MECHANICAL PROPERTIES

Metsä

Kerto® LVL

Design values

Design values for Kerto LVL products are given in tables 1 and 2. The values are according standard EN 14374 and are to be used for structural calculations with EN 1995 (Eurocode 5). Definitions of strength and stiffness orientations are presented in figure 1. Veneer lay-ups for Q-panel, L-panel and Qp-beam are presented in tables 7 and 8.

TABLE 1. THE CHARACTERISTIC STRENGTH VALUES FOR KERTO LVL PRODUCTS

Property	Symbol	Figure 1	S-beam 27-75 mm	T-stud 27-75 mm	Qp-beam 39-51 mm	Qp-beam 54-75 mm
Fullfils strength class			**LVL 48 P**	**LVL 32 P**		
Characteristic values [N/mm²]						
Bending strength: Edgewise (depth 300 mm)	$f_{m,0,edge,k}$	A	44.0	27.0	36.0	38.0
Bending strength: Size effect parameter	s	-	0.12	0.15	0.12	0.12
Bending strength: Flatwise, parallel to grain	$f_{m,0,flat,k}$	B	50.0	32.0	36.0	36.0
Bending strength: Flatwise, perpendicular to grain	$f_{m,90,flat,k}$	C	-	-	-	-
Tensile strength: Parallel to grain (length 3,000 mm)	$f_{t,0,k}$	D	35.0	22.0	28.0	30.0
Tensile strength: Perpendicular to grain, edgewise	$f_{t,90,edge,k}$	E	0.8	-	3.0	2.5
Tensile strength: Perpendicular to grain, flatwise	$f_{t,90,flat,k}$	F	-	-	-	-
Compressive strength: Parallel to grain	$f_{c,0,k}$	G	35.0[1]	26.0[1]	28.0[1]	30.0[1]
Compressive strength: Perpendicular to grain, edgewise	$f_{c,90,edge,k}$	H	6.0	4.0	6.0	6.0
Compressive strength: Perpendicular to grain, flatwise	$f_{c,90,flat,k}$	I	2.2	0.8	1.8	1.8
Shear strength: Edgewise	$f_{v,0,edge,k}$	J	4.2	3.6	4.1	4.1
Shear strength: Flatwise, parallel to grain	$f_{v,0,flat,k}$	K	2.3	2.0	1.3	1.3
Shear strength: Flatwise, perpendicular to grain	$f_{v,90,flat,k}$	L	-	-	-	-

[1] In the service class 2 the values 28.0 N/mm² and 30.0 N/mm² is recommended to be divided by 1.2

Source: Kerto LVL S-beam: Declaration of performance MW/LVL/311-001/CPR/DOP and UK Declaration of Conformity MW/LVL/311-001/UKCA/UKDOC
Kerto LVL T-stud: Declaration of performance MW/LVL/314-001/CPR/DOP and UK Declaration of Conformity MW/LVL/314-001/UKCA/UKDOC
Kerto LVL Qp-beam: Declaration of performance MW/LVL/313-001/CPR/DOP and UK Declaration of Conformity MW/LVL/313-001/UKCA/UKDOC

TABLE 2. THE CHARACTERISTIC STRENGTH VALUES FOR KERTO LVL PRODUCTS

Property	Symbol	Figure 1	Q-panel 21 -24 mm	Q-panel 27-75 mm	L-panel 21-24 mm	L-panel 27-75 mm
Fullfils strength class			**LVL 32 C**	**LVL 36 C**		
Characteristic values [N/mm²]						
Bending strength: Edgewise (depth 300 mm)	$f_{m,0,edge,k}$	A	28.0	32.0	19.0	20.5
Bending strength: Size effect parameter	s	-	0.12	0.12	0.15	0.15
Bending strength: Flatwise, parallel to grain	$f_{m,0,flat,k}$	B	32.0	36.0	22.5	25.0
Bending strength: Flatwise, perpendicular to grain	$f_{m,90,flat,k}$	C	see table 6	8.0	5.5	6.5
Tensile strength: Parallel to grain (length 3,000 mm)	$f_{t,0,k}$	D	19.0	26.0	15.0	17.0
Tensile strength: Perpendicular to grain, edgewise	$f_{t,90,edge,k}$	E	6.0	6.0	4.0	4.0
Tensile strength: Perpendicular to grain, flatwise	$f_{t,90,flat,k}$	F	-	-	-	-
Compressive strength: Parallel to grain	$f_{c,0,k}$	G	19.0 [1]	26.0 [1]	18.0 [1]	19.0 [1]
Compressive strength: Perpendicular to grain, edgewise	$f_{c,90,edge,k}$	H	9.0	9.0	8.0	8.0
Compressive strength: Perpendicular to grain, flatwise	$f_{c,90,flat,k}$	I	2.2	2.2	2.0	2.0
Shear strength: Edgewise	$f_{v,0,edge,k}$	J	4.5	4.5	4.0	4.0
Shear strength: Flatwise, parallel to grain	$f_{v,0,flat,k}$	K	1.3	1.3	1.2	1.2
Shear strength: Flatwise, perpendicular to grain	$f_{v,90,flat,k}$	L	0.6	0.6	0.5	0.5

