SIN PROFILES

(CORRUGATED WEB PROFILES)

TECHNICAL DOCUMENTATION

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CHAPTER 1

General rules and static calculation guide

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1 GEOMETRY

Corrugated web (SIN) beams consist of a thin-walled corrugated web and flat, wide flanges.

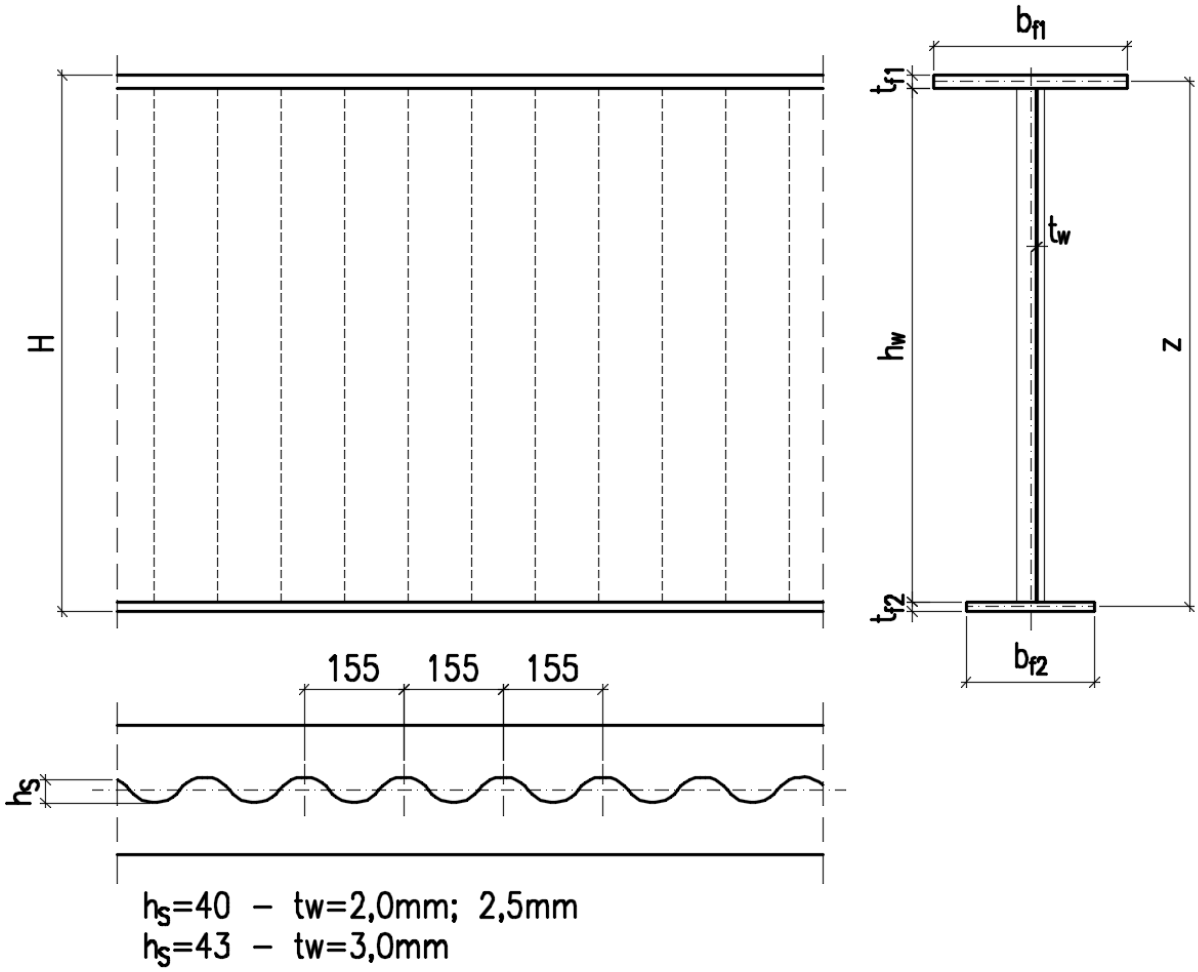

Fig. 1. SIN profile – geometry

Web dimensions:
Web heights: 333, 500, 625, 750, 1000, 1250, 1500
Web thicknesses: 2.0 mm, 2.5 mm, 3.0 mm (4.0mm, 5.0mm, 6.0mm on special request)

Flanges:
Width: 160 mm – 450 mm
Thickness: 8 mm – 30 mm

Supplied lengths: 4000 mm – 16400 mm

On special request any intermediate web height between 333 mm and 1500 mm can be produced. But the additional costs for waste material due to cut-off respectively procurement of a minimum quantity of special coil material and longer delivery times shall be taken into account.

It is possible to use beams with different dimensions of top and bottom flanges, as well as tapered beams with a taper of 250 mm – 1250 mm, so that the sum of the heights of the web at both ends is equal to one of the basic web heights specified above. In such case, cutting one section of the web diagonally produces two identical tapered beams.

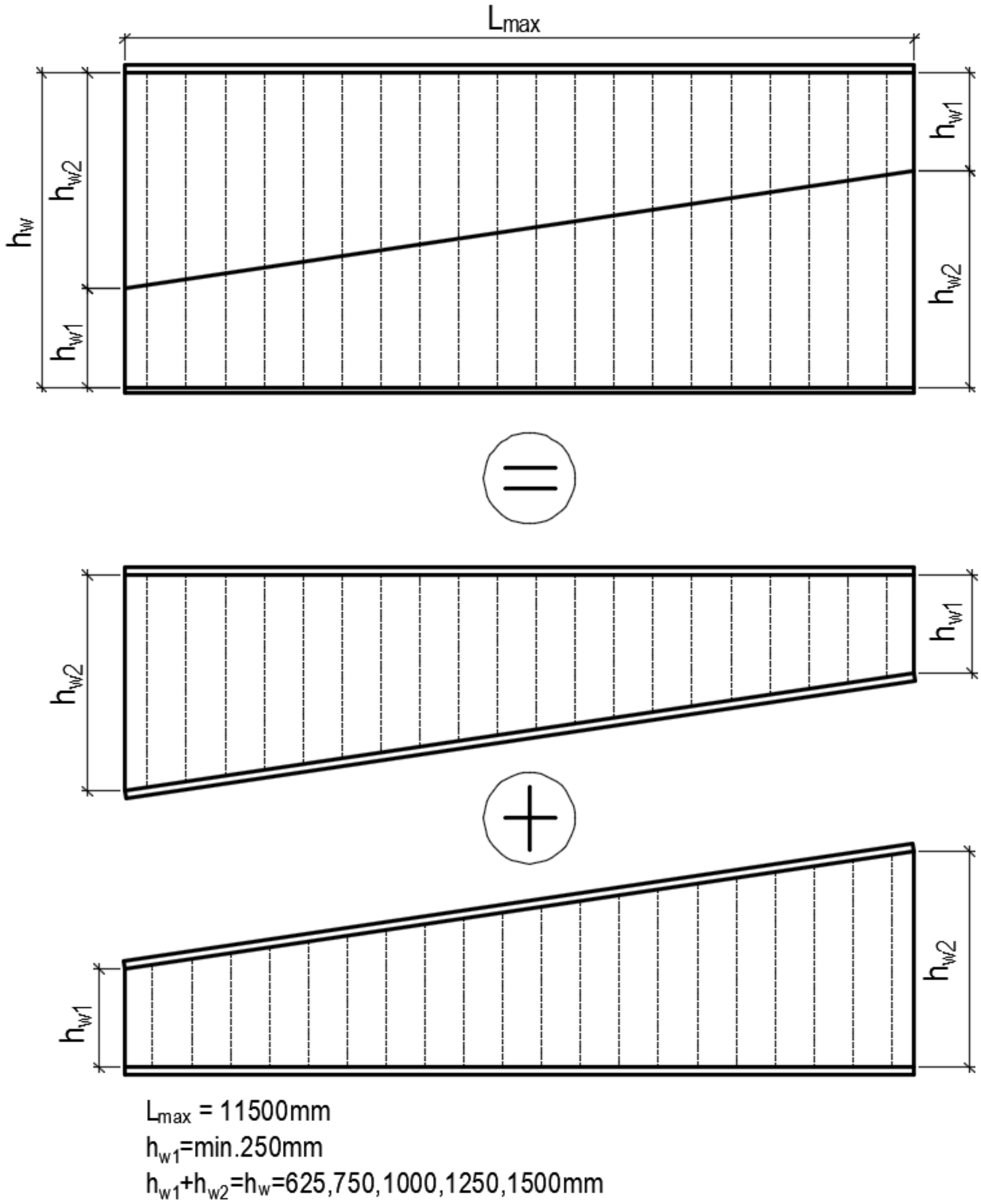

Fig. 2. Tapered SIN profile – dimensions

The SIN beam name may suggest that the web shape is a sinusoidal one. However, it is only an approximation of the sinusoidal shape. This is due to web production technology, which is created by deforming a flat sheet through a system of rollers in a special machine. The method of production of the corrugated web is that the curves, which are fragments of a circle, are joined together by straight segments. The difference between the actual shape of the web and the sinusoid is small and may be overlooked in further considerations.

