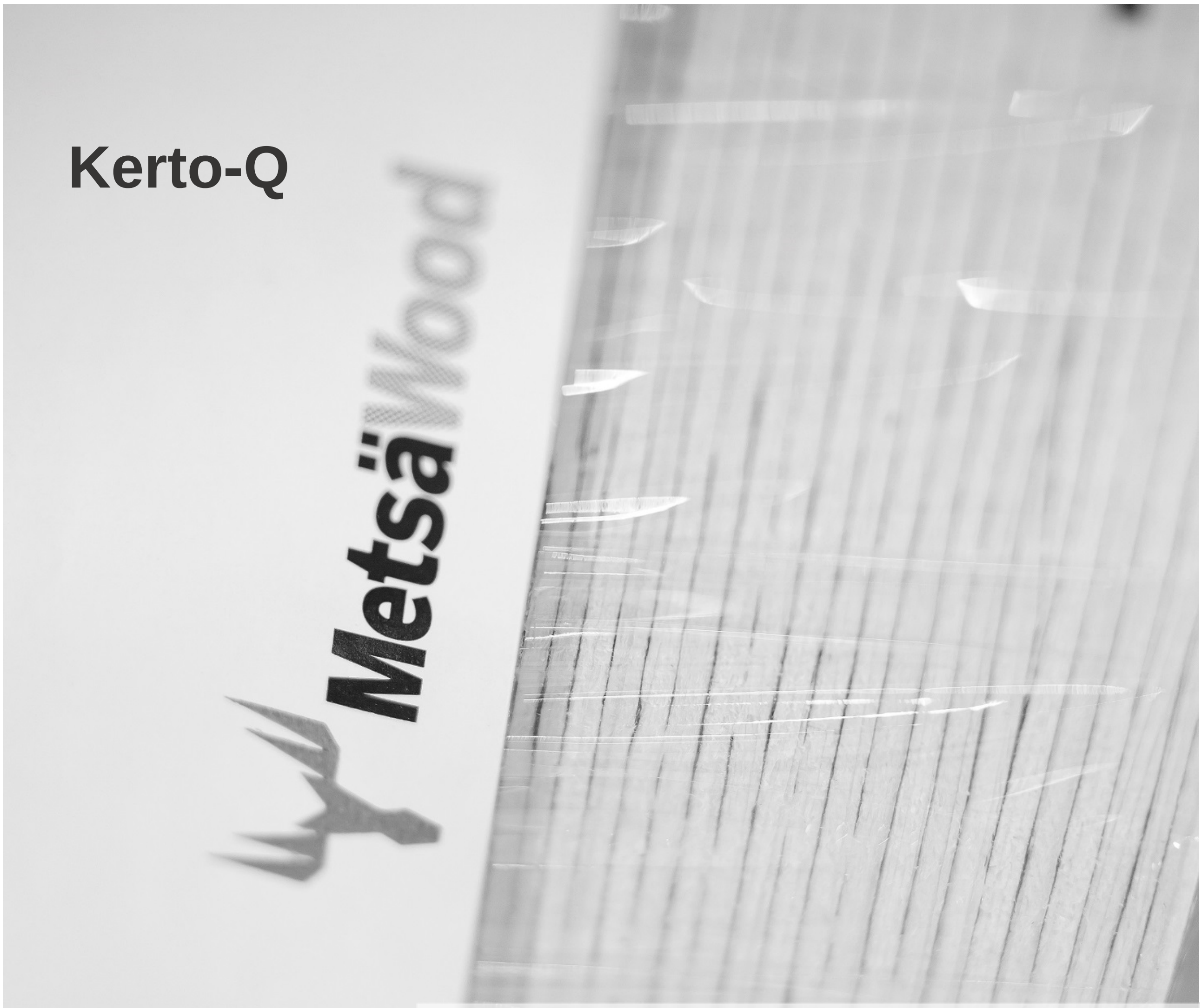
Kerto-Q



MetsäWood

1 Kerto-Q – benefits

- Kerto-Q products can be used to brace buildings of different sizes, regardless of the frame material.
- The large production dimensions of Kerto-Q products improve installation efficiency by reducing the amount of lifting required on the construction site.
- Kerto-Q products are available globally.
- Kerto-Q products can be sawn according to the dimensions of the construction project. In many cases, this eliminates on-site waste completely.
- Kerto-Q products are easy to design using Finnwood® software.
- In addition to construction, Kerto-Q products are suitable for industrial applications that require dimensional stability, lightweight and strength.
- Using Kerto-Q products enhances efficiency and is part of modern timber construction.

Kerto® laminated veneer lumber (LVL) is a product made of bonded softwood veneers for use as structural or non-structural elements in buildings and bridges. The thickness of Kerto-Q varies from 21-75 mm; other dimensions vary according to customer requirements. The product is manufactured mainly from spruce veneers, but small part of the veneers may also be pine. The nominal thickness of the veneers is 3 mm and they are bonded together using phenol formaldehyde adhesive suitable for exterior use. About one fifth of the veneers in Kerto-Q are cross grained.

Figure 1: Metsä Wood's Kerto® products – quality for builders and industrial applications.

Figure 2: Versatile use of Kerto-Q panels in floors and walls.

2 Kerto-Q for all wooden structures

Kerto-Q is a load-bearing panel product that can be used in both horizontal and vertical structures. About one fifth of the veneers are crosswise to the surface veneer, which enhances the transverse strength and stiffness of the panel. Kerto-Q can be sawn according to the customer's dimensions, without having to take into account the ratio between the height and width of the beam structures, for example. Apart from the maximum dimensions, Kerto-Q panels have no standard sizes - they are manufactured according to the customer requirements.

The thickness range of the Kerto-Q panels is 21-75 mm. Standard thicknesses are available at intervals of 3 mm up to 33 mm, and at intervals of 6 mm for thicker panels. The surfaces of Kerto-Q panels can be optically sanded to enhance their appearance or calibrated to a specific thickness with an accuracy of ±0.5 mm. The maximum sizes of Kerto-Q panels are 2.5 m x 20 m and 1.8 m x 25 m. Local transport restrictions may limit the maximum size. Untreated Kerto LVL has reaction to fire class D-s1,d0.

Kerto-Q is suitable for the most challenging wooden structures, and it can be glued together to create composite structures and elements to serve as a load-bearing member or as a beam to transfer horizontal and vertical loads. Holes and notches machined in the Kerto-Q structures only have limited reduction to the load-bearing capacity. The edges of the panels can be profiled to create diaphragms and prevent displacement differences at panel joints. Kerto LVL is suitable for use in service classes 1 and 2, and with an additional protective treatment in service class 3. Protective treatment is outside of the scope of VTT certificate.

Kerto-Q products can be machined using normal woodworking tools. In addition, Kerto-Q can be treated against weather and mould , and it can be coated with paints or varnishes. Kerto-Q products do not require pre-drilling for fastening as their characteristic density is 480 kg/m^3. The need for pre-drilling comes only from the fastener requirements. For example, large screws and nails, as well as all bolts and dowels, require pre-drilling.

Figure 3: Kerto-Q panels with thicknesses of 33 mm, 45 mm and 69 mm.

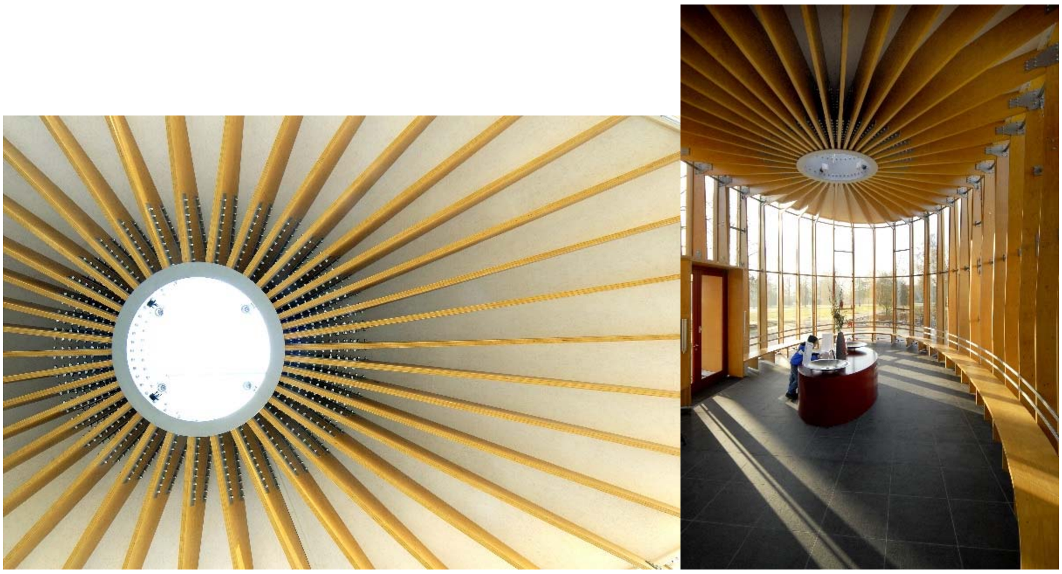


Figure 4: Kurpark Wuellpavillon (Bode Petters Architekten) in Germany uses Kerto-Q in radial rafters and wall columns. Photo: Hanns Joosten.

3 Kerto-Qp – a stiff and tall beam

Kerto-Qp is a dimensionally stable beam suitable for roof and intermediate floor structures in both new constructions and renovation projects. The structural height of Kerto-Qp beams allow spacious interiors while reducing the amount of supporting structures. An insulation layer with a thickness of around 500 mm can be installed between the tall beams to achieve excellent thermal resistance of the structure. With dimension of 42 mm × 500 mm, 51 mm × 620 mm and 63 mm × 830 mm, the Kerto-Qp beam is suitable for horizontal spans of up to 14 m, with a centre-to-centre spacing of 1200 mm. Shorter centre-to-centre spacing between the beams allow horizontal spans up to approximately 18 m.

Kerto-Qp beams have a unique structure and are manufactured taller and thinner than Kerto-S beams. Kerto-Qp beams also have better strength and stiffness properties than Kerto-Q, which allow more cost-effective construction. The crosswise veneers in the structure, for example, minimise moisture deformations.

Figure 5: Kerto-Qp product.

Figure 6: Kerto-Qp rafters.

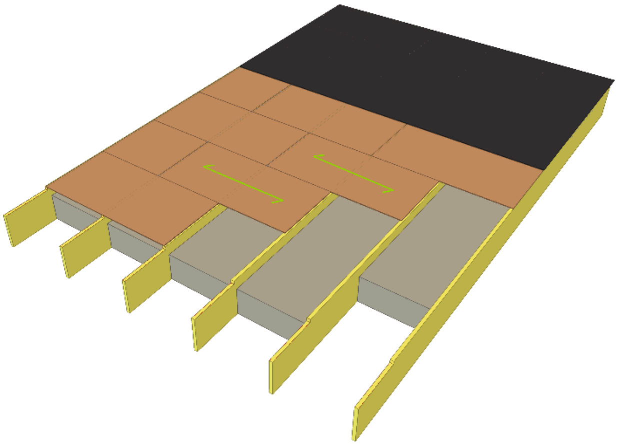
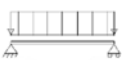


Figure 7: Principle of using Kerto-Q roof panels on top of Kerto-Qp rafters.

Table 1: Preliminary design table for a single-span Kerto-Qp rafter for different cross-sections, spacing and loads. EN 1995-1-1 + NA:FI*), service class 1. Rafter has buckling support at spacing of ≤ 600 mm. The rafter is loaded through buckling supports. Deflection limit $w_{net,fin} \leq L/200$. Roof slope 30 degrees or less.

Permanent load		g [kN/m^2]	0.60					1.20				
Snow load on the ground		s_k [kN/m^2]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof		s [kN/m^2]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load		w [kN/m^2]	±0.60					±0.60				
Maintenance load		q [kN/m^2]	0.40					0.40				
b [mm]	h [mm]	c/c [mm]	Single-span Kerto-Qp rafter, maximum horizontal spans in mm									
42	500	1200	7482	7482	7317	6980	6451	7006	6772	6633	6391	6018
42	500	900	8426	8270	8045	7681	7352	7707	7456	7300	7049	6806
42	500	600	9812	9396	9145	8746	8383	8781	8504	8331	8045	7785
51	620	1200	10106	9898	9630	9197	8807	9231	8928	8746	8443	8149
51	620	900	11318	10833	10548	10089	9664	10123	9803	9604	9275	8963
51	620	600	12756	12236	11933	11440	10981	11474	11128	10911	10556	10219
63	830	1200	14860	14246	13882	13284	12739	13328	12912	12661	12228	11821
63	830	900	16151	15510	15129	14505	13934	14549	14107	13847	13397	12964
63	830	600	18021	17363	16965	16315	15709	16367	15900	15623	15138	14679



	L is less than 10000 mm
	L is 10000–15000 mm
	L is more than 15000 mm

*) Other National Annexes may give different results.

Note! The preliminary design table does not replace project-specific structural design by a qualified person.

4 Horizontal structures and overhangs

Kerto-Q panels are suitable for horizontal load-bearing panel structures in roofs and intermediate floors. Using thicker panels allows longer spans between supports. In roof structures, Kerto-Q panels form a durable base for roofing. MouldGuard treated panels are recommended to be used in unheated spaces to reduce the risk of mould growth. Preliminary design Tables 2-5 give different panel thicknesses as well as permanent and snow loads for single and multi-span panels both perpendicular and parallel to the supports. The preliminary design tables do not replace project-specific structural design by a qualified person.

Due to its excellent strength properties, Kerto-Q panels can be used in thin roof line overhangs as a load-bearing structure without the need of separate supports. The corner overhangs can also be built without additional supports.

