TECHNICAL INFORMATION

KVH® SOLID STRUCTURAL TIMBER

(structural finger-jointed timber pursuant to EN 15497:2014)

DUOBALKEN®, TRIOBALKEN®

(glued solid timber pursuant to EN 14080:2013)

Published by:
Überwachungsgemeinschaft
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www.radermacher-pr.de

Picture credits:
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Page 4: Thomas Koculak, Informationsdienst Holz; architektur_raum, bauer sternberg, Bonn

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Contents

1 A high-precision material

Building with wood has a very long tradition. Man has used wood for his buildings and structures for thousands of years. Buildings and structures from bygone centuries and still used today prove the durability as well as the high residential value of wooden structures.

Better than required by the standard

Residential structures have to meet high requirements concerning safety and comfort. The buildings are expected to provide good thermal insulation in winter, heat protection in summer as well as noise protection at any time. The building materials used are to be harmless under ecological and health aspects, while building elements that remain visible are to create an aesthetically pleasing appearance which need little maintenance. Besides, modern timber construction nowadays requires dimensionally stable and accurate as well as kiln-dried solid timber products. The changed production technology in the carpentry businesses that often employ CNC-controlled assembly systems requires a clearly defined material for a smooth production process.

The above-mentioned requirements concerning solid timber products are reflected in stricter standards. The requirements set out in the agreements on solid structural timber KVH® [1] and Duobalken®/Triobalken® [2] are clearly far more stringent than those in the related standards, as will be shown below.

Technology advantage

The development of KVH® Structural Timber along with the Duobalken® and Triobalken® has led to the availability of precise materials that are dried gently, are dimensionally accurate, planed or levelled and are available off the shelf in many different dimensions and lengths. KVH® as well as Duobalken® and Triobalken® are protected trademarks.

Supervised quality

The internal quality control of solid structural timber KVH® is governed by the stringent rules of the Überwachungsgemeinschaft KVH® (KVH® quality surveillance organization), while the individual companies are additionally and regularly supervised by external and independent inspection bodies. The supervision conditions of the Überwachungsgemeinschaft are laid down in the agreement with Holzbau Deutschland (Holzbau Deutschland – Bund Deutscher Zimmermeister [Association of German Carpenters]). The supervision of Duobalken® and Triobalken® is done in a similar way.

KVH® solid structural timber (structural finger-jointed timber) pursuant to EN 15497:2014 [3]

Visually or automatically strength-graded, kiln-dried and planed or levelled[1)] solid timber with defined dimensional accuracy for use in visible and concealed areas. KVH® is usually finger-jointed and 13 m long. Larger sizes are available on request. KVH® satisfies the requirements of EN 15497 (for structural finger-jointed timber) or of EN 14081-1 [4] (for structural solid timber not finger-jointed). Moreover, the compliance with the additional requirements stipulated in the agreement about solid structural timber is monitored by internal and external inspections.

[1)] Levelled: Shaped into a uniform size using appropriate woodwork techniques (e.g. sawing, planing, grinding) without guaranteeing a clean, uniform surface.

***Duobalken® and Triobalken®* (glued solid timber) pursuant to EN 14080:2013 [5]**

Cross section of the solid timber combined from two or three single boards with identical cross-sections glued together. The lamellas are usually finger-jointed. The Duobalken® and Triobalken® beams are usually 13 m long. Larger sizes are available on request. Duobalken® and Triobalken® are produced in accordance with EN 14080:2013. Inquiries about quality requirements exceeding the standard, such as requirements concerning the surface, can be addressed in accordance with the agreement about Duobalken® and Triobalken® to Holzbau Deutschland. As is the case with KVH®, the compliance with these additional quality requirements is monitored in the course of internal and external inspections by independent institutions.

Sustainability

Wood has an ecological edge over other building materials. Apart from its unique feature of being the only constructive building material that regrows in large quantities, short haulage distances, its easy processing and the production without waste are just some of the reasons why the production of a functionally equal wooden construction element requires far less energy than building elements made of other materials.

More detailed information can be found in the environmental product declarations [6], [7] on the homepage www.kvh.eu.

Precise pre-fabrication and energy-saving construction

The small dimensional tolerances of KVH®, Duobalken® and Triobalken® (see also Tables 3.1 and 3.2) is an important prerequisite for the efficient machining of timber in the wood construction industry. It would not be possible without these types of timber products to employ cost-saving CNC-controlled machines and to achieve such a high degree of pre-fabrication.

Well insulated buildings require a permanent air-tightness of the building shell. The building elements must therefore be produced in such a way that they fit accurately. Dimensional changes due to moisture must not affect the air-tightness. High-tech timber, such as KVH®, Duobalken® and Triobalken®, will permanently ensure air-tight and thus energy-saving timber structures with a high heat insulation standard.

2 Production and technical characteristics

For the production of KVH®, Duobalken® and Triobalken®, softwood, usually spruce, is used for primary conversion to rough beams on state-of-the-art chipper and circular saw lines. The waste wood from the processing, such as bark, chopped wood and chips, is completely recycled and used for the generation of power, in the paper production or for producing derived timber materials.

After having been dried in fully automatic, computer-controlled kilns, the timber is strength-graded. Growth non-conformities which could reduce the strength of the product are cut out of the beams. The individual cross-sections thus generated will then be re-joined with so-called finger-joints at the ends, so that, theoretically, infinitely long strings can be obtained.

After the finger-jointing (subject to length, this can be dispensed with on request), the pieces of timber are cut to length and planed or leveled to an exact size.

For glued solid timber this is followed by gluing two to five single lamellas together, so that an overall cross-section is achieved; all this is planed once more. The products thus gained are cured and stored in air-conditioned storage facilities, so as to ensure that the beams are dry and dimensionally stable, before they are delivered. Every stage of production is subject to permanent quality controls (internal and external inspections by independent institutions).

TABLE 2.1 - Species, strength classes and building physics characteristics

Technical characteristics	KVH®	Duobalken®/Triobalken®
Species	spruce also fir, pine, larch, douglas fir on request	
strength class pursuant to DIN EN 338 [8] grading class pursuant to DIN 4074-1 [9][1)]	C24 / S 10 TS[2)] oder C24 / S 10 K[3)] TS[2)] oder C24 M[4)] TS[2)]	
moisture content u_m[5)]	15 % ± 3 %	≤ 15%
swelling & shrinkage ratio	0,24 % pro 1 % change of moisture content	
reaction to fire classes pursuant to EN 13501-1 [10]	D-s2, d0	
thermal conductivity λ	0,13 W / (mK)	
water vapor diffusion resistance factor μ	40	

1) *For other European grading standards an allocation of the national grading classes to strength class C24 can be taken from EN 1912:2013 [11]. The note concerning the grading standard can be disregarded for the machine strength grading.*

2) *The identifier „TS" stands for „dry-graded", i.e. for the grading at a moisture content of $u_m \leq 20$ %*

3) *The identifier „K" marks a board or plank graded like a scantling.*

4) *The identifier „M" marks mechanical grading.*

5) *In practice, the mean moisture content um is decisive for assessing the wood moisture, with um being the arithmetical mean value of the measuring results obtained from each piece of wood with the electrodes having an insertion depth of 5 mm each (surface moisture), of half of the wood thickness (core moisture) and of a third of the wood thickness (mean wood moisture).*

3 Requirements and fields of application for structures dimensioned pursuant to EN 1995-1-1 (Eurocode 5)

Solid structural timber – KVH®

Sub-section 3.2 „Solid timber" of EN 1995-1-1:2010 [12] demands, on the one hand, strength grading pursuant to EN 14081-1 and finger joints pursuant to EN 385 [13], on the other. Structural finger-jointed timber, such as KVH®, can basically be used in those fields of application, where the use of solid timber is also permitted. There is an additional restriction for structural finger-jointed timber in as much, as it must only be used in service classes 1 and 2.

