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End use performance of wood products – Utilisation and improvement of existing methods to estimate service life

Slutanvändningsprestanda hos trävaror – Användning och förbättring av existerande metoder för uppskattning av brukstid

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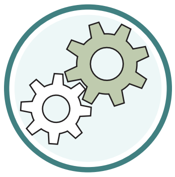

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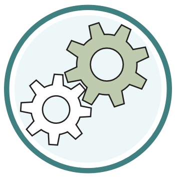

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TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 16816

April 2015

ICS 79.080

English Version

End use performance of wood products - Utilisation and improvement of existing methods to estimate service life

Performances des produits en bois dans leur emploi - Utilisation et amélioration des méthodes existantes pour estimer la durée de vie

Leistungseigenschaften von Holzprodukten

This Technical Report was approved by CEN on 21 March 2015. It has been drawn up by the Technical Committee CEN/TC 38.

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Foreword

This document (CEN/TR 16816:2015) has been prepared by Technical Committee CEN/TC 38 “Durability of wood and wood-based products”, the secretariat of which is held by AFNOR.

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

1 Scope

The scope of WG28 Performance Classification is expressed in this Technical Report:

Guidance on the determination of end use performance of wood products: utilization and improvement of existing test methods to estimate service life, in order to give input to the harmonized product standards dealing with the durability requirement of the CPD and future Regulation (EU) No 305/2011 (The Construction Products Regulation CPR).

This Technical Report brings together the evaluations and discussions to date that have occurred within CEN/TC38/WG28 Performance Classification.

This technical report does not address panel products specifically.

2 Background

2.1 General

The development of performance-based design methods for durability requires that models are available to predict performance in a quantitative and probabilistic format. The relationship between performance during testing and in service needs to be quantified in statistical terms and the resulting predictive models need to be calibrated to provide a realistic measure of service life, including a defined acceptable risk of non-conformity.

Service-life prediction or planning is a process for ensuring that, as far as possible, the service life of a building will equal or exceed its design life, while taking into account (and preferably optimising) its life-cycle costs (ISO 15686 [1]). For a long time, the international organizations CIB and RILEM have been leading this development, which has had an impact on standardization work nationally, regionally, and globally through ISO.

Service-life prediction should be integrated into the design process for constructions, but it is also applicable to existing buildings and other construction works.

Drivers for establishing service-life planning methodology and routines include the need for building owners to be able to forecast and control costs throughout the design life of a building or construction. It also influences the reliability of constructed assets, and hence the health and safety of users.

The construction sector is under pressure to improve its cost effectiveness, quality, energy efficiency and environmental performance and to reduce the use of non-renewable resources. A key issue for the competitiveness of wood is the delivery of reliable components of controlled durability with minimum maintenance needs and life-cycle costs.

The importance of service-life issues is reflected in the Construction Products Directive (CPD) with its six essential requirements, which should be fulfilled by construction products during a ‘reasonable service life’.

2.2 ISO/TC 59/SC14 “Design life”

The development of performance-based design methods for durability requires that models are available to predict performance in a quantitative and probabilistic format. The relationship between performance during testing and in service needs to be quantified in statistical terms and the resulting predictive models need to be calibrated to provide a realistic measure of service life, including a defined acceptable risk of non-conformity.

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2.3 CEN/TC 350 Sustainability of Construction Words

CEN/TC 350 is responsible for the development of voluntary horizontal standardized methods for the assessment of the sustainability aspects of new and existing construction works and for standards for the environmental product declaration of construction products.

The objective is to ensure that LCA-based data for environmental product declarations are consistent, comparable, verifiable and scientifically based. Since the life cycle has to be defined, it is essential to include information on service lives, including reference service lives.

Methods for sustainability assessments should be based on a performance-based approach, and should cover environmental, social and economic performance.

2.4 CEN/TC 351 Construction Products: Assessment of release of dangerous substances

The work of CEN/TC 351 is directed to the area covered by the Biocidal Products Directive and REACH. Indicators, criteria and developed standards will have significant influence in the future on the materials available for construction products and on service-life design options.

2.5 COST Action E37 sustainability through new technologies for enhanced wood durability

The Task Force Performance Classification (TFPC) was established at the COST Action E37 workshop in Ljubljana in 2004 [2]. Its aim was to outline principles for a performance-based classification of wood durability, in particular in using the natural durability of untreated wood and for modified wood products, traditional and non-traditional treatments and non-biocidal measures for wood protection.

The COST Action ended in September 2008, and the TFPC submitted a final report for inclusion in the overall documentation of the Action [3]. Standards for durability of wood and wood-based products, not least those produced by CEN/TC 38 Durability of wood and wood-based materials, were of primary interest to the TFPC. They considered that the present standards could not deliver adequate performance-based data. One goal of the Task Force was therefore to address the way durability is treated in standardization. It was conceived that well-founded proposals on amalgamating modern, material-independent methods of service-life prediction and design with traditional wood assessment methods would be of direct use, e.g. to CEN/TC 38 and the construction industry.

