METSEC
MEZZANINE FLOORS

TECHNICAL MANUAL
METSEC MEZZANINE FLOORS

Structural system for mezzanine floors

voestalpine Profilform s.r.o.
www.voestalpine.com/profilform-cz/en

voestalpine
ONE STEP AHEAD.

Contents

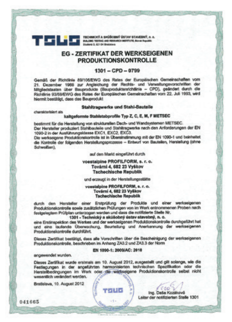
About the Company

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

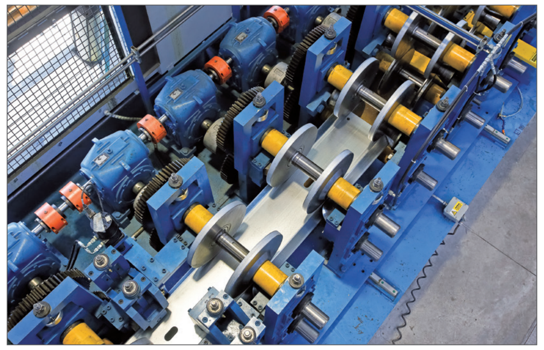
Today, voestalpine Profilform s.r.o. is one of the companies making up the Metal Forming Division within the voestalpine Concern based in Krems, Austria.

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.

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 enhanced services: consulting, technical and software support, and logistics.



Preamble

This Technical Manual presents a system solution for mezzanine floors used mainly in logistics halls. The Manual contains the basic design features of this system, which should be respected when designing, making stress analysis calculations and creating the manufacturing documentation. Failure to observe these principles may result in steel construction collapse in the extreme case. The Technical Manual is intended not only for design studios that will use the system for their projects, but also for contractors – the system installers.

The system consists of thin-walled cold-formed and galvanised C and C+ sections from which all horizontal structural elements, such as floor beams and girders, are created. This horizontal thin-walled structure must be complemented by steel columns and different accessories such as railings, floor beam stabilising bars, cleats for stair stringers, etc., which are made as traditional steelwork and can be painted or galvanised.

Apart from floor beams and girders, the voestalpine Profilform comprehensive deliveries include stabilising angle bars, stiffeners for posts and stair stringers if required. Additional components are supplied by our cooperating partners – steelwork manufacturers. We can recommend the most suitable partners and coordinate the structure design and delivery with them.

The construction can be designed using our Profilform DESIGNER software, which aids in calculation of stress analysis of all horizontal structural elements (girders and floor beams), their mutual joints and girder connections to the supporting columns. Load-bearing columns should be calculated in one of the commonly used software for designing of steelworks (e.g. Dlubal, Scia etc.)

The mezzanine floor steel structure is complemented by a suitable deck, formed mostly by chipboard or steel floor gratings. As the deck interacts with the mezzanine steel structure, proper attention needs to be paid to its design and calculation. Recommended materials for the deck are given in this Manual, along with structural and design details.

The principles and methods used in the design of the METSEC mezzanine floor system are based on many years of experience and research carried out by voestalpine Profilform s.r.o.

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 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 the manufacturers of thin-walled structural systems. Our tests and research cover a wide range of issues related to the behaviour of thin-walled floor beams and girders, including their joints. They have been carried out in cooperation with the Faculty of Civil Engineering of the Brno University of Technology (FCE-BUT). Prof. Ing. Marcela Karmazínová and Ing. Martin Horáček from the Department of Steel Structures, FCE-BUT collaborated in this research with Ing. Zbyněk Poeffel, head of the technical department for steel structures at voestalpine Profilform s.r.o.

Structural systems of METSEC mezzanine floors are designed in accordance with EC standards, taking into account the results of tests performed at the Department of Steel Structures, FCE-BUT.

The design procedures have been established based on experimental and theoretical research. Test results of different components and their behaviour within the systems as defined by us have been used for the determination of the maximum safe load. These tests and theoretical methods include designs of thin-walled steel structures according to the theories of the first and second order combined with the finite element method and design analyses based on the mentioned EC standards.

Standards and Tests Used in Calculations

Standards used in designing the METSEC mezzanine floor systems

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

The design of the Metsec systems for use in the Slovak Republic is governed by the Slovak National Application Document.

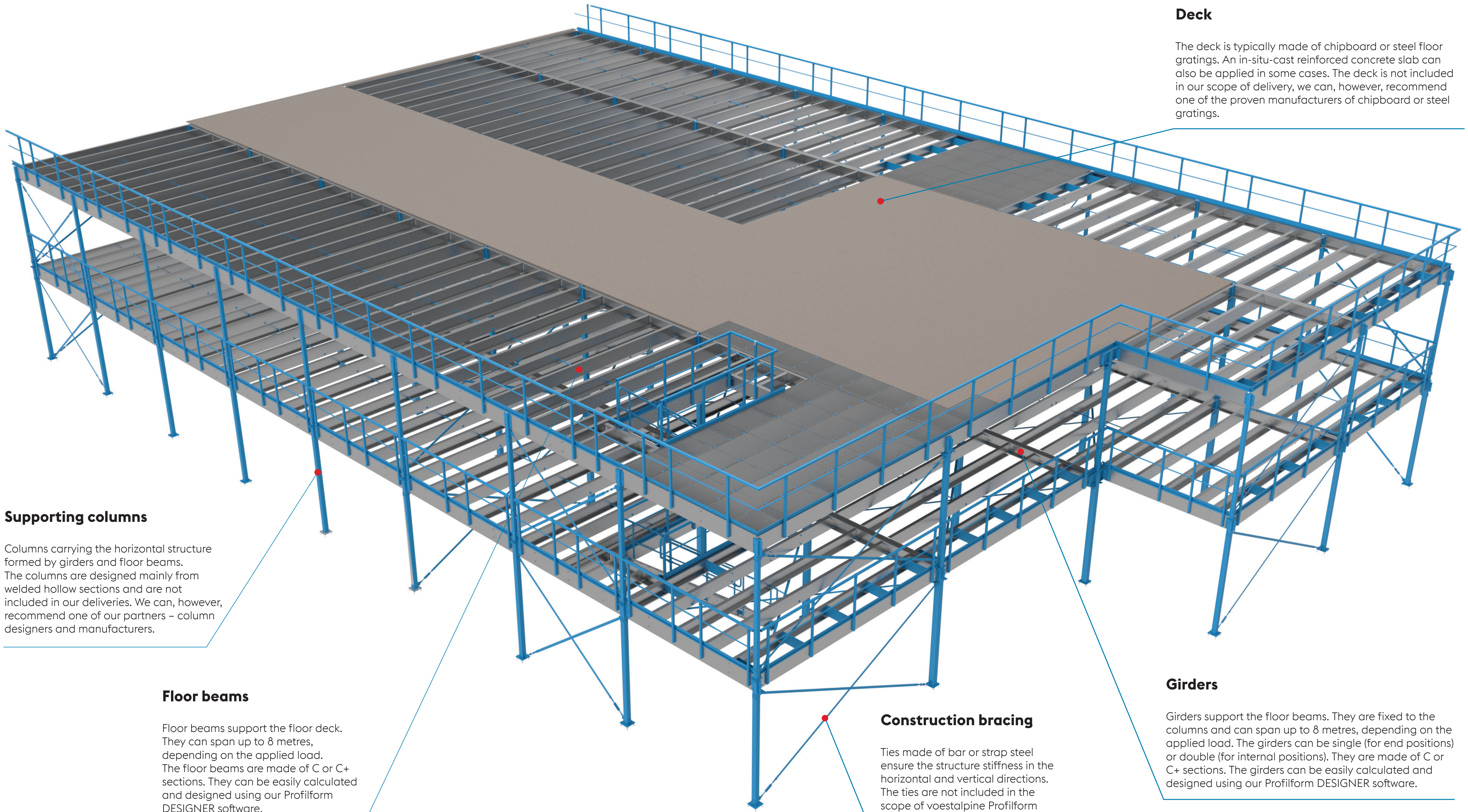
Tests performed on the METSEC mezzanine floor systems

1. Streamlining the design of thin-walled cold-formed steel beams in terms of load-bearing capacity and fire resistance – carried out in cooperation between voestalpine Profilform s.r.o. and the Department of Steel Structures, FCE-BUT (01/2020 - 06/2021)

System Structures for Mezzanine Floors

Structure description

METSEC construction systems for mezzanine floors are a smart and efficient solution for expanding the useful space, especially warehousing space in logistics halls.
They can be applied in any size ranging from small applications covering tens of square metres to complete storage floors of several thousand square metres.



Deck

The deck is typically made of chipboard or steel floor gratings. An in-situ-cast reinforced concrete slab can also be applied in some cases. The deck is not included in our scope of delivery, we can, however, recommend one of the proven manufacturers of chipboard or steel gratings.

Supporting columns

Columns carrying the horizontal structure formed by girders and floor beams.
The columns are designed mainly from welded hollow sections and are not included in our deliveries. We can, however, recommend one of our partners – column designers and manufacturers.

Floor beams

Floor beams support the floor deck. They can span up to 8 metres, depending on the applied load.
The floor beams are made of C or C+ sections. They can be easily calculated and designed using our Profilform DESIGNER software.

Construction bracing

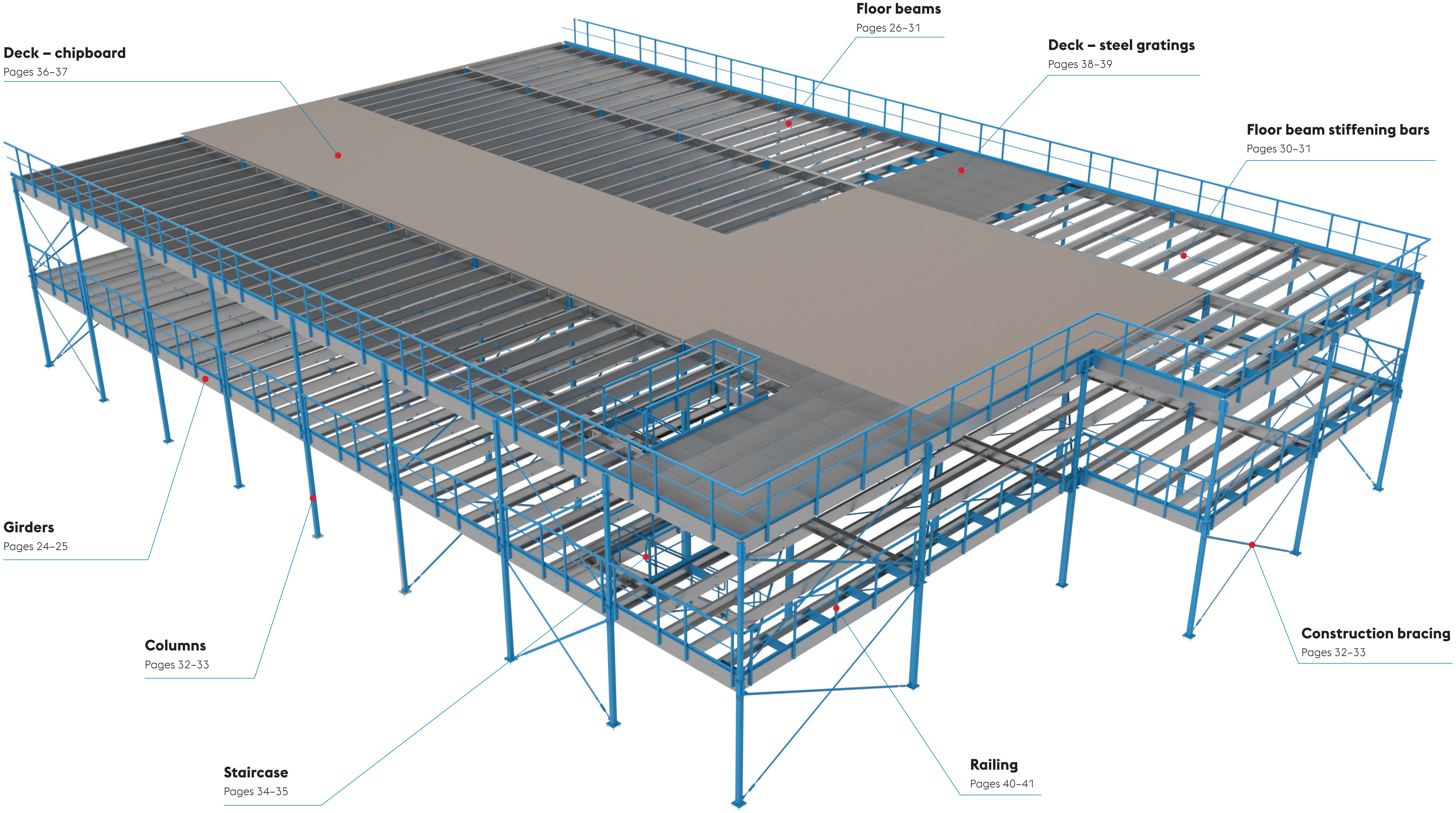
Ties made of bar or strap steel ensure the structure stiffness in the horizontal and vertical directions. The ties are not included in the scope of voestalpine Profilform delivery.

Girders

Girders support the floor beams. They are fixed to the columns and can span up to 8 metres, depending on the applied load. The girders can be single (for end positions) or double (for internal positions). They are made of C or C+ sections. The girders can be easily calculated and designed using our Profilform DESIGNER software.

System Structures for Mezzanine Floors

Main construction components



PORTFOLIO OF SECTIONS

Section Reference Code

AAA B CC

CC - reference to the material thickness. Thickness used: 1.3 – 1.4 – 1.5 -1.6 – 1.8 – 2.0 – 2.3 – 2.5 -2.7 – 2.9 – 3.0 – 3.2 – 3.5 mm

B - reference to the section shape or component group

AAA - section height in mm, height range 142–452 mm

Reference code example

402 C+ 35

Section height of 402 mm

C-shaped section with double flange bracket

Section height of 402 mm

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 / component group

C+ C-shaped section with double flange bracket. It is used mainly for girders, but it can also be used for floor beams, especially if heavily loaded. Their portfolio is listed on pages 20–21.

