

LIGNOLOC® WOODEN NAILS

Technical Manual

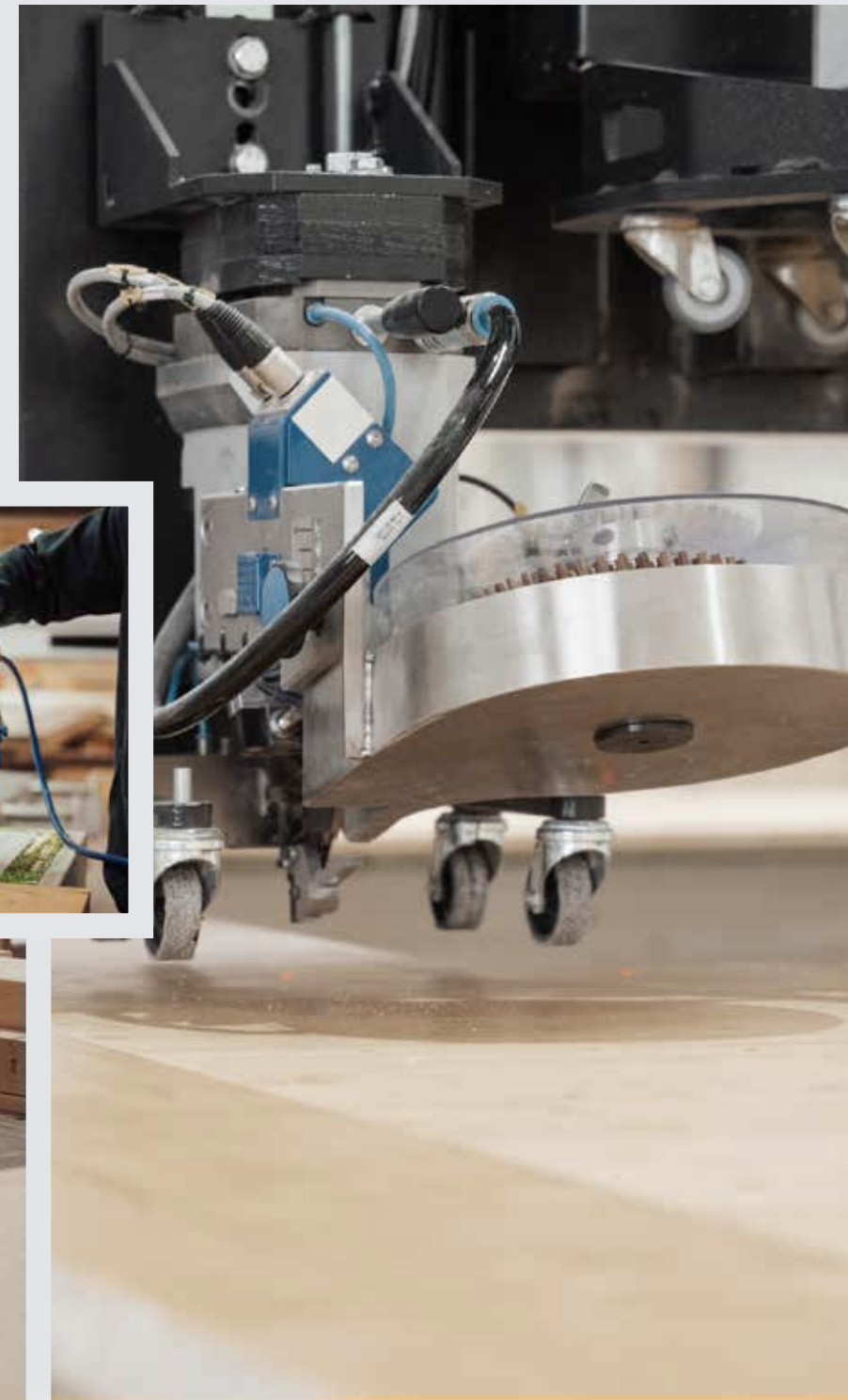


2026

We do not wait for the solution – we create it.



LIGNOLOC®
wooden nails
enable metal-
free construction
systems.



Contents



About BECK

Founded in 1904, BECK is a fourth-generation family-owned company based in Mauerkirchen, Upper Austria. As a pioneer in fastening technology, the brand stands for innovation and uncompromising quality. With LIGNOLOC® – the world’s first shootable wooden nail – BECK continues to set new standards. This system enables wood-to-wood connections without metal and reduces CO₂ emissions by up to 66%¹ compared with steel nails of equivalent load-bearing capacity. With this and other innovative fastening solutions, BECK has been shaping contemporary construction for more than 120 years.

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“We want to rethink timber construction – for a future where building remains circular and relevant.”

Christian Beck,
General Manager & CEO, BECK



LIGNOLOC® wooden nails

LIGNOLOC® wooden nails are the world's first shootable wooden nails, enabling fast and efficient installation. They are pneumatically driven into wood using hand tools or fully automated nailing heads mounted on multifunctional bridges. No pre-drilling or adhesive is required, which significantly accelerates the construction process. Unlike metal nails, LIGNOLOC® wooden nails cause virtually no tool wear, extending the service life of saws and other cutting tools. In solid timber construction, the technical performance of these wooden nails makes a crucial difference – especially their high tensile and shear strengths, which are key to the stability of solid wood structures. A unique feature of LIGNOLOC® is its lignin adhesion: during the driving process, the heat generated by friction creates a bond between the nail and the wood. Good to know: The beech wood in LIGNOLOC® wooden nails is sourced from PEFC-certified forests (certificate QA-PEFC-COC-000147).



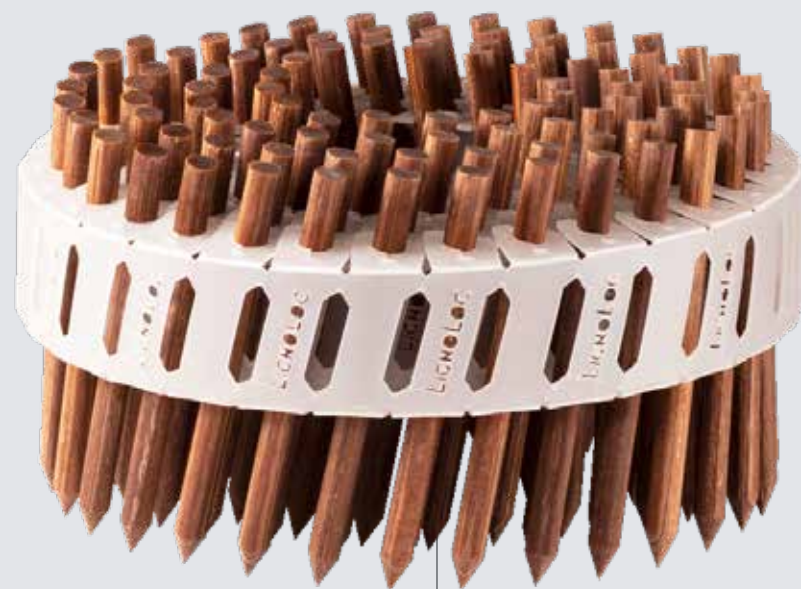
Scan the QR-code
for more information

“LIGNOLOC® makes it possible to join wood to wood. This creates a truly special connection.”

Michaela Beck,
Marketing Director | BECK



Technical benefits of LIGNOLOC®



Metal-free fastening

LIGNOLOC® delivers up to 66% lower CO₂ emissions compared with steel nails of equivalent load-bearing capacity.¹



Efficient and time-saving

LIGNOLOC® wooden nails are pneumatically driven into wood, eliminating the need for pre-drilling and gluing typically required for wooden dowels.



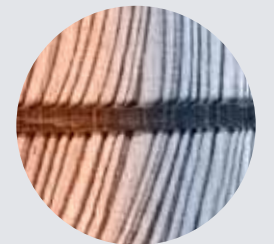
Improved fire performance

Unlike steel nails, LIGNOLOC® wooden nails do not fail suddenly in the event of fire – instead, they perform like mass timber.



Naturally beautiful

LIGNOLOC® wooden nails offer a natural appearance and touch, with no chemical interaction that could affect the wood's aesthetics over time.



Favourable thermal performance

LIGNOLOC® wooden nails minimize thermal bridges, contributing to energy-efficient construction.

Lignin adhesion

The term lignin adhesion refers to a bonding process. It occurs when two or more pieces of wood – or other materials rich in lignin – are briefly heated to approximately 180 °C and then pressed together.

Under the influence of heat, the lignin contained in the material changes its state, becoming soft and tacky. Upon cooling, the lignin re-solidifies. The lignin-rich layers that were pressed together during this phase remain bonded through adhesion forces.

This process of lignin adhesion occurs particularly when wooden nails are driven into wood. The surface friction generated between the nail and the wood matrix raises the temperature at the contact zone above 180 °C. As the nail displaces the wood material, the matrix pushes back against the nail, increasing pressure and enhancing the adhesive effect.

When LIGNOLOC® wooden nails are driven into wood, the combination of high temperature and lateral pressure creates ideal conditions for initiating the adhesion of lignin. As a result, the withdrawal resistance of the wooden nail is twice as high as that of a geometrically comparable steel nail.

Resistant to corrosion and chemicals

LIGNOLOC® wooden nails with head are suitable for outdoor use and corrosive environments, as they do not rust.



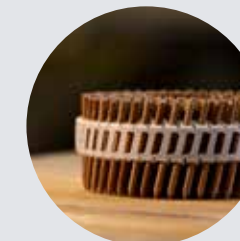
Post-processing without tool wear

LIGNOLOC® wooden nails are gentle on tools and saw blades during the post-processing of timber components.



Patented technology

Our patented LIGNOLOC® wooden nail technology provides a distinct competitive edge for our partners.



The advantages are obvious: LIGNOLOC® wooden nails and the construction methods based on them are in line with the principles of circular construction (see EPD, page 54). Compared with the production of steel nails of equivalent load-bearing capacity, manufacturing our wooden nails generates up to 66% lower CO₂ emissions¹ – a significant difference that makes LIGNOLOC® particularly well suited to innovative timber construction projects. The wooden nails by BECK are made of densified laminated beech wood.²

Structural design for planners and carpenters

ETA-23/0041 | ETA-23/0330



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- Product range
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- General principles

LIGNOLOC® wooden nails

Edge distances – LIGNOLOC® wooden nails

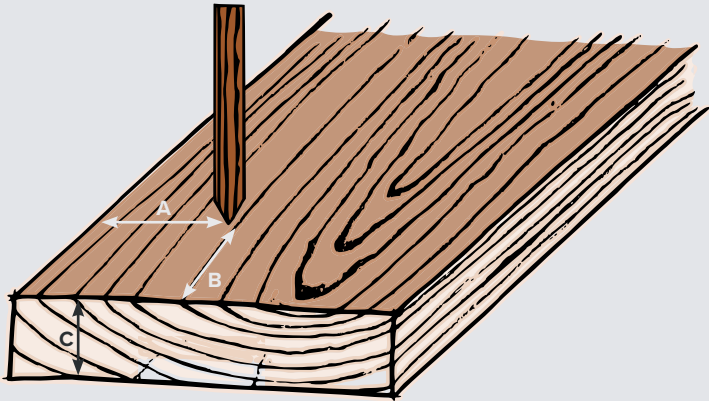
based on DIN EN 1995-1-1:2010-12

	Wood Density	
	≤ 420 kg/m³	420 kg/m³ - 500 kg/m³
A	5*d	7*d ¹
B	10*d	15*d ¹
C	7*d	7*d ¹
D	When nails are driven in a row, an offset of 1*d should be maintained between them.	

	Wood density ≤ 420 kg/m³		
	ø 3.7	ø 4.7	ø 5.3
A	18.5	23.5	26.5
B	37.0	47.0	53.0
C	25.9	32.9	37.1

	Wood density ≤ 420 kg/m³ - 500 kg/m³		
	ø 3.7	ø 4.7	ø 5.3
A	25.9	32.9	37.1
B	55.5	70.5	79.5
C	25.9	32.9	37.1

d = nail diameter
¹ = values also apply to wood species classified as prone to splitting (e.g. silver fir)
Wood moisture content should be below 18%.

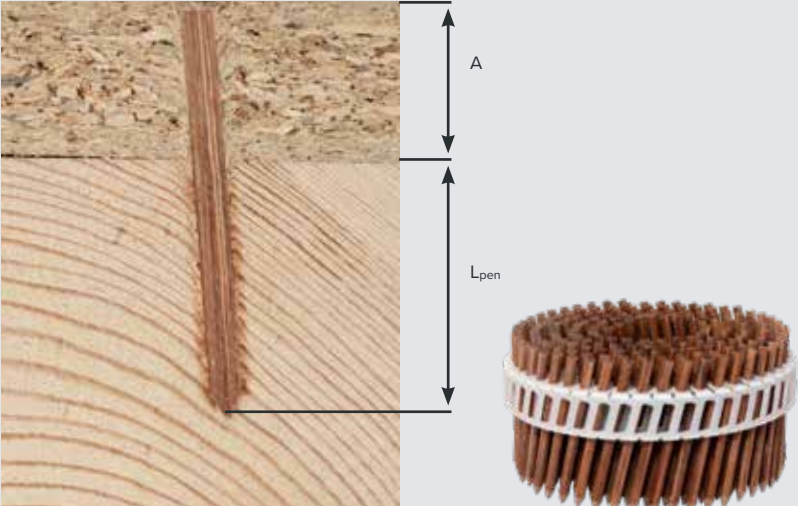


Penetration depth – LIGNOLOC® wooden nails

Minimum penetration depth – LIGNOLOC® wooden nails

Diameter	Top Layer	Substructure
[mm]	[mm]	[mm]
ø 3.7	14.8	29.6
ø 4.7	18.8	37.6
ø 5.3	21.2	42.4

The top layer (A) should be at least 4 times the nail diameter in thickness. LIGNOLOC® wooden nails should penetrate the substructure to a depth of at least 8 times the nail diameter (L_{pen}).

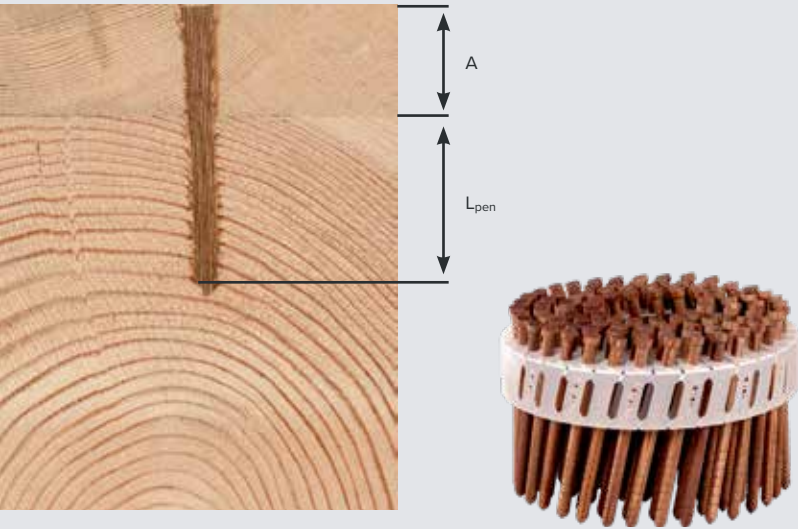


LIGNOLOC® wooden nails with head – penetration depth

Minimum penetration depth – LIGNOLOC® wooden nails

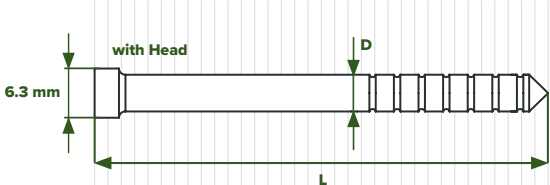
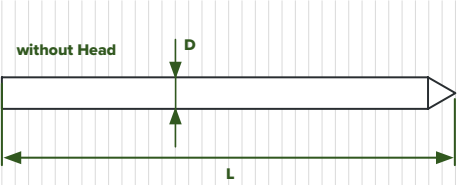
Diameter	Top layer	Substructure
[mm]	[mm]	[mm]
ø 4.7	18.8	37.6

The top layer (A) should be at least 4 times the nail diameter in thickness. LIGNOLOC® wooden nails should penetrate the substructure to a depth of at least 8 times the nail diameter (L_{pen}).



