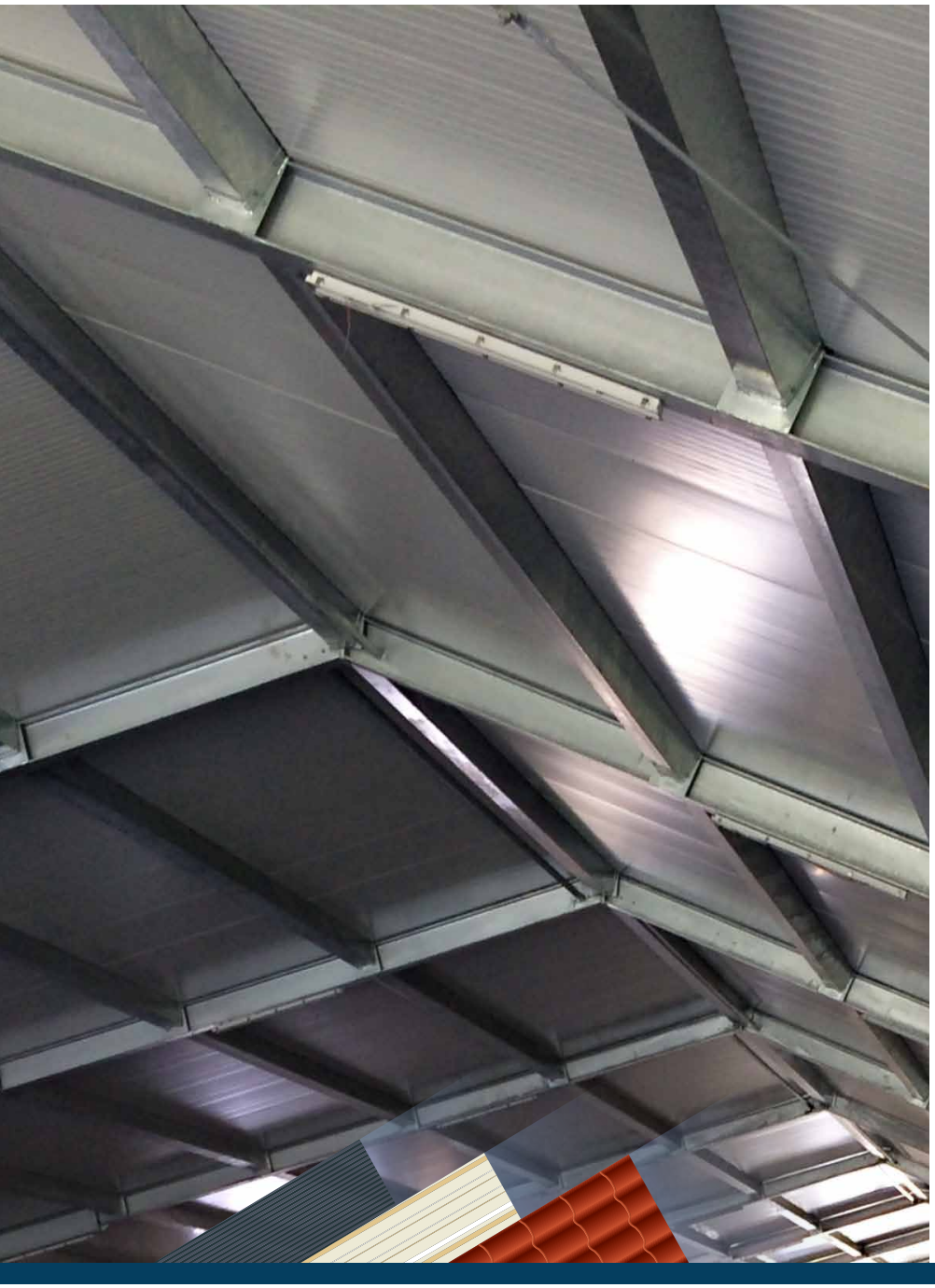
Z, SIGMA & DELTA PROFILES

Technical description

MR059 / 1220



JORISIDE

THE STEEL FUTURE

Index

Z, Sigma & Delta profiles

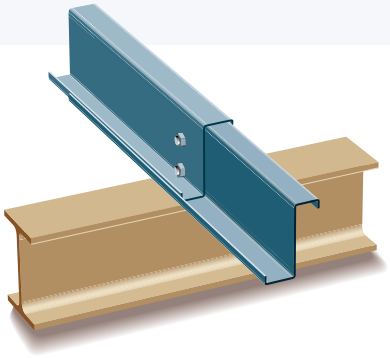
Technical description

Robust structures, tailored perfectly to all your projects!

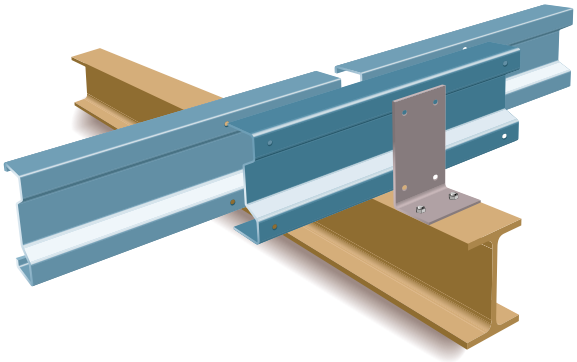
We are able to arrange rapid deliveries thanks to our 30 years of experience and our production sites.

Joris Ide offers you the right technical support. Our engineering department can draw up all implementation plans and production and installation drawings for all your roof structures. Our technical department calculates the purlins according to your instructions.

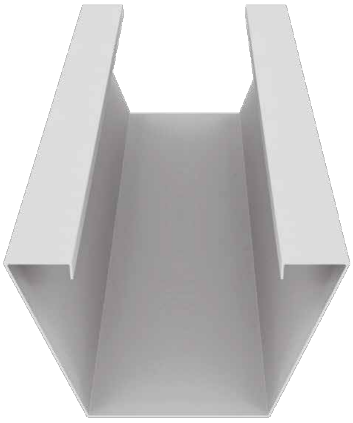
Joris Ide can supply all the cladding materials needed for your structure. We also offer you a complete product range for roofs and façades. Please do not hesitate to contact our technical department for more detailed information!



Continuous Z purlin (Z140 to Z250).



Continuous Sigma purlin.



Delta profile

Z profile

1. Foreword

1.1. Z purlins in the construction sector

In recent years, our products have become subject to increasingly stringent requirements. Economic efficiency is becoming increasingly important. The construction sector is not spared from this development and has made good progress in terms of flexibility and possibilities. To meet this demand, Joris Ide NV offers an alternative to traditional roof purlins and side rails: Z purlins, cold-rolled galvanised profiles, which are a simple replacement for timber or rolled sections. Our Z purlins are the ideal solution for new construction and renovation projects.

1.2. Description and advantages

Description

- Z purlins are cold-rolled profiles with a Z section with a perpendicular web plate and flanges
- thanks to the different flange widths, the profiles can be slid into each other
- the profiles are available with or without perforation
- they can be punched to your specifications
- Figure 1.1 shows the spacing between perforations A [mm] and D [mm] according to the height of the Z profile
- the perforation serves to: - secure the profiles to the cleats
  - attach overlapping sleeved purlins to each other
  - attach the spacers

After perforation, the purlin profiles are cut to size and an inscription is placed in accordance with the intended use: roof purlin or side rail.

Type	Size A	Size D	B1	B2	ø	C
Z 140	70,0	36	65	60	14	22
Z 160	70,0	46	65	60	14	22
Z 180	81,5	50	65	60	14	22
Z 200	100,0	51	65	60	14	22
Z 220	120,0	51	65	60	14	22
Z 250	150,0	50	80	70	18	22
Z 300	190,0	55	95	87	18	30
Z 350	240,0	55	95	87	18	30
Z 400	290,0	55	95	87	18	30

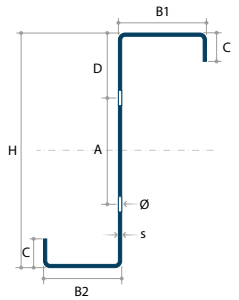


Figure 1.1

Advantages

	Z purlin	Wood	I profile
Weight (daN/m²)	3,5 to 17,2	> 7	> 7
Purlin distance per profile (m)	> 10 m	< 7 m	> 10 m
Finish	galvanised	post-treatment	post-treatment
Mounting	bolted	nailed	welded or bolted
Production	to size and punched	cut to size	cut to size and punched
Length (m)	0 to 15 m	5 to 6 m	12 m
Processing	light	light	heavy

Cold-rolled Z profiles are easier to process because they weigh less than rolled profiles or wood. There are numerous economical installation options thanks to the perforations and the many custom lengths. The compact packaging also guarantees lower transport costs.

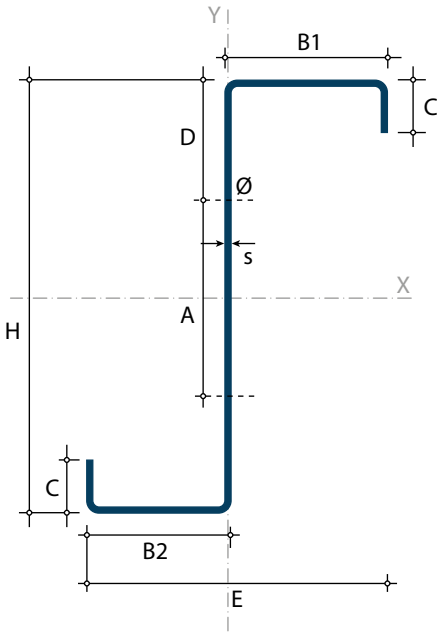
Z-profile

1.3. Source material

We use high-grade galvanised steel with the following characteristics as source material:

- steel quality in accordance with EN 10346 S280GD / EN 10346 S350GD
- galvanising Z275 gr/m^2, Z600 gr/m^2 or hot-dip galvanised in accordance with EN 1461
- yield strength 280 N/mm2 (Z140 to Z220) / 350 N/mm2 (Z250 to Z400)
- treatment not oiled

1.4. Technical properties



Type	Thickness	Weight	B1	B2	C	E	H	A	D	ø	fy
	mm	daN/m	mm	mm	mm	mm	mm	mm	mm	mm	N/mm²
Z140	3,50	3,45	65,5	59,5	22	123,5	140	70,0	36,00	14	280
	2,00	4,55	65,5	59,5	22	123,0	140	70,0	36,00	14	280
	5,65	5,60	65,5	59,5	22	122,5	140	70,0	36,00	14	280
Z160	3,80	3,70	65,5	59,5	22	123,5	160	70,0	46,00	14	280
	5,10	4,85	65,5	59,5	22	123,0	160	70,0	46,00	14	280
	2,50	6,00	65,5	59,5	22	122,5	160	70,0	46,00	14	280
Z180	4,00	3,95	65,5	59,5	22	123,5	180	81,5	50,25	14	280
	2,00	5,20	65,5	59,5	22	123,0	180	81,5	50,25	14	280
	2,50	6,40	65,5	59,5	22	122,5	180	81,5	50,25	14	280
Z200	4,20	4,15	65,5	59,5	22	123,5	200	100,0	51,00	14	280
	2,00	5,50	65,5	59,5	22	123,0	200	100,0	51,00	14	280
	2,50	6,80	65,5	59,5	22	122,5	200	100,0	51,00	14	280
Z220	4,50	4,40	65,5	59,5	22	123,5	220	120,0	51,00	14	280
	6,00	5,80	65,5	59,5	22	123,0	220	120,0	51,00	14	280
	7,50	7,20	65,5	59,5	22	122,5	220	120,0	51,00	14	280
	9,00	8,70	65,5	59,5	22	122,0	220	120,0	51,00	14	280

Z-profile

Technical properties

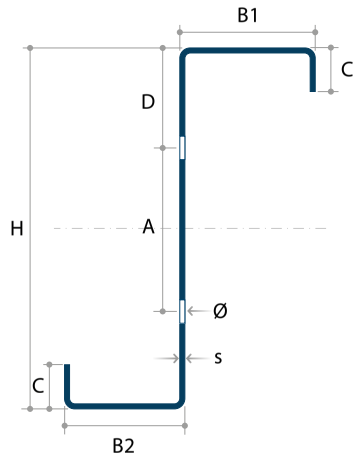
Type	Thickness	A_{br}	I_{br}	$A_{s,eff}$	$I_{s,eff}$	Large pressed flange							Small pressed flange						
						$A_{s,eff,fl1}$	$I_{s,eff,fl1}$	$W_{eff,1a}$	$W_{eff,1b}$	A_{fz1}	W_{fz1}	I_{fz1}	$A_{s,eff,fl2}$	$I_{s,eff,fl2}$	$W_{eff,2a}$	$W_{eff,2b}$	A_{fz2}	W_{fz2}	I_{fz2}
	mm	mm^2	mm^4	mm^2	mm^4	mm^2	mm^4	mm^3	mm^3	mm^3	mm^3	mm^4	mm^2	mm^4	mm^3	mm^3	mm^3	mm^3	mm^4
Z140	1,5	439,69	1357554	318,76	1231404	424,2	1298525	18352	18753	161,35	2860	98780	431,19	1328606	18319	19691	152,35	2497	78548
	2,0	581,4	1779129	477,21	1727681	573,77	1761296	24877	25453	212,7	3702	127866	575,88	1769108	24629	25952	200,7	3224	101465
	2,5	720,67	2185656	640,7	2174322	712,97	2172781	30606	31486	262,84	4491	155137	712,97	2171676	30209	31884	247,84	3903	122844
Z160	1,5	469,69	1853625	319,26	1649703	453,61	1772488	21906	22412	167,35	2922	104062	460,61	1812108	21884	23475	158,35	2549	82847
	2,0	621,4	2432230	479,83	2329909	612,79	2403260	29766	30320	220,7	3783	134789	615,13	2414744	29429	30979	208,7	3295	107089
	2,5	770,67	2991677	648,55	2955967	762,97	2974790	36697	37685	272,84	4592	163641	762,97	2973436	36252	38131	257,84	3990	129741
Z180	1,5	499,69	2443626	319,44	2130530	476,26	2316580	25227	26274	173,35	2975	108979	479,38	2354744	24978	27468	164,35	2595	86833
	2,0	661,4	3209599	481,57	3027342	651,88	3166181	34923	35441	228,7	3855	141227	654,35	3181621	34480	36268	216,7	3356	112298
	2,5	820,67	3951820	653,72	3865139	812,97	3930369	43132	44223	282,84	4681	171544	812,97	3928757	42640	44715	267,84	4066	136122
Z200	1,5	529,69	3133559	319,43	2673691	489,01	2913455	28019	30343	179,35	3023	113567	491,87	2957704	27747	31665	170,35	2636	90537
	2,0	701,4	4119239	482,74	3820112	691,06	4057800	40344	40815	236,7	3918	147231	693,64	4077897	39790	41818	224,7	3409	117136
	2,5	870,67	5076086	657,3	4903596	862,49	5045306	49891	51028	292,84	4759	178908	862,97	5047642	49370	51634	277,84	4133	142045
Z220	1,5	559,69	3929425	319,29	3278974	501,15	3585994	30813	34607	185,35	3065	117858	503,73	3635799	30512	36054	176,35	2672	93990
	2,0	741,4	5169150	483,5	4708193	730,29	5085887	46029	46443	244,7	3974	152842	732,98	5111365	45360	47629	232,7	3457	121642
	2,5	920,67	6374477	660	6073773	911,58	6327360	56967	58087	302,84	4829	185786	912,97	6340094	56440	58886	287,84	4192	147556
	3,0	1097,52	7545786	850	7393122	1087,31	7503095	67489	68947	359,76	5632	216755	1087,31	7500226	66726	69707	341,76	4880	171795

A_{br} - I_{br} = unloaded, gross sections
$A_{s,eff}$ - $I_{s,eff}$ = pressure loaded, effective properties
$A_{s,eff,fl1}$ - $I_{s,eff,fl1}$ - $W_{eff\ 1a,b}$ = flexural loaded, large pressed flange
$A_{s,eff,fl2}$ - $I_{s,eff,fl2}$ - $W_{eff\ 2a,b}$ = flexural loaded, small pressed flange

Z-profile

Technical properties

Type	Thickness	Weight	B1	B2	C	D	A	Ø	fy
	mm	daN/m	mm	mm	mm	mm	mm	mm	N/mm²
Z250	1,5	5,10	78	67	21,5	51	150	18	350
	1,75	5,85	78	67	21,5	51	150	18	350
	2	6,60	78	67	21,5	51	150	18	350
	2,5	8,40	79	68	22,0	51,5	150	18	350
	3	9,85	80	69	22,5	52	150	18	350
	3,5	11,70	80	69	22,5	52	150	18	350
Z300	2	8,15	93	85	29,5	56	190	18	350
	2,5	10,15	94	86	30,0	56,5	190	18	350
	3	12,20	95	87	30,5	57	190	18	350
	3,5	14,50	96	88	31,5	57,5	190	18	350



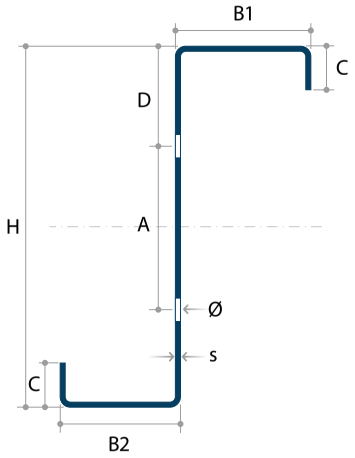
A_{br} - I_{br} = unloaded, gross sections
$A_{s,eff}$ - $I_{s,eff}$ = pressure loaded, effective properties
$A_{s,eff,fl1}$ - $I_{s,eff,fl1}$ - $W_{eff\ 1a,b}$ = flexural loaded, large pressed flange
$A_{s,eff,fl2}$ - $I_{s,eff,fl2}$ - $W_{eff\ 2a,b}$ = flexural loaded, small pressed flange

Type	Thickness	A_{br}	I_{br}	$A_{s,eff}$	$I_{s,eff}$	Large pressed flange							Small pressed flange						
						$A_{s,eff,fl1}$	$I_{s,eff,fl1}$	$W_{eff,1a}$	$W_{eff,1b}$	A_{fz1}	W_{fz1}	I_{fz1}	$A_{s,eff,fl2}$	$I_{s,eff,fl2}$	$W_{eff,2a}$	$W_{eff,2b}$	A_{fz2}	W_{fz2}	I_{fz2}
	mm	mm²	mm⁴	mm²	mm⁴	mm²	mm⁴	mm³	mm³	mm³	mm³	mm⁴	mm²	mm⁴	mm³	mm³	mm³	mm³	mm⁴
Z250	1,5	628,69	5715052	293	4013781	495,49	4604402	32383	42707	210,10	3854	178516	503,89	4738841	32303	45875	193,60	3074	123716
	1,75	731,35	6569491	382,22	5082122	620,99	5668523	41962	49981	244,84	4508	209387	628,71	5816273	41572	53561	225,59	3597	145299
	2	837,4	7539944	475,76	6235599	756,4	6871280	52797	57813	280,3	5170	241310	758,57	6972096	51313	61632	258,3	4128	167671
	2,5	1050,67	9505167	665,3	8422915	1025,93	9226644	73365	74266	351,59	6510	306713	1027,2	9274171	71113	77553	324,09	5202	213672
	3	1265,52	11503045	867,55	10597264	1241,27	11252903	88733	90616	423,36	7869	374223	1248,87	11343924	87267	93745	390,36	6294	261379
	3,5	1481,94	13533861	1087	12828969	1458,75	13322345	104273	107234	495,62	9248	443881	1466,58	13420539	103151	110100	457,12	7405	310827
Z300	2	1035,4	13637985	526,9	10174465	860,51	11546483	69387	87081	346,3	8135	443048	868,38	11738723	69204	90734	330,3	7153	358451
	2,5	1298,17	17164672	765,55	14484900	1193,04	15904838	101548	110930	434,09	10224	561362	1196,68	16072707	100156	115197	414,09	8993	454720
	3	1562,52	20738912	1004,45	18497895	1530,48	20215364	134050	134594	522,36	12337	682792	1532,07	20285094	130765	139059	498,36	10856	553743
	3,5	1828,44	24361047	1254,17	22446828	1797,85	23901967	158009	158575	611,12	14473	807386	1804,66	24021378	155170	163197	583,12	12740	655566

Z-profile

Technical properties

Type	Thickness	Weight	B1	B2	C	D	A	Ø	fy
	mm	daN/m	mm	mm	mm	mm	mm	mm	N/mm2
Z350	2	9,00	93	85	29,5	56,5	240	18	350
	2,5	11,25	94	86	30,0	56,5	240	18	350
	3	13,50	95	87	30,5	56,5	240	18	350
	3,5	15,75	96	88	31,0	56,5	240	18	350
Z400	2	9,80	93	85	29,5	56,5	290	18	350
	2,5	12,25	94	86	30,0	56,5	290	18	350
	3	14,70	95	87	30,5	56,5	290	18	350
	3,5	17,50	96	88	31,0	56,5	290	18	350



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$A_{s,eff,fl2}$ - $I_{s,eff,fl2}$ - $W_{eff\ 2a,b}$ = flexural loaded, small pressed flange

Type	Thickness	A_{br}	I_{br}	$A_{s,eff}$	$I_{s,eff}$	Large pressed flange							Small pressed flange						
						$A_{s,eff,fl1}$	$I_{s,eff,fl1}$	$W_{eff,1a}$	$W_{eff,1b}$	A_{fz1}	W_{fz1}	I_{fz1}	$A_{s,eff,fl2}$	$I_{s,eff,fl2}$	$W_{eff,2a}$	$W_{eff,2b}$	A_{fz2}	W_{fz2}	I_{fz2}
	mm	mm^2	mm^4	mm^2	mm^4	mm^2	mm^4	mm^3	mm^3	mm^3	mm^3	mm^4	mm^2	mm^4	mm^3	mm^3	mm^3	mm^3	mm^4
Z350	2,0	1135,40	19705103	502,86	13537294	896,04	16140985	81033	107743	366	8311	469697	903,44	16385892	80845	111988	350	7303	380112
	2,5	1423,17	24785317	736,11	19479723	1209,80	22246122	113580	136694	459	10449	595232	1216,02	21983328	112741	141819	439	9185	482290
	3,0	1712,52	29927883	977,85	25313721	1572,04	27929217	152665	166191	552	12611	724114	1565,57	27868863	148067	171203	528	11090	587428
	3,5	2003,44	35133194	1223,42	30886594	1940,95	34002323	191345	195081	646	14798	856394	1928,75	33949455	185429	200987	618	13019	695575
Z400	2,0	1235,40	27191425	501,65	17903738	929,49	21570127	92659	129777	386	8459	493588	936,46	21869636	92462	134603	370	7428	399433
	2,5	1548,17	34184876	734,66	25806784	1254,74	29037000	129749	164790	484	10637	625605	1259,95	29346393	128735	170579	464	9344	506892
	3,0	1862,52	41257443	977,05	33629323	1629,95	37347489	174016	200385	582	12841	761181	1619,10	37203848	168690	206167	558	11286	617496
	3,5	2178,44	48409566	1224,37	41174244	2013,12	45441028	217726	235089	681	15071	900370	1999,85	45315646	211224	241734	653	13252	731300

Z-profile

2. Basic principles

2.1. Installation

General

When installed as a roof purlin, the Z profile is suspended on the cleat perpendicular to the roof plane of the building with the upper flange facing the cam (Figure A). The purlin is mounted to a cleat, which is bolted or welded.

To prevent the purlin from being pressure loaded, about 5 mm should be left between the bottom flange and the rafter.

When used as a wall application, the profile is referred to as a side rail, and is placed horizontally on a cleat with the outer flange facing downwards. (Figure B)

Spacers and tie wires are placed between each roof purlin or side rail where necessary. Refer to Chapter 3 for a more detailed explanation of spacers and tie wires. It must be determined whether spacers and tie wires must be used based on the design calculations.

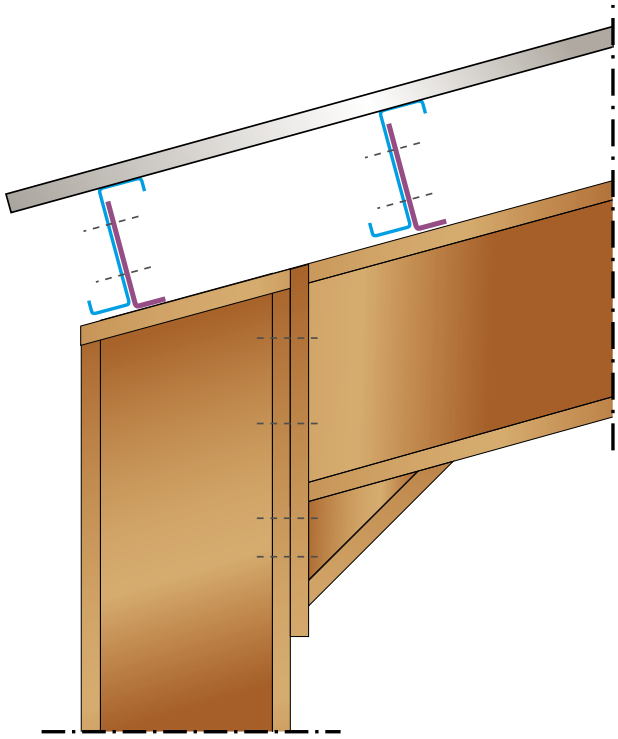


Figure A

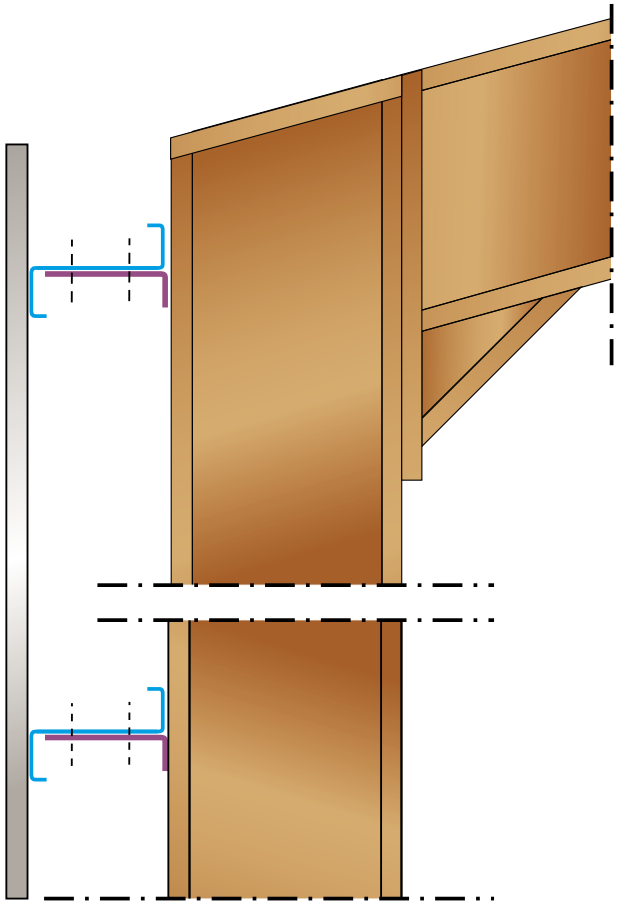


Figure B

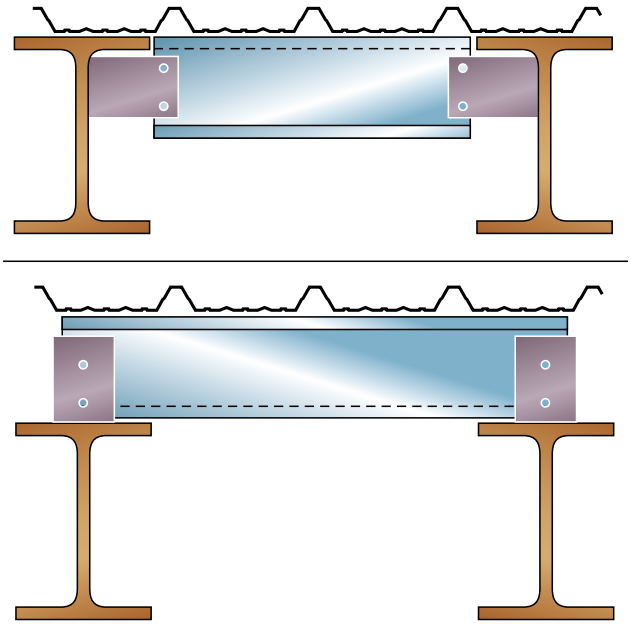
Z-profile

Installation

There are three possible installation methods:
- single bay
- two-bay (purlins supported by three support points)
- continuous girder system

Placement on two supports

- as a roof purlin: for small rafter distances
  mounting between or on top of the rafters (Figures A & B)
- as a side rail: for small rafter distances
  mounting between the columns (Figure C)



example: (Z140 to Z250)
Figure A - purlins between the rafters
Figure B - purlins on top of the rafters

