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Interested committees:

Title: BS EN 1995-2 Eurocode 5 - Design of timber structures

Part 2: Bridges

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Eurocode 5 - Design of timber structures - Part 2: Bridges

Eurocode 5 - Calcul des structures en bois - Part 2:
Ponts

Eurocode 5 - Bemessung und Konstruktion von
Holzbauten - Teil 2: Brücken

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 250.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 1995-2:2023) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI. CEN/TC 250 is responsible for all Structural Eurocodes and has been assigned responsibility for structural and geotechnical design matters by CEN.

This document will supersede EN 1995-2:2004.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

The main changes compared to the previous edition are listed below:

- Categorization of bridges depending on intended service life (4.1.2);
- Major changes to clause on Durability (Clause 6);
- Examples for detailing of Timber Bridges (Annex D);
- Requirements for inspection (6.4);
- Design rules for timber concrete composite-bridges (8.2);
- Changes to clause on serviceability limit states (Clause 9);
- Changes to clause on Fatigue (Clause 10).

Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

- EN 1990 Eurocode: Basis of structural and geotechnical design
- EN 1991 Eurocode 1: Actions on structures
- EN 1992 Eurocode 2: Design of concrete structures
- EN 1993 Eurocode 3: Design of steel structures
- EN 1994 Eurocode 4: Design of composite steel and concrete structures
- EN 1995 Eurocode 5: Design of timber structures
- EN 1996 Eurocode 6: Design of masonry structures
- EN 1997 Eurocode 7: Geotechnical design
- EN 1998 Eurocode 8: Design of structures for earthquake resistance
- EN 1999 Eurocode 9: Design of aluminium structures
- New parts are under development, e.g. Eurocode for design of structural glass

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, soft-ware developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

0.2 Introduction to EN 1995 (all parts)

EN 1995 (all parts) describes the principles and requirements for safety, serviceability and durability of timber structures. It is based on the limit state concept used in conjunction with a partial factor method.

Numerical values for partial factors and other reliability parameters are recommended as basic values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and of quality management applies. When EN 1995-2 is used as a base document by other CEN/TCs the same values need to be taken.

EN 1995 (all parts) applies to the design of buildings and civil engineering works in timber (solid timber, sawn, planed or in pole form, structural finger jointed timber, glued solid timber, glued laminated timber, cross laminated timber and structural laminated veneer lumber), wood-based panels and softboards as sheeting of timber frame members jointed together with adhesives or mechanical fasteners. It complies with the principles and requirements for the safety and serviceability of structures, the basis of their design and verification that are given in EN 1990.

EN 1995 (all parts) is only concerned with requirements for mechanical resistance, serviceability, durability and fire resistance of timber structures. Other requirements, e.g. concerning thermal or sound insulation, are not considered.

EN 1995 is subdivided in various parts:

- EN 1995-1 Design of timber structures — Part 1: General rules and rules for buildings
- EN 1995-2 Design of timber structures — Part 2: Bridges
- EN 1995-3 Design of timber structures — Part 3: Execution

EN 1995-1 in itself does not exist as a physical document, but comprises the following 3 separate parts:

- EN 1995-1-1 Design of timber structures — Part 1-1 General rules and rules for buildings
- EN 1995-1-2 Design of timber structures — Part 1-2: Structural fire design
- CEN/TS 19103 Eurocode 5 — Design of Timber Structures — Structural design of timber-concrete composite structures — Common rules and rules for buildings

EN 1995-2 “Bridges” refers to the common rules in EN 1995-1-1 and supplements, modifies or supersedes them, where relevant.

EN 1995-3 “Execution” refers to the common rules in EN 1995-1-1 and supplements, modifies or supersedes them, where relevant

0.3 Introduction to EN 1995-2

This document provides general design rules for the structural parts of timber bridges.

0.4 Verbal forms used in the Eurocodes

The verb “shall” expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may” expresses a course of action permissible within the limits of the Eurocodes.

The verb “can” expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National annex for EN 1995-2

National choice is allowed in this document where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing EN 1995-2 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this document is to be used.

When no national choice is made and no default is given in this document, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 1995-2 through notes to the following clauses:

4.1.2.1	4.3.1.3	9.2	10.4
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National choice is allowed in EN 1995-2 on the application of the following informative annexes:

Annex B	Annex C	Annex D	Annex E
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The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

1 Scope

1.1 Scope of EN 1995-2

(1) This document gives general design rules for the structural parts of bridges, i.e. structural members of importance for the reliability of the whole bridge or major parts of it, made of timber or other wood-based materials, either singly or compositely with concrete, steel or other materials.