In intermediate floor structures, Kerto-Q panels enable sparser frame spacing and strong and stiff floor panelling. The properties of Kerto-Q can also be utilised when designing frames for buildings. For example, Kerto-Q flooring can be used as horizontal bracing, which can usually replace separate bracing structures. The large panel size of Kerto-Q allows faster installation of large areas with less lifting. Using a panel size of 2.4 m x 10 m, for instance, an intermediate floor of 9.6 m x 10 m can be installed using only four panels. The panels may be single or multi spanned depending on the frame spacing. Preliminary design Tables 6-9 give different panel thicknesses as well as permanent and imposed loads for single and multi-span panels, both perpendicular and parallel to the supports.

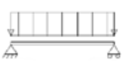
Kerto-Q panels can be used in unique applications, such as warehouse shelfs and industrial solutions, since the panels are lightweight and easy to replace.

Figure 8: Kerto-Q roof panelling; two layers of panels with staggered joints.

Figure 9: Kerto-Q panels in a roof structure bracing.

Table 2: Preliminary design table for a single-span roof panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 10. EN 1995-1-1 + NA:FI*), service class 2. Point loads not taken into account. Deflection limit $w_{net,fin} \leq L/150$. Roof slope is not limited.

Surface structure	g_2 [kN/m^2]	0.20					0.60				
Snow load on the ground	s_k [kN/m^2]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m^2]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m^2]	±0.60					±0.60				
Maintenance load	q_H [kN/m^2]	0.40					0.40				
Single-span roof panel, maximum spans in mm, face grain direction **perpendicular** to supports											
Panel thickness [mm]	21	1250	1160	1120	1040	970	1100	1050	1020	960	910
	24	1420	1320	1270	1190	1110	1260	1200	1160	1100	1040
	27	1620	1520	1460	1370	1280	1450	1380	1340	1270	1200
	33	1970	1840	1770	1660	1550	1760	1680	1630	1540	1460
	39	2300	2160	2080	1950	1830	2060	1970	1910	1820	1720
	45	2630	2470	2390	2240	2100	2360	2260	2200	2090	1980
	51	2950	2780	2690	2520	2370	2660	2540	2480	2350	2230
	57	3270	3090	2980	2800	2630	2960	2830	2750	2620	2490
	63	3580	3380	3270	3080	2900	3250	3110	3030	2880	2740
	69	3890	3680	3560	3360	3160	3530	3380	3300	3140	2990
	75	4190	3970	3850	3630	3420	3810	3660	3570	3400	3230

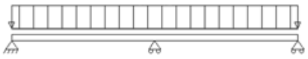


(white)	*L* is less than 1200 mm
(light green)	*L* is 1200–3000 mm
(green)	*L* is more than 3000 mm

*) Other National Annexes may give different results.

Table 3: Preliminary design table for a multi-span roof panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 11. EN 1995-1-1 + NA:FI *), service class 2. Point loads not taken into account. Deflection limit $w_{net,fin} \leq L/150$. Roof slope is not limited.

Surface structure	g_2 [kN/m^2]	0.20					0.60				
Snow load on the ground	s_k [kN/m^2]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m^2]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m^2]	±0.60					±0.60				
Maintenance load	q_H [kN/m^2]	0.40					0.40				
Multi-span roof panel, maximum span in mm, face grain direction **perpendicular** to supports											
Panel thickness [mm]	21	1530	1430	1370	1280	1190	1360	1290	1250	1180	1120
	24	1740	1630	1560	1460	1360	1550	1470	1430	1350	1270
	27	2000	1870	1800	1680	1570	1790	1700	1650	1560	1480
	33	2430	2270	2190	2050	1920	2170	2070	2010	1900	1800
	39	2840	2670	2570	2410	2250	2550	2430	2360	2240	2120
	45	3250	3050	2940	2760	2590	2920	2780	2710	2570	2440
	51	3640	3430	3310	3110	2920	3280	3140	3050	2900	2750
	57	4040	3810	3680	3460	3250	3650	3490	3390	3230	3060
	63	4420	4180	4040	3800	3570	4000	3830	3730	3550	3370
	69	4800	4540	4390	4140	3890	4360	4170	4060	3870	3680
	75	5180	4900	4740	4470	4210	4700	4510	4390	4190	3980

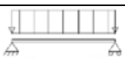


- *L* is less than 1200 mm
- *L* is 1200–3000 mm
- *L* is more than 3000 mm

*) Other National Annexes may give different results.

Table 4: Preliminary design table for a single-span roof panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 10. EN 1995-1-1 + NA:FI*), service class 2. Point loads not taken into account. Deflection limit $w_{net,fin} \leq L/150$. Roof slope is not limited.

Surface structure	g_2 [kN/m^2]	0.20					0.60				
Snow load on the ground	s_k [kN/m^2]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m^2]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m^2]	±0.60					±0.60				
Maintenance load	q_H [kN/m^2]	0.40					0.40				
Single-span roof panel, maximum spans in mm, face grain direction **parallel** to supports											
Panel thickness [mm]	21	610	570	540	510	470	540	510	500	470	440
	24	690	650	620	580	540	610	580	570	530	500
	27	920	860	820	770	710	810	770	750	710	670
	33	1110	1040	1000	930	870	990	940	910	860	810
	39	1300	1220	1170	1090	1020	1160	1100	1070	1010	960
	45	1480	1390	1340	1250	1170	1330	1270	1230	1170	1100
	51	1670	1570	1510	1410	1320	1500	1430	1390	1310	1240
	57	1850	1740	1680	1570	1470	1660	1590	1540	1460	1380
	63	2020	1910	1840	1730	1620	1820	1740	1690	1610	1520
	69	2200	2070	2000	1880	1760	1980	1900	1850	1750	1660
	75	2370	2240	2160	2030	1910	2140	2050	2000	1900	1800

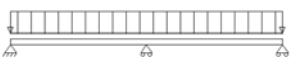


- *L* is less than 1200 mm
- *L* is 1200–2500 mm (maximum width of Kerto-Q panel is 2.5 m)

*) Other National Annexes may give different results.

Table 5: Preliminary design table for a multi-span roof panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 11. EN 1995-1-1 + NA:FI*), service class 2. Point loads not taken into account. Deflection limit $w_{net,fin} \leq L/150$. Roof slope is not limited.

Surface structure	g_2 [kN/m^2]	0.20					0.60				
Snow load on the ground	s_k [kN/m^2]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m^2]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m^2]	±0.60					±0.60				
Maintenance load	q_H [kN/m^2]	0.40					0.40				
Multi-span roof panel, maximum spans in mm, face grain direction **parallel** to supports											
Panel thickness [mm]	21	750	700	670	620	580	660	630	610	570	540
	24	850	790	760	710	660	750	720	690	660	620
	27	1130	1050	1010	940	870	1000	950	920	870	820
	33	1250*	1250*	1250*	1140	1060	1250*	1150	1120	1050	990
	39				1250*	1250*		1250*	1250*	1250*	1250*



- *L* is less than 1200 mm
- *L* is 1200–1250 mm (maximum width of Kerto-Q panel is 2.5 m)
- *) Double span panel

*) Other National Annexes may give different results.

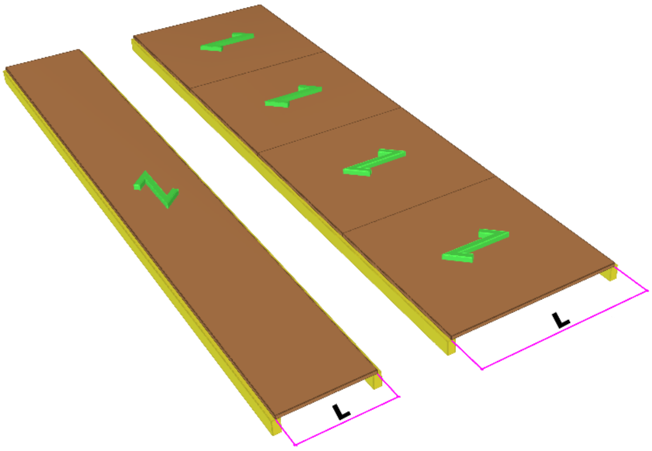
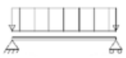


Figure 10: Single span Kerto-Q panel. The face veneer grain direction of the panel in relation to the load-bearing frame. On the left, the span is parallel and on the right, perpendicular.

Table 6: Preliminary design table for a single-span floor panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 10. EN 1995-1-1 + NA:FI*), service class 1, load categories (residential A, office B and congregated C). Point loads not taken into account. Deflection limits $w_{inst} \leq L/400$ and $w_{net,fin} \leq L/300$.

Surface structure	g_2 [kN/m²]	0.25				0.50				1.50			
Imposed load	q [kN/m²]	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00
Single-span floor panel, maximum spans in mm, face grain direction **perpendicular** to supports													
Panel thickness [mm]	21	890	820	770	660	840	790	740	650	710	680	650	590
	24	1020	940	880	750	960	900	850	740	810	770	740	670
	27	1180	1090	1020	880	1110	1040	990	870	950	910	870	790
	33	1430	1330	1250	1080	1350	1270	1200	1060	1150	1100	1060	970
	39	1680	1560	1470	1270	1590	1490	1420	1250	1360	1300	1250	1140
	45	1920	1790	1690	1460	1820	1720	1630	1440	1560	1500	1440	1320
	51	2170	2020	1910	1660	2060	1930	1840	1620	1760	1690	1630	1490
	57	2400	2250	2120	1850	2290	2150	2040	1810	1960	1890	1820	1660
	63	2640	2470	2330	2040	2510	2370	2250	2000	2160	2080	2000	1830
	69	2870	2690	2540	2230	2740	2580	2460	2180	2360	2270	2190	2000
	75	3100	2910	2750	2410	2960	2790	2660	2360	2560	2460	2370	2170
		*L* is less than 1200 mm											
		L is 1200–3000 mm											
		L is more than 3000 mm											

*) Other National Annexes may give different results.

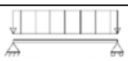
Table 7: Preliminary design table for a multi-span floor panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 11. EN 1995-1-1 + NA:FI*), service class 1, load categories (residential A, office B and congregated C). Point loads not taken into account. Deflection limits $w_{inst} \leq L/400$ and $w_{net,fin} \leq L/300$.

Surface structure	g_2 [kN/m²]	0.25				0.50				1.50			
Imposed load	q [kN/m²]	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00
Multi-span floor panel, maximum spans in mm, face grain direction **perpendicular** to supports													
Panel thickness [mm]	21	1000	910	850	720	960	890	830	710	830	780	750	670
	24	1140	1040	970	830	1090	1010	950	820	940	890	850	760
	27	1320	1210	1130	970	1270	1180	1110	960	1110	1050	1000	900
	33	1610	1480	1380	1190	1540	1440	1350	1170	1350	1280	1230	1100
	39	1900	1750	1630	1400	1820	1690	1600	1380	1590	1510	1450	1300
	45	2180	2010	1880	1620	2090	1950	1840	1590	1830	1740	1660	1500
	51	2450	2270	2120	1830	2350	2200	2070	1800	2060	1970	1880	1690
	57	2730	2530	2370	2040	2620	2450	2310	2010	2300	2190	2100	1890
	63	3000	2790	2610	2250	2880	2690	2550	2220	2530	2410	2310	2080
	69	3270	3040	2850	2470	3140	2940	2780	2430	2770	2640	2530	2280
	75	3540	3290	3090	2680	3400	3180	3010	2640	3000	2860	2740	2470
		*L* is less than 1200 mm											
		L is 1200–3000 mm											
		L is more than 3000 mm											

*) Other National Annexes may give different results.

Table 8: Preliminary design table for a single-span floor panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 10. EN 1995-1-1 + NA:FI*), service class 1, load categories (residential A, office B and congregated C). Point loads not taken into account. Deflection limits $w_{inst} \leq L/400$ and $w_{net,fin} \leq L/300$.

Surface structure	g_2 [kN/m²]	0.25				0.50				1.50			
Imposed load	q [kN/m²]	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00
	Single-span floor panel, maximum spans in mm, face grain direction **parallel** to supports												
Panel thickness [mm]	21	430	400	370	320	410	380	360	310	340	330	310	280
	24	490	460	420	360	470	430	410	350	390	370	360	320
	27	650	600	560	480	620	570	540	470	520	490	470	420
	33	790	730	680	580	750	700	660	570	630	600	580	520
	39	930	860	810	690	880	820	780	670	740	710	680	610
	45	1070	990	930	790	1010	940	890	780	850	810	780	700
	51	1200	1120	1050	900	1140	1070	1010	880	960	920	880	800
	57	1340	1240	1170	1000	1260	1190	1120	980	1070	1030	980	890
	63	1470	1360	1280	1100	1390	1300	1230	1080	1180	1130	1090	980
	69	1600	1490	1400	1210	1510	1420	1350	1180	1290	1230	1180	1070
	75	1720	1610	1510	1310	1640	1540	1460	1280	1390	1340	1280	1160



(white)	L is less than 1200 mm
(green)	L is 1200–2500 mm (maximum width of Kerto-Q panel is 2.5 m)

*) Other National Annexes may give different results.

Table 9: Preliminary design table for a multi-span floor panel for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 11. EN 1995-1-1 + NA:FI*), service class 1, load categories (residential A, office B and congregated C). Point loads not taken into account. Deflection limits $w_{inst} \leq L/400$ and $w_{net,fin} \leq L/300$.

