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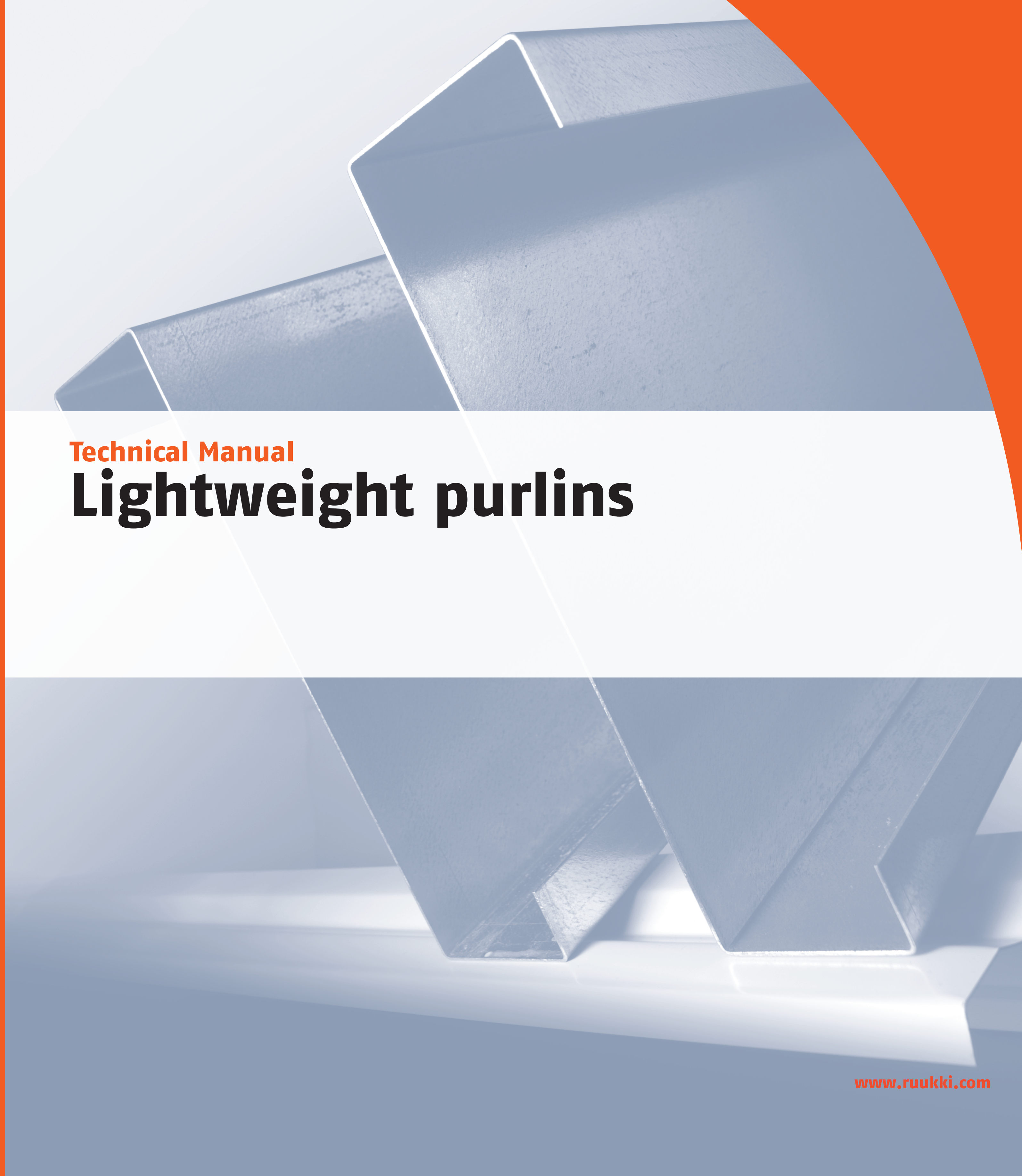
Technical Manual
Lightweight purlins



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Rautaruukki Corporation PL 138 (Suolakivenkatu 1), FI-00811 Helsinki, Finland
+358 (0)20 59 11 +358 (0)20 592 9088 www.ruukki.com

Table of contents

1 Ruukki lightweight purlins

1.1 Advantages of lightweight purlins

Ruukki offers wide range of lightweight purlins with high quality, durability and versatility of shapes and applications. Production technology and top quality raw materials assure of high load bearing capacity and stiffness leading to increase of span lengths. Purlins are widely applied as secondary roof and wall structures for almost all kind of buildings. Ruukki lightweight purlins offer several considerable advantages over alternative structures:

- The purlins are lightweight in proportion to their load bearing capacity. Thus, roof structures built using lightweight purlins are very light.
- The use of material is very efficient. Owing to the high strength of the base material, the required load bearing capacity is achieved with a smaller cross-sectional thickness, which translates into savings in materials and costs.
- Lightweight purlins produce savings in transport costs. The purlins require little space in transport, purlins for quite a large roof can be transported as a single delivery.
- Local increase of the load bearing capacity of lightweight purlins is easy, by e.g. lapping purlins inside each other without having to make changes in the structural system of the whole roof or wall.
- Longer spans are possible with lightweight purlins than with alternative applicable solutions.
- Lightweight purlins are made of zinc-coated material with good corrosion resistance. This makes lightweight purlins applicable also in difficult conditions.
- Lightweight purlins are fully recyclable material. Waste steel can be reused in the roof as weather protection, and the reuse of the whole roof at the end of its service life requires only little energy.

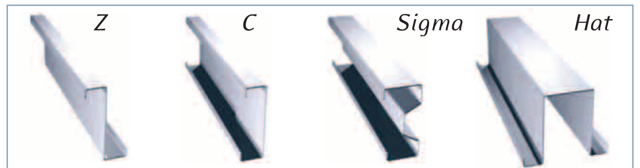
1.2 Material of lightweight purlins

Lightweight purlins are made of cold rolled thin gauge steel sheet, which is delivered in coils. The material of the hot dip galvanised (20µm) thin gauge steel sheet is grade S350GD+Z275, in compliance with EN 10346. The yield strength of the steel sheet is minimum 350N/mm².

1.3 Manufacture of Ruukki lightweight purlins

Lightweight purlins can be roll formed or press braked from cold rolled thin gauge steel sheet. The purlins can also be pre-punched at factory.

1.4 Cross-sections of Ruukki lightweight purlins



Section dimensions shown at chapter 1.6.

1.5 Sections

- Material thickness of sections 1.0-3.0mm
- Section heights 100-400mm
- Maximum length 18m (roll-formed)
- Tolerance standards applied to cross-sections:
  - Press braked: EN 1090-2
  - Roll formed: EN 10162

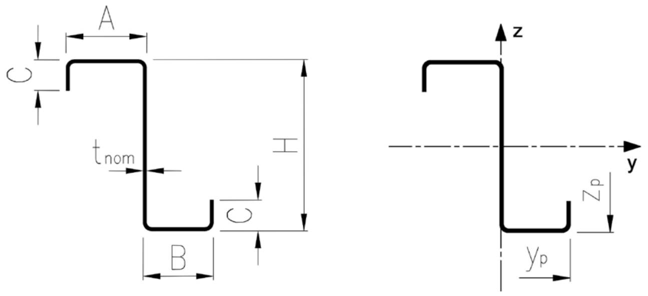
The Z section is excellently suited as a roof purlin. The major principal inertia axis is in pitched roofs with normal inclination in an approximately vertical position and thereby provides optimum load bearing capacity against the weight of structures and snow. The second moment of area about the minor axis, on the other hand, is so low that it is usually advisable to tie the sheet section on the slope of the roof to the opposite slope by a ridge moulding. The Z section is installed on the roof with the upper flange pointing toward the ridge. Z sections are applicable also as wall purlins, installed with the outer flange facing down.

C sections can be used as wall purlins or wall posts. The C section differs from the Z section by its centre of torsion, which in the C section is on the back side. Due to torsion, a vertical load acting on the section causes a transverse force component on the flange of the section, acting from the web up toward the upper flange. If C sections are used as roof purlins, they need to be installed with the upper flange pointing toward the ridge. As wall purlins, on the other hand, they are installed with the flange facing up, whereby wind pressure loads partly counteract the self-weight of the wall structure. With wind suction loads, the transverse force components strengthen one another, and tie rods may be required to counteract their influence.

A sigma section exhibits several plane areas separated by folds. This makes the manufacture of sigma sections more complex than the manufacture of Z and C sections, but this is compensated by the higher durability values owing to the better efficiency of the dimensionally smaller plane areas. Thanks to this improved efficiency, the height of sigma profiles can be increased more than the height of Z and C sections. Sigma sections can be used on longer spans, or e.g. in sigma frameworks which are used in large span buildings to achieve moderate spans. A sigma framework is built joining two sigma sections back-to-back with 8-12mm distance pieces, with similar gauge sheet used as gusset pieces.

The top hat section is wider than the sections referred to above. This gives it considerably higher lateral stiffness, which makes it suited to applications where the purlin is subjected to transverse loads, as well. Top hat purlins are attached directly from the flanges. They are used as roof purlins, wall purlins or, for example, as truss chords.

1.6 Geometries and characteristics of cross-sections



Lightweight purlin Z

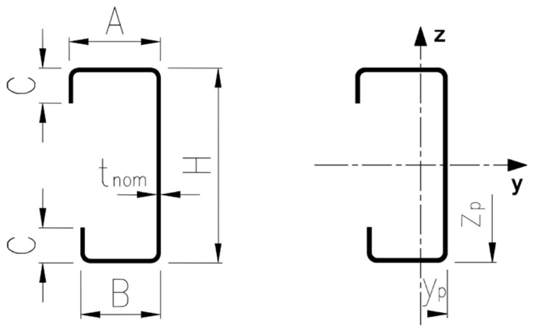
Steel grade:	S350GD+Z
Yield strength:	fy = 350 MPa
Tensile strength:	fu = 420 MPa

Purlin Z – Cross-section geometries

No.	Type of purlin	Thickness	Height	Width of wide flange	Width of narrow flange	Fold	Weight	Cross-section area, gross	Cross-section area, effective	Centre of gravity	Centre of gravity
		t_{nom}	H	A	B	C	g	A_{gross}	A_{eff}	Y_p	Z_p
		mm	mm	mm	mm	mm	kg/m	cm²	cm²	mm	mm
1.	Z100	1,00	100	45,00	39,00	18,00	1,63	2,03	1,22	40,60	50,40
2.		1,20		45,40	39,40	18,00	1,96	2,45	1,72	40,60	50,40
3.		1,50		46,00	40,00	18,00	2,45	3,08	2,42	40,60	50,40
4.		2,00		47,00	41,00	18,00	3,27	4,13	3,64	40,60	50,40
5.	Z120	1,00	120	45,00	39,00	18,00	1,81	2,22	1,22	40,50	60,50
6.		1,20		45,40	39,40	18,00	2,17	2,68	1,71	40,50	60,50
7.		1,50		46,00	40,00	18,00	2,71	3,37	2,43	40,50	60,50
8.		2,00		47,00	41,00	18,00	3,61	4,52	3,69	40,50	60,50
9.	Z150	1,00	150	45,00	39,00	18,00	2,04	2,51	1,21	40,30	75,70
10.		1,20		45,40	39,40	18,00	2,45	3,03	1,70	40,30	75,70
11.		1,50		46,00	40,00	18,00	3,06	3,81	2,42	40,30	75,70
12.		2,00		47,00	41,00	18,00	4,08	5,11	3,72	40,30	75,70
13.	Z200	1,50	200	70,00	62,00	26,00	4,36	5,50	2,77	64,90	101,10
14.		2,00		71,00	63,00	26,00	5,81	7,38	4,67	64,90	101,10
15.		2,50		72,00	64,00	26,00	7,26	9,25	6,56	64,90	101,10
16.		3,00		73,00	65,00	26,00	8,71	11,13	8,56	64,90	101,10
17.	Z250	1,50	250	70,00	62,00	26,00	4,92	6,23	2,75	64,70	126,30
18.		2,00		71,00	63,00	26,00	6,56	8,36	4,63	64,70	126,30
19.		2,50		72,00	64,00	26,00	8,20	10,48	6,55	64,70	126,30
20.		3,00		73,00	65,00	26,00	9,84	12,61	8,59	64,70	126,30
21.	Z300	1,50	300	89,00	81,00	26,00	5,95	7,52	2,63	83,70	151,30
22.		2,00		90,00	82,00	26,00	7,93	10,09	4,57	83,70	151,30
23.		2,50		91,00	83,00	26,00	9,91	12,65	6,85	83,70	151,30
24.		3,00		92,00	84,00	26,00	11,89	15,21	9,19	83,70	151,30
25.	Z350	2,00	350	90,00	82,00	30,00	8,87	11,20	4,75	83,60	176,20
26.		2,50		91,00	83,00	30,00	11,09	14,05	7,09	83,60	176,20
27.		3,00		92,00	84,00	30,00	13,31	16,90	9,51	83,60	176,20