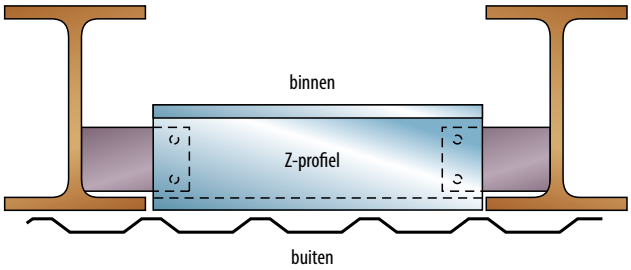
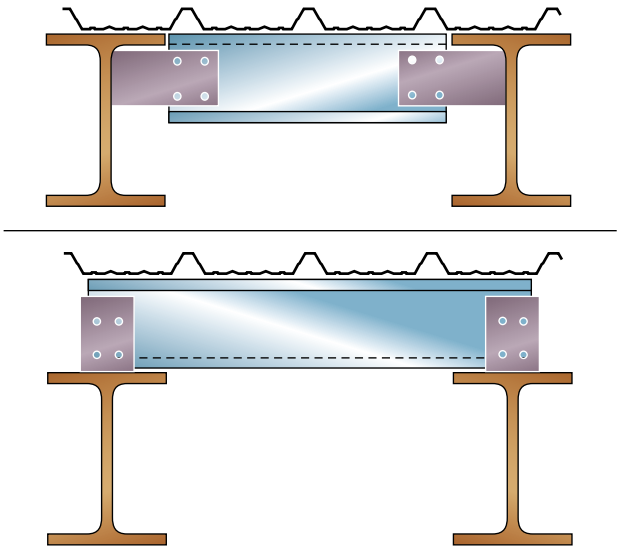
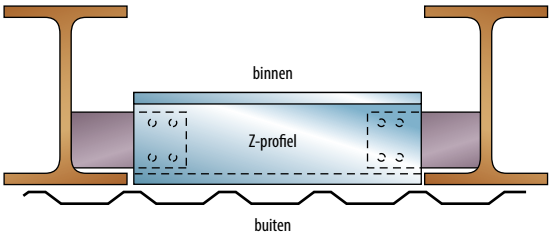


Figure C - side rails between the rafters



example: (Z300 to Z400)
Figure A - purlins between the rafters
Figure B - purlins on top of the rafters



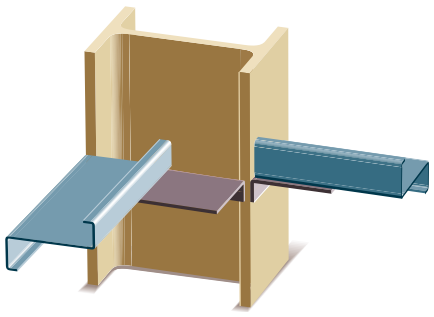


Figure C side rails between the rafters

Z-profile

Basic principles

Continuous installation

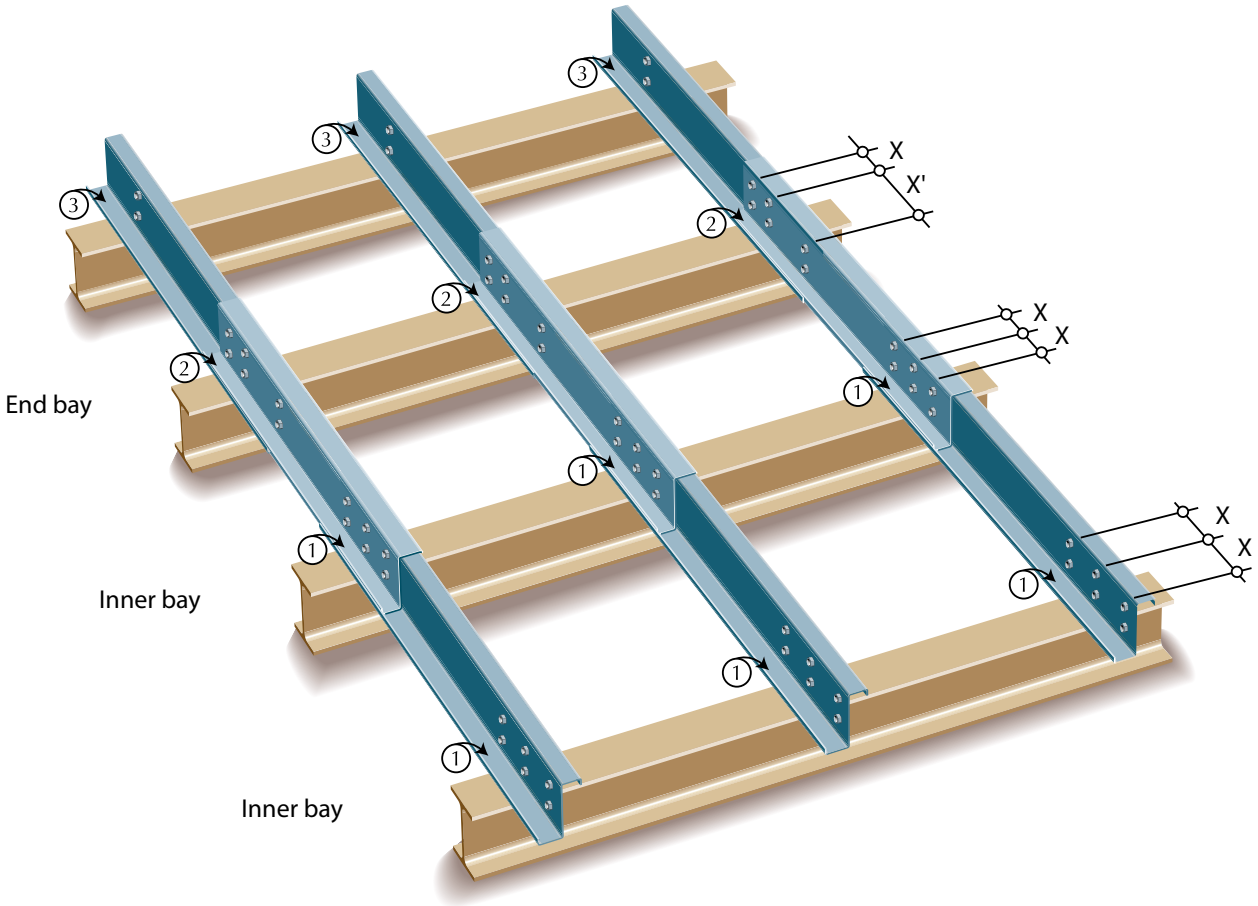
- as a roof purlin — mounting on top of the rafters, larger bays and/or purlin distance
- as a side rail — the same options

In a continuous girder system, each purlin spans one bay at a time, in which system continuity is guaranteed above each support point by sliding the purlin profiles into each other to create an overlap zone. By creating this overlap, you create a double section over a certain length, resulting in virtually complete continuity.
The sagging moment increases in the end bays, based on which these purlins are generally thicker than the inner bays. (For example, this will lead to a thickness of 1.5 mm for the inner bay and 2 mm for the end bay)

The overlap zones are calculated as follows for Z140 to Z300:

x' =	$\frac{\text{Purlin height (mm) x bay (m)}}{1,5}$	= (mm)*	(Z140 to Z300)
x =	$\frac{\text{Purlin height (mm) x bay (m)}}{3}$	= (mm)*	(Z140 to Z300)

***Rounded up (to 0 or 5)**



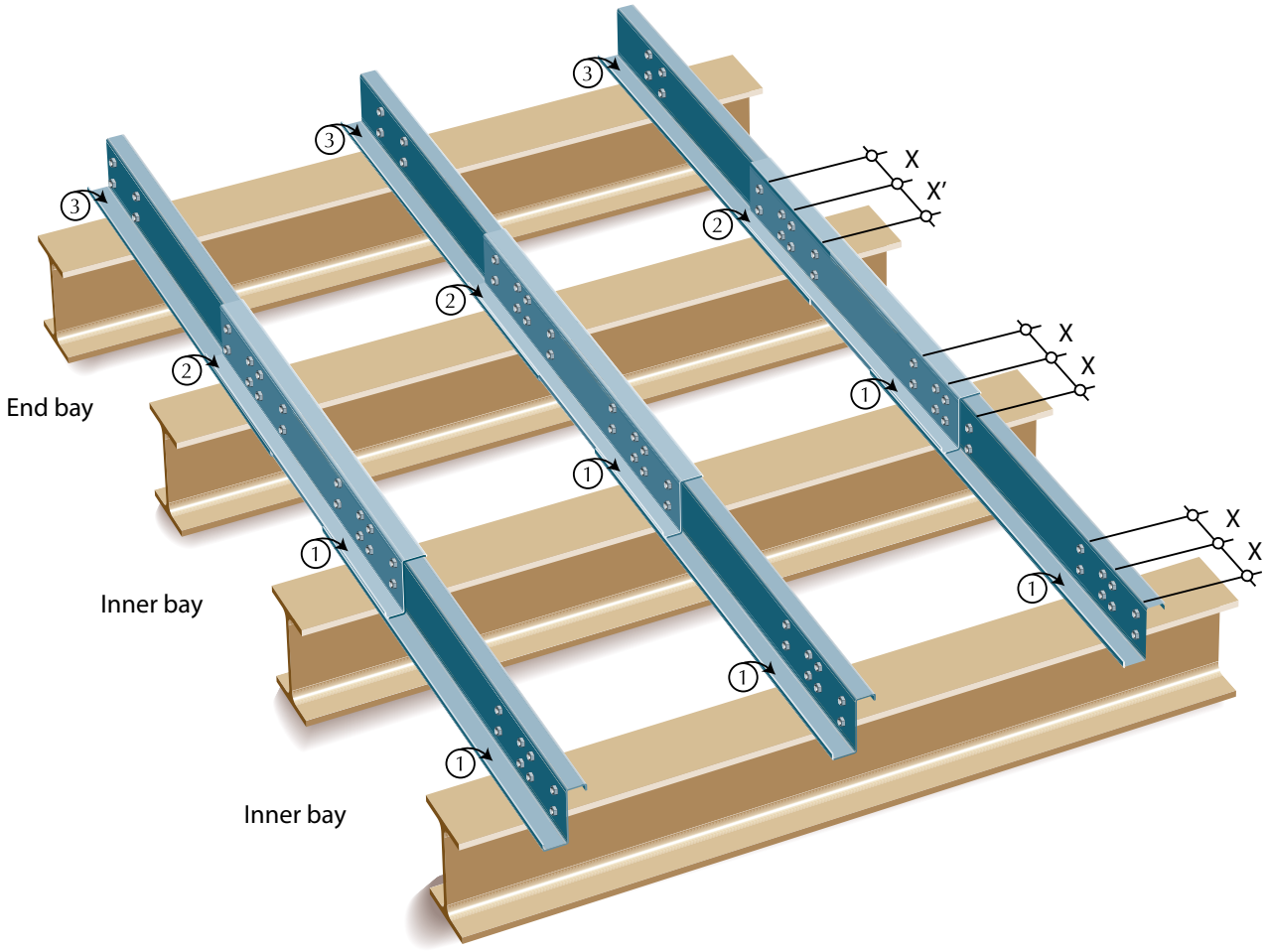
example: (Z140 to Z250)

Z-profile

The overlap zones are calculated as follows for Z350 and Z400:

x' =	0.15 x bay (m)	= (mm)*	(Z350 to Z400)
x =	0,10 x bay (m)	= (mm)*	(Z350 to Z400)

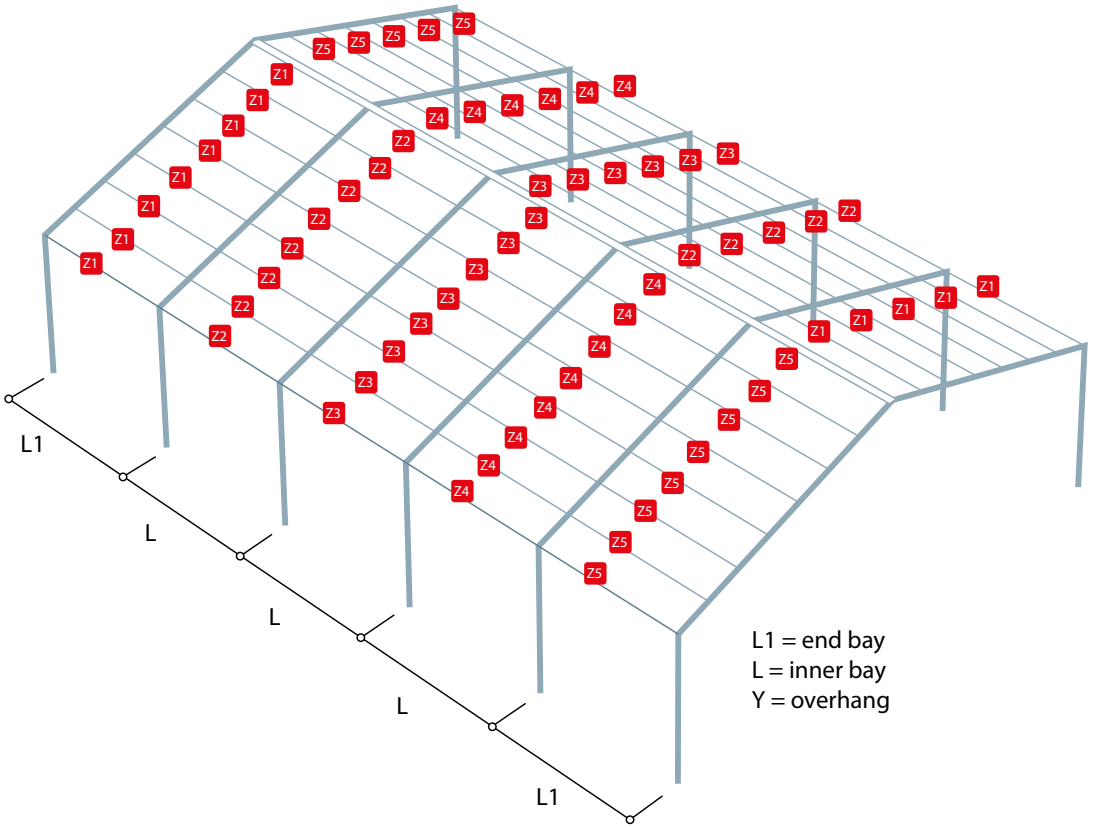
*Rounded up (to 0 or 5)

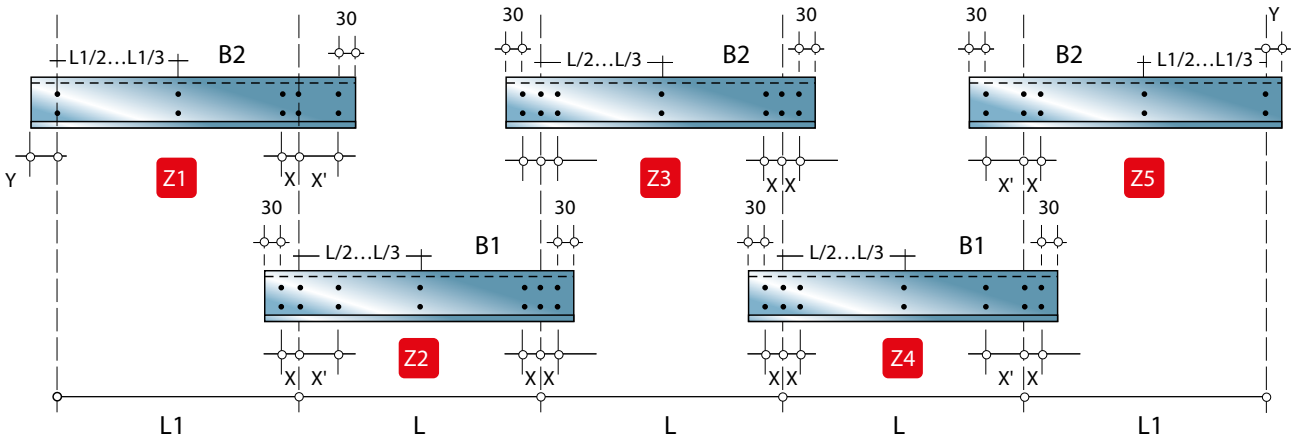


example: (Z300 to Z400)

Z-profile

Continuous Z purlins

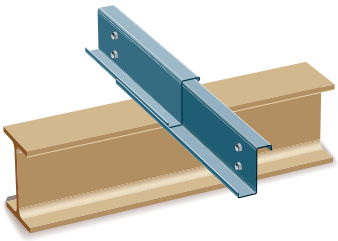


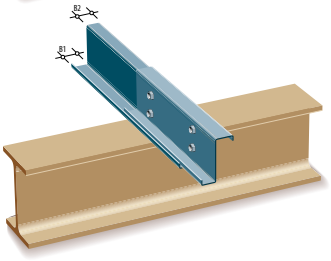


(hole pattern representative of Z140 to Z250)

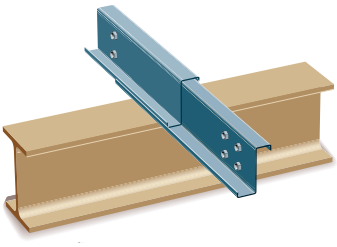
Z-profile

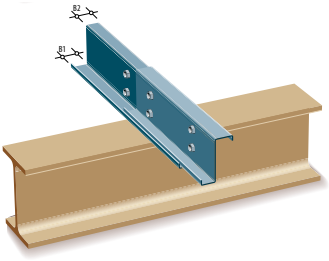
Continuous Z purlins (Z140 to Z250)

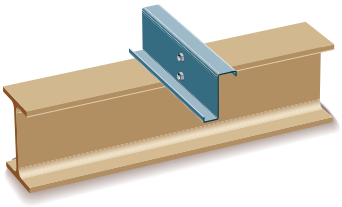




Continuous Z purlins (Z300 to Z400)







2.2. Types of roof and wall cladding

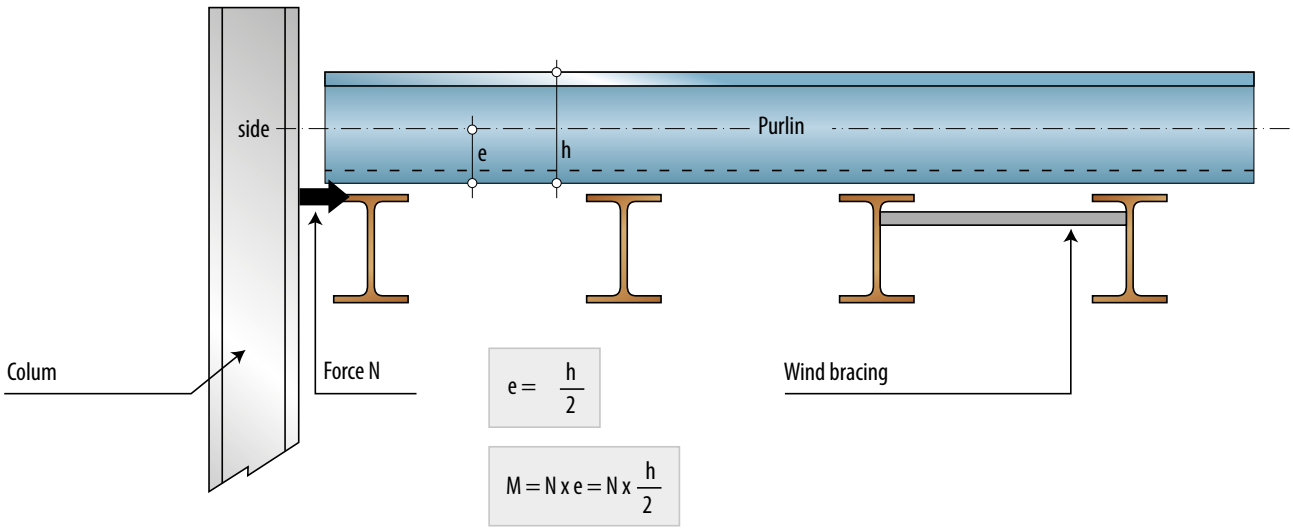
- single-walled profile sheet: steel only
- PIR and rockwool sandwich panels
- fibre cement boards
- Other: forces exerted parallel to the roof slope must be absorbed

2.3. Calculation instructions

If the roof or wall cladding is not supplied by us, the customer should always specify the permanent load per project.

The following rules are used for calculating the weather conditions:
- wind load EN 1991 Part 1.4 + National annexe
- snow load EN 1991 Part 1.3 + National annexe

In the design calculations of the purlins, not only the permanent, wind, and snow loads are considered, but also any regular force on the front façade caused by the wind. It is assumed that this load is exerted on the underside of the purlin, leading to additional torque between the bottom flange and the neutral fibre (half of the height of the purlin). This is considered in the technical calculations.



The builder must take the necessary structural measures in order to comply with these principles. The builder will also provide the following information:
- permanent load, wind area, snow load
- outline of the structure with the laying pattern of the roof purlins and side rails

Joris Ide supplies the roof purlins and side rails complete with:
- the installation plan of the roof and/or side rails
- the substantiating calculation notes

These documents must specifically be addressed to the technical inspector of the project.

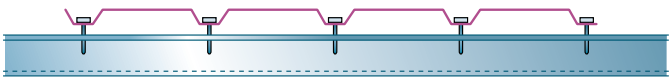
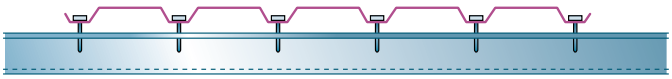
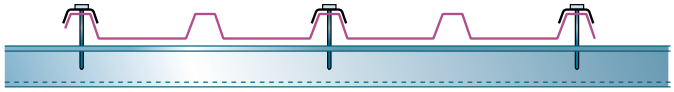
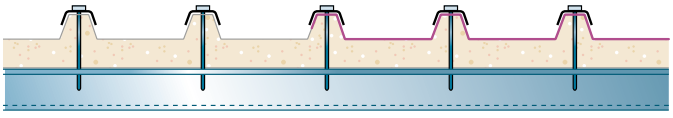
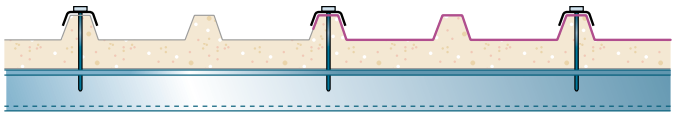
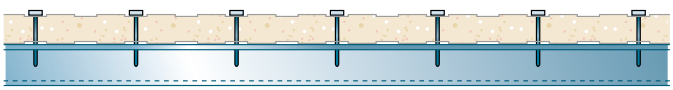
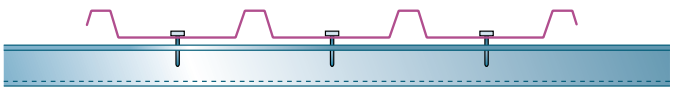
Z-profile

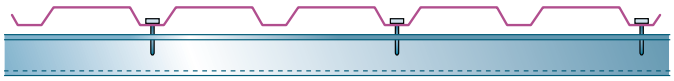
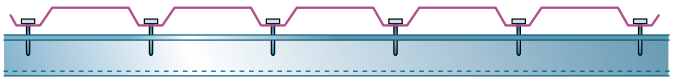
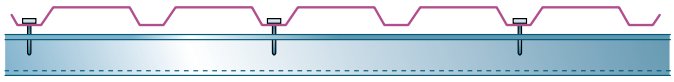
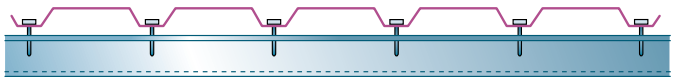
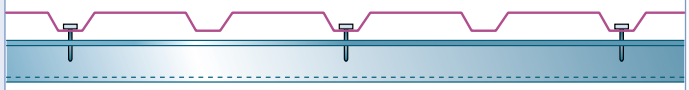
2.4. Purlin calculations

You can always rely on our technical department for design calculations for your Z profiles for roof or wall cladding. We use the calculation standard EN 1993.1.3 and the National annexe.

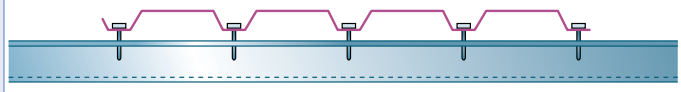
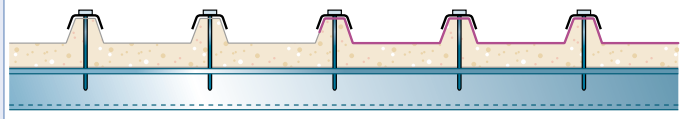
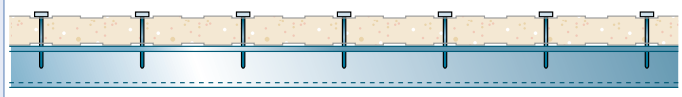
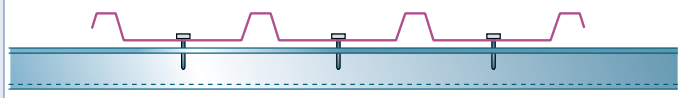
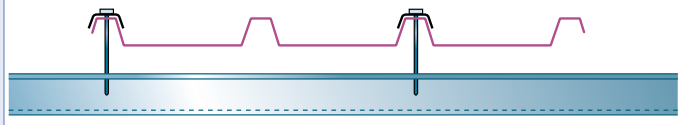
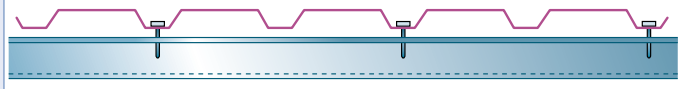
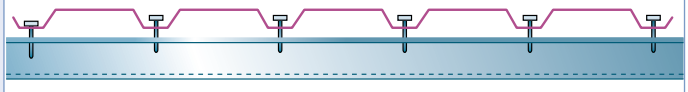
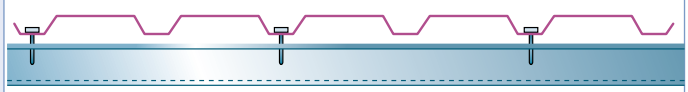
Scope:
- class II roofs for which CDA values are defined
- class III roofs (e.g. fibre cement roofs) which only serve to transfer loads to the main structure (software code 15 for Z140 to Z220 and 45 for Z250 and Z400)

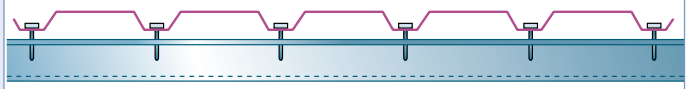
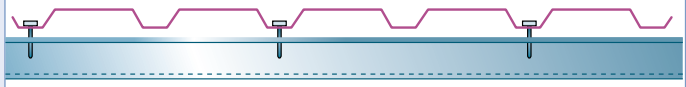
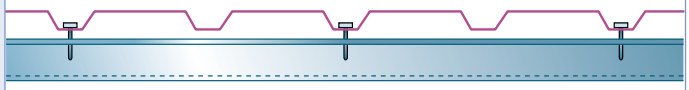
Some installation examples of roof and wall profiles have been set out below. Various parameters are used to calculate the profiles for each mounting and/or profile type. The customer must inform us which type of mounting and profile he wants to use. When using profiles not supplied by Joris Ide, the customer must provide us with the characteristics of these profiles.

Mounting types Z140 to Z220					
Report	Type of roof purlin	↓	C_{DA} kNm/m/rad	↑	C_{DA} kNm/m/rad	Software-code
LMO 98 - 0508	 Cold sheet with dimensions of 45-333 - thickness 0.75 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		0,965		0,839	01
LMO 98 - 0508	 Cold sheet with dimensions of 45-333 - thickness 0.63 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		0,888		0,469	02
LMO 98 - 0508	 Cold sheet with dimensions of 35-207 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		0,659		0,731	03
LMO 98 - 0508	 Cold sheet with dimensions of 35-207 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		0,87		0,914	04
LMO 98 - 0508	 Cold sheet with dimensions of 33-250 - thickness 0.63 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,291		0,324	05
LMO 98 - 0508	 Sandwich panel with dimensions of 33-250 - thickness 0.63 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		1,850		1,963	06
LMO 98 - 0508	 Sandwich panel with dimensions of 33-250 - thickness 0.63 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,364		0,584	07
LMO 98 - 0508	 Wall sandwich panel - thickness 0.63 mm - Mounting every 250 mm		1,842		1,399	08
LMO 98 - 0508	 Cold sheet - Mounting with saddle washers/ridge boards		0,33		0,272	9

Mounting types Z140 to Z220						
Report	Type of roof purlin	↓	C_{DA} kNm/m/rad	↑	C_{DA} kNm/m/rad	Software-code
LMO 00 - 011	 Cold sheet with separate insulation - dimensions of 45-333 - thickness 0.63 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,417		1,42	13
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,925		1,15	21
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		1,712		1,538	22
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - perforated - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,801		0,887	23
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		1,537		1,835	24
LMO 98 - 1908	 Cold sheet with dimensions of 39-333 - Colour profile - thickness 0.63 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,548		0,513	27
LMO 02 - 004	 Cold sheet with dimensions of 37-267 - perforated - thickness 0.72 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,575		0,671	26

Z-profile

Mounting types Z250 to Z400						
Report	Type of roof purlin	↓	C_{DA} kNm/m/rad	↑	C_{DA} kNm/m/rad	Software-code
LMO 99 - 038	 Cold sheet with dimensions of 45-333 - thickness 0.72 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		0,500		1,038	31
LMO 99 - 038	 Cold sheet with dimensions of 25-267 - thickness 0.60 mm - Mounting with saddle washers/ boards		0,980		1,352	32
LMO 99 - 038	 Sandwich panel with dimensions of 33-250 - thickness 0.56 mm PIR - Mounting to the crown/corrugation with saddle washers/ridge boards		1,749		1,732	33
LMO 99 - 038	 Wall sandwich panel - thickness 0.56 mm - Mounting every 250 mm		1,552		1,537	34
LMO 99 - 038	 Cold sheet - thickness 0.72 mm - Mounting with saddle washers/ridge boards		0,873		1,139	35
LMO 00 - 011	 Cold sheet with dimensions of 45-333 - thickness 0.75 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards - steel S280		0,952		1,008	40
LMO 00 - 011	 Cold sheet with separate insulation - dimensions of 45-333 60 mm - thickness 0.75 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,740		0,846	41
LMO 00 - 011	 Cold sheet with dimensions of 45-333 - thickness 0.75 mm - Mounting to the crown/corrugation with saddle washers/ridge boards - steel S350		0,953		0,917	42
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,857		0,788	51
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		1,509		2,412	52
LMO 01 - 005	 Cold sheet with dimensions of 37-267 - perforated - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		1,267		1,292	53

Mounting types Z250 to Z400						
Report	Type of roof purlin	↓	C_{DA} kNm/m/rad	↑	C_{DA} kNm/m/rad	Software-code
LMO 01 - 005	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		1,637		2,659	54
LMO 01 - 005	 Cold sheet with dimensions of 37-267 - perforated - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		1,104		0,907	55
LMO 02 - 004	 Cold sheet with dimensions of 37-267 - perforated - thickness 0.72 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,520		1,031	56

Purlins for slightly sloping roofs (gradient of 3%) have to be dimensioned for water and snow accumulation loads.