Surface structure	g_2 [kN/m²]	0.25				0.50				1.50			
Imposed load	q [kN/m²]	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00	1.50	2.00	2.50	4.00
	Multi-span floor panel, maximum spans in mm, face grain direction **parallel** to supports												
Panel thickness [mm]	21	490	440	410	350	460	430	400	340	400	380	360	320
	24	550	510	470	400	530	490	460	390	450	430	410	360
	27	730	670	620	520	700	650	600	510	600	560	540	480
	33	890	810	760	640	850	790	740	630	730	690	660	580
	39	1050	960	890	760	1000	930	870	740	860	810	770	690
	45	1200	1100	1030	870	1150	1060	1000	860	990	930	890	790
	51	1250*	1250*	1160	990	1250*	1200	1130	970	1120	1060	1010	890
	57			1250*	1100		1250*	1250*	1080	1250*	1180	1120	1000
	63				1210				1190		1250*	1250*	1100
	69				1250*				1250*				1200
	75												1250*

(white)	L is less than 1200 mm
(green)	L is 1200–1250 mm (maximum width of Kerto-Q panel is 2.5 m)
*)	Double span panel

*) Other National Annexes may give different results.

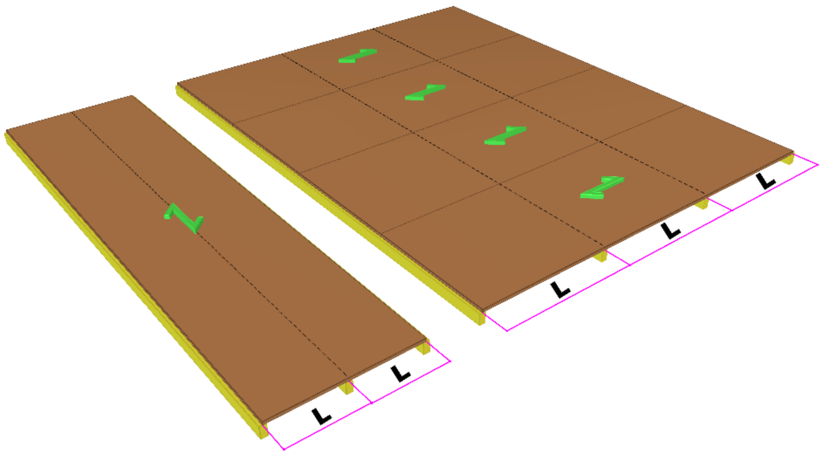


Figure 11: Multi-span Kerto-Q panel. The face veneer grain direction of the panel in relation to the load-bearing frame. On the left, the span is parallel and on the right, perpendicular.

4.1 Point loaded panels

Kerto-Q panels have good resistance against concentrated loads. The concentrated loads determine a minimum panel thickness against the local effects on structures. Table 10 present the maximum concentrated load for a given panel thicknesses and support spacing.

Table 10: Preliminary design table for a floor panel for different Kerto-Q thicknesses and point loads (50x50 mm^2). The panel is supported by continuous supports from all edges. EN 1995-1-1 + NA:FI*), service class 1, CC1, load categories (residential A, office B and congregated C). Deflection limits $w_{net,fin} \leq \min(L/100; 6\text{ mm})$. Values are valid also for optically sanded products.

Imposed load	Q_k [kN]	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Panel thickness [mm]	Maximum spans in mm, face grain direction **perpendicular** to supports							
	27	1200	1200	900	600	600	-	-
	33	1200	1200	1200	900	900	600	600
	Maximum spans in mm, face grain direction **parallel** to supports							
	27	1200	900	600	-	-	-	-
	33	1200	1200	600	600	600	-	-

*) Other National Annexes may give different results.

4.2 Eaves and roofs overhangs

Roof overhangs and eaves made of Kerto-Q panels are thin and elegant structures. The underside of eave panels may be custom designed and coated with paint or varnish. Additional elements, such as decorative wooden elements, can easily be fastened underneath of the panels. The maximum width of roof overhangs and eaves depends on the installation direction and the thickness of the panel. When designing and installing panels, it must be taken into account that the panels have different load-bearing capacity depending on the grain direction of the face veneer.

The panels can be machined and surface treated at the mill, which significantly increases installation speed on-site (see Chapter 11 for information on available surface treatments). Roof panels provide a good slip resistant working platform as soon as they are fastened to the supports. The panels can be fastened to timber, concrete or a steel frame. The wide range of dimensions enable an optimal solution for each application. Panel structures are suitable for both flat and pitched roofs regardless of the roof slope.

Structural designs should specify the number and type of fasteners required. Panel fastening must also be designed to withstand the upward wind effect. When needed, an installation plan should be prepared that indicates, for example, the installation order.

Tables 11 and 12 present roof overhang lengths for Kerto-Q panels with different thicknesses and surface, and snow loads. The face veneer grain direction of the panel in relation to the overhang direction is presented in Figure 12. The field span length of the overhanging panel should be at least L_c and at most 2x L_c.

Table 11: Preliminary design table for overhang width L_c for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 13. EN 1995-1-1 + NA:FI*), service class 2. Point loads not taken into account. Deflection limit for overhang $w_{net,fin} \leq L/75$ and for field $w_{net,fin} \leq L/150$. Roof slope is not limited.

Surface structure	g_2 [kN/m²]	0.20					0.60				
Snow load on the ground	s_k [kN/m²]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m²]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m²]	0.60 / -1.20					0.60 / -1.20				
Maintenance load	q_H [kN/m²]	0.40					0.40				
Roof panel, maximum overhang length in mm, face grain direction **parallel** to overhang											
Panel thickness [mm]	21	580	540	510	480	440	510	480	470	440	410
	24	650	610	590	540	510	580	550	530	500	470
	27	760	710	680	630	590	670	640	620	590	560
	33	920	860	830	770	720	820	780	760	720	680
	39	1070	1010	970	910	850	960	910	890	840	800
	45	1230	1150	1110	1040	970	1100	1050	1020	970	920
	51	1380	1300	1250	1170	1100	1240	1180	1150	1090	1030
	57	1520	1440	1390	1300	1220	1380	1310	1280	1220	1150
	63	1670	1580	1520	1430	1350	1510	1440	1410	1340	1270
	69	1810	1710	1660	1560	1470	1640	1570	1530	1460	1380
	75	1960	1850	1790	1690	1590	1780	1700	1660	1580	1500
		L is less than 500 mm									
		L is 500–1000 mm									
		L is more than 1000 mm									

*) Other National Annexes may give different results.

Table 12: Preliminary design table for overhang width L_c for different Kerto-Q thicknesses and loads. The panel is supported by continuous supports according to Figure 13. EN 1995-1-1 + NA:FI*), service class 2. Point loads not taken into account. Deflection limit for overhang $w_{net,fin} \leq L/75$ and for field $w_{net,fin} \leq L/150$. Roof slope is not limited.

Surface structure	g_2 [kN/m²]	0.20					0.60				
Snow load on the ground	s_k [kN/m²]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m²]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m²]	0.60 / -1.20					0.60 / -1.20				
Maintenance load	q_H [kN/m²]	0.40					0.40				
Roof panel, maximum overhang length in mm, face grain direction **perpendicular** to overhang											
Panel thickness [mm]	21	280	260	250	230	210	250	230	220	210	200
	24	320	290	280	260	240	280	260	260	240	230
	27	420	390	370	350	320	370	350	340	320	300
	33	510	470	450	420	390	450	430	410	390	360
	39	590	560	530	500	460	530	500	490	460	430
	45	680	640	610	570	530	610	570	560	530	490
	51	760	710	690	640	600	680	650	630	590	560
	57	850	790	760	710	660	760	720	700	660	620
	63	930	870	840	780	730	830	790	770	730	680
	69	1000	950	910	850	800	900	860	840	790	750
	75	1080	1020	980	920	860	970	930	900	860	810
		L_c is less than 500 mm									
		L_c is 500–1000 mm									
		L is more than 1000 mm									

*) Other National Annexes may give different results.

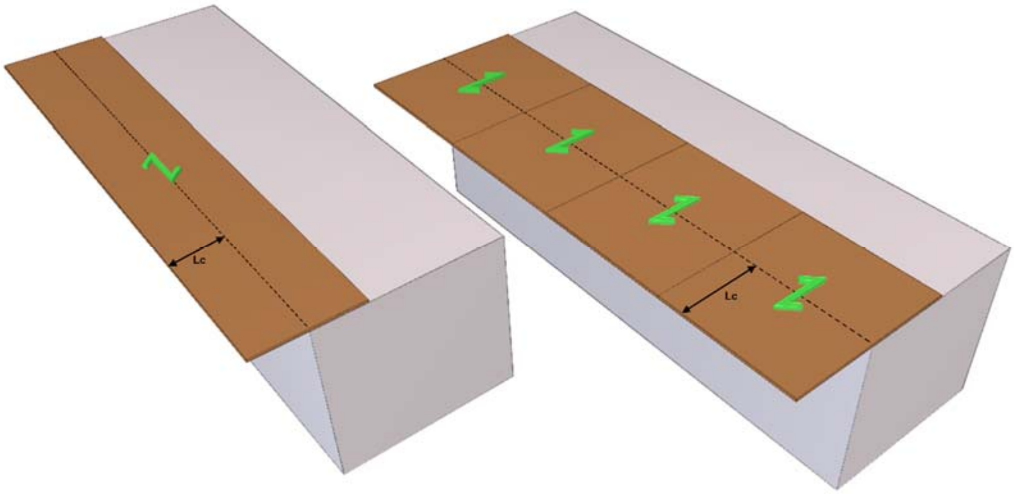


Figure 12: The face veneer grain direction of the panel in relation to the overhang direction. On the left, the projection is perpendicular and on the right, parallel.

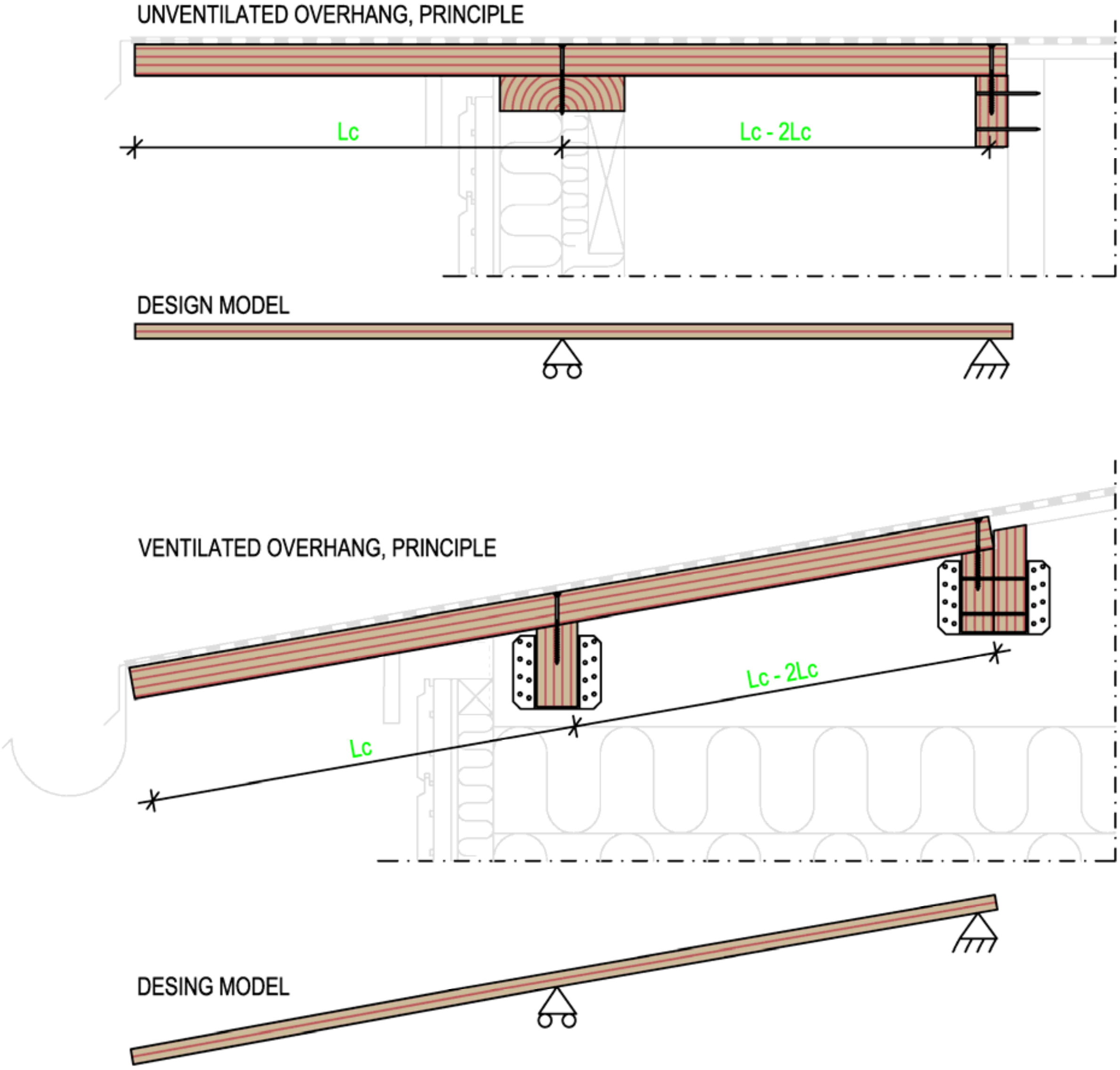


Figure 13: Principles of overhang solutions; overhang widths L_c for various panel thicknesses are presented in Tables 11 and 12. Field span length at least L_c and at most 2x L_c.

4.3 Corner overhang

The use of Kerto-Q as overhangs is described above. Overhangs without supporting beams for the whole overhang area including corner overhangs, need to be buildable with Kerto-Q panels. Table 13 presents roof corner overhang lengths for Kerto-Q panels with different thicknesses and permanent and snow loads. The face veneer grain direction of the panel in relation to the overhang direction is presented in Figure 14. The panel is supported with continuous support according to Figure 13.

Table 13: Preliminary design table for corner overhang width L_c [mm] for different Kerto-Q thicknesses and loads. EN 1995-1-1 + NA:FI*), service class 2. Point loads not taken into account. The surface veneer grain direction can be in either overhang direction. Deflection limit $w_{net,fin}$ for overhang L_c is $L/75$ and for corner overhang $\sqrt{2} \cdot L/75$. Roof slope is not limited.

