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Timber structures — Methods of test for evaluation of long-term performance — Part 1: Wood-based products in bending

Structures en bois — Méthodes d'essai pour l'évaluation du comportement à long terme — Partie 1: Produits à base de bois en flexion

PROOF/ÉPREUVE

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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ISO 24322 was prepared by Technical Committee ISO/TC 165, *Structural timber*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document sets out a framework to establish the duration of load and creep characteristics of timber structural products from test results on a sample drawn from a clearly defined reference population.

It is the intention that the document can be used on any structural product including but not limited to: sawn timber, glulam, structural composite lumber, I-beams, wood-based panels, poles and round timber. Whenever it is used, the document alerts the user to the basic requirements for the determination of consistent characteristic values. It permits the characterisation of duration of load and creep behaviour based on testing of commercial sized specimens.

Timber structures — Methods of test for evaluation of long-term performance — Part 1: Wood-based products in bending

1 Scope

This document gives methods of determination of duration of load and creep factors under bending actions at ambient temperatures for a defined population of structural timber products such as solid timber, LVL, OSB, plywood, particleboard, I-beams calculated from test values.

It presents methods for

a) determining the duration of load and creep factors for new timber products,

b) establishing whether a previously defined set of duration of load and creep factors can be applied to a tested product, and

c) an optional method for establishment of sensitivity of duration of load and creep factors to changes in environmental conditions.

NOTE 1 This document is intended to apply to wood-based products for which a duration of load factor or a creep factor is used in design.

NOTE 2 The effect of elevated temperature on the duration of load factor and creep factor that is derived using these methods for use with timber products can need additional consideration.

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.

ISO 12122-1, *Structural timber — Determination of Characteristic values — Part 1: Basic principles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
characteristic value
value of a property taken to represent the property of a designated population using a process of sampling

Note 1 to entry: The sampling is as determined in accordance with ISO 12122-1.

3.2
creep
time-dependent increase of deformation of the material under a sustained load

3.3
duration of load
cumulative total time during which a load acts on a member

3.4
linear creep
time-dependent increase of deformation, which is linearly related to the load level

Note 1 to entry: Linear creep usually applies with low load levels.

3.5
non-linear creep
time-dependent increase of deformation, which is non-linearly related to the load level

Note 1 to entry: Non-linear creep usually applies with high load levels.

3.6
service class
class assigned to a structure based on the climatic conditions

Note 1 to entry: The service class system is mainly aimed at assigning strength values and for calculating deformations under defined environmental conditions.

Note 2 to entry: The climatic conditions are according to EN 1995-1-1.

4 Symbols (and abbreviated terms)

Symbols defined in the relevant ISO product or test standard shall be used.

In addition, the following apply:

C_R	is the average creep recovery within 30 days of unloading
F	is the total force applied to the specimen
$D_{f,90}$	is the fractional deflection after 90 days
F_{max}	is the short term maximum load applied in a single short-term test, where the term is used in a long-term test, it refers to the maximum load applied in the matched short-term test.
N_{90}	number of specimen failures at the end of 90 days
N_C	critical order statistic used to estimate the lower 5 % non-parametric tolerance limit based on the number of specimens under long-term load
SC1	is service class 1
SC2	is service class 2
SC3	is service class 3
S_L	is the stress level of a loading (%)
t	is time after loading in a long-term test
t_f	is time to failure in a long-term test
$X_{0,05}$	is the 5 % point estimate of the capacity of a short-term test group
a	is a deflection reading in a creep test

a_0 is a deflection reading before a load is applied in a creep test

a_1 is a deflection reading 1 min after the application of a load in a creep test

a_t is a deflection reading time, t, after the application of a load in a creep test

c is the intercept on a plot of $\log_{10}t$ versus S_L to evaluate the duration of load factor

e is the intercept of an S_L versus t plot (= c/m)

f is the slope of an S_L versus t plot (= $1/m$)

f_b is the minimum applied bending stress

h is the depth of the specimen

$k_{d,t}$ is duration of load factor after time, t

l is the test span in a bending test

l_1 is the span of the deflection measurement yoke used in shear-free creep tests

m is the slope on a plot of $\log_{10}t$ versus S_L to evaluate the duration of load factor

w is the deformation in millimetres

$\Delta_{1\text{-min}}$ is the initial deflection measured 1 min after loading

Δ_{30} is the deflection measured 30 days after loading

Δ_{60} is the deflection measured 60 days after loading

Δ_{90} is the deflection measured 90 days after loading

Δ_{creep} is the total creep deflection accumulated over the long-term load test

$\Delta_{initial}$ is initial deflection gauge reading prior to loading

$\Delta_{load\text{-}end}$ is deflection gauge reading just prior to unloading

$\Delta_{recovered}$ is the total creep deflection recovered within 30 days after unloading