[1] In service class 2 the values 18.0 N/mm², 19.0 N/mm² and 26.0 N/mm² are recommended to be divided by 1.2

Source: Kerto LVL Q-panel: Declaration of performance MW/LVL/312-001/CPR/DOP and UK Declaration of Conformity MW/LVL/312-001/UKCA/UKDOC
Kerto LVL L-panel: Declaration of performance MW/LVL/318-001/CPR/DOP and UK Declaration of Conformity MW/LVL/318-001/UKCA/UKDOC

TABLE 3. THE CHARACTERISTIC AND MEAN STIFFNESS VALUES FOR KERTO LVL PRODUCTS

Property	Symbol	Figure 1	S-beam 27-75 mm	T-stud 27-75 mm	Qp-beam 39-51 mm	Qp-beam 54-75mm
Fullfils strength class			**LVL 48 P**	**LVL 32 P**		
Characteristic values [N/mm²]						
Modulus of elasticity: Parallel to grain	$E_{0,k}$	A B D G	11,600	8,000	9,800	10,300
Modulus of elasticity: Compression perpendicular to grain, edgewise	$E_{c,90,edge,k}$	H	350	-	-	-
Modulus of elasticity: Compression perpendicular to grain, flatwise	$E_{c,90,flat,k}$	I	100	-	-	-
Modulus of elasticity: Bending Perpendicular to face veneer grain	$E_{m,90,k}$	C	-	-	-	-
Shear modulus: Edgewise	$G_{0,edge,k}$	J	400	330	400	400
Shear modulus: Flatwise, parallel to grain	$G_{0,flat,k}$	K	270	240	100	100
Shear modulus: Flatwise, perpendicular to grain	$G_{90,flat,k}$	L	-	-	-	-
Mean values [N/mm²]						
Modulus of elasticity: Parallel to grain	$E_{0,mean}$	A B D G	13,800	9,600	11,700	12,300
Modulus of elasticity: Compression perpendicular to grain, edgewise	$E_{c,90,edge,mean}$	H	430	-	-	-
Modulus of elasticity: Compression perpendicular to grain, flatwise	$E_{c,90,flat,mean}$	I	130	-	-	-
Modulus of elasticity: Bending Perpendicular to face veneer grain	$E_{m,90,mean}$	C	-	-	-	-
Shear modulus: Edgewise	$G_{0,edge,mean}$	J	600	500	600	600
Shear modulus: Flatwise, parallel to grain	$G_{0,flat,mean}$	K	380	320	120	120
Shear modulus: Flatwise, perpendicular to grain	$G_{90,flat,mean}$	L	-	-	-	-

Source: Kerto LVL S-beam: Declaration of performance MW/LVL/311-001/CPR/DOP
UK Declaration of Conformity MW/LVL/311-001/UKCA/UKDOC
Eurofins EUFI29-20000676-C
Kerto LVL T-stud: Declaration of performance MW/LVL/314-001/CPR/DOP and UK Declaration of Conformity MW/LVL/314-001/UKCA/UKDOC
Kerto LVL Qp-beam: Declaration of performance MW/LVL/313-001/CPR/DOP and UK Declaration of Conformity MW/LVL/313-001/UKCA/UKDOC

NOTE.

The design values given in tables 2 and 3 can be used in temperatures up to 50 °C when designing long-term loads.