The above-mentioned EN 385 was withdrawn in September 2013 and has been replaced by EN 15497: 2014, which was then published in the Official Journal of the EU under the date of October 10, 2014, so that it is basically applicable at European level from that date. It might be necessary for applying EN 15497 that the regulations for the application valid in the relevant EU countries and the details contained in the relevant national appendix to Eurocode 5 will have to be observed.

EN 15497 regulates the performance and (minimum) production requirements concerning finger-jointed construction timber with rectangular cross-sections made from certain coniferous species. Solid structural timber KVH® is structural finger-jointed timber which is subject to additional requirements concerning the dimensional tolerances and the surface quality.

The European product standard EN 14081-1 is applicable to KVH® that is not finger-jointed.

In addition to the above requirements imposed by the construction supervision authorities, solid structural timber KVH® must satisfy the additional requirements of the „Agreement on solid structural timber", see also Table 3.1.

Fields of application for KVH®

Finger-jointed KVH® must only be used in service classes 1 and 2 pursuant to EN 1995-1-1 (see Table 3.3) in structures that are not prone to fatigue.

It is produced with adhesives of type I pursuant to EN 301 or EN 15245 and clearly remains below the limit for formaldehyde emissions class E1 (formaldehyde emission ≤ 0.124 mg/m³ of air). The usability of KVH® with a different natural durability or with preservative treatment is regulated at national level.

KVH® not finger-jointed with the relevant natural durability can also be used in service class 3.

TABLE 3.1 - Requirements to be met by solid structural timber KVH®

Grading criterion	Requirements to be met by KVH®		Remarks
	visible applications (KVH®-Si)	non-visible applications (KVH®-NSi)	
Strength class	C24, C24M		other strength classes need to be agreed separately
Product standard	EN 14081-1 for KVH® not finger-jointed EN 15497 for finger-jointed KVH®		
Wood moisture	15% ± 3% kiln-dried: wood dried for at least 48 h to a moisture content of u ≤ 20% in a process-controlled technical plant that is suitable for this purpose at a temperature of T ≥ 55°C.		the specified moisture content is a prerequisite for dispensing with a preventive preservative treatment to a large extent and may also be a precondition for finger joint assembly.
Type of cutting	cutting in such a way that the pith of an ideally grown log is cut through in two strands; on request: a heart plank with d ≥ 40 mm is removed	cutting in such a way that the pith of an ideally grown log is cut through in two strands.	
Wane	not admissible	≤ 10% of the smaller cross-section side	
Dimensional tolerances of the cross-section	DIN EN 336 [16] tolerance class 2 ≤ 10 cm = ±1 mm; >10 cm and ≤ 30 cm = ±1,5 mm		The dimensional tolerances for longitudinal dimensions will have to be agreed between customer and supplier.
Knot condition	loose knots and dead knots are not admissible; occasional faulty knots or parts of knots up to a maximum diameter d of 20 mm are permitted		
Knots	d ≤ 70 mm		applicable in the case of machine grading: • knot sizes can be disregarded for KVH®-NSi • A ≤ 2/5 is applicable for KVH® -Si (Knotiness A measured pursuant to DIN 4074-1)..
Ingrown bark	not admissible		bark will be added to the knot
Cracks	crack width b ≤ 3% not more than 6 mm	crack width b ≤ 5%	crack width b related to the relevant side of the cross-section without restrictions as to the length or the number of cracks
Pitch pockets	width b ≤ 5 mm	*)	without restriction as to the length or the number of pitch pockets
Discoloration	not admissible	blue stains: admissible nailable brown and red stripes: up to 2/5 blight, white rot: not admissible	measured pursuant to DIN 4074-1
Insect attack	not admissible (DIN 68365 Quality Class 1)	worm grooves up to a diameter of 2 mm admissible	
Twisting	1 mm per 25 mm height		measured pursuant to DIN 4074-1
Longitudinal warping	≤ 8 mm/2m when the heart plank is cut out ≤ 4 mm/2m	For split-heart cut ≤ 8 mm/2m	measured pursuant to DIN 4074-1
Finishing of the ends	trimmed perpendicularly		
Surface quality	planed and chamfered	leveled and chamfered	

*) Correction of printing errors (July 2016)

Duobalken® / Triobalken® glued solid timber

Glued solid timber is not mentioned in EN 1995-1-1, since it has not yet been subject of a European regulation at the time of printing this standard. Glued solid timber is usually used, when KVH® proves to be uneconomical due to large cross-sections.

EN 14080 regulates performance and production requirements concerning glued solid timber made from certain soft species as well as from poplar. In accordance with EN 14080, glued solid timber must be produced

- from lamellas with a maximum thickness of 85 mm with the same strength class;
- with a maximum overall cross-section of 280 mm;

from lamellas without and with finger-jointing that are glued together with adhesive type I (pursuant to EN 301 [14] or EN 15425 [15]) for service class 1 or with adhesive type II for service classes 1 and 2.

Duobalken® and Triobalken® satisfying more than the requirements of EN 14080:2013 can be ordered that meet the additional requirements of the Agreement about Duobalken®/Triobalken®, see also Table 3.1.

TABLE 3.2 - Requirements to be met by Duobalken® und Triobalken® beams

Grading criterion	Requirements		Remarks
	visible applications (Si)	non-visible applications (NSi)	
Technical rule	EN 14080:2013		
Grading class	C24 / C24M		other strength classes available on request
Moisture content	maximum 15%		precondition for gluing
Dimensional tolerances of the cross-section	EN 336, tolerance class 2 ≤ 10 cm = ±1 mm, >10 und ≤ 30 cm = ±1,5 mm, > 30 cm = ±2 mm		the dimensional tolerances for the longitudinal dimensions are to be agreed between customer and supplier
Twisting	≤ 4 mm/2 m		for comparison: DIN 4074-1; S10: ≤ 8 mm/2m
Longitudinal warping	≤ 4 mm/2 m		for comparison: DIN 4074-1; S10: ≤ 8 mm/2m
Surface quality	planed and chamfered	leveled and chamfered	the right-hand sides (sides adjacent to the heart) must face outwards
Finishing of the ends	trimmed perpendicularly		

Fields of application for Duobalken® and Triobalken®

Duobalken® and Triobalken® beams can be used in service classes 1 and 2 in accordance with EN 1995-1-1 (see Table 3.3); as for the rest, the details and explanations on KVH® apply.

TABLE 3.3 - Service classes

Service classes (SC) pursuant to EN 1995-1-1[1)]	Mean wood moisture u_m	Description
SC 1	≤ 12	Service class 1 is characterized by a moisture content in the building materials that corresponds to a temperature of 20 °C and a relative humidity in the ambient air that exceeds a value of 65 % for a few weeks in the year only.
SC 2	≤ 20	Service class 2 is characterized by a moisture content in the building materials that corresponds to a temperature of 20 °C and a relative humidity in the ambient air that exceeds a value of 85 % for a few weeks in the year only.
SC 3	> 20 %	Service class 3 covers climatic conditions resulting in a moisture content higher than that in service class 2.

4 Product range and preferred cross-sections

KVH®, Duobalken® and Triobalken® beams made of the species spruce are available in a wide range of cross-sections for immediate delivery from stock. The species pine and fir as well as the more moisture-resistant species larch and Douglas fir are available on request.

Cost savings with preferred cross-sections

Preferred cross-sections in the construction dimensions typically used in timber construction facilitate considerable cost savings. The stocks of timber held by timber wholesalers save businesses specializing in timber construction from maintaining extensive stocks themselves and give them planning freedom without tying down operating capital. Industrial production systems enable manufacturers to produce at low costs.

Timber also supplied cut to special dimensions as listed

The organization of production is so flexible that it is also possible to supply lengths cut to specific building-related dimensions "as listed". This means that dried and dimensionally stable timber can also be supplied to places, where job-order planning is the preferred option.