Structural design for planners

Product range



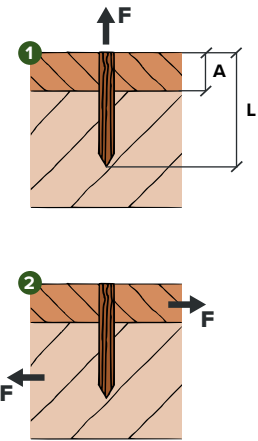
ITEM	D DIAMETER [mm]	L LENGTH [mm]	ITEM-NO.
 LIGNOLOC® wooden nails 3.7	3.7	38	CN37AGWON.1
		50	CN37AGWON.2
		55	CN37AGWON.3
		60	CN37AGWON.4
 LIGNOLOC® wooden nails 4.7	4.7	65	CN47AGWO.2
		75	CN47AGWO.3
		90	CN47AGWO.4
 LIGNOLOC® wooden nails 5.3	5.3	65	CN53AGWO.1
		75	CN53AGWO.2
		90	CN53AGWO.3
 LIGNOLOC® wooden nails 4.7 with head	4.7	58	CN47AGWO-H.6
		64	CN47AGWO-H.10
		78	CN47AGWO-H.9

Mechanical properties

ITEM	DIAME-TER [mm]	CHARACTERISTIC WITHDRAWAL PARAMETER F _{ax,k} [N/mm ²]	CHARACTERISTIC TENSILE CAPACITY F _{tens, k} [kN]	CHARACTERISTIC YIELD MOMENT M _{u, k} [Nmm]	CHARACTERISTIC HEAD PULL-THROUGH PARAMETER F _{head, k} [Nmm ²]
LIGNOLOC® wooden nails 3.7	3.7	7	1.2	1200	
LIGNOLOC® wooden nails 4.7	4.7	7	1.4	2200	
LIGNOLOC® wooden nails 5.3	5.3	7	2	3600	
LIGNOLOC® wooden nails 4.7 with head	4.7	7	1.4	1800	12

LIGNOLOC® wooden nails 3.7

CHARACTERISTIC WITHDRAWAL CAPACITY ①			F _{ax,k} [N]		F _{ax,k-Top layer} [N]
Top layer	A	L	C16	C24	
	[mm]				
Solid wood	24	55	729	803	504
Plywood	15	50	823	907	241
	18	50	752	829	347
	20	55	823	907	428
OSB3/4	15	50	823	907	303
	18	50	752	829	436
1-layer / 3-layer	16	50	799	881	224
	18-20	50	705	777	284
Gypsum fibre board	15	50	823	907	456

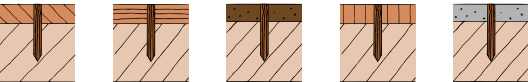


WITHDRAWAL CAPACITY ①			F _{ax,Rd} [N]						F _{ax,Rd-Top layer} [N]		
Top layer	A	L	Medium		Short		Very short		Medium	Short	Very short
	[mm]		C16	C24	C16	C24	C16	C24			
Solid wood	24	55	224	247	280	309	449	494	155	194	310
Plywood	15	50	253	279	317	349	506	558	80	100	161
	18	50	231	255	289	319	463	510	116	145	231
	20	55	253	279	317	349	506	558	143	178	285
	25	60	253	279	317	349	506	558	143	178	285
OSB3/4	15	50	253	279	317	349	506	558	101	126	202
	18	50	231	255	289	319	463	510	145	182	291
1-layer / 3-layer	16	50	246	271	307	339	492	542	69	86	138
	18-20	50	217	239	271	299	434	478	87	109	175
Gypsum fibre board	15	50	253	279	317	349	506	558	140	175	281

Load duration considered (incl. k_{mod} and γ_M)

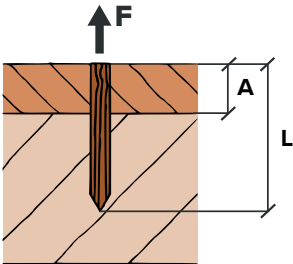
SHEAR VALUE ②			F _{v,Rd} [N]									
Top layer	A	L	Permanent		Long-term		Medium-term		Short-term		Very short-term	
	[mm]		C16	C24	C16	C24	C16	C24	C16	C24	C16	C24
Solid wood	24	55	104	107	120	123	143	147	166	171	225	232
Plywood	15	50	109	113	126	131	151	156	175	182	238	246
	18	50	109	113	126	131	151	156	175	182	238	246
	20	55	109	113	126	131	151	156	175	182	238	246
OSB3/4	15	50	109	112	127	132	158	164	188	195	254	264
	18	50	109	112	127	132	158	164	188	195	254	264
1-layer / 3-layer	16	50	104	107	120	123	143	147	166	171	211	215
	18-20	50	104	107	120	123	143	147	166	171	225	232
Gypsum fibre board	15	50	124	130	132	137	165	172	196	205	270	282

Load duration considered (incl. k_{mod} and γ_M)



LIGNOLOC® wooden nails 4.7

CHARACTERISTIC WITHDRAWAL CAPACITY			F _{ax,k} [N]		F _{ax,k} -Top layer [N]
Top layer	A	L	C16	C24	
	[mm]				
 Solid wood	24	65	1,224	1,349	504
	28	75	1,403	1,546	686
	35	90	1,642	1,810	1,072
 Plywood	20/21	65	1,314	1,448	428
	24/25	65	1,194	1,316	616
	27	75	1,433	1,579	780
	35	90	1,642	1,810	1,311
 OSB3/4	22	65	1,284	1,415	652
	25	65	194	1,316	842
	30	75	1,344	1,481	1,212
1-layer / 3-layer	20	65	1,344	1,481	350
	23/24	65	1,224	1,349	463
	26	65	1,164	1,283	592
	27	75	1,433	1,579	638
	32	75	1,284	1,415	896
	40	90	1,493	1,645	1,316

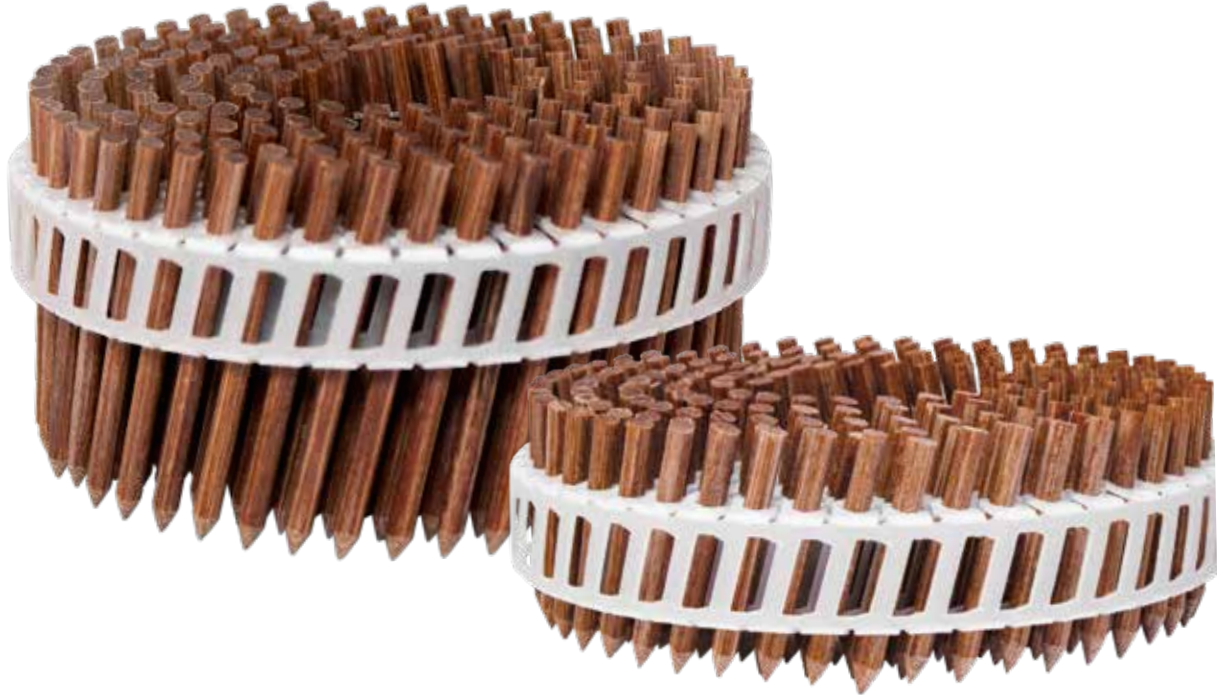
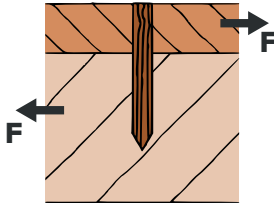


WITHDRAWAL CAPACITY			F _{ax,Rd} [N]						F _{ax,Rd-Top layer} [N]		
Top Layer	A	L	Medium		Short		Very short		Medium	Short	Very short
	[mm]		C16	C24	C16	C24	C16	C24			
 Solid wood	24	65	377	415	471	519	753	830	155	194	310
	28	75	432	476	540	595	863	951	211	264	422
	35	90	505	557	632	696	1,010	1,114	330	412	660
 Plywood	20/21	65	404	446	505	557	809	891	132	165	263
	24/25	65	367	405	459	506	735	810	190	237	379
	27	75	441	486	551	607	882	972	240	300	480
	35	90	505	557	632	696	1,010	1,114	403	504	807
 OSB3/4	22	65	395	435	494	544	790	871	217	272	435
	25	65	60	405	75	506	119	810	281	351	561
	30	75	414	456	517	570	827	911	404	505	808
 1-layer / 3-layer	20	65	414	456	517	570	827	911	108	135	215
	23/24	65	377	415	471	519	753	830	142	178	285
	26	65	358	395	448	493	716	790	182	228	364
	27	75	441	486	551	607	882	972	196	245	393
	32	75	395	435	494	544	790	871	276	345	551
	40	90	459	506	574	633	919	1,012	405	506	810

Load duration considered (incl. k_{mod} and γ_M)

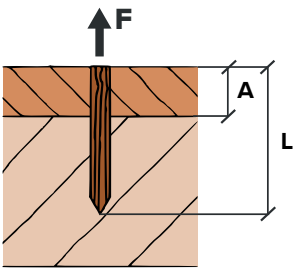
SHEAR VALUE			F _{v,Rd} [N]									
Top layer	A	L	Permanent		Long-term		Medium-term		Short-term		Very short-term	
	[mm]		C16	C24	C16	C24	C16	C24	C16	C24	C16	C24
 Solid wood	24	65	152	156	175	181	209	216	243	251	329	340
	28	75	152	156	175	181	209	216	243	251	329	340
	35	90	152	156	175	181	209	216	243	251	329	340
 Plywood	20/21	65	160	166	185	192	221	229	257	266	348	360
	24/25	65	160	166	185	192	221	229	257	266	348	360
	27	75	160	166	185	192	221	229	257	266	348	360
	35	90	160	166	185	192	221	229	257	266	348	360
 OSB3/4	22	65	159	165	186	193	231	240	275	286	372	387
	25	65	159	165	186	193	231	240	275	286	372	387
	30	75	159	165	186	193	231	240	275	286	372	387
 1-layer / 3-layer	20	65	152	156	175	181	209	216	243	251	308	318
	23/24	65	152	156	175	181	209	216	243	251	329	340
	26	65	152	156	175	181	209	216	243	251	329	340
	27	75	152	156	175	181	209	216	243	251	329	340
	32	75	152	156	175	181	209	216	243	251	329	340
	40	90	152	156	175	181	209	216	243	251	329	340

Load duration considered (incl. k_{mod} and γ_M)



LIGNOLOC® wooden nails 5.3

CHARACTERISTIC WITHDRAWAL CAPACITY			F _{ax,k} [N]		F _{ax,k-Top layer} [N]	
Top layer	A	L	C16	C24		
	[mm]					
	Solid wood	24	75	1,717	1,892	504
		28	75	1,582	1,744	686
		35	90	1,852	2,041	1,072
	Plywood	20/21	65	1,481	1,632	428
		24/25	75	1,683	1,855	616
		27	75	1,616	1,781	780
		35	90	1,852	2,041	1,311
	OSB3/4	22	65	1,448	1,595	652
		25	75	1,683	1,855	842
		30	90	2,020	2,226	1,212
	1-layer / 3-layer	20	65	1,515	1,670	350
		23/24	75	1,717	1,892	463
		26/27	75	1,616	1,781	592
		32	90	1,953	2,152	896
		40	90	1,683	1,855	1,400

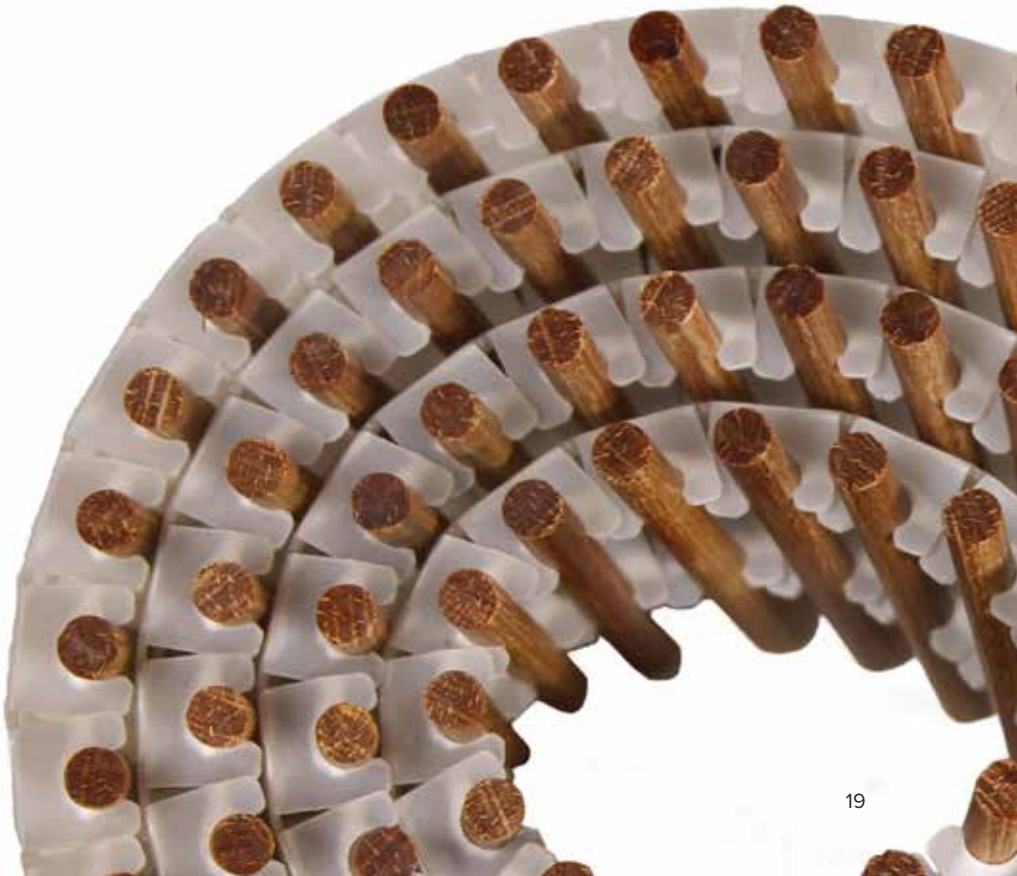
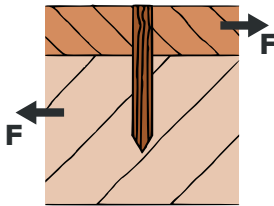


