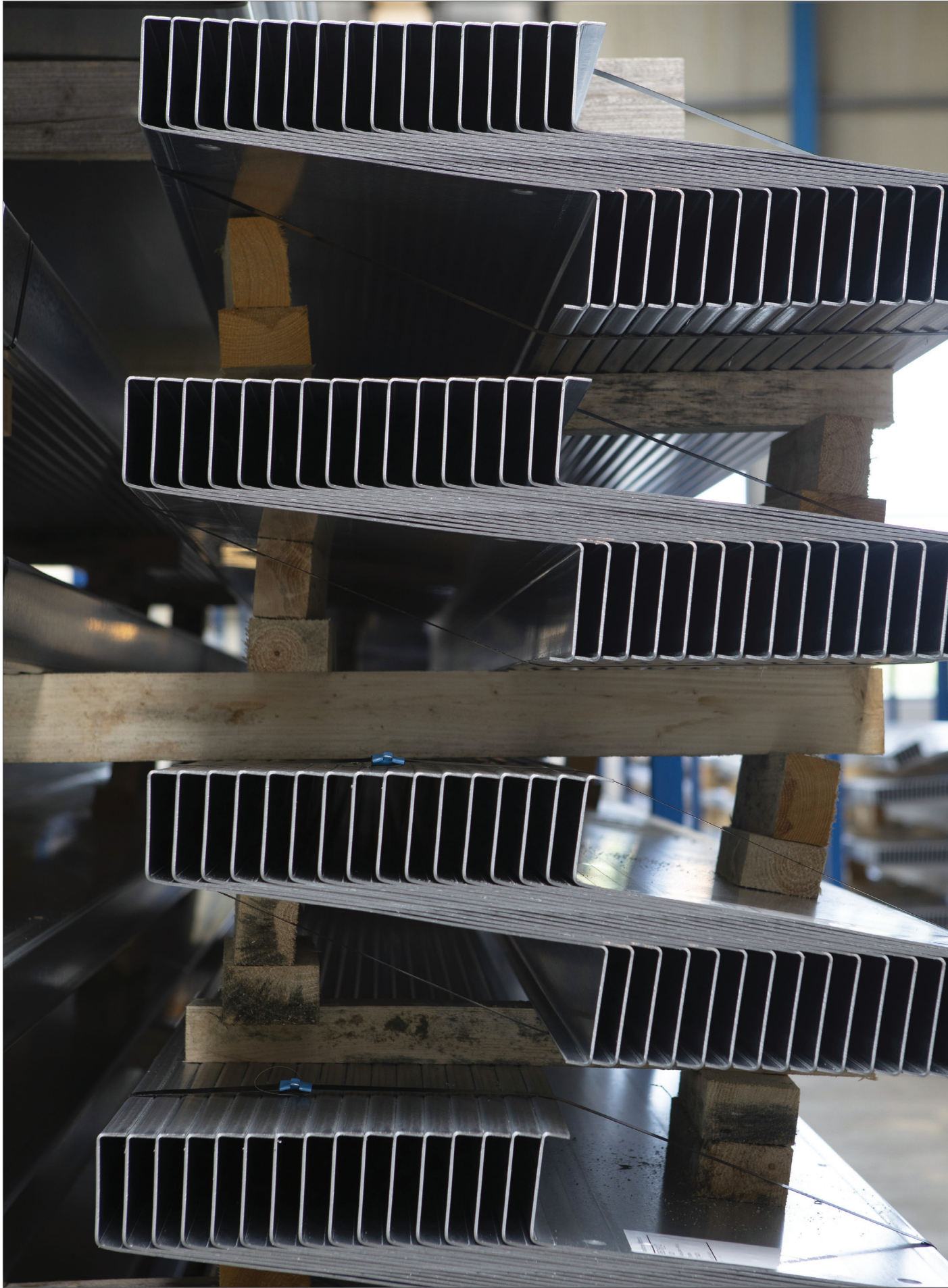




TECHNICAL MANUAL

METSEC CONSTRUCTION SYSTEMS FOR SECONDARY STEEL STRUCTURES

Purlins
Side rails
Mezzanine floor beams and systems



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Photos and 3D models used in this manual come from the archives of voestalpine Profilform s.r.o. and STEELINXPRO spol. s.r.o.



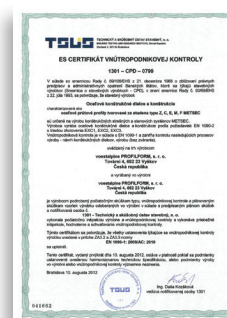
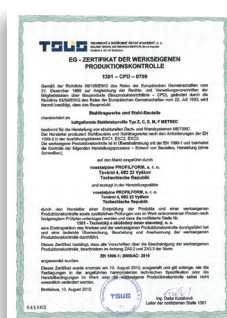
About the Company

Voestalpine Profilform s.r.o. was established in 1996 as a subsidiary of voestalpine Krems GmbH in reaction of the Austrian voestalpine Corporation to the increasing demand for thin-walled steel sections in Central and Eastern Europe.

Today, voestalpine Profilform s.r.o. is part of the Metal Forming Division within the voestalpine Corporation based in Krems, Austria.

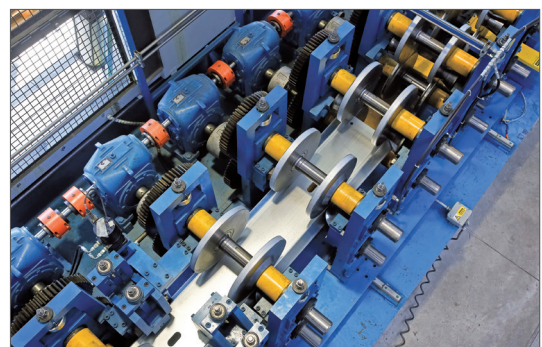
The company's production plant is located in the industrial zone of Vyškov, 40 km from the city of Brno. On an area of about 7,700 m², it annually produces about 15,000 tons of steel sections designed for various applications predominantly in the building industry but also in mechanical engineering and automotive industries.

The voestalpine Profilform products can be found not only in the Czech Republic, but also in many other European countries, the Russian Federation, Kazakhstan and some African countries.





- Highly qualified employees and advanced production technologies guarantee the production of high quality sections.
- Modern and flexible production facilities allow for rapid implementation of purchase orders to meet the required delivery terms.
- Production, however, is not all we do. Our main priorities include superior services: consulting, technical and software support, and logistics.



Preamble

This Technical Manual presents the METSEC Construction Systems for purlins, side rails and floor beams. The Manual contains the basic design features of these systems, which should be respected when designing, making static calculations and creating the manufacturing documentation. Failure to observe these principles may result in the collapse of the secondary or even the primary steel construction in the extreme case. The Technical Manual has been developed not only for design offices that use METSEC Construction Systems in their projects, but also for construction companies that erect or assemble secondary steel structures.

Principles and methods applied in designing METSEC Construction Systems are based on years of experience and research conducted by voestalpine Metsec Ltd. in Great Britain and voestalpine Profilform s.r.o. in the Czech Republic.

As results of the research and tests have been applied in the calculation methods, the designs generated by our software are significantly more economical compared to the basic conservative methodology described in EC standards that do not consider our research. EC standards permit such an approach and allow customisation of some calculations based on tests and research carried out by manufacturers of thin-walled structural systems. Our tests and research conducted at the University of Strathclyde, UK, cover a wide range of behavioural issues of thin-walled purlin and side-rail systems. The research and tests have been conducted by Professor Jim Rhodes, one of the world's leading experts in designing thin-walled steel structures.

METSEC Construction Systems are designed according to EC standards while taking into account the results of tests conducted at the Department of Mechanical Engineering, University of Strathclyde, UK.

The design procedures have been established on the basis of experimental and theoretical research. Test results of different components and their behaviour within the systems defined by us have been used for the determination of the maximum safe load. These tests and theoretical methods include designs of secondary structures according to the theories of the first and second order combined with the finite element method and design analyses according to BS5950: Part 5 and EC3: Part 1.3.

In the case of the SLEEVED system (primary coupling system), attention has been paid to the rigidity and strength of the sleeves to make sure they can redistribute and transfer the bending moment above the sleeve-equipped supports, where the moment was originally greater than in the bay, but the correct stiffness and strength of the sleeves redistributes it into the ideal moment curvature – i.e. the same magnitude in the bay and over the support.

For loading states induced by the wind uplift, the baseline design criteria are based on EC3: Part 1.3 and modified in the light of experimental results.

In the case of the METLAP system (featuring overlapping purlins above supports) a default seven-bay layout has been used for behaviour testing of this widely variable structural system to determine the worst possible combination of bending stress, shear stress and web buckling. The results of this testing have been summarised in our design software. No redistribution of bending moments or other plasticity behaviour have been applied in the METLAP system.

Standards and Tests Used in Calculations

Standards used in designing the METSEC Construction Systems

- EN 1990: Basis of Structural Design
- EN 1991-1-1: Actions on Structures – Part 1-1: General actions
- EN 1991-1-3: Actions on Structures – Part 1-3: General actions - Snow loads
- EN 1991-1-4: Actions on Structures – Part 1-4: General actions - Wind actions
- EN 1993-1-1: Design of Steel Structures – Part 1-1: General rules and rules for buildings
- EN 1993-1-3: Design of Steel Structures – Part 1-3: General rules - Supplementary rules for cold-formed members and sheeting
- EN 1993-1-5: Design of Steel Structures – Part 1-5: Plated structural elements

METSEC Construction System Tests Performed

1. Load tests performed on sleeved/overlapping systems with restraining sheathing (trapezoidal sheet) – J. Rhodes: Report for Metal Sections Ltd. (June 1997).
2. Components Tests of METSEC Purlin Systems – J. Rhodes: Report for Metal Sections Ltd. (June 2001).
3. Tests of Component Rigidity and Stiffness for the Z Section Sleeved System – J. Rhodes: Report for Metal Sections Ltd. (January 2008).
4. Tests of Purlins of Z35 Material under Vertical Gravity Load – J. Rhodes and J. Zaras: Report for Metal Sections Ltd. (January 1987).
5. Tests and Analyses of High Z Sections – J. Rhodes and T. H. Lim: Report for Metal Sections Ltd. (October 1994).
6. Tests and Analyses of High Z Sections – J. Rhodes and T. H. Lim: Report for Metal Sections Ltd. (November 1994).
7. Test of Purlins under Simulated Load of Wind Uplift – J. Rhodes and J. Zaras: Report for Metal Sections Ltd. (May 1986).
8. Testing of Purlin Systems – J. Rhodes, C. B. Chan and S. H. Tan: Report for Metal Sections Ltd. (June 1990).



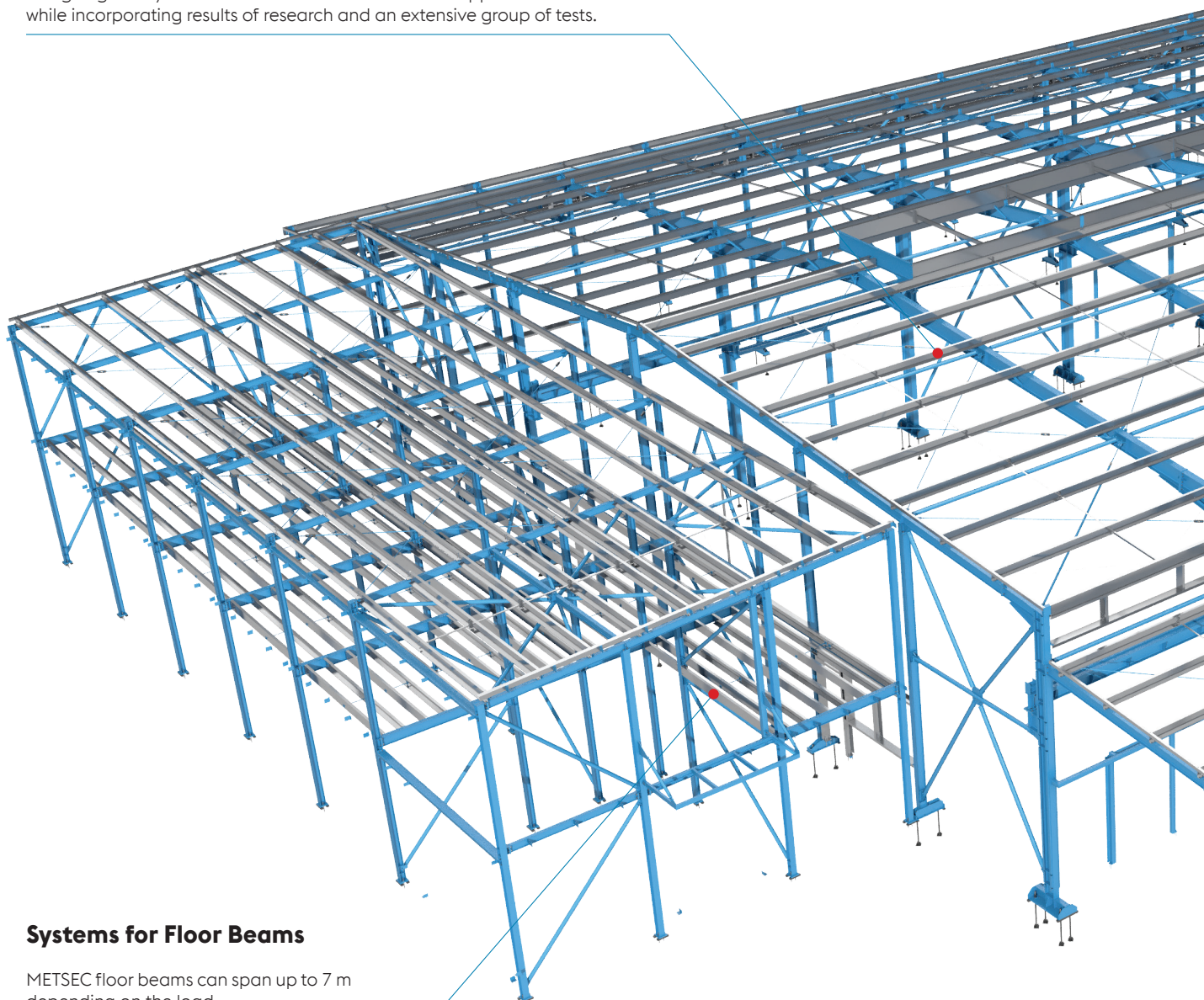


Construction Systems



Systems for Purlins

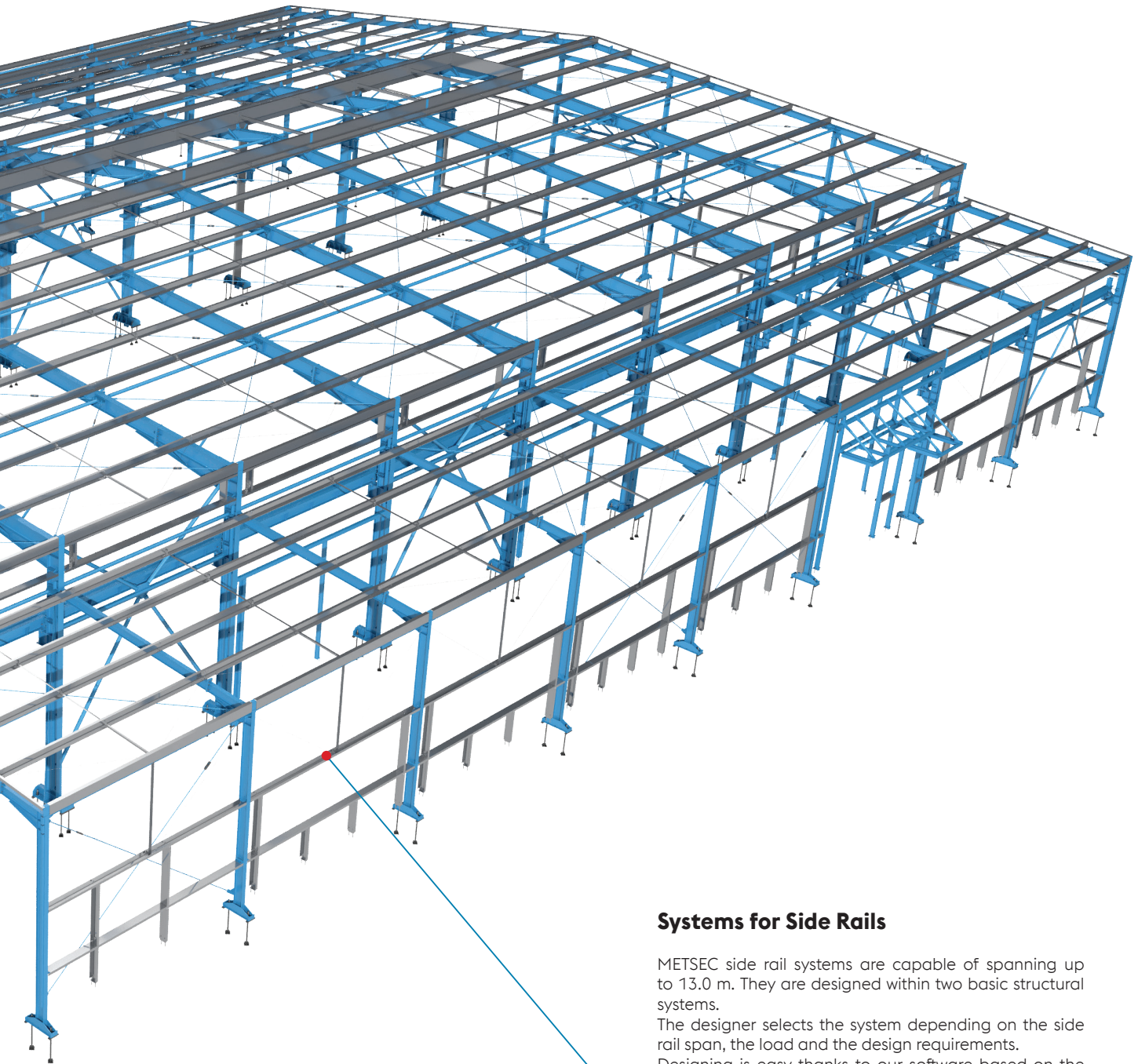
METSEC purlin systems are capable of spanning up to 14.5 m. They are designed within four basic structural systems. The designer selects the system depending on the purlin span and the load. Designing is easy thanks to our software based on the applicable EN standards while incorporating results of research and an extensive group of tests.



Systems for Floor Beams

METSEC floor beams can span up to 7 m depending on the load. Designing is easy thanks to our software based on the applicable EN standards while incorporating results of research and tests.

METSEC Construction Systems - a name that you can trust and the synonym of an elegant and efficient solution for secondary steel structures of hall-type buildings. Our portfolio includes thousands of successful deliveries of purlin and side-rail systems for halls of various purposes ranging from a few hundred square metres to huge logistics, manufacturing and shopping centres.



Systems for Side Rails

METSEC side rail systems are capable of spanning up to 13.0 m. They are designed within two basic structural systems.

The designer selects the system depending on the side rail span, the load and the design requirements.

Designing is easy thanks to our software based on the applicable EN standards while incorporating results of research and an extensive group of tests.

Construction Systems

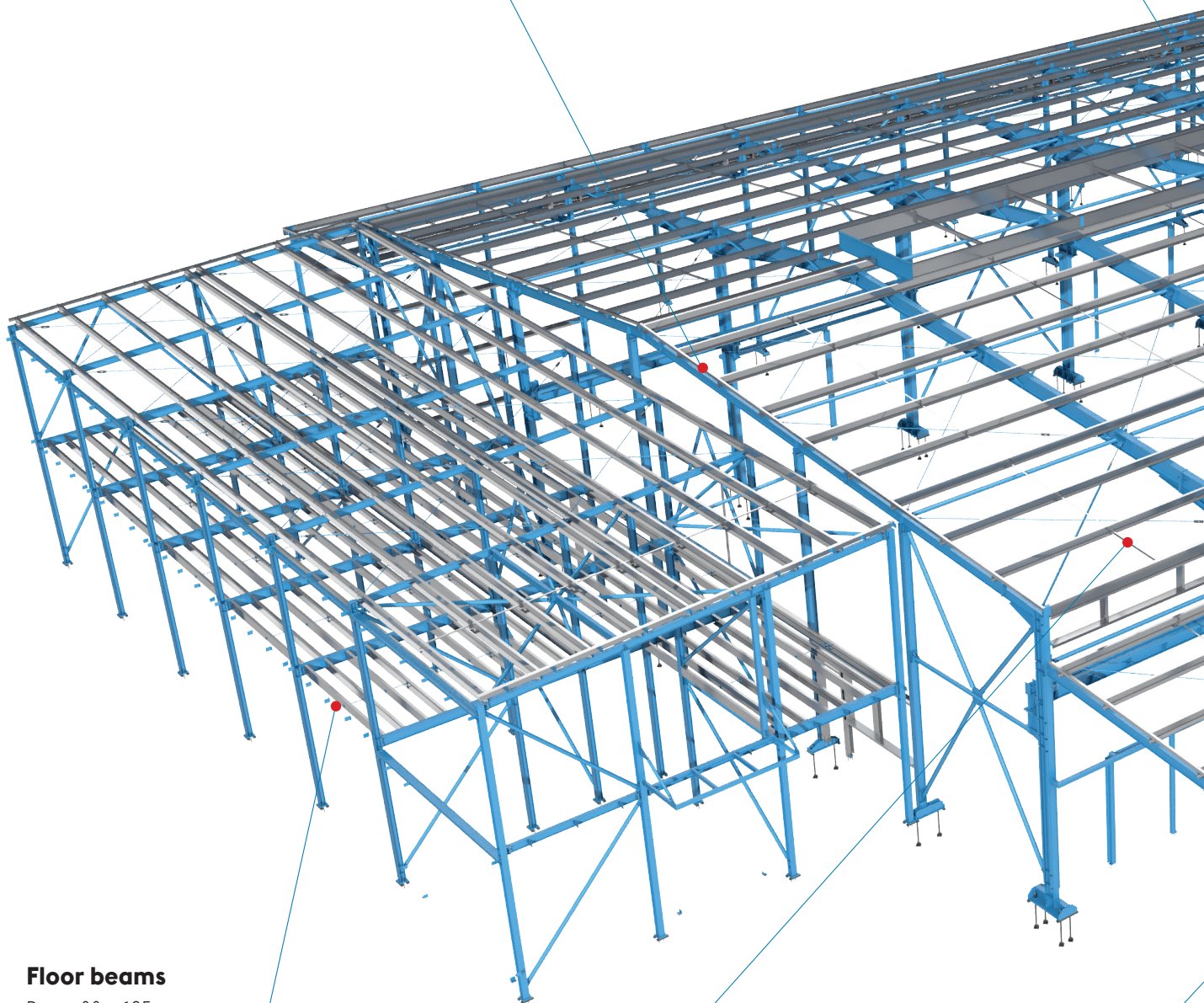


Cleader angle bars and cantilevers

Pages 45 and 51

Purlin struts and ties

Pages 38 - 44



Floor beams

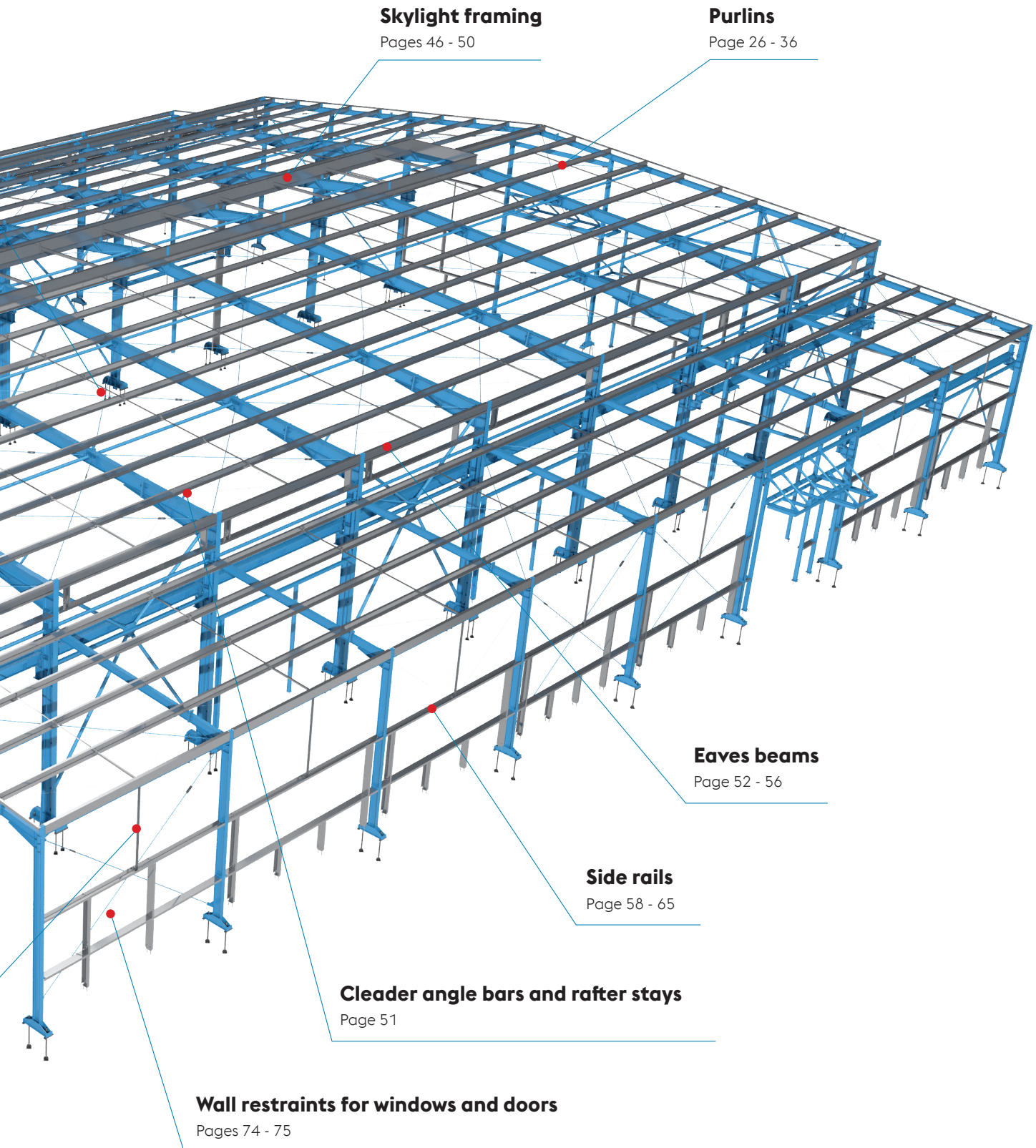
Pages 88 - 105

Eaves beam struts

Pages 43 - 44

Side rail supports

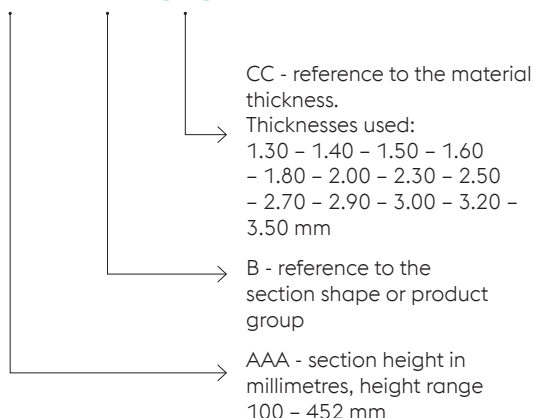
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PORTFOLIO OF STRUCTURAL SECTIONS

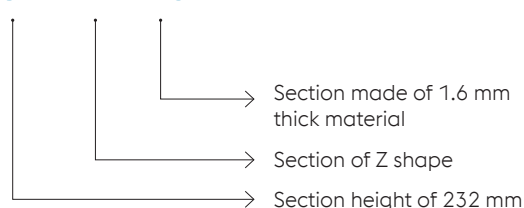
Section Reference Code

AAA B CC



Example of a Reference Code

232 Z 16



The cross-sectional characteristics listed in the tables of our products are for solid cross-sections, except for the capacity moments that have been set for effective cross-sections.

Reference Code for Section Shape / Product Group

- Z** Z-shaped sections used predominantly for purlins and possibly for side rails. For the range of sections see pages 14-17.
- C** C-shaped sections used predominantly for side rails and roof trimmers, usable also for purlins to a limited extent. For the range of sections see pages 18-21.
- E** C-shaped sections that can have their top flange sloping in the range of -10° to $+25^\circ$. These sections are used as eaves beams. For the range of sections see page 53.
- C+** C-shaped sections with doubly reinforced flange, used predominantly for mezzanine floors (girders and floor beams). They can, however, be used for side rails, too. For the range of sections see pages 22 -25 or 94-97.
- M** C-shaped sections used for mezzanine floors, mainly as secondary floor beams. These sections can also be used for girders. For the range of sections see pages 90-93.
- F** C- and U-shaped sections used for structural facade systems. The range of F sections is not included in this technical manual but is listed in a separate manual of Structural Facade Systems.

Materials Used

All sections of the construction systems are made of steel with a yield strength of 450 MPa, zinc-galvanised to the Z350 grade, which corresponds to a layer of 25 μm .

If a higher grade of surface finish, is required, we provide the following coatings:

- 600 g/m² double-sided / 42 μm single-sided
- 800 g/m² double-sided / 56 μm single-sided
- 1000 g/m² double-sided / 70 μm single-sided

Our sales department needs to be consulted if a higher grade of surface finish is required.

Some sections from our portfolio are supplied with galvanised edges.

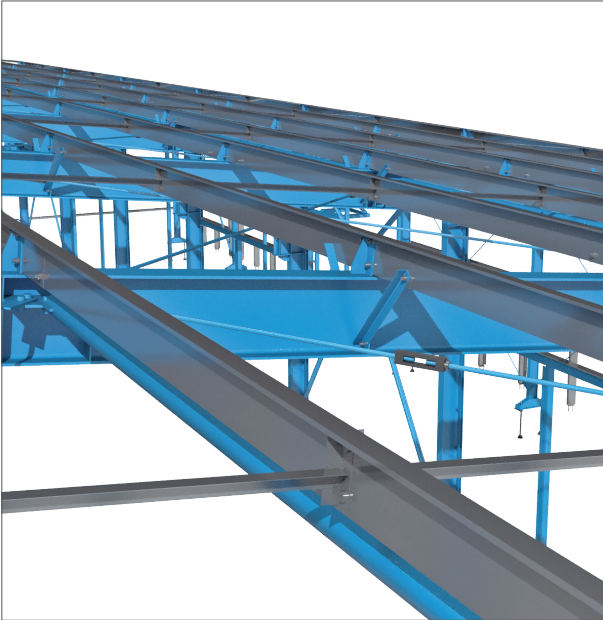


Fig. 1 – Purlins

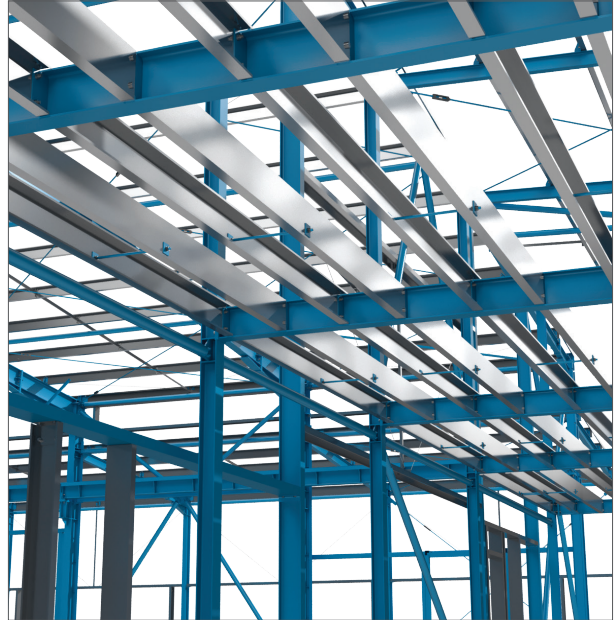


Fig. 2 – Mezzanine floor beams



Fig. 3 – Side rails in walls

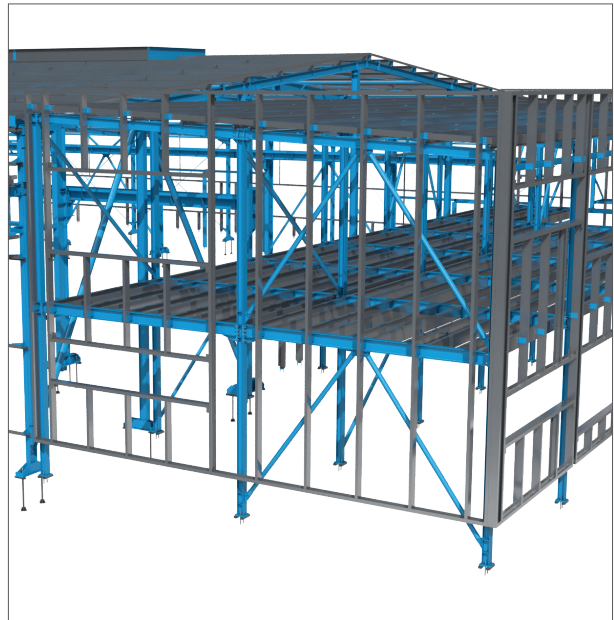


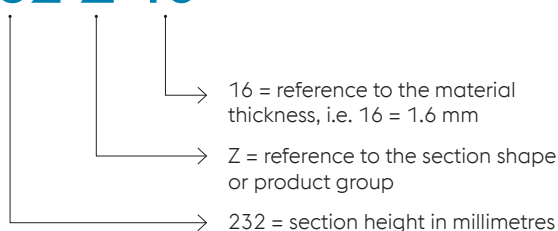
Fig. 4 – Main structures of facades

Z - SECTIONS

Range of sections and their cross-sectional characteristics

Section Reference Code

232 Z 16



General rules for making holes in sections

Transverse location of holes

Section web up to 5 different reference axes.

Section flange up to 2 different reference axes.

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of hole per one type of component are allowed.

Possible types of holes

- Straight, round: diameters of 9, 11, 12, 14, 18, 22 mm
- Straight, oval: dimensions of 12×30, 14×30, 18×30, 22×30 mm

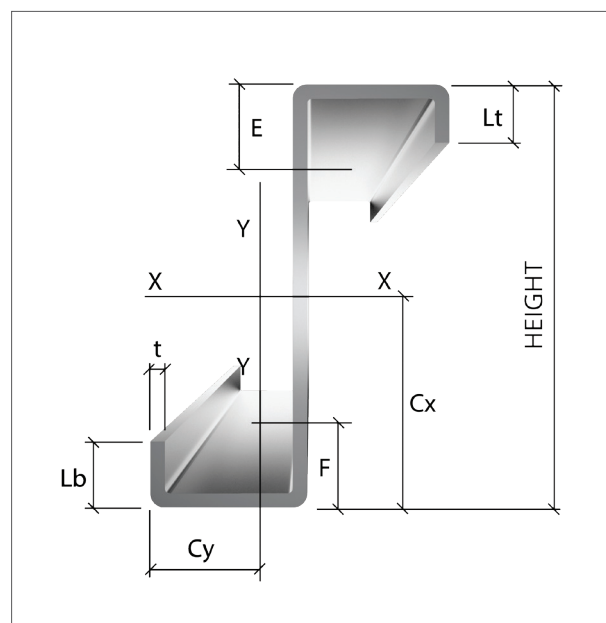
Standard locations of holes

This means the system holes recommended for system joints, such as the purlin attachment to the primary structure, details of sleeves and overhangs.

Standard holes in section web

18 mm in diameter (14 mm for type 122 sections) located along the standard axes in the transverse direction - the positions of axes are shown in Figure 1 and Table 1.

Standard holes in section flanges - 14 mm in diameter, located in the centre of the flange dimension in the transverse direction.



Tab. 1 – Z sections / hole positions, lengths of flange brackets

Section reference height	Lt mm	Lb mm	E mm	F mm
122	14	16	34	32
142 - 262	14	16	44	42
302 - 342	19	21	55	52
402 - 452	20	22	55	52

Non-standard locations of holes

This includes all other positions of holes off the system axes described in Table 1 – used for trimmers, non-standard accessories, or for additional structures attached to purlins, for example.

As the permitted number of reference axes on the section web is 5, three additional axes for non-standard holes can be added to the two standard system axes. The minimum axis distance from the section edge, i.e. 42 mm, must be observed. The minimum distance is 32 mm for sections of the 122 series.

General rules for making notches

The minimum notch length is 52 mm, the maximum 350 mm.
The maximum notch depth = 1/2 of the section height minus 2 mm.

Positioning of notch is unrestricted along the section length.

Notches may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes are allowed to be made in sections. These are oval holes 32×72 mm.

The holes need to be positioned in the section axis with the possibility of their offsetting to the position of standard holes in the web – see dimension E/F in Table 1.

Service holes can be made only along one reference axis within one type of component.

Tab. 2 – Permitted combinations of holes in one component – section web

Section reference	Straight holes	Counterformed holes	Service holes	Notches
122	Max. 2 different diameters along five different reference axes	No	No	Yes
142 - 452	Max. 3 different diameters along five different reference axes	No	Max. 1 dimension along one reference axis	Yes

Tab. 3 – Permitted combinations of holes in one component – section flange

Section reference	Straight holes	Counterformed holes	Service holes	Notches
122 - 452	Max. 2 different diameters along two different reference axes	No	No	Yes

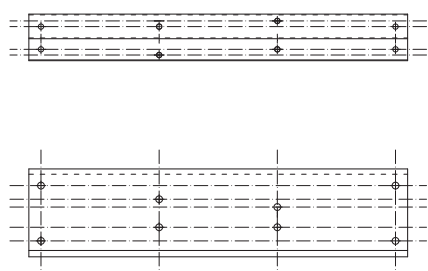


Fig. 5 – Possible layout of holes

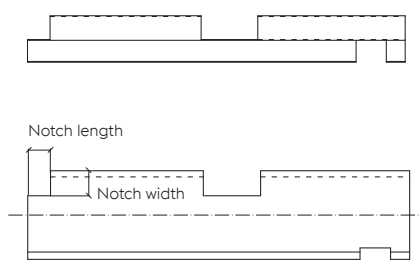


Fig. 6 – Possible layout of notches

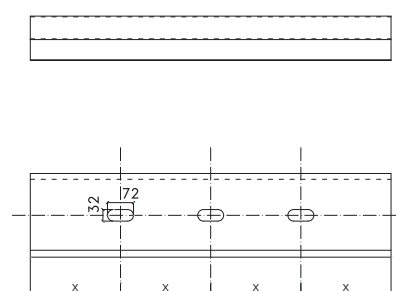


Fig. 7 – Possible layout of service holes

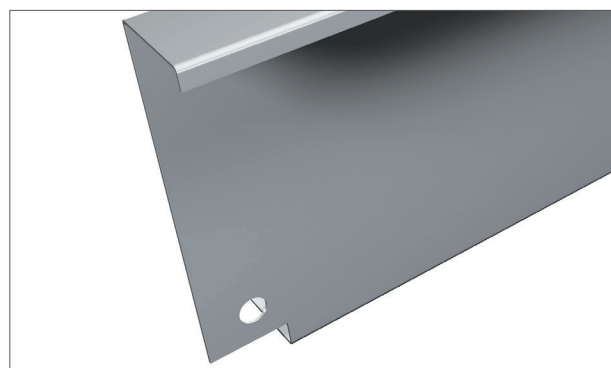


Fig. 8 – Notch in Z section

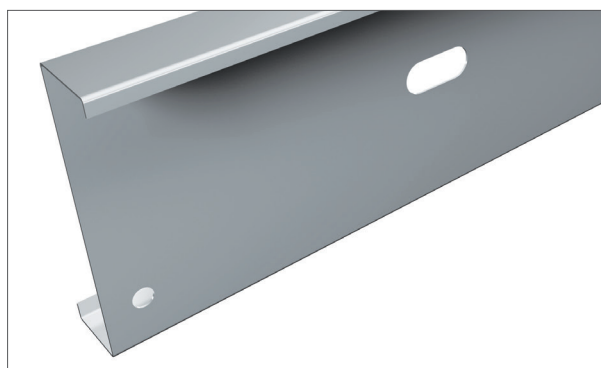


Fig. 9 – Service holes in Z section

Reference code	Weight	Area	Height	Top flange	Bottom flange	Thickness	I _{yy}	I _{zz}
	kg/m	mm ²	mm	mm	mm	mm	mm ⁴	mm ⁴
122Z13	2.59	330	122	60	55	1.30	828,502	271,835
122Z14	2.78	355	122	60	55	1.40	889,250	290,975
122Z15	2.97	379	122	60	55	1.50	949,579	309,870
122Z16	3.16	404	122	60	55	1.60	1,009,489	328,522
122Z18	3.54	452	122	60	55	1.80	1,128,061	365,102
142Z13	2.84	362	142	60	55	1.30	1,174,071	271,859
142Z14	3.05	389	142	60	55	1.40	1,260,513	291,001
142Z15	3.26	416	142	60	55	1.50	1,346,409	309,899
142Z16	3.47	442	142	60	55	1.60	1,431,761	328,554
142Z18	3.89	495	142	60	55	1.80	1,600,838	365,139
142Z20	4.30	548	142	60	55	2.00	1,767,756	400,771
172Z13	3.25	414	172	65	60	1.30	1,926,137	338,606
172Z14	3.49	445	172	65	60	1.40	2,068,767	362,597
172Z15	3.73	476	172	65	60	1.50	2,210,616	386,304
172Z16	3.98	506	172	65	60	1.60	2,351,685	409,427
172Z18	4.45	567	172	65	60	1.80	2,631,490	455,731
172Z20	4.93	628	172	65	60	2.00	2,908,197	500,622
172Z23	5.63	717	172	65	60	2.30	3,317,478	565,903
172Z25	6.09	776	172	65	60	2.50	3,586,500	608,073
202Z14	3.82	487	202	65	60	1.40	3,010,300	362,628
202Z15	4.09	521	202	65	60	1.50	3,217,456	386,338
202Z16	4.35	554	202	65	60	1.60	3,423,575	409,765
202Z18	4.88	621	202	65	60	1.80	3,832,707	455,776
202Z20	5.40	688	202	65	60	2.00	4,237,712	500,676
202Z23	6.17	786	202	65	60	2.30	4,837,518	565,973
202Z27	7.19	916	202	65	60	2.70	5,622,968	649,273
232Z14	4.12	522	232	65	60	1.40	4,173,212	362,655
232Z15	4.44	566	232	65	60	1.50	4,461,219	386,368
232Z16	4.73	602	232	65	60	1.60	4,747,894	409,798
232Z18	5.30	675	232	65	60	1.80	5,317,259	455,817
232Z20	5.87	748	232	65	60	2.00	5,881,325	500,725
232Z23	6.71	855	232	65	60	2.30	6,717,529	566,036
232Z25	7.27	926	232	65	60	2.50	7,268,428	608,229
262Z15	4.76	603	262	65	60	1.50	5,962,154	386,395
262Z16	5.11	650	262	65	60	1.60	6,346,243	409,828
262Z18	5.73	729	262	65	60	1.80	7,109,446	455,853
262Z20	6.34	808	262	65	60	2.00	7,866,034	500,769
262Z23	7.26	924	262	65	60	2.30	8,988,559	566,094
262Z25	7.86	1001	262	65	60	2.90	9,728,699	608,298
262Z29	9.06	1154	262	65	60	2.90	11,189,372	689,538
302Z20	7.86	1002	302	90	82	2.00	13,558,656	1,328,956
302Z23	9.01	1147	302	90	82	2.30	15,513,110	1,509,440
302Z25	9.76	1244	302	90	82	2.50	16,804,706	1,627,130
302Z29	11.27	1435	302	90	82	2.90	19,360,711	1,856,274
342Z23	9.73	1239	342	90	82	2.30	20,849,706	1,509,624
342Z25	10.55	1344	342	90	82	2.50	22,590,898	1,627,337
342Z27	11.37	1448	342	90	82	2.70	24,320,719	1,742,967
342Z30	12.58	1603	342	90	82	3.00	26,894,191	1,912,549
342Z32	13.35	1692	342	90	82	3.20	28,595,704	2,023,056
342Z35	14.55	1844	342	90	82	3.50	31,126,840	2,185,042
402Z25	12.16	1549	402	100	92	2.50	35,493,294	2,229,458
402Z27	13.01	1669	402	100	92	2.70	38,226,515	2,389,803
402Z30	14.41	1849	402	100	92	3.00	42,297,133	2,625,518
402Z32	15.42	1954	402	100	92	3.20	44,991,448	2,779,491
402Z35	16.81	2131	402	100	92	3.50	49,003,853	3,005,747
432Z25	12.73	1613	432	100	92	2.50	42,206,872	2,229,592
432Z27	13.72	1738	432	100	92	2.70	45,462,239	2,389,953
432Z30	15.19	1926	432	100	92	3.00	50,311,947	2,625,698
432Z32	16.22	2056	432	100	92	3.20	53,522,905	2,779,692
432Z35	17.64	2236	432	100	92	3.50	58,306,156	3,005,984
452Z27	14.14	1792	452	100	92	2.70	50,726,062	2,390,049
452Z30	15.67	1986	452	100	92	3.00	56,143,152	2,625,812
452Z32	16.73	2120	452	100	92	3.20	59,730,432	2,779,820
452Z35	18.19	2306	452	100	92	3.50	65,075,269	3,006,137

W_{yy}	W_{zz}	i_{yy}	i_{zz}	C_y	C_z	M_{cy}	M_{cz}	Reference code
mm ³	mm ³	mm	mm	mm	mm	kNm	kNm	
13,406	4,652	49.3	28.3	61.8	55.3	5.110	2.105	122Z13
14,389	4,984	49.3	28.2	61.8	55.2	5.760	2.255	122Z14
15,365	5,312	49.2	28.1	61.8	55.2	6.354	2.402	122Z15
16,334	5,637	49.2	28.1	61.8	55.1	6.911	2.548	122Z16
18,253	6,274	49.1	27.9	61.8	55.0	8.04	2.835	122Z18
16,340	4,647	57.0	27.0	72.0	55.2	6.017	2.105	142Z13
17,543	4,979	57.0	27.0	72.0	55.2	6.780	2.254	142Z14
18,739	5,307	57.0	27.0	72.0	55.1	7.573	2.402	142Z15
19,927	5,631	57.0	27.0	72.0	55.1	8.394	2.548	142Z16
22,280	6,268	56.0	27.0	72.0	55.0	9.816	2.835	142Z18
24,602	6,892	56.0	27.0	72.0	54.9	11.039	3.115	142Z20
22,169	5,328	68.0	29.0	87.0	60.1	7.500	2.355	172Z13
23,810	5,710	68.0	28.0	87.0	60.1	8.459	2.587	172Z14
25,443	6,088	68.0	28.0	87.0	60.0	9.456	2.757	172Z15
27,066	6,462	68.0	28.0	87.0	60.0	10.491	2.925	172Z16
30,287	7,198	68.0	28.0	87.0	59.9	12.658	3.257	172Z18
33,471	7,920	68.0	28.0	87.0	59.8	14.832	3.582	172Z20
38,181	8,974	67.0	28.0	87.0	59.6	17.181	4.055	172Z23
41,276	9,657	67.0	28.0	87.0	59.5	18.575	4.362	172Z25
29,531	5,704	78.0	27.0	102.0	60.0	10.045	2.586	202Z14
31,563	6,082	78.0	27.0	102.0	60.0	11.228	2.757	202Z15
33,585	6,455	78.0	27.0	102.0	59.9	12.454	2.925	202Z16
37,598	7,191	78.0	27.0	102.0	59.8	15.022	3.257	202Z18
41,571	7,912	78.0	27.0	102.0	59.7	17.724	3.581	202Z20
47,454	8,965	78.0	27.0	102.0	59.6	21.354	4.055	202Z23
55,158	10,317	78.0	26.0	102.0	59.4	24.821	4.662	202Z27
35,674	5,699	88.0	26.0	117.0	60.0	11.647	2.586	232Z14
38,136	6,077	88.0	26.0	117.0	59.9	13.017	2.757	232Z15
40,586	6,450	88.0	26.0	117.0	59.9	14.437	2.925	232Z16
45,453	7,186	88.0	26.0	117.0	59.8	17.411	3.257	232Z18
50,275	7,906	88.0	26.0	117.0	59.7	20.538	3.581	232Z20
57,422	8,958	88.0	26.0	117.0	59.5	25.359	4.054	232Z23
62,131	9,641	88.0	25.0	117.0	59.4	27.954	4.361	232Z25
45,161	6,072	98.0	25.0	132.0	59.9	14.822	2.756	262Z15
48,070	6,446	98.0	25.0	132.0	59.8	16.438	2.925	262Z16
53,851	7,181	98.0	25.0	132.0	59.7	19.822	3.256	262Z18
59,581	7,900	98.0	25.0	132.0	59.6	23.380	3.581	262Z20
68,083	8,952	98.0	25.0	132.0	59.5	28.866	4.054	262Z23
73,689	9,634	98.0	25.0	132.0	59.4	32.029	4.361	262Z25
84,752	10,955	98.0	24.0	132.0	59.2	38.134	4.954	262Z29
88,704	15,153	116.0	36.0	153.0	82.3	30.340	6.891	302Z20
101,489	17,240	116.0	36.0	153.0	82.1	37.974	7.833	302Z23
109,937	18,605	116.0	36.0	153.0	82.0	43.351	8.449	302Z25
126,657	21,272	115.0	36.0	153.0	81.8	54.673	9.650	302Z29
120,561	17,223	129.0	35.0	173.0	82.1	43.358	7.833	342Z23
130,628	18,587	129.0	35.0	173.0	82.0	49.493	8.448	342Z25
140,629	19,930	129.0	35.0	173.0	81.8	55.853	9.053	342Z27
155,508	21,906	129.0	34.0	173.0	81.7	65.754	9.943	342Z30
165,345	23,198	129.0	34.0	173.0	81.6	72.176	10.525	342Z32
179,978	25,097	128.0	34.0	173.0	81.4	80.710	11.379	342Z35
174,863	22,843	151.0	38.0	203.0	91.9	60.612	10.383	402Z25
188,328	24,510	151.0	38.0	203.0	91.8	68.528	11.135	402Z27
208,380	26,968	150.0	38.0	203.0	91.6	80.915	12.244	402Z30
221,652	28,579	150.0	37.0	203.0	91.5	89.464	12.969	402Z32
241,417	30,952	150.0	37.0	203.0	91.4	102.579	14.037	402Z35
193,588	22,832	160.0	37.0	218.0	91.9	65.449	10.382	432Z25
208,518	24,498	160.0	37.0	218.0	91.7	73.994	11.135	432Z27
230,760	26,956	160.0	37.0	218.0	91.6	87.366	12.243	432Z30
245,486	28,565	160.0	37.0	218.0	91.5	96.596	12.969	432Z32
267,422	30,938	160.0	36.0	218.0	91.3	110.756	14.037	432Z35
222,430	24,491	167.0	36.0	228.0	91.7	77.655	11.135	452Z27
246,181	26,948	167.0	36.0	228.0	91.6	91.688	12.243	452Z30
261,909	28,557	167.0	36.0	228.0	91.5	101.374	12.968	452Z32
285,343	30,929	166.0	36.0	228.0	91.3	116.235	14.037	452Z35

C - SECTIONS

Range of sections and their cross-sectional characteristics

Section Reference Code

232 C 16

- 16 = reference to the material thickness, i.e. 16 = 1.6 mm
- C = reference to the section shape or product group
- 232 = section height in millimetres

General rules for punching holes in sections

Transverse location of holes

Section web up to 5 different reference axes.

Section flange up to 2 different reference axes.

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of hole per one type of component are allowed.

