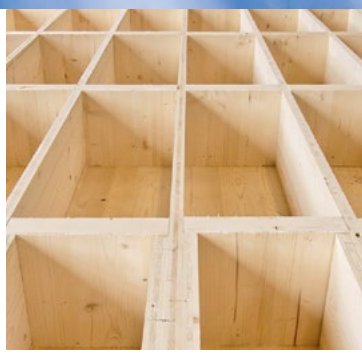
NOVATOP ELEMENT
Technical documentation



NOVATOP

CONTENT

NOVATOP ELEMENT
For ceilings and roofs

CERTIFICATES, ATTESTS AND REPORTS

ETA-11/0310 NT ELEMENT, TaZÚS
Declaration of properties NT ELEMENT
Certificate of constancy of performance NT ELEMENT, TaZÚS
Fire resistance classification report NT ELEMENT, Fires
Airborne and impact sound insulation – a test certificate, CSI

Certificates, attests and reports can be downloaded on www.novatop.system.cz

Version: 08/2021

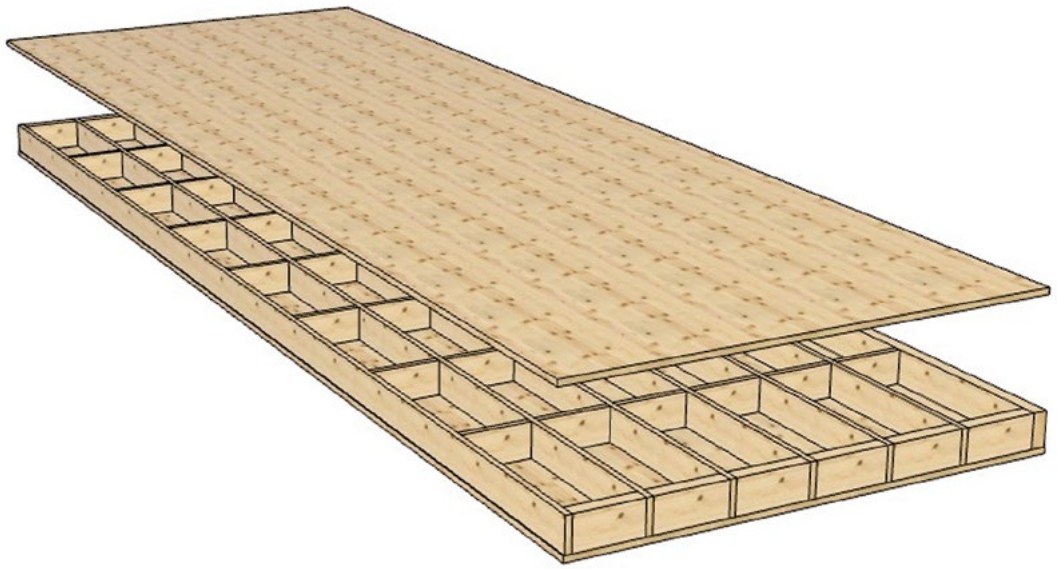
NOVATOP ELEMENT
TECHNICAL DATA SHEET

DESCRIPTION

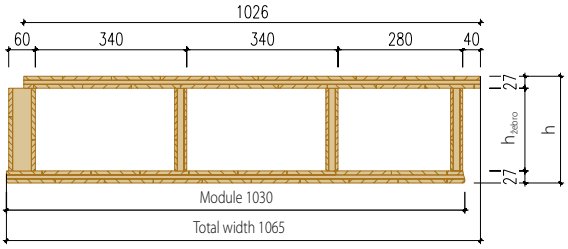
NOVATOP ELEMENT are large ribbed components made of multi-layer solid panels. The structure of the element is composed of a bearing bottom multi-layer panel, whose thickness depends on the required fire resistance of the construction. Transverse and longitudinal ribs, whose height depends on the bearing capacity of the element, are glued to it. The whole structure is enclosed with a top multi-layer panel.

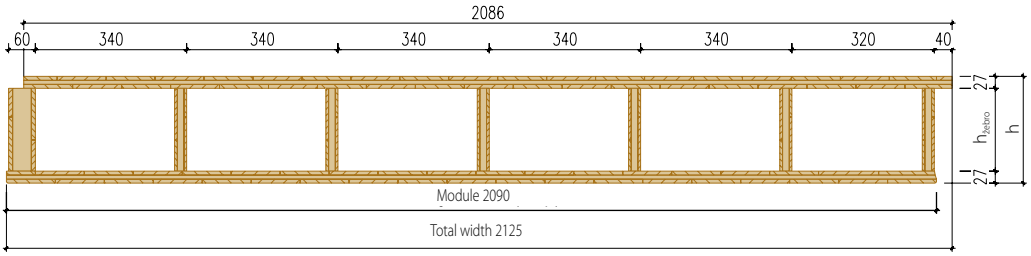
Application	For ceilings and roofs
Demands	ETA-11/0310
Wood Species	Local spruce
Surface quality	No-visual construction, visual living space. Sorting of quality according to internal regulations of AGROP NOVA a.s.
Large-area format	Max 12000 x 2450 mm
Standard formats (mm)	**Height:** 160, 180, 200, 220, 240, 280, 300, 320, max. 400 **Width:** 690, 1030, 2090, 2450, max 2450 **Length:** is arbitrarily selectable according to the project documentation, standardly 6, max. 12 m. (Prolongation with inlay finger joint with internal reinforcement).
Dimensional tolerances according to EN 13 353	Tolerance of nominal width and length: ± 2 mm Straightness of the sides: ± 1 mm/m Rectangularity: ±1 mm/m
Surface	Sanded – K 50, 100
Adhesive	Melamine adhesive according to EN 301, PU according to EN 15425
Formaldehyde emission class	E1 according to EN 717-1 (max. 0.124 mg/m^3)
Moisture	10 ± 3%
Specific thermal capacity c_p	1600 J/kg.K according to EN ISO 10456
Coefficient of shrinkage and swelling	α (%/%) 0.002 - 0.012 %
Density (SWP)	approximately 490 kg/m^3
Reaction to fire	D-s2,d0 according to EN 13501-1
Thermal conductivity (λ) of panels used for production	0.13 W/mK, at a density of panels of 490 kg/m^3 according to EN ISO 10456
Diffusion resistance (SWP)	200/70 (dry/wet) according to EN ISO 10456