Surface structure	g_2 [kN/m²]	0.20					0.60				
Snow load on the ground	s_0 [kN/m²]	1.00	1.60	2.00	2.75	3.50	1.00	1.60	2.00	2.75	3.50
Snow load on the roof	s [kN/m²]	0.80	1.28	1.60	2.20	2.80	0.80	1.28	1.60	2.20	2.80
Wind load	w [kN/m²]	0.60 / -1.20					0.60 / -1.20				
Maintenance load	q_H [kN/m²]	0.40					0.40				
Panel thickness [mm]	24	300	-	-	-	-	-	-	-	-	-
	27	400	350	350	300	300	350	300	300	300	-
	33	500	450	400	400	350	400	400	400	350	350
	39	550	500	500	450	400	500	450	450	400	400
	45	650	600	550	550	500	550	550	500	500	450
	51	750	700	650	600	550	650	600	600	550	500
	57	800	750	700	650	600	700	650	650	600	550
	63	900	800	800	750	700	800	750	700	650	650
	69	950	900	850	800	750	850	800	800	750	700
	75	1000	950	950	850	800	900	850	850	800	750
	(white)	L_c is less than 500 mm									
	(green)	L_c is 500–1000 mm									

*) Other National Annexes may give different results.

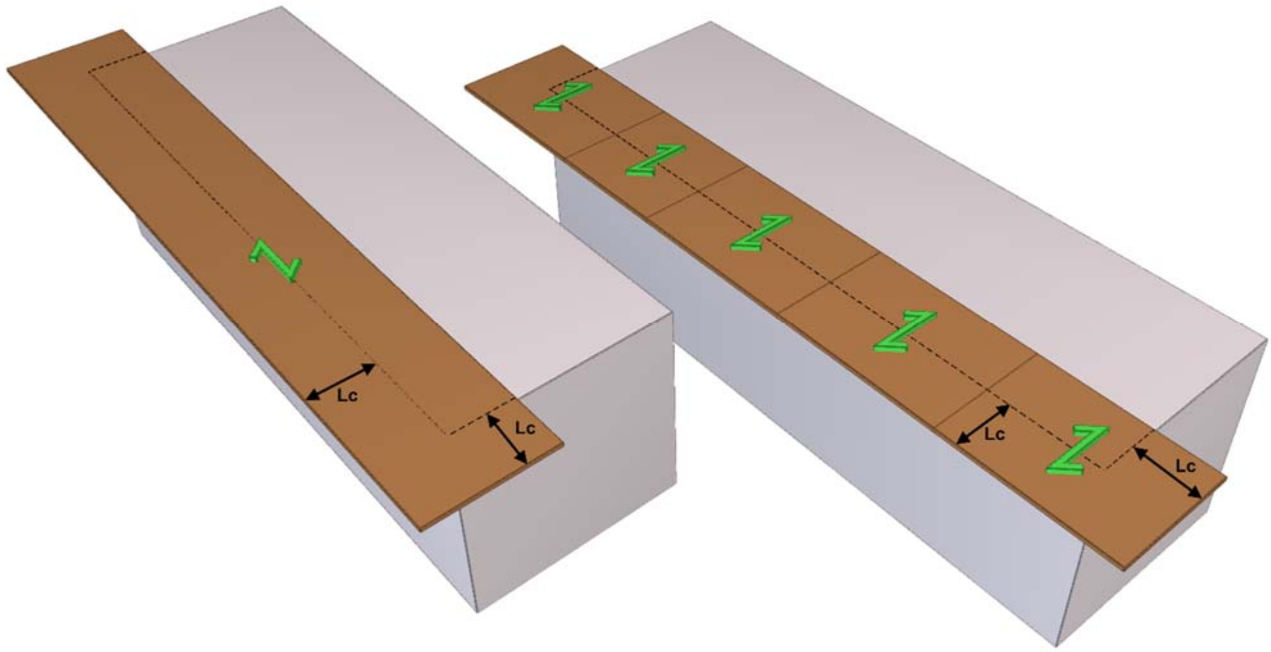


Figure 14: The face veneer grain direction of the panel in relation to the overhang direction. On the left, the projection is perpendicular and on the right, parallel.

Figure 15: Corner overhang made from Kerto-Q panel.

Figure 16: Kerto-Q eave panelling.

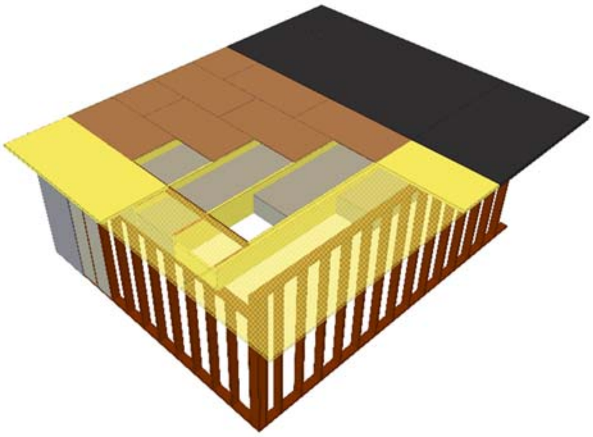


Figure 17: Principle of Kerto-Q corner overhang.

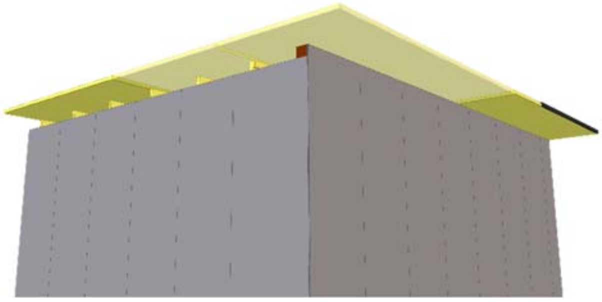


Figure 18: Principle of Kerto-Q corner overhang.

4.4 Panel joint types

The following joint types can be used to connect Kerto-Q panels. The actual structural load-bearing capacity depends on the project, and must be checked separately in every individual case. More information of the minimum dimensions for nailed or screwed connections can be found from Chapter 10.1.1. For connector positioning, the acting force direction is parallel to the joint. If the force direction is perpendicular to the joint, information on the connector positioning can be found from the Kerto Manual connection cards.

Structurally supported panel joints

Panels may be supported using structural supports as presented in Figure 19. The panel edges in these joints are usually non-machined and the force acting parallel to the joint is transferred through the load-bearing structure from one panel to the next. The diameter, spacing and insertion depths of the fasteners should be according to the structural design.

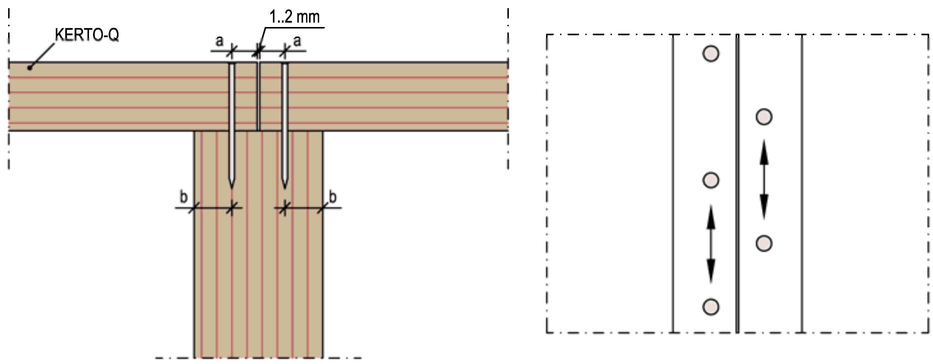


Figure 19: Panel joint on wooden construction, for minimum spacing see chapter 10.1.1.

Self-supported panel joints

The edge of the panel can be machined for self-supporting panel joists (see Figures 20 and 21). Usually, they form a half-lap connection where part of the panel thickness is machined to create matching pairs of the edges. The diameter, spacing and insertion depths of the fasteners should be according to the structural design.

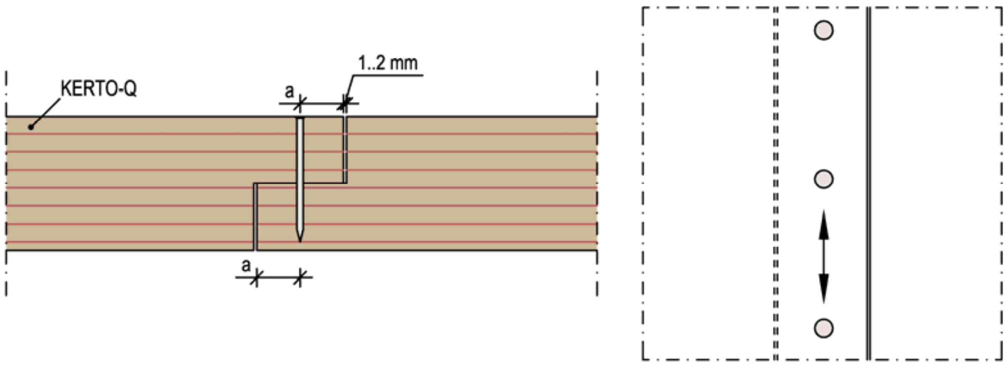


Figure 20: Joint with half lap, for minimum spacing see chapter 10.1.1.

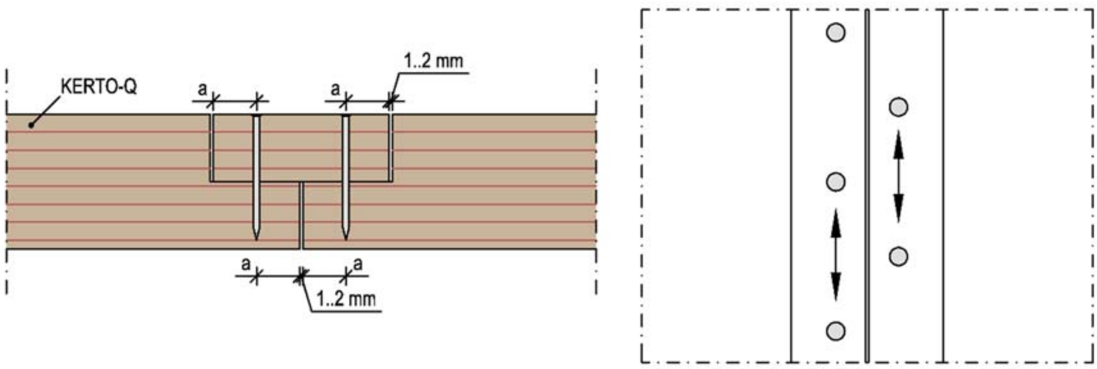


Figure 21: Joint with half lap and seam piece, for minimum spacing see chapter 10.1.1.

5 Panel bracing

All building frames need bracing that transfer horizontal loads, such as wind load, to the foundations. In most buildings, panel bracing is used. Kerto-Q is an ideal product for panel bracing in various types of buildings as it is easy to fasten to most materials. The thicknesses of Kerto-Q are greater than those of commonly used wood-based panels. This allows sparser frame spacing than normal without the risk of bracing panel buckling. When Kerto-Q panels are used for bracing, additional bracing systems are not usually needed.

Kerto-Q panels are suitable for both horizontal and vertical bracing. Horizontal bracing panels transfer horizontal loads to the vertical bracing panels; the vertical bracing panels in turn transfer forces downwards. Preliminary design values for fastening bracing panels are presented in Chapter 10.1.1.

In addition to bracing the buildings, Kerto-Q panels can be designed to act as a load-bearing member that transfers vertical loads, thus removing the need for a separate load-bearing frame structure. In walls and roofs of conventional buildings, Kerto-Q panels can also be utilised as a water vapour and air barrier, in which case no separate barrier layer is needed. The fire behaviour of Kerto-Q is highly predictable, which makes it a suitable bracing panel also for situations such as fire.

Figure 22: A hall braced with Kerto-Q panels.

6 Columns

Kerto-Q columns can be used as combined members suitable for transferring vertical loads in various structures. When using built-up columns in a framed structure, it is possible to use timber-to-timber connections between the members without using separate steel parts. The crosswise veneers in Kerto-Q panels provide good connection strength, and usually there is no risk of cracking in typical corner connections. For example, Kerto-Q columns can be used in three-hinged frames and, depending on the width of the frame, the rafters are either Kerto-S or glulam.

A column in a three-hinged frame consists of two or more Kerto-Q panels. An intermediate piece is installed between the panels to form a box structure. The thickness of the intermediate piece is advisable to be the same as the width of the rafter, in which case the rafter can be installed between the Kerto-Q panels. When choosing the dimensions of the column, it is worth noting that Kerto-Q panels and Kerto-S rafters can be sawn into a single tapered shape. In this case, the cross-section of the column can be smaller at the level of the foundations than at the level of the bending resistant connection. The most cost-effective option is to choose a tapered shape that utilizes the maximum panel width. For example, a column with a smaller width of 600 mm and a larger width of 1200 mm equals to 1800 mm, which is the production line width at the Kerto mill in Lohja (see Figure 23).

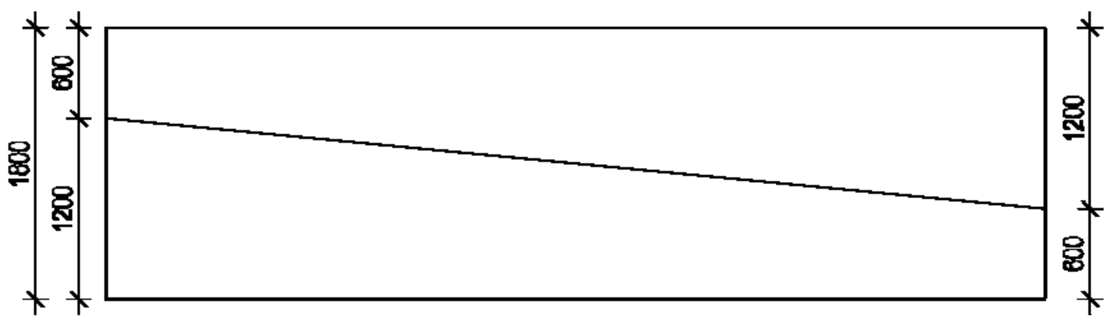


Figure 23: Principle of optimal sawing of single tapered beams.