Possible types of hole

- Straight, round: diameters of 9, 11, 12, 14, 18, 22 mm
- Straight, oval: dimensions of 12×30, 14×30, 18×30, 22×30 mm
- Counterformed, round: diameters of: 14, 18 mm

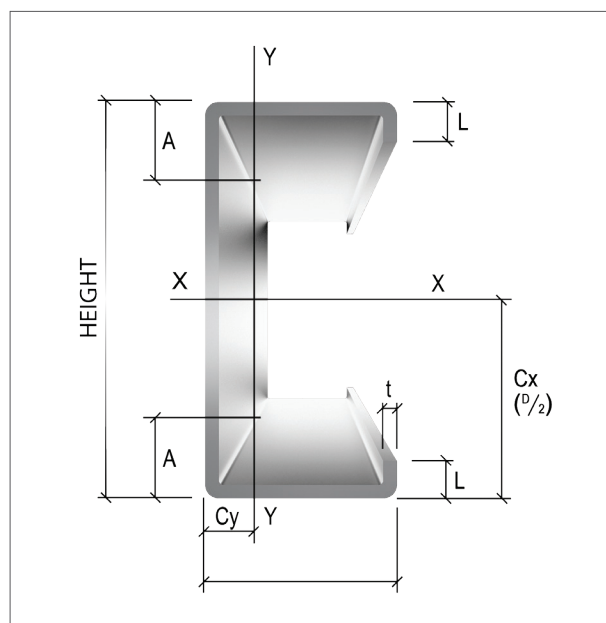
Standard locations of holes

This means the system holes recommended for system joints, such as the purlin/side rail attachment to the primary structure, details of sleeves and overhangs.

Standard holes in section web

18 mm in diameter (14 mm for type 122 sections) located along the standard axes in the transverse direction - the positions of axes are shown in Figure 4 and Table 1.

Standard holes in section flanges – 14 mm in diameter, located in the centre of the flange dimension in the transverse direction.



Tab. 4 – C sections / hole positions, lengths of flange brackets

Section reference height	A	L
	mm	mm
122	33	13
142	43	13
172, 202	43	13
232, 262	43	13
302	53.5	18
342	53.5	18
402	53.5	20

Non-standard locations of holes

This includes all other positions of holes off the system axes described in the table 4 – used for trimmers, non-standard accessories, or for additional structures attached to purlins/side rails, for example.

As the permitted number of reference axes on the section web is 5, three additional axes for non-standard holes can be added to the two standard system axes. The minimum axis distance from the section edge, i.e. 43 mm must be observed. The minimum distance is 33 mm for sections of the 122 series.

General rules for making notches

The minimum notch length is 52 mm, the maximum 350 mm.

The maximum notch depth = 1/2 of the section height – 2 mm.

Positioning of notches is unrestricted along the section length.

Notches may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes are allowed to be made in sections.

These are oval holes 32×72 mm.

The holes need to be positioned in the section axis with the possibility of their offsetting to the position of standard holes in the web – see dimension A in Table 4.

Service holes can be made only along one reference axis within one type of component.

Tab. 5 – Permitted combinations of holes in one component – section web

Section reference	Straight holes	Counterformed holes	Service holes	Notches
122	Max. 2 different diameters along five different reference axes	No	No	Yes
142 - 342	Max. 3 different diameters along five different reference axes	Max. 2 different diameters along five different reference axes	Max. 1 dimension along one reference axis	Yes
402	Max. 3 different diameters along five different reference axes	Max. 1 diameter along five different reference axes	Max. 1 dimension along one reference axis	Yes

Tab. 6 – Permitted combinations of holes in one component – section flange

Section reference	Straight holes	Counterformed holes	Service holes	Notches
122 - 452	Max. 2 different diameters along two different reference axes	No	No	Yes

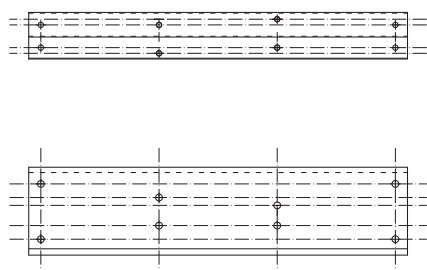


Fig. 10 – Possible layout of holes

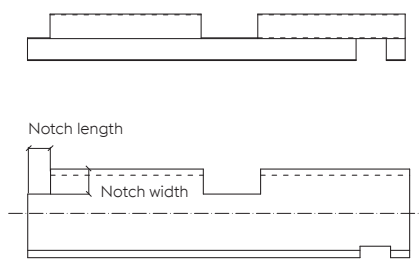


Fig. 11 – Possible layout of notches

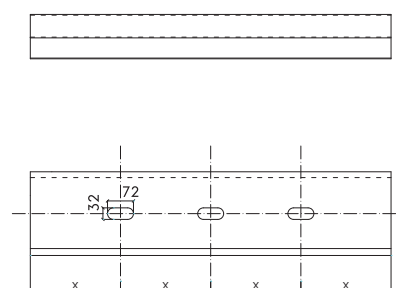


Fig. 12 – Possible layout of service holes



Fig. 13 – Notch in C section



Fig. 14 – Service holes in C section

Reference code	Weight	Area	Height	Flange	Thickness	I _{yy}	I _{zz}
	kg/m	mm ²	mm	mm	mm	mm ⁴	mm ⁴
122C13	2.59	330	122	60	1.30	841,026	167,405
122C14	2.78	355	122	60	1.40	902,696	179,288
122C15	2.97	379	122	60	1.50	963,939	191,034
122C16	3.16	404	122	60	1.60	1,024,759	202,642
122C18	3.54	452	122	60	1.80	1,145,131	225,451
142C13	2.84	362	142	60	1.30	1,189,756	175,793
142C14	3.05	389	142	60	1.40	1,277,354	188,275
142C15	3.26	416	142	60	1.50	1,364,401	200,612
142C16	3.47	442	142	60	1.60	1,450,896	212,806
142C18	3.89	495	142	60	1.80	1,622,239	236,766
142C20	4.30	548	142	60	2.00	1,791,395	260,163
172C13	3.25	414	172	65	1.30	1,947,042	226,639
172C14	3.49	445	172	65	1.40	2,091,220	242,820
172C15	3.73	476	172	65	1.50	2,234,609	258,826
172C16	3.98	506	172	65	1.60	2,377,209	274,660
172C18	4.45	567	172	65	1.80	2,660,051	305,810
172C20	4.93	628	172	65	2.00	2,939,761	336,279
172C23	5.63	717	172	65	2.30	3,353,484	380,720
172C25	6.09	776	172	65	2.50	3,625,426	409,517
202C14	3.82	487	202	65	1.40	3,039,007	254,459
202C15	4.09	521	202	65	1.50	3,248,138	271,232
202C16	4.35	554	202	65	1.60	3,456,222	287,824
202C18	4.88	621	202	65	1.80	3,869,255	320,465
202C20	5.40	688	202	65	2.00	4,278,121	352,392
202C23	6.17	786	202	65	2.30	4,883,645	398,961
202C27	7.19	916	202	65	2.70	5,676,579	458,624
232C14	4.11	522	232	65	1.40	4,208,805	264,273
232C15	4.44	566	232	65	1.50	4,499,268	281,691
232C16	4.73	602	232	65	1.60	4,788,387	298,919
232C18	5.30	675	232	65	1.80	5,362,607	332,814
232C20	5.87	748	232	65	2.00	5,931,481	365,965
232C23	6.71	855	232	65	2.30	6,774,813	414,317
232C25	7.27	926	232	65	2.50	7,330,407	445,647
262C15	4.75	603	262	65	1.50	6,008,247	290,627
262C16	5.11	650	262	65	1.60	6,395,304	308,399
262C18	5.73	729	262	65	1.80	7,164,406	343,360
262C20	6.34	808	262	65	2.00	7,926,841	377,554
262C23	7.26	924	262	65	2.30	9,058,039	427,424
262C25	7.86	1001	262	65	2.50	9,803,898	459,736
262C29	9.06	1154	262	65	2.90	11,275,852	522,156
302C20	7.86	1002	302	88	2.00	13,603,265	930,267
302C23	9.01	1147	302	88	2.30	15,563,997	1,057,658
302C25	9.76	1244	302	88	2.50	16,859,719	1,140,883
302C29	11.27	1435	302	88	2.90	19,423,833	1,303,300
342C23	9.73	1239	342	88	2.30	20,907,971	1,092,726
342C25	10.55	1344	342	88	2.50	22,653,890	1,178,692
342C27	11.37	1448	342	88	2.70	24,388,385	1,263,264
342C30	12.58	1603	342	88	3.00	26,968,766	1,387,531
402C25	12.16	1549	402	95	2.50	35,137,910	1,540,614
402C27	13.01	1669	402	95	2.70	37,842,916	1,652,153
402C30	14.41	1849	402	95	3.00	41,871,270	1,816,332

W_{yy}	W_{zz}	i_{yy}	i_{zz}	C_y	C_z	M_{cy}	M_{cz}	Reference code
mm ³	mm ³	mm	mm	mm	mm	kNm	kNm	
13,787	4,111	49.6	22.1	61	19.28	5.090	1.640	122C13
14,798	4,403	49.6	22.1	61	19.28	5.740	1.770	122C14
15,802	4,692	49.5	22.0	61	19.28	6.360	1.900	122C15
16,799	4,977	49.5	22.0	61	19.28	6.920	2.030	122C16
18,773	5,538	49.4	21.9	61	19.29	8.050	2.290	122C18
16,757	4,182	56.9	21.9	71	17.96	5.990	1.640	142C13
17,991	4,479	56.8	21.8	71	17.96	6.750	1.770	142C14
19,217	4,773	56.8	21.8	71	17.97	7.550	1.910	142C15
20,435	5,063	56.7	21.7	71	17.97	8.370	2.040	142C16
22,848	5,634	56.7	21.6	71	17.98	9.830	2.300	142C18
25,231	6,192	56.6	21.6	71	17.99	11.200	2.560	142C20
22,640	4,832	68.1	23.2	86	18.09	7.460	1.850	172C13
24,317	5,177	68.1	23.2	86	18.10	8.420	2.000	172C14
25,984	5,519	68.0	23.1	86	18.10	9.410	2.160	172C15
27,642	5,857	68.0	23.1	86	18.11	10.450	2.310	172C16
30,931	6,523	67.9	23.0	86	18.12	12.610	2.610	172C18
34,183	7,174	67.8	22.9	86	18.13	14.840	2.910	172C20
38,994	8,125	67.6	22.8	86	18.14	17.550	3.350	172C23
42,156	8,742	67.5	22.7	86	18.15	18.970	3.640	172C25
30,089	5,259	78.5	22.7	101	16.62	9.990	2.010	202C14
32,160	5,607	78.4	22.7	101	16.63	11.170	2.160	202C15
34,220	5,951	78.4	22.6	101	16.63	12.400	2.310	202C16
38,310	6,628	78.3	22.5	101	16.65	14.960	2.620	202C18
42,358	7,290	78.2	22.4	101	16.66	17.660	2.920	202C20
48,353	8,257	78.0	22.3	101	16.68	21.760	3.360	202C23
56,204	9,497	77.8	22.1	101	16.71	25.290	3.940	202C27
36,283	5,325	88.7	22.2	116	15.37	11.580	2.010	232C14
38,787	5,677	88.6	22.2	116	15.38	12.950	2.160	232C15
41,279	6,025	88.6	22.1	116	15.39	14.360	2.320	232C16
46,229	6,711	88.5	22.0	116	15.41	17.330	2.620	232C18
51,134	7,382	88.3	21.9	116	15.42	20.450	2.920	232C20
58,404	8,362	88.2	21.8	116	15.45	25.270	3.370	232C23
63,193	8,997	88.1	21.7	116	15.47	28.040	3.660	232C25
45,865	5,734	98.6	21.7	131	14.31	14.740	2.170	262C15
48,819	6,086	98.5	21.6	131	14.32	16.350	2.320	262C16
54,690	6,779	98.4	21.5	131	14.35	19.730	2.620	262C18
60,510	7,457	98.3	21.5	131	14.37	23.280	2.920	262C20
69,145	8,447	98.2	21.3	131	14.40	28.760	3.370	262C23
74,839	9,090	98.0	21.2	131	14.42	31.910	3.660	262C25
86,075	10,333	97.8	21.0	131	14.47	38.490	4.240	262C29
90,088	13,967	115.9	30.3	151	21.40	30.140	5.330	302C20
103,073	15,886	115.8	30.2	151	21.42	37.720	6.170	302C23
111,654	17,140	115.7	30.1	151	21.44	43.060	6.730	302C25
128,635	19,590	115.5	29.9	151	21.47	54.270	7.840	302C29
122,269	16,054	129.2	29.5	171	19.93	43.060	6.180	342C23
132,479	17,322	129.1	29.4	171	19.95	49.150	6.740	342C25
142,622	18,570	129.0	29.3	171	19.97	55.450	7.300	342C27
157,712	20,407	128.8	29.2	171	20.01	65.240	8.130	342C30
174,816	20,702	150.0	32.0	201	21.00	60.170	7.940	402C25
188,273	22,208	150.0	31.0	201	21.00	67.970	8.600	402C27
208,315	24,427	150.0	31.0	201	21.00	80.130	9.590	402C30

C+ SECTIONS

Range of sections and their cross-sectional characteristics

Section Reference Code

232 C+ 16

- 16 = reference to the material thickness, i.e. 16 = 1.6 mm
- C+C+ = reference to the section shape or product group
- 232 = section height in millimetres

General rules for punching holes in sections

Transverse location of holes

- Section web** up to 5 different reference axes
- Section flange** up to 2 different reference axes

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of holes per one type of component are allowed.

Possible types of holes

- Straight, round: diameters of 9, 11, 12, 14, 18, 22 mm
- Straight, oval: dimensions of 12×30, 14×30, 18×30, 22×30 mm
- Counterformed, round: diameter of 18 mm

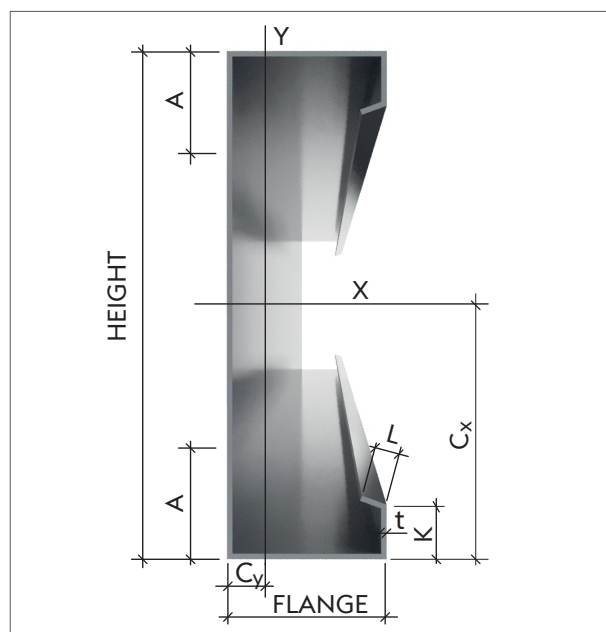
Standard locations of holes

This means the system holes recommended for system joints, such as the beam attachment to the primary structure, details of sleeves and overhangs.

Standard holes in section web

18 mm in diameter, located along the standard axes in the transverse direction – the positions of axes are shown in the figure and in Table 7.

Standard holes in section flanges - 14 mm in diameter, located in the centre of the flange dimension in the transverse direction.



Tab. 7 – Hole positions and dimensions of flange brackets in C+

Section reference height	Dimension A	Dimension K	Dimension L
mm	mm	mm	mm
142	41	25	12
172	41	25	12
202	41	25	12
232	59	25	12
262	59	25	12
302	59	25	12
342	59	25	12
402	59	25	12
432	59	25	12
452	59	25	12

Non-standard locations of holes

This includes all other positions of holes off the system axes described in Table 7 – used for trimmers, non-standard accessories, or for additional structures attached to beams, for example.

As the permitted number of reference axes on the section web is 5, three additional axes for non-standard holes can be added to the two standard system axes. The minimum axis distance from the section edge, i.e. 41 mm must be observed.

General rules for making notches

The minimum notch length is 52 mm, the maximum 350 mm.

The maximum notch depth = 1/2 of the section height – 2 mm.

Positioning of notches is unrestricted along the section length.

Notches may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes are allowed to be made in sections.

These are oval holes 32×72 mm.

The holes need to be positioned in the section axis with the possibility of their offsetting to the position of standard holes in the web – see dimension A in Table 7.

Service holes can be made only along one reference axis within one type of component.

Tab. 8 – Permitted combinations of holes in one component – section web

Section reference	Straight holes	Counterformed holes	Service holes	Notches
142 - 452	Max. 3 different diameters along five different reference axes	Max. 1 diameter along five different reference axes	Max. 1 dimension along one axis	Yes

Tab. 9 – Permitted combinations of holes in one component – section flange

Section reference	Straight holes	Counterformed holes	Service holes	Notches
142 - 452	Max. 2 different diameters along two different reference axes	No	No	Yes

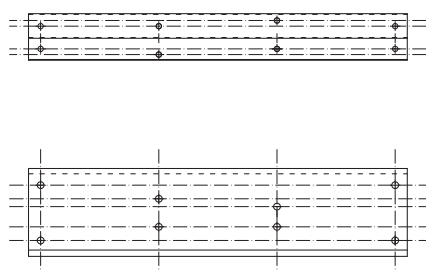


Fig. 15 – Possible layout of holes

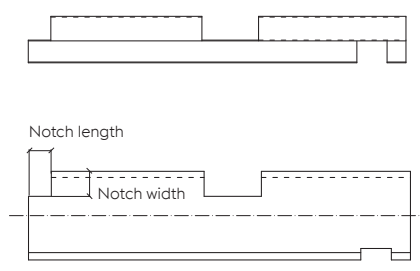


Fig. 16 – Possible layout of notches

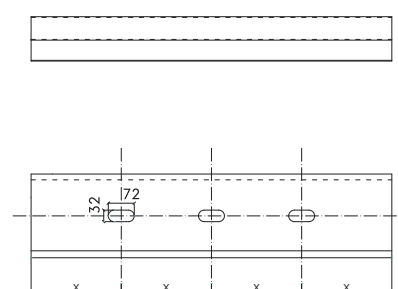


Fig. 17 – Possible layout of service holes

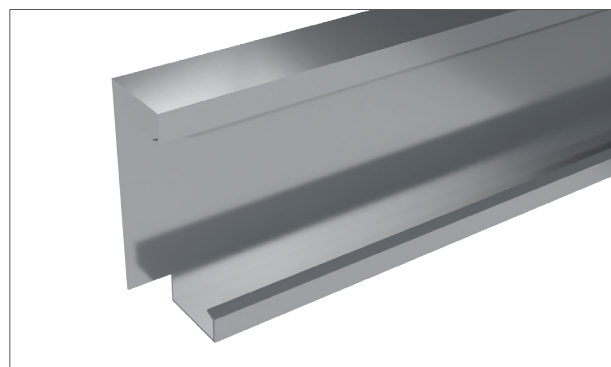


Fig. 18 – Notch in C+ section

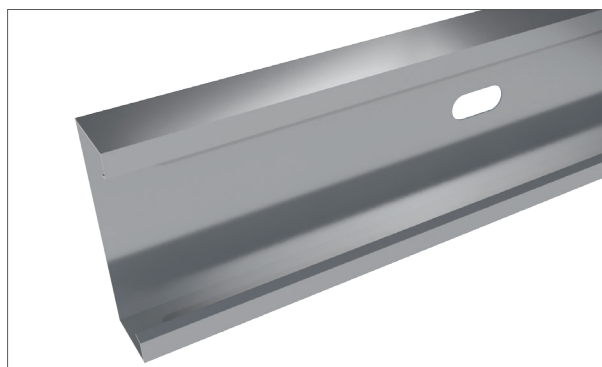


Fig. 19 – Service holes in C+ section

Reference code	Weight	Area	Height	Flange	Thickness	I _{yy}	I _{zz}
	kg/m	mm ²	mm	mm	mm	mm ⁴	mm ⁴
142C+15	4.03	511	142	73	1.50	1,720,898	450,419
142C+16	4.30	544	142	73	1.60	1,830,331	478,042
142C+18	4.82	611	142	73	1.80	2,047,234	532,410
142C+20	5.35	678	142	73	2.00	2,261,525	585,617
172C+15	4.39	556	172	73	1.50	2,686,611	483,231
172C+16	4.67	592	172	73	1.60	2,858,121	512,864
172C+18	5.25	665	172	73	1.80	3,198,314	571,188
172C+20	5.82	738	172	73	2.00	3,534,749	628,263
172C+23	6.68	847	172	73	2.30	4,032,375	711,561
172C+25	7.25	919	172	73	2.50	4,359,456	765,565
202C+15	4.74	601	202	73	1.50	3,910,297	511,268
202C+16	5.05	640	202	73	1.60	4,160,649	542,612
202C+18	5.68	719	202	73	1.80	4,657,504	604,298
202C+20	6.30	798	202	73	2.00	5,149,236	664,660
202C+23	7.22	916	202	73	2.30	5,877,253	752,744
202C+25	8.46	1072	202	73	2.70	6,830,116	865,663
232C+16	5.43	688	232	73	1.60	5,759,516	568,319
232C+18	6.10	773	232	73	1.80	6,449,103	632,899
232C+20	6.77	858	232	73	2.00	7,131,987	696,086
232C+25	8.42	1068	232	73	2.50	8,809,951	848,040
262C+15	5.45	691	262	73	1.50	7,212,586	556,658
262C+18	6.53	827	262	73	1.80	8,597,411	657,854
262C+20	7.24	918	262	73	2.00	9,510,001	723,496
262C+23	8.31	1054	262	73	2.30	10,862,979	819,261
262C+25	9.01	1143	262	73	2.50	11,754,380	881,324
302C+20	8.73	1106	302	100	2.00	15,772,244	1,585,457
302C+23	10.02	1270	302	100	2.30	18,035,410	1,800,875
302C+25	10.87	1378	302	100	2.50	19,529,390	1,941,327
302C+29	12.59	1596	302	100	2.90	22,481,908	2,214,725
342C+23	10.74	1362	342	100	2.30	24,146,589	1,869,912
342C+27	12.59	1596	342	100	2.70	28,142,315	2,158,794
342C+32	14.89	1887	342	100	3.20	33,052,622	2,505,291
402C+25	13.24	1678	402	110	2.50	40,356,524	2,653,714
402C+27	14.29	1812	402	110	2.70	43,443,816	2,843,611
402C+30	15.86	2010	402	110	3.00	48,035,708	3,122,421
402C+32	16.91	2143	402	110	3.20	51,070,967	3,304,299
402C+35	18.46	2340	402	110	3.50	55,584,890	3,571,174
432C+25	13.83	1753	432	110	2.50	47,869,348	2,706,950
432C+30	16.57	2100	432	110	3.00	56,992,809	3,184,839
432C+35	19.29	2445	432	110	3.50	65,966,888	3,642,313
452C+30	17.04	2160	452	110	3.00	63,492,096	3,223,594
452C+35	19.84	2515	452	110	3.50	73,501,456	3,686,470

W_{yy}	W_{zz}	i_{yy}	i_{zz}	C_y	C_z	M_{cy}	M_{cz}	Reference code
mm ³	mm ³	mm	mm	mm	mm	kNm	kNm	
24,238	10,208	57.1	29.2	71	28.88	8.937	3.780	142C+15
25,779	10,829	57.0	29.2	71	28.86	9.874	4.150	142C+16
28,834	12,050	57.0	29.1	71	28.82	11.661	4.900	142C+18
31,853	13,242	56.9	29.0	71	28.78	13.329	5.460	142C+20
31,240	10,430	68.5	29.0	86	26.67	11.123	3.820	172C+15
33,234	11,065	68.4	29.0	86	26.65	12.283	4.200	172C+16
37,190	12,314	68.3	28.9	86	26.61	14.715	4.920	172C+18
41,102	13,534	68.3	28.8	86	26.58	17.278	5.480	172C+20
46,888	15,310	68.2	28.6	86	26.52	20.528	6.300	172C+23
50,691	16,459	68.1	28.5	86	26.49	22.700	6.840	172C+25
38,716	10,603	79.5	28.8	101	24.78	13.332	3.850	202C+15
41,195	11,250	79.5	28.7	101	24.77	14.717	4.240	202C+16
46,114	12,520	79.4	28.6	101	24.73	17.618	4.930	202C+18
50,983	13,762	79.3	28.5	101	24.70	20.674	5.490	202C+20
58,191	15,570	79.2	28.3	101	24.66	25.502	6.320	202C+23
67,625	17,883	79.0	28.1	101	24.59	30.431	7.390	202C+25
49,651	11,398	90.3	28.4	116	23.14	17.171	4.260	232C+16
55,596	12,686	90.2	28.3	116	23.11	20.547	4.940	232C+18
61,483	13,945	90.1	28.2	116	23.08	24.101	5.500	232C+20
75,948	16,966	89.9	27.9	116	23.02	33.596	6.870	232C+25
55,058	10,857	100.9	28.0	131	21.73	17.800	3.890	262C+15
65,629	12,822	100.8	27.9	131	21.69	23.495	4.940	262C+18
72,595	14,095	100.7	27.8	131	21.67	27.552	5.510	262C+20
82,924	15,951	100.5	27.6	131	21.64	33.950	6.340	262C+23
89,728	17,152	100.4	27.5	131	21.62	38.381	6.890	262C+25
104,452	22,503	118.3	37.5	151	29.54	34.111	8.560	302C+20
119,440	25,542	118.2	37.3	151	29.49	42.439	9.890	302C+23
129,334	27,521	118.1	37.2	151	29.46	48.311	10.770	302C+25
148,887	31,367	117.9	37.0	151	29.39	60.710	12.500	302C+29
141,208	25,831	132.1	36.8	171	27.61	48.548	9.900	342C+23
164,575	29,798	131.9	36.5	171	27.55	62.222	11.660	342C+27
193,290	34,547	131.6	36.2	171	27.48	80.573	13.800	342C+32
200,779	32,546	154.1	39.5	201	28.46	66.976	12.390	402C+25
216,138	34,864	153.9	39.4	201	28.44	75.530	13.400	402C+27
238,984	38,264	153.8	39.2	201	28.40	88.935	14.910	402C+30
254,084	40,480	153.7	39.1	201	28.37	98.208	15.900	402C+32
276,542	43,728	153.5	38.9	201	28.33	112.546	17.370	402C+35
221,617	32,738	164.2	39.0	216	27.31	72.359	12.390	432C+25
263,856	38,491	163.9	38.7	216	27.26	96.067	14.920	432C+30
305,402	43,989	163.6	38.4	216	27.20	121.559	17.380	432C+35
280,939	38,628	170.6	38.4	226	26.55	100.841	14.920	452C+30
325,228	44,148	170.3	38.1	226	26.50	127.592	17.390	452C+35

PURLINS

Overview of construction systems

SLEEVED system – single span lengths (continuous beam)

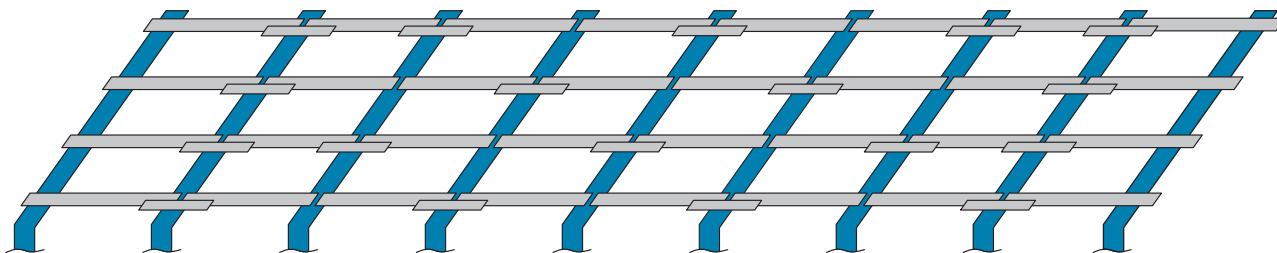


Fig. 20 – Arrangement of the SLEEVED purlin system

This construction system is intended for roofs with at least 2 bays of the same span.

The system uses purlins of one size. The system continuity is achieved by sleeves made of Z sections of the same size as

the purlins. The sleeves are to be installed at each purlin-to-frame joint on the penultimate frames and alternately on the other frames. The system can be used for spans up to 13.00 metres, it is recommended for spans up to 6.00 metres.

HEB system – single span lengths (continuous beam)

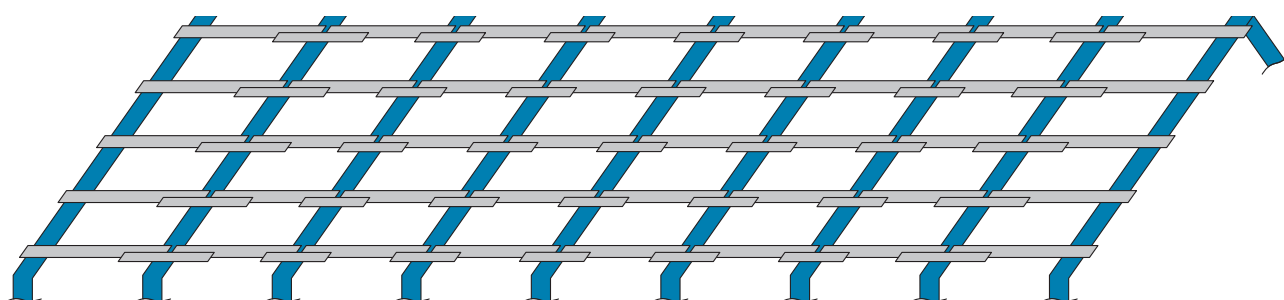


Fig. 21 – Arrangement of the HEB purlin system – single span lengths

This construction system is intended for roofs with at least 5 bays of the same span.

The system usually uses Z sections of two sizes. The stronger sections are positioned in the end bays and weaker in the inner bays.

The system continuity is achieved by two types of sleeve: the longer ones made of the same section as the purlins in the

end bays are to be installed at each purlin-to-frame joint on the penultimate frames, while the shorter sleeves of the same section as the purlins are used for inner bays.

The system can be used for purlin spans up to 13.00 metres, it is recommended for spans of 6 to 10 metres.

BUTT system (simple beam)

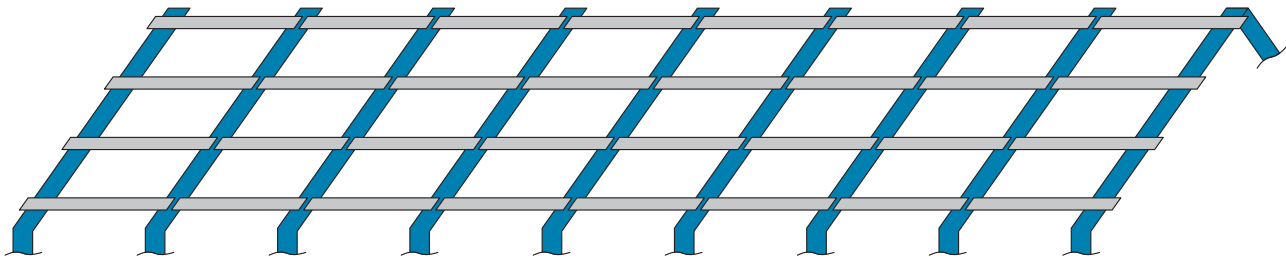


Fig. 22 – Arrangement of the BUTT purlin system

The construction system can be designed as inset or oversail.

It is intended for small spans or loads, or wherever the use of the simply supported beam is required.

The recommended maximum span is 12 metres.

METLAP system (continuous beam)

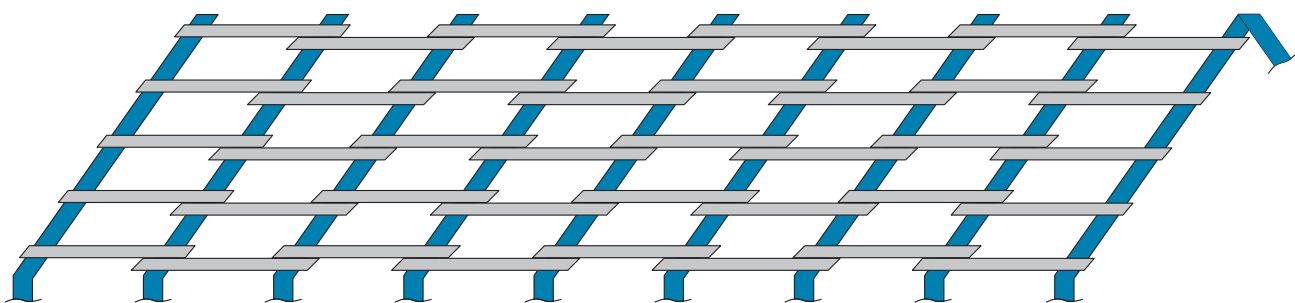


Fig. 23 – Arrangement of the standard METLAP purlin system

The standard form of this construction system is intended for purlin lines over at least 4 bays of the same span.

The system is usually made of two different sections of the same height but different thickness. Purlins in the end bays are typically made of thicker sections than the purlins in inner bays. This system is recommended for spans greater than 10.00 metres or where a heavy load is applied.

The non-standard form of this construction system is intended for purlin lines over 2 or 3 bays of the same span or for purlin rows with varying spans, where the minimum number of bays is 2 and the maximum 8.

Continuity of the beam is achieved by purlin overlaps above supports. Purlins can span up to 14.5 metres.

Purlins / SLEEVED Construction System

Structural Arrangement and Details

Purlins

Static model of purlins	Continuous beam with overhangs
Maximum purlin span	13.00 metres
Minimum number of bays of the same span in one purlin row	2 bays
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and purlin interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm

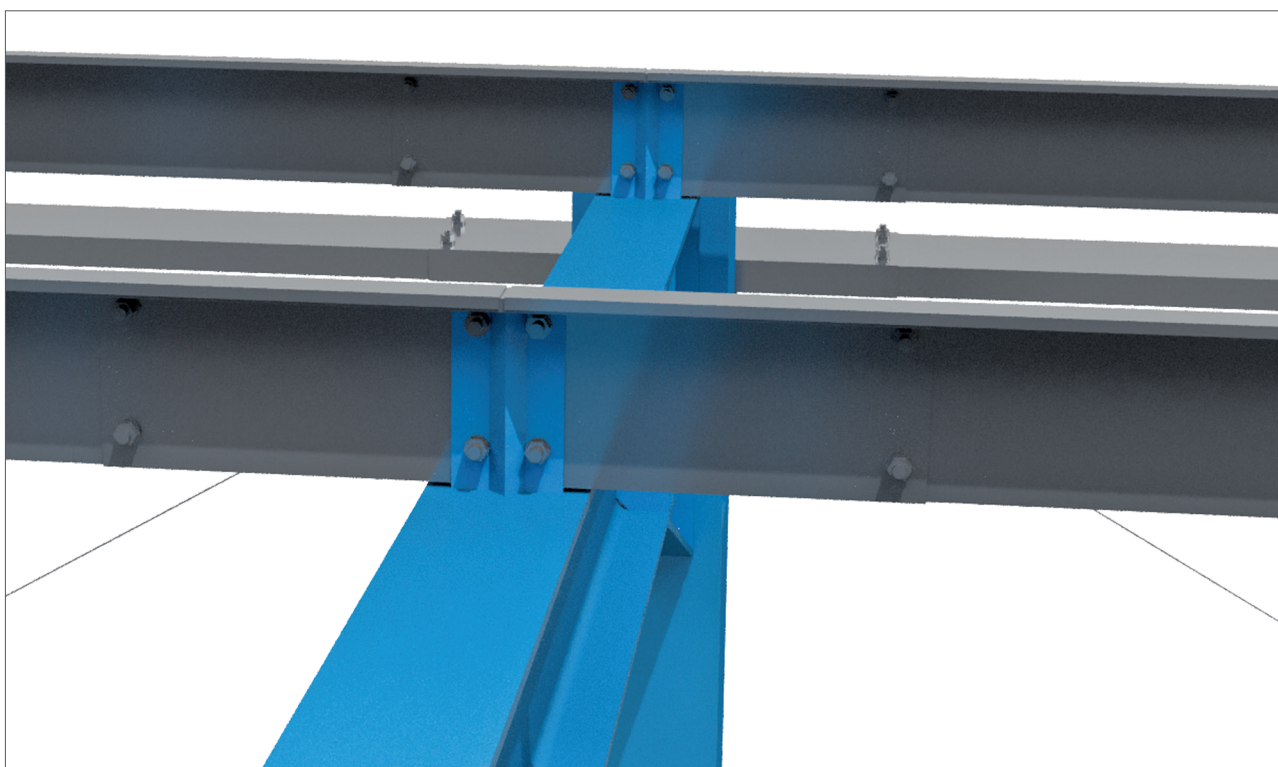


Fig. 24 – Detail of the purlin/sleeve connection to the primary structure in the SLEEVED system

The SLEEVED construction system is designed as a continuous beam with interconnecting sleeve. Sleeves are to be installed at each purlin joint to the primary structure on the penultimate frames, and staggered at purlin joints to the primary structure on inner frames. A schematic layout of sleeves is shown in Figure 25.

Purlins must be connected to the primary structure by means of cleats; fixing through the purlin bottom flange is unacceptable.

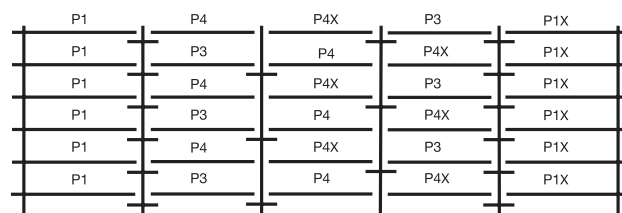


Fig. 25 – Arrangement of purlins in the SLEEVED system

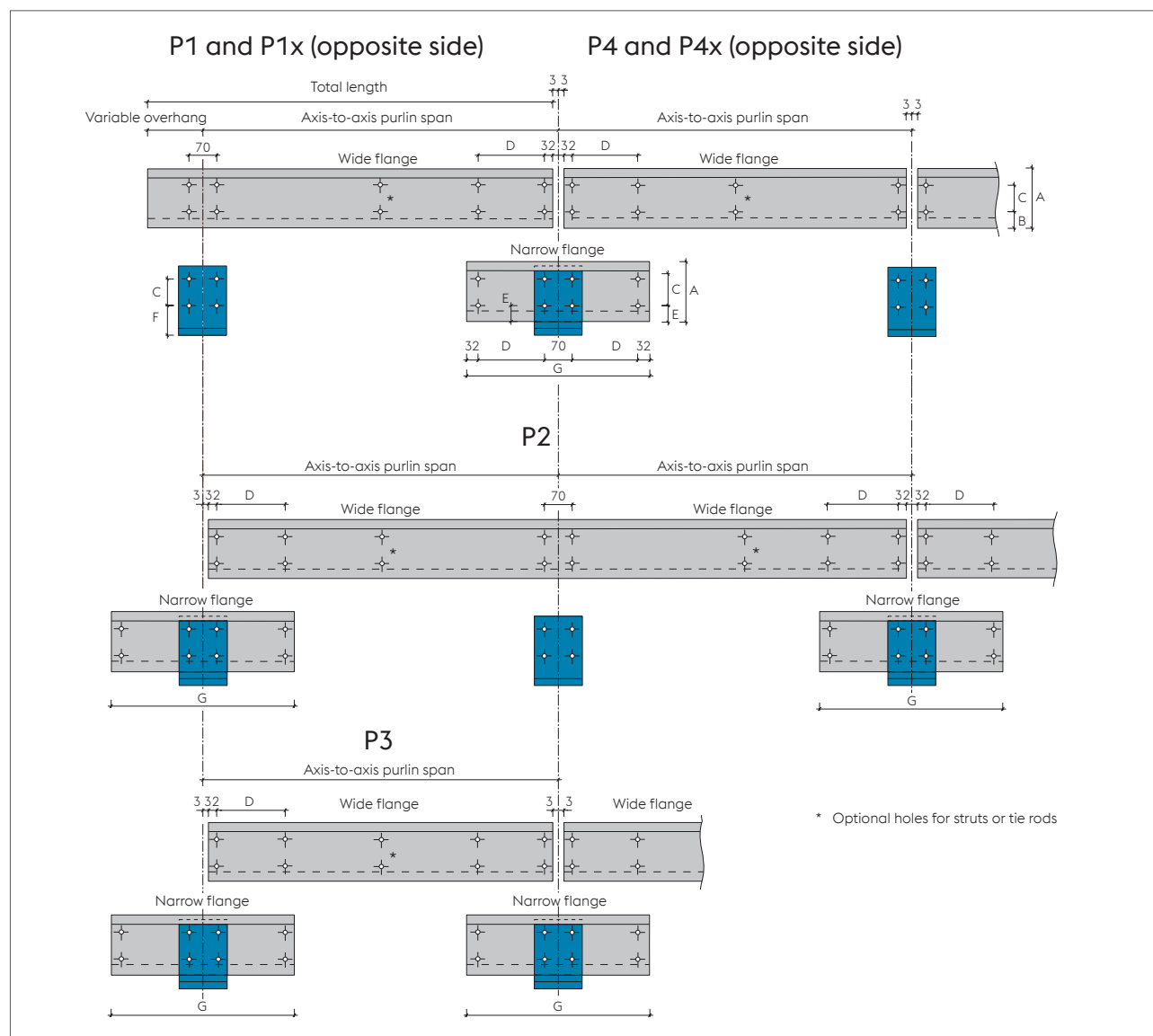


Fig. 26 – Design details of the SLEEVED system

Design Principles

- **Fixing the sleeve to the purlins**
 - 8 bolts for sections 232 or higher
 - 6 bolts for sections 122 – 202
- **System standard holes** = 18 mm diameter for M16 bolts of 8.8 grade (joints to the primary structure, joints of sleeves or struts). If a smaller diameter of hole/bolt is to be used, a joint stress analysis must be performed.
- **Non-standard holes** must be made in accordance with the principles described on pages 14-15.

Tab. 10 – Positions of holes in section web within the SLEEVED system

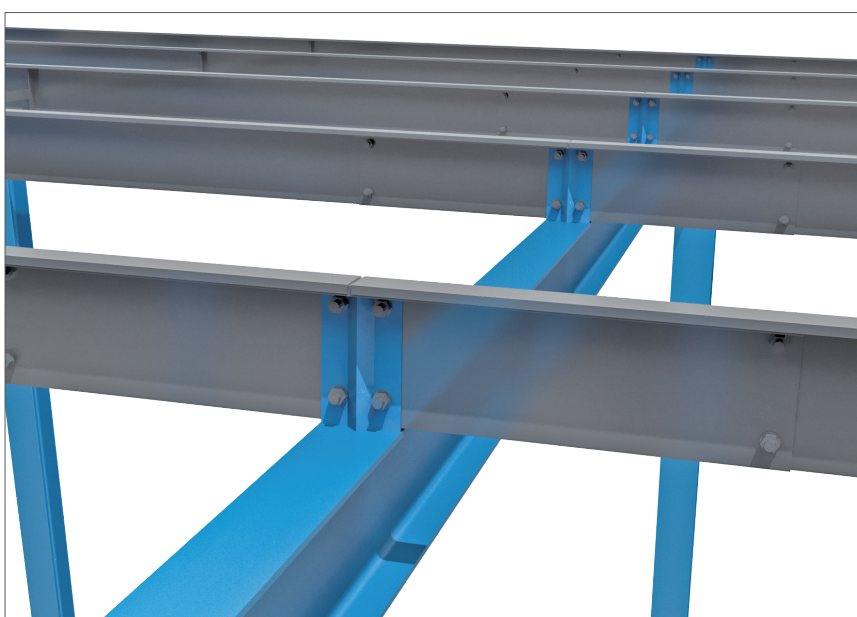
A	B	C	D	E	F	G
mm	mm	mm	mm	mm	mm	mm
122	32	56	185	34	40	504
142	42	56	240	44	50	614
172	42	86	290	44	50	714
202	42	116	350	44	50	834
232	42	146	410	44	50	954
262	42	176	460	44	50	1054
302	52	195	610	55	60	1354
342	52	235	760	55	60	1654
402	52	295	1000	55	60	2134

Purlins / HEB Construction System

Structural Arrangement and Details

Purlins

Static model of purlins	Continuous beam with sleeves
Maximum recommended purlin span	13.00 metres
Minimum number of bays of the same span in one purlin row	5 bays
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and purlin interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm



The HEB construction system has been designed as a continuous beam with sleeves and is usually made of two different dimensions of sections within one height group. Continuity is achieved by the sleeves installed at purlin joint to the primary structure. The purlin section for the terminal bay is typically made of thicker material than that for the inner bays. Sleeves installed at the penultimate frames are made of the same section as the end bay purlins and are longer than the sleeves in joints at other inner frames; these sleeves are made of the same section as the inner bay purlins. Positions of sleeves are shown in Figures 28 and 29.

Joints to the primary structure are always to be made by means of cleats. Fixing through the purlin bottom flange is unacceptable.

Fig. 27 – Detail of the purlin connection to the primary structure in the HEB system

Arrangement of purlins in the single span system

- End bay purlins (P1 and P1x) and sleeves at the penultimate frames are of the same section.
- Purlins and sleeves in inner bays (P3, P5, P5x) are made of the same section.
- All interconnections of purlins must be reinforced by sleeves.
- Lengths of purlins need to bridge a single bay, the maximum length is 16.5 metres.

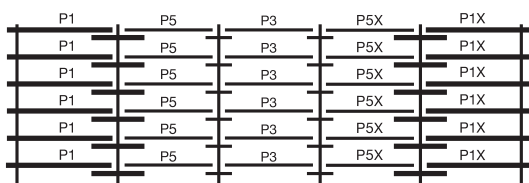


Fig. 28 – Purlins and sleeves in single bay arrangement

Arrangement of purlins in the double span system

- Purlins over the terminal bays (P1 and P1x) and sleeves at the penultimate frames are of the same section.
- Purlins and sleeves in inner bays (P2, P5, P5x, P6, P6x) are made of the same section.
- All interconnections of purlins must be reinforced by sleeves.
- Lengths of the inner purlins are to bridge two bays – the maximum span of inner bays is 8 metres, the maximum length of the two-bay purlin is 16.5m.
- Lengths of terminal purlins are always for the end bay only.

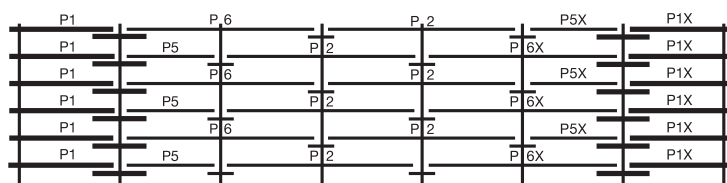


Fig. 29 – Purlins and sleeves in double bay arrangement

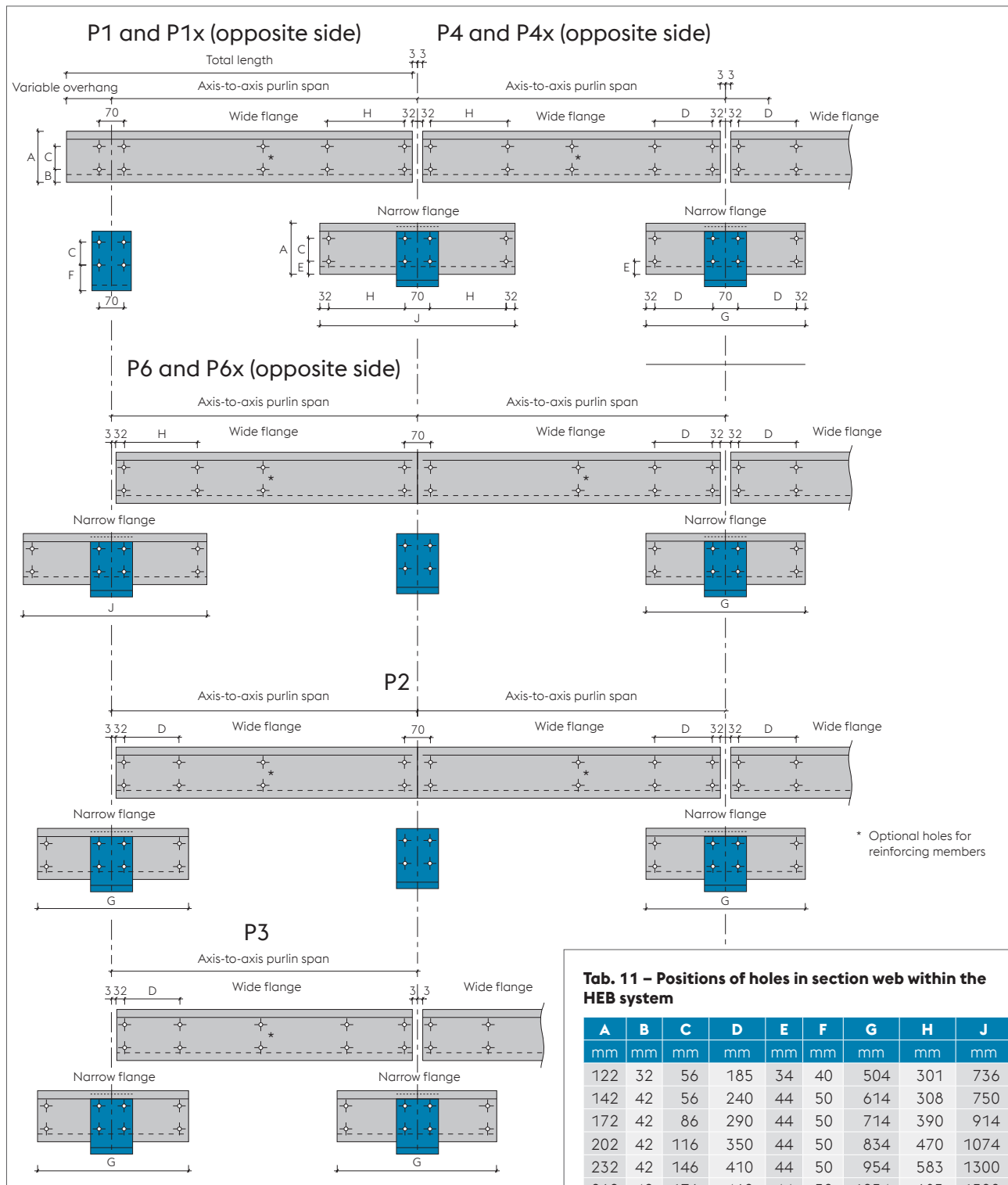


Fig. 30 – Design details of the HEB system

Design Principles

- **Fixing the sleeve to the purlins**
 - 8 bolts for sections 232 or higher
 - 6 bolts for sections 122 – 202
- **System standard holes** = 18 mm diameter for M16 bolts of 8.8 grade (joints to the primary structure, joints of sleeves or struts). If a smaller diameter of holes/bolts is to be used, a joint stress analysis must be performed.
- **Non-standard holes** must be made in accordance with the principles described on pages 14-15.
- **Purlins over the terminal and inner bays** must be of the same height.
- **Sections of purlins over terminal bays** have usually thicker walls than those over the inner bays.

Tab. 11 – Positions of holes in section web within the HEB system

A	B	C	D	E	F	G	H	J
mm	mm	mm	mm	mm	mm	mm	mm	mm
122	32	56	185	34	40	504	301	736
142	42	56	240	44	50	614	308	750
172	42	86	290	44	50	714	390	914
202	42	116	350	44	50	834	470	1074
232	42	146	410	44	50	954	583	1300
262	42	176	460	44	50	1054	683	1500
302	52	195	610	55	60	1354	783	1700
342	52	235	760	55	60	1654	933	2000
402	52	295	1000	55	60	2134	1213	2560

Purlins / BUTT Construction System

Structural Arrangement and Details

Static model of purlins	Simply supported beam
Maximum purlin span	12.00 metres
Minimum number of bays of the same span in one purlin row	1 bays
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and purlin interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm

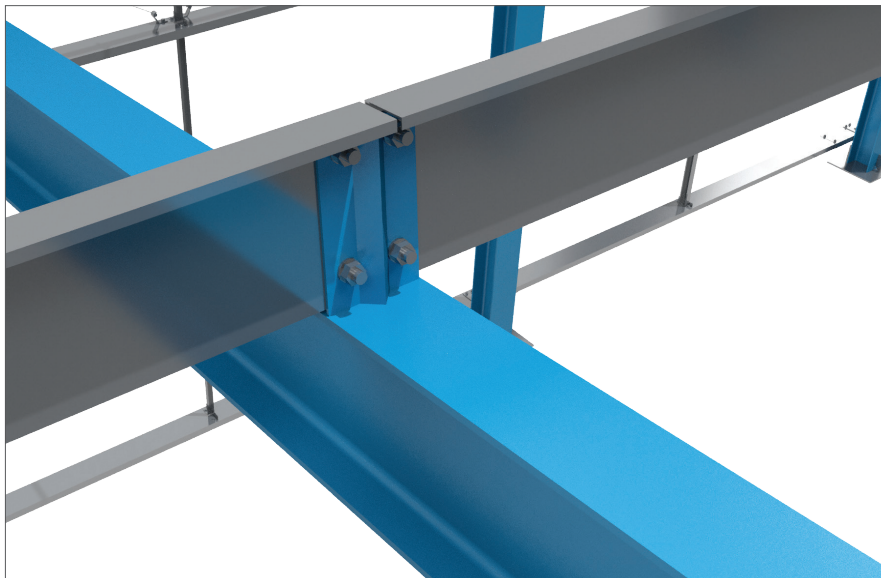


Fig. 31 - Detail of the purlin connection to the primary structure in the BUTT system

The BUTT Construction System uses purlins designed as simply supported beams. The purlins may be oversailing above the primary structure frames or inset between them.