1.2 Assumptions

(1) The general assumptions of EN 1990 apply.

(2) EN 1995-2 is intended to be used in conjunction with EN 1990, EN 1991 (all parts), EN 1995 (all parts), CEN/TS 19103, EN 1997 (all parts) and EN 1998-2.

(3) Rules for prestressed TCC elements are not covered by this document. Rules for the design of stress-laminated timber decks used as part of a TCC system are given.

(4) Systems which rely on friction between wood and concrete are with the exception of stress-laminated timber decks not covered by this document.

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.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. in 'should' clauses), permissions ('may' clauses), possibilities ('can' clauses), and in notes.

EN 1990:2023, *Eurocode - Basis of structural and geotechnical design*

EN 1991 (all parts), *Eurocode 1 — Actions on structures*

EN 1992-1-1:—,¹ *Eurocode 2 — Design of concrete structures — Part 1-1: General rules and rules for buildings, bridges and civil engineering structures*

EN 1993-1-4:—,² *Eurocode 3 — Design of steel structures — Part 1-4: Stainless steel structures*

EN 1993-1-11:—,³ *Eurocode 3 — Design of steel structure — Part 1-11: Tension components*

EN 1993-2:—,⁴ *Eurocode 3 — Design of steel structures — Part 2: Bridges*

EN 1995-1-1:—,⁵ *Eurocode 5 — Design of timber structures — Part 1-1: General rules and rules for buildings*

EN 1995-3:—,⁶ *Eurocode 5 — Design of timber structures Part 3: Execution*

¹ Under preparation. Stage at the time of publication: prEN 1992-1-1:2021.

² Under preparation. Stage at the time of publication: prEN 1992-1-4:2023.

³ Under development.

⁴ Under development.

⁵ Under preparation. Stage at the time of publication: prEN 1995-1-1:2023.

⁶ Under preparation. Stage at the time of publication: prEN 1995-3:2023.

CEN/TS 19103, *Eurocode 5: Design of Timber Structures - Structural design of timber-concrete composite structures - Common rules and rules for buildings*

EN 1998-1-1:—,⁷ *Eurocode 8 – Design of structures for earthquake resistance – Part 1-1: General rules and seismic action*

EN 1998-2:—,⁸ *Eurocode 8 — Design of structures for earthquake resistance — Part 2: Bridges*

EN 13183-2, *Moisture content of a piece of sawn timber — Part 2: Estimation by electrical resistance method*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1995-1-1:—⁵, CEN/TS 19103, EN 1995-3:—⁶ and the following apply.

3.1.1

protected bridge

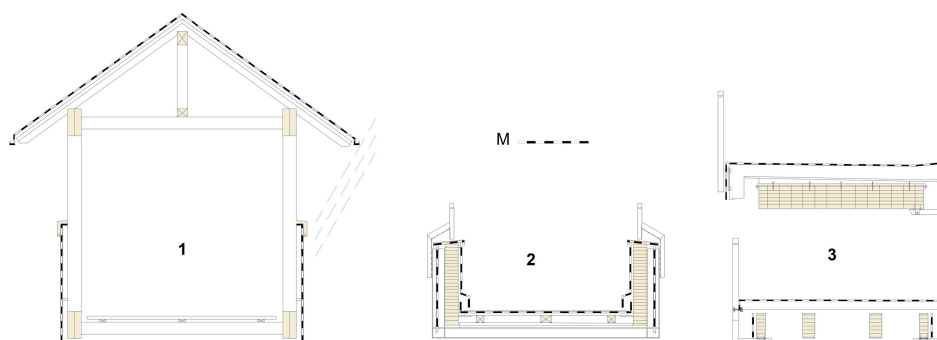
bridge in which all main bearing members are designed as *protected members* (3.1.2)

3.1.2

protected member

structural member not exposed to direct weathering such as rain, snow or other sources of moisture ingress

Note 1 to entry: Protected members are provided with weather protection, e.g. in form of claddings or side faces, sealed deck surface or an adequate roof overhang in both longitudinal and transversal directions (see Figure 3.1), so that an accumulation of moisture is unlikely. This includes truss nodes and end grain areas as well. For more in detail see design examples of detailing in Annex D.



Key

- M Membrane or weather-resistant layer
- 1 Covered pedestrian bridge (bridge with a roof)
- 2 Trough bridge
- 3 Deck bridges

Figure 3.1 — Examples of protected bridges

⁷ Under preparation. Stage at the time of publication: prEN 1998-1-1:2022.