M C-shaped section with single flange bracket. It is used almost exclusively for floor beams, but it can be used for girders to a limited extent, especially if moderately loaded. Their portfolio is listed on pages 16–17.

Materials Used

All structural sections are made of steel with a yield strength of 450 MPa, hot-dip galvanised with a basic quality of Z350 (both-sided zinc finish of 350 g/m^2, which corresponds to a layer of 25 μm).

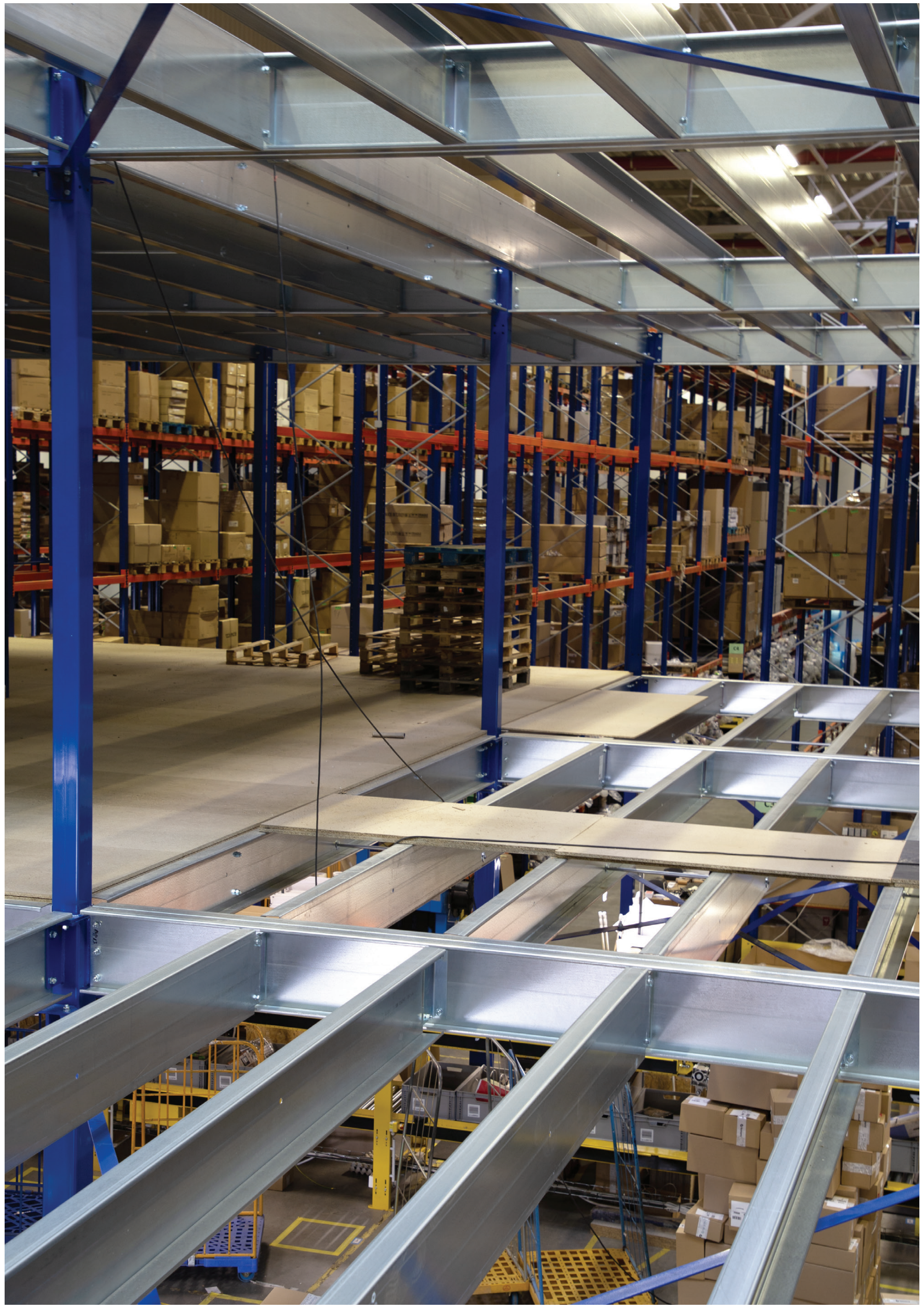
If a higher surface quality is required, we can supply galvanised finishes of:

- Z600 – both-sided zinc finish of 600 g/m^2 corresponding to a layer of 42 μm. This finish quality is available for the entire portfolio of our sections.
- Z800 – both-sided zinc finish of 800 g/m^2 corresponding to a layer of 56 μm. This finish quality is available for a limited range of sections and its use needs to be approved by us before ordering.
- Z1000 – both-sided zinc finish of 1000 g/m^2 corresponding to a layer of 70 μm. This finish quality is available for a limited range of sections, its use needs be approved by us before ordering.

The materials used for the production of structural sections follow the standards of:

– EN 10143 Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape

– EN 10346 Continuously hot-dip coated steel flat products for cold forming. Technical delivery conditions.



M SECTIONS

Portfolio 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 floor structural systems. **The system holes in M sections are differently positioned than those in the C sections intended for the secondary steel structures.**

232 = section height in millimetres

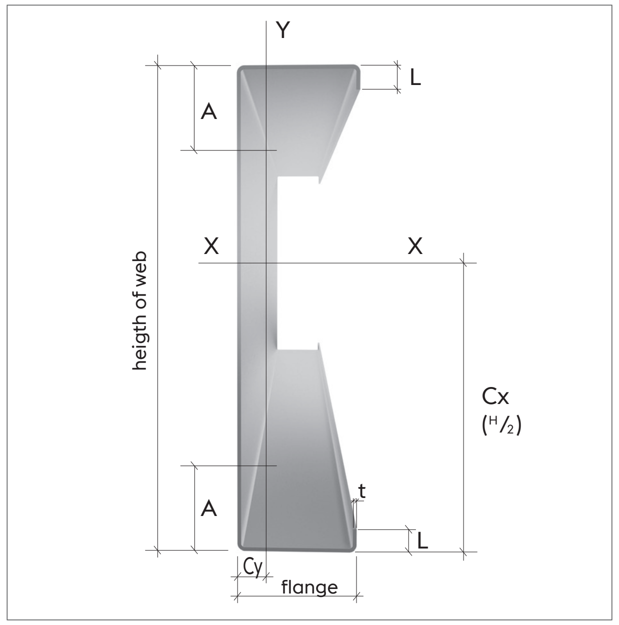


Fig. 1 – M-type section

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 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.

Standard locations of holes

This means the system holes recommended for system joints, such as the floor beam or girder attachment to an adjacent structure.

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 1 and in 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 – Positions of holes and lengths of flange brackets 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 1 and Figure 1 – 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. A minimum axis distance of 41 mm from the section edge must be observed.

General rules for making cutouts in sections

The minimum cutout length is 52 mm, and the maximum is 350 mm.

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

Positioning of cutouts 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 stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes can 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.

The Z800 or Z1000 surface treatments must be approved by us before ordering, as they are not available for the entire portfolio of our sections.

Some sections from our portfolio are supplied with galvanised edges.

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

Reference to section	Straight holes	Counterformed holes	Service holes	Cutouts
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:

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

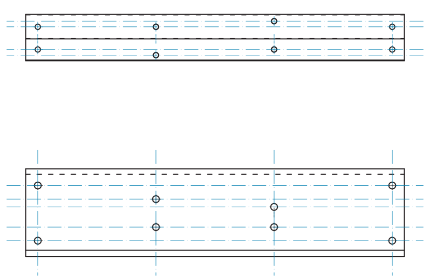


Fig. 2 – Possible layout of holes

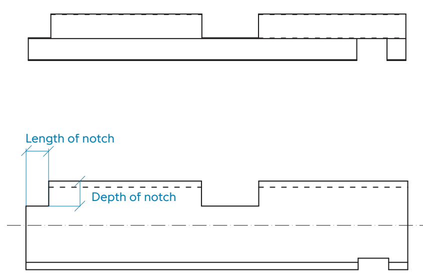


Fig. 3 - Possible layout of cutouts

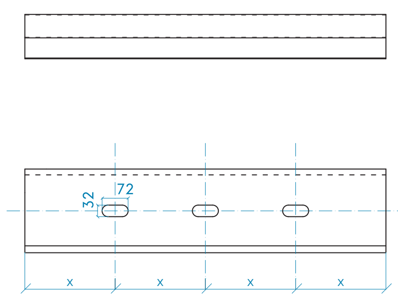


Fig. 4 – Possible layout of service holes

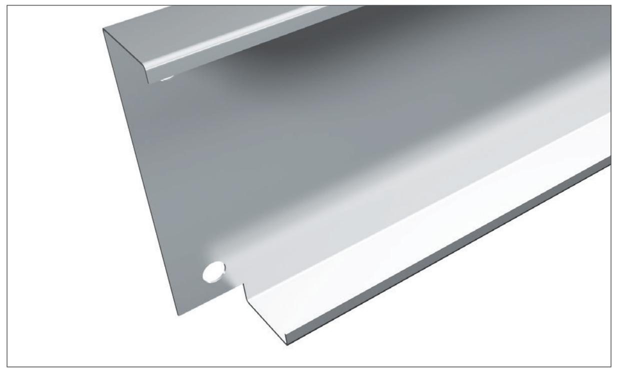


Fig. 5 – Cutout in M section

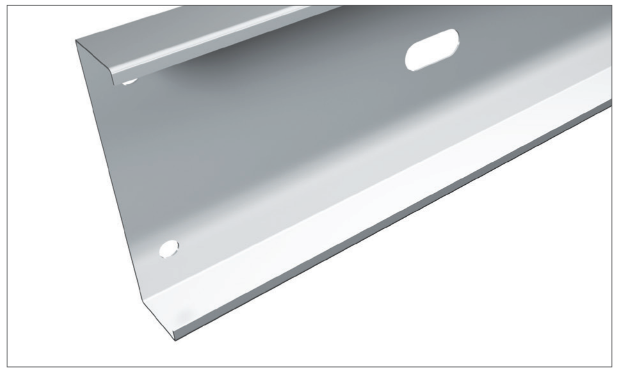


Fig. 6 – Service hole in M section

Reference code	Weight	Area	Height	Flange	Thickness	I_{yy}	I_{zz}
	kg/m	mm²	mm	mm	mm	mm⁴	mm⁴
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
mm³	mm³	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

Portfolio 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 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.

Standard locations of holes

This means the system holes recommended for system joints, such as the floor beam or girder attachment to an adjacent structure.

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 7 and in Table 4.

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

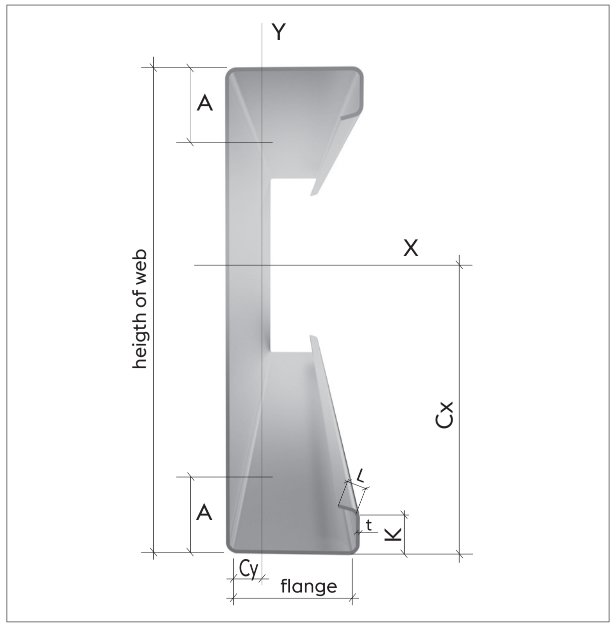


Fig. 7 – C+ type section

Tab. 4 – 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 4 and Figure 7 – 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. A minimum axis distance of 41 mm from the section edge must be observed.

General rules for making cutouts

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

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

Positioning of cutouts 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 stress analysis.

If necessary, contact our technical department.

General rules for making 'service holes'

Service holes can 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.

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.

The Z800 or Z1000 surface treatments must be approved by us before ordering, as they are not available for the entire portfolio of our sections.

Some sections from our portfolio are supplied with galvanised edges.

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

Reference to section	Straight holes	Counterformed holes	Service holes	Cutouts
142 - 452	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

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

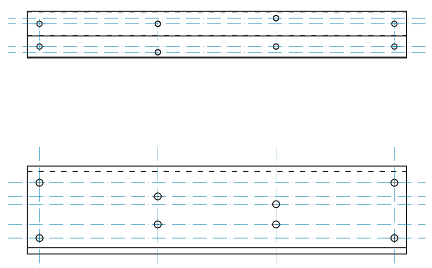


Fig. 8 – Possible layout of holes

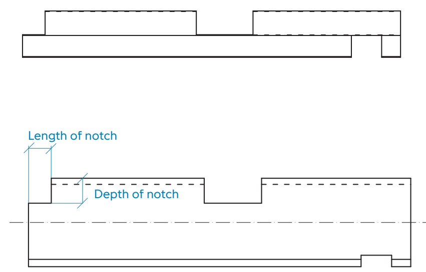


Fig. 9 - Possible layout of cutouts

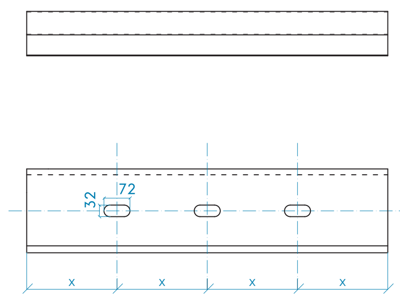


Fig. 10 – Possible layout of service holes

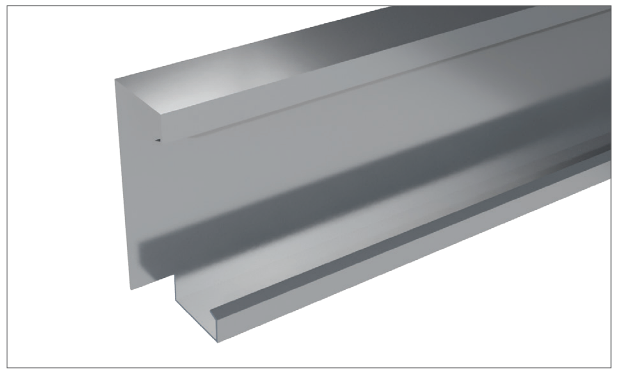


Fig. 11 – Cutouts in C+ section

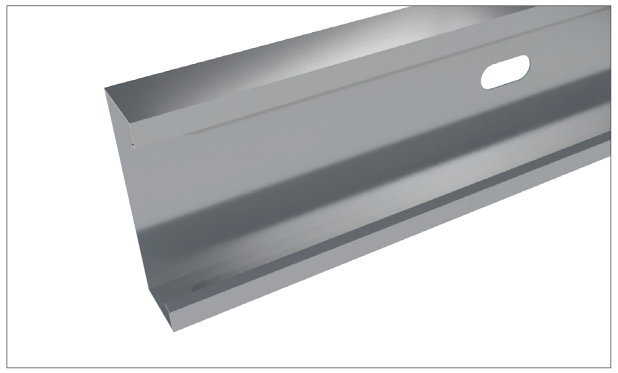


Fig. 12 – Service holes in C+ section

Reference code	Weight	Area	Height	Flange	Thickness	I_{yy}	I_{zz}
	kg/m	mm²	mm	mm	mm	mm⁴	mm⁴
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+27	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
mm³	mm³	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+27**
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**

STRUCTURE AND ITS DESIGN

Structure description

The floor construction consists of a system of **thin-walled girders** and **floor beams** supported by standard steel columns.