Joints to the primary structure are always to be made by means of cleats. Fixing through the purlin bottom flange is unacceptable.

Tab. 12 - Positions of system holes within the BUTT construction system

A	B	C	H
mm	mm	mm	mm
122	32	56	40
142	42	56	50
172	42	86	50
202	42	116	50
232	42	146	50
262	42	176	50
302	52	195	60
342	52	235	60
402	52	295	60
432	52	325	60
452	52	345	60

Arrangement of purlins in the BUTT system

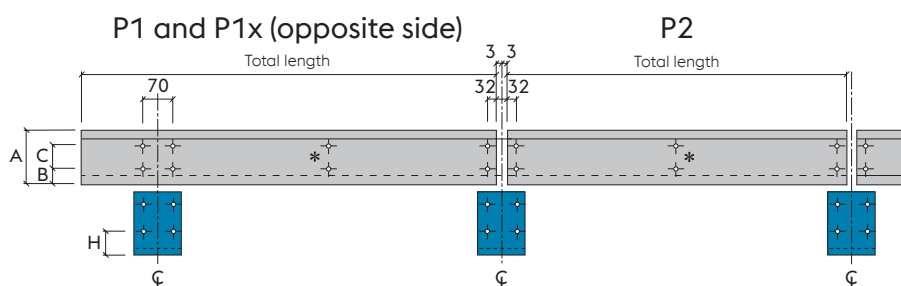


Fig. 32 - Design details of the BUTT system

* Optional holes for reinforcing members

P1	P2	P2	P2	P1X
P1	P2	P2	P2	P1X
P1	P2	P2	P2	P1X
P1	P2	P2	P2	P1X
P1	P2	P2	P2	P1X
P1	P2	P2	P2	P1X
P1	P2	P2	P2	P1X

Fig. 33 - Arrangement of purlins in the BUTT system

Design Principles

- System standard holes** = 18 mm diameter for M16 bolts of 8.8 grade (joints to the primary structure and joints of struts). If a smaller diameter of hole/ bolt is to be used, a joint stress analysis must be performed.
- Non-standard holes** must be made in accordance with the principles described on pages 14-15.



METLAP Construction System

Structural Arrangement and Details

Purlins

Static model of purlins	Continuous beam with overhangs
Maximum recommended purlin span	14.50 metres
Minimum number of bays of the same span in one purlin row	4 bays
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and purlin interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm

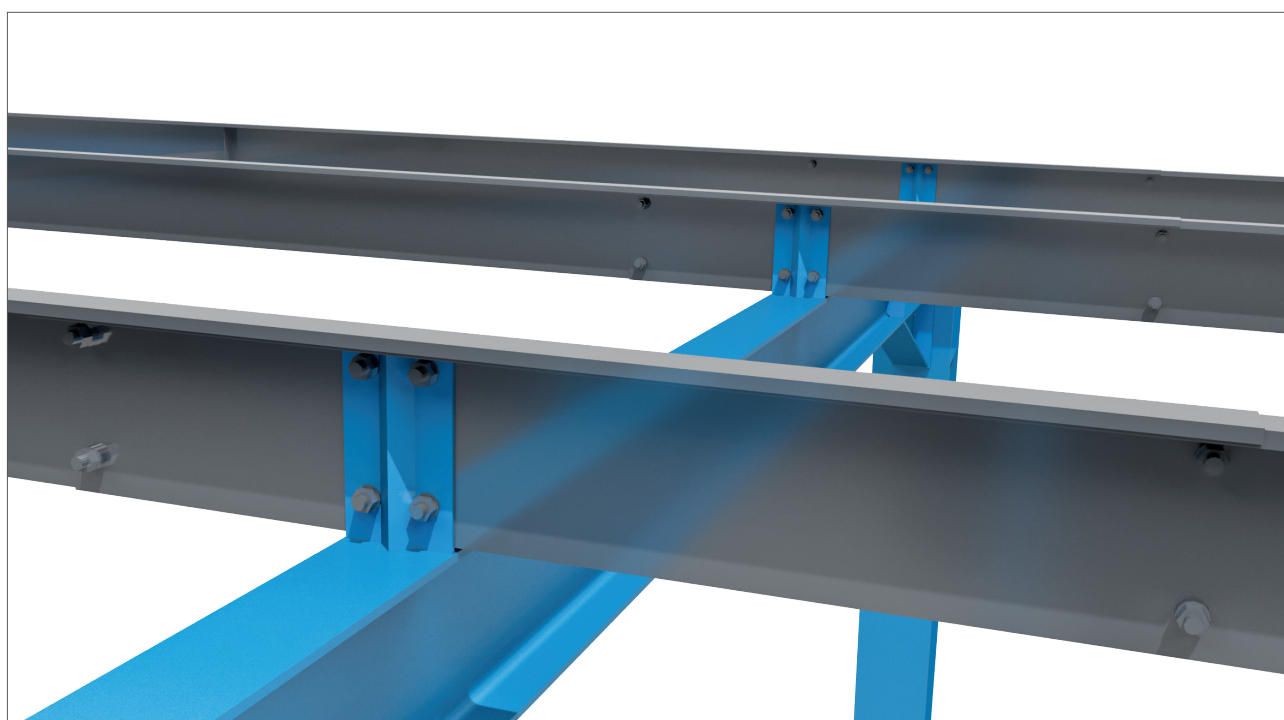


Fig. 34 – Detail of the end bay purlin connection to the primary structure in the METLAP system

Standard arrangement – purlin row across at least 4 bays

The system is typically made of two different section dimensions within one height group. Purlins of the terminal bays are usually made of thicker sections than the inner bays.

Continuity of beams is achieved by purlin overlaps at the joints to the primary structure. Overlaps of the terminal bay purlins are twice as long as overlaps of purlins over inner bays. Lengths of overlaps have been designed to efficiently cover the bending moments and shearing forces. Lengths of overhangs are presented in Table 13.

Non-standard arrangement – purlin rows across 2 to 3 bays of the same span, or purlin rows across up to 8 bays of different spans.

If a purlin row runs over bays of different spans, spans of inner bays must be at least 40 % of the largest bay within the row while the terminal bay span must be at least 50 %.

The end bay may be reinforced by sleeves of the same section as the purlins. These sleeves reinforce the purlins for the 2nd limit state, i.e. deformation. The design principles for sleeves are shown in Figure 38.

Lengths of overhangs for rows stretching across 2-3 bays of identical spans are shown in Table 14..

Lengths of overlaps for rows with up to 8 bays of different spans are shown in Table 13; lengths of the overlaps connecting the neighbouring bays are determined by the length required for the larger span.

Joints to the primary structure are always to be made by means of cleats. Fixing through the purlin bottom flange is unacceptable.

Standard arrangement of the METLAP system

Standard arrangement of the METLAP system. Arrangement for at least 4 bays of the same span. Purlins within the same row must be made of sections of the same height, stronger sections are usually used for purlins over the terminal bays.

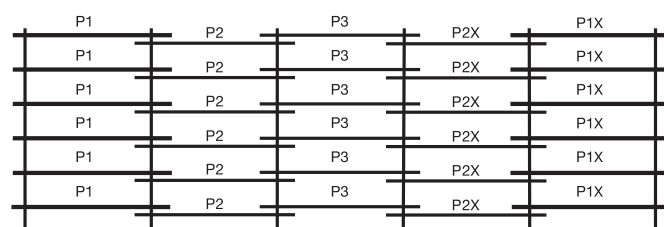


Fig. 35 – 35 – Standard arrangement of the METLAP system

Non-standard arrangement of the METLAP system

Arrangement for 2-3 bays of the same span.

Purlins within one row need to be made of sections of the identical height, the section thickness should be based on the stress analysis calculation.

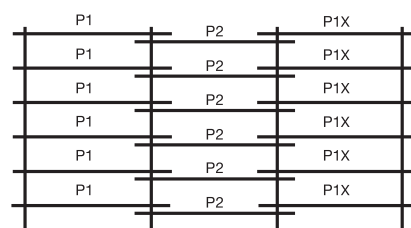


Fig. 36 – Non-standard arrangement of the METLAP system (2 to 3 bays of the same span)

Arrangement for a row with up to 8 bays of different spans.

Purlins within one row need to be made of sections of the identical height, the section thickness should be based on the stress analysis calculation. Lengths of overhangs are presented in Table 13, the larger of the two adjacent bays determines the length.

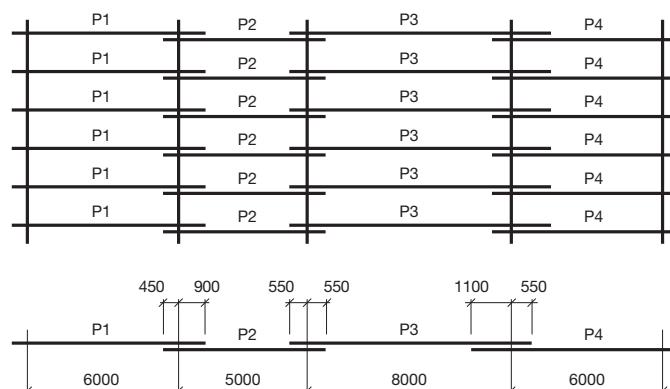


Fig. 37 37 – Example of an arrangement of non-standard METLAP system (2 to 8 bays of different spans)

Tab. 13 – Purlin overhangs in standard arrangement of the METLAP system

Spans	Overhang E	Overhang F
m	mm	mm
up to 5	350	700
> 5 - 6	400	800
> 6 - 7	450	900
> 7 - 8	500	1,000
> 8 - 9	550	1,100
> 9 - 10	600	1,200
> 10 - 11	650	1,300
> 11 - 12	700	1,400
> 12 - 13	700	1,400
> 13 - 14	700	1,400
> 14 - 15	700	1,400

Tab. 14 – Purlin overhangs in non-standard arrangement of the METLAP system, with 2-3 bays of the same span, or with purlin rows across up to 8 bays of different spans

Spans	Přesah E	Přesah F
m	mm	mm
up to 5.0	400	800
5.1 - 6.0	450	900
6.1 - 7.0	500	1,000
7.1 - 8.0	550	1,100
8.1 - 9.0	600	1,200
9.1 - 10.0	650	1,300
10.1 - 11.0	700	1,400
11.1 - 12.0	700	1,400
12.1 - 13.0	700	1,400
13.1 - 14.0	700	1,400
14.1 - 15.0	700	1,400

◀ **An example of determining the length of overhangs** for a row with spans of 6m + 5m + 8m + 6m. The lengths of overhangs are presented in Table 13, the overhang being determined by the larger of the two adjacent bays.

METLAP Construction System

Structural Arrangement and Details

Purlins

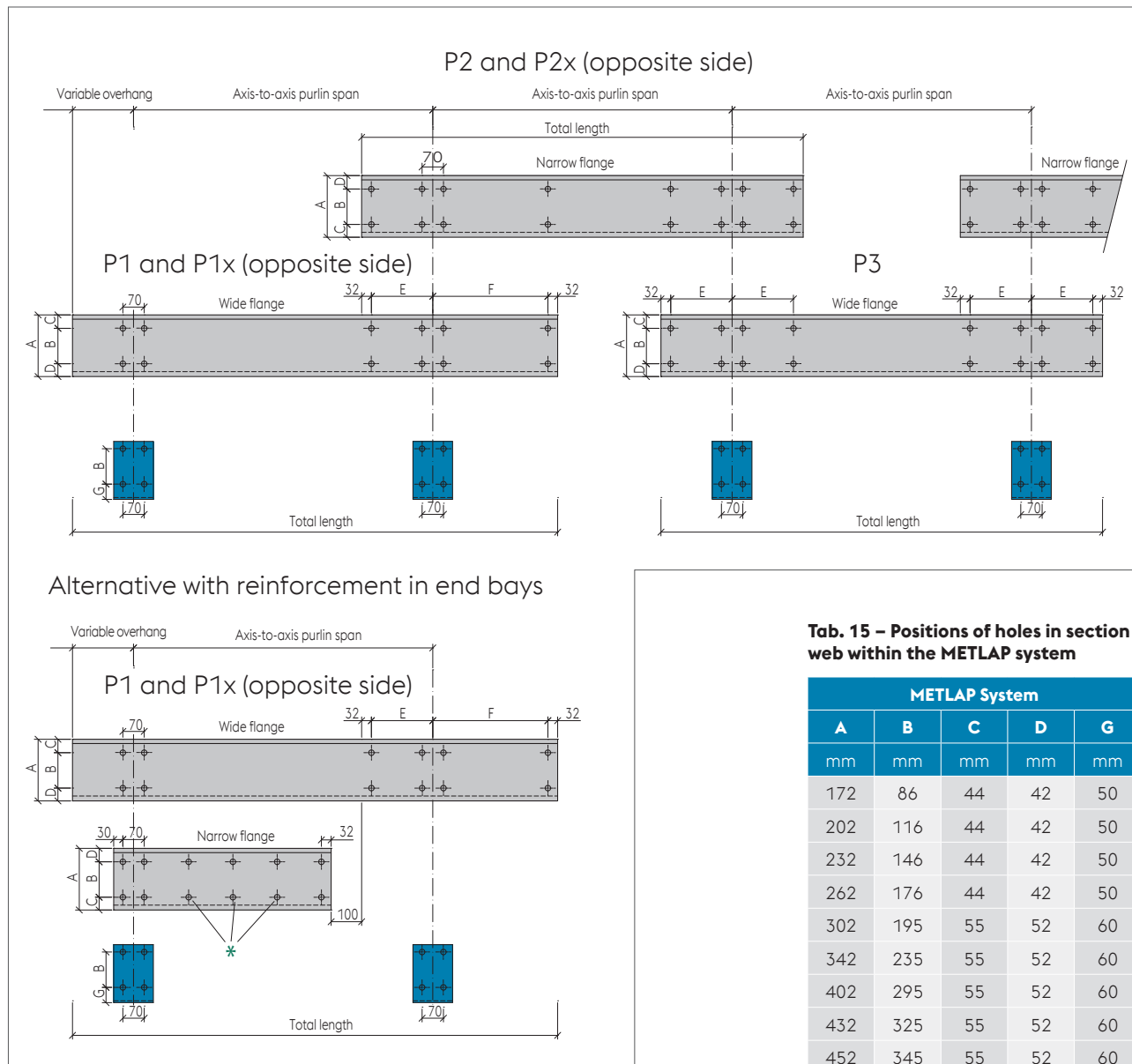


Fig. 38 – Design details of the METLAP system

Design Principles

- **System holes** in the section web are 18 mm in diameter and are intended for M16 bolts of the 8.8 grade.
- **Alternative holes** for connecting stabilising struts -
 - If systemic stabilising struts are to be used, the positions and diameters of these holes must respect the system design.
 - If non-systemic struts are to be used, these holes may be made according to the designer's requirements, provided they respect the principles specified on pages 14-15.
- **Non-system holes** – Additional holes, notches and/or service

holes can be pierced in the sections while respecting the principles specified on pages 14-15.

- **Designing of production documentation** – it needs to be born in mind that purlins interconnected by overlaps are always turned by 180° against each other so that their narrow and wide flanges match.
Position of holes in both webs and flanges of the sections must be adapted to this arrangement.
- **The maximum production length of the section** is 17.0 m.
- **Reinforcing sleeves** must be connected by an odd number of pairs of bolts (holes marked with *) located along the sleeve between the end pairs of holes connecting the sleeve to the purlin. The recommended pitch of these pairs of bolts is approximately 1.000 m.



Purlins / Bracing and Stabilising

Construction Components

Purlins can be braced and stabilised by struts and tie rods. Their layout and number are governed by the requirements set out in the stress analysis while respecting the design principles stipulated in this chapter.

ASB Purlin Struts

Component description: The strut with the same brackets at both ends further stabilising purlins, especially when non-restraining cladding is used, and securing non-rigid section flanges against wind uplift.

The individual strut components are riveted together (3 rivets per joint), the strut is fixed to the purlin by M16 bolts.

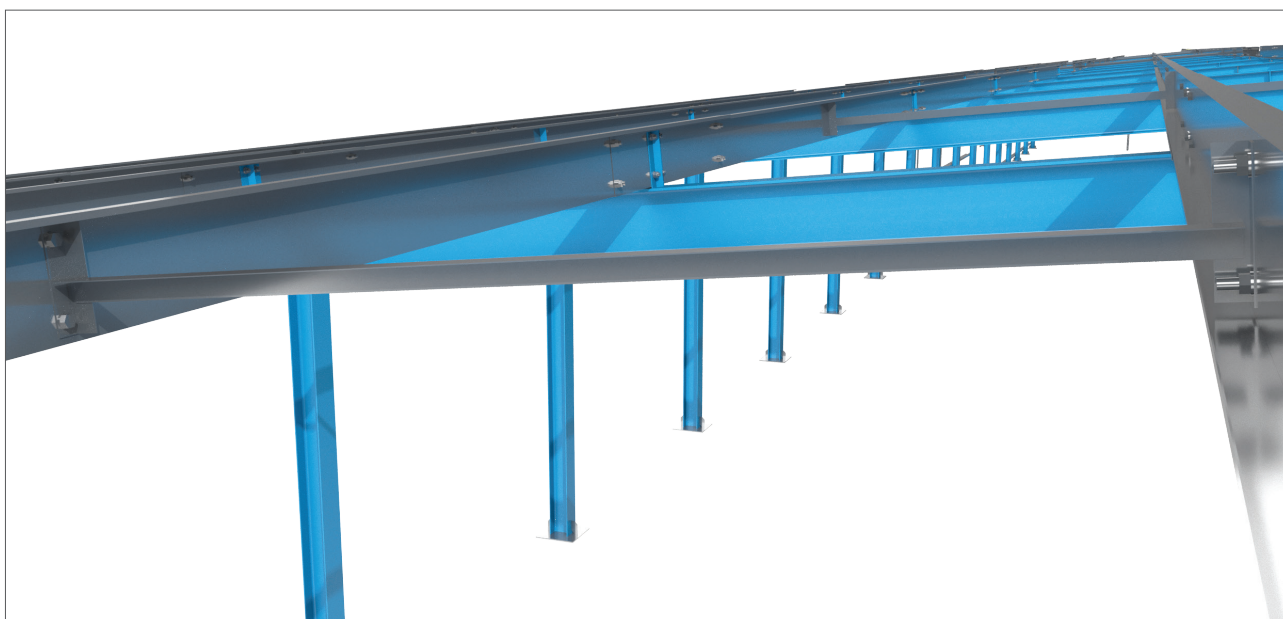
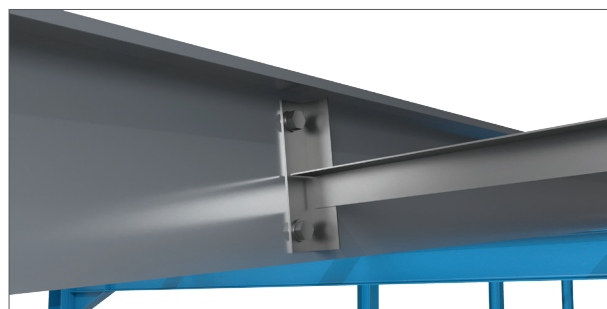


Fig. 39 – Details of ASB struts

Use	Section series 122 - 342
Material	L section 45 × 45 × 2 mm
Steel grade	S250GD
Surface finish	Galvanised with Z350 (Z600 / Z800 / Z1000 on request)
Range of lengths	Min. 0.30 m / max. 2.50 m
Bolts required for fixing to the purlin	M16
Weight	1.45 kg / m (including end brackets) / 1.37 kg / m (only 45 × 45 × 2 mm L section)

Standard axes for holes in purlins.

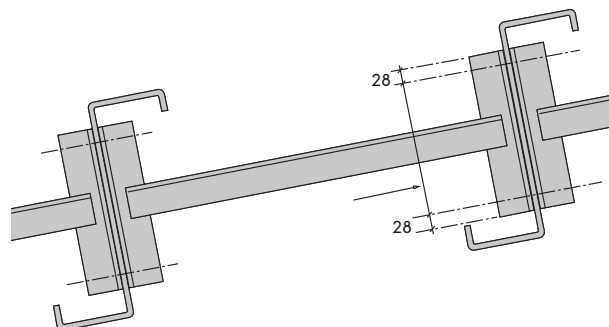


Fig. 40 – ASB strut made of 45 × 45 × 2 mm L section

SEB Eaves Beam Struts

Component description: A non-standard strut with variable end brackets for connecting to different rows of sections on each side. The end brackets can be connected to the strut's main part at different angles. These struts further stabilise the purlins, especially when non-restraining cladding is used, and secure the non-rigid section flanges against wind uplift. The individual strut components are riveted together (3 rivets per joint), the strut is fixed to the purlin by M16 bolts.

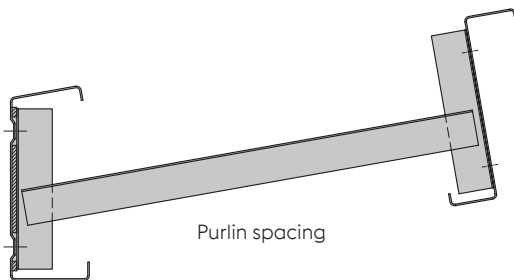


Fig. 41 – SEB non-standard purlin strut

Use	Section series 122 - 342
Material	L section 45 × 45 × 2 mm
Steel grade	S250GD
Surface finish	Galvanised with Z350 (Z600 / Z800 / Z1000 on request)
Range of lengths	Min. 0.30 m / max. 2.50 m
Bolts required for fixing to the purlin	M16
Weight	1.45 kg / m (including end brackets) / 1.37 kg / m (only 45 × 45 × 2 mm L section)

AA Apex Angle

Component description: A standard tie of ridge purlins with the same brackets at both ends. It can be used autonomously or in combination with the ASB and SEB struts. These ties must be used for all designs of duo-pitch roofs. The individual tie components are riveted together (3 rivets per joint), the tie is fixed to the purlins by M16 bolts.

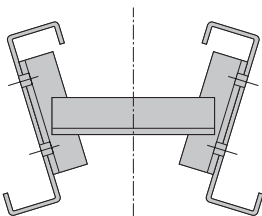


Fig. 42 – AA Apex Angle

Use	Section series 122 - 342
Material	L section 45 × 45 × 2 mm
Steel grade	S250GD
Surface finish	Galvanised with Z350 (Z600 / Z800 / Z1000 on request)
Range of lengths	Min. 0.30 m / max. 2.50 m
Bolts required for fixing to the purlin	M16
Weight	1.45 kg / m (including end brackets) / 1.37 kg / m (only 45 × 45 × 2 mm L section)

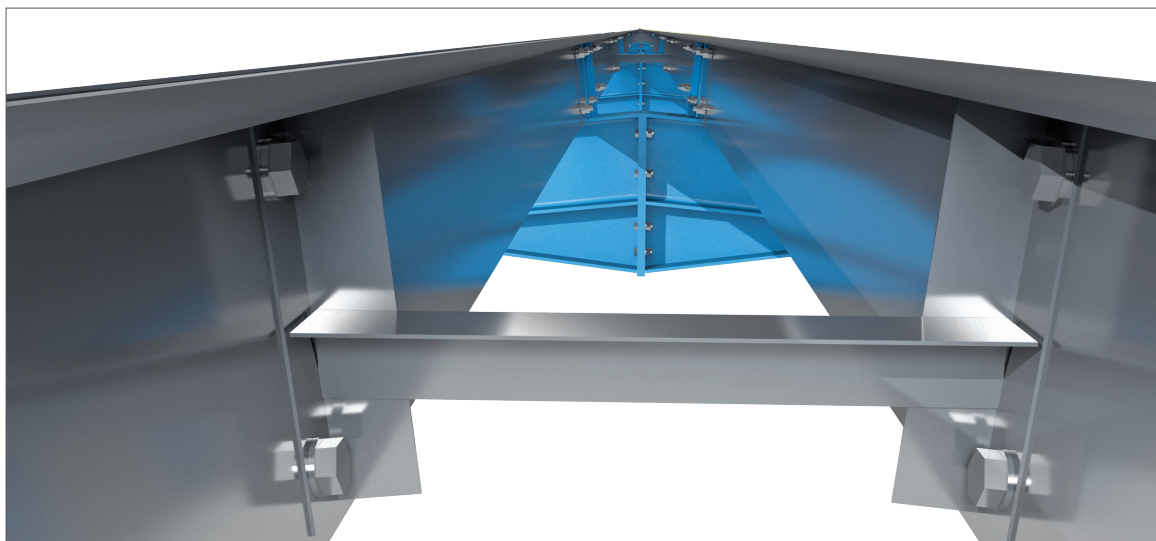


Fig. 43 – AA Apex Angle installation detail

HCS Strut

Component description: A standard heavy strut with variable end brackets on both sides. These struts further stabilise the purlins, especially when non-restraining cladding is used, and secure the non-rigid section flanges against wind uplift. They are primarily intended for sections 402 - 452. They can also be used for series 142 - 342 if the purlin spacing is greater than 2.5 m and the ASB strut can not be used. Individual strut components are riveted together (3 rivets per joint), the strut is fixed to the purlin by M16 bolts.

Use	Primarily sections 402 - 452 and sections 142 - 342 with spacing greater than 2.5 m, where ASB can not be used
Material	Central piece 100C13, end brackets L 45 × 45 × 2 mm
Steel grade	Central piece S450GD, end brackets S250GD
Surface finish	Galvanised with Z350 (Z600 / Z800 / Z1000 on request)
Range of lengths	Min. 0.50 m / max. 4.00 m
Bolts required for fixing to the purlin	M16
Weight	2.39 kg/m (including end brackets) / 2.14 kg/m (only section 100C13)

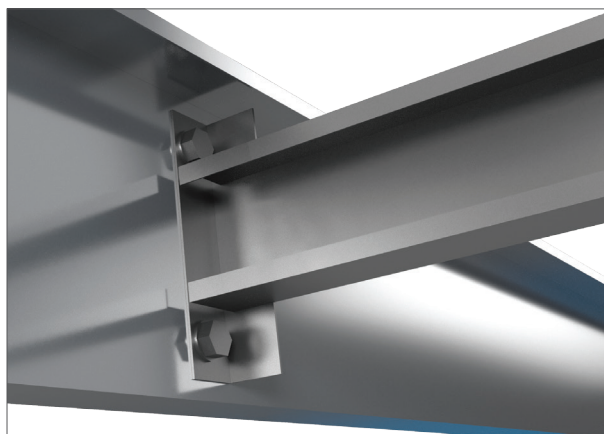
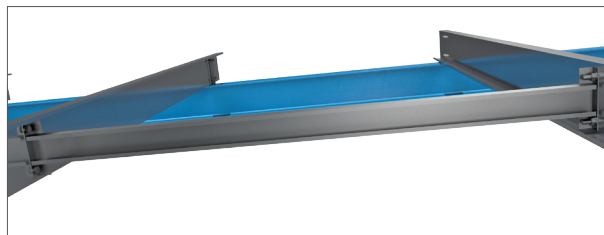


Fig. 44 – Detail of a purlin strut made of 100 mm high C section (HCS)

Tab. 16 – Spacing of holes in end brackets of ASB, SEB, HCS struts and of AA apex ties

Reference to section	122	142	172	202	232	262	302	342	402	432	452
Hole spacing (mm)	56	56	86	116	146	176	195	235	295	325	345

Wire Diagonal Ties (WDT)

Component description: A diagonal cable complementing the purlin reinforcement elements. The basic component is a steel wire strand of 5 mm in diameter, which is completed

with end connecting brackets that provide for connections at variable angles and for the necessary rectification for stretching the tie.

Use	All series of sections
Material	Steel wire cable (diameter 5 mm) + end brackets (thickness 6 mm) of S250GD steel
Load capacity	10 kN in tension (design load)
Surface finish	Galvanised with Z275
Range of lengths	Min. 0.50 m / max. 5.00 m
Bolts required for fixing to the purlin	M16
Weight	0.5 kg/m (including end brackets)

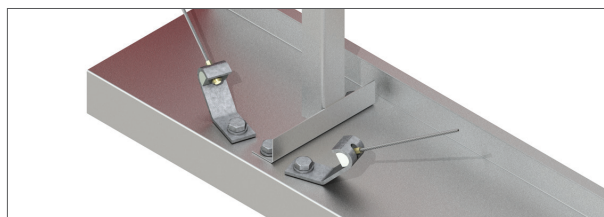
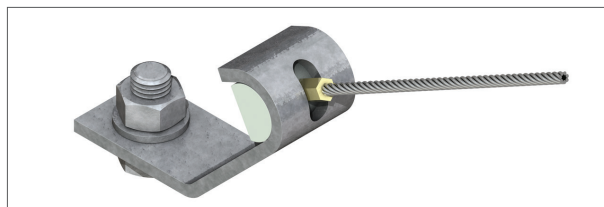


Fig. 45 – Details of wire diagonal ties

Purlins / Bracing and Stabilising

Design Principles and Arrangement

Duo-Pitch Roofs

Duo-pitch roofs must always be fitted with AA ties that interconnect the ridge purlins. At least 1-3 ties are required depending on the purlin span, unless otherwise specified in the stress analysis.

Duo-pitch roofs must be reinforced according to the principles given in Table 17 or to the requirements specified in the stress analysis.

Duo-pitch roofs with a slope length greater than 20 metres should always be equipped with at least one row of stiffening struts, supplemented with at least one row of WDTs for every 20 metres of the slope length, regardless of the purlin spans.

Tab. 17 – Recommended minimum bracing of purlins in duo-pitch roofs

Bracing components	Restraining roof cladding											
	Duo-pitch roof $\leq 25^\circ$						Duo-pitch roof $> 25^\circ$					
	Slope length						Slope length					
	≤ 20 m			> 20 m			≤ 20 m			> 20 m		
	Span (m)			Span (m)			Span (m)			Span (m)		
	3.0 - 7.0	7.1 - 12.0	12.1 - 15.0	3.0 - 7.0	7.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0
AA Apex Angles	min. 1	min. 2 **	min. 3 **	min. 1	min. 2 **	min. 3 **	min. 1	min. 2 **	min. 3 **	min. 1	min. 2 **	min. 3 **
ASB (SEB), HCS purlin struts	no *	min. 1 *	min. 2 *	no *	min. 1 *	min. 2 *	min. 1 *	min. 2 *	min. 3 *	min. 1 *	min. 2 *	min. 3 *
WDT wire diagonal ties	no	no	no	1 row per 20 m	1 row per 20 m	1 row per 20 m	no	no	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m

* Unless required otherwise by the stress analysis

** It is recommended to equip each row of struts with an apex angle

Bracing components	Non-restraining roof cladding											
	Duo-pitch roof $\leq 20^\circ$						Duo-pitch roof $> 20^\circ$					
	Slope length						Slope length					
	≤ 20 m			> 20 m			≤ 20 m			> 20 m		
	Span (m)			Span (m)			Span (m)			Span (m)		
	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0
AA Apex Angles	min. 1	min. 2 **	min. 3 **	min. 1	min. 2 **	min. 3 **	min. 1	min. 2 **	min. 3 **	min. 1	min. 2 **	min. 3 **
ASB (SEB), HCS purlin struts	min. 1 *	min. 1 *	min. 2 *	min. 1 *	min. 1 *	min. 2 *	min. 1 *	min. 2 *	min. 3 *	min. 1 *	min. 2 *	min. 3 *
WDT wire diagonal ties	no	min. 1 row	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m	min. 1 row	min. 1 row	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m

* Unless required otherwise by the stress analysis

** It is recommended to equip each row of struts with an apex angle

Purlins / Bracing and Stabilising

Design Principles and Arrangement

Mono-Pitch Roofs

Mono-pitch roofs must be equipped with at least 1 row of WDT ties.

Mono-pitch roofs with slope length up to 20 m must be reinforced according to the principles given in Table 18 or to the requirements specified in the stress analysis.

Mono-pitch roofs with a slope length greater than 20 metres should always be equipped with at least one row of stiffening struts, supplemented with at least one row of WDTs for every 20 metres of the slope length, regardless of the purlin spans.

Tab. 18 – Recommended minimum bracing of purlins in mono-pitch roofs

Bracing components	Restraining roof cladding											
	Mono-pitch roof $\leq 25^\circ$						Mono-pitch roof $> 25^\circ$					
	Slope length						Slope length					
	≤ 20 m			> 20 m			≤ 20 m			> 20 m		
	Span (m)			Span (m)			Span (m)			Span (m)		
	3.0 - 7.0	7.1 - 12.0	12.1 - 15.0	3.0 - 7.0	7.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0
ASB (SEB), HCS purlin struts	no *	min. 1 *	min. 2 *	no *	min. 1 *	min. 2 *	min. 1 *	min. 2 *	min. 3 *	min. 1 *	min. 2 *	min. 3 *
WDT wire diagonal ties	min. 1 row **	min. 1 row	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m	min. 1 row	min. 1 row	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m

* Unless required otherwise by the stress analysis

** The purlin rows featuring WDTs must be equipped with the necessary number of struts in the braced bay

Bracing components	Non-restraining roof cladding											
	Mono-pitch roof $\leq 20^\circ$						Mono-pitch roof $> 20^\circ$					
	Slope length						Slope length					
	≤ 20 m			> 20 m			≤ 20 m			> 20 m		
	Span (m)			Span (m)			Span (m)			Span (m)		
	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0	3.0 - 6.0	6.1 - 12.0	12.1 - 15.0
ASB (SEB), HCS purlin struts	min. 1 *	min. 1 *	min. 2 *	min. 1 *	min. 1 *	min. 2 *	min. 1 *	min. 2 *	min. 3 *	min. 1 *	min. 2 *	min. 3 *
WDT wire diagonal ties	min. 1 row	min. 1 row	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m	min. 1 row	min. 1 row	min. 1 row	1 row per 20 m	1 row per 20 m	1 row per 20 m

* Unless required otherwise by the stress analysis

** The purlin rows featuring WDTs must be equipped with the necessary number of struts in the braced bay

Bracing of purlins in duo-pitch or mono-pitch roofs featuring one row of struts

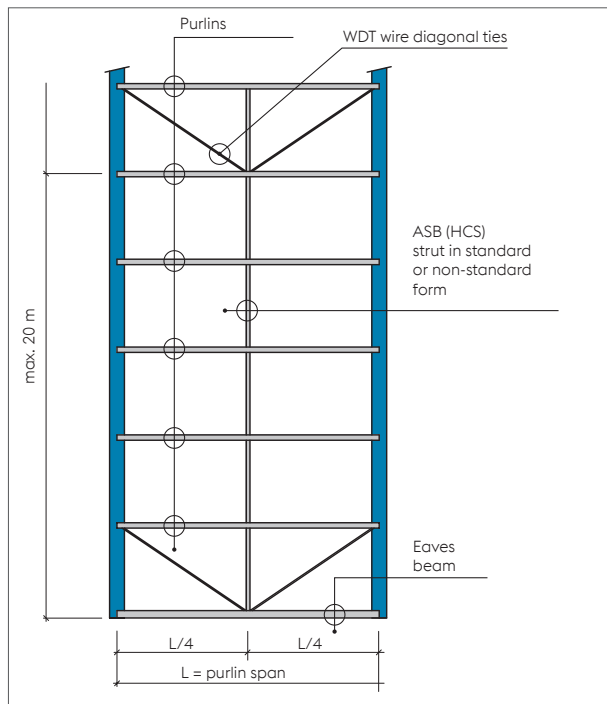


Fig. 46 – Bracing of purlins in duo-pitch or mono-pitch roofs featuring one row of struts

Design Prerequisites

- Ridge purlins must be fitted with the AA apex angles and other members according to the minimum bracing requirements in Table 17 in the case of duo-pitch roofs or in Table 18 for mono-pitch roofs.
- Duo-pitch roofs with a slope length ≤ 20 m and fitted with the AA apex angles do not need to be fitted with a row of WDT ties.
- The diagram generally does not apply to roofs with non-restraining roof cladding.

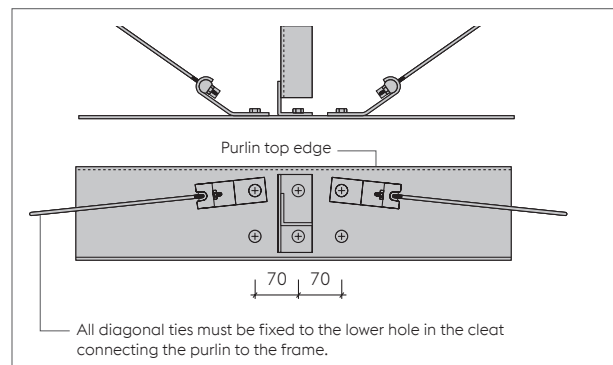


Fig. 47 – Detail of joining a strut and a diagonal tie to the purlin in an inner braced bay

Bracing of purlins in duo-pitch or mono-pitch roofs featuring two rows of struts

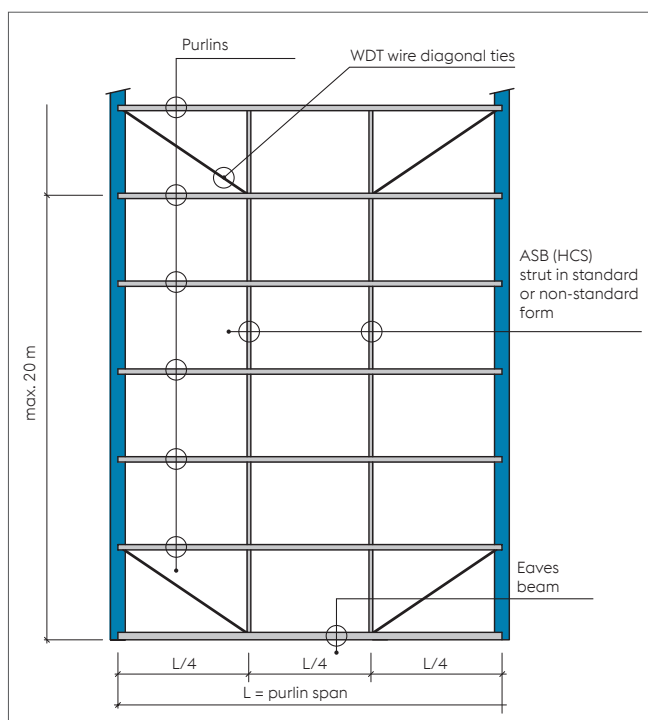


Fig. 48 – Bracing of purlins in duo-pitch or mono-pitch roofs featuring two rows of struts

Design Prerequisites

- Ridge purlins must be fitted with the AA apex angles and other members according to the minimum bracing requirements in Table 17 in the case of duo-pitch roofs or in Table 18 for mono-pitch roofs.
- Duo-pitch roofs with a slope length ≤ 20 m and fitted with the AA apex angles do not need to be fitted with a row of WDT ties.
- The diagram generally does not apply to roofs with non-restraining roof cladding.

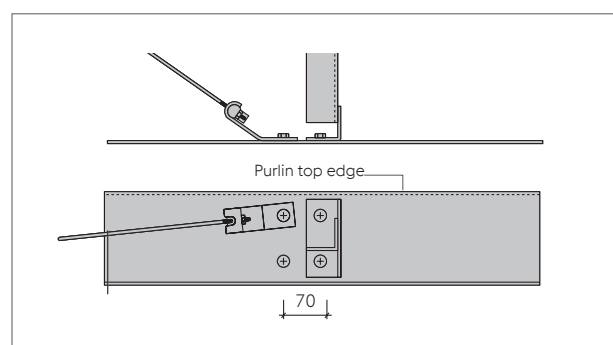


Fig. 49 – Detail of joining a strut and a diagonal tie to the purlin in an end braced bay

Bracing of purlins in double- or single-pitch roofs featuring three rows of struts

Purlins

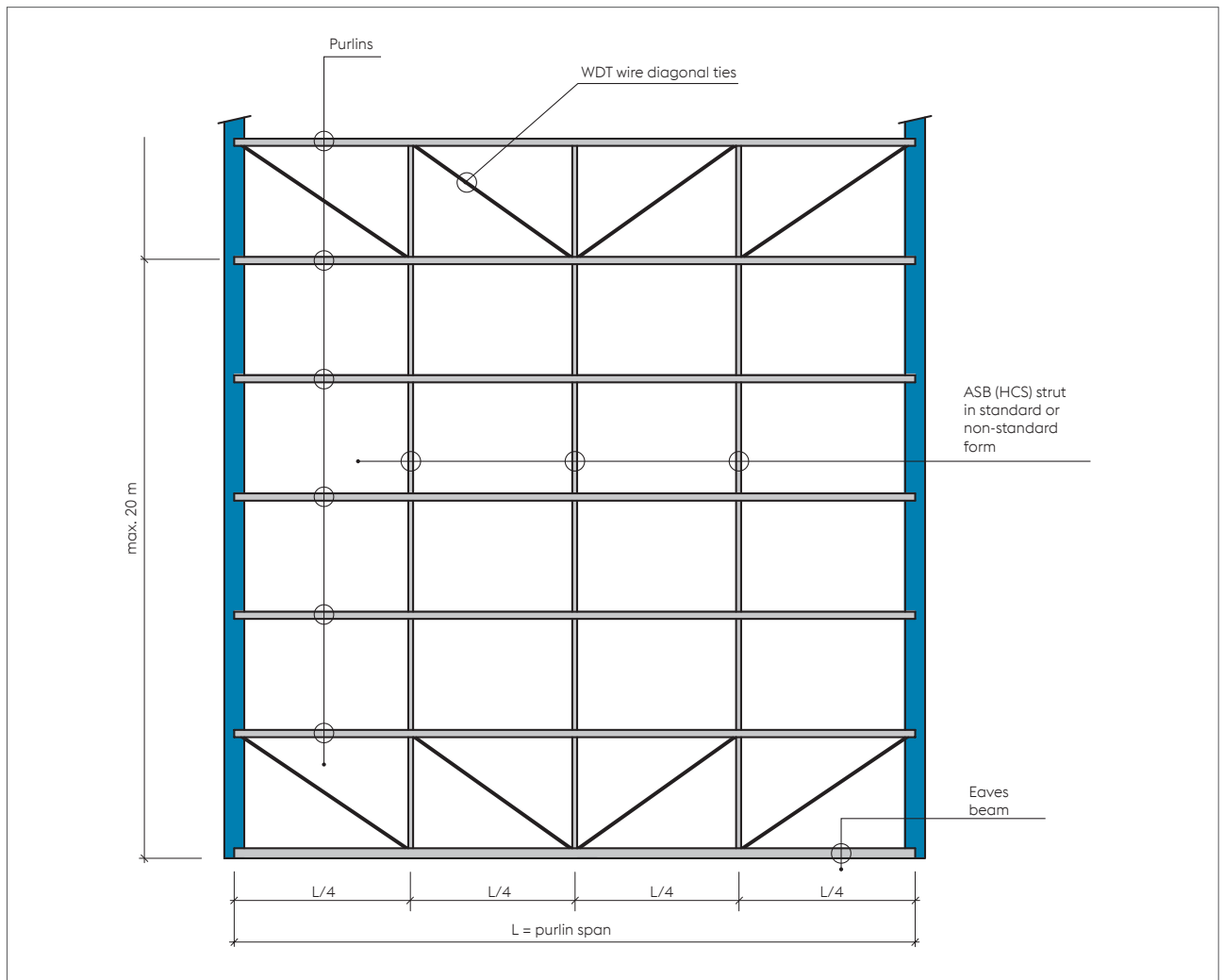


Fig. 50 – Bracing of purlins in double- or single-pitch roofs featuring three rows of struts

Design Prerequisites

- Ridge purlins must be fitted with the AA apex angles according to the minimum bracing requirements in Table 17 in the case of duo-pitch roofs or in Table 18 for mono-pitch roofs.
- Duo-pitch roofs with a slope length ≤ 20 m and fitted with the AA apex angles do not need to be fitted with a row of WDT ties.
- The diagram generally does not apply to roofs with non-restraining roof cladding.

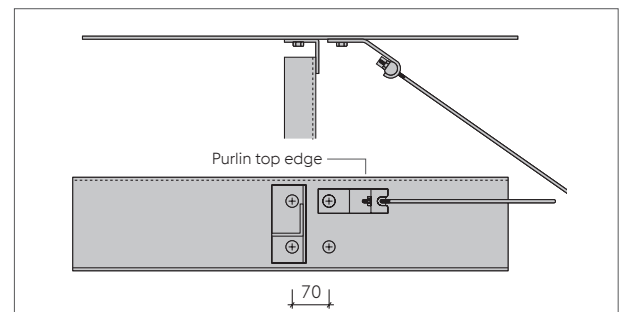


Fig. 51 – Detail of jointing a strut and a diagonal tie to the purlin in an inner braced bay

Purlins / Cantilevers and Purlin Overhangs

Structural Arrangement

If purlins overhang the gable wall up to 0.60 metres, no stress analysis or complex structural measures need to be applied in most cases. In the case of overhangs longer than 0.60 metres, however, these are considered cantilevers where it is necessary to perform a stress analysis and observe the recommended structural measures.

Cantilever length ≤ 0.60 m	No stress analysis is required
Cantilever length > 0.60 m and $\leq 35\%$ of the end bay span	Stress analysis is required
Stress analysis by	Profilform Designer
Construction systems for cantilevers	BUTT or METLAP
Cantilever end bracing	Angle 45×45×2 mm for purlin spacing up to 2.4 m
	Angle 50×50×2 mm for purlin spacing up to 3.5 m
	U sections (Table 19) = alternative bracing for purlin spacing of up to 5 m
Use of WDT ties	Yes - at least 1 tie for every 10 m of slope length

Tab. 19 – Terminating U sections for cantilevers

Reference code	Thickness	Height	Top flange	Bottom flange	Weight
	mm	mm	mm	mm	kg/m
127U13	1.3	127	50	50	2.14
147U13	1.3	147	66	66	2.84
177U13	1.3	177	51	51	2.84
207U14	1.4	207	56	56	3.49
238U15	1.5	238	55	55	4.09
268U16	1.6	268	55	55	4.73
308U20	2.0	308	65	65	6.83
350U23	2.3	350	77	77	9.01
410U25	2.5	410	66	66	10.50
440U25	2.5	440	91	91	12.03

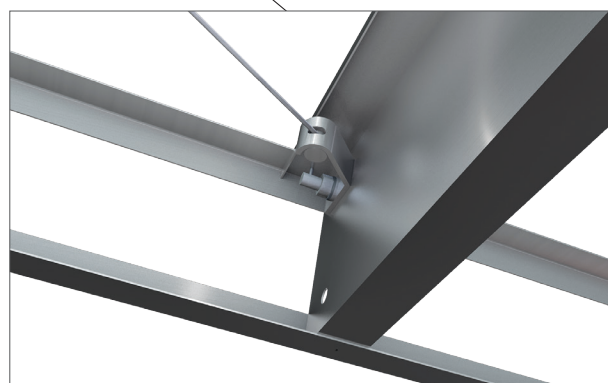
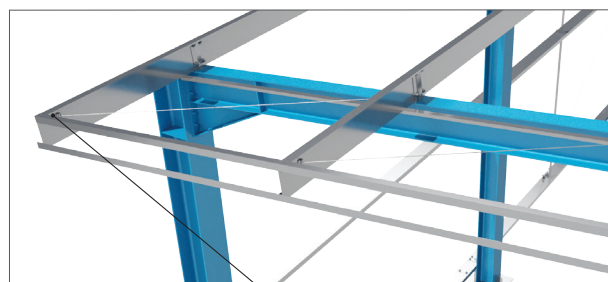
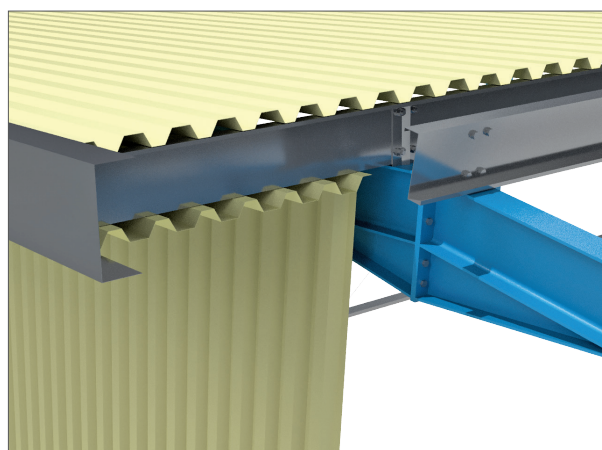


Fig. 52 – Cantilever bracing with L sections and a WDT tie

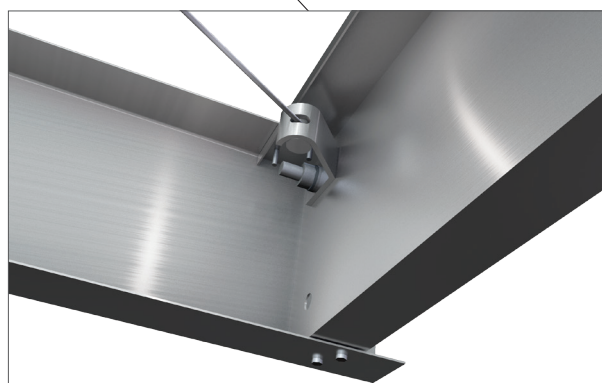
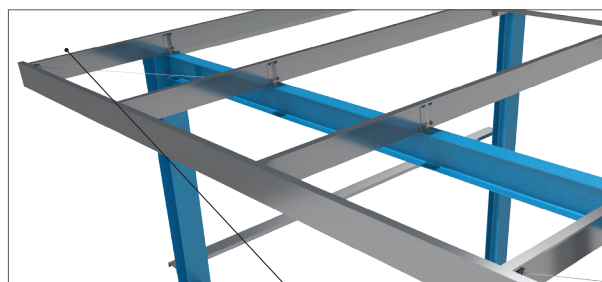


Fig. 53 – Cantilever bracing with U section and a WDT tie

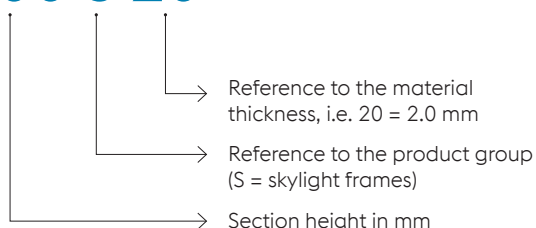
Purlins / Skylight Frames

Portfolio of Sections and their Structural Arrangements

Sections used for skylight frames are referred to as S sections. The skylight frames are mostly designed as structurally non-load bearing i.e. they carry only the skylight without substituting the purlin. Should these be used as main structure elements, a stress analysis must be performed.

Section Reference Code

300 S 20



General rules for punching holes in sections

Transverse location of holes

Section web up to 5 different reference axes

Section flange up to 2 different reference axes

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of holes per one type of component are allowed.

Possible types of holes

- Straight, round: diameters of 9, 11, 12, 14, 18, 22 mm
- Straight, oval: dimensions of 12×30, 14×30, 18×30, 22×30 mm

General rules for making notches

- The minimum notch length is 52 mm, the maximum 350 mm.
- The maximum notch depth = 1/2 of the section height – 2 mm.
- Positioning of notches is unrestricted along the section length.
- Cutouts may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.
- If necessary, contact our technical department.

Service or counterformed holes are not normally pierced in the skylight section. Any requests for their use must be approved by our design department.