Purlin Z – Cross-section characteristics

No.	Type of purlin	Thickness	Moment of inertia, gross	Section modulus, gross	Moment of inertia, effective/ Top flange compressed	Section modulus, effective/ Top flange compressed	Moment of inertia, effective/ Bottom flange compressed	Section modulus, effective/ Bottom flange compressed	Radius of gyration	Max. bending moment, in span/ Top flange compressed	Max. bending moment, in span/ Bottom flange compressed
		t_{nom}	I_y	W_y	I_{yeff}	W_{yeff}	I_{yeff}	W_{yeff}	i_y	$M_{b,Rd}$	$M_{b,Rd}$
		mm	cm⁴	cm³	cm⁴	cm³	cm⁴	cm³	cm	kNm	kNm
1.	Z100	1,00	31,155	6,124	28,509	5,583	29,269	5,517	3,918	1,954	1,931
2.		1,20	37,607	7,378	36,787	7,319	37,566	7,365	3,918	2,562	2,578
3.		1,50	47,262	9,244	47,262	9,244	47,262	9,244	3,917	3,236	3,236
4.		2,00	63,289	12,319	63,289	12,319	63,289	12,319	3,915	4,312	4,312
5.	Z120	1,00	47,935	7,857	42,517	6,736	43,610	6,681	4,647	2,357	2,338
6.		1,20	57,866	9,469	56,178	9,364	57,166	9,267	4,647	3,277	3,243
7.		1,50	72,727	11,871	72,727	11,871	72,727	11,871	4,646	4,155	4,155
8.		2,00	97,403	15,834	97,403	15,834	97,403	15,834	4,642	5,542	5,542
9.	Z150	1,00	81,548	10,705	69,252	8,465	70,950	8,430	5,700	2,963	2,950
10.		1,20	98,450	12,906	91,721	11,910	93,081	11,653	5,700	4,169	4,079
11.		1,50	123,746	16,190	123,285	16,167	123,153	16,039	5,699	5,659	5,614
12.		2,00	165,761	21,616	165,761	21,616	165,761	21,616	5,695	7,566	7,566
13.	Z200	1,50	333,533	32,753	283,572	25,933	290,230	25,885	7,787	9,077	9,060
14.		2,00	447,103	43,798	434,899	43,351	439,243	42,482	7,784	15,173	14,869
15.		2,50	560,349	54,756	560,349	54,756	560,349	54,756	7,783	19,165	19,165
16.		3,00	673,275	65,630	673,275	65,630	673,275	65,630	7,778	22,970	22,970
17.	Z250	1,50	565,589	44,516	459,302	32,522	469,740	32,569	9,528	11,383	11,399
18.		2,00	758,256	59,562	706,889	54,572	712,819	53,299	9,524	19,100	18,655
19.		2,50	950,410	74,508	941,654	74,238	940,734	73,187	9,523	25,983	25,615
20.		3,00	1142,055	89,356	1142,055	89,356	1142,055	89,356	9,517	31,275	31,275
21.	Z300	1,50	998,750	65,688	703,886	38,532	717,448	38,677	11,524	13,486	13,537
22.		2,00	1339,303	87,940	1104,498	65,606	1125,651	65,707	11,521	22,962	22,998
23.		2,50	1679,111	110,071	1531,571	96,944	1548,546	95,735	11,521	33,931	33,507
24.		3,00	2018,181	132,080	1954,500	129,298	1953,385	125,158	11,519	45,254	43,805
25.	Z350	2,00	1956,978	110,463	1585,278	79,693	1611,874	79,741	13,219	27,893	27,909
26.		2,50	2453,684	138,303	2198,183	117,355	2218,175	115,895	13,215	41,074	40,563
27.		3,00	2949,382	166,008	2803,871	156,077	2798,258	151,283	13,211	54,627	52,949



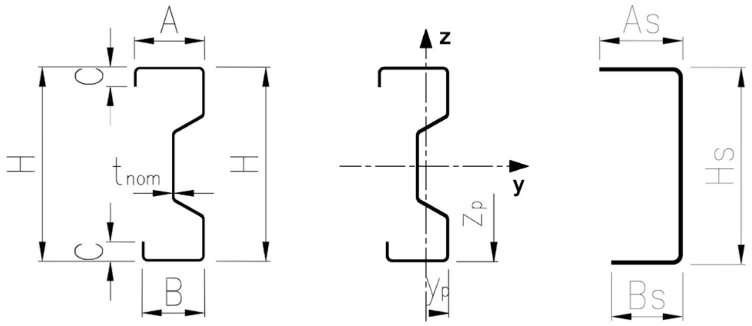
Lightweight purlin C
Steel grade: S350GD+Z
Yield strength: f_y = 350 MPa
Tensile strength: f_u = 420 MPa

Purlin C – Cross-section geometries

No.	Type of purlin	Thickness	Height	Width of wide flange	Width of narrow flange	Fold	Weight	Cross-section area, gross	Cross-section area, effective	Centre of gravity	Centre of gravity
		t_{nom}	H	A	B	C	g	A_{gross}	A_{eff}	Y_p	Z_p
		mm	mm	mm	mm	mm	kg/m	cm²	cm²	mm	mm
1.	C100	1,00	100	45,00	39,00	18,00	1,63	2,03	1,22	14,70	50,40
2.		1,20		45,40	39,40	18,00	1,96	2,45	1,72	14,70	50,40
3.		1,50		46,00	40,00	18,00	2,45	3,08	2,42	14,70	50,40
4.		2,00		47,00	41,00	18,00	3,27	4,13	3,64	14,70	50,40
5.	C120	1,00	120	45,00	39,00	18,00	1,81	2,22	1,22	13,40	60,50
6.		1,20		45,40	39,40	18,00	2,17	2,68	1,71	13,40	60,50
7.		1,50		46,00	40,00	18,00	2,71	3,37	2,43	13,40	60,50
8.		2,00		47,00	41,00	18,00	3,61	4,52	3,67	13,40	60,50
9.	C150	1,00	150	45,00	39,00	18,00	2,04	2,52	1,22	12,00	75,50
10.		1,20		45,40	39,40	18,00	2,45	3,04	1,72	12,00	75,50
11.		1,50		46,00	40,00	18,00	3,06	3,82	2,44	12,00	75,50
12.		2,00		47,00	41,00	18,00	4,08	5,13	3,74	11,90	75,50
13.	C200	1,50	200	70,00	62,00	26,00	4,36	5,50	2,77	20,40	101,10
14.		2,00		71,00	63,00	26,00	5,81	7,38	4,67	20,40	101,10
15.		2,50		72,00	64,00	26,00	7,26	9,25	6,56	20,40	101,10
16.		3,00		73,00	65,00	26,00	8,71	11,13	8,56	20,40	101,10
17.	C250	1,50	250	70,00	62,00	26,00	4,92	6,23	2,75	18,00	126,30
18.		2,00		71,00	63,00	26,00	6,56	8,36	4,63	18,00	126,30
19.		2,50		72,00	64,00	26,00	8,20	10,48	6,55	18,00	126,30
20.		3,00		73,00	65,00	26,00	9,84	12,61	8,59	18,00	126,30
21.	C300	1,50	300	89,00	81,00	26,00	5,95	7,52	2,63	22,30	151,30
22.		2,00		90,00	82,00	26,00	7,93	10,08	4,57	22,30	151,30
23.		2,50		91,00	83,00	26,00	9,91	12,65	6,85	22,30	151,30
24.		3,00		92,00	84,00	26,00	11,89	15,21	9,19	22,30	151,30
25.	C350	2,00	350	90,00	82,00	30,00	8,87	11,20	4,75	21,20	176,20
26.		2,50		91,00	83,00	30,00	11,09	14,05	7,09	21,20	176,20
27.		3,00		92,00	84,00	30,00	13,31	16,90	9,51	21,20	176,20

Purlin C – Cross-section characteristics

No.	Type of purlin	Thick-ness	Moment of inertia, gross	Section modulus, gross	Moment of inertia, effective/ Top flange compressed	Section modulus, effective/ Top flange compressed	Moment of inertia, effective/ Bottom flange compressed	Section modulus, effective/ Bottom flange compressed	Radius of gyration	Max. bending moment, in span/ Top flange compressed	Max. bending moment, in span/ Bottom flange compressed
		t_{nom}	I_y	W_y	I_{yeff}	W_{yeff}	I_{yeff}	W_{yeff}	i_y	$M_{b,Rd}$	$M_{b,Rd}$
		mm	cm⁴	cm³	cm⁴	cm³	cm⁴	cm³	cm	kNm	kNm
1.	C100	1,00	31,155	6,124	28,624	5,620	29,432	5,567	3,918	1,967	1,948
2.		1,20	37,607	7,378	36,812	7,321	37,566	7,365	3,918	2,562	2,578
3.		1,50	47,262	9,244	47,262	9,244	47,262	9,244	3,917	3,236	3,236
4.		2,00	63,289	12,319	63,289	12,319	63,289	12,319	3,915	4,312	4,312
5.	C120	1,00	47,935	7,857	42,646	6,768	43,793	6,725	4,647	2,369	2,354
6.		1,20	57,866	9,469	56,346	9,374	57,392	9,327	4,647	3,281	3,264
7.		1,50	72,727	11,871	72,727	11,871	72,727	11,871	4,646	4,155	4,155
8.		2,00	97,403	15,834	97,403	15,834	97,403	15,834	4,642	5,542	5,542
9.	C150	1,00	81,872	10,779	69,498	8,471	71,579	8,546	5,700	2,965	2,991
10.		1,20	98,841	12,995	92,084	11,923	94,238	11,891	5,702	4,173	4,162
11.		1,50	124,239	16,302	123,851	16,283	123,716	16,168	5,703	5,699	5,659
12.		2,00	166,423	21,765	166,423	21,765	166,423	21,765	5,696	7,618	7,618
13.	C200	1,50	333,533	32,753	284,286	26,036	291,220	26,021	7,787	9,112	9,107
14.		2,00	447,103	43,798	435,933	43,388	440,601	42,697	7,784	15,186	14,944
15.		2,50	560,349	54,756	560,349	54,756	560,349	54,756	7,783	19,165	19,165
16.		3,00	673,275	65,630	673,275	65,630	673,275	65,630	7,778	22,970	22,970
17.	C250	1,50	565,589	44,516	460,126	32,610	470,892	32,688	9,528	11,413	11,441
18.		2,00	758,256	59,562	708,138	54,727	714,300	53,474	9,524	19,155	18,716
19.		2,50	950,410	74,508	943,088	74,282	942,613	73,423	9,523	25,999	25,698
20.		3,00	1142,055	89,356	1142,055	89,356	1142,055	89,356	9,517	31,275	31,275
21.	C300	1,50	998,750	65,688	704,848	38,607	718,788	38,779	11,524	13,513	13,573
22.		2,00	1339,303	87,940	1105,971	65,738	1127,403	65,861	11,527	23,008	23,051
23.		2,50	1679,111	110,071	1533,544	97,143	1550,836	95,957	11,521	34,000	33,585
24.		3,00	2018,181	132,080	1956,934	129,561	1956,195	125,446	11,519	45,346	43,906
25.	C350	2,00	1956,978	110,463	1587,383	79,851	1614,608	79,941	13,219	27,948	27,980
26.		2,50	2453,684	138,303	2200,985	117,588	2221,387	116,154	13,215	41,156	40,654
27.		3,00	2949,382	166,008	2807,307	156,384	2802,178	151,617	13,211	54,734	53,066

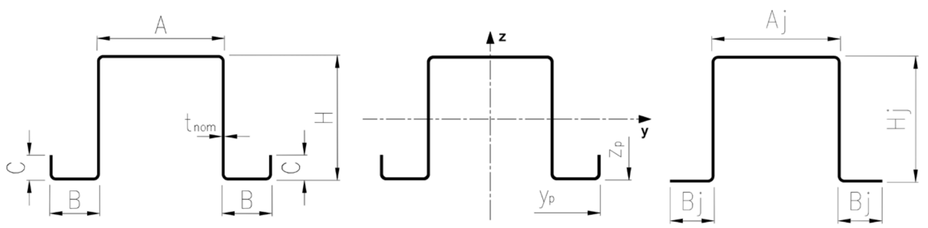


Lightweight purlin Sigma

Steel grade: S350GD+Z
Yield strength: f_y = 350 MPa
Tensile strength: f_u = 420 MPa

Purlin Sigma – Cross-section geometries												Sleeve connection piece		
No.	Type of purlin	Thick-ness	Height	Width of wide flange	Width of narrow flange	Fold	Weight	Cross-section area, gross	Cross-section area, effective	Centre of gravity	Centre of gravity	Height	Width of wide flange	Width of narrow flange
		t_{nom}	H	A	B	C	g	A_{gross}	A_{eff}	Y_p	Z_p	H_s	A_s	B_s
		mm	mm	mm	mm	mm	kg/m	cm²	cm²	mm	mm	mm	mm	mm
1.	S150	1,50	150	72,00	64,00	20,00	4,12	5,07	4,00	26,20	75,60	156,00	77,00	69,00
2.		2,00		72,00	64,00	20,00	5,50	6,80	6,07	26,20	75,60	157,00	78,00	70,00
3.		2,50		72,00	64,00	20,00	6,87	8,52	8,01	26,20	75,60	158,00	79,00	71,00
4.		3,00		72,00	64,00	20,00	8,24	10,24	9,81	26,20	75,60	159,00	80,00	72,00
5.	S175	1,50	175	72,00	64,00	20,00	4,59	5,44	4,11	24,50	88,20	182,00	77,00	69,00
6.		2,00		72,00	64,00	20,00	6,12	7,29	6,26	24,40	88,20	183,00	78,00	70,00
7.		2,50		72,00	64,00	20,00	7,65	9,14	8,36	24,40	88,20	184,00	79,00	71,00
8.		3,00		72,00	64,00	20,00	9,18	10,98	10,41	24,40	88,20	185,00	80,00	72,00
9.	S200	1,50	200	72,00	64,00	20,00	4,95	5,80	4,22	24,90	100,90	207,00	77,00	69,00
10.		2,00		72,00	64,00	20,00	6,59	7,78	6,46	24,90	100,90	208,00	78,00	70,00
11.		2,50		72,00	64,00	20,00	8,24	9,75	8,68	24,90	100,90	209,00	79,00	71,00
12.		3,00		72,00	64,00	20,00	9,89	11,72	10,90	24,90	100,90	210,00	80,00	72,00
13.	S250	1,50	250	80,00	70,00	25,00	5,71	6,92	4,44	27,10	126,50	258,00	85,00	75,00
14.		2,00		80,00	70,00	25,00	7,61	9,28	7,19	27,10	126,50	259,00	86,00	76,00
15.		2,50		80,00	70,00	25,00	9,52	11,63	9,96	27,10	126,50	260,00	87,00	77,00
16.		3,00		80,00	70,00	25,00	11,42	13,99	12,62	27,10	126,50	261,00	88,00	78,00
17.	S300	1,50	300	80,00	70,00	25,00	5,95	7,65	4,37	27,70	151,70	309,00	85,00	75,00
18.		2,00		80,00	70,00	25,00	7,93	10,26	7,14	27,70	151,70	310,00	86,00	76,00
19.		2,50		80,00	70,00	25,00	9,91	12,86	9,94	27,70	151,70	311,00	87,00	77,00
20.		3,00		80,00	70,00	25,00	11,89	15,47	12,82	27,70	151,70	312,00	88,00	78,00
21.	S350	1,50	350	80,00	70,00	25,00	6,89	8,38	4,28	28,10	176,90	360,00	85,00	75,00
22.		2,00		80,00	70,00	25,00	9,18	11,24	7,04	28,10	176,90	361,00	86,00	76,00
23.		2,50		80,00	70,00	25,00	11,48	14,09	10,10	28,10	176,90	362,00	87,00	77,00
24.		3,00		80,00	70,00	25,00	13,78	16,95	13,02	28,10	176,90	363,00	88,00	78,00
25.	S400	2,00	400	80,00	70,00	25,00	9,81	12,22	7,17	28,50	202,10	412,00	86,00	76,00
26.		2,50		80,00	70,00	25,00	12,27	15,32	9,94	28,50	202,10	413,00	87,00	77,00
27.		3,00		80,00	70,00	25,00	14,72	18,43	12,87	28,50	202,10	414,00	88,00	78,00