⁸ Under preparation. Stage at the time of publication: prEN 1998-2:2023.

3.1.3**unprotected member**

structural member that is not protected or partially unprotected from weathering but is within the limits of Service Class (SC) 3

3.1.4**unprotected bridge**

bridge where some main structural members have not a full protection and *durability* (3.1.9) requirements are not fully met

3.1.5**timber bridge protected for a 50-year design service life**

bridge in which all main bearing members are protected to ensure a design service life T_{life} of 50 years (see Table 4.1, line 2)

3.1.6**covered bridge**

bridge with roof structure

3.1.7**sealing system**

layer preventing the penetration of water and moisture

Note 1 to entry: A sealing system consists of the layers primer, sealant membrane and protection (base) layer adapted to each other.

3.1.8**floating sealing system**

sealing system (3.1.7) where there is no shear connection between surface composition and superstructure

Note 1 to entry: See e.g. a rear-ventilated road surface as it is shown in Annex D.

3.1.9**durability**

ability of a structure or structural member to satisfy, with planned maintenance, its design performance requirements over the design service life

[SOURCE: EN 1990:2023, definition 3.1.2.31]

Note 1 to entry: For timber this also includes evaluation of its inherent resistance against wood destroying organisms.

3.1.10**ancillary structural element**

replaceable structural element that does not form part of the main structure of the bridge but is provided for other reasons

Note 1 to entry: Examples of ancillary structural elements are handrails, plankings, claddings, guard rails, ladders, transition joints and pavements.

Note 2 to entry: Kerbs, bearings or parts of bearings, and cantilevered parapets are not ancillary structural elements.

3.1.11

secondary seismic element

structural member that is not considered as part of the primary system and whose resistance and stiffness against seismic actions are neglected

[SOURCE: EN 1998-1-1:—7, 3.1.31]

3.1.12

shear connection

interconnection between two or more components that has sufficient strength and stiffness to enable the two components to be designed as parts of a single structural member

Note 1 to entry: Examples include reinforcing steel of any material, notches, plates and continuous fasteners, any of which can be either mechanically fixed or bonded.

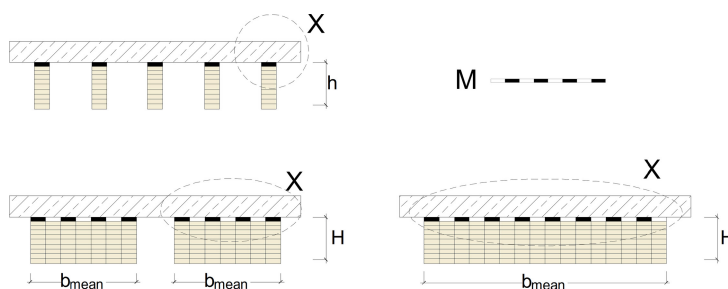
3.1.13

timber-concrete composite

TCC

superstructure made of timber and concrete connected by *shear connections* (3.1.12)

Note 1 to entry: For examples, see Figure 3.2.



Key

X Connection between timber and concrete

M Membrane or weather-resistant layer

NOTE For established TCC connections, see Figure D.4.2.

Figure 3.2 — Examples of cross sections from TCC bridge types

3.1.14

notched connection

shear connection (3.1.12) consisting of a concrete cam embedded in the timber component and a reinforcing steel or similar aid that prevents the concrete component from lifting off

Note 1 to entry: for examples see Figure D.4.2 and CEN/TS 19103.

Note 2 to entry: an example of a notched connection in a girder that has no constant height is shown in Figure 8.2.

3.1.15

adhesively bonded timber-concrete composite (TCC) bridge

TCC bridge in which the *shear connection* (3.1.12) between concrete slab and the wooden longitudinal beams of the superstructure is achieved by direct bonding

3.1.16**laminated timber deck**

deck consisting of adjacent laminations that are joined together edgewise or flatwise by means of mechanical fastening, gluing, or prestressing

Note 1 to entry: Glued laminated timber decks consisting of layers are typically made of glulam according to EN 14080 (edgewise orientation), block glued glulam according to EN 14080 or GLVL according to a European Technical Assessment (ETA).

Note 2 to entry: See Figure 8.1 and EN 1995-1-1:—⁵, Figure U.1, for different types of laminates.