This usually requires a residual gradient of 1% at any point of the roof structure.

'Overflow facilities' must be installed at raised gutters.

The drainage must be properly dimensioned and maintained to prevent water accumulation.

.

Z-profile

2.5. Perforations

Some basic rules can be helpful when determining the perforations:

Purlin:

- viewing direction: from gutters to cam
- flange of the purlin directed towards the cam

Side rail:

- viewing direction: from outside to inside
- outer flange directed towards the ground

Example of Z200 as roof purlin in a continuous girder system

- sbays of 6 m
- overlap: end bay X'= 200 x 6/1,5 = 800 mm
  inner bay: X= 200 x 6/3 = 400 mm

Example of Z350 as roof purlin in a continuous girder system

- bays of 12 m
- overlap: end bay X'= 12000 x 0,15 = 1800 mm
  inner bay: X= 12000 x 0,10 = 1200 mm

Z-profile

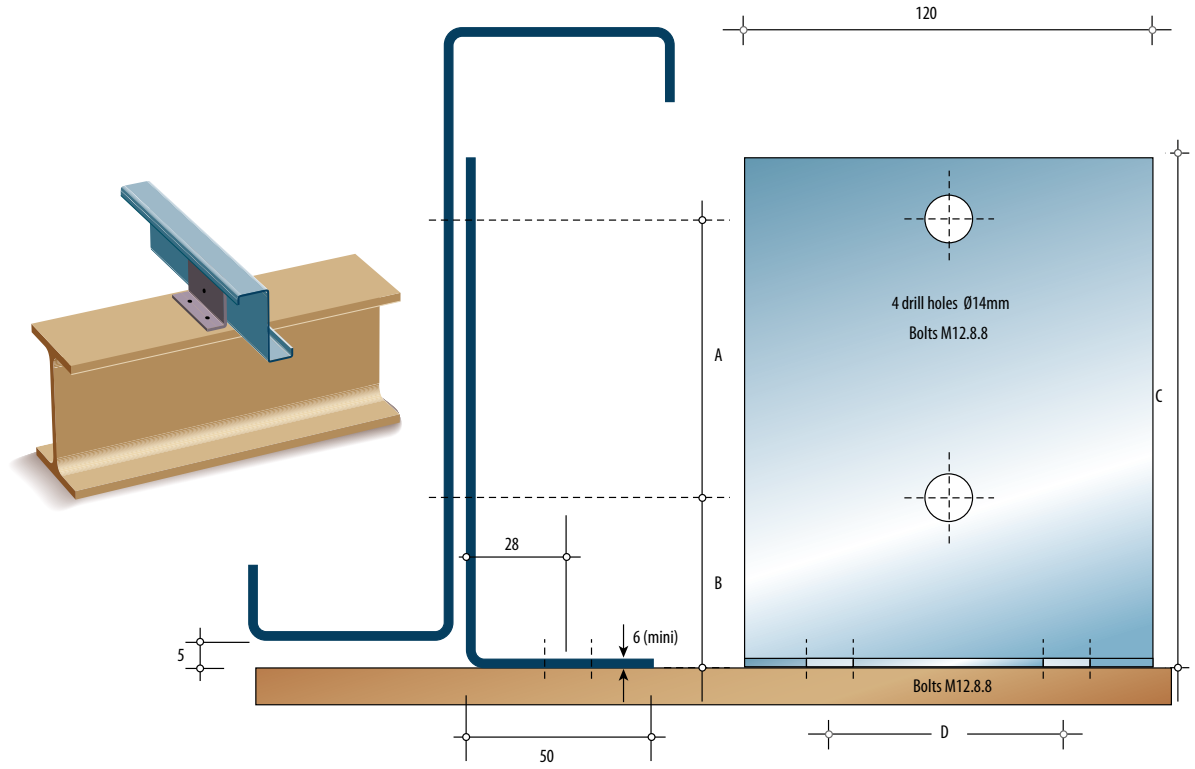
3. Accessories

3.1. Cleats

Z140 to Z220

Cleats serve to fix the purlins to the rafters.
The cleat is at least 6 mm thick and 120 mm wide; the height depends on the purlin type.
In addition to the perforations to secure the purlins, there are two perforations with a diameter of 14 mm for mounting to the rafter. Distance D is 80 mm by default, but can be changed on request.

Available in hot-dip galvanised steel
Characteristics: F_{rd} = 36 kN



Type 2: The same system is used if the side rail is mounted to the columns.

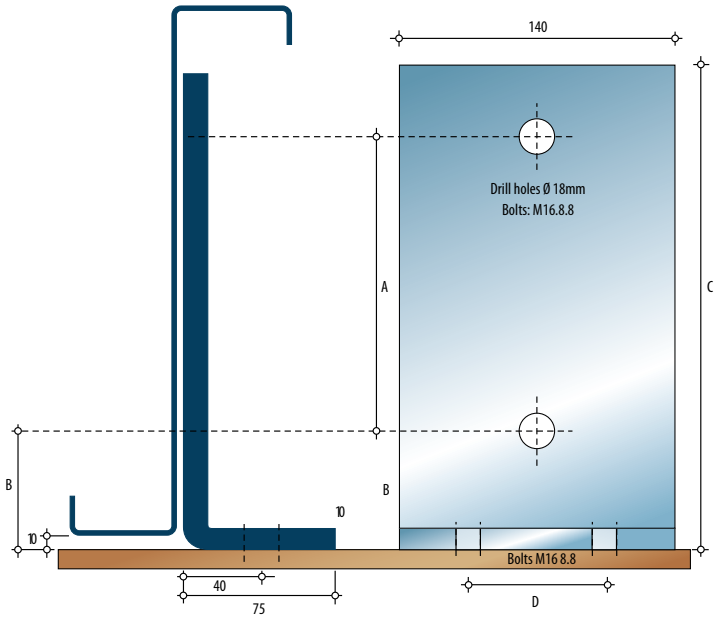
Type	Size A	Size B	Size C	Size D
Z 140	70,0	40	130	80 - Ø 14
Z 160	70,0	50	140	80 - Ø 14
Z 180	81,5	55	155	80 - Ø 14
Z 200	100,0	55	175	80 - Ø 14
Z 220	120,0	55	195	80 - Ø 14

Z-profile

Z250 (normal version)

Cleats Z250 (type 4)

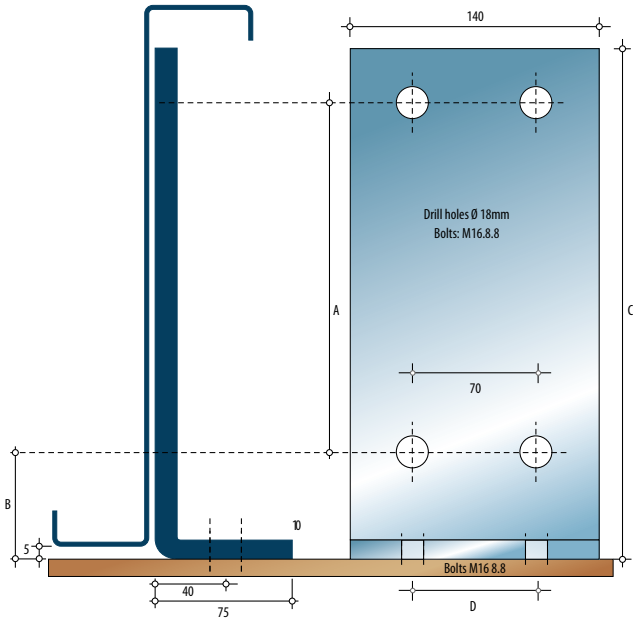
Characteristic:
F_{rd} = 70,08 kN



Z300 (normal version)

Cleats Z300 (type 6)

Characteristic:
F_{rd} = 75,36 kN

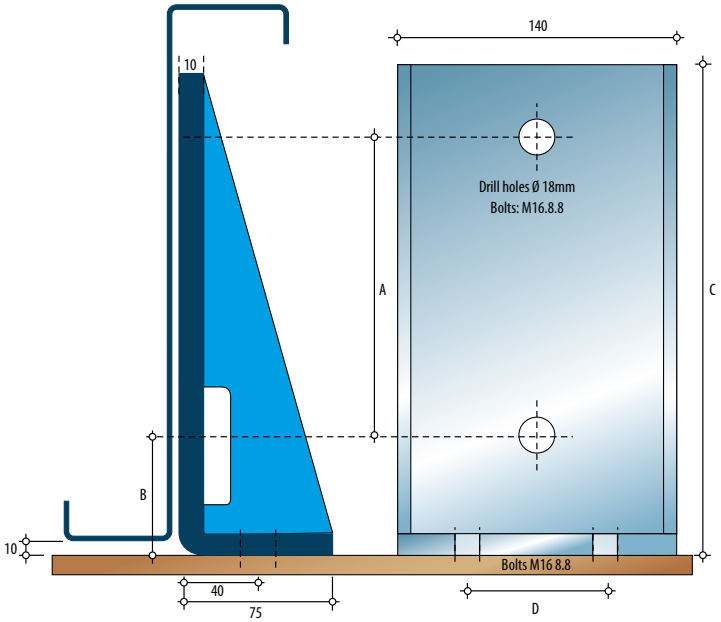


Type	Size A	Size B	Size C	Size D
Z250	150	60	245	70 - Ø 18
Z300	190	60	285	70 - Ø 18

Z-profile

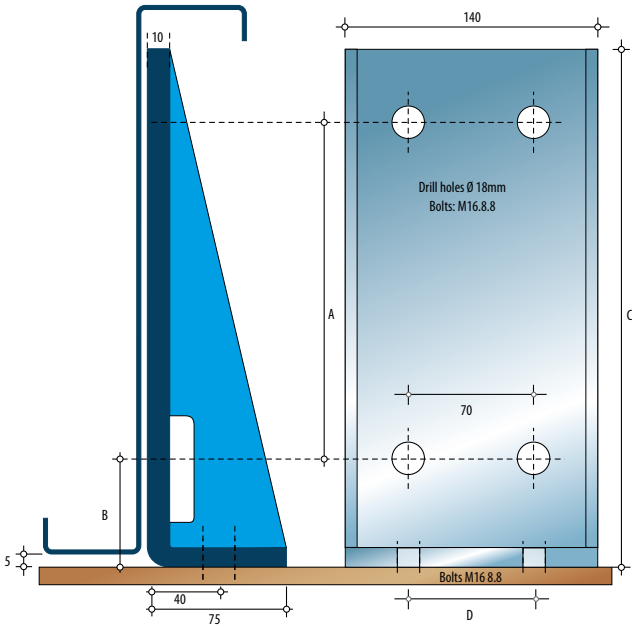
Z250 (reinforced version)

Cleats Z250 (with reinforcement)



Z300 (reinforced version)

Cleats Z300 (with reinforcement)



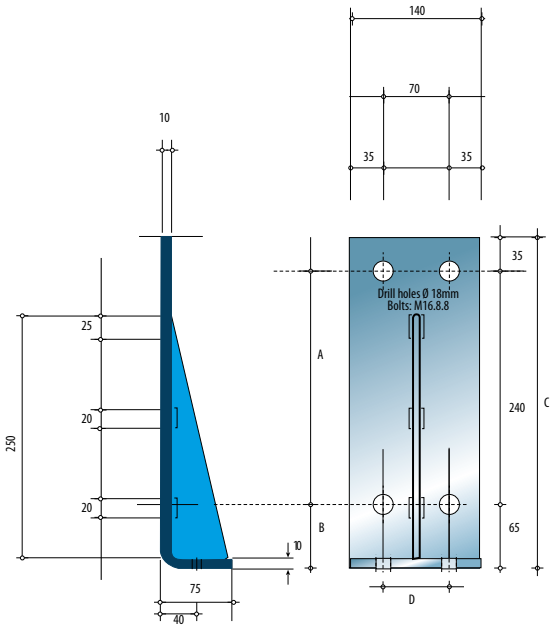
Type	Size A	Size B	Size C	Size D
Z250	150	60	245	70 - Ø 18
Z300	190	60	285	70 - Ø 18

Z-profile

Z350

Cleats Z350 (type 10)

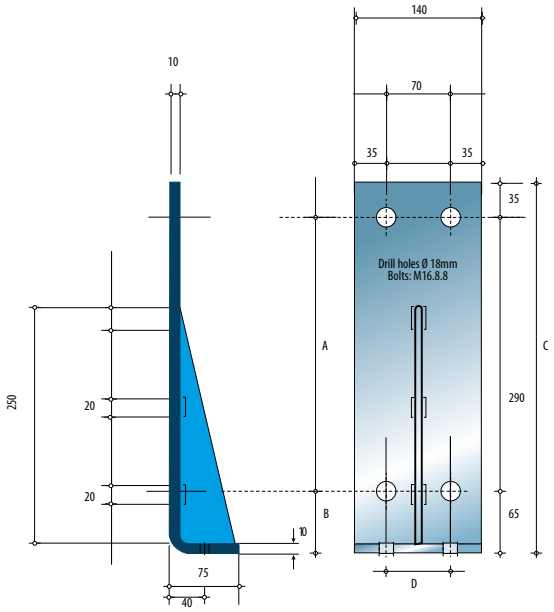
Characteristics:
F_{rd} = 123,4 kN



Z400

Cleats Z400 (type 12)

Characteristic:
F_{rd} = 123,7 kN



Type	Size A	Size B	Size C	Size D
Z350	240	65	340	70 - Ø 18
Z400	290	65	390	70 - Ø 18

Z-profile

3.2. Spacers

Spacers prevent the profiles from sagging into the roof plane. Always use spacers for fibre cement boards. For steel sheets, the solution will be chosen on the basis of the design calculations. This allows a design with or without spacers. The system with spacers is, however, preferred. The spacers are mounted between each row of purlins at the centre or at 2/3rd to 1/5th from the bays.

Joris Ide offers two types of spacers:

- a spacer consisting of a galvanised steel tube of 30 x 1.25 mm, with two perforated painted 5 mm (Z140 to Z300) and 10 mm (Z350 to Z400) endplates welded to each tube end. The spacers are mounted with M12 x 30 bolts, grade 8.8 (Z140 to Z220) or M16 x 35 bolts, grade 8.8 (Z250 to Z400). This system is suitable for models Z140 to Z400
- a spacer consisting of a galvanised steel tube of 30 x 1.25 mm (Z140 to Z250) with press-fitted synthetic caps. The one end piece has a male thread of M12 x 30, grade 8.8, and the other end piece an M12 female thread, grade 8.8. This system is suitable for models Z140 to Z250..

We usually recommend:

- one spacer per bay for small rafter distances.
- two (maximum of four) spacers per bay for larger spans

Building with pitched roof

- spacers on both roof planes
- for the cam spacer, you should specify the roof pitch and the distance between the centreline of the purlin and the cam measured on the purlin

Building with lean-to roof

- spacers between each row of purlins

The same principles apply for side rails.
Spacers are always used in combination with tie wires. This installation method is explained in paragraph 3.4.

Characteristics

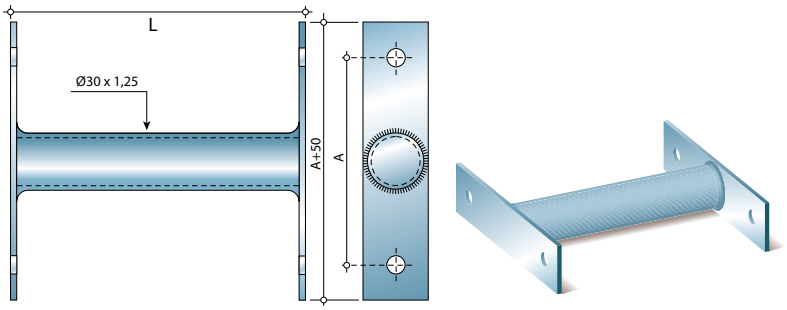
- standard NF EN 10025
- steel type S235 JR
- spacers with plastic caps
- welded spacers

Fy	= 235 N/mm^2
F_{rd}	= 11,41 kN (Z140 to Z250)
F_{rd}	= 9,25 kN (Z140 to Z220)
F_{rd}	= 8,98 kN (Z300)
F_{rd}	= 20,08 kN (Z350)
F_{rd}	= 14,46 kN (Z400)

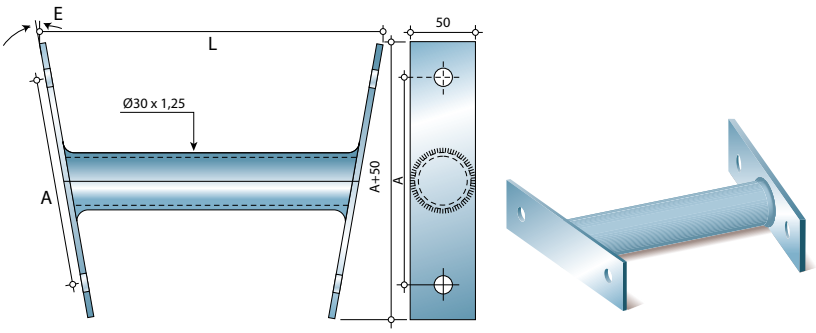
Z-profile

H: 140 to 400 mm				
Type	Dim A	Ø (mm)	End plate (mm)	Type
Z 140	70,0	14	5	2
Z 160	70,0	14	5	2
Z 180	81,5	14	5	2
Z 200	100,0	14	5	2
Z 220	120,0	14	5	2
Z 250	150	18	5	4
Z 300	190	18	5	6
Z 350	240	18	10	8
Z 400	290	18	10	10

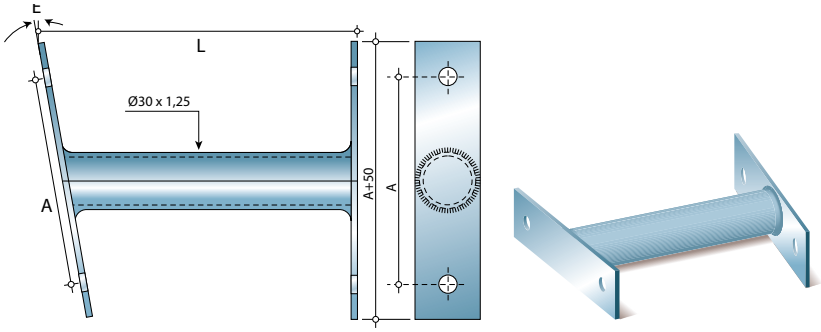
Spacer (Z140 to Z400)



Cam spacer (Z140 to Z400)



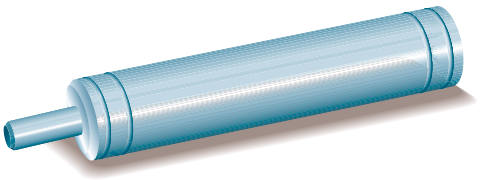
Spacer (Z140 to Z400)



Z-profile

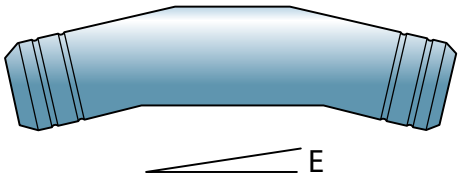
Spacer (type 3, Z140 to Z250)

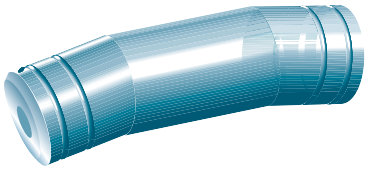
Ø30 x 1,25



Cam spacer (type 3, Z140 to Z250)

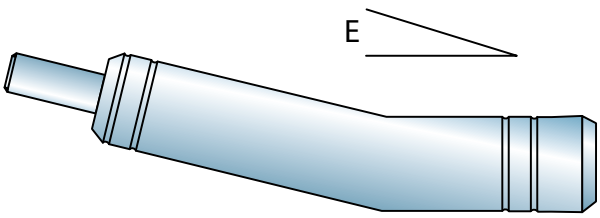
Ø30 x 1,25

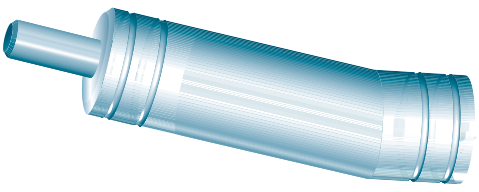




Spacer (type 3, Z140 to Z250)

Ø 30 x 1,25





3.3. Tie wires

Tie wires in combination with spacers prevent the purlin from sagging into the roof and/or wall plane

Tie wires are steel cables with a diameter of 5 mm, consisting of two endplates. One with an M10 thread to allow adjustment of the tie wire length.
When ordering tie wires, it is sufficient to indicate lengths L1 and L2.

Characteristics
F_{rd} = 12,45 kN

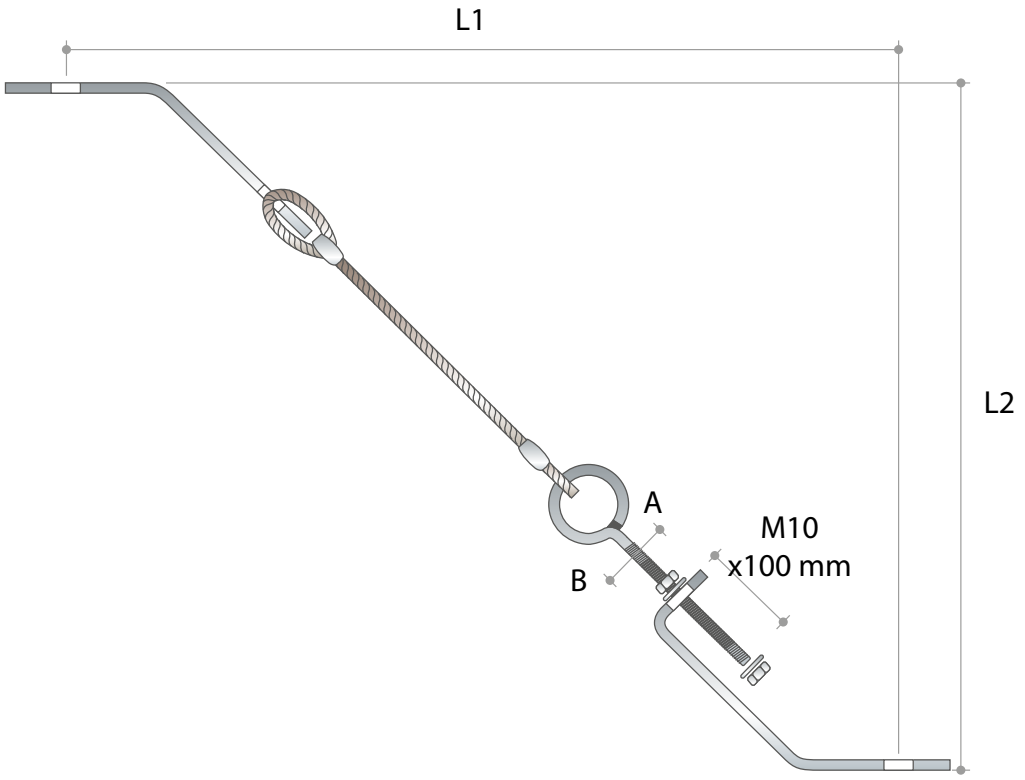
Installation specifications

The endplates are mounted to both ends (purlin and cleat).