Purlin Sigma – Cross-section characteristics										
No.	Type of purlin	Thickness	Moment of inertia, gross	Section modulus, gross	Moment of inertia, effective/Top flange compressed	Section modulus, effective/ Top flange compressed	Moment of inertia, effective/ Bottom flange compressed	Section modulus, effective/ Bottom flange compressed	Radius of gyration	Max. bending moment, in span/ Top flange compressed	Max. bending moment, in span/ Bottom flange compressed
		t_{nom}	I_y	W_y	I_{yeff}	W_{yeff}	I_{yeff}	W_{yeff}	i_y	$M_{b,Rd}$	$M_{b,Rd}$
		mm	cm⁴	cm³	cm⁴	cm³	cm⁴	cm³	cm	kNm	kNm
1.	S150	1,50	168,598	22,087	150,008	19,155	155,180	19,414	5,767	6,704	6,795
2.		2,00	225,959	29,503	216,968	28,829	220,847	28,450	5,764	10,090	9,957
3.		2,50	283,134	36,847	280,046	36,695	281,477	36,504	5,765	12,843	12,776
4.		3,00	340,127	44,120	340,127	44,120	340,127	44,120	5,763	15,442	15,442
5.	S175	1,50	239,094	26,880	211,881	23,144	219,280	23,530	6,630	8,100	8,236
6.		2,00	320,463	35,926	305,706	34,653	311,428	34,350	6,630	12,128	12,023
7.		2,50	401,578	44,892	394,539	44,575	396,924	44,076	6,628	15,601	15,427
8.		3,00	482,444	53,780	480,667	53,701	482,444	53,780	6,629	18,795	18,823
9.	S200	1,50	329,549	32,438	291,824	27,871	301,866	28,360	7,538	9,755	9,926
10.		2,00	441,726	43,372	419,579	41,490	427,556	41,225	7,535	14,522	14,429
11.		2,50	553,563	54,219	541,174	53,716	544,796	52,883	7,535	18,801	18,509
12.		3,00	665,065	64,979	659,216	64,744	662,366	64,567	7,533	22,660	22,598
13.	S250	1,50	605,424	47,585	513,699	38,474	534,527	39,420	9,354	13,466	13,797
14.		2,00	811,686	63,670	749,632	58,501	768,115	58,490	9,352	20,475	20,471
15.		2,50	1017,409	79,650	981,559	78,304	987,291	76,028	9,353	27,406	26,610
16.		3,00	1222,601	95,525	1197,862	94,708	1202,504	93,097	9,348	33,148	32,584
17.	S300	1,50	943,581	61,887	794,212	49,268	821,825	50,168	11,106	17,244	17,559
18.		2,00	1265,137	82,840	1155,969	74,724	1185,418	75,028	11,104	26,153	26,260
19.		2,50	1585,896	103,671	1513,136	99,896	1523,491	97,489	11,105	34,964	34,121
20.		3,00	1905,863	124,382	1847,630	122,706	1856,851	119,503	11,099	42,947	41,826
21.	S350	1,50	1377,324	77,523	1152,197	60,702	1182,615	61,081	12,820	21,246	21,378
22.		2,00	1846,805	103,801	1671,735	92,100	1710,631	92,171	12,818	32,235	32,260
23.		2,50	2315,175	129,941	2188,893	123,204	2315,175	129,941	12,818	43,121	45,479
24.		3,00	2782,443	155,946	2673,973	151,606	2782,443	155,946	12,812	53,062	54,581
25.	S400	2,00	2568,941	126,497	2296,135	109,316	2523,951	122,036	14,499	38,260	42,713
26.		2,50	3220,625	158,389	3022,919	148,283	3217,718	158,047	14,499	51,899	55,317
27.		3,00	3870,842	190,131	3693,448	182,483	3870,842	190,131	14,492	63,869	66,546



Lightweight purlin Hat
Steel grade: S350GD+Z
Yield strength: f_y = 350 MPa
Tensile strength: f_u = 420 MPa

Purlin Hat – Cross-section geometries												Hat stengthening		
No.	Type of purlin	Thick-ness	Height	Width of wide flange	Width of narrow flange	Fold	Weight	Cross-section area, gross	Cross-section area, effective	Centre of gravity	Centre of gravity	Height	Width of wide flange	Width of narrow flange
		t_{nom}	H	A	B	C	g	A_{gross}	A_{eff}	Y_p	Z_p	H_j	A_j	B_j
		mm	mm	mm	mm	mm	kg/m	cm²	cm²	mm	mm	mm	mm	mm
1.	H100	1,00	100	100,00	40,00	20,00	3,30	3,88	2,07	87,80	48,40	98,00	95,00	44,00
2.		1,20		100,00	40,00	20,00	3,96	4,68	2,92	87,80	48,40	98,00	94,60	44,40
3.		1,50		100,00	40,00	20,00	4,95	5,89	4,19	87,70	48,40	98,00	94,00	45,00
4.		2,00		100,00	40,00	20,00	6,59	7,90	6,49	87,80	48,40	98,00	93,00	46,00
5.	H125	1,00	125	100,00	40,00	20,00	3,53	4,36	2,08	87,70	60,60	122,50	95,00	44,00
6.		1,20		100,00	40,00	20,00	4,24	5,26	2,94	87,70	60,60	122,50	94,60	44,40
7.		1,50		100,00	40,00	20,00	5,30	6,62	4,25	87,80	60,60	122,50	94,00	45,00
8.		2,00		100,00	40,00	20,00	7,07	8,88	6,64	87,80	60,60	122,50	93,00	46,00
9.	H150	1,00	150	100,00	40,00	20,00	3,96	4,84	2,08	87,80	72,80	147,00	95,00	44,00
10.		1,20		100,00	40,00	20,00	4,76	5,84	2,95	87,70	72,80	147,00	94,60	44,40
11.		1,50		100,00	40,00	20,00	5,95	7,35	4,27	87,70	72,90	147,00	94,00	45,00
12.		2,00		100,00	40,00	20,00	7,93	9,86	6,74	87,70	72,90	147,00	93,00	46,00
13.	H200	1,00	200	120,00	50,00	20,00	4,91	6,18	2,06	107,70	97,60	196,00	115,00	54,00
14.		1,20		120,00	50,00	20,00	5,89	7,47	2,97	107,70	97,60	196,00	114,60	54,40
15.		1,50		120,00	50,00	20,00	7,36	9,39	4,49	107,80	97,60	196,00	114,00	55,00
16.		2,00		120,00	50,00	20,00	9,81	12,60	7,24	107,70	97,60	196,00	113,00	56,00
17.	H250	1,50	250	120,00	50,00	20,00	8,71	10,84	4,49	107,70	122,10	245,00	114,00	55,00
18.		2,00		120,00	50,00	20,00	11,62	14,54	7,27	107,80	122,10	245,00	113,00	56,00
19.		2,50		120,00	50,00	20,00	14,52	18,24	10,53	107,80	122,10	245,00	112,00	57,00

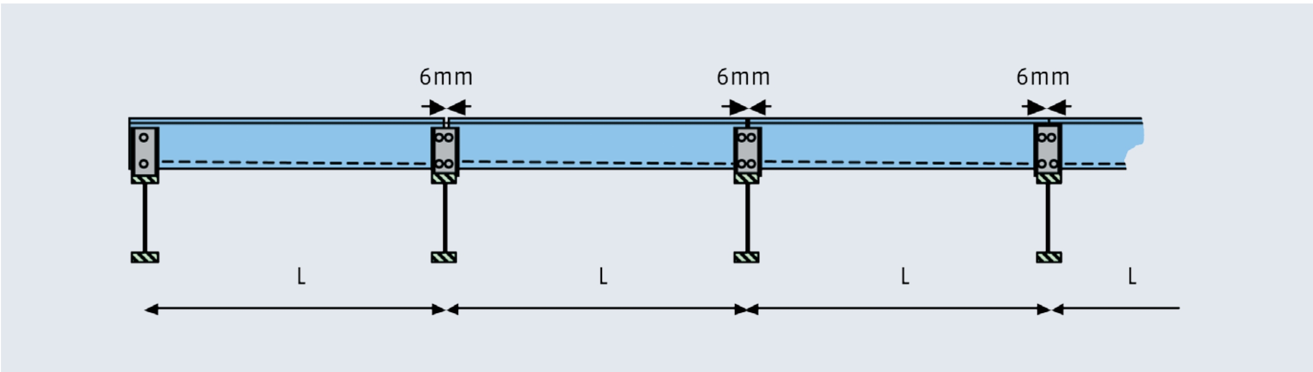
Purlin Hat – Cross-section characteristics											
No.	Type of purlin	Thickness	Moment of inertia, gross	Section modulus, gross	Moment of inertia, effective/Top flange compressed	Section modulus, effective/Top flange compressed	Moment of inertia, effective/ Bottom flange compressed	Section modulus, effective/ Bottom flange compressed	Radius of gyration	Max. bending moment, in span/Top flange compressed	Max. bending moment, in span/ Bottom flange compressed
		t_{nom}	I_y	W_y	I_{yeff}	W_{yeff}	I_{yeff}	W_{yeff}	i_y	$M_{b,Rd}$	$M_{b,Rd}$
		mm	cm⁴	cm³	cm⁴	cm³	cm⁴	cm³	cm	kNm	kNm
1.	H100	1,00	60,335	11,926	42,427	7,000	58,246	11,607	3,943	2,450	4,063
2.		1,20	72,847	14,373	56,592	9,823	72,689	14,374	3,945	3,438	5,031
3.		1,50	91,580	18,020	75,817	13,499	91,580	18,020	3,943	4,725	6,307
4.		2,00	122,708	24,036	110,196	20,325	122,708	24,036	3,941	7,114	8,413
5.	H125	1,00	101,802	16,057	69,610	9,011	94,749	14,629	4,832	3,154	5,120
6.		1,20	122,920	19,361	93,007	12,645	122,203	19,358	4,834	4,426	6,775
7.		1,50	154,541	24,289	129,979	18,695	154,541	24,289	4,832	6,543	8,501
8.		2,00	207,093	32,432	187,502	27,834	207,093	32,432	4,829	9,742	11,351
9.	H150	1,00	156,877	20,602	104,222	11,069	140,991	17,640	5,693	3,874	6,174
10.		1,20	189,429	24,848	139,504	15,527	183,702	24,261	5,695	5,434	8,491
11.		1,50	238,175	31,187	197,198	23,341	238,175	31,187	5,693	8,169	10,915
12.		2,00	319,200	41,673	291,019	36,206	319,200	41,673	5,690	12,672	14,585
13.	H200	1,00	351,697	34,683	205,782	15,573	273,435	23,518	7,544	5,450	8,231
14.		1,20	424,734	41,848	277,455	21,898	365,979	33,336	7,540	7,664	11,668
15.		1,50	534,141	52,558	395,640	33,031	504,780	48,855	7,542	11,561	17,099
16.		2,00	716,093	70,306	614,696	55,550	716,093	70,306	7,539	19,443	24,607
17.	H250	1,50	910,835	71,923	645,489	42,272	817,855	61,016	9,167	14,795	21,356
18.		2,00	1221,240	96,264	1006,922	71,017	1175,993	92,312	9,165	24,856	32,309
19.		2,50	1530,882	120,460	1403,338	105,289	1530,882	120,460	9,161	36,851	42,161

2 Structural systems

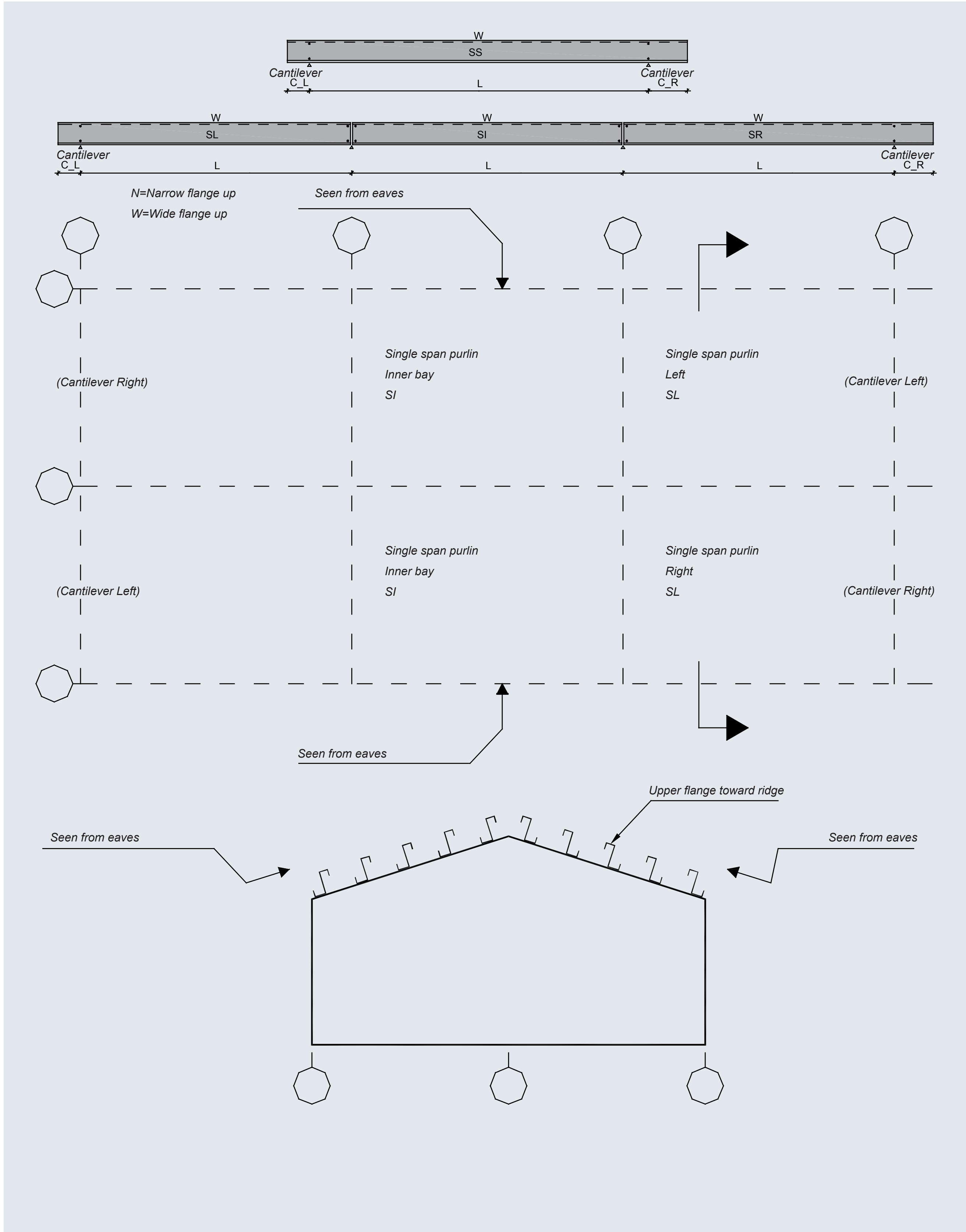
There are four alternative roof purlin systems for different applications, as well as various combinations of these systems. The properties of the systems and the selection criteria are discussed below.