The columns are typically made of welded square hollow sections (pipes), complete with welded connecting plates for girders, and a base plate.

The girders are of thin-walled C+ or C sections, bolted with at least two bolts to the connecting plates welded onto columns. The number of bolts and their specifications are subject to stress analysis calculation.

The floor beams are of thin-walled C or C+ sections, bolted to girders via connecting angle pieces. The number of bolts and their specifications, as well as the specifications of the angle piece, are subject to stress analysis calculation. Each pair of floor beams must be interconnected by a stiffening bar located at the bottom of the section height. This stiffening bar prevents the section from deflecting under the applied load.

The construction stability is ensured by a system of bracing formed by ties in the planes of the columns and of the floor. In case of the floor plane, the ties are located below the bottom edge of the girders and floor beams.
The number and locations of the bracing ties needs to be determined by a stress analysis calculation.

The basic (primary) construction includes a staircase, which can be made as traditional steelwork or in the thin-walled version.
In the case of the thin-walled version, the structure is supplemented by connecting components manufactured as a traditional steel structure.

The primary construction is equipped with railings made as a traditional steel structure. For stabilising reasons, the floor structure must be provided with stiffeners at the points of the railing posts, located between the floor beam carrying the railing post and the adjacent floor beam.

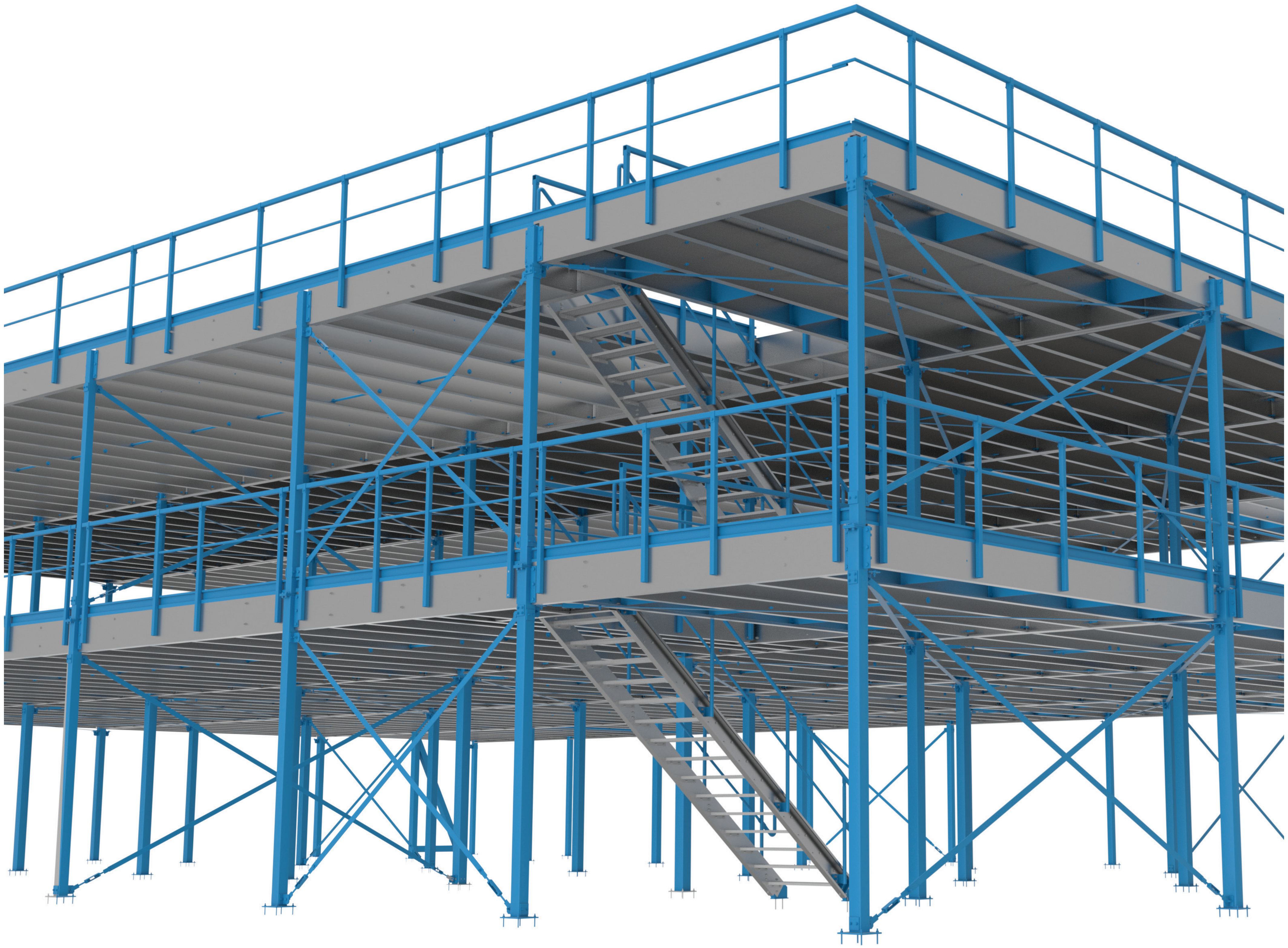
The deck is designed from chipboard of a standard thickness of 38 mm, which can be supplemented with steel floor gratings. The applicability of gratings is usually determined by fire protection design of the building. Both the board and the gratings must be able to carry the required surface load but must also be assessed in terms of the local loading effects. Since the deck gives stability to the structure, its proper fixing to the girders and floor beams is of great importance.

The chipboard is attached to the structure with 6.3 mm self-tapping screws; their maximum spacing is 600 mm. The floor grating is attached by means of metric bolts with a minimum diameter of 6 mm and a maximum spacing of 600 mm.

Components of the traditional steelwork (i.e. columns, railings or some accessories) or deck components are not supplied by voestalpine Profilform.

The stress analysis and design of thin-walled structures is carried out in the Profilform DESIGNER software developed by voestalpine Profilform s.r.o. in cooperation with Idea StatiCa s.r.o. One of the commonly used software packages for the design of steel structures needs to be used for designing the traditional steelwork parts.

A detailed description and design recommendations for the different structural components are given on the following pages.



STRUCTURE AND ITS DESIGN

Girders

Girders are primary beams supporting multiple floor beams. They are of thin-walled C+ or C sections in single or double form. Double girders are formed by a pair of sections, bolted together back-to-back at connecting points of the floor beams. They are used mainly for inner, sometimes for peripheral positions – wherever a single girder bearing capacity would not suffice. Double girders are equipped with liners at the joints of the floor beams. The liner is of the same thickness as the plate connecting the girder to the column. The connecting plate is usually welded onto the column, or alternatively it can be bolted to it.

Girders and their connections can be designed using our specialised Profilform DESIGNER software.

Girder Summary

Span	Maximum span = 8.00m
Static model	Simply supported beam
Stress analysis	Profilform DESIGNER (PFD), System Mezzanine module Standard Girdle Connection shown in Fig. 13 can be designed using PFD. Non-standard girdle connection shown in Fig. 14 can be designed using IDEA StatiCa Connection
Structural section	C+ / C IN SINGLE OR DOUBLE FORM
Fasteners	Bolts, at least M16 and 8.8 grade. Holes for fasteners = bolt diameter + 2 mm (standard 18 mm holes for M16 bolts)

Design rules

- Girders are always calculated 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 joint are designed using the IDEA StatiCa Connection software, which is incorporated in Profileform DESIGNER.
- Girders are designed without co-action of the ceiling slab, their stabilisation ensured by the attached floor beams. The floor deck, however, does contribute to girder stability and therefore it needs to be adequately attached to the girder with spacing of fasteners not greater than 600 mm.
- The girder is typically fixed to the column with 1–3 pairs of M16 bolts of 8.8 grade, with washers under the bolt head and under the nut. Profilform DESIGNER cannot be used if a different type of connection is required.
- 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 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.

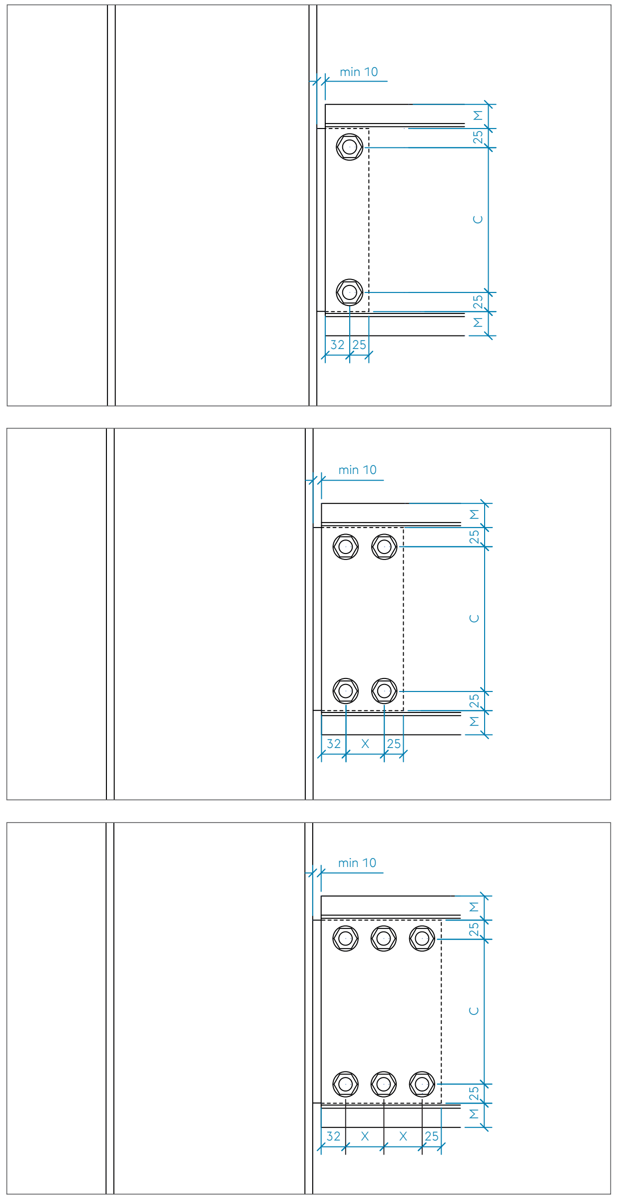


Fig. 13 – Girder connection to the column using one to three pairs of bolts

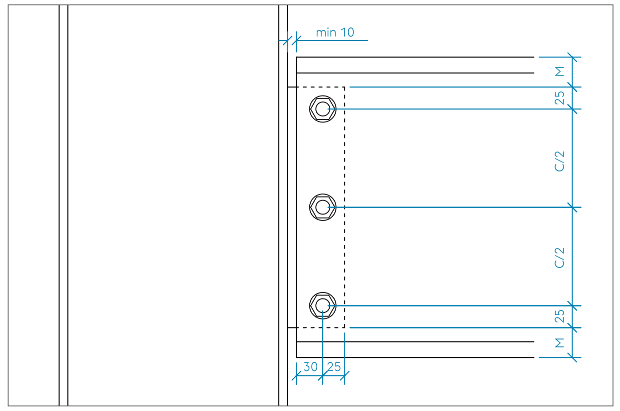
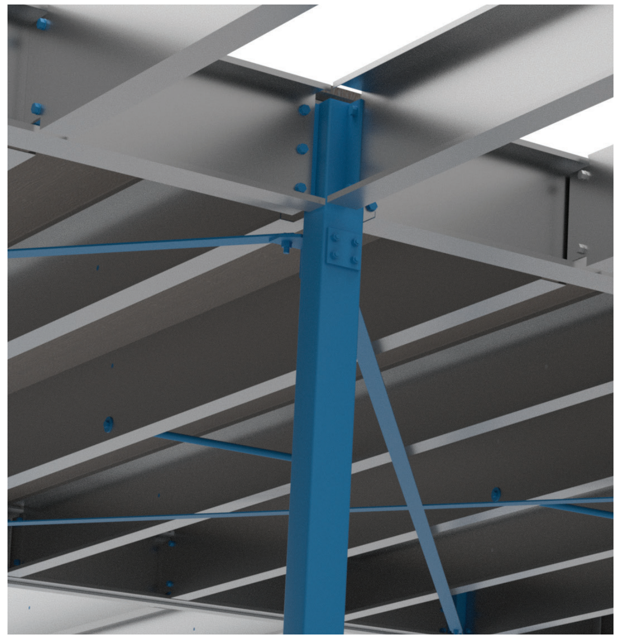