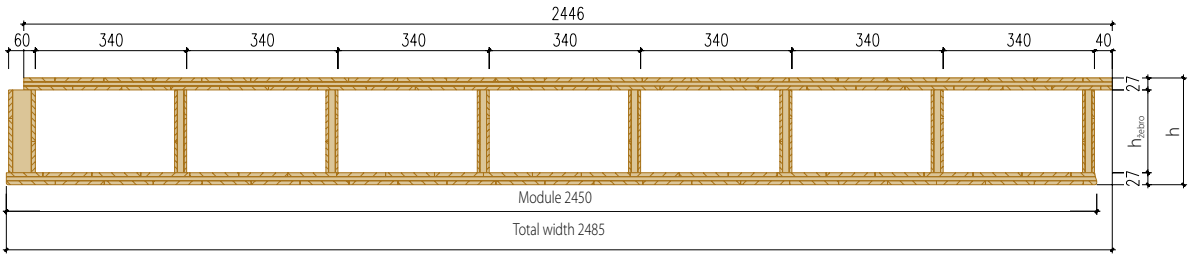
NOVATOP ELEMENT TYPES



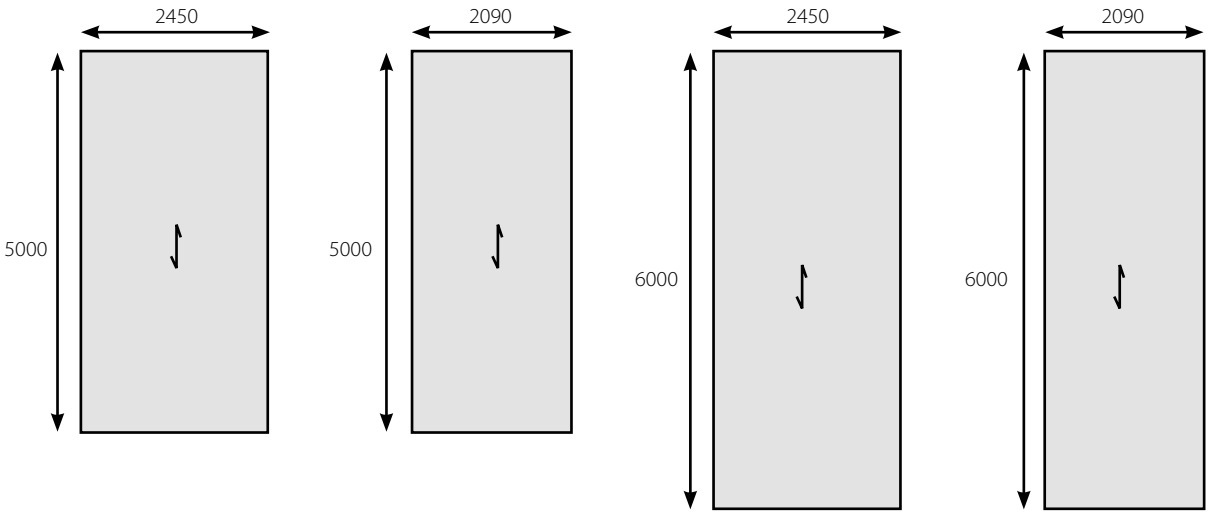
STANDARD WIDTH





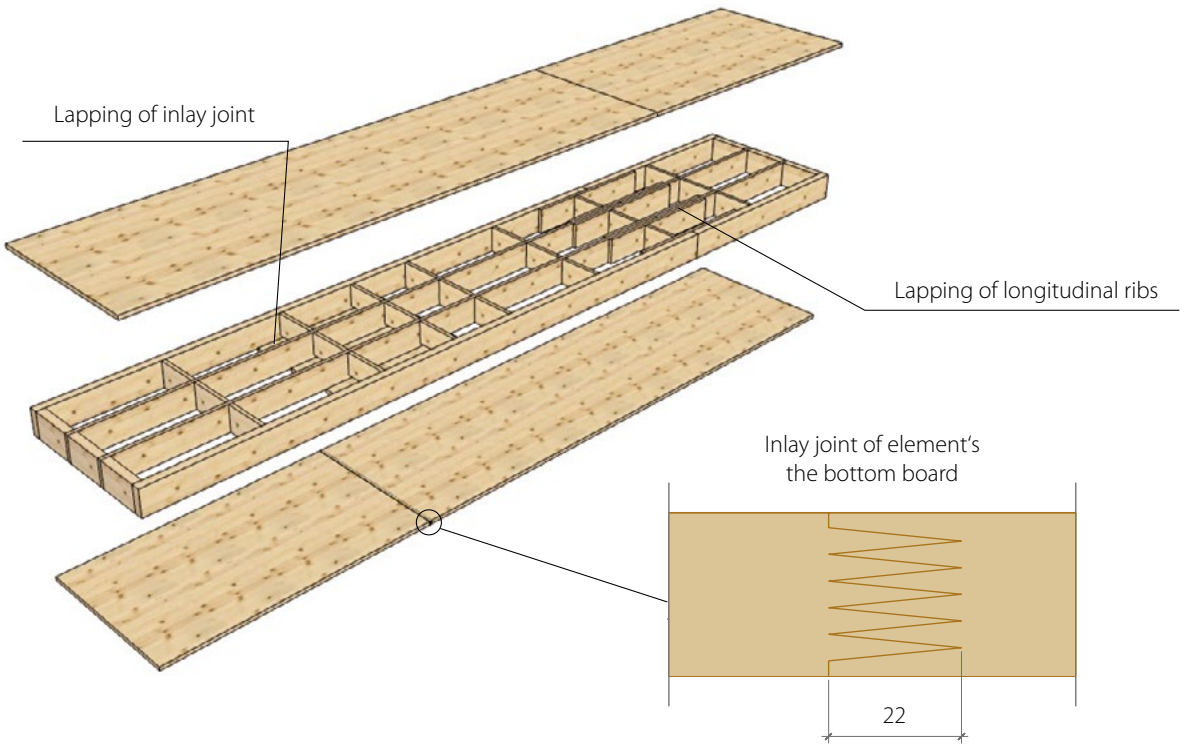


NOVATOP ELEMENT STANDARD FORMATS

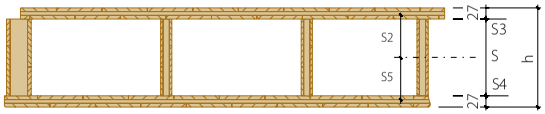


Height: 160, 180, 200, 220, 240, 280, 300, 320, max. 400
Width: 1030, 2090, 2450, max 2.450
Length: is arbitrarily selectable according to the project documentation, standardly 6 m, max. 12 m. (Prolongation with inlay finger joint with internal reinforcement)
Maximal format 12.000 x 2.450 mm
Certified by ETA up to 12 m.

EXAMPLE OF ELEMENT PROLONGATION OVER 6 m

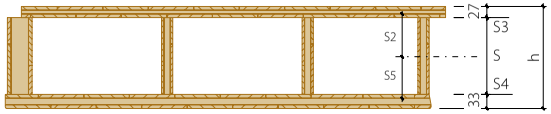


Cross-sectional values



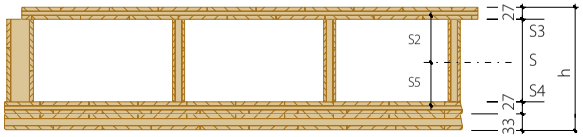
Element height	$h_{Element}$	mm	160	180	200	220	240	260	280	300	320	340	360	380	400
Composition of the top-bottom SWP		mm	27 (9/9/9) - 27 (9/9/9)												
Dead weight	g dead weight	kN/m²	0,31	0,32	0,33	0,34	0,34	0,35	0,36	0,37	0,38	0,38	0,39	0,40	0,41
Range	ℓ	mm	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Height of ribs	h_{rib}	mm	106	126	146	166	186	206	226	246	266	286	306	326	346
Reference width	b	mm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Span of ribs	e	mm	340	340	340	340	340	340	340	340	340	340	340	340	340
Effective width of the top panel	$b_{eff\ of\ the\ top\ panel}$	mm	963	963	963	963	963	963	963	963	963	963	963	963	963
Effective width of the bottom panel	$b_{eff\ of\ the\ bottom\ panel}$	mm	963	963	963	963	963	963	963	963	963	963	963	963	963
Effective cross-sectional area	A	mm²	38423	39129	39835	40541	41247	41952	42658	43364	44070	44776	45482	46188	46894
Centre of gravity of the section:	$z_{s\ from\ the\ top\ edge}$	mm	80	90	100	110	120	130	140	150	160	170	180	190	200
	$z_{s\ from\ the\ bottom\ edge}$	mm	80	90	100	110	120	130	140	150	160	170	180	190	200
Static moments	S2 (joint in the top panel)	mm³	6,55E+05	7,41E+05	8,28E+05	9,15E+05	1,00E+06	1,09E+06	1,17E+06	1,26E+06	1,35E+06	1,43E+06	1,52E+06	1,61E+06	1,70E+06
	S3 (glued joint, ribbed top panel)	mm³	1,15E+06	1,33E+06	1,50E+06	1,67E+06	1,85E+06	2,02E+06	2,19E+06	2,37E+06	2,54E+06	2,71E+06	2,89E+06	3,06E+06	3,23E+06
	S4 (glued joint, ribbed bottom panel)	mm³	1,15E+06	1,33E+06	1,50E+06	1,67E+06	1,85E+06	2,02E+06	2,19E+06	2,37E+06	2,54E+06	2,71E+06	2,89E+06	3,06E+06	3,23E+06
	S5 (joint in the bottom panel)	mm³	6,55E+05	7,41E+05	8,28E+05	9,15E+05	1,00E+06	1,09E+06	1,17E+06	1,26E+06	1,35E+06	1,43E+06	1,52E+06	1,61E+06	1,70E+06
	S (centre of gravity)	mm³	1,20E+06	1,40E+06	1,59E+06	1,79E+06	2,00E+06	2,21E+06	2,42E+06	2,63E+06	2,85E+06	3,07E+06	3,30E+06	3,53E+06	3,76E+06
Moment of inertia of the cross-section according to theory of elasticity	I	mm⁴	1,60E+08	2,12E+08	2,72E+08	3,39E+08	4,15E+08	4,99E+08	5,92E+08	6,93E+08	8,03E+08	9,21E+08	1,05E+09	1,19E+09	1,33E+09
Cross-section moduli according to theory of elasticity	W_{top}	mm³	2,00E+06	2,35E+06	2,72E+06	3,09E+06	3,46E+06	3,84E+06	4,23E+06	4,62E+06	5,02E+06	5,42E+06	5,83E+06	6,24E+06	6,66E+06
	W_{bottom}	mm³	2,00E+06	2,35E+06	2,72E+06	3,09E+06	3,46E+06	3,84E+06	4,23E+06	4,62E+06	5,02E+06	5,42E+06	5,83E+06	6,24E+06	6,66E+06
Effective bending stiffness	EI_{eff}	Nmm²	1,75E+12	2,32E+12	2,96E+12	3,69E+12	4,50E+12	5,39E+12	6,37E+12	7,44E+12	8,59E+12	9,83E+12	1,12E+13	1,26E+13	1,41E+13

Cross-sectional values



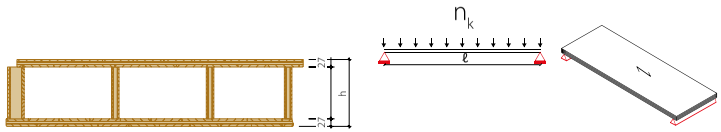
Element height	$h_{Element}$	mm	160	180	200	220	240	260	280	300	320	340	360	380	400
Composition of the top-bottom SWP		mm	27 (9/9/9) - 33 (9/15/9)												
Dead weight	g dead weight	kN/m²	0,34	0,35	0,36	0,36	0,37	0,38	0,39	0,40	0,40	0,41	0,42	0,43	0,44
Range	ℓ	mm	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Height of ribs	h_{rib}	mm	100	120	140	160	180	200	220	240	260	280	300	320	340
Reference width	b	mm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Span of ribs	e	mm	340	340	340	340	340	340	340	340	340	340	340	340	340
Effective width of the top panel	$b_{eff\ of\ the\ top\ panel}$	mm	963	963	963	963	963	963	963	963	963	963	963	963	963
Effective width of the bottom panel	$b_{eff\ of\ the\ bottom\ panel}$	mm	962	962	962	962	962	962	962	962	962	962	962	962	962
Effective cross-sectional area	A	mm²	38184	38890	39595	40301	41007	41713	42419	43125	43831	44537	45243	45948	46654
Centre of gravity of the section:	$z_{s,\ from\ the\ top\ edge}$	mm	78	88	98	108	118	128	138	148	158	168	178	188	198
	$z_{s,\ from\ the\ bottom\ edge}$	mm	82	92	102	112	122	132	142	152	162	172	182	192	202
Static moments	S2 (joint in the top panel)	mm³	6,40E+05	7,26E+05	8,13E+05	8,99E+05	9,86E+05	1,07E+06	1,16E+06	1,25E+06	1,33E+06	1,42E+06	1,50E+06	1,59E+06	1,68E+06
	S3 (glued joint, ribbed top panel)	mm³	1,12E+06	1,30E+06	1,47E+06	1,64E+06	1,82E+06	1,99E+06	2,16E+06	2,33E+06	2,51E+06	2,68E+06	2,85E+06	3,03E+06	3,20E+06
	S4 (glued joint, ribbed bottom panel)	mm³	1,13E+06	1,30E+06	1,48E+06	1,65E+06	1,82E+06	2,00E+06	2,17E+06	2,34E+06	2,52E+06	2,69E+06	2,86E+06	3,04E+06	3,21E+06
	S5 (joint in the bottom panel)	mm³	6,68E+05	7,55E+05	8,42E+05	9,29E+05	1,02E+06	1,10E+06	1,19E+06	1,28E+06	1,36E+06	1,45E+06	1,54E+06	1,62E+06	1,71E+06
	S (centre of gravity)	mm³	1,17E+06	1,36E+06	1,56E+06	1,76E+06	1,96E+06	2,17E+06	2,38E+06	2,59E+06	2,81E+06	3,03E+06	3,26E+06	3,48E+06	3,72E+06
Moment of inertia of the cross-section according to theory of elasticity	I	mm⁴	1,53E+08	2,04E+08	2,63E+08	3,29E+08	4,03E+08	4,86E+08	5,77E+08	6,76E+08	7,84E+08	9,01E+08	1,03E+09	1,16E+09	1,31E+09
Cross-section moduli according to theory of elasticity	W_{top}	mm³	1,96E+06	2,31E+06	2,67E+06	3,04E+06	3,41E+06	3,79E+06	4,18E+06	4,57E+06	4,96E+06	5,36E+06	5,77E+06	6,18E+06	6,59E+06
	W_{bottom}	mm³	1,88E+06	2,23E+06	2,58E+06	2,94E+06	3,31E+06	3,69E+06	4,07E+06	4,45E+06	4,85E+06	5,24E+06	5,64E+06	6,05E+06	6,46E+06
Effective bending stiffness	EI_{eff}	Nmm²	1,69E+12	2,24E+12	2,87E+12	3,58E+12	4,38E+12	5,26E+12	6,22E+12	7,27E+12	8,41E+12	9,63E+12	1,09E+13	1,23E+13	1,38E+13