3.1.17**stress-laminated timber deck**

laminated deck plate made of edgewise arranged laminations with the surfaces being either sawn or planed, held together by prestressing

Note 1 to entry: See Figure 8.1 a) and c).

3.1.18**glued laminated timber deck**

laminated deck plate made of flatwise oriented glulam, block glued glulam or GLVL, see Figure 8.1 b)

3.1.19**cross-laminated timber deck**

laminated deck plate made of cross-laminated timber

3.1.20**prestressing**

permanent stress acting on a structure as a result of controlled forces and/or deformations

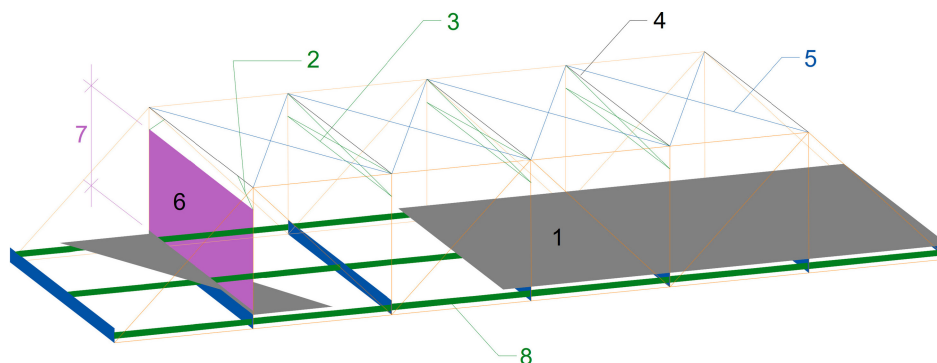
Note 1 to entry: An example is the lateral prestressing of timber deck plates by means of bars or tendons, see Figure 8.1 a) and c).

3.1.21

bracing

structure to stabilize members

Note 1 to entry: Possible elements of bracing systems are struts and ties, portal bracing, sway bracing, cross or lateral bracing, see Figure 3.3.



Key

- 1 Deck
- 2 Portal frame / portal bracing
- 3 Sway bracing
- 4 Strut
- 5 Lateral wind bracing
- 6 Clearance gauge (area)
- 7 Headroom (height of the clearance gauge)
- 8 Stringer

Figure 3.3 — Typical elements of bracing systems

3.1.22

European Technical Product Specification

— a European Product Standard (EN),

— or a European Technical Specification (TS),

— or a European Technical Assessment (ETA) based on a European Assessment Document (EAD),

— or a product documentation based on a transparent and reproducible assessment that complies with all requirements of the relevant EAD

3.2 Symbols and abbreviations

For the purpose of this document, the following symbols and abbreviations apply.

3.2.1 Latin upper case letters

A	area, bridge floor area
$A_{\text{conc,eff}}$	effective area of the concrete cross section
A_{tim}	area of the timber cross section
E_{conc}	modulus of elasticity of the concrete cross section
E_{tim}	modulus of elasticity of the timber cross section
F	force
F_{cupping}	cupping force (see Annex E)
$F_{\text{t,Ed}}$	design value of tensile force between cross section members
$F_{\text{v,Ed}}$	design value of shear force between cross section members
$F_{\text{p,min}}$	minimum long-term residual compressive force due to prestressing
$F_{\text{p,min,d}}$	design minimum long-term residual compressive force per unit length due to prestressing.
$F_{\text{v,x,d}}$	design shear force per unit length, caused by horizontal actions
$F_{\text{v,z,d}}$	design shear force per unit length, caused by vertical actions
F_{Wk}	limiting value for wind force
H	depth of a cross section
H_1	depth of the plate of a timber-concrete element
H_2	depth of the timber element of a timber-concrete element
I_{conc}	moment of inertia of the concrete cross section
I_{tim}	moment of inertia of the timber cross section
L	span of the beam; distance between points of contraflexure in the beam
L_{sea}	distance from the sea.
L_{street}	distance from roads with heavy traffic with de-icing salt
L_{v}	length of timber in front of the notch
M^*	modal mass of a bridge in kg
M^*_{vert}	modal mass of a bridge in kg for vertical vibrations
M^*_{hor}	modal mass of a bridge in kg for horizontal vibrations
N_{obs}	number of heavy vehicles expected per year and per slow lane
Q_{fWk}	characteristic value of the concentrated load (wheel load) on a footbridge;
R_{T}	stress ratio (arithmetical minimum stress to maximum stress of a particular stress cycle) in timber design
T_{lf}	design service life of the structure expressed in years
C_{E}	atmospheric exposure category
CL	comfort level according

