27. Internationalen Holzbau-Forum (IHF) 2023

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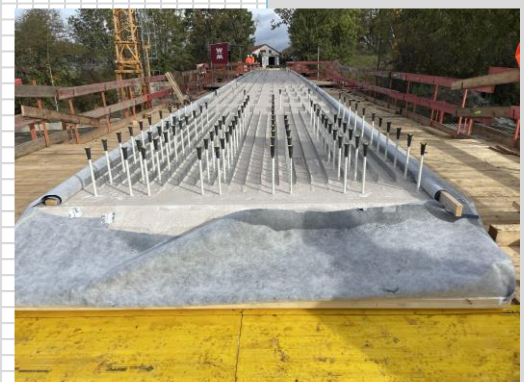
Der neue Eurocode 5-2 Holzbrücken – Änderungen und Neuerungen



The new Eurocode 5 – Part 2: Timber Bridges – Changes and innovations

prEN 1995-2: 2023-08

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1 Entstehung der neuen europäischen Normenreihe EN 1995 Holzbau

1951 Montanunion

↓

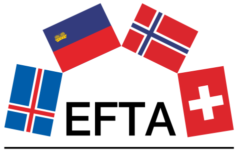
1969 Versuch: Wirtschafts- und Währungsunion

↓

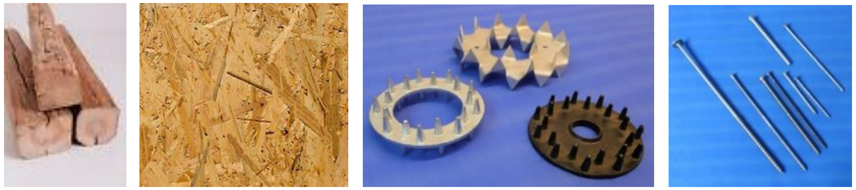
1993 Europäische Union (EU)

Ziel zusammen mit

Europäischer Freihandelszone



u.a. Ermöglichung freier Warenverkehr - u.a. von Bauprodukten

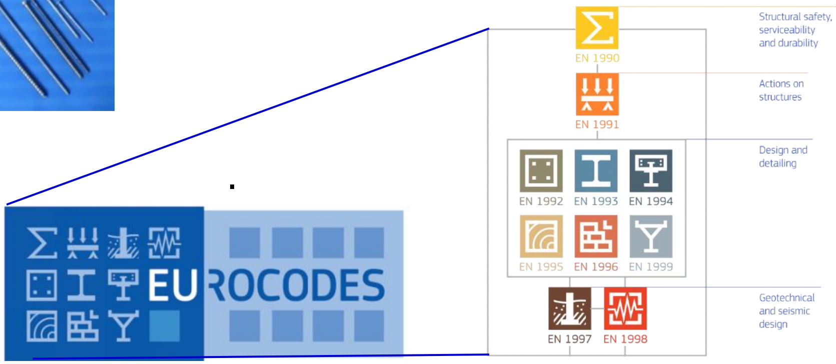


→ Harmonisierung Produkt- + Bemessungsnormen

1. Eurocode-Generation 2005 - 2010

2. Eurocode-Generation seit 2015

Normungsarbeit erfolgt über **CEN**
(Comité Européen de Normalisation;
European Committee for Standardisation;
Europäische Komitee für Normung)



Europäische Bemessungsnormen – Eurocodes
Quelle: Europäische Kommission, 2021

1 Einleitung: 2. Eurocode-Generation

Stark unterschiedliche Entwicklungen innerhalb Europas

Angelsachsen (u.a. Großbritannien)

- BS + Normen kennen kaum Zeichnungen
- Fast alles verbal beschrieben
- Dicke Standards

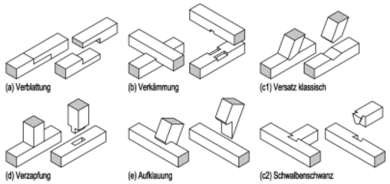
Nordeuropa (Skandinavien)


- größte Waldbesitzer Europas
- Holz wird geschält, in Kleinstücke aufgetrennt
- Kleinstücke werden mit Leim/Kleber zu Bauprodukten (z.B. LVL, TJI)
- Einsatz chemischer Holzschutzmittel (z.B. Creosot) oder Kupfer

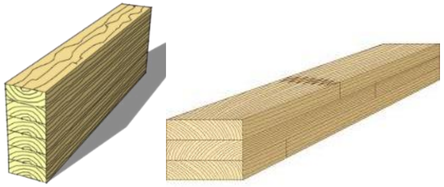


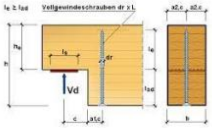
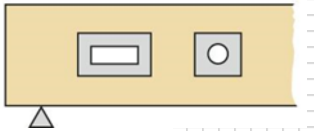
Mitteleuropa (insbesondere D-A-CH-Staaten)

- stark ausgeprägte Zimmermannskunst (eigenes Ausbildungs- und Fortbildungswesen); Verwendung Vollholz entsprechend Abmessungen im Bauwerk
- 1906 Patent Otto Hetzer → heute ‚Brettschichtholz' Stamm wird in ca. 45 mm dicke Bretter aufgetrennt, über Keilzinkung zum Endlosbrett verbunden, anschließend auf Länge abgeschnitten
- Entwicklung zugehöriger Verbindungstechniken (Kleben, Stabdübel, Ausklinkungen, Durchbrüche)



Südeuropa (Mittelmeer-Anrainerstaaten)

- Überwiegend reiner Mauerwerksbau
- Zimmermannsmäßige Bauweise nur in Südtirol
- Andere Holzarten (Pappel, Eukalyptus)

2. Generation der Eurocodes 5:2027

- Hauptziel 1: Reduktion Anzahl der NDP‘s (Nationally Determined Parameters)
- Hauptziel 2: Ease of Use (klare Strukturen, Vereinfachungen, etc.)
- Ferner: Weiterentwicklung im EC 5 bestehender Regelungen
- Regionale Bauweisen wurden in die Normteile aufgenommen

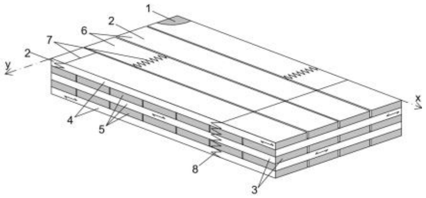
  (z.B. Moderne Zimmermannsbauweise, Durchbrüche/Ausklinkungen, Verstärkungen)

  ➔ Entfall nationaler Regelungen in den Anhängen

- Neue Materialien und Verbindungen wurden aufgenommen

  z.B. Cross-Laminated-Timber (CLT),

  Vollgewindeschraube



- Neue Entwicklungen und Bauweisen wurden aufgenommen

  z.B. Holz-Beton-Verbund

Wesentliche Änderungen im Entwurf prEN 1995-2:

Haupt-Anforderung für Brücken aller Materialien nach EC 0: Geplante Lebensdauer 100 Jahre

Verbreiterung der Bemessungsregeln (neben den für den Eurocode 5 bereits Genannten) für:

- Hauptziel 3: Ermüdung unter Verkehrslasten (u.a. → prEN 1995-1-1, 10)
- Widerstand gegen biologische Organismen (→ prEN 1995-1-1)
- Dauerhaftigkeit (einschließlich Detailierung Annex D, Abdichtungs-Systeme)
- Erhaltung und Prüfung (Anhang B)
- Holz-Beton-Verbund (TCC) – zusätzlich zum Abschnitt "Other composite members"
- Spezielle Brücken-Strukturen, z.B. Deck plates (u.a. → prEN 1995-1-1, Anhänge L+O), Integrale Brücken

Überarbeitung der Bemessungsregeln für:

- Schwingungen von Brücken und Dämpfung

Neue Bemessungsregeln für:

- Erdbeben-Bemessung für Holzbrücken (u.a. → prEN 1998-2, Anhang C)
- Maßliche Änderungen aufgrund von Umwelteinflüssen (Anhang E)

→ Umfang EC 5-2 voraussichtlich 84 Seiten + 10 Seiten NA(D) > ca. 32 Seiten + 20 Seiten NA (D);

dafür aber viele neue Möglichkeiten und Detaillierungen

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Inhalt / Content prEN 1995-2 / 1

1 Einleitung: Inhalte prEN 1995-2

Inhalt / Content prEN 1995-2 / 2

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1 Einleitung: Neue Struktur der Eurocodes

Chapter number / Chapter heading	Cold-state design of timber constructions: EN 1995 -1-1:2004	Cold-state design of timber constructions: EN 1995 -1-1:2027	Fire protection design of timber constructions: EN 1995-1-2:2004	Fire protection design of timber constructions: EN 1995 -1-2:2027	Timber bridges: EN 1995 -2:2004	Timber bridges: EN 1995 -2:2027
Scope	1	1	1	1	1	1
Normative references	1	2	1	2	1	2
Terms, definitions, and symbols	1	3	1	3	1	3
Basis of design	2	4	2	4	2	4
Materials	3	5	3	5	3	5
Durability	4	6			4	6
Structural analysis	5	7			5	7
Ultimate limit states	6	8			6	8, T/□T/□mc/□T Annex E
Tabulated proofs			n.i.	6		
Simplified design methods			3,4,5	7		
More precise design methods			Annex B	8		
Design of timber constructions with natural fire curves			Annex A	Annex A		
Serviceability limit states	7	9			7	9, Annex C (only low seismic areas, bearings)
Fatigue	n.i.	10			Annex A	10
Joints and connections	8	11			8	11
Connections under fire exposure			6	8		
Composite construction elements and support structures	9	12				TCC Annex A
Roof, floor and wall diaphragm slabs	9	13				
Execution and monitoring	10	Separate document			9	Annex B – Inspection and Maintenance
Execution of details			7	10	-	Annex D (examples of structural timber preservation)
Foundation on timber piles	n.i.	14				
Oscillations caused by persons/pedestrians	7	9			Annex B	9 (incl. traffic)
Legend: n.i. = not included						

Structural comparison of the codes EN 1995:2004 and 2027

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1 Einleitung: Verb-formen, NDP's

Drafting work – Use of verbal forms according to CEN-rules:

shall	muss	requirement strictly to be followed ➔ ()P principle
should	sollte	recommendation (highly);
		alternative approach where technically justified
may	darf/möglich	permission within the limits of Eurocodes
		only a few mays in the code, because it is no textbook
can	kann	possibility and capability ➔ only in NOTEs

… coloured images and flowcharts are allowed in Standards.