Cross-sectional values3



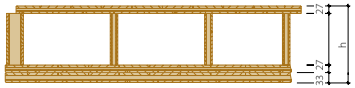
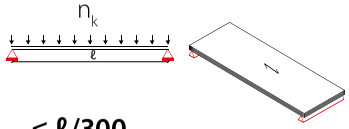
Element height	$h_{Element}$	mm	160	180	200	220	240	260	280	300	320	340	360	380	400
Composition of the top-bottom SWP		mm	27 (9/9/9) - 60 (9/9/9 + 9/15/9)												
Dead weight	g dead weight	kN/m²	0,46	0,47	0,48	0,49	0,50	0,50	0,51	0,52	0,53	0,54	0,54	0,55	0,56
Range	ℓ	mm	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Height of ribs	h_{rib}	mm	73	93	113	133	153	173	193	213	233	253	273	293	313
Reference width	b	mm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Span of ribs	e	mm	340	340	340	340	340	340	340	340	340	340	340	340	340
Effective width of the top panel	$b_{ef,f\ of\ the\ top\ panel}$	mm	963	963	963	963	963	963	963	963	963	963	963	963	963
Effective width of the bottom panel	$b_{eff\ of\ the\ bottom\ panel}$	mm	962	962	962	962	962	962	962	962	962	962	962	962	962
Effective cross-sectional area	A	mm²	54565	55271	55977	56683	57389	58095	58800	59506	60212	60918	61624	62330	63036
Centre of gravity of the section:	$z_{s,\ from\ the\ top\ edge}$	mm	89	102	114	127	140	152	165	177	189	202	214	226	238
	$z_{s,\ from\ the\ bottom\ edge}$	mm	71	78	86	93	100	108	115	123	131	138	146	154	162
Static moments	S2 (joint in the top panel)	mm³	7,32E+05	8,43E+05	9,53E+05	1,06E+06	1,17E+06	1,28E+06	1,39E+06	1,50E+06	1,60E+06	1,71E+06	1,82E+06	1,92E+06	2,03E+06
	S3 (glued joint, ribbed top panel)	mm³	1,31E+06	1,53E+06	1,75E+06	1,97E+06	2,19E+06	2,41E+06	2,62E+06	2,84E+06	3,05E+06	3,27E+06	3,48E+06	3,69E+06	3,90E+06
	S4 (glued joint, ribbed bottom panel)	mm³	1,37E+06	1,62E+06	1,87E+06	2,13E+06	2,38E+06	2,64E+06	2,90E+06	3,17E+06	3,43E+06	3,70E+06	3,97E+06	4,24E+06	4,51E+06
	S5 (joint in the bottom panel)	mm³	1,24E+06	1,42E+06	1,61E+06	1,80E+06	2,00E+06	2,19E+06	2,39E+06	2,58E+06	2,78E+06	2,98E+06	3,18E+06	3,38E+06	3,59E+06
	S (centre of gravity)	mm³	1,37E+06	1,63E+06	1,89E+06	2,15E+06	2,41E+06	2,68E+06	2,96E+06	3,24E+06	3,52E+06	3,80E+06	4,10E+06	4,39E+06	4,69E+06
Moment of inertia of the cross-section according to theory of elasticity	I	mm⁴	1,69E+08	2,29E+08	2,99E+08	3,80E+08	4,71E+08	5,73E+08	6,86E+08	8,10E+08	9,45E+08	1,09E+09	1,25E+09	1,42E+09	1,60E+09
Cross-section moduli according to theory of elasticity	W_{top}	mm³	1,90E+06	2,25E+06	2,62E+06	2,99E+06	3,37E+06	3,76E+06	4,16E+06	4,57E+06	4,99E+06	5,41E+06	5,84E+06	6,27E+06	6,71E+06
	W_{bottom}	mm³	2,38E+06	2,93E+06	3,50E+06	4,09E+06	4,70E+06	5,32E+06	5,95E+06	6,59E+06	7,24E+06	7,90E+06	8,56E+06	9,23E+06	9,91E+06
Effective bending stiffness	EI_{eff}	Nmm²	1,83E+12	2,48E+12	3,23E+12	4,10E+12	5,07E+12	6,15E+12	7,34E+12	8,64E+12	1,01E+13	1,16E+13	1,32E+13	1,50E+13	1,69E+13

NOVATOP ELEMENT
PRELIMINARY DIMENSIONING



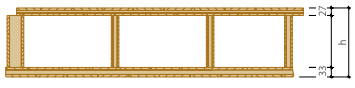
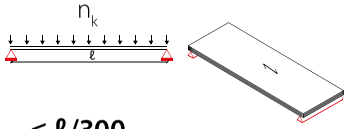
Preliminary dimensioning without fill $w_{inst} \leq \ell/300$

Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/9/9)																
		3	3,5	4	4,5	5	5,5	6	6,5	7	7,5	8	8,5	9	9,5	10	10,5	11
1	1,5	160	160	160	160	160	180	200	220	240	260	280	300	320	340	360	380	400
	2	160	160	160	160	160	180	200	220	240	260	300	320	340	360	380	400	-
	3	160	160	160	160	180	200	220	260	280	300	320	360	380	400	-	-	-
	4	160	160	160	180	200	220	260	280	300	340	360	380	-	-	-	-	-
	5	160	160	160	200	220	240	280	300	320	360	380	-	-	-	-	-	-
1,5	1,5	160	160	160	160	160	180	200	220	240	260	300	320	340	360	380	400	-
	2	160	160	160	160	180	200	220	240	260	280	300	340	360	380	400	-	-
	3	160	160	160	180	200	220	240	260	300	320	340	380	400	-	-	-	-
	4	160	160	160	180	220	240	260	280	320	340	380	400	-	-	-	-	-
	5	160	160	180	200	220	260	280	300	340	360	400	-	-	-	-	-	-
2	1,5	160	160	160	160	180	200	220	240	260	280	300	340	360	380	400	-	-
	2	160	160	160	160	180	200	220	260	280	300	320	360	380	400	-	-	-
	3	160	160	160	180	200	240	260	280	300	340	360	400	-	-	-	-	-
	4	160	160	160	200	220	240	280	300	320	360	380	-	-	-	-	-	-
	5	160	160	180	200	240	260	280	320	340	380	-	-	-	-	-	-	-
2,5	1,5	160	160	160	160	180	200	240	260	280	300	320	360	380	400	-	-	-
	2	160	160	160	180	200	220	240	260	300	320	340	360	400	-	-	-	-
	3	160	160	160	200	220	240	260	300	320	360	380	-	-	-	-	-	-
	4	160	160	180	200	220	260	280	320	340	380	400	-	-	-	-	-	-
	5	160	160	180	220	240	260	300	320	360	400	-	-	-	-	-	-	-
3	1,5	160	160	160	180	200	220	240	280	300	320	340	380	400	-	-	-	-
	2	160	160	160	180	200	220	260	280	300	340	360	380	-	-	-	-	-
	3	160	160	180	200	220	260	280	300	340	360	400	-	-	-	-	-	-
	4	160	160	180	200	240	260	300	320	360	380	-	-	-	-	-	-	-
	5	160	180	200	220	240	280	300	340	380	400	-	-	-	-	-	-	-

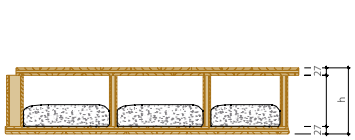
Preliminary dimensioning without fill $w_{inst} \leq \ell/300$

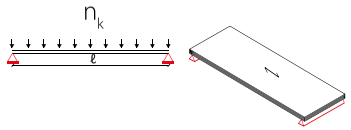
Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 60 (9/9/9 + 9/15/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	160	180	200
	2	160	160	160	160	180	180	200
	3	160	160	160	160	180	200	220
	4	160	160	160	180	200	220	240
	5	160	160	180	200	220	240	260
1,5	1,5	160	160	160	160	180	180	200
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	240
	4	160	160	160	180	200	240	260
	5	160	160	180	200	220	240	280
2	1,5	160	160	160	160	180	200	220
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	260
	4	160	160	180	200	220	240	260
	5	160	180	200	220	240	260	280
2,5	1,5	160	160	160	180	180	200	220
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	240	260
	4	160	160	180	200	220	260	280
	5	160	180	200	240	260	280	300
3	1,5	160	160	160	180	200	220	240
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	240	280
	4	160	180	200	220	240	260	280
	5	180	200	220	240	260	280	300

Preliminary dimensioning without fill $w_{inst} \leq \ell/300$

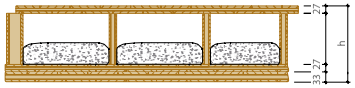
Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 33 (9/15/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	160	180	200
	2	160	160	160	160	160	180	200
	3	160	160	160	160	180	220	240
	4	160	160	160	180	200	220	260
	5	160	160	180	200	220	240	280
1,5	1,5	160	160	160	160	160	180	200
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	240
	4	160	160	160	180	220	240	260
	5	160	160	180	200	220	260	280
2	1,5	160	160	160	160	180	200	220
	2	160	160	160	160	180	220	240
	3	160	160	160	180	200	240	260
	4	160	160	180	200	220	240	280
	5	160	160	180	200	240	260	300
2,5	1,5	160	160	160	160	180	220	240
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	240	280
	4	160	160	180	200	240	260	280
	5	160	160	180	220	240	280	300
3	1,5	160	160	160	180	200	220	240
	2	160	160	160	180	200	220	260
	3	160	160	180	200	220	260	280
	4	160	160	180	220	240	260	300
	5	160	180	200	220	260	280	320

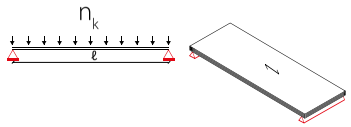




Preliminary dimensioning with limestone fill 40 kg/m², $w_{inst} \leq \ell/300$

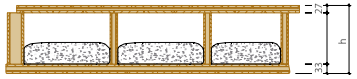
Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/9/9)															
		3	3,5	4	4,5	5	5,5	6	6,5	7	7,5	8	8,5	9	9,5	10	10,5
1	1,5	160	160	160	160	160	180	200	220	240	260	280	300	340	360	380	400
	2	160	160	160	160	180	200	220	240	260	280	300	320	360	380	400	-
	3	160	160	160	180	200	220	240	260	280	320	340	360	400	-	-	-
	4	160	160	160	180	200	240	260	280	320	340	360	400	-	-	-	-
	5	160	160	180	200	220	260	280	300	340	360	400	-	-	-	-	-
1,5	1,5	160	160	160	160	180	200	220	240	260	280	300	320	360	380	400	-
	2	160	160	160	160	180	200	220	260	280	300	320	340	380	400	-	-
	3	160	160	160	180	200	220	260	280	300	340	360	380	-	-	-	-
	4	160	160	160	200	220	240	260	300	320	360	380	-	-	-	-	-
	5	160	160	180	200	240	260	280	320	340	380	-	-	-	-	-	-
2	1,5	160	160	160	160	180	200	220	260	280	300	320	340	380	400	-	-
	2	160	160	160	180	200	220	240	260	280	320	340	360	400	-	-	-
	3	160	160	160	180	220	240	260	300	320	340	380	400	-	-	-	-
	4	160	160	180	200	220	260	280	300	340	360	400	-	-	-	-	-
	5	160	160	180	220	240	260	300	320	360	400	-	-	-	-	-	-
2,5	1,5	160	160	160	180	200	220	240	260	300	320	340	380	400	-	-	-
	2	160	160	160	180	200	220	240	280	300	320	360	380	-	-	-	-
	3	160	160	180	200	220	260	280	300	340	360	400	-	-	-	-	-
	4	160	160	180	200	240	260	300	320	360	380	-	-	-	-	-	-
	5	160	180	200	220	240	280	300	340	380	400	-	-	-	-	-	-
3	1,5	160	160	160	180	200	240	260	280	300	340	360	400	-	-	-	-
	2	160	160	160	180	200	240	260	280	320	340	380	400	-	-	-	-
	3	160	160	180	200	240	260	300	320	360	380	-	-	-	-	-	-
	4	160	160	180	220	240	280	300	340	360	400	-	-	-	-	-	-
	5	160	180	200	220	260	280	320	360	380	-	-	-	-	-	-	-

