on-site assessment of load-bearing timber structures in heritage buildings. It is intended for all those concerned with the conservation of heritage buildings which contain wooden elements, from the building owners or authorities who are responsible for them to the professionals employed. It should also help decision-making regarding the need for immediate measures. Its aim is to guarantee that condition survey and assessment provide the necessary data for historical analysis, structural safety assessment and planning of intervention works.

This document is applicable to any kind of timber member and to any kind of historic timber structures. It is not applicable to timber members made of engineered wood based panels and glued laminated timber.

This document provides a comprehensive procedure for the on-site assessment. With a practical and technical evaluation of the damage found and based on the responsibility of the involved professionals, a sufficient assessment can also be made when not all the steps are followed.

In each different country, the document is expected to be applied in accordance with National legislation and regulations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 335, *Durability of wood and wood-based products — Use classes: definitions, application to solid wood and wood-based products*

EN 1912, *Structural Timber — Strength classes — Assignment of visual grades and species*
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EN 1995-1-1, *Eurocode 5: Design of timber structures — Part 1-1: General — Common rules and rules for buildings*

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

EN 16085, *Conservation of Cultural property — Methodology for sampling from materials of cultural property - General rules*

EN 16096, *Conservation of cultural property — Condition survey and report of built cultural heritage*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14081-1, EN 1912 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

EN 17121:2019 (E)**3.1****action**

set of forces (loads) applied to the structure

[SOURCE: EN 1990:2002, 1.5.3.1, modified]

3.2**alteration**

change in condition, beneficial or not, intentional or not

[SOURCE: EN 15898:2011, 3.2.4]

3.3**biological damage**

damage caused by living organisms such as fungi and insects

Note 1 to entry: In load bearing timber structures, the damage is considered in terms of reduction of the effective cross-section.

3.4**condition survey**

inspection to assess the condition of the structure

[SOURCE: EN 15898:2011, 3.6.4, modified]

3.5**critical area/zone**

part of a timber element over a length of 150 mm or equal to the depth of the member, whichever is the greater, which is considered to be relevant to the structural performance of the structure because of strength reducing characteristics, position, state of preservation and also stress conditions as determined by structural analysis

3.6**critical cross-section**

cross-section which is representative of a critical zone; all the defects, alterations, damage and other characteristics that are present in the critical zone and have an influence on its strength are attributed to the critical section

3.7**damage**

alteration that reduces significance or stability

[SOURCE: EN 15898:2011, 3.2.7]

3.8**defects****defects of wood**

wood growth features which can negatively influence strength and stiffness, and/or the general structural behaviour (e.g. the efficiency of joints) of timber members

3.9**diagnosis**

process of identifying the present condition of a structure and determining the nature and causes of any change, as well as the conclusions drawn

[SOURCE: EN 15898:2011, 3.6.6, modified]

3.10**dowelled connection**

connection made with a circular cylindrical rod of timber or steel, with or without a head, fitting tightly in prebored holes and used for transferring loads perpendicular to the dowel axis

3.11**effective cross-section**

part of the cross-section of a timber member which is assumed to be in a good state to resist stressors

3.12**in-situ load testing**

testing of the structure or part of it by loading to evaluate its behaviour or mechanical properties, or to predict its load-bearing capacity

3.13**rot**

decomposition of wood by fungi resulting in softening, progressive loss of mass and strength, and often a change of texture and colour

[SOURCE: EN 1001-1:2005, N. 385]

3.14**semi-destructive test**

test that has a minor impact on a timber member and that influences its load-bearing capacity or its appearance negligibly

3.15**non-destructive test**

test that has no impact on a timber member and that does not influence its load-bearing capacity or change its appearance

3.16**strength reducing characteristics**

property or feature of a piece of timber that reduces its load-bearing capacity

[SOURCE: EN 14081-1:2016, 3.8, modified]

3.17**structural safety**

evaluation that the structure or parts of the structure will not fail under the planned loading

3.18**serviceability assessment**

evaluation that the structure or parts of the structure comply with specified limit states concerning service conditions

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EN 17121:2019 (E)**3.19****strength grading**

procedure through which a single timber member can be allocated to a grade that corresponds to a known level of mechanical performance

3.20**structural system**

load-bearing members of a building or civil engineering works and the way in which these members function together

[SOURCE: EN 1990:2002, 1.5.1.9]

3.21**structural member type**

classification of timber members, through structural analysis, according to the type of their loading condition (compression, tension, bending, shear, or combination of these), necessary for their strength grading

3.22**survey**

inspection of a structure to determine its geometry, its detailing and its existing condition

3.23**wane**

original rounded surface of a log, with or without bark, on any face or edge of sawn timber

[SOURCE: EN 844-3:1998, 3.6]

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3.24**wood moisture content**

mass of moisture in wood expressed as a percentage of its oven-dry mass

[SOURCE: EN 844-4:1997, 4.1]

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4 Assessment procedure**4.1 General**

The procedure required for the on-site examination and assessment of an historic timber structure is briefly as follows:

a) **First phase, preliminary assessment** dealt with in detail in Clause 4 of this standard. This includes:

- 1) a **desk study**, that should provide information and documentation that will help in determining the history of the structure and if possible the corresponding load history. This should also clearly indicate the intentions of the building owner so that the intended ultimate load and environmental conditions are known.
- 2) a **visual survey**. This is to obtain an overview of the structure that is sufficient to plan the next stage, identifying also what provisions need to be made to gain access to the timbers.