Dimensions

The maximum available cross-sectional dimensions of KVH® are limited by the kiln-drying and the minimum split-heart cutting requirements. With maximum dimensions of approx. 14/24 cm, KVH® is capable of meeting most requirements, such as those concerning the cross-sections for ceiling beams. For larger cross-sections and higher requirements in terms of appearance, Duobalken® and Triobalken® beams are available, the cross-sectional dimensions of which are subject to the limits set by EN 14080: 2013.

KVH®	b/h ≤ 14/24 cm
Duobalken®	b/h ≤ 16/28 cm (2 x 8/28 cm)
Triobalken®	b/h ≤ 24/28 cm (3 x 8/28 cm)
	b/h ≤ 10/36 cm (3 x 10/12 cm)

- *No cross-sections with a width of more than 140 mm because of the technical drying process. The use of glued solid timber or glued laminated timber is recommended for widths larger than 140 mm.*
- *Cross-sections for other species (e.g. pine, Douglas fir, larch) on request.*
- *Cross-sections in visual quality (Si) on request.*
- *Other strength classes than C24/C24M on request*

TABLE 4.1 - Preferred cross-sections for solid structural timber KVH® NSi made from spruce/fir of strength class C24/C24M

Height (mm) / Width (mm)	100	120	140	160	180	200	220	240
60	■	■	■	■	■	■	■	■
80		■		■	■	■	■	■
100	■			■		■		■
120		■		■		■		■
140			■					

As regards the load-bearing capacity, it is irrelevant whether the glue joint runs horizontally or vertically. Unless the manufacturer declares different strengths in the direction of both axes, which is not done by now. If a certain direction is required, it shall be stated when placing the order.

Preferred cross-sections for other strength classes or species on request.

TABLE 4.2 - Preferred cross-sections for spruce/fir (Si and NSi) and pine (NSi) of strength class C24/C24 M

Height (mm) / Width (mm)	100	120	140	160	180	200	220	240
60[1)]	■	■	■	■	■	■	■	■
80[1)]	■	■	■	■●	■●	■●	■	■
100	■	■	■●	■●	■●	■●	■●	■●
120		■●		■●	■●	■●	■●	■●
140			■●	■●	■●	■●	■●	■●
160				■●		■●	■●	■●
180					■●	■●	■●	■●
200						■●	■●	■●
240								■●

[1)] According to EN 14080 these cross sections are denominated as glulam, but typically they are subsumed as glued solid timber.

● *= Si visble application*

■ *= NSi non-visible application*

5 Design

Design pursuant to EN 1995-1-1 (Eurocode 5-1-1)

General matters concerning Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings – The current status as regards the development of the Eurocodes

5.1 Basic Information

The European Design standards, the so-called Eurocodes, have been developed since the mid-1970s and have become effective all over Europe in the meantime. The Eurocodes have been published as European standards of the series EN 1990 - 1999.

The Eurocodes contain so-called nationally determined parameters (NDPs). The EU countries are permitted to draw up national appendices for the implementation and application of the Eurocodes. These appendices stipulate national parameters, e.g. partial safety factors for load and material parameters, so as to enable the national construction supervision authorities to ensure the required national safety level. The NDPs are determined in a National Annex (NA) to each part of the relevant Eurocode. Apart from the NDPs, the National Annexes may also contain complementary regulations and explanations that do not contradict the Eurocode (non-contradictory complementary information = NCI). The National Annexes are marked in the set of German standards by the suffix „/NA" that complement the number of the relevant standard. As an example, DIN EN 1995-1-1/NA is the der German Annex to DIN EN 1995-1-1 [17].

The following parts of Eurocode 5 have been developed for timber construction:

- EN 1995-1-1: 2010 in conjunction with EN 1995-1-1/A2:2014 - Design of timber structures - Part 1-1: General - Common rules and rules for buildings
- EN 1995-1-2 [18] 2010 - Eurocode 5: Eurocode 5: Design of timber structures - Part 1-2: General - Structural fire design
- EN 1995-2 [19]: 2010 - Eurocode 5: Design of timber structures - Part 2: Bridges

The safety strategy of the partial safety factors

EN 1995-1-1 is based on the semi-probabilistic safety strategy with partial safety factors. As is the case with most other building materials, Eurocode 5 for timber structures also differentiates between the verifications for the load-bearing safety and for the serviceability (deflection, vibration).

When verifying the load-bearing capacity it must checked that the design values[1)] of the strain (E_d) do not exceed in any design situation the design values of the stress resistance (building component resistance R_d). The design values are determined by multiplying the characteristic[2)] impacts from permanent and variable loads (G_k bzw. Q_k) with the partial safety factors γ_G or γ_Q. Similarly, the characteristic building component resistance R_k is reduced by a partial safety factor γ_M of the material.

Verification:	$E_d \leq R_d$
Design values for loads:	$E_d = \gamma_G \cdot G_k + \gamma_Q \cdot Q_k$
Design values for strengths and resistances:	$= \frac{k_{mod} \cdot R_k}{\gamma_M}$

1) Design values are marked with the index d (design)

2) characteristic values are marked with index k

When verifying the load-bearing capacity, the factor k_{mod} takes into account, as a so-called modification factor, the specific properties of wood in dependency of the prevailing climatic conditions and of the load duration. The climatic conditions are defined within the framework of the service classes, see Table 3.3. When verifying the serviceability, the relevant deformation factors k_{def} must be used that take the different creep behavior of the wood and of the derived timber products into account. The material's partial safety factors γ_M, the modification factors k_{mod} as well as the deformation factors k_{def} can initially be taken from EN 1995-1-1. Values from EN 1995-1-1 shall only be applicable, if the relevant National Annex (in Germany DIN EN 1995-1-1/NA) does not specify any other values.

TABLE 5.1 – Factors γ_M, k_{mod} and k_{def} , an example for Germany

	DIN EN 1995-1-1	DIN EN 1995-1-1/NA (National Annex in Germany)[1)]
Partial safety factor γ_M	EN 1995:2010, Table 2.3 does not apply!	Applicable are: DIN EN 1995-1-1/NA:2013, Table NA.2, Table NA.3 Values are added for several products not listed in EN 1995-1-1.
Modification factors k_{mod}	DIN EN 1995:2010, Table 3.1	Additionally applicable: DIN EN 1995-1-1/NA:2013, Table NA.4 Values are added for several products not listed in EN 1995-1-1.
Deformation factors k_{def}	DIN EN 1995:2010, Table 3.2	Additionally applicable: DIN EN 1995-1-1/NA:2013, Table NA. 5 Values are added for several products not listed in EN 1995-1-1.

1) The National Annexes of the other EU countries may contain other regulations that must be observed.

Characteristic strength and rigidity properties and their marking

As regards the design of structural solid timber that is not finger-jointed, the Eurocode 5-1-1 makes reference to the harmonized European product standard EN 14081-1. It is additionally demanded for structural finger-jointed timber that the finger-joints must conform to EN 385.

The product „glued solid timber" (generic term for Duobalken® and Triobalken®) is not defined in EN 1995-1-1; it is usually dimensioned like solid timber.

TABLE 5.2 – European product standards

Product	Product regulation
Strength graded structural timber with rectangular cross-section	DIN EN 14081-1
Structural finger-jointed timber	DIN EN 15497
Duobalken®, Triobalken® (glued solid timber)	DIN EN 14080

Construction timber for load-bearing applications has had to be marked with the CE sign in accordance with EN 14081-1 since August 1, 2012. The CE marking shall indicate the strength class pursuant to EN 338 (see also section 8 hereof).

Structural timber can be strength graded visually or by machine. When visually strength graded, DIN 4074-1:2012 „Strength grading of wood - Part 1: Coniferous sawn timber" is usually applied in Germany.