Adjustable tie wire

Adjustable double tie wire

Spacer end perforation Ø 14 mm (Z140 to Z250)
Spacer end perforation Ø 18 mm (Z300 to Z400)



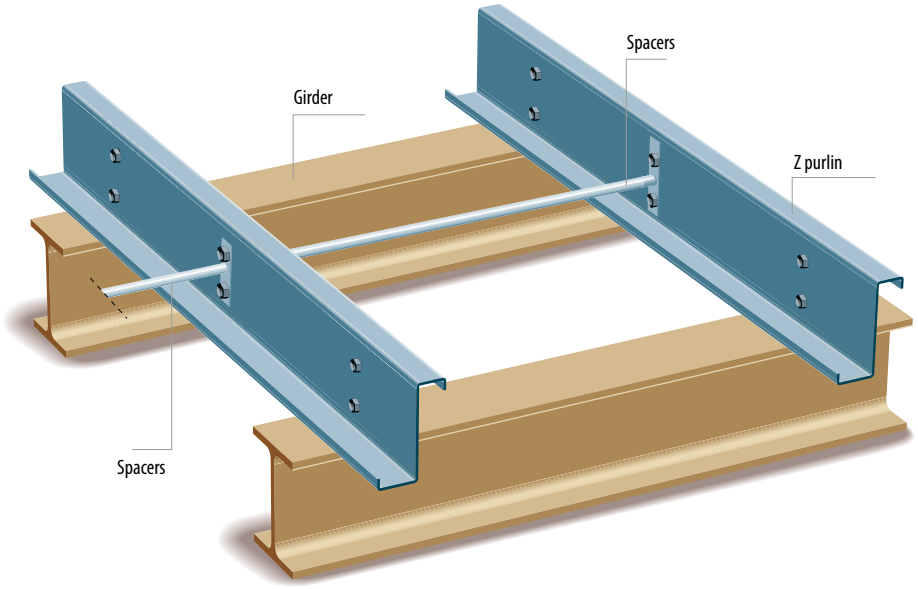
Cleat end perforation Ø 14 mm (Z140 to Z220)
Cleat end perforation Ø 18 mm (Z250 to Z400)

Cleat end perforation Ø 14 mm
(Z140 to Z220)
Cleat end perforation Ø 18 mm
(Z250 to Z400)

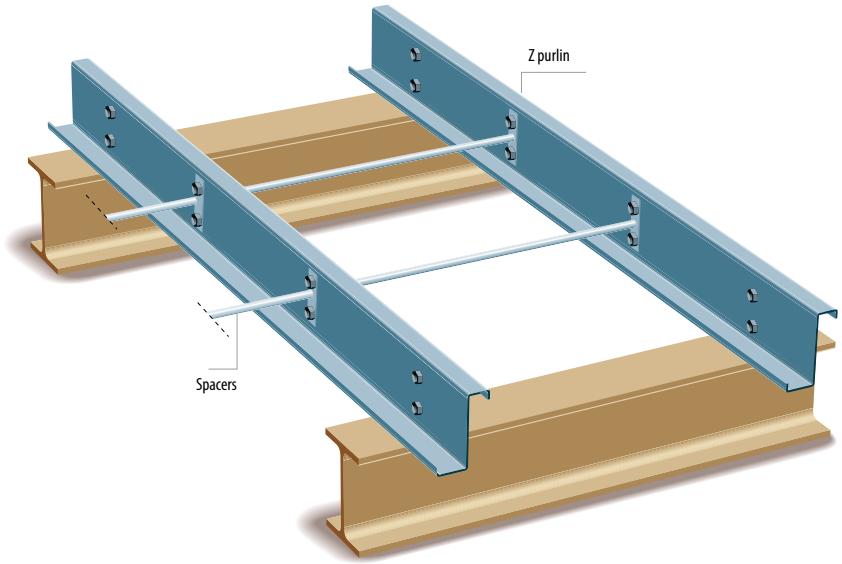
Spacer end perforation Ø 14 mm (Z140 to Z250)
Spacer end perforation Ø 18 mm (Z300 to Z400)

3.4. Installation examples

Roof purlins (small rafter distances)
One row of spacers

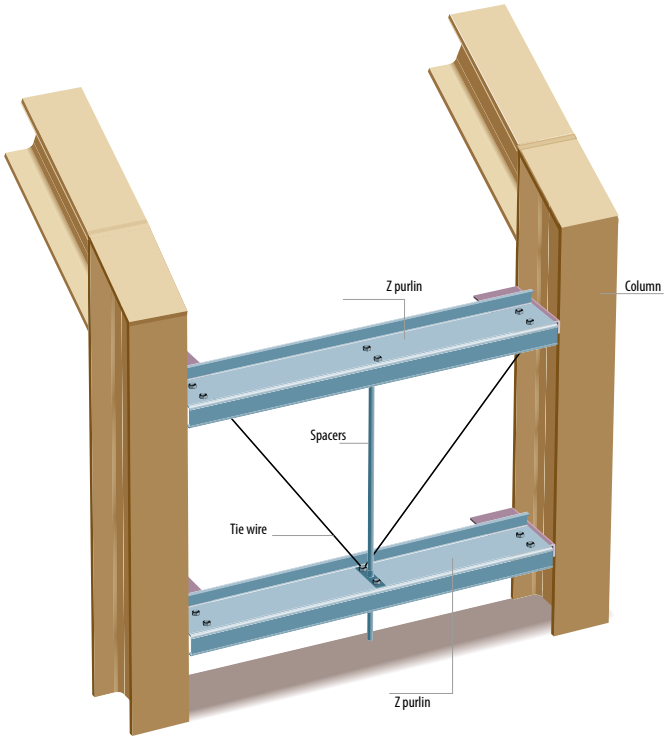


Roof purlins (larger spans)
2 rows of spacers

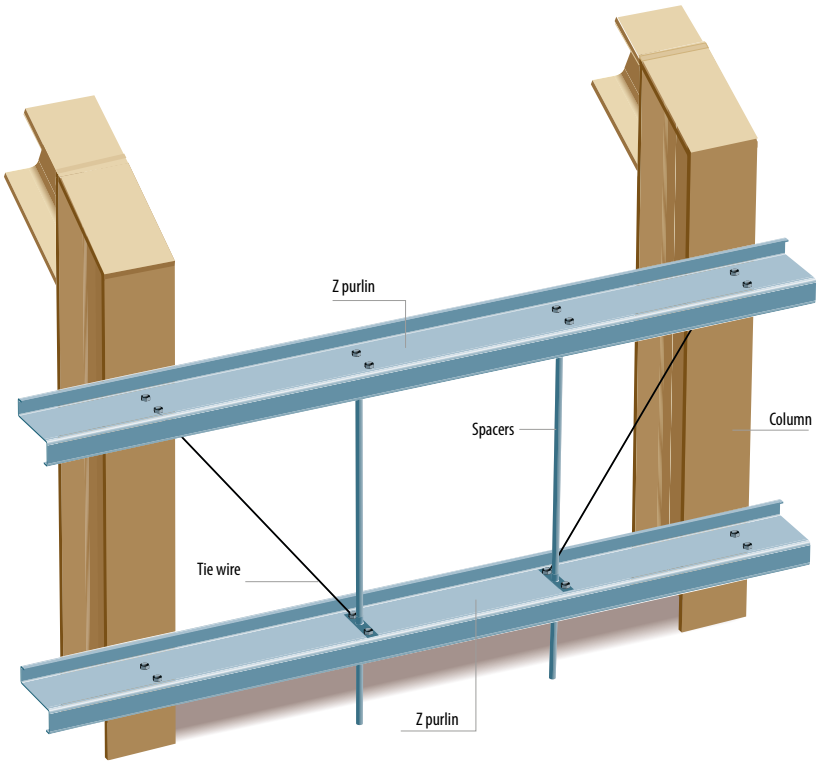


Z-profile

Side rail mounted between the columns



Side rail mounted to the columns

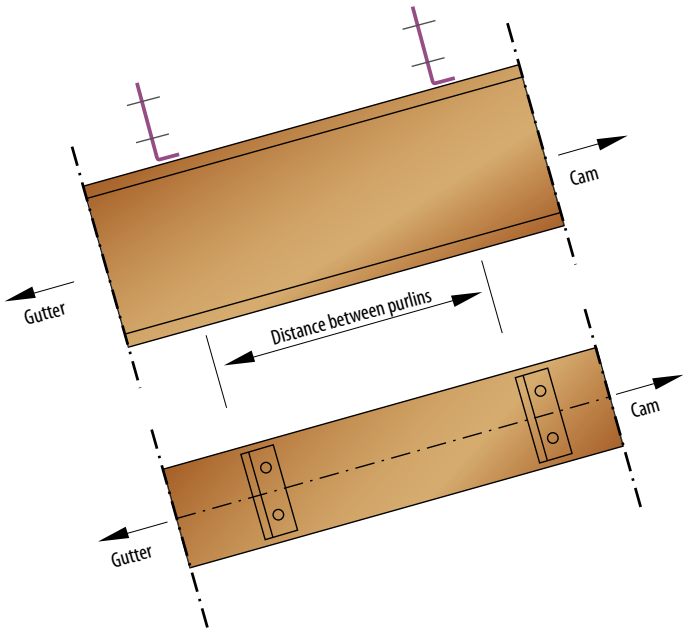


4. Installation guidelines

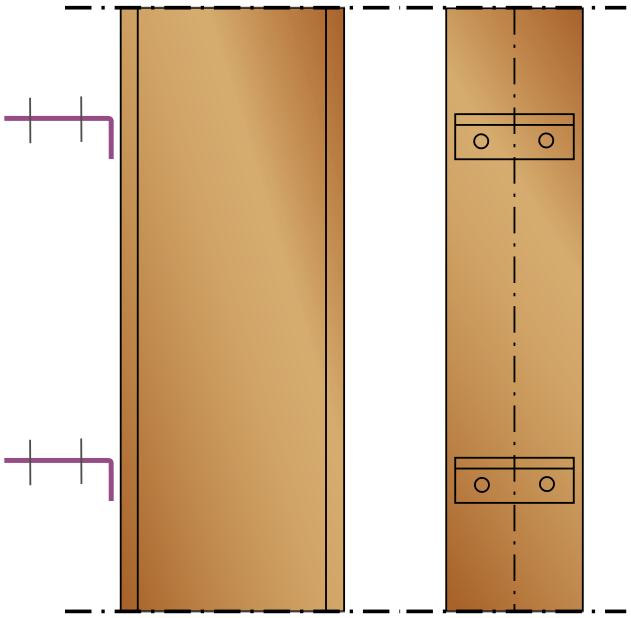
4.1. Installation of cleats for roof purlins or side rails

The cleats are welded or bolted to the rafter or the column. They are welded or bolted in accordance with the laying pattern. When mounting spacers, the maximum permissible intermediate spacing tolerance is 1 mm. For bolted cleats, the perforations in the rafter are 28 mm (Z140 to Z220) and 40 mm (Z250 to Z400) (respectively) higher than the centreline of the purlin. The purlins are only mounted after the cleats have been secured.

Mounting to roof purlins



Mounting to side rails



4.2. Installation of roof purlins

The purlins are mounted to cleats with two M12 x 25 bolts, grade 8.8 (Z140 to Z220), two M16 x 35 bolts, grade 8.8 (Z250), and four M16 x 35 bolts, grade 8.8 (Z300 to Z400). They are bolted to the cleats with the flange of the roof purlin facing the cam.

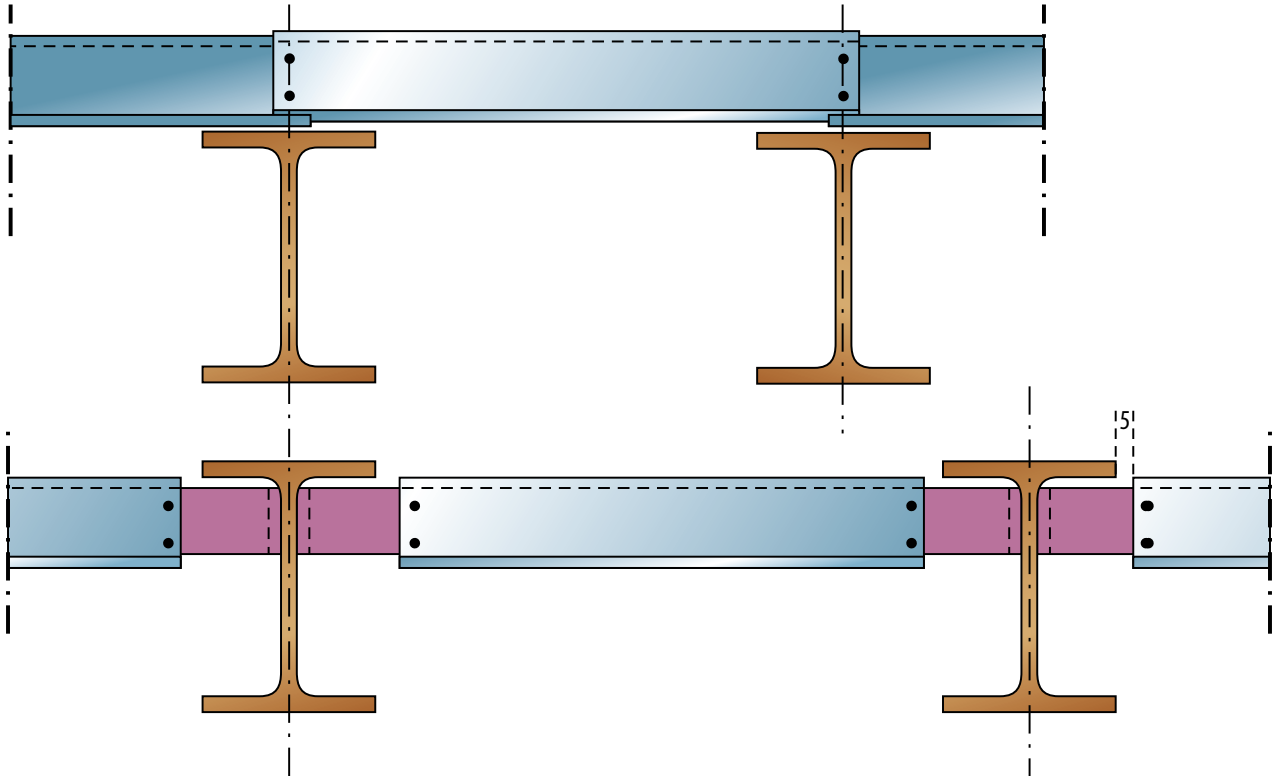
Purlin on top of rafters on two supports

The purlins are only sleeved to secure them. In this case, each cleat spans two purlins. The resulting overlap between purlins is disregarded in the design calculations.

Purlin between rafters

Allow 5 mm space from the edge of the rafter on either side of the purlin. The same rules apply for side rails that are mounted in front of or between the columns.

Purlins placed on two supports



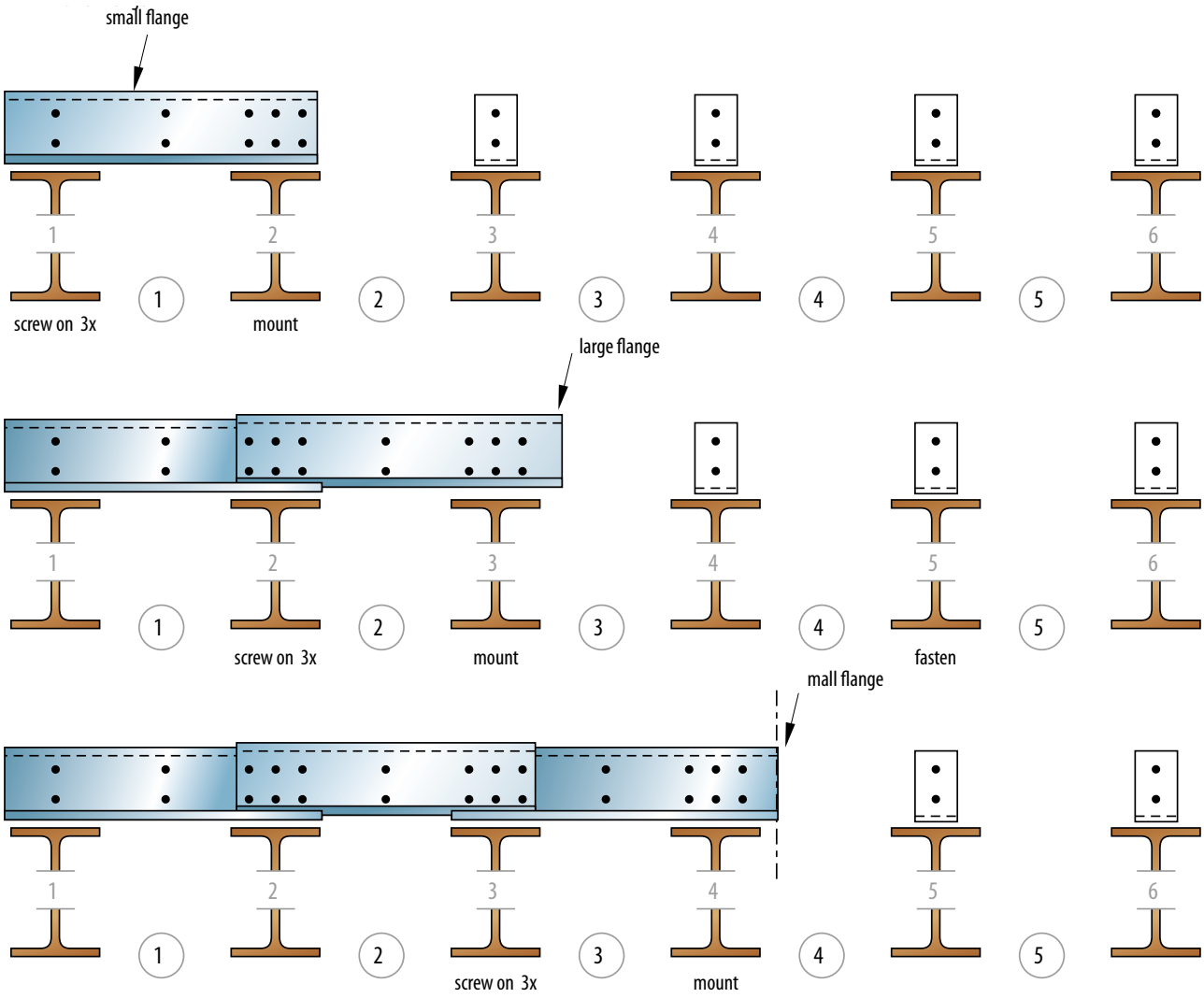
(example Z140 to Z250)

Z-profile

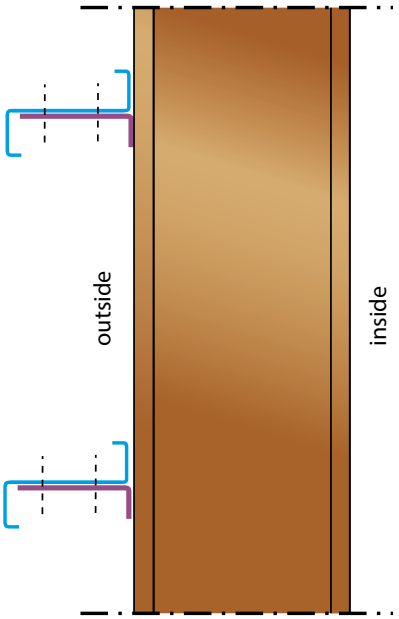
Installation example of purlins in a continuous girder system (Z140 to Z220)

For purlins in a continuous girder system, start with the smallest flange of the purlin facing upwards and the largest flange facing downwards in the first bay. In the second bay, the purlin is mounted with the wide flange facing upwards.

This assembly is repeated continuously further into the building.



4.3. Installation of side rails



4.4. Mounting roof and wall sheeting

The sheeting should be fixed correctly to absorb a potential diaphragm effect. If necessary, spacers and tie wires must be mounted before installing the roof or wall cladding.

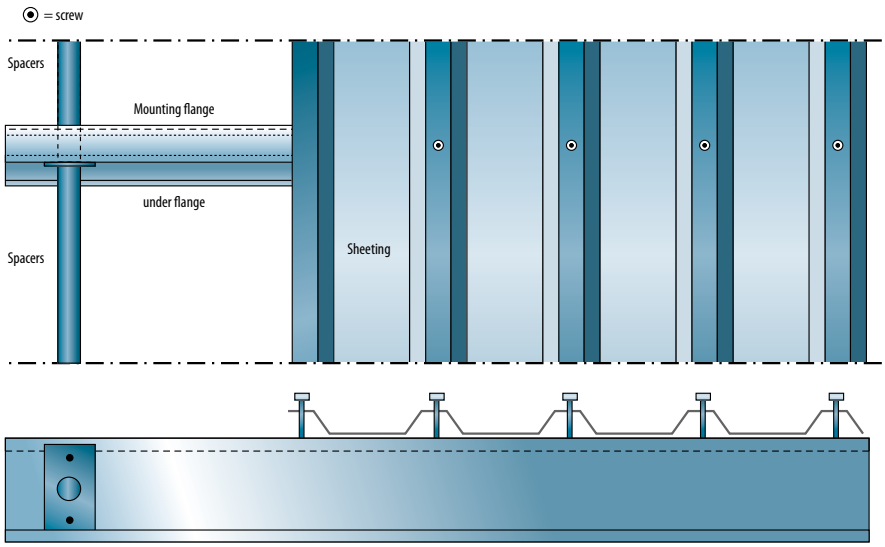
If no spacers are used, the installation company must verify that the purlins are completely straight in the roof plane.

An installation template can be used to align the purlins properly for small rafter distances. The sheets are mounted with self-tapping screws into the centreline of the flange of the Z profile.

A tolerance of ± 10 mm is allowed to mount the profile fasteners correctly in relation to the centreline of the flange.

The installer can place a guidewire above the sheets across the entire length of the centreline of the flanges of the purlins to comply with these tolerances.

Mounting in the centreline of the flange of the Z profile



4.5. Mounting the spacers and tie wires

Spacers

There are two types of spacers:
- a spacer made of galvanised tube with painted endplates
- a spacer made of galvanised tube with plastic caps

The classic spacer made of galvanised tube with endplates (Z140 to Z400) is fixed between the roof purlins or side rails before the roof or wall cladding is mounted. These are mounted with two M12 x 25 bolts, grade 8.8 (Z140 to Z220), two M16 bolts, grade 8.8 (Z250-Z400). The spacers are made to measure based on the purlin distance.

The spacer with plastic caps (Z140 to Z250) is fixed between the roof purlins or side rails prior to mounting the roof or wall cladding. The last spacer (= gutter side) is mounted with an M12 x 45 bolt, grade 8.8.

The roof or side rail purlin system can be executed in different ways:

- without spacers: recommended only for small rafter distances
- with one spacer per bay, at the centre
- with two spacers per bay, at one-third
- three (and up to four) spacers for larger spans

The execution method of the roof or side rail system depends on the building design and the design studies carried out by Joris Ide.

Tie wires

The tie wires are secured at the location of the spacers and the cleat, thus transferring the forces occurring in these spacers to the steel structure.

The laying pattern of the tie wires in the roof or side rails system is determined based on the design calculations and should, for this reason, be listed in the corresponding installation plan.

Below, you can find the various mounting options for buildings with:
- a pitched roof
- a lean-to roof

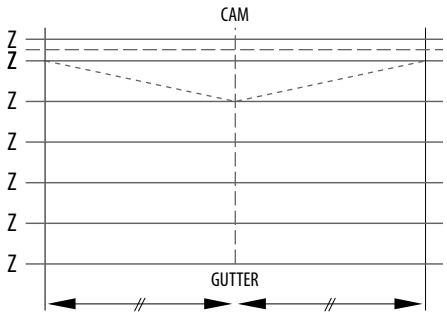
The tie wires for side rails must preferably be placed between the first and second upper rail.

Z-profile

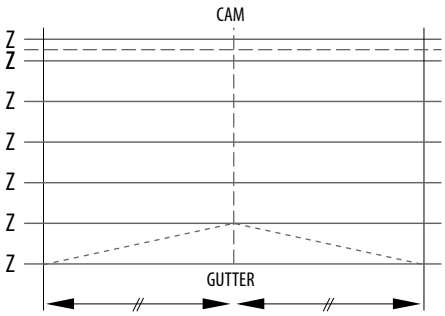
Installation with one spacer

PITCHED ROOF

Tension is crucial

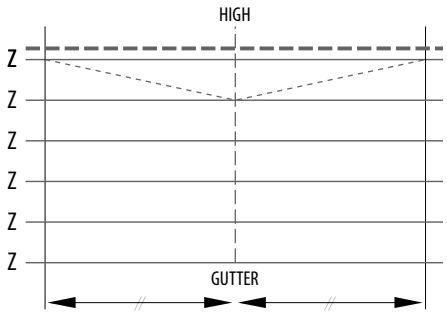


Pressure is crucial

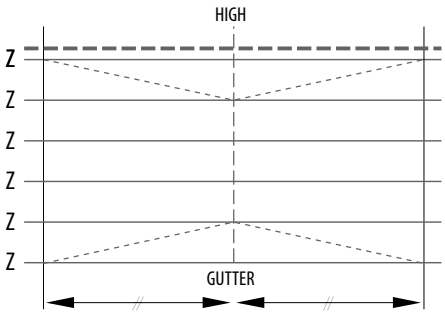


LEAN-TO ROOF

Tension is crucial



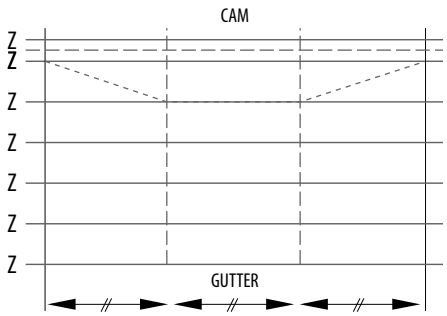
Pressure is crucial



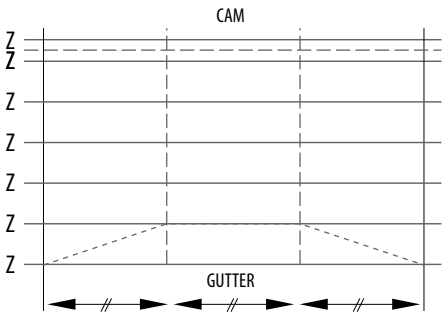
Installation with two spacers

PITCHED ROOF

Tension is crucial

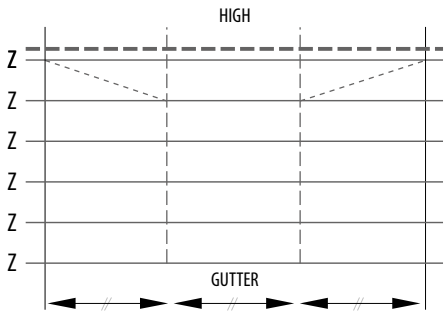


Pressure is crucial

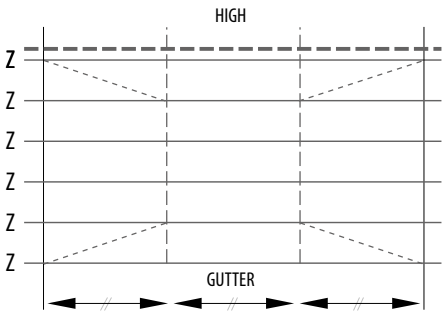


LEAN-TO ROOF

Tension is crucial



Pressure is crucial

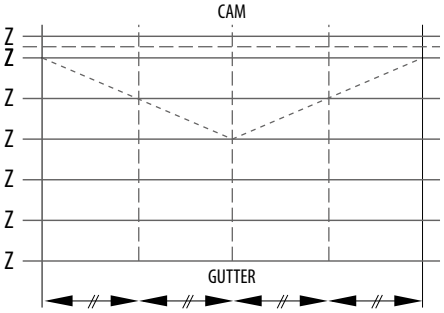


Z-profile

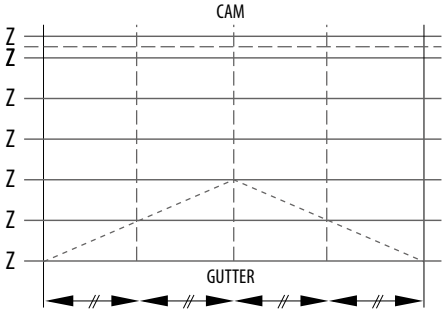
Installation with three spacers

PITCHED ROOF

Tension is crucial

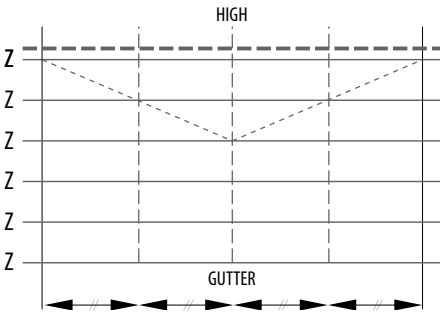


Pressure is crucial

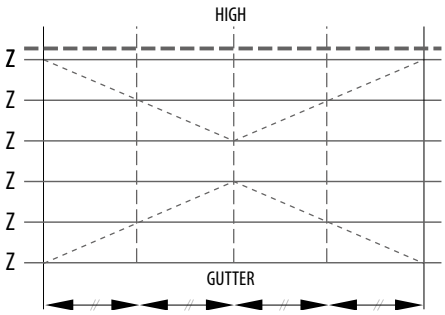


LEAN-TO ROOF

Tension is crucial



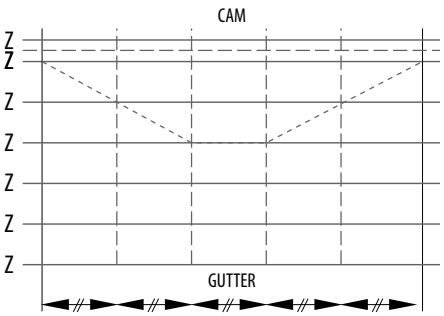
Pressure is crucial



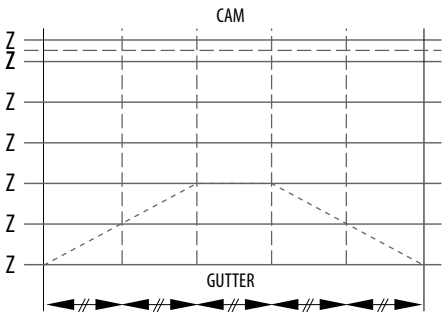
Installation with four spacers

PITCHED ROOF

Tension is crucial

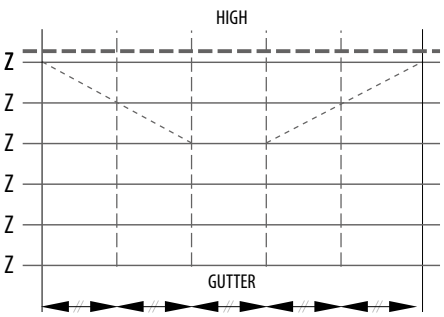


Pressure is crucial

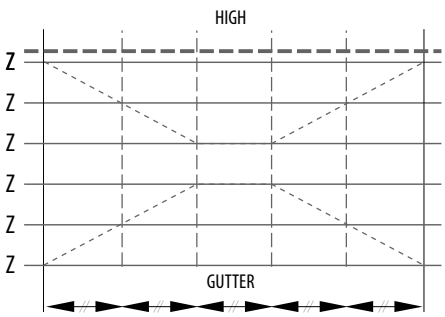


LEAN-TO ROOF

Tension is crucial



Pressure is crucial

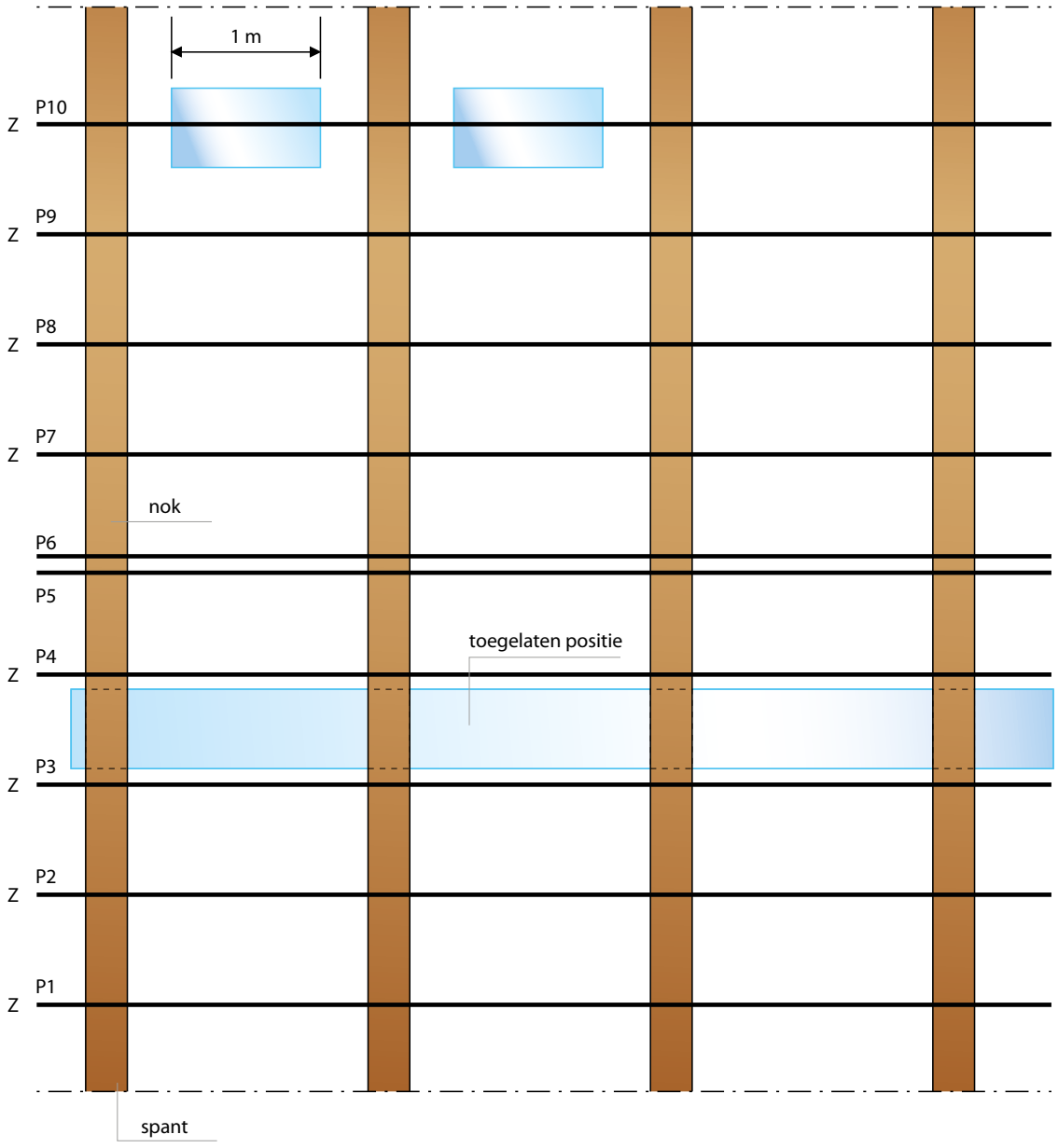


4.6. Installation of skylights

In order to consider the diaphragm effect in the design calculations, the purlin must be stabilised crosswise in the cladding plane using the steel profile and associated mounting equipment.