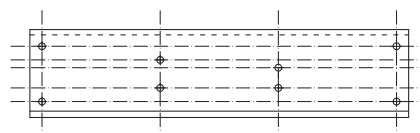
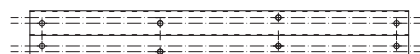


Fig. 54 – Possible layout of holes

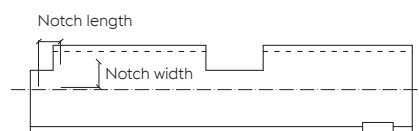
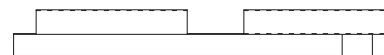


Fig. 55 - Possible layout of cutouts

Tab. 20 – Range and dimensions of skylight sections (shape 1) with reinforced top flange

Reference code	Weight	Area	Height	Bottom flange	Top flange	Top rein-forcer	Thickness
	kg/m	mm ²	mm	mm	mm	mm	mm
300S20	7.86	989	300	88	100	20	2.00
300S23	9.01	1134	300	88	100	20	2.30
300S25	9.76	1231	300	88	100	20	2.50
300S29	11.27	1422	300	88	100	20	2.90
340S23	9.73	1226	340	88	100	20	2.30
340S25	10.55	1331	340	88	100	20	2.50
340S27	11.37	1435	340	88	100	20	2.70
340S30	12.58	1590	340	88	100	20	3.00
360S23	9.73	1226	360	70	100	18	2.30
360S25	10.55	1331	360	70	100	18	2.50
360S27	11.37	1435	360	70	100	18	2.70
360S30	12.58	1590	360	70	100	18	3.00
400S25	12.16	1516	400	100	100	22	2.50
450S27	13.67	1737	450	95	95	20	2.70
450S32	16.14	2051	450	95	95	20	3.20

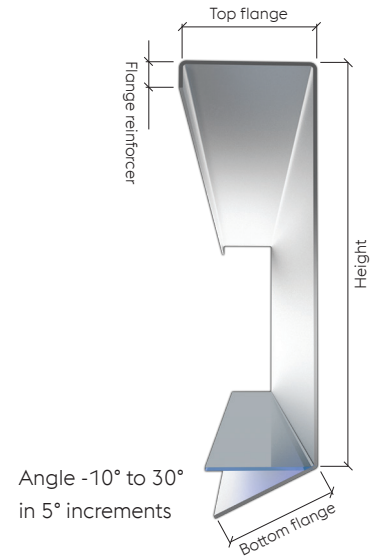


Fig. 56 – Skylight frame section - shape 1

Tab. 21 – Range and dimensions of skylight sections (shape 2) non-reinforced top flange

Reference code	Weight	Area	Height	Bottom flange	Top flange	Thickness
	kg/m	mm ²	mm	mm	mm	mm
302S20	7.86	986	302	100	100	2.00
302S23	9.01	1132	302	100	100	2.30
302S25	9.76	1229	302	100	100	2.50
302S29	11.27	1422	302	100	100	2.90
342S23	9.76	1224	342	100	100	2.30
342S25	10.55	1329	342	100	100	2.50
342S27	11.37	1434	342	100	100	2.70
342S30	12.58	1362	342	100	100	3.00
362S23	9.73	1224	362	100	80	2.30
362S25	10.55	1329	362	100	80	2.50
362S27	11.37	1434	362	100	80	2.70
362S30	12.58	1590	362	100	80	3.00
402S25	12.16	1379	402	80	80	2.50
452S27	13.67	1731	452	100	100	2.70
452S32	16.14	2046	452	100	100	3.20

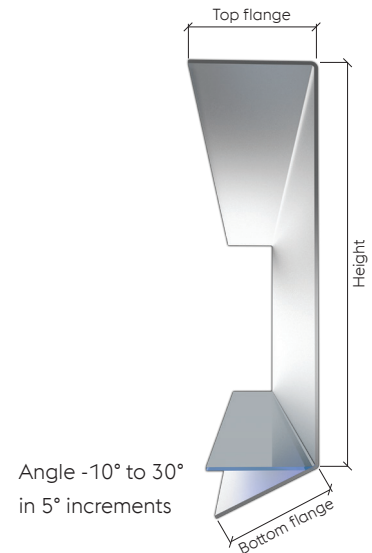


Fig. 57 – Skylight frame section - shape 2

Skylight Frames

Structural Arrangement and Details of Skylight Parallel to Purlins

Purlins

The following figures show the structural arrangement and details of a skylight positioned in parallel with purlins.

The skylight frame section can be fixed to the top flange of the purlin by self-tapping screws.

In this case, the skylight structure must be equipped with (ASB or HCS) struts that provide the necessary skylight frame stiffness.

Details of ASB and HCS struts are presented on pages 38-40.

Another solution for fixing the skylight sections to the primary structure is by means of cleats that are part of the primary structure and the skylight frame section is bolted to them.

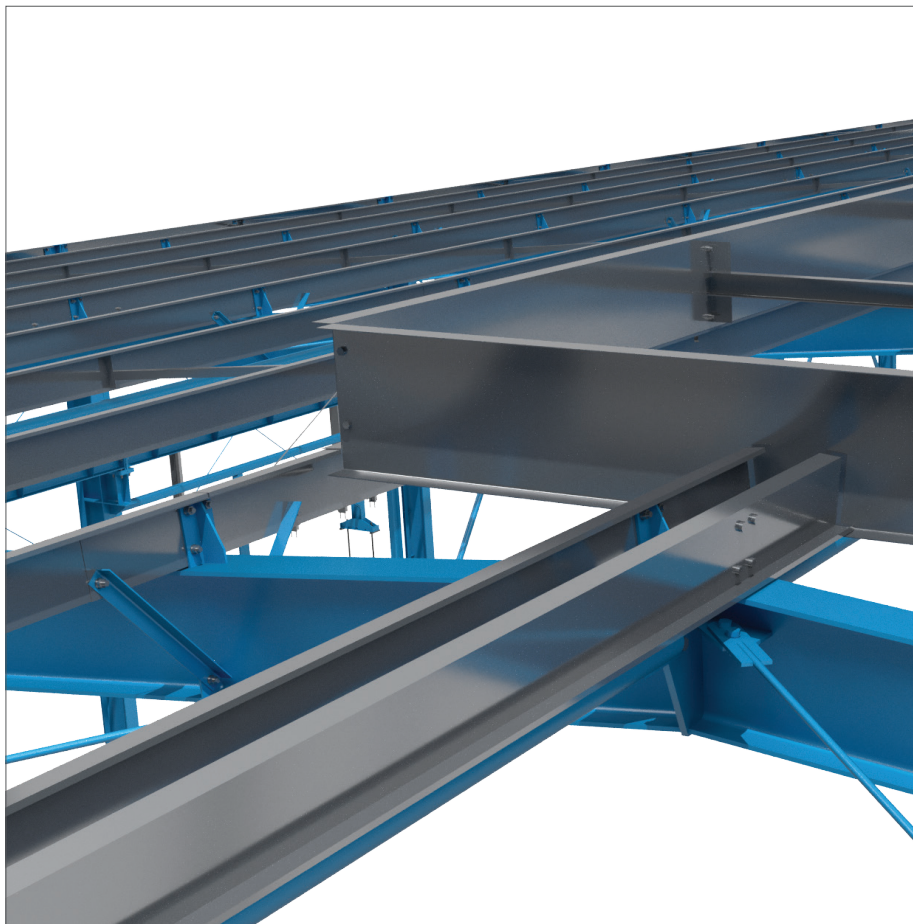


Fig. 58 – Structural arrangement of a skylight parallel to the purlins

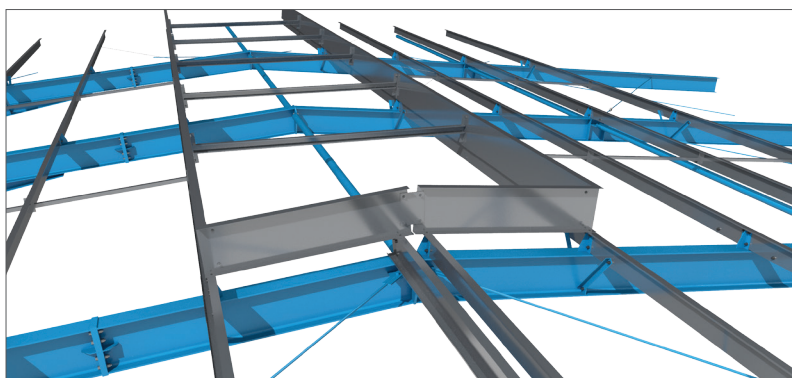


Fig. 59 – Detail of the skylight frame front - shaped according to the roof ridge

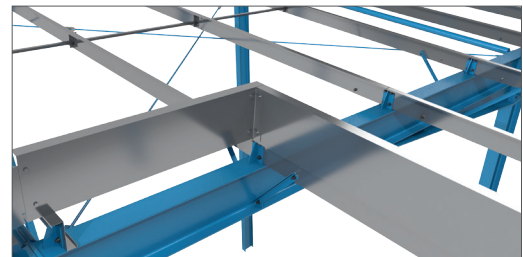
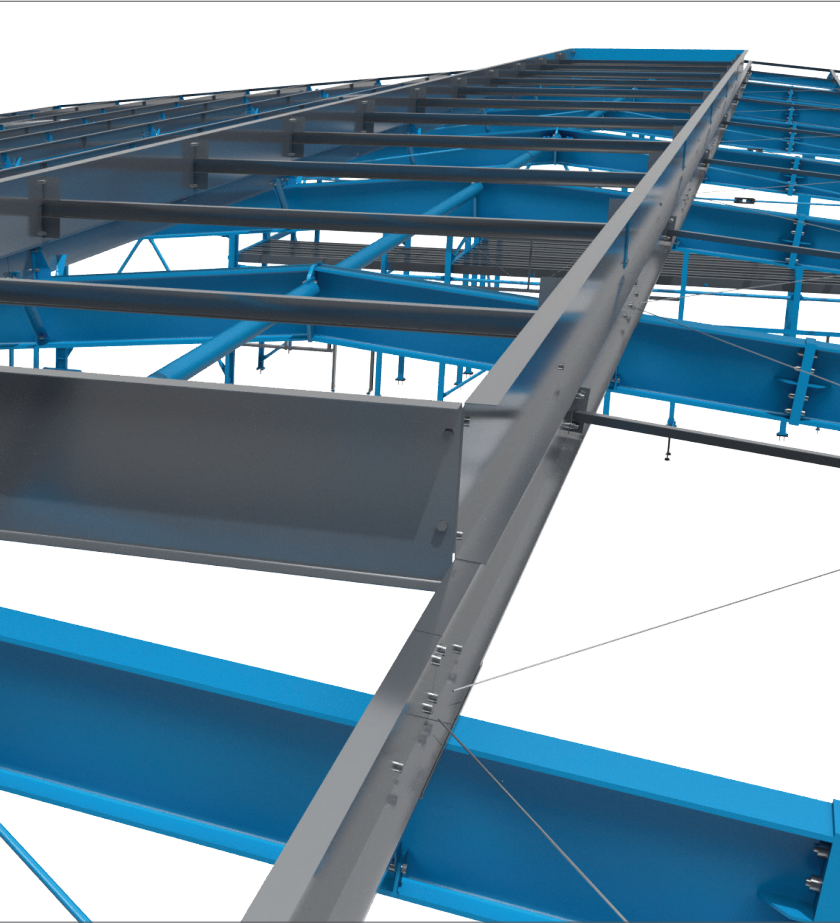


Fig. 60 - Jointing of the skylight frame longitudinal and transverse (frontal) sections. The joint is made of an angle piece and M10 - M16 bolts. The connecting angle piece is not a standard component of the METSEC systems.

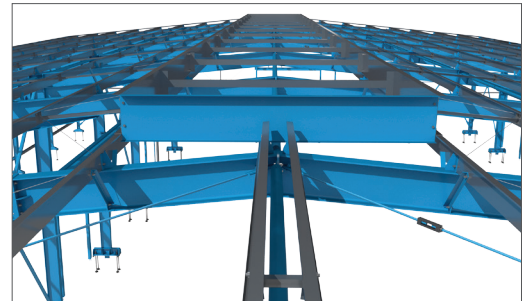


Fig. 61 - Structural arrangement of a skylight frame straight front in the roof ridge



Fig. 62 - Connection of the skylight frame to the purlin using self-tapping screws with a maximum spacing of 1,000 mm. The skylight frame section is positioned on the top flange of the purlin.

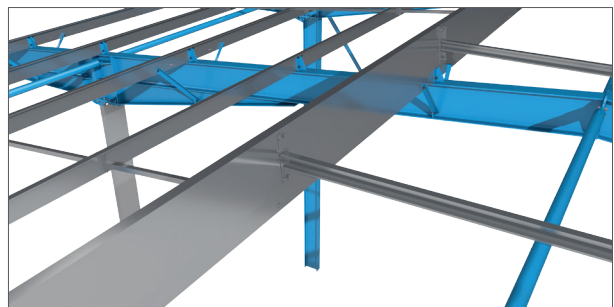


Fig. 63 - Detail of a bracing strut connection to the skylight frame section. A standard joint made by M16 bolts.

Skylight Frames

Structural Arrangement and Details of Skylight Perpendicular to Purlins

The structural arrangement of a skylight frame positioned perpendicularly to purlins is shown in Figure 64.

The bottom flange of the skylight frame is fixed to the top flange of purlins by means of self-tapping screws.

Components of the skylight frame are interconnected by bolt through angle pieces of the TC type or through atypical angle pieces.

The range of TC angle pieces is listed on page 87.

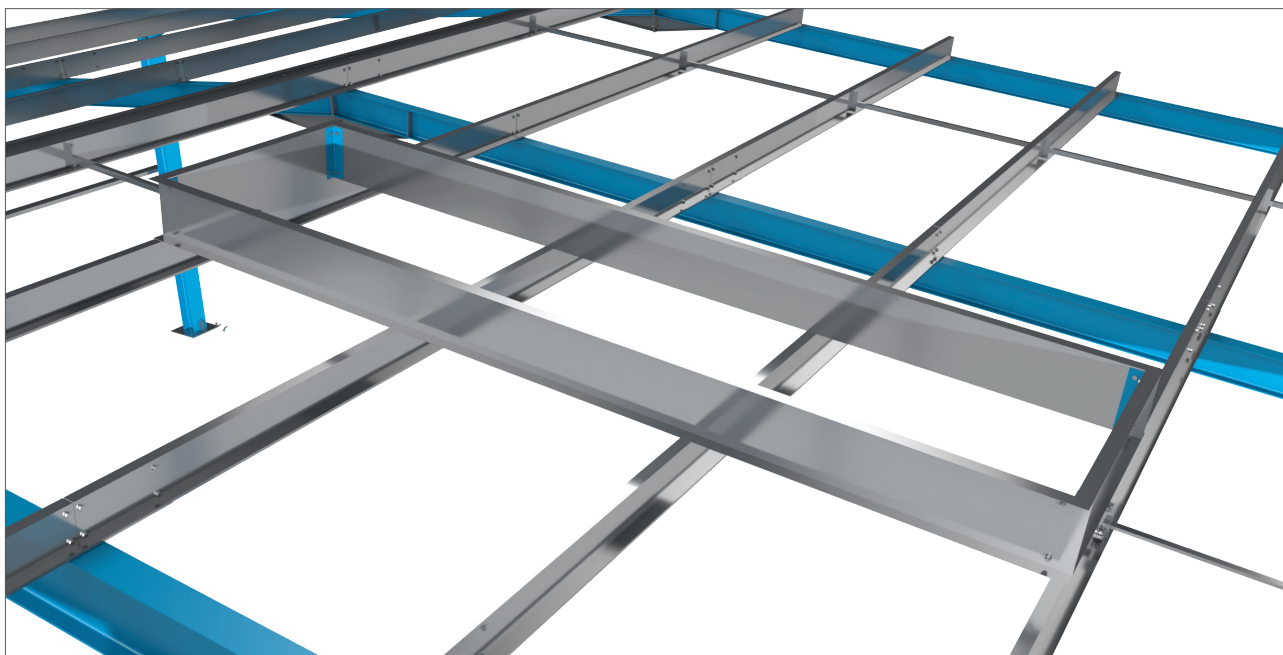


Fig. 64 – Structural arrangement of a skylight frame positioned perpendicularly to the purlins

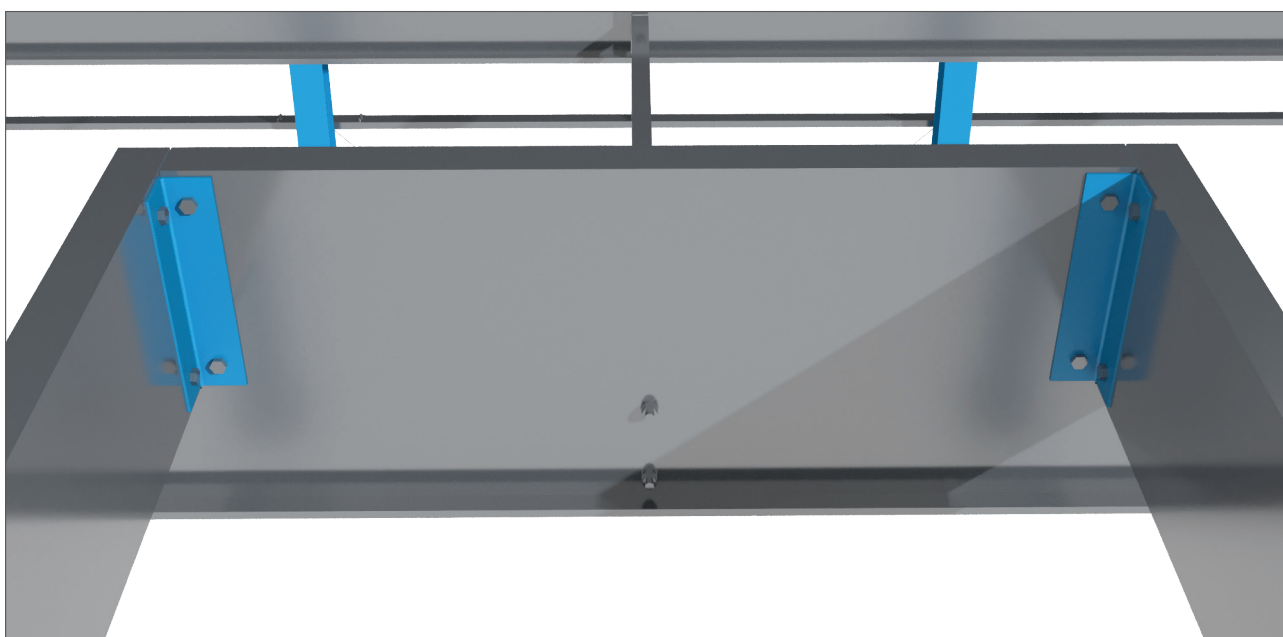


Fig. 65 – Detail of the interconnection of the skylight frame elements by means of bolts and an atypical angle piece

Cleader Angle Bars and Rafter Stays

Structural Arrangement

Cleader angle bars are used for various designs, especially for the termination of purlins in gable frames, and also rafter stays increasing their stability.

It should be stressed that rafter stays have been designed only for tensile stressing and as such they do not change the mathematical model of the purlin into the „stay type“. It is assumed that if pressure-loaded, the stay would buckle and become ineffective.

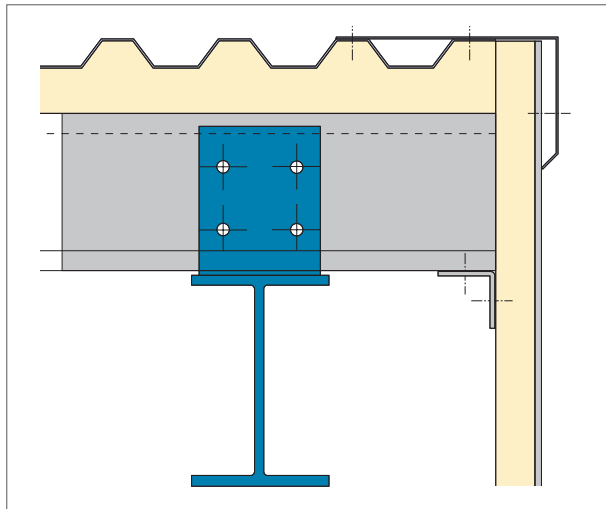


Fig. 66 – Example of a detail of joining the sheathing to the purlin overhang by means of a cleader angle bar

Cleader angle bars

They are made of the S250GD steel with standard Z275 galvanising. Upon request, we are able to apply thicker zinc coatings on these angle bars: Z600, Z800 or Z1000.

Range of cleader angle bars

Tab. 22: Range of cleader angle bars

Section dimensions mm	Weight kg/m
45 x 45 x 2	1.37
70 x 60 x 2	2.00
70 x 60 x 2.5	2.50
80 x 50 x 2	2.00
80 x 50 x 2.5	2.50
120 x 100 x 2	4.30

We recommend 45×45×2 mm or 70×60×2 angles for purlin spacing of up to 2.4 m and 80×50×2 angles or larger for greater purlin spacings.

Figures 67 and 68 illustrate the use and jointing of cleader angle bars. A minimum of 28 mm overlap beyond the joint axis is recommended for these angle pieces due to their thickness.

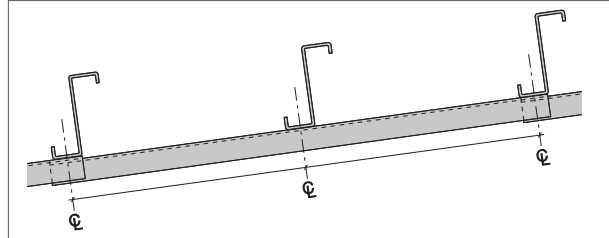


Fig. 67 – Example of use of cleader angle bar

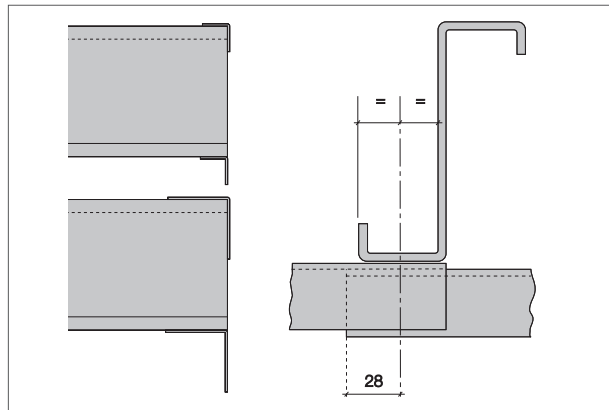


Fig. 68 – Example of positioning and fixing the cleader angle bar

Rafter Stays

Angle pieces from the range listed in Table 22 can be used for rafter stays. System holes (normally used for ties or overlaps) may be used for fixing the stays to purlins, or additional holes need to be pierced to accommodate the stays at 45°.

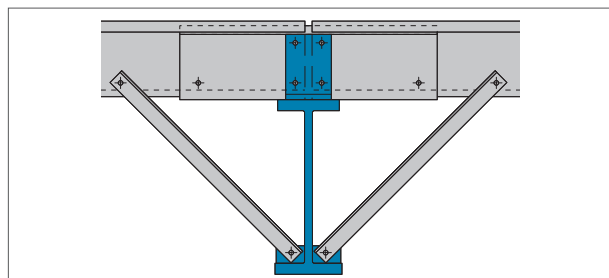


Fig. 69 – Example of rafter stays fixed to the purlins through additional holes

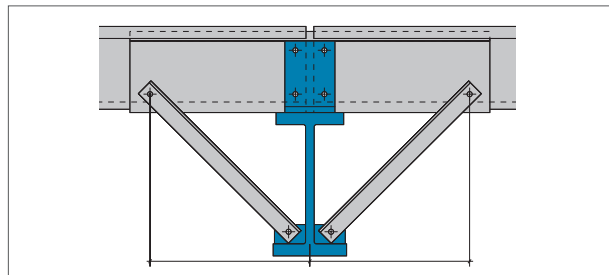


Fig. 70 – Example of rafter stays fixed to the purlins through system holes designed for ties or overlaps

EAVES BEAM

Portfolio of Sections and their Structural Arrangements

The eaves beam in the METSEC system is designed as a C section with the possibility of making the top flange sloping between -10° and $+30^\circ$ in 5° increments to copy the slope of the roof and simplify installation of the roof cladding.

Section Reference Code

230 E 25

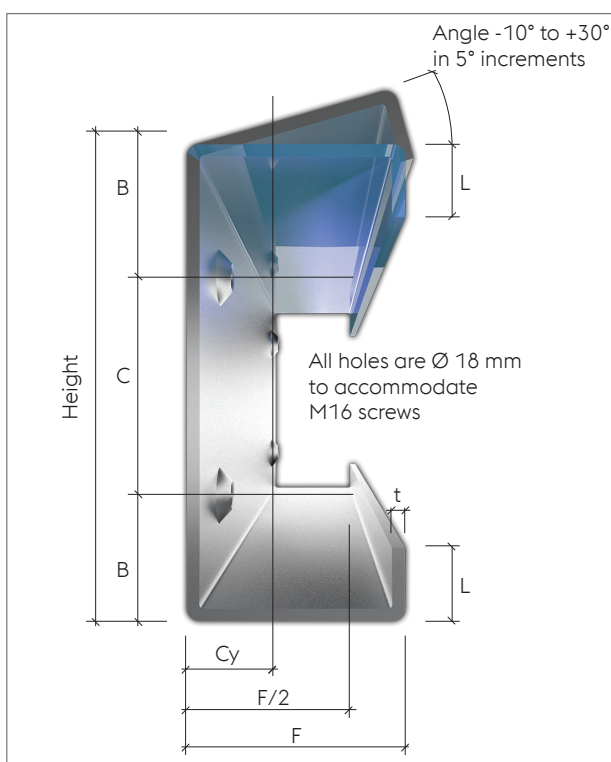
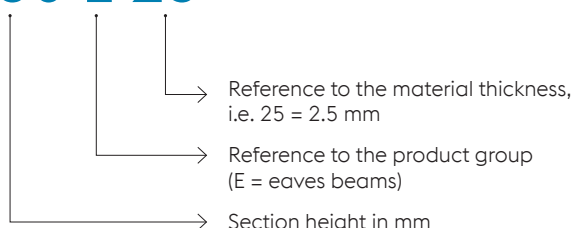


Fig. 71 – Eaves beam section

Tab. 23 – Positions of standard holes in the eaves beam

Reference code	Dimension B mm	Dimension C mm	Dimension F mm	Dimension L mm
170	42	86	90	19
200	42	116	90	19
230	42	146	90	19
270	47	176	100	22
330	47	236	100	21
420	50	320	100	22

General rules for punching holes in sections

Transverse location of holes

Section web up to 5 different axes

Section flange up to 2 different reference axes

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of holes per one type of component are allowed.

Possible types of holes

- Straight, round: diameters of 9, 11, 12, 14, 18 and 22 mm.
- Straight, oval: dimensions of 12×30 , 14×30 , 18×30 and 22×30 mm.
- Counterformed holes with a diameter of 18 mm (14 mm if approved by our technical department). In the case of counterformed holes, a packing plate (PP) must be used in the joint – see Figure 74 and Table 25 on page 54.
- Counterformed holes of solely 18 mm in diameter may be used in 420 mm high sections.

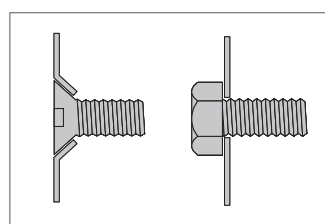


Fig. 72 – Options for making holes in the eaves beam (counterformed/straight)

General rules for making notches

- The minimum notch length is 52 mm, the maximum 350 mm.
- The maximum notch depth = $1/2$ of the section height – 2 mm.
- Positioning of notches is unrestricted along the section length.
- Cutouts may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.
- If necessary, contact our technical department.

Service holes are not made in the eaves beam.

Tab. 24 – Permitted combinations of holes in one component

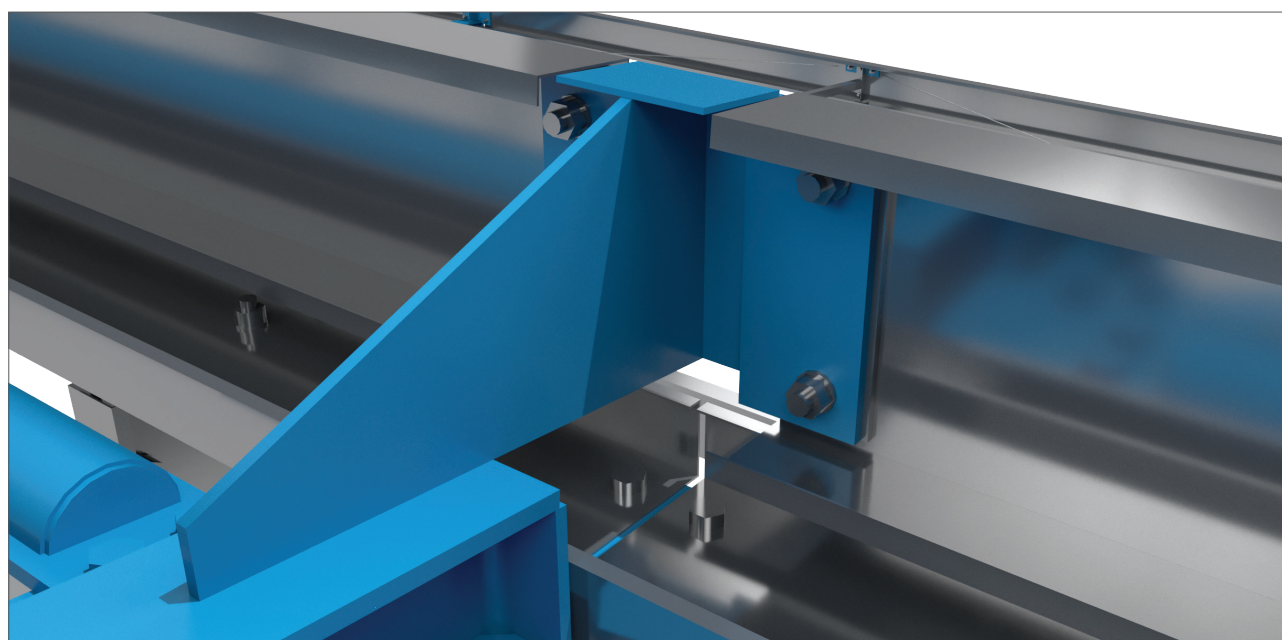
Reference to section		Straight holes	Counterformed holes	Service holes	Notches in section	Top flange angle of slope
170 - 420	Web	Max. 3 different diameters along five different reference axes	1 diameter along five reference axes. Only 18 mm diameter for sections 420	No	Ywe	Min. -10° Max. +30°
	Flange	Max. 2 different diameters along two different reference axes	No	No	Yes	

Range of sections for eaves beams

Section reference code	Weight	Area	Height	Flange	Thick-ness	I _{yy}	I _{zz}	W _{yy}	W _{zz}	i _{yy}	i _{zz}	C _y	C _z	M _{cy}	M _{cz}
	kg/m	mm ²	mm	mm	mm	mm ⁴	mm ⁴	mm ³	mm ³	mm	mm	mm	mm	kNm	kNm
170E20	5.83	740	170	90	2.00	3,681,045	839,640	43,306	13,928	69.6	33.2	85.00	29.72	16.500	5.600
170E23	6.67	847	170	90	2.30	4,203,631	954,884	49,455	15,841	69.5	33.8	85.00	29.70	20.010	6.480
200E20	6.30	800	200	90	2.00	5,328,945	885,516	53,290	14,194	80.6	32.9	100.00	27.61	19.630	5.610
200E25	7.81	993	200	90	2.50	6,590,691	1,086,581	65,907	17,421	80.4	32.6	100.00	27.63	27.600	7.090
230E20	6.77	860	230	90	2.00	7,345,845	925,138	63,877	14,410	91.4	32.4	115.00	25.80	22.790	5.620
230E25	8.41	1068	230	90	2.50	9,092,569	1,135,233	79,066	17,689	91.1	32.2	115.00	25.82	32.600	7.100
270E25	9.70	1233	270	100	2.50	14,291,884	1,620,379	105,866	22,549	106.5	35.9	135.00	28.14	40.280	8.900
270E29	11.19	1422	270	100	2.90	16,465,635	1,854,914	121,968	25,820	106.3	35.7	135.00	28.16	50.980	10.380
330E25	10.84	1378	330	100	2.50	22,731,479	1,690,290	137,767	22,543	127.2	34.7	165.00	25.02	49.610	8.740
330E29	12.52	1591	330	100	2.90	26,207,408	1,934,704	158,833	25,813	127.0	34.5	165.00	25.02	62.780	10.200
420E27	13.64	1733	420	100	2.70	43,614,723	1,962,807	207,689	25,163	157.3	33.4	210.00	22.00	72.900	9.690
420E32	16.08	2044	420	100	3.20	51,348,625	2,287,833	244,517	29,352	157.0	33.1	210.00	22.05	95.090	11.550

Eaves beam

Static model of purlins	Simply supported beam
Maximum purlin span	12.00 metres
Minimum number of bays of the same span in one purlin row	1 bay
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and purlin interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm



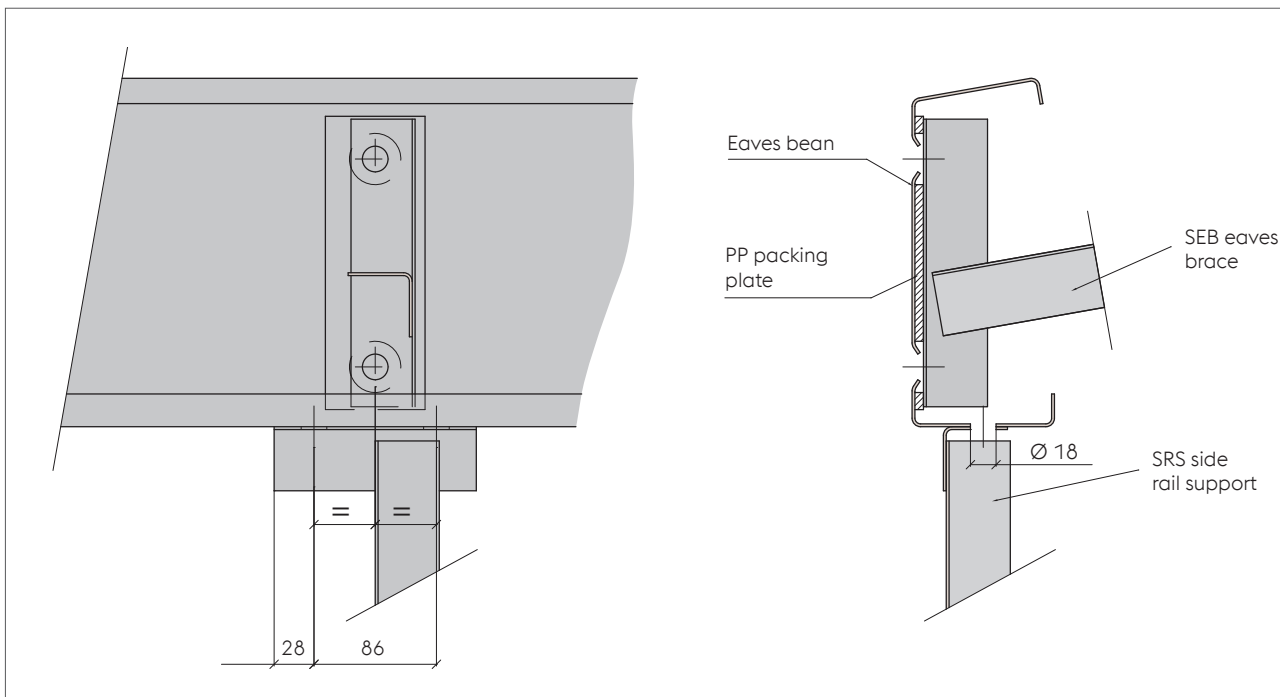


Fig. 73 - Detail of the eaves beam at the joint with the eaves brace

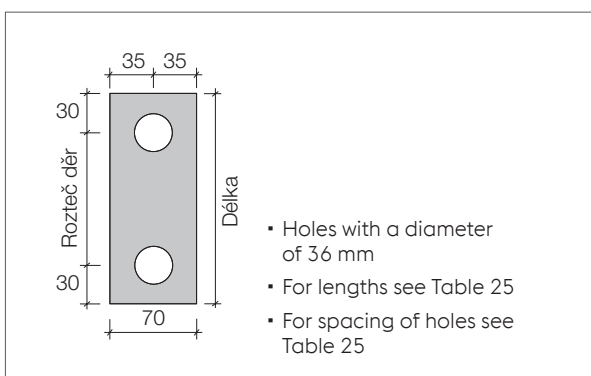
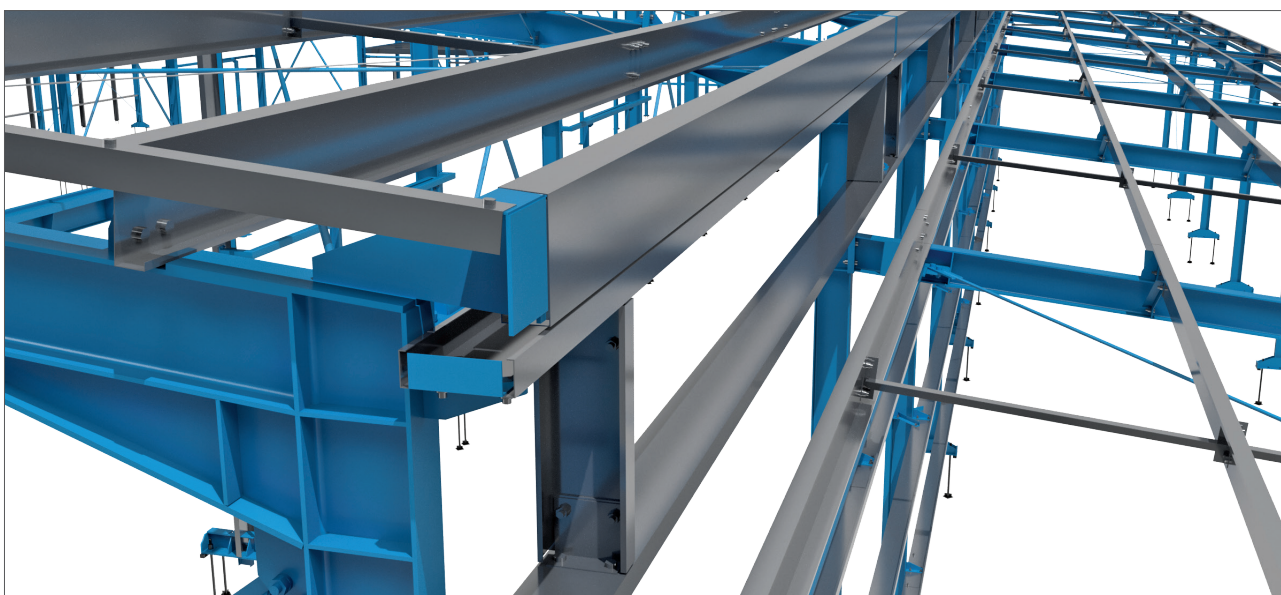
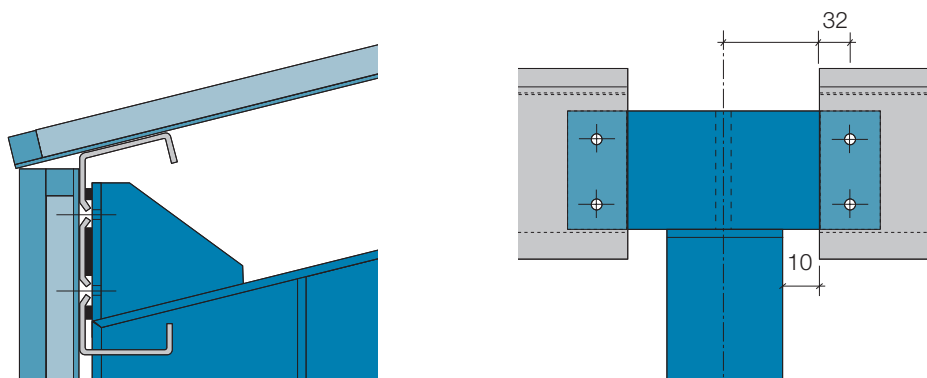


Fig. 74 - PP packing plate

Tab. 25 – Range and dimensions of PP packing plates

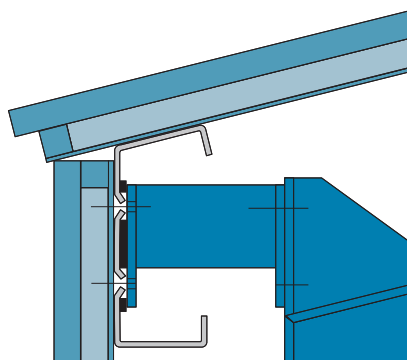
Packing plate reference code	Reference to section	Spacing of holes	Length
	mm	mm	mm
PP 1	142	56	116
PP 2	172/170	86	146
PP 3	202	116	176
PP 4	232/230	146	206
PP 5	262/270	176	236
PP 6	302	195	255
PP 7	342/330	235	295
PP 8	402	295	355
PP 9	420	320	380





Cladding flush with column face

Total length of the eaves beam = column spacing - column width - 20 mm
(10 mm at each end)



Cladding outside column face

Total length of the eaves beam = column spacing - 6 mm
(3 mm at each end)

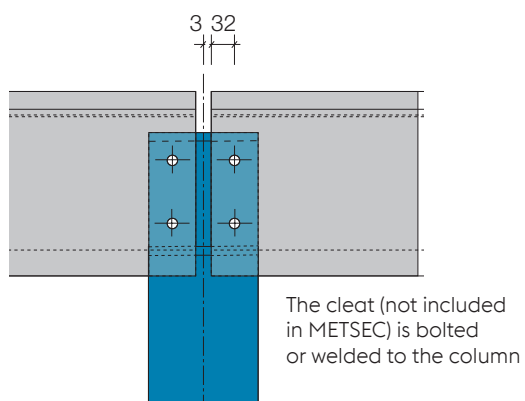


Fig. 75 – Details of eaves beam fixing to the column of the primary structure

Tab. 26 - Recommended design of eaves bracing

Eaves beam span	SEB eaves brace	WDT wire diagonal ties
4.0 – 6.0 m	1 at mid-span	2 diagonal ties
6.1 – 10.0 m	2 at span thirds	2 diagonal ties
10.1 – 12.0 m	3 at span quarters	4 diagonal ties

Schematic diagram and rules for eaves beam bracing are given on pages 43-44.

Eaves Beam

Spacer Beams for Frame Corners

Eaves beam sections can also be used as spacer beams for columns, effectively replacing spacer beams made of hot-rolled sections. Spacer beams are supplied as separate components and are only assembled at the site into one structural element. They provide a very good loading capacity considering their low weight.

Eaves beam

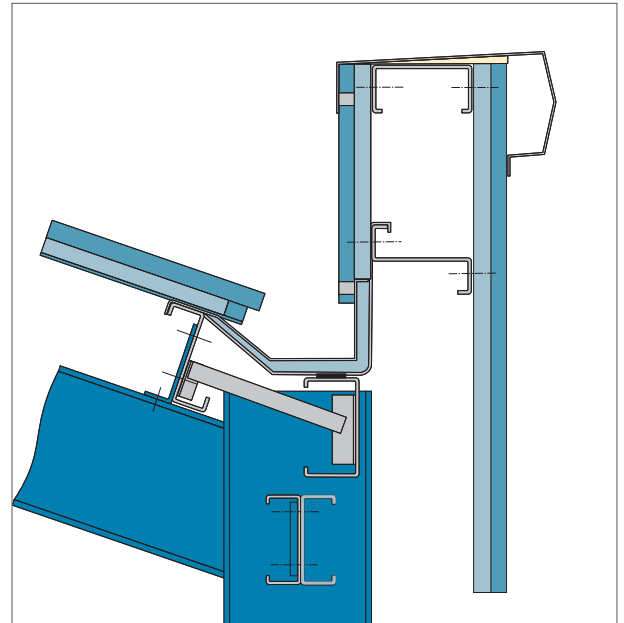
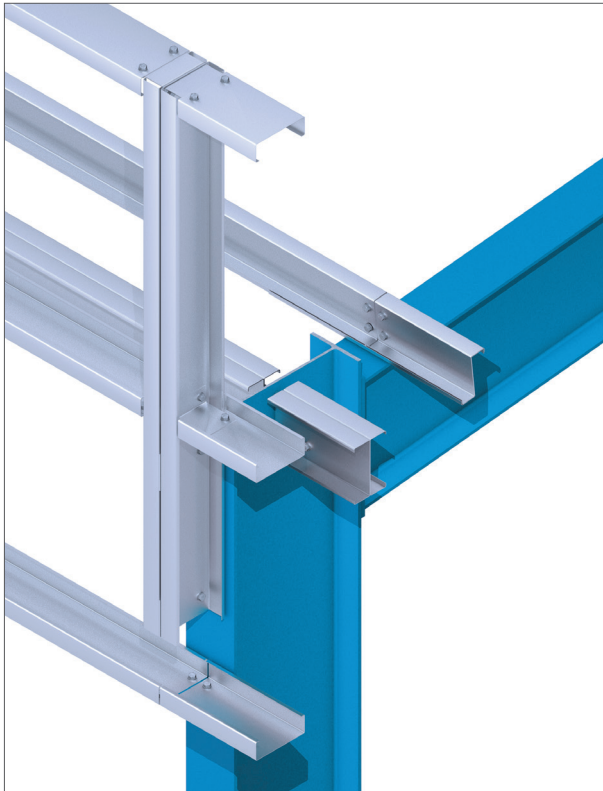


Fig. 76 – Detail of the eaves with a parapet and a spacer beam made of two C sections stabilising the frame corner

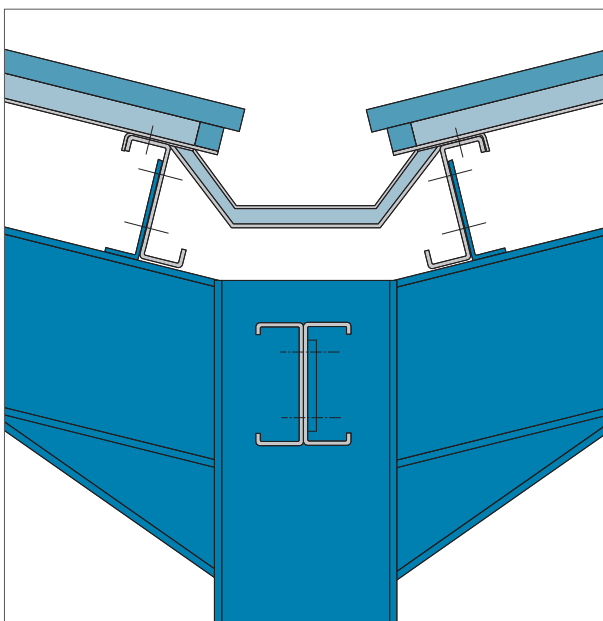


Fig. 77 – Detail of a spacer beam at a column under the inner gutter

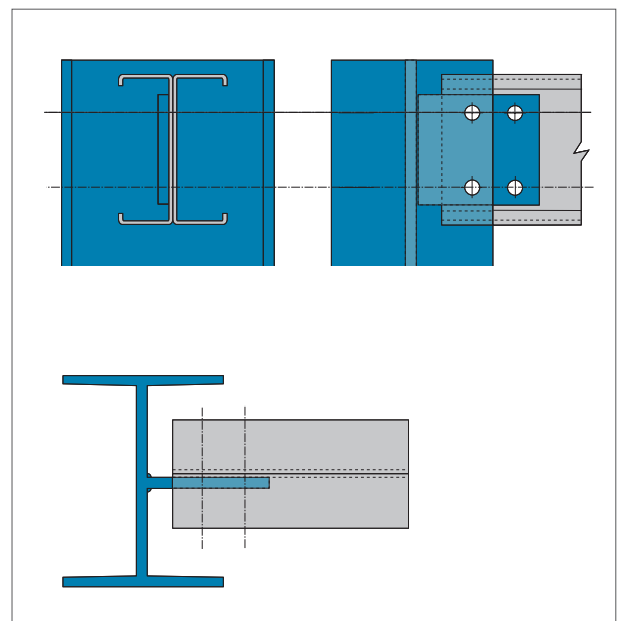
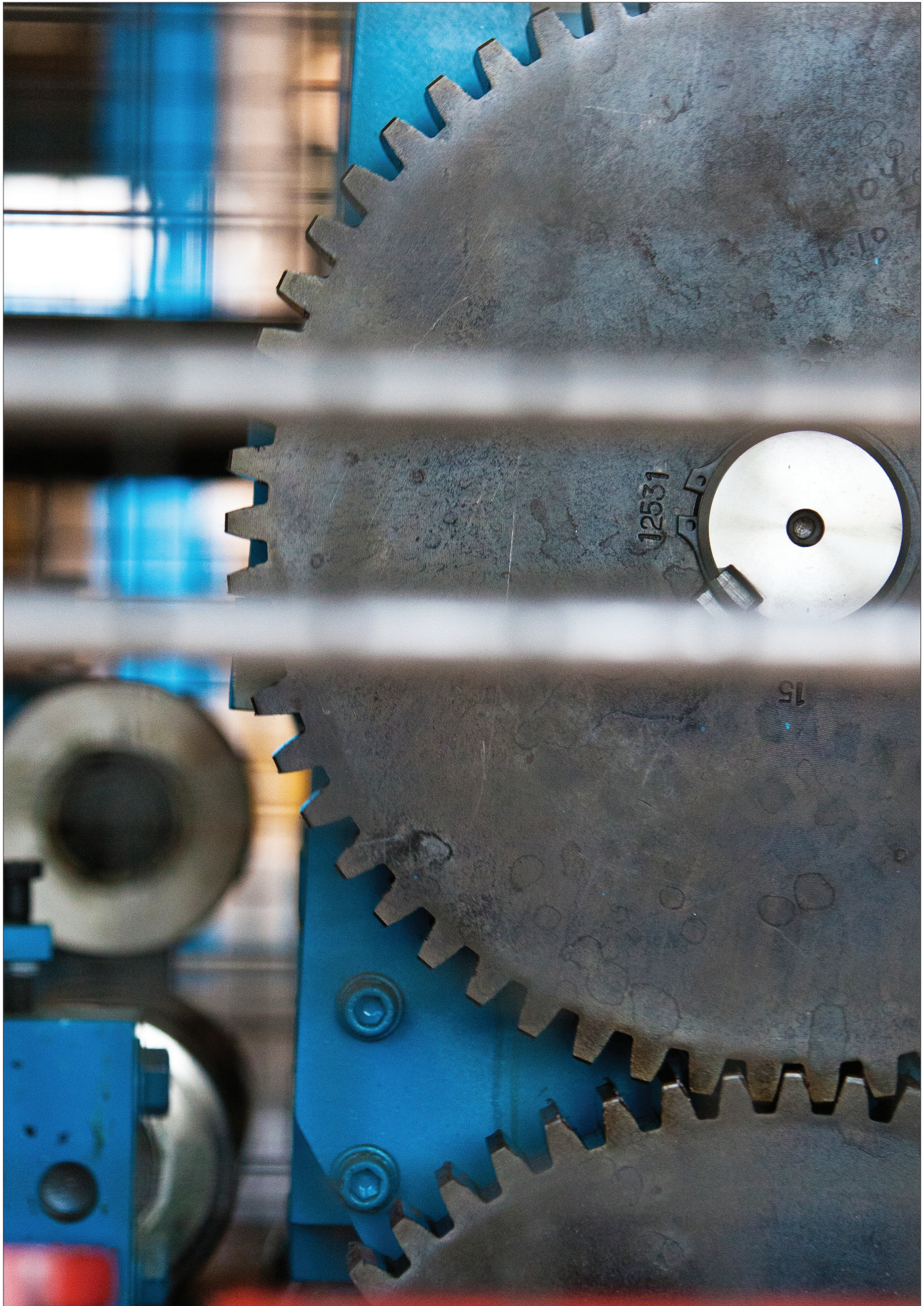


Fig. 78 – Detail of the connection of the spacer beam to the primary steel structure



Eaves beam

SIDE RAILS

Introduction

The METSEC side rail systems form a reliable and efficient secondary structure supporting wall cladding of various types.

- The stress analysis and resulting design of the METSEC side rail systems can easily be done using our Profilform Designer software.
- The standard form of METSEC side rail systems can span up to 13.00 metres. Please contact our technical department if side rails for larger spans are needed.
- The side rail systems can be made of Z or C sections in two basic construction systems:
 - simply supported beam called BUTT system
 - continuous beam with sleeves called SLEEVED system.