C_R	resistance class for metal fastener or connector made of carbon steel to corrosion
R_T	stress ratio (arithmetical minimum stress to maximum stress of a particular stress cycle) in timber design
S_δ	seismic action index
T_E	timber exposure category according
T_{R3}	timber resistance class according
TC	traffic class according
$T_{N,max}$	maximum uniform bridge temperature component
T_{max}	maximum air temperature in the shade with an annual probability of exceedance of 0,02
$T_{N,min}$	minimum uniform bridge temperature component
T_{min}	minimum air temperature in the shade with an annual probability of exceedance of 0,02

3.2.2 Latin lower case letters

$a_{hor,1}$	horizontal acceleration caused by 1 person crossing the bridge
$a_{hor,n}$	horizontal acceleration caused by n persons crossing the bridge
$a_{lim,horizontal}$	limiting horizontal acceleration
$a_{lim,vertical}$	limiting vertical acceleration
$a_{vert,1}$	vertical acceleration caused by 1 person crossing the bridge
$a_{vert,n}$	vertical acceleration caused by n persons crossing the bridge
b	minimum cross sectional width between exposed surfaces
b_{ef}	effective width / breadth
b_{mean}	mean value of the width of the cross section
b_w	width of the loaded area on the contact surface of the pavement;
$b_{w,system}$	width based on timber deck system
r	radius
$c_{min,dur}$	minimum concrete cover for durability of steel reinforcement
c_{nom}	nominal concrete cover to the reinforcement
d	diameter of a fastener, reinforcing steel or rebar; density of pedestrians [P/m ²]
d_{eg}	effective displacement due to spatial variation
d_{es}	effective seismic displacement of bearing due to structural deformation
d_{Ed}	design value of displacement in seismic design situation
d_E	design seismic displacement
d_G	long-term displacement due to permanent and quasi-permanent actions
d_T	displacement due to thermal movements
e	effective inner cantilever of the timber cross section
f_{hor}	horizontal / lateral fundamental natural frequency of the bridge
f_k	characteristic strength

f_{vert}	vertical and longitudinal fundamental natural frequency of the bridge
$k_{\text{def,comp}}$	deformation factor in the timber-concrete composite (TCC)
$k_{\text{def,M}}$	final deformation factor of timber
k_{fat}	factor representing the reduction of fatigue strength with number of load cycles
k_n	factor for pedestrians on the loaded surface, depending on the traffic class
k_{mat}	factor accounting for the material behaviour and degree of compressive deformation perpendicular to grain
k_{sys}	system strength factor
$l_{c,90}$	<i>compressed length parallel to grain</i>
l_{ov}	minimum overlap length
l_m	minimum length of bearing for safe transmission of force
m	mass per unit length
mc	moisture content [%]
mc_{max}	maximum moisture content per year in [%]
mc_{min}	minimum moisture content per year in [%]
mc_{use}	expected moisture content in use
n	number of pedestrians on the loaded surface, depending of the traffic class TC
q	behaviour factor in horizontal direction in seismic areas
q_R	behaviour factor component accounting for overstrength due to the redistribution of seismic action effects in redundant structures
q_D	behaviour factor component accounting for the deformation capacity and energy dissipation capacity of a fixed based structure
q_s	behaviour factor component accounting for overstrength due to all other sources
t	thickness
t_v	thickness of wood-based wearing surface
z	distance between the centres of gravity of the cross sections

3.2.3 Greek upper case letters

Δmc	variation of yearly moisture content in [%] averaged over the cross section
$\Delta \varphi_{\text{comp},i}$	effective creep coefficient in the concrete cross section in the interval i
$\Delta k_{\text{def,comp},i}$	effective creep coefficient in the timber cross section in the interval i
Δmc	expected yearly moisture variation in [%]
$\Delta \varphi_{M,i}$	increase of the material creep coefficient of the concrete within the interval i
$\Delta \psi_i$	creep coefficient of the composite cross section
$\Delta k_{\text{def,M},i}$	increase of the material coefficient in the timber in the interval i
$\Delta T_{M,\text{heat}}$	linear temperature difference component (heating)
$\Delta T_{M,\text{cool}}$	linear temperature difference component (cooling)

$\theta_{load,2}$ angle of dispersion to the horizontal for the laminated timber deck, in degrees