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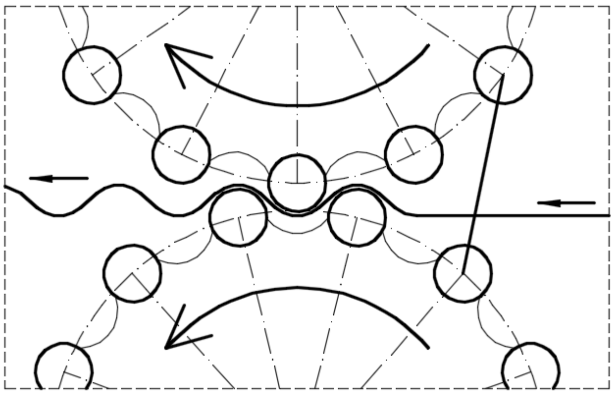
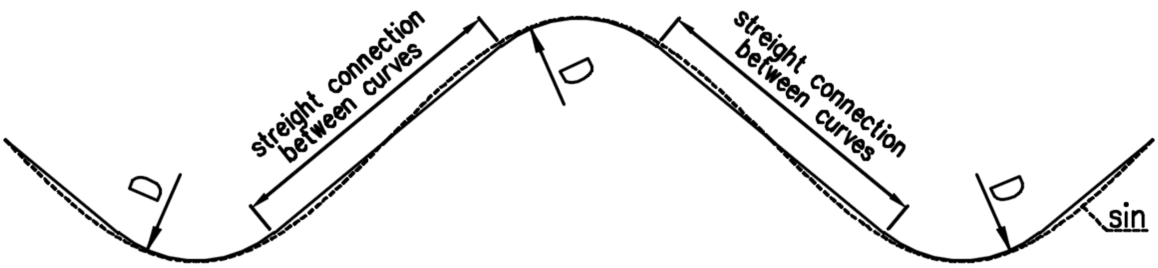


Adoption of the sinusoidal shape in further consideration allows for the application of trigonometry and derivations of mathematical formulas, which allow for easier description of the web shape geometry.



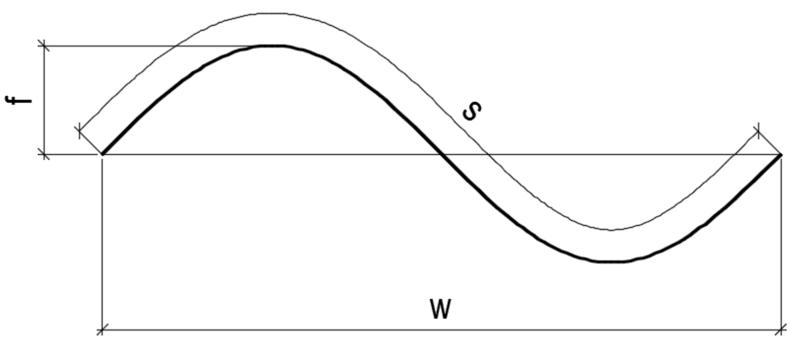


Fig. 3. Geometry of a sinusoidal wave

The geometry of a sinusoidal wave web can be described by the formula:

$$y(x) = f \cdot \sin\left(\frac{\pi \cdot x}{0{,}5 \cdot w}\right) \qquad (1)$$

$$s = \int_0^w \sqrt{1 + \left[\frac{h_S \cdot \pi}{w} \sin\left(\frac{2\pi x}{w}\right)\right]^2} dx \qquad (2)$$

$$I_w = \int_0^w \frac{1}{12} t^3 + t\left[\frac{h_S}{2} \sin\left(\frac{2\pi x}{w}\right)\right]^2 dx \qquad (3)$$

$h_s = 2f$

Table 1 provides the moments of inertia of a single wave

t [mm]	f [mm]	I_w [cm^4]
2,0	20	6,21
2,5	20	7,77
3,0	21,5	10,78

Tab. 1. Moments of inertia of a single wave

Annex 1 specifies the geometric characteristics of the SIN beams for the selected flange thicknesses and widths. For other flange dimensions or for beams with different flanges, the values provided in the table are to be calculated.

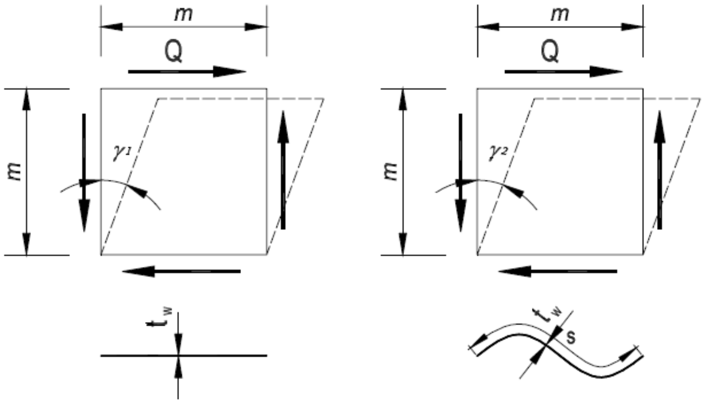
2 MATERIALS

Flanges: S235JR or S355J2+N acc. to EN 10 025
Web: S235JR

All other steel grades are treated as special grades. For webs of thickness 3mm or more, there is a possibility of using material of increased strength S355J2+N. In this case, the information about the web steel grade shall be clearly described in the design documentation, drawings and material lists. For such special steel grades or thicker web materials additional costs for procurement of a minimum quantity of special coil material and longer delivery times shall be taken into account.

- elastic modulus: $E = 210\,000\ N/mm^2$
- shear modulus: $G = 81\,000\ N/mm^2$

The corrugation of the web causes that the shear strain of the sinusoidal web is greater than the strain of the flat web with the same boundary conditions and geometric and material parameters. Using a Timoshenko beam model, the sinusoidal web shall be replaced by a flat web of the same shear deformability. The conformity of the strains is ensured by the adoption of a substitute reduced shear modulus.



We demand that with the same dimensions and Q transverse force values, the shear strain angles γ of the flat sheet (1) and the corrugated sheet (2) are equal:

$$\gamma_1 = \gamma_2 \tag{4}$$

where:

$$\gamma_1 = \frac{\tau_1}{G_1} = \frac{\frac{Q}{t_w \cdot m}}{G_1} \qquad \gamma_2 = \frac{\tau_2}{G_2} = \frac{\frac{Q}{t_w \cdot s}}{G_2} \tag{5}$$

it follows that the value of the shear modulus should be reduced

$$G_{red} = G_2 = G_1 \cdot \frac{m}{s}. \tag{6}$$

For SIN beams, the m/s ratio is a fixed value of

$$\frac{m}{s} = \frac{155}{178} = 0,87 \tag{7}$$

the reduced value of the shear modulus is equal to

$$G_{red} = 69,7\ [\text{GPa}] \tag{8}$$

3 FIRE PROTECTION

Protection of steel structures against fire is primarily determined by national – often local - regulations and still national approvals. Although this subject is covered by EUROCODEs and ETAs (European Technical Approvals) on

European level. Under this precondition the following procedures are recommended in case of fire protective requirements:

R0 or **R15**: Unprotected sin beams can be classified as R15. According test were carried out in Austria and Czech Republic.