WITHDRAWAL CAPACITY				F _{ax,Rd} [N]						F _{ax,Rd-Top layer} [N]		
Top layer	A	L	Medium		Short		Very short		Medium	Short	Very short	
	[mm]		C16	C24	C16	C24	C16	C24				
	Solid wood	24	75	528	582	660	728	1,057	1,164	155	194	310
		28	75	487	537	608	671	974	1,073	211	264	422
		35	90	570	628	712	785	1,140	1,256	330	412	660
	Plywood	20/21	65	456	502	570	628	911	1,004	132	165	263
		24/25	65	518	571	647	713	1,036	1,142	190	237	379
		27	75	497	548	622	685	994	1,096	240	300	480
		35	90	570	628	712	785	1,140	1,256	403	504	807
	OSB3/4	22	65	446	491	557	613	891	982	217	272	435
		25	75	518	571	647	713	1,036	1,142	281	351	561
		30	90	622	685	777	856	1,243	1,370	404	505	808
	1-layer / 3-layer	20	65	466	514	583	642	932	1,028	108	135	215
		23/24	75	528	582	660	728	1,057	1,164	142	178	285
		26/27	75	497	548	622	685	994	1,096	182	228	364
		32	90	601	662	751	828	1,202	1,324	276	345	551
		40	90	518	571	647	713	1,036	1,142	431	538	862

Load duration considered (incl. k_{mod} and γ_M)

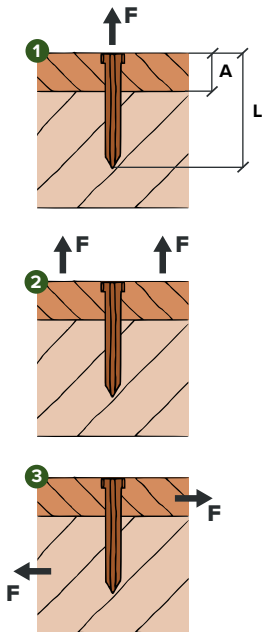
SHEAR VALUE			F _{v,Rd} [N]										
Top layer	A	L	Permanent		Long-term		Medium-term		Short-term		Very short-term		
	[mm]		C16	C24	C16	C24	C16	C24	C16	C24	C16	C24	
	Solid wood	24	75	202	208	233	240	278	287	323	334	400	412
		28	75	202	208	233	240	278	287	323	334	438	452
		35	90	202	208	233	240	278	287	323	334	438	452
	Plywood	20/21	65	213	221	246	255	294	305	336	348	410	425
		24/25	75	213	221	246	255	294	305	342	354	463	479
		27	75	213	221	246	255	294	305	342	354	463	479
		35	90	213	221	246	255	294	305	342	354	463	479
	OSB3/4	22	65	211	219	248	257	307	320	365	380	495	515
		25	75	211	219	248	257	307	320	365	380	495	515
		30	90	211	219	248	257	307	320	365	380	495	515
	1-layer / 3-layer	20	65	182	187	212	219	242	250	272	281	333	344
		23/24	75	202	208	233	240	278	287	313	323	383	395
		26/27	75	202	208	233	240	278	287	323	334	433	447
		32	90	202	208	233	240	278	287	323	334	438	452
		40	90	202	208	233	240	278	287	323	334	438	452

Load duration considered (incl. k_{mod} and γ_M)



LIGNOLOC® wooden nails 4.7 with head

CHARACTERISTIC WITHDRAWAL CAPACITY 1			F _{ax,k} [N]		F _{ax,k-Top layer} [N]
Top layer	A	L	C16	C24	
	[mm]				
Solid wood (55 mm length)	18	58	1,194	1,316	476
	20	58	1,135	1,250	476
	25	64	1,164	1,283	476
	25	78	1,582	1,744	476



WITHDRAWAL VALUE ①			F _{ax,Rd} ¹ [N]					
Top layer	A	L	Medium		Short		Very Short	
	[mm]		C16	C24	C16	C24	C16	C24
Solid wood (55 mm length)	18	58	367	405	459	506	735	810
	20	58	349	385	437	481	698	769
	25	64	358	395	448	494	717	790
	25	78	487	537	608	671	974	1,073

HEAD PULL-THROUGH VALUE ②			F _{head,Rd} ¹ [N]					F _{head,Rd} ² [N]				
Top layer	A	L	Perma- nent	Long- term	Medium- term	Short- term	Very short- term	Perma- nent	Long- term	Medium- term	Short- term	Very short- term
	[mm]											
Solid wood (55 mm length)	18	58	128	146	183	220	330	128	146	146	183	220
	20	58	128	146	183	220	330	128	146	146	183	220
	25	64	0	146	183	220	330	128	146	146	183	220
	25	78	128	146	183	220	330	128	146	146	183	220

Load duration considered (incl. k_{mod} and γ_M)

SHEAR VALUE ③			F _{v,Rd} ¹ [N]									
Top layer	A	L	Permanent		Long-term		Medium-term		Short-term		Very short-term	
	[mm]		C16	C24	C16	C24	C16	C24	C16	C24	C16	C24
Solid wood (55 mm length)	18	58	137	142	158	163	189	195	220	227	277	286
	20	58	137	142	158	163	189	195	220	227	298	307
	25	64	137	142	158	163	189	195	220	227	298	307
	25	78	137	142	158	163	189	195	220	227	298	307

SHEAR VALUE ③			F _{v,Rd} ² [N]									
Top layer	A	L	Permanent		Long-term		Medium-term		Short-term		Very short-term	
	[mm]		C16	C24	C16	C24	C16	C24	C16	C24	C16	C24
Solid wood (55 mm length)	18	58	137	142	158	163	196	175	201	207	243	251
	20	58	137	142	158	163	196	175	201	207	243	251
	25	64	137	142	158	163	196	175	201	207	243	251
	25	78	137	142	158	163	169	175	201	207	243	251

¹Service class 1 & 2
²Service class 3
Load duration considered (incl. k_{mod} and γ_M)

General principles

The characteristic values, including the mechanical strengths and geometric parameters of LIGNOLOC® wooden nails, are determined and presented based on EN 1995-1-1 and in accordance with the specifications of ETA-23/0041 and ETA-23/0330.

The design values are derived from the characteristic values as follows:

$$F_{ax,t,d} = F_{ax,t,k} \cdot k_{mod,ax} / \gamma_M$$
$$F_{head,d} = F_{max,k} \cdot k_{mod} / \gamma_M$$

The coefficients k_{mod,ax} and γ_M are taken from the relevant standard.

The calculations are based on a characteristic mean density of 350 kg/m³ and a penetration depth of t = 8d.

LOAD DURATION CLASS	k _{mod, M}	k _{mod, ax}	k _{mod, M}	k _{mod, M}		
	Service class 1 and 2		Service class 1 and 3*	Solid wood, 3-layer, plywood	OSB3/4	Gypsum fibre board
Permanent	0.35	-	0.35	0.6	0.4	0.2
Long-term	0.4	-	0.4	0.7	0.5	0.4
Medium-term	0.5	0.4	0.4	0.8	0.7	0.6
Short-term	0.6	0.5	0.5	0.9	0.9	0.8
Very Short-term	0.9	0.8	0.6	1.1	1.1	1.1

* for LIGNOLOC® wooden nails 4,7 with head

For nails under combined loading both perpendicular and axial to the nail direction, the following design rules apply:

$$\frac{F_{ax,Ed}}{F_{ax,Rd}} + \frac{F_{v,Ed}}{F_{v,Rd}} \leq 1$$

For shear resistance, the fibre orientation resulting in the lowest value is assumed (a = 90°).

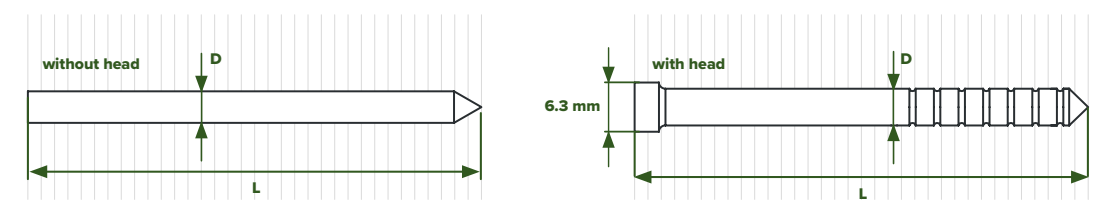
The characteristic density and partial safety factor γ_M used in the calculations can be taken from the following table:

	rk [kg/m ³]	gM
Solid wood	350	1.3
Plywood	450	1.3
OSB3/4	600	1.2
1-layer / 3-layer	350	1.3
Gypsum fibre board	1,000	1.3

Spacing between fasteners and distances to edges are in accordance with EN 1995-1-1. The design and verification of timber components and panels must be carried out separately.

Structural design for carpenters

Product range



ITEM	DIAMETER [mm]	LENGTH [mm]	ITEM NO.
 LIGNOLOC® wooden nails 3.7	3.7	38	CN37AGWON.1
		50	CN37AGWON.2
		55	CN37AGWON.3
		60	CN37AGWON.4
 LIGNOLOC® wooden nails 4.7	4.7	65	CN47AGWO.2
		75	CN47AGWO.3
		90	CN47AGWO.4
 LIGNOLOC® wooden nails 5.3	5.3	65	CN53AGWO.1
		75	CN53AGWO.2
		90	CN53AGWO.3
 LIGNOLOC® wooden nails 4.7 with head	4.7	58	CN47AGWO-H.6
		64	CN47AGWO-H.10
		78	CN47AGWO-H.9

Mechanical properties

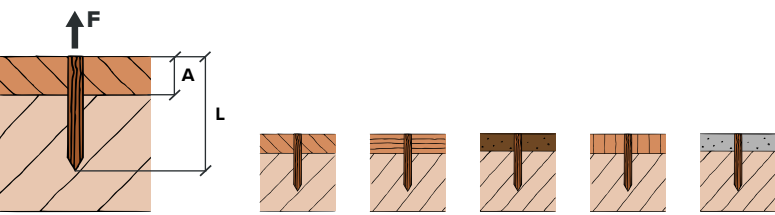
ITEM	DIAMETER [mm]	CHARACTERISTIC WITHDRAWAL PARAMETER $F_{ax,k}$ [N/mm ²]	CHARACTERISTIC TENSILE CAPACITY $F_{tens,k}$ [kN]	CHARACTERISTIC YIELD MOMENT $M_{0,k}$ [Nmm]	CHARACTERISTIC HEAD PULL-THROUGH PARAMETER $F_{head,k}$ [Nmm ²]
LIGNOLOC® wooden nails 3.7	3.7	7	1.2	1200	
LIGNOLOC® wooden nails 4.7	4.7	7	1.4	2200	
LIGNOLOC® wooden nails 5.3	5.3	7	2	3600	
LIGNOLOC® wooden nails 4.7 with head	4.7	7	1.4	1800	12

LIGNOLOC® wooden nails 3.7

LIGNOLOC® WOODEN NAILS 3.7			Withdrawal capacity			Shear value	
			F _{ax,d}		F _{ax,k-Top layer}	F _{v,Rd}	
			[kg]		[kg]	[kg]	
			Medium		Medium	Permanent	
Top layer	A	L	C16	C24		C16	C24
	[mm]						
Solid wood	24	55	22.9	25.2	15.8	10.6	10.9
Plywood	15	50	25.8	28.4	8.2	11.1	11.5
	18	50	23.6	26.0	11.8	11.1	11.5
	20	55	25.8	28.4	14.5	11.1	11.5
OSB3/4	15	50	25.8	28.4	10.3	11.1	11.4
	18	50	23.6	26.0	14.8	11.1	11.4
1-layer / 3-layer	16	50	25.1	27.6	7.0	10.6	10.9
	18-20	50	22.1	24.4	8.9	10.6	10.9
Gypsum fibre board	15	50	25.8	28.4	14.3	12.6	13.3

LIGNOLOC® wooden nails 4.7

LIGNOLOC® WOODEN NAILS 4.7			Withdrawal capacity			Shear value	
			F _{ax,k}		F _{ax,k-Top layer}	F _{v,Rd}	
			[kg]		[kg]	[kg]	
			Medium		Medium	Permanent	
Top layer	A	L	C16	C24		C16	C24
	[mm]						
Solid wood	24	65	38.4	42.3	15.8	15.5	15.9
	28	75	44.0	48.5	21.5	15.5	15.9
	35	90	51.5	56.8	33.6	15.5	15.9
Plywood	20/21	65	41.2	45.4	13.4	16.3	16.9
	24/25	65	37.5	41.3	19.3	16.3	16.9
	27	75	44.9	49.5	24.5	16.3	16.9
	35	90	51.5	56.8	41.1	16.3	16.9
OSB3/4	22	65	40.3	44.4	22.2	16.2	16.8
	25	65	6.1	41.3	28.6	16.2	16.8
	30	75	42.2	46.5	41.2	16.2	16.8
1-layer / 3-layer	20	65	42.2	46.5	11.0	15.5	15.9
	23/24	65	38.4	42.3	14.5	15.5	15.9
	26	65	36.5	40.2	18.6	15.5	15.9
	27	75	44.9	49.5	20.0	15.5	15.9
	32	75	40.3	44.4	28.1	15.5	15.9
	40	90	46.8	51.6	41.3	15.5	15.9

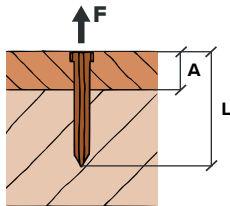


LIGNOLOC® wooden nails 5.3

LIGNOLOC® WOODEN NAILS 5.3			Withdrawal capacity			Shear value		
			F _{ax,k}		F _{ax,k-Top-layer}	F _{v,Rd}		
			[kg]		[kg]	[kg]		
			medium-term			permanent		
Top layer	A	L	C16	C24		C16	C24	
	[mm]							
	Solid wood	24	75	1,717	1,892	504	20.6	21.2
		28	75	1,582	1,744	686	20.6	21.2
		35	90	1,852	2,041	1,072	20.6	21.2
	Plywood	20/21	65	1,481	1,632	428	21.7	22.5
		24/25	75	1,683	1,855	616	21.7	22.5
		27	75	1,616	1,781	780	21.7	22.5
		35	90	1,852	2,041	1,311	21.7	22.5
	OSB3/4	22	65	1,448	1,595	652	21.5	22.3
		25	75	1,683	1,855	842	21.5	22.3
		30	90	2,020	2,226	1,212	21.5	22.3
	1-layer / 3-layer	20	65	1,515	1,670	350	18.6	19.1
		23/24	75	1,717	1,892	463	20.6	21.2
		26/27	75	1,616	1,781	592	20.6	21.2
		32	90	1,953	2,152	896	20.6	21.2
		40	90	1,683	1,855	1,400	20.6	21.2

LIGNOLOC® wooden nails 4.7 with head

LIGNOLOC® WOODEN NAILS 4.7 WITH HEAD			Withdrawal capacity			Shear value	
			F _{ax,k}		F _{head,k-Top-layer}	F _{v,Rd}	
			[kg]		[kg]	[kg]	
			medium-term	medium-term	permanent	permanent	
Top layer	A	L	C16	C24		C16	C24
	[mm]						
Solid wood	18	58	37	41	13.1	14.0	14.5
	20	58	36	39	13.1	14.0	14.5
	25	64	37	40	13.1	14.0	14.5
	25	78	50	55	13.1	14.0	14.5



General principles

To simplify practical application for carpenters, only the most unfavourable load duration classes – medium-term and permanent – have been considered. Therefore, the values provided represent conservative minimum values and are universally applicable. For more detailed structural verifications, values for other load duration classes can be taken from ETA-compliant calculations.