3.2.4 Greek lower case letters

β	factor based on the damage consequence
γ_1	composite factor
$\gamma_{M,fat}$	material partial factor for fatigue loading
$\delta_{conc,1,1}$	flexibility of the concrete cross section
$\delta_{tim,1,1}$	flexibility of the timber cross section
ζ	ratio of critical damping to the relevant natural frequency
η_{cc}	factor to account for the difference between the undistributed compressive strength of a cylinder and the effective compressive strength that can be developed in the structural member
θ_{load}	angle of dispersion for concentrated loads
μ	coefficient of friction
μ_0	static value of coefficient of friction parallel to grain
μ_{90}	static value of coefficient of friction perpendicular to grain
$\sigma_{d,max}$	signed design maximum fatigue stress
$\sigma_{d,min}$	signed design minimum fatigue stress
φ_{comp}	effective composite creep coefficient in the concrete cross section
φ_M	final material creep coefficient of concrete
ψ	factor
ψ_0	combination factor
ψ_2	combination factor
ψ_{vert}	reduction coefficient for the critical range of natural vertical frequencies
ψ_{hor}	reduction coefficient for the critical range of first natural horizontal frequency

3.2.5 Abbreviations

BGLT	block glued glulam
CLT	cross laminated timber
DC	durability class according
FLM	Fatigue Load Model
FST	structural finger jointed timber
GLT	glued laminated timber
GLVL-C	glued laminated veneer lumber with crossband veneers
GLVL-P	glued laminated veneer lumber with parallel veneers
gr1, gr2	combination factors for footbridges
GST	glued solid timber
LVL-P	laminated veneer lumber

PLY	plywood
SC	service class
ST	structural solid wood
SWP	solid wood panel
TCC	timber-concrete composite
UC	use class

4 Basis of design

4.1 General rules

4.1.1 Basic requirements

(1) Unless otherwise stated, the design of timber bridges shall be in accordance with the general rules given in EN 1990, EN 1991 (all parts), EN 1995-1-1:—⁵ and CEN/TS 19103 and the specific design provisions for timber bridges given in this document.

(2) Durability shall be ensured during the design service life.

NOTE This document provides durability requirements suitable for protected members, which are more onerous than the durability requirements in EN 1995-1-1:—⁵ that provide a lower design service life, see 4.1.2 for design service life.

(3) Regarding durability especially for timber bridges the focus shall be on moisture content and moisture variation.

(4) Timber bridges shall be designed for fatigue for their design service life; see Clause 10.

(5) Bridges shall be designed to avoid damages from excessive deformation and deterioration during the intended service life.

(6) Timber bridges shall be executed according to EN 1995-3:—⁶.

4.1.2 Design service life

4.1.2.1 General

(1) The design service life of timber bridges T_{if} should be specified according to EN 1990:2023, 4.5.

NOTE The value of T_{if} is given in Table 4.1 (NDP) for different categories of timber structures, unless the National Annex gives different values. These values align with those provided in EN 1990:2023, Table A.2.2(NDP).

(2) Timber bridges should be designed as protected timber bridges.

NOTE A lower value of design service life can be relevant, for example, for bridges in a low consequence class where the economic consequences of replacement after a shorter design service life are agreed to be acceptable by the relevant authority or relevant parties.

Table 4.1 (NDP) — Design service lives for categories of timber bridges

	Category of timber bridges	Design service life, T_{lf} [years]
1	Protected timber bridges (including their foundations and steel tension components according to EN 1993-1-11:— ³), other civil engineering structures supporting road or railway traffic ^a	100 ^b
2	Timber bridges with the main structural members protected for a 50-year design service life ^b	50 ^b
3	Replaceable structural parts of bridges line 1 and 2 ^c	25
4	Temporary structures ^d	≤ 10
a see EN 1990:2023, Table A.2.2 (NDP) footnote a. b see EN 1990:2023, Table A.2.2 (NDP) footnote b. Line 2 can be relevant, for example, for bridges in a low consequence class where the economic consequences of replacement after a shorter design service life are agreed to be acceptable by the relevant authority, or where not specified, agreed for a specific project by the relevant parties, for bridges in another building and noise barriers on bridges with walls made of timber elements c A value of 25 years may be given for replaceable structures or parts of structures as well. The protection of steel elements against corrosion should fulfil the design service life. Steel tension components according EN 1993-1-11:—³ shall be designed with a design service life of 100 years (see 4.1.2.2), even if they should be replaceable. Ancillary structures should be classified as replaceable parts of the main structure. d see EN 1990:2023, Table A.2.2 (NDP) footnote c. Unprotected timber members should be classified as temporary structures. For timber with a high durability class see 6.1.2 (6).		