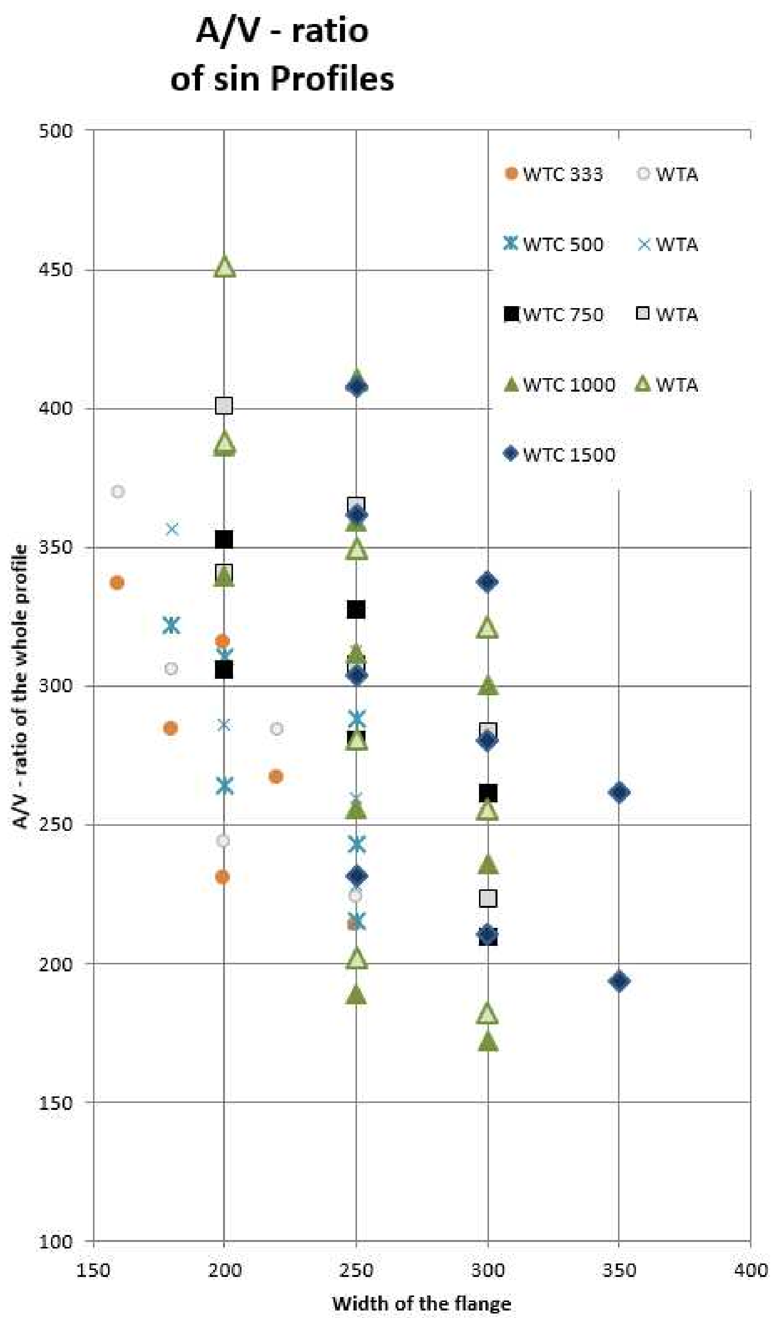
R 30: Protection by intumescent painting is recommended.

The thickness and application has to follow the provisions of the material specific approval of the manufacturer, similar to conventional built-up girders.

The material specific approvals defines the maximum A/V value and the minimum material thickness for which this material was tested and therefore is allowed to be used.
The necessary dry film thickness in according to the actual A/V relation of the specific sin beam can be taken from the material specific approval.

> **R30**: protection by cladding with approved fire protective panels is recommended. The thickness and application has to follow the provisions of the material specific approval of the manufacturer.

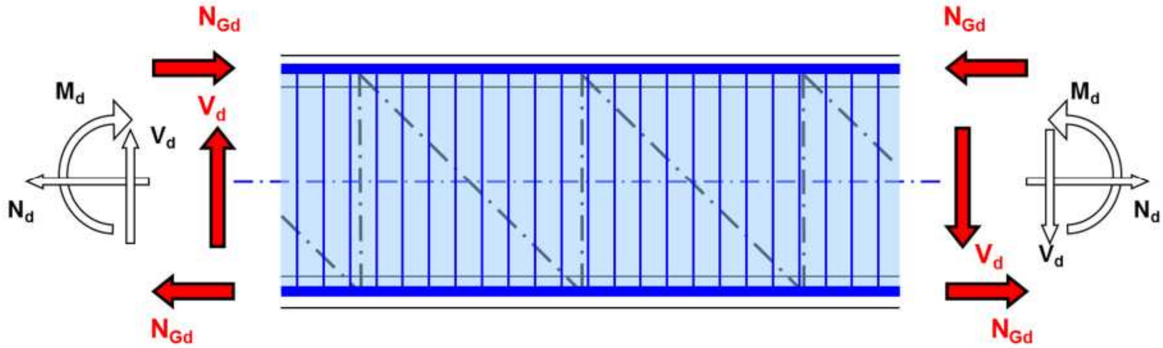
The A/V relation for a number of sin beams is given in the table below or can easily be calculated for web / flange combinations not in the table.



4 BASIS OF CALCULATIONS

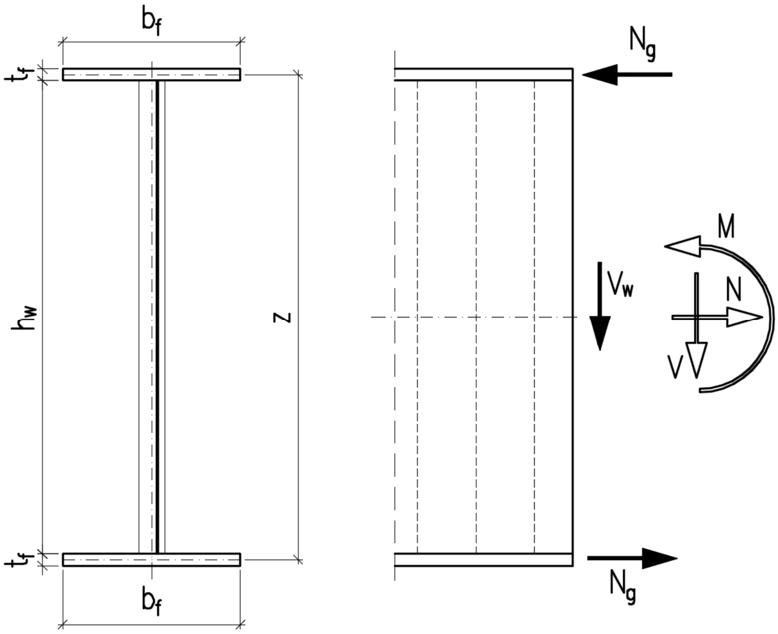
From a static point of view, the SIN beam works like a typical truss. The bending moments and axial forces are only transmitted through the flanges and the shear forces are fully absorbed by the web.

By application of this mechanical model, sin beams and columns can be brought not only into correspondence with EUROCODE, but also with any other steel design code worldwide as e.g. Russian, Chinese code and others.



Following the analogy of truss design consequently, all design situations in connection with sin beams can be solved. So the enclosed catalogue of typical design details can be adopted and extended on demand.

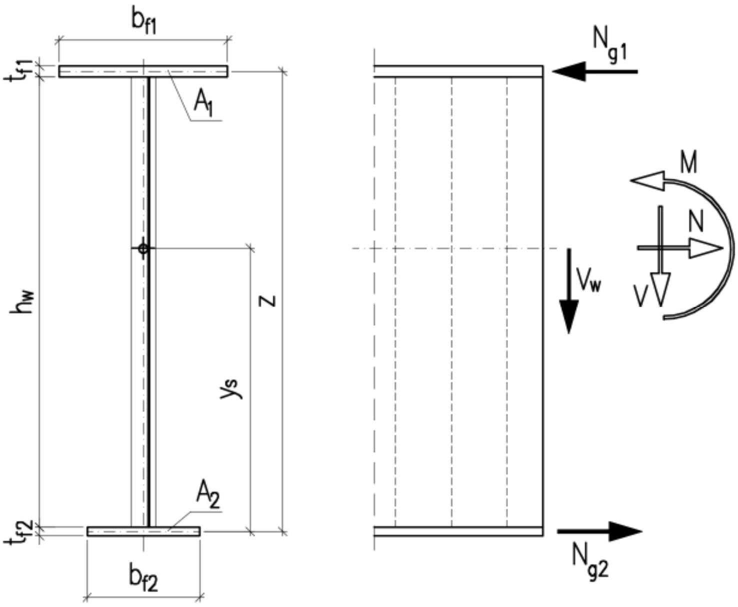
a. Determination of forces in flanges for beams with equal flange dimensions



$$N_g = \frac{M}{z} \pm \frac{N}{2} \qquad (9)$$

$$V_w = V \qquad (10)$$

b. Determination of forces in flanges for beams with <u>different</u> flange dimensions



$A_1 = b_{f1} \times t_{f1}$ (11)

$A_2 = b_{f2} \times t_{f2}$ (12)