The machine strength grading is based on EN 14081-4: 2009 „Timber structures - Strength graded structural timber with rectangular cross section - Part 4: Machine grading - Grading machine settings for machine controlled systems". Since, due to historical reasons, numerous visual grading standards exist that take geographic specificities into account (species, growing areas, growth characteristics and traditions), it is impossible at the moment to determine a single acceptable set of rules for visual grading.

An overview over the various grading standards can be found in the currently valid version of EN 1912:2013, Table A.1 [11], if the need arises.

TABLE 5.3 - Allocation of German visual grading classes to European strength classes

Species (softwood)	Grading class pursuant to DIN 4074-1	Strength class
spruce, fir, pine, larch, Douglas fir	S 10[1] TS oder S 10K[2] TS	C 24

[1] Admissible bending strength in N/mm² pursuant to DIN 1052:1988/1996 which is no longer applicable.

[2] The identifier K marks a board or a plank that is graded like a scantling.

TABLE 5.4 - Strength & stiffness parameters in N/mm² and raw density parameters in kg/m³ pursuant to EN 338 for KVH® and for Duobalken®/Triobalken® members

Parameter	Explanation	Symbol	C24
Bending strength		$f_{m,k}$	24
Tensile strength	parallel to the grain vertical to the grain	$f_{t,0,k}$ $f_{t,90,k}$	14 0,4
Compressive strength	parallel to the grain vertical to the grain	$f_{c,0,k}$ $f_{c,90,k}$	21 2,5
Shear strength (shear and torsion)		$f_{v,k}$	4[1]
Rolling shear strength		$f_{R,k}$	1
Modulus of elasticity	mean value parallel to the grain	$E_{0,mean}$	11.000
	5% quantile parallel to the grain	$E_{0,05}$	7.400
	mean value vertical to the grain	$E_{90,mean}$	370
Shear modulus		G_{mean}	690
Rolling shear modulus		$G_{R,mean}$	69
Raw density	5% quantile	ρ_k	350
	mean value	ρ_{mean}	420

[1] In order to prove the shear stress as a result of a shear force, $f_{v,k}$ shall be reduced by the factor k_{cr} as specified in the relevant National Annex.

5.2 Example design for a timber beam ceiling

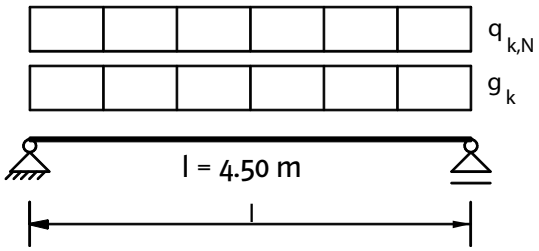
The example is based on German National Annexes.

$q_{k,N}$ = Live load for habitable rooms and office floor space pursuant to EN 1991-1-1 and to the German National Annex [20],[21] plus addition for partition walls 0.8 kN/m²

1. System, building component dimensions

Timber beam ceiling in the form of a single span girder spacing between the beams: e = 62.5 cm, l=4.50m

Material: solid structural timber KVH®, C 24



2. Characteristic loads

permanent (dead loads) g_k = 1.75 kN/m²

variable (live load including lightweight partition walls) $q_{k,N}$ = 2.80 kN/m²

Load combinations (LC) for the verification of the load-bearing capacity

Load duration class (LDC) pursuant to EN 1995-1-1, Table 2.1 in conjunction with DIN EN 1995-1-1/NA, Table. NA.1

k_{mod} - see below

Combination factors ψ for several changeable loads pursuant to EN 1990/NA [22] for live loads of categories A or B (habitable rooms, office floor space) ψ_0 = 0,7 / ψ_1 = 0,5 / ψ_2 = 0,3

Values pursuant to EN 338 in conjunction with DIN 20000-5 [23]

No.	Combination	Combination rule	Design value	LDC	k_{mod}
LC 1	g	$1.35 \cdot g_k$	Σq_d = 2.36 kN/m²	permanent	0.60
LC 2	g + p	$1.35 \cdot g_k + 1.5 \cdot q_k$	Σq_d = 6.56 kN/m²	medium	0.80

Decisive is clearly LC 2 which will be pursued below.

3. Strength and stiffness properties C 24

Characteristic value of bending strength $f_{m,k}$ = 24.0 N/mm²

Characteristic value of shear strength $f_{v,k}$ = 2.0 N/mm²

Modulus of elasticity parallel to the grain $E_{0,mean}$ = 11.000 N/mm²

4. Design values of the strengths

Partial safety factor and modification factor taken from EN 1995-1-1, Tab. 2.3 (γ_M) and 3.1 (k_{mod}) in conjunction with DIN EN 1995-1-1/NA, Tables NA.2, NA.3 & NA.4

Modification factor for solid timber k_{mod} = 0.80

Partial safety factor γ_M = 1.3

Design value of bending strength $f_{m,d} = 0.8 \cdot 24.0 / 1.3$ $f_{m,d}$ = 14.8 N/mm²

Design value of shear strength $f_{v,d} = 0.8 \cdot 2.0 / 1.3$ $f_{v,d}$ = 1.23 N/mm²

5. Strain – Bending moments, lateral forces and support reactions

Cutting sizes per beam (e = 62.5 cm)

$$R_d = \frac{k_{mod} \cdot R_k}{\gamma_M}$$

Design moment for LC 2:

$M_d = \Sigma q_d \cdot l^2 / 8 = 6.56 \cdot 4.50^2 / 8 \cdot 0.625$ M_d = 10.38 kNm

Design lateral force for LC 2:

$V_d = \Sigma q_d \cdot l / 2 = 6.56 \cdot 4.50 / 2 \cdot 0.625$ $\quad V_d = 9.23$ kN

Characteristic support reaction for the decisive LC 2:

End supports A and B: $A_{g,k} = B_{g,k} = 1.75 \cdot 4.50 / 2$ $\quad A_{g,k} = 3.94$ kN/m

$A_{q,k} = B_{q,k} = 2.80 \cdot 4.50 / 2$ $\quad A_{q,k} = 6.30$ kN/m

6. Pre-dimensioning

Required section modulus:

$W_{y,req} = M_d / f_{m,d} = 10.38 \cdot 10^3 / 14.8$ $\quad W_{y,req} = 701$ cm³

Chosen cross section:		
for $M_d = 10.38$ kNm	**w/h = 8/24 cm**	with $W_y = 768$ cm³

7. Verifications of load-bearing capacity

Design value of the bending strength:

$\sigma_{m,y,d} = M_d / W_y = 10.38 / 768 \cdot 10^3$ $\quad \sigma_{m,y,d} = 13.5$ N/mm²

verification

$$\frac{\sigma_{m,y,d}}{f_{m,d}} = \frac{13.5}{14.8} = 0.91 < 1$$

Design value of the shear stress:

$\tau_d = 1.5 \cdot V_d / A = 1.5 \cdot 9.23 / 192$ $\quad \tau_d = 0.72$ N/mm²

verification:

$$\frac{\tau_d}{f_{v,d}} = \frac{0.72}{1.23} = 0.59 < 1$$

8. Verification of serviceability

It is recommended in accordance with EN 1995-1-1, subsection 2.2.3, that the two following cases are always examined:

a) Restriction of the initial deflection without creep influences:

$$w_{inst} = w_{inst,G} + w_{inst,Q1} + \sum w_{inst,Q,i} \text{ (with i being > 1)} \leq l/300 \text{- } l/500$$

b) Restriction of the final deflection with creep influences that are depending on time:

$$w_{fin} = w_{fin,G} + w_{fin,Q1} + \sum w_{fin,Qi} \leq l/150 - l/300$$

If there is a planned precamber w_0, the following shall be examined as well:

c) final deflection $w_{net,fin}$ with the precamber w_0 being deducted:

$$w_{net,fin} = w_{fin} - w_0 \leq l/250 - l/350$$

EN 1995-1-1 stipulates recommended deflection limitations in sub-section 7.2 (2). The determination of a specific limit depends primarily on the question, which kind of deformation is deemed to be acceptable for technical or optical reasons in the individual case concerned. It is assumed that the maximum deflection values specified must be complied with.