TABLE 4. THE CHARACTERISTIC AND MEAN STIFFNESS VALUES FOR KERTO LVL PRODUCTS

Property	Symbol	Figure 1	Q-panel 21-24 mm	Q-panel 27-75 mm	L-panel 21-24 mm	L-panel 27-75 mm
Fullfils strength class			**LVL 32 C**	**LVL 36 C**		
Characteristic values [N/mm²]						
Modulus of elasticity: Parallel to grain	$E_{0,k}$	A B D G	8,300	8,800	5,500	6,500
Modulus of elasticity: Compression perpendicular to grain, edgewise	$E_{c,90,edge,k}$	H	2,000	2,000	1,400	1,400
Modulus of elasticity: Compression perpendicular to grain, flatwise	$E_{c,90,flat,k}$	I	100	100	-	-
Modulus of elasticity: Bending Perpendicular to face veneer grain	$E_{m,90,k}$	C	see table 6	1,700	600	1,100
Shear modulus: Edgewise	$G_{0,edge,k}$	J	400	400	330	330
Shear modulus: Flatwise, parallel to grain	$G_{0,flat,k}$	K	60	100	55	55
Shear modulus: Flatwise, perpendicular to grain	$G_{90,flat,k}$	L	16	16	14	14
Mean values [N/mm²]						
Modulus of elasticity: Parallel to grain	$E_{0,mean}$	A B D G	10,000	10,500	6,700	7,500
Modulus of elasticity: Compression perpendicular to grain, edgewise	$E_{c,90,edge,mean}$	H	2,400	2,400	1,700	1,700
Modulus of elasticity: Compression perpendicular to grain, flatwise	$E_{c,90,flat,mean}$	I	130	130	-	-
Modulus of elasticity: Bending Perpendicular to face veneer grain	$E_{m,90,mean}$	C	see table 6	2,000	700	1,300
Shear modulus: Edgewise	$G_{0,edge,mean}$	J	600	600	500	500
Shear modulus: Flatwise, parallel to grain	$G_{0,flat,mean}$	K	80	120	70	70
Shear modulus: Flatwise, perpendicular to grain	$G_{90,flat,mean}$	L	22	22	18	18

Source: Kerto LVL Q-panel: Declaration of performance MW/LVL/312-001/CPR/DOP
UK Declaration of Conformity MW/LVL/312-001/UKCA/UKDOC
Eurofins EUFI29-20000676-C
Kerto LVL L-panel: Declaration of performance MW/LVL/318-001/CPR/DOP

TABLE 5. THE DENSITY VALUES FOR KERTO LVL PRODUCTS

Property	Symbol	Figure 1	S-beam 27-75 mm	Q-panel 21-24 mm	Q-panel 27-75 mm	T-stud 27-75 mm	Qp-beam 39-51 mm	Qp-beam 54-69 mm	L-panel 21-24 mm	L-panel 27-75 mm
Density [kg/m³]										
Characteristic density	ρ_k	-	480	480	480	410	480	480	410	410
Mean density	ρ_{mean}	-	510	510	510	440	510	510	440	440

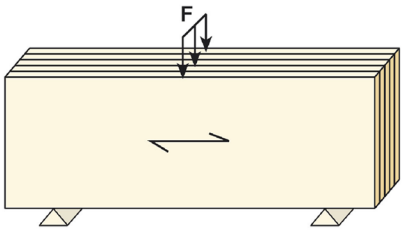
Source: Kerto LVL S-beam: Declaration of performance MW/LVL/311-001/CPR/DOP
Kerto LVL Q-panel: Declaration of performance MW/LVL/312-001/CPR/DOP
Kerto LVL T-stud: Declaration of performance MW/LVL/314-001/CPR/DOP
Kerto LVL Qp-beam: Declaration of performance MW/LVL/313-001/CPR/DOP
Kerto LVL L-panel: Declaration of performance MW/LVL/318-001/CPR/DOP

TABLE 6. KERTO LVL Q-PANEL 21-24 MM, PROPERTIES PERPENDICULAR TO SURFACE VENEER DIRECTION

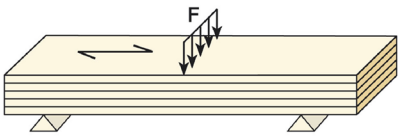
Property	Symbol	Unit	21 mm I-III-I	21 mm II-I-II	24 mm II-II-II	Figure 1
Characteristic bending strength: Flatwise, perpendicular to grain	$f_{m,90,flat,k}$	[N/mm²]	14.0	7.0	7.0	C
Characteristic modulus of elasticity: Bending perpendicular to grain	$E_{m,90,k}$	[N/mm²]	2,900	1,000	1,000	C
Mean modulus of elasticity: Bending perpendicular to grain	$E_{m,90,mean}$	[N/mm²]	3,300	1,200	1,200	C

Source: Declaration of performance MW/LVL/312-001/CPR/DOP
UK Declaration of Conformity MW/LVL/312-001/UKCA/UKDOC

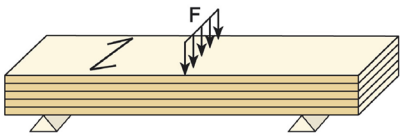
Figure 1. Definition of strength and stiffness orientations (grain direction of the face veneer ⇄).