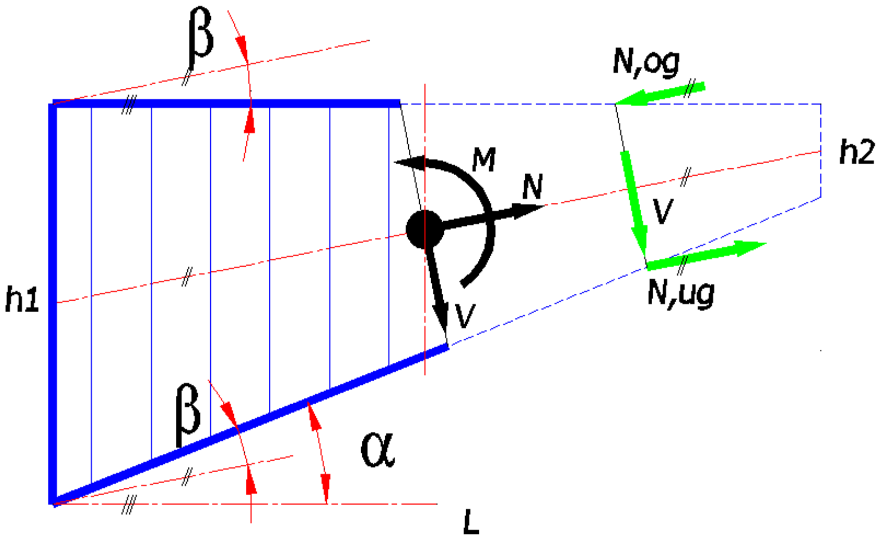
$$N_{g1} = \frac{M}{z} \pm N \cdot \frac{A_1}{A_1 + A_2} \quad (13)$$

$$N_{g2} = \frac{M}{z} \pm N \cdot \frac{A_2}{A_1 + A_2} \quad (14)$$

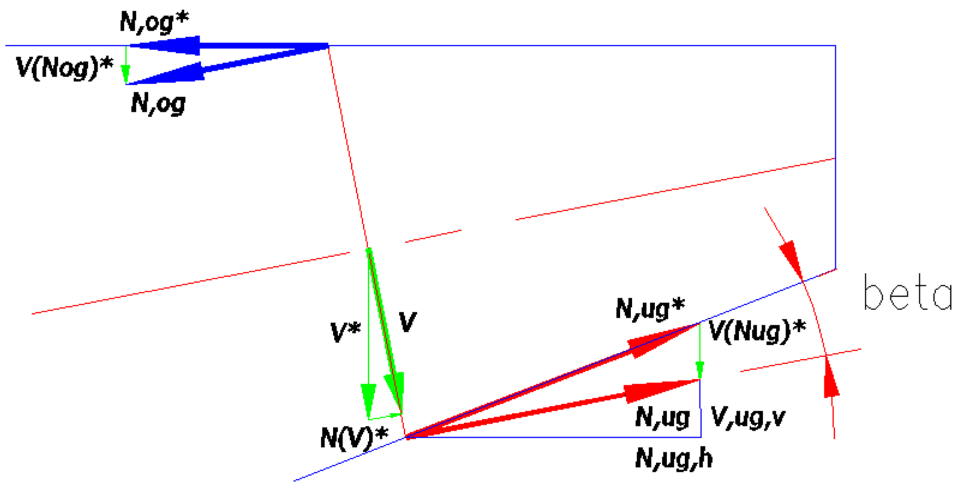
$V_w = V$ (15)

c. Determination of forces in flanges for a <u>tapered</u> beam

In the case of a tapered beam, none of the flanges is parallel to the axis of the beam. The distribution of internal forces (M and N) on the forces in the flanges results in forces that are not axial forces in the flanges N,og and N,ug



The components of these forces act on both the flanges and the web, increasing or decreasing the shear force. It should be remembered that the generating line of the web wave is always perpendicular to one of the flanges, which means that the shear force is also distributed between the forces transmitted by both the flanges and the web.



$$Nog^* = \cos(\beta) \cdot Nog \tag{16}$$

$$V(Nog)^* = \sin(\beta) \cdot Nog \tag{17}$$

$$Nug,h = Nug \cdot \cos(\beta) \tag{18}$$

$$Vug,v = Nug \cdot \sin(\beta) \tag{19}$$

$$Nug^* = \frac{Nug,h}{\cos(\alpha)} \tag{20}$$

$$V(Nug)^* = Nug,h \cdot \sin(\alpha) - Vug,v \tag{21}$$

$$N,og = [N + N(V)^*] \cdot \frac{A,og}{A,og + A,ug} - \frac{M}{(H,steg + \frac{t,og + t,ug}{2})} \tag{22}$$

$$N,ug = [N + N(V)^*] \cdot \frac{A,ug}{A,og + A,ug} + \frac{M}{(H,steg + \frac{t,og + t,ug}{2})} \tag{23}$$

The corrugated shape of the web helps to avoid the loss of web stability, which allows the use of a web with lower thickness and without the transverse or longitudinal stiffeners that are most commonly required for flat web girders.

In addition to the advantages of production technology, a sinusoidal shape web has the advantage of a trapezoidal web by eliminating the local instability that occurs on the flat sections of the trapezoidal web.

Based on many tests and scientific research since beginning of 1990, the mechanical model of truss girder/column was verified and the application of the design formulas of EUROCODE, EN 1993-1-5, Annex D, can be used with some improvements considering the specific sin corrugation and the design rules of this manual.

4.1 Resistance of flanges

The flanges are subjected to compressive or tensile forces from the bending moment and to axial forces bypassing the web.

4.1.1 Tension flange – section resistance:

According to EN-1993-1-1 6.2.3

- in the case of gross cross-sections

$$N_{t.Rd} = N_{pl.Rd} = \frac{A \cdot f_y}{\gamma_{M0}} \tag{24}$$

- in the case of cross-sections with connectors

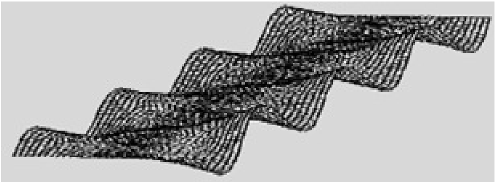
$$N_{t.Rd} = N_{u.Rd} = \frac{0{,}9 \cdot A_{net} \cdot f_u}{\gamma_{M2}} \tag{25}$$

4.1.2 Compression flange – section resistance:

According to EN-1993-1-1 6.2.4

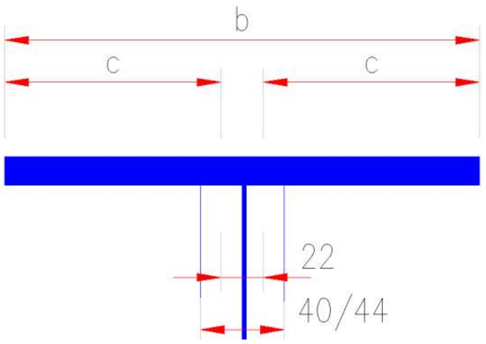
$$N_{c,Rd} = \frac{A f_y}{\gamma_{M0}} \tag{26}$$

4.1.3 Compression flange – flange local buckling



According to EN-1993-1-5 4.4

Flange design model – outstand elements fixed in corrugated web



$$\bar{b} = c \tag{27}$$

We strive to adopt such dimensions of the flange that it is not necessary to reduce the area of the flange section taking into account local flange buckling.

$\rho = 1{,}0$ (28)

The maximum plate slenderness that meets the above condition is:

$$\bar{\lambda}_p \leq 0{,}748 \tag{29}$$

Assuming that the distribution of compression stress is uniform across the entire cross-section, we assume:

$k\sigma = 0{,}43$ (table 4.2) (30)

After inserting the above values into the formula:

$$\bar{\lambda}_p = \sqrt{\frac{f_y}{\sigma_{cr}}} = \frac{\bar{b}/t}{28{,}4\,\varepsilon\,\sqrt{k_\sigma}} \tag{31}$$

We arrive at an equation that allows the full utilisation of the flange resistance:

$$\begin{aligned}\bar{b} &\le t \cdot 28{,}4 \cdot \boldsymbol{\varepsilon}\sqrt{k_{\sigma}} \cdot \bar{\boldsymbol{\lambda}}_p \\ \bar{b} &\le t \cdot 28{,}4 \cdot \boldsymbol{\varepsilon}\sqrt{0{,}43} \cdot 0{,}748 \\ \bar{b} &\le t \cdot \boldsymbol{\varepsilon} \cdot 13{,}9\end{aligned} \tag{32}$$

where:

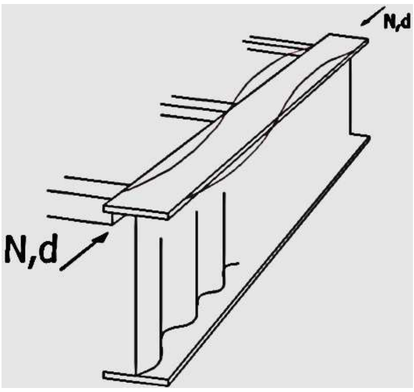
$$\varepsilon = \sqrt{\frac{235}{f_y\left[N/mm^2\right]}} \tag{33}$$

The width of the flange, at the assumed thickness, must comply with the condition:

$$b \le \bar{b} \cdot 2 + 22mm \tag{34}$$

If this condition (34) is not met, the reduction coefficient must be calculated in accordance with section 4.4 of EN-1993-1-5, taking into account plate buckling and the reduced flange cross-section must be assumed for further calculations.

4.1.4 Compression flange – flange global buckling



We consider a section of the flange locally stabilised with side bracing with the spacing of L. The articulated rod model is assumed.

The calculations are made in accordance with EN-1993-1-1 6.3.