2.1 Single span system

Used in walls and roofs, in moderate spans
- A simple system
- Same support reactions of primary rafters in centre bays
- Small number of joint components
- Whole roof consists of similar purlins
- Higher consumption of steel
- Higher deflections
- Can be implemented with Z, C, hat and sigma purlins.



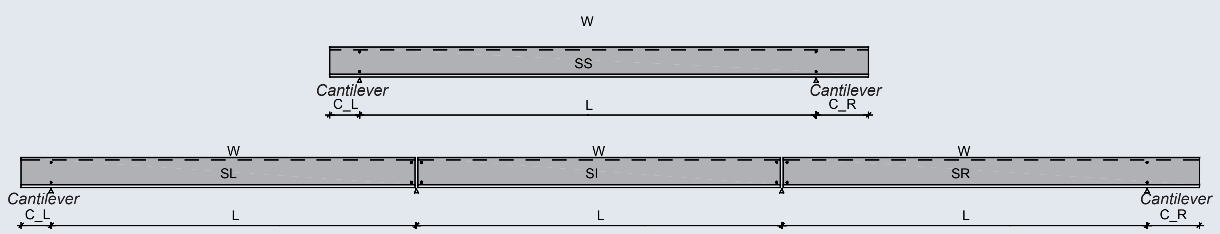
2.1.1 Single span system, purlin designation diagram



ruukki more with metals

2.1.2 Single span system, purlins

Note! On site the purlin is seen from the eaves



N=Narrow flange up

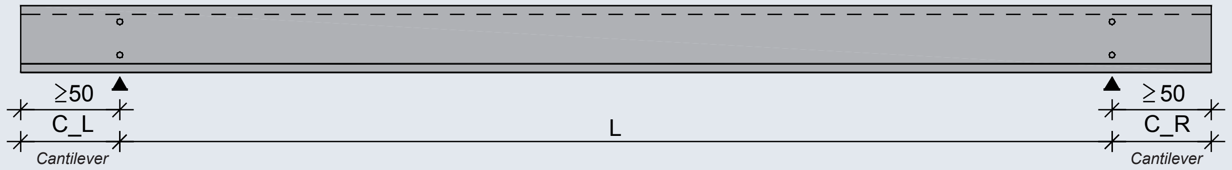
W=Wide flange up

Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

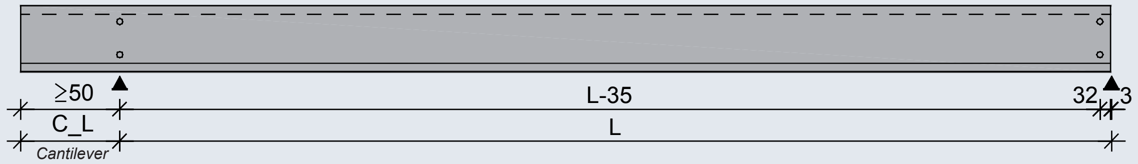
Note! In manufacturing drawings the purlin is seen with the wide flange down and toward the reader

L=span

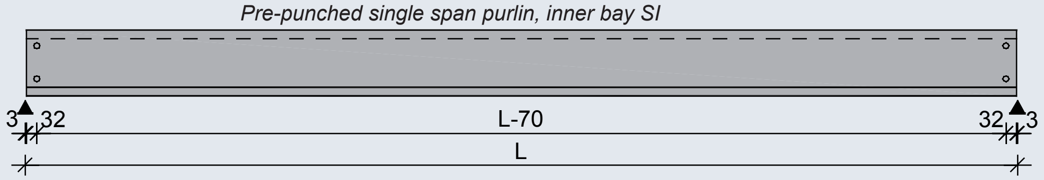
Pre-punched single span single purlin SS



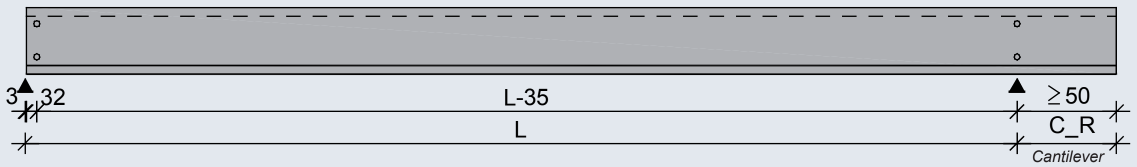
Pre-punched single span purlin, left end bay SL



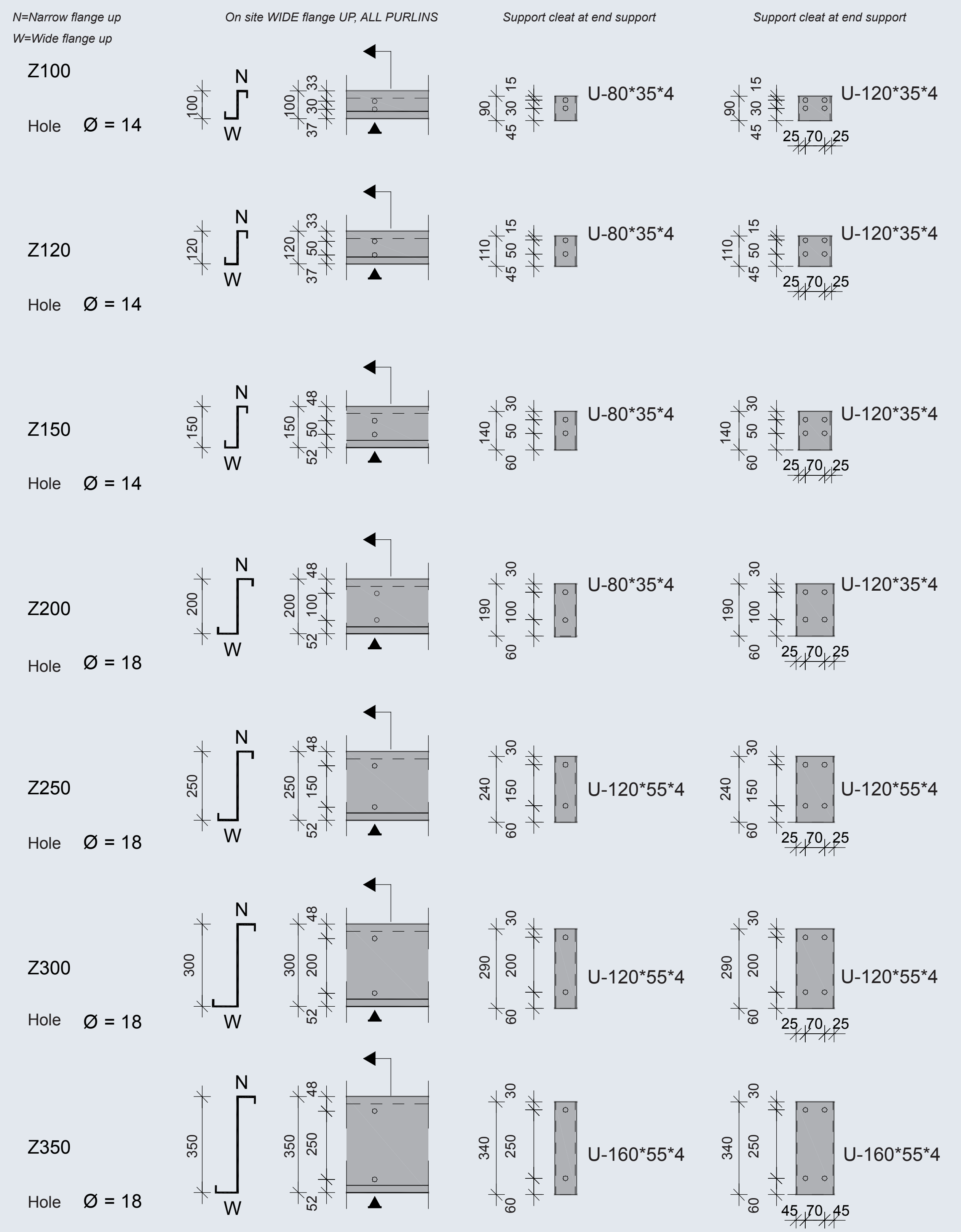
Pre-punched single span purlin, inner bay SI



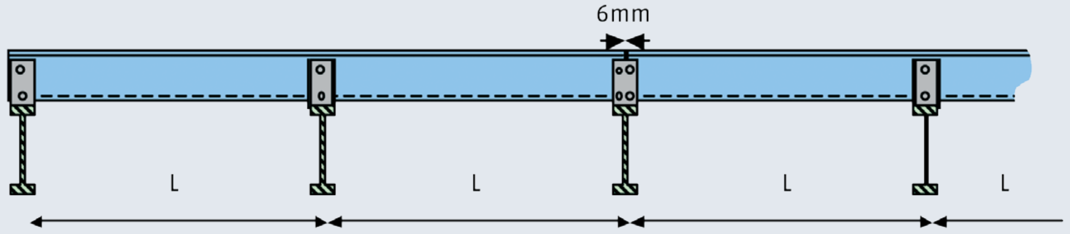
Pre-punched single span purlin, right end bay



2.1.3 Single span system, support cleats



2.2 Double span system



Used in walls in 4-6m spans, and in roofs in moderate spans

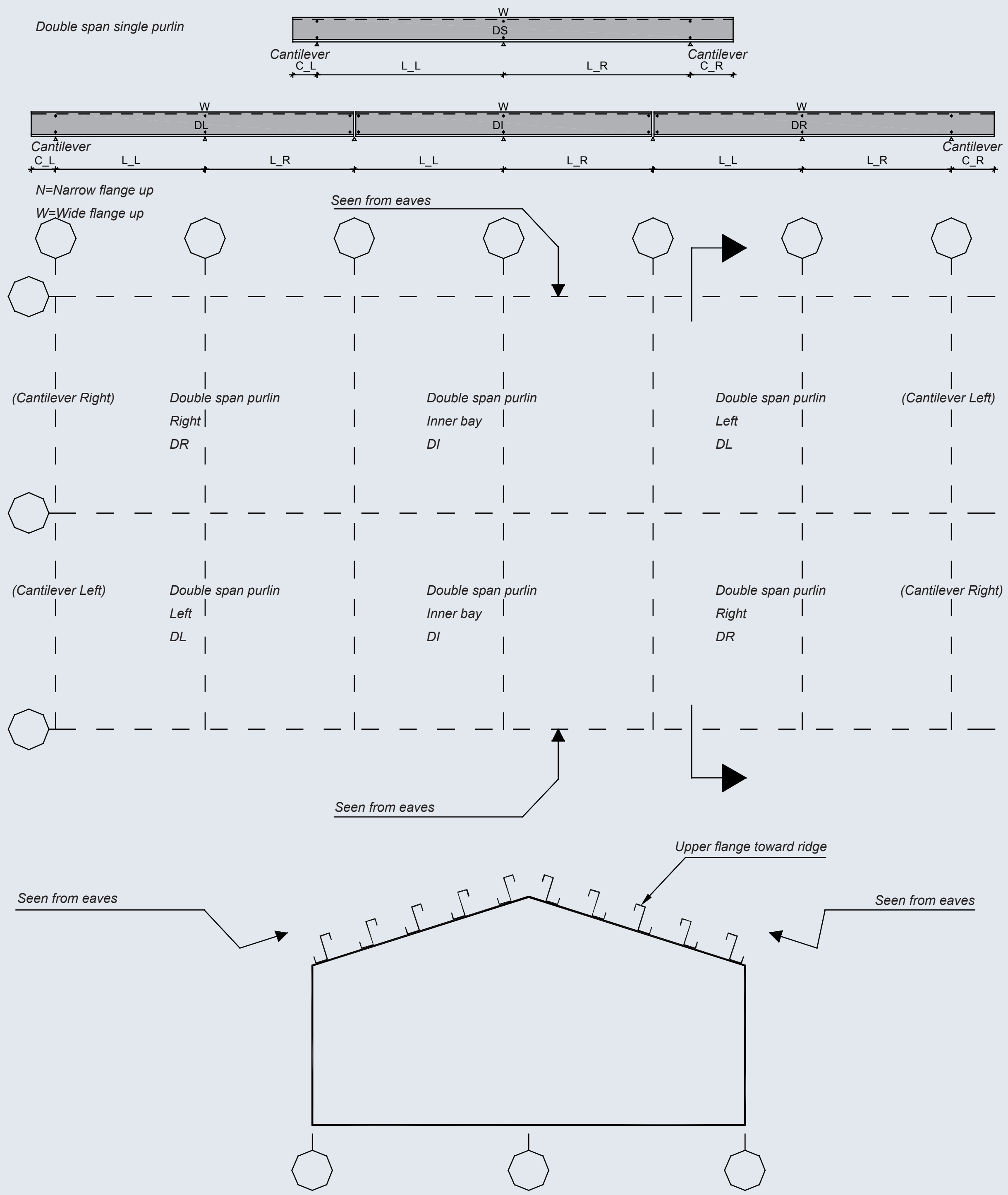
- Small deflections
- Small number of parts requiring installation
- Amount of installation work limited
- Different support reactions of principal rafters
- Long sections, more difficult to handle
- Can be implemented with Z, C, hat and sigma purlins

It is possible to use the same support cleat at intermediate support of each 2-span purlin as at purlin joint.

A top hat purlin always has to be equipped with a brace section. The material thickness of this brace section is recommended to be the same as the material thickness of the purlin itself. The dimensions of the brace section are shown together with the cross-sectional dimensions of the top hat purlin, see section 1.6.