The characteristic values, including the mechanical properties and geometric parameters of LIGNOLOC® wooden nails, are determined and presented in accordance with EN 1995-1-1 and the specifications of ETA-23/0041 and ETA-23/0330.

The design values are derived from the characteristic values as follows:

$$F_{ax,t,d} = F_{ax,t,k} \cdot k_{mod,ax} / \gamma_M$$
$$F_{head,d} = F_{max,k} \cdot k_{mod} / \gamma_M$$

The coefficients $k_{mod,ax}$ and γ_M are taken from the relevant standard.

The calculations are based on a characteristic density of 350 kg/m³ and a penetration depth of t = 8d.

LOAD DURATION CLASS	k _{mod, M}	k _{mod, ax}	k _{mod, M}	k _{mod, M}		
	Service class 1 and 2		Service class 1 and 3*	Solid wood, 3-layer, plywood	OSB3/4	Gypsum fibre board
Permanent	0.35	-	0.35	0.6	0.4	0.2
Long-term	0.4	-	0.4	0.7	0.5	0.4
Medium-term	0.5	0.4	0.4	0.8	0.7	0.6
Short-term	0.6	0.5	0.5	0.9	0.9	0.8
Very short-term	0.9	0.8	0.6	1.1	1.1	1.1

* for LIGNOLOC® wooden nails 4.7 with head

For nails subjected to combined loading perpendicular and parallel to the nail axis, the following applies:

$$\frac{F_{ax,Ed}}{F_{ax,Rd}} + \frac{F_{v,Ed}}{F_{v,Rd}} \leq 1$$

For shear resistance, the fibre orientation resulting in the lowest value is assumed (a = 90°).

The characteristic density and partial safety factor γ_M used in the calculations can be taken from the following table:

	rk [kg/m³]	gM
Solid wood	350	1.3
Plywood	450	1.3
OSB3/4	600	1.2
1-layer / 3-layer	350	1.3
Gypsum fibre board	1000	1.3

Spacing between fasteners and distances to edges are in accordance with EN 1995-1-1. The design and verification of timber components and panels must be carried out separately.

Structural analysis of a shear wall in wood panel construction

According to DIN EN 1995-1-1:2010-12 with LIGNOLOC® wooden nails

Calculation performed by:
BIGA
Structural Engineers
Prof. Dr. Ing. Patrik Aondio
An der Halde 3 | 87448 Waltenhofen | Germany
Phone: +49 (0) 8379 / 880 900-3
Email: aondio@biga-bauingenieure.de
Website: biga-bauingenieure.de

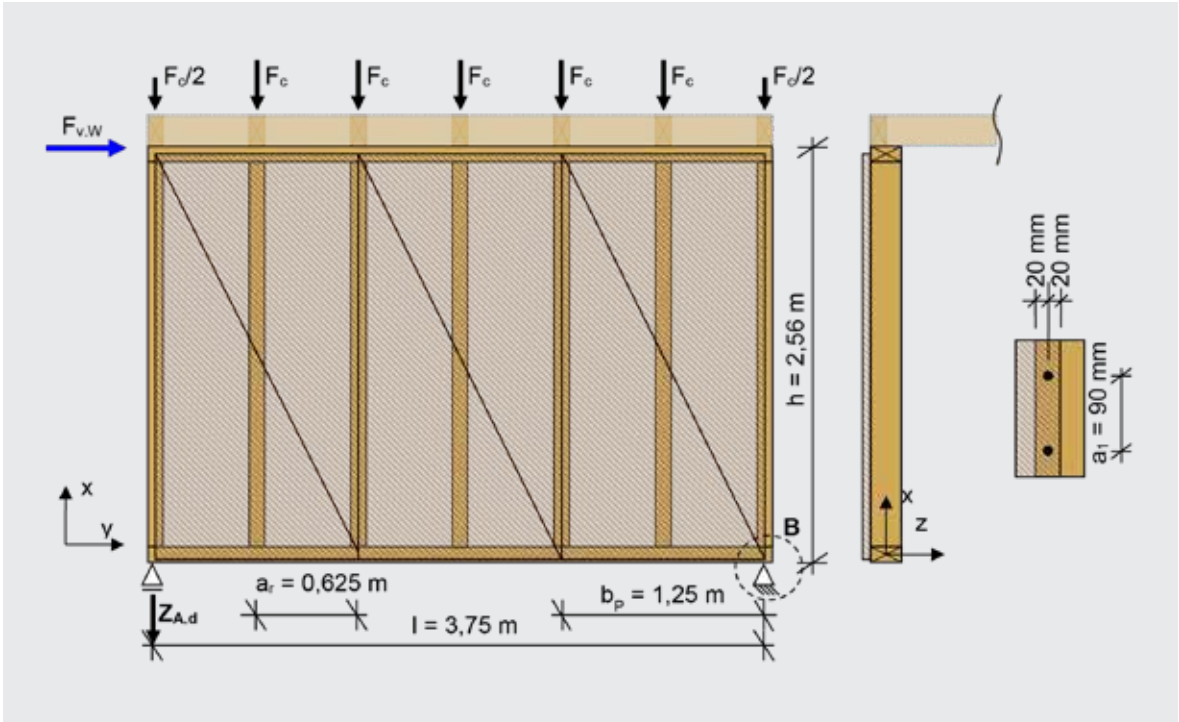


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01 // System

A single-family home constructed using timber panel construction is considered. The exterior wall element presented below was identified as the most critical and will be used for the subsequent structural design.

- Edge studs:** Softwood C24, $b_{Ri} \times h_{Ri} = 80 \times 120 \text{ mm}^2$, NKL 1
- Inner studs:** Softwood C24, $b_{Ri} \times h_{Ri} = 80 \times 120 \text{ mm}^2$, NKL 1, $a_r = 0,625 \text{ m}$ (stud spacing)
- Bottom/Top plates:** Softwood C24, $b_s \times h_s = 60 \times 120 \text{ mm}^2$, NKL 1
- Sheathing:** OSB/4, $t_p = 18 \text{ mm}$, applied on one side according to DIN EN 12369-1:2001
- Fasteners:** LIGNOLOC® wooden nails, $d = 3.7 \text{ mm}$, $l = 50 \text{ mm}$, $a_i = 90 \text{ mm}$



LOAD TYPE	CHARACTERISTIC VALUE	LOAD DURATION CLASS	ψ_0
Permanent load	$F_{c,g,k} = 2.0 \text{ kN}$	Permanent	-
Imposed load	$F_{c,q,k} = 5.0 \text{ kN}$	Medium-term	0.7
Snow load < 1000 m	$F_{c,s,k} = 3.0 \text{ kN}$	Short-term	0.5
Wind load (in plane)	$F_{v,w,k} = 5.0 \text{ kN}$	Short/very short-term	0.6
Wind load (out-of-plane)	$w_k = 0.4 \text{ kN/m}^2$	Short/very short-term	0.6



02 // Application requirement

For the simplified design of shear walls according to method A of DIN EN 1995-1-1:2010-12

Anchorage

Is end anchorage provided? ✓

9.2.4.2 (1)

Sheathing

Is the width of each panel at least $h/4$?

9.2.4.2 (2)

$$b_p = 1,25 \text{ m} \geq \frac{h}{4} = \frac{2,56}{4} = 0,64 \text{ m} \checkmark$$

Is there a maximum of one horizontal panel joint? ✓

9.2.4.2 (NA.20)

Are the panel edges rigidly connected in shear? ✓

Fasteners as per ETA-23/0041, analogous to non-pre-drilled nails per EN 1995-1-1:2010-12

Is a consistent fastener spacing provided along all edges?

9.2.4.2 (2)

$\alpha_1 = 90 \text{ mm} \checkmark$

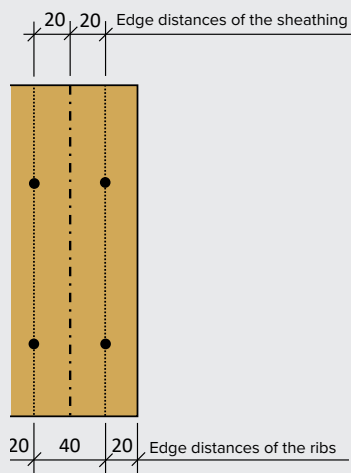
Fastener Spacing Verification

$\alpha_1 = 90 \text{ mm} \leq 150 \text{ mm}$ (Nails) ✓

10.8.2 (1)

$\alpha_1 = 90 \text{ mm} \leq 80 \cdot d = 80 \cdot 3,7 = 296 \text{ mm} \checkmark$

8.3.1.3 (NA.12)



Have the minimum fastener spacing requirements in the studs been met?

Table 8.2

$$a_{1,min,VH} = (5 + 5/\cos \alpha) \cdot d = (5 + 5(\cos 0^\circ)) \cdot 3,7 = 37 \text{ mm} \leq 90 \text{ mm} \checkmark$$

$$a_{2,min,VH} = 5 \cdot d = 5 \cdot 3,7 = 18,5 \text{ mm} \leq 40 \text{ mm} \checkmark$$

$$a_{4,c,min,VH} = 5 \cdot d = 5 \cdot 3,7 = 18,5 \text{ mm} \leq 20 \text{ mm} \checkmark$$

Have the minimum fastener spacings in the OSB panel been met?

$$a_{4,c,min} = 3 \cdot d = 3 \cdot 3,7 = 11,1 \text{ mm} \leq 20 \text{ mm} \checkmark$$

8.3.1.3 (NA.13)

03 // Load on the edge rib

Characteristic axial forces in the edge stud

$$\text{From permanent load: } F_{Ri,G,k} = 0,5 \cdot F_{c,G,k} = 0,5 \cdot 2,0 \text{ kN} = 1,0 \text{ kN}$$

$$\text{From imposed load: } F_{Ri,Q,k} = 0,5 \cdot F_{c,Q,k} = 0,5 \cdot 5,0 \text{ kN} = 2,5 \text{ kN}$$

$$\text{From snow load: } F_{Ri,S,k} = 0,5 \cdot F_{c,S,k} = 0,5 \cdot 3,0 \text{ kN} = 1,5 \text{ kN}$$

$$\text{From wind load: } F_{Ri,W,k} = F_{v,W,i,k} \cdot h/l = 5,0 \text{ kN} \cdot 2,56 \text{ m} / 3,75 \text{ m} = 3,41 \text{ kN}$$

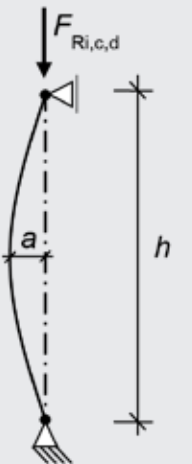
Design verification based on the following load case (wind as leading action)

$$E_d = E \left\{ \sum_{j \geq 1} \gamma_{G,j} \cdot G_{k,j} \oplus \gamma_{Q,1} \cdot Q_{k,1} \oplus \sum_{i \geq 2} \gamma_{Q,i} \cdot \psi_{0,i} \cdot Q_{k,i} \right\}$$

$$F_{Ri,c,d} = 1,35 \cdot F_{Ri,G,k} + 1,5 \cdot F_{Ri,W,k} + 1,5 \cdot 0,7 \cdot F_{Ri,Q,k} + 1,5 \cdot 0,5 \cdot F_{Ri,S,k}$$

$$F_{Ri,c,d} = 1,35 \cdot 1,0 \text{ kN} + 1,5 \cdot 3,41 \text{ kN} + 1,5 \cdot (0,7 \cdot 2,5 \text{ kN} + 0,5 \cdot 1,5 \text{ kN}) = 10,21 \text{ kN}$$

NOTE: According to DIN EN 1990/NA:2010-12, all possible combinations of actions must be considered. In the design of timber structures, different k_{mod} values must be applied depending on the load duration class. To maintain clarity in this example, only a single load combination is considered. However, for practical structural verification, all relevant load cases must be analysed in full.



Design value of the bending moment due to imperfection

10.2 (1)

$$M_d = F_{Ri,c,d} \cdot a = F_{Ri,c,d} \cdot \frac{h}{300} = 10,21 \text{ kN} \cdot \frac{2,56}{300} = 0,09 \text{ kNm}$$

Design value of the bending moment due to wind

$$M_{d,Wind} = (1,5 \cdot 0,4 \text{ kN/m}^2 \cdot 0,625 \text{ m} / 2) \cdot 2,56^2 \text{ m}^2 / 8 = 0,154 \text{ kNm}$$

$$M_{d,ges} = M_d + M_{d,Wind} = 0,09 \text{ kNm} + 0,154 \text{ kNm} = 0,24 \text{ kNm}$$

04 // Shear flow in the composite and sheathing layers

Design value of horizontal action

$$F_{v,d} = \gamma_Q \cdot F_{v,W,k} = 1,5 \cdot 5,0 \, kN = 7,5 \, kN$$

Design value of shear flow

$$s_{v,0,d} = \frac{F_{v,d}}{l} = \frac{7,5 \, kN}{3,75 \, m} = 2,0 \, \frac{kN}{m}$$

05 // Calculation of the governing anchorage forces

Note: The maximum uplift force can be determined for the load cases “permanent load” and “wind”. Since the effect of “permanent load” is stabilising, it must be multiplied by the partial safety factor $\gamma_{G,stb} = 0.9$ in accordance with DIN EN 1990/NA:2010-12, Table NA.A.1.2(A).