Figure 24: Built-up columns made of Kerto-Q are used in three-hinged frames.

Figure 25: A box column made of two Kerto-Q panels.

Figure 26: A rafter installed between the Kerto-Q members and connected with bolts.

When a rafter is installed between the two Kerto-Q members of a column, the corner connection can be designed according to the instructions of the timber-to-timber connections. Commonly available fasteners, such as bolts, dowels, screws or nails, are suitable for the connection. Fasteners are chosen according to the loads affecting the bending resistant connection. Nails can be used for smaller loads while screws, dowels and bolts are used for higher loads.

7 Holes, notches and free-shaped beams

Due to its crosswise veneers, Kerto-Q is suitable for use as a beam with holes or notches. The crosswise veneers distribute the load perpendicular to the face veneer grain direction while reinforcing the structure of the beam. The size of a notch can even cover the entire beam and thus give shape to the whole structure.

Maximum hole size 70% of the beam height

It is possible to make round or rectangular holes in Kerto beams. The maximum diameter for a circular hole is 70% of the beam height. The maximum height of a rectangular hole is 30% of the beams height. Holes should be positioned along the centre line of the beam. If the position differs from the centre line, additional limitations are given. The Kerto product certificate provides design instructions that are in line with standard EN 1995-1-1 for determining the shear and bending capacity of a beam with holes. The effect of an individual hole on the deflection of the beam is minor and does not need to be taken into account. In the case of multiple holes, the effect on the deflection should be considered.

Figure 27: Ventilation channels and water pipes in an intermediate floor made of Kerto.

Figure 28: Holes in the beams of a floor element.

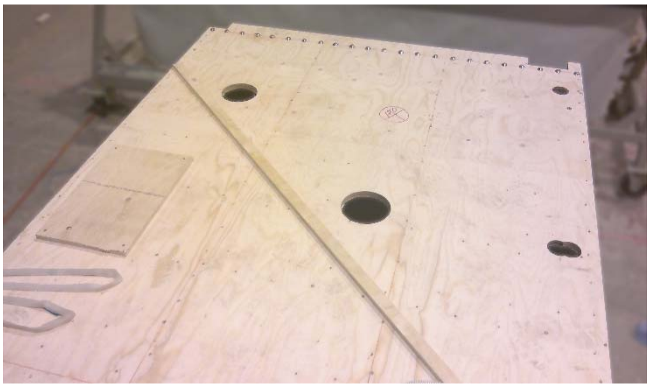


Figure 29: Holes in a Kerto-Q panel.

Load-bearing notch

Kerto-Q beams can be machined to include various types of notches and chamfers. The most typical is a notch at the end the beam. If notches in a beam are located on the side of the support, the shear capacity of the beam decreases as a result of cracking in the grain direction. Kerto-Q beams are well resistant to cracking, meaning the design shear capacity is usually close to the shear capacity of the residual cross-section.

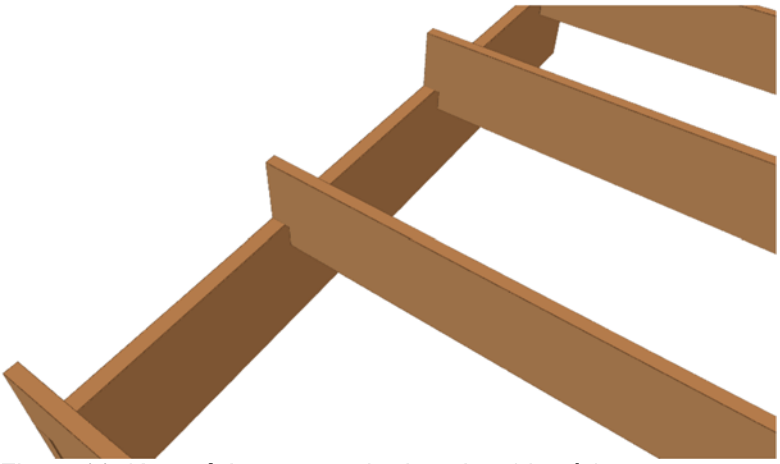


Figure 30: Kerto-Q beams notched on the side of the support.

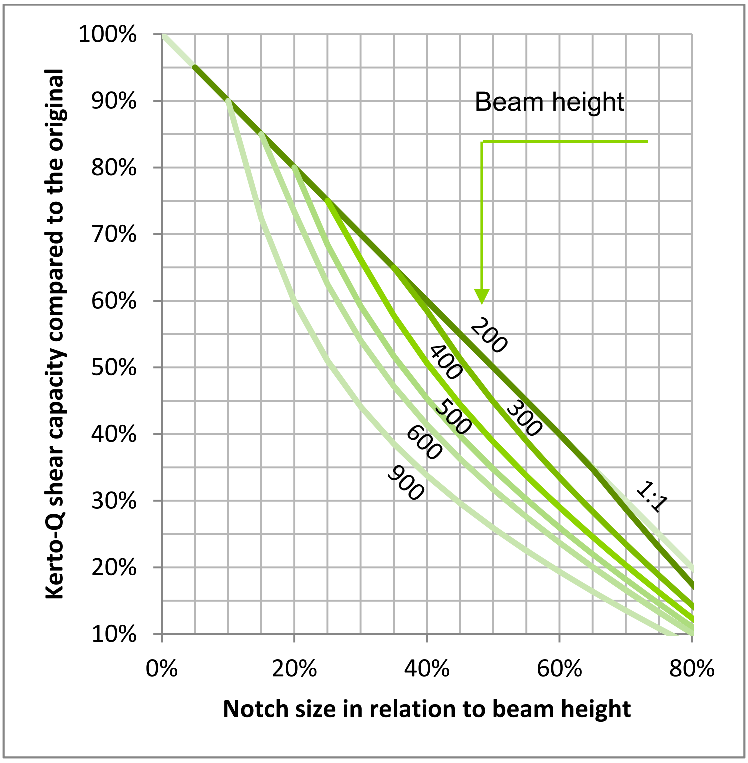


Figure 31: Shear capacity of a notched Kerto-Q beam.

- Notched Kerto-Q beams can be designed edgewise in accordance with standard EN 1995-1-1 and the VTT-C-184-03 certificate.
- In the design table, x = 0.5*h* and *i* = 0 meaning the notch is vertical.
- k_n = 16 for edgewise Kerto-Q
- The decrease of shear capacity for beams with a notch on the side of the support is presented for various beam heights.
- 1:1 indicates the decrease of shear capacity for beams with a notch at the opposite side of the support.

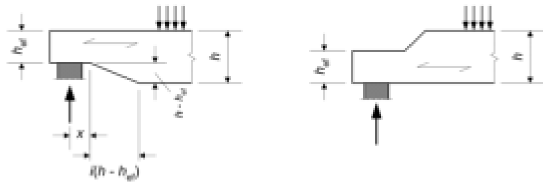


Figure 32: Notched end of a beam. Source: EN 1995-1-1, Figure 6.11.

Free-shaped member allow unlimited shape for buildings

The entire Kerto-Q beam can be machined to curved, pitched cambered, double tapered or free-shaped members. Shaped members are manufactured by cutting the required shape from a rectangular panel, which allows visually impressive and multi-dimensional structures. Instructions are available for calculating the capacity of Kerto-Q beam in cases where the face veneer grain direction and the centre line of the member create an angle in relation to one another. There is no limitation on the angle - it can vary between 0 and 90 degrees. The reduction factors are presented in Table 14.

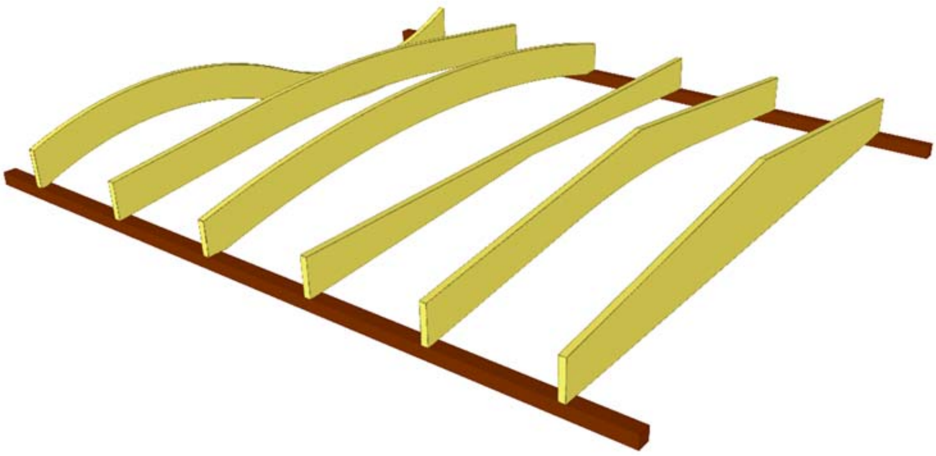


Figure 33: Free-shaped Kerto-Q beams.

Figure 34: Curved Kerto-Q rafters in a detached house.

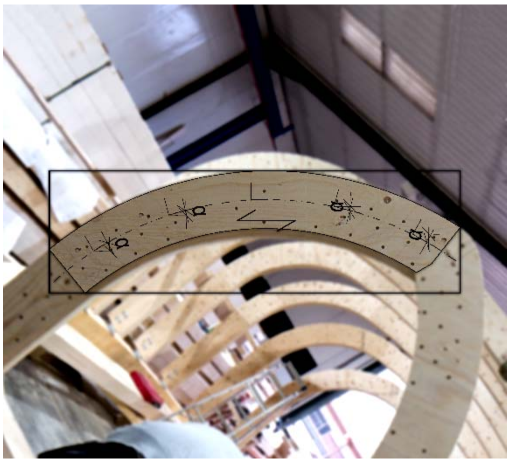


Figure 35: A curved Kerto-Q member where the angle between the face veneer grain direction and the member centre line varies.

Table 14: Strength and stiffness reduction factors for Kerto-Q when the member is sawn at the angle α in relation to the face veneer grain direction. Source: VTT-C-184-03.

		Angle α[1)] in relation to the face veneer grain direction								
	Symbol	0	2.5	5	10	15	30	45	60	90
Edgewise bending	$f_{m,0,edge,k}$	1.00	0.90	0.75	0.55	0.40	0.25	0.20	0.20	0.22
Flatwise bending	$f_{m,0,flat,k}$	1.00	1.00	0.90	0.70	0.50	0.25	0.20	0.20	0.22
Tension parallel to grain	$f_{t,0,k}$	1.00	1.00	0.90	0.70	0.40	0.25	0.20	0.20	0.23
Compression parallel to grain	$f_{c,0,k}$	1.00	1.00	0.90	0.70	0.50	0.35	0.25	0.25	0.35
Modulus of elasticity	E_{mean} and $E_{0,05}$	1.00	0.90	0.80	0.60	0.40	0.15	0.10	0.10	0.23

[1)] Intermediate values can be interpolated

Figure 36: Kerto-Q arches for the roof structure of a windmill. The structure consists of several curved members.

8 Glued components – optimal use of Kerto

The structural gluing of Kerto-Q panels allows large cross-sections that exceed the maximum dimensions of the standard product. Glued Kerto components are CE marked according to a European Technical Assessment (ETA-13/0504), which also includes the basic information for design. A glued component can have a solid rectangular, I-shaped or box cross-section. The maximum production length (20 or 25 metres) and transportation limit the size of glued components. Due to the manufacturing process, members with a cross-section of 144 mm × 1800 mm x 18 m and smaller are easier to manufacture than larger cross-sections.

Kerto-Ripa elements can be manufactured by combining the properties of Kerto-Q panels and Kerto-S ribs. Kerto-Ripa elements create efficient structures by optimally utilizing the properties of Kerto products.

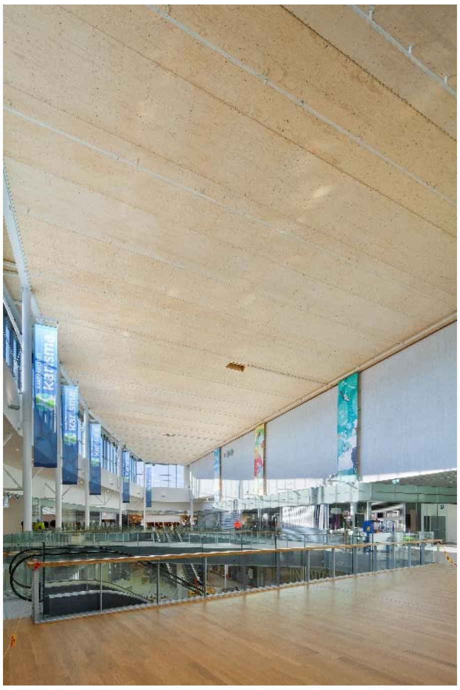


Figure 37: Kerto-Ripa elements in the roof structure of shopping centre.

Figure 38: Kerto-Ripa elements in the roof structure of a hall.

Figure 39: Kerto-Ripa elements in the floor structure of an apartment building and massive glued Kerto-Q columns.

9 Industrial applications

The excellent strength properties of Kerto-Q, combined with lightweight and durability, make Kerto-Q an ideal product for industrial solutions.

Figure 40: Kerto-Q web in a concrete formwork beam due to its excellent shear capacity.

Figure 41: Strong, long and light Kerto-Q panels coated for use as base plates in the concrete product industry.