Reduction number of National Determined Parameters (NDPs)

No.	Clause in EN 1995-2:2004	Corresponding clause in prEN 1995-2	Parameter	Recommended value	Category of NDP	Status	Comment
			e.g. characteristic values of self-weight	e.g. nominal value	· Essential NDP · Other NDP	Retained Removed New	Please provide: · justification for the retention of other NDPs; · confirmation as to whether consensus has been reached on NDPs to be removed; · justification for the introduction of new NDPs.
1		4.1.2.1 Table 4.1	Design service life	nominal value	Essential NDP	New	Design service life; see prEN1990-2 Annex A2
2	2.3.1.2 (1)	4.3.1.3 Table 4.3	Load-duration classes	nominal value	Essential NDP	Retained	Load-duration assignment
3	2.4.1	Moved to prEN 1995-1-1	Characteristic material values	nominal value	Essential NDP	Retained	Partial factors for material properties; all factors should be mentioned in EN 1995-1-1
4	7.2.	9.2 Table 9.1	Limiting values for deflection	nominal value	Essential NDP	Retained	Limiting values for deflection
5	7.3.1 (2)	10.4 Table 10.1	Values of damping ratios	nominal value	Essential NDP	Retained	Damping ratios
6	Annex A (informative) Fatigue verification				· Other NDP	Removed	Moved to normative text
7	Annex B (informative) Vibrations caused by pedestrians				· Other NDP	Removed	Moved to normative text
8		Annex B	Annex B (informative) Inspection and maintenance of timber bridges	recommended guidance	· Other NDP	New	New content
~~9~~		~~Annex B.4(2)~~	~~Frequency of inspection~~	~~nominal value~~	~~· Other NDP~~	~~New~~	~~New content~~
10		Annex C	Annex C (informative): Additional Information on Timber Bridges under Seismic Loads	recommended guidance	· Other NDP	New	New content
11		Annex D	Annex D (informative): Examples for Detailing	recommended guidance	· Other NDP	New	New content, variations in building tradition
12		Annex E	Annex E (informative): Dimensional Changes due to environmental effects	recommended guidance	· Other NDP	New	New content, variation in place of use

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2 Unterschiede zur noch gültigen EN 1995-2 - themenbezogen

2.1 Durability and Quality Management

Ich bleibe jetzt bei den engl. Originaltexten
- die vom DIN beauftragten Übersetzungen sind schlecht.
- So ergeben sich für Sie vielleicht Hinweise zur Kommentierung (ENQ).

prEN 1990

Definition **3.1.2.27**
maintenance (ge: *Instandhaltung)*
set of activities performed during the service life of the structure so that it fulfils the requirements for reliability
Note 1 to entry: Activities to restore the structure after an accidental or seismic event are normally outside the scope of maintenance.

A.2.5 Durability (ge: *Dauerhaftigkeit)*
(1) All structural parts that rely on a design assumption of inspection or maintenance in order to satisfy their durability requirements over the design service life, shall be designed to permit inspection and maintenance.
NOTE 1 See 4.6 regarding durability requirements.
NOTE 2 Inspection and maintenance is needed of structural members designed using the damage tolerant method for fatigue. Material related guidance on damage tolerant method is given in relevant material Eurocodes.
NOTE 3 Maintenance activities can include: renewal of protective coatings; renewal of replaceable structural parts or elements other than structural; cleaning; treatment of detected fatigue cracks.
(2) Where inspection or maintenance of a structural part is not possible, the structural part shall be designed to achieve adequate durability over the design service life without inspection or maintenance.
NOTE See the other Eurocodes for measures to achieve adequate durability over the design service life without inspection or maintenance, which can include: provision of sacrificial material; protection of the part; use of materials with enhanced durability; control of the environment surrounding the part.

4.8 Quality management (ge: *Qualitätsmanagement)*
(1) Appropriate quality management measures should be implemented to provide a structure that corresponds to the design requirements and assumptions.
(2) The following quality management measures should be implemented:
— organizational procedures in design, execution, use, and maintenance;
— controls at the stages of design, detailing, execution, use, and maintenance.
NOTE See Annex B and the other Eurocodes for guidance on appropriate quality management measures.

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2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

Durability and Detailing mainly subclause 6, Annex B, D

Requirements see prEN 1990 Annex A.2 Table A.2.2

Line 2 can be valid e.g. for skiing bridges, bridges in adventure parks

→

Table 4.1 (NDP) – Design Service Life for categories of timber bridges

	Category of Timber Structures	Design Service Life, T_{lf} [years]
1	Protected timber bridges (including their foundations and steel tension components according EN 1993-1-11), other civil engineering structures supporting road or railway traffic [a]	100 [b]
2	Timber bridges where 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 classification of 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 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 to be classified as replaceable parts of the main structure.

d see EN 1990:202x, Table A.2.2 (NDP) footnote c
Unprotected timber members should to be classified as temporary structures. For timber with a high durability see 6.1.2 (6).

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

To fulfill the normal requirement of a design service life of 100 years it is necessary also to give detailed information how to protect and maintain timber bridges.
The protection of timber bridges and the regular maintenance at least refer to safety – and not to execution.

Definition text 3.1.2 in the main **protected member**
structural member not exposed to direct weathering such as rain, snow or other sources of moisture ingress

Für den Anwender
gleich zu Beginn der Norm
damit er weiß wohin die Reise geht:
Terms and definitions zu protected members + bridges, unprotected m + b

Key

1 Covered footbridge (bridge with a roof)
2 Bridge with deck located at the base of the main bridge structure
3 Bridge with deck located above the main bridge structure

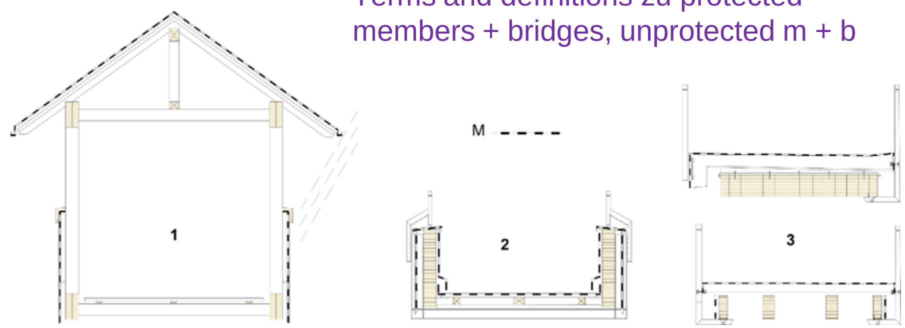

Figure 3.1 – Examples of protected bridges

Because of readability / ease of use:
Full page as example figures are given in Annex D (informative)
instead of having these figures in the main text.
Other examples can be added by national choice (NCI) to Annex D.

Annex B (informative) Inspection and Maintenance of Timber Bridges
Inspection time interval e.g. see national regulations.

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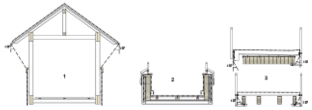
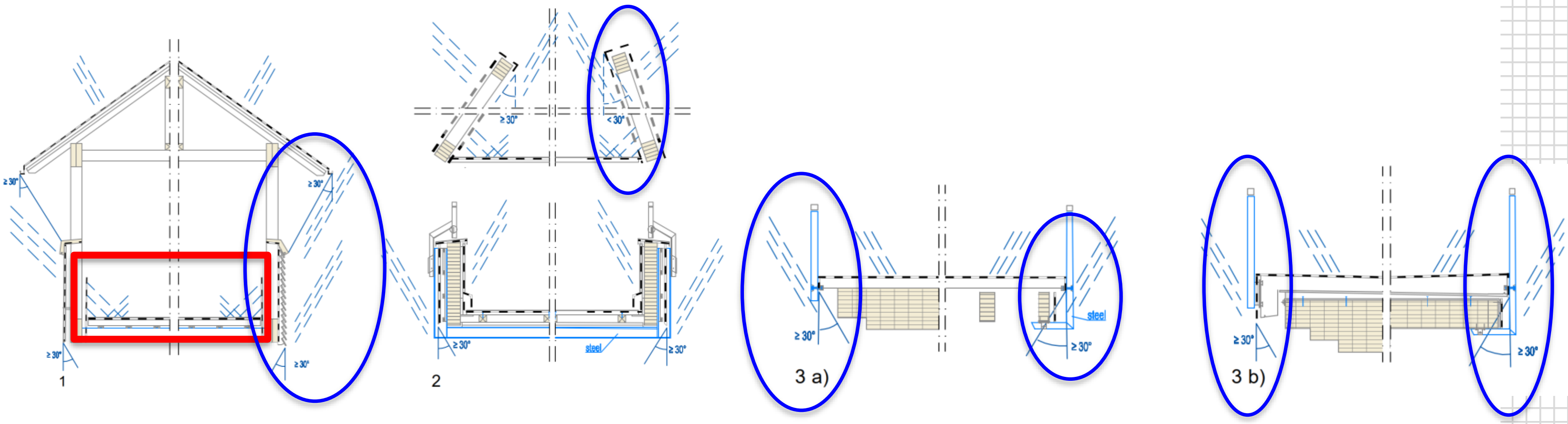
2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

Starting with Figure 3.1  more in detail:

First: The angle of windblown rain is added



Key

1 Covered road bridge (with traffic inside)
2 Arch bridge (up) and Trough bridge (down)
with deck located at the base of the main bridge structure
3 Bridge with deck located above the main bridge structure; e.g.
a) sealing system
b) timber-concrete-composite

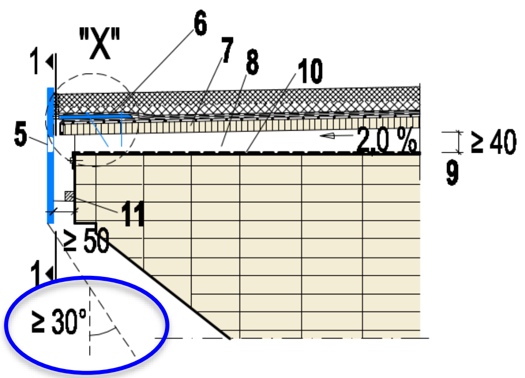
Figure D.4.1 - Examples of protected timber bridges (extension of Figure 3.1)

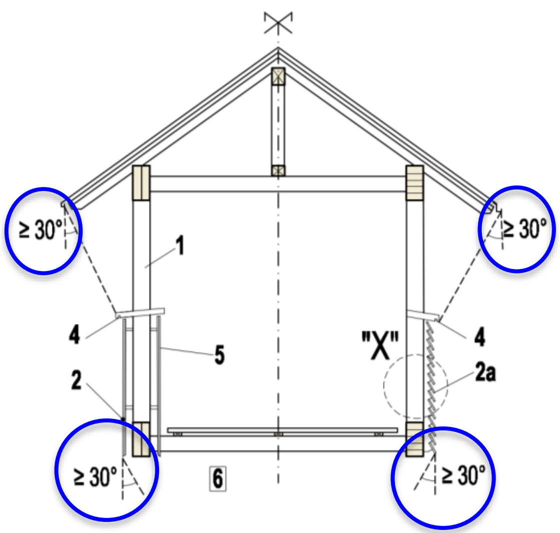
→ Detailing
Annex D
Possibilities
T- Pos 1
T- Pos 2

T- Pos 3, 4, 5

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

Example for wood protection in general: roof and claddings because of rain





Surfaces covered by an overhang and an angle of at least 30° can often be regarded as protected / may be increased in accordance with local experiences