Force equilibrium about point B

$$Z_{A,d} = \frac{1}{l} \cdot \left[\gamma_Q \cdot F_{v,W} \cdot h - \gamma_{G,stb} \cdot F_{c,G,k} \cdot \left(a_r + 2 \cdot a_r + 3 \cdot a_r + 4 \cdot a_r + 5 \cdot a_r + 6 \cdot a_r \cdot 1/2 \right) \right]$$

$$Z_{A,d} = \frac{1}{3,75} \cdot \left[1,5 \cdot 5,0 \, kN \cdot 2,56 - 0,9 \cdot 2,0 \, kN \cdot \left(0,625 + 2 \cdot 0,625 + 3 \cdot 0,625 + 4 \cdot 0,625 + 5 \cdot 0,625 + 6/2 \cdot 0,6252 \right) \right]$$

$$Z_{A,d} = -0,28 \, kN$$

The anchorage force is compressive, i.e. there is no net uplift at the end of the wall. Structurally, no fasteners are required to resist uplift.

06 // Verification of the edge stud

In-plane buckling

6.3.1 (NA.5)

$$\left. \begin{aligned} a_r &= 62,5 \, cm \leq 50 \cdot t_P = 50 \cdot 1,8 \, cm = 90 \, cm \\ h_{Ri}/b_{Ri} &= 120/80 = 1,5 \leq 4 \end{aligned} \right\} \text{No Buckling}$$

Out-of-plane buckling

6.3.2

$$\sigma_{c,0,d} = \frac{F_{Ri,c,d}}{A} = \frac{10,21 \, kN \cdot 10^{-3}}{0,12 \cdot 0,08 \, m^2} = 1,06 \, MN/m^2$$

$$\sigma_{m,d} = \frac{M_{d,ges}}{W} = \frac{0,24 \, kNm \cdot 10^{-3} \cdot 6}{0,12^2 \cdot 0,08 \, m^3} = 1,25 \, MN/m^2$$

$$f_{c,o,d} = k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} = \frac{1,0 \cdot 21 \, MN/m^2}{1,3} = 16,15 \, MN/m^2$$

$$f_{m,d} = k_{mod} \cdot \frac{f_{m,k}}{\gamma_M} = \frac{1,0 \cdot 24 \, MN/m^2}{1,3} = 18,46 \, MN/m^2$$

Buckling coefficient

according to Schneider (24th ed.), table 9.29a or equation (6.25)

$$\lambda_y = \frac{l_{ef}}{i_y} = \frac{2,56}{0,289 \cdot 0,12} = 73,8$$

$$\text{Interpolation of table values: } k_{c,y} = 0,51$$

Lateral-torsional buckling coefficient

according to Schneider (24th ed.), table 9.32 or equation (6.34)

$$\frac{l_{ef} \cdot h}{b^2} = \frac{2,56 \cdot 0,12}{0,08^2} = 48 \leq 135$$

$$k_{crit} = 1,0$$

Verification

equation (NA.60)

$$\eta = \frac{\sigma_{c,0,d}}{k_{c,y} \cdot f_{c,o,d}} + \frac{\sigma_{m,d}}{k_{crit} \cdot f_{m,d}} = \frac{1,06 \, MN/m^2}{0,51 \cdot 16,15} + \frac{1,25 \, MN/m^2}{1,0 \cdot 18,46} = 0,20 \leq 1,0 \checkmark$$

07 // Verification of bottom plate compression

Overhangs

$$u_{li} = \min \left\{ \begin{array}{c} 30 \text{ mm} \\ a \\ l \\ l_1/2 \end{array} \right\} = \min \left\{ \begin{array}{c} 30 \text{ mm} \\ - \\ 80 \text{ mm} \\ (625-80)/2=272,5 \text{ mm} \end{array} \right\} = 30 \text{ mm}$$

$$\sigma_{c,90,d} = \frac{F_{Ri,c,d}}{A_{ef}} = \frac{10,21 \cdot 10^{-3}}{0,12 \cdot (0,08+0,03)} = 0,77 \text{ MN/m}^2$$

Perpendicular-to-grain bearing coefficient

Continuous support, sole plate made of softwood (VH)

$$l_1 = (0,625 - 0,08) = 0,545 \text{ m} \geq 2 \cdot h_{Ri} = 2 \cdot 0,08 \text{ m} = 0,16 \text{ m}$$

$$\Rightarrow k_{c,90} = 1,25 \quad 6.1.5 (3)$$

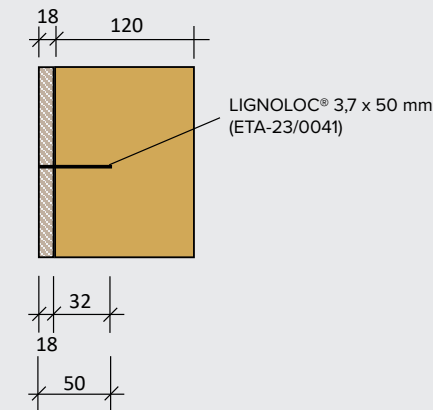
$$f_{c,90,d} = k_{mod} \cdot \frac{f_{c,90,k}}{\gamma_M} = 1,0 \cdot \frac{1,2 \cdot 2,5 \text{ MN/m}^2}{1,3} = 2,31 \frac{\text{MN}}{\text{m}^2} \quad 9.2.4.2 (NA.21)$$

(20% increase in load-bearing capacity)

Verification

$$\eta = \frac{\sigma_{c,90,d}}{k_{c,90} \cdot f_{c,90,d}} = \frac{0,77 \text{ MN/m}^2}{1,25 \cdot 2,31 \text{ MN/m}^2} = 0,27 \leq 1,0 \checkmark$$

08 // Verification of the LIGNOLOC® fasteners



Embedment strength of the OSB board

Gl. (8.22)

$$f_{h,1,k} = 65 \cdot d^{-0,7} \cdot t_P^{0,1} = 65 \cdot 3,7^{-0,7} \cdot 18^{0,1} = 34,73 \text{ N/mm}^2$$

$$f_{h,1,d} = f_{h,1,k} \cdot \frac{k_{mod,1}}{\gamma_M} = 34,73 \text{ N/mm}^2 \cdot \frac{1,0}{1,3} = 26,7 \text{ N/mm}^2$$

Embedment strength of solid wood (α=0°)

according to the ETA

$$f_{h,2,k} = 0,082 \cdot \rho_k \cdot d^{-0,3} = 0,082 \cdot 350 \text{ kg/m}^3 \cdot 3,7^{-0,3} = 19,38 \text{ N/mm}^2$$

$$f_{h,2,d} = f_{h,2,k} \cdot \frac{k_{mod,1}}{\gamma_M} = 19,38 \text{ N/mm}^2 \cdot \frac{1,0}{1,3} = 14,91 \text{ N/mm}^2$$

$$\beta = \frac{f_{h,2,d}}{f_{h,1,d}} = \frac{14,91 \text{ N/mm}^2}{26,7 \text{ N/mm}^2} = 0,56 \leq 1,0$$

Design value of the yield moment

ETA table B.1

$$M_{u,k} = 1200 \text{ Nmm}$$

$$M_{u,d} = M_{u,k} \cdot \frac{k_{mod,M}}{\gamma_M} = 1200 \text{ Nmm} \cdot \frac{0,9}{1,3} = 830,77 \text{ Nmm}$$

Required minimum embedment depth 1 (OSB/4)

according to the ETA

$$t_{1,req} = \sqrt{\frac{\beta}{1+\beta}} + 1 \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,1,d} \cdot d}} = \sqrt{\frac{0,56}{1+0,56}} + 1 \cdot \sqrt{\frac{4 \cdot 830,77 \text{ Nmm}}{0,75 \cdot 26,7 \frac{\text{N}}{\text{mm}^2} \cdot 3,7}} = 7,81 \text{ mm}$$

$$t_{1,req} = 7,81 \text{ mm} \leq t_{vorh} = 18,0 \text{ mm} \checkmark$$

Required member thickness 2 (solid timber)

according to the ETA

$$t_{2,req} = \sqrt{\frac{1}{1+\beta}} + 1 \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,2,d} \cdot d}} = \sqrt{\frac{1}{1+0,56}} + 1 \cdot \sqrt{\frac{4 \cdot 830,77 \frac{Nmm}{mm^2} \cdot 3,7}{0,75 \cdot 14,91 \frac{N}{mm^2} \cdot 3,7}} = 11,48 \, mm$$

$$t_{2,req} = 11,48 \, mm \leq t_{vorh} = 32,0 \, mm$$

Design of the load-bearing capacity per nail

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot \beta}{1+\beta}} \cdot \sqrt{1,5 \cdot M_{u,d} \cdot f_{h,1,d} \cdot d}$$

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot 0,56}{1+0,56}} \cdot \sqrt{1,5 \cdot 830,77 \, Nmm \cdot 26,7 \, N/mm^2 \cdot 3,7 \, mm}$$

$$F_{v,Rd,Na} = 297,30 \, N$$

Maximum permissible shear flow of the connection

$$S_{v,0,R,d} = \frac{F_{v,Rd}}{a_1} = \frac{297,30 \cdot 10^{-3} \, kN}{0,09 \, m} = 3,30 kN/m$$

Verification of the shear connection

$$\eta = \frac{S_{v,0,d}}{S_{v,0,R,d}} = \frac{2,0 \, kN/m}{3,30 \, kN/m} = 0,61 \leq 1,0 \checkmark$$

Verification of the sheathing

Load-bearing capacity of the sheathing considering the arrangement

9.2.4.2 (NA.16)

$$f_{v,0,d} = \frac{k_{mod} \cdot 0,33 \cdot f_{v,k,OSB}}{\gamma_M} = \frac{1,0 \cdot 0,33 \cdot 6,9}{1,3} = 1,75 \, kN/m^2$$

Plate buckling of the sheathing

$$\frac{a_r}{35} = \frac{625}{35} = 17,86 \, mm < t_P = 18 \, mm$$

Plate buckling need not be considered.

Verification of the sheathing

$$\eta = \frac{F_{v,Rd,Na}/(t_P \cdot a_1)}{f_{v,d}} = \frac{297,30 \, N/(18 \, mm \cdot 90 \, mm)}{1,75 \, N/mm^2} = 0,10 \leq 1,0 \checkmark$$

09 // Horizontal deformation

Conditions

$$\text{panel length} \qquad l = 3,75 \, m \geq h/3 = 2,56/3 = 0,85 \, m$$

$$\text{panel width} \qquad b_p = 1,25 \, m \geq h/4 = 2,56/4 = 0,64 \, m$$

- + Panel supported by a rigid substructure
- + no increase in the fastener load-bearing capacity according to EC 9.2.4.2 (5) considered
- no verification required



Fastening of clapboard siding

with LIGNOLOC® wooden nails | ETA-23/0330



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Calculation performed by:
BIGA
Structural Engineers
Prof. Dr. Ing. Patrik Aondio
An der Halde 3 | 87448 Waltenhofen | Germany
Phone: +49 (0) 8379 / 880 900-3
Email: aondio@biga-bauingenieure.de
Website: biga-bauingenieure.de

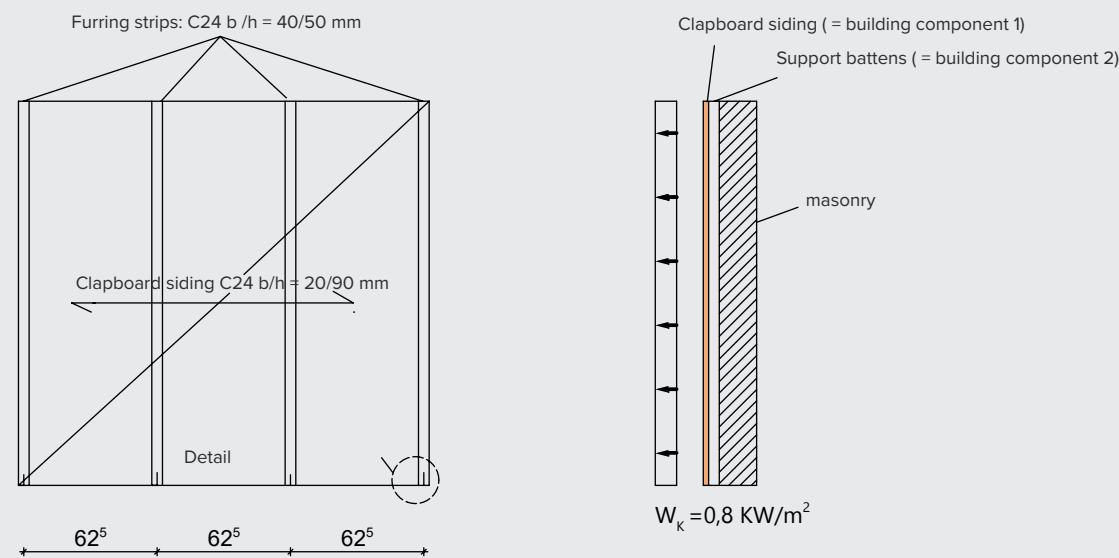
01 // System

A clapboard siding installed on a structural framework made of spruce timber is considered. Based on the local conditions, the façade can be assigned to Service Class 2.

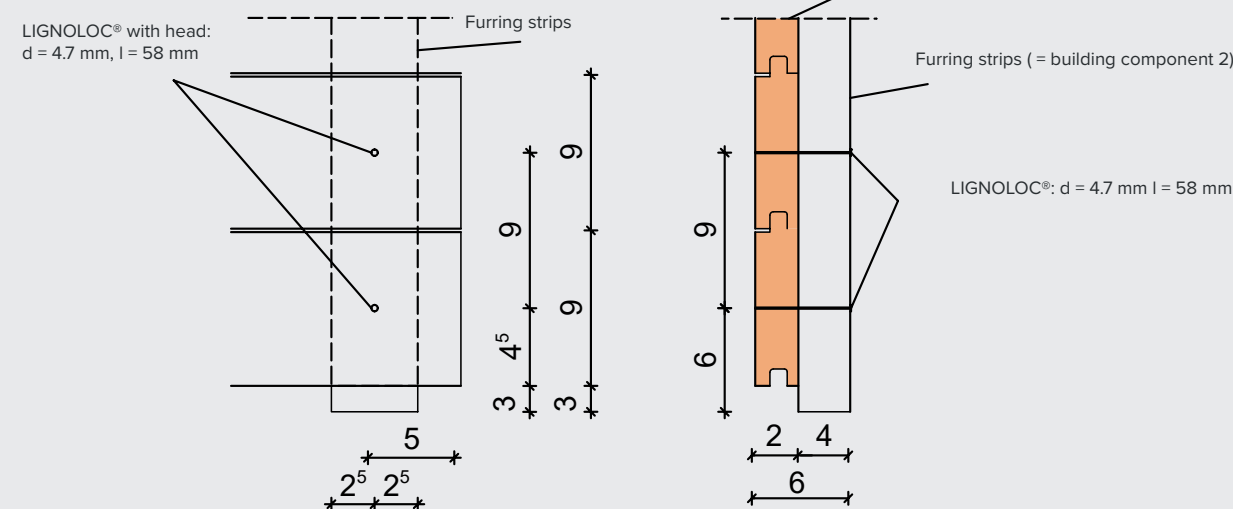
Support battens: Softwood C24, $b_{Ri} \times h_{Ri} = 40 \times 50$ mm, $e = 625$ mm, NKL 2

Clapboard siding: Softwood C24, $b_s \times h_s = 20 \times 90$ mm, NKL 2

Connection: LIGNOLOC® wooden nail with head, $d = 4,7$ mm, $l = 58$ mm, $a_i = 90$ mm



Detail



An analysis of the entire building resulted in a governing characteristic wind uplift load of $0,8 \text{ kN/m}^2$. For the clapboard siding, an average unit weight of $\rho_{\text{mean, Timber}} = 4,2 \text{ kN/m}^2$ can be assumed.