Fig. 14 – Detail of the girder-to-column connection using three bolts



STRUCTURE AND ITS DESIGN

Floor beams

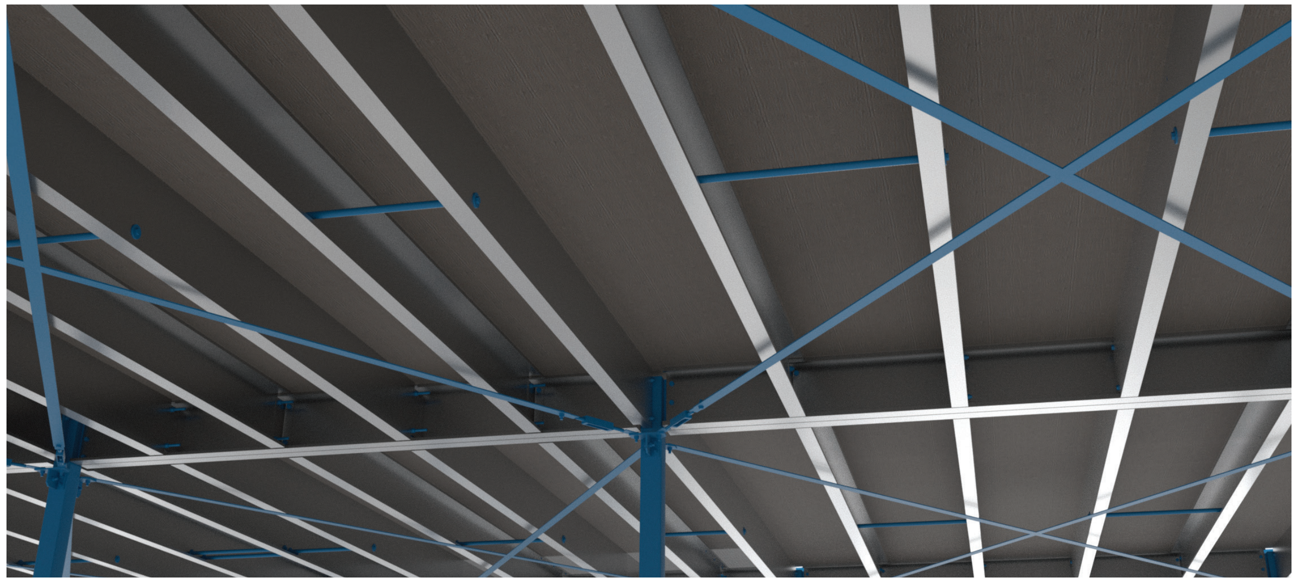
Floor beams carry the floor deck. They are of thin-walled C sections or C+ sections in the case of heavily loaded structures. The floor beams are connected to the girders by means of angle pieces and two pairs of M16 bolts.
The connecting angle pieces are designated as MLC cleats and their dimensions need to be calculated by a stress analysis.

Floor Beam Summary

Span	Maximum span = 8.00m
Static model	Simply supported beam
Stress analysis	Profilform DESIGNER (PFD), System Mezzanine module Floor Beam Design + Connections
Fasteners	Bolts, at least M16 and 8.8 grade. Holes for fasteners = bolt diameter + 2 mm (standard 18 mm holes for M16 bolts)
Floor beam interconnection	A threaded rod or a tie with a diameter of at least 12 mm, located horizontally in the middle of the span and vertically in the lower half of the section height

Design rules

- The recommended difference between the girders and the floor beams is two reference heights of the sections. This may be three reference heights for floor beams made of 150, 432 or 220 sections. This rule applies to the connections of a thin-walled floor beam to a thin-walled girder.
  It does not have to be observed in case of girders made of IPE, HEA or similar sections.
- These types of joints can be designed using the IDEA StatiCa Connection software, which is incorporated in Profileform DESIGNER.
- The stability of the compressed flange of the floor beam is ensured by the deck. It is crucial to ensure adequate fixing of the deck using self-tapping screws (chipboard floor) or metric bolts (floor gratings) with a distance between them not larger than 600 mm.
- Pairs of floor beams must be interconnected by a bar fixed above the lower flange (tables 9 and 10 show the recommended distance of the hole for the rod from the section's lower edge) at least in the middle of the floor beam span, as shown in Figure 24. In the case of an odd number of floor beams, the last three need to be interconnected, with two bars being used for the odd beam, as shown in Figure 25.
- The recommended maximum spacing of the floor beams is 1.00 metre. Please contact our technical support if a larger spacing is required.



Floor beams

Detail of the connection of the floor beam without a cut-out to the girder

The B and C dimensions are shown in Table 7.

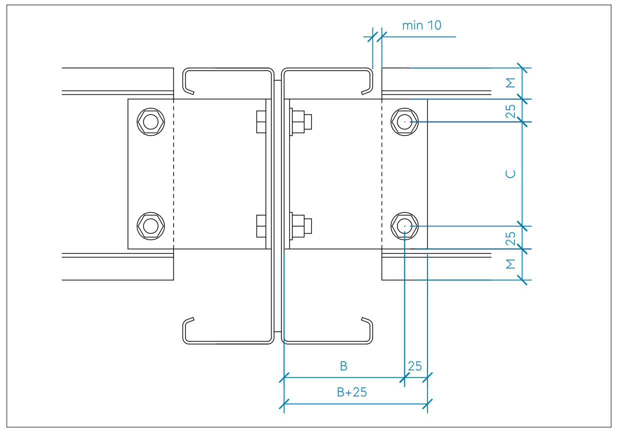


Fig. 15 – Detail of double-sided floor beam connection to a C+ girder

The B and C dimensions are shown in Table 7.

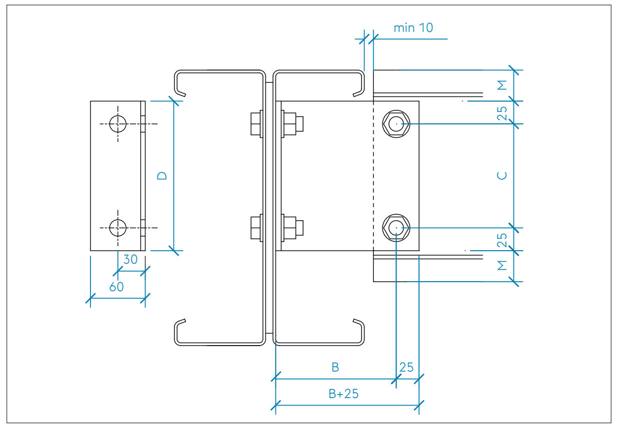


Fig. 16 – Detail of one-sided floor beam connection to a C+ girder

C+ girders and floor beams of the M 142, 150, 165, 172, 202 sections cannot be combined.
This is due to the collision of the connecting angle piece and the double bracket of the C+ section flange.

If such a combination is inevitable, a non-standard connection detail needs to be developed.

If a girder is made of M-type sections, it can be combined with the entire portfolio of floor beam sections.

Tab. 7 – B and C dimensions of the floor beam to girder connection

Section reference height	Dimension B	Dimension C
mm	mm	mm
142	variable - 25	60
150	variable - 25	60
165	variable - 25	70
172	variable - 25	70
202	variable - 25	100
220	variable - 25	100
232	variable - 25	114
262	variable - 25	144
302	variable - 25	184
342	variable - 25	224
402	variable - 25	284
432	variable - 25	314
452	variable - 25	334

Floor beams

Detail of the connection of the floor beam with a cut-out to the girder

Legend to Figures 17–22
f - flange width (see Metsec catalogue)
t - girder section thickness
k - gap between floor beam cutout and girder (15mm)

The position of bolts in the floor beam is always: X2 = f-2
Cutout height in C+ sections: 33 mm
Cutout height in M sections: v = lip + 4

C+ girders and floor beams of the M 142, 150, 165, 172, 202 sections cannot be combined.
This is due to the collision of the connecting angle piece and the double bracket of the C+ section flange.

If such a combination is inevitable, a non-standard connection detail needs to be developed.

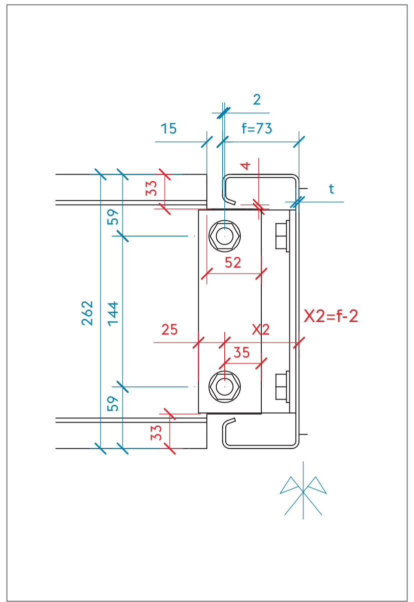


Fig. 17 – Example of a connection of a floor beam made of 262C+15 to a girder made of 262C+25

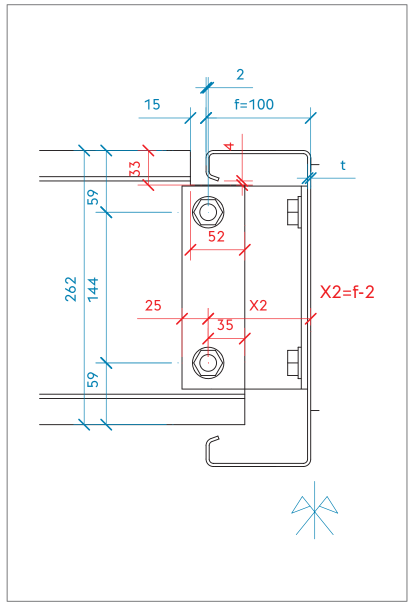


Fig. 18 – Example of a connection of a floor beam made of 262C+15 to a girder made of 302C+25

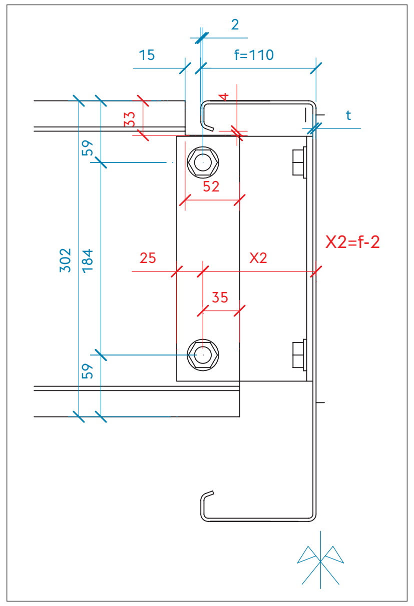


Fig. 19 – Example of a connection of a floor beam made of 302C+20 to a girder made of 402C+25

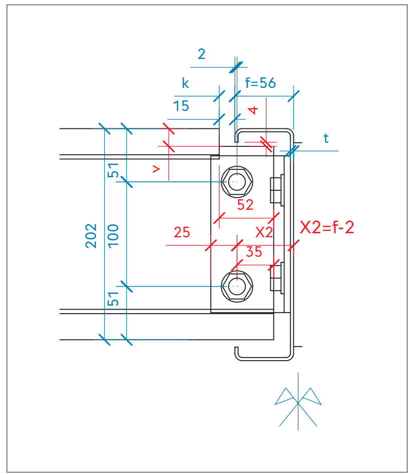


Fig. 20 – Example of a connection of a floor beam made of 202M15 to a girder made of 220M25

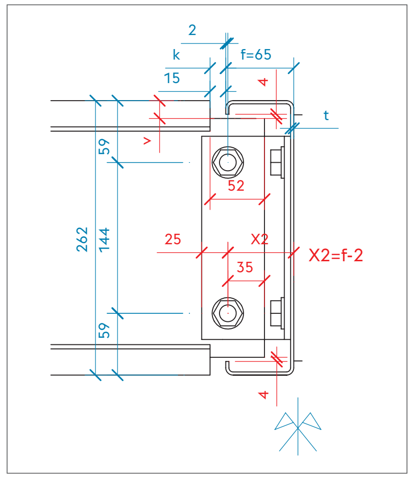


Fig. 21 – Example of a connection of a floor beam made of 262C+15 to a girder made of 262M25

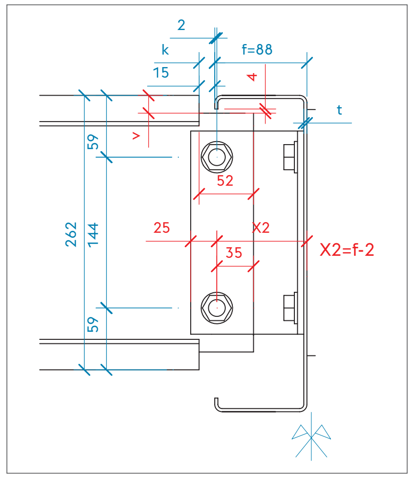


Fig. 22 – Example of a connection of a floor beam made of 262C+15 to a girder made of 302M25

Floor beams

MLC Cleats

They are used for fixing a floor beam to a girder or alternatively for fixing a girder to a column.
The required MLC thickness needs to be determined by stress analysis. The length of this cleat is variable, depending on the joint detail. It must be specified in the production documentation.