Deflection stiffness for cross-section b/h = 8/24 cm

Calculation of deflection

$$E_{0,mean} \cdot I_y = 11.00 \cdot 92.16 \cdot 10^6 = 1.014 \cdot 10^{12} \text{ Nmm}^2$$

$$w_{inst,G} = \frac{5}{384} \cdot \frac{g_k \cdot l^4}{E \cdot I} = \frac{5}{384} \cdot \frac{(1.75 \cdot 0.625) \cdot 4500^4 \cdot 12}{11.000 \cdot 80 \cdot 240^3} = 5.8 \text{ cm}$$

Deformation factor k_{def} in accordance with DIN EN 1995-1-1, Table 3.2, in conjunction with DIN EN 1995-1-1/NA, Table NA.5 – for solid timber and glued solid timber: k_{def} (SC 1)= 0.6

$$w_{fin,G} = w_{inst,G} (1 + k_{def}) = 5.8 \cdot (1 + 0.6) = 9.3 \text{ mm}$$

$$w_{inst,Q} = \frac{5}{384} \cdot \frac{g_k \cdot l^4}{E \cdot I} = \frac{5}{384} \cdot \frac{(2.80 \cdot 0.625) \cdot 4500^4 \cdot 12}{11.000 \cdot 80 \cdot 240^3} = 9.2 \text{ cm}$$

$$w_{fin,G} = w_{inst,Q} (1 + k_{def}) = 9.2 \cdot (1 + 0.6) = 14.7 \text{ mm}$$

Proof of deflection

Case a) $w_{inst} = w_{inst,G} = 5.8 + 9.2 = 15\ mm$

for $w_{inst,max} = l/300 = 4500/300 = 15\ mm \rightarrow = w_{inst} \rightarrow$ OK

for $w_{inst,max} = l/500 = 4500/500 = 9\ mm \rightarrow > w_{inst} \rightarrow$ enlargement of cross-section required

Case b) $w_{fin} = w_{fin,G} + \psi^2 * w_{fin,QG} = 9.3 + 0.3 * 14.7 = 13.7\ mm$

for $w_{fin,max} = l/150 = 4500/150 = 30\ mm \rightarrow > w_{fin} \rightarrow$ OK

for $w_{fin,max} = l/300 = 4500/300 = 15\ mm \rightarrow = w_{fin} \rightarrow$ OK.

Case c) $w_{net,fin} = w_{fin} - w_0$ can be disregarded, since there is no precamber.

Vibration verification

EN 1995-1-1 regulates exclusively the vibration of apartment ceilings with a natural frequency (first order vibration) of f1 > 8 Hz. Everything else requires special tests and analyses that will not be described here in more detail. A simplified verification on the basis of a deflection limitation is not offered.

DIN EN 1995-1-1, Clause 7.3

The following conditions need to be satisfied:

$w / F \leq a$ und $v \leq b^{(f1 \cdot \zeta - 1)}$

whereby

w is the largest initial vertical deflection as a result of a concentrated single vertical static load F that can act at any place and is established by taking into account the load distribution. It is reasonable in this case to use the so-called man load with 1.0 kN as an approach for stepping onto the ceiling;

v is the uniform pulse speed response;

ζ is the modal damping ratio (is usually calculated with 0.01).

The vibration behavior of a timber beam ceiling is primarily determined by the rigidity of the load-bearing beams. The width of the ceiling is merely included in the calculation with the contribution of the load-bearing ceiling planks and their ability to transmit the vibration vertically to the position of the beams. In order to simplify matters, a fictitious ceiling width of 1.0 m is assumed in future calculations. The most important vibration parameters can be applied to any ceiling widths. The example below assumes the existence of tongue-and groove boards for the formwork with a thickness of 24 mm.

Input values

$l_{ceiling} = l_{beams} = 4.5\ m$ | $b_{ceiling} = 1.0\ m$ | $b_{beams} = 8\ cm = 0.08\ m$

$h_{beams} = 24\ cm\ 0.24\ m$ | $F = 1.0\ kN$ | $m = 1.75\ kN/m^2 = 175\ kg/m^2$

Calculation of the rigidity lengthwise $(EI)_l$ and crosswise $(EI)_b$ to the position of the beams.

$(EI)_l > (EI)_b$ is always applicable

$$(EI)_l = E_{beam} \cdot \frac{b_{beam} \cdot h_{beam}^3}{12 \cdot e_{beam}} = 11.000 \cdot 10^6 \cdot \frac{0.08 \cdot 0.24^3}{12 \cdot 0.625} = 1.622 \cdot 10^6\ Nm^2/m$$

$$(EI)_b = E_{planking} \cdot \frac{b_{ceiling} \cdot d_{planking}^3}{12} = 11.000 \cdot 10^6 \cdot \frac{1.0 \cdot 0.024^3}{12} = 12.67 \cdot 10^3\ Nm^2/m$$

A crucial parameter for the vibration behavior is the natural frequency f_1 of the building component that must drop below 8.0 Hz when conducting the verification.

$$f_1 = \frac{\pi}{2 \cdot l^2} \cdot \sqrt{\frac{(EI)_l}{m}} = \frac{\pi}{2 \cdot 4.5^2} \cdot \frac{1.622 \cdot 10^6}{175} = 7.46\ Hz < f_{1,min} = 8.0\ Hz$$

The required natural frequency of 8,0 Hz cannot be obtained with the cross-section chosen.
→ newly selected cross-section for the beam: 10/24 cm

$$(EI)_l = E_{beam} \cdot \frac{b_{beam} \cdot h_{beam}^3}{12 \cdot e_{beam}} = 11.000 \cdot 10^6 \cdot \frac{0.10 \cdot 0.24^3}{12 \cdot 0.625} = 2.027 \cdot 10^6\ Nm^2/m$$

$$f_1 = \frac{\pi}{2 \cdot 4.5^2} \cdot \sqrt{\frac{2.027 \cdot 10^6}{175}} = 8.23\ Hz > f_{1,min} = 8.0\ Hz$$

The ceiling mass must meet a minimum requirement with regard to the speed response. This is to ensure that the vibration reaction is kept as low as possible, when the ceiling is exposed to heavy impacts (such as jumping, hopping etc.). It is applicable for hinged ceilings

$$v = \frac{4 \cdot (0.4 + 0.6 \cdot n_{40})}{m \cdot b \cdot l + 200}$$

with

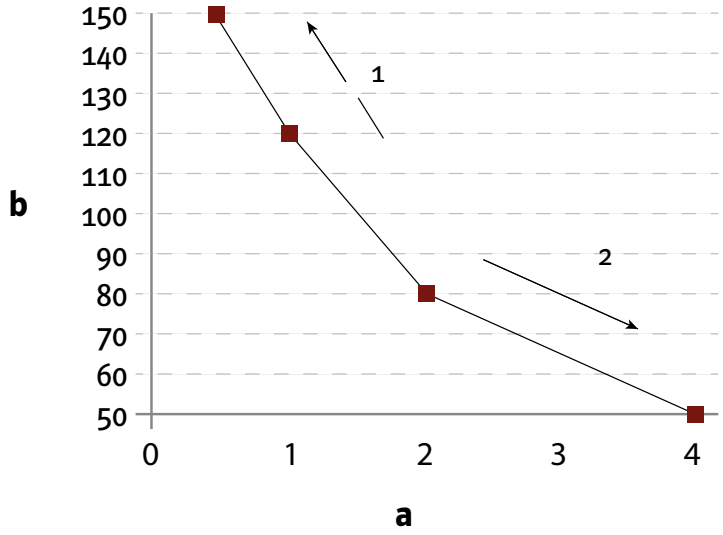
$$n_{40} = \left\{\left[\left(\frac{40}{f_1}\right)^2 - 1\right] \cdot \left(\frac{b}{l}\right)^4 \cdot \frac{(EI)_l}{(EI)_b}\right\}^{0.25} = \left\{\left[\left(\frac{40}{8.23}\right)^2 - 1\right] \cdot \left(\frac{1.0}{4.5}\right)^4 \cdot \frac{2.027 \cdot 10^6}{12.67 \cdot 10^3}\right\}^{0.25} = 1.72$$

The result of the ceiling chosen in the example is therefore

$$v = \frac{4 \cdot (0.4 + 0.6 \cdot 1.72)}{175 \cdot 1.0 \cdot 4.5 + 200} = 5.80 \cdot 10^{-3}$$

The value v must not exceed a certain limit. Fig. 7.2 in EN 1995-1-1 shows the relation between the two recommended values a and b. In this case, the value a should not exceed 1.5, since otherwise the ceiling would have a rather unfavorable vibration behavior.