02 // Verification of the Minimum Spacings

Fasteners according to ETA-23/0330, analogous to non-pre-drilled nails in DIN EN 1995-1-1:2010-12

Are the minimum spacings in the clapboard siding (Component 1) met?

table 8.2

$$a_{1,\text{min},\text{VH}} = (5 + 5 \cdot (\cos \alpha)) \cdot d = (5 + 5 \cdot (\cos 90^\circ)) \cdot 4,7 = 23,5 \text{ mm} \leq 625 \text{ mm} \checkmark$$

$$a_{3,\text{c},\text{min},\text{VH}} = 10 \cdot d = 10 \cdot 4,7 = 47,0 \text{ mm} \leq 50 \text{ mm} \checkmark$$

$$a_{4,\text{t},\text{min},\text{VH}} = (5 + 2 \cdot \sin \alpha) \cdot d = (5 + 2 \cdot (\sin 90^\circ)) \cdot 4,7 = 32,9 \text{ mm} \leq 45 \text{ mm} \checkmark$$

$$a_{4,\text{c},\text{min},\text{VH}} = 5 \cdot d = 5 \cdot 4,7 = 23,5 \text{ mm} \leq 45 \text{ mm} \checkmark$$

Are the minimum spacings in the furring strips (Component 2) met?

table 8.2

$$a_{1,\text{min},\text{VH}} = (5 + 5 \cdot (\cos \alpha)) \cdot d = (5 + 5 \cdot (\cos 0^\circ)) \cdot 4,7 = 47 \text{ mm} \leq 90 \text{ mm} \checkmark$$

$$a_{3,\text{t},\text{min},\text{VH}} = (10 + 5 \cdot (\cos \alpha)) \cdot d = (10 + 5 \cdot (\cos 0^\circ)) \cdot 4,7 = 70,5 \text{ mm} \leq 60 \text{ mm} \checkmark$$

$$a_{4,\text{c},\text{min},\text{VH}} = 5 \cdot d = 5 \cdot 4,7 = 23,5 \text{ mm} \leq 25 \text{ mm} \checkmark$$

03 // Loads per Nail

From permanent load

$$F_{V,G,k} = \rho_{\text{mean, Timber}} \cdot b_s \cdot h_s \cdot e = 4,2 \frac{\text{kN}}{\text{m}^2} \cdot 0,020 \text{ m} \cdot 0,090 \text{ m} \cdot 0,625 \text{ m} = 4,7 \cdot 10^{-3} \text{ kN} = 4,7 \text{ N}$$

Design level

$$F_{V,G,d} = F_{V,G,k} \cdot \gamma_G = 4,7 \text{ N} \cdot 1,35 = 6,3 \text{ N}$$

Wind load

$$F_{ax,W,k} = \underbrace{1,25}_{\text{continuity factor}} \cdot w_k \cdot h_s \cdot e = 1,25 \cdot 0,8 \frac{\text{kN}}{\text{m}^2} \cdot 0,090 \text{ m} \cdot 0,625 \text{ m} = 0,056 \text{ kN} = 56,2 \text{ N}$$

At the design level

$$F_{ax,W,d} = F_{ax,W,k} \cdot \gamma_Q = 56,2 \text{ N} \cdot 1,5 = 84,3 \text{ N}$$

04 // Verification of Permanent Load

Embedding strength of solid timber – nail head side (α₁=90°) according to ETA

$$f_{h,1,k} = \frac{0,082 \cdot \rho_{k,1} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_1 + \cos^2 \alpha_1}$$
$$f_{h,1,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 90^\circ)^2 + (\cos 90^\circ)^2} = 12,70 \text{ N/mm}^2$$
$$k_{mod,1} = 0,6$$
$$f_{h,1,d} = \frac{f_{h,1,k} \cdot k_{mod,1}}{\gamma_{M,1}} = \frac{12,70 \cdot 0,6}{1,3} = 5,86 \text{ N/mm}^2$$

according to DIN EN 1995-1-1, Tab. 3.1

Embedding strength of solid timber – nail tip side (α₂ = 0°) according to ETA

$$f_{h,2,k} = \frac{0,082 \cdot \rho_{k,2} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_2 + \cos^2 \alpha_2} =$$
$$f_{h,2,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 0^\circ)^2 + (\cos 0^\circ)^2} = 18,04 \text{ N/mm}^2$$
$$k_{mod,2} = 0,6$$
$$f_{h,2,d} = \frac{f_{h,2,k} \cdot k_{mod,2}}{\gamma_{M,2}} = \frac{18,04 \cdot 0,6}{1,3} = 8,33 \text{ N/mm}^2$$
$$\beta = \frac{f_{h,2,d}}{f_{h,1,d}} = \frac{8,33 \text{ N/mm}^2}{5,86 \text{ N/mm}^2} = 1,42$$

according to DIN EN 1995-1-1, Tab. 3.1

Design value of the yield moment ETA-table B.1

$$M_{u,k} = 1800 \text{ Nmm}$$
$$M_{u,d} = M_{u,k} \cdot \frac{k_{mod,M}}{\gamma_M} = 1800 \text{ Nmm} \cdot \frac{0,35}{1,3} = 485 \text{ Nmm}$$

Required minimum embedment depth 1 – nail head side according to ETA

$$t_{1,req} = \left(\sqrt{\frac{\beta}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,1,d} \cdot d}} = \left(\sqrt{\frac{1,42}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 485 \text{ Nmm}}{0,75 \cdot 5,86 \cdot \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 17,11 \text{ mm}$$
$$t_{1,req} = 17,11 \text{ mm} \leq t_{1,vorh} = 20,0 \text{ mm} \checkmark$$

Required minimum embedment depth 2 – nail tip side according to ETA

$$t_{2,req} = \left(\sqrt{\frac{1}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,2,d} \cdot d}} = \left(\sqrt{\frac{1}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 485 \text{ Nmm}}{0,75 \cdot 8,33 \cdot \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 13,35 \text{ mm}$$
$$t_{2,req} = 13,35 \text{ mm} \leq t_{2,vorh} = 40,0 \text{ mm} \checkmark$$

Design of the load-bearing capacity in shear per nail

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot \beta}{1+\beta}} \cdot \sqrt{1,5 \cdot M_{u,d} \cdot f_{h,1,d} \cdot d}$$
$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot 1,42}{1+1,42}} \cdot \sqrt{1,5 \cdot 485 \text{ Nmm} \cdot 5,86 \text{ N/mm}^2 \cdot 4,7 \text{ mm}}$$
$$F_{v,Rd,Na} = 153 \text{ N}$$

Verification

$$\eta = \frac{F_{V,G,d}}{F_{v,Rd,Na}} = \frac{6,3 \text{ N}}{153 \text{ N}} = 0,04 < 1,0 \text{ (utilization ratio 4\%)}$$

05 // Verification of permanent and temporary loads

Embedding strength of solid timber – nail head side (α₁ = 90°) according to ETA

$$f_{h,1,k} = \frac{0,082 \cdot \rho_{k,1} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_1 + \cos^2 \alpha_1}$$
$$f_{h,1,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 90^\circ)^2 + (\cos 90^\circ)^2} = 12,70 \text{ N/mm}^2$$
$$k_{mod,1} = 1,0 \quad \text{Load duration class: medium, between short-term and very short-term}$$
$$f_{h,1,d} = \frac{f_{h,1,k} \cdot k_{mod,1}}{\gamma_{M,1}} = \frac{12,70 \cdot 1,0}{1,3} = 9,77 \text{ N/mm}^2$$

according to DIN EN 1995-1-1, Tab. 3.1

Embedment strength of solid timber – nail tip side (α₂ = 0°)

according
to ETA

$$f_{h,2,k} = \frac{0,082 \cdot \rho_{k,2} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_2 + \cos^2 \alpha_2} =$$

$$f_{h,2,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 0^\circ)^2 + (\cos 0^\circ)^2} = 18,04 \text{ N/mm}^2$$

$$k_{mod,2} = 1,0 \quad \text{(Load duration class: medium, between short-term and very short-term)} \quad \text{according to DIN EN 1995-1-1, Tab. 3.1}$$

$$f_{h,2,d} = \frac{f_{h,2,k} \cdot k_{mod,2}}{\gamma_{M,2}} = \frac{18,04 \cdot 1,0}{1,3} = 13,88 \text{ N/mm}^2$$

$$\beta = \frac{f_{h,2,d}}{f_{h,1,d}} = \frac{13,88 \text{ N/mm}^2}{9,77 \text{ N/mm}^2} = 1,42$$

Design value of the yield moment

ETA-table B.1

$$M_{u,k} = 1800 \text{ Nmm}$$

To remain on the safe side, the load duration class “short-term” is assumed for the wind action.

$$M_{u,d} = M_{u,k} \cdot \frac{k_{mod,M}}{\gamma_M} = 1800 \text{ Nmm} \cdot \frac{0,60}{1,3} = 831 \text{ Nmm}$$

Required member thickness 1 – nail head side

according to ETA

$$t_{1,req} = \left(\sqrt{\frac{\beta}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,1,d} \cdot d}} = \left(\sqrt{\frac{1,42}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 831 \text{ Nmm}}{0,75 \cdot 9,77 \cdot \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 17,35 \text{ mm}$$

$$t_{1,req} = 17,35 \text{ mm} \leq t_{1,vorh} = 20,0 \text{ mm} \checkmark$$

Required member thickness 2 – nail tip side

according to ETA

$$t_{2,req} = \left(\sqrt{\frac{1}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,2,d} \cdot d}} = \left(\sqrt{\frac{1}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 831 \text{ Nmm}}{0,75 \cdot 13,88 \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 13,54 \text{ mm}$$

$$t_{2,req} = 13,54 \text{ mm} \leq t_{2,vorh} = 40,0 \text{ mm} \checkmark$$

Design of the load-bearing capacity in shear per nail

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot \beta}{1+\beta}} \cdot \sqrt{1,5 \cdot M_{u,d} \cdot f_{h,1,d} \cdot d}$$

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot 1,42}{1+1,42}} \cdot \sqrt{1,5 \cdot 831 \text{ Nmm} \cdot 12,70 \text{ N/mm}^2 \cdot 4,7 \text{ mm}}$$

$$F_{v,Rd,Na} = 259 \text{ N}$$

Determination of the withdrawal capacity

Verification of the minimum penetration depth in component 2 – nail tip side:

$$t_{pen,min,2} = 8 \cdot d = 8 \cdot 4,7 \text{ mm} = 37,6 \text{ mm}$$

$$t_{pen,min,2} = 37,6 \text{ mm} \leq t_{pen,vorh,2} = 38,0 \text{ mm} \checkmark$$

Withdrawal capacity on the nail head side – component 1

$$F_{ax,Rd,1} = \min \left\{ \frac{1}{\frac{t_{pen,1}}{8 \cdot d}} \right\} \cdot \frac{f_{ax,k} \cdot k_{mod,ax}}{\gamma_{M,1}} \cdot d \cdot t_{pen,1} \cdot \left(\frac{\rho_{k,1}}{350} \right)^{0,8} =$$

$$F_{ax,l,Rd,1} = \min \left\{ \frac{1}{\frac{20}{8 \cdot 4,7}} \right\} \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 20 \text{ mm} \cdot \left(\frac{350}{350} \right)^{0,8} =$$

$$F_{ax,l,Rd,1} = 0,53 \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 20 \text{ mm} \cdot 1,0 = 135 \text{ N}$$

Head pull-through capacity – component 1:

$$F_{ax,a,Rd,1} = \frac{f_{head} \cdot k_{mod,M}}{\gamma_{M,1}} \cdot d_h^2 \cdot \left(\frac{\rho_{k,1}}{350} \right)^{0,8}$$

$$F_{ax,a,Rd,1} = \frac{12 \text{ N/mm}^2 \cdot 0,6}{1,3} \cdot (6,3 \text{ mm})^2 \cdot \left(\frac{350}{350} \right)^{0,8} = 220 \text{ N}$$

Withdrawal capacity on the nail head side – component 1:

$$F_{ax,Rd,1} = \max \left\{ F_{ax,l,Rd,1} \right\} = \max \left\{ 135 \text{ N} \right\} = 220 \text{ N}$$

Withdrawal capacity on the nail tip side – component 2

$$F_{ax,Rd,2} = \min \left\{ \frac{1}{\frac{t_{pen,2}}{8 \cdot d}} \right\} \cdot \frac{f_{ax,k} \cdot k_{mod,ax}}{\gamma_{M,2}} \cdot d \cdot t_{pen,2} \cdot \left(\frac{\rho_{k,2}}{350} \right)^{0,8} =$$

$$F_{ax,Rd,2} = \min \left\{ \frac{1}{\frac{38}{8 \cdot 4,7}} \right\} \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 38 \text{ mm} \cdot \left(\frac{350}{350} \right)^{0,8} =$$

$$F_{ax,Rd,2} = 1,0 \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 38 \text{ mm} \cdot 1,0 = 481 \text{ N}$$

Withdrawal resistance:

$$F_{ax,Rd} = \min \left\{ F_{ax,Rd,1} \right\} = \min \left\{ 220 \text{ N} \right\} = 220 \text{ N}$$

Verification (combined verification)

$$\eta = \frac{F_{V,G,d}}{F_{v,Rd,Na}} + \frac{F_{ax,W,d}}{F_{ax,Rd}} = \frac{6,3 \text{ N}}{259 \text{ N}} + \frac{84,3 \text{ N}}{220 \text{ N}} = 0,41 < 1,0 \quad \left(\text{utilization ratio } 41\% \right)$$

Fastening of a rhombus façade

with LIGNOLOC® wooden nails according to ETA-23/0330

Calculation performed by:
BIGA
Structural Engineers
Prof. Dr. Ing. Patrik Aondio
An der Halde 3 | 87448 Waltenhofen | Germany
Phone: +49 (0) 8379 / 880 900-3
Email: aondio@biga-bauingenieure.de
Website: biga-bauingenieure.de