Side rails



Side Rails

Overview of construction systems

BUTT system

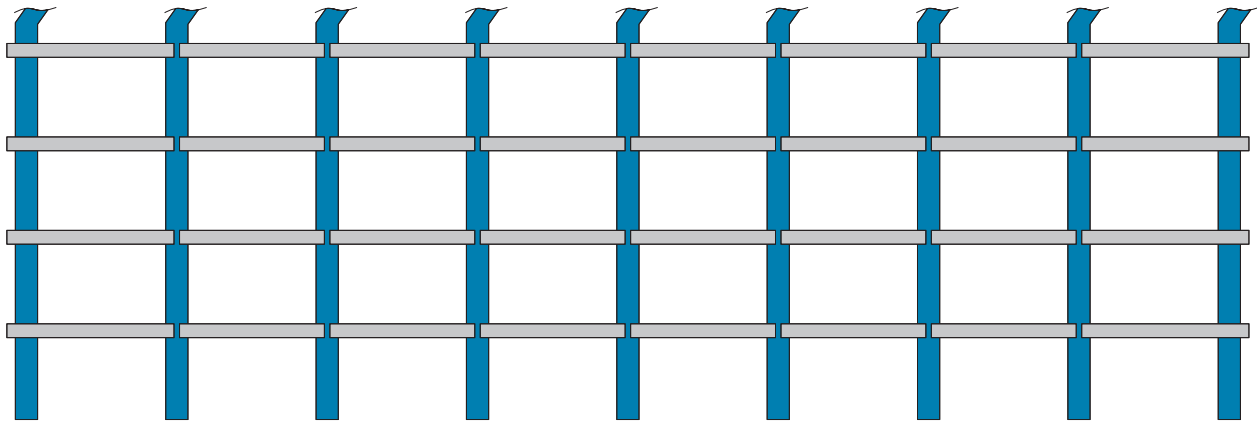


Fig. 79 – Arrangement of side rails in the BUTT system

Construction system made of simply supported beams.

The side rails may be oversailing above the primary steel structure frames/rafters or inset between them.
The system requires at least 1 bay with the maximum column spacing of 12.00 metres.

SLEEVED system – single span side rails

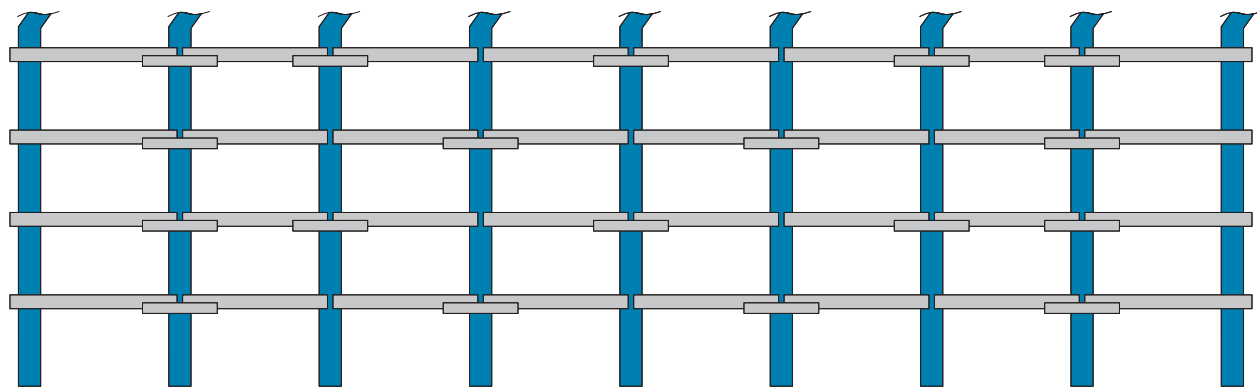


Fig. 80 – Arrangement of side rails in the SLEEVED system

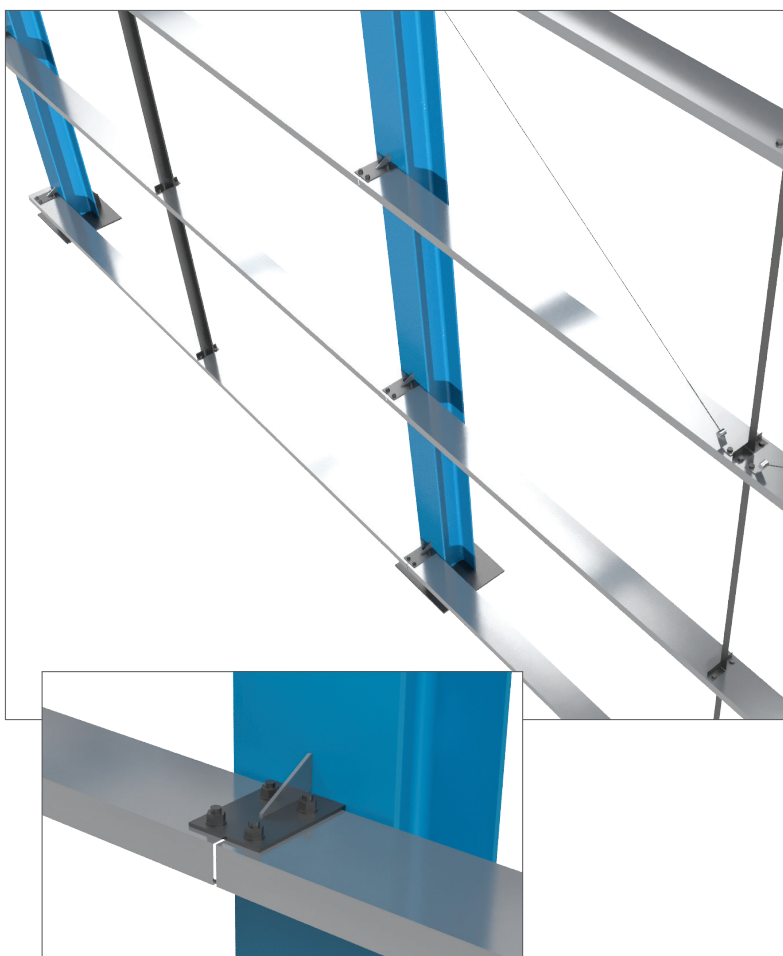
Construction system made of continuous beams over two or three bays.

Beam continuity is achieved by means of sleeves reinforcing the joints at the penultimate columns. The sleeves are staggered at inner columns, as shown in Figure 80. Side rails of the SLEEVED system require at least 2 bays; they can be used for spans of up to 13.00 metres in their standard form.

Side Rails / BUTT Construction System of C Sections

Structural Arrangement and Details

Static model of side rails	Simply supported beam
Maximum side rail span	12.00 metres
Minimum number of bays of the same span in one side rail row	1 bay
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and side rail interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm



The BUTT side rail system made of simply supported beams is suitable for structures with one or more bays.

It can be used autonomously or in combination with other systems. It has primarily been designed for small spans and loads. It is applicable in the case of uneven spans in a side rail row or where a continuous beam cannot be used for some reason. Side rails are fixed to the columns of the primary structure by means of cleats and can be made as oversailing or inset between the primary structure columns.

This system can be used for spans of up to 12.00 metres, depending on the load applied.

Tab. 27 – Positions of standard holes in the C section web

A	B	C	H
mm	mm	mm	mm
122	33	56	40
142	43	56	50
172	43	86	50
202	43	116	50
232	43	146	50
262	43	176	50
302	53.5	195	60
342	53.5	235	60
402	53.5	295	60

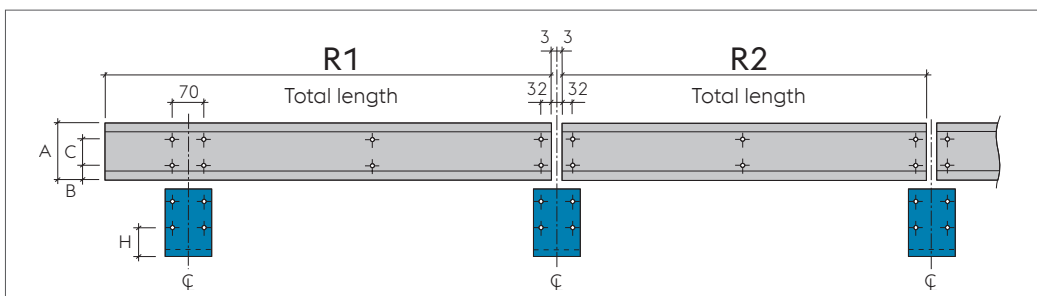
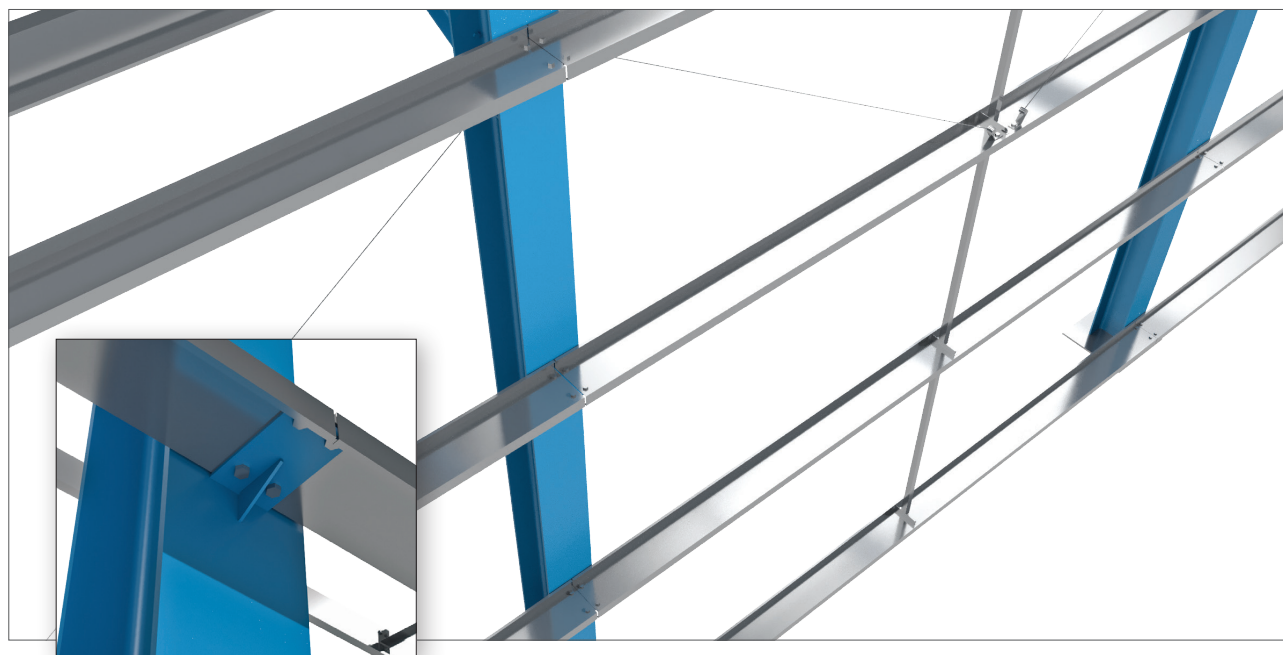


Fig. 81 – Design details of the BUTT side rail system of C sections

Side Rails / BUTT Construction System of Z Sections

Structural Arrangement and Details



The BUTT side rail system made of simply supported beams is suitable for structures with one or more bays.

It can be used autonomously or in combination with other systems. It has primarily been designed for small spans and loads. It is applicable in the case of uneven spans in a side rail row or where a continuous beam cannot be used

for some reason. Side rails are fixed to the columns of the primary structure by means of cleats and can be made as oversailing or inset between the primary structure columns.

This system can be used for spans of up to 12.00 metres, depending on the load applied.

Side rails

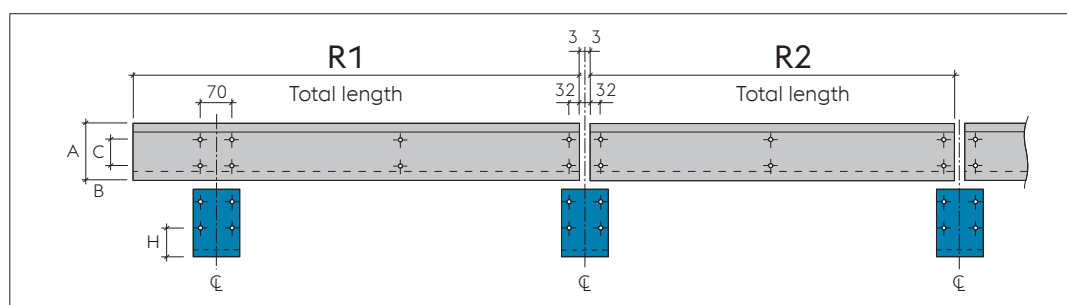


Fig. 82 – Design details of the BUTT side rail system of Z sections

Arrangement of side rails in the BUTT system

R1	R2	R2	R2	R1X
R1	R2	R2	R2	R1X
R1	R2	R2	R2	R1X
R1	R2	R2	R2	R1X
R1	R2	R2	R2	R1X
R1	R2	R2	R2	R1X
R1	R2	R2	R2	R1X

Fig. 83 – Arrangement of side rails in the BUTT system. The purlins can be made as oversailing or inset between the frames.

Tab. 28 – Positions of standard holes in the Z section web

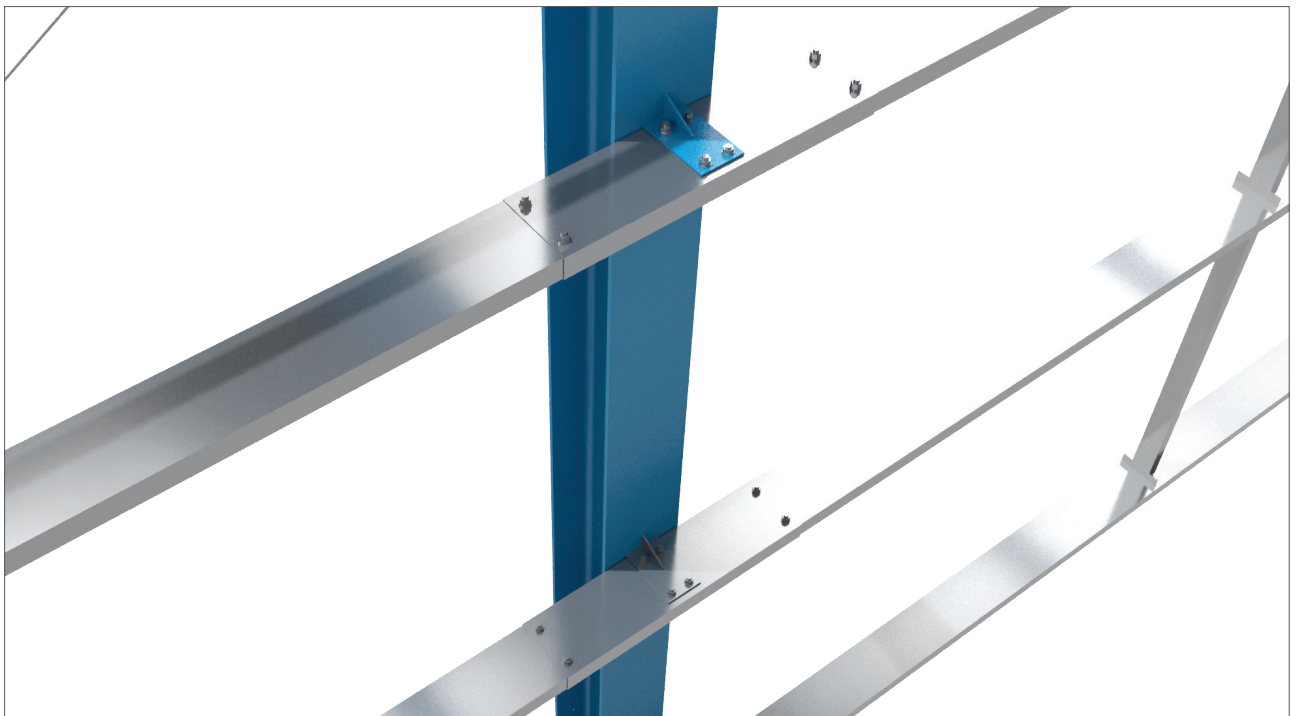
A	B	C	H
mm	mm	mm	mm
122	33	56	40
142	42	56	50
172	42	86	50
202	42	116	50
232	42	146	50
262	42	176	50
302	52	195	60
342	52	235	60
402	52	295	60

Side Rails / SLEEVED Construction System of C Sections

Structural Arrangement and Details

Static model of side rails	Continuous beam with sleeves
Maximum side rail span	13.00 metres
Minimum number of bays of the same span in one side rail row	2 bay
System design	Profilform DESIGNER computing software
Bolts required for connections to the primary structure and side rail interconnections	M16 in 8.8 grade
Requirements for reinforcing cladding	Max. spacing of connecting elements: 600 mm

Side rails



Arrangement of side rails in the single span BUTT system

Side rails in the single span configuration can be used for spans up to 13.00 metres and can have a total length of up to 15.50 metres. Sleeves are installed at each side rail joint on the penultimate columns and staggered on inner columns as shown in Figure 84.

R1	R4X	R4	R3	R1X
R1	R3	R4X	R4	R1X
R1	R4X	R4	R3	R1X
R1	R3	R4X	R4	R1X
R1	R4X	R4	R3	R1X
R1	R3	R4X	R4	R1X
R1	R4X	R4	R3	R1X

Fig. 84 – Arrangement of side rails in the single span SLEEVED system

The SLEEVED side rail system made of continuous beams is suitable for structures with at least two bays.

The beam continuity is achieved by sleeves of U sections optimising the bending moment. Sleeves are installed at each side rail joint on the penultimate columns and staggered on inner columns to form a system of continuous beams over two or three spans. The side rails are always fixed to the primary structure pillars by means of cleats. Cleat details are presented on page 86 of this manual.

This system can be used for spans of up to 13.00 metres, depending on the load applied.

Design Principles

- **System holes** in the section web are 18 mm in diameter and are intended for M16 bolts of the 8.8 grade.
- **Alternative holes for stabilising struts** – if systemic stabilising struts are to be used, the positions and diameter of these holes must be respected. If non-systemic struts are to be used, these holes can be made according to the designer's

requirements, provided they respect the principles specified on pages 18 a 19.

- **Non-system holes**, cutouts and service holes can be made according to the principles presented on pages 18 and 19.

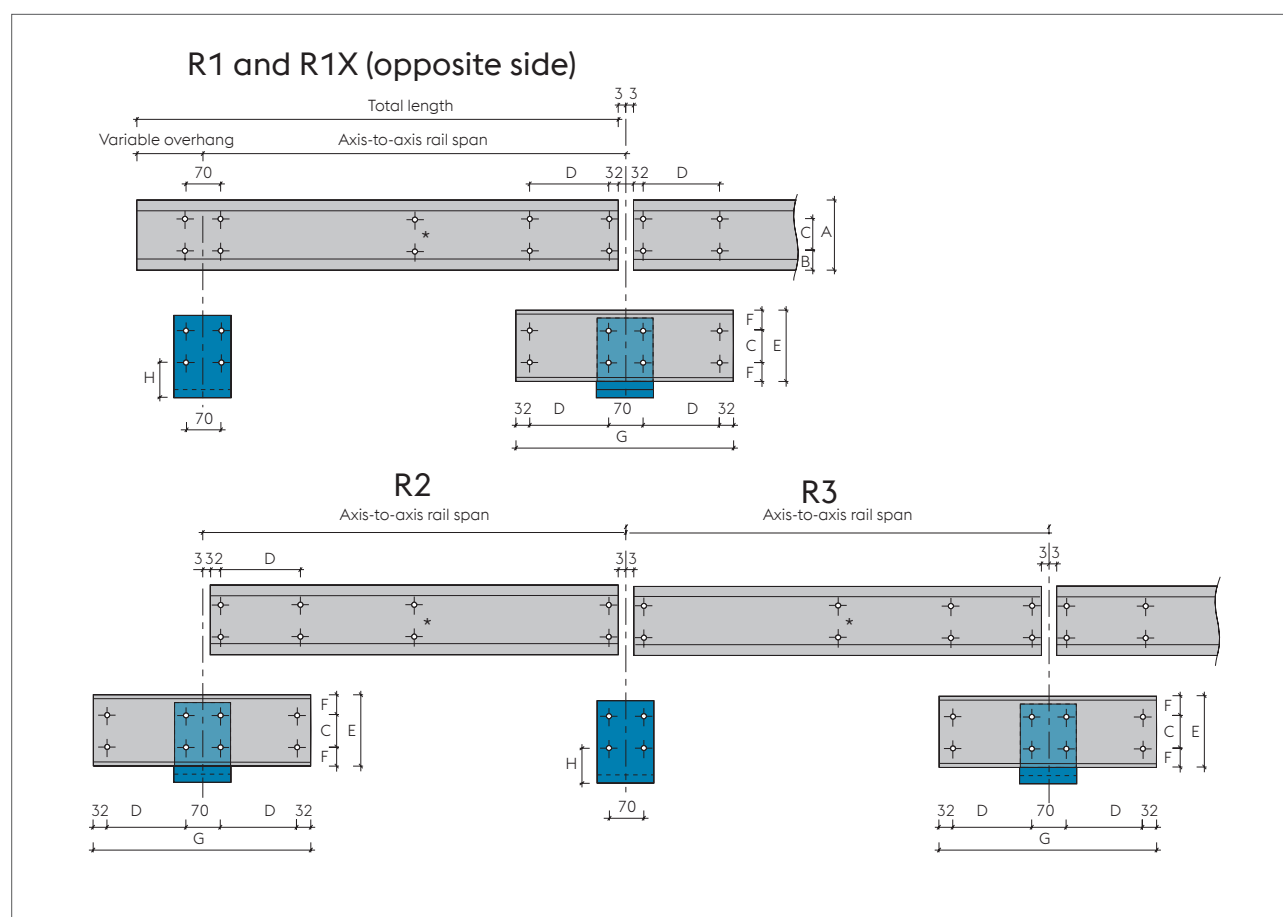


Fig. 85 – Design details of the SLEEVED side rail system of C sections

Tab. 29 – C section sleeves

Reference code	Thickness mm	Weight kg
CS 122	2.0	2.17
CS 142	2.0	2.64
CS 172	2.5	4.78
CS 202	2.7	5.46
CS 232	2.5	6.34
CS 262	2.9	9.55
CS 302	2.9	15.26
CS 342	3.0	20.81

The portfolio of C section sleeves features one material thickness for each section height.

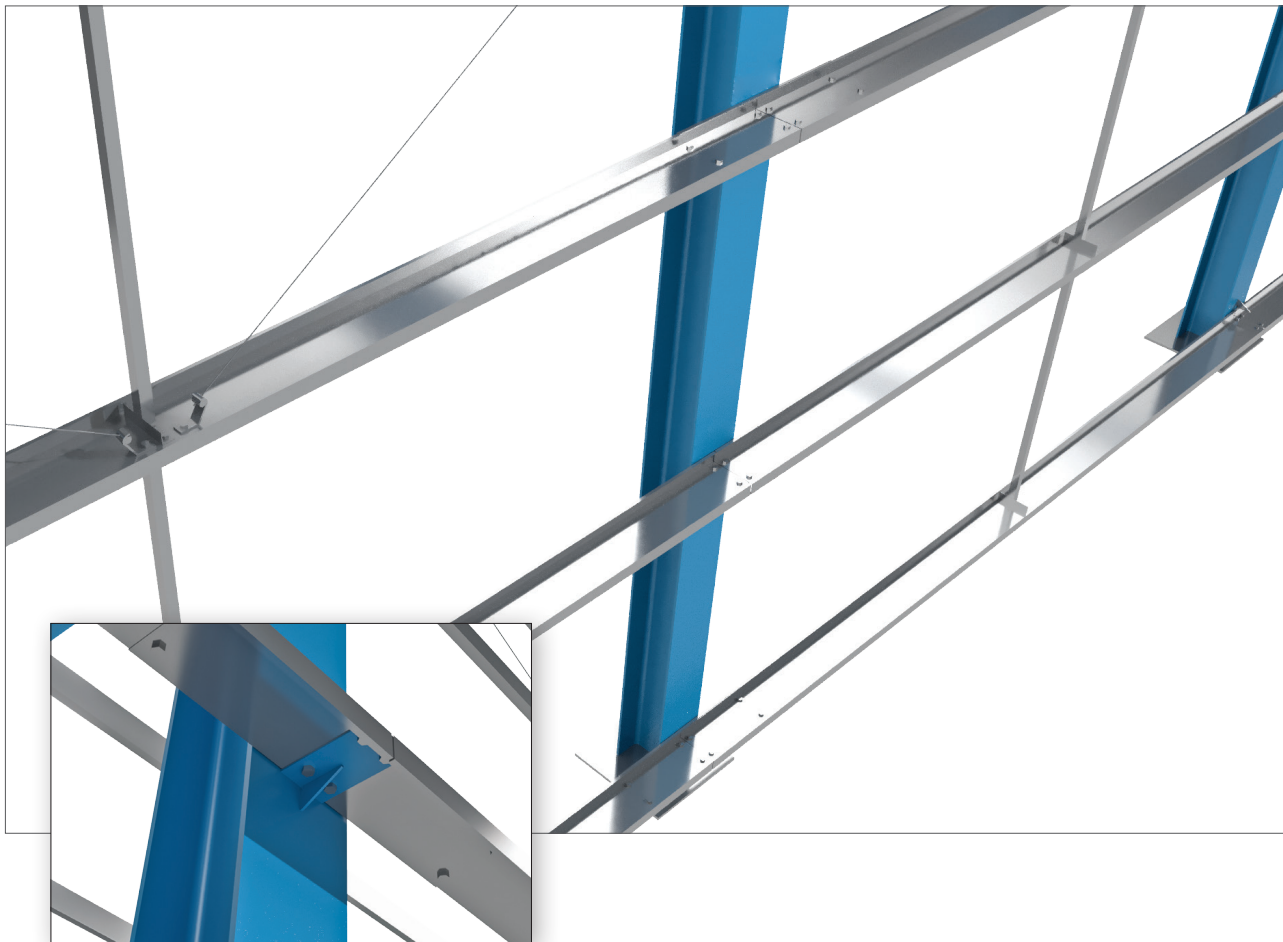
Tab. 30 – Positions of standard holes in the C section web

A	B	C	D	E	F	G	H
mm	mm	mm	mm	mm	mm	mm	mm
122	33	56	185	127	35.5	504	40
142	43	56	240	147	45.5	614	50
172	43	86	290	177	45.5	714	50
202	43	116	350	207	45.5	834	50
232	43	146	410	238	46.0	954	50
262	43	176	460	268	46.0	1054	50
302	53.5	195	610	308	56.5	1354	60
342	53.5	235	760	349	57.0	1654	60

Side Rails / SLEEVED Construction System of Z Sections

Structural Arrangement and Details

Side rails



Arrangement of side rails in the single span SLEEVED system

Side rails in the single span configuration can be used for spans up to 13.00 metres and can have a total length of up to 15.50 metres. Sleeves are installed at each side rail joint on the penultimate columns and staggered on inner columns as shown in Figure 86.

R1	R4	R4X	R3	R1X
R1	R3	R4	R4X	R1X
R1	R4	R4X	R3	R1X
R1	R3	R4	R4X	R1X
R1	R4	R4X	R3	R1X
R1	R3	R4	R4X	R1X
R1	R4	R4X	R3	R1X

Fig. 86 – Arrangement of side rails in the single span SLEEVED system

The SLEEVED side rail system made of continuous beams is suitable for structures with at least two bays.

Continuity is achieved by sleeves of Z sections optimising the bending moment. Sleeves are installed at each side rail joint on the penultimate columns and staggered on inner columns to form a system of continuous beams over two or three spans. The side rails are always fixed to the primary structure pillars by means of cleats. Cleat details are presented on page 86 of this catalogue.

This system can be used for spans of up to 13.00 metres, depending on the load applied.

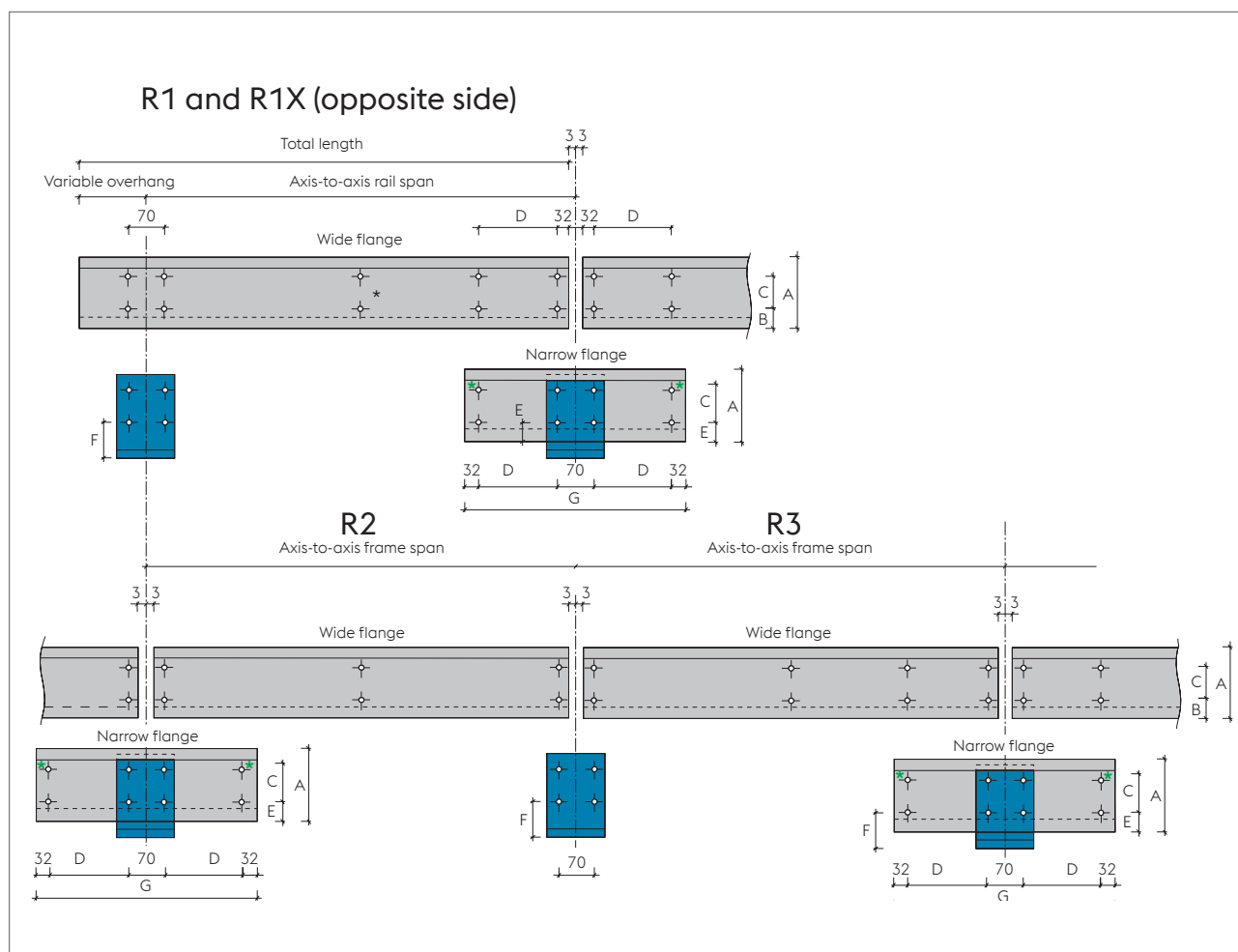


Fig. 87 – Design details of the SLEEVED side rail system of Z sections

Tab. 31 – Standard holes in the Z section web

A	B	C	D	E	F	G
mm	mm	mm	mm	mm	mm	mm
122	32	56	185	34	40	504
142	42	56	240	44	50	614
172	42	86	290	44	50	714
202	42	116	350	44	50	834
232	42	146	410	44	50	954
262	42	176	460	44	50	1054
302	52	195	610	55	60	1354
342	52	235	760	55	60	1654
402	52	295	1000	55	60	2134

Design Principles

- **System holes** in the section web are 18 mm in diameter and are intended for M16 bolts of the 8.8 grade.
- **The joints for sections 122-202** featuring sleeves can be made using just 6 bolts (* holes where no bolt is required). 8 bolts must always be used for joints of sections 232-402.
- **Alternative holes** for stabilising struts. If systemic stabilising struts are to be used, the positions and diameters of these holes must be respected. If non-systemic struts are to be used, these holes can be made according to the designer's requirements, provided they respect the principles specified on pages 14 and 15.
- **Non-system holes**, cutouts and service holes must be made according to the principles presented on pages 14 and 15.
- **The sleeves for Z sections** are of the same lengths as the sleeves for purlin systems.

Side Rails

Bracing and Supports

Struts and ties are frequently required to ensure the stiffness of the side rail systems. These struts and ties do not only provide the flatness of the side rail system, but also secure the loose section's flange against buckling under the wind suction load.

The METSEC systems offer several options for designing the side rail supporting and bracing systems to meet the required loading capacity.

Supports are recommended for all side rails spanning more than 6 m.

Shorter spans than 6 m must have supports if required by the stress analysis.

Temporary supports are recommended for spans of less than 6 metres during cladding installation to eliminate their vertical deflections from their own weight, even where supports are not designed.

Side rails



Side Rails

Arrangement of Side Rail Bracing and Supports

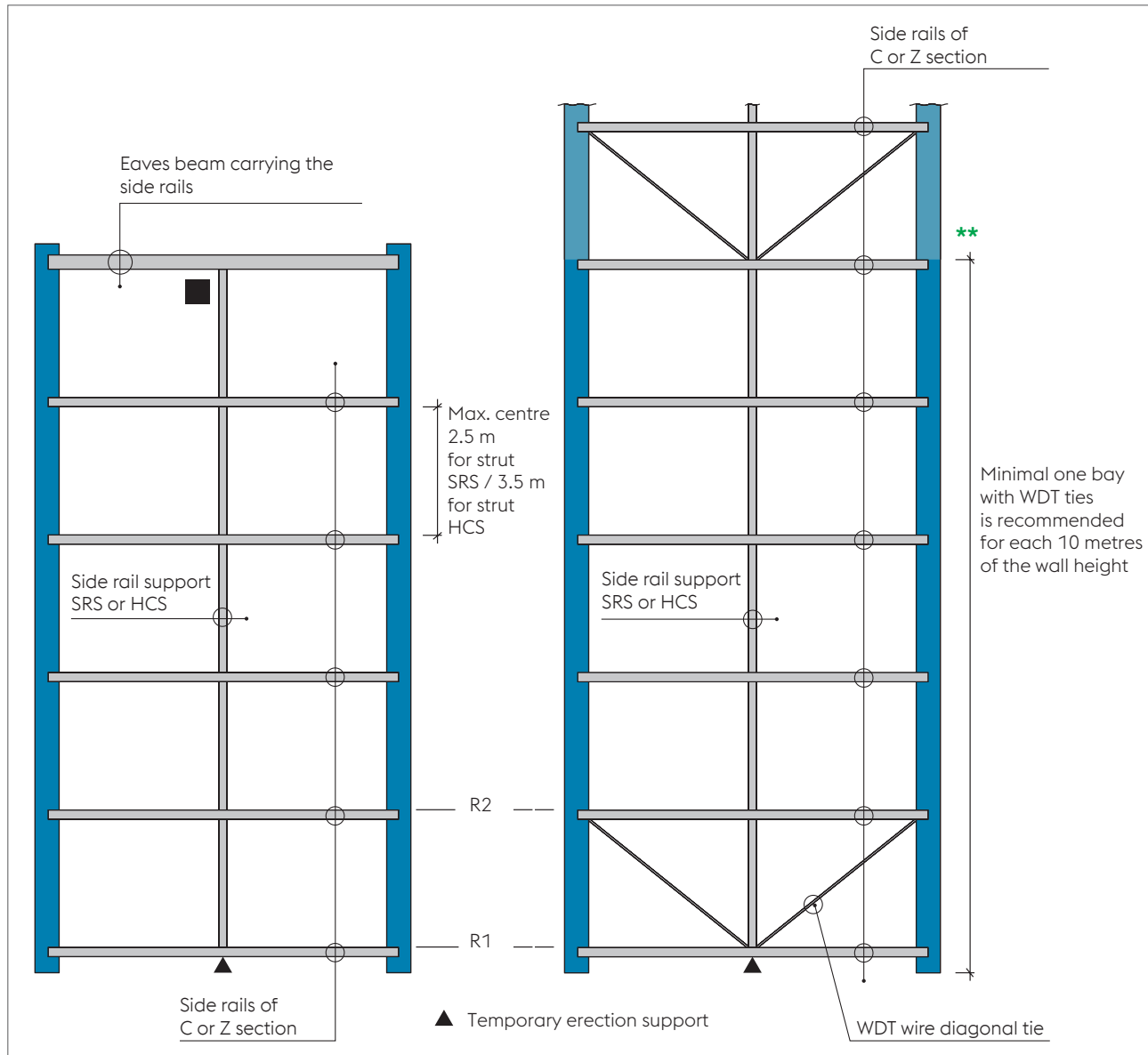


Fig. 88 – Layout of side rail supports for spans of 3.20 - 6.00 metres

The following Figures 88-93 show the basic recommended arrangements of the side rail supports depending on their span.

The side rails are supported predominantly by vertical supports (SRS) and diagonal ties (WDT). The supports mainly ensure their stiffness and eliminate their sagging during the cladding installation. The SRS/HCS supports also fix the loose section's flange of the side rails against buckling under the wind suction load if a non-restraining cladding is used, as it is the loose flange that is pressurised.

If side rails are combined with the eaves beam, they can be suspended from the eaves beam and diagonal ties can be eliminated in walls of up to 10.00 m of height. In the case of walls higher than 10 m, it is possible to combine the suspension from the eaves beam and diagonal ties.

If the WDT diagonal tie angle is smaller than 25°, more supports need to be used as indicated in Figure 89.

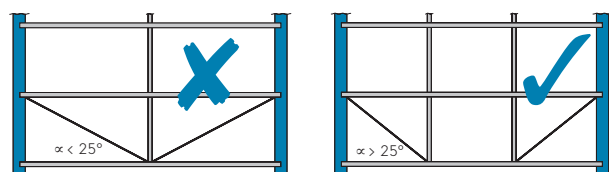


Fig. 89 – Arrangement of supports if the WDT angle is less than 25°

Side Rails

Arrangement of Side Rail Bracing and Supports

Side rails

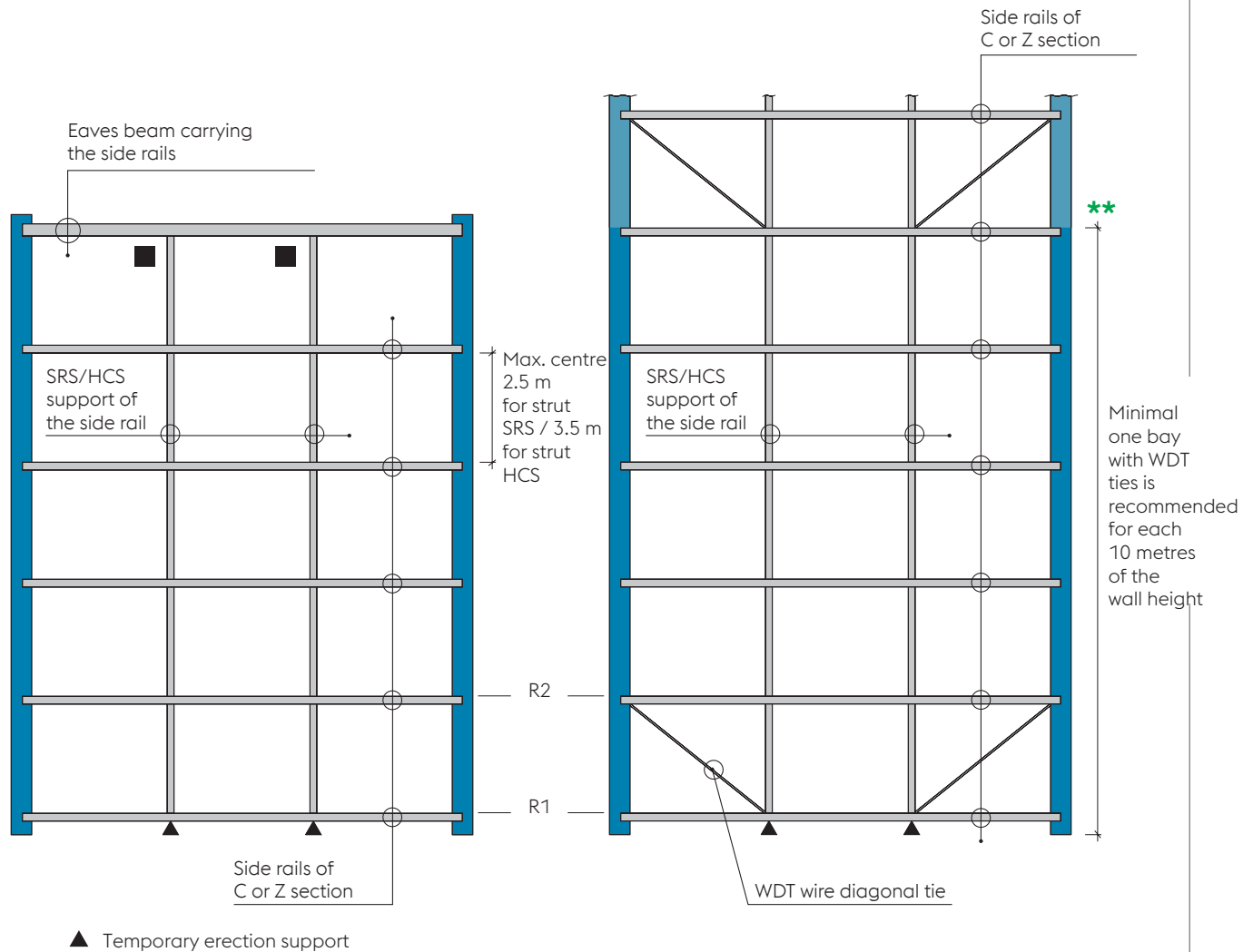


Fig. 90 – Layout of side rail supports for spans of 6.10 - 10.00 metres

If the WDT diagonal tie angle is smaller than 25° , more supports need to be used as indicated in Figure 91.

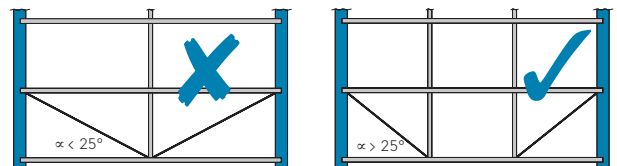


Fig. 91 – Arrangement of supports if the WDT angle is less than 25°

Side Rails

Arrangement of Side Rail Bracing and Supports

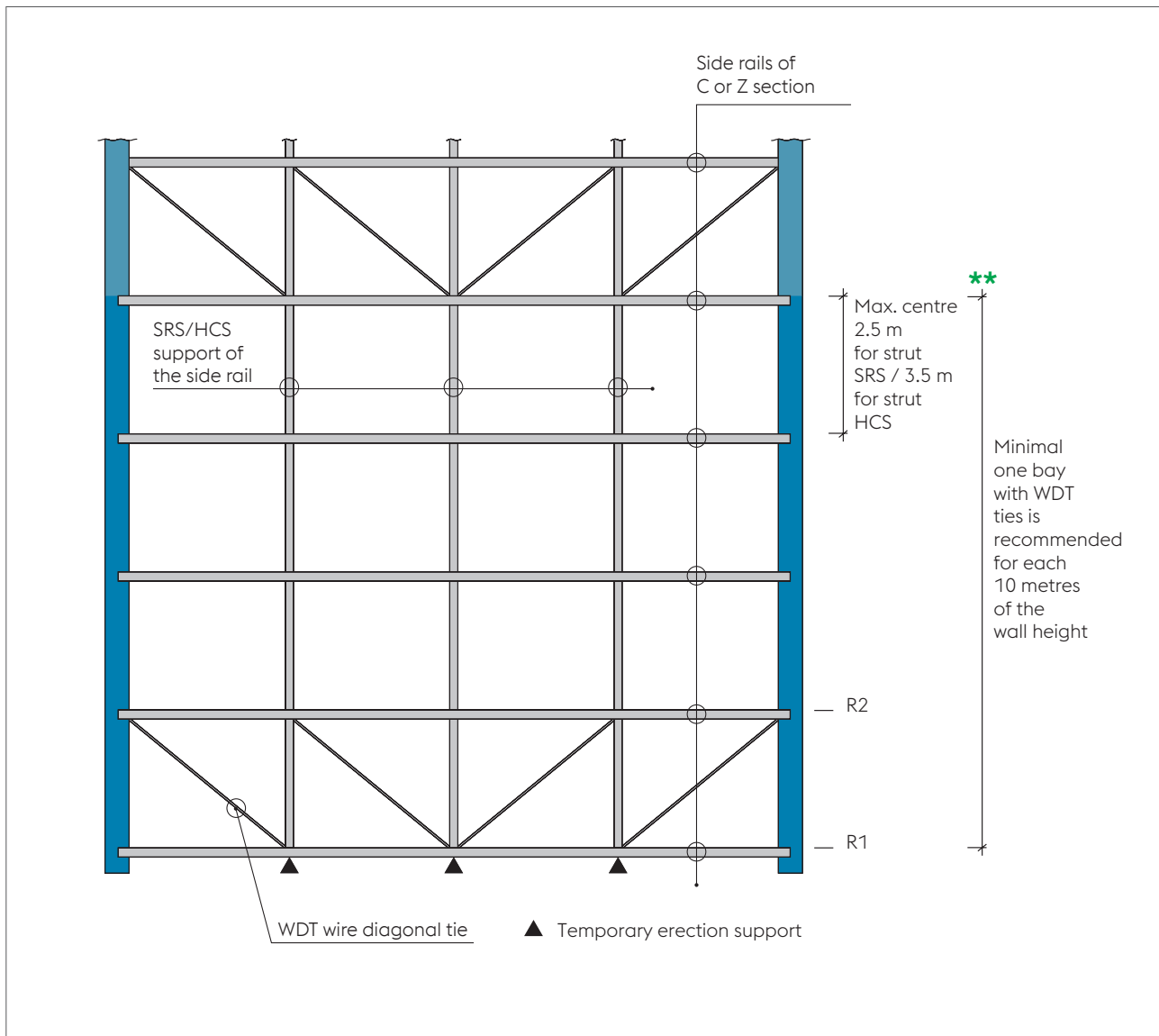


Fig. 92 – Layout of side rails for spans of 10.10 - 13.00 metres

If the WDT diagonal tie angle is smaller than 25° , more supports need to be used as indicated in Figure 93.

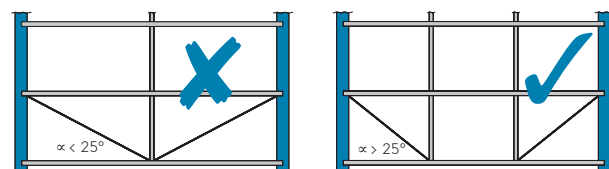


Fig. 93 – Arrangement of supports if the WDT angle is less than 25°

Side Rails

Bracing and Supports – Design Details

The side rail accessories include their supporting components, especially SRS/HCS supports, WDT diagonal ties and various connecting and fixing angle pieces. The side rail accessories are usually compatible with purlins and eaves beams.

SRS/HCS for vertical supporting and bracing of side rails.

The SRS supports have been designed for sections 122-262; up to a maximum length of 2.5 metres. The supports are made of an 45×45×2 angle. Individual components of the SRS support are riveted together.

The HCS supports have been designed for sections 302-262 up to a maximum length of 4.00 metres. They are made of 100F13 (central component) and 45×45×2 (end braces) sections. Individual components are riveted together.

Both of these supports are bolted to the side rails with M16 bolts.

Side rails

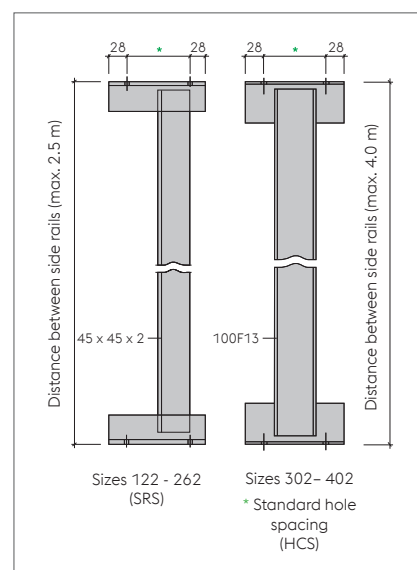
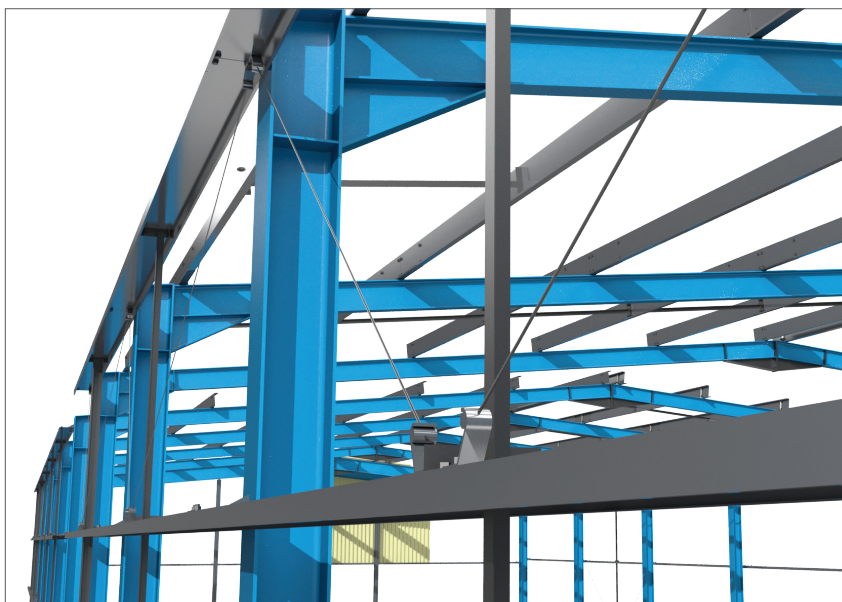


Fig. 94 – SRS/HCS supports of side rails

WDT diagonal ties for supporting and bracing of side rails.

The tie consists of a steel cable of 5 mm in diameter, equipped with terminal brackets for connecting to the side rails. One end of the cable is adapted for rectification.