Figure 7.2 Recommended area and relation between a and b



According to Fig. 7.2, EN 1995-1-1 is applicable for

a = 0 – 2 → better and

a = 2 – 4 → poorer vibration behavior

1 = better vibration behavior

2 = poorer vibration behavior

It must be proven that

$$\frac{w}{F} \leq a \leq 1.5 \text{ mm / kN}$$

whereby the deflection w of the ceiling shall be calculated when exposed to a single load F, with F being usually assumed as man load of 1.0 kN. The deflection in this example therefore results to

$$w = \frac{Fl^3}{48\ EI} = \frac{1000 \cdot 4500^3 \cdot 12}{48 \cdot 11.000 \cdot 100 \cdot 240^3} = 1.5 \text{ mm}$$

$$\rightarrow \quad \frac{w}{F} = \frac{1.5}{1.0} = 1.5 \text{ mm / kN}$$

Hence, the limit for a has just been achieved. It can be taken from Fig. 7.2 in EN 1995-1-1 that the recommended value b = 100, so that it can be proved that

$$v \leq b^{(f1 \cdot \zeta - 1)} \rightarrow 5.80 \cdot 10^{-3} \leq 100^{(8{,}23 \cdot 0{,}01 - 1)} = 0.015 \rightarrow \text{OK}$$

It can be seen that the relevant limits of the structure chosen for this example have been observed both with regard to the natural frequency f1 and with regard to the deflection from the excitation load F. Although it has thus been proved that the vibration still remains within the limits, no tolerances are stated for the structure itself with regard to the execution in practice. It is therefore recommended in such cases to allow a safety distance to the limits by choosing larger cross-sections for the beams.

6 Tenders and technical rules

A performance requirement shall be clearly and comprehensively described, so that all bidders understand and interpret the description/specification in the same way and that they can calculate their prices safely and without substantial preparatory work. You can only safely expect to get the right product, if the wording of your tender documents is clear, technically correct and complete. The high quality demands to be met by KVH®, Duobalken® and Triobalken® require a careful internal quality control. You should therefore make sure in your own interest that the timber and its production are subjected to a strict quality inspection. You can find an up-to-date list of supervised companies in the Internet under www.kvh.eu.

Special requests - Species

KVH® as well as Duobalken® and Triobalken® beams are supplied as standard in spruce/fir. They are also available in pine, larch and Douglas fir on request.

Tender specification for the supply of KVH® construction timber

Item ...: ... m³ Supply of solid structural timber KVH® Si, C24

solid structural timber KVH® Si (for the visible application)
pursuant to EN 15497 (if finger-jointed) or EN 14081-1 (if not finger-jointed), strength class C24,
moisture content u_m = 15 ± 3 %,
type of cutting: split-heart, surface planed and chamfered,
tolerance class 2 pursuant to EN 336, from controlled production.

Item ... ... m³ Supply of solid structural timber KVH® NSi

solid structural timber KVH® NSi (for non-visible application)
pursuant to EN 15497 (if finger-jointed) or EN 14081-1 (if not finger-jointed), strength class C24,
moisture content u_m = 15 ± 3%,
type of cutting: split-heart, surface leveled and chamfered,
tolerance class 2 pursuant to EN 336, from controlled production.

Tender specification for the supply of glued solid timber

Item ... ... m³ Supply of glued solid timber Duobalken® beams Si

glued solid timber Duobalken® Si beams (for visible application),
made from two planks bonded together pursuant to EN 14080,
strength class C24, moisture content u_m = max. 15 %, surface planed and chamfered,
tolerance class 2 pursuant to EN 336, from controlled production.

Item ... ... m³ Supply of glued solid timber Triobalken® beams Si

glued solid timber Triobalken® beams Si (for visible application),
made from three planks bonded together pursuant to EN 14080,
strength class C24, moisture content u_m = max. 15 %, surface planed
and chamfered, tolerance class 2 pursuant to EN 336, from quality-controlled production.

7 Declarations of Performance, CE-marking and additional control in accordance with the agreements about KVH®

7.1 KVH® without finger-joints

The manufacturer is required to issue a Declaration of Performance, of which an example of such Declaration of Performance for KVH® without finger-jointing can be found below. The red text need to be adapted to the manufacturer's specific conditions.

Declaration of Performance

No. xyz

1.	Unambiguous ID code of the product type:	name of product type 1 name of product type 2 name of product type 3
2.	Intended use:	buildings and bridges
3.	Manufacturer:	name of company street post code & place country
4.	Authorized representative:	no external authorized representative
5.	System for assessing and verifying the constancy of performance:	System 2+
6.a	Harmonized standard:	EN 14081-1:2011
	Notified body:	No. 1234

7 Performance declared:

ESSENTIAL CHARACTERISTICS	PERFORMANCE
Modulus of elasticity	dry graded
Bending strength	spruce (PCAB)
Compressive strength	grading pursuant to DIN 4074-1, allocated pursuant to EN 1912
Tensile strength	mechanical characteristics of the strength classes pursuant to EN 338 for:
Shear strength	name of product type 1: C18 (S7)
	name of product type 2: C24 (S10)
	The allocation of the construction products supplied to the individual strength classes can be taken from the accompanying documents.
Reaction to fire	D-s2,d0
Durability	durability class against fungi: 5

The characteristics of the above product conform to the performance declared. The above named manufacturer is exclusively responsible for preparing the Declaration of Performance in accordance with Regulation EU/305/2011.

Signed on behalf of the manufacturer and in his name by:

.....

(name und function)

.....

(Place & Date of issue) (Signature)

The CE marking is based on the Declaration of Performance and shall be attached to the product or to the accompanying document or to the packaging. Alternatively, the product itself can be marked with the relevant text which must contain the following information pursuant to EN 14081-1:

- *name of the manufacturer;;*
- *grading class and standard,*
- *„M" if mechanically graded;*
- *„DRY GRADED", if applicable;*
- *ID code number identifying the product from the accompanying document;*
- *„PT" if treated with preservative agents*

CE 1234		*CE marking pursuant to Directive 93/68/EEC* *Number of the notified body*
Name of company 14 No. xyz		*Name or sign of the manufacturer* *Please note: The address of the manufacturer can be added* *Last two figures: year of the initial inspection* *Number of the Declaration of Performance*
EN 14081-1:2011 Construction timber graded according to strength for load-bearing applications in buildings and bridges		*Standard number with year of publication* *Product description and field of application*
Modulus of elasticity Bending strength Compressive strength Tensile strength Shear strength	dry graded spruce (PCAB) grading pursuant to DIN 4074-1, allocated pursuant to EN 1912 C24 (S10)	*Mandated characteristics*
Reaction to fire class	D-s2,d0	
natural durability against wood destroying fungi	durability class against fungi: 5	

Figure 7.1: Example of a CE mark for KVH® without finger-jointing pursuant to EN 14081-1

7.2 KVH® with finger-joints

The manufacturer is required to issue a Declaration of Performance, of which an example of such Declaration of Performance for KVH® with finger-jointing can be found below. The red text need to be adapted to the manufacturer's specific conditions.