The design resistance of a buckling compression flange is determined as follows:

$$N_{b,Rd} = \frac{\chi A f_y}{\gamma_{M1}} \tag{35}$$

The relative slenderness of the flange in its plane (in the plane of buckling) shall be determined. This slenderness is defined by the formula:

$$\bar{\lambda} = \sqrt{\frac{Af_y}{N_{cr}}} = \frac{L_{cr}}{i}\frac{1}{\lambda_1} \tag{37}$$

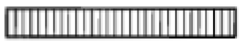
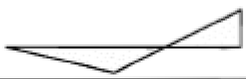
where:

i - radius of inertia of the gross section

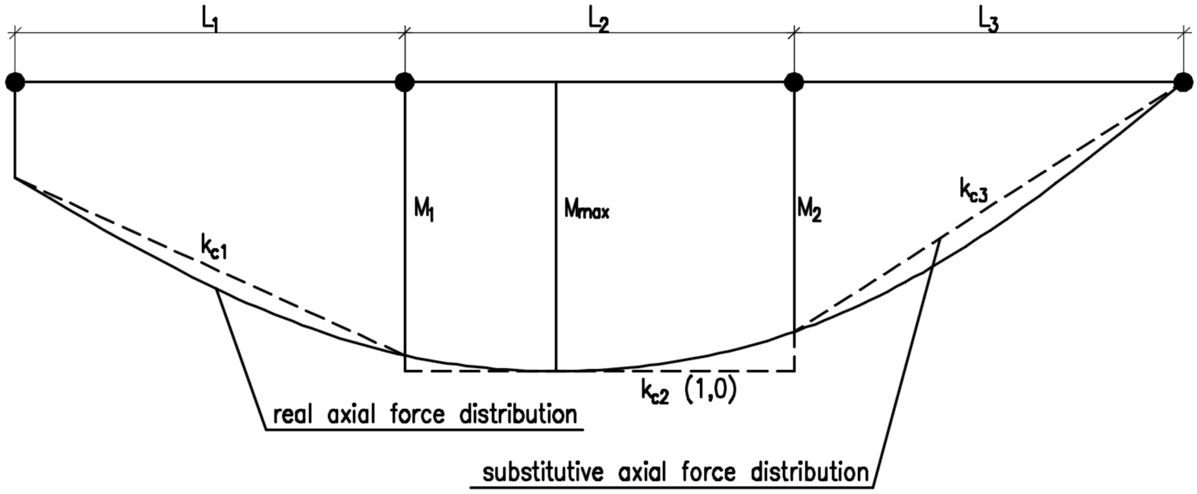
L_{cr} - buckling length in the flange plane.

The L_{cr} buckling length of the flange depends on the course of the axial force in the flange and is defined using the k_c correction factor. The method of determining the k_c factor is presented in Table 6.6 in EN 1993-1-1. In addition to the typical cases of members which are simply supported and single-side fixed and loaded uniformly over their length or by a transverse force, the table also gives the method of calculating the k_c factor for any linear course of the axial force in the flange.

Table 6.6: Correction factors k_c

Moment distribution	k_c
 $\psi = 1$	1,0
 $-1 \le \psi \le 1$	$\frac{1}{1{,}33 - 0{,}33\psi}$
	0,94
	0,90
	0,91
	0,86
	0,77
	0,82

For the curvilinear course of the axial force between the points of lateral support, an approximation of the values of the axial forces at the points of lateral support may be used, resulting in an equivalent linear course, and then use the formula given in the second line in Table 6.6. The k_c factor shall be calculated separately for each section determined by the lateral support points.



$$L_{cr.i} = k_{c.i} \cdot L_i \tag{39}$$

$$\lambda_1 = \pi \sqrt{\frac{E}{f_y}} = 93{,}9\varepsilon \tag{40}$$

$$\varepsilon = \sqrt{\frac{235}{f_y}} \quad (f_y \text{ w N/mm}^2) \tag{41}$$

The value of the buckling factor χ for the respective relative slenderness can be taken from the curves in Figure 6.4 of the EN-1993-1-1 standard. The buckling curve c should be used (as for solid members)

The value of the buckling factor χ for the respective relative slenderness can also be calculated from the formula:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \le 1{,}0 \tag{42}$$

where:

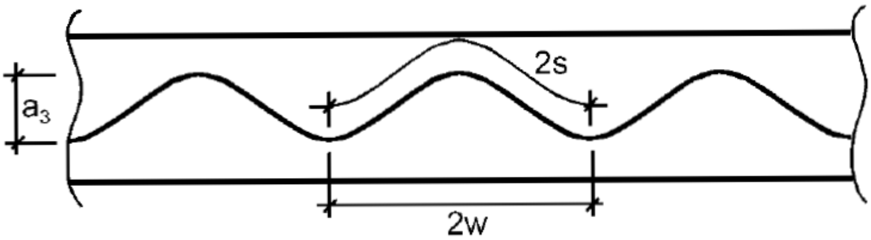
$$\Phi = 0{,}5\left[1 + \alpha\left(\bar{\lambda} - 0{,}2\right) + \bar{\lambda}^2\right] \tag{43}$$

taking the imperfection parameter α = 0.49 (for the buckling curve c)

Annex 2 specifies the resistance of the flange sections for the selected flange thicknesses and widths and the flange side stiffener spacings. A constant course of axial force in the flange is assumed (k_c=1.0).

4.2 Web resistance

We verify the web resistance under shear force. We are considering a wave section with the length of 2w.



2w = 155mm

2s = 178mm

a_3 = 40mm for t_w = 2,0mm, 2,50mm

a_3 = 43mm for t_w = 3,0mm

The web resistance for shear is determined as follows:

$$V_{Rd} = \chi_c \frac{f_{yw}}{\gamma_{M1}\sqrt{3}} h_w t_w \qquad (44)$$

where:

χ_c - reduction factor equal to the lower value between the local and global buckling factors

4.2.1 Global buckling factor $\chi_{c,g}$

$$\chi_{c,g} = \frac{1,5}{0,5 + \overline{\lambda}_{c,g}^2} \leq 1,0 \qquad (45)$$

where:

$$\overline{\lambda}_{c,g} = \sqrt{\frac{f_y}{\tau_{cr,g}\sqrt{3}}} \qquad (46)$$

$$\tau_{cr,g} = \frac{32,4}{t_w\, h_w^2} \sqrt[4]{D_x\, D_z^3} \qquad (47)$$

(48)

$$D_x = \frac{E\,t_w^3}{12\left(1-\nu^2\right)}\frac{w}{s}$$

$$D_z = \frac{E\,I_z}{w} \tag{49}$$

I_z – moment of inertia of a single wave in relation to the cross-sectional wave axis

COMMENT: Table 1 specifies the moments of inertia for a single full sinusoidal wave. The Eurocode shall take half of its full length in the calculation of the buckling factor. For D_z calculations, half of the values given in Table 1 shall be used.

4.2.2 Local buckling factor $\chi_{c,l}$

$$\chi_{c,\ell} = \frac{1,15}{0,9+\bar{\lambda}_{c,\ell}} \le 1,0 \tag{50}$$

where:

$$\bar{\lambda}_{c,\ell} = \sqrt{\frac{f_y}{\tau_{cr,\ell}\sqrt{3}}} \tag{51}$$

$$\tau_{cr,\ell} = \left(5,34+\frac{a_3 s}{h_w t_w}\right)\frac{\pi^2 E}{12(1-\nu^2)}\left[\frac{t_w}{s}\right]^2 \tag{52}$$

where:

a_3 = 2 x f

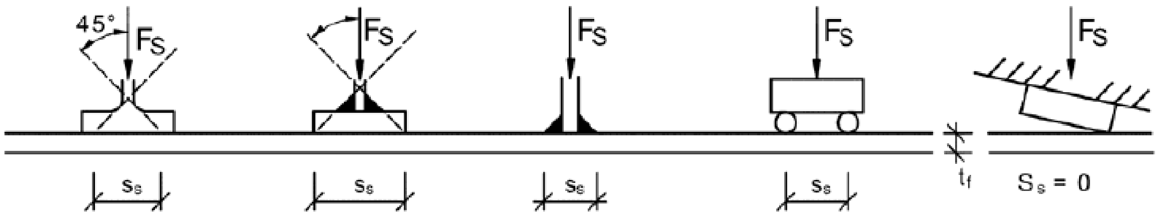
The local buckling factor according to formula (50) presented in Annex D of the standard can be applied to beams with sinusoidal and trapezoidal corrugated webs. This factor takes into account the fact that trapezoidal webs consist of flat surfaces which are much more prone to plate buckling. For sinusoidal webs, the application of the formula presented in the standard may lead to oversizing the web. Studies and calculations of the local buckling factor were carried out for a corrugated web beam at the university in Cottbus. On the basis of these studies, formula (53) was proposed (D. Hannebauer), which better describes the behaviour of the corrugated web under the influence of shear forces. It shows that in case of WTB (2,5mm) and WTC (3,0mm) profiles local buckling of the web doesn’t occur. The formula below shows that it can only occur in very thin and slender webs. In most other cases, local web buckling is not a decisive condition for web resistance. To reach this goal it is recommended to limit the height of WTA (2,0mm) profiles to 1000mm.

$$\chi_{c.l} = \frac{1,0}{0,62 + \bar{\lambda}_{c,l}} \leq 1,0 \tag{53}$$

Annex 3 presents the web resistance according to the assumptions of the study by D. Hannebauer.