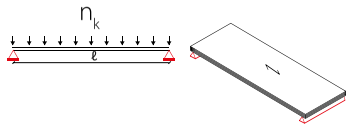




Preliminary dimensioning with limestone fill 40 kg/m², $w_{inst} \leq \ell/300$

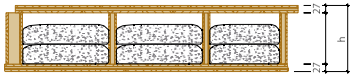
Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 60 (9/9/9 + 9/15/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	160	180	200
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	240
	4	160	160	160	180	200	240	260
	5	160	160	180	200	220	240	280
1,5	1,5	160	160	160	160	180	200	220
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	240
	4	160	160	180	200	220	240	260
	5	160	180	200	220	240	260	280
2	1,5	160	160	160	160	180	200	220
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	240	260
	4	160	160	180	200	220	240	280
	5	160	180	200	220	240	260	280
2,5	1,5	160	160	160	180	200	220	240
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	240	280
	4	160	180	200	220	240	260	280
	5	180	200	220	240	260	280	300
3	1,5	160	160	160	180	200	220	260
	2	160	160	180	200	200	240	260
	3	160	160	180	200	240	260	280
	4	160	180	200	220	240	260	300
	5	180	200	220	240	280	300	320

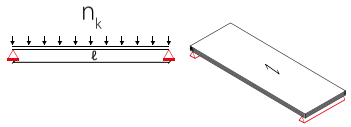




Preliminary dimensioning with limestone fill 40 kg/m², $w_{inst} \leq \ell/300$

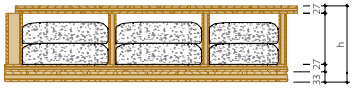
Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/15/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	160	180	200
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	240
	4	160	160	160	180	220	240	260
	5	160	160	180	200	220	260	280
1,5	1,5	160	160	160	160	180	200	220
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	240	260
	4	160	160	180	200	220	240	280
	5	160	160	180	200	240	260	300
2	1,5	160	160	160	160	180	200	240
	2	160	160	160	180	200	220	240
	3	160	160	160	200	220	240	260
	4	160	160	180	200	220	260	280
	5	160	160	180	220	240	260	300
2,5	1,5	160	160	160	180	200	220	240
	2	160	160	160	180	200	220	260
	3	160	160	180	200	220	260	280
	4	160	160	180	220	240	260	300
	5	160	180	200	220	240	280	300
3	1,5	160	160	160	180	200	240	260
	2	160	160	160	180	220	240	260
	3	160	160	180	200	240	260	300
	4	160	160	200	220	240	280	300
	5	160	180	200	220	260	280	320

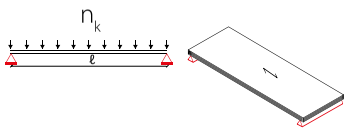




Preliminary dimensioning with limestone fill 80 kg/m², $w_{inst} \leq \ell/300$

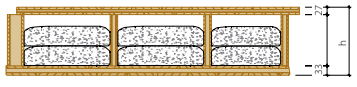
Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/9/9)														
		3	3,5	4	4,5	5	5,5	6	6,5	7	7,5	8	8,5	9	9,5	10
1	1,5	160	160	160	160	180	200	220	240	260	280	300	320	340	380	400
	2	160	160	160	160	180	200	220	240	280	300	320	340	360	400	-
	3	160	160	160	180	200	220	240	280	300	320	360	380	-	-	-
	4	160	160	160	200	220	240	260	300	320	360	380	-	-	-	-
	5	160	160	180	200	220	260	280	320	340	380	400	-	-	-	-
1,5	1,5	160	160	160	160	180	200	220	240	280	300	320	340	360	400	-
	2	160	160	160	160	200	220	240	260	280	300	340	360	380	-	-
	3	160	160	160	180	220	240	260	280	320	340	380	400	-	-	-
	4	160	160	180	200	220	260	280	300	340	360	400	-	-	-	-
	5	160	160	180	200	240	260	300	320	360	380	-	-	-	-	-
2	1,5	160	160	160	180	200	220	240	260	280	320	340	360	400	-	-
	2	160	160	160	180	200	220	240	280	300	320	360	380	400	-	-
	3	160	160	180	200	220	240	280	300	340	360	400	-	-	-	-
	4	160	160	180	200	240	260	300	320	360	380	-	-	-	-	-
	5	160	180	180	220	240	280	300	340	360	400	-	-	-	-	-
2,5	1,5	160	160	160	180	200	220	260	280	300	340	360	380	-	-	-
	2	160	160	160	180	200	240	260	280	320	340	360	400	-	-	-
	3	160	160	180	200	240	260	280	320	340	380	-	-	-	-	-
	4	160	160	180	220	240	280	300	340	360	400	-	-	-	-	-
	5	160	180	200	220	260	280	320	340	380	-	-	-	-	-	-
3	1,5	160	160	160	200	220	240	260	300	320	360	380	-	-	-	-
	2	160	160	160	200	220	240	280	300	320	360	380	-	-	-	-
	3	160	160	180	220	240	260	300	340	360	400	-	-	-	-	-
	4	160	160	200	220	260	280	320	340	380	-	-	-	-	-	-
	5	160	180	200	240	260	300	320	360	400	-	-	-	-	-	-

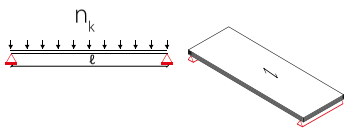




Preliminary dimensioning with limestone fill 80 kg/m², $w_{inst} \leq \ell/300$

Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 60 (9/9/9 + 9/15/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	180	200	220
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	240
	4	160	160	180	200	220	240	260
	5	160	180	200	220	240	260	280
1,5	1,5	160	160	160	160	180	200	220
	2	160	160	160	180	200	220	240
	3	160	160	160	180	220	240	260
	4	160	160	180	200	220	240	280
	5	160	180	200	220	240	260	280
2	1,5	160	160	160	180	200	220	240
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	240	260
	4	160	180	200	220	240	260	280
	5	180	200	220	240	260	280	300
2,5	1,5	160	160	160	180	200	220	240
	2	160	160	180	180	200	220	260
	3	160	160	180	200	220	260	280
	4	160	180	200	220	240	260	300
	5	180	200	220	240	260	300	320
3	1,5	160	160	180	200	220	240	260
	2	160	160	180	200	220	240	260
	3	160	180	200	220	240	260	300
	4	160	200	220	240	260	280	300
	5	180	220	240	260	280	300	320

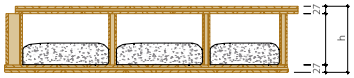
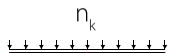


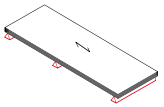


Preliminary dimensioning with limestone fill 80 kg/m², $w_{inst} \leq \ell/300$

Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) + 33 (9/15/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	180	200	220
	2	160	160	160	160	180	200	220
	3	160	160	160	180	200	220	260
	4	160	160	180	200	220	240	260
	5	160	160	180	200	240	260	280
1,5	1,5	160	160	160	160	180	200	220
	2	160	160	160	180	200	220	240
	3	160	160	160	200	220	240	260
	4	160	160	180	200	220	260	280
	5	160	160	180	220	240	260	300
2	1,5	160	160	160	180	200	220	240
	2	160	160	160	180	200	220	240
	3	160	160	180	200	220	260	280
	4	160	160	180	200	240	260	300
	5	160	180	200	220	240	280	300
2,5	1,5	160	160	160	180	200	240	260
	2	160	160	160	180	220	240	260
	3	160	160	180	200	240	260	300
	4	160	160	200	220	240	280	300
	5	160	180	200	220	260	280	320
3	1,5	160	160	160	200	220	240	260
	2	160	160	180	200	220	240	280
	3	160	160	180	220	240	280	300
	4	160	180	200	220	260	280	320
	5	160	180	220	240	260	300	320

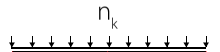
NOVATOP ELEMENT
PRELIMINARY DIMENSIONING

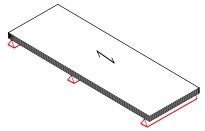





Preliminary dimensioning with limestone fill 40 kg/m², $w_{inst} \leq \ell/300$

Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/9/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	180	200	220	220
	2	160	160	180	200	220	240	260
	3	160	180	200	220	240	260	280
	4	200	220	240	260	280	320	340
	5	220	240	280	300	340	360	380
1,5	1,5	160	160	180	200	220	240	260
	2	160	180	200	220	240	260	280
	3	180	200	220	240	260	280	300
	4	200	220	260	280	300	340	360
	5	220	260	300	320	340	380	400
2	1,5	160	180	200	220	240	260	280
	2	180	200	220	240	260	280	300
	3	180	220	240	260	280	300	340
	4	220	240	280	300	320	360	380
	5	240	280	300	340	360	400	-
2,5	1,5	180	200	220	240	260	280	300
	2	180	220	240	260	280	320	340
	3	200	220	260	280	300	320	360
	4	220	260	280	320	340	380	400
	5	260	280	320	360	380	-	-
3	1,5	180	220	240	260	280	300	340
	2	200	240	260	280	300	340	360
	3	220	240	260	300	320	340	380
	4	240	280	300	340	360	400	-
	5	260	300	340	380	400	-	-

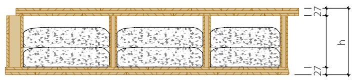



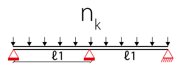


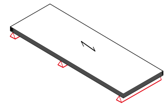
Preliminary dimensioning without fill, $w_{inst} \leq \ell/300$

Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/9/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	160	160	180	200	200
	2	160	160	160	180	200	220	240
	3	160	180	200	220	220	240	260
	4	180	200	220	260	280	300	320
	5	200	240	260	280	320	340	360
1,5	1,5	160	160	160	180	200	220	240
	2	160	160	180	200	220	240	260
	3	160	180	200	220	240	260	280
	4	200	220	240	260	300	320	340
	5	220	240	280	300	340	360	380
2	1,5	160	160	180	200	220	240	260
	2	160	180	200	220	240	260	280
	3	180	200	220	240	260	300	320
	4	200	240	260	280	320	340	360
	5	240	260	300	320	360	380	-
2,5	1,5	160	180	200	220	240	260	280
	2	180	200	220	240	260	300	320
	3	200	220	240	260	280	320	340
	4	220	240	280	300	340	360	380
	5	240	280	300	340	380	400	-
3	1,5	180	200	220	240	260	280	320
	2	200	220	240	260	300	320	340
	3	200	220	260	280	300	340	360
	4	220	260	300	320	340	380	400
	5	260	300	320	360	400	-	-