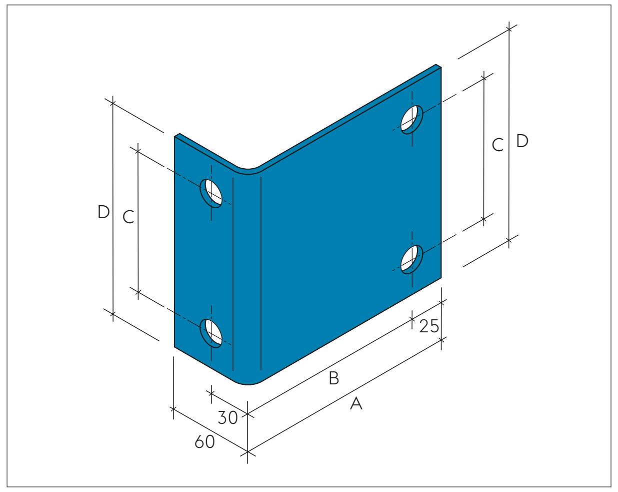
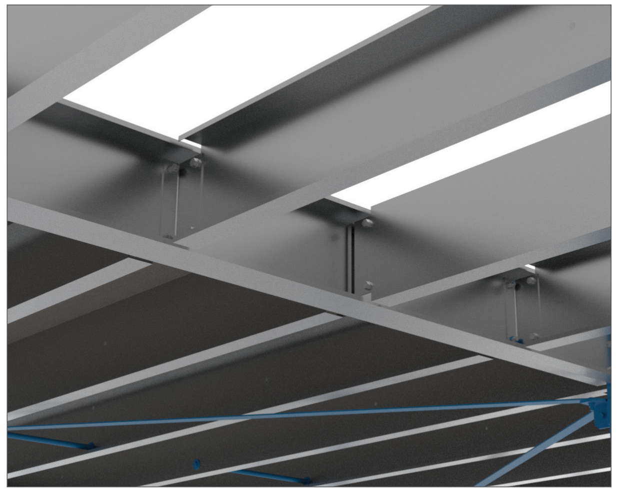


Fig. 23 – MLC cleat



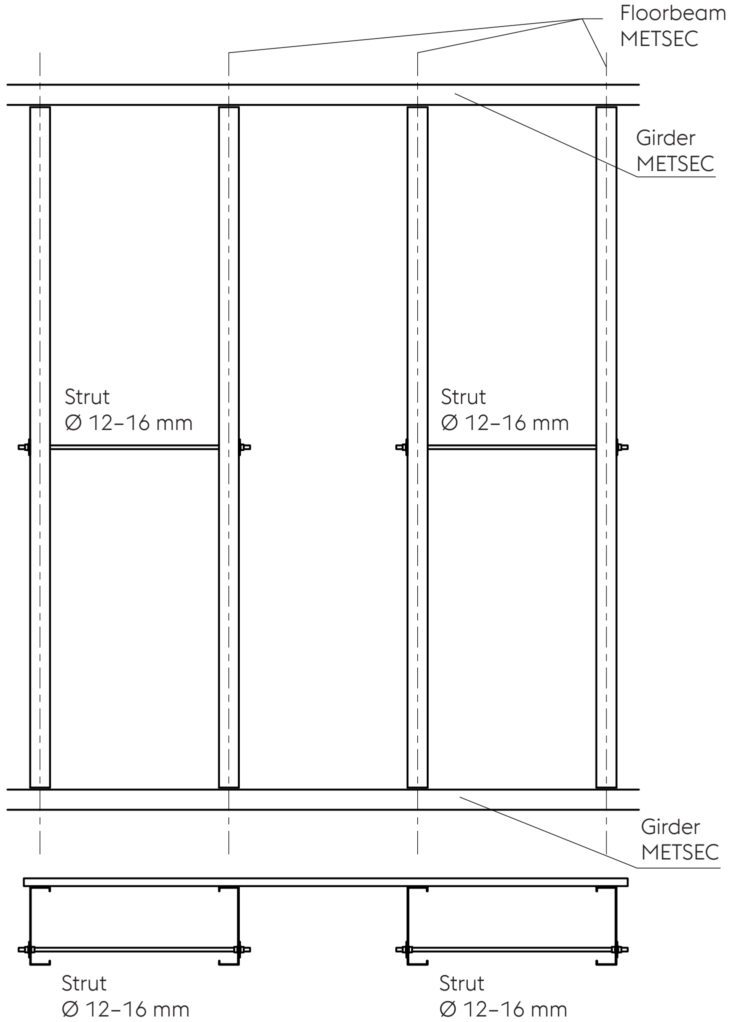
Tab. 8 – MLC cleat dimensions

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	334	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.

Floor beams

Stiffening Bars – Even Number of Floor Beams

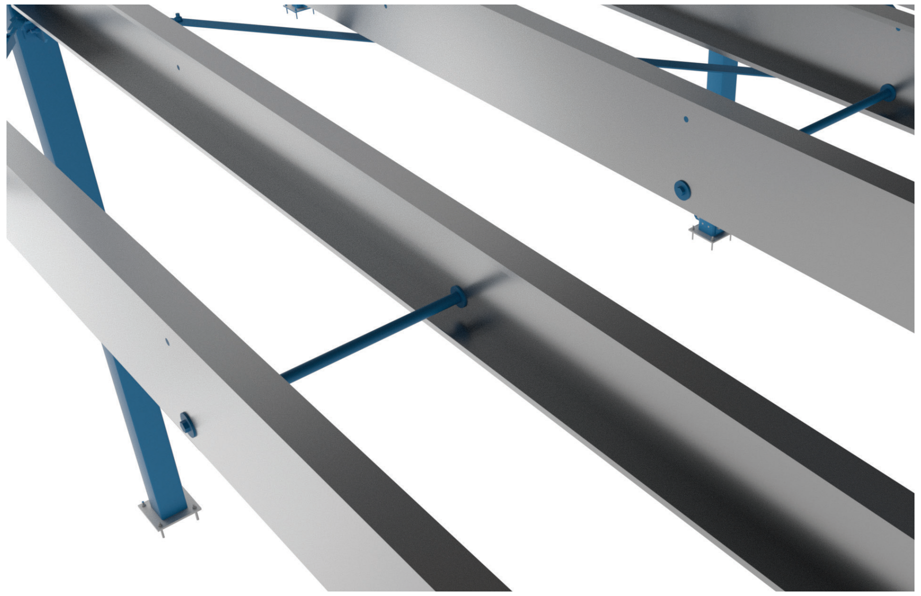


- Each pair of floor beams must be interconnected by a bar fixed in the lower half of the floor beam section. The position of the hole for the bar is given by the system and is fixed for different section heights – see Table 9.

Rules for placement of stiffening bars

- **Floor beam span of 2–5 m = 1 bar in the middle of the span**
- **Floor beam span of 5–6 m with design load of up to 10 kN/m² = 1 bar in the middle of the span**
- **Floor beam span of 5–6 m with design load of over 10 kN/m² = 2 bars in the thirds of the span**
- **Floor beam span of 6–8 m = 2 bars in the thirds of the span**
- The stiffening bar stabilises the position of the lower flanges of the floor beams when under load.
- The stiffening bar can be designed as a threaded rod, round steel, or a pipe with a diameter of 12–16 mm.
- A washer with a diameter of at least 50 mm and a thickness of 4 mm must be used at the points of the stiffening bar connection to the floor beam.
- The washer should be located on the outer side of the floor beam section.

Fig. 24 – Diagram of the stiffening bars in a layout with an even number of floor beams



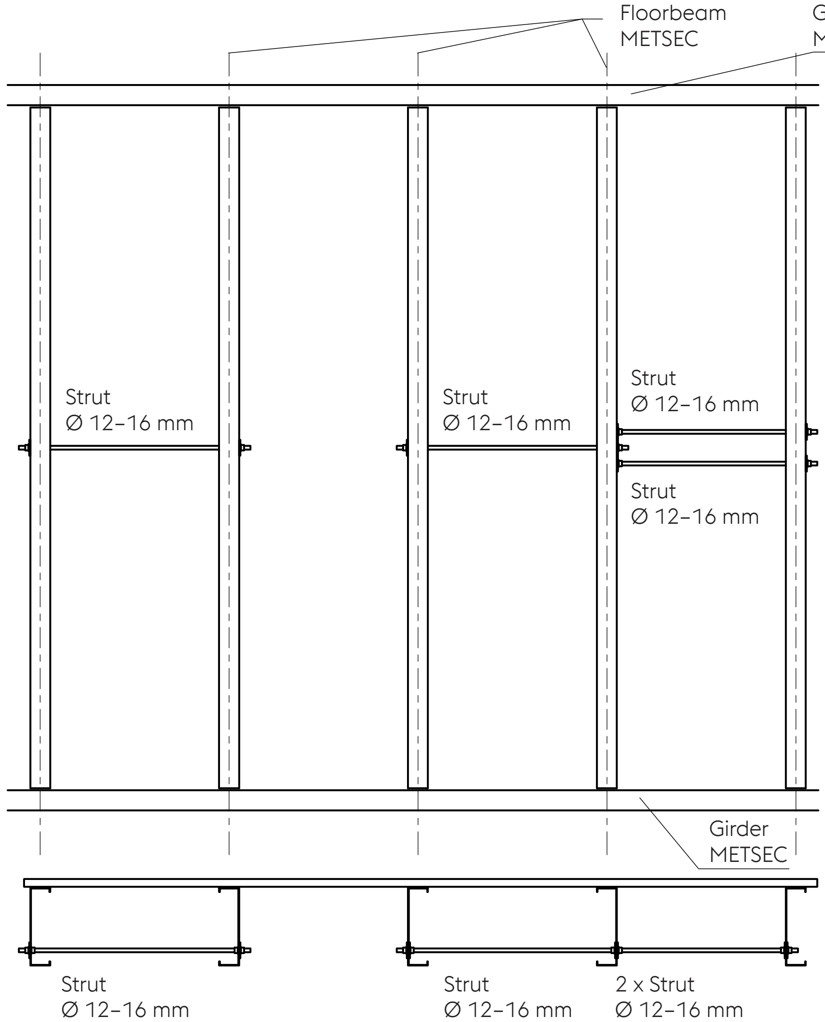
Tab. 9 – distance of the hole for the bar from the lower edge of the floor beam

Section reference height	Dimension A
mm	mm
142	41
150	45
165	47.5
172	51
202	51
220	60
232	59
262	59
302	59
342	59
402	59
432	59
452	59

METSEC

Floor beams

Stiffening Bars – Odd Number of Floor Beams



- Each pair of floor beams must be interconnected by a bar fixed in the lower half of the floor beam section. The position of the hole for the bar is given by the system and is fixed for different section heights – see Table 10.

Rules for placement of stiffening bars

- **Floor beam span of 2–5 m = 1 bar in the middle of the span**
- **Floor beam span of 5–6 m with design load of up to 10 kN/m² = 1 bar in the middle of the span**
- **Floor beam span of 5–6 m with design load of over 10 kN/m² = 2 bars at each third of the span**
- **Floor beam span of 6–8 m = 2 bars at each third of the span**
- The stiffening bar stabilises the position of the lower flanges of the floor beams when under load.
- The stiffening bar can be designed as a threaded rod, round steel, or a pipe with a diameter of 12–16 mm.
- A washer with a diameter of at least 50 mm and a thickness of 4 mm must be used at the points of the stiffening bar connection to the floor beam.
- The washer should be located on the outer side of the floor beam section. In the case of an odd floor beam, the washer should be used on both sides of the floor beam section.

Fig. 25 – Diagram of the stiffening bars in a layout with an odd number of floor beams

Tab. 10 – distance of the hole for the bar from the lower edge of the floor beam

Section reference height	Dimension A
mm	mm
142	41
150	45
165	47.5
172	51
202	51
220	60
232	59
262	59
302	59
342	59
402	59
432	59
452	59

STRUCTURE AND ITS DESIGN

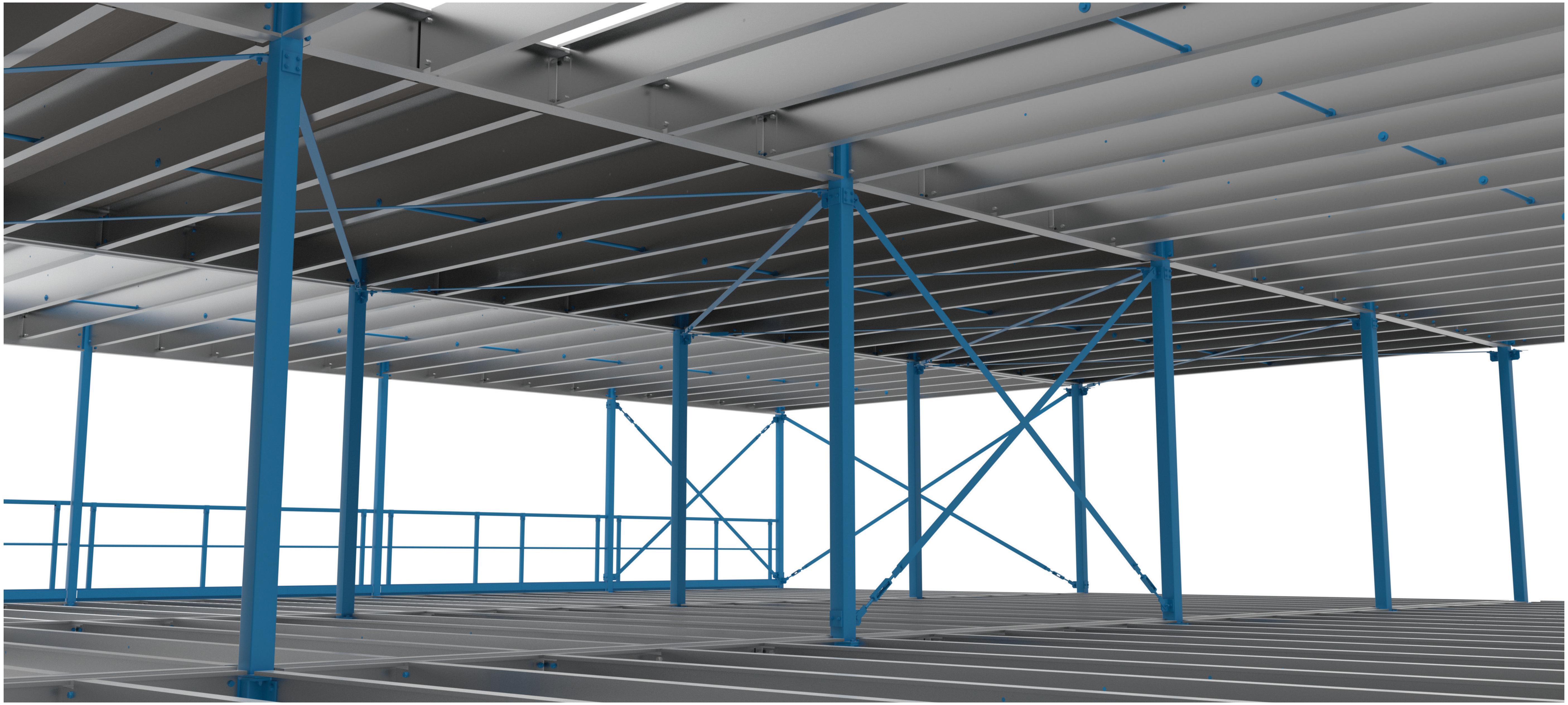
Columns and Bracing

The columns support horizontal structural elements, such as girders and possibly floor beams, if located at the intersections of system axes. The columns are usually made of square-shaped hollow steel sections and are completed with welded fixing plates for girders and possibly floor beams. The columns are also equipped with brackets for attaching the structural stiffeners (bracing), in both the horizontal and vertical planes.