The following resulting limitations must be taken into account when installing skylights
.

Skylight locations

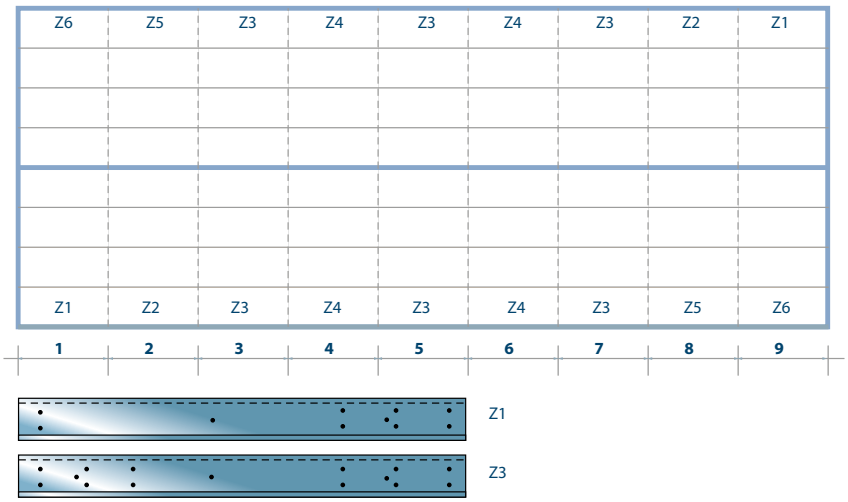


If the skylights are located perpendicular to the purlins, a width of 1 m is allowed. The roof ensures that the purlins stay in place in case of skylights between two adjacent roof purlins.

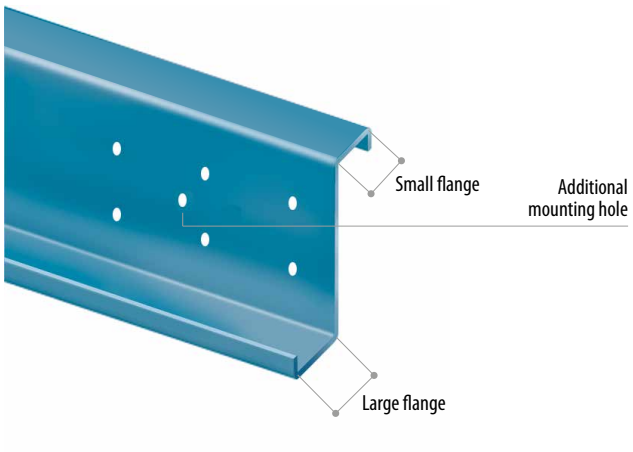
4.7. Economical continuous system (ECS)

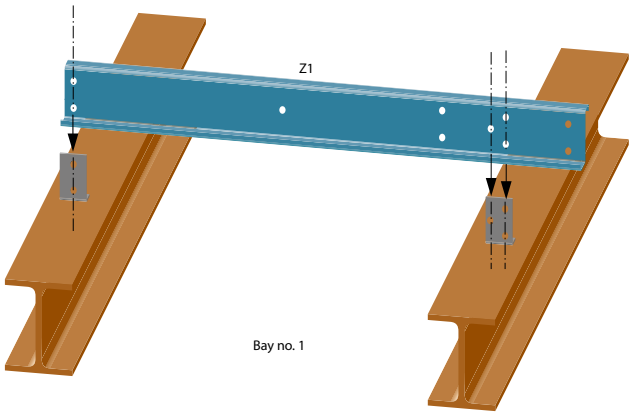
The most economical way to mount purlins is continuous installation. Additional perforations in the web of the purlin ensure a faster installation.

The drawing below, with associated text, explains this simple installation method.



Above bays 1 and 3, the purlins are mounted with the small flange (B2) facing upwards through the additional mounting hole. The purlin can be fully secured at the end wall.

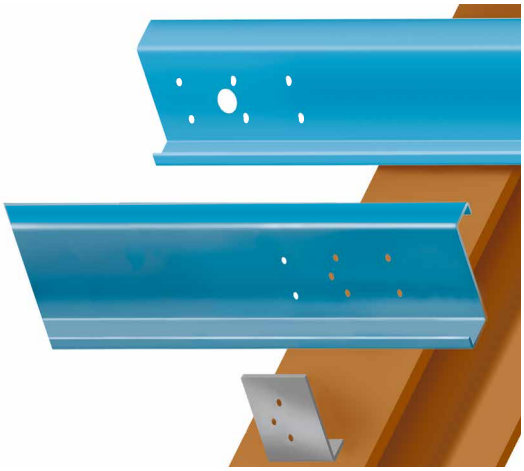




top of small flange

Z-profile

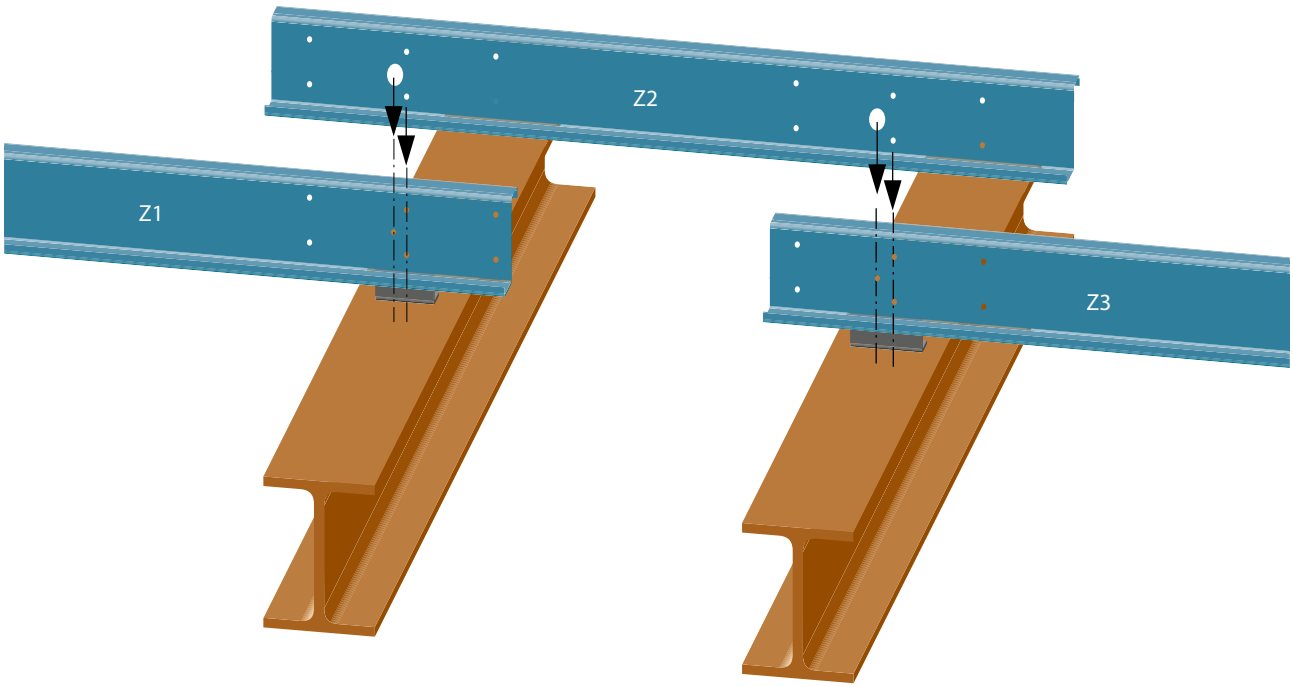
After the installation of Z1 and Z3, Z2 is mounted with the large flange facing upwards. The additional perforation of Z2 has a larger diameter, which means that Z2 fits over the already mounted bolts of Z1 and Z3.



The first 2 rafters can now be finished. In the next step, Z3 is remounted in bay 5, and Z4 fits over Z3 twice in bay 4.

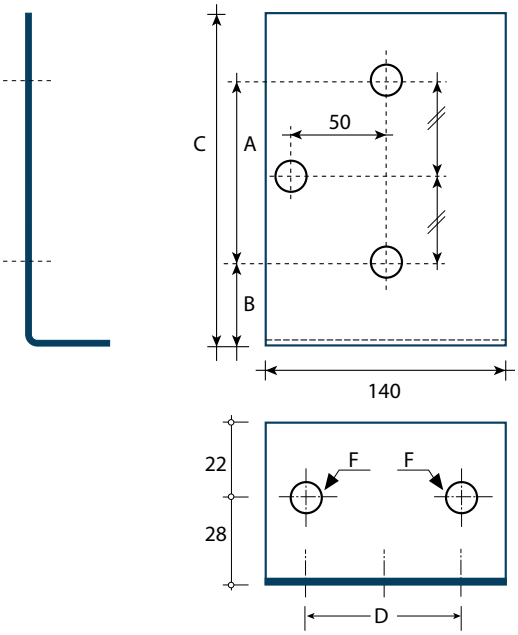
Comments:

- the additional perforations are placed horizontally at 50 mm to the left of the purlin centreline and vertically in the middle of the final installation holes
- a customer only needs to indicate whether the extra hole is small or large when placing an order



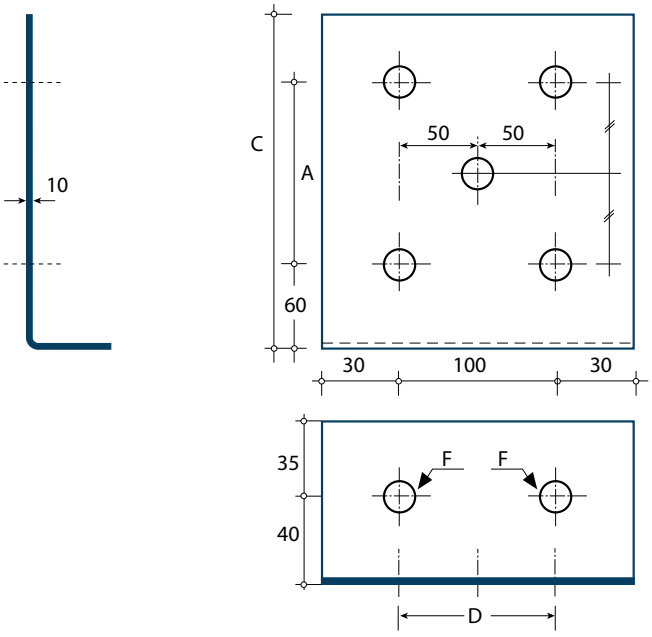
Z-profile

Bolted cleat Z140 - Z250



perforations diam. 14 (Z140-Z220)
perforations diam. 18 (Z250)

Bolted cleat Z300 - Z400



perforations ø 18 mm

Sigma-profile

5. Foreword

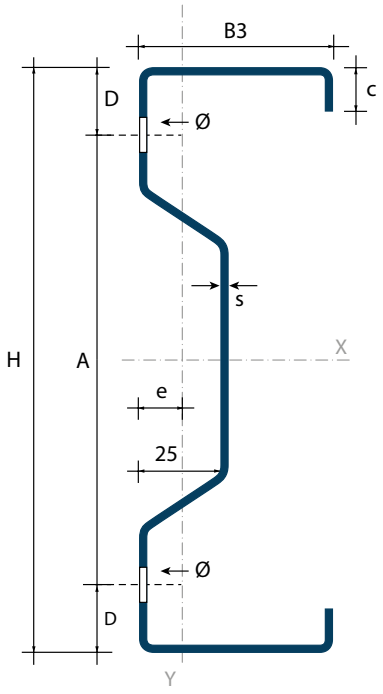
5.1. Sigma purlins in the construction sector

Products have become subject to increasingly stringent requirements in recent years. Economic efficiency is becoming increasingly important. The construction sector is not spared from this development and has made good progress in terms of flexibility and possibilities.

To meet this demand, Joris Ide NV offers an alternative to traditional roof purlins and side rails: Sigma purlins, cold-rolled galvanized profiles, which are a simple replacement for timber or rolled sections: Our Sigma purlins are the ideal solution for new construction and renovation projects.

Type	H	B3	D	A	ø	C
	mm	mm	mm	mm	mm	mm
Σ140	140	56	20	100	14	15
Σ170	170	56	20	130	14	15
Σ200	200	56	20	160	14	15
Σ230	230	56	20	190	14	15

Type	Thickness	Weight	E
	mm	daN/m	mm
Σ140	1,5	3,50	20,6
	2	4,55	20,8
	2,5	5,65	20,9
Σ170	1,5	3,80	21,2
	2	5,10	21,2
	2,5	6,3	21,2
Σ200	1,5	4,20	21,5
	2	5,5	21,5
	2,5	6,8	21,5
Σ230	1,5	4,50	22,3
	2	6,00	22,4
	2,5	7,5	22,9



Sigma-profile

5.2. Description and advantages

- Sigma purlins are cold-rolled profiles that are symmetrical in relation to a horizontal centreline
- the web profile height varies from 140 mm to 230 mm in increments of 30 mm. The thickness is 1.5 mm, 2 mm, or 2.5 mm
- the flanges of the purlin are 56 mm wide
- Sigma profiles are available with or without perforations
- customised longitudinal perforations can be made in the profile. The perforations are 14 mm in diameter
- the dimensions A [mm] and D [mm] depend on the height of the Sigma profile

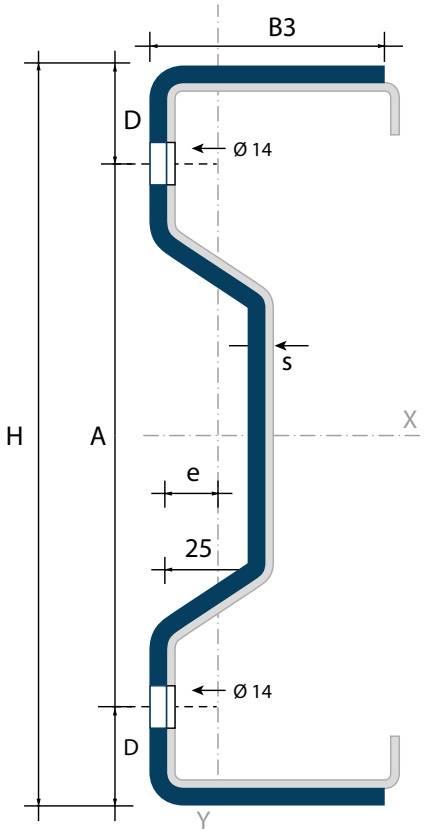
The perforations serve to: secure the Sigma profiles to the cleats
to mount the spacers

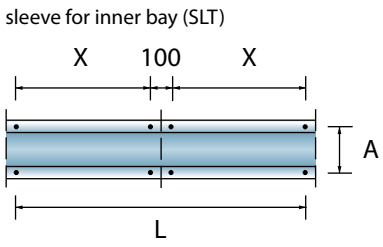
After punching, the purlin profiles and the spacers are cut to size and marked according to the roof purlin or side rail layout plan.

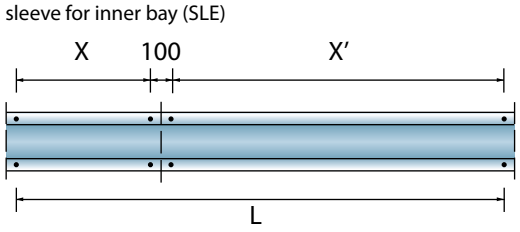
Sleeve

Sigma profiles are connected to each other using specially made sleeves.

Type	Thickness	A	X	X'	$L_{normaal}$	$L_{uitw.}$
	mm	mm	mm	mm	mm	mm
Σ140	2,5	100	270	540	700	970
Σ170	3	130	320	640	800	1120
Σ200	3	160	420	840	1000	1420
Σ230	3	190	520	1040	1200	1720







Sigma-profile

Advantages

These profiles are easier to process because they weigh less than rolled profiles or wood.
There are numerous economical installation options thanks to the perforations and the many custom lengths.
The compact packaging also guarantees lower transport costs.

	Z-gording	Wood	I-profile
Weight (daN/m²)	3,5 to 7,5	> 7	> 7
Purlin distance per profile (m)	8 m	< 7 m	> 10 m
Finish	galvanised	post-treatment	post-treatment
Mounting	bolted	nailed	welded or bolted
Production	to size and punched	cut to size	cut to size and punched
Length (m)	12 m and more	5 to 6 m	12 m
Processing	light	light	heavy

Sigma-profile

5.3. Source material

We use galvanised steel with the following characteristics as source material for the Sigma profiles:

- steel quality in accordance with EN 10346 S350 GD Z275
- galvanising Z275 gr/m^2, Z600 gr/m^2 or hot-dip galvanised in accordance with EN 1461
- yield strength 350 N/mm2
- treatment not oiled

5.4. Technical properties

Sigma-profile

Type	Thickness	Pressed flange				$A_{s, eff, fl}$	$I_{n'n', eff, fl}$	$W_{eff\ y}$	A_{fz}	W_{fz}	I_{fz}
		$A_{s, gross}$	$I_{n'n', gross}$	$A_{s, eff}$	$I_{n'n', eff}$						
	mm	mm^2	mm^4	mm^2	mm^4	mm^2	mm^4	mm^3	mm^3	mm^3	mm^4
Σ140	1,5	440,25	1270700	412,33	1144194	405,57	1108392	17270	133,46	1889	57717
	2	581,72	1664117	561,80	1575675	574,25	1631185	23595	175,52	2430	74268
	2,5	720,56	2042885	705,00	1974301	716,38	2022000	29072	216,36	2929	89563
Σ170	1,5	485,25	2018796	444,51	1818360	450,50	1777553	22612	140,96	1947	62049
	2	641,72	2648724	619,19	2498782	633,08	2591346	30892	185,52	2507	79921
	2,5	795,56	3257668	776,89	3134143	789,98	3217193	38138	228,86	3025	96475
Σ200	1,5	530,25	2985253	452,02	2685840	495,42	2649139	28443	150,59	2007	66941
	2	701,72	3922105	642,56	3690165	692,04	3831994	38845	198,33	2586	86276
	2,5	870,56	4830453	834,61	4632158	863,75	4762640	48026	244,84	3122	104217
Σ230	1,5	575,25	4190322	454,98	3751998	540,34	3743292	34744	159,36	2032	69868
	2	761,72	5511260	651,41	5165913	751,12	5379491	47427	210,14	2618	90062
	2,5	945,56	6794988	853,50	6496395	937,65	6691320	58704	259,75	3161	108802

$A_{s, gross}$ - $I_{n'n', gross}$ unloaded, gross sections
$A_{s, eff}$ - $I_{n'n', eff}$ burdened under pressure, effective properties
$A_{s, eff, fl}$ - $I_{n'n', eff, fl}$ - $W_{eff\ y}$ flexural loaded, pressed flange

Sleeve

Type	Thickness	Pressure load		$A_{s, eff, s}$	$I_{n'n', eff, s}$	$W_{eff\ y, s}$	$A_{fz, s}$	$W_{fz, s}$	$I_{fz, s}$
		$A_{s, gross, s}$	$I_{n'n', gross, s}$						
	mm	mm^2	mm^4	mm^2	mm^4	mm^3	mm^3	mm^3	mm^4
Σ140	2,5	664,678	1947688	616,29	1701446	21360	219,86	1725	65100
Σ170	3	889,847	3717415	847,30	3391247	35143	295,27	2100	81921
Σ200	3	979,847	5474983	937,30	4998244	43654	329,64	2098	82194
Σ230	3	1069,85	7673482	1027,30	6986003	52852	370,82	2202	84473

$A_{s, gross, s}$ - $I_{n'n', gross, s}$ unloaded, gross sections
$A_{s, eff, s}$ - $I_{n'n', eff, s}$ burdened under pressure, effective properties
$W_{eff\ y, s}$ flexural loaded, sleeve

6. Basic principles

6.1. Installation

General

Sigma purlin profiles are mounted to the rafter with bolted or welded cleats, perpendicular to the roof plane of the building and with the upper flange facing the cam. (Figure A)
To prevent the purlin from being burdened under pressure, space should be left between the bottom flange and the rafter.
As façade cladding, the profile - called a side rail - is placed horizontally on a cleat with the outer flange facing upwards. (Figure B)
Spacers and tie wires are placed between each roof purlin or side rail where necessary. Refer to Chapter 3 for a more detailed explanation of spacers and tie wires.
It must be determined whether spacers and tie wires must be used based on the design calculations.

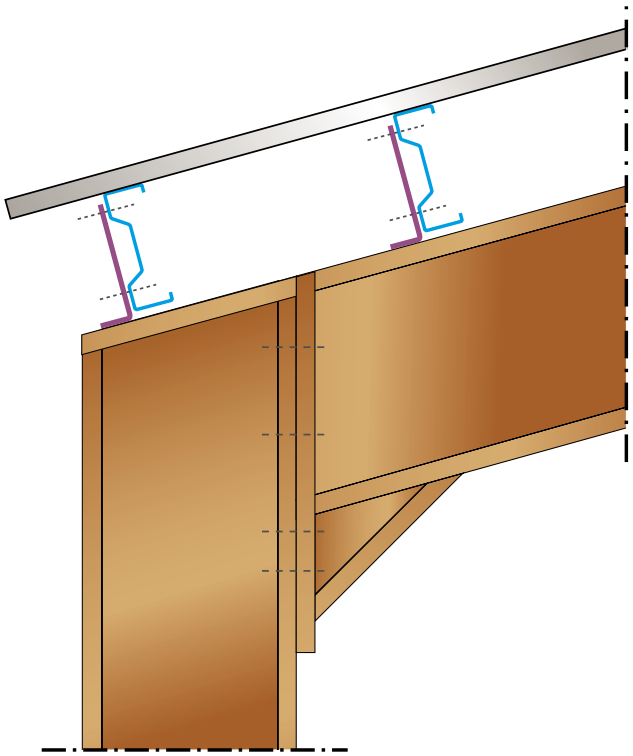


Figure A

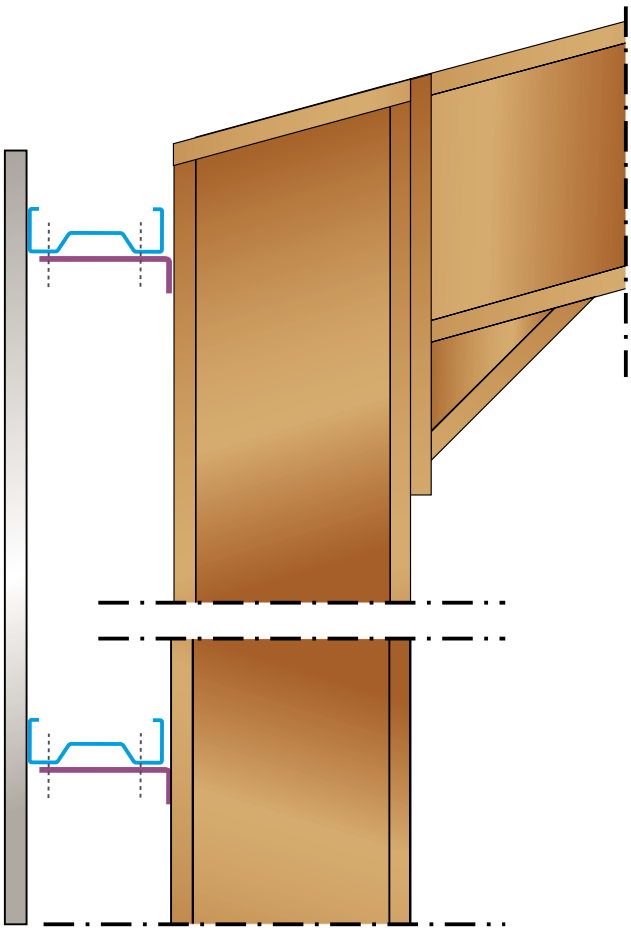


Figure B

Sigma-profile

Design options

There are three different options:
- placement on two supports
- placement on three supports
- continuous girder system

Placement on two supports

- as a roof purlin: for small rafter distances
  mounting between or on top of the rafters (Figures A & B)
- as a side rail: for small rafter distances
  mounting between or in front of the columns (Figure C)

Figure A - purlins between the rafters

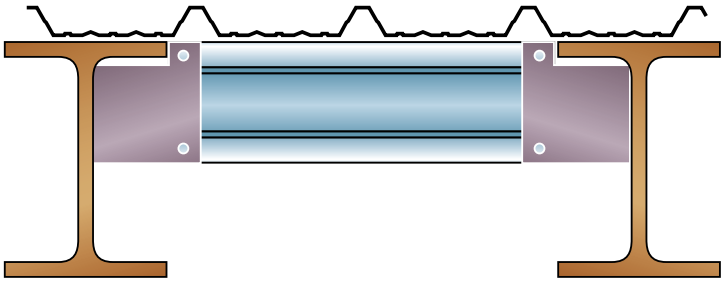


Figure B - purlins on top of the rafters

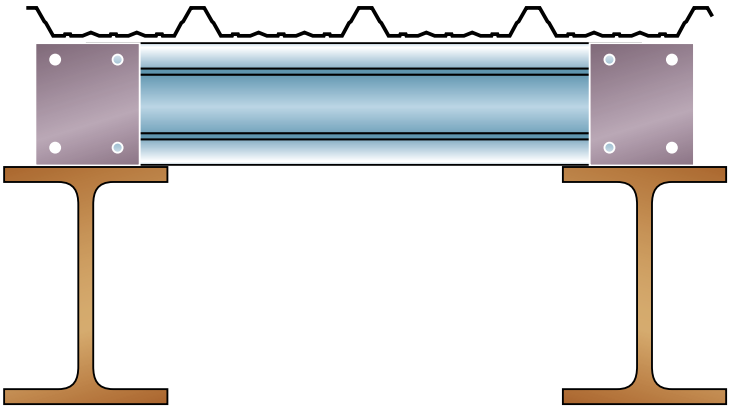
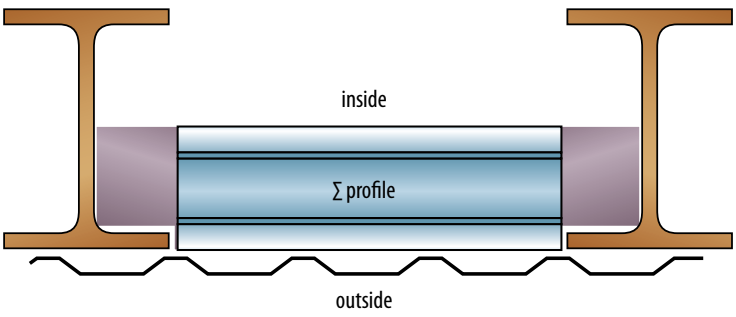