NOVATOP







Preliminary dimensioning
with limestone fill 80 kg/m², $w_{inst} \leq \ell/300$

Permanent load (g_k)	Live load (n_k)	Range / Composition 27 (9/9/9) - 27 (9/9/9)						
		3	3,5	4	4,5	5	5,5	6
1	1,5	160	160	180	200	220	240	240
	2	160	180	200	220	240	260	280
	3	180	200	220	240	260	280	300
	4	200	220	260	280	300	320	360
	5	220	260	280	320	340	380	400
1,5	1,5	160	180	200	220	240	260	280
	2	180	200	220	240	260	280	300
	3	180	200	240	260	280	300	320
	4	220	240	260	300	320	340	380
	5	240	280	300	340	360	400	-
2	1,5	180	200	220	240	260	280	300
	2	180	220	240	260	280	300	320
	3	200	220	240	280	300	320	340
	4	220	260	280	320	340	360	400
	5	260	280	320	360	380	-	-
2,5	1,5	180	200	240	260	280	300	320
	2	200	220	260	280	300	320	360
	3	200	240	260	300	320	340	380
	4	240	260	300	320	360	380	-
	5	260	300	340	360	400	-	-
3	1,5	200	220	260	280	300	320	360
	2	220	240	280	300	320	360	380
	3	220	260	280	300	340	360	400
	4	240	280	320	340	380	400	-
	5	280	320	340	380	-	-	-

NOVATOP ELEMENT
EXAMPLES OF DIMENSIONING

1 General information

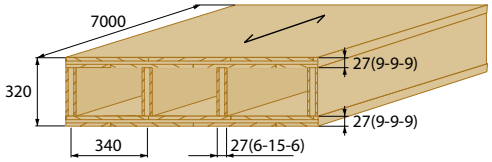
In the following document, the bearing element (the load of the panels and the direction of the fibres of the surface layers in the direction of the span) of the company AGROP NOVA AG shows a detailed calculation and performance of the assessment according to standards DIN EN 1995 - 1-1/NA / A1 (2012-02 -) applicable to Germany.

Proofs of load capacity and applicability are provided.

2 System and load

2.1 Material:

NOVATOP-bearing element type A1	h = 320 mm
(Composition: 9/9/9 – 6/15/6 – 9/9/9, th. = 27 mm)	
Range of a girder of one field	ℓ = 7000 mm
Reference width for the calculation	b = 340 mm
Distance between the ribs in the longitudinal direction	e = 340 mm



Solid wood panel	9/9/9	6/15/6
Modulus of elasticity longitudinally $E_{m,0}$ [N/mm²]	7800	5300
Characteristic bending stiffness $f_{m,0,k}$ [N/mm²]	20,3	13,9
Characteristic tensile strength $f_{t,0,k}$ [N/mm²]	11,5	9,3
Characteristic compression strength $f_{c,0,k}$ [N/mm²]	20,3	13,9
Characteristic shear strength $f_{v,k}$ [N/mm²]	3,0	3,0
Characteristic shear strength of a glued joint $f_{v,glue,k}$ [N/mm²]	4,0	4,0
Shear modulus G [N/mm²]	600	600

Strength values are characteristic.

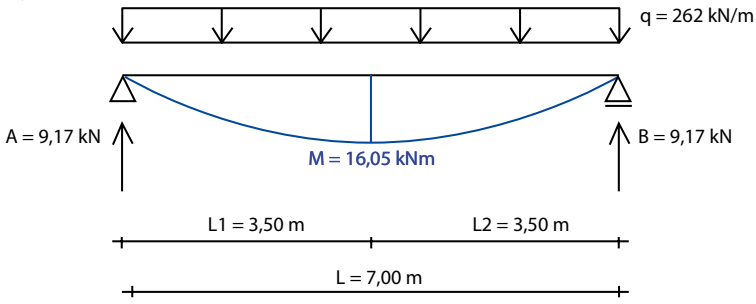
Static values from the table:	
Effective moment of inertia	$I_{eff} = 3{,}01 \times 10^8$ mm⁴
Relation module E	$E_v = 11{,}0 \times 10^3$ N/mm²
Effective bending stiffness	$E_{Ieff} = 3{,}31 \times 10^{12}$ Nmm²
Centre of gravity distance from the bottom edge	$z_s = 160$ mm
Static moment to the centre of gravity	$S_1 = 1{,}07 \times 10^6$ mm³
Static moment to the glued joint	$S_2 = 9{,}54 \times 10^5$ mm³
Deformation coefficient	$k_{def} = 0{,}60$

2.2 Load:

Class of application	1
Dead load of the element:	$g_1 = 0{,}38$ kN/m²
Permanent load:	$g_k = 2{,}00$ kN/m²
Live load:	$q_k = 3{,}00$ kN/m²; Category C
→	$k_{mod} = 0{,}90$
→	$\Psi_2 = 0{,}60$

2.2.1 Proofs of load capacity

$q_d = 1{,}35 \cdot (0{,}38 + 2{,}0) \cdot 0{,}34 + 1{,}5 \cdot 3{,}0 \cdot 0{,}34 = 2{,}62$ kN/m



The maximum bending moment

$$M_d = \frac{q_d \cdot \ell^2}{8} = \frac{2{,}62 \cdot 7{,}00^2}{8} = 16{,}05 \text{ kNm}$$

The maximum transverse force

$$V_d = \frac{q_d \cdot \ell}{2} = \frac{2{,}62 \cdot 7{,}00}{2} = 9{,}17 \text{ kN}$$

2.2.2 Proofs of load capacity

Survey of loads

$q_{k,g} = (0{,}38 + 2{,}0) \cdot 0{,}34 = 0{,}809$ kN/m

$q_{k,q} = 3{,}0 \cdot 0{,}34 = 1{,}02$ kN/m

3 Proofs of load capacity

3.1 Proof of bending of the tension edge

$$\sigma_{m,d} = \frac{M_d}{l_{elf}} \cdot \frac{E_{m,0}}{E_v} \cdot z_s = \frac{16{,}1 \cdot 10^6}{3{,}01 \cdot 10^8} \cdot \frac{7800}{11000} \cdot 160 = 6{,}06 \text{ N/mm}^2$$

$$f_{m,d} = \frac{f_{m,0} \cdot k_{mod}}{\gamma_m} = \frac{20{,}3 \cdot 0{,}9}{1{,}3} = 14{,}1 \text{ N/mm}^2$$

$$\frac{\sigma_{m,d}}{f_{m,d}} = \frac{6{,}06}{14{,}1} = 0{,}43 < 1{,}0$$

3.2 Proof of tension in the centre of gravity in the bottom layer

Range Z_i centre of gravity generally to the centre of gravity in the bottom layer:

$$z_i = z_s - \frac{9 + 9 + 9}{2} = 146{,}5 \text{ mm}$$

NOVATOP ELEMENT
EXAMPLES OF DIMENSIONING

$$\sigma_{t,d} = \frac{M_d}{I_{elf}} \cdot \frac{E_{m,0}}{E_v} \cdot z_i = \frac{16{,}1 \cdot 10^6}{3{,}01 \cdot 10^8} \cdot \frac{7800}{11000} \cdot 146{,}5 = 5{,}56 \text{ N/mm}^2$$

$$f_{t,d} = \frac{f_{t,0} \cdot k_{mod}}{\gamma_m} = \frac{11{,}5 \cdot 0{,}9}{1{,}3} = 7{,}96 \text{ N/mm}^2$$

$$\frac{\sigma_{t,d}}{f_{t,d}} = \frac{5{,}56}{7{,}96} = 0{,}70 < 1{,}0$$

3.3 Proofs of the shear stress

3.3.1 The shear stress in the centre of gravity

$$\tau_{v,d} = \frac{V_d \cdot S_1}{I_{elf} \cdot t} = \frac{9{,}17 \cdot 10^3 \cdot 1{,}07 \cdot 10^6}{3{,}01 \cdot 10^8 \cdot 27} = 1{,}21 \text{ N/mm}^2$$

$$f_{t,d} = \frac{3 \cdot 0{,}9}{1{,}3} = 2{,}08 \text{ N/mm}^2$$

$$\frac{\tau_{v,d}}{f_{v,d}} = \frac{1{,}21}{2{,}08} = 0{,}58 < 1{,}0$$

3.3.2 The shear stress in the panel

Shear failure mode 1 according to ETA.11/0310
In the fold, there is expected shear failure of wood in the width of the lamella on the inner surface layer in the glued part of the lamella.

$$\tau_{v,1,d} = \frac{V_d \cdot S_2}{I_{eff} \cdot t} = \frac{9{,}17 \cdot 10^3 \cdot 9{,}54 \cdot 10^5}{3{,}01 \cdot 10^8 \cdot 27} = 1{,}08 \text{ N/mm}^2$$

$$f_{v,k} = \frac{3 \cdot 0{,}9}{1{,}3} = 2{,}08 \text{ N/mm}^2$$

$$\frac{\tau_{v,1,d}}{f_{v,k}} = \frac{1{,}08}{2{,}08} = 0{,}52 < 1{,}0$$

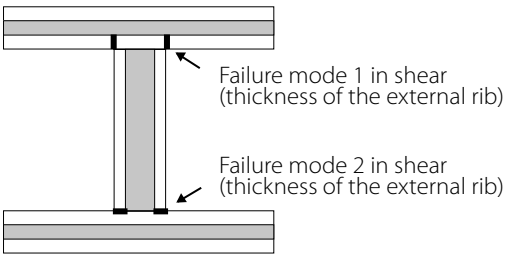
3.3.3 The shear stress in the glued joint

Shear Failure mode 2 according to ETA-11/0310
Only a glued area t_{netto} of fibrous parallel layers is used.

$$\tau_{v,2,d} = \frac{V_d \cdot S_2}{I_{eff} \cdot t_{netto}} = \frac{9{,}17 \cdot 10^3 \cdot 9{,}54 \cdot 10^5}{3{,}01 \cdot 10^8 \cdot (2 \cdot 6)} = 2{,}42 \text{ N/mm}^2$$

$$f_{v,d} = \frac{4 \cdot 0{,}9}{1{,}3} = 2{,}77 \text{ N/mm}^2$$

$$\frac{\tau_{v,2,d}}{f_{v,d}} = \frac{2{,}42}{2{,}77} = 0{,}88 < 1{,}0$$



4 Proof of applicability according to DIN EN 1995-1-1

4.1 The flexible initial bend (characteristic combination)

The proportion of lamella deformation shear:

$$w_{b,g,inst} = \frac{5}{384} \cdot \frac{q_{k,g} \cdot \ell^4}{EI_{eff}} = \frac{5}{384} \cdot \frac{0{,}809 \cdot 7000^4}{3{,}31 \cdot 10^{12}} = 7{,}64 \text{ mm}$$

$$w_{b,q,inst} = \frac{5}{384} \cdot \frac{q_{k,q} \cdot \ell^4}{EI_{eff}} = \frac{5}{384} \cdot \frac{1{,}02 \cdot 7000^4}{3{,}31 \cdot 10^{12}} = 9{,}64 \text{ mm}$$