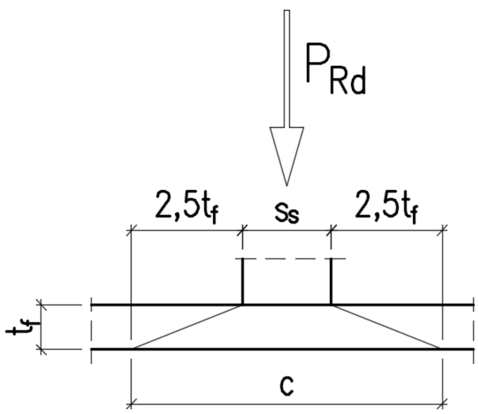
4.3 Transverse load web

One of the advantages of the web shape is that there is no need for the use of stiffeners. In this situation, the problem of web resistance under transverse force arises. The entire force is transmitted by the connection between the web and the flange.



The length of the effective web section is determined by the formula:

$$c = s_s + 5 \cdot t_f \tag{54}$$



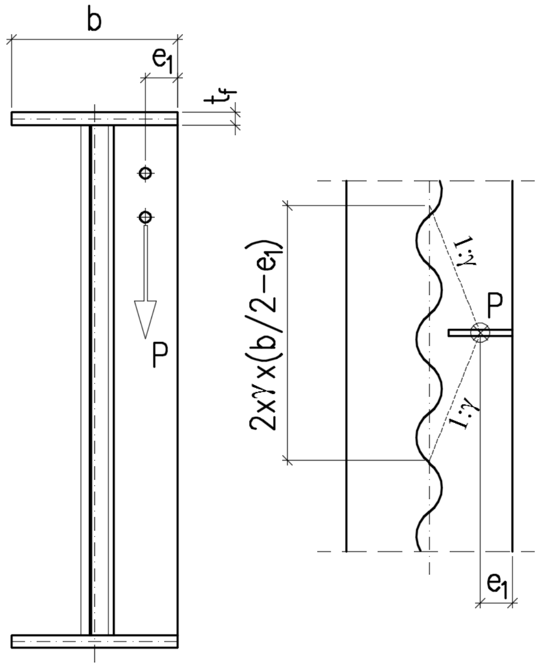
The design resistance of the web to transverse load is determined as follows:

$$F_{Rd} = t_w \cdot 1,2 \cdot c \cdot f_y/\gamma_{M0} \tag{55}$$

Annex 4 specifies the web resistance under transverse loads for some values of the width of the transverse force. For other s_s values, the appropriate calculations must be made.

4.4 Transverse force loading through a stiffener

In practice, it is often the case that the SIN beam is connected to a perpendicular element that cannot be connected on the top flange. This is usually the case when there is a need to make maximum use of the available construction height. In this case, the element must be connected to the SIN beam on the side. Such a situation also occurs in connections of wall girts to the column. The corrugated shape of the web makes it difficult to solve the connection geometry correctly. The simplest situation is to separate the stiffener from the web and to transfer the vertical forces from the stiffener to the web using flanges.



Assuming that the stresses in steel are distributed, 1:η the effective section of the flange is determined. Using the formula for strength in a complex state of stress:

$$\sigma = \sqrt{\sigma_x^2 + \sigma_y^2 + \sigma_x \cdot \sigma_y + 3 \cdot \tau_z^2} \leq f_y \qquad (56)$$

the maximum force P that can be applied to the stiffener without connecting it to the web can be determined (the shear force transmitted to the web through the flanges).

In the above formula values of σ_y and τ_z are derived from the force P acting on the effective section of the flange. σ_x is the tensile stress in the flange resulting from all loads acting on the member. The maximum force P shall be calculated by assuming the degree of utilisation of normal flange stress.

$$\sigma_x = \alpha \cdot f_y \qquad (57)$$

$$\sigma_x = \frac{6 \cdot \eta \cdot P}{2 \cdot \gamma \cdot t_f^2} \qquad (58)$$

$$\tau_z = \frac{\eta \cdot P}{2 \cdot \gamma \cdot (\frac{b}{2} - e_1) \cdot t} \quad (59)$$

where:

α - fraction expressing the utilisation of normal flange stress

γ - angle of distribution of stresses in the flange expressed by the ratio of the sides of the stress triangle as shown in the drawing

η = 1 for a stiffener connected to only one (top or bottom) flange

η = 0.5 for a stiffener connected to two flanges with equal thicknesses

In the case of flanges with different thicknesses, the distribution of force P between the top and bottom flange shall be:

$$P_i = \mathrm{P} \cdot \eta_i = \mathrm{P} \cdot \frac{t_i^3}{t_1^3 + t_2^3} \quad (60)$$

i = 1..2 – flange number designation

After inserting formulas (57) to (59) into the formula (56), the square equation (61) is obtained due to the force P, which, when solved, shall give us the maximum force P that can be applied to the stiffener without the need to connect it to the web.

$$\left[\left(\frac{6 \cdot \eta}{2 \cdot \gamma \cdot t^2}\right)^2 + 3 \cdot \left(\frac{\eta}{2 \cdot \gamma \cdot \left(\frac{b}{2} - e_1\right) \cdot t}\right)^2\right] \cdot P^2 - \frac{\alpha \cdot f_{y.} \cdot 6 \cdot \eta}{2 \cdot \gamma \cdot t^2} \cdot P - f_y^2 \cdot (1 - \alpha^2) = 0 \quad (61)$$

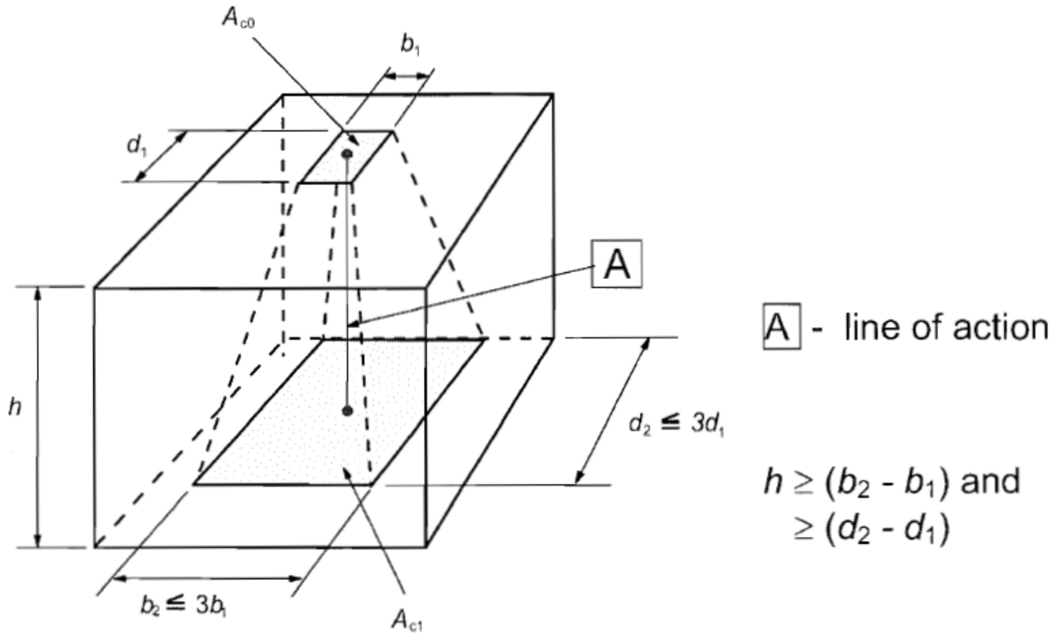
In the case of different upper and lower flange dimensions and different flange efforts, the fact that $\sigma_{x1} \neq \sigma_{x2}$ and $\eta \neq 0.5$ must be taken into account in the equation (x).

Annex 5 specifies the maximum values of the shear forces at which the stiffeners need not be welded to the web.

4.5 Bearing on concrete

Where details shown in Figures A.1 and A.2 are used, the conditions of bearing on concrete shall be checked. The model and formulas shown in EN-1993-1-8 p. 6.2.5 should be used.

If the standard bearing conditions directly below the base plate (t_p) are not met, extend the reach of the b_{eff} area by using washers (t_s). The following calculations assume that the edges of the concrete do not limit the separation area, i.e. b_2=3xb_1, d_2=3xd_1.