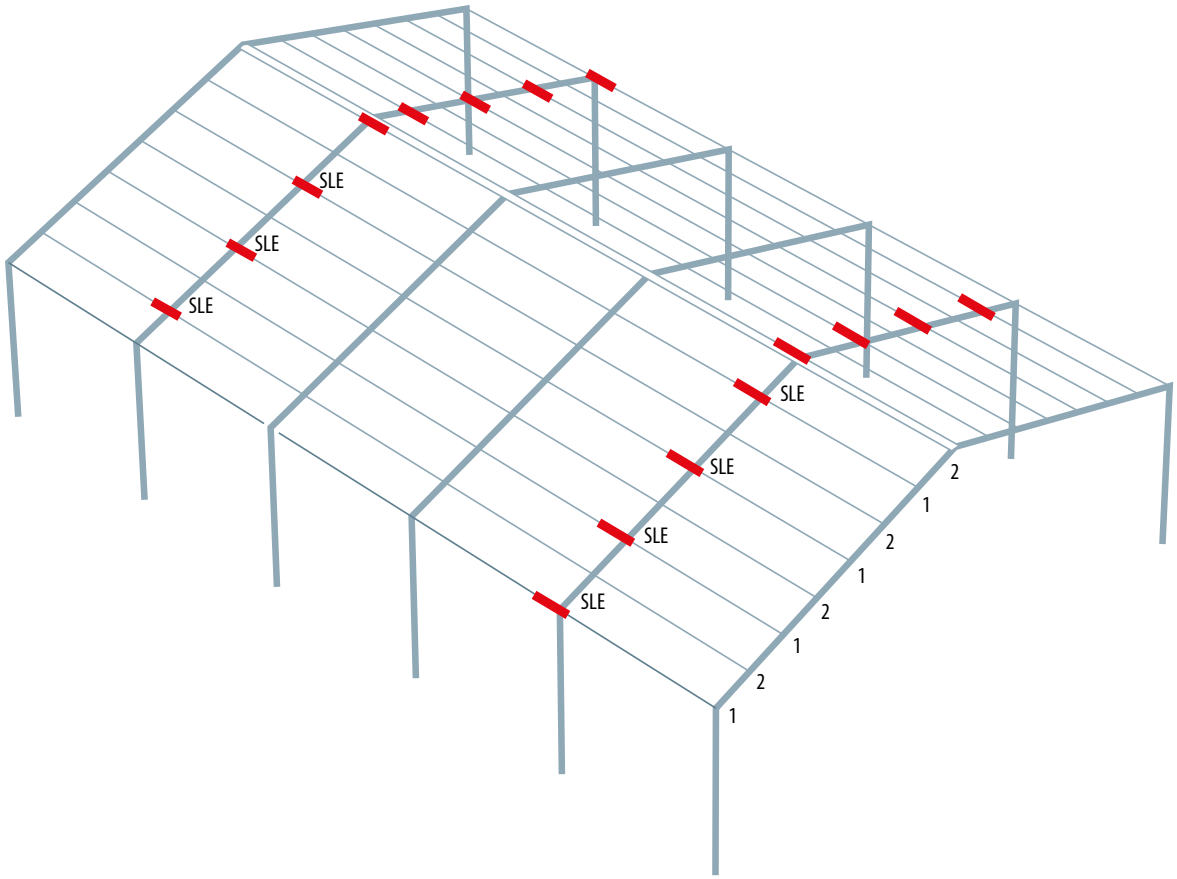
Figure C side rails between the columns

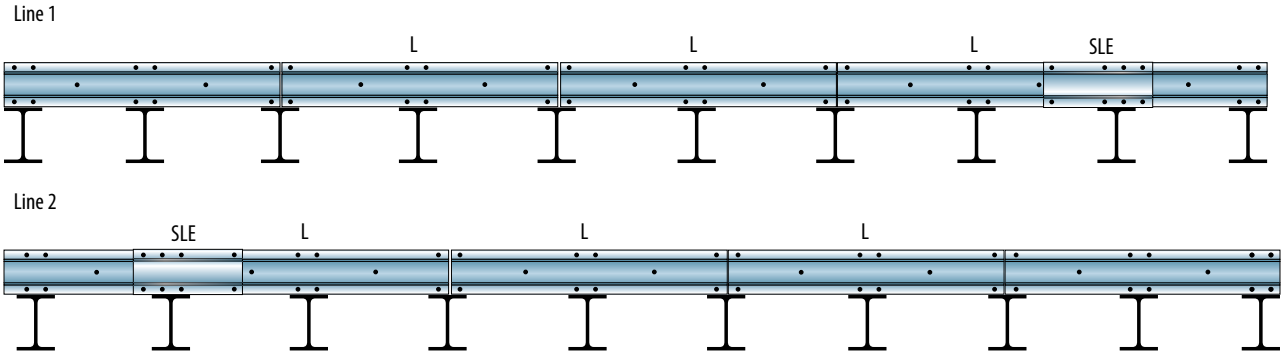


Sigma-profile

Placement on three supports

When placed on three support points, roof purlins or side rails span two bays at the same time. They are placed staggered for an even load distribution of the rafters. A sleeve is placed in the bays where the profile rests on two supports.





Sigma-profile

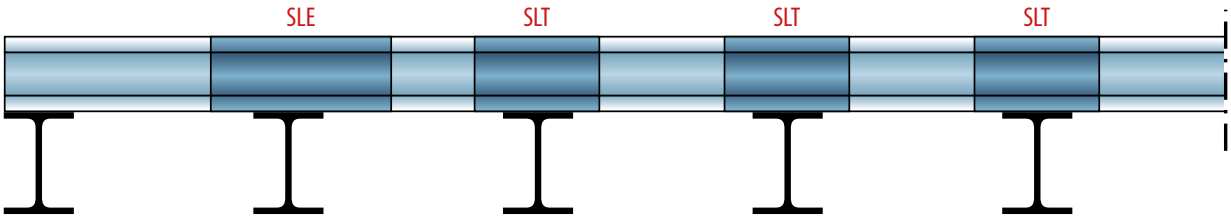
Continuous installation

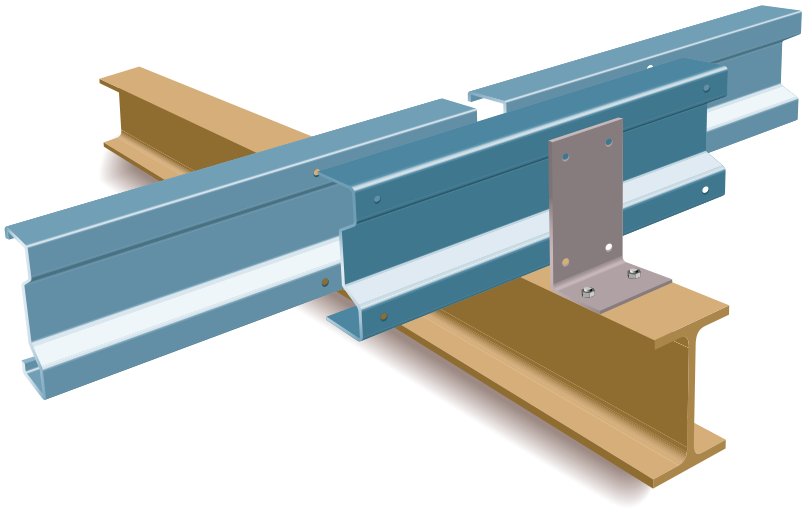
- as a purlin — installation above the rafters, bays of ± 6 m to 8 m, and with large purlin distances
- as a side rail — the same options

In a continuous girder system, each purlin spans one bay one at a time, but the continuity is guaranteed by placing a sleeve at each support point. This creates a double section over a certain length, resulting in virtually complete continuity.
The sagging moment increases at the end bays, based on which these purlins are generally thicker than the inner bays. (For example, this will lead to a thickness of 1.5 mm for the inner bay and 2 mm for the end bay)

For this reason, Joris Ide supplies:
- a long sleeve for end bays: SLE
- a short sleeve for inner bays: SLT

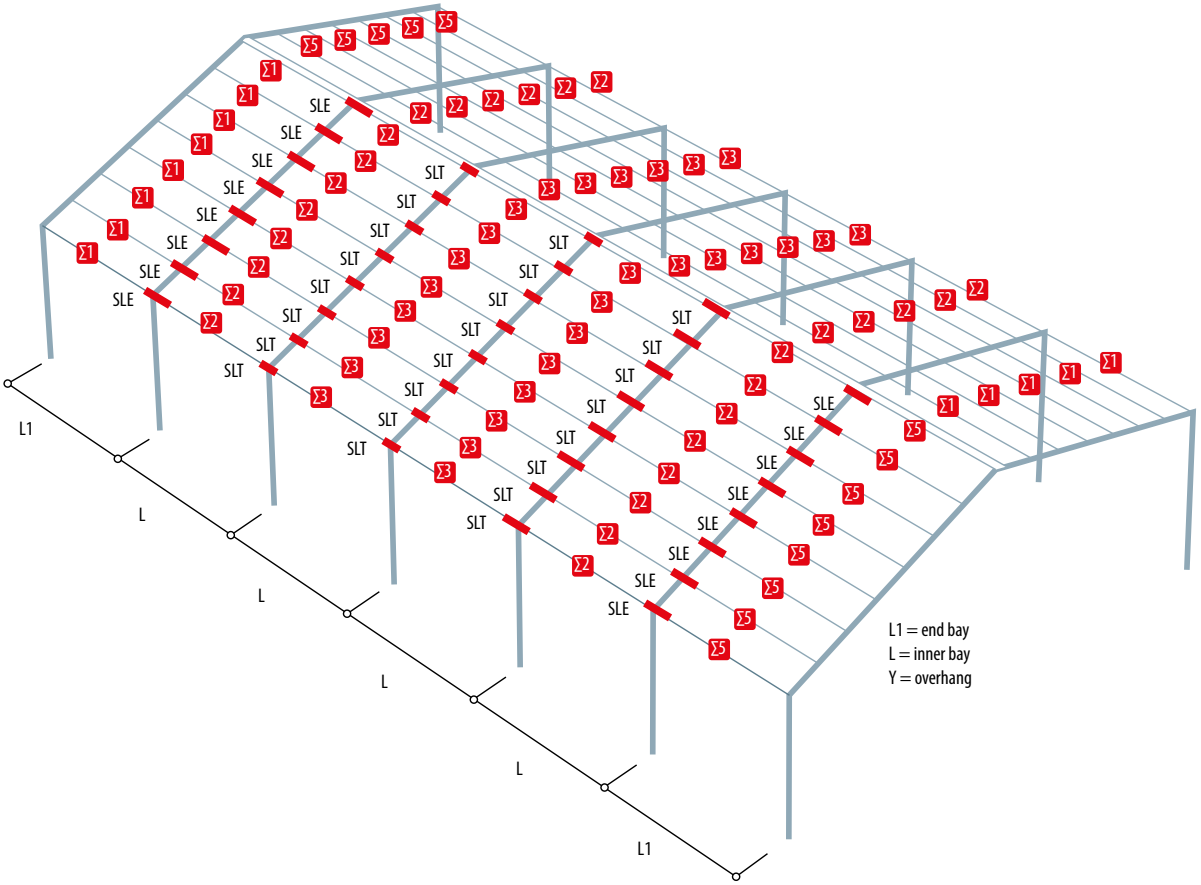
Continuous Sigma purlins

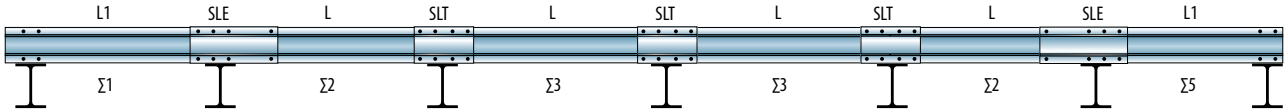




Sigma-profile

Continuous Sigma purlins





6.2. Types of roof and wall cladding

- single-walled profile sheet: steel only
- PIR and rockwool sandwich panels
- fibre cement boards
- Other: forces exerted parallel to the roof slope must be absorbed

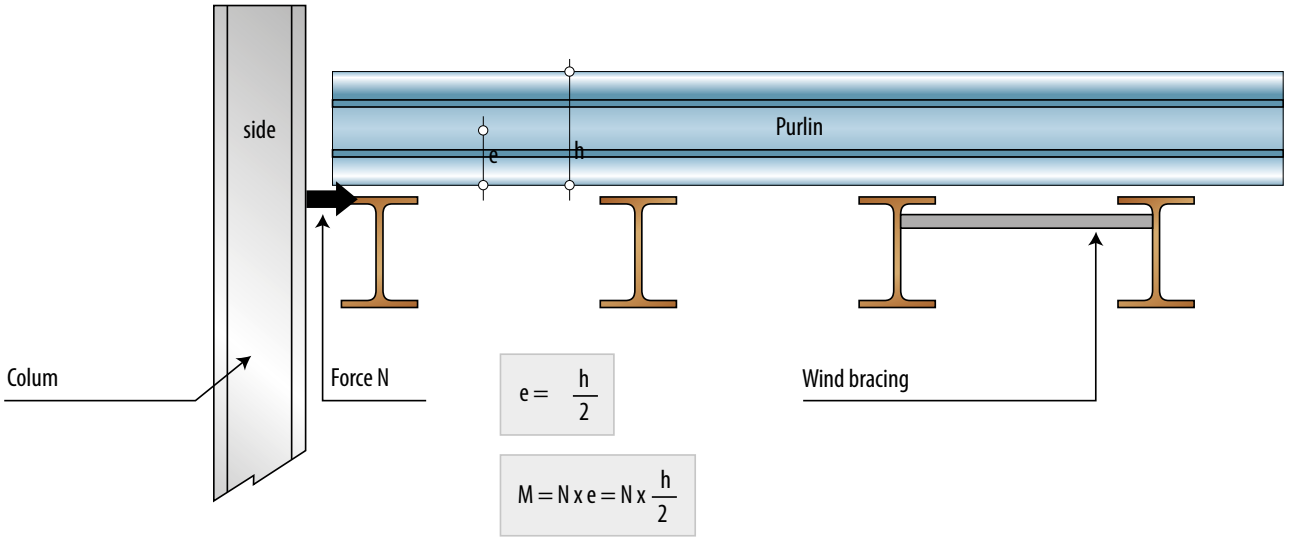
6.3. Calculation instructions

If the roof or façade cladding is not supplied by us, the customer should always specify the permanent load per project.

The following rules are used for calculating the weather conditions:

- wind load EN 1991 Part 1.4 + National annexe
- snow load EN 1991 Part 1.3 + National annexe

In the design calculations of the purlins, not only the permanent, wind, and snow loads are considered, but also any regular force on the front façade caused by the wind. It is assumed that this load is exerted on the underside of the purlin, leading to additional torque between the bottom flange and the neutral fibre (half of the height of the purlin). This is considered in the technical calculations.



The designer must take the necessary structural measures in order to comply with these principles. The designer must also provide data on the permanent load and normal force:
- snow or wind load to be taken into account
- outline of the structure with the laying pattern of the roof purlins and side rails
- stability and resistance to wind load of the girders

Joris Ide supplies the roof purlins and side rails complete with:
- the installation plan of the roof and/or side rails
- the substantiating calculation notes

These documents must specifically be addressed to the technical inspector of the project.

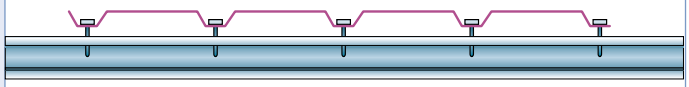
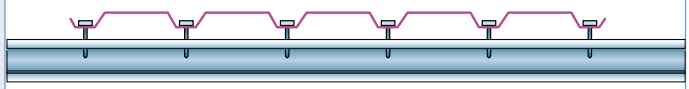
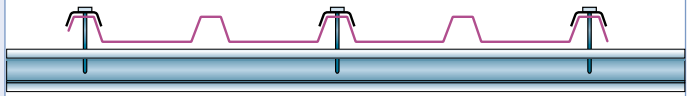
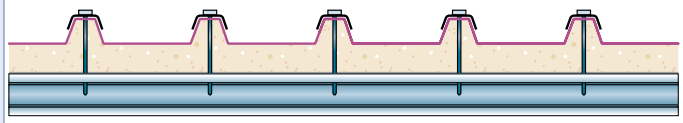
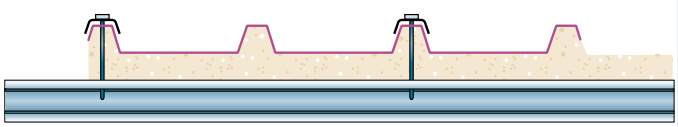
6.4. Purlin calculations

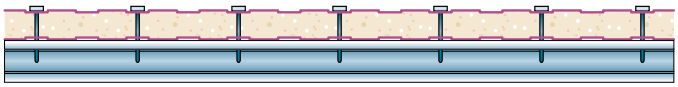
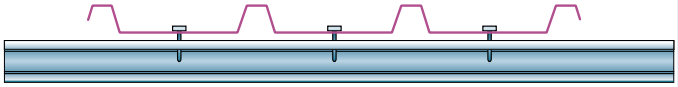
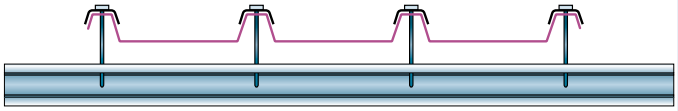
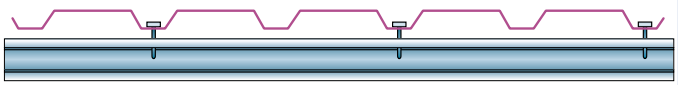
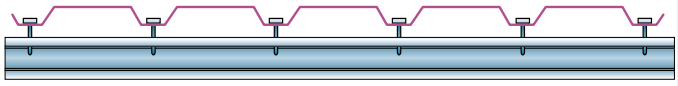
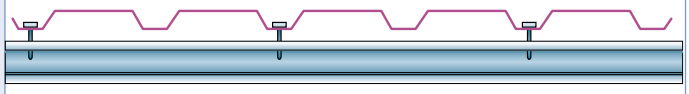
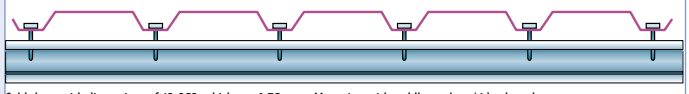
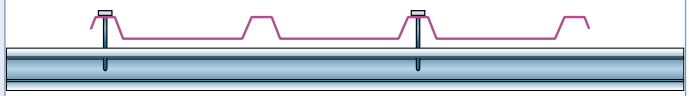
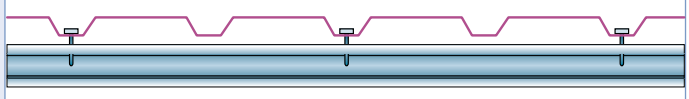
You can always rely on our technical department to create design calculations for your Sigma profiles for roof or wall cladding. We use the calculation standard EN 1993.1.3 and the National annexe.

Scope:

- class II roofs for which CDA values are defined
- class III roofs (e.g. fibre cement roofs) which only serve to transfer loads to the main structure (software code 75)

Some installation examples of roof and wall profiles have been set out below. For each mounting and/or profile type, various parameters are used to calculate the Sigma profiles. The customer must inform us which type of mounting and profile he wants to use. When using profiles not supplied by Joris Ide, the customer must provide us with the characteristics of these profiles.

Mounting types Σ140 to Σ230						
Report	Type of roof purlin	↓	C_{DA} kNm/m/rad	↑	C_{DA} kNm/m/rad	Software-code
PV30496	 Cold sheet with dimensions of 45-333 - thickness 0.72 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		1,4654 IDEPEK20		1,0668 IDEPEK26	61
PV30496	 Cold sheet with dimensions of 45-333 - thickness 0.63 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		1,3668 IDEPEK21		0,6187 IDEPEK27	62
PV30496	 Cold sheet with dimensions of 25-267 - thickness 0.55 mm - Mounting in the crown/corrugation with saddle washers/ridge boards		0,798 IDPEK33		0,633 IDEPEK35	63
PV30496	 Cold sheet with dimensions of 35-207 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		0,870		0,914	64
PV30496	 Cold sheet with dimensions of 33-250 - thickness 0.58 mm - Mounting to the second crown/corrugation with saddle washers/ridge bo		0,4467 IDEPEK23		0,4329 IDEPEK29	65
PV30496	 JI Eco PIR with dimensions of 33-250 - thickness 0.60 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		1,1512 IDEPEK50		0,6187 IDEPEK53	74
PV30496	 Sandwich panel with dimensions of 45-333 - thickness 0.56 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		1,107 IDEPEK25		0,863 IDEPEK31	71
PV30496	 Sandwich panel with dimensions of 45-333 - thickness 0.56 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		1,0637 IDEPEK24		0,8271 IDEPEK30	70

Mounting types Σ140 to Σ230						
Report	Type of roof purlin	↓	C_{DA} kNm/m/rad	↑	C_{DA} kNm/m/rad	Software-code
PV30496	 Wall sandwich panel - thickness 0.56 mm - Mounting every 250 m		0,8396 IDEPEK32		0,3513 IDEPEK34	68
PV30496	 Cold sheet with dimensions of 45-333 - thickness 0.56 mm - Mounting with saddle washers/ridge boards		0,6696 IDEPEK22		0,6482 IDEPEK28	69
PV30496	 Cold sheet with dimensions of 45-333 - thickness 0.75 mm - Mounting to the crown/corrugation with saddle washers/ridge boards		0,7066 IDEPEK48		0,9831 IDEPEK51	90
PV30496	 Cold sheet with separate insulation - dimensions of 45-333 - thickness 0.63 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,905 IDEPEK49		0,4414 IDEPEK52	73
PV30496	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,5658 IDEPEK36		0,4846 IDEPEK42	81
PV30496	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		0,7004 IDEPEK37		0,5248 IDEPEK43	82
PV30496	 Cold sheet with dimensions of 42-252 - perforated - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,4179 IDEPEK38		0,3712 IDEPEK44	83
PV30496	 Cold sheet with dimensions of 42-252 - thickness 0.75 mm - Mounting with saddle washers/ridge boards		0,6941 IDEPEK39		0,4672 IDEPEK45	84
PV30496	 Cold sheet with dimensions of 39-333 - thickness 0.63 mm - Mounting to the second crown/corrugation with saddle washers/ridge boards		0,4916 IDEPEK40		0,3356 IDEPEK46	87
PV30496	 Hacier panel with dimensions of 34-258, 75-1035 - thickness 0.75 mm - Mounting in the second crown/corrugation with saddle washers/ridge boards		0,6636 IDEPEK41		0,4979 IDEPEK47	88

Purlins for slightly sloping roofs (gradient of 3%) have to be dimensioned for water and snow accumulation loads. You can check this by considering the burdens and strains. Usually, a residual gradient of 1% is required at any point of the roof structure under the weighted load of the dead weight + snow. 'Overflow facilities' must be installed for raised roof edges to prevent the rainwater drainage pipes from getting blocked. The rainwater drainage must be properly dimensioned and maintained to prevent water accumulation.

Sigma-profile

6.5. Perforations

The Sigma profiles are perforated longitudinally based on the position of the perforations provided for this purpose and the cleats.

In a continuous girder with sleeve, perforations are also provided for this purpose, to enable the sleeve to be screwed into place together with the purlins.

7. Accessories

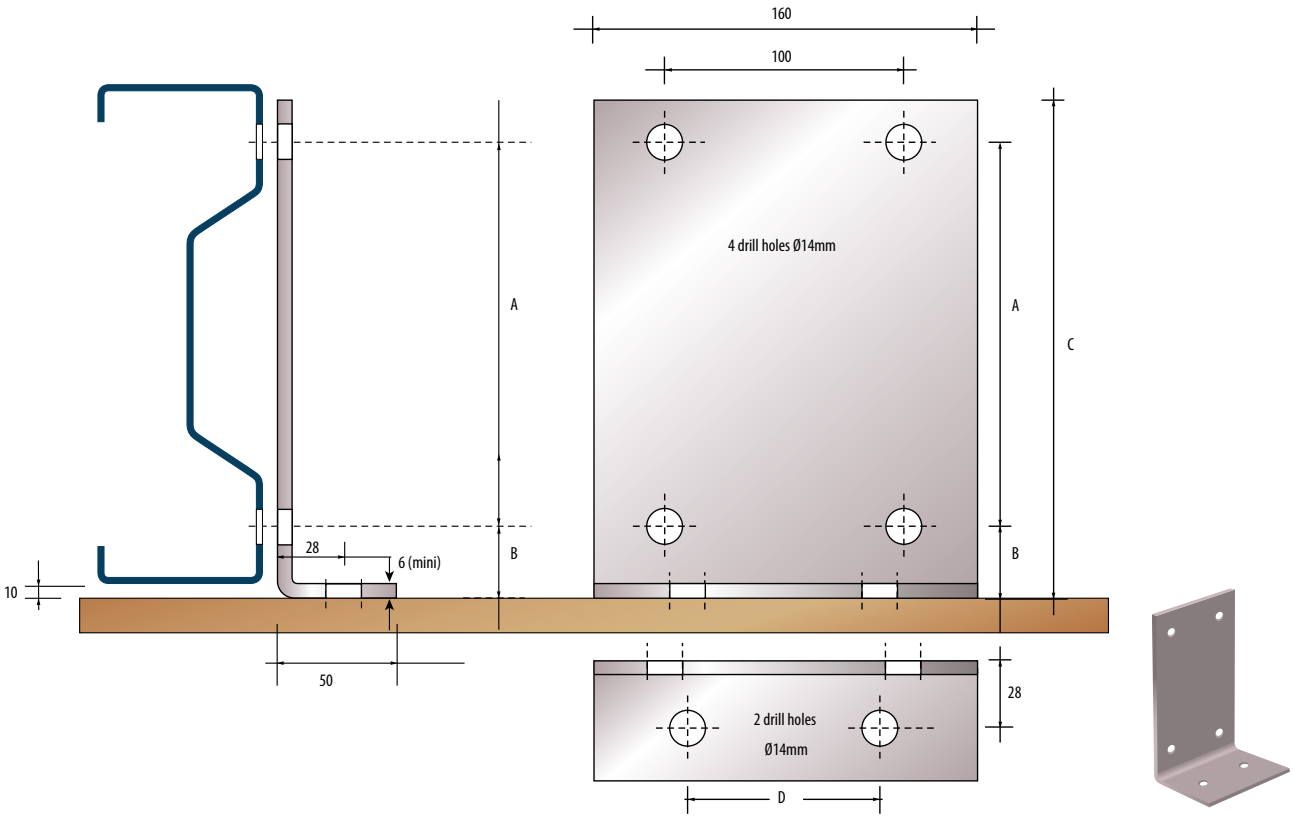
7.1. Cleats

The bolted cleat is at least 6 mm or 10 mm thick and 160 mm wide; the height depends on the purlin type. In addition to the perforations to secure the purlins, there are two perforations with a diameter of 14 mm for mounting to the rafter. Distance D is 80 mm by default, but can be changed on request.

Bolted cleats

Available in hot-dip galvanised steel
Characteristics
F_{rd} = 36 kN

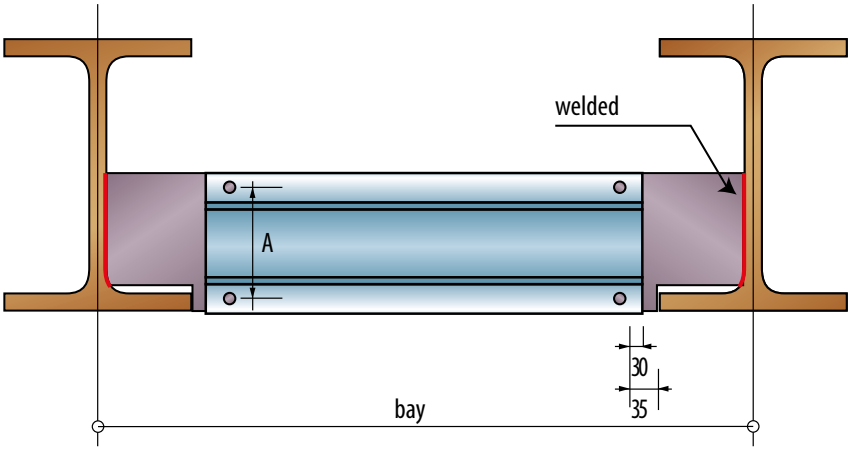
The same system is used if the side rail is mounted to the columns.