Declaration of Performance

No. xyz

1.	Unambiguous ID code of the product type:	name of product type 1 name of product type 2
2.	Intended use::	buildings and bridges
3.	Manufacturer:	name of company street post code & place country
4.	Authorized representative:	no external authorized representative
5.	System for assessing and verifying the constancy of performance:	System 1
6.a	Harmonized standard:	EN 15497:2014
	Notified body:	No. 1234

7 Performance declared:

ESSENTIAL CHARACTERISTICS	PERFORMANCE	
Mechanical characteristics as		
Modulus of elasticity	Mechanical characteristics of the strength classes pursuant to EN 14081-1 for:	
Bending strength	name of product type 1:	C18 (S7)
Compressive strength	name of product type 2:	C24 (S10)
Tensile strength Shear strength	The allocation of the construction products supplied to the individual strength classes can be taken from the accompanying documents.	
Bonding strength as		
Bending strength of the finger joints	name of product type 1: name of product type 2:	18 N/mm² 24 N/mm²
Durability of the bonding strength as		
Species	name of product type 1: name of product type 2:	spruce spruce

Adhesive	for all product types: adhesive for finger joints: PUR, adhesive type I
Durability against biological attack as	
Natural durability class against wood destroying fungi EN 350-2	for all product types: 5
Fire resistance as	
Geometric data	for all product types: widths ranging between 60 and 140 mm heights ranging between 100 and 240 mm
Charring rate as • characteristic density	The allocation of the building components supplied to the individual cross-sectional dimensions can be taken from the accompanying documents
• Species	for all product types: characteristic raw density of the relevant strength class name of product type 1: spruce name of product type 2: spruce
Reaction to fire as	
Reaction to fires class	for all product types D-s2, d0
Emission of formaldehyde as	
formaldehyde emission class	for all product types: E 1
Release of other dangerous substances	
Release of other dangerous substances	for all product types: not relevant

The characteristics of the above product conform to the performance declared. The above named manufacturer is exclusively responsible for preparing the Declaration of Performance in accordance with Regulation EU/305/2011.

Signed on behalf of the manufacturer and in his name by:

……

(Name und function)

……

(Place & date of issue) (Signature)

The CE marking is based on the Declaration of Performance and shall be attached to the product or to the accompanying document or to the packaging. Alternatively, the product itself can be marked with the relevant text. The information provided by the CE marking and the way of attaching it corresponds to the above requirements for KVH® without finger-jointing.

CE marking pursuant to Directive 93/68/EEC *Number of the notified body*	CE 1234
Name or sign of the manufacturer *Please note: The address of the manufacturer can be added* *Last two figures: year of the initial inspection* *Number of the Declaration of Performance*	Name of company 14 No. xyz
Standard number with year of publication *Product description and field of application*	EN 15497:2014 Structural finger-jointed timber for applications in buildings and bridges
Mandated characteristics	**Mechanical characteristics and fire resistance** as
geometric data (mm)	60 x 120 x 12000
strength class and characteristic raw density	C 24
Species	spruce (picea abies)
Bonding strength as	
bending strength of finger joints	24 N/mm²
Durability of the bonding strength as	
Species	spruce (picea abies)
adhesive for finger joints	PUR, I
Durability of other characteristics as	
natural durability against wood destroying fungi	5
Reaction to fire	D-s2, d0
Emission of formaldehyde	E1

Figure 7.2: Example of a CE mark for structural finger-jointed timber made of spruce without preservative treatment

7.3 Glued solid timber (Duobalken®/Triobalken®)

The manufacturer is required to issue a Declaration of Performance, of which an example of such Declaration of Performance for Duobalken® beams can be found below. The red text need to be adapted to the manufacturer's specific conditions.

Declaration of Performance

No. xyz

1.	Unambiguous ID code of the product type:	name of product type 1 name of product type 2
2.	Intended use:	buildings and bridges
3.	Manufacturer:	name of company street post code & place country
4.	Authorized representative	no external authorized representative
5.	System for assessing and verifying the constancy of performance:	System 1
6.a	Harmonized standard:	EN 14080:2013
	Notified body:	No 1234

7 Performance declared:

ESSENTIAL CHARACTERISTICS	PERFORMANCE
Mechanical characteristics as	
Modulus of elasticity Bending strength Compressive strength Tensile strength Shear strength	mechanical characteristics of the strength classes pursuant to EN 14081-1 for: name of product type 1: C18 (S7) name of product type 2.. C24 (S10) The allocation of the construction products supplied to the individual strength classes can be taken from the accompanying documents. k_{sys} pursuant to EN 1995-1-1:2004, sub-section 6.6(4) must not be applied
Geometric data	for all product types: widths ranging b etween 60 and 160 mm heights ranging between 80 and 240 mm The relevant product dimensions can be taken from the accompanying documents.

Bonding strength as	
Bending strength of finger joints	name of product type 1: 18 N/mm²
	name of product type 2: 24 N/mm²
Glue line integrity of the surface bonding	delamination test pursuant to EN 14080, Annex C, Method B
Durability of the bonding strength as	
Species	for all product types: spruce (picea abies)
adhesive	adhesive for finger joints: PUR, adhesive type I
	adhesive for surface bonding: MUF, IGP70S
Durability against biological attack as	
Natural durability class against wood destroying fungi EN 350-2	5
Fire resistance as	
Geometric data	see „Geometric data"
Charring rate as	
• characteristic density	characteristic raw density of the relevant strength class
• Species	for all product types: spruce (picea abies)
Reaction to fire as	
Reaction to fires class	D-s2, d0
Emission of formaldehyde as	
formaldehyde emission class	E 1
Release of other dangerous substances	
Release of other dangerous substances	not relevant

The characteristics of the above product conform to the performance declared. The above named manufacturer is exclusively responsible for preparing the Declaration of Performance in accordance with Regulation EU/305/2011.

Signed on behalf of the manufacturer and in his name by:

.....

(Name und function)

.....

(Place & date of issue) (Signature)

CE 1234		*CE marking pursuant to Directive 93/68/EEC* *Number of the notified bodyame*
Name of company 14 No. xyz		*Name or sign of the manufacturer* *Please note: The address of the manufacturer can be added* *Last two figures: year of the initial inspection* *Number of the Declaration of Performance*
EN 14080:2013 Glued solid timber made of spruce without preservative treatment for applications in buildings and bridges		*Standard number with year of publication* *Product description and field of application*
Mechanical characteristics and fire resistance as		*Mandated characteristics*
geometric data (mm)	160 x 240 x 12000	
strength class and characteristic raw density	C 24	
Species	spruce (picea abies)	
Bonding strength as		
bending strength of finger joints	24 N/mm²	
glue line integrity test	B	
Reaction to fire	D-s2, d0	
Emission of formaldehyde	E1	
Durability of the bonding strength as		
Species adhesive for the surface bonding between lamellas	5	
adhesive for finger joints adhesive for surface bonding:	PUR, adhesive type I MUF, IGP70S	
Durability of other characteristics as		
natural durability against wood destroying fungi	5	