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

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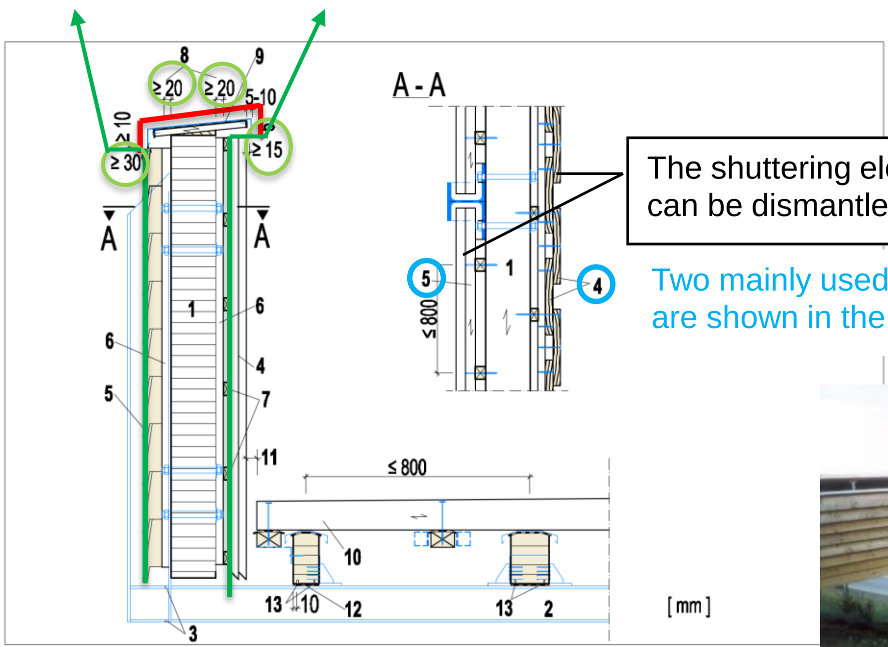
Example for wood protection in general: ventilation openings, chimney effect

No aerodynamic verification necessary if ventilation openings
- horizontal ≥ 100 cm²/m
- vertical ≥ 50 cm²/m
- minimum width 20mm

More in detail see
www.harrer.ing-net
or
www.holzbrueckenbau.com
University of applied sciences Erfurt

Chimney effect

Chimney effect



The shuttering elements / cladding can be dismantled for inspection

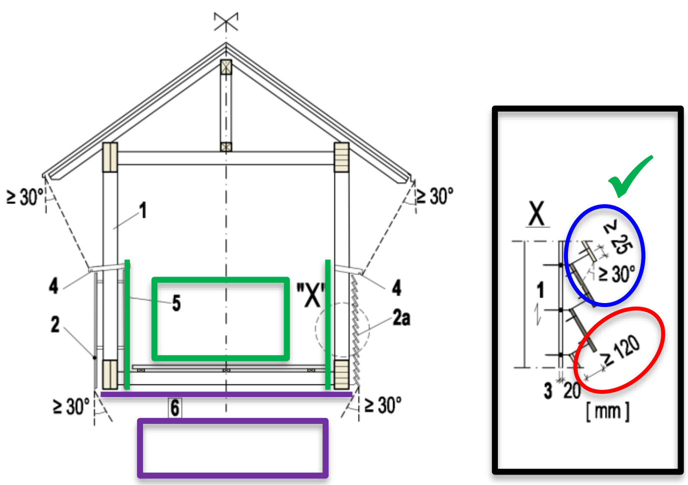
Two mainly used examples of claddings are shown in the Section A-A:

5

4

Durability: Detailing Annex D, Examples constructional wood protection more in detail

Language neutral
→ Key



Spacing of minimum 120 mm on shuttering elements can ensure possibility of inspection.

Key

…

5 For vehicle bridges, the lower chords and the truss nodes of the main girder, also need to be protected inside

6 Eventually constructional wood protection at bottom to prevent possible entry of moisture from below (e.g. over a waterfall)

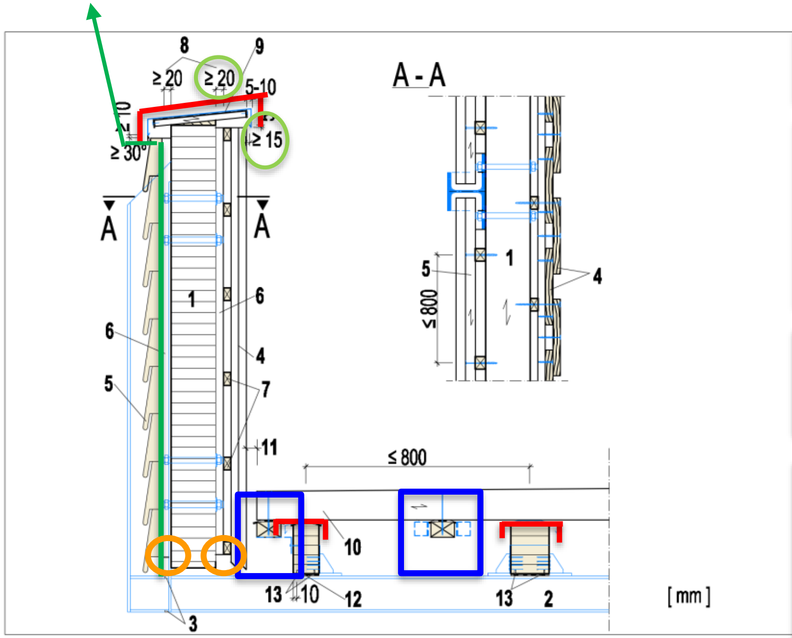
Figure D.5.1 – Detailing T-Pos 1 – Durability: constructional wood protection – Possibility 1: Covered bridge (protective roof with boarding)

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details



Ventilation openings

Chimney effect ✓



Protection of main girder on 3 surfaces.

Top protection with aluminium or titan-zinc plate extending over the wood shuttering on both sides. Place a separation layer beneath metal plate to prevent accumulation of condensation water

The shuttering elements can be dismantled for inspection. Insect meshes between cladding 4 and 5 and main girder 1.

Fixing the deck in horizontal direction to the longitudinal beam of the footpath and at the bearing of the superstructure.
Lifting forces at the end shall be considered.

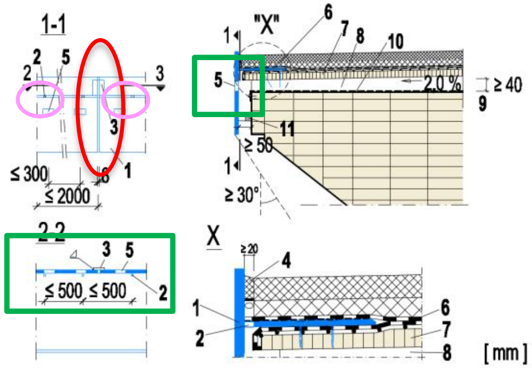
Figure D.5.2 – Detailing T-Pos 2 – Durability: constructional wood protection – Possibility 2: Covered bridge – weather protection of trough bridge

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

Table B.1 – Expected design service lives T_{lf} for sealing systems

	Sealing system	Design Service Life, T_{lf} [years]
a	Sealant membrane and its protective layer	25 - 30
b	Wearing surface made of e.g. mastic asphalt	25
c	Timber planking with a Durability Class DC 1 or DC 2	25
d	Timber planking used as wearing surface	15

Figure 6.1 – Example of a sealing system with mastic asphalt



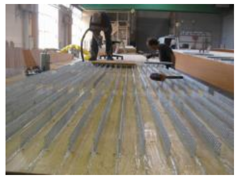
Spacing of bituminous expansion joint normally every 50 m.
The fringe angle has to be lapped at a minimum of 4 m intervals.

A monitoring system for surveillance and early warning of leakages in the sealing surface should be installed – especially if there are no horizontal ventilation and inspection openings.

Blistering may be avoided by limiting the maximum thickness of the protection layer to 25 mm.
Wearing boards can be provided on bridges with wooden pavements. Arrangement of bridge drains *(see T – Trans 1)* can be necessary.

Figure D.5.3– Detailing T-Pos 3 – Durability: constructional wood protection – Possibility 3: Closed road surface: sealing system

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

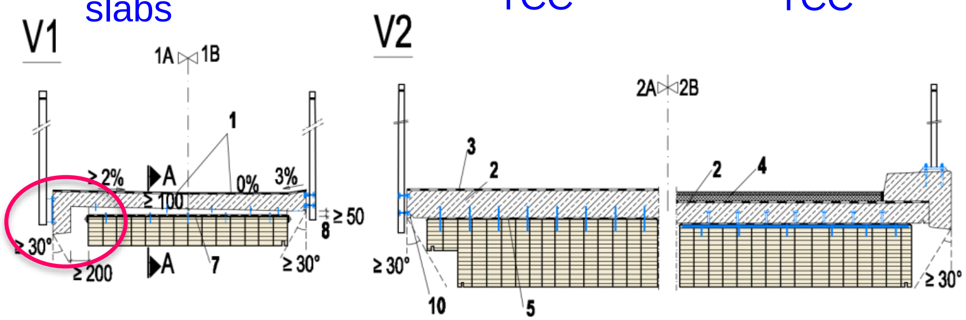


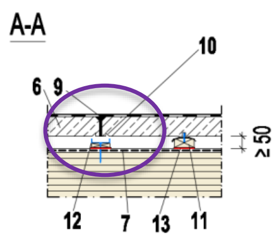
prefabricated concrete or natural stone slabs

TCC

TCC

TCC with notches; integral abutments





Key

...

12 Gutter with incline under

9 Bitumen grouting

[mm]

Beside the Key three NOTEs are given:

A lateral concrete apron makes building control more difficult.

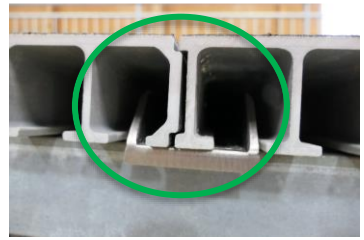
Fixing of concrete slabs over sideways attatched angles is benefical.

Guard rail, kerb respectively impact protection, and pavement surface on road bridges, refer to national regulations.

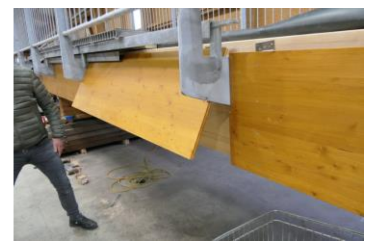
Figure D.5.4 – Detailing T-Pos 4 – Durability: constructional wood protection – Possibility 4: Closed raod surface: reinforced concrte-plates

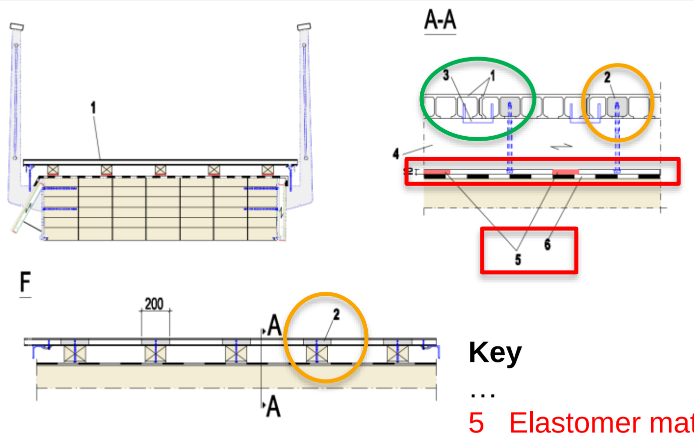
2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details







Key

…

5 Elastomer mat upwards of

6 Permeable protection layer

Beside the Key 2 NOTEs are given:

If GRP-boards with a click system are used, no transverse through under every joint (see Section A-A) is needed.