- 3) a **measured survey** to determine the overall disposition of the structural members and locate main problems. This survey should include principal dimensions and the nominal sizes of the members that are critical for the preliminary structural assessment. It should also note any obvious signs of damage, decay or structural problems, which will need to be investigated in more detail at a subsequent stage.
 - 4) a **preliminary structural analysis** to determine the overall forces, the structural type of each member and general levels of stress and deflections/deformations within the structure.
 - 5) a **preliminary report** shall be prepared that includes a general description of the structure and its existing condition, with a note of areas of concern that require more detailed study and which possibly require immediate safety measures and actions. It shall include also a description of the pathology, the service conditions and the structural behaviour. Vulnerable areas shall be identified, together with those members and connections that are carrying the larger stresses and/or deformations; any problems and/or strength reducing characteristic within the structure shall be noted together with a general preliminary assessment of the present condition of the structure and guidelines/proposals for the continuation of the investigation. These guidelines will specify any additional survey work that may be necessary. This would indicate any aspects of the structure, which require further investigation and the methods recommended.
- b) **Second phase, detailed survey** dealt with in detail in Clause 5.
- 1) A **detailed survey** as indicated in the preliminary report. This should include the measurement of areas of biological attack and damage, the assessment of timber grades and the results of non-destructive methods where appropriate and will also consider the adequacy of joints.
 - 2) A **diagnostic report** on the condition of the structure and causes of distress with proposals for remedial measures where necessary. This may imply a new structural analysis considering the data gathered in the detailed survey.

Although the list above suggests a linear process it is essential to recognize that conservation work frequently involves iterations. For example, the preliminary visual survey might raise questions that could be answered by a more thorough desk study, able to document changes that have been observed in the structure. Iterations between structural analysis and repair strategy stages are also often required.

A holistic approach is always required, considering and assessing the structure as a whole, rather than just the individual members and joints.

4.2 Preliminary assessment

4.2.1 Need for the preliminary assessment

The purpose of the assessment is to determine whether the structure is at present adequate to carry the loads that it is required to carry and will continue to be adequate for the foreseeable future. The work should be carried out by professionals, which should have knowledge on timber structures. Note that structures that have proved to be adequate in the past will continue to be adequate requiring no detailed assessment of timber mechanical properties, except in the following circumstances:

- a) there is a possible change in loads (due to e.g. a change in use of the structure);
- b) there has been significant rot or/and insect attack to the timbers, or the structure has suffered damage, e.g. due to fire;

EN 17121:2019 (E)

- c) there has been mechanical damage, failures or excessive deflection indicating overloading of the timbers in the past, the materials used are of poor quality, there was inferior initial design or/and workmanship. The evaluation depends on the type of structure, its historic importance and on national regulation;
- d) there have been alterations or interventions to the structure during its lifetime, that have resulted in a reduction of its structural capacity or changes to the original structural scheme;
- e) to ensure that the structure is adequate to withstand extreme climatic or loading events (earthquake, wind, ground sliding, etc.);
- f) there has been a variation of the thermo-hydrometric conditions, that have changed the service conditions.

NOTE 1 In some cases, rather than adopt extensive strengthening measures, safety can be ensured by limiting the allowable loads. This can involve limiting public access.

NOTE 2 The deformation/deflection limits for historic structures can be different and less strict from the ones that the modern codes specify (serviceability limit state design) for a new timber structure.

The preliminary assessment may include:

- g) retrieval of possible historical documentation, to date the structure and identify the sequence of changes made (historical phases);
- h) a written description of the structure and a photographic documentation;
- i) a survey of the structure and a graphic representation of its geometrical and constructional features in 2D and 3D (isometric or axonometric) drawings;
- j) identification of the species used for the structure (load-bearing and non-load-bearing members);
- k) a description of the structural system. Note that this may need to include some description of the supporting system (foundation, masonry or other type of structure);
- l) a description of the environmental service conditions (usual values and variations of hydro-thermal conditions) and the consequent moisture content of wood and possible moisture gradients;
- m) a recording of the pathology and the identification of any areas of biological attack or mechanical damage together with a first description of the possible causes of the damages (diagnosis).

4.2.2 Principles

According to EN 16096, all surveys and diagnostic methods used for the assessment of heritage structures shall be semi or non-destructive so that no part of the structure shall be removed for laboratory testing except for small samples used for identification of physical, mechanical properties, timber species, biological agents and dendrochronology. In any case the sampling shall be according to EN 16085 and shall not modify the load bearing capacity of the elements or have an impact on the other properties (e.g. aesthetical or historical) of the timber structure.

4.2.3 Time dependant results

Note that the assessment results pertain to the moment of assessment since degradation is generally a continuing process and further deterioration shall be anticipated until suitable remedial measures have been adopted and become effective.