Figure 42: Dimensionally precise and strong Kerto-Q panels for door frameworks.

Figure 43: Glued Kerto-Q deck components for railway crossings.

10 Technical details

Kerto products are CE marked according to the harmonized standard of structural laminated veneer lumber EN 14374. The performance levels of products are assessed, and production in the mills is monitored in accordance with Assessment and Verification of Constancy of Performance (AVCP) System 1, which requires continuous surveillance of factory production control by the notified product certification body (VTT Expert Services Ltd.).

Table 15: Strength, stiffness and density properties of Kerto products.

Basic property	Symbol	Kerto-Q 21–24 mm	Kerto-Q 27–75 mm	Kerto-Qp*) 39–51 mm	Kerto-Qp*) 54–75 mm
Strength, fifth percentile values		N/mm² or kg/m³			
Bending strength					
Edgewise (depth 300 mm)	$f_{m,0,edge,k}$	28.0	32.0	36.0	38.0
Size effect parameter	s	0.12			
Flatwise, parallel to grain	$f_{m,0,flat,k}$	32.0	36.0	36.0	
Flatwise, perpendicular to grain	$f_{m,90,flat,k}$	8.0[1]	8.0	-	
Compression strength					
Parallel to grain	$f_{c,0,k}$	19.0	26.0	28.0	30.0
Perpendicular to grain, edgewise	$f_{c,90,edge,k}$	9.0		6.0	
Perpendicular to grain, flatwise	$f_{c,90,flat,k}$	2.2		1.8	
Tension strength					
Parallel to grain (length 3,000 mm)	$f_{t,0,k}$	19.0	26.0	28.0	30.0
Perpendicular to grain, edgewise	$f_{t,90,edge,k}$	6.0		3.0	2.5
Perpendicular to grain, flatwise	$f_{t,90,flat,k}$	-			
Shear strength					
Edgewise	$f_{v,0,edge,k}$	4.5		4.1	
Flatwise, parallel to grain	$f_{v,0,flat,k}$	1.3			
Flatwise, perpendicular to grain	$f_{v,90,flat,k}$	0.6		-	
Modulus of elasticity and shear modulus					
Modulus of elasticity, mean					
Parallel to grain, along	$E_{0,mean}$	10000	10500	11700	12300
Parallel to grain, along, flatwise	$E_{0,flat,mean}$	10000	10500	11300	11400
Parallel to grain, across	$E_{90,mean}$	1200[1]	2000	-	
Perpendicular to grain, edgewise	$E_{90,edge,mean}$	2400		-	
Perpendicular to grain, flatwise	$E_{90,flat,mean}$	130		-	
Modulus of elasticity, fifth percentile value					
Parallel to grain, along	$E_{0,k}$	8300	8800	9800	10300
Parallel to grain, along, flatwise	$E_{0,flat,k}$	8300	8800	9500	9600
Parallel to grain, across	$E_{90,k}$	1000[1]	1700	-	
Perpendicular to grain, edgewise	$E_{90,edge,k}$	2000		-	
Perpendicular to grain, flatwise	$E_{90,flat,k}$	100		-	
Shear modulus, mean					
Edgewise	$G_{0,edge,mean}$	600			
Flatwise, parallel to grain	$G_{0,flat,mean}$	60	120	120	
Flatwise, perpendicular to grain	$G_{90,flat,mean}$	22		-	
Shear modulus, fifth percentile value					
Edgewise	$G_{0,edge,k}$	400			
Flatwise, parallel to grain	$G_{0,flat,k}$	50	100	100	
Flatwise, perpendicular to grain	$G_{90,flat,k}$	16		-	
Density					
Density, mean	ρ_{mean}	510			
Density, fifth percentile value	ρ_k	480			

[1] For the lay-up |-|||-|, the values 14.0, 2900 and 3300 can be used instead of the values 8.0, 1000 and 1200.
*) Kerto-Qp products are suitable for beam applications.

10.1 Panel connections

CE marked fasteners (EN 14592 or ETA) should be used in the connections of load-bearing structures. For non-load-bearing structures, we also recommend the use of CE marked fasteners. Preliminary design tables are presented in the following sections. The capacity of connecting structures should always be designed case-by-case. The preliminary design tables do not replace project-specific structural design by a qualified person.

10.1.1 Fastening panels to vertical or horizontal frames

Connections of Kerto-Q panels can be designed according to EN 1995-1-1 instructions for timber-to-timber connections. Commonly available fasteners can be used in the connections. The connection capacities for panel and fastener combinations for connecting Kerto-Q to Kerto-S, glulam or solid timber frame are presented below.

Table 16: Pre-design table for the lateral load-carrying capacity of **nailed connection** between a Kerto-Q panel and Kerto-S beam/column; load-duration class between instantaneous and medium-term.

h[1]	*d*[2]	L_{min}[3]	≥*a*[4]	≥*b*[5]	≥*c*[6]	R_k[7] [N]
24	2.1	50	9	15	51	473
27	2.5	60	10	18	57	638
33	2.8	70	12	20	75	772
45	3.1	90	13	22	75	937
57	3.4	100	14	24	2 × 51	1060
69	4.2	125	17	30	2 × 63	1533

[1] *h* [mm] is the thickness of the Kerto-Q panel
[2] *d* [mm] is the diameter of the nail
[3] L_{min} [mm] is the minimum length of the nail
[4] *a* [mm] is the edge and end distance of the panel
[5] *b* [mm] is the edge distance of the beam
[6] *c* [mm] is the minimum width of the beam
[7] R_k [N] is the characteristic lateral load-carrying capacity of the connection

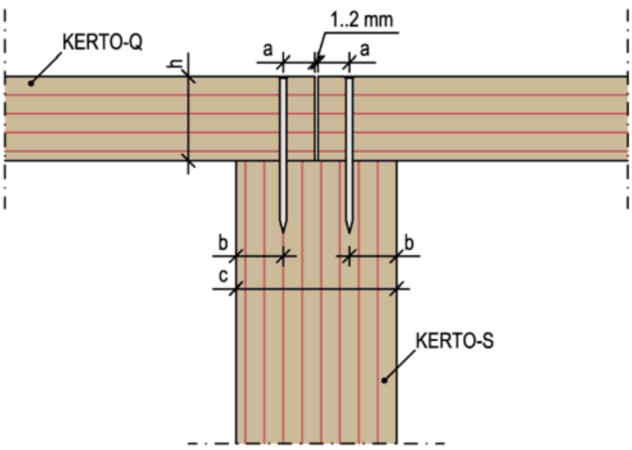


Figure 44: Nailed connection of a Kerto-Q panel and a Kerto-S beam or column.

Table 17: Pre-design table for the lateral load-carrying capacity of a **nailed connection** between Kerto-Q panel and C24 or GL30c beam/column; load-duration class between instantaneous and medium-term

$h^{1)}$	$d^{2)}$	$L_{min}{}^{3)}$	$\geq a^{4)}$	$\geq b^{5)}$	$\geq c^{6)}$	$R_k{}^{7)}$ [N]
24	2.1	50	9	11	48	440
27	2.5	60	10	13	48	597
33	2.8	70	12	14	75	722
45	3.1	90	13	16	75	883
57	3.4	100	14	17	75	985
69	4.2	125	17	21	90	1424

1) h [mm] is the thickness of the Kerto-Q panel
2) d [mm] is the diameter of the nail
3) L_{min} [mm] is the minimum length of the nail
4) a [mm] is the edge and end distance of the panel
5) b [mm] is the edge distance of the beam
6) c [mm] is the minimum width of the beam
7) R_k [N] is the characteristic lateral load-carrying capacity of the connection

Table 18: Pre-design table for the lateral load-carrying capacity of a **screwed connection** between a Kerto-Q panel and a C24 or GL30c beam/column; the load-duration class is between instantaneous and medium-term.

$h^{1)}$	$d^{2)}$	$L_{min}{}^{3)}$	$\geq a^{4)}$	$\geq b^{5)}$	$\geq c^{6)}$	$R_k{}^{7)}$ [N]
24	4.5	60	18	32	100	1018
27	5.0	70	20	35	115	1226
33	5.0	70	20	35	115	1226
45	6.0	90	24	42	140	1692
57	7.0	100	28	49	165	2223
69	8.0	120	32	56	190	2819

1) h [mm] is the thickness of the Kerto-Q panel
2) d [mm] is the outer diameter of the threaded part of screw
3) L_{min} [mm] is the minimum length of the screw
4) a [mm] is the edge and end distance of the panel
5) b [mm] is the edge distance of the beam
6) c [mm] is the minimum width of the beam
7) R_k [N] is the characteristic lateral load-carrying capacity of the connection

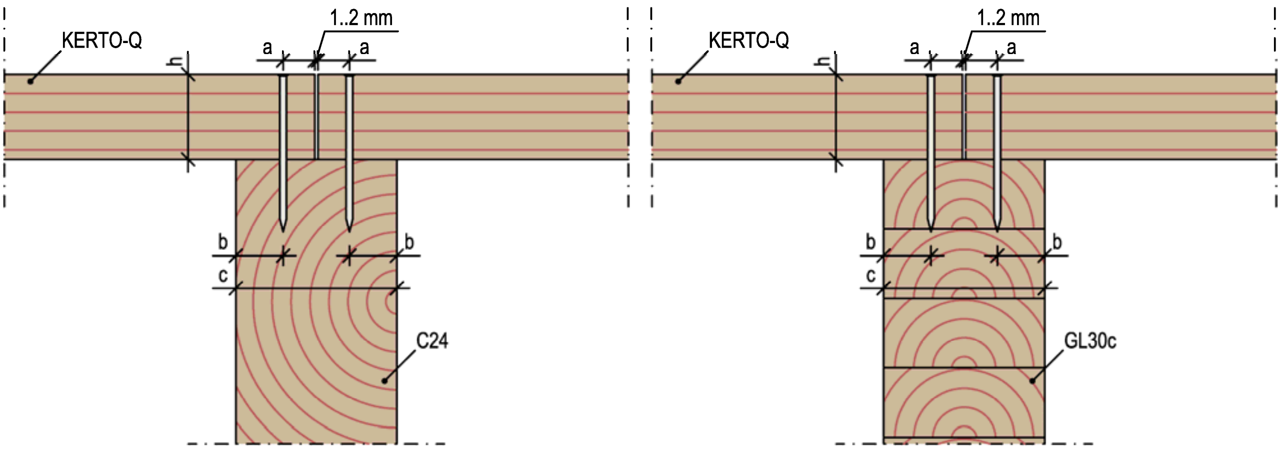


Figure 45: Nailed connection of a Kerto-Q panel and glulam or a solid timber beam or column.

Figure 46: Nailing a Kerto-Q roof panel to the frame.

Figure 47: Kerto-Q wall panelling.

10.1.2 Wall bracing

Kerto-Q panels serving as diaphragms can be utilized for bracing. Design can be done according to Chapter 9.2.4 of EN 1995-1-1. The following design guidelines are according to 9.2.4.2 Method A.

Information on the national choice for the wall diaphragm design may be found in the National Annex. In Finland, the national choice allows the use of Method A.

There are fewer densely nailed panel joints in the wall diaphragm when 2.4 m wide Kerto-Q panels are used. This speeds up the installation work and reduces the number of fasteners required without reducing the load-carrying capacity.

Preliminary design tables for a single Kerto-Q panel fastened to a wooden frame are presented below. If the wall consists of several panels, the total capacity is the sum of its sectional capacities. The anchoring of the wall diaphragm to the structures below should be designed separately. Wall sections with openings cannot be part of the bracing. The tables are suitable for maximum frame spacing of 2400 mm, although not more than the width of the panel. The capacities are determined for the panel and fastener combinations presented in Chapter 10.1.1.

Table 19: Preliminary design table for characteristic racking load-carrying capacity with **nailed** connections between Kerto-Q bracing panels and a Kerto-S frame. The height of the Kerto-Q panel is 3.0 m; the load-duration class is between instantaneous and medium-term. The distance between the frame studs should not be more than 2400 mm.

Nail spacing on panel edge		Panel width 2.4 m	c/c150	c/c100	c/c75	Panel width 1.8 m	c/c150	c/c100	c/c75	Panel width 1.2 m	c/c150	c/c100	c/c75
on panel centre			c/c300	c/c200	c/c150		c/c300	c/c200	c/c150		c/c300	c/c200	c/c150
h [1]	Nail [3]		$F_{i,v,Rk}$ [2] [kN]				$F_{i,v,Rk}$ [2] [kN]				$F_{i,v,Rk}$ [2] [kN]		
24	2.1 × 50		8.9	13.4	18.0		6.7	10.1	13.5		3.6	5.4	7.2
27	2.5 × 60		12.2	18.2	24.5		9.2	13.7	18.4		4.9	7.3	9.8
33	2.8 × 70		14.6	22.1	29.5		11.0	16.6	22.1		5.9	8.8	11.8
45	3.1 × 90		17.8	26.9	35.8		13.3	20.2	26.8		7.1	10.8	14.3
57	3.4 × 100		20.2	30.5	40.6		15.1	22.9	30.4		8.1	12.2	16.2
69	4.2 × 125		29.3	43.9	58.8		22.0	32.9	44.1		11.7	17.6	23.5

[1] h [mm] is the thickness of the Kerto-Q panel

[2] $F_{i,v,Rk}$ [kN] is the characteristic racking load-carrying capacity of the wall panel

[3] The diameter and minimum length of the nail ($d \times L_{min}$)

Capacities marked in green require staggered nails perpendicular to the grain by the thickness of the nail.

Table 20: Preliminary design table for characteristic racking load-carrying capacity with **nailed** connections between Kerto-Q bracing panels and a C24 or GL30c frame. The height of the Kerto-Q panel is 3.0 m; the load-duration class is between instantaneous and medium-term. The distance between the frame studs should not be more than 2400 mm.