A Edgewise bending, parallel to grain (m,0,edge)

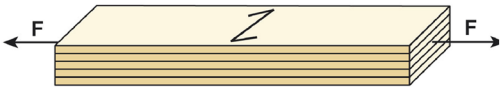


B Flatwise bending, parallel to grain (m,0,flat)

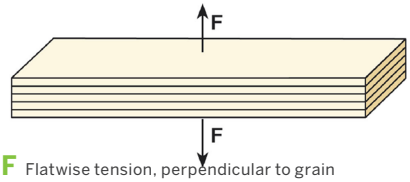


C Flatwise bending, perpendicular to grain (m,90,flat)

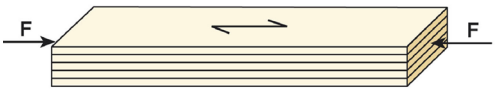
D Tension, parallel to grain (t,0)



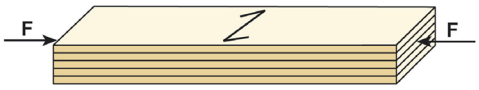
E Edgewise Tension, perpendicular to grain (t,90, edge)



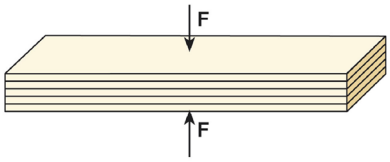
F Flatwise tension, perpendicular to grain (t,90,flat)



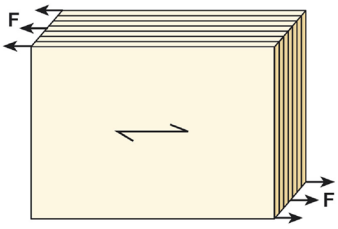
G Compression, parallel to grain (c,0)



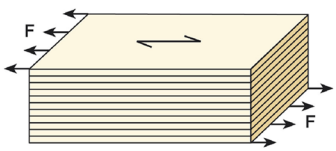
H Edgewise compression, perpendicular to grain (c,90,edge)



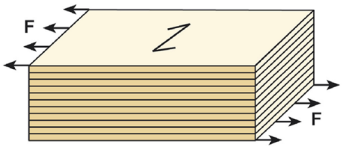
I Flatwise compression, perpendicular to grain (c,90,flat)



J Edgewise shear, parallel to grain (v,0,edge,k)



K Flatwise shear, parallel to grain (v,0,flat,k)



L Flatwise shear, perpendicular to grain (v,90,flat,k)

TABLE 7. VENEER LAY-UP FOR KERTO LVL Q-PANEL AND L-PANEL

NOMINAL THICKNESS [mm]	NUMBER OF PLIES	LAY-UP
21	7	|–|||–|
21	7	||–|–||
24	8	||–||–||
27	9	||–|||–||
30	10	||–||||–||
33	11	||–|||||–||
39	13	||–|||–|||–||
45	15	||–||||–||||–||
51	17	||–|||||–|||||–||
57	19	||–|||–|||||–|||–||
63	21	||–|||–|||–|||–|||–||
69	23	||–||||–|||–||||–||
75	25	||–|||||–|||–|||–|||||–||

TABLE 8. VENEER LAY-UP FOR KERTO LVL Qp-BEAM

THICKNESS [mm]	NUMBER OF VENEERS	LONG GRAINED	CROSS GRAINED	LAY-UP
39	13	11	2	||–|||||||–||
42	14	12	2	||–||||||||–||
45	15	13	2	||–|||||||||–||
48	16	14	2	||–||||||||||–||
51	17	15	2	||–|||||||||||–||
54	18	16	2	||–||||||||||||–||
57	19	17	2	||–|||||||||||||–||
60	20	18	2	||–||||||||||||||–||
63	21	19	2	||–|||||||||||||||–||
66	22	20	2	||–||||||||||||||||–||
69	23	21	2	||–|||||||||||||||||–||
72	24	22	2	||–||||||||||||||||||–||
75	25	23	2	||–|||||||||||||||||||–||

Partial factor for the material

Kerto LVL partial factor $\gamma_M = 1.2$

NOTE.

Defined separately in National Annex for each country, 1.2 is the recommended value in the standard EN 1995-1-1.