The construction bracing is achieved by a system of bars in the horizontal and vertical planes. The horizontal plane is located below the lower flanges of the girders or floor beams. The stiffeners are usually made of strap (or round) steel and are equipped with tensioners for their bracing. The number and positions of stiffeners should be determined by the stress analysis of the whole construction.

Columns and bracing cannot be designed within the Profilform DESIGNER software, specialised software for the design of steel structures needs to be used.

Neither columns nor bracing are supplied by voestalpine Profilform s.r.o.



STRUCTURE AND ITS DESIGN

Staircase

The staircase is designed as a combination of thin-walled and welded structural components.
The stair stringers are of thin-walled sections, bolted to the stair girders or to the floor via cleats of welded steel. The stair steps are usually made of steel grating.

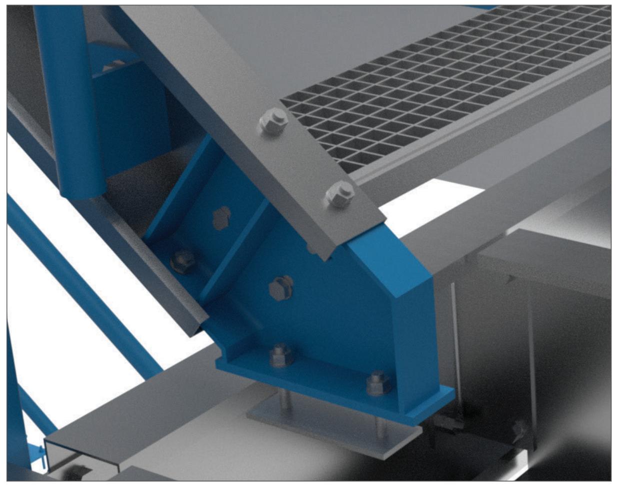
Span	Recommended maximum length = 10.00 m
Static model	Simply supported beam
Stress analysis	Please contact our technical department
Structural section	C + / minimum section height: 232 mm
Fasteners	Bolts, at least M16 and 8.8 grade. Holes for fasteners = bolt diameter + 2 mm (standard 18 mm holes for M16 bolts)

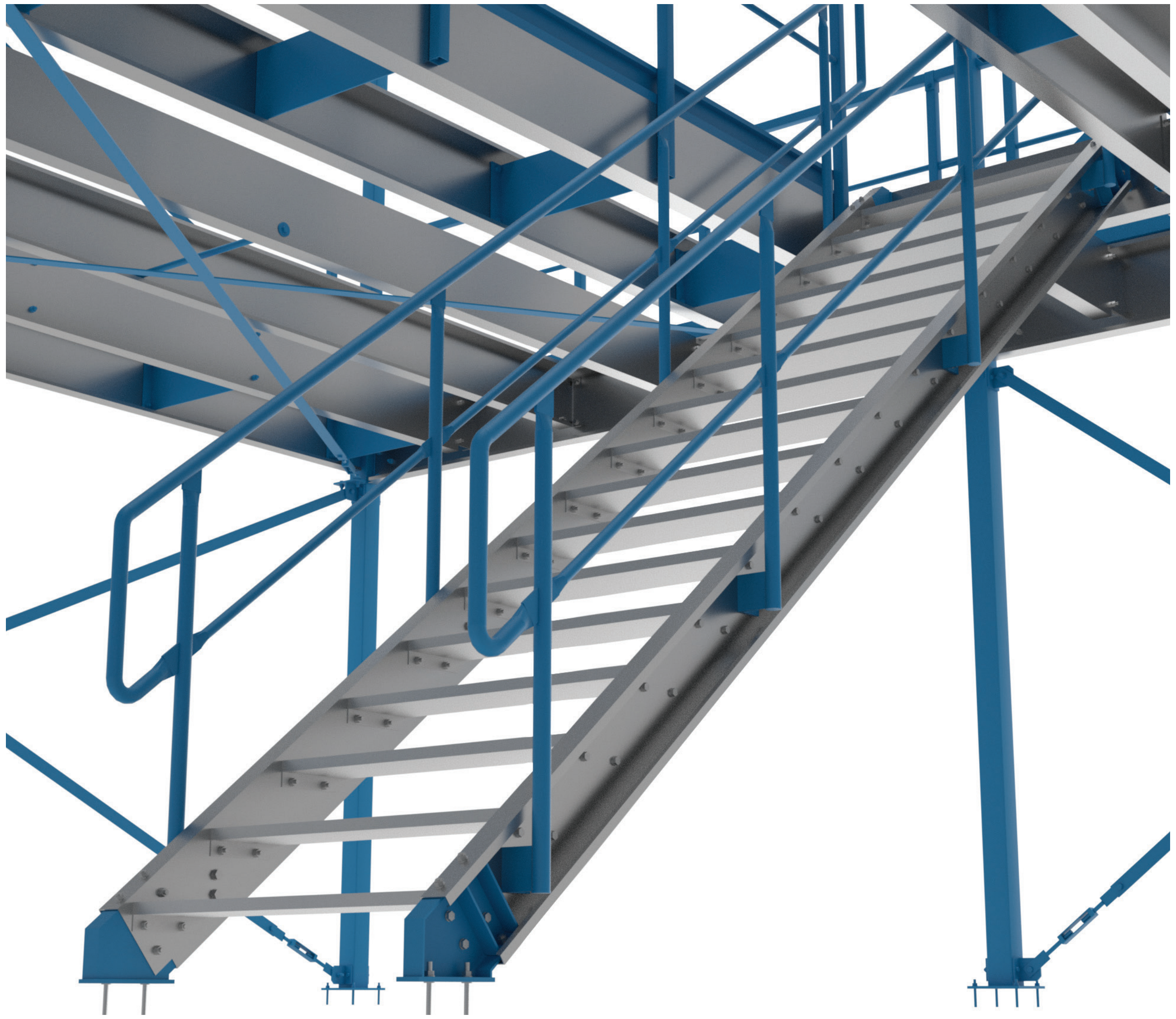
Design rules

- Always use the C+ sections for stair stringers.
- The minimum height of the stair stringer should be 232 mm. We recommend using the thickest section available within the range of sections of the selected height.
- We recommend designing stair stringers for a deflection of at least L/300, where L = length of the stair stringer.
- Connection to the chipboard deck – The deck should always be supported with a stair girder or a reinforcing beam at the staircase connection point.

METSEC

Staircase





STRUCTURE AND ITS DESIGN

Chipboard Deck

The system floor deck of chipboard transfers the load to the secondary floor beams, which then transfer it to the primary beams (girders). The deck is an important structural component that gives rigidity to the floor structure and holds the floor beam upper flanges against deflection. The deck must be firmly fixed to the floor beams and girders; the maximum spacing of the fasteners is 600 mm. The deck itself must be designed to carry the design load plus the point loads generated, for example, by the pallet truck wheels, rack system columns, etc. The deck must also meet the maximum allowable deflection criteria.

Design rules

- The recommended deck thickness is 38 mm.
- The maximum span of self-tapping screws fixing the deck to the floor beams and girders is 600 mm. The layout of the screws is shown in Fig. 26.
- We recommend using self-tapping screws with a diameter of 6.3 mm. The screws must be applicable to steel with a yield strength of 450 MPa. When selecting screws, make sure that their ‚drilling' capacity is sufficient for the material thickness of the different beams and girders.
- Joints of the boards must always be on top of beams and each board end fixed with its own screws – see Fig. 26.
- The maximum recommended board overlap over the beam edge (cantilever) is 200 mm.
- Chipboard manufacturer's rules and installation instructions must be followed when installing the deck.

Chipboard Deck

Standard method of fixing 38 mm DTD board to Metsec sections forming a mezzanine floor

(cut-out from the deck structure)

Example of fixing the 1000×2500 mm boards to floor beams spaced at 833 mm.

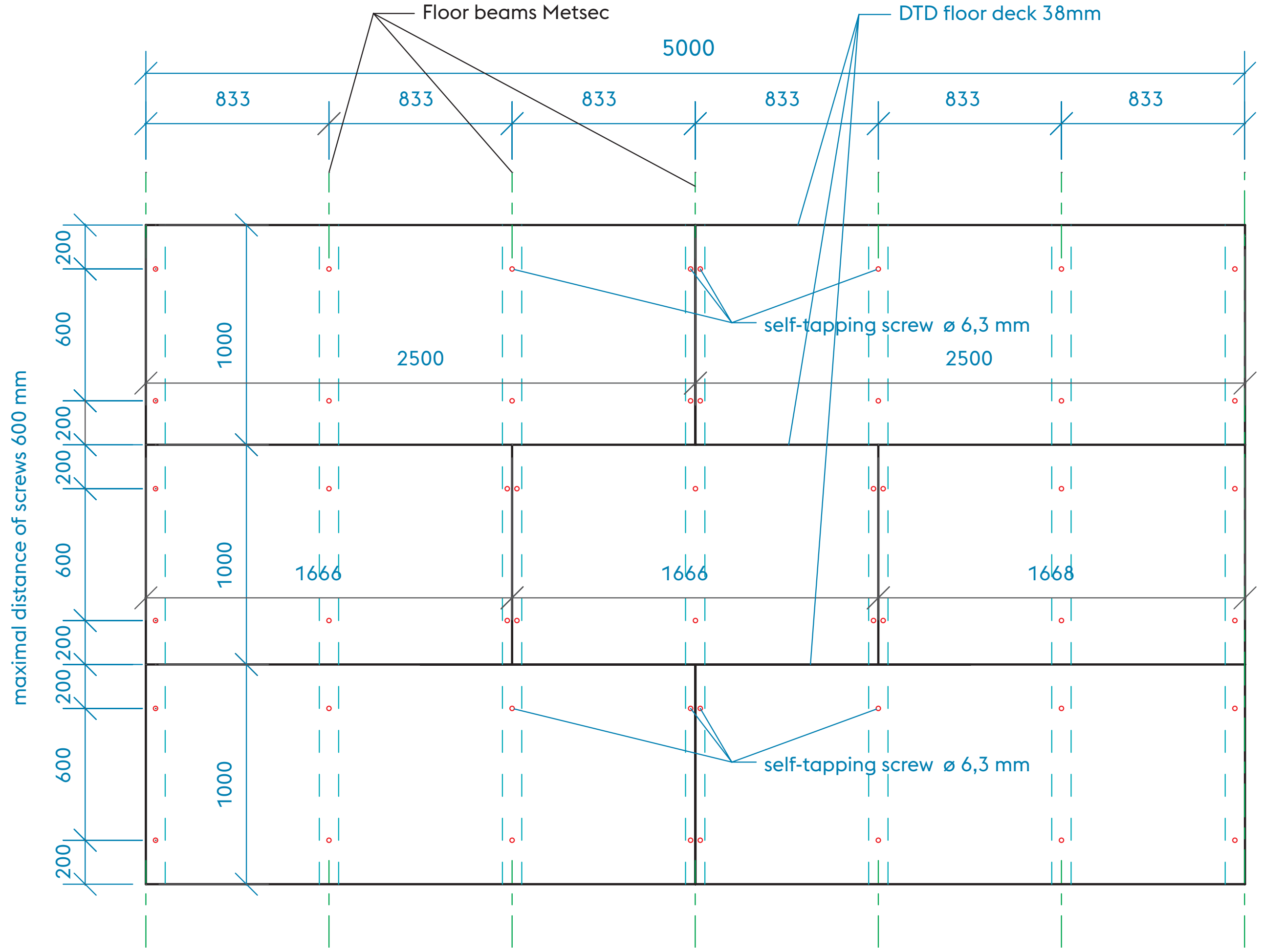


Fig. 26 – Layout of the screws fixing the deck to the floor beams

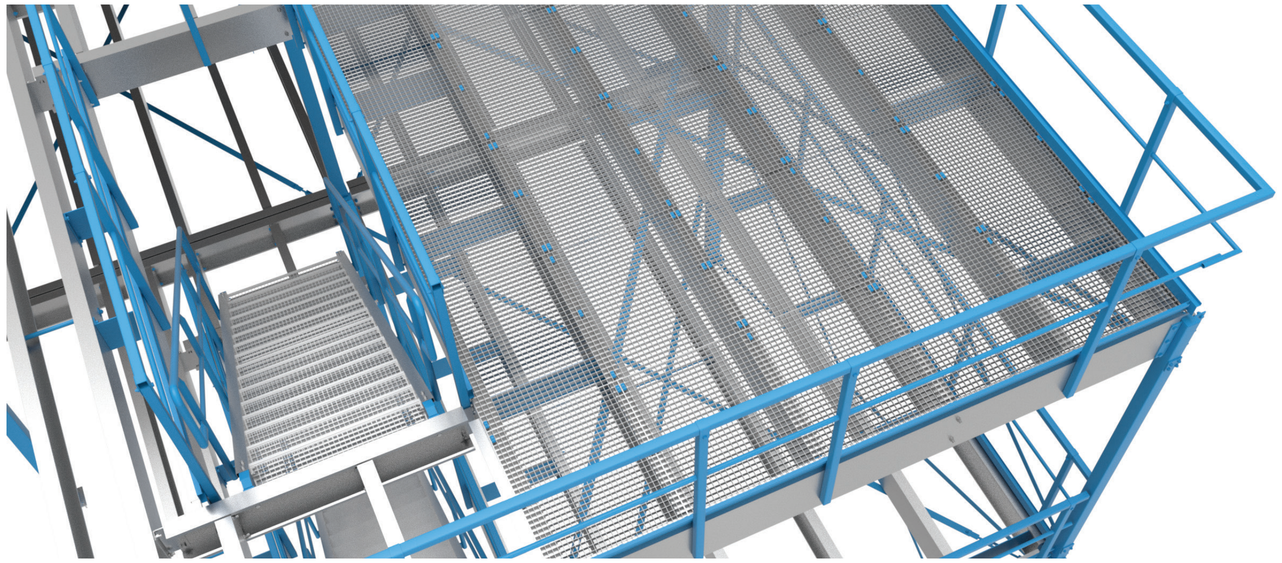
STRUCTURE AND ITS DESIGN

Floor Gratings

Steel floor gratings are another alternative for creating a deck. These are used especially in places where the fire protection aspect of the construction requires the free passage of smoke in the event of a fire.