The initial bend as a result of permanent load:

$$w_{v,g,inst} = \frac{1}{8} \cdot \frac{q_{k,g} \cdot \ell^2}{G.A} = \frac{1}{8} \cdot \frac{0{,}809 \cdot 7000^2}{600. (266.27)} = 1{,}15 \text{ mm}$$

$$w_{v,q,inst} = \frac{1}{8} \cdot \frac{q_{k,q} \cdot \ell^2}{G.A} = \frac{1}{8} \cdot \frac{1{,}02 \cdot 7000^2}{600. (266.27)} = 1{,}45 \text{ mm}$$

The initial bend as a result of permanent load:

$$w_{g,inst} = w_{b,g,inst} + w_{v,g,inst} = 7{,}64 + 1{,}15 = 8{,}79 \text{ mm}$$

The initial bend as a result of variable load:

$$w_{q,inst} = w_{b,q,inst} + w_{v,q,inst} = 9{,}64 + 1{,}45 = 11{,}09 \text{ mm}$$

The flexible initial bend (characteristic combination):

$$w_{inst} = w_{g,inst} + w_{q,inst} = 8{,}79 + 11{,}09 = 19{,}9 \text{ mm}$$

4.2 The final bend

$$w_{fin} = w_{g,inst} \cdot (1 + k_{def}) + w_{q,inst} \cdot (1 + \Psi_2 + k_{def})$$

$$w_{fin} = 8{,}79 \cdot (1 + 0{,}6) + 11{,}09 \cdot (1 + 0{,}6 \times 0{,}6) = 29{,}1 \text{ mm}$$

4.3 Net – the final bend (quasi-stable combination)

$$w_{net,fin} = w_{g,inst} \cdot (1 + k_{def}) + w_{q,inst} \cdot (1 + k_{def}) \cdot \Psi_2$$

$$w_{net,fin} = 8{,}79 \cdot (1 + 0{,}6) + 11{,}09 \cdot (1 + 0{,}6) \cdot 0{,}6 = 24{,}7 \text{ mm}$$

4.4 Check of recommended limit values

4.4.1 The flexible initial bend

$$w_{inst} = 19{,}9 \text{ mm} < \frac{\ell}{300} = \frac{7000}{300} = 23{,}3 \text{ mm} \qquad (\eta_k = 0{,}85)$$

4.4.2 The final bend

$$w_{fin} = 29{,}1 \text{ mm} < \frac{\ell}{150} = \frac{7000}{150} = 46{,}7 \text{ mm} \qquad (\eta = 0{,}62)$$

4.4.3 Net - the final bend

$$w_{net,fin} = 24{,}7 \text{ mm} < \frac{\ell}{250} = \frac{7000}{250} = 28{,}0 \text{ mm} \qquad (\eta = 0{,}88)$$

5 Comparison with the range of 7.50 m

If we choose a range of 7.50 m for the same element with the same load, it results in:
Proportion of the bend:

$$w_{b,g,inst} = \frac{5}{384} \cdot \frac{q_{k,g} \cdot \ell^4}{EI_{eff}} = \frac{5}{384} \cdot \frac{0{,}809 \cdot 7500^4}{3{,}31 \cdot 10^{12}} = 10{,}1 \text{ mm}$$

$$w_{b,q,inst} = \frac{5}{384} \cdot \frac{q_{k,q} \cdot \ell^4}{EI_{eff}} = \frac{5}{384} \cdot \frac{1{,}02 \cdot 7500^4}{3{,}31 \cdot 10^{12}} = 12{,}7 \text{ mm}$$

Proportion of deformation by shear of the lamella:

$$w_{v,g,inst} = \frac{1}{8} \cdot \frac{q_{k,g} \cdot \ell^2}{G \cdot A} = \frac{1}{8} \cdot \frac{0{,}809 \cdot 7500^2}{600 \cdot (266 \cdot 27)} = 1{,}32 \text{ mm}$$

$$w_{v,q,inst} = \frac{1}{8} \cdot \frac{q_{k,g} \cdot \ell^2}{G \cdot A} = \frac{1}{8} \cdot \frac{1{,}02 \cdot 7500^2}{600 \cdot (266 \cdot 27)} = 1{,}66 \text{ mm}$$

$$w_{inst} = 10{,}1 + 12{,}7 + 1{,}32 + 1{,}66 = 25{,}6 \text{ mm}$$

$$w_{inst} = 25{,}6 \text{ mm} > \frac{\ell}{300} = \frac{7500}{300} = 25{,}0 \text{ mm}$$

$$w_{net,fin} = (10{,}1 + 1{,}32) \cdot (1 + 0{,}6) + (12{,}7 + 1{,}66) \cdot (1 + 0{,}6) \cdot 0{,}6 = 32{,}1 \text{ mm}$$

$$w_{net,fin} = 32{,}1 \text{ mm} > \frac{\ell}{250} = \frac{7500}{250} = 30{,}0 \text{ mm}$$

→ The element is not sufficient.
It is no longer listed in the table.

Checking of vibration for NOVATOP ELEMENT according to standard DIN EN 1995-1-1 (Eurocode 5) or, possibly, explanatory notes to standard DIN 1052-2004-08

1 The frequency criterion

According to Eurocode 5, Article 7.3.3Ceilings of residential buildings it is necessary to check whether the natural frequency is f1 ≤ 8 Hz or f1> 8 Hz. Calculation of the natural frequency for ceilings placed on four sides when taking into account the continuous action:

$$f_0 = k_f \cdot \frac{\pi}{2 \cdot \ell^2} \cdot \sqrt{\frac{EI_\ell}{m}}$$

with:
f_0 The natural frequency without taking into account the transverse load distribution
k_f Coefficient for taking into account the continuous action
ℓ Range of the ceiling field in m
EI_ℓ Effective bending stiffness in the direction of the range (per m) in Nm²/m
m The weight of the ceiling in kg/m² under almost permanent action $(g + \psi_2 \cdot p)$

Table 0-1 – Coefficient K_f to take into account the continuous action on a girder of two fields. (Mohr 2001) coefficient K_f for a running girder of two fields.

ℓ_1 / ℓ	1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
k_f	1,00	1,09	1,15	1,20	1,24	1,27	1,30	1,33	1,38	1,42	1,56

Taking into account the transverse load distribution:

$$f_1 = f_0 \cdot \sqrt{\ell + \frac{\ell}{\alpha^4}} \qquad \alpha = \frac{b}{\ell} \cdot \sqrt[4]{\frac{EI_\ell}{EI_b}}$$

with:
f_1 The natural frequency without taking into account the transverse load distribution
α Coefficient to take into account the transverse stiffness
b Width of the ceiling field in m
EI_b Effective bending stiffness in the transverse direction (width) per m in Nm²/m, $EI_\ell > EI_b$

According to Hamm, Richter (2009), the following transverse bending stiffness can be used for wooden ceiling structures:

A wooden structure, nailed or connected with pins (type of connection) $EI_b = 0{,}0005\ EI_\ell$
A wooden structure, glued together $EI_b = 0{,}3\ EI_\ell$

Because in literature, it is hard to find a reference to transverse bending stiffness, which is necessary to be used, on the safe side, we propose using transverse bending stiffness $EI_b = 0{,}0005\ EI_\ell$

If the natural frequency f_1 > 8 Hz, other requirements should be met (further in Sections 2 and 3). Checking of other requirements is described according to Eurocode 5. If the natural frequency $f_1 \leq 8$ Hz, a specific check should be performed (further in Sections 4 and 5). The specific check must be carried out according to the interpretation of standard DIN 1052:2004 because in Eurocode 5, there is not explained any procedure.

2 Deflection by the action of a single load F = 1 kN

$$\frac{w}{f} \leq \alpha \qquad \text{mm/kN}$$

with:
w The largest initial vertical deflection as a result of concentrated static single load F (1kN) which acts on any place and is determined when taking into account load distribution
α the limit value as shown in Figure 1

NOVATOP ELEMENT MECHANICAL PROPERTIES

For a girder of one field, or a panel of one field, under single load, the following formula applies:

$$w = \frac{\ell}{48} \cdot \frac{F \cdot \ell^3}{EI_\ell \cdot b_F} \qquad b_F = \frac{\ell}{1{,}1} \cdot \sqrt[4]{\frac{EI_\ell}{EI_b}} = \frac{b}{1{,}1 \cdot \alpha}$$

where:

b_F Effective width of the panel for single load

The recommended range of limit values, limit a and b, as well as their context, is shown in Figure 1. Lower values for a (direction „1“) mean better response of the ceiling, higher values for a (direction „2“) mean worse response of the ceiling. For higher requirements, it is necessary to observe the limit values in the range of 1 (α ≤ 1).

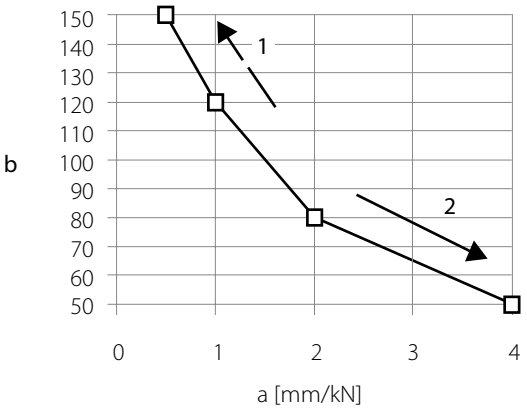


Fig. 1: Limit values according to Eurocode 5

3 Speed as a result of impulse I = 1Ns (do 40 Hz)

$$v \leq b^{(f1.\zeta-1)}$$

where:

v speed of a unit impulse response in m/s
b limit value according to Fig. 1 (from a≤1 results b ≥120)
ζ modal damping factor (Table 0-2)

Table 0-2 – attenuation values (according to the explanation for standard DIN 1052:2004, or SIA 265)

Construction of the ceiling	ζ
Ceilings without floating base layers	0,01
Ceilings of glued lumber piles with floating base layers	0,02
Wooden beamed ceilings and mechanically connected ceilings of lumber piles with floating base layers	0,03

For NOVATOP ELEMENT, there are no values available based on the experience regarding damping values. On the safe side, you can expect ζ = 0,01.

It is:

$$v = \frac{4 \,.\, (0{,}4 + 0{,}6 \,.\, n_{40})}{m \,.\, b \,.\, \ell + 200} \qquad a \qquad n_{40} = \left\{ \left(\left(\frac{40}{f_1} \right)^2 - 1 \right) \cdot \left(\frac{b}{\ell} \right)^4 \frac{EI_\ell}{EI_b} \right\}^{0{,}25}$$

where:

m The weight of the ceiling in kg/m² under almost permanent action $(g + \psi_2 \,.\, p)$
b Width of the ceiling field in m
ℓ Length of the ceiling field in m
n_{40} Number of vibrations up to 40 Hz

4 A special speed test due to the occurrence of „heeldrop" I = 55 Ns, t = 0,05 s

$$v \leq 6.b^{(f1.\zeta-1)}$$

The occurrence of „heeldrop" is described by impulse s I = 55 Ns lasting about 0.05 s. A relation for the initial velocity v can be derived from the assessment of the measurement.

$$v \cong \frac{950 \,.\, \alpha}{f_0 \,.\, m \,.\, b \,.\, \ell \,.\, \gamma}$$

The formulas correspond to the ones that were previously used.