There should be minimum two clampings per plank.

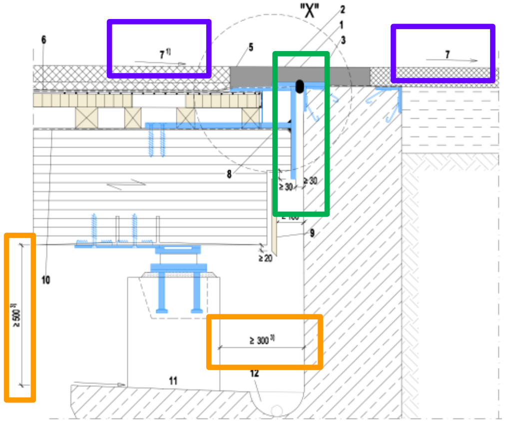
Figure D.5.5 – Detailing T-Pos 5 – Durability: constructional wood protection – Possibility 5: Road surface: Glass fibre reinforced plastic (GRP) board

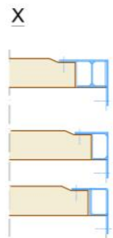
2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

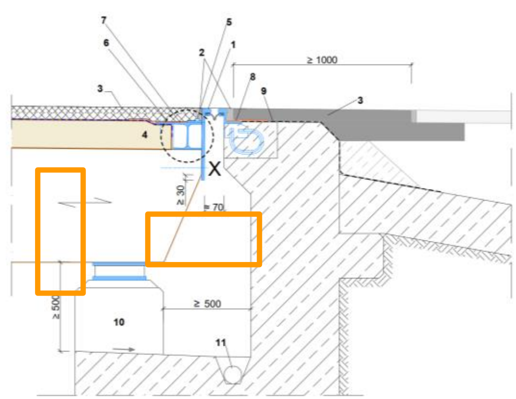
Durability: Detailing Annex D, Examples wood protection on the boundaries of the superstructure

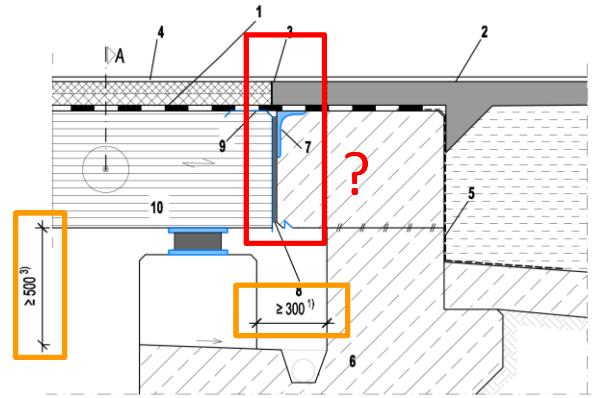
Longitudinal and transverse direction shall lead to an inclination of minimum 2 % at all places.

The clearance between support and abutment shall allow for inspection. Clearance of working space means that the distance between bearing and abutment should be wide enough for inspection.

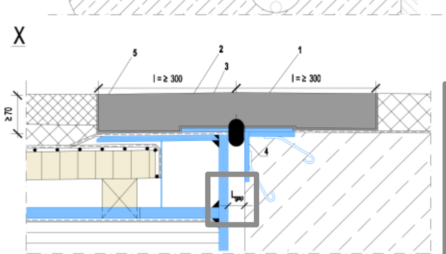








Die Abdichtung mit Asphalt kann durch Rotation zwischen Brücke und Widerlager reißen.



The following value of gap sizing L_{gap} shall be considered:
+ 25 mm extension, and
−12,2 mm compression from vertical displacement

Figure D.5.6 to 5.8 – Detailing T-Trans 1 to 3 – Durability: Transition joint –

5.6 **Closed solution with mastic asphalt - Sliding bearing** (Solution 1)
5.7 **Solution timber bridges with joint - Sliding bearing** (Solution 2)
5.8 **Solution timber bridges with mastic asphalt – Fixed bearing** (Solution 3)

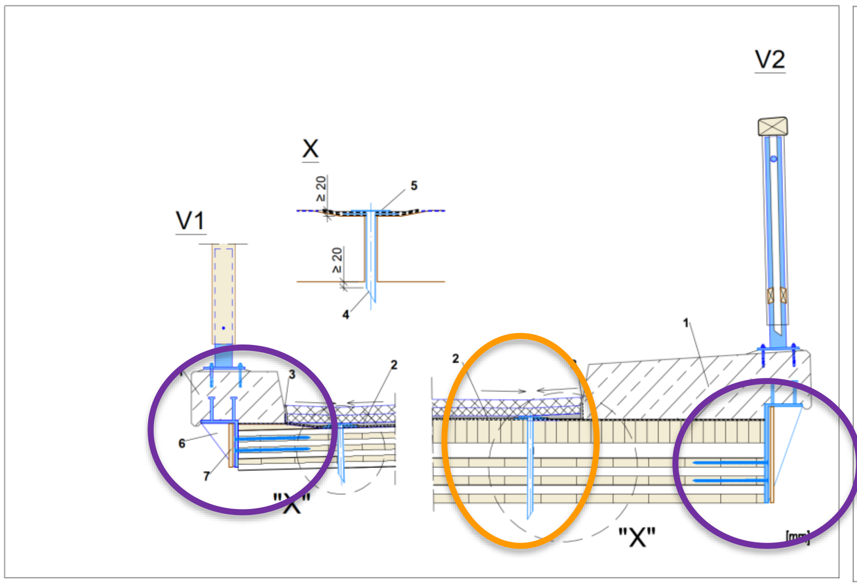
2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

Beside the Key the following NOTEs are given:

The kerb should be connected to the bridge by means of shear connectors.

The guard rail post shall be designed as a week link of an impact (predetermined breaking spot).

Longitudinal and transverse slopes shall be in accordance with the drainage concept.



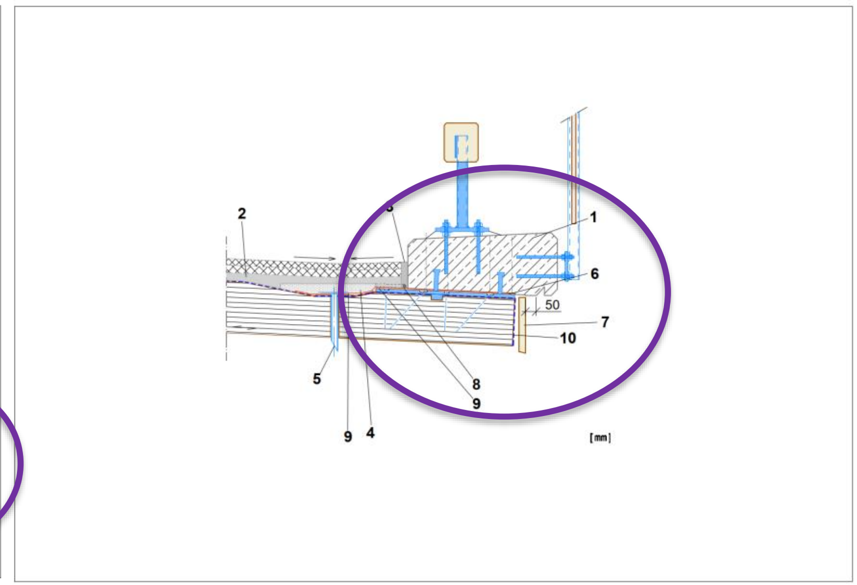


Figure D.5.9 / 5.10 – Detailing T-Kerb 1 / 2 – Durability: Edge sealing system on timber deck slab with concrete kerb - Solution 1 / Solution 2

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit; Details

Harrer Ingenieure

Durability aspects

Protection is about good design practice.
The code covers subjects such as:

- Standing water
- Run off and splashing water
- Inclination
- Distance to ground and flowing water
- Sealing
- Corrosion

Partly requirements; partly informative through drawings (Annex D)

Important constructive wood protection measures:

- keep away rainfall or derive quickly water
- avoid moisture permeation from flanking materials / elements
- avoid condensation (e.g. in box cross sections)
- protect during transportation, storage and erection
- Good assorting of timber
- Regularly maintenance and care, possibly monitoring

A technical group from CEN/TC 124/WG 4 and members SC5 brought in their work on

"Protection of steel components against corrosion" regarding FprEN 14592:2018

- Service classes (EN 1995-1-1)
- Resistance to corrosion / Fasteners (EN 1995-1-1, 6.3 / 11)
- Steel parts other than fasteners (EN 1993-1-4 and EN 1993-2)
- Timber corrosivity classes TC1 – TC5 (FprEN 14592:2019-03)
- Atmospheric corrosivity classes C1 – C5 (FprEN 14592:2019-03)
- Corrosion protection EN ISO 2081

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit: Korrosionsschutz

prEN 1995-2

Table 6.2 —
Timber exposure categories T_E
and
Atmospheric exposure categories C_E

with examples of minimum requirement for thicknesses for pure zinc coating, hot-dipped galvanized coating and types of stainless steels

for bridges (outdoor)

with a design service life of 100 years [50years]

Situation	Timber exposure category [a] T_E	Service class SC	Atmos-pheric exposure category [b] C_E	Typical atmospheric exposure [c] (informative)	Examples of minimum: zinc thickness	Examples of minimum: stainless steel grade (type) [d]
Protected outdoor with access of pollution	T_E3	SC3	C_E2	L_{sea} > 10 km L_{street} > 100 m and/or low polluted area (< 5 µg/m³ of SO_2)	C_R2: 40 µm [e] (n.a. [f] if T_E4) [20 µm [e]] (55 µm if T_E4)]	CRC II (e.g. 1.4301)
	T_E3/T_E4	SC3	C_E3	10 km > L_{sea} > 3 km 100 m > L_{street} > 10 m and/or medium polluted area (5 µg/m³ ≤ SO_2 ≤ 30 µm/m³)	C_R3: 110 µm [80 µm]	CRC III (e.g. 1.4401)
	T_E3/T_E4	SC3	C_E4	3 km > L_{sea} > 0,25 km L_{street} < 10 m and/or high polluted area (30 µg/m³ < SO_2 ≤ 90 µm/m³)	C_R4: n.a. [f] [110 µm]	CRC III (e.g. 1.4401)
	T_E3/T_E4	SC3	C_E5	L_{sea} < 0,25 km and/or very high polluted area (90 µg/m³ < SO_2)	C_R5: n.a. [f] [n.a. [f]]	CRC III (e.g. 1.4529)
Permanent in contact with ground or fresh-water [c]	T_E5	SC4	n.a. [f]		C_R5: n.a. [f] [n.a. [f]]	CRC III to CRC V

a) Timber exposure categories T_E3, T_E4 and T_E5 according EN 1995-1-1:202x, Table 6.1

b) Atmospheric exposure categories C_E3, C_E4 and C_E5 according EN 1995-1-1:202x, Table 6.2 and 6.3

c) The specified values for SO_2 are references values only and may vary.