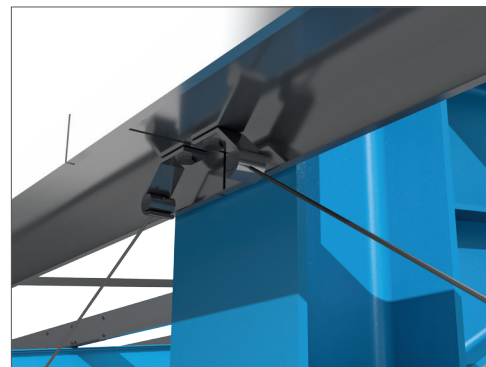


Fig. 95 – Detail of the diagonal tie terminal bracket featuring an oval hole for opening for variable tie sloping between 25° and 65°

Side Rails

Bracing and Supports – Design Details

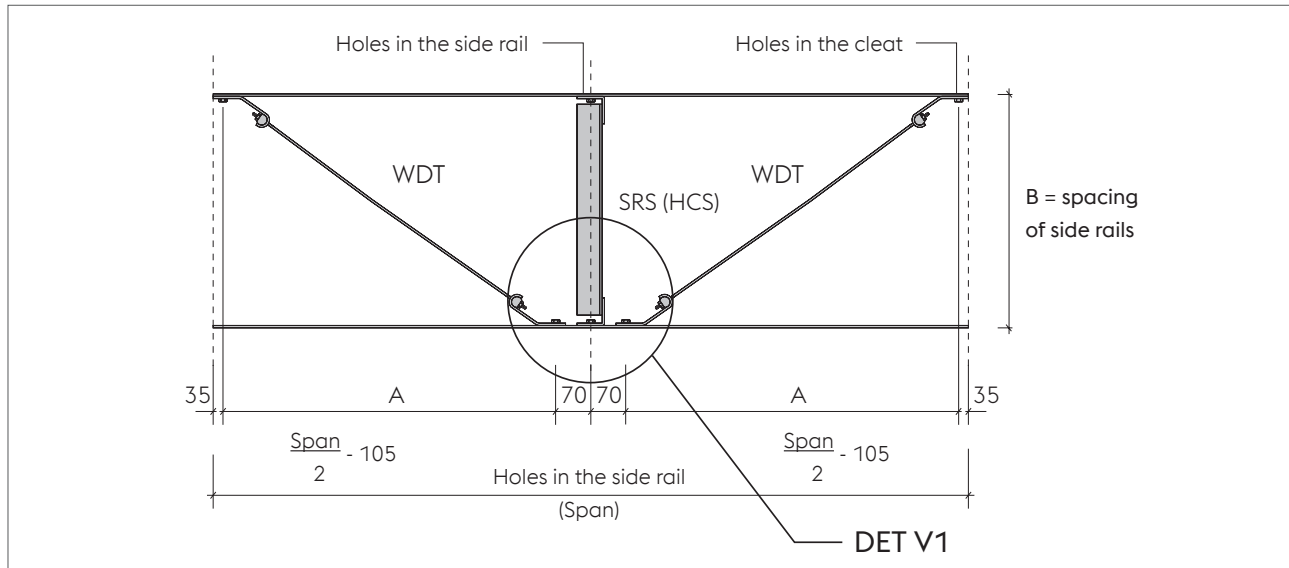
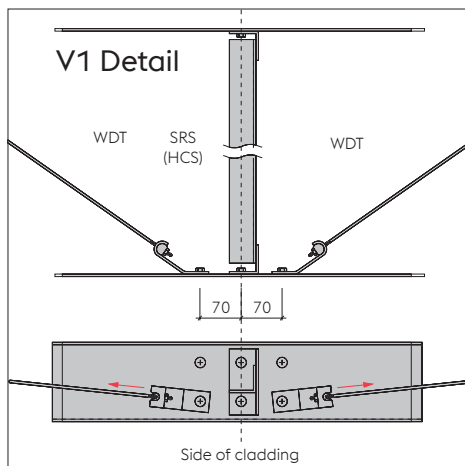


Fig. 96 – Joint detail of side rail supports for spans of 3.20 - 6.00 metres



Legend:

SRS / HCS = side rail supports
WDT = diagonal tie

- Direction of the tie fastening – bolt in the cleat on the side of cladding
- Direction of the tie fastening – bolt in the cleat on the side of the column



Side Rails

Bracing and Supports – Design Details

Structural Details

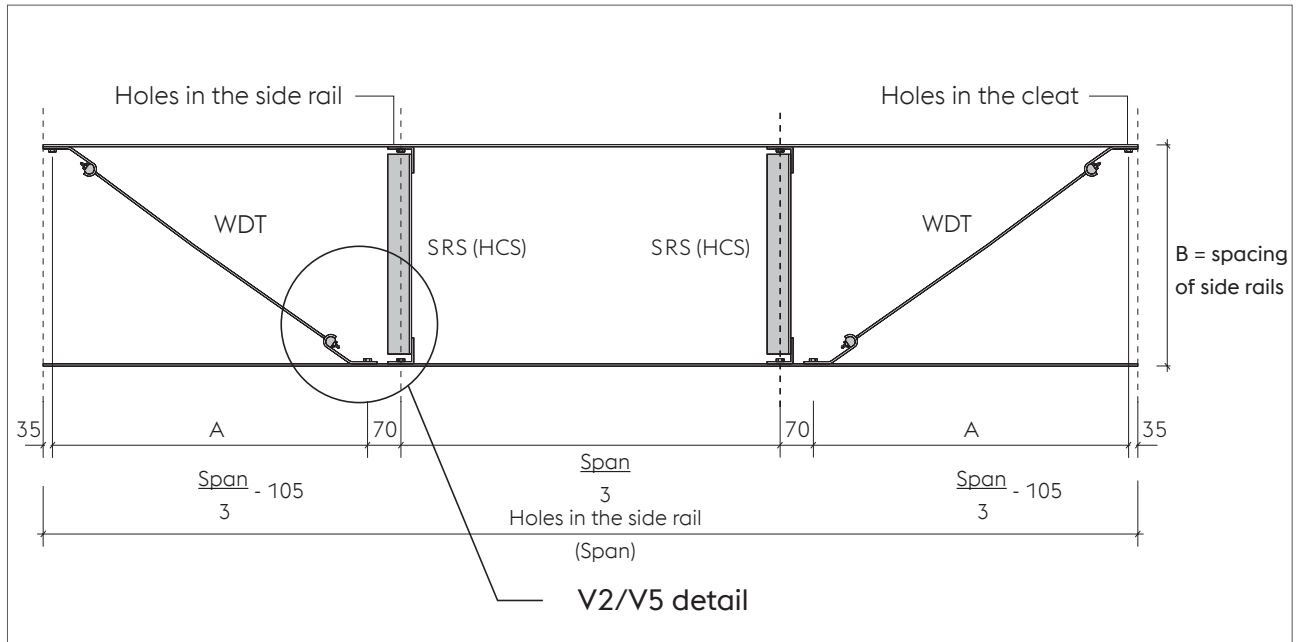
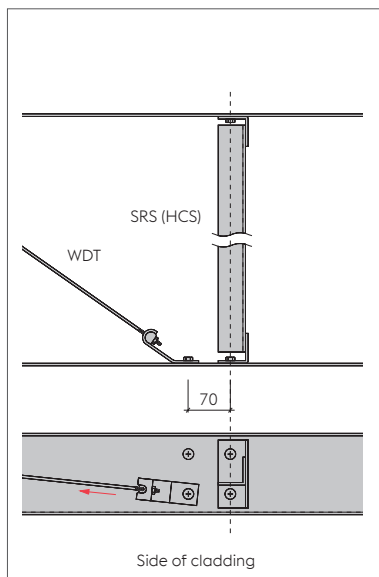


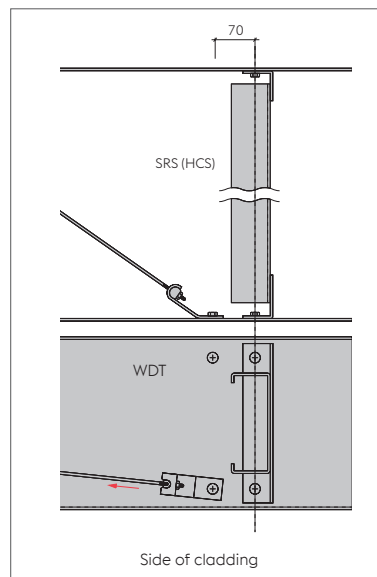
Fig. 97 – Joint detail of side rail supports for spans of 6.10 - 10.00 metres

Side rails

V2 Detail



V5 Detail - sizes 302 and 342



Legend:

SRS / HCS = side rail supports
WDT = diagonal tie

- Direction of the tie fastening – bolt in the cleat on the side of cladding
- Direction of the tie fastening – bolt in the cleat on the side of the column

Side Rails

Bracing and Supports – Design Details

Structural Details

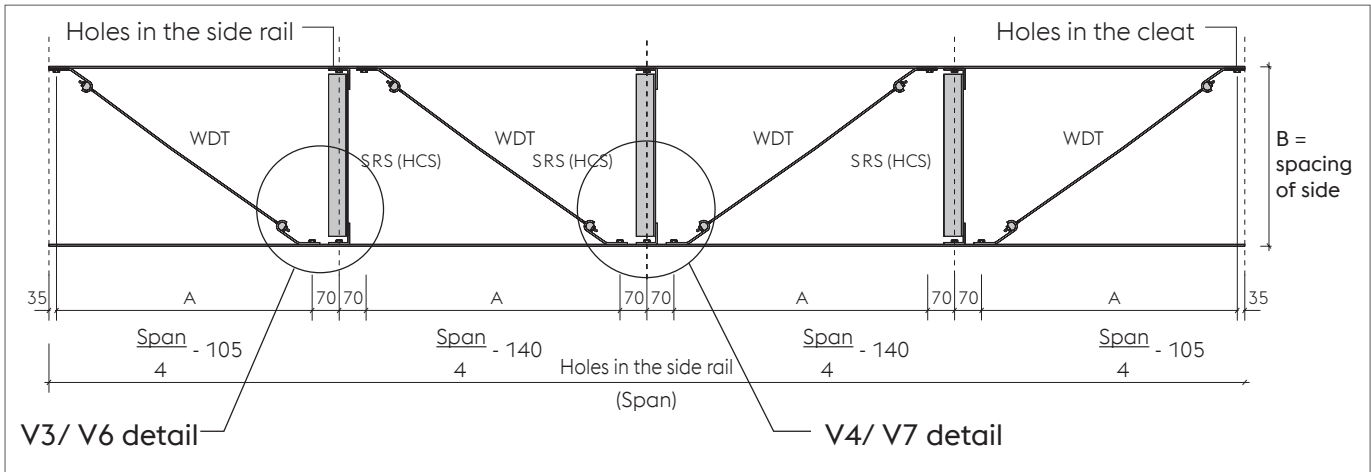
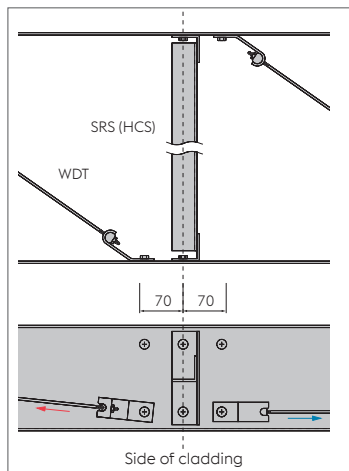
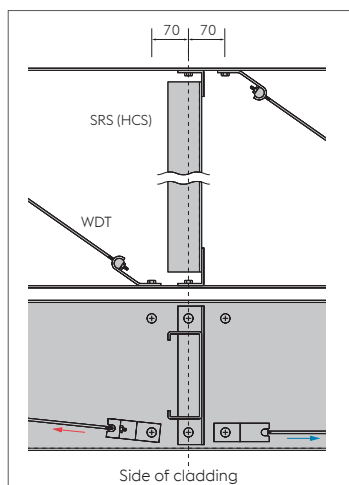


Fig. 98 – Joint detail of side rail supports for spans 10.6 - 13.00 metres

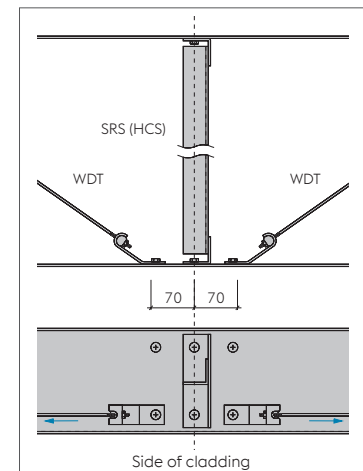
V3 Detail



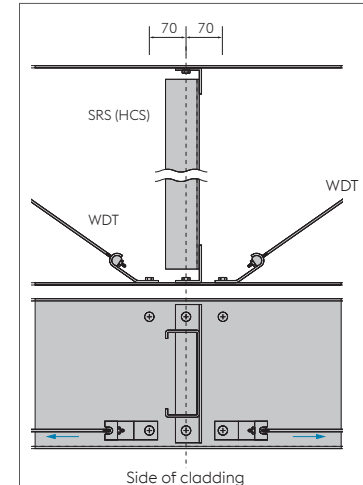
V6 Detail - sizes 302 and 342



V4 Detail



V7 Detail - sizes 302 and 342




Side rails

Legend:

SRS / HCS = side rail supports
WDT = diagonal tie

← Direction of the tie fastening
– bolt in the cleat on the side
of cladding

 Direction of the tie fastening – bolt in the cleat on the side of the column

Side Rails

Wall Restraints for Windows and Doors

When designing walls with windows and doors, proper bracing of the side rails needs to be considered to eliminate their undesirable sagging.

This can be done in several ways:

- The cladding is not supported by a plinth or by brickwork – the side rails will be braced only by their supports (SRS or HCS) and diagonal ties (WDT). It is recommended to install at least one row of braces (supports and ties) for each window band.

- The cladding is resting on a plinth or on brickwork – the bottom window band can be braced only by means of supports. If there are several window bands above each other, it is recommended to use bracing consisting of supports and diagonal ties for each additional band.

An example of a layout of a wall with windows is shown in Figure 99.

Side rails

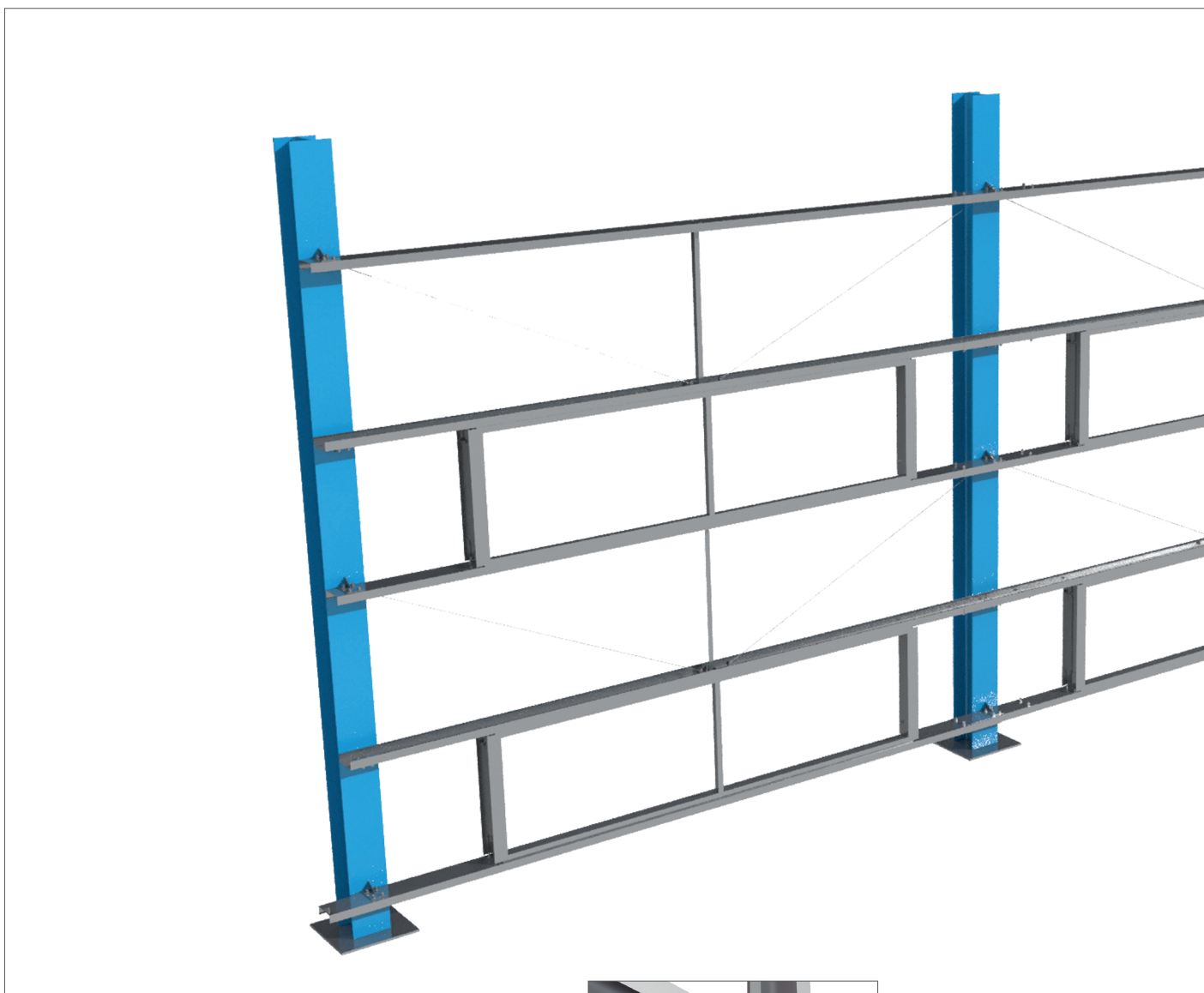
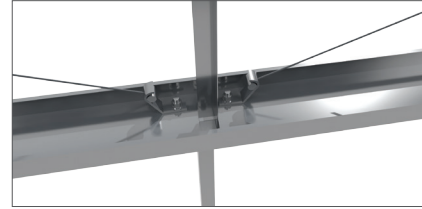
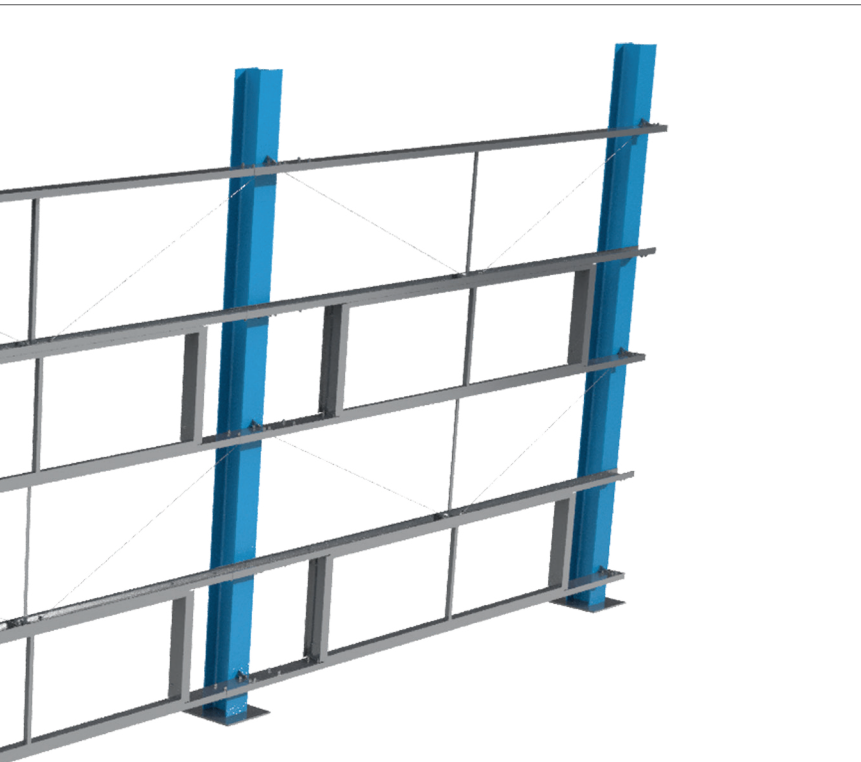


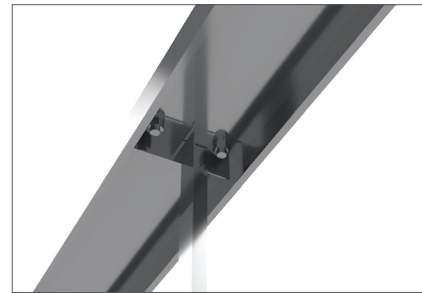
Fig. 99 – Wall with side rails and restraining frames for windows



Fig. 100 – Detail of the side rail connection to the window (door) framing section and the skirting section connection to the floor bay means of a connecting angle piece. A standard TC angle piece can be used for this joint.



101 – Detail of an SRS support and two diagonal ties. The support and both rods are each fixed through a separate hole for easier assembly. Holes can be punched in pairs or individually. It is recommended to make the holes in pairs – then the side rail orientation does not have to be considered.



102 - Detail of bracing using an SRS support

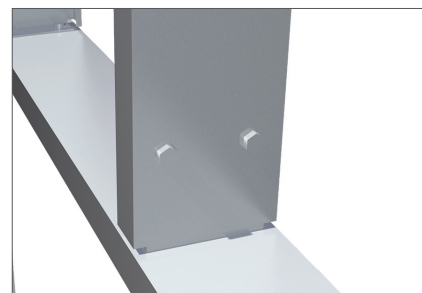


Fig. 103 – Detail of a window framing made of a C section of the same height as the side rail section. The framing section is connected to the side rail through an angle piece (TC). Holes in the framing section can be made as standard or counterformed. If counterformed holes are used, a PP packing plate is required. If straight holes are used the size of the window opening needs to be enlarged by the size of the bolt heads.

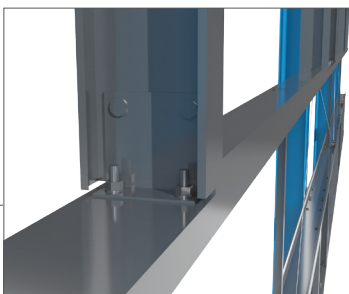


Fig. 105 – Detail of the window framing section connection by means of a connecting angle piece (TC). The same rules apply to the framing of door openings as for the window ones.

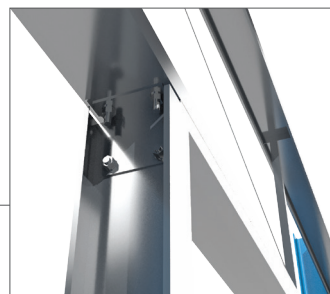


Fig. 104 – Detail of the window framing section connection by means of a connecting angle (TC).

Side Rails

Bracing and Supports of Side Rails carrying Heavy Cladding

Alternative 1 – cladding own weight over 15 kg/m², not supported by an autonomous supporting structure (plinth, concrete foundation, etc.).

Number of diagonal tie rows = $\frac{\text{cladding weight}}{15}$ = Number of tie rows for a 10 m high wall

Round the calculated ratio down to get the required number of rows of WDT diagonal ties.

Side rails

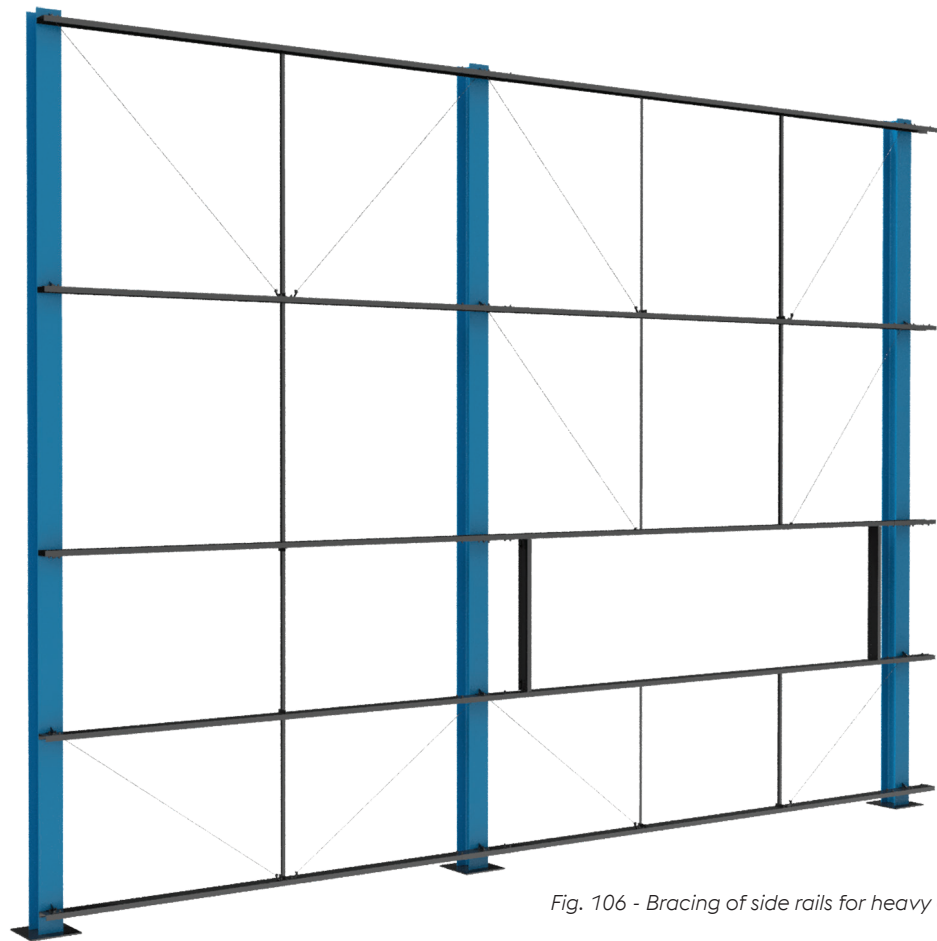
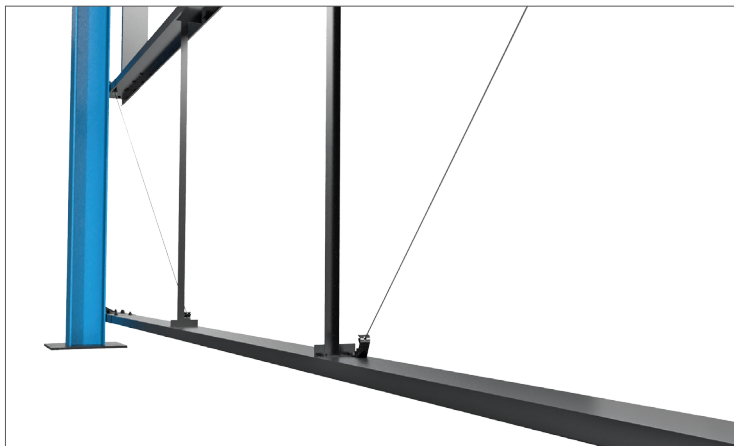


Fig. 106 - Bracing of side rails for heavy cladding



In the case of specific designs, consideration must be given to

- WD tie load bearing capacity = 10 kN (design value).
- The minimum number of supports according to the rules on pages 67-69.

The number of ties is generally prescribed for every started 10 metres of wall height.

Alternative 2 – cladding own weight over 15 kg/m², supported by an autonomous supporting structure (plinth, concrete foundation, etc.).

The wall does not feature windows or other openings = no need for WDT diagonal ties, the structure is fully resting on an separate supporting construction.

The wall features windows or other openings = it is necessary to support the side rails above them.

Number of diagonal tie rows = $\frac{\text{cladding weight}}{15}$ = Number of tie rows for a 10 m high wall.

Round the calculated ratio down to get the required number of rows of WDT diagonal ties.

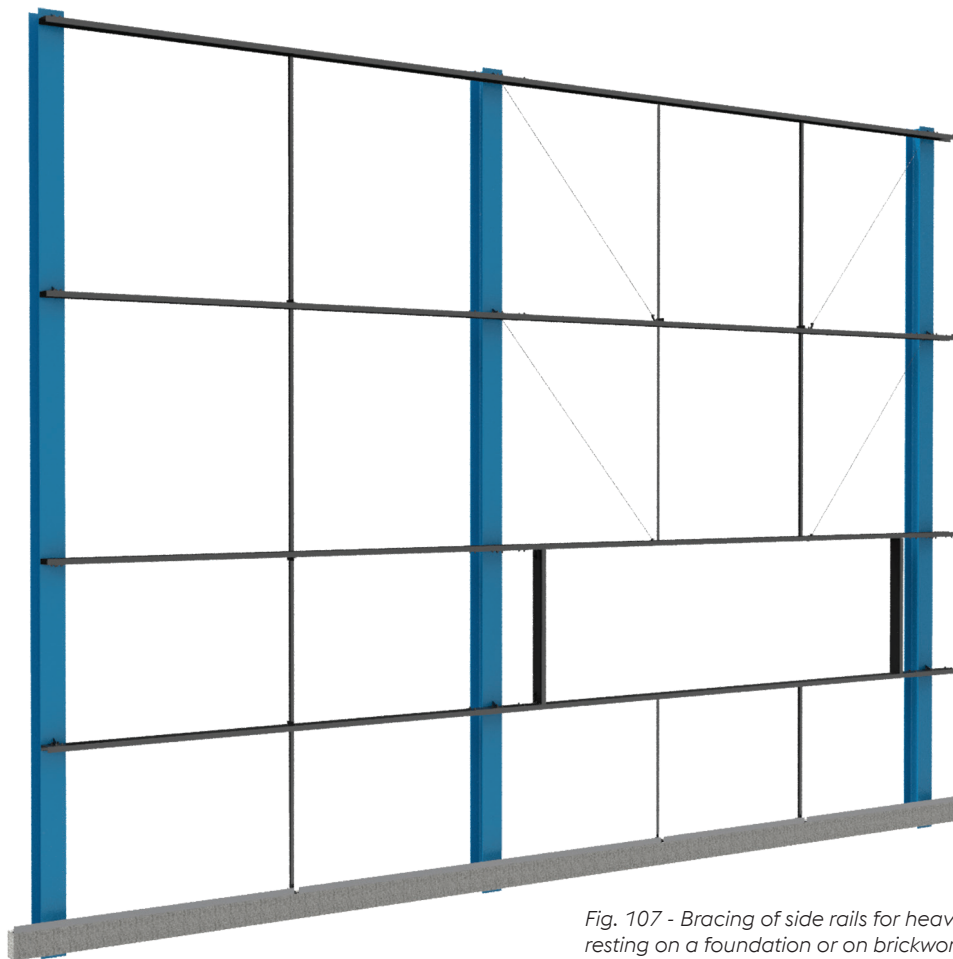
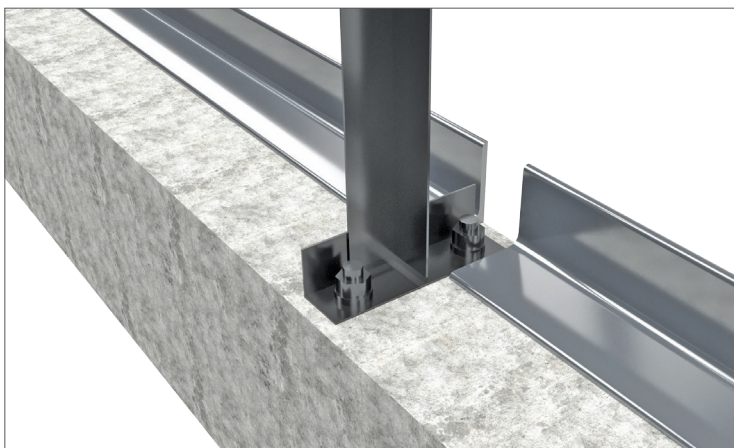


Fig. 107 - Bracing of side rails for heavy cladding resting on a foundation or on brickwork

Side rails



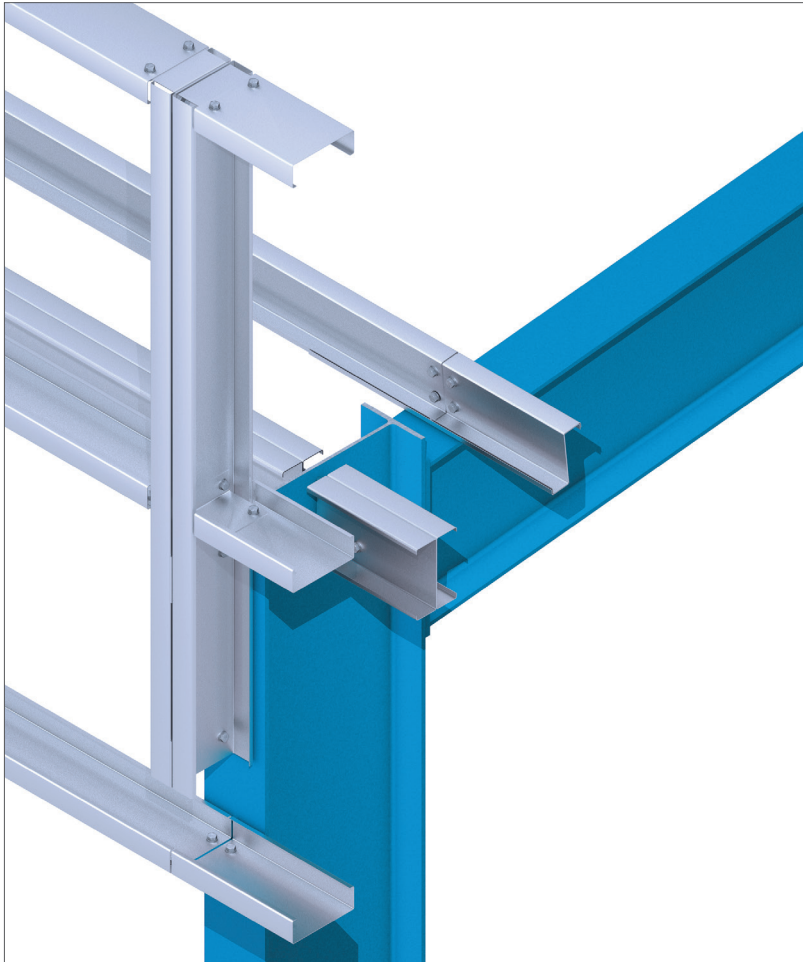
In the case of specific designs, consideration must be given to

- WD tie load bearing capacity = 10 kN (design value).
- The minimum number of supports according to the rules on pages 67-69.

The number of ties is generally prescribed for every started 10 meters of wall height.

Parapet of Z and C sections

Side rails



Parapet posts can be made of two C sections combined into a composite element including fixing angle pieces.

Sections can be supplied as separate components to be assembled before the installation in the construction.

Parapet posts made of C sections offer an economical solution compared to traditional sections.

The parapet posts are attached directly to the columns of the prime structure, with a 8 mm offset from the column's face (using the same section height as for the side rails). If the side rails and the parapet posts use different sections, this offset from the column needs to be adjusted so that the outer edges of the rails and posts flush.

All parapet side rails can be attached to the parapet posts by standard cleats fixed to the posts before connecting to the structure.

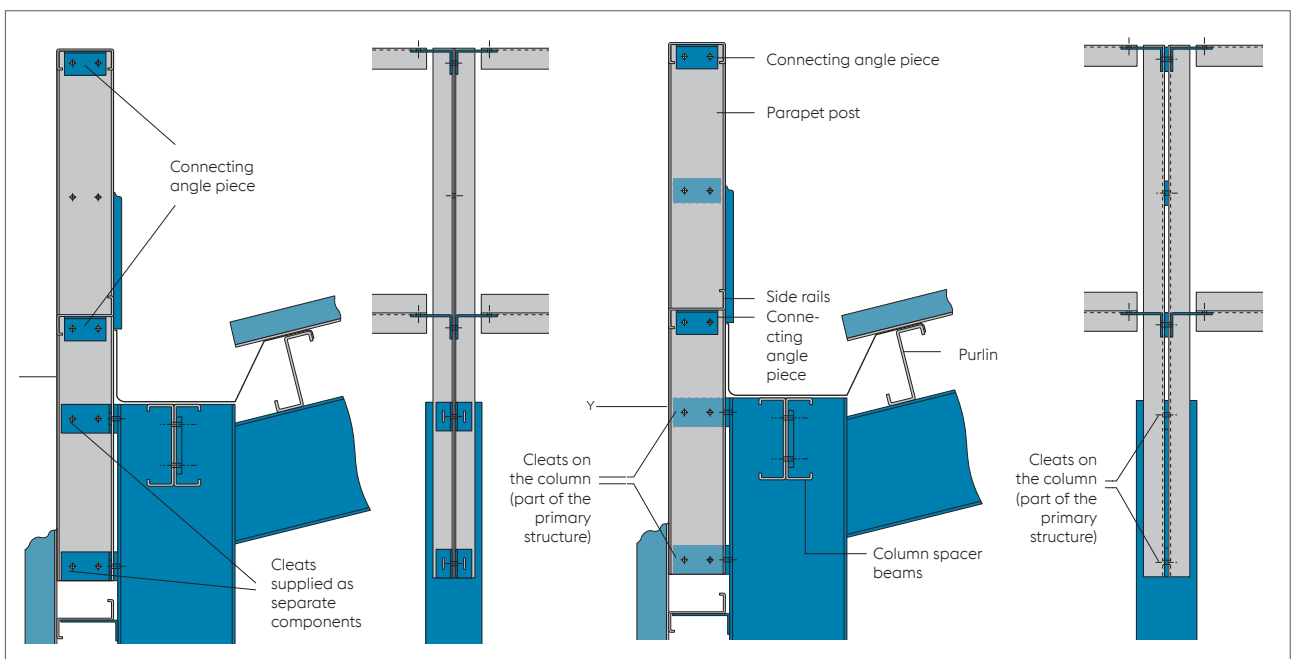


Fig. 108 – Details of a parapet made of C and Z sections



Side rails

Window / Skylight Trimmers for Concrete Frames

Structural Arrangement and Details

METSEC system sections can also be used for secondary steel structures within concrete frames, mainly as window trimmers in the walls or skylight trimmers in the roof cladding.

Similarly to other secondary constructions, trimmers must be calculated as to their stress analysis and manufacturing documentation is required for their production. When designing longitudinal components of window trimmers, their

bearing capacity must be considered. If the stress analysis of these components results in a requirement for sections of material thinner than 2 mm, it is recommended to always go for a thickness of at least 2.00 mm.

The wall cladding must always be attached to these longitudinal members with self-tapping screws with a pitch of up to 600 mm.

Side rails

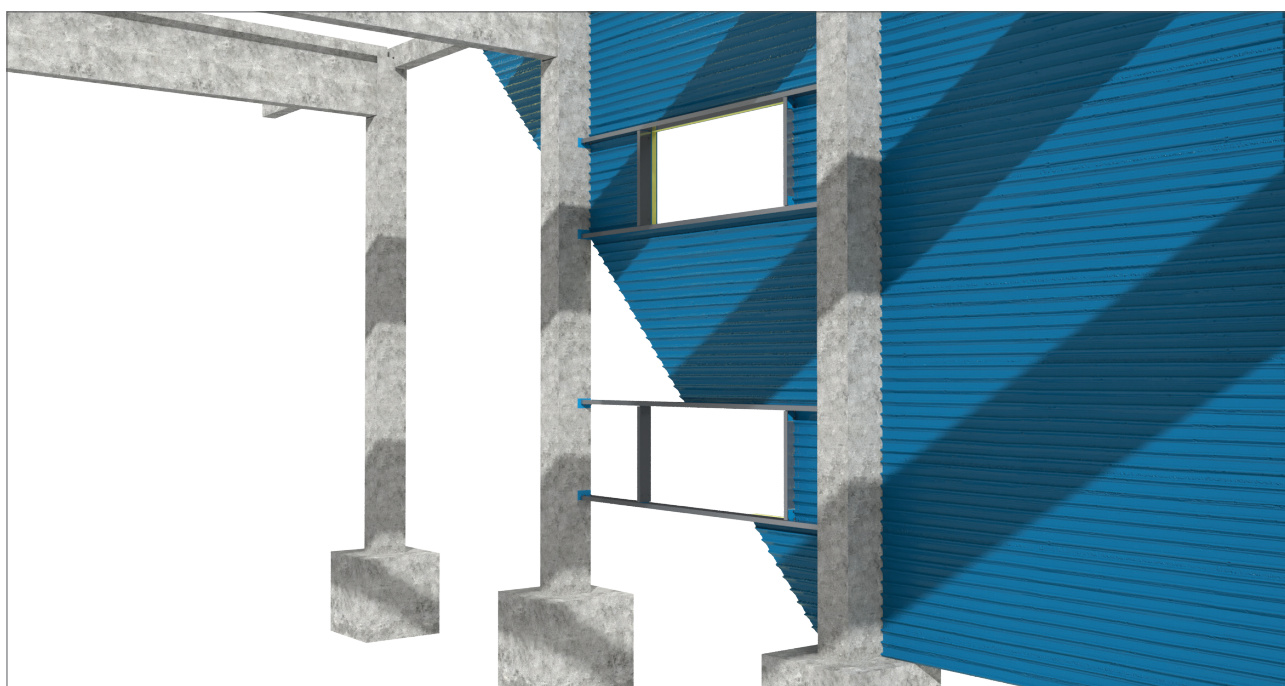


Fig. 109 – Window trimmers in concrete frames

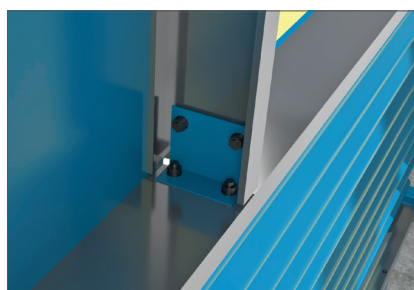


Fig. 110 – Detail of the connection of trimmer components. The joint is bolted through a TC angle piece. Alternatively, the holes in the vertical member can be made as counterformed, in which case a PP packing plate is required.

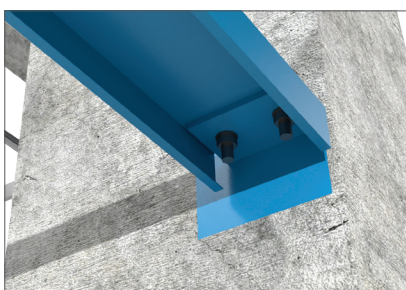


Fig. 111 – Detail of the longitudinal trimmer connection to a concrete element by means of an angle piece welded to a steel plate located in the concrete element

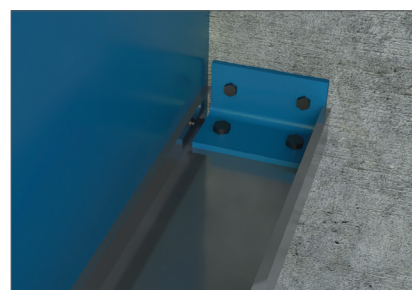


Fig. 112 – Detail of the longitudinal trimmer connection to a concrete element by means of an angle piece, which is fixed by bolts (chemical anchors or dowels)

The section size for skylight trimmers must always be based on a stress analysis, there is no recommendation as to the minimum section thickness, as in the case of window trimmers. The interim transverse beams can be made of thinner sections than the main trimmer beams to achieve a more economical design.

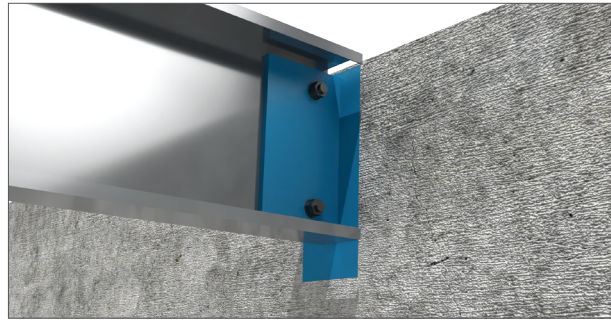


Fig. 113 – Detail of the longitudinal trimmer connection to a concrete element by means of an angle piece welded to a steel plate located in the concrete element

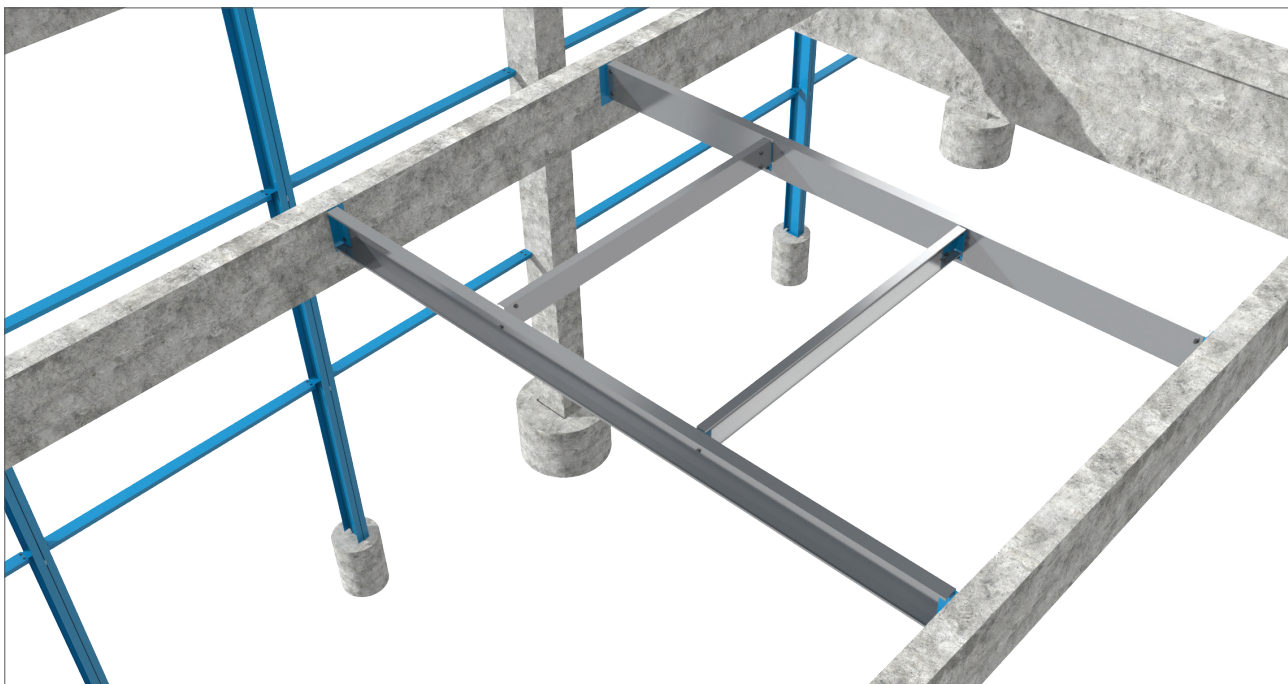


Fig. 114 – Skylight trimmers for concrete frames

Side rails

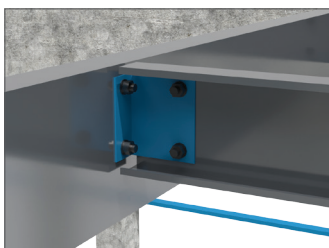


Fig. 115 – Detail of the connection of trimmer components. The joint is bolted through a TC angle piece.

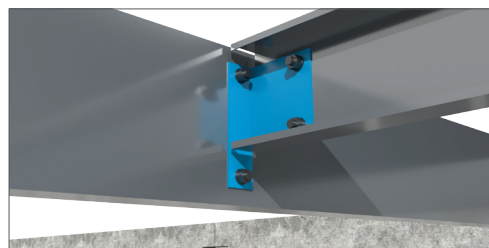


Fig. 116 – Detail of the connection of trimmer components. The joint is bolted through an atypical angle piece. The cross member is made of a lower section than the main trimmer beam. Holes in the trimmer main beam are punched along the standard reference axes, but an atypical connecting angle piece must be used. Should the cross member be connected through a standard TC angle piece, the holes in the trimmer main beam need to be made as non-standard.

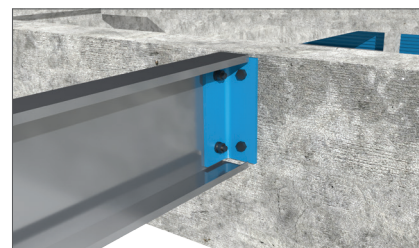


Fig. 117 – Detail of the longitudinal trimmer connection to a concrete element by means of an angle piece, which is fixed by bolts (chemical anchors or dowels)

Gable Columns, Interior Columns and Columns for Sheathing

Please contact our technical department for the design of gable wall columns.

The gable columns are designed from a compound dual C section in which both C sections are turned back-to-back – see Figure 120. The use of gable columns described in this chapter is conditioned by the use of side rails. The rules for designing columns without side rails are presented on pages 84 and 85.

Side rails

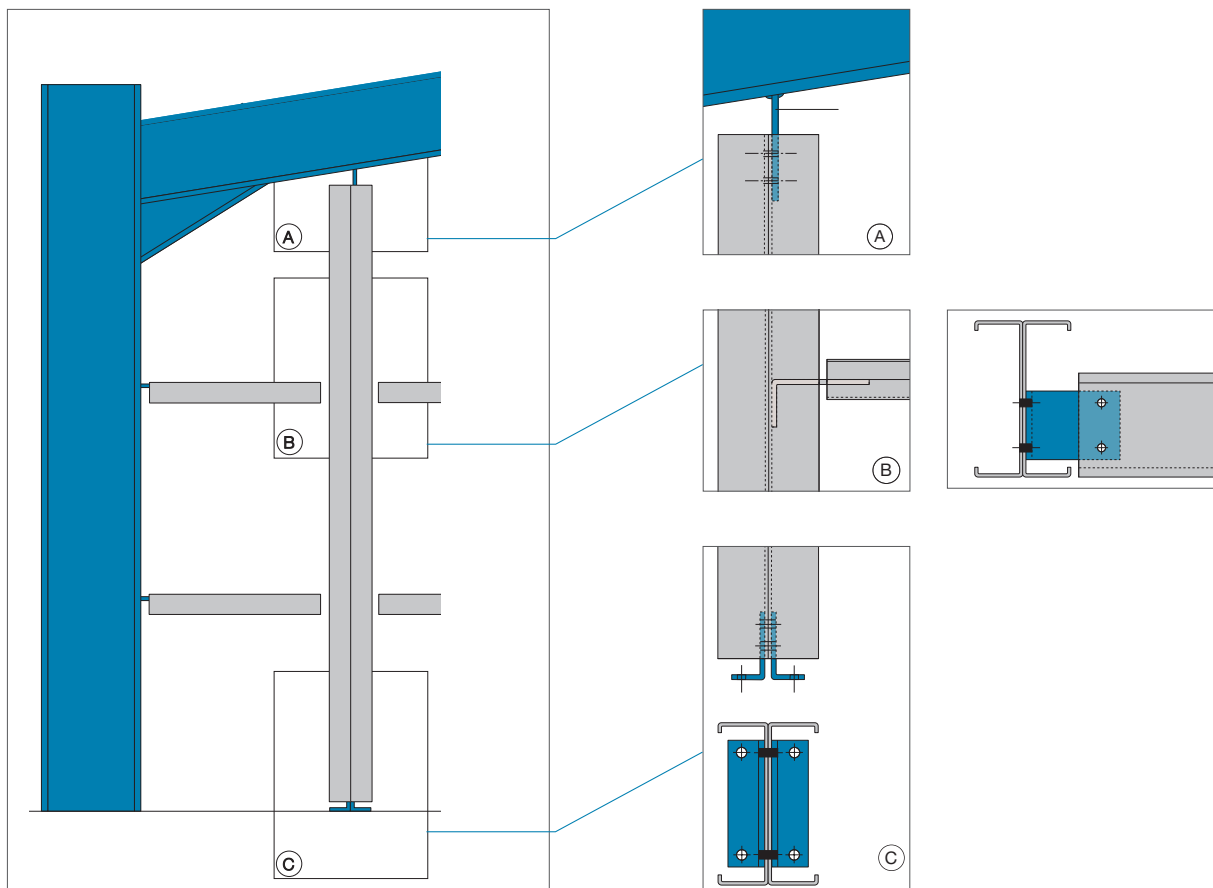


Fig. 118 – Gable wall columns

The combined section of the gable wall column is made up of two mutually bolted C sections. The number of these bolts is determined by a stress analysis. The bolts are located along standard reference axes. Washers are required under both the bolt head and the nut.

Column anchoring

The columns must be adequately attached to the primary structure at the bottom and the top in a way consistent with the stress analysis.

The end joints use 2 or 4 bolts in located on the standard reference axes on the web.

The cleats that are part of the gantry beam must be designed to withstand the required load. Stays may also be required - their necessity and details for their use will be determined by a stress analysis.

All the joints will be made using M16 bolts of the 8.8 grade complete with washers.

The calculated bolt bearing capacity will be achieved by using washers under the head and the nut in the section connections to the primary structure.

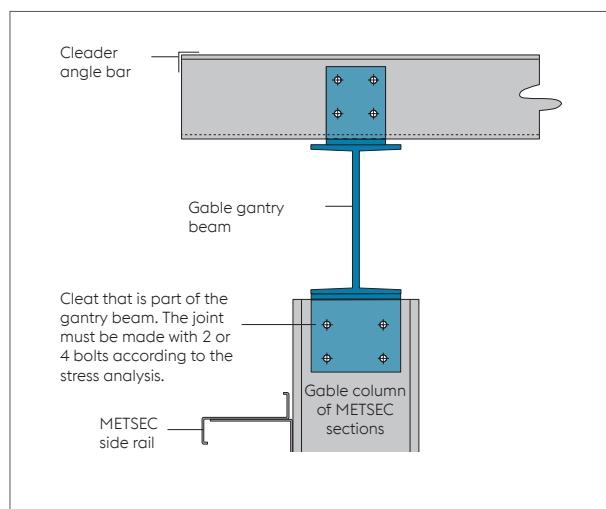


Fig. 119 – Gable column of C sections



Side rails

Gable, Perimeter and Internal Columns in Concrete Frames

Structural Arrangement and Details

The METSEC construction systems include a solution for interim columns for cladding of mostly concrete frames of hall-type structures.