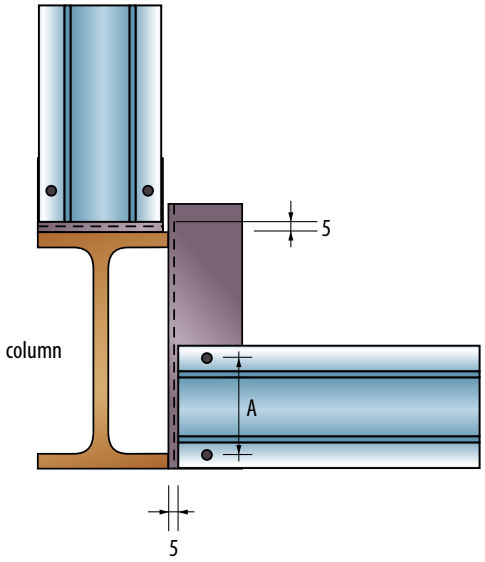


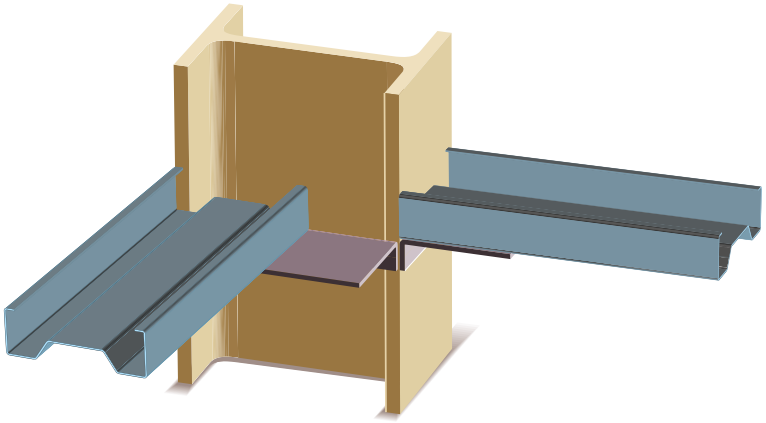
Type	A	C	B	D
	mm	mm	mm	mm
Σ140	100	138	30	80 - Ø 14
Σ170	130	168	30	80 - Ø 14
Σ200	160	198	30	80 - Ø 14
Σ230	190	228	30	80 - Ø 14

Sigma-profile

Mounting the side rails between the columns







Type	Size A
	mm
Σ140	100
Σ170	130
Σ200	160
Σ230	190

Sigma-profile

7.2. Spacers

Spacers prevent the profiles from sagging into the roof plane. Always use spacers for fibre cement boards. For steel sheets, the solution will be chosen on the basis of the design calculations. This allows a design with or without spacers. The system with spacers is, however, preferred. The spacers are mounted between each row of purlins at the centre or at 1/3rd from the bays.

We offer you:

A spacer consisting of a galvanised steel tube of 30 x 1.25 mm with press-fitted synthetic caps. The one end piece has a male thread of M12 x 30, grade 8.8, and the other end piece an M12 female thread, grade 8.8. The spacers are mounted inside each other.

We usually recommend:

- one spacer per bay for small rafter distances.
- two (maximum of four) spacers per bay for larger spans

Building with pitched roof

- spacers on both roof planes + cam connection piece.
- for the cam spacer, you should specify the roof pitch and the distance between the centreline of the purlin and the cam measured on the purlin

Building with lean-to roof

- Spacers between each row of purlins.

The same principles apply for side rails.
Spacers are always used in combination with tie wires.
This installation method is explained in chapter 7.4.

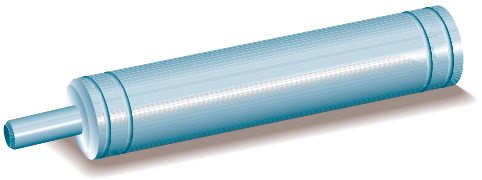
Characteristics:

• standard	NF EN 10025	
• steel type	S235 JR	Fy = 235 N/mm2
• spacers with plastic caps		Frd = 11.41 kN

Sigma-profile

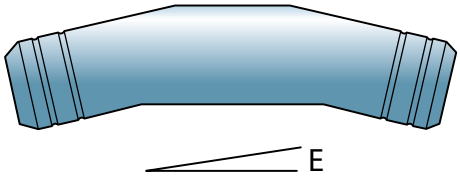
Spacer type 3

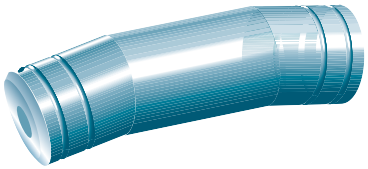
Ø30 x 1,25



Cam spacer type 3

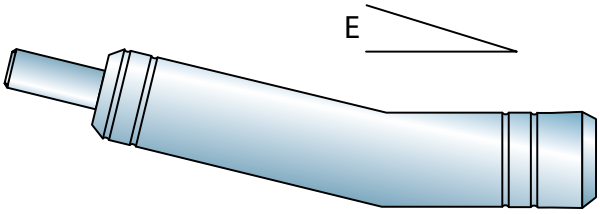
Ø30 x 1,25

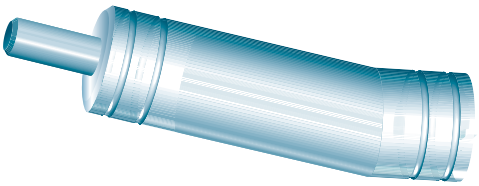




Spacer type 3

Ø 30 x 1,25





7.3. Tie wires

Tie wires in combination with spacers prevent the purlin from sagging into the roof and/or wall plane

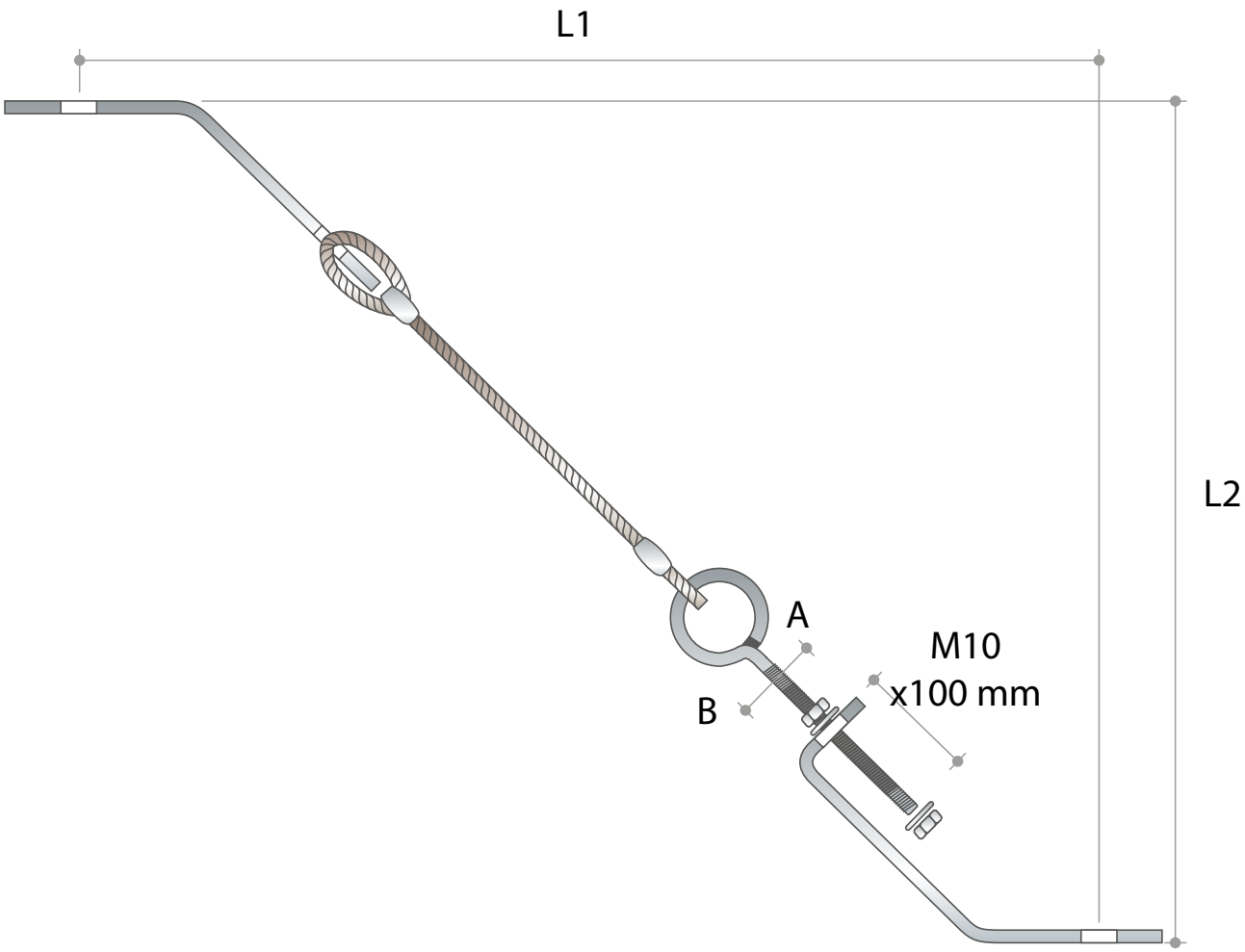
Tie wires are steel cables with a diameter of 5 mm, consisting of two endplates. One with an M10 thread to allow adjustment of the tie wire length.
When ordering tie wires, it is sufficient to indicate lengths L1 and L2.

Characteristics
F_{rd} = 12,45 kN

Installation specifications

The endplates are mounted to both ends (purlin and cleat).

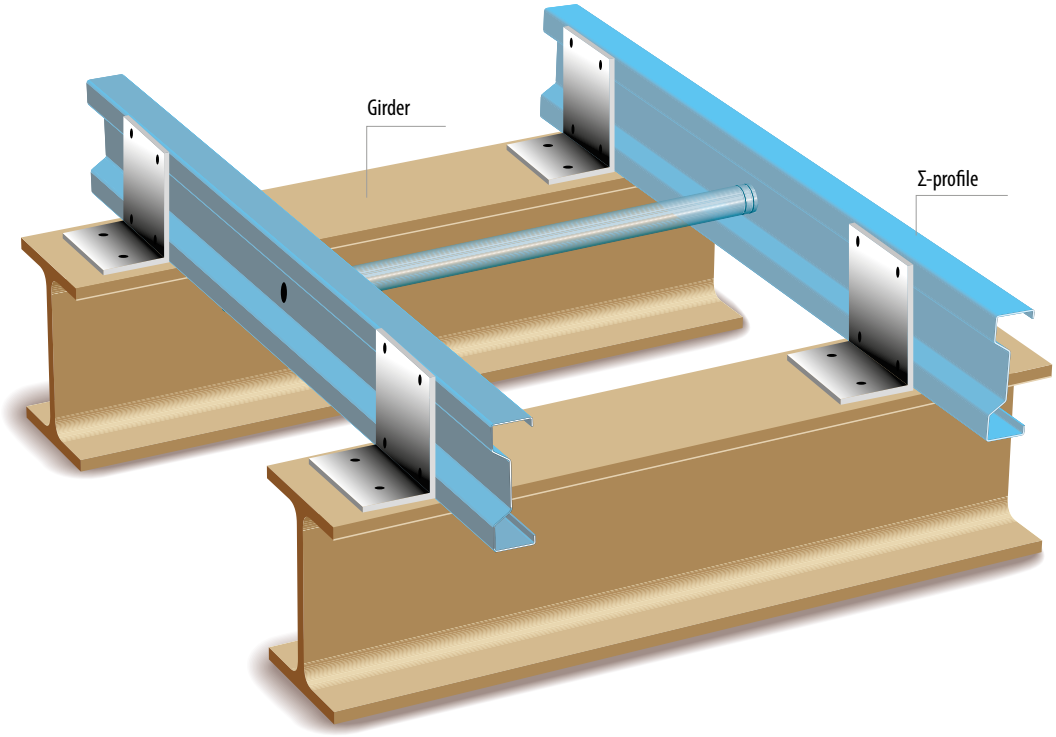
Adjustable single tie wire



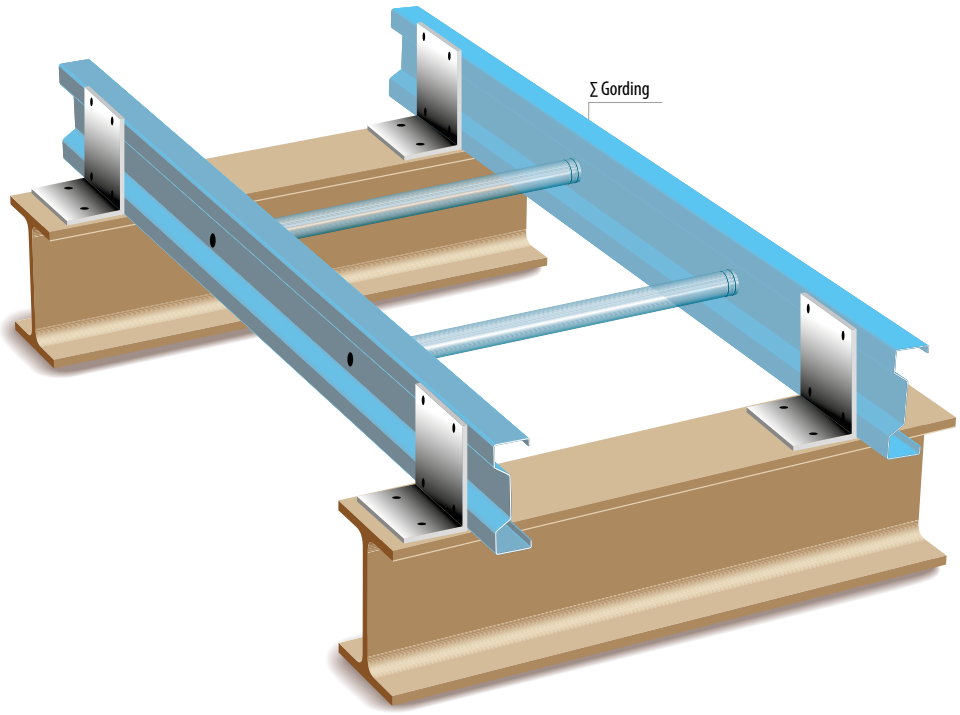
Adjustable double tie wires

7.4. Installation examples

Roof purlins (small rafter distances)
1 row of spacers

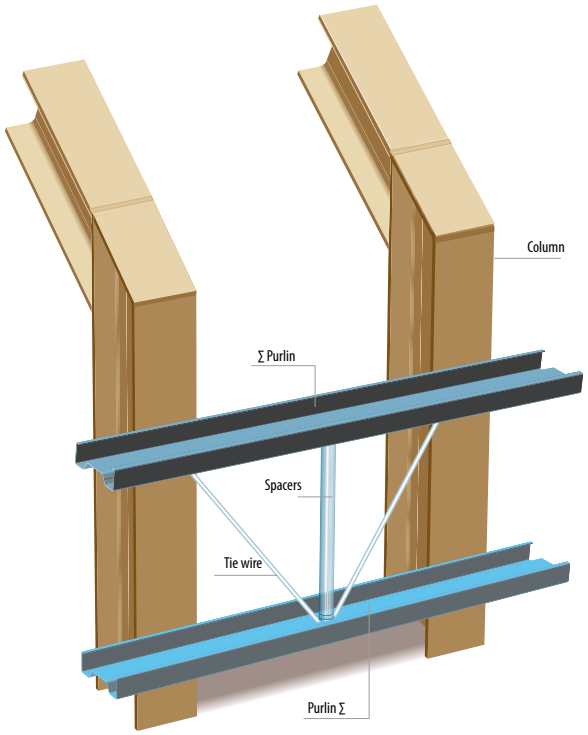


Roof purlins (larger spans)
2 rows of spacers

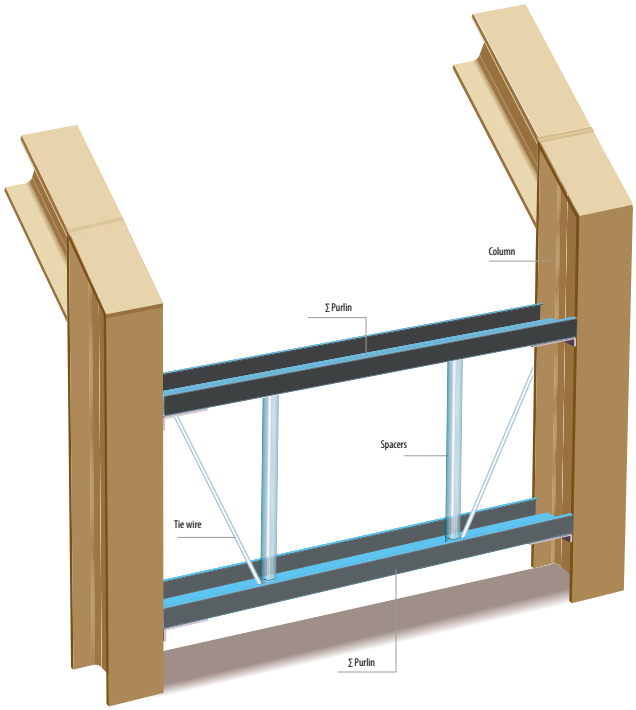


Sigma-profile

Side rail mounted to the columns



Side rail mounted between the columns



8. Installation guidelines

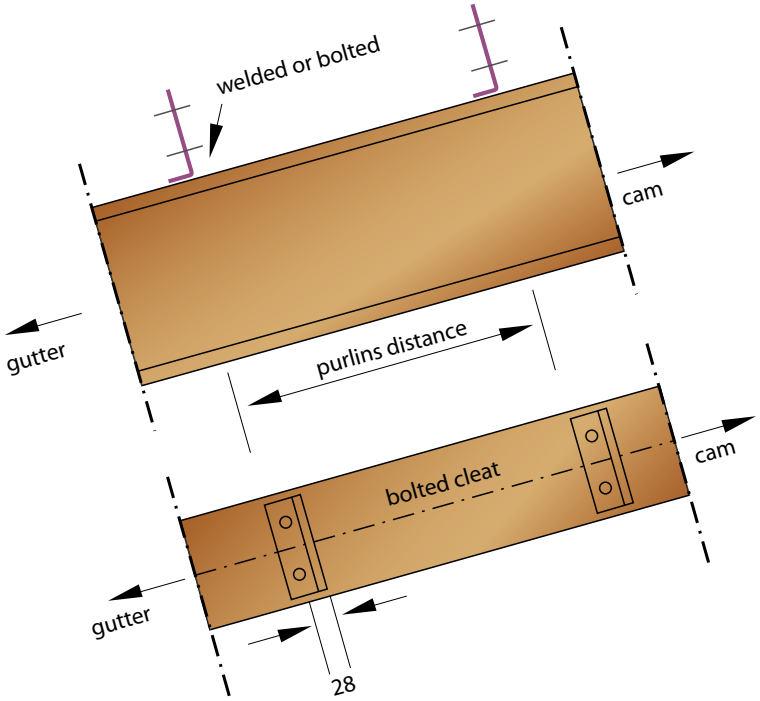
8.1. Installation of cleats for roof purlins or side rails

The cleats are welded or bolted to the rafter or the column.

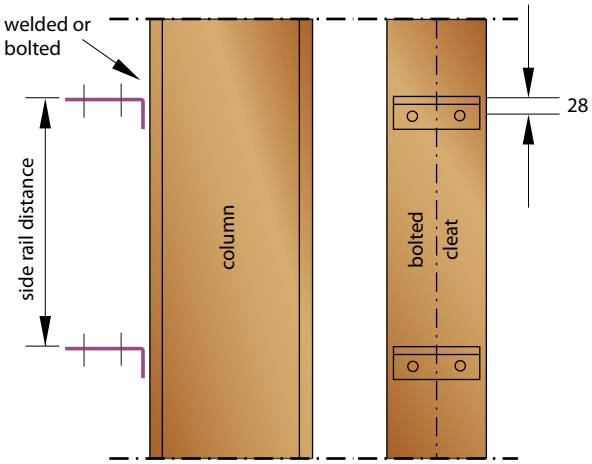
They are bolted as shown in Figures A and B. When mounting spacers, the maximum permissible intermediate spacing tolerance is 1 mm. Perforations are made in the rafter for the bolted cleats according to the diagram below.

The purlins are mounted only after the cleats have been secured.

Mounting to purlins (A)



Mounting to side rails (B)



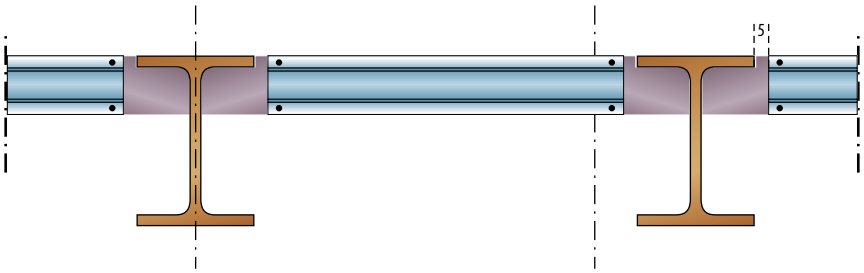
Sigma-profile

8.2. Installation of roof purlins

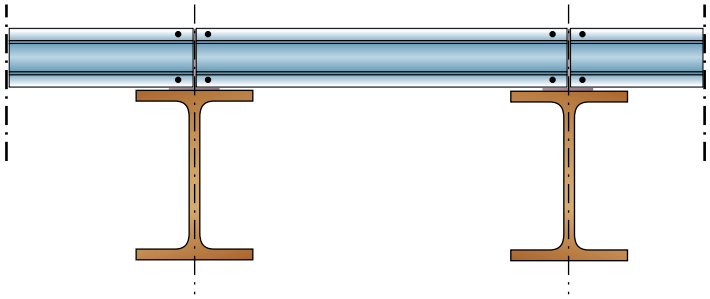
The purlins are mounted to cleats with two M12 x 25 bolts, grade 8.8, per purlin. They are bolted to the cleats with the flange of the purlin facing the cam.
The purlins are mounted to two supports with two bolts on each cleat.

Purlin between rafters

Allow 5 mm space from the edge of the rafter on either side of the purlin.
The same rules apply for side rails that are mounted in front of or between the columns.

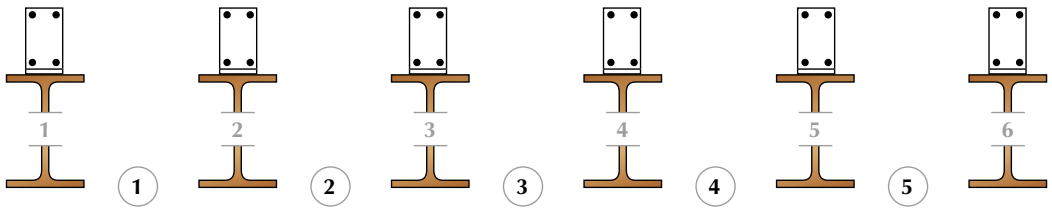


Purlins placed on two supports on top of the rafters

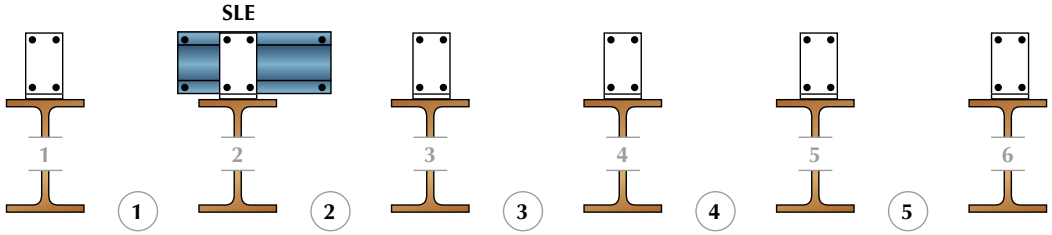


Mounting example of purlins in two-bay system

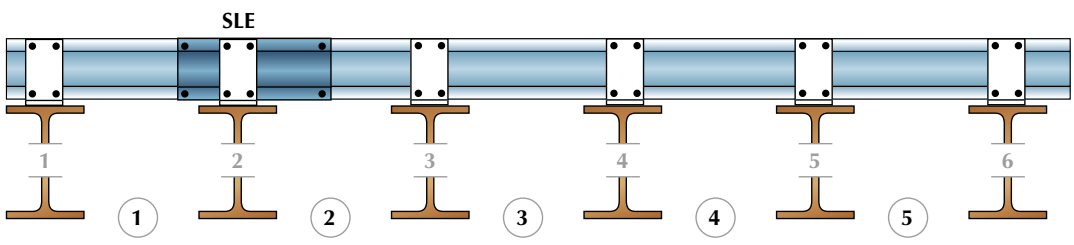
Step 1



Step 2



Step 3



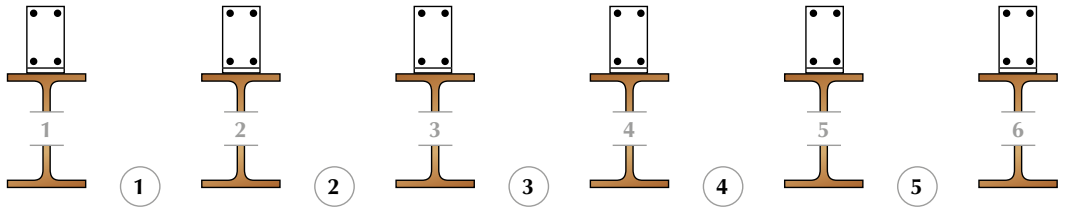
Sigma-profile

Continuous installation

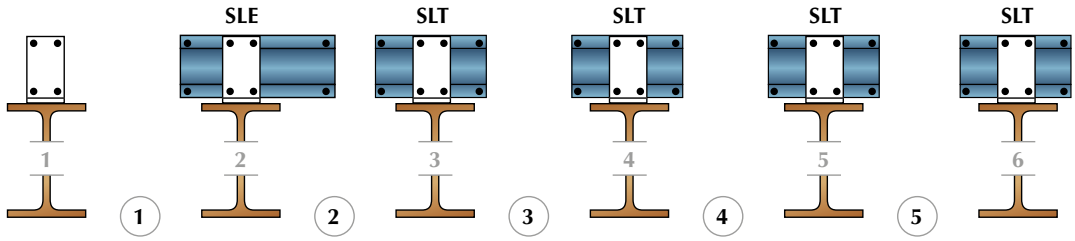
- the cleats are mounted first
- the sleeves are mounted temporarily, with due observance of the following instructions:
  - only mount without tightening
  - an SLE sleeve is mounted to the second rafter, with the longest side (x') facing the third rafter
  - SLT sleeves are mounted to the intermediate rafter
  - another SLE sleeve is mounted to the penultimate rafter (line 2)
- The roof purlins or side rails are mounted at the correct position, as shown in the installation drawing. The sleeves and roof purlins or side rails are mounted at the same time
- the four bolts are mounted to the cleats together with the four bolts of the sleeves

Continuous purlins

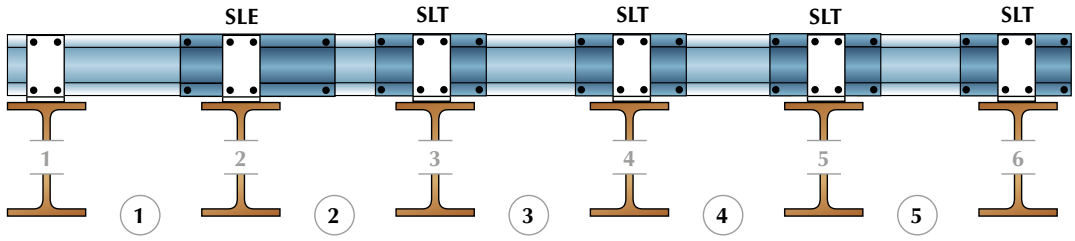
Step 1



Step 2



Step 3



8.3. Installation of side rails

The installation instructions are identical to those of the roof purlins.

Sigma-profile

8.4. Mounting roof and wall sheeting

The sheeting should be fixed correctly to absorb the calculated diaphragm effect. If necessary, spacers and tie wires must be mounted before installing the roof purlins.

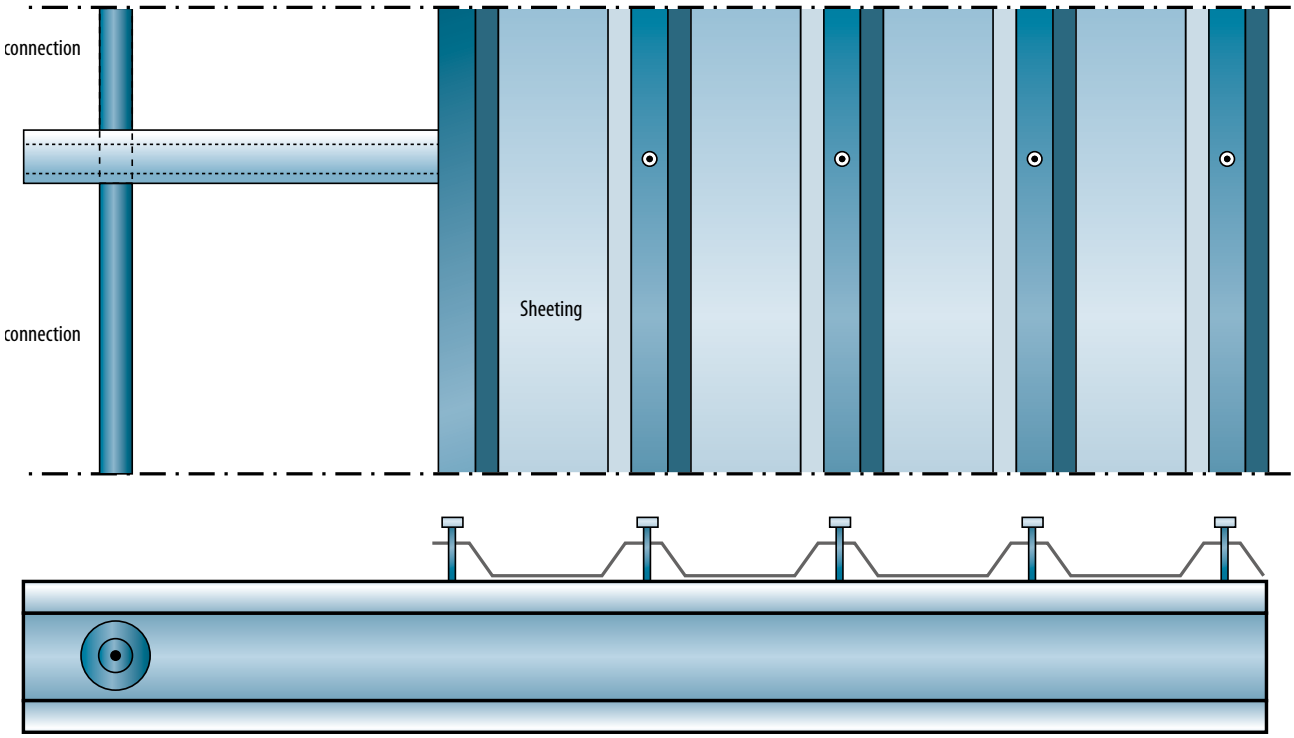
If no spacers are used, the installation company must verify that the purlins are completely straight in the roof plane.