		Panel width 2.4 m			Panel width 1.8 m			Panel width 1.2 m		
Nail spacing on panel edge		c/c150	c/c100	c/c75	c/c150	c/c100	c/c75	c/c150	c/c100	c/c75
on panel centre		c/c300	c/c200	c/c150	c/c300	c/c200	c/c150	c/c300	c/c200	c/c150
h [1]	Nail	$F_{i,v,Rk}$ [2] [kN]			$F_{i,v,Rk}$ [2] [kN]			$F_{i,v,Rk}$ [2] [kN]		
24	2.1 × 50	8.4	12.5	16.8	6.3	9.4	12.6	3.4	5.0	6.7
27	2.5 × 60	11.3	17.0	22.8	8.5	12.8	17.1	4.5	6.8	9.1
33	2.8 × 70	13.7	20.6	27.6	10.3	15.5	20.7	5.5	8.3	11.0
45	3.1 × 90	16.8	25.2	33.8	12.6	18.9	25.4	6.7	10.1	13.5
57	3.4 × 100	18.7	28.3	37.7	14.0	21.2	28.3	7.5	11.3	15.1
69	4.2 × 125	27.1	40.8	54.5	20.3	30.6	40.9	10.8	16.3	21.8

[1] h [mm] is the thickness of the Kerto-Q panel
[2] $F_{i,v,Rk}$ [kN] is the characteristic racking load-carrying capacity of the wall panel

Table 21: Preliminary design table for characteristic racking load-carrying capacity with **screwed** connections between Kerto-Q bracing panels and C24 or GL30c frame. The height of the Kerto-Q panel is 3.0 m; load-duration class between instantaneous and medium-term. The distance between the frame studs should not be more than 2400 mm.

		Panel width 2.4 m			Panel width 1.8 m			Panel width 1.2 m		
Nail spacing on panel edge		c/c200	c/c150	c/c100	c/c200	c/c150	c/c100	c/c200	c/c150	c/c100
on panel centre		c/c300	c/c300	c/c200	c/c300	c/c300	c/c200	c/c300	c/c300	c/c200
h [1]	Screw [3]	$F_{i,v,Rk}$ [2] [kN]			$F_{i,v,Rk}$ [2] [kN]			$F_{i,v,Rk}$ [2] [kN]		
24	4.5 × 60	14.6	19.4	29.3	11.0	14.6	22.0	5.9	7.8	11.7
27	5.0 × 70	17.5	23.5	35.3	13.1	17.6	26.5	7.0	9.4	14.1
33	5.0 × 70	17.5	23.5	35.3	13.1	17.6	26.5	7.0	9.4	14.1
45	6.0 × 90	24.2	32.4	48.7	18.2	24.3	36.5	9.7	13.0	19.5
57	7.0 × 100	31.9	42.5	63.8	23.9	31.9	47.9	12.8	17.0	25.5
69	8.0 × 120	40.6	54.0	81.1	30.4	40.5	60.8	16.2	21.6	32.4

[1] h [mm] is thickness of Kerto-Q panel
[2] $F_{i,v,Rk}$ [kN] is the characteristic racking load-carrying capacity of the wall panel
[3] d×L, screw diameter d and minimum length L

Capacities marked in green require staggered screws perpendicular to the grain by the thickness of screw.

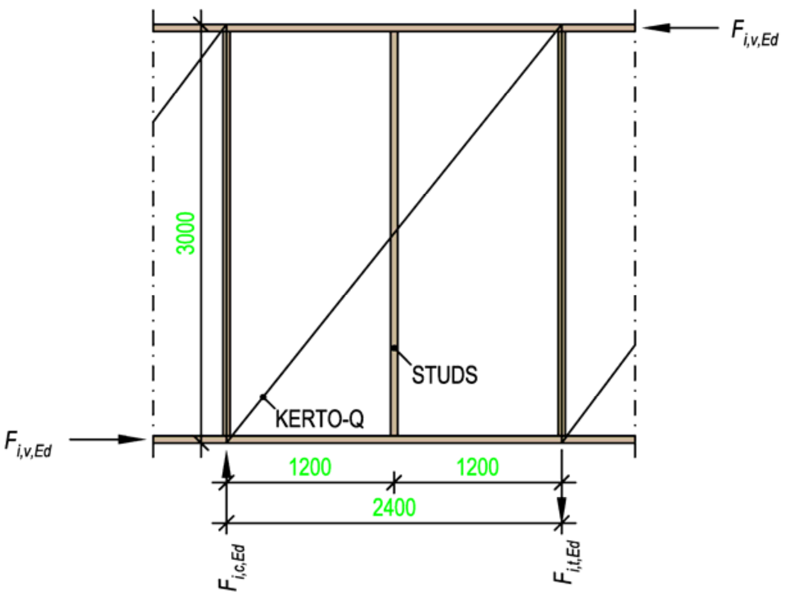


Figure 48: Principle of wall bracing.


Figure 49: A bracing column made of glued Kerto-Q component.

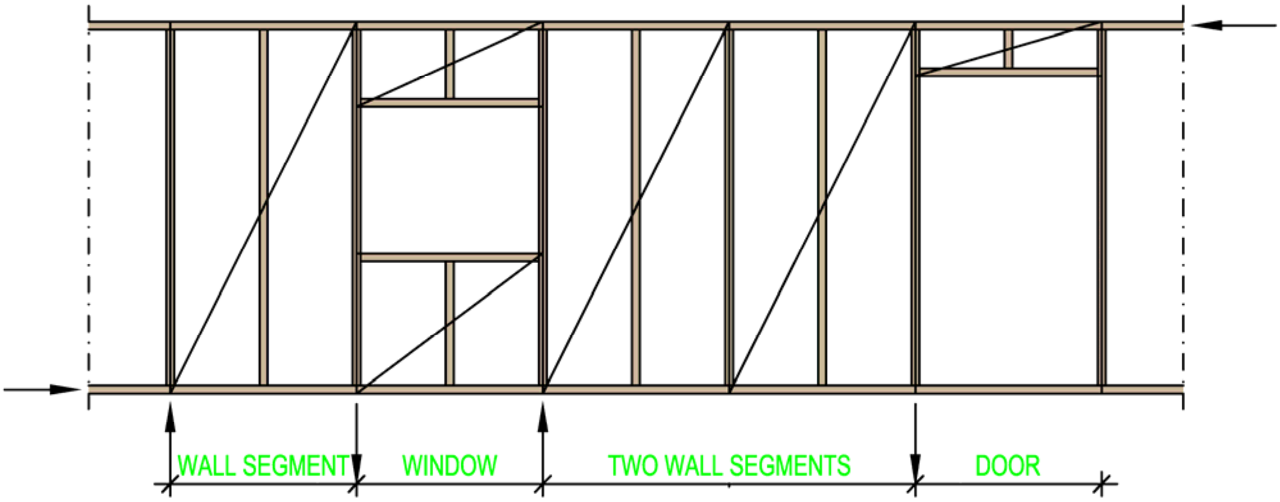


Figure 50: Example of a wall assembly consisting of several wall panels.

As an example, Figure 48 presents a wall bracing with Kerto-Q bracing panels and Kerto-S or solid wood studs. Due to the large dimensions of Kerto-Q, the stud spacing can be increased. For estimating the minimum thickness of the Kerto-Q panel against the external load $F_{i,v,Ed}$ in service class 2 and in the load-duration class "instantaneous", the values from Tables 19-21 can be used. According to the tables, the external load for 33 mm Kerto-Q cannot be more than 13.3 kN (k_{mod} / $\gamma_M \cdot F_{i,v,Rk}$ = 1.1 / 1.2 · 14.6 kN) when the panel is nailed on the edges c/c 150 mm and in the middle c/c 300 mm using 2.8 × 70 nails. The capacity can even be doubled if shorter spacing between nails is used.

Kerto-Q panels can be used to build high wall diaphragms. Figure 49 presents a prefabricated Kerto-Q bracing component with a height of around 20 metres. The panel can also be utilized as a column which transfers vertical loads in a four-storey apartment building. It is even possible to brace multi-storey buildings with a single prefabricated component.

Table 22: Comparison table of the racking load-carrying capacity of Kerto-Q panels, softwood plywood and plasterboard with Kerto-S studs. The wall is 2.4 m high and 2.4 m wide; **service class 1**; load-duration class "instantaneous".

Nail spacing on panel edge		Kerto-Q	c/c150	c/c100	c/c75	Softwood plywood	c/c150	c/c100	c/c75	Plasterboard, normal[4]	c/c150	c/c100	c/c75
on panel centre			c/c300	c/c200	c/c150		c/c300	c/c200	c/c150		c/c300	c/c200	c/c150
h[1]	Nail[3]		$F_{i,v,Rd}$[2] [kN]				$F_{i,v,Rd}$[2] [kN]				$F_{i,v,Rd}$[2] [kN]		
13	2.5 × 35		-	-	-		-	-	-		5.1	7.7	10.2
15	2.5 × 35		-	-	-		9.3	13.9	18.6		-	-	-
27	2.5 × 60		11.2	16.7	22.4		-	-	-		-	-	-
57	3.4 × 100		18.5	27.9	37.2		-	-	-		-	-	-

[1] h [mm] is the thickness of the panel
[2] $F_{i,v,Rd}$ [kN] is the characteristic racking load-carrying capacity of the wall section
[3] Diameter and minimum length of the nail (d×L_{min})
[4] Fasteners approved by the manufacturer must be used for fastening plasterboard

Table 23: Comparison table of the racking load-carrying capacity of Kerto-Q panels, softwood plywood and plasterboard with Kerto-S studs. The wall is 2.4 m high and 2.4 m wide; **service class 2**; load-duration class "instantaneous".

Nail spacing on panel edge		Kerto-Q	c/c150	c/c100	c/c75	Softwood plywood	c/c150	c/c100	c/c75	Windbreak plasterboard[4]	c/c150	c/c100	c/c75
on panel centre			c/c300	c/c200	c/c150		c/c300	c/c200	c/c150		c/c300	c/c200	c/c150
h[1]	Nail[3]		$F_{i,v,Rd}$[2] [kN]				$F_{i,v,Rd}$[2] [kN]				$F_{i,v,Rd}$[2] [kN]		
9	3.0 × 35		-	-	-		-	-	-		4.5	6.8	9.1
15	2.5 × 35		-	-	-		9.3	13.9	18.6		-	-	-
27	2.5 × 60		11.2	16.7	22.4		-	-	-		-	-	-
57	3.4 × 100		18.5	27.9	37.2		-	-	-		-	-	-

[1] h [mm] is the thickness of the panel
[2] $F_{i,v,Rd}$ [kN] is the characteristic racking load-carrying capacity of the wall section
[3] Diameter and minimum length of the nail (d×L_{min})
[4] Fasteners approved by the manufacturer must be used for fastening plasterboard

A comparison of the racking load-carrying capacities of various panel types is presented in the table below. It is possible to achieve higher racking load-carrying capacities with Kerto-Q panels than by using other panel types suitable for similar use. In a typical single-family house, commonly used softwood plywood or plasterboard can brace the building. However, if the building has a large glass wall or bracing walls are sparse or the building is higher than a standard house, Kerto-Q panels are suitable for bracing these types of buildings as well. An example of single-family house bracing wall layout is presented in Figure 50.

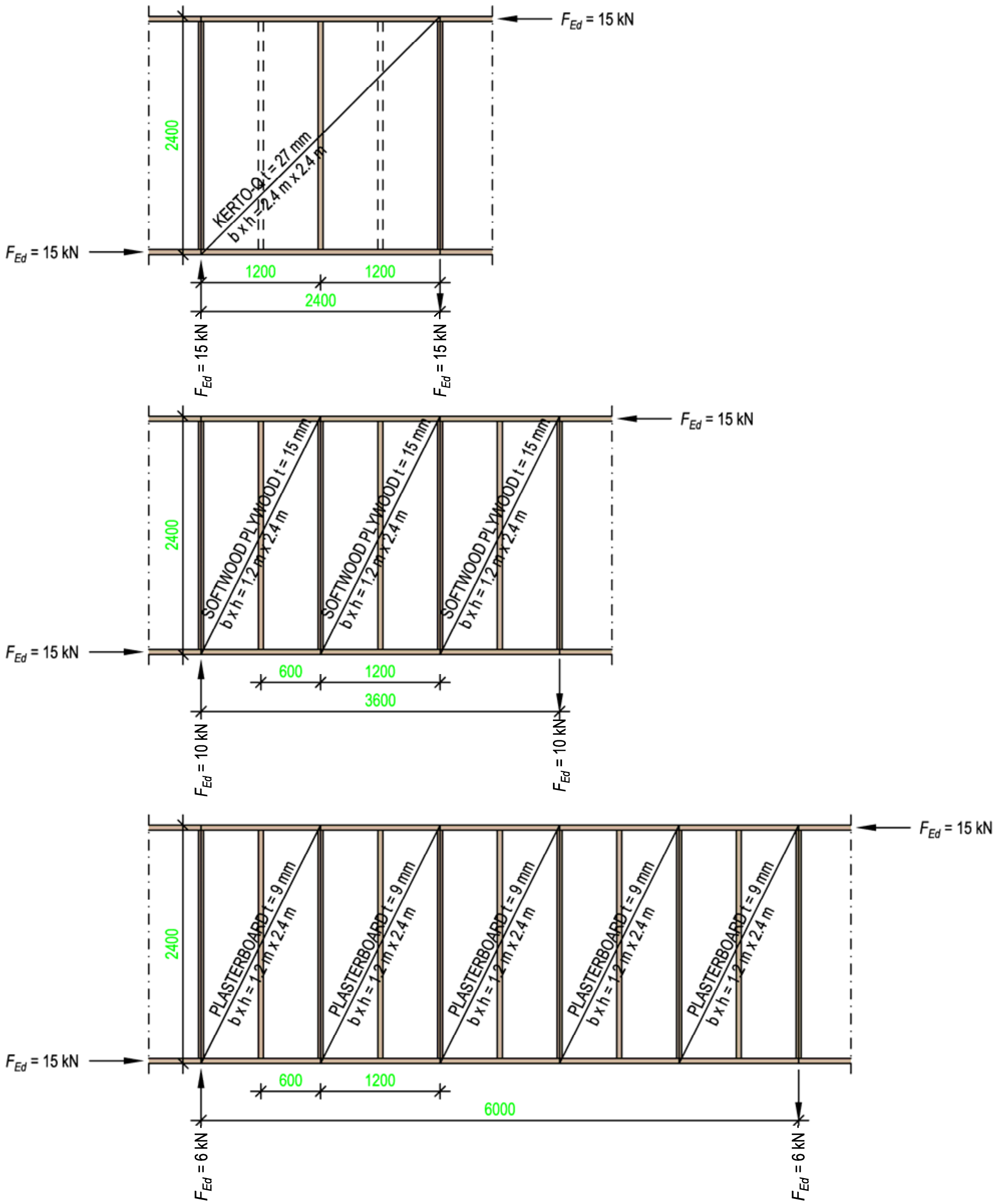


Figure 51: Comparison of bracing wall solutions using different materials. All panels are connected with nails and have c/c 100 mm on the panel edges and c/c 200 mm on the panel center. Racking load-carrying capacities are in accordance with Table 23.