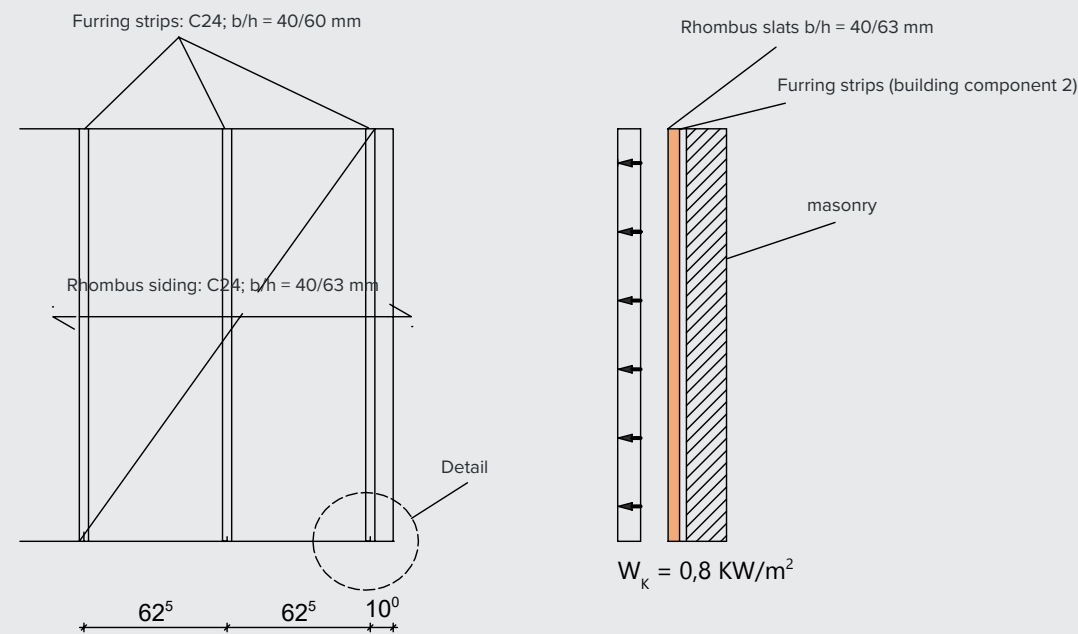


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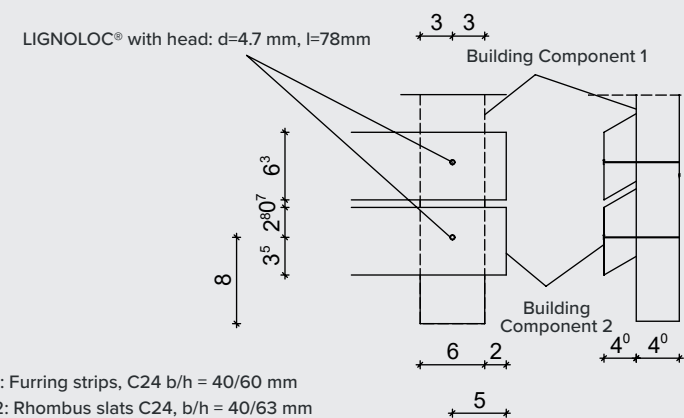
01 // System

A rhombus façade installed on a structural framework made of spruce timber is considered. Based on the local conditions, the façade can be assigned to Service Class 2.

- Furring strips:** Softwood C24, $b_{Ri} \times h_{Ri} = 40 \times 60$ mm, $e = 625$ mm, NKL 2
- Rhombus Façade:** Softwood C24, $b_s \times h_s = 40 \times 63$ mm, NKL 2
- Fastening:** LIGNOLOC® wooden nail with head, $d = 4.7$ mm, $l = 78$ mm



Detail



Building Component 1: Furring strips, C24 $b/h = 40/60$ mm
Building Component 2: Rhombus slats C24, $b/h = 40/63$ mm

An analysis of the entire building resulted in a governing characteristic wind uplift action of 0.8 kN/m^2 . For the rhombus profile slats, an average density of $\rho_{\text{mean, Timber}} = 4.2 \text{ kN/m}^2$ can be assumed.

02 // Verification of Minimum Spacings

Fasteners according to ETA-23/0330, analogous to non-pre-drilled nails in DIN EN 1995-1-1:2010-12

Are the minimum spacings in the rhombus slats (Component 1) met?

table 8.2

$$a_{1,\text{min,VH}} = (5 + 5 \cdot (\cos \alpha)) \cdot d = (5 + 5 \cdot (\cos 90^\circ)) \cdot 4.7 = 23.5 \text{ mm} \leq 625 \text{ mm} \checkmark$$

$$a_{3,\text{c,min,VH}} = 10 \cdot d = 10 \cdot 4.7 = 47.0 \text{ mm} \leq 50 \text{ mm} \checkmark$$

$$a_{4,\text{t,min,VH}} = (5 + 2 \cdot \sin \alpha) \cdot d = (5 + 2 \cdot (\sin 90^\circ)) \cdot 4.7 = 32.9 \text{ mm} \leq 35 \text{ mm} \checkmark$$

$$a_{4,\text{c,min,VH}} = 5 \cdot d = 5 \cdot 4.7 = 23.5 \text{ mm} \leq 28 \text{ mm} \checkmark$$

Are the minimum spacings in the furring strips (Component 2) met?

table 8.2

$$a_{1,\text{min,VH}} = (5 + 5 \cdot (\cos \alpha)) \cdot d = (5 + 5 \cdot (\cos 0^\circ)) \cdot 4.7 = 47 \text{ mm} \leq 70 \text{ mm} \checkmark$$

$$a_{3,\text{t,min,VH}} = (10 + 5 \cdot (\cos \alpha)) \cdot d = (10 + 5 \cdot (\cos 0^\circ)) \cdot 4.7 = 70.5 \text{ mm} \leq 80 \text{ mm} \checkmark$$

$$a_{4,\text{c,min,VH}} = 5 \cdot d = 5 \cdot 4.7 = 23.5 \text{ mm} \leq 30 \text{ mm} \checkmark$$

03 // Loads per Nail

From permanent load

$$F_{V,G,k} = \rho_{\text{mean, Timber}} \cdot b_s \cdot h_s \cdot e = 4.2 \frac{\text{kN}}{\text{m}^2} \cdot 0.04 \text{ m} \cdot 0.063 \text{ m} \cdot 0.625 \text{ m} = 6.6 \cdot 10^{-3} \text{ kN} = 6.6 \text{ N}$$

Design level

$$F_{V,G,d} = F_{V,G,k} \cdot \gamma_G = 6.6 \text{ N} \cdot 1.35 = 8.9 \text{ N}$$

Wind load

$$F_{ax,W,k} = \underbrace{1.25}_{\text{continuity factor}} \cdot w_k \cdot h_s \cdot e = 1.25 \cdot 0.8 \frac{\text{kN}}{\text{m}^2} \cdot 0.063 \text{ m} \cdot 0.625 \text{ m} = 0.039 \text{ kN} = 39.4 \text{ N}$$

At the design level

$$F_{ax,W,d} = F_{ax,W,k} \cdot \gamma_Q = 39.4 \text{ N} \cdot 1.5 = 59.1 \text{ N}$$

04 // Verification of Permanent Load

Embedding strength of solid timber – nail head side (α₁=90°)

$$f_{h,1,k} = \frac{0,082 \cdot \rho_{k,1} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_1 + \cos^2 \alpha_1}$$
$$f_{h,1,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 90^\circ)^2 + (\cos 90^\circ)^2} = 12,70 \text{ N/mm}^2$$
$$k_{mod,1} = 0,6$$
$$f_{h,1,d} = \frac{f_{h,1,k} \cdot k_{mod,1}}{\gamma_{M,1}} = \frac{12,70 \cdot 0,6}{1,3} = 5,86 \text{ N/mm}^2$$

according to ETA

according to
DIN EN 1995-1-1, Tab. 3.1

Embedding strength of solid timber – nail tip side (α₂ = 0°)

$$f_{h,2,k} = \frac{0,082 \cdot \rho_{k,2} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_2 + \cos^2 \alpha_2} =$$
$$f_{h,2,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 0^\circ)^2 + (\cos 0^\circ)^2} = 18,04 \text{ N/mm}^2$$
$$k_{mod,2} = 0,6$$
$$f_{h,2,d} = \frac{f_{h,2,k} \cdot k_{mod,2}}{\gamma_{M,2}} = \frac{18,04 \cdot 0,6}{1,3} = 8,33 \text{ N/mm}^2$$
$$\beta = \frac{f_{h,2,d}}{f_{h,1,d}} = \frac{8,33 \text{ N/mm}^2}{5,86 \text{ N/mm}^2} = 1,42$$

according to ETA

according to
DIN EN 1995-1-1, Tab. 3.1

Design value of the yield moment

$$M_{u,k} = 1800 \text{ Nmm}$$
$$M_{u,d} = M_{u,k} \cdot \frac{k_{mod,M}}{\gamma_M} = 1800 \text{ Nmm} \cdot \frac{0,35}{1,3} = 485 \text{ Nmm}$$

ETA-table B.1

Required minimum embedment depth 1 – nail head side

according to ETA

$$t_{1,req} = \left(\sqrt{\frac{\beta}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,1,d} \cdot d}} = \left(\sqrt{\frac{1,42}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 485 \text{ Nmm}}{0,75 \cdot 5,86 \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 17,11 \text{ mm}$$
$$t_{1,req} = 17,11 \text{ mm} \leq t_{1,vorh} = 40,0 \text{ mm} \checkmark$$

Required minimum embedment depth 2 – nail tip side

according to ETA

$$t_{2,req} = \left(\sqrt{\frac{1}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,2,d} \cdot d}} = \left(\sqrt{\frac{1}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 485 \text{ Nmm}}{0,75 \cdot 8,33 \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 13,35 \text{ mm}$$
$$t_{1,req} = 13,35 \text{ mm} \leq t_{1,vorh} = 40,0 \text{ mm} \checkmark$$

Design of the load-bearing capacity in shear per nail

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot \beta}{1+\beta}} \cdot \sqrt{1,5 \cdot M_{u,d} \cdot f_{h,1,d} \cdot d}$$
$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot 1,42}{1+1,42}} \cdot \sqrt{1,5 \cdot 485 \text{ Nmm} \cdot 5,86 \text{ N/mm}^2 \cdot 4,7 \text{ mm}}$$
$$F_{v,Rd,Na} = 153,32 \text{ N}$$

Verification:

$$\eta = \frac{F_{v,G,d}}{F_{v,Rd,Na}} = \frac{8,9 \text{ N}}{153,32 \text{ N}} = 0,06 < 1,0 \text{ (utilization ratio 6 \%)}$$

05 // Verification of permanent and temporary loads

Embedding strength of solid timber – nail head side (α₁ = 90°)

according to ETA

$$f_{h,1,k} = \frac{0,082 \cdot \rho_{k,1} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_1 + \cos^2 \alpha_1}$$
$$f_{h,1,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 90^\circ)^2 + (\cos 90^\circ)^2} = 12,70 \text{ N/mm}^2$$
$$k_{mod,1} = 1,0$$
$$f_{h,1,d} = \frac{f_{h,1,k} \cdot k_{mod,1}}{\gamma_{M,1}} = \frac{12,70 \cdot 1,0}{1,3} = 9,77 \frac{\text{N}}{\text{mm}^2}$$

Embedding strength of solid timber – nail tip side (α₂=0°)

according to ETA

$$f_{h,2,k} = \frac{0,082 \cdot \rho_{k,2} \cdot d^{-0,3}}{(1,35 + 0,015 \cdot d) \cdot \sin^2 \alpha_2 + \cos^2 \alpha_2} =$$
$$f_{h,2,k} = \frac{0,082 \cdot 350 \text{ kg/m}^3 \cdot 4,7^{-0,3}}{(1,35 + 0,015 \cdot 4,7) \cdot (\sin 0^\circ)^2 + (\cos 0^\circ)^2} = 18,04 \text{ N/mm}^2$$
$$k_{mod,2} = 1,0 \text{ (Load duration class: medium, between short-term and very short-term)}$$
$$f_{h,2,d} = \frac{f_{h,2,k} \cdot k_{mod,2}}{\gamma_{M,2}} = \frac{18,04 \cdot 1,0}{1,3} = 13,88 \text{ N/mm}^2$$
$$\beta = \frac{f_{h,2,d}}{f_{h,1,d}} = \frac{13,88 \text{ Nmm}^2}{9,77 \text{ Nmm}^2} = 1,42$$

according to
DIN EN 1995-1-1, Tab. 3.1

Design value of the yield moment

ETA-table B.1

$$M_{u,k} = 1800 \text{ Nmm}$$

To remain on the safe side, the load duration class “short-term” is assumed for the wind action.

$$M_{u,d} = M_{u,k} \cdot \frac{k_{mod,M}}{\gamma_M} = 1800 \text{ Nmm} \cdot \frac{0,60}{1,3} = 831 \text{ Nmm}$$

Required minimum embedment depth 1 – nail head side

according to ETA

$$t_{1,req} = \left(\sqrt{\frac{\beta}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,1,d} \cdot d}} = \left(\sqrt{\frac{1,42}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 831 \text{ Nmm}}{0,75 \cdot 9,77 \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 17,35 \text{ mm}$$

$$t_{1,req} = 17,35 \text{ mm} \leq t_{1,vorh} = 40,0 \text{ mm} \checkmark$$

Required minimum embedment depth 2 – nail tip side

according to ETA

$$t_{2,req} = \left(\sqrt{\frac{1}{1+\beta}} + 1 \right) \cdot \sqrt{\frac{4 \cdot M_{u,d}}{0,75 \cdot f_{h,2,d} \cdot d}} = \left(\sqrt{\frac{1}{1+1,42}} + 1 \right) \cdot \sqrt{\frac{4 \cdot 831 \text{ Nmm}}{0,75 \cdot 13,88 \frac{\text{N}}{\text{mm}^2} \cdot 4,7}} = 13,54 \text{ mm}$$

$$t_{2,req} = 13,54 \text{ mm} \leq t_{2,vorh} = 40,0 \text{ mm} \checkmark$$

Design of the load-bearing capacity in shear per nail

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot \beta}{1+\beta}} \cdot \sqrt{1,5 \cdot M_{u,d} \cdot f_{h,1,d} \cdot d}$$

$$F_{v,Rd,Na} = \sqrt{\frac{2 \cdot 1,42}{1+1,42}} \cdot \sqrt{1,5 \cdot 831 \text{ Nmm} \cdot 9,77 \text{ N/mm}^2 \cdot 4,7 \text{ mm}}$$

$$F_{v,Rd,Na} = 259 \text{ N}$$

Determination of the withdrawal capacity

Verification of the minimum penetration depth in component 2 – nail tip side:

$$t_{pen,min,2} = 8 \cdot d = 8 \cdot 4,7 = 37,6 \text{ mm}$$

$$t_{pen,min,2} = 37,6 \text{ mm} \leq t_{pen,vorh,2} = 38,0 \text{ mm} \checkmark$$

Withdrawal capacity on the nail head side – component 1:

$$F_{ax,l,Rd,1} = \min \left\{ \frac{1}{\frac{t_{pen,1}}{8 \cdot d}} \right\} \cdot \frac{f_{ax,k} \cdot k_{mod,ax}}{\gamma_{M,1}} \cdot d \cdot t_{pen,1} \cdot \left(\frac{\rho_{k,1}}{350} \right)^{0,8} =$$

$$F_{ax,l,Rd,1} = \min \left\{ \frac{1}{\frac{40}{8 \cdot 4,7}} \right\} \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 40 \text{ mm} \cdot \left(\frac{350}{350} \right)^{0,8} =$$

$$F_{ax,l,Rd,1} = 1,0 \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 40 \text{ mm} \cdot 1,0 = 506 \text{ N}$$