For this assumption, area A_{c1} = 9 x A_{c0} (according to EN-1992-1-1)

When inserted into the formula, bearing resistance is as follows:

$$F_{Rdu} = A_{c0} \cdot f_{cd} \cdot \sqrt{\frac{A_{c1}}{A_{c0}}} = 3 \cdot f_{cd} \cdot A_{c0} \qquad (62)$$

Using the above equation in the formula for the bearing strength of the joint and assuming β = 2/3, the result is:

$$f_{jd} = \frac{\beta \cdot F_{Rdu}}{A_{c0}} = 2 \cdot f_{cd} \qquad (63)$$

The maximum range of the stiff bearing is specified by the formula:

$$c = t \cdot \sqrt{\frac{f_y}{3 \cdot f_{jd} \cdot \gamma_{M0}}} = t \cdot \sqrt{\frac{f_y}{6 \cdot f_{cd} \cdot \gamma_{M0}}} \qquad (64)$$

Annex 6 specifies the summary thickness of the base plate and the washers at which the bearing conditions are met for the different concrete grades and steel grades.

4.6 Holes in the web

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In the case of holes in the web, the shear resistance of the web must be checked at the point of weakness. If holes in the web are required, the following rules should be applied:

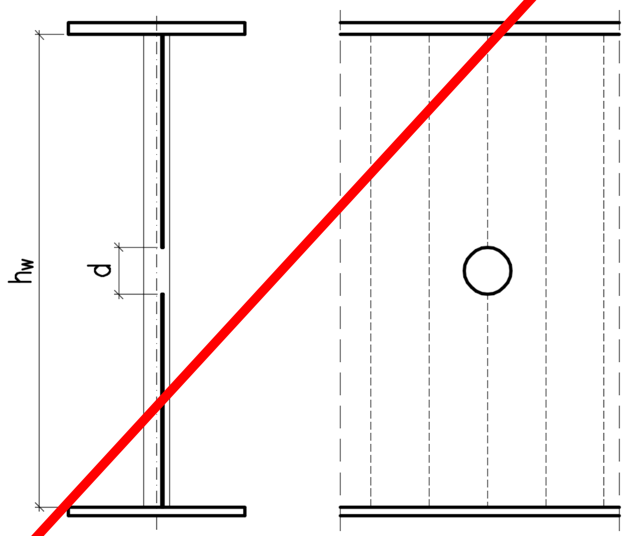
- the hole can be located only in the place where the shear force is not greater than 2/3 of the shear resistance of the web

- holes in flanges should be placed as close to the centre of the beam as possible

- hole sizes

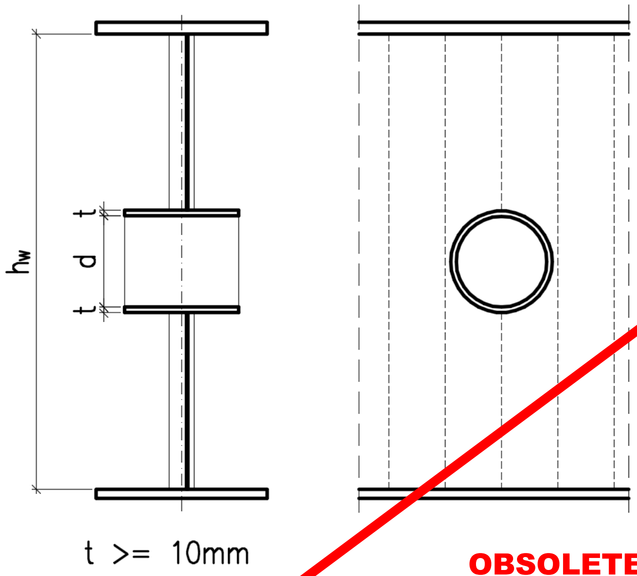
a. hole smaller than $h_w/10$

No additional safeguards need to be applied in this case



b. hole larger than $h_w/10$ but smaller than $h_w/3$

A round pipe should be used at the hole by welding it to the web.



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c. hole larger than $h_w/3$

In this case, the web replacement should be used

If these conditions cannot be met, a web replacement with a flat plate should be used, as in the case of Vierendel girders.

4.7 Displacements

The characteristic values of the loads shall be used to calculate the structure displacements.

With the traditional calculation method, the effects of shear forces can be taken into account by applying the Maxwell-Mohr formula as follows:

$$f_{MV} = \sum_{1}^{u} \left(\int_{S} \frac{M \cdot M_1}{E \cdot I_y} \cdot dS + \int_{S} k \cdot \frac{Q \cdot Q_1}{G \cdot A} \cdot dS \right) \tag{65}$$

where: M1, Q1 - bending moments and shear forces due to the application of unit force at the deflection calculation location $f_{MQ,\,k}$ - cross-section shear coefficient according to the classical theory of elasticity, with correction for the shear flexibility of the web

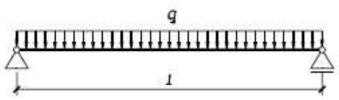
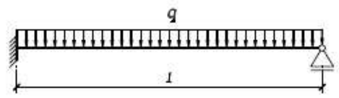
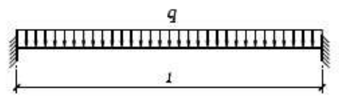
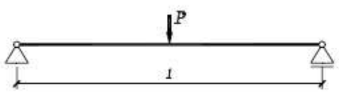
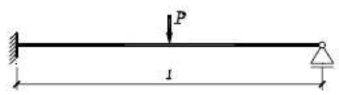
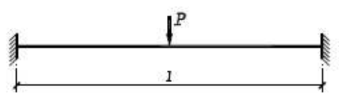
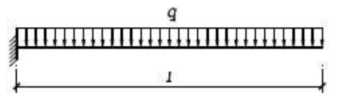
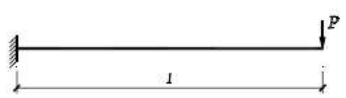
$$k = \frac{A}{A_w \cdot \frac{m}{s}} \tag{66}$$

where: A - total section area (flanges + web), Aw - total section area of the web, m, s - respectively, wave projection length and wave expansion length m/s = 155/178 = 0.87.

Table 5 shows the deflection formulas for beams with simple load diagrams taking into account the effects of moments and shear forces.

The application of an increased shear factor k precludes the simultaneous application of a reduced value of the shear modulus G_{red}. It is also important to note how the shear factor is defined in the software (some programs require a shear factor of 1/k).

When calculating deformations of corrugated web beams using the most popular computer software, one should usually remember to use material with a modified G_{red} modulus and to take shear deformations into account in the member characteristics.

	$f_{MV} = \frac{5}{384} \cdot \frac{q \cdot l^4}{E \cdot I_y} \cdot \left(1 + 9{,}6 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{1}{18} \cdot \frac{q \cdot l^4}{E \cdot I_y} \cdot \left(1 + 22{,}6 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{1}{384} \cdot \frac{q \cdot l^4}{E \cdot I_y} \cdot \left(1 + 48 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{1}{48} \cdot \frac{P \cdot l^3}{E \cdot I_y} \cdot \left(1 + 12 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{2}{215} \cdot \frac{P \cdot l^3}{E \cdot I_y} \cdot \left(1 + 27{,}7 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{1}{192} \cdot \frac{P \cdot l^3}{E \cdot I_y} \cdot \left(1 + 48 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{1}{8} \cdot \frac{q \cdot l^4}{E \cdot I_y} \cdot \left(1 + 4 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$
	$f_{MV} = \frac{1}{3} \cdot \frac{P \cdot l^3}{E \cdot I_y} \cdot \left(1 + 3 \cdot k \cdot \frac{E \cdot I_y}{G \cdot A \cdot l^2}\right)$

Tab. 5. Deflections of beams susceptible to shear

5 EXAMPLE

- beam span L = 7.5 m
- characteristic value of permanent load (with own weight) g = 10.0 kN/m,
- characteristic value of useful load p = 16.0 kN/m,
- flange steel – f_{yf} = 355 MPa,
- web steel – f_{yw} = 235 MPa,
- longitudinal elastic modulus E = 205 GPa,
- shear modulus G_{red} = 69 GPa

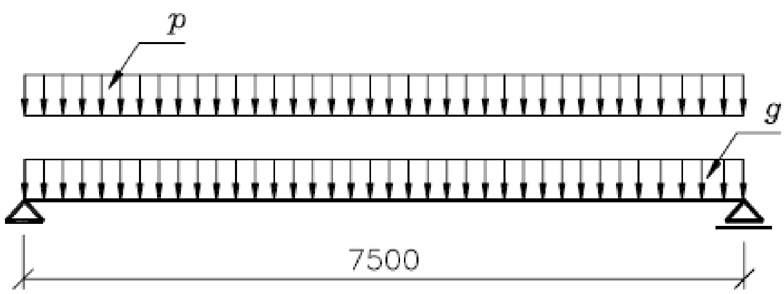
Assumed beam: WTB 500 – 200x12

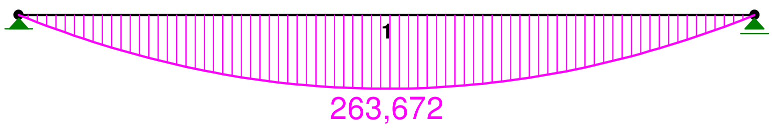
<u>Design loads</u>

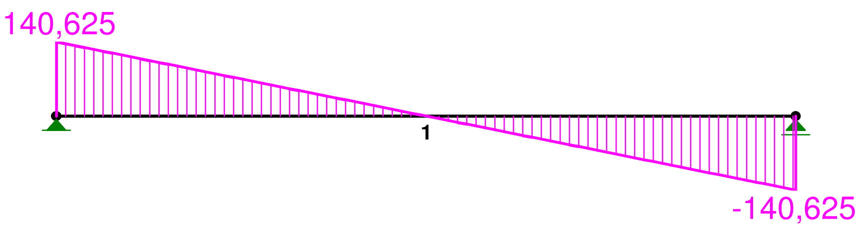
g_d = 1,35 x 10 = 13,5 kN/m
p_d = 1,50 x 16 = 24,0 kN/m