An installation template can be used to align the purlins properly for small rafter distances. The sheets are mounted into the centreline of the flange of the profile using self-tapping screws.

A tolerance of ± 10 mm is allowed to mount the profile fasteners correctly in relation to the centreline of the flange.

The installer can place a guidewire above the sheets across the entire length of the centreline of the flanges of the purlins to comply with these tolerances.

Mounting in the centreline of the flange of the Sigma profile



8.5. Mounting the spacers and tie wires

Spacers

The spacers are made to measure based on the purlin distance.

The spacer is mounted between the roof purlins or side rails prior to attaching the roof or façade cladding. The last spacer (= gutter side) is mounted with an M12 x 25 bolt, grade 8.8.
The roof or side rail purlin system can be executed in different ways:

- without spacers: recommended only for small rafter distances
- with one spacer per bay, at the centre
- with two spacers per bay, at one-third
- three (and up to four) spacers for larger spans

The execution method of the roof or side rail system depends on the building design and the design studies carried out by Joris Ide.

Tie wires

The tie wires are secured at the location of the spacers and the cleat, transferring the forces in these spacers to the steel structure.

The laying pattern of the tie wires in the roof or side rails system is determined based on the design calculations and should, for this reason, be listed in the corresponding installation plan.

Below, you can find the various mounting options for buildings with:
- a pitched roof
- a lean-to roof

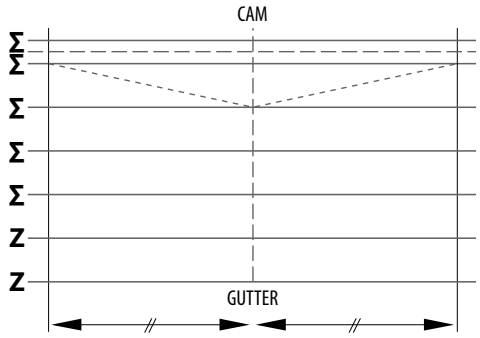
Depending on the loads for which spacers are needed.
The tie wires for side rails must preferably be placed between the first and second upper rail.

Sigma-profile

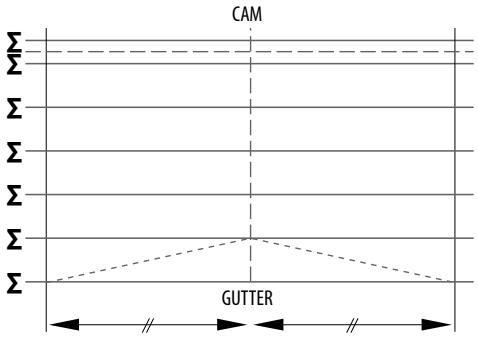
Installation with one spacer

PITCHED ROOF

Tension is crucial

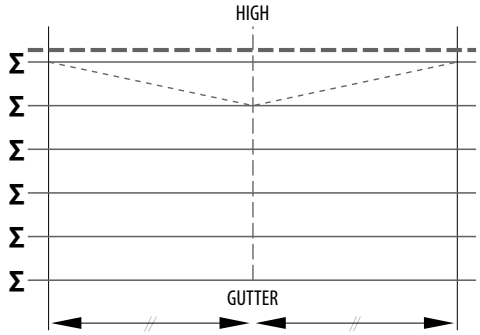


Pressure is crucial

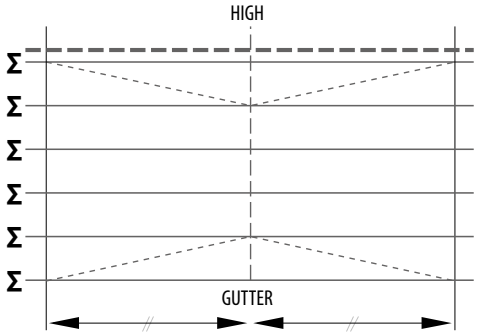


LESSENAARSDAK

Tension is crucial



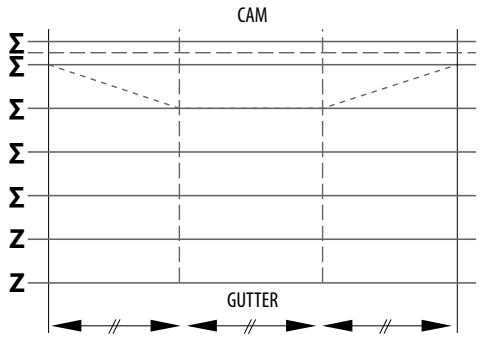
Pressure is crucial



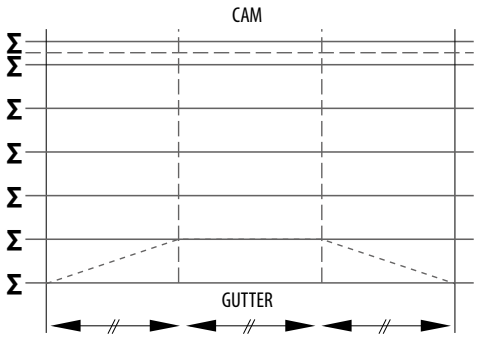
Installation with two spacers

PITCHED ROOF

Tension is crucial

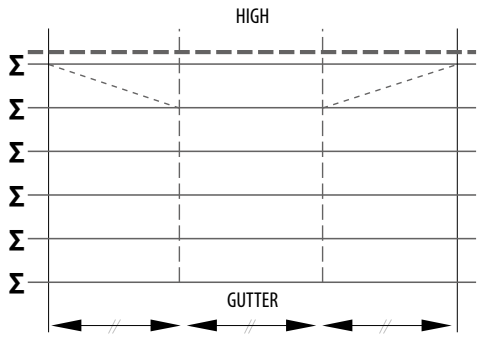


Pressure is crucial

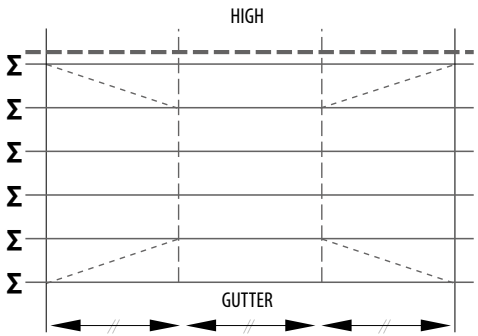


LESSENAARSDAK

Tension is crucial



Pressure is crucial

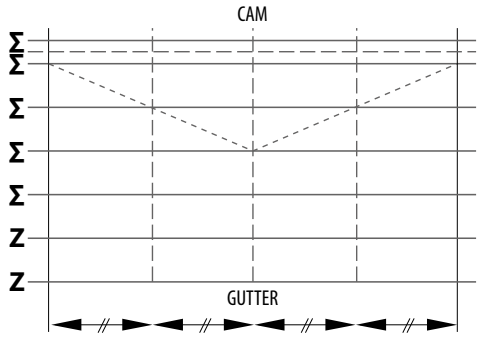


Sigma-profile

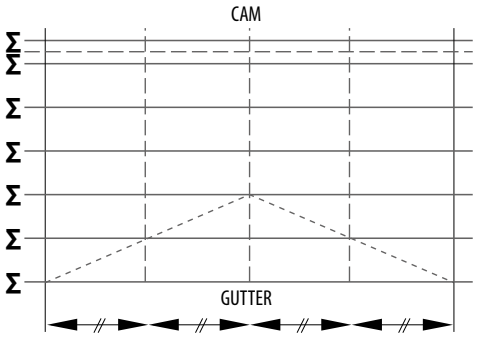
Installation with three spacers

PITCHED ROOF

Tension is crucial

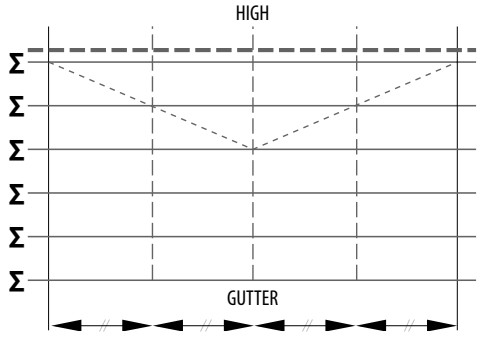


Pressure is crucial

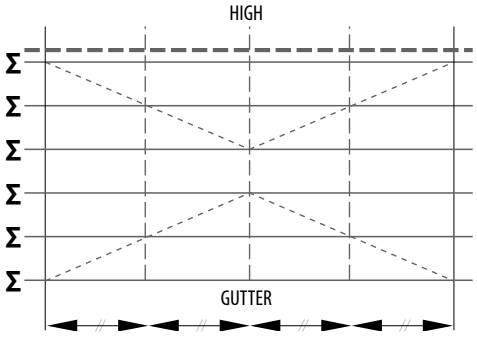


LESSENAARSDAK

Tension is crucial



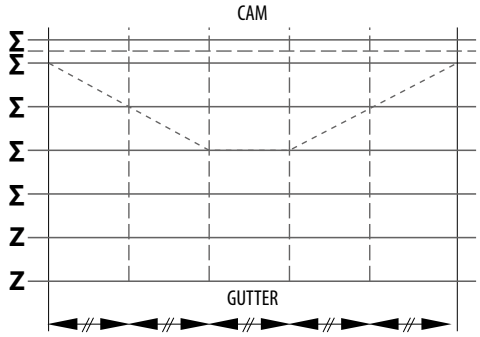
Pressure is crucial



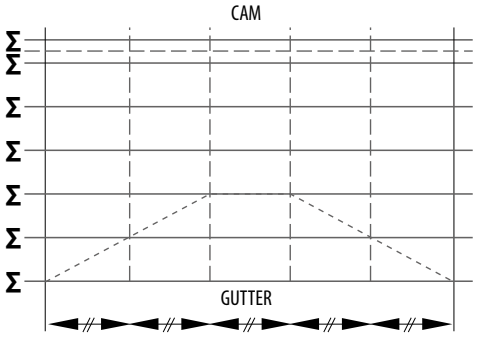
Installation with four spacers

PITCHED ROOF

Tension is crucial

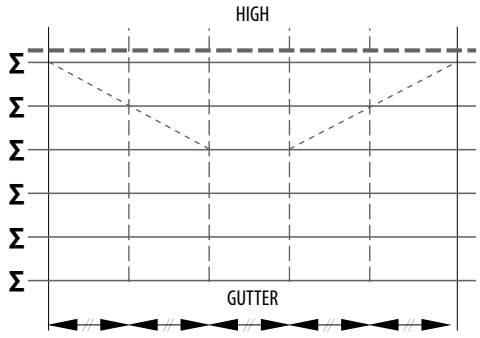


Pressure is crucial

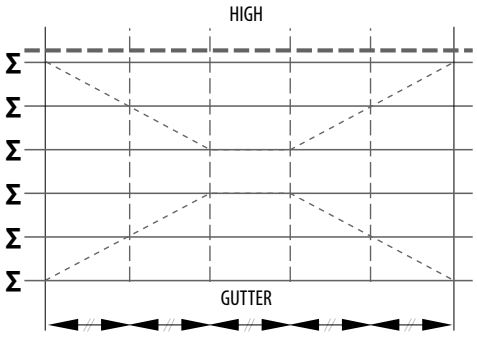


LESSENAARSDAK

Tension is crucial



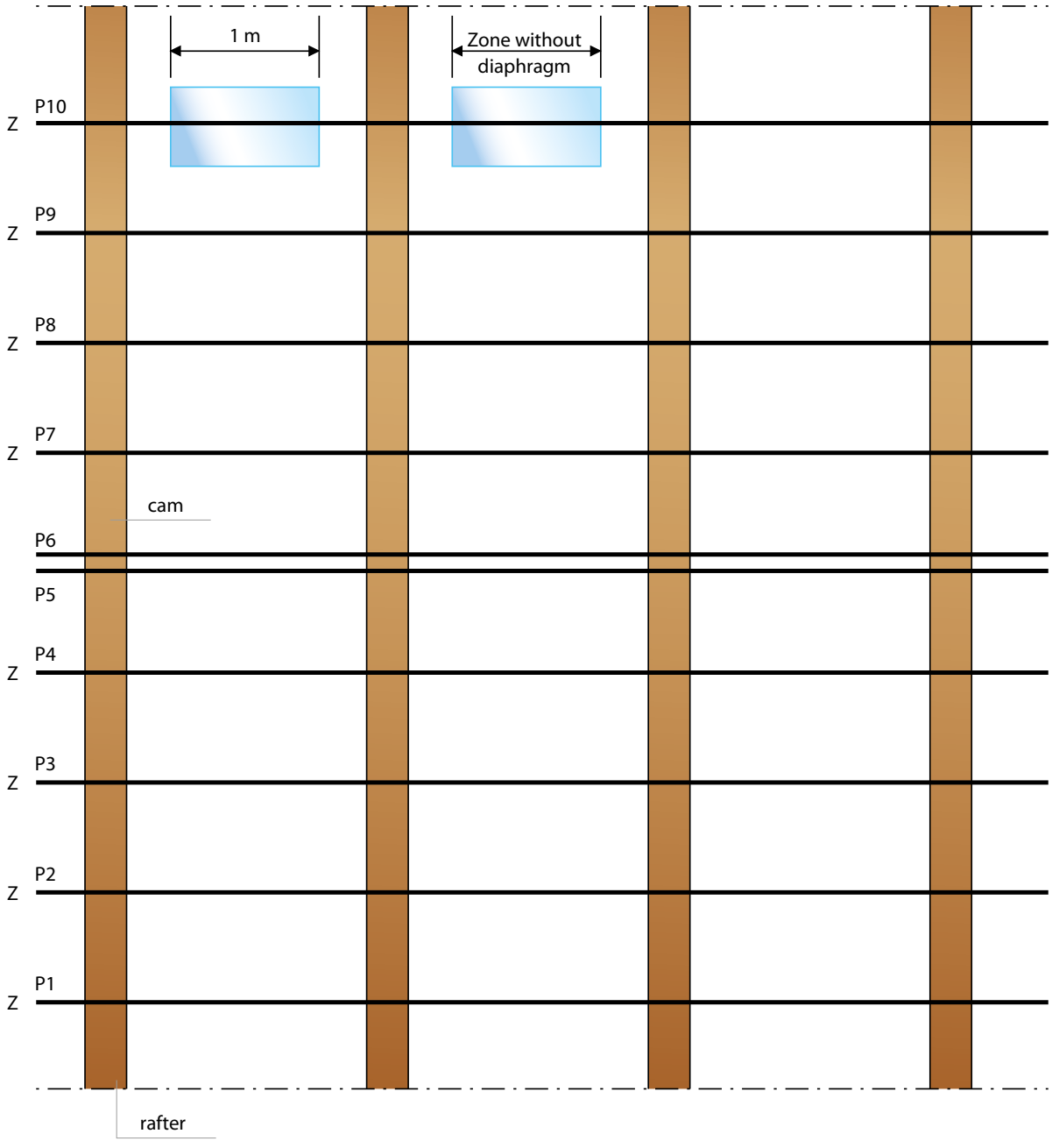
Pressure is crucial



8.6. Installation of skylights

In order to consider the diaphragm effect in the design calculations, the purlin must be stabilised crosswise in the cladding plane using the steel profile and associated mounting equipment.

The following resulting limitations must be taken into account when installing polyester skylights.



If the skylights are located perpendicular to the purlins, a width of 1 m is allowed. The roof ensures that the purlins stay in place in case of skylights between two adjacent roof purlins.

Delta-profile

9. Foreword

9.1. Delta purlins in the construction sector

The Delta purlin has been specifically developed for the agricultural market. This purlin has a unique patented cross-section, which ensures a sealed connection with the structure and the roof plane.

Generally, ceilings in the poultry sector must be as smooth as possible with concealed purlins, but the Delta remains visible.

The Delta is clamped between the structure using a special cleat. (Refer to the installation profile drawing).

Naturally, ventilation is very important if no interior ceiling is installed.
An inlet valve is used in order to direct the air along the purlins, in which speed and direction are independent of each other.

The Delta purlins do not affect the ideal ventilation design, provided that the direction of the incoming air can be controlled with an air intake system specifically selected for the given situation.

However, this application requires thorough advice.

9.2. Example and advantages

Example

A poultry house constructed using insulated concrete sidewall panels, a roof of sandwich panels type JI Roof PIR 80 mm, PIR-B s2, d0, HPS 200 Ultra outer skin and Colorfarm interior. Visibly mounted hot-dip galvanised Delta purlins, entirely supported by the steel structure with a centre-to-centre distance of 7000 mm.

Advantages

- simpler steel structure thanks to greater centre-to-centre distance of 7000 mm
- fewer installation steps, 15 bays instead of 21
- fewer purlins thanks to larger centre to centre distance of 2250 mm with 80 mm JI Roof PIR panel compared to cement fibre board with a centre-to-centre distance of 1325 mm, 1005 m less purlin
- one cam purlin thanks to unique shape (refer to cam purlin drawing)
- single layer of roof cladding in the form of sandwich panel Rc 3.75
- no ceiling
- interior sandwich panel Colorfarm, 15-year warranty

In addition to the above advantages, pipes can run through the purlins and feed lines can be attached.

9.3. Multiple applications

The Delta purlins are also widely used in environments with additional demands on the indoor climate.

Because of the closed design, it is also an ideal profile for spaces where no dust and/or other residues may settle on the purlin.

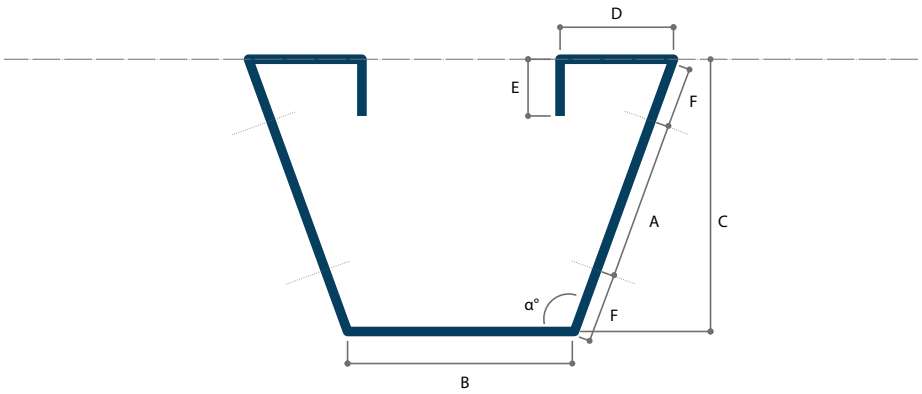
It is a versatile product.

Do not hesitate to contact us for technical information.

Delta-profile

9.4. Technical properties

daN / m	1,50	2,00	2,50	3,00
D120	5,80	7,68	9,56	11,40
D140	6,32	8,38	10,42	12,45
D160	6,85	9,08	11,32	13,50
D180	7,35	9,75	12,15	14,50
D200	8,75	11,63	14,49	17,29
D220	9,21	12,23	15,25	18,20
D250	10,19	13,58	16,55	20,18
D300	11,82	15,76	19,58	23,38



	A	B	C	D	E	F	ø	α
	mm	mm	mm	mm	mm	mm	mm	°
D120	70	100	120	50	25	28,90	14	110
D140	70	100	140	50	25	39,50	14	110
D160	70	100	160	50	25	50,10	14	110
D180	81,50	100	180	50	25	55,00	14	110
D200	100	160	200	60	30	51,50	14	100
D220	120	160	220	60	30	51,50	14	100
D250	150	190	250	60	30	51,90	18	100
D300	190	225	300	60	30	57,30	18	100

Delta-profile

9.5. Section characteristics

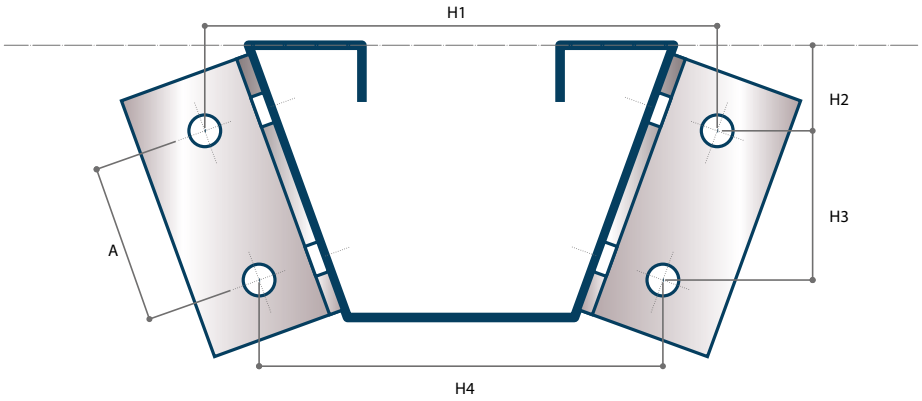
Type	Thickness	A_{br}	I_{br}	Positive deflection			Negative deflection		
				$A_{s,eff,pos}$	$I_{s,eff,pos}$	$W_{eff,pos}$	$A_{s,eff,neg}$	$I_{s,eff,neg}$	$W_{eff,neg}$
	mm	mm^2	mm^4	mm^2	mm^4	mm^3	mm^2	mm^4	mm^3
D120	1,50	698	1494707	682	1460644	25391	640	1249889	18472
	2,00	930	1970615	930	1970615	34908	881	1777005	27367
	2,50	1157	2428562	1157	2428562	43047	1128	2315455	36939
	3,00	1381	2868784	1381	2868784	50881	1375	2848385	46801
D140	1,50	760	2156170	745	2105054	31299	669	1754779	21759
	2,00	1013	2847426	1012	2843571	42994	965	2584229	34212
	2,50	1262	3515059	1262	3515059	53212	1233	3360678	45939
	3,00	1507	4159333	1507	4159333	62981	1501	4131391	58009
D160	1,50	823	2969514	792	2865324	36777	639	2349242	24970
	2,00	1097	3926627	1092	3905336	51363	1048	3583805	41650
	2,50	1367	4853688	1367	4853688	64072	1337	4651939	55677
	3,00	1633	5750987	1633	5750987	75918	1627	5714366	70095
D180	1,50	885	3947210	812	3703312	41036	715	3040350	28214
	2,00	1180	5224957	1172	5171240	60093	1112	4727490	48494
	2,50	1471	6465452	1471	6465451	75626	1442	6210284	66143
	3,00	1759	7669008	1759	7669009	89690	1753	7622581	83050
D200	1,50	1053,50	6284965	903,60	5505434	50052	768,70	4093514	32694
	2,00	1407	8340330	1371,80	8108689	79997	1193,40	6443887	56659
	2,50	1756,80	10346849	1747,30	10265933	102847	1610,40	8807447	82232
	3,00	2102,90	12304923	2102,90	12304923	123950	1972,30	10975110	105329
D220	1,50	1113	7873963	928	6782657	55335	788	5038052	36145
	2,00	1487	10455846	1408	9987193	88116	1225	7936882	62500
	2,50	1857	12979918	1846	12867008	117158	1710	11117059	94586
	3,00	2223	15446614	2223	15446615	141460	2093	13834177	120788
D250	1,50	1245,50	11331653	988,20	9379112	63589	818,10	6696326	41701
	2,00	1664,80	15061696	1489,80	13825425	100527	1275,50	10589683	72187
	2,50	2080,40	18715658	2019,20	18210940	138884	1801,70	14958788	110514
	3,00	2492,30	22294018	2487,40	22222096	172654	2285,80	19131614	148038
D300	1,50	1444,90	18556208	1067,70	14434535	76769	863,40	10006503	50859
	2,00	1932,40	24693204	1597,00	21276196	120112	1349,60	15908542	88076
	2,50	2416,30	30719960	2166,10	28166724	166178	1911,30	22536356	134652
	3,00	2896,40	36637024	2781,20	35375224	217122	2540,70	29790572	190793

A_{br} - I_{br} = unloaded, gross sections
$A_{s,eff,pos}$ - $I_{s,eff,pos}$ - $W_{eff\,pos}$ = flexural loaded, positive deflection
$A_{s,eff,neg}$ - $I_{s,eff,neg}$ - $W_{eff\,neg}$ = flexural loaded, negative deflection

Delta-profile

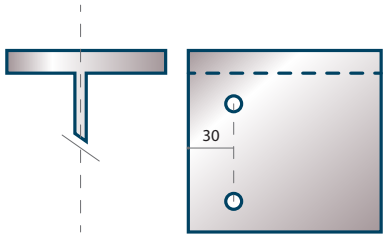
10. Basic principles

10.1. Installation



	X	A	H1	H2	H3	H4	ø
D120	70	70	226	37	66	178	14
D140	70	70	233	48	66	185	14
D160	70	70	240	58	66	193	14
D180	81,50	70	252	62	77	196	14
D200	100	70	274	56	98	239	14
D220	120	70	281	56	118	139	14
D250	150	70	321	57	148	269	18
D300	190	70	372	62	187	306	18

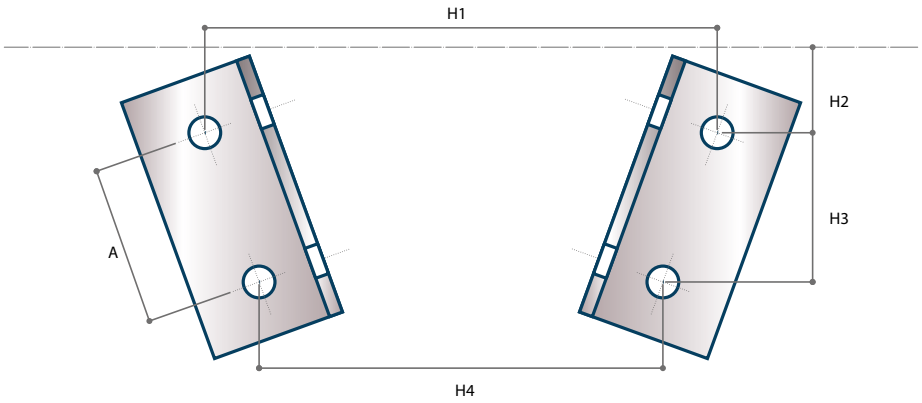
10.2. Cross-section



Perf. Ø 14 mm (120 to 220) - Ø 18 mm (250 to 300)

Delta-profile

10.3. Mounting instructions

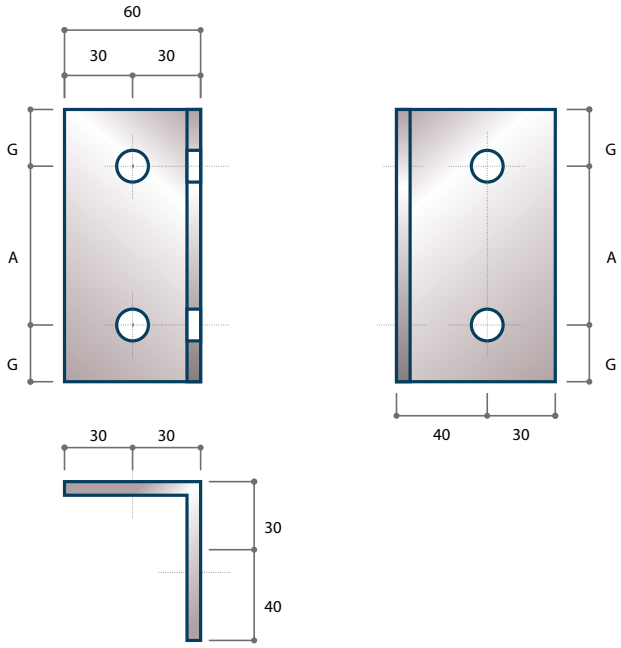


The cleats must be mounted to the steel structure. The Delta profiles must be placed and mounted in the cleats. Use bolts M12x30 (Delta 120-140-160-180-200-220) and bolts M16x30 (Delta 250-300). The installer must ensure that the top of the Delta purlin is level with the top of the girders.

We recommend placing waterproof Illmod tape to each flange of the Delta purlin to achieve a watertight connection between the Delta purlin and the roof cladding.

Delta-profile

11. Cleats



	A	C	G	ø
	mm	mm	mm	mm
D120	70	120	25	14
D140	70	120	25	14
D160	70	120	25	14
D180	81,50	131,50	25	14
D200	100	150	25	14
D220	120	170	25	14
D250	150	210	30	18
D300	190	250	30	18