The deck formed by gratings is an important structural component that ensures the stability of the floor beam upper flanges and that is why its correct fixing to them is crucial. The maximum spacing of the fasteners is 600 mm, as with the chipboard.

Floor gratings must be designed to safely carry the design load. When designing the grate, not only the area load must be considered, but also the point loads that may be generated by the pallet truck wheels, rack system columns, etc. The criterion of is particular load is decisive in many cases. The third important design criterion is the grate usability in terms of deflection. The gratings must be designed in such a way that their deflections induced by the applied load allow trouble-free operation for which the deck is being designed.



Design rules

- Recommended are welded-type gratings, which show sufficient rigidity compared to the stamped type and offer a lower weight with the same load capacity compared to stamped gratings in most cases.
- The recommended height of floor gratings is at least 30 mm. Lower gratings can also be used, but in such a case we recommend consulting the grate supplier regarding the planned operation on the future floor to make sure that the gratings meet the required specifications.
- The bearing strips in the gratings must be sufficiently supported – the minimum length of the support is 30 mm to achieve the grating's designed load-bearing capacity.
- The maximum span of bolts fixing the gratings to the floor beams and girders is 600 mm. The layout of the bolts is shown in Fig. 27. We strongly recommend using M 6 metric bolts for fixing the gratings to the beams. Due to the purpose and operation of the mezzanine floors, it will be essential to check the grate fixing and tighten the bolts if necessary during inspections of the whole steel structure, which will not be possible in case of self-tapping screws. Verification tests have shown that bolted joints provide better deck rigidity and by that better stabilisation of the floor beam upper flanges.
- Design-assisting tables and grate manufacturer's recommendations need to be followed when designing the gratings.
- We recommend laying the gratings on the floor beams in a „brickwork" pattern - the floor construction thus features greater rigidity. It is recommended interconnecting the grating segments to compensate for deflections when loading the gratings.

Floor Gratings

Standard method of fixing steel floor gratings to Metsec sections forming a mezzanine floor

(cut-out from the deck structure)

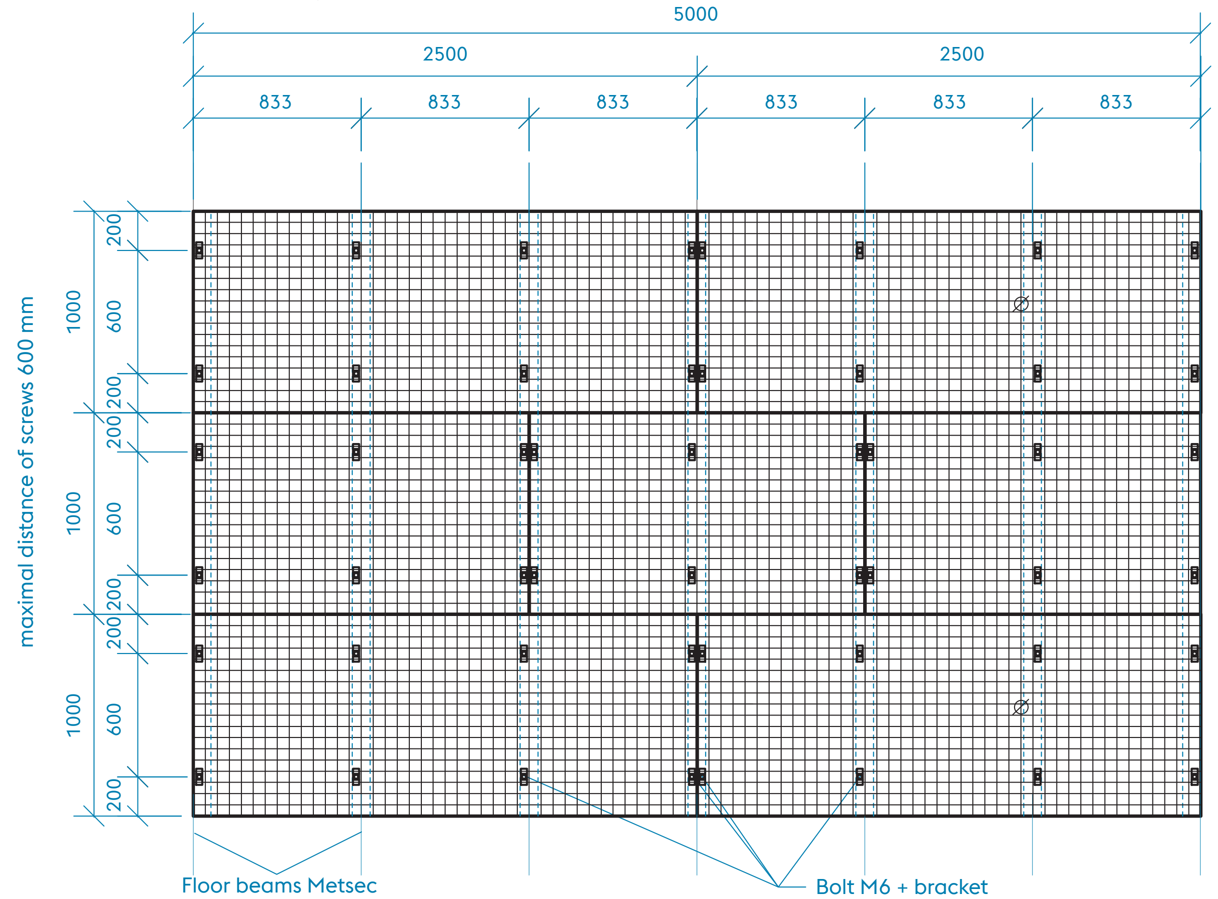


Fig. 27 – Layout of the bolts fixing the deck made of gratings to the floor beams

View perpendicular to the bearing grate strips

View perpendicular to the non-bearing grate strips

The grate running over the floor beam

The end of the grate on top of the floor beam

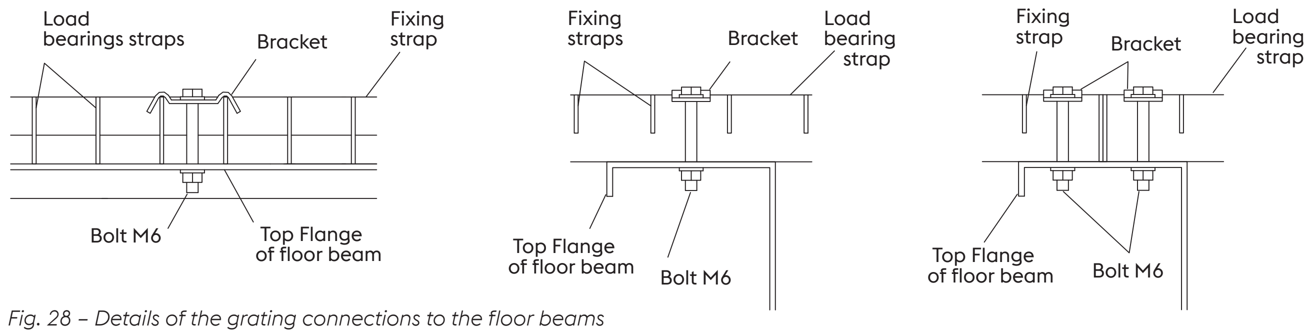
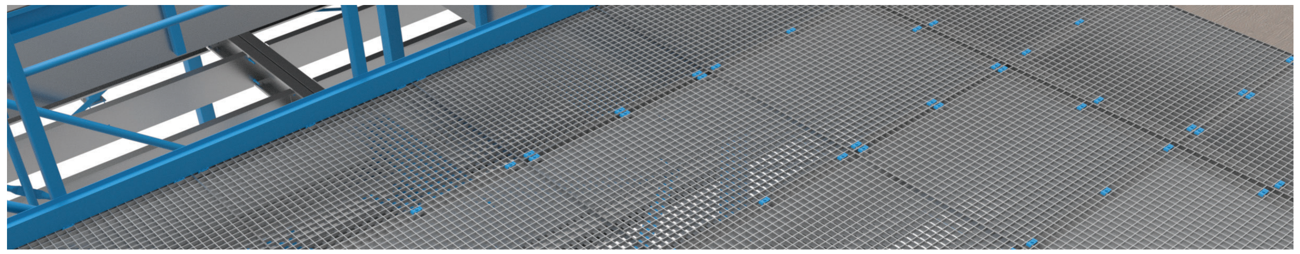


Fig. 28 – Details of the grating connections to the floor beams



STRUCTURE AND ITS DESIGN

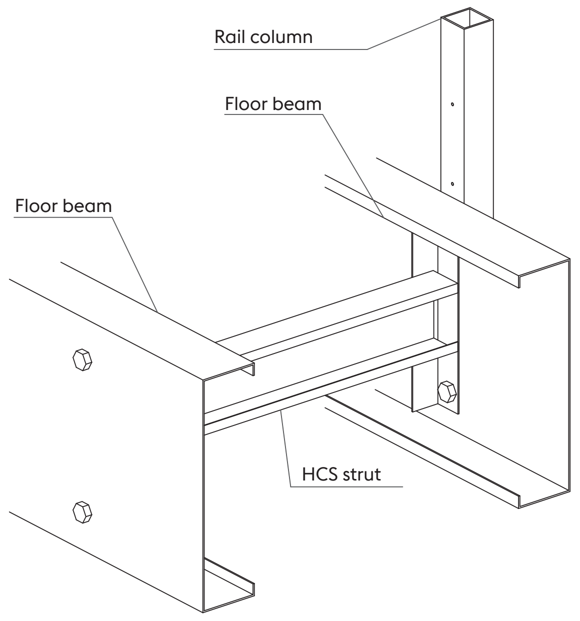
Railing

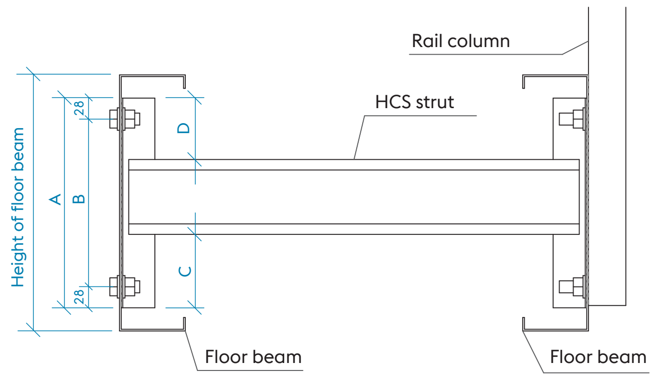
The railing must be designed in such a way as to meet the requirements for safe operation of storage mezzanine floors.
The railing design is not addressed in this Technical Manual. The mezzanine floor structure must feature adequate reinforcement of the floor beams in the direction perpendicular to the railing, as shown in the illustrative figures.

Design rules

- If the railing is installed parallel to the floor beams, they need to be equipped with stiffeners at points of the railing posts. The stiffener should be placed between the floor beam carrying the railing posts and the adjacent floor beam.
- The stiffener can be made of sheet metal, as shown in the figures, or our system component designated as HCS can be used. Ways of using the HCS system component can be seen in Figure 29.
- The central element of the HCS stiffener is formed by a 100 mm high C-section made of 1.3 mm thick sheet metal. The connection angle pieces are made of 45 × 45 × 2 mm sections.
- The HCS component should be fixed to the floor beams by pairs of M16 bolts provided with washers under the bolt heads and under the nuts.