Interim columns are made of two C sections of identical dimensions positioned back-to-back. The sections are bolted together by a pair of M16 bolts running through liners of the same thickness as angle pieces by means of which connections are made to the primary structure and the foundation. An liner must be used in each joint where a bracing element is connected to the column to ensure the stability of the column section. The pitch of the bolt interconnections of the sections forming the column must not exceed 3.00 metres.

Members ensuring the column stability can be made of C or Z sections. They are connected to the columns via the TC angle pieces and M16 bolts. The number and cross section of the stabilising members is determined by the stress analysis of the column.

The maximum recommended column height is 13.00 metres. The maximum recommended column spacing is 8 metres. If the column spacing is greater than 6.00 m, it is recommended to add stabilising members made of dual C sections. The dimensions of the stabilising members are shown in Table 24.

The entire range of C sections and their accessories listed in this manual can be used for cladding columns.

Tab. 32 – Recommended dimensions of stabilising members for cladding columns

COLUMN SECTION	RECOMMENDED STABILISING SECTION
2x /122Cxx	C/Z 122
2x /142Cxx	C/Z 122
2x /172Cxx	C/Z 122
2x /202Cxx	C/Z 142
2x /232Cxx	C/Z 172
2x /262Cxx	C/Z 202
2x /302Cxx	C/Z 232
2x /342Cxx	C/Z 262
2x /402Cxx	C/Z 302

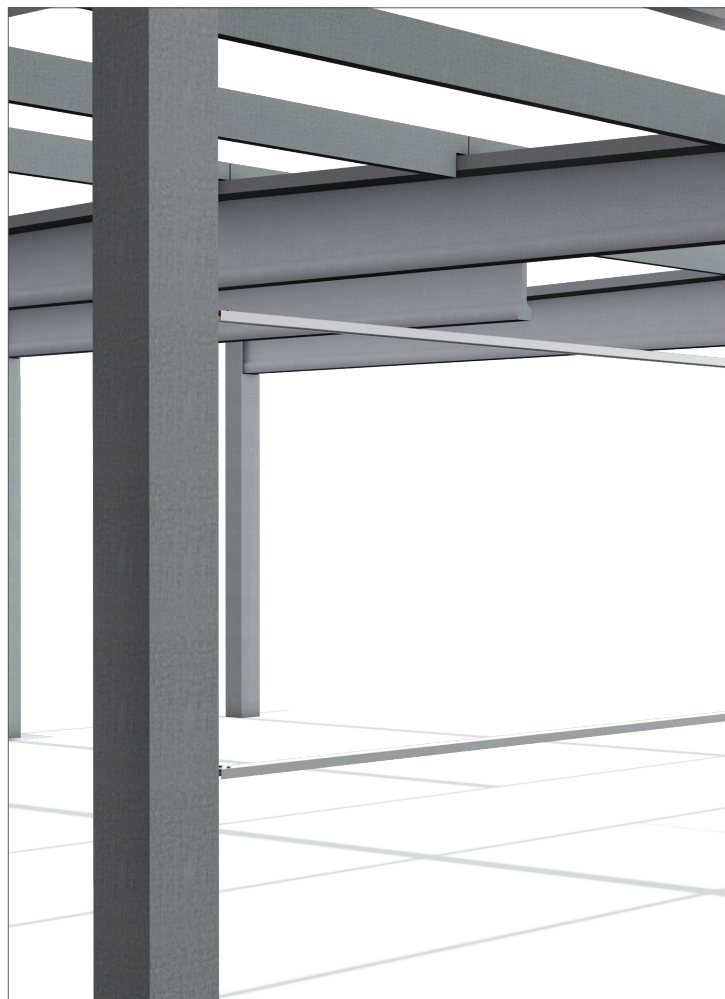


Fig. 120 – Cladding columns in concrete frames

The details in Figures 121-124 are only schematic. When designing and implementing these details, the positions of concrete reinforcing bars need to be taken into account.

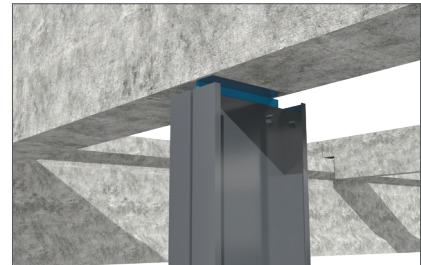


Fig. 121 – Detail of the column connection to the eaves beam, which is part of the primary concrete structure. The column is connected by means of an angle piece welded to a steel plate, which is included in the concrete purlin. Alternatively, this angle piece can be attached to the concrete purlin by means of chemical anchors or dowels. The column is connected to the angle piece with a pair of M16 bolts. Two pairs of M16 bolts can be used if necessary.



Fig. 122 – Detail of the transverse stabilising member connection to the concrete column. The joint is made of an angle piece and a pair of M16 bolts. The angle piece is welded to a steel plate incorporated in the concrete column.

Side rails

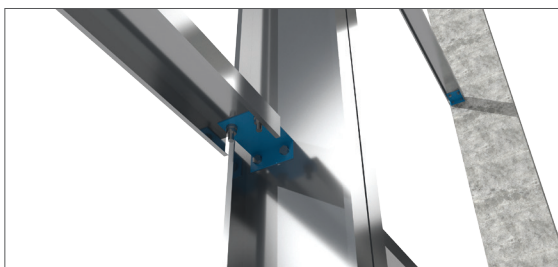


Fig. 124 – Detail of a joint of the column and one or two stabilising members. The stabilising members are attached to the column by means of connecting angle pieces and M16 bolts. There must always be a liner between the column forming C sections at the point of the node. The stabilising member section does not have to be of the same height as the column section. The recommended minimum heights of the stabilising sections are shown in Table 32.

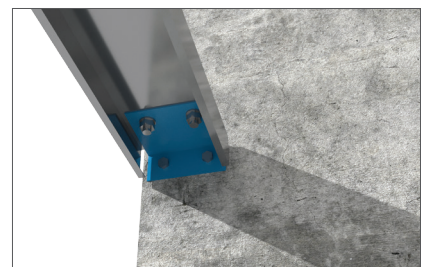


Fig. 123 – Detail of the stabilising member connection to the concrete column. The connecting angle piece is fixed to the concrete column by means of chemical anchors.

CLEATS

Purlin and Side Rail Connections to the Primary Structure; Connections of Z and C Sections

All connections of purlins and side rails to the primary structure are made by means of cleats.
Their fixing through their bottom flange is prohibited.

Cleats can be

- Part of the primary structure, i.e. welded in during the manufacturing process. If supplied by us, these are cleats marked as WOC.

- Separately from the primary structure (the primary structure has only holes prepared in the production), i.e. cleats are only bolted to the primary structure on the construction site. If supplied by us, these cleats of the BOC type.

Cleats

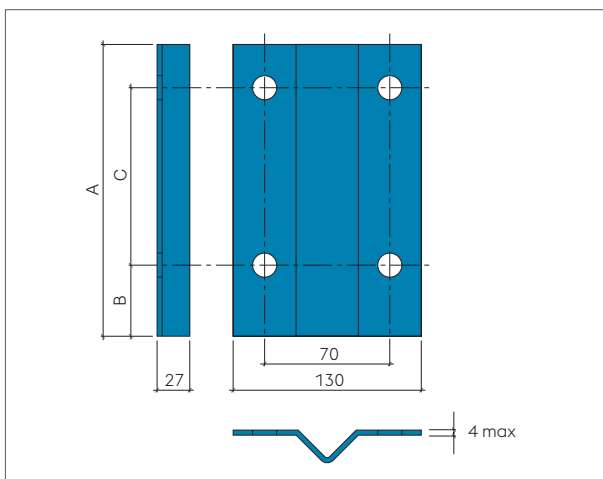


Fig. 125 – WOC cleats designed for welding to the primary structure / sections 142 - 262

Tab. 33 – Dimensions of WOC/BOC cleats

Cleat reference	A	B*	C	D	E	F
mm	mm	mm	mm	mm	mm	mm
122	120	40	56	35	65	6
142	130	50	56	35	65	6
172	160	50	86	35	65	6
202	190	50	116	35	65	6
232	220	50	146	35	65	8
262	250	50	176	35	65	8
302	280	60	195	40	75	8
342	320	60	235	40	75	8
402	380	60	295	40	75	8
432	410	60	355	50	90	8
452	430	60	375	50	90	8

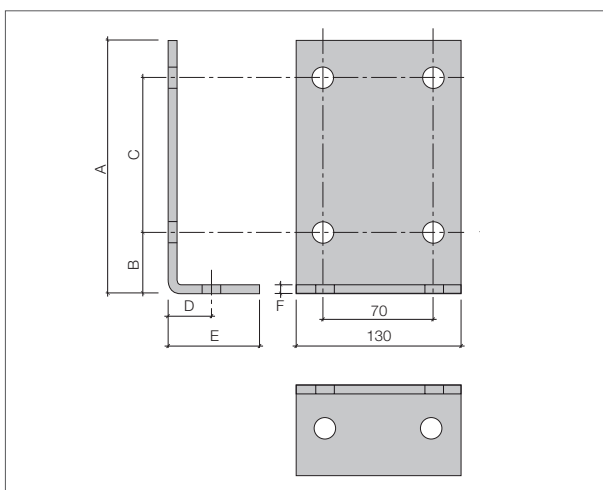


Fig. 126 – BOC cleats designed for bolting to the primary structure / sections 142 - 262

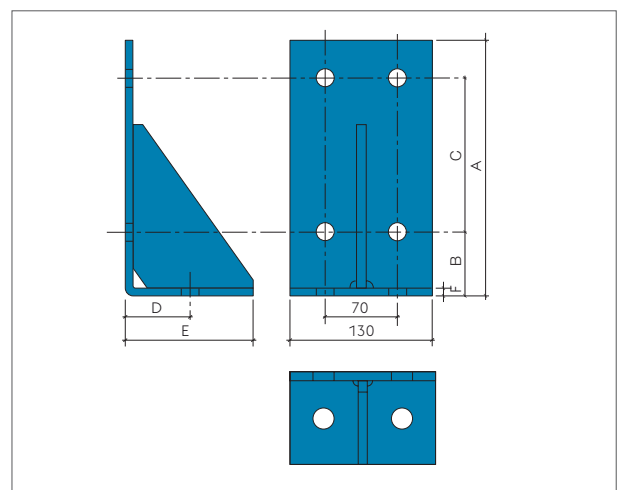


Fig. 127 – BOC cleats designed for bolting to the primary structure / sections 302 - 452

Design principles for cleats

- The minimum distance between the frame/truss upper flange and the purlin/side rail lower flange must be 8 mm.

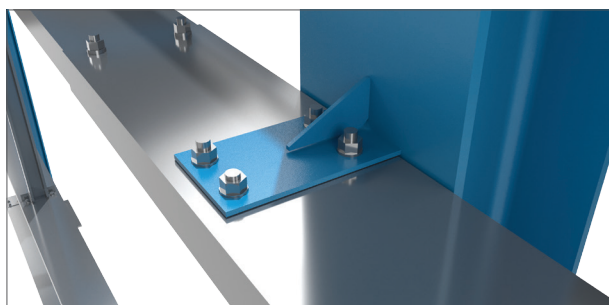


Fig. 128 – Cleat welded to the primary structure

Mutual connections of Z and C sections made by cleats in form of angle pieces. The angles pieces supplied by us are marked as XXXTC – TC = abbreviation for connecting angle pieces; XXX = section reference height. Example: 202TC specifies an angle piece for connecting sections of the height of 202 mm.

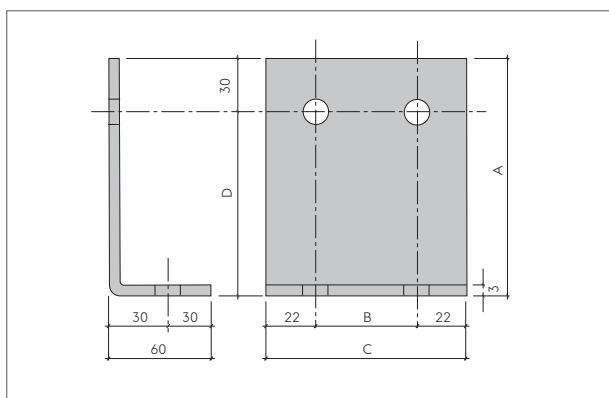


Fig. 130 – TC connecting angle piece

Design principles and recommendations for the use of TC connecting angle pieces

- They have been designed primarily for not heavily loaded joints.
- They are not intended for connecting sections to the primary structure; if you want to use them for this purpose, they need to be approved by a stress analysis.
- TC angle pieces feature holes 18 mm in diameter for M16 bolts, or holes 14 mm in diameter for sections of the 122 series.
- If TC angle pieces are used for connecting sections with counterformed holes, the joint must be fitted with a PP packing plate for levelling the counterformed holes (see page 54).

- Use M16 bolts of 8.8 grade. Bolts of smaller diameters must be approved by a stress analysis.
- Cleats for sections of the 302 series or above must always feature a welded reinforcing rib as shown in Figure 129.

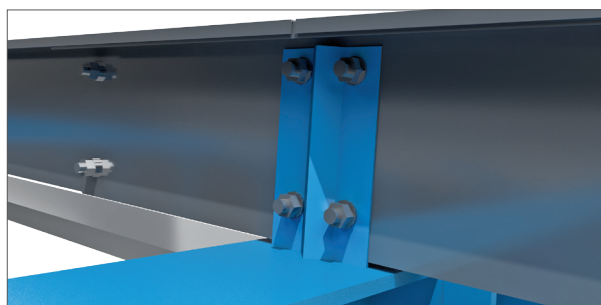


Fig. 129 – WOC cleat welded to the primary structure

If two sections of different sizes need to be connected, we can produce non-standard connecting angle pieces – contact our sales representatives or our design department in this case to verify the production feasibility.

Tab. 34 – Dimensions of TC angle pieces

Angle reference	A	B	C	D
mm	mm	mm	mm	mm
122 TC	126	56	90	96
142 TC	126	56	100	96
172 TC	136	86	130	106
202 TC	136	116	160	106
232 TC	142	146	190	112
262 TC	146	176	220	116
302 TC	156	195	239	126
342 TC	166	235	279	136
402 TC	170	295	339	140

TC angle pieces for sections of the 432 and 452 series are designed in a non-standard way; please contact our technical support.

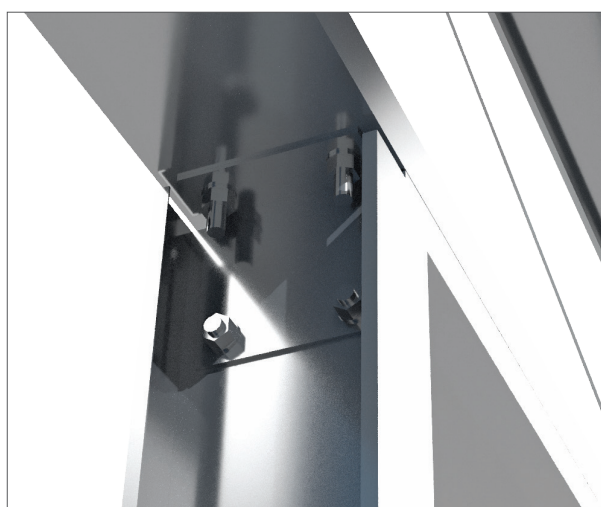


Fig. 131 – Connection of two C sections by means of a TC angle piece

MEZZANINE FLOOR BEAMS AND SYSTEMS

Introduction and System Description

Mezzanine floor systems include mainly components of the primary (girders) and secondary beams (floor beams) and their combinations.

Thin-walled floor beams can complement the classic steel primary floor construction in which they are mostly used only as secondary (i.e. floor) beams. They can be designed from C or C+ sections.

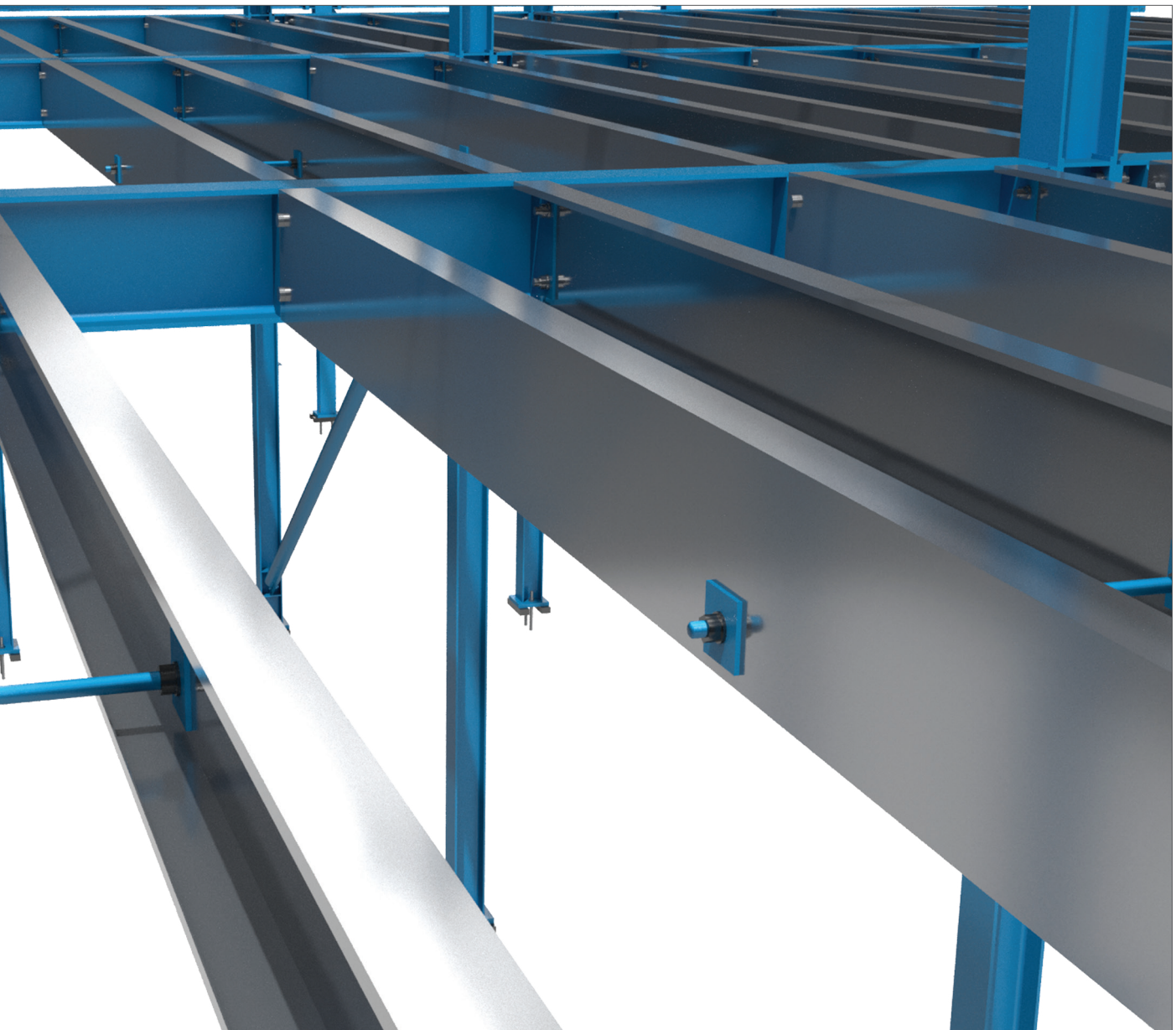
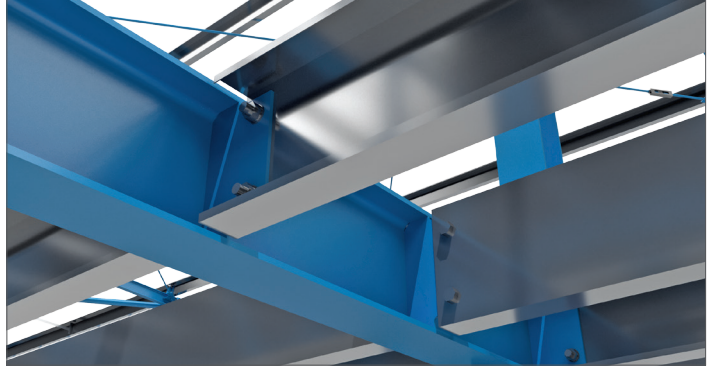
The thin-walled sections, however, can form a complete mezzanine construction: primary beams (girders) made of thin-walled C/C+ sections and secondary (floor) beams of C/C+ sections.

C and C+ sections are typically used for this type of structure. The C+ sections have an average of 15% greater bending capacity than the conventional C sections, so they are recommended primarily for the primary beams (girders).

In the METSECI system, component sections are referred to as:

- **M = standard C sections. Their range is listed on pages 90 - 93.**
- **C+ = C sections with double flange reinforcement. Their range is listed on pages 94 - 97.**





Mezzanine floor beams
and systems

M SECTIONS

Range of sections and their cross-sectional characteristics

Section Reference Code

232 M 16

- 16 = reference to the material thickness, i.e. 16 = 1.6 mm
- M = reference to the section shape or product group. M stands for C sections for use in mezzanine floor systems. The system holes in M sections are differently positioned than the system holes in the C sections intended for the side rails.
- 232 = section height in millimetres

General rules for making holes in sections

Transverse location of holes

Section web up to 5 different reference axes.

Section flange up to 2 different reference axes.

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of holes per one type of component are allowed.

Possible types of holes

- Straight, round: diameters of 9, 11, 12, 14, 18, 22 mm
- Straight, oval: dimensions of 12×30, 14×30, 18×30, 22×30 mm

Standard locations of holes

This means the system holes recommended for system joints, such as the beam attachment to the primary structure, installation of sleeves and overhangs.

Standard holes in section web

18 mm in diameter, located along the standard axes in the transverse direction – the positions of axes are shown in Figure 132 and in Table 35.

Standard holes in section flanges -14 mm in diameter, located in the centre of the flange dimension in the transverse direction.

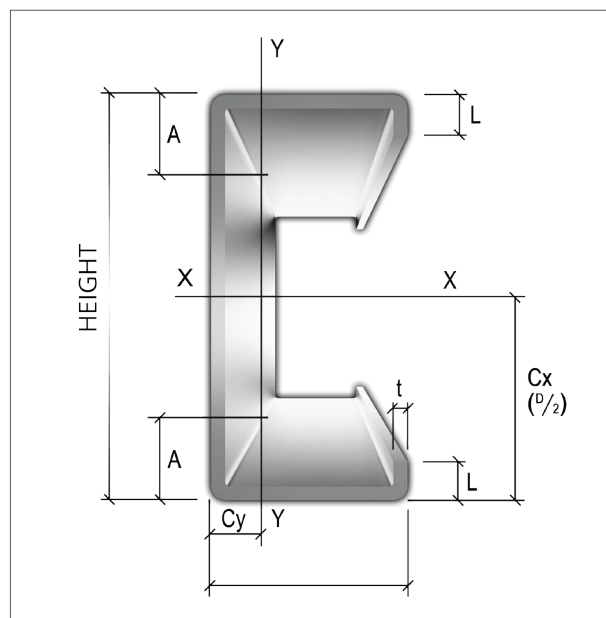


Fig. 132 – M-type section

Tab. 35 – Positions of holes and lengths of flange reinforcements in M sections

Section reference height	Dimension A	Dimension L
mm	mm	mm
142	41	13
150	45	13
165	47,5	14
172	51	13
202	51	13
220	60	13
232	59	13
262	59	13
302	59	18
342	59	18
402	59	19

Non-standard locations of holes

This includes all other positions of holes off the system axes described in Table 35 and Figure 132 – used for trimmers, non-standard accessories, or for additional structures attached to the beams, for example.

As the permitted number of reference axes on the section web is 5, three additional axes for non-standard holes can be added to the two standard system axes. The minimum axis distance from the section edge, i.e. 41 mm must be observed.

General rules for making notches in sections

The minimum notch length is 52mm, the maximum 350 mm.

The maximum notch depth = 1/2 of the section height – 2 mm.

Positioning of notches is unrestricted along the section length.

Notches may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes are allowed to be made in sections.

These are oval holes 32×72 mm.

The holes need to be positioned in the section axis with the possibility of their offsetting to the position of standard holes in the web – see dimension A in Table 35.

Service holes can be made only along one reference axis within one type of component.

Surface finish

All sections are made of hot-dip galvanised steel with a yield strength of 450 MPa and a standard zinc coating of 350 g/m² on both sides. If a higher grade of surface finish, is required, we provide 600/800/1000 g/m² double-sided coatings.

Tab. 36 – Permitted combinations of holes in one component – section web:

Reference to section	Straight holes	Counterformed holes	Service holes	Notches
142 - 342	Max. 3 different diameters along five different reference axes	No	Max. 1 dimension along one reference axis	Yes
402	Max. 3 different diameters along five different reference axes	No	Max. 1 dimension along one reference axis	Yes

Tab. 37 – Permitted combinations of holes in one component – section flange:

Reference to section	Straight holes	Counterformed holes	Service holes	Notches
142 - 402	Max. 2 different diameters along two different reference axes	No	No	Yes

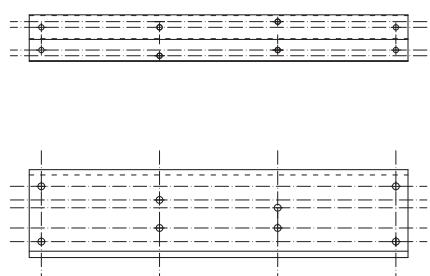


Fig. 133 – Possible layout of holes

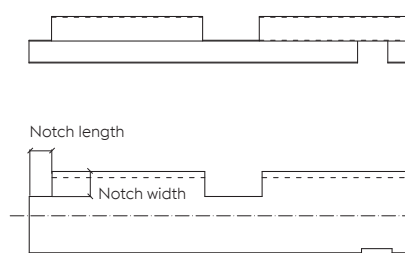


Fig. 134 – Possible layout of notches

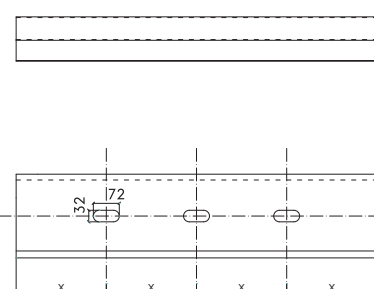


Fig. 135 – Possible layout of service holes

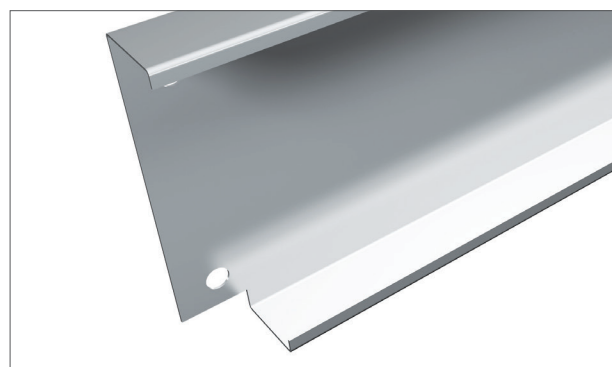


Fig. 136 – Notch in M section



Fig. 137 – Service hole in M section

Reference code	Weight	Area	Height	Flange	Thickness	I_{yy}	I_{zz}
	kg/m	mm ²	mm	mm	mm	mm ⁴	mm ⁴
142M13	2.84	362	142	60	1.30	1,189,756	175,793
142M14	3.05	389	142	60	1.40	1,277,354	188,275
142M15	3.26	416	142	60	1.50	1,364,401	200,612
142M16	3.47	442	142	60	1.60	1,450,896	212,806
142M18	3.89	495	142	60	1.80	1,622,239	236,766
142M20	4.30	548	142	60	2.00	1,791,395	260,163
150M15	3.26	416	150	56	1.50	1,481,778	172,481
150M20	4.30	548	150	56	2.00	1,945,715	223,314
165M15	3.73	476	165	67	1.50	2,084,520	281,917
165M20	4.93	628	165	67	2.00	2,742,095	366,637
172M13	3.25	414	172	65	1.30	1,947,042	226,639
172M14	3.49	445	172	65	1.40	2,091,220	242,820
172M15	3.73	476	172	65	1.50	2,234,609	258,826
172M16	3.98	506	172	65	1.60	2,377,209	274,660
172M18	4.45	567	172	65	1.80	2,660,051	305,810
172M20	4.93	628	172	65	2.00	2,939,761	336,279
172M23	5.63	717	172	65	2.30	3,353,484	380,720
172M25	6.09	776	172	65	2.50	3,625,426	409,517
202M14	3.82	487	202	65	1.40	3,039,007	254,459
202M15	4.09	521	202	65	1.50	3,248,138	271,232
202M16	4.35	554	202	65	1.60	3,456,222	287,824
202M18	4.88	621	202	65	1.80	3,869,255	320,465
202M20	5.40	688	202	65	2.00	4,278,121	352,392
202M23	6.17	786	202	65	2.30	4,883,645	398,961
202M27	7.19	916	202	65	2.70	5,676,579	458,624
220M15	4.09	521	220	56	1.50	3,646,742	192,109
220M20	5.40	688	220	56	2.00	4,802,881	248,705
232M14	4.11	522	232	65	1.40	4,208,805	264,273
232M15	4.44	566	232	65	1.50	4,499,268	281,691
232M16	4.73	602	232	65	1.60	4,788,387	298,919
232M18	5.30	675	232	65	1.80	5,362,607	332,814
232M20	5.87	748	232	65	2.00	5,931,481	365,965
232M23	6.71	855	232	65	2.30	6,774,813	414,317
232M25	7.27	926	232	65	2.50	7,330,407	445,647
262M15	4.75	603	262	65	1.50	6,008,247	290,627
262M16	5.11	650	262	65	1.60	6,395,304	308,399
262M18	5.73	729	262	65	1.80	7,164,406	343,360
262M20	6.34	808	262	65	2.00	7,926,841	377,554
262M23	7.26	924	262	65	2.30	9,058,039	427,424
262M25	7.86	1001	262	65	2.50	9,803,898	459,736
262M29	9.06	1154	262	65	2.90	11,275,852	522,156
302M20	7.86	1002	302	88	2.00	13,603,265	930,267
302M23	9.01	1147	302	88	2.30	15,563,997	1,057,658
302M25	9.76	1244	302	88	2.50	16,859,719	1,140,883
302M29	11.27	1435	302	88	2.90	19,423,833	1,303,300
342M23	9.73	1239	342	88	2.30	20,907,971	1,092,726
342M25	10.55	1344	342	88	2.50	22,653,890	1,178,692
342M27	11.37	1448	342	88	2.70	24,388,385	1,263,264
342M30	12.58	1603	342	88	3.00	26,968,766	1,387,531
402M25	12.16	1549	402	95	2.50	35,137,910	1,540,614
402M27	13.01	1669	402	95	2.70	37,842,916	1,652,153
402M30	14.41	1849	402	95	3.00	41,871,270	1,816,332

W_{yy}	W_{zz}	i_{yy}	i_{zz}	C_y	C_z	M_{cy}	M_{cz}	Reference code
mm ³	mm ³	mm	mm	mm	mm	kNm	kNm	
16,757	4,182	56.9	21.9	71.00	17.96	5.990	1.640	142M13
17,991	4,479	56.8	21.8	71.00	17.96	6.750	1.770	142M14
19,217	4,773	56.8	21.8	71.00	17.97	7.550	1.910	142M15
20,435	5,063	56.7	21.7	71.00	17.97	8.370	2.040	142M16
22,848	5,634	56.7	21.6	71.00	17.98	9.830	2.300	142M18
25,231	6,192	56.6	21.6	71.00	17.99	11.200	2.560	142M20
19,757	4,314	59.2	20.2	75.00	16.02	7.880	1.720	150M15
25,943	5,589	58.9	20.0	75.00	16.04	11.670	2.310	150M20
25,267	5,938	65.8	24.2	82.50	19.52	9.140	2.330	165M15
33,238	7,726	65.6	24.0	82.50	19.54	14.280	3.140	165M20
22,640	4,832	68.1	23.2	86.00	18.09	7.460	1.850	172M13
24,317	5,177	68.1	23.2	86.00	18.10	8.420	2.000	172M14
25,984	5,519	68.0	23.1	86.00	18.10	9.410	2.160	172M15
27,642	5,857	68.0	23.1	86.00	18.11	10.450	2.310	172M16
30,931	6,523	67.9	23.0	86.00	18.12	12.610	2.610	172M18
34,183	7,174	67.8	22.9	86.00	18.13	14.840	2.910	172M20
38,994	8,125	67.6	22.8	86.00	18.14	17.550	3.350	172M23
42,156	8,742	67.5	22.7	86.00	18.15	18.970	3.640	172M25
30,089	5,259	78.5	22.7	101.00	16.62	9.990	2.010	202M14
32,160	5,607	78.4	22.7	101.00	16.63	11.170	2.160	202M15
34,220	5,951	78.4	22.6	101.00	16.63	12.400	2.310	202M16
38,310	6,628	78.3	22.5	101.00	16.65	14.960	2.620	202M18
42,358	7,290	78.2	22.4	101.00	16.66	17.660	2.920	202M20
48,353	8,257	78.0	22.3	101.00	16.68	21.760	3.360	202M23
56,204	9,497	77.8	22.1	101.00	16.71	25.290	3.940	202M27
33,152	4,466	83.1	19.1	110.00	12.98	11.850	1.730	220M15
43,663	5,788	82.8	18.8	110.00	13.03	18.380	2.320	220M20
36,283	5,325	88.7	22.2	116.00	15.37	11.580	2.010	232M14
38,787	5,677	88.6	22.2	116.00	15.38	12.950	2.160	232M15
41,279	6,025	88.6	22.1	116.00	15.39	14.360	2.320	232M16
46,229	6,711	88.5	22.0	116.00	15.41	17.330	2.620	232M18
51,134	7,382	88.3	21.9	116.00	15.42	20.450	2.920	232M20
58,404	8,362	88.2	21.8	116.00	15.45	25.270	3.370	232M23
63,193	8,997	88.1	21.7	116.00	15.47	28.040	3.660	232M25
45,865	5,734	98.6	21.7	131.00	14.31	14.740	2.170	262M15
48,819	6,086	98.5	21.6	131.00	14.32	16.350	2.320	262M16
54,690	6,779	98.4	21.5	131.00	14.35	19.730	2.620	262M18
60,510	7,457	98.3	21.5	131.00	14.37	23.280	2.920	262M20
69,145	8,447	98.2	21.3	131.00	14.40	28.760	3.370	262M23
74,839	9,090	98.0	21.2	131.00	14.42	31.910	3.660	262M25
86,075	10,333	97.8	21.0	131.00	14.47	38.490	4.240	262M29
90,088	13,967	115.9	30.3	151.00	21.40	30.140	5.330	302M20
103,073	15,886	115.8	30.2	151.00	21.42	37.720	6.170	302M23
111,654	17,140	115.7	30.1	151.00	21.44	43.060	6.730	302M25
128,635	19,590	115.5	29.9	151.00	21.47	54.270	7.840	302M29
122,269	16,054	129.2	29.5	171.00	19.93	43.060	6.180	342M23
132,479	17,322	129.1	29.4	171.00	19.95	49.150	6.740	342M25
142,622	18,570	129.0	29.3	171.00	19.97	55.450	7.300	342M27
157,712	20,407	128.8	29.2	171.00	20.01	65.240	8.130	342M30
174,816	20,702	150.3	31.5	201.00	20.58	60.170	7.940	402M25
188,273	22,208	150.2	31.4	201.00	20.61	67.970	8.600	402M27
208,315	24,427	150.0	31.2	201.00	20.64	80.130	9.590	402M30

C+ SECTIONS

Range of sections and their cross-sectional characteristics

Section Reference Code

232 C+ 16

- 16 = reference to the material thickness, i.e. 16 = 1.6 mm
- C+ = reference to the section shape or product group
- 232 = section height in millimetres

General rules for making holes in sections

Transverse location of holes

Section web up to 5 different axes.

Section flange up to 2 different axes.

Longitudinal location of holes

Not limited, subject to the requirements specified in the manufacturing documentation. The minimum distance between holes must follow the rules given by applicable standards.

Diameters of holes

Up to three different diameters/shapes of holes per one type of component are allowed.

Possible types of holes

- Straight, round: diameters of 9, 11, 12, 14, 18 and 22 mm.
- Straight, oval: dimensions of 12×30, 14×30, 18×30 and 22×30 mm.
- Counterformed, round: diameter of 18 mm.

Standard locations of holes

This means the system holes recommended for system joints, such as the beam attachment to the primary structure, installation of sleeves and overhangs.

Standard holes in section web

18 mm in diameter, located along the standard axes in the transverse direction – the positions of axes are shown in Figure 138 and in Table 38.

Standard holes in section flanges 14 mm in diameter, located in the centre of the flange dimension in the transverse direction.

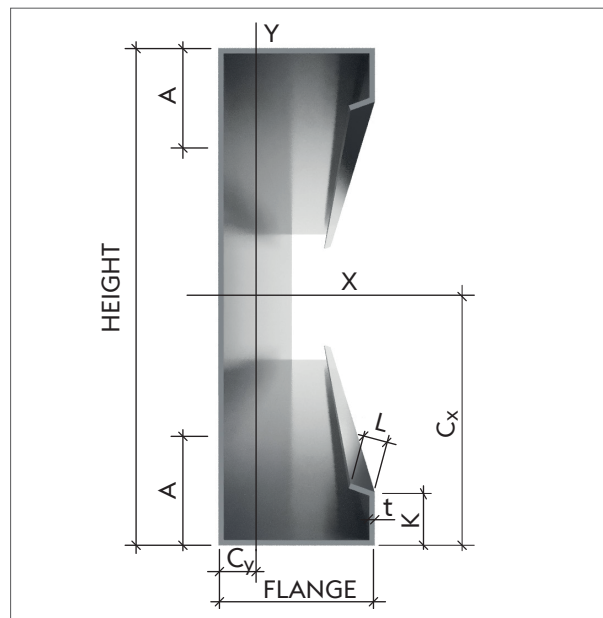


Fig. 138 – C+ type section

Tab. 38 – Hole positions and dimensions of flange brackets in C+

Section reference height	Dimension A	Dimension K	Dimension L
mm	mm	mm	mm
142	41	25	12
172	51	25	12
202	51	25	12
232	59	25	12
262	59	25	12
302	59	25	12
342	59	25	12
402	59	25	12
432	59	25	12
452	59	25	12

Non-standard locations of holes

This includes all other positions of holes off the system axes described in Table 38 and Figure 138 – used for trimmers, non-standard accessories, or for additional structures attached to the beams, for example.

As the permitted number of reference axes on the section web is 5, three additional axes for non-standard holes can be added to the two standard system axes. The minimum axis distance from the section edge of 41 mm must be observed.

General rules for making notches

The minimum notch length is 52 mm, the maximum 350 mm.

The maximum notch depth = 1/2 of the section height – 2 mm.

Positioning of notches is unrestricted along the section length.

Notches may weaken the section's load-bearing capacity, so they need to be approved by the designer responsible for the stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes are allowed to be made in sections. These are oval holes 32×72 mm.

The holes need to be positioned in the section axis with the possibility of their offsetting to the position of standard holes in the web – see dimension A in Table 38.

Service holes can be made only along one reference axis within one type of component.

Tab. 39 – Permitted combinations of holes in one component – section web

Reference to section	Straight holes	Counterformed holes	Service holes	Notches
142 - 452	Max. 3 different diameters along five different axes	Max. 1 diameter along five different axes	Max. 1 dimension along one reference axis	Yes

Tab. 40 – Permitted combinations of holes in one component – section flange

Reference to section	Straight holes	Counterformed holes	Service holes	Notches
142 - 452	Max. 2 different diameters along two different axes	No	No	Yes

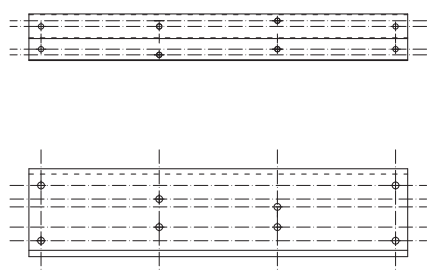


Fig. 139 – Possible layout of holes

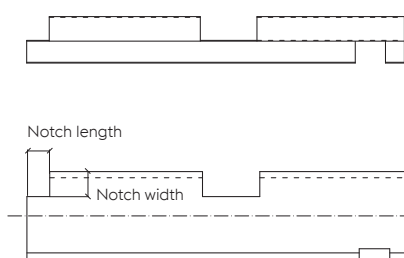


Fig. 140 - Possible layout of notches

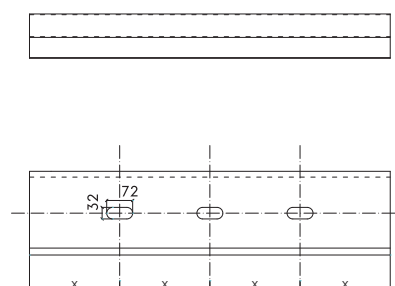


Fig. 141 – Possible layout of service holes

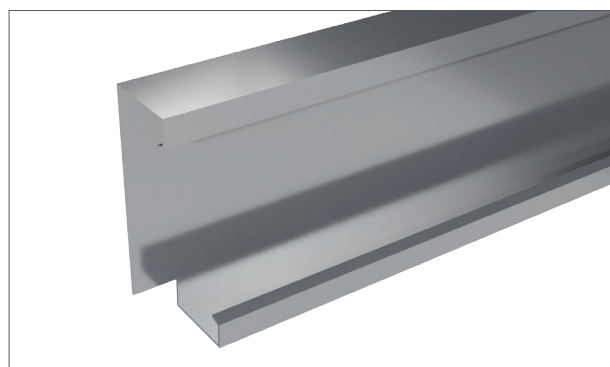


Fig. 142 – Notch in C+ section

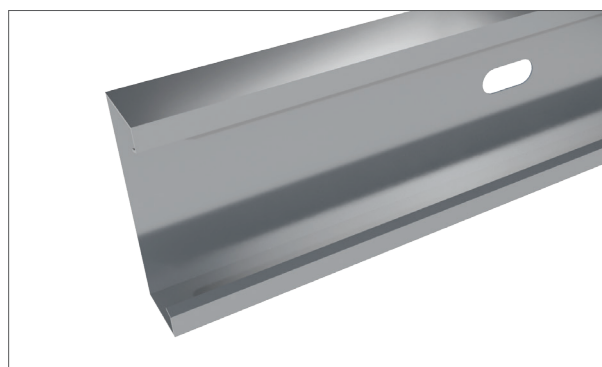


Fig. 143 – Service holes in C+ section

Reference code	Weight kg/m	Area mm ²	Height mm	Flange mm	Thickness mm	I _{yy} mm ⁴	I _{zz} mm ⁴
142C+15	4.03	511	142	73	1.50	1,720,898	450,419
142C+16	4.30	544	142	73	1.60	1,830,331	478,042
142C+18	4.82	611	142	73	1.80	2,047,234	532,410
142C+20	5.35	678	142	73	2.00	2,261,525	585,617
172C+15	4.39	556	172	73	1.50	2,686,611	483,231
172C+16	4.67	592	172	73	1.60	2,858,121	512,864
172C+18	5.25	665	172	73	1.80	3,198,314	571,188
172C+20	5.82	738	172	73	2.00	3,534,749	628,263
172C+23	6.68	847	172	73	2.30	4,032,375	711,561
172C+25	7.25	919	172	73	2.50	4,359,456	765,565
202C+15	4.74	601	202	73	1.50	3,910,297	511,268
202C+16	5.05	640	202	73	1.60	4,160,649	542,612
202C+18	5.68	719	202	73	1.80	4,657,504	604,298
202C+20	6.30	798	202	73	2.00	5,149,236	664,660
202C+23	7.22	916	202	73	2.30	5,877,253	752,744
202C+25	8.46	1072	202	73	2.70	6,830,116	865,663
232C+16	5.43	688	232	73	1.60	5,759,516	568,319
232C+18	6.10	773	232	73	1.80	6,449,103	632,899
232C+20	6.77	858	232	73	2.00	7,131,987	696,086
232C+25	8.42	1068	232	73	2.50	8,809,951	848,040
262C+15	5.45	691	262	73	1.50	7,212,586	556,658
262C+18	6.53	827	262	73	1.80	8,597,411	657,854
262C+20	7.24	918	262	73	2.00	9,510,001	723,496
262C+23	8.31	1054	262	73	2.30	10,862,979	819,261
262C+25	9.01	1143	262	73	2.50	11,754,380	881,324
302C+20	8.73	1106	302	100	2.00	15,772,244	1,585,457
302C+23	10.02	1270	302	100	2.30	18,035,410	1,800,875
302C+25	10.87	1378	302	100	2.50	19,529,390	1,941,327
302C+29	12.59	1596	302	100	2.90	22,481,908	2,214,725
342C+23	10.74	1362	342	100	2.30	24,146,589	1,869,912
342C+27	12.59	1596	342	100	2.70	28,142,315	2,158,794
342C+32	14.89	1887	342	100	3.20	33,052,622	2,505,291
402C+25	13.24	1678	402	110	2.50	40,356,524	2,653,714
402C+27	14.29	1812	402	110	2.70	43,443,816	2,843,611
402C+30	15.86	2010	402	110	3.00	48,035,708	3,122,421
402C+32	16.91	2143	402	110	3.20	51,070,967	3,304,299
402C+35	18.46	2340	402	110	3.50	55,584,890	3,571,174
432C+25	13.83	1753	432	110	2.50	47,869,348	2,706,950
432C+30	16.57	2100	432	110	3.00	56,992,809	3,184,839
432C+35	19.29	2445	432	110	3.50	65,966,888	3,642,313
452C+30	17.04	2160	452	110	3.00	63,492,096	3,223,594
452C+35	19.84	2515	452	110	3.50	73,501,456	3,686,470

W_{yy}	W_{zz}	i_{yy}	i_{zz}	C_y	C_z	M_{cy}	M_{cz}	Reference code
mm ³	mm ³	mm	mm	mm	mm	kNm	kNm	
24,238	10,208	57.1	29.2	71	28.88	8.937	3.780	142C+15
25,779	10,829	57.0	29.2	71	28.86	9.874	4.150	142C+16
28,834	12,050	57.0	29.1	71	28.82	11.661	4.900	142C+18
31,853	13,242	56.9	29.0	71	28.78	13.329	5.460	142C+20
31,240	10,430	68.5	29.0	86	26.67	11.123	3.820	172C+15
33,234	11,065	68.4	29.0	86	26.65	12.283	4.200	172C+16
37,190	12,314	68.3	28.9	86	26.61	14.715	4.920	172C+18
41,102	13,534	68.3	28.8	86	26.58	17.278	5.480	172C+20
46,888	15,310	68.2	28.6	86	26.52	20.528	6.300	172C+23
50,691	16,459	68.1	28.5	86	26.49	22.700	6.840	172C+25
38,716	10,603	79.5	28.8	101	24.78	13.332	3.850	202C+15
41,195	11,250	79.5	28.7	101	24.77	14.717	4.240	202C+16
46,114	12,520	79.4	28.6	101	24.73	17.618	4.930	202C+18
50,983	13,762	79.3	28.5	101	24.70	20.674	5.490	202C+20
58,191	15,570	79.2	28.3	101	24.66	25.502	6.320	202C+23
67,625	17,883	79.0	28.1	101	24.59	30.431	7.390	202C+25
49,651	11,398	90.3	28.4	116	23.14	17.171	4.260	232C+16
55,596	12,686	90.2	28.3	116	23.11	20.547	4.940	232C+18
61,483	13,945	90.1	28.2	116	23.08	24.101	5.500	232C+20
75,948	16,966	89.9	27.9	116	23.02	33.596	6.870	232C+25
55,058	10,857	100.9	28.0	131	21.73	17.800	3.890	262C+15
65,629	12,822	100.8	27.9	131	21.69	23.495	4.940	262C+18
72,595	14,095	100.7	27.8	131	21.67	27.552	5.510	262C+20
82,924	15,951	100.5	27.6	131	21.64	33.950	6.340	262C+23
89,728	17,152	100.4	27.5	131	21.62	38.381	6.890	262C+25
104,452	22,503	118.3	37.5	151	29.54	34.111	8.560	302C+20
119,440	25,542	118.2	37.3	151	29.49	42.439	9.890	302C+23
129,334	27,521	118.1	37.2	151	29.46	48.311	10.770	302C+25
148,887	31,367	117.9	37.0	151	29.39	60.710	12.500	302C+29
141,208	25,831	132.1	36.8	171	27.61	48.548	9.900	342C+23
164,575	29,798	131.9	36.5	171	27.55	62.222	11.660	342C+27
193,290	34,547	131.6	36.2	171	27.48	80.573	13.800	342C+32
200,779	32,546	154.1	39.5	201	28.46	66.976	12.390	402C+25
216,138	34,864	153.9	39.4	201	28.44	75.530	13.400	402C+27
238,984	38,264	153.8	39.2	201	28.40	88.935	14.910	402C+30
254,084	40,480	153.7	39.1	201	28.37	98.208	15.900	402C+32
276,542	43,728	153.5	38.9	201	28.33	112.546	17.370	402C+35
221,617	32,738	164.2	39.0	216	27.31	72.359	12.390	432C+25
263,856	38,491	163.9	38.7	216	27.26	96.067	14.920	432C+30
305,402	43,989	163.6	38.4	216	27.20	121.559	17.380	432C+35
280,939	38,628	170.6	38.4	226	26.55	100.841	14.920	452C+30
325,228	44,148	170.3	38.1	226	26.50	127.592	17.390	452C+35

Mezzanine Floor Beams and Systems

Stress Analysis

The stress analysis of floor beams and floor structures can be done using the Profilform DESIGNER software.

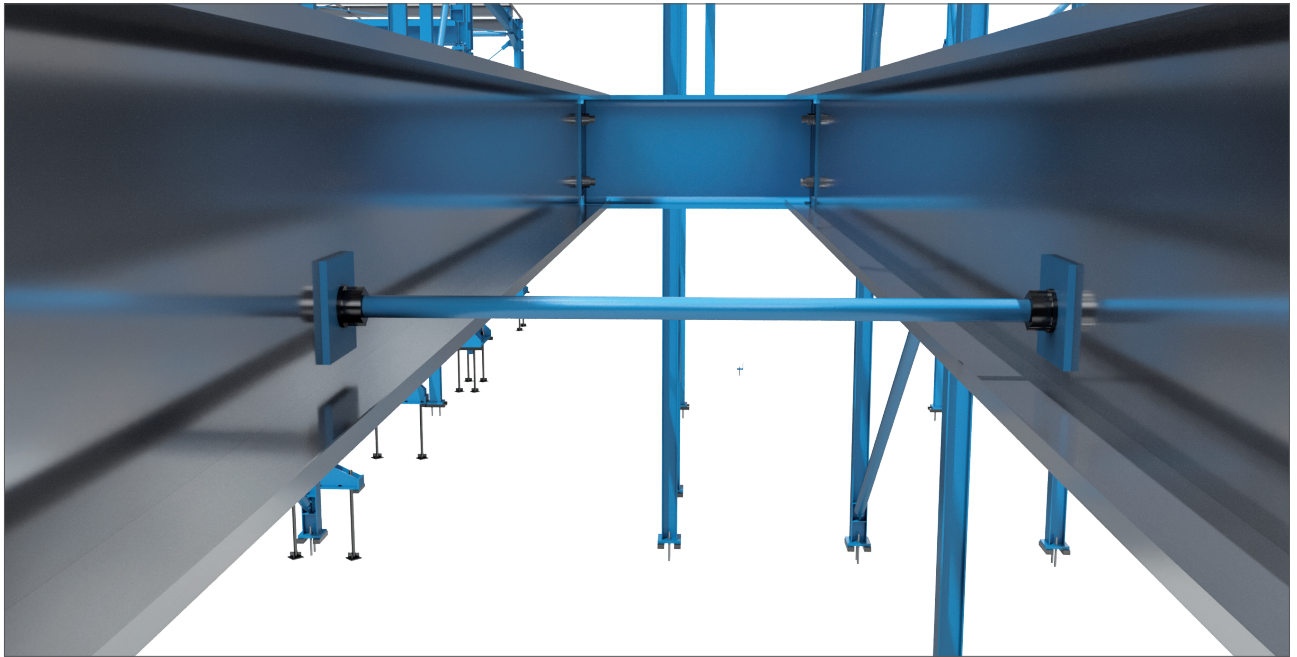
Stress analyses are carried out in accordance with the following standards:

- EN 1990, Basis of Structural Design and 1991-1-1, Actions on Structures
- EN 1993-1-1, Design of Steel Structures – Part 1-1, General Rules
- EN 1993-1-3, Design of Steel Structures – Part 1-3, Supplementary Rules for Cold-Formed Members and Sheeting
- EN 1993-1-5, Design of Steel Structures – Part 1-5, Plated Structural Elements

The stress analysis calculations have been complemented and positively influenced by the incorporation of tests carried out by the Department of Mechanical Engineering at The University of Strathclyde, UK.