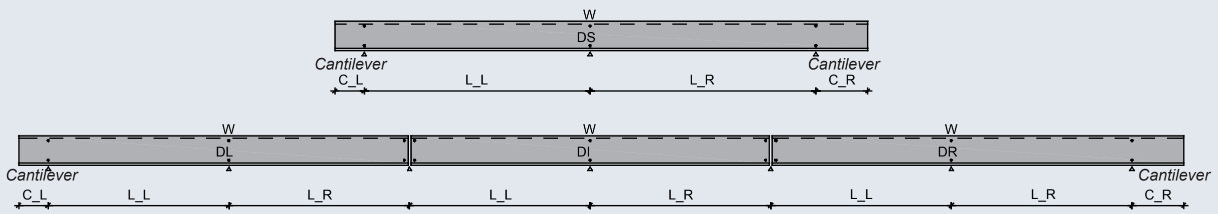
Length of brace section L>Max(3*s, 2*H), where s is the support width and H is the height of the section.

2.2.1 Double span system, purlin designation diagram



2.2.2 Double span system, purlins

Note! On site, the purlin is seen from the eaves



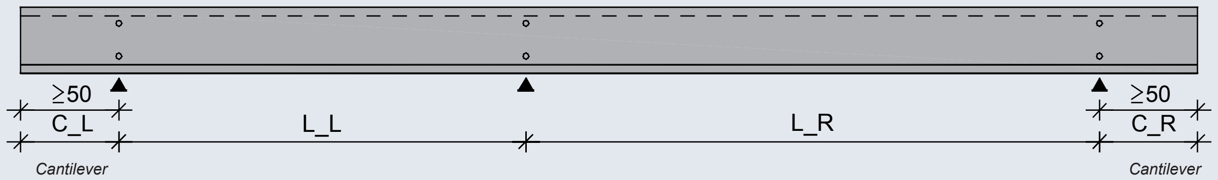
N=Narrow flange up
W=Wide flange up

Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

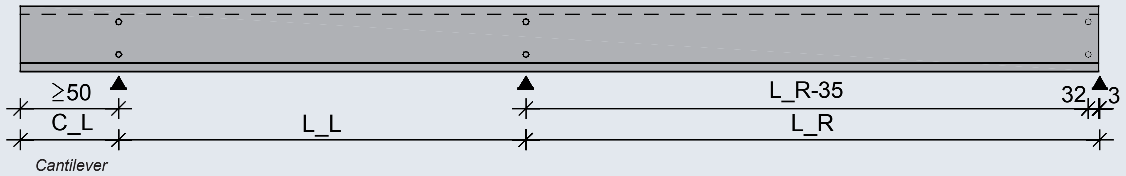
Note! In manufacturing drawings the purlin is seen with the wide flange down and toward the reader

L=span
L_L=Left span length
L_R=Right span length

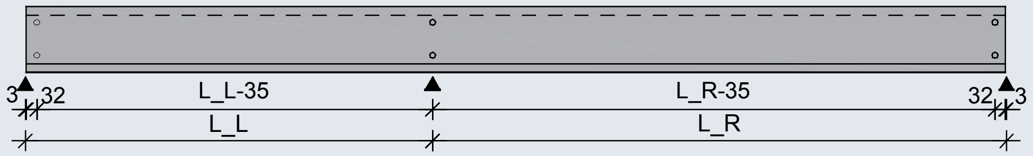
Pre-punched single span single purlin DS



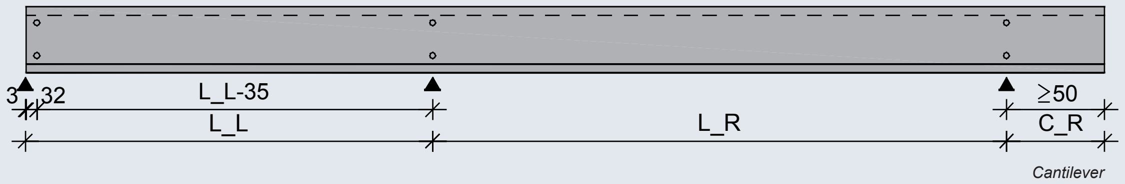
Pre-punched single span purlin, left end bay DL



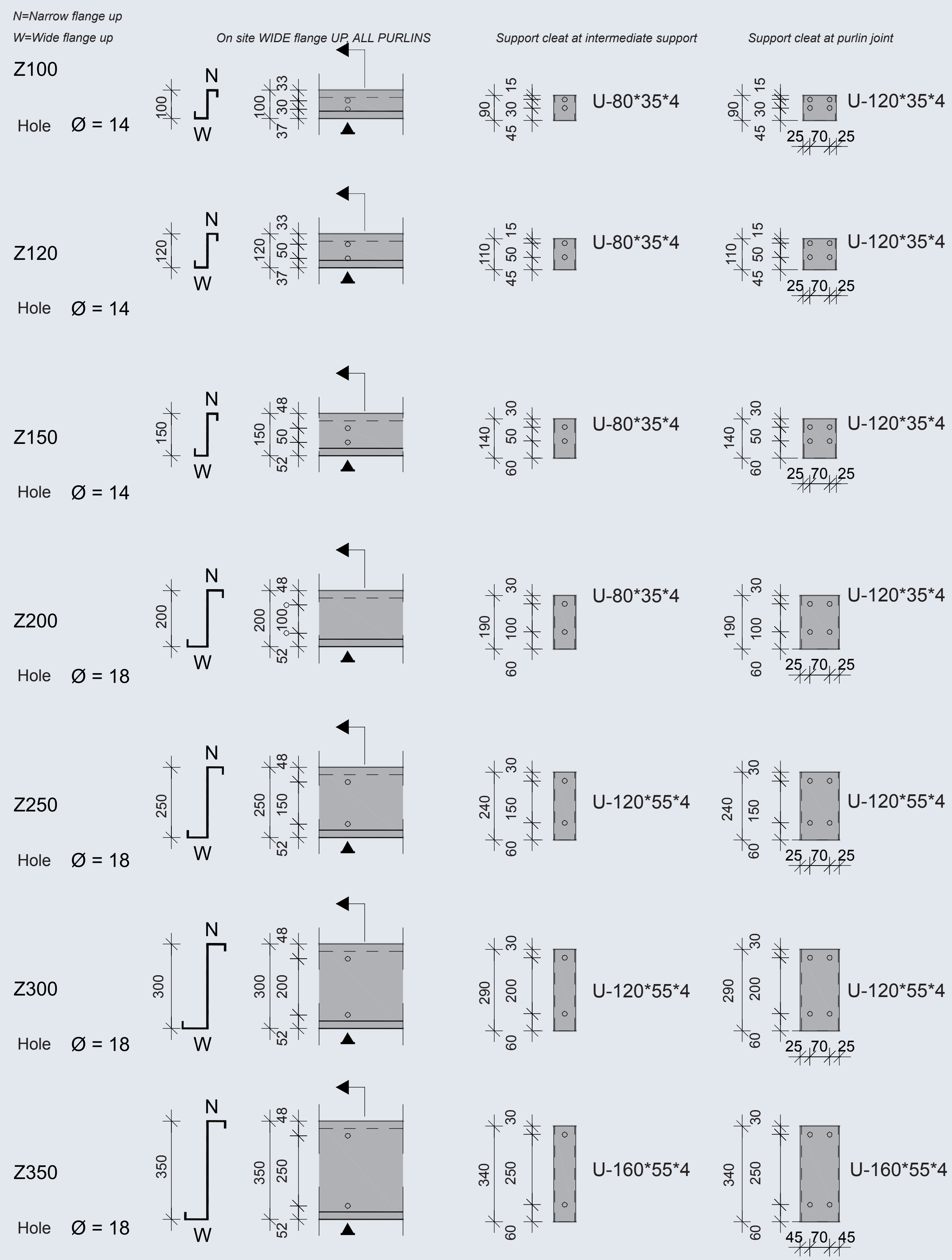
Pre-punched single span purlin, inner bay DI



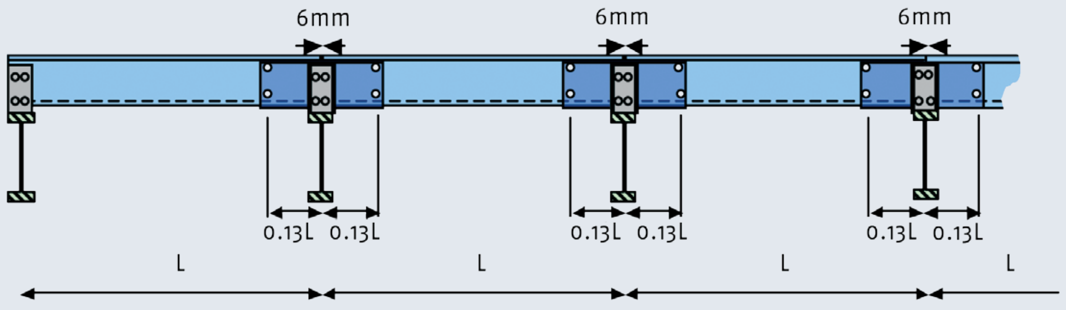
Pre-punched single span purlin, right end bay DR



2.2.3 Double span system, support cleats



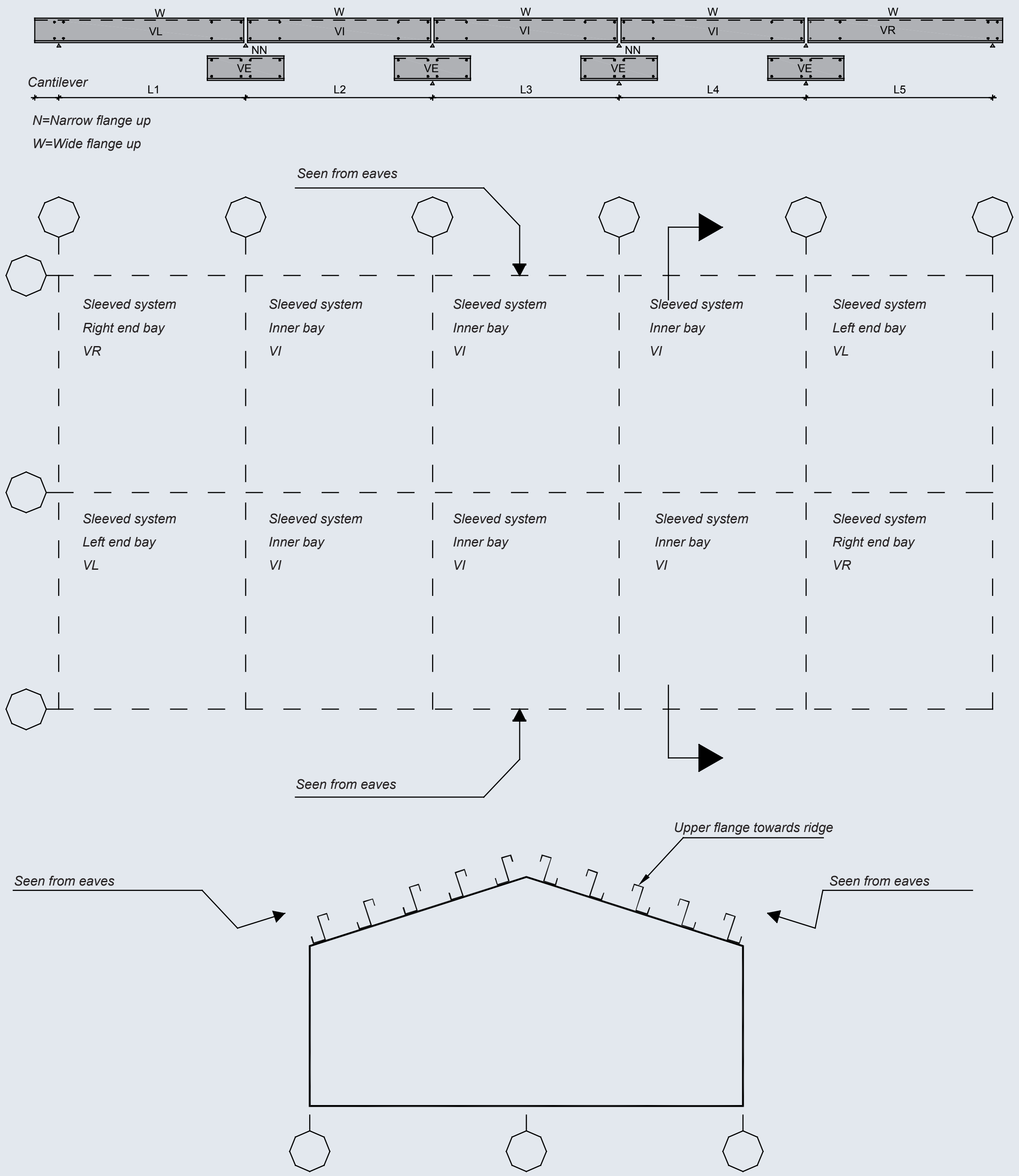
2.3 Sleeved system – alternative design with Ruukki's PurCalc software



Used in roof and wall structures
System contains a special sleeve section, normally either similar gauge to basic purlin or max. 0.5 mm thicker.

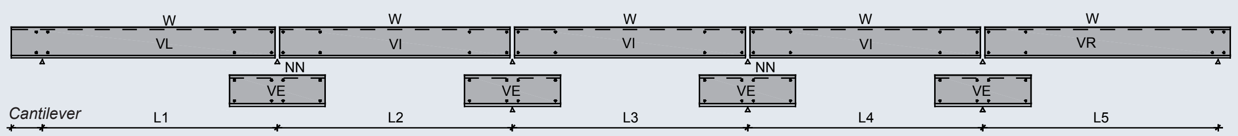
- Optimal weight
- Small deflections
- Sections easy to handle
- A larger number of components
- More installation work
- For Z sections the sleeve section is identical to the basic purlin section
- Dimensions of sleeve section are shown together with the cross-sectional dimensions of the sigma purlin, see section 1.6.