5 For special checks of acceleration, checks of vibration resonance, the following limit values apply according to the explanation for standard DIN 1052:2004

$$a = \frac{56}{m \,.\, b \,.\, \ell \,.\, \zeta \,.\, \gamma}$$

For special checks of vibration acceleration, the following limit values apply according to the explanation for standard DIN 1052:2004.

$a < 0{,}1 m/s^2$	Well-being
$a < 0{,}35$ bis $0{,}7 m/s^2$	noticeable, but not disturbing
$a > 0{,}7 m/s^2$	disturbing

Literature:

Mohr, B (2001): Schwingungen von Wohnungsdecken aus Holz, Stahl und Beton; Vorschläge für eine zutreffende Bewertung. In: Tagungsband „Ingenieurholzbau, Karlsruher Tage 2001". Herausgeber: Bruderverlag Albert Bruder GmbH, Karlsruhe.

Blaß, H.J.; Ehlbeck, J.; Kreuzinger, H.; Steck, G. (2004). Erläuterungen zu DIN 1052:2004-08. DGfH Innovations- und Service GmbH, München. Bruderverlag, Karlsruhe.

Hamm, P.; Richter, A. (2009): Bemessungs- und Konstruktionsregeln zum Schwingungsnachweis von Holzdecken. In: Fachtagungen Holzbau 2009. Leinfelden-Echterdingen, 26. November 2009. Herausgeber: Landesbeirat Holz Baden-

Württemberg e.V., Stuttgart. S. 15-29.

NOVATOP ELEMENT
HEAT INSULATION / FIRE RESISTANCE

HEAT INSULATION:

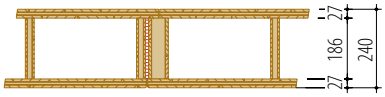
U – Heat transfer coefficient when using mineral and wood-fibre insulation

Height h (mm)	Mineral insulation λ = 0,035 W/mK	Fibreboard λ = 0,038 W/mK
	U – value W/m²K	U – value W/m²K
160	0,33	0,35
200	0,26	0,27
240	0,21	0,22
280	0,18	0,19
320	0,15	0,16

FIRE RESISTANCE

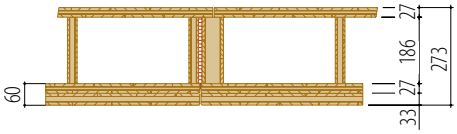
Standard execution with a 27 mm bottom board (type A2)
Report number: PR-18-0325 (FIRES, SK)

REI 45 ✓



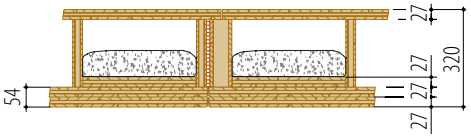
Execution with a reinforced 60 mm bottom board (type C2)
Report number: PR-18-0325 (FIRES, SK)

REI 60 ✓



Execution with a reinforced bottom board (2 x 27 mm) + limestone 40 kg/m² placed on SWP 27 mm filling
Report number: PK2-03-22-005-C-0, (PAVUS a.s., CZ)

REI 60 ✓

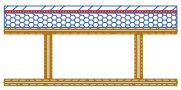
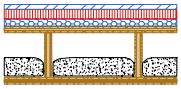
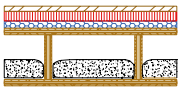
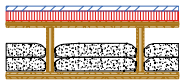
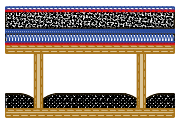
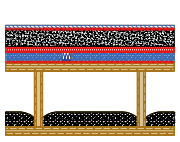


The current reports on fire resistance classification can be found in the downloads section at:
https://novatop-system.com/downloads/certificates/

NOVATOP ELEMENT ACOUSTICS

Composition of the roof	Airborne sound insulation (dB)	Impact sound reduction (dB)
Glued parquets 10 mm		
Concrete screed 80 mm		
Mineral fibres – impact sound insulation 20 mm		
Extra polystyrene 30 mm		
NOVATOP ELEMENT 350 mm	$D_{l,tot}$ = 58 **	L'_{tot} = 49 **
3-ply panel 27 mm	Evaluation acc. to the standard	
Cavity with crushed lime stone, ca. 40 kg/m²	ISO 717-1/SIA 181/2006	ISO 717-2/SIA 181/2006
3-ply panel 27 + 33 mm (REI 60)		
Based on building measurement (2007); BFH Architektur, Holz und Bau, CH Biel		
Glued parquets 10 mm		
Concrete screed 80 mm		
Mineral fibres – impact sound insulation 20 mm		
Extra polystyrene 30 mm		
NOVATOP ELEMENT 350 mm	$D_{l,tot}$ = 47 **	L'_{tot} = 59 **
3-ply panel 27 mm	Evaluation acc. to the standard	
Cavity empty 263 mm	ISO 717-1/SIA 181/2006	ISO 717-2/SIA 181/2006
3-ply panel 27 + 33 mm (REI 60)		
Based on building measurement (2007); BFH Architektur, Holz und Bau, CH Biel		
Panels OSB 2 x 15 mm		
Mineral fibres – impact sound insulation 30 mm		
NOVATOP ELEMENT 240 mm	R_w = 55	$L_{n,w}$ = 58
3-ply panel, 27 mm	Evaluation acc. to the standard	
Cavity 186 mm + crushed lime stone circa 40 kg/m²	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
3-ply panel 27 mm		
Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
Flooring – carpet 10 mm		$L_{n,w}$ = 62
Flooring – PVC 3.5 mm		$L_{n,w}$ = 75
NOVATOP ELEMENT 240 mm		
3-ply panel, 27 mm	Evaluation acc. to the standard	
Cavity 186 mm + crushed lime stone circa 40 kg/m²		ISO 717-2/ISO 140-6
3-ply panel 27 mm		
Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
NOVATOP ELEMENT 240 mm	R_w = 27	$L_{n,w}$ = 93
3-ply panel 27 mm	Evaluation acc. to the standard	
Cavity empty 186 mm	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
3-ply panel 27 mm		
Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
NOVATOP ELEMENT 240 mm	R_w = 36	$L_{n,w}$ = 88
3-ply panel 27 mm	Evaluation acc. to the standard	
Cavity 186 mm + crushed lime stone circa 40 kg/m²	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
3-ply panel 27 mm		
Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
NOVATOP ELEMENT 240 mm	R_w = 37	$L_{n,w}$ = 86
3-ply spruce. Panel, thickness of 27 mm	Evaluation acc. to the standard	
Wooden grill 180 mm, limestone grit filling 80 kg/m²	ISO 717-1/ISO 10140-2	ISO 717-2/ISO 10140-3
3-ply spruce. Panel, thickness of 33 mm		
Based on laboratory measurements (2007); Centrum stavebního inženýrství, a.s. (Centre for Civil Engineering, a.s.) Prague, CZ, department in Zlín (Certificate no. 134/15)		
Fermacell plate thickness 20 mm		
Steico standard plate thickness 8 mm		
Concrete plate thickness 38 mm, 90 kg/m²		
Steico Therm plate thickness 20 mm		
NOVATOP ELEMENT 240 mm	R_w = 52	$L_{n,w}$ = 66
3-ply panel 27 mm	Evaluation acc. to the standard	
Cavity empty 186 mm	ISO 717-1/SIA 181/2006	ISO 717-2/SIA 181/2006
3-ply panel 27 mm		
Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
OSB board thickness. 22 mm		
Steico standard plate thickness. 8 mm		
Concrete tile thickness 38 mm, 90 kg/m²		
Steico Therm plate thickness 20 mm		
NOVATOP ELEMENT 240 mm	R_w = 50	$L_{n,w}$ = 65
3-ply panel 27 mm	Evaluation acc. to the standard	
Cavity empty 186 mm	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
3-ply panel 27 mm		
Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		

NOVATOP ELEMENT ACOUSTICS

	Composition of the roof	Airborne sound insulation (dB)	Impact sound reduction (dB)
	Fermacell plate thickness 20 mm		
	Steico standard plate thickness 8 mm		
	Fermacell sub-base with honeycomb, th. 60 mm, 90 kg/m²		
	NOVATOP ELEMENT 240 mm	$R_w = 59$	$L_{n,w} = 60$
	3-ply panel 27 mm	Evaluation acc. to the standard	
	Cavity empty 186 mm	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
	3-ply panel 27 mm		
	Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
	Fermacell plate thickness 20 mm		
	Steico Therm plate thickness 40 mm		
	Fermacell sub-base with honeycomb, th. 30 mm, 45 kg/m²		
	NOVATOP ELEMENT 240 mm	$R_w = 62$	$L_{n,w} = 54$
	3-ply panel 27 mm	Evaluation acc. to the standard	
	Cavity 186 mm + crushed lime stone circa 40 kg/m²	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
	3-ply panel 27 mm		
	Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
	OSB board thickness 22 mm		
	Steico Therm plate thickness 40 mm		
	Fermacell sub-base with honeycomb, th. 30 mm, 45 kg/m²		
	NOVATOP ELEMENT 240 mm	$R_w = 62$	$L_{n,w} = 56$
	3-ply panel 27 mm	Evaluation acc. to the standard	
	Cavity 186 mm + crushed lime stone circa 40 kg/m²	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
	3-ply panel 27 mm		
	Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
	Concrete plate thickness 50 mm, 115 kg/m²		
	Plate ORSIL N 40 mm		
	NOVATOP ELEMENT 240 mm	$R_w = 58$	$L_{n,w} = 67$
	3-ply panel 27 mm	Evaluation acc. to the standard	
	Cavity 186 mm + crushed lime stone circa 40 kg/m²	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
	3-ply panel 27 mm		
	Based on laboratory measurements (2007); Accredited Testing Laboratory Zlín		
	Plate Fermacell thickness 20 mm		
	Plate Steico Therm. thickness 40 mm		
	NOVATOP ELEMENT 240 mm	$R_w = 60$	$L_{n,w} = 62$
	3-ply panel 27 mm	Evaluation acc. to the standard	
	Cavity 186 mm + crushed lime stone circa 75 kg/m²	ISO 717-1/ISO 140-3	ISO 717-2/ISO 140-6
	3-ply panel 27 mm		
	Based on laboratory measurement (2007); Centre of Building construction; Engineering; CZ – Zlín		
	Oak parquet floor, thickness of 12 mm		
	Steico Underfloor, thicknes of 5 mm		
	Concrete screed, thickness of 50 mm		
	Isover TDPT, thickness of 20 mm		
	Isover TDPT, thickness of 30 mm		
	Starlon, thickness of 6 mm		
	NOVATOP ELEMENT 240 mm	$R_w = 63$	$L_{n,w} = 44$
	3-ply spruce. Panel, thickness of 27 mm	Evaluation acc. to the standard	
	Wooden grill 180 mm, limestone grit filling 80 kg/m²	ISO 717-1/ISO 10140-2	ISO 717-2/ISO 10140-3
	3-ply spruce. Panel, thickness of 33 mm		
	Based on laboratory measurements (2007); Centrum stavebního inženýrství, a.s. (Centre for Civil Engineering, a.s.) Prague, CZ, department in Zlín (Certificate no. 135/15)		
	Oak parquet floor, thickness of 12 mm		
	Steico Underfloor, thicknes of 5 mm		
	Concrete screed, thickness of 50 mm		
	Isover TDPT, thickness of 20 mm		
	Limestone grit filling, thickness of 30 mm		
	Starlon, thickness of 6 mm		
	NOVATOP ELEMENT 240 mm	$R_w = 63$	$L_{n,w} = 45$
	3-ply spruce. Panel, thickness of 27 mm	Evaluation acc. to the standard	
	Wooden grill 180 mm, limestone grit filling 80 kg/m²	ISO 717-1/ISO 10140-2	ISO 717-2/ISO 10140-3
	3-ply spruce. Panel, thickness of 33 mm		
	Based on laboratory measurements (2007); Centrum stavebního inženýrství, a.s. (Centre for Civil Engineering, a.s.) Prague, CZ, department in Zlín (Certificate no. 136/15)		

Footnote to the building measurement: ** values are measured by means of building – customary possible extensions. Absolute performance of the selected super-structure cannot be attained by inserting primary supporting structure and inserted cable culverts in concrete screed.