Design factors

Moisture content of the product, load duration, and effect of deformations shall be taken into account in structural design. Modification factor for duration of load and moisture content k_{mod} and deformation factor k_{def} are presented in tables 9 and 10 as given in Eurocode 5.

NOTE.

Changes in moisture content may cause relatively large deformations in wood products and increase creep.

TABLE 9. MODIFICATION FACTOR FOR DURATION OF LOAD AND MOISTURE CONTENT k_{mod}

	PERMANENT ACTION	LONG TERM ACTION	MEDIUM TERM ACTION	SHORT TERM ACTION	INSTANTANEOUS ACTION
Service Class 1	0.60	0.70	0.80	0.90	1.10
Service Class 2	0.60	0.70	0.80	0.90	1.10
Service Class 3	0.50	0.55	0.65	0.70	0.90

Source: EN 1995-1-1

TABLE 10. DEFORMATION FACTOR k_{def}

	FIGURE 1	SERVICE CLASS 1	SERVICE CLASS 2	SERVICE CLASS 3
S-beam: All strength and stiffness orientations	A-L	0.60	0.80	2.00
Q-panel: Bending edgewise	A	0.60	0.80	2.00
Q-panel: Bending flatwise	B, C	0.80	1.00	2.50
Q-panel: Other strength and stiffness orientations	D-L	0.60	0.80	2.00
Qp-beam: Bending edgewise	A	0.60	0.80	2.00
Qp-beam: Bending flatwise	B, C	0.80	1.00	2.50
Qp-beam: Other strength and stiffness orientations	D-L	0.60	0.80	2.00
T-stud: All strength and stiffness orientations	A-L	0.60	0.80	2.00
L-panel: Bending edgewise	A	0.60	0.80	2.00
L-panel: Bending flatwise	B, C	0.80	1.00	2.50
L-panel: Other strength and stiffness orientations	D-L	0.60	0.80	2.00

Source: EN 1995-1-1 and Laminated veneer lumber (LVL) bulletin, New European strength classes, September 2020

Size effect parameter

The effect of member size on edgewise bending strength and tensile strength parallel to grain shall be taken into account in structural design. This is made by factors k_h and k_l which are given below as defined in Eurocode 5. The formulas include size parameter s which is product specific. Size effect parameters for different Kerto LVL products are given in tables 1 and 2.

$$k_h = \min \begin{cases} 1.2 \\ \left(\frac{300}{h}\right)^s \end{cases}$$ for members subjected to edgewise bending

$$k_l = \min \begin{cases} 1.1 \\ \left(\frac{3000}{l}\right)^{\frac{s}{2}} \end{cases}$$ for members subjected to tension parallel to grain

h = depth of the member
l = length of the member

EXAMPLE:

Design edgewise bending strength $f_{m,d}$ for S-beam
- h = 400 mm
- Service Class 1
- medium term action.

$$f_{m,d} = k_h \cdot \frac{k_{mod}}{\gamma_M} \cdot f_{m,k} = \min\left(1.2; \left(\frac{300mm}{400mm}\right)^{0.12}\right) \cdot \frac{0.8}{1.2} \cdot 44\,\frac{N}{mm^2} = 28.3\,N/mm^2$$

$f_{m,d}$ = design bending strength
$f_{m,k}$ = characteristic bending strength
k_h = depth factor
k_{mod} = modification factor for duration of load and moisture content
g_M = partial factor for material properties

Compression perpendicular to the grain

According to Eurofins statement No EUFI29-23001225-T2 in design of compression perpendicular to the grain, the contact length of Kerto LVL products can be increased as specified in table 11. Furthermore, the coefficient $k_{c,90}$ according to table 11 can be used.

TABLE 11. COMPRESSION PERPENDICULAR TO THE GRAIN PARAMETERS OF S-BEAM, Q-PANEL AND QP-BEAM FOR THE DESIGN METHOD OF CLAUSE 6.1.5 OF EUROCODE 5.