2.3.1 Sleeved system, purlin designation diagram



2.3.2 Sleeved system, purlins

Note! On site, the purlin is seen from the eaves

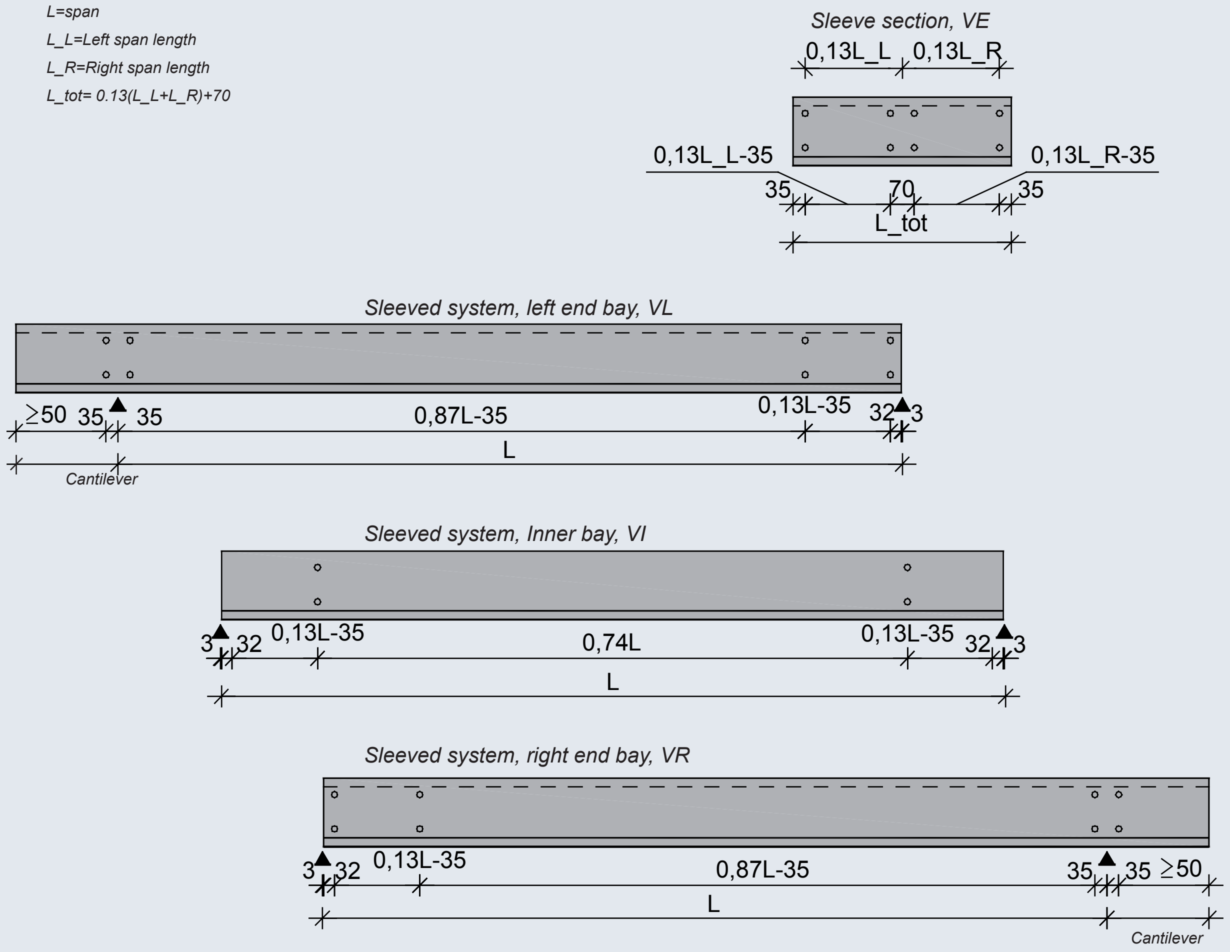


N=Narrow flange up
W=Wide flange up

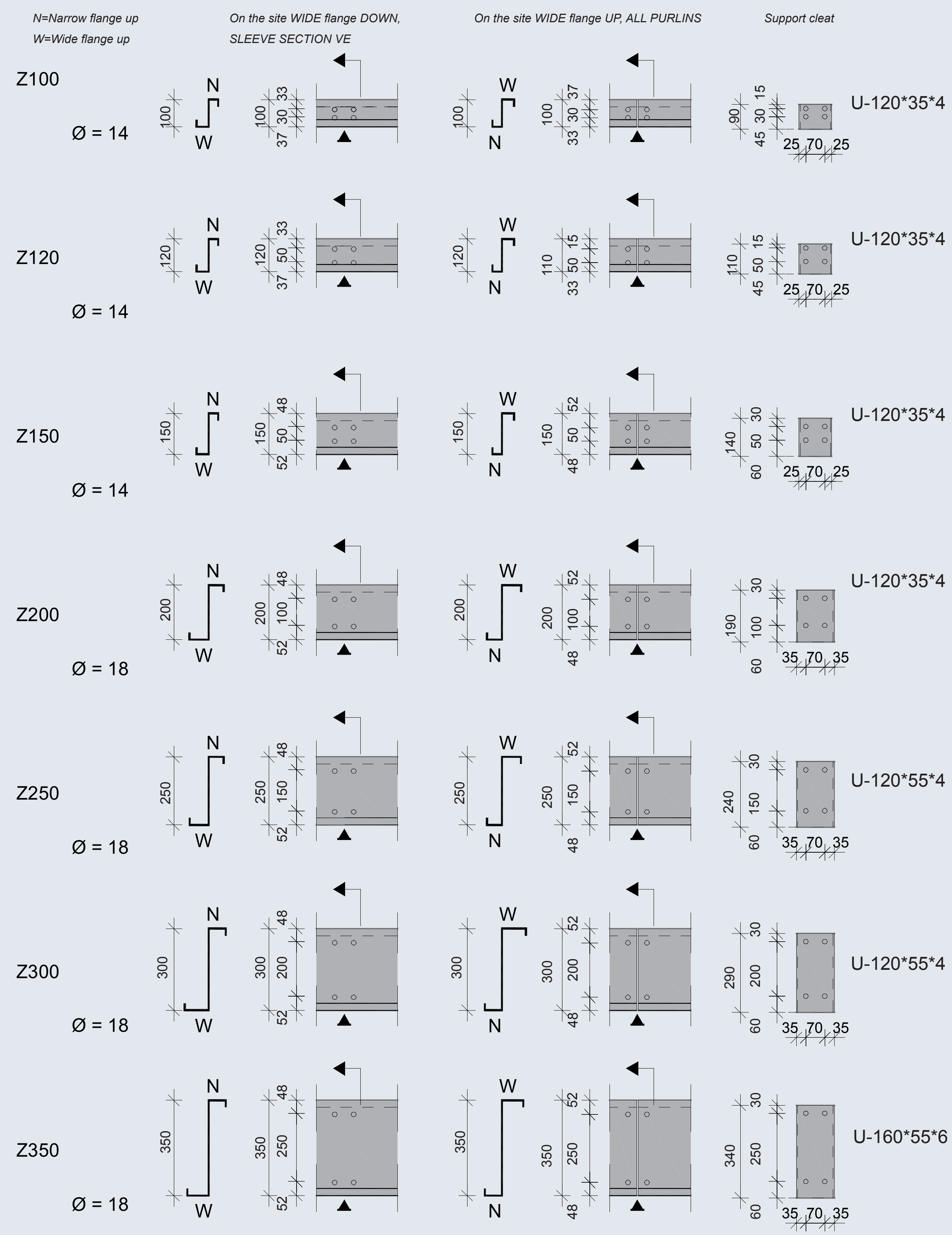
Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

Note! In manufacturing drawings the purlin is seen with the wide flange down and toward the reader

L=span
L_L=Left span length
L_R=Right span length
L_tot= 0.13(L_L+L_R)+70

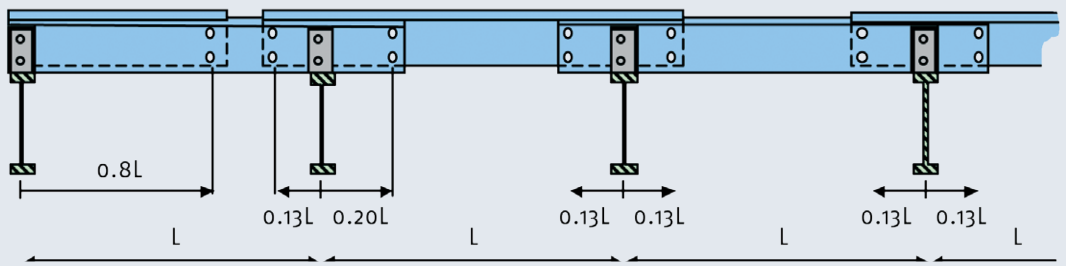


2.3.3 Sleeved system, support cleats



more with metals

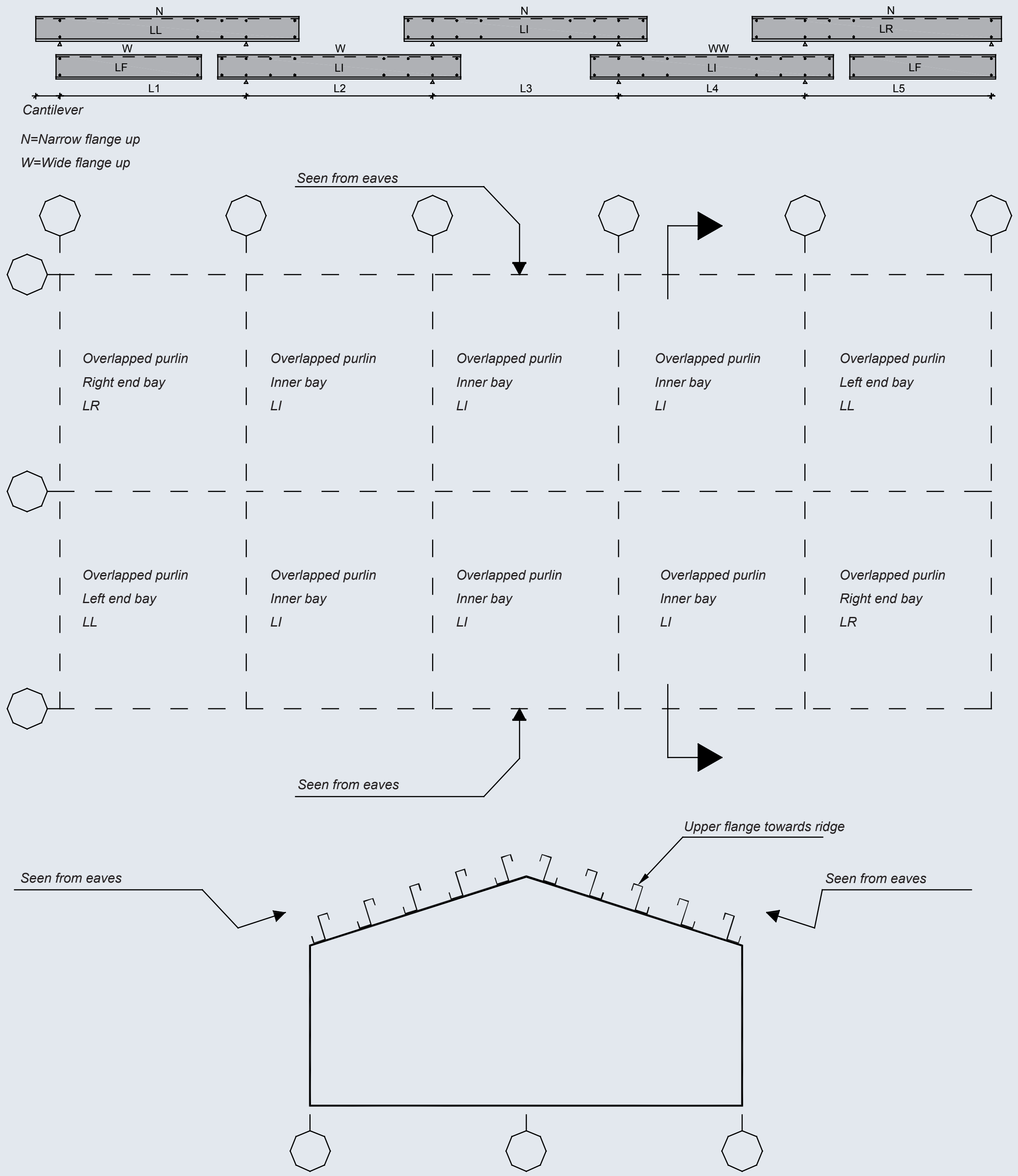
2.4 Overlapped system - recommended by Ruukki



Used in roof and wall purlins, in spans of 6-10m
The purlins are overlapped inside one another.
A double purlin or a thicker section in end bay.