Legend of the table:

$D_{l,tot} = D_{nT,w}(C;C_v)$ = building measurement; standard difference of noise level, evaluated subject to reverberation time;
$L'_{tot} = L'_{nT,w}(C_I;C_v)$ = measurement; standard difference of impact sound noise level, evaluated subject to reverberation time;
R_w = laboratory measurement, without extensions, for evaluated degree of sound insulation;
$L_{n,w}$ = laboratory measurement, without extensions, for evaluated degree of sound insulation, acc. to the standard;
C_v = volume correction;
C_I = spectrum value of accommodation, for evaluation of preferential shares of impact sound noise of low frequency.

NOVATOP ELEMENT
PROCESSING, LABELLING AND PACKING

PROCESSING

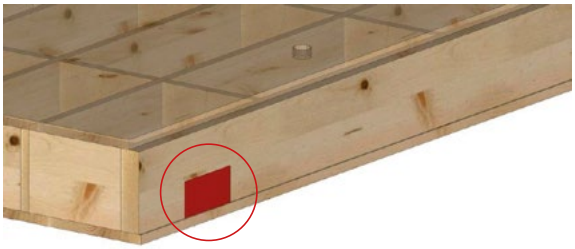
NOVATOP ELEMENT panels are processed from multi-layer boards glued from massive solid wood (SWP); the moisture content at dispatch is 10% ± 3%. The structure of the element consists of a bearing bottom panel, a ribbed structure that is subsequently assembled on it, and a cover panel that is levelled by means of positional pins and glue. The ribs and panels are joined solely by gluing and cold pressing. According to the requirements of the project, the cavities between the ribs can be fitted with thermal and sound insulation, or there can be prepared routes for the distribution of installations in them.
All the processing is performed on the basis of the agreed production documentation on CNC machines that operate according to CAD data. The elements are most often supplied as fully processed with no further need of processing on the construction site.

Warning: Wood properties of this product are maintained, so it responds to changes in temperature and humidity by shrinking or, possibly, by swelling. Improper storage and use in extreme conditions (extreme temperatures and humidity) can cause cracking and deformations.

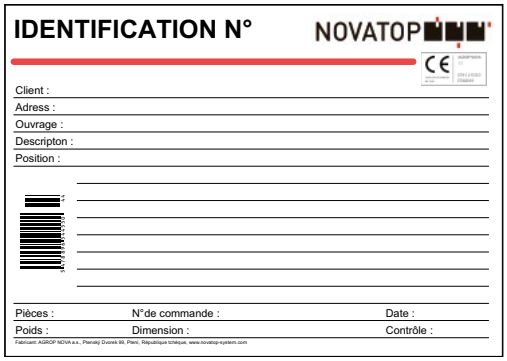
LABELLING AND PACKING

Each panel is fitted with an identification label. Following the final quality inspection, the panels are packed, wrapped in PE foil (protection against changes in humidity, contamination and partially against mechanical damage) and tightened on all sides with a tape. Each package is fitted with an identification label with a description.

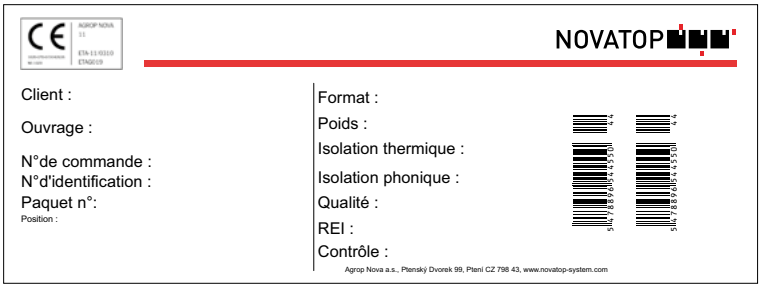
Placement of a label on the panel



Label on the package



Label on the panel



NOVATOP ELEMENT STORAGE, TRANSPORT

STORAGE

The panels must be stored in an enclosed, dry space and positioned horizontally. After the removal of the protective casing, they must be carefully covered, preferably with a different sheet material.
The panels must be protected from adverse weather conditions, even on the construction site, and stored there for only the necessary time. It is essential to avoid exposing of the panels to rain and flowing water. For the protection against water, dirt and excessive solar radiation, we recommend using tarps.

Warning: Improper storage may result in damage, for which the producer assumes no liability.

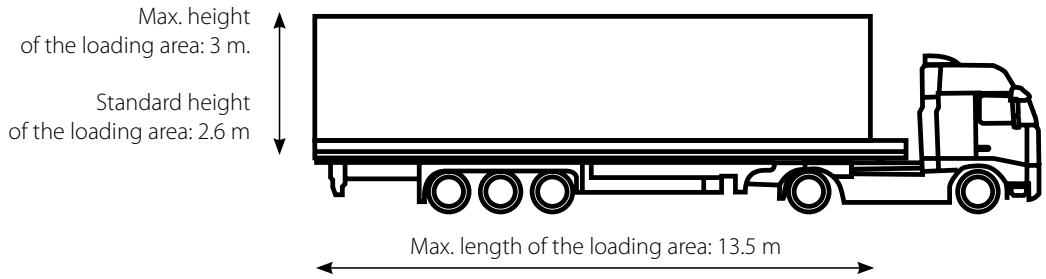
TRANSPORT

As a standard, the panels are transported in lorries (covered semi-trailers), possibly in containers. For the lorries, it is necessary to ensure entry in and exit from the construction site.

Warning: The panels must be at all times protected against adverse weather conditions. During longer transport under adverse climatic conditions, a change in the moisture of the panels may occur; that is why we recommend acclimatisation before processing it (gradual drying, gradual changes of temperature).

Maximum parameter of the load: 50 m³/24 t
At present, only horizontal loading of packages is possible. The transport of NOVATOP components is possible with different types of trucks and depends on the dimensions of the packages, ways of unloading and transport accessibility to the building site. It is necessary to ensure entry and exit of these vehicles onto the site. According to the particular conditions, when the cargo is smaller, a surcharge will be imposed due to inefficient utilization of the transport capacity.

package width	length packet	way of landing	transportation facilities	supplementary charge
≤ 2,1 m	max. 6 m	electric crane	trailer with a standard-size sheet	
		lift truck	trailer with a standard-size sheet	
max. 2,4 m	max. 12 m	electric crane	trailer with a sheet with a possibility of removing the support in the upper part	
		lift truck	trailer with a sheet with the possibility of displacement of the central pillars	
max. 2,5 m	max. 6,5 m	electric crane	uncovered trailer	✓
		lift truck	trailer with a sheet with the possibility of displacement of the central pillars	
max. 2,48 m	max. 12 m	electric crane	uncovered trailer	✓
		lift truck	trailer with a sheet with the possibility of displacement of the central pillars	
2,5–3 m	max. 12 m	electric crane	uncovered trailer	✓
		lift truck	uncovered trailer	✓



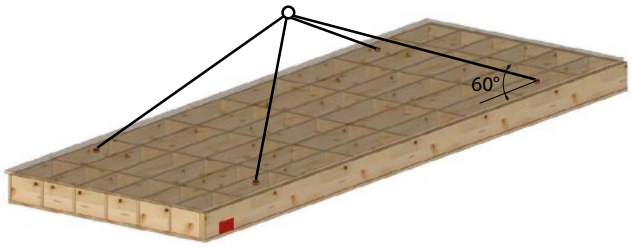
NOVATOP ELEMENT MANIPULATION, ASSEMBLY

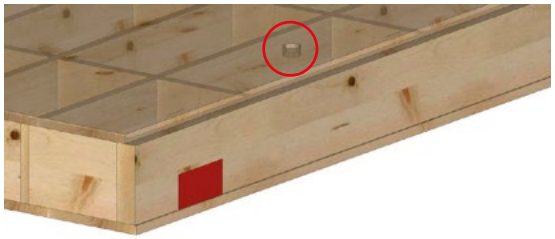
MANIPULATION

Due to the high weights of the panels, cranes and special vehicles (forklift trucks) are suitable for manipulation; it is always necessary to define the maximum lifting load and range. During manipulation, it is necessary to ensure protection of the packaging material, surfaces and edges of the panels to avoid damage.
NOVATOP ELEMENT panels are ready for manipulation during the production. In the top board of the element, there are openings, into which special suspension straps are placed. The elements must be placed in the required assembly position using 4 suspension straps. It is important to ensure that there was an angle of approx. 60° between the element and the strap system. The maximum load is given by the load capacity of the suspension straps and the load capacity of the top board. Usually with straps with a load capacity of 500 kg. The number of suspension straps per panel is determined by the load capacity of individual straps, usually there are 4 pieces.
Suspension straps can be ordered with the producer (price list item 011.003). Crane straps, chains and thimbles must be provided by the customer.

Warning: The panels must be at all times protected against adverse weather conditions.

Recommended manipulation





ASSEMBLY

The custom-made panels are forwarded directly to the assembly point. The assembly plan, which precisely defines the course of the assembly, is an inseparable part of the production process. Each element is fitted with an identification label stating the position number in the assembly plan.
Individual panels are fitted by means of a crane and then anchored to the bottom structure with various kinds of ironmongery. We recommend determining the exact position with the help of tightening ratchets. When hammering the components together, it is necessary to take into account the position of the ribs; when hammered together unprofessionally, the element may get damaged. For more information, see "Instructions for assembly".

Warning: The panels must be at all times protected against adverse weather conditions.

The recommended relative humidity of the environment in which NOVATOP panels are installed is 55% at 20°C. Wood cracks may occur due to low air humidity.

Warning: Wood properties of this product are maintained, so they respond to changes in temperature and humidity by shrinking or, possibly, by swelling. Improper storage and use in extreme conditions (extreme temperatures and humidity) can cause cracking and distortions.

The producer assumes no liability for the damage of the product due to improper storage, processing, unsuitable use or nonobservance of work procedures during the assembly.

NOTES

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Manufacturer certificates:

The technical documentation and the certificates can be downloaded at www.novatop-system.com