L_{sea} indicates distance from the sea. The actual exposure depends on the prevailing wind direction and the topography of the coast to saltwater seas e.g. Atlantic Ocean, North Sea, Baltic Sea, Mediterranean See, Black Sea, Irish Sea

L_{street} indicates distance from roads with heavy traffic with de-icing salt

For T_E5/SC4 in case of seawater each case should evaluated individually.

d) Minimum corrosion resistance class for stainless steel grade shall be determined in accordance with EN 1993-1-4:2006/A1:2015

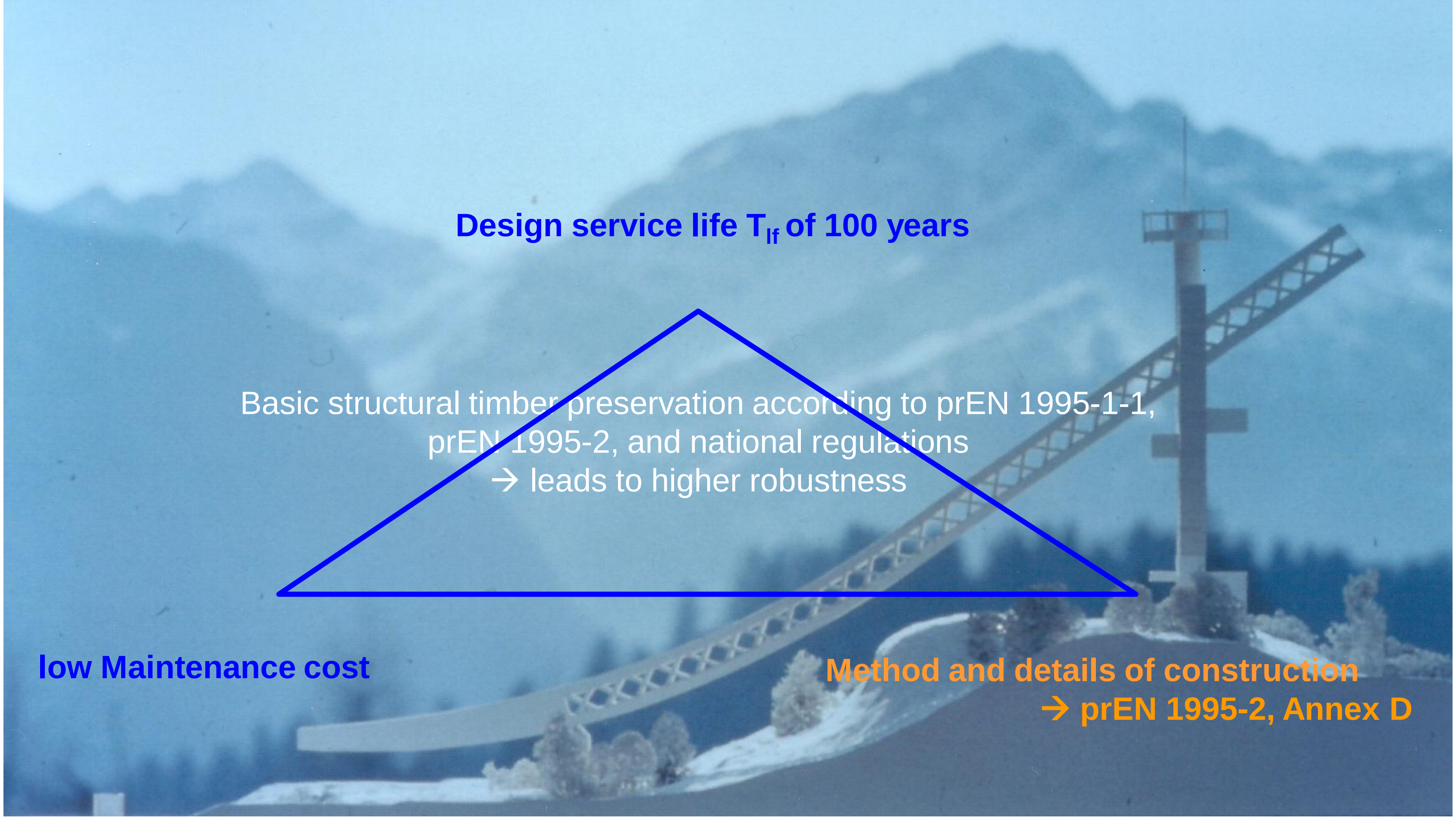
e) CRC III passivation may allow the reduction of zinc thickness by 25 % and CRC VI passivation by 50 %

f) not applicable

2.1 Dauerhaftigkeit, Robustheit, Nachhaltigkeit, Details

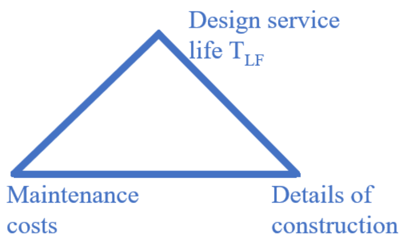
Durability and thus sustainability ensure the economic viability of timber structures.

Therefore, the following so called „magic trinagle“ must be observed:



2.2 Inspection and maintenance

- Inspection is needed for ensuring the integrity of the bridges
- Design determines the accessibility
- Design determines the replacabitly of parts



Requirements are more functional than specific, but they are clearly stated

Minimum inspection measurements having every time on board

2.2 Prüfung und Unterhaltung: Monitoring

Harrer Ingenieure

Moisture and Temperature measurement

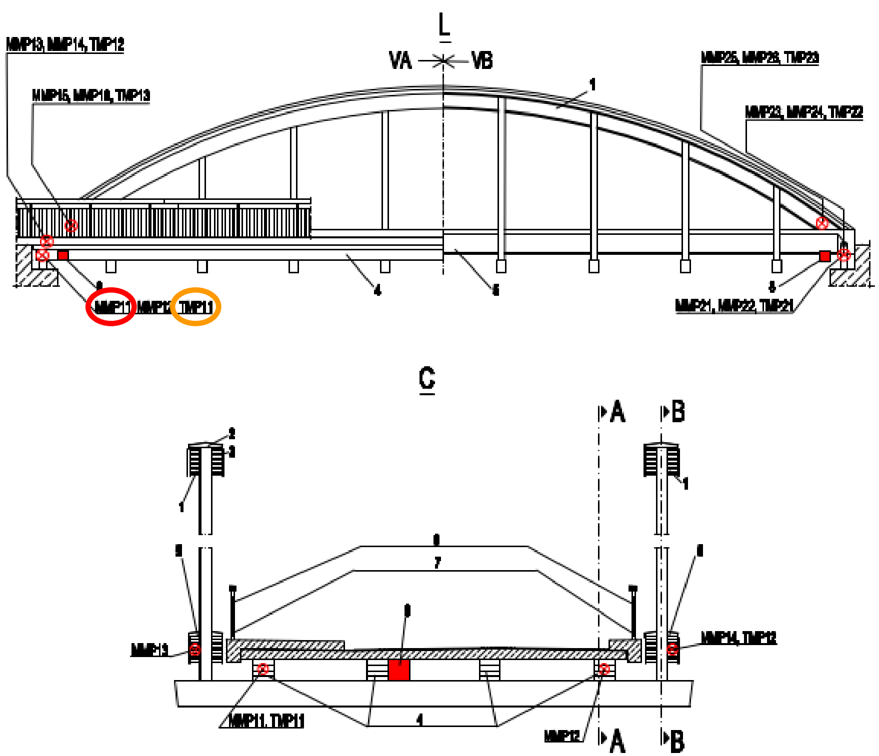


Table D.1 – Components of an arch road bridge (example)

Component	Use class (UC) [Service class (SC)]	Protective measure	Wood type	Durability Class (DC)
	EN 335 [EN 1995-1-1]	EN 1995-2 Sample drawings	EN 13556	EN 350 Table B.1
Longitudinal Beam	2[2]	Weather protection through roadway slab and planking and transition 1, protection of the edges (grain-cut timber), protection against insect attack through technical drying, visibility and control of insect infestation	Spruce as glulam	4
Arch truss / pliers beam	2[2]	Weather protection by cladding and shuttering, protection against insects by technical drying and insect protection grid, visual inspection every 6 years by removal of claddings	Spruce as glulam	4
Railing	Vertical: 3.1 [3] Horizontal: 3.2 [3]	None, maintenance Component	European larch	3

Figure D.6.1 – Detailing T-Mon – Moisture Monitoring – Example arch truss (timber bridge) – Use classes UC

2.2 Prüfung und Unterhaltung

Geschützt bauen heißt

sich in der **Nutzungsklasse (NKl) / Service Class (SC) 2** zu bewegen.

Die maximale Holzfeuchte in der SC 2 ist definiert mit $mc_{max} \leq 20$ % - warum?

… or the limit given in 6.2.2.1(1), the uncertainty of measuring the highest moisture content in a member and the tolerances of moisture meters have been taken into account.

(d.h. Sicherheitsmarge)

Der Entwurf der prEN 1995-1-1 lässt aber für SC 2 jahreszeitlich bedingte, kurzzeitige Schwankungen zu:

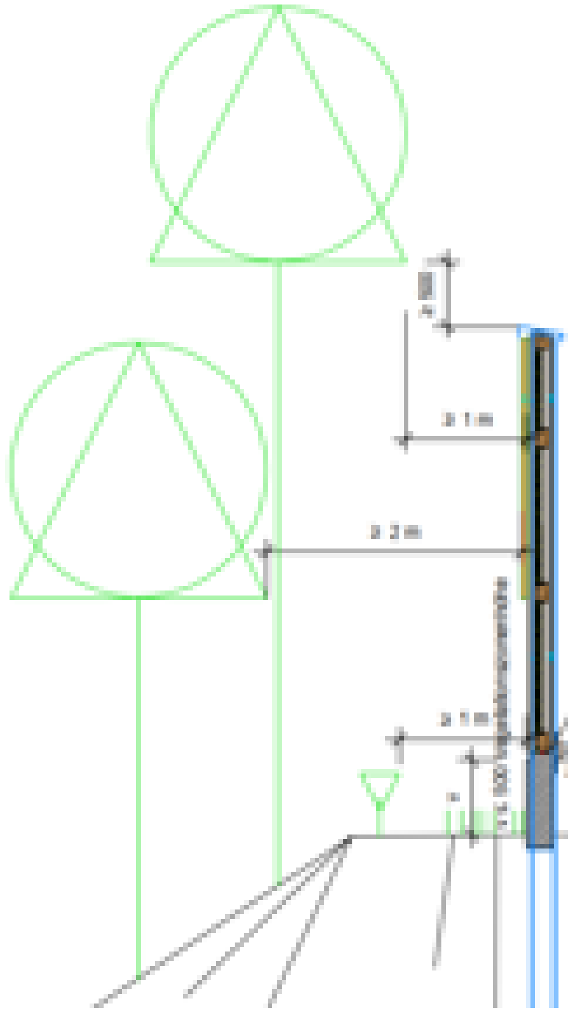
There will typically be no reduction of strength and stiffness by wood-destroying fungi if moisture content exceeds fibre saturation (24 % and 32 % moisture content) for several days for up to three months per year. ... .