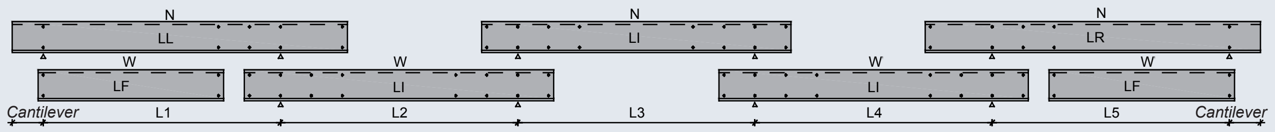
- Optimal weight
- Small deflections
- Long spans can be achieved
- A larger number of joints
- More installation work
- Can be implemented with Z sections

2.4.1 Overlapped system, purlin designation diagram



2.4.2 Overlapped system, purlins

Note! On site, the purlin is seen from the eaves



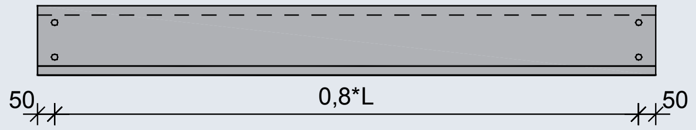
N=Narrow flange up
W=Wide flange up

Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

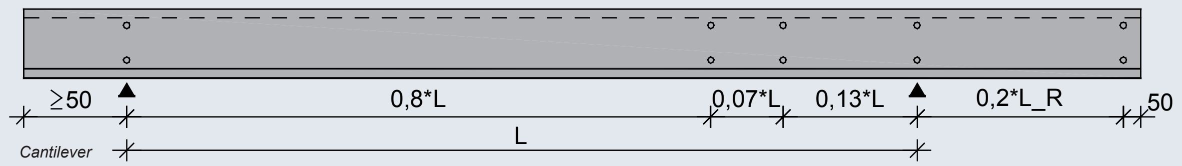
Note! In manufacturing drawings the purlin is seen with the wide flange down and toward the reader

L=span
L_L=Left bay length
L_R=Right bay length

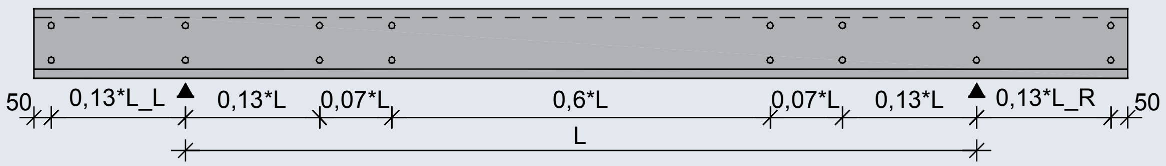
Overlapped reinforcement purlin LF, if required, in end fields



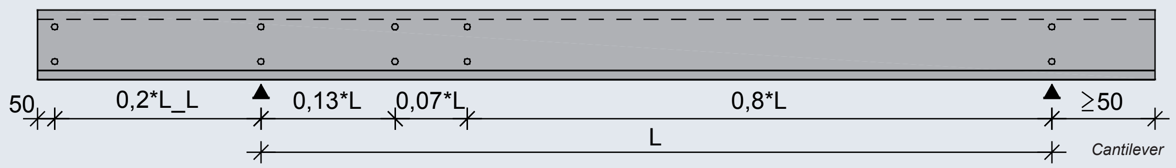
Overlapped purlin LL, left end bay



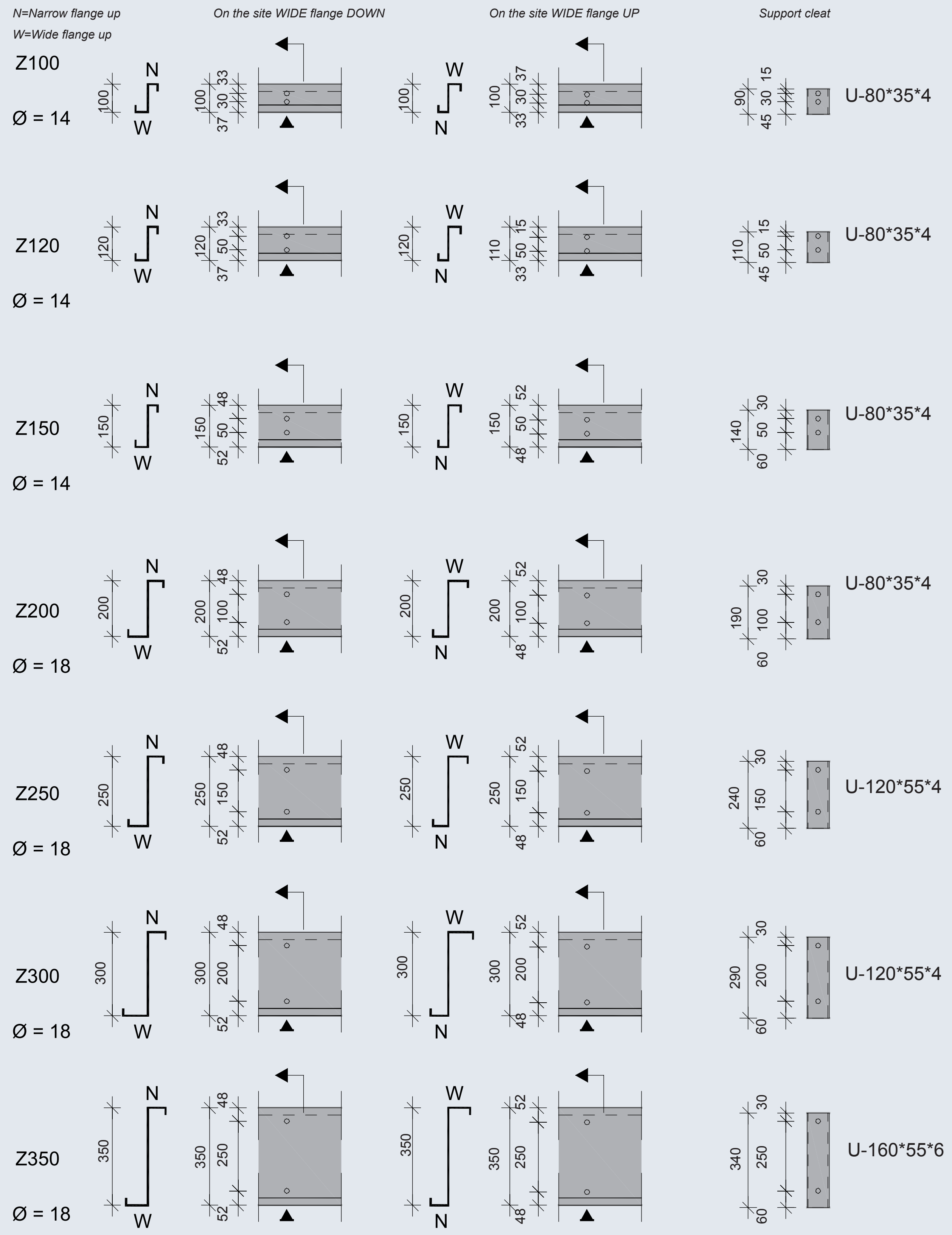
Overlapped purlin LI, inner bay



Overlapped purlin LR, right end bay



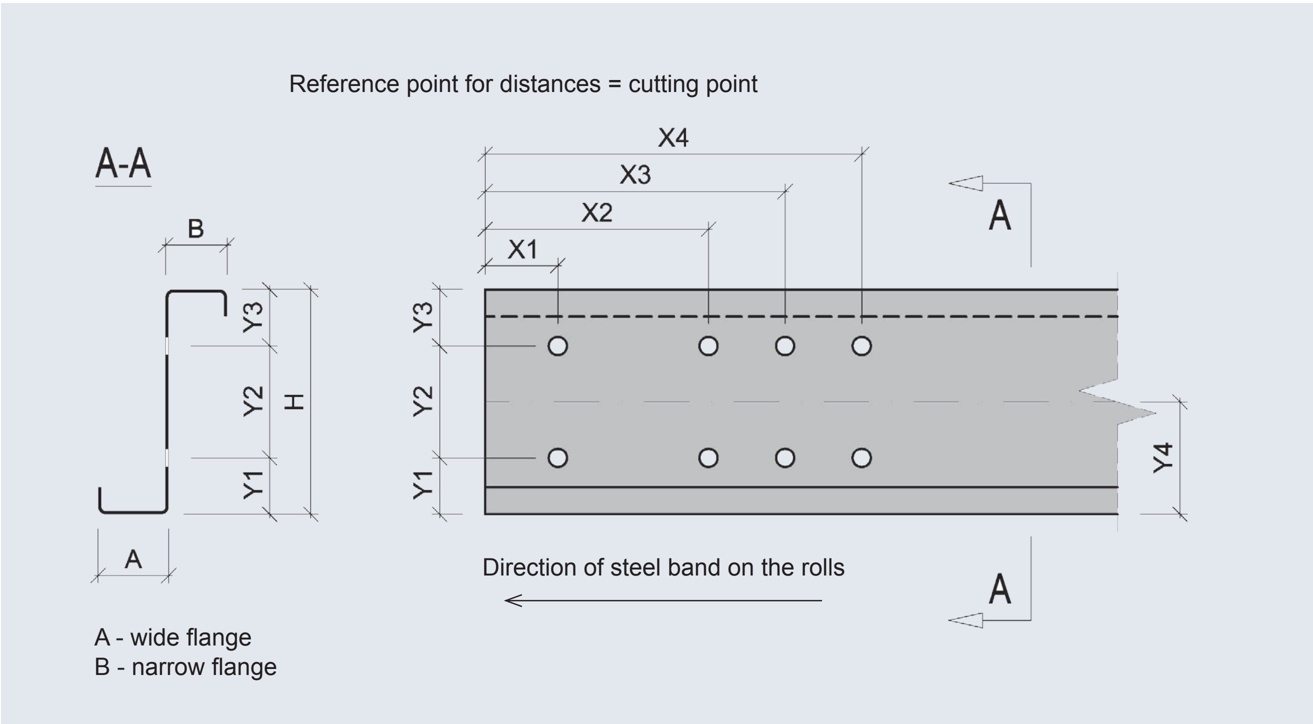
2.4.3 Overlapped system, support cleats



2.5 Hole design principle for manufacture

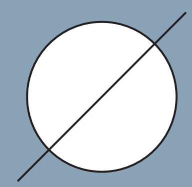
Standard pre-punching is used for each purlin system. The pre-punching dimensions are given with the lower flange toward the viewer and the wider flange of the section as the lower flange. The longitudinal location of the holes is given as a distance from the cutting point, from left to right. The dimensioning of holes for fixing screws is standardised.

Pre-punching is implemented using punches of different sizes and forms. The selection of punches varies depending on the production plant and the section manufacturing method. The standardised sizes and locations of holes for fixing screws are presented below. Additional information about the pre-punching possibilities can be obtained by contacting us.



2.6 Types of holes

Holes are made during production at continuous line – information:
- max. material thickness 3mm
  (for ø 60mm max. material thickness 2mm),
- holes can be made in a row,
- oval and rectangular holes can be rotated by 90°.

Type of hole	Diameter [mm]	Rotation
	[mm]	[°]
	7	-
	10	-
	12	-
	14	-
	16	-
	18	-
	20	-
	22	-
	26	-
	60	-
	12×24	90
	14×24	90
	16×35	90
	18×31,7	90
	18×35	90
	20×35	90
	5×25	90

No limitation in number of holes during production.

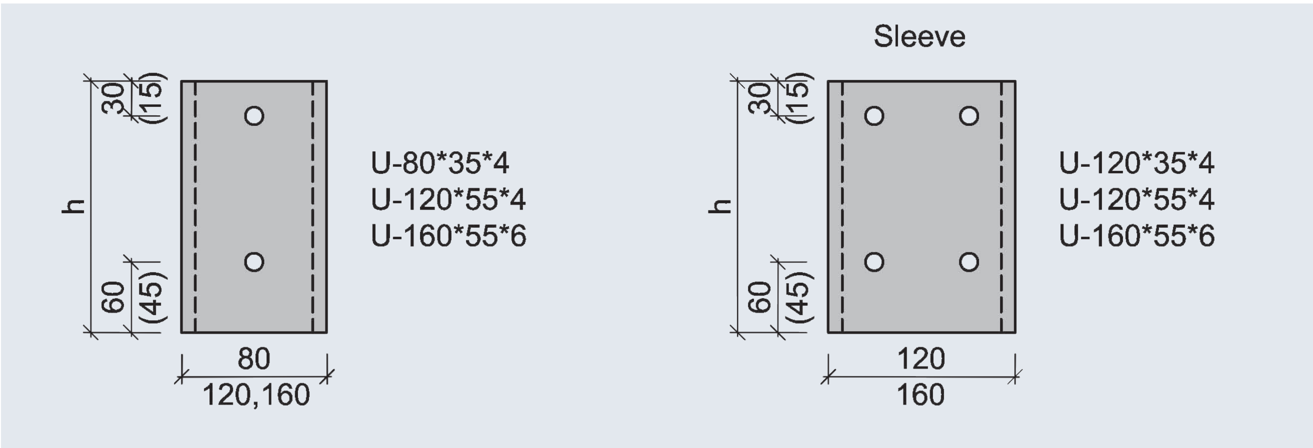
2.7 Support cleats

Purlin systems utilise support cleats attached to the primary beams of the building frame. The purlins are fixed to these support cleats from the web with screw joints. In Ruukki systems the support cleats are U sections made of at least steel grade S235. In the design of the support cleats, the tying of the section sheet on the roof ridge with a ridge moulding is taken into account. If a ridge moulding is not used, the dimensioning of the U section and its fixing to the primary rafter must be separately checked due to the stresses caused by the load component acting in the direction of the roof slope.

When screw joints are used, the support cleats are delivered with pre-drilled holes for hexagon screws, diameter either 14mm or 18mm depending on the size of the purlin. The sizes and the distances are shown in the purlin diagram. A sleeved system features two vertical rows of fixings, an overlapped system either one or two rows depending on selected support cleats. Single and double span systems have one or two rows, depending on the location of the support cleat and on the selection of support cleat. The program PurCalc for purlin dimensioning also determines the required number of fixings.

If self-drilling screws are to be used for some reason, the support cleat is not pre-drilled. However, it should be noted that screw joints must always be used if the material thickness of the purlin exceeds 1.5mm, due to joint ductility requirements.

Examples of support cleats:



C, Z and Sigma purlins are supported from their web to the primary rafter using the following U sections at low roof slopes, and when the section sheet is tied to the opposite slope sheet with a ridge moulding. Otherwise the fixing sections have to be dimensioned specifically for loads acting in the direction of the slope plane.

H<	U-Section
200	U-80*35*4
300	U-120*55*4
350	U-160*55*6

3 Factors to be considered in the use of lightweight purlins

3.1 Torsional rigidity

Lightweight purlins exhibit an open cross-section and low torsional rigidity in proportion to their bending rigidity. Due to the low torsional rigidity the lateral buckling resistance of an unsupported purlin restricts the load bearing capacity significantly.

3.2 Improving torsional rigidity

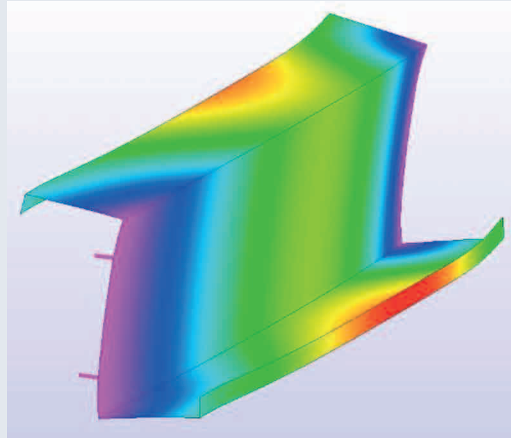
Torsional rigidity can be improved by fixing the purlin to a form plate or corresponding that provides transverse support to the upper flange of the purlin. The bending rigidity of the form plate also increases the rotational rigidity of the purlin.