Stiffening HCS component





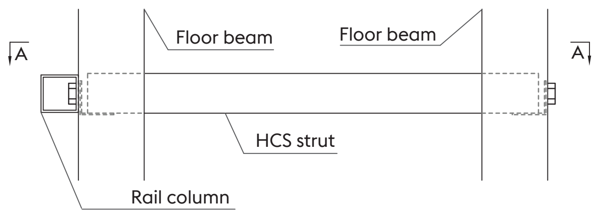


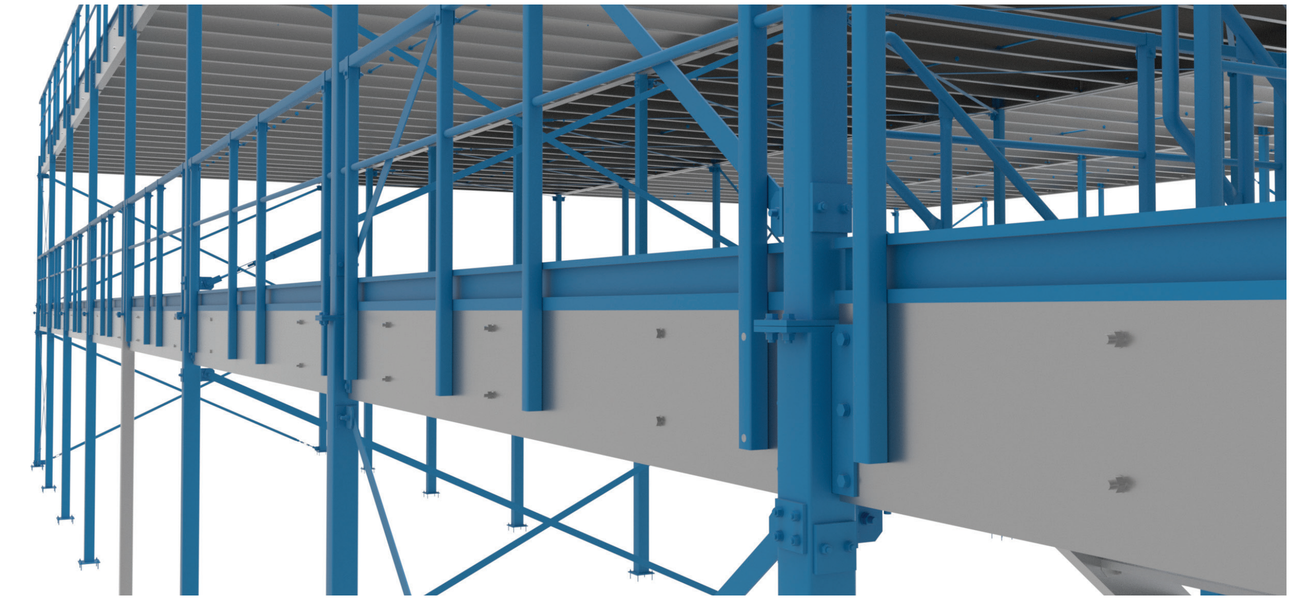
Fig. 29 - HCS stiffener for railing posts

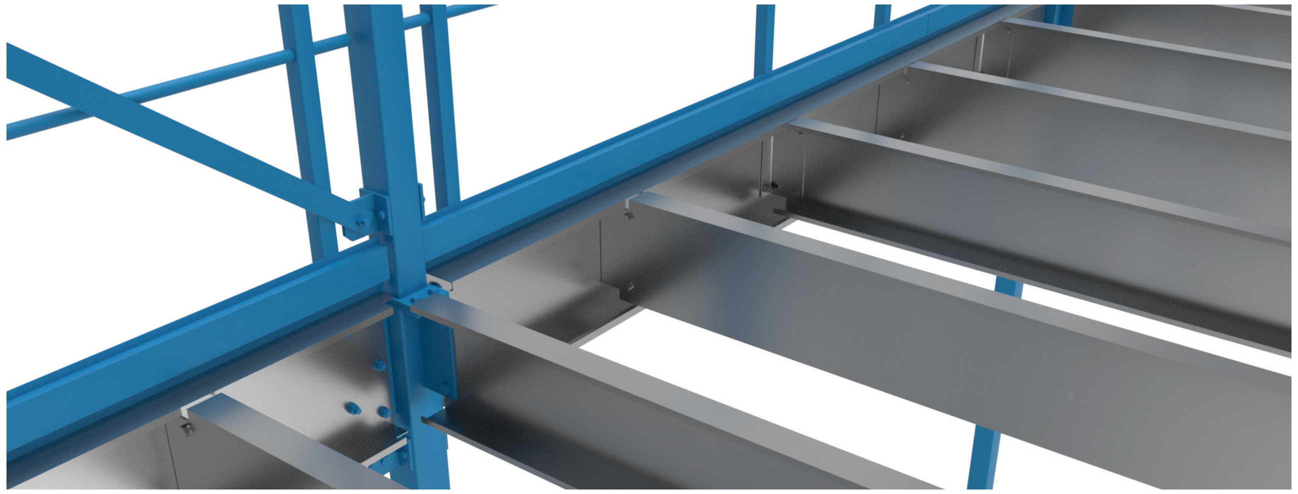
Tab. 11 – dimensions of angle pieces connecting the HCS component to a floor beam made of M or C+ section

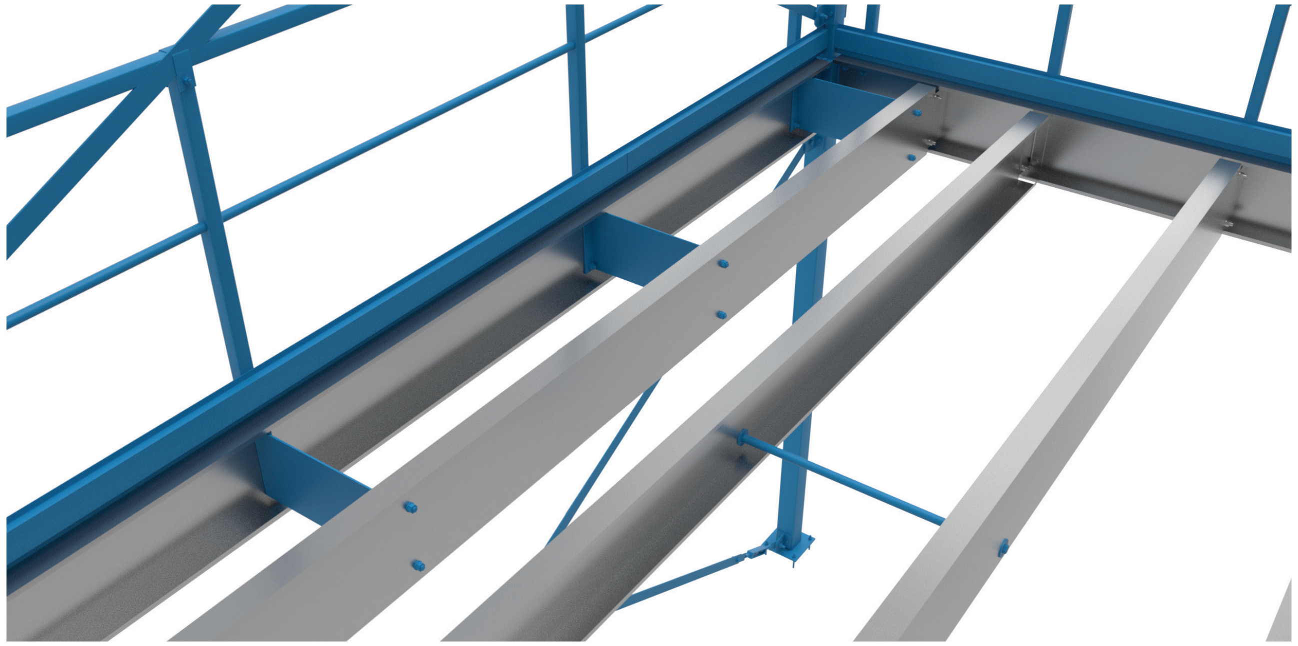
SECTION	A	B	C	D
	mm	mm	mm	mm
142*	112	56	6	6
172*	142	86	42	0
202	172	116	57	15
232	202	146	51	51
262	232	176	66	66
302	251	195	76	75
342	291	235	96	95
402	351	295	125	124
432	381	325	141	140
452	401	345	151	150

* The reinforcement cannot be used in combination with 142 C+ or 172 C+ sections

Railing







DESIGN AND STRESS ANALYSIS OF STEEL NODES

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

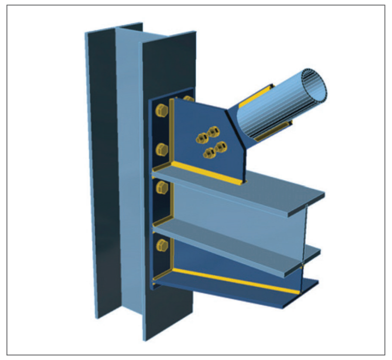
There is no limit to the number or type of members connected to a node. The node shape is based on project requirements and is not limited by the possibilities of the software.

ANY LOAD

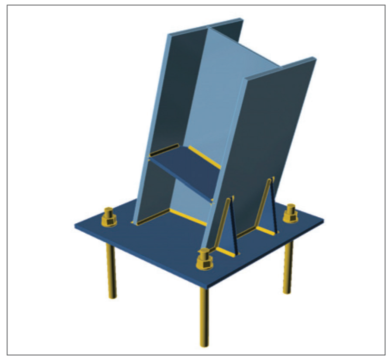
All components of the load are taken into account. The overall node evaluation includes the interaction of all members attached. Designers get a clear picture of the construction state.

ONLY A FEW MINUTES

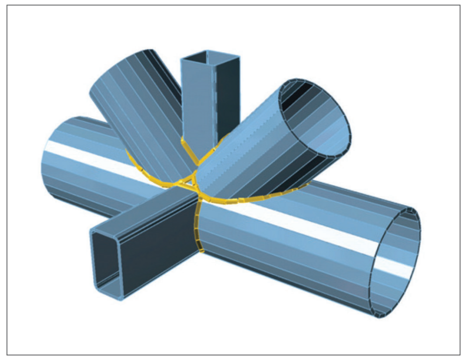
The whole design and assessment process is rapid enough to be part of the everyday work of designers and manufacturers of steel structures all over the world.



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.

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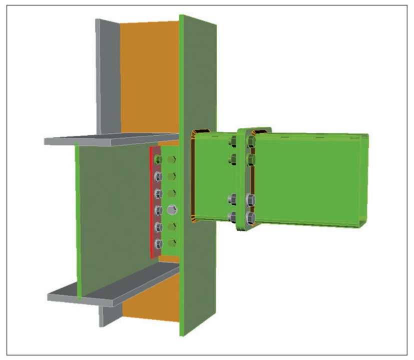
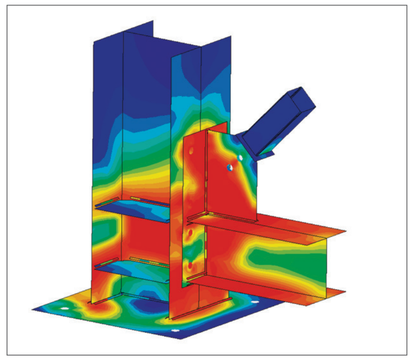
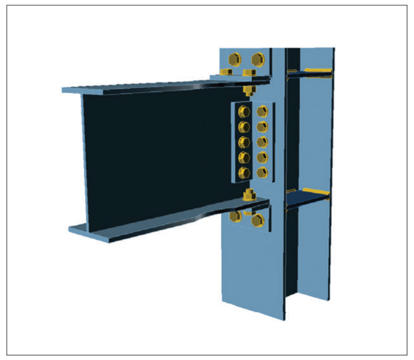


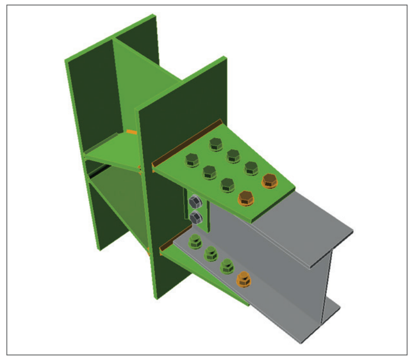
Stress/deformation analysis
A steel node FEM model is generated automatically



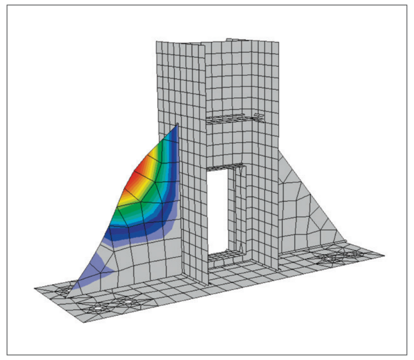
Stiffness analysis
Rotational and axial stiffness of any joint



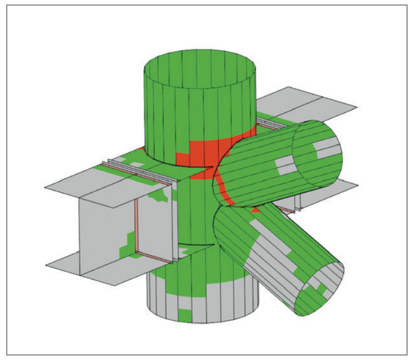
Seismicity assessment
Node assessment as to the load bearing capacity of the connected member



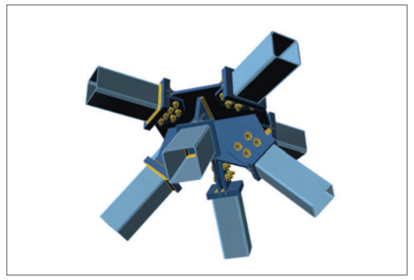
Stability analysis
Local loss of stability and critical load factors



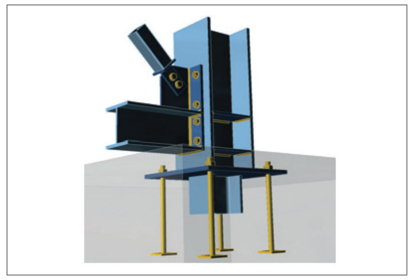
Node design capacity
Maximum acceptable load, reserve in the node capacity



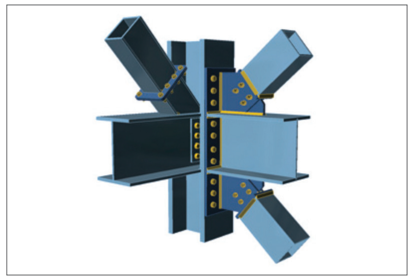
Designed by IDEA StatiCa Connection



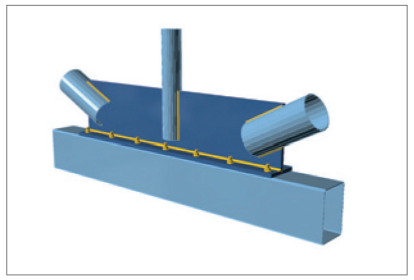
Stadium roof



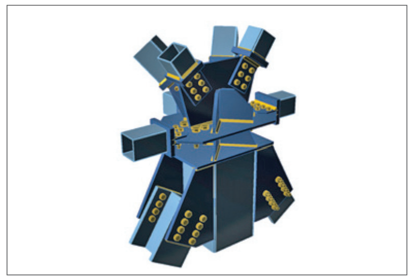
Warehouse



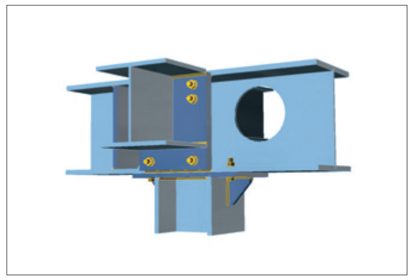
Industry hall



Footbridge



Power plant



Stadium roof

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