$\Delta_{unload\text{-}30}$ is deflection gauge reading within 30 days after unloading

5 Reference population

The population to which the duration of load and creep factors apply shall be fully described. The description shall reference all of the attributes that may affect either the strength or stiffness and restrict the pieces to the grouping for which the characteristic value is required. These include but are not be limited to:

a) reference to the relevant product standard or manufacturing specification;

b) species or species grouping;

c) designation of grade of the product;

d) size or size range of the product;

e) moisture condition of the product at the commencement of the tests;

f) detail of any adhesives used in the product including method and time of curing;

g) treatment of the product; or

h) period in which the product was manufactured.

The reference population shall be a grouping from which it is possible to draw a representative sample, and on which it is possible to perform tests on specimens to characterize the required properties.

Where the reference population includes a range of products (e.g. different thicknesses), the population may be characterised by testing the extremes of the range. Where the results of the extremes are significantly different, some other tests may be required to determine the nature of the variation within the range.

6 Sampling

6.1 Sampling method

The sampling method shall aim to produce a sample that is representative of the variants in the defined reference population that may affect the tested properties. The sampling shall minimise selection bias, and shall be appropriate to the purpose of the tests and the nature of the reference population.

The matched short-term and long-term specimens shall be clearly identified and marked so that the same matched face is loaded in both long-term and short-term tests.

The sampling method shall be documented. The documentation shall include details of the steps taken to ensure that each of the variants listed in the population as described in Clause 5 is included in the representative sample.

6.2 Matched groups within a sample

Matched test representative groups are required for comparative short- and long-term tests.

Matching is a technique that attempts to subdivide the initial sample population into two or more separate groups that possess near identical distributional form and scale for bending properties. Matching specimens for the purposes of testing for this document should be done with care, considering errors introduced by the process and the characteristics of the material under test.

Where two matched groups are required, specimens shall be matched in pairs (each specimen shall be matched to another specimen and shall be marked to enable the pair of matched specimens to be identified.

Where three matched groups are required, specimens shall be matched in threes (each specimen shall be matched to two other specimens and shall be marked to enable the three matched specimens to be identified.

The method of obtaining matched samples shall be documented.

The following methods of matching groups of specimens may be used:

a) Side matching for products with sufficient widths (e.g. panels, SCL)

b) End matching for width limited products (e.g. I-joists)

c) MOE matching for width and length limited products (e.g. solid timber)

6.3 Sample size

The sample shall be large enough to cover variants of the product that impact on the tested properties, and give statistical significance to the result.

Minimum sample sizes for short-term and long-duration tests are detailed in Clauses 9 and 10.

Materials with larger assumed or assigned population coefficient of variation, C_V, of the tested properties, should have a larger sample size.

Some product standards can define a minimum number of tests that shall be undertaken to determine characteristic values to be used with described products.

NOTE Annex A gives some guidance on selecting sample size.

For some populations, a number of different sub-groups within the population may need to be sampled (e.g. different cross-sectional sizes). In these cases, the size of each of the sub-groups can have to be sufficient to allow meaningful pooling of the results as indicated in Annex A.

Where characteristic values are to support limit states (or LRFD) design, the sample size should be appropriate for the statistical method selected to determine the 5th percentile value strength (full distribution or tail-fit). However, where the data is used to support a full reliability design method, the sample size should be appropriate to also enable the full statistical distribution of the property to be defined.

7 Sample conditioning prior to testing

Test specimens shall be conditioned prior to testing. The conditioning shall target moisture content that is compatible with the definition of the population and with the moisture conditions at the commencement of the long-duration tests specified in Clauses 9 and 10.

The test laboratory shall normally be maintained at the controlled environment, but when other conditions apply, they shall be reported.

8 Bending tests

8.1 Test method

8.1.1 General

Subject to the requirements of 8.1.2 to 8.1.4, the test data shall be derived in accordance with an appropriate test method for the properties and for the reference population.

For tests on some product types, discrimination of results on the basis of failure mode can be required to ensure that the results are compatible with objectives of the test program and the property being determined.

Test methods involve many variables that may affect results including loading configuration and rates, specimen positioning and measurement methods. The selection of these variables shall be appropriate to the objectives of the testing and may require some adjustments specified in 8.2.

8.1.2 Load location on specimens

The load locations on the bending test specimens shall be at random locations.

There should be no attempt to bias the test location.

NOTE A test at mid position of each specimen can be regarded as random position tests.

8.1.3 Load configuration

Tests shall be conducted using load points at 1/3 of the span as shown in Figure 1. Lateral restraints shall be used when necessary to maintain lateral stability.