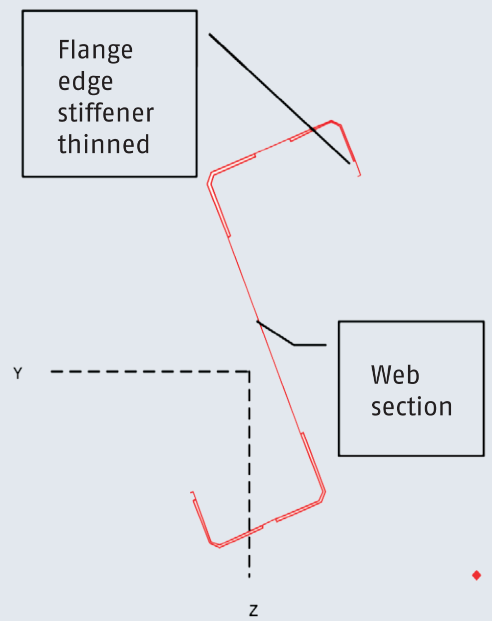
3.3 Local buckling

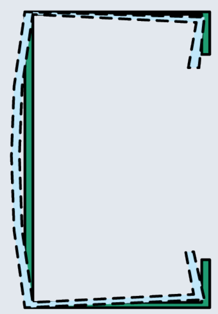
The resistance of a thin gauge sheet cross-section is restricted due to buckling of plate-like cross-sectional parts under compression, or by buckling under compression of plate-like stiffeners that resist buckling. A plane section does not loose its load bearing capacity completely; in fact, a plane section often retains a considerable part of its capacity in this state. This is modelled in calculations by removing a part under the most stress from the plane section, or by thinning the edge stiffener and the part of the plane section considered to be part of it.

3.4 Distortion of section

In cross-sections of certain shapes, distortion of the section also restricts the load bearing capacity.

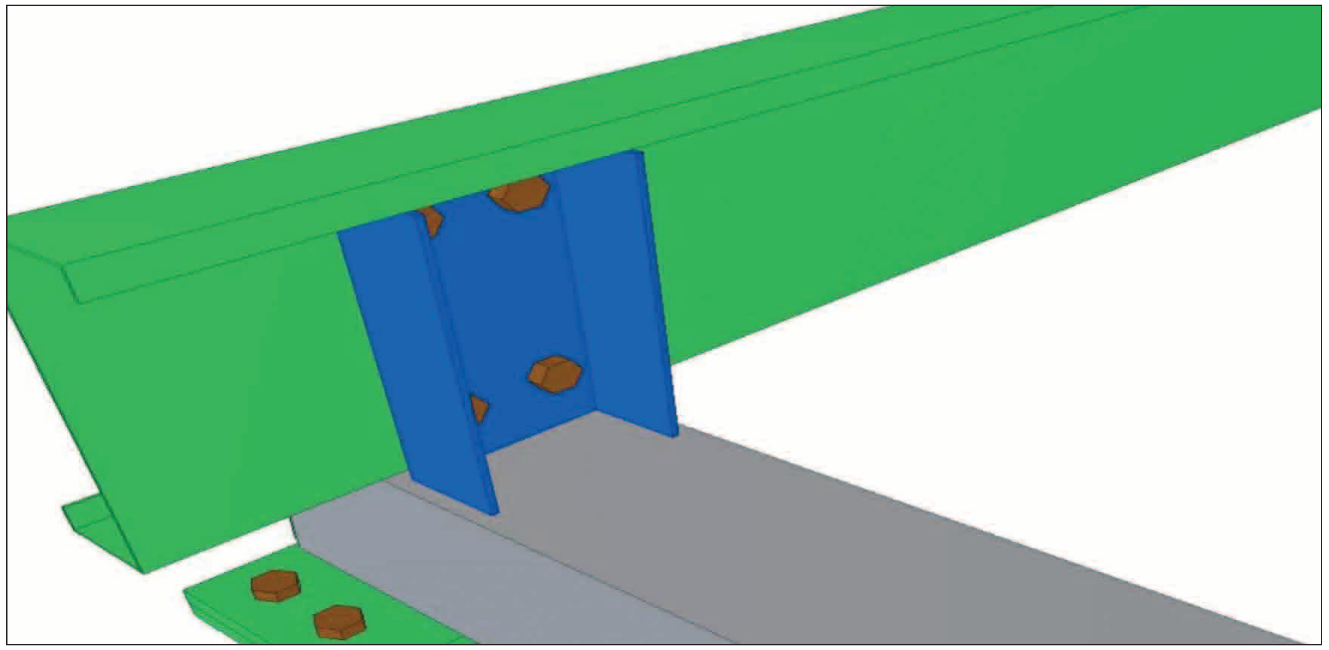






3.5 Resistance to support reactions

Buckling of the plane section is also possible in the support cleat, whereby the web of the purlin as a result of the support reaction tends to deviate from its plane, which restricts the load bearing capacity of the purlin. For reinforcement, a support cleat is normally used, e.g. a U section that is fixed from its back to the web of the purlin so that the support cleat alone transmits the support reaction to the rafter.



3.6 Purlins that are supported at the flange

Top hat purlins are always provided with a brace piece (cf. cross-sectional dimensions of top hat purlins), which is fixed together with the basic purlin through its flanges directly to the primary rafter. The resistance to the support reactions is then produced by the top hat purlin and the brace section together.

3.7 Transverse rigidity

The rigidity of thin gauge sheet purlins in the direction of the minor axis is low. This causes bending at the roof slope plane, unless the slope has sheet rigidity. This could be the case, for example, if the sheet seams from the ridge toward the eaves are not fixed. However, it is recommended that the section sheets of the slopes are tied together with a ridge moulding. In practice, this will prevent the bending of the purlin in the direction of the roof slope, and at the same time essentially reduce the stresses acting on the support cleats.

3.8 Unsupported lower flange

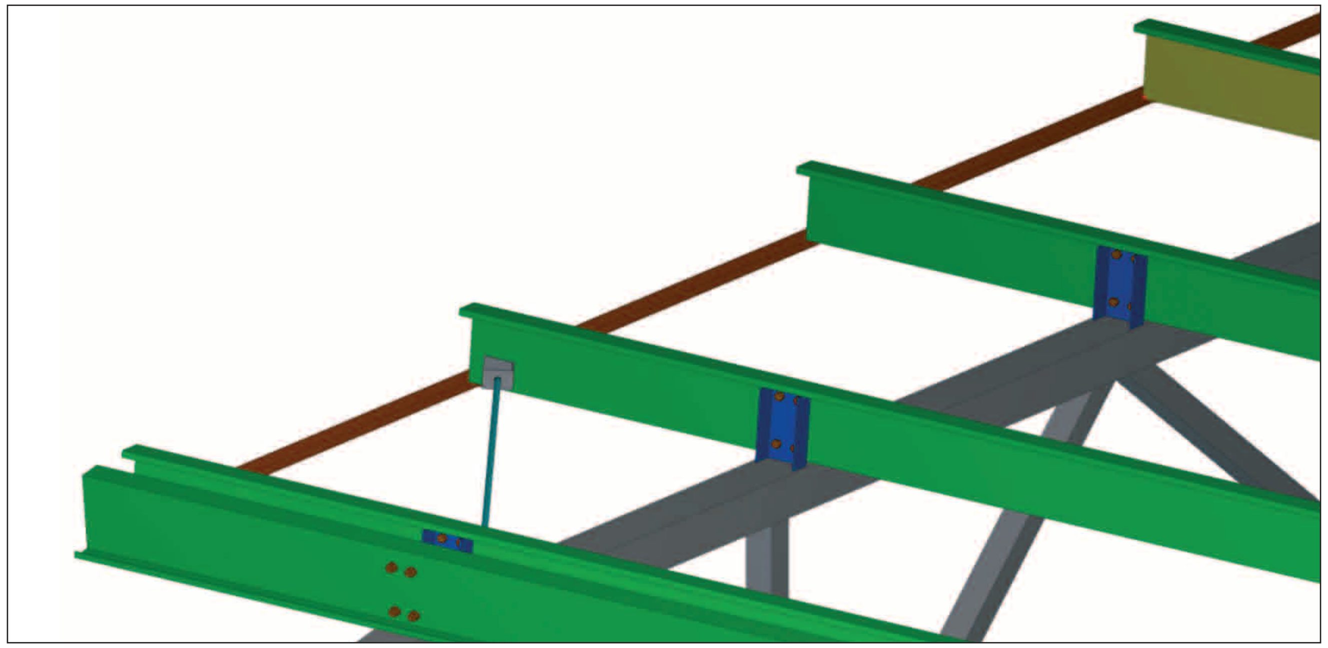
In single span purlins the unsupported lower flange of the purlin may be under compression due to wind uplift, whereby it can buckle in the transverse direction. This applies particularly to wall purlins, in which the self-weight of the structure does not counteract the suction pressure, as is the case in roof structure.

3.9 Unsupported lower flange under compression

In continuous purlins the unsupported lower flange of the purlin is under compression at the brace moment, whereby it tends to buckle. This restricts the load bearing capacity of the purlin.

3.10 Cantilever purlin

The load bearing capacity of cantilever purlins is low, but it can be increased to some extent by fixing the cantilever end rigidly to the face section.



If distortion of the end of a cantilever purlin is prevented using e.g. a U section of the same height as the purlin, fixed from its flanges to the flanges of the cantilever purlin, the following shall be valid for the end support:

$$N_{sd}/A_{eff} + M_{y,Sd}/W_{eff,y} \le M_{c,Rd,V}/W_{eff,y}$$

where

- N_{sd} is the design value of normal force
- A_{eff} is the effective area of the cross-section in axial compression
- $M_{y,Sd}$ is the design value of the moment with an end support
- $W_{eff,y}$ is the effective bending resistance of the cross-section against bending about the y axis
- $M_{c,Rd,V}$ is the bending resistance, when account is taken of the influence of shear force

Otherwise the following shall be valid

$$N_{sd}/A_{eff} + M_{y,Sd}/W_{eff,y} \le 2M_{c,Rd,V}/3W_{eff,y}$$

Minimum dimensions of the section that joins the free flanges of a cantilever purlin (upper flanges of the cantilever purlin are provided with continuous support by a form plate)

Purlin height	L-section
max 150	45*45-1.5
max 200	70*70-1.5
max 300	70*70-2.0
max 350	70*70-2.5

4 PurCalc purlin design software

Design with PurCalc software enables the most economical solution for cold-formed purlin-based roof structure.

The software includes Ruukki's offering of Z, Hat, Sigma and C purlins The options included in the software enables following calculations methods:
- Calculation of purlin structure based on Eurocode, without purlin restrainment.
- Calculation of purlins structure based on test results, when purlins are restrained with Ruukki's profile sheet
- Calculation of purlin structure based on test results, when purlins are restrained by Ruukki's roof sandwich panels.

Language options in the software are; Romanian, Hungarian, Slovak, Czech, Polish English, Swedish and Finnish.

5 Handling, transport and storage of lightweight purlins

5.1 Handling

All necessary health and safety precautions have to be taken into account when handling the purlins. When handling the products, it is recommended to use protective clothing and cut resistance gloves. When cutting the products, please use also respirator as cutting may release dust and small particles.

Also special care shall always be exercised to prevent any damages to purlins itself. Even small dents and deflections may impair the load bearing capacity of the purlin significantly. Scratches on the zinc coating of the components be avoided.

The materials shall be sufficiently protected against moisture and damages at various stages of their handling. If components are handled manually, appropriate protective gloves shall be worn to prevent injuries.

5.2 Transport

The purlins and the fixing components are at the production plant packed in packages that are easy to handle. Purlins are bundled together and small components are packed in separate packages. The content is clearly marked on each package to ensure they are transported to the correct site. On the site the materials should be carefully checked to ensure the correct quantity and condition of the products. The supplier shall be informed in writing of any deficiencies and transport damages immediately. Damaged products are not allowed to install without Ruukki's approval.

5.3 Storage

Materials should be stored as closed as possible to the final installation location indicated in the installation diagrams to avoid unnecessary liftings and transports.

Purlins shall be stored in a dry place protected against rain and snow, on a level base. The dry storing conditions will prevent white rust on galvanised surface. Products shall be supported at regular intervals to prevent deformation. It is recommended that products are supported in a slightly inclined position (1:20), to ensure that possible water leaking onto the purlins will be drained. The packages should be raised above ground to allow ventilation of the bottom side of the packages. Materials should not be piled on top each other, as this may damage the sections.

If purlins get wet in rain, they must be separated and dried to eliminate the possibility of white rust. If required, sufficient support shall be provided for the packages to prevent them from tipping or falling over.

6 Installation of lightweight purlins

All necessary health and safety precautions have to be taken into account when handling the purlins. When handling the products, it is recommended to use protective clothing and cut resistance gloves. When cutting the products, please use also respirator as cutting may release dust and small particles.

The installation of lightweight purlins is swift and easy. The purlins are primarily fixed with hexagon screw joints using pre-drilled holes, or sometimes with self-drilling screws. It should be noted that purlins with a thickness of more than 1.5 mm must not be fixed to support cleats or to each other with self-drilling screws, but hexagon screw joints must be used. The low cost of installation is based on the swiftness of the work and on prefabricated structural parts. The small weight and the small space requirements of the structural parts reduce transport costs.

Lightweight purlins are installed according to an installation diagram drawn up by the designer.

The installation specification should contain at least the following information:

- project data
- designer
- installation technician
- material list and layout diagram
- storage of components on site
- handling of transport packages on site
- installation equipment
- installation stages
- screw joints
- temporary bracing during installation
- installation tolerances
- qualification of structures and quality control

Structural parts must not be forced in place so that they are deformed or subjected to stresses. Thin gauge sheet structures are sensitive to local damage, and for this reason special attention shall be paid in installation to preventing the parts from being dented or otherwise damaged.

Roof purlins do not usually require temporary bracing during installation, but this shall be verified when longer spans or higher slopes are concerned. Z roof purlins shall always be installed with the upper flange toward the ridge, cf. the Figure. In addition, the lower flange of a Z purlin must be installed at a distance of ca. 10 mm from the upper chord of the truss or the beam.

The work specification, the drawings, the installation plan and the quality control plan shall be studied before installation is started. The acceptance inspection of the materials, accessories, installation parts and lightweight purlins shall include an inspection of waybills, dispatch notes, transport damages and handling damages. It is important to verify that the materials and accessories comply with standards or are delivered with certified product declarations.

It is recommended that during installation, attention is paid to the following factors:

- location of structures
- straightness of structures
- angles
- joints between components
- main dimensions
- other dimensions
- handling, lifting and storage of materials, accessories and parts
- scaffolding
- tightening and locking of screws and nuts

The installation sequence shall be determined before the purlins are installed. The bundles of purlins are lifted in the correct locations according to the installation diagram drawn up by the designer. Purlins with the wide flange down are installed first.