The TFPC recognized the use of Reference Service Life (RSL) as a basis for estimations of Estimated Service Life (ESL). The estimates are not necessarily reached by use of the Factor Method as in ISO 15686, but the basic principle is useful. To develop a range of performance classes, the scientific community must connect better and cooperate with user groups and stakeholders and define reference products that can be evaluated under reference service conditions. Test results on any commodities, products and components will then be compared with agreed RSLs, and this can form the foundation for a range of performance classes. During this development, existing use classes have to be taken into account and, if necessary, adapted to suit a forthcoming system for performance classification. As an input to Factor A (Quality of components) in the Factor Method, it will be necessary to define a range of Resistance Classes to feed into the assessments. This work is carried forward in CEN/TC 38 WG28 and the WoodExter project.

2.6 WoodExter project

The WoodExter project [4] (2007 – 2010) was a collaborative pan-European-funded research project supported by WoodWisdom-Net and the Building with Wood industry initiative. Its objective was to take the first steps towards introducing performance-based engineering design for wood and wood-based building components in outdoor above-ground situations. This enables capture of the benefits of 'design for durability' and has delivered a practical engineering tool for service-life estimation based on a novel methodology. The project focused on cladding and decking as two test case products to rigorously assess this methodology.

The project aims were to:

— characterize climatic influence on performance of timber cladding;

— characterize new and existing techniques as in-service indicators of performance prediction;

— combine the above in an engineering-based model;

— calibrate and rigorously test the model for the selected Use Class 3 products, cladding and decking;

— transfer knowledge to enable confident specification of timber cladding and decking.

A pilot model has been developed in the WoodExter project incorporating key input data and the interactions between them that influence performance of cladding www.kstr.lth.se/guideline. The consequence class depends on the severity of consequences in case of non-performance and is described by the factor γ_d.

The exposure index I_{sk} is conceived as a 'characteristic (safe) value' accounting for uncertainties. The exposure index is assumed to depend on:

— geographical location determining global climate;

— local climate conditions;

— the degree of sheltering;

— distance from the ground;

— detailed design of the wood component;

— use and maintenance of coatings.

2.7 Design value I_{Rd} for resistance factor depending on material

The design resistance index I_{Rd} for selected wood materials is determined on the basis of resistance class according to Table 1. This is a simplified first step for a material resistance classification based on a balanced expert judgment of moisture dynamics and durability class. The resistance class term is based on a combination of durability class data according to EN 350-2, test data, experience of treatability and permeability for wood species as well as experience from practice.

Biological durability is the key factor determining performance for wood in different use classes. The robust laboratory and field test methods that exist make it possible to assign a durability rating to timber linked to the intended use class according to EN 335, assuming a worst case scenario. Other factors determine the likelihood of the worst case scenario occurring in practice.

The natural durability of wood is classified into durability classes as described in EN 350-1 and presented as durability classes for heartwood of timber species in EN 350-2. Durability class is a classification on five levels from non-durable to very durable. This is based on decades of data from ground contact field trials for use class 4. The natural durability for a wood species can vary widely.

Table 1 — Resistance classification of selected wood materials and corresponding design resistance index

Material resistance class	Examples of wood materials[a]	I_{Rd}
A	Heartwood of very durable tropical hardwoods, e.g. afzelia, robinia (durability class 1) Preservative-treated sapwood, industrially processed to meet requirements of use class 3.	10,0
B	Heartwood of durable wood species e.g. sweet chestnut (durability class 2)	5,0
C	Heartwood of moderately and slightly durable wood species e.g. Larch and Scots pine (durability class 3 and 4,)	2,0
D	Slightly durable wood species having low water permeability (e.g. Norway Spruce)	1,0
E	Sapwood of all wood species (and where sapwood content in the untreated product is high)	0,7

[a] For the majority of wood materials there is variability in material resistance. The material resistance classification should defer to local knowledge based on experience of performance of cladding and decking and where this is not available field test data and then laboratory test data. It is possible that a classification with different design resistance indices may need to be adopted for specific regions or countries, based on practical experience e.g. from the use of a material in that region.

For out of ground contact (e.g. exterior wood cladding) the challenge is to translate durability class from use class 4 to use class 3. In EN 350-1 the term “markedly different” is used to describe the additional benefits of low permeability on the performance of wood out of ground contact. Expert advice is recommended for assigning the material resistance class for wood materials such as:

Preservative treated wood is often a combination of mixed treated heartwood and sapwood. The treated sapwood should be thoroughly treated and enhanced to durability class 1. The heartwood is more resistant to treatment and the enhancement of the heartwood can be considered to be slightly higher than the natural durability class of the heartwood for the species (EN 350-2). Therefore, for preservative treated decking it may be more sensible to take a mid-point between the resistance class of the treated sapwood and the treated heartwood. E.g. for pine heartwood treated (resistance class C) and pine sapwood treated (resistance class A) the overall batch of preservative treated wood should then be classified as resistance class B.

For untreated wood if there is a mixture of heartwood and sapwood present in the wood species then the material resistance can either be classified as the mid-point between the class of the heartwood (resistance class A to D) and the sapwood (resistance class E). If this risk is not acceptable then the material resistance class should be taken as the worst case (E), the least resistant competent of the overall material.

The durability of modified wood, e.g. acetylated, furfurylated and thermally modified, is specific to the technologies employed and may vary between specifications for the different materials. Expert advice is recommended for assigning the material resistance class for modified wood.