4.1.2.2 Protected timber bridges

(1) The main members shall be designed in accordance with the rules given in Clause 6 for protected timber bridges.

NOTE Design service life of 100 years; see line 1 in Table 4.1.

(2) Members that cannot be replaced or can only be replaced with considerable effort and expense, such as main beams, and members not accessible for inspection and cleaning, shall be designed for a design service life of 100 years.

(3) Protected members may typically be assigned to Service Class (SC) 2 and Use Class (UC) 2.

4.1.2.3 Timber bridges protected for a 50-year design service life

(1) For timber bridges with a 50-year design service life the relevant parties shall agree to deviate from the recommendations for protected bridges.

NOTE See line 2 in Table 4.1.

(2) For a 50-year design service life, the durability requirements of EN 1995-1-1:—⁵ should be applied; this includes deviating from the requirements in 4.1.2.2 regarding

- thickness of sheeting
- protection/penetration of main structural members with preservative treatment
- protection of fasteners, connectors and other steel elements from corrosion (50-year values [in squared brackets] in Table 6.2 may be used).

(3) Regional and local conditions can allow simpler protection if proven sufficient, or where necessary, can otherwise be proven to raise requirements.

(4) Replaceable and ancillary structures or parts of structure that are designed to be replaceable easily shall be classified as replaceable parts with a minimum design service life of 25 years (line 3 of Table 4.1).

4.1.2.4 Replaceable structures or parts of structure

(1) According to EN 1990, structural parts, and elements other than structural, that cannot be designed to achieve the design service life of a bridge should be replaceable, see EN 1990.

NOTE 1 Examples of replaceable structural parts and elements are given in EN 1990:2023, 4.5.

NOTE 2 Requirement on replaceable parts, see EN 1990:2023, A.2.3 (2).

(2) Ancillary structural elements of timber bridges (e.g. railings, planks) that are designed to be replaceable shall be classified as replaceable parts.

NOTE 1 Minimum design service life of 25 years; see line 3 in Table 4.1.

NOTE 2 This includes elements for a protected bridge.

(3) Replaceable structures or parts of structures may be installed without weather protection, provided that materials with a higher durability are used.

4.1.2.5 Temporary structures and unprotected timber members

(1) A lower design service life may be used for

- temporary structures, and
- unprotected timber bridges.

NOTE Minimum design service life of 10 years; see line 4 in Table 4.1.

4.1.3 Robustness

(1) The requirements for robustness given in EN 1990 should apply.

NOTE See EN 1990:2023, 4.4.

(2) Minimum dimensions of structural timber members should be considered as given in Table 4.2.

NOTE The basis of the minimum dimensions given in Table 4.2 are to achieve structural integrity over the design service life, for durability, and for practical robustness of the elements during construction.

Table 4.2 — Minimum dimensions of structural timber members for timber bridges

	Structural members	Smallest cross sectional Dimension [mm]	Smallest cross sectional Area [mm ²]
1	Main members made of structural solid wood (strength class < D50), glulam, block glued glulam, cross laminated timber (CLT), glued laminated veneer lumber (GLVL) or glued solid timber (with the exception of trussed girders and beams in timber decks)	115	23 000
2	Members made of plywood or laminated veneer lumber (LVL)	90	20 000
3	Single-section bars	40	4 800
4	Individual sections of built-up members	30	3 600
5	Gusset plates and fishing plates as well as webs made of plywood (with a minimum of five layers)	12	a)
6	Load bearing pavement made of a single layer of solid wood	30 ^{b)}	-
7	Load bearing pavement made of wood-based panels (plywood, LVL and GLVL)	20	-
a Minimum thickness of gusset plates and fishing plates: 120 mm.			
b A wearing course according to Table 6.1 should be added to this value if necessary.			

(3) Abutments and piers should be supplied with ground electrodes with sufficient capacity for installation of lightning protection or other grounding needs.

NOTE Lightning can cause significant damage to timber; see EN 1995-1-1:—⁵, 4.1.1.

4.2 Principles of limit state design

(1) All relevant design situations shall be considered, including relevant phases of erection stage.

4.3 Basic variables

4.3.1 Actions and environmental influences

4.3.1.1 General

(1) The actions to be used for the design of timber bridges should be obtained from the relevant parts of EN 1991.

(2) For pedestrian bridges a traffic band for wind action may be ignored – except EN 1991-1-4:—⁹, Table E.8 shall be considered for the construction height and the parapet.