Compression	$f_{c,90,k}$ N/mm²	Increasing of contact lenght [1]	$k_{c,90}$ [2] (a)	$k_{c,90}$ [2] (b)
S-beam, edgewise	6.0	15 mm along	1.0	≤ 1.2 [4]
S-beam, flatwise [3]	2.2	30 mm along 15 mm across	1.4	1.6
Q-panel, edgewise	9.0	15 mm along	1.0	1.0
Q-panel, flatwise [3]	2.2	30 mm along 15 mm across	1.4	1.6
Qp-beam, edgewise	6.0	15 mm along	1.0	≤ 1.2 [4]
Qp-beam, flatwise [3]	1.8	30 mm along 15 mm across	1.4	1.6

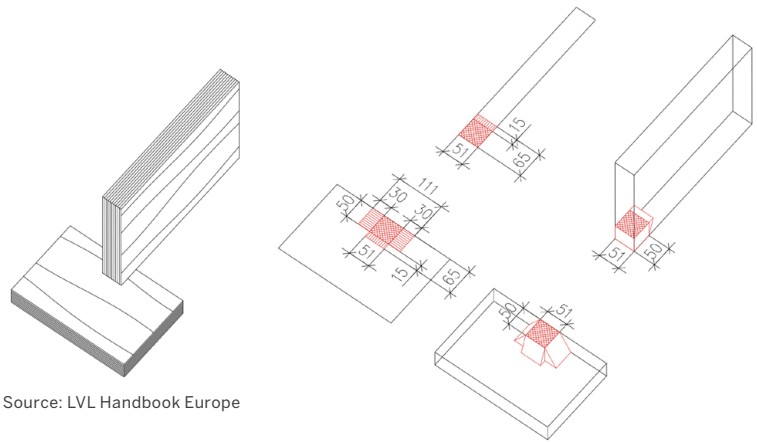
1) For the effective contact length, the actual contact length is increased at each side by this distance, but not more than a, l or $l_1/2$ according to Eurocode 5.
Along = contact length parallel to the grain direction of face veneers.
Across = contact length perpendicular to the grain direction of face veneers.

2) Member on (a) continuous or (b) discrete supports provided that $l_1 \geq 2h$ according to Eurocode 5.

3) When a compression deformation up to 20% is accepted for thicknesses less than 45 mm.

4) For S-beam and Qp-beam edgewise at discrete supports (b):

$$k_{c,90} = \begin{cases} 1.2 & l < 100mm \\ 1.4 - l/500 & 100mm \leq l \leq 200mm \\ 1.0 & l > 200mm \end{cases}$$



Source: LVL Handbook Europe

Factor for notched members

Standard EN 1995-1-1 (equation 6.63) gives factor k_n = 4,5 for LVL.
According to certificate Eurofins EUFI29-20000676-C,
the following factors can be used for Kerto LVL:

- k_n = 6 S-beam edgewise
- k_n = 16 Q-panel edgewise

Reduction factor for various load angles

TABLE 12. REDUCTION FACTORS FOR KERTO LVL Q-PANEL WHEN A MEMBER IS SAWN AT AN ANGLE α TO THE GRAIN DIRECTION OF THE FACE VENEER

	Figure 1	Angle α [1]								
		0°	2,5°	5°	10°	15°	30°	45°	60°	90°
Edgewise bending	A	1.00	0.90	0.75	0.55	0.40	0.25	0.20	0.20	0.22
Flatwise bending	B	1.00	1.00	0.90	0.70	0.50	0.25	0.20	0.20	0.22
Tension, parallel to grain	D	1.00	1.00	0.90	0.70	0.40	0.25	0.20	0.20	0.23
Compression, parallel to grain	G	1.00	1.00	0.90	0.70	0.50	0.35	0.25	0.25	0.35
Modulus of elasticity		1.00	0.90	0.80	0.60	0.40	0.15	0.10	0.10	0.23

[1] Intermediate values can be interpolated.

Source: Eurofins EUFI29-20000676-C

TABLE 13. REDUCTION FACTORS FOR KERTO LVL S-BEAM WHEN A MEMBER IS SAWN AT AN ANGLE α TO THE GRAIN DIRECTION OF THE FACE VENEER

	Figure 1	Angle α [1]								
		0°	2,5°	5°	10°	15°	30°	45°	60°	90°
Edgewise bending	A	1.00	0.90	0.75	0.45	0.25	0.10	0.05	0.05	0.02
Flatwise bending	B	1.00	0.90	0.80	0.55	0.30	0.10	0.05	0.05	0.02
Tension, parallel to grain	D	1.00	1.00	0.90	0.60	0.30	0.05	0.02	0.02	0.02
Compression, parallel to grain	G	1.00	1.00	0.90	0.65	0.40	0.20	0.17	0.17	0.17
Modulus of elasticity		1.00	0.90	0.80	0.60	0.40	0.15	0.05	0.05	0.03

[1] Intermediate values can be interpolated.

Source: Eurofins EUFI29-20000676-C