Head pull-through capacity – component 1:

$$F_{ax,a,Rd,1} = \frac{f_{head} \cdot k_{mod,M}}{\gamma_{M,1}} \cdot d_h^2 \cdot \left(\frac{\rho_{k,1}}{350} \right)^{0,8}$$

$$F_{ax,a,Rd,1} = \frac{12 \text{ N/mm}^2 \cdot 0,6}{1,3} \cdot (6,3 \text{ mm})^2 \cdot \left(\frac{350}{350} \right)^{0,8} = 220 \text{ N}$$

Withdrawal capacity on the nail head side – component 1:

$$F_{ax,Rd,1} = \max \left\{ \begin{matrix} F_{ax,l,Rd,1} \\ F_{ax,a,Rd,1} \end{matrix} \right\} = \max \left\{ \begin{matrix} 506 \text{ N} \\ 220 \text{ N} \end{matrix} \right\} = 506 \text{ N}$$

Withdrawal capacity on the nail tip side – component 2:

$$F_{ax,Rd,2} = \min \left\{ \frac{1}{\frac{t_{pen,2}}{8 \cdot d}} \right\} \cdot \frac{f_{ax,k} \cdot k_{mod,ax}}{\gamma_{M,2}} \cdot d \cdot t_{pen,2} \cdot \left(\frac{\rho_{k,2}}{350} \right)^{0,8}$$

$$F_{ax,Rd,2} = \min \left\{ \frac{1}{\frac{38}{8 \cdot 4,7}} \right\} \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 3,7 \cdot 38 \text{ mm} \cdot \left(\frac{350}{350} \right)^{0,8} =$$

$$F_{ax,Rd,2} = 1,0 \cdot \frac{7,0 \frac{\text{N}}{\text{mm}^2} \cdot 0,5}{1,3} \cdot 4,7 \cdot 38 \text{ mm} \cdot 1,0 = 481 \text{ N}$$

Withdrawal resistance:

$$F_{ax,Rd} = \min \left\{ \begin{matrix} F_{ax,Rd,1} \\ F_{ax,Rd,2} \end{matrix} \right\} = \min \left\{ \begin{matrix} 506 \text{ N} \\ 481 \text{ N} \end{matrix} \right\} = 481 \text{ N}$$

Verification (combined verification)

$$\eta = \frac{F_{V,G,d}}{F_{v,Rd,Na}} + \frac{F_{ax,W,d}}{F_{ax,Rd}} = \frac{8,9 \text{ N}}{259 \text{ N}} + \frac{59,1 \text{ N}}{481 \text{ N}} = 0,16 < 1,0 \text{ (utilization ratio 16 \%)}$$

Approvals // Certifications

EUROPEAN TECHNICAL ASSESSMENT ETA-23/0041

The ETA-23/0041 contains all the required characteristic values for the structural design of LIGNOLOC® wooden nails without head for timber frame construction in accordance with Eurocode 5.

EUROPEAN TECHNICAL ASSESSMENT ETA-23/0330

The ETA-23/0330 contains all the necessary characteristic values for the structural design of LIGNOLOC® wooden nails with head for load-bearing wood-to-wood and wood-based panel connections in outdoor applications.

IAPMO Report #UEL5065

LIGNOLOC® has received official IAPMO approval (IAPMO Group). This certification confirms the use of LIGNOLOC® wooden nails for wood-to-wood or panel-to-wood connections in the United States.

PEFC | Programme for the Endorsement of Forest Certification Certificate QA-PEFC-COC-000147

The beech wood used to manufacture LIGNOLOC® wooden nails comes from PEFC-certified forests.

EPD | Environmental Product Declaration according to ISO 14025 and EN 15804+A2

The Environmental Product Declaration (EPD) for LIGNOLOC® is based on a life cycle assessment and documents the product's environmental impacts from raw material extraction to end-of-life.



Design calculation solutions

PLAN AND CALCULATE WITH LIGNOLOC® WOODEN NAILS

THE ENVIRONMENTAL DATA FOR LIGNOLOC® WOODEN NAILS ARE LISTED IN ÖKO-BAUDAT, THE DATABASE OF THE GERMAN FEDERAL MINISTRY FOR HOUSING, URBAN DEVELOPMENT AND BUILDING (BMWSB), AND CAN THEREFORE BE USED DIRECTLY IN BUILDING LIFE CYCLE ASSESSMENTS, E.G. UNDER BNB, DGNB OR QNG.

Structural design and technical planning in accordance with ETA:

Structural capacities and project-specific parameters can be determined quickly and precisely using our free calculation tool.

For more complex requirements, our individual engineering service is also available.

- + Efficient design aid for the rapid calculation of individual connections
- + Determination of characteristic resistances for shear and withdrawal
- + ETA-compliant verification of the relevant design parameters
- + Practice-oriented material selection for typical timber connections

Please note: The file is not available for public download. You can request the tool via our contact form, we will send it to you by email. The tool runs locally and does not require a cloud connection. A spreadsheet program is required.



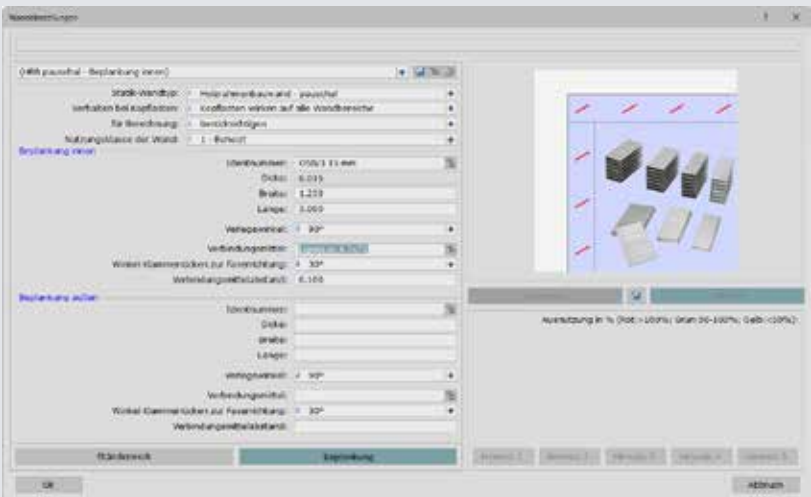
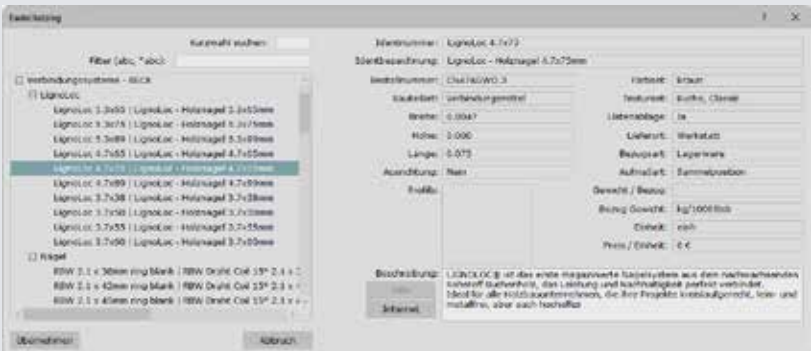
To the calculation tool

DC-STATIK FROM DIETRICH'S®

The structural analysis software DC-Statik by Dietrich's® (from version 25 onwards) enables the calculation and load distribution of LIGNOLOC® wooden nails directly within the building model. The integration is based on the design values from the ETAs (ETA-23/0041, ETA-23/0330) and allows code-compliant verification of load-bearing timber connections. Designers can thus dimension timber frame walls without metal fasteners – efficiently and directly within the digital workflow, without any additional software customization.

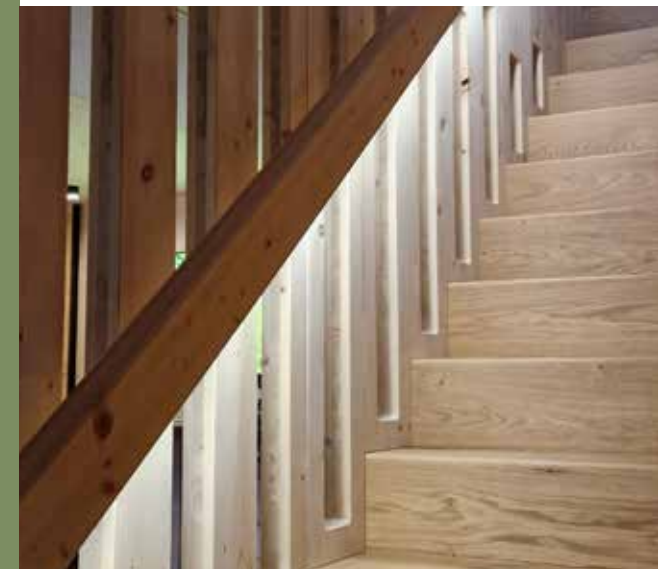


Scan the QR code to learn more



Timber frame construction with LIGNOLOC®

Selected project references



OFFICE COMPLEX – WISSEL TIMBER CONSTRUCTION

For its own company headquarters, Zimmerei Wissel built an office building featuring a modern timber frame structure – entirely planned and executed in-house. The interior walls were clad on both sides with three-layer spruce panels, fastened with LIGNOLOC® wooden nails. LIGNOLOC® nails were also used in the acoustic partition wall: visible spruce battens were installed, contributing to both the acoustic performance and architectural quality of the interior space. A particular highlight of the design and craftsmanship is the folded oak staircase: its steps are precisely milled into the wall structure – a visible expression of precision joinery, innovation, and the potential of modern timber construction.



SINGLE-FAMILY HOME – ASCHAFFENBURG

In Aschaffenburg, a single-family home for six people was built with a high degree of owner participation. Ceilings, floors and stairs were constructed entirely from spruce timber. The building envelope features a continuous metal façade, while all interior walls were constructed using timber-frame technology with three-layer spruce panels. These were fastened exclusively on both sides with LIGNOLOC® wooden nails. The walls were finished by the owners with clay plaster made from clay excavated on site, creating a vapour-permeable indoor environment. Heating is provided by a Römer stove and infrared ceiling panels, powered by a photovoltaic system. Domestic hot water is supplied by decentralised instantaneous water heaters, providing an efficient and low-maintenance solution. The project combines well-considered building services with precise craftsmanship, realised by Zimmerei Wissel GmbH in collaboration with Ewich Innen Architektur.



SENIOR CARE FACILITY – MÜNCHENSTIFT

A senior care facility with 261 residential places was built using modern timber frame construction with exposed timber surfaces, executed by Zimmerei Höfle. The wall elements were manufactured using a WEINMANN® WALLTEQ M-300 and assembled entirely metal-free with LIGNOLOC® wooden nails by BECK. The visible connections give the wall surfaces a distinctive appearance and enable easy, tool-friendly reworking. The project exemplifies the combination of precision, prefabrication efficiency and innovative timber construction technology.



Alternative wall assemblies

Project references





Haus Paradies Bitterfeld

NiTO® SOLID WOOD BLOCKS

In Bitterfeld, Haus Paradies was built as a solid timber bungalow using the modular NiTO® construction system. The load-bearing walls are made from NiTO® solid wood blocks approved by the DIBt (approval number Z-9.1-909), each consisting of six plank sections. These are joined exclusively with LIGNOLOC® wooden nails, forming dimensionally stable solid blocks – enabling a metal-free construction in line with the principles of circular construction. Thanks to the precise tongue-and-groove system, the blocks allow for fast and simple assembly with excellent dimensional accuracy. In total, 57,000 LIGNOLOC® wooden nails were used.



Woodbloc®

LIGNOLOC® CLT MASS TIMBER WALLS

Penzkofer Bau, based in Regen in the Bavarian Forest, has developed Woodbloc®: solid timber walls made from solid, untreated wood. The various timber layers of the Woodbloc® system are securely joined using LIGNOLOC® wooden nails. The wood used for Woodbloc® is sourced from renewable forests in the Bavarian Forest region. The use of locally grown spruce supports the regional economy and promotes sustainable forestry practices. The mass timber elements are produced in a fully automated process at the factory, from laying the boards to nailing them with LIGNOLOC® wooden nails. This method ensures consistently high quality and independence from weather conditions during manufacturing. Woodbloc® has already proven itself in several single-family housing projects. In addition, Woodbloc® walls are suitable for multi-storey residential buildings, commercial properties, and public construction projects as well.





Apartment house – Traunstein

VERTICALLY INSTALLED SOLID LOG WALL

In Traunstein, Chiemgauer Holzhaus realised a solid timber building with six residential units. The structural load-bearing capacity is provided by diagonal boarding, which is fastened without metal using LIGNOLOC® wooden nails – creating a solid timber wall without additional adhesives or metal fasteners. The building meets the Efficiency House 40 standard and is certified under the Quality Seal for Sustainable Buildings (QNG). It combines an innovative solid timber construction with a high level of living comfort. Low operating costs, maximum energy efficiency – photovoltaics, a heat pump, and insulation come together in a well-designed concept.

Single-family home Reisecker

VERTICALLY INSTALLED SOLID LOG WALL

As part of the modernization of a historic four-sided farmstead in the Innviertel region of Upper Austria, this new single-family home was built entirely from wood, with a particular focus on construction based on the principles of circular building. For ecological reasons, the owners selected fir wood as the primary building material. All components were designed for easy disassembly and recyclability at the end of their life cycle. The load-bearing walls were built in a vertical log construction using double tongue-and-groove joints, featuring a refined exposed timber appearance. Additional bracing is provided by a diagonally installed tongue-and-groove sheathing, fastened to the log wall elements with LIGNOLOC® wooden nails. The entire structural framework of the house is made of wood. This eliminated the need for metal fasteners and additional adhesives between the layers of wood. A particular highlight: the floor slab, storey ceilings, and the roof structure are also made entirely of solid timber elements. The exterior walls are insulated with 26 cm of cellulose and clad with a rear-ventilated, rough-sawn board-and-batten façade made of fir. The windows, also crafted from fir, were inserted from the outside into the façade.





Solid timber home – Gars

VERTICALLY INSTALLED SOLID LOG WALL

In Gars am Inn, Chiemgauer Holzhaus built a single-family home in solid timber construction. The structural load is carried by diagonally arranged timber boarding fastened with LIGNOLOC® wooden nails – creating a metal-free solid timber wall with high load-bearing capacity. The construction combines natural materials, a well-planned energy concept, and a minimalist architectural design language. Large window openings create a strong connection to the surrounding landscape, while the solid timber components contribute to a balanced and comfortable indoor climate.



Building at RIO industrial park

WOODEN NAIL-LAMINATED TIMBER ELEMENTS

At the RIO Industrial Park in Osterburken, prema® completed an industrial building in just ten months using an innovative timber construction system with a high degree of prefabrication. The load-bearing structure is made almost entirely of proprietary prema® panels in nail-laminated timber (NLT) construction – metal-free elements joined with LIGNOLOC® wooden nails. Solid timber components were used throughout the project – from wall elements up to nine metres in height to the solid timber floor slab. Architecture, planning, and execution were all carried out solely by prema®.



BECK Fastening GmbH
Raimund-Beck-Strasse 1
5270 Mauerkirchen | Austria
T +43 7724 2111-0
sales@beck-fastening.com
BECK-FASTENING.COM