NOTE See EN 1991-1-4:—⁹, E.6.2.1 (5)

⁹ Under development

(3) For pedestrian bridges wind actions should not be combined with traffic loads ($gr1$, $gr2$ and F_{wk}).

NOTE In the case of a combination of wind action and traffic loads, the combination factor for wind loads according to EN 1990:2023, A.2.6.5, is therefore set to $\psi_0 = 0,1$ except CC3, unless the National Annex gives no different assignments for use in a country.

(4) For pedestrian bridges forces on the top of the pedestrian parapet as given in EN 1991-2:—¹⁰6.8 (3) should only be considered locally and not on the global model.

(5) For pedestrian bridges Q_{fwk} as given in EN 1991-2:—¹⁰ may be considered as covering horse hoofbeat where relevant.

(6) Unless more precise values are available, the moisture variation for bridges made of TCC elements may be determined according to CEN/TS 19103.

NOTE General approaches see E.3.2 (2), valid for “all” situations.

4.3.1.2 Moisture content

(1) It shall be ensured that the equilibrium moisture content mc measured according to EN 13183-2 does not exceed 24 %.

NOTE 1 A biological attack can start from a locally higher area, e.g. a higher near-surface moisture content or from moisture concentrations at joints or fissures. Therefore, the given limit value can be linked to a SC 3 and covers the uncertainty of measuring the part of the timber member having the highest moisture content.

NOTE 2 An infestation with wood-destructive fungi (a fungal attack) occurs only above the fibre saturation (wood moisture content of 23 % to 25 % (oak) or 28 % to 32 % (others)). The recommended limit of 20 % equilibrium moisture therefore includes a safety margin.

4.3.1.3 Load-duration classes

(1) Load duration classes on variable actions due to the passage of vehicular and pedestrian traffic as well as changes in temperature shall be specified.

NOTE Table 4.3 (NDP) provides examples of loading for each load-duration class unless the National Annex gives different values.

Table 4.3 (NDP) — Load-duration classes and examples of load-duration assignment

Examples of loading	Load-duration class	Order of accumulated duration of characteristic load
differential settlements	Permanent	more than 10 years
moisture variations temperature (uniform)	Medium-term	1 week – 6 months
traffic loads temperature (gradient variation) initial prestressing forces perpendicular to the grain	Short-term	less than 1 week

(2) Swelling and shrinkage perpendicular to the grain shall be considered.

¹⁰ Under preparation. Stage at the time of publication: FprEN 1991-2:2023.

(3) Changes in length due to changes of moisture content and temperature may be neglected except in TCC bridges.

NOTE For dimensional changes due to changes of moisture content and temperature see Annex E.

(4) For TCC bridges, if moisture movement is delayed and members are designed as protected members, quasi-constant environmental conditions may be assumed.

NOTE 1 The simplification of 7.2 (2) is introduced for additional boundary conditions.

NOTE 2 For quasi-constant environmental conditions, see CEN/TS 19103:2021, 5.1.

4.3.1.4 Service Classes (SC)

(1) Protected members should be assigned to service class SC 2 according to EN 1995-1-1:—⁵.

NOTE 1 Service class SC 2 is characterized by a measured equilibrium moisture content of $mc \leq 20$ %. In case of accumulated time up to three months per year, mc value can be higher, see 6.1.2.

NOTE 2 The requirements in 6.2 and 6.1.3 ensure SC 2.

(2) Unprotected structural members shall be within the limits of service class SC 3. Considering fibre saturation, the moisture content should be $mc \leq 24$ %.

NOTE An equilibrium moisture content of $mc \leq 24$ % can be reached by runoff water and no accumulation of water.

4.3.2 Seismic design - Ductile behaviour

(1) EN 1998-2:—⁸ shall be applied for timber bridges in seismic areas.

NOTE The Informative Annex C in this document provides supplementary information to EN 1998-2:—⁸, Annex C, regarding bearings in seismic areas and timber bridges under low seismic action.

4.4 Verification by the partial factor method

(1) The rules on design values of actions and the design values of material properties shall be in accordance with EN 1995-1-1:—⁵.

5 Materials

5.1 Timber

(1) Depending on the applicability in the respective service and use class, the following materials may be used for structural members:

- structural solid wood (ST-c, ST-d);
- structural finger jointed timber (FST);
- glued solid timber (GST);
- glued laminated timber (GLT-c, GLT-d);
- block glued glulam (BGLT);
- solid wood panel (SWP);