Unschädlich aufgrund Fasersättigungspunkt und

Austrocknungsmöglichkeit bei stärkerer Befeuchtung von nur wenigen Tagen

Maintenance: Quality management

Notes regarding Vegetation:
- fixing the terrain up to a distance of at least 0,5 m. This implies the consistent cutting the green and the systematic removal of weds.
- minimum distance of 2 m from tree crowns and great bushes



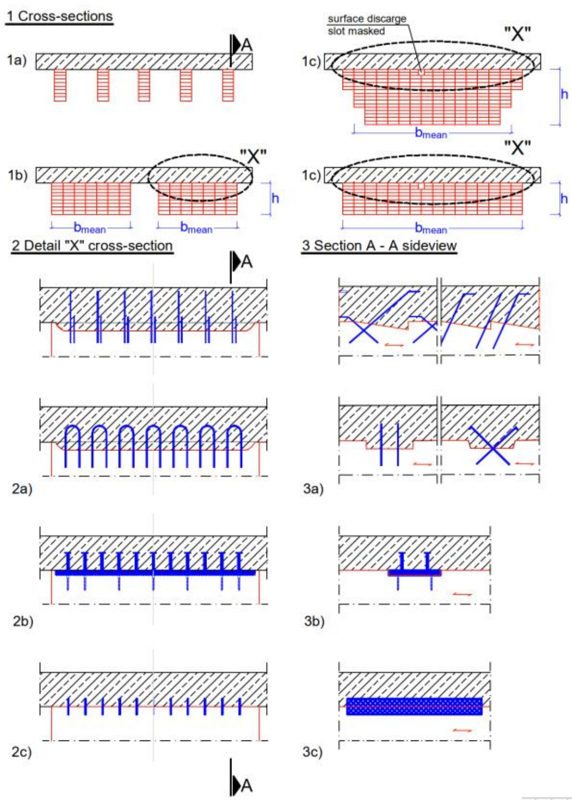
2.3 Timber-Concrete-Composites (TCC)

all subclauses

Structure of the code / ease of use:

Having all clauses to TCC <u>in the main part</u> prEN 1995-1-3

Annex A (normative) Evaluation of effective composite creep coefficients is needed for bridges with their special cross sections.



Key

…

2a), 3a) Notched connection with glued in reinforcement

2b), 3b) Notched steel plate with shear studs and screws

2c), 3c) Glued in connectors

Figure D.4.2 – Examples TCC-bridge types with mainly used connections

Definition

3.1.14 notched connection

Shear connection consisting of a concrete cam embedded in the timber component and the reinforcing steel or similar aid that prevent the concrete from lifting off

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

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

Key

M protection (see 5 below)
1 Timber
2 Concrete
3 Notched connection
4 Reinforcing steel (e.g. glued-in reinforcement, dowel type fastener - mainly with a kerb)
5 Protection against penetration of water in cement grout
H_1 Depth of the plate of a concrete-timber element
H_2 Depth of the timber element of a concrete-timber element
l_v Length of timber in front of the notch

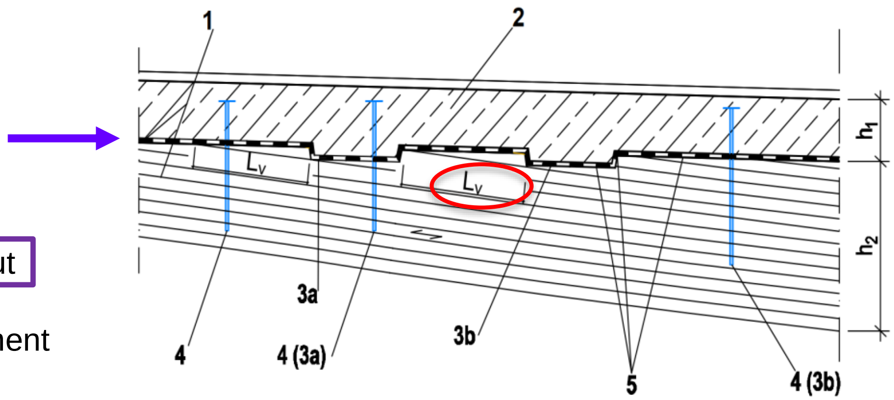
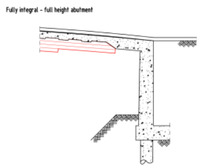


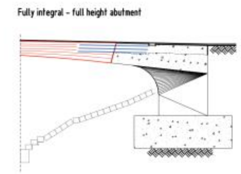
Figure 8.2 – Example of notched connection (see Figure D.2)
with an angle between grain and the bottom of the concrete slab

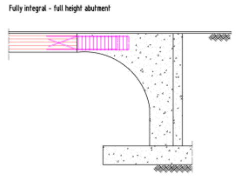
The length l_v is needed in CEN/TS 19103, Formula (10.6) (c).

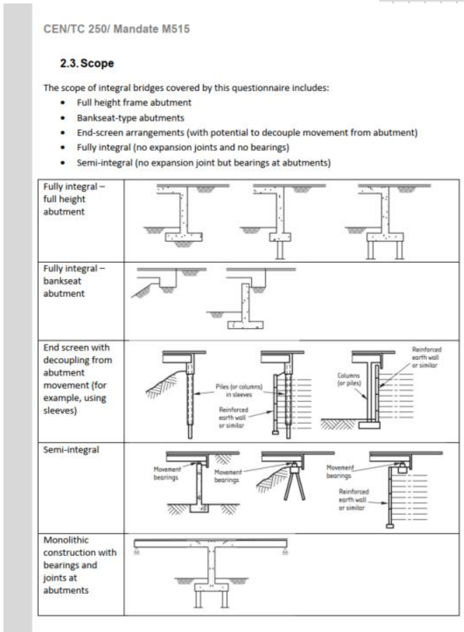
2.3 Holz-Beton-Verbund (HBV)

Integral bridges see EN 1990-2 subclause 11.2.2





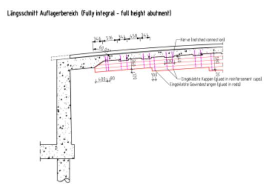


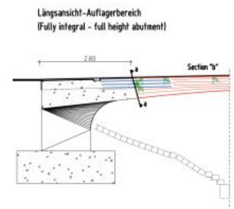

CEN/TC 250/ Mandate M515

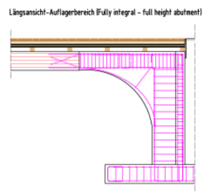
2.3. Scope

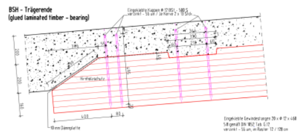
The scope of integral bridges covered by this questionnaire includes:
- Full height frame abutment
- Bankseat-type abutments
- End-screen arrangements (with potential to decouple movement from abutment)
- Fully integral (no expansion joints and no bearings)
- Semi-integral (no expansion joint but bearings at abutments)

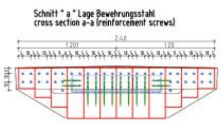
Fully integral – full height abutment	
Fully integral – bankseat abutment	
End screen with decoupling from abutment movement (for example, using sleeves)	Piles (or columns) in sleeves; Reinforced earth wall or similar; Columns (or piles); Reinforced earth wall or similar
Semi-integral	Movement bearings; Movement bearings; Movement bearings; Reinforced earth wall or similar
Monolithic construction with bearings and joints at abutments	

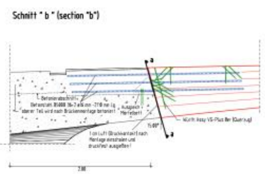


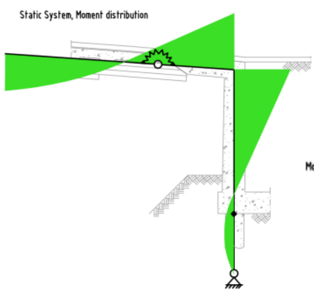


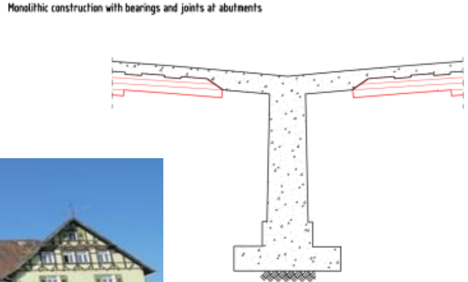


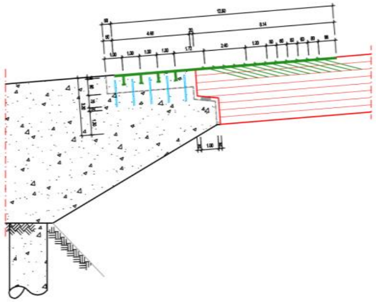




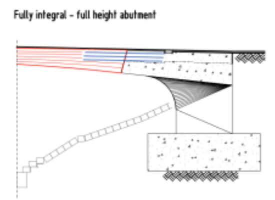








2.4 Hölzerne Fahrbahnplatten

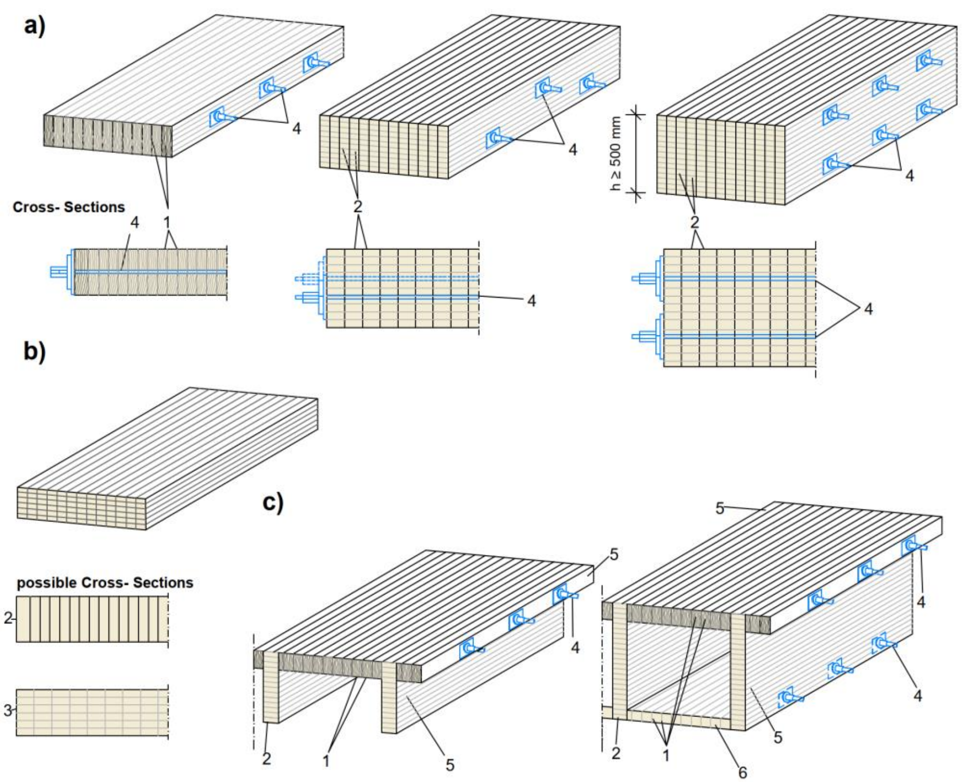


2.4 Special bridge structures

- Timber Concrete Bridges and integral abutments
- Transversal post tensioned timber deck - current rules much based on american rules (Ritter)