10.1.3 Floor and roof bracing

Kerto-Q panels serving as diaphragms can be utilized for bracing. Design for roofs and floors can be done according to Chapter 9.2.3 of EN 1995-1-1. When carrying out preliminary dimensioning, the capacities presented in Chapter 10.1 can be used as the lateral load-carrying capacity for the fasteners.

Information on the national choice for the floor and roof diaphragm design may be found in the National Annex.

10.1.4 Suspended loads

Kerto-Q panels provide an excellent fixing base for various types of fastenings. Self-tapping screws are recommended for axially loaded fastenings as well as axially and laterally loaded fastenings.

The capacity of a suspension connection can be maximised when the threaded part of a screw covers the entire thickness of the point side panel. The preliminary design table for a single tensile-loaded screw is presented below for screws in which the threaded root diameter is 60–75% of the nominal diameter. Fastenings with multiple connectors and/or the capacity of the load-bearing structures should be designed separately.

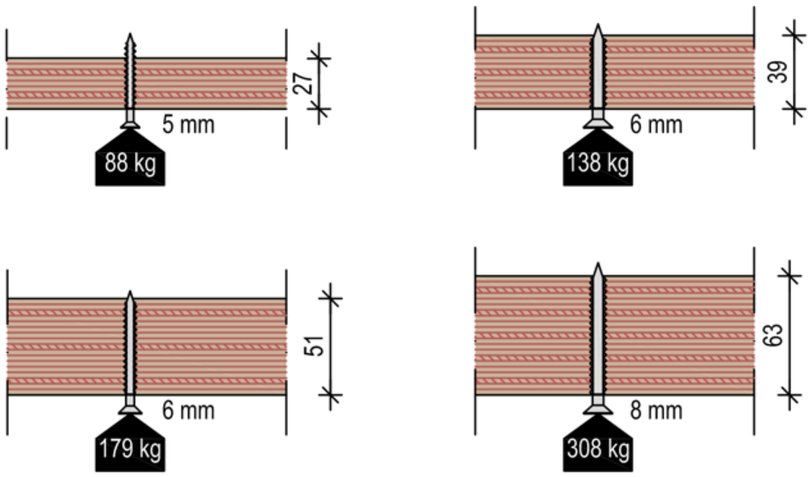


Figure 52: The maximum allowed suspension load for selected combinations of Kerto-Q panels and connectors.

Table 24: Pre-design table for a single tensile-loaded screw in a Kerto-Q panel.

h_{min} 1)	$l_{ef,min}$ 2)	Screw	$F_{ax,Rk}$ 3) [kN]	$F_{ax,all}$ 4) [kg]
21	21*)	5	1.91	72
24	24*)	5	2.12	80
27	27*)	5	2.33	88
33	30	5	2.54	95
39	36	6	3.66	138
45	40	6	3.98	150
51	50	6	4.76	179
63	60	6	5.50	207
63	60	8	8.18	308

1) h_{min} [mm] is the minimum thickness of the Kerto-Q panel
2) $l_{ef,min}$ [mm] is the minimum penetration depth of the threaded part in a Kerto-Q panel, *)the narrowed tip must penetrate through panel completely
3) $F_{ax,Rk}$ [kN] is the characteristic load-carrying capacity of the suspension connection
4) $F_{ax,all}$ [kg] is the permitted load for the suspension connection (service class: 1, load-duration class: permanent, k_{mod} = 0.6 and γ_M = 1.2).

All general connector types can be used in laterally loaded connections of Kerto-Q panels. These include nails, screws, dowels and bolts. The panel can be located on the head or point side of the fastener. The preliminary design table for various lateral screw connections is presented below. The table can be applied for self-tapping screws when the threaded root diameter is 60-75% of the nominal diameter. Fastenings with multiple connectors and/or the capacity of the load-bearing structures should be designed separately.

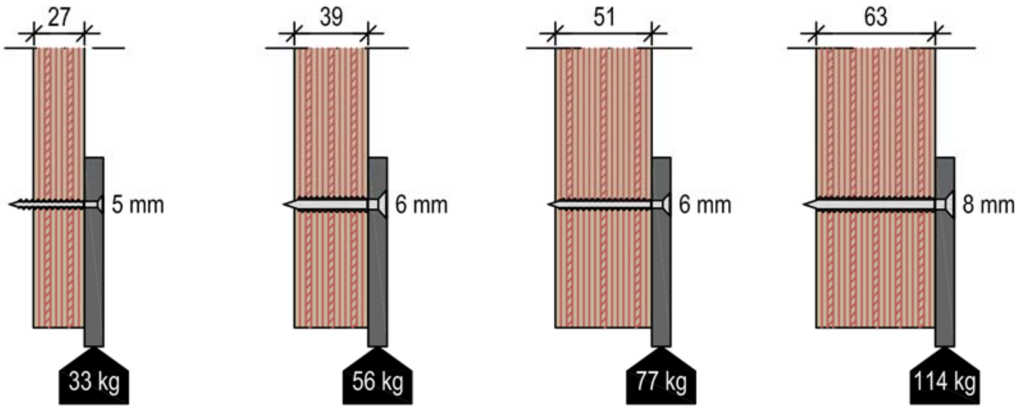


Figure 53: The maximum allowed suspension load for selected combinations of Kerto-Q panels and connectors.

Table 25: Pre-design table for a single laterally loaded screw in a Kerto-Q panel.

h_{min} [1)]	$l_{ef,min}$ [2)]	Screw	$F_{v,Rk}$ [3)] [kN]	$F_{v,all}$ [4)] [kg]
21	21[*)]	5	0.76	28
24	24[*)]	5	0.87	32
27	27[*)]	5	0.89	33
33	30	5	1.08	41
39	36	6	1.48	56
45	40	6	1.65	62
51	50	6	2.06	77
63	60	6	2.11	79
63	60	8	3.02	114

[1)] h_{min} [mm] is the minimum thickness of the Kerto-Q panel
[2)] $l_{ef,min}$ [mm] is the minimum penetration depth of the threaded part in a Kerto-Q sheet, [*)]the narrowed tip must penetrate through the panel completely
[3)] $F_{ax,Rk}$ [kN] is the characteristic load-carrying capacity of the suspension connection
[4)] $F_{ax,all}$ [kg] is the permitted load for the suspension connection (service class: 1, load-duration class: permanent, k_{mod} = 0.6 and γ_M = 1.2)

Figure 54: Sprinkler pipes and nozzles suspended from a Kerto-Q panel.

Figure 55: Ventilation ducts suspended from a Kerto-Q panel.

The combined lateral and axial load-carrying capacity can be calculated accord to standard EN 1995-1-1 using the equation (8.27) for smooth nails and equation (8.28) for screws and treaded nails. Figure 56 can be used for checking the combined capacity for screws in accordance with preliminary design Tables 24 or 25.

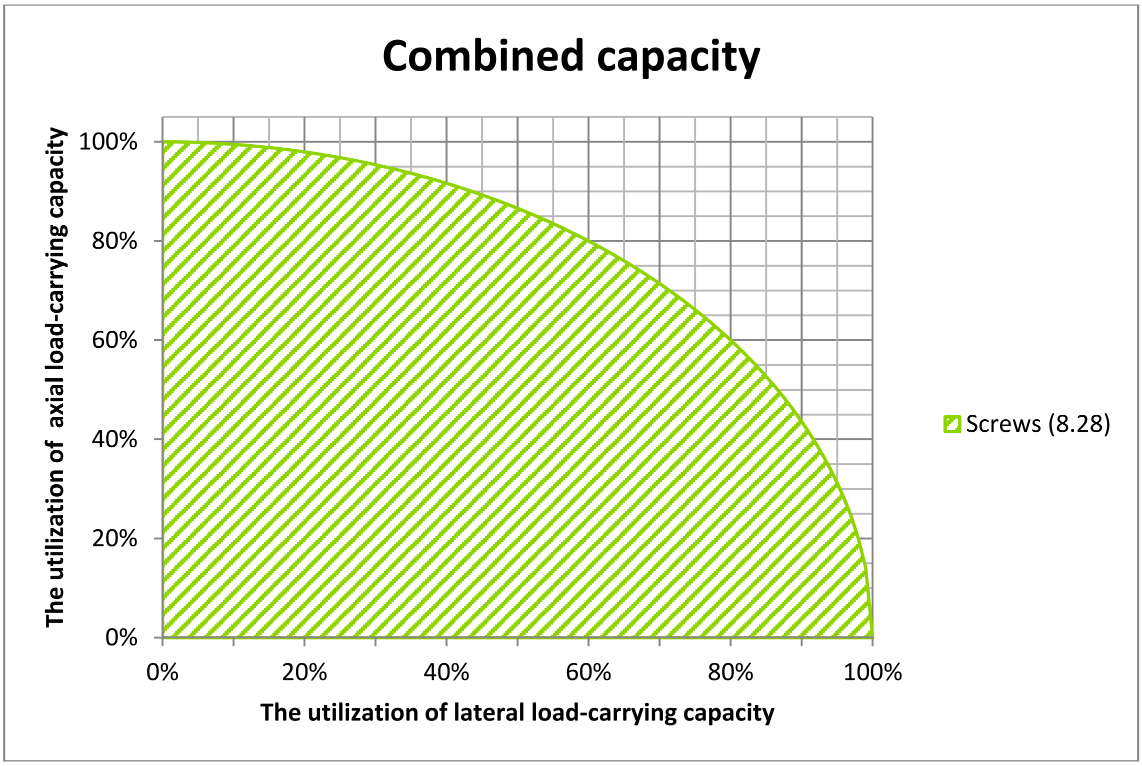


Figure 56: Combined capacity of laterally and axially loaded screws.

11 Protective treatments

Kerto products can be protected using various surface treatments. Surface treatments can be applied at the mill for Kerto products with a maximum width/height of 900 mm and a maximum length of 15 m. Check the availability of larger treated panels from the local sales office.

Kerto WeatherGuard - temporary protection against rain during construction

Figure 57: WeatherGuard treated Kerto LVL.

The WeatherGuard treated surface is resistant rainwater and reduces the absorption of water in Kerto products. At the same time, the surface allows the panel to breathe and water vapour to move freely to and fro. The reduced absorption of water reduces moisture deformations of Kerto LVL, which improves the dimensional stability and decreases the time and energy needed for drying the structures. The treatment provides temporary protection during storage and construction. If long-term protection is needed, the wooden surface can be coated with paints, lacquers, varnishes and protection treatments applicable on wood products. It is recommended that the applicability of the coating is confirmed by the treatment supplier.

Kerto WeatherGuard is suitable for use in service classes 1 and 2. The treatment has no effect on the strength properties of Kerto; nor does it have an effect on reaction to fire, resistance to fire, and slip resistance of the surface. Furthermore, the treatment has no effect on the corrosion resistance of the metal fasteners used in the connections. The colour of WeatherGuard treatment is transparent and it does not contain biocides.

The moisture content of WeatherGuard treated product remains lower than untreated products. In addition, the risk of damage caused by moisture-affected structures decreases. WeatherGuard treated products can be disposed of in the same way as untreated wood products since they do not contain environmentally harmful substances. Kerto WeatherGuard has the Finnish M1 emissions classification for building materials, as does untreated Kerto LVL. Formaldehyde emissions for both treated and non-treated products are far below the class E1 requirements.

Kerto MouldGuard - reduces the risk of mould growth on surfaces

Kerto MouldGuard is surface impregnated with a wood protective agent. It significantly reduces the risk of surface mould compared to untreated Kerto LVL. Kerto MouldGuard is ideal for structures in unheated spaces, as load-bearing roofing panels and in ventilated floor structures. The product has a light orange colour and the surface can be further treated with standard paints, lacquers and varnishes applicable on wood products. It is recommended that the applicability of the coating is confirmed by the treatment supplier.

Kerto MouldGuard is suitable for use in service classes 1 and 2. The treatment has no effect on the strength properties of Kerto; nor does it have an effect on reaction to fire, resistance to fire, and slip resistance of the surface. Furthermore, the treatment has no effect on the corrosion resistance of the metal fasteners used in connections. Kerto MouldGuard has the Finnish M1 emissions classification for building materials and formaldehyde emissions are far below the class E1 requirements. Direct contact with foodstuffs, animal feed or similar must be avoided.

Kerto MouldGuard can be considered as biofuel (EN 14961-1) and it can be safely burnt when the combustion temperature is at least 850°C and correct combustion conditions are maintained. Due to preservative treatment, the correct combustion conditions and suitable waste burning plants should be checked locally.