Design rules presented in this technical manual, especially positions of the system holes and their minimum distances from the section edges must be observed when designing a construction and processing the manufacturing documentation. Should the positions of the system hole axes change, they need to be verified by a stress analysis.

The stress analysis does not consider composite action of the ceiling slab. However, it must be designed in such a way as to provide adequate reinforcement of the beams against tilting. The maximum pitch of the bolts connecting the ceiling slab to the beam is 300 mm.

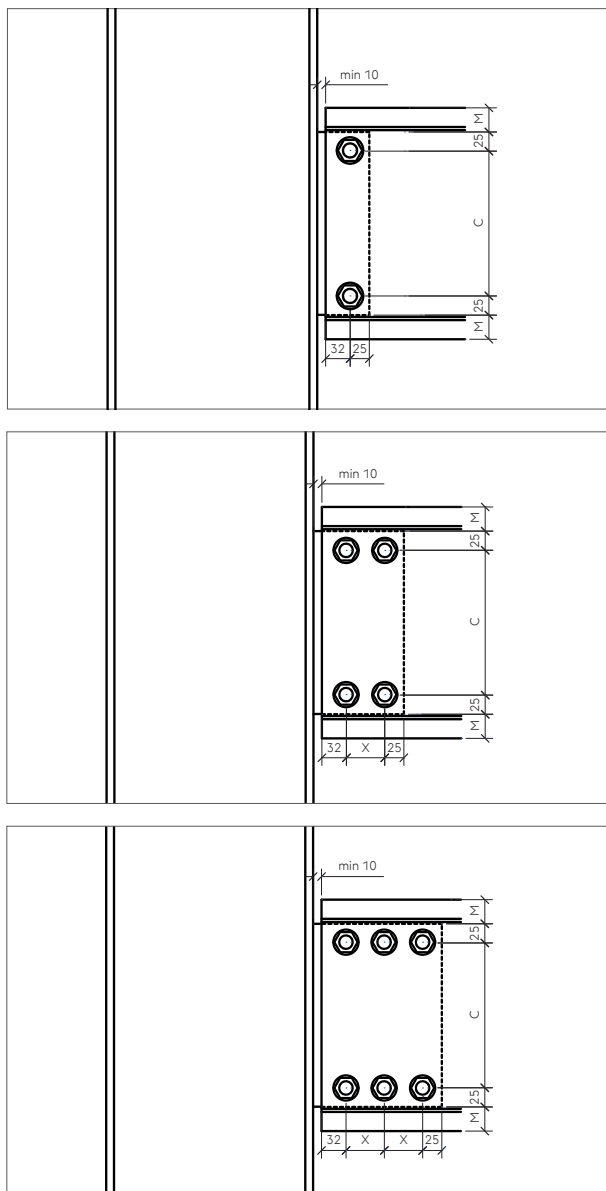


Mezzanine Floor Beams and Systems

Primary Beams (girders)

Girders carry the secondary floor beams. They are designed as simply supported beams. We recommend making them of C+ sections as they have a higher load bearing capacity than the C sections.

Static model	Simply supported beam
Stress Analysis	Profilform DESIGNER software
Proposed sections	C+ / C
Connections and connectors	Holes 18 mm, M16 bolts of 8.8 grade
Maximum span	6 m



Design rules

- Girders are always designed as simply supported beams. Profilform DESIGNER software considers the stiffness of the girder-to-column connection as it may positively influence the bending moment pattern and thus the design of the girder itself.
- These types of joints are designed using the IDEA StatiCa Connection software, which is incorporated in Profilform DESIGNER.
- Girders are designed without co-action of the ceiling slab, their stabilisation is ensured by the attached floor beams. However, it is recommended to attach the ceiling slab (trapezoidal sheet metal, OSB boards, grate walkways, etc.) to the girder with the spacing of the connecting members of max. 600 mm.
- The girder is fixed to the column with 1 - 3 pairs of M16 bolts of 8.8 grade, with washers under the bolt head and the nut.
- The girder formed by a pair of C or C+ sections needs to be equipped with a liner of the same thickness as the thickness of the connecting plate (min. 6 mm) at each point connection of a floor beam to the girder.
- The distance between the bolts in the joint (dimension X) must respect the stress analysis, but must not be less than 40 mm.

Fig. 144 – Girder connection to the column using one to three pairs of bolts

Mezzanine Floor Beams and Systems

Secondary Beams (Floor Beams)

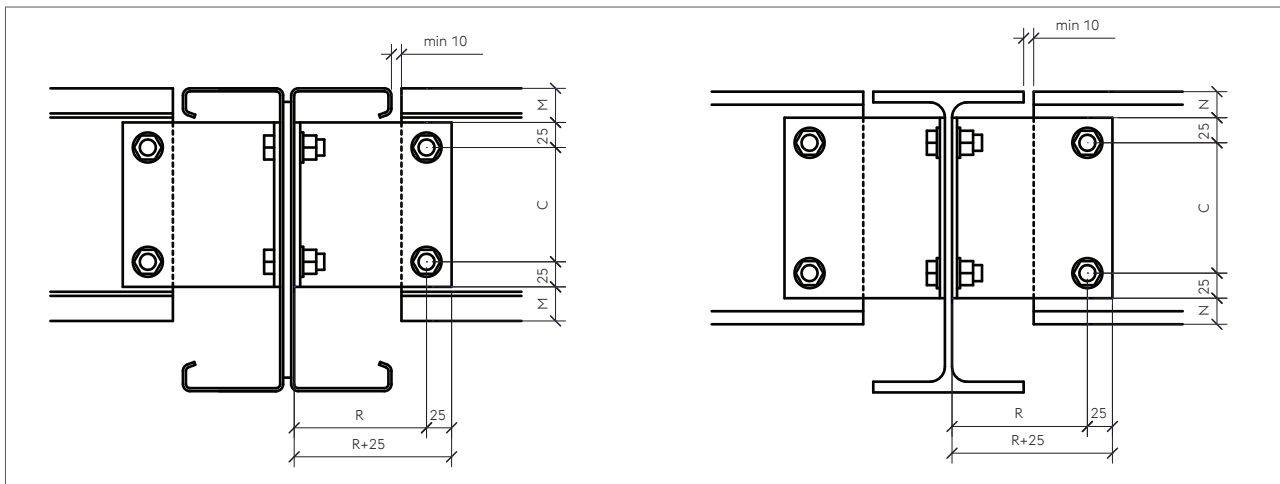


Fig. 145 – Detail of the connection of two M-type secondary beams to a girder made of C+ sections or an IPE section

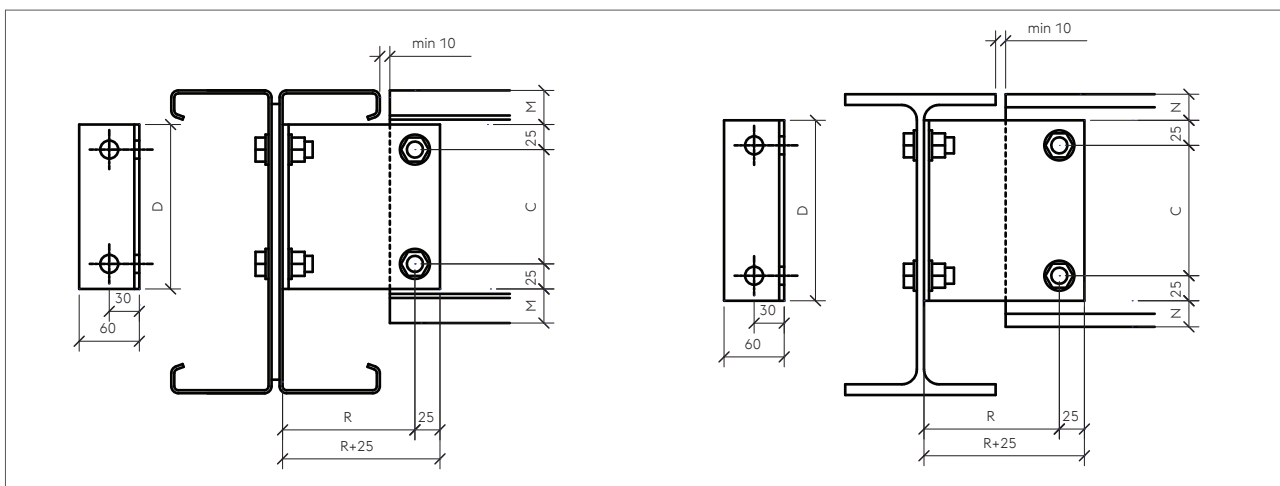


Fig. 146 – Detail of the connection of one M-type secondary beam to a girder made of C+ sections or an IPE section.

The recommended disproportion between the primary beams (girders) and the attached secondary (floor) beams is two section reference heights. This may be three reference heights for 402, 432 and 452 sections. This rule applies to a combination of a thin-walled girder and a thin-walled floor beam.

Secondary (floor) beams are attached to the primary beams (girders) using systemic angle pieces called MLC. The floor beams can be designed of C or C+ sections. Thin-walled floor beams are designed in such a way to be easily connect to any girder – whether made of a thin-walled steel section, hot-rolled section or concrete.

In most cases, floor beams are designed as inset between girders, but they can also be oversailing.

Static model	Simply supported beam
Stress analysis	Profilform DESIGNER software
Proposed sections	C / C+
Connections and connectors	Holes 18 mm, M16 bolts of 8.8 grade
Maximum recommended span	6.00 m

Mezzanine Floor Beams and Systems

Examples of Floor Beam to Girder Connections

Girder of C/C+ Section(s) (Single or Double Design)

An MLC angle piece is recommended for connecting a floor beam to the girder. The length of the MLC angle piece must be determined with respect to the sections used.

Girder designs using C/C+ sections must not combine C sections and C+ sections in one girder.

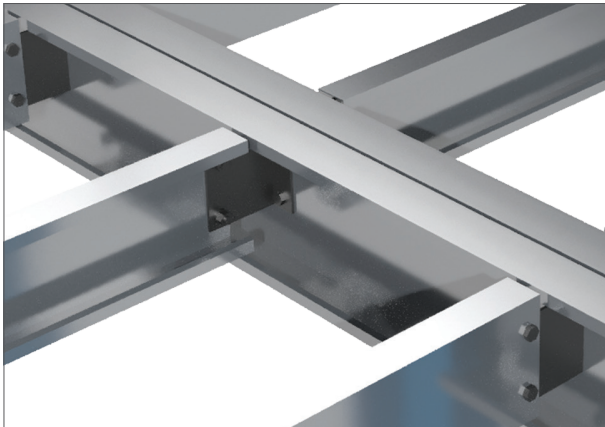


Fig. 147 – Detail of floor beam inset connection to a girder of thin-walled C+ section

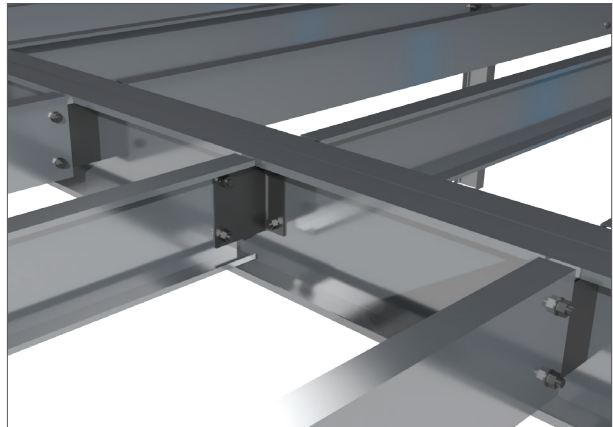


Fig. 148 – Detail of floor beam inset connection to a girder of thin-walled C section

Girder Made of IPE, HEA or HEB Hot-Rolled Section

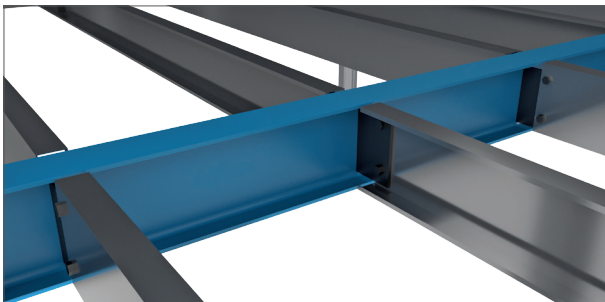


Fig. 149 – Detail of thin-walled floor beam inset connection to a girder of hot-rolled IPE section

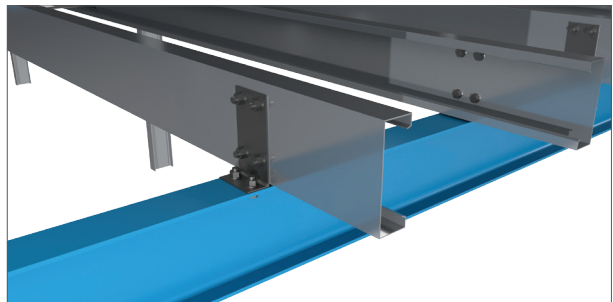


Fig. 150 – Detail of thin-walled floor beam oversailing connection to a girder of hot-rolled IPE, HEA or HEB section

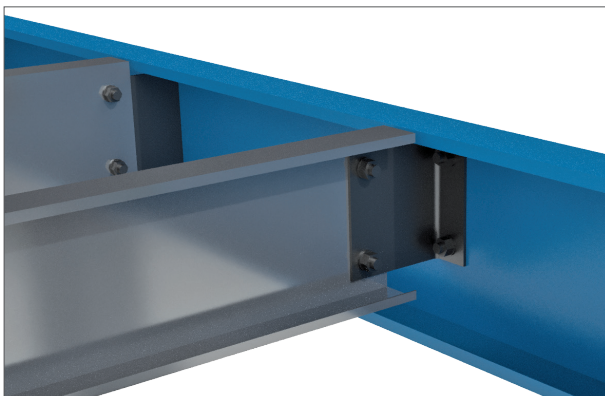


Fig. 151 – Connection using a cleat

The cleat for attaching a thin-walled floor beam to a hot-rolled girder is not supplied as part of the system and it is not always possible to use our MLC cleat. Please contact our sales representative or our design office if you need a different cleat than our MLC type.

Mezzanine Floor Beams and Systems

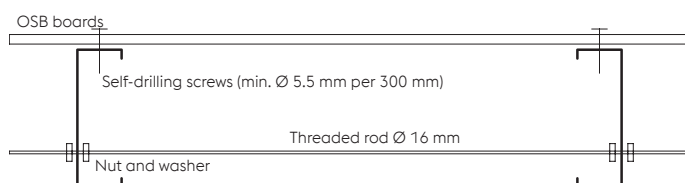
Stabilisation of Floor Beams in Lightweight Floor Structures

Individual floor beams must be paired by means of bars that provide stability of the floor beam sections under full floor load. The bars can be made of a threaded rod of at least 16 mm diameter.

In case of a lightweight floor, the bar uses only standard washers used for M16 bolts.

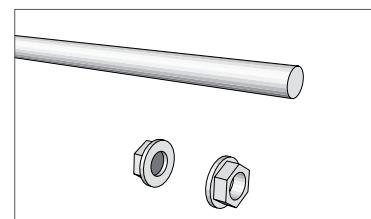


Fig. 152 – Stabilising bar in a lightweight floor construction



Design Recommendations

- The self-weight of the floor construction and the flooring layers is up to 50 kg/m²
- The self-drilling screws do not generate a composite action of the floor beams and slab.
- Threaded bar – always at least 1 at mid span.
- Spans ≤ 2.0 metres do not require the stabilising bars.
- The recommended maximum spacing of floor beams is 1 metre.
- Use threaded bar(s) for each pair of floor beams.
- In the case of an odd number of floor beams, use 2 bars in the last bay as shown in Figure 154.



153 – Stabilising bar assembly set

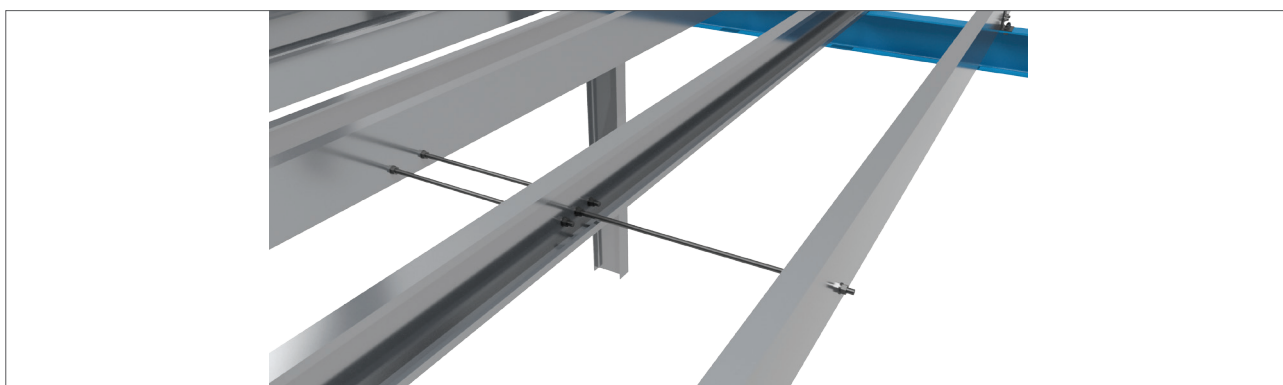
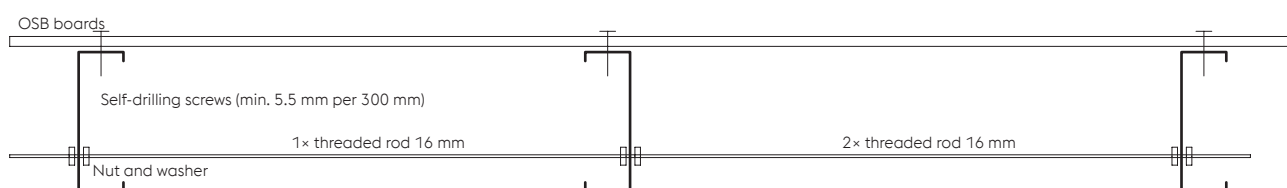


Fig. 154 – Arrangement of stabilising bars in case of an odd number of floor beams in a lightweight floor construction



Mezzanine Floor Beams and Systems

Stabilisation of Floor Beams in Heavy Floor Structures

Individual floor beams must be paired by means of bars that provide stability of the floor beam sections under full floor load. The bars can be made of a threaded rod of at least 16 mm diameter.

In case of a heavy floor construction, the stabilising bar uses 70×70 mm square plates used for M16 bolts.

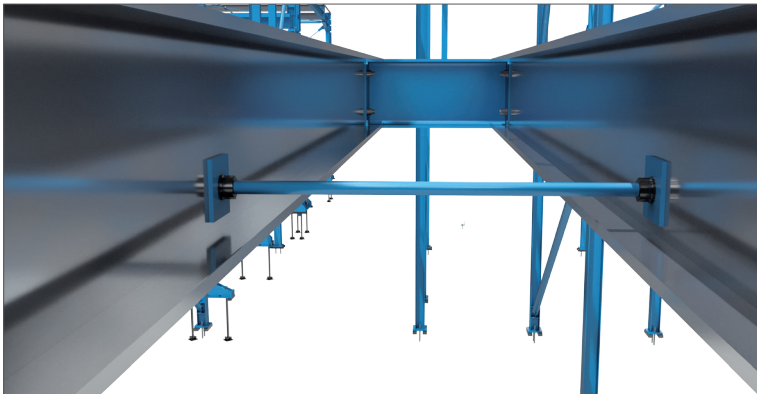


Fig. 155 – Stabilising bar in a heavy floor construction

Design Recommendations

- The self-weight of the floor construction and the flooring layers is $> 50 \text{ kg/m}^2$.
- The self-drilling screws do not generate a composite action of the floor beams and slab.
- Threaded bar – always at least 1 at mid span.
- Spans ≤ 2.0 metres do not require stabilising bars.
- The recommended maximum spacing of floor beams is 1 metre.
- Use threaded bar(s) for each pair of floor beams.
- In the case of an odd number of floor beams, use 2 bars in the last bay as shown in Figure 157.

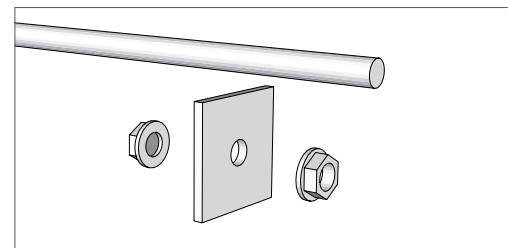
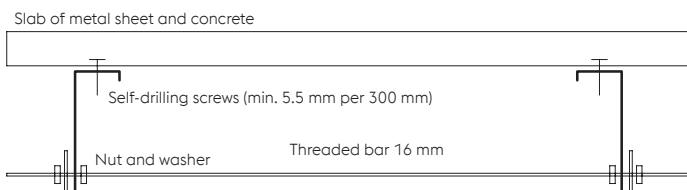


Fig. 156 – Stabilising bar assembly set

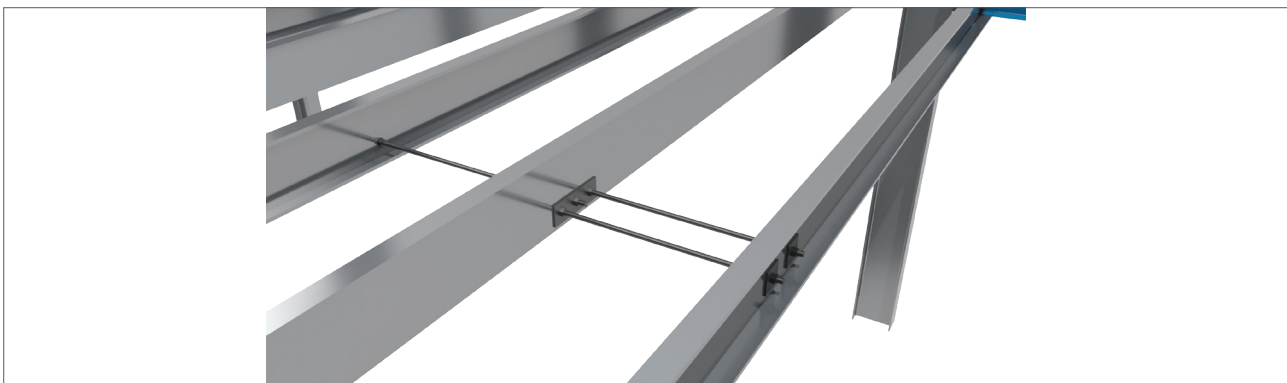
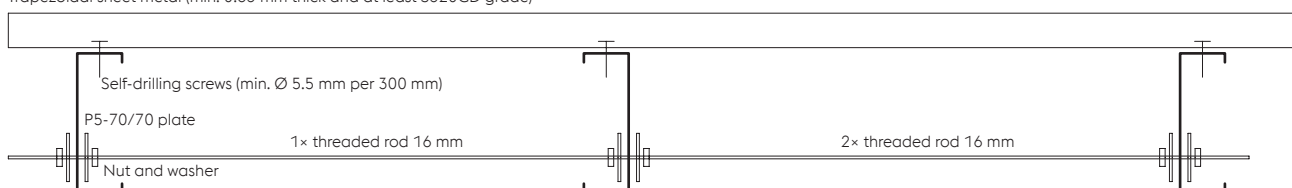


Fig. 157 – Arrangement of stabilising bars in case of an odd number of floor beams in a heavy floor construction

Trapezoidal sheet metal (min. 0.63 mm thick and at least S320GD grade)



Mezzanine Floor Beams and Systems

MLC Cleats (Angle Pieces)

MLC cleats are used for connecting floor beam to girders. Alternatively, they can be used to attach girders to columns. As the MLC cleats are used for load-bearing joints, it is always necessary to perform a stress analysis. The stress analysis and design of MLC cleats is done by by Profilform DESIGNER software as part of the designing process of sections for floor beams and girders.

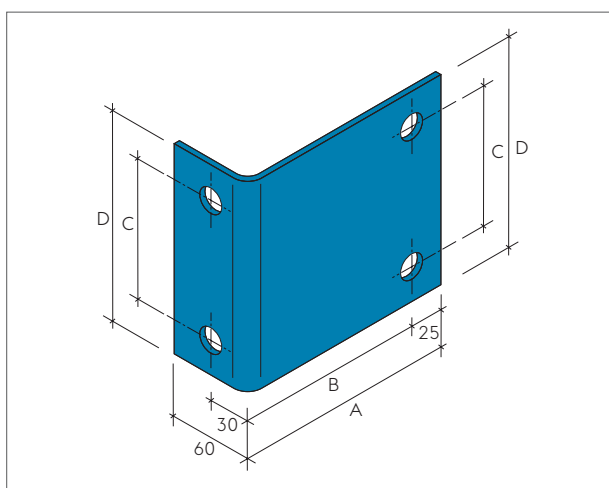


Fig. 158 – MLC cleat

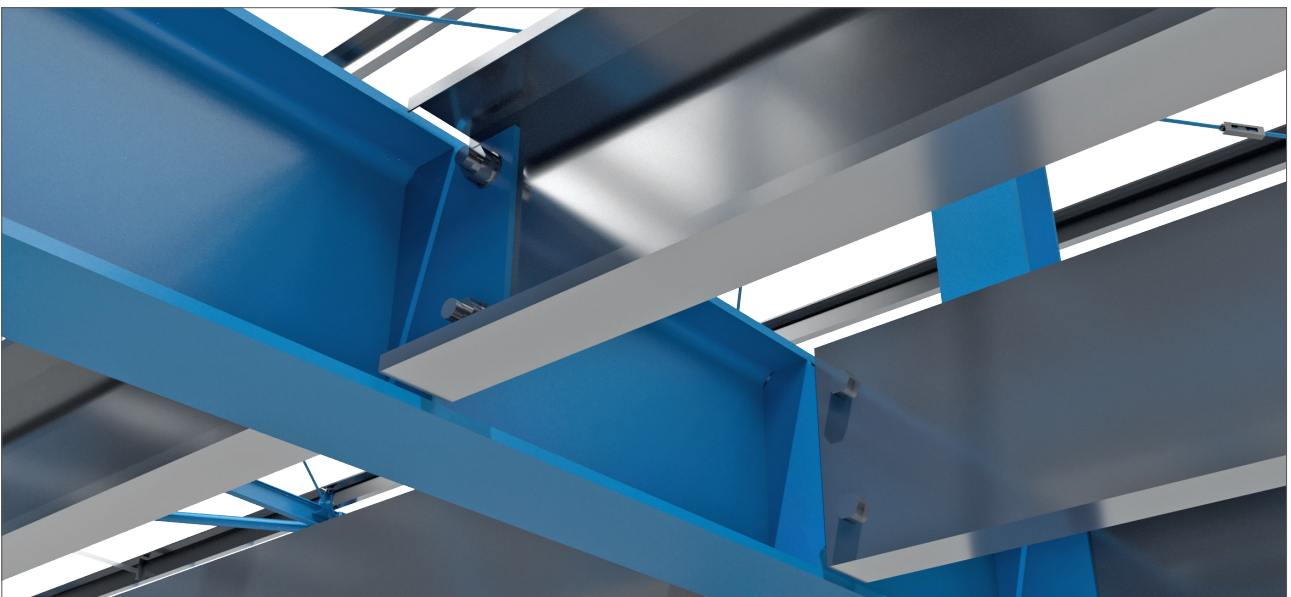
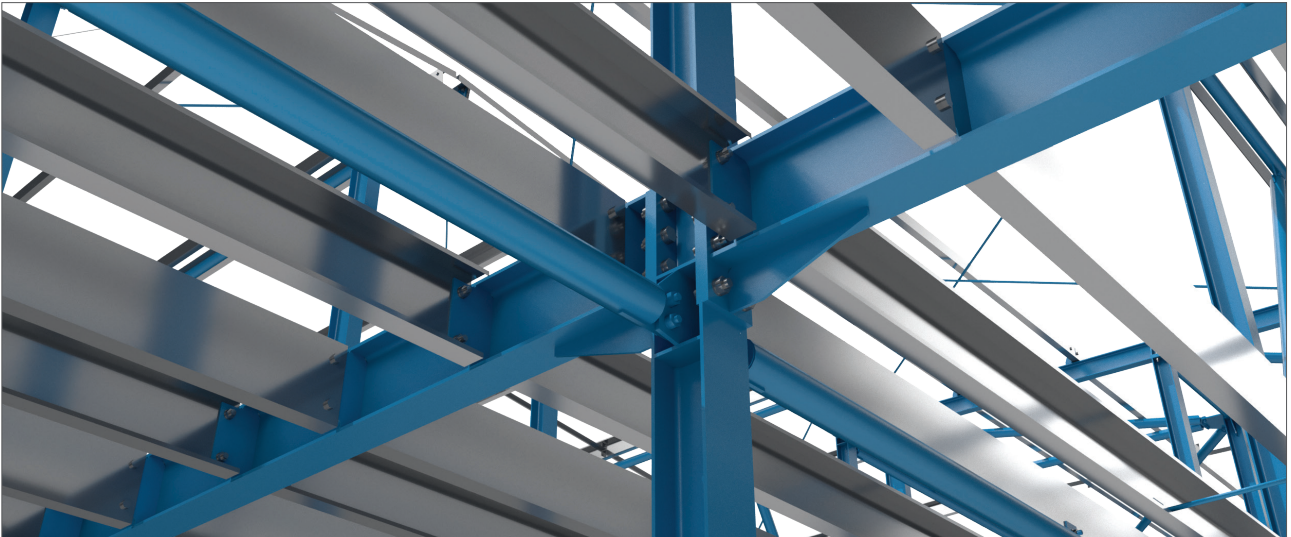
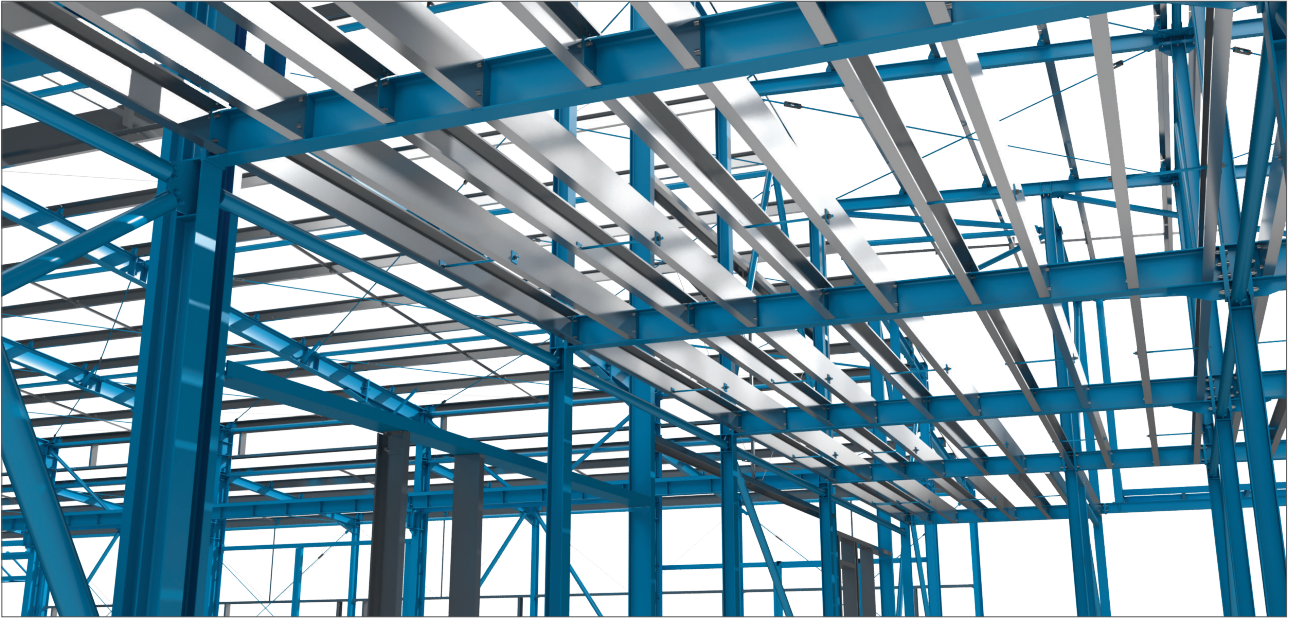
The length of the MLC cleat is variable as it depends on sections to connect; it needs to be specified when designing the manufacturing documentation.

Cleats of the MLC type are manufactured in thicknesses of 4 / 5 / 6 / 8 mm.

Tab. 41 – MLC cleat dimensions

Reference code	Dimension A	Dimension B	Dimension C	Dimension D	Approximate weight
	mm	mm	mm	mm	kg per unit
MLC 142 4/5/6/8	variable	variable - 25	60	110	0.88
MLC 150 4/5/6/8	variable	variable - 25	60	110	0.88
MLC 165 4/5/6/8	variable	variable - 25	70	120	0.96
MLC 172 4/5/6/8	variable	variable - 25	70	120	0.96
MLC 202 4/5/6/8	variable	variable - 25	100	150	1.20
MLC 220 4/5/6/8	variable	variable - 25	100	150	1.20
MLC 232 4/5/6/8	variable	variable - 25	114	164	1.31
MLC 262 4/5/6/8	variable	variable - 25	144	194	1.56
MLC 302 4/5/6/8	variable	variable - 25	184	234	2.21
MLC 342 5/6/8	variable	variable - 25	224	274	2.58
MLC 402 5/6/8	variable	variable - 25	284	334	3.15
MLC 432 5/6/8	variable	variable - 25	314	364	3.43
MLC 452 5/6/8	variable	variable - 25	336	384	3.62

The approximate weight is determined for dimension A = 110 mm (MLC142-262) / 140 mm (MLC 302-452) and a thickness of 6 mm.



Mezzanine floor beams
and systems

Suspended Ceiling

Structural Arrangement and Details

METSEC construction systems include structures for suspended ceilings. The suspended ceiling can be applied to primary structures of all materials: steel, concrete, wood, or their combinations.

The supporting grid for a suspended ceiling is made up of Z or C sections interconnected by stabilising members. The stabilising members may be made of ASB angle struts, HCS struts, or C sections (or Z sections) connected to the main ceiling beams by means of cleats (angle pieces) and bolts. When using C or Z sections, these can be produced with cutouts at the ends to allow connection to the main beams with minimum eccentricity.

The ceiling supporting grid must be fitted with a system of WDT diagonal ties. It is not possible to prescribe the exact number of these ties – their number and positions may vary for each

particular project and it is the designer's job to design a sufficiently stiff and stable grid structure. However, it is recommended to make at least one row of diagonal ties for every 6 rows of the ceiling main beams.

The supporting grid is suspended from the primary structure on hanger wires as shown in the following figures. These hanger wires are not included in the METSEC systems.

The entire range of sections and their accessories listed in this manual can be used for suspended ceilings.

Details of the ASB and HCS cross struts are presented on pages 38 - 40.

Details of the WDT diagonal ties are presented on page 40.

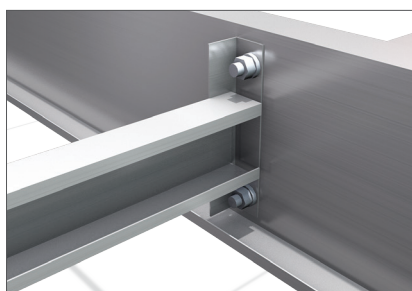


Fig. 159 – Detail HCS stabilising strut connection to the main beam of the ceiling grid. The standard joint is made with M16 bolts. If smaller bolts are needed, a requirement for a non-standard version of the HCS strut needs to be specified in the secondary steel structure documentation.

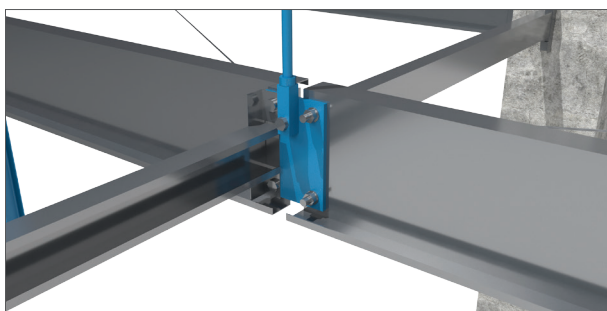


Fig. 160 – Detail of the HCS transverse stabilising strut and the hanger wire connection. The standard joint is made with M16 bolts. If the joint is to be made using smaller bolts, a non-standard version of the HCS strut needs to be requested.

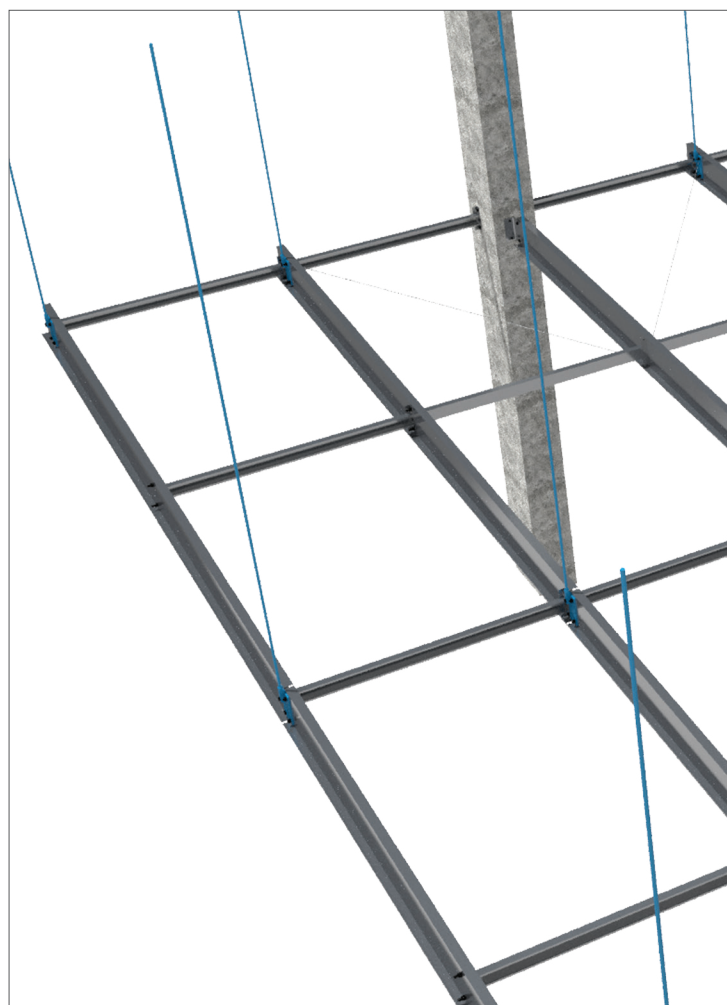
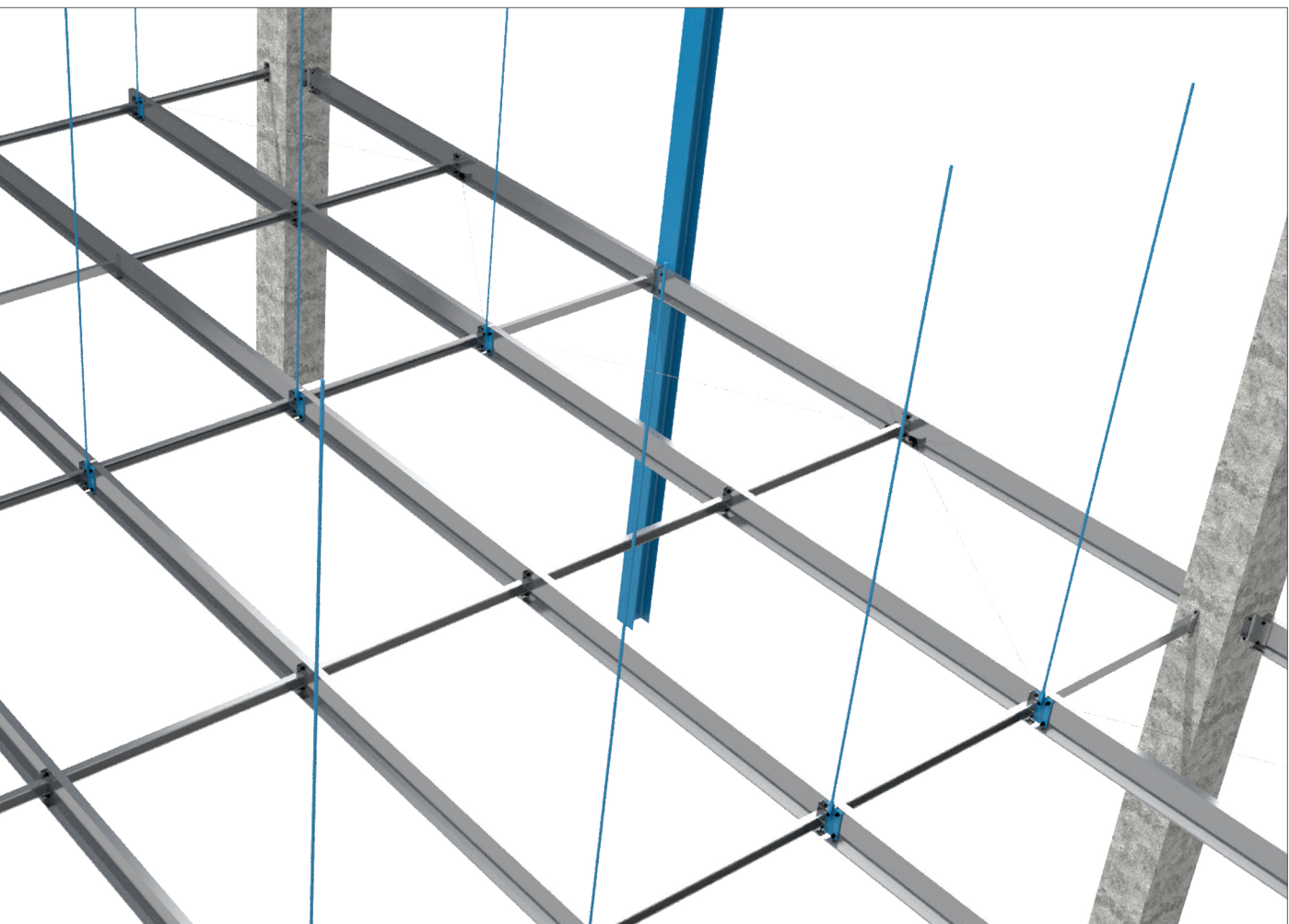
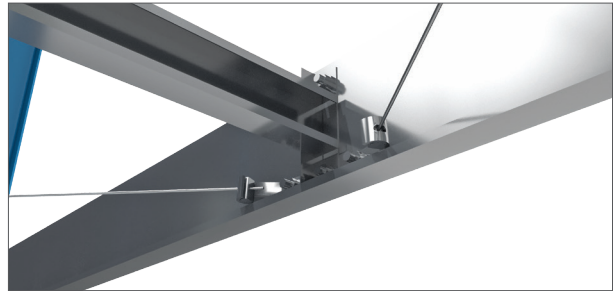


Fig. 161 – Layout of a ceiling suspended on hanger wires

Fig. 162 – Detail of the connection of the main ceiling beam and the transverse strut to a concrete column of the primary structure. The main ceiling beam is connected by means of a cleat (angle piece) and the transverse strut with an end bracket that is part of the strut.



163 – Detail of HCS transverse strut and WDT diagonal tie connection to the beam. The standard joint is made with M16 bolts. The WDT diagonal ties are made only for M16 bolt connections.



DESIGN AND STRESS ANALYSIS OF STEEL NODES

IDEA StatiCa®

IDEA StatiCa introduces a new way of designing and analysing steel connections and nodes, allowing civil engineering designers to easily design residential, industrial, infrastructure and other projects. The designers receive complete assessment reports in line with EC/AISC/CISC within minutes as well as a clear final report bearing all the details.

IDEA StatiCa Connection

IDEA Statica Connection assists in designing all types of welded and bolted joints, base plates and bracing. It generates accurate assessments and results of strength, rigidity and stability analyses of the steel nodes. Bolts, welds and foundation blocks are assessed in accordance with EC/AISC/CISC. It supports all types of rolled and welded sections and contains templates for common types of joint.

ANY SHAPE

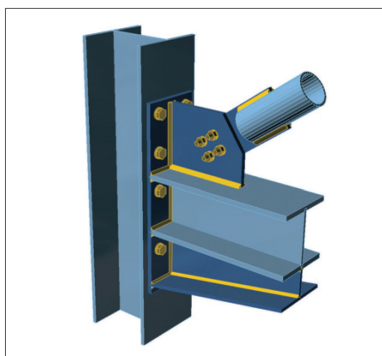
There is no limit to the number or type of members connected to a node. The node shape is based on project requirements and is not limited by the possibilities of the software.

ANY LOAD

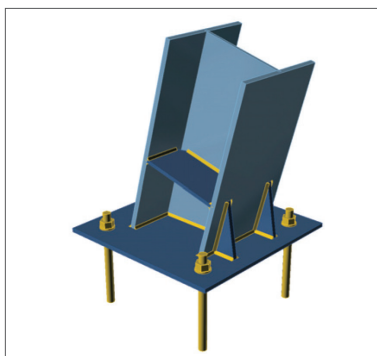
All components of the load are taken into account. The overall node evaluation includes the interaction of all members attached. Designers get a clear picture of the construction state.

ONLY A FEW MINUTES

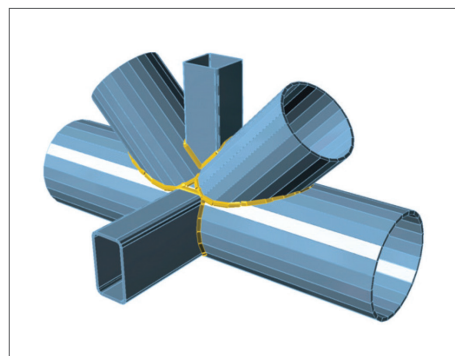
The whole design and assessment process is fast enough to be part of the everyday work of designers and manufacturers of steel structures all over the world.



2D frames & truss-work



Base plates & anchoring



3D frames & truss-work

Interface with other software

MKP programmes

Design your node from scratch or use the feature for geometry/load import from SCIA Engineer, AxisVM, RFEM, Robot, Revit, SAP 2000, ConSteel, ETABS, Advance Design or STAAD.Pro.

CAD programmes

Take advantage of the integration with Tekla Structures and Advance Steel, which will generate shop drawings and take the entire production process into consideration.

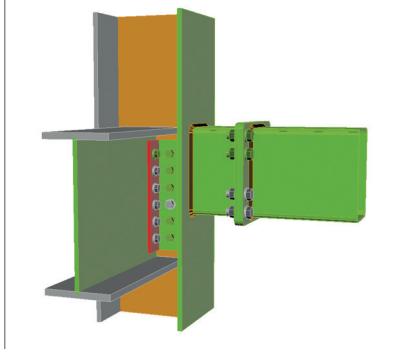
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IDEA StatiCa Connection Provides

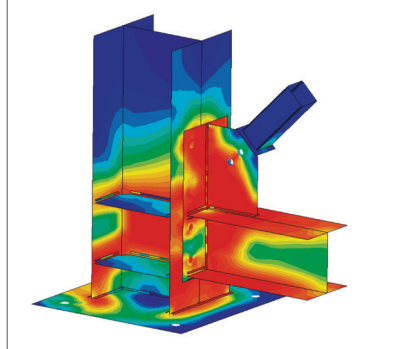
Overall assessment

In accordance to several national standards



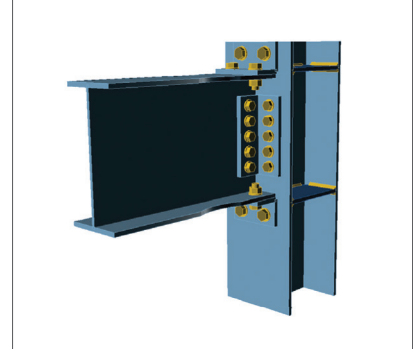
Stress/deformation analysis

A steel node FEM model is generated automatically



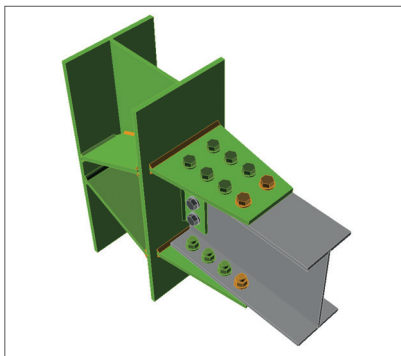
Stiffness analysis

Rotational and axial stiffness of any joint



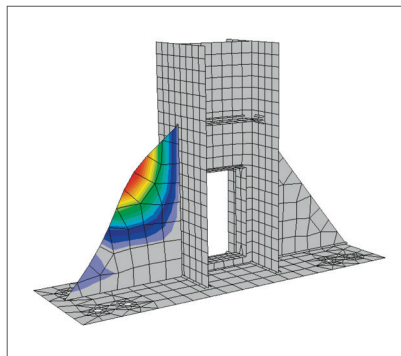
Seismicity assessment

Node assessment as to the load bearing capacity of the connected member



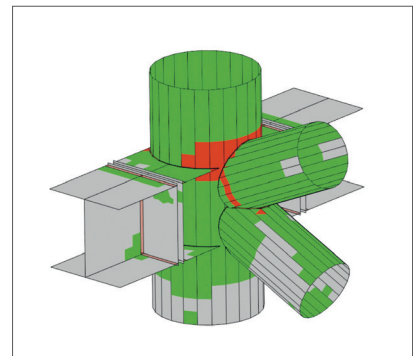
Stability analysis

Local loss of stability and critical load factors

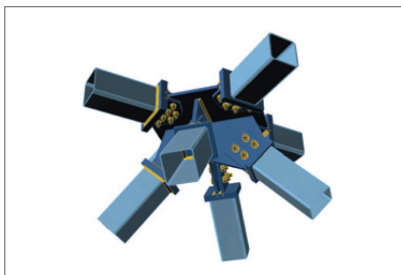


Node design capacity

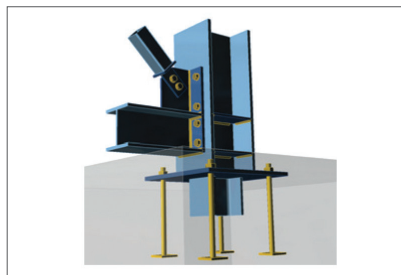
Maximum acceptable load, reserve in the node capacity



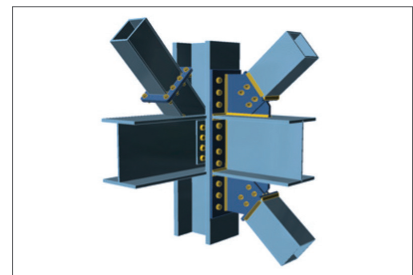
Designed by IDEA StatiCa Connection



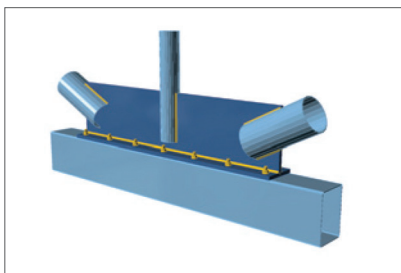
Stadium roof



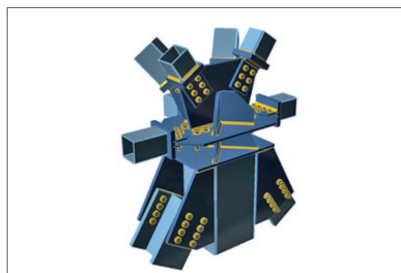
Warehouse



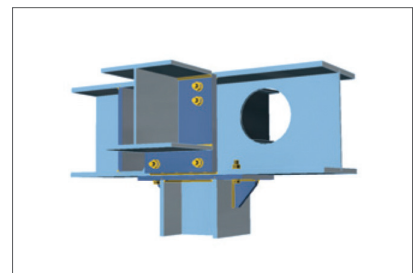
Industry hall



Footbridge



Power plant



Stadium roof

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