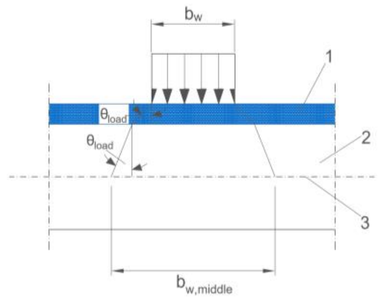
Deck plates subclauses 7.1, 8.2 and 9.4 and Annex L+O

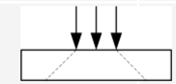
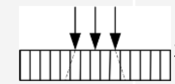
- meanwhile in
  EN 1995-1-1, Annex L
- FE analysis
  EN 1995-1-1, Annex O
- Design, Execution



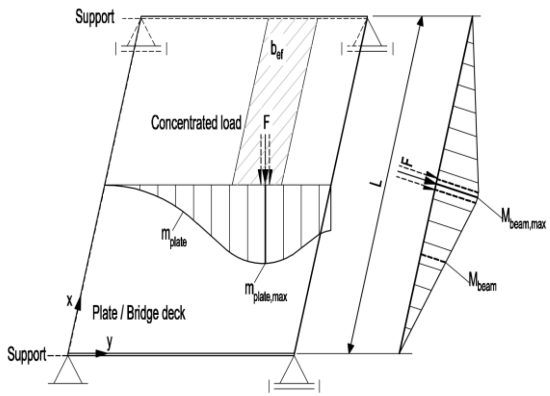
2.4 Hölzerne Fahrbahnplatten

- Concentrated Vertical Load

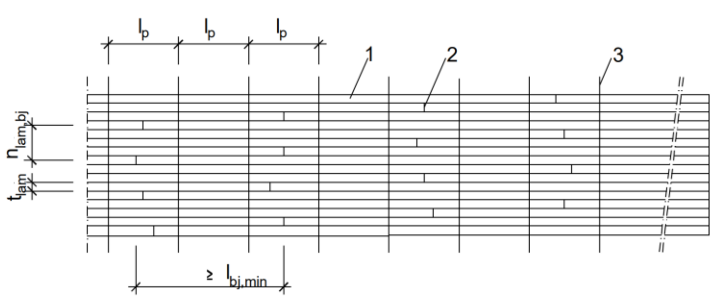


Pavement (in accordance with EN 1991-2 clause 4.3.6)		45°
Boards and planks		45°
Laminated timber deck plates:		
– in the direction of the grain		45°
– perpendicular to the grain		15°
Plywood and cross-laminated deck plates		45°

- Effective width b_{ef}



- Butt joint



2.5 Durchbiegung, Überhöhung, Maßänderung unter wechselnden Umweltbedingungen

2.5 Deflections

subclause 9.2 Annex E

Table 9.1 (NDP) – Limiting Values for deflections for timber beams, plates and trusses

Action (Frequent load value)	Range of Limiting Values	
	vertical	horizontal
Traffic loads on road bridges [1)]	L/500 to L/650	-
Traffic loads on footways, cycle tracks and footbridges	L/500 to L/900	-
Wind forces	-	L/600 to L/1500

1) In the design the vehicle may be positioned in the middle of a lane for laminated timber decks and positioned as close to the deck edge as possible for ancillary structural elements

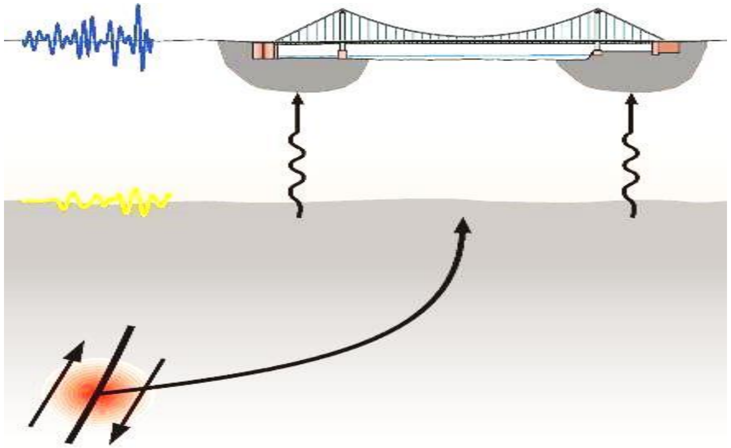
A pre-camber should be given to flat bridges due to water drainage issues and for aesthetical reasons.
The pre-camber should be at least the equal to the deformations from permanent loads.

It‘s worth pointing out that in the new informative Annex E hints to deformations and changes in deflections of timber structures under changing environmental conditions like temperature or moisture content are given as well as hints to transvers post-tensioned timber plates (e.g. regarding uplift of the edge of a deck plate (so called „cupping“).

2.6 Seismic areas / design

subclause 4.2.3 and Annex C

Seismic design for bridges see EN 1998-2



Material specific now EN 1998-2 Annex C (informative) mainly

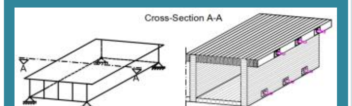
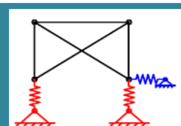
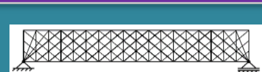
Additions to bearings for (light) timber bridges

and timber bridges in low seismic areas (action (1,25 m/s² ≤ S_δ ≤ 3,0 m/s²)

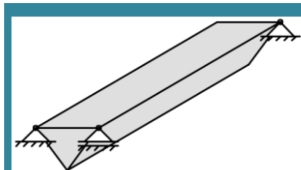
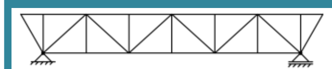
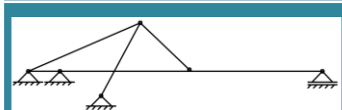
→ EN 1995-2 Annex C (informative)

2.6 Erdbeben-Bemessung

EN 1998-2, Table C.1 – Examples of Structural Types of Timber Bridges

Examples of Structural Types *	Bridge Type / used Span L	Similar to building type in EN 1998-1-2 Table 13.1	Structural System; Source of energy dissipation / ductility (if any)	NOTE: Values to identify or to calculate
	c-b) Prestressed deck plates (materials see EN 1995-2 Figure 3.5; with solid or glulam or CLT elements) L ≤ 25 m	c) Log structures	Single-span or continuous girder with friction between the beams or torsion spring coupling	1st eigenfrequencies: horizontal + vertical + torsion (if hollow cross section)
 	e-b) Timber pier made of a truss system (part of the bridge or the abutment) L ≤ 10 m Horizontal bracings of bridges (part of the bridge) L ≤ 90 m	e) Braced frame structure with dowel-type connections here: in cross direction of the bridge	Timber frame with dowel-type fastener connections / fastener plasticization	as for the main bridge For modelling soil, embedding of the abutments and piles see paragraph C.2 (3)
	g-b) Lattice-girder bridges (sometimes called tunnel) protected by claddings fixed with nails or screws L ≤ 90 m	g) Braced frame structures with carpentry connections and masonry infill	Single-span girder	1st eigenfrequencies: horizontal + vertical
   	i-b) Tied-arch bridges L ≤ 40 m; Suspension bridges L ≤ 50 m; Arch bridges with or without hangers L ≤ 90 m; Spandrel-braced bridges L ≤ 90 m	i) Two-pin and three-pin arches, three-pin frames and dome structures	Single-span girder	1st eigenfrequencies: horizontal + vertical

2.6 Erdbeben-Bemessung

 	k-b) Hollow-box-girder bridges L ≤ 80 m; Truss bridge L ≤ 150 m	j) Large-span timber truss portal frame structures	Single-span girder	1st eigenfrequencies: horizontal + vertical + torsion
	k-b) Stressed ribbon bridges L > 150 m	j) Large-span timber truss portal frame structures	Continuous girder	1st eigenfrequencies: horizontal + vertical + torsion
	l-b) Cable stayed bridges / Construc-tions with pylons 50 m ≤ L ≤ 200 m	-	Continuous girder; Effective modal mass	1st eigenfrequencies: horizontal + vertical + torsion (sometimes)

*** The drawings in Table C.1 depict the wooden or steel part of a structure.**

Table C.5-1 — Default Values of q for Timber Bridges with low seismicity action

Type of ductile members	Ductility class			
	DC1	DC2		
	$q=q_s$	q_R	q_D	$q = q_s \cdot q_D \cdot q_R$
j-b) Lattice-truss bridges (sometimes called tunnel) with carpentry joints and portal frame structures (see e-b))	1,5	1,1	1,2	2,0
Large-span truss bridge with portal frame structures (see e-b))	1,5	n/a	n/a	n/a
k-b) T-beam and box girder with transversal post-tensioned timber deck	1,5	1,1	1,2	2,0

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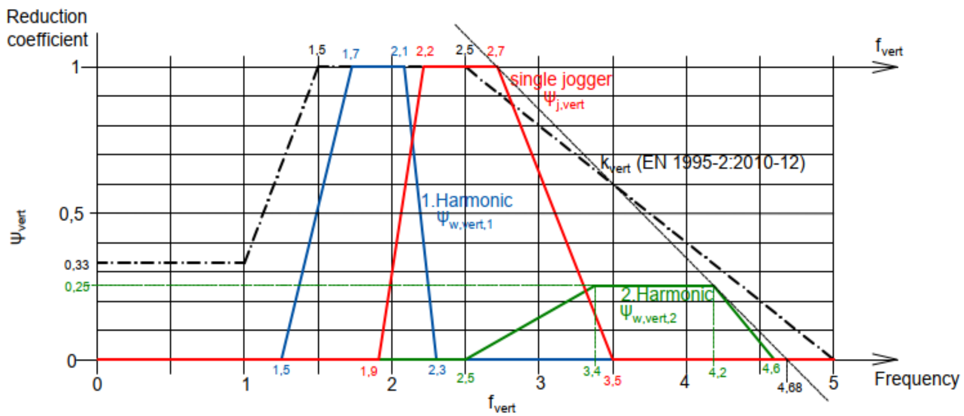
2.7 Vibrations, damping

subclause 9.3

The old Annex B (normative) Vibrations was moved in the main body of prEN 1995-2, 9.3