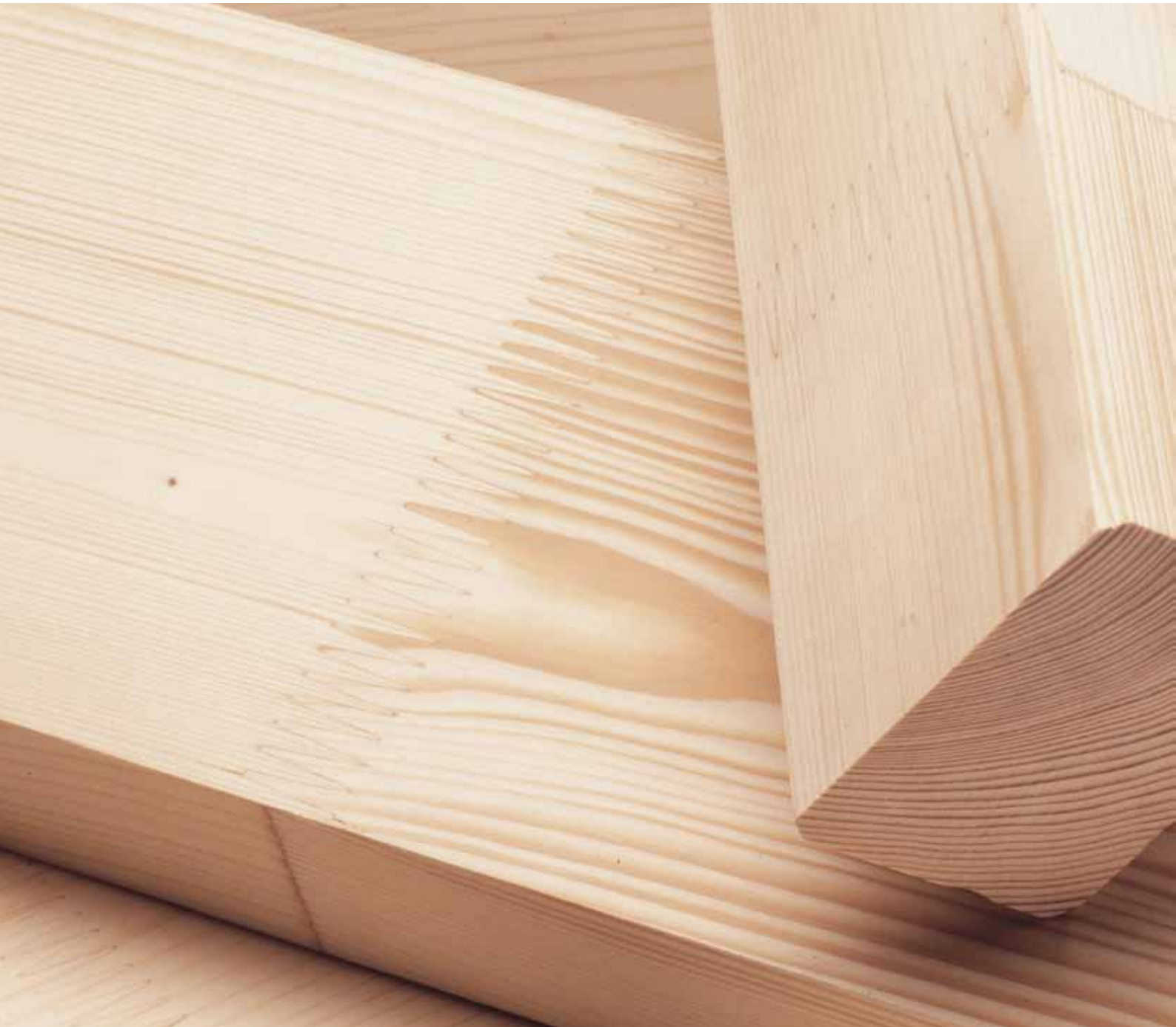
Figure 7.3 — Example of a CE-mark for glued solid timber (Duobalken®)

7.4 KVH® inspection mark

The members of the Überwachungsgemeinschaft Konstruktionsvollholz e.V. monitor the quality of their products by internal inspections (self-control) and by additional inspections carried out by independent institutions. This does not only apply to the conditions imposed by the construction supervision authorities but also to additional requirements arising from the agreement about solid structural timber.

Only solid structural timber produced and controlled by the member companies of the Überwachungsgemeinschaft Konstruktionsvollholz e.V. must be marked with the internationally protected KVH® trademark sign.

Figure 7.4
KVH® inspection mark



8 Literature and list of standards

[1] Bund Deutscher Zimmermeister and Überwachungsgemeinschaft Konstruktionsvollholz e.V. (2015): Agreement about KVH® (solid structural timber) made of spruce, fir, pine, larch and Douglas fir

[2] Bund Deutscher Zimmermeister and Überwachungsgemeinschaft Konstruktionsvollholz e.V. (2015): Agreement about Duo /Trio beams made of spruce, fir, pine, larch and Douglas fir

[3] EN 15497:2014: Structural finger-jointed timber – Performance requirements and minimum production requirements

[4] EN 14081-1:2011: Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements

[5] EN 14080:2013: Structural timber – glued laminated timber and glued solid timber – Requirements

[6] Institut Bauen und Umwelt e.V. (2014): Environmental Product Declaration pursuant to ISO 14025 and EN 15804 for solid structural timber KVH®

[7] Institut Bauen und Umwelt e.V. (2013): Environmental Product Declaration pursuant to ISO 14025 and EN 15804 for Duobalken® & Triobalken® members (glued solid timber)

[8] EN 338:2009: Structural timber – strength classes

[9] DIN 4074-1:2012: Strength grading of wood - Part 1: Coniferous sawn timber

[10] EN 13501-1:2009: Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests

[11] EN 1912:2013: Structural timber - Strength classes - Assignment of visual grades and species

[12] EN 1995-1-1:2010, Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings

[13] EN 385:2001: Structural finger joints – Performance requirements and minimum production requirements (withdrawn)

[14] EN 301:2013: Adhesives, phenolic and aminoplastic, for load-bearing timber structures - Classification and performance requirements

[15] EN 15425:2008: Adhesives - One component polyurethane (PUR) for load-bearing timber structures - Classification and performance requirements

[16] EN 336:2013: Structural timber - Sizes, permitted deviations

[17] DIN EN 1995-1-1/NA:2013: National Annex - Nationally determined parameters - Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings

[18] EN 1995-1-2:2009, Eurocode 5: Design of timber structures - Part 1-2: General - Structural fire design

[19] EN 1995-2: 2004, Eurocode 5: Design of timber structures - Part 2: Bridges

[20] EN 1991-1-1:2009, Eurocode 1: Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings

[21] DIN EN 1991-1-1/NA:2010, National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings

[22] DIN EN 1990/NA:2010, National Annex - Nationally determined parameters

[23] DIN 20000-5:2012: Application of construction products in structures - Part 5: Strength graded structural timber with rectangular cross section

Advantages of KVH®

- dry timber construction components with cross-sections up to a maximum of 14/24 cm available
- dimensionally stable, since kiln-dried to 15 ± 3 % and split-heart cut (heart-free on request)
- available in two qualities:
  - planed for visible applications (Si)
  - leveled for non-visible applications (NSi)
- meets higher requirements as compared with EN 14080 or EN 14081-1
- recommended as solid structural timber for the construction of timber frames and wooden houses
- low input for invitations to tender thanks to an unambiguous quality agreement
- insensitive to insects due to kiln-drying; preservative treatment with chemicals can be dispensed with
- economically preferred cross-sections and lengths of up to 13 m immediately available from stock

Advantages of Duobalken® und Triobalken®

- **larger cross-sections of up to a maximum of 28/24 cm or 10/36 cm immediately available**
- **dimensionally stable, since kiln-dried to a maximum of 15 %, cut split-heart bonded**
- **fewer glue joints as compared with glued laminated timber (2 as a maximum), glue joint hardly visible**
- **available in two qualities:**
  - **planes for visible applications (Si)**
  - **leveled for non-visible applications (NSi)**
- **recommended for voluminous or large cross-sections with high optical requirements**
- **insensitive to insects due to kiln-drying; preservative treatment with chemicals can be dispensed with**
- **economically preferred cross-sections and lengths of up to 13 m immediately available from stock, larger lengths on request**

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