Determination of Accelerations

Simplified model is given ("ease of use"; valid for any bridge type and material independent)



e.g.
Figure in the background document (BGD)

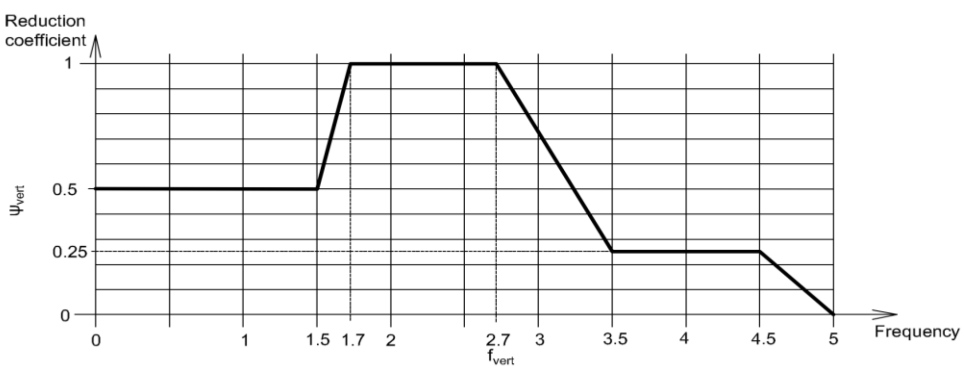


Figure 9.1 – Relationship between the vertical fundamental natural frequency f_{vert} and the reduction coefficient ψ_{vert} (both walking and *jogging)*

Simplified curve / encasing with simplified design

$$a_{vert,1} = \frac{100}{M^{*}\zeta} \cdot \psi_{vert}$$

2.7 Schwingungen, Dämpfung

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Comfort levels: EN 1990:2022, Table H.1

Recommended Comfort Levels and corresponding permitted accelerations

Comfort level	Degree of Comfort	Explanation	Vertical Acceleration $a_{lim,vertical}$ m/s^2	Horizontal Acceleration $a_{lim,horizontal}$ m/s^2
CL 3	Maximum	Accelerations practically imperceptible to the users	≤ 0.5	≤ 0.1 ≈ 0.15
CL 2	Medium	Accelerations merely perceptible to the users	≤ 1.0	≤ 0.3
CL 1	Minimum	Accelerations perceived by the users, but not intolerable	≤ 2,5	≤ 0.8 ≈ 0.75
CL 0	No limit set	Accelerations strongly perceived by the users, intolerable by most	> 2,5	> 0.8 ≈ 0.75

Footnotes:

a In cases where the risk of resonance is considered negligible after calculating the natural frequencies of the bridge structure, comfort level is automatically considered sufficient; see 9.3.1.3 (1).

b Where appropriate, e.g. in rural areas, landscape and spots of low traffic frequency, comfort level 0 i.e. no limit can be chosen.

c Bridges classified in CL1 or CL0 will experience strong vibrations and deformations. During the planning process, the designer should advice the client / building owner on this fact.

Missing explanations were included now in the draft prEN 1995-2, 9.3.1.2 as NOTEs

2.7 Schwingungen, Dämpfung

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Traffic Classes: EN 1990.202x, Table G.1 prEN 1995-2 see 9.3.1.3

Table 9.2 – Pedestrian steams for Traffic Classes (extracted from EN 1991-2, Table G.1)

mainly, added

Traffic Class	Description	Explanation	(G.4) Pedestrian Stream [P/m²]
TC 1	Very weak traffic	Seldom used footbridge; bridge built to link sparsely populated areas	0.1
TC 2	Weak traffic	Footbridge for standard use; bridge that may occasionally be crossed by large groups of people but that will never be loaded throughout its bearing area	0.2
TC 3	Dense traffic	Urban footbridge linking up populated areas; bridge subjected to road traffic and that may occasionally be loaded throughout its bearing area	0.5
TC 4	Very dense traffic	Urban footbridge linking up high pedestrian density areas; bridge located for instance, nearby a rail or underground station	1.0
TC 5	Exceptionally dense traffic	Urban footbridge linking up exceptionally high pedestrian density areas; bridge located for instance, nearby an arena that could accommodate a large number of spectators	1.5

Normally no dynamic analyses are required for footbridges in traffic class TC1.
For very light footbridges, e.g. girder-type bridges with pavement consisting of light material, it is advised to select at least TC2 to ensure a minimum amount of comfort. Very light footbridges may show high accelerations without any resonance.

The weight of a single person is 0.8 kN according to EN 1990-2 Annex A

The owner of the bridge should specify the appropriate traffic class, based on the level of pedestrian traffic that the bridge is expected to be subjected to.

2.7 Schwingungen, Dämpfung

Damping Ratio subclause 9.3.1.6

Where no other values have been determined through experimental tests,
the damping ratio according to Lehr in case of vertical vibrations (Serviceability limit states)
should be taken given in Table 9.3

Table 9.3 — The damping ratio ζ according to Lehr for different structural types of timber bridges

ζ	Structure type
0.5 %	cable-stayed bridges with very long cables vibrating themselves
1,0 %	superstructures without mechanical joints
	timber-concrete-composite superstructures
	for bridges with light-weight timber deck (e.g. roofed bridge with planked timber deck) with main girders with mechanical joints
1.5 %	superstructures with mechanical joints
	timber bridges with a heavy bridge deck (e.g. stress laminated decks or block-glued decks) with a floating layer; e.g. a sealant system
2.0 %	bridge system consisting of a heavy deck supported by arches or trusses
	superstructures with a floating deck

The damping ratio ζ according to Lehr is the rate of damping respectively the percentage of the critical damping (with viscous damping $\xi \ll 1$, which is typical for structures); see Hamm 2003. The conversion of the logarithmic damping decrement δ into the damping ratio according to Lehr is than $\zeta \approx \delta / (2\pi)$.

Damping ratio values needed for Ultimate limit states in context with e.g. wind loads for elements are normally logarithmic damping decrements.

In case of seismic design and if no other values are proven damping ratios according to Lehr given in EN 1998-2 can be used.

2.8 Fatigue

clause 10

PT6 and WG6 discussed 4 different verification models – at the end remained only one model:
the "old" k_{fat}-verification method (for FLM 3 of EN 1991-2), because no other data are available for the design of notches under dynamic behavior.
Discussion with Prof. Pietro Croce c/o Horizontal Group Bridges (HGB); see BGD Fatigue

Most of the subclauses of the old Annex A (Fatigue rules) already moved into EN 1995-1-1, clause 10 (e.g. bell towers, connection between elevator and shafts, floors with machinery, wind mills, halls with cranes, traffic or vehicle traffic) including the design of notches under dynamic behavior.
The remaining text was deleted.

2.8 Ermüdung

For bridges a simplification of the verification model is given in EN 1995-2 (T_{lf} = 100 years, N_{obs} = $2 \cdot 10^6$ per year for two lanes). Some omission criterias are given.

Table 10.1 – Reduction factors k_{fat} for a simplified verification for ß = 1 [ß = 3]

	Compression	Bending and tension	Connections with dowels
$-1 \leq R_T < 0$ (reversed loading)	-	0,13 [0,08]	0,04 [-]
$0 \leq R_T$ (non-reversed loading)	0,52 [0,49]	0,17 [0,13]	0,28 [0,24]

The values in brackets belong to ß = 3 for damage / substantial consequences.

3 Zusammenfassung

Many thanks

Members of **Project Team PT6** on TC 250 SC5-level:
Matthias Gerold (DE) (lead), Roberto Crocetti (SW),
Kristoffer Ekholm (SW), Frank Miebach (DE), Andreas Müller (CH)

supported by **WG 6 members**
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Rune Abrahamson (NO), Patrice Godonou (S),
Valentina Bruno Huré (VBH); Antje Simon (DE)

supported by **national experts** (e.g. Durability: Kurt von Felten, Helen Belschner;
TCC: Jörg Schänzlin (member PT2), Jochen Marschall, Fabian Wolf;
Vibrations, Damping: Patricia Hamm, Steffen zu Jeddeloh;
Fatigue: Mike Sieder (member PT3), Peter Niebuhr,
Ulrike Kuhlmann (chair EC3)/Simon Mönch

Upcoming steps

September – December 2023, Enquiry drafts available on:

- Part 1-1: General rules and rules for buildings
- Part 1-2: Structural fire design
- Part 2: Bridges
- Part 3: Excecution

In Europe, for commenting please contact your national standardization body.

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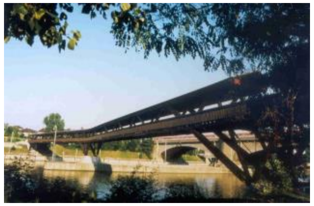
3 Zusammenfassung

Time schedule / Zeitschiene

Committee/Group	Task/Milestone	Date
EU	Mandate M 515	2012
CEN	Technical work starts	2015
TC 250/SC 5	Work of project teams (PT)	2016-2021
SC 5	SC ends Review for Formal Enquiry (ENQ)	29.09.2022
TC 250	TC 250 chair/secretariat end check for ENQ	23.12.2022
CCMC	CCMC ends editing for ENQ	30.03.2023
CCMC	DIN/AFNOR ends translation for ENQ	20.06.2023
TC 250	Start CEN Enquiry	14.09.2023
TC 250	**End of CEN Enquiry**	**04.01.2024**
TC 250/SC 5	Estimated time needed to review CEN enquiry comments and update the standard	in between
TC 250	SC ends Review for Formal Vote (FV)	25.08.2023
TC 250	TC 250 chair/secretariat end check for FV	18.10.2024
CCMC	CCMC ends editing for FV	22.11.2024
CCMC	DIN/AFNOR ends (updated) translation for FV	21.02.2025
TC 250	Start FV	01.04.2025
TC 250	End of FV	26.05.2025
CCMC	CCMC ends editing for publication	24.06.2025
CCMC	DIN/AFNOR ends (final) translation for publication	29.07.2025
TC 250, CCMC	Crossover CEN/TS 19103 (TCC) into EN 1995-1-3	2025-2026
DIN	Drafting new national Annexes (NAD's)	2023-2025
DIBt	Withdraw contrary national regulations	2027-??
EU	Publication in the Official Journal	2027-07 ?

3 Zusammenfassung

In the past / status quo: many failures and sometimes damages





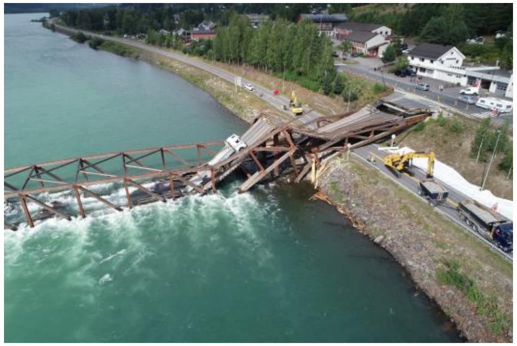


I hope you‘ve got now an impression of the new prEN 1995-2

to be more familiar with the new regulations

and that such failures and damages

doesn‘t happen in future.



3 Zusammenfassung








Thank you very much for your attention - Do you have any questions?