<u>Design internal forces</u>

$$M_d = \frac{(g_d + p_d) \cdot L^2}{8} = \frac{(13{,}5 + 24{,}0) \cdot 7{,}5^2}{8} = 263{,}7kNm$$
$$V_d = \frac{(g_d + p_d) \cdot \mathrm{L}}{2} = \frac{(13{,}5 + 24{,}0) \cdot 7{,}5}{2} = 140{,}6kN$$







Design forces in flanges

- Upper flange

$$N_g = \frac{M_d}{\frac{t_g}{2} + h_w + \frac{t_d}{2}} + \frac{N_d}{2} = \frac{263{,}7 \cdot 10^3}{\frac{12}{2} + 500 + \frac{12}{2}} + \frac{0}{2} = 515{,}0\ \text{kN (compression)}$$

- Lower flange

$$N_d = \frac{-M_d}{\frac{t_{fg}}{2} + h_w + \frac{t_{fd}}{2}} + \frac{N_d}{2} = \frac{-263{,}7 \cdot 10^3}{\frac{12}{2} + 500 + \frac{12}{2}} + \frac{0}{2} = -515{,}0\ \text{kN (tension)}$$

Tension flange resistance

$$N_{t.Rd} = \frac{A \cdot f_{yf}}{\gamma_{M0}} = \frac{12 \cdot 200 \cdot 355 \cdot 10^{-3}}{1{,}0} = 852{,}0\ \text{kN}$$

$$\frac{N_d}{N_{t.Rd}} = \frac{515}{852} = 0{,}61 \leq 1{,}0$$

Compression flange resistance

- verification of the local buckling condition of the compression flange

$$\varepsilon = \sqrt{\frac{235}{\text{f}_\text{y}\ [N/mm^2]}} = \sqrt{\frac{235}{355}} = 0{,}814$$

$$\text{t} = 12\text{mm}$$

$$b = 200mm\ \leq 2\ \cdot t \cdot \varepsilon \cdot 13{,}9 + 22 = 2 \cdot 12 \cdot 0{,}814 \cdot 13{,}9 + 22 = 293\text{mm}$$

Condition met. No local buckling of the flange shall occur. For further calculations, the entire cross-sectional area of the flange was used.

- Section resistance

$$N_{c.Rd} = \frac{A \cdot f_{yf}}{\gamma_{M0}} = \frac{12 \cdot 200 \cdot 355}{1{,}0} = 852{,}0\ \text{kN}$$

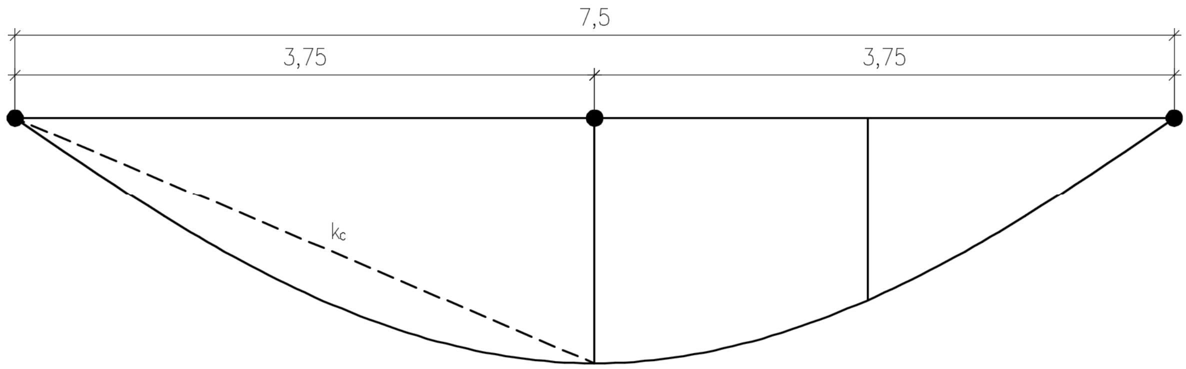
- Taking account of buckling in the flange plane

The distance between the local side stiffeners of the flange L_c = 3.75 m (at the mid-span of the flange) is assumed. The top flange was divided into 2 sections. In the example, the two sections are equal and the course of the forces in the flange is the same. It is, therefore, sufficient to consider the resistance of the flange in one section.

For such a course of axial force, the k_c coefficient is 0.75 (ψ=0)

The buckling length assumed for the calculation:

L_{cr} = 0,75 x 3,75 = 2,81m



ε = 0,814

$$\lambda_1 = 93{,}9 \cdot \varepsilon = 93{,}9 \cdot 0{,}814 = 76{,}4$$

$$I_z = \frac{t_f . b^3}{12} = \frac{1{,}2 \cdot 20{,}0^3}{12} = 800\ cm^4$$

$$A = t_f . b = 1{,}2 \cdot 20{,}0 = 24{,}0\ cm^2$$

$$i_z = \sqrt{\frac{I_z}{A}} = \sqrt{\frac{800}{24}} = 5{,}77\ \mathrm{cm}$$

$$\bar{\lambda} = \frac{L_{cr}}{i_z} \cdot \frac{1}{\lambda_1} = \frac{2{,}81 \cdot 10^2}{5{,}77} \cdot \frac{1}{76{,}4} = 0{,}637$$

α = 0,49 – for buckling curve c

$$\Phi = 0{,}5 \cdot [1 + \alpha \cdot (\bar{\lambda} - 0{,}2) + \bar{\lambda}^2] = 0{,}5 \cdot [1 + 0{,}49 \cdot (0{,}637 - 0{,}2) + 0{,}637^2] = 0{,}81$$

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} = \frac{1}{0{,}81 + \sqrt{0{,}81^2 - 0{,}637^2}} = 0{,}763$$

Buckling compression flange resistance

$$N_{b.Rd} = \frac{\chi \cdot A \cdot f_{yf}}{\gamma_{M1}} = \frac{0{,}763 \cdot 12 \cdot 200 \cdot 355 \cdot 10^{-3}}{1{,}0} = 650{,}1\ \mathrm{kN}$$

$$\frac{N_g}{N_{b.Rd}} = \frac{515}{650{,}1} = 0{,}79 \leq 1{,}0 - \text{condition met}$$

<u>Web resistance</u>

- Local buckling factor $\chi_{c,l}$

$$\tau_{cr.l} = \left(5{,}34 + \frac{a_3 \cdot s}{h_w \cdot t_w}\right) \cdot \frac{\pi^2 \cdot E}{12 \cdot (1 - \nu^2)} \cdot \left[\frac{t_w}{s}\right]^2$$
$$= \left(5{,}34 + \frac{40 \cdot \frac{178}{2}}{2{,}5 \cdot 500}\right) \cdot \frac{\pi^2 \cdot 210 \cdot 10^3}{12 \cdot (1 - 0{,}3^2)} \cdot \left[\frac{2{,}5}{\frac{178}{2}}\right]^2 = 1226{,}2\ \mathrm{MPa}$$

$$\bar{\lambda}_{c,l} = \sqrt{\frac{f_{yw}}{\tau_{cr.l} \cdot \sqrt{3}}} = \sqrt{\frac{235}{1226{,}3 \cdot \sqrt{3}}} = 0{,}333$$

$$\chi_{c,l} = \frac{1{,}00}{0{,}62 + \bar{\lambda}_{c,l}} = \frac{1{,}00}{0{,}62 + 0{,}333} = 1{,}04 > 1{,}0$$

Assumed $\chi_{c,l} = 1{,}0$

- Global buckling factor $\chi_{c,g}$

$$\mathrm{D}_x = \frac{E \cdot t_w^3}{12 \cdot (1 - \nu^2)} \cdot \frac{w}{s} = \frac{210 \cdot 10^9 \cdot 2{,}5^3 \cdot 10^{-9}}{12 \cdot (1 - 0{,}3^2)} \cdot \frac{\frac{155}{2}}{\frac{178}{2}} = 261{,}7\mathrm{Nm}$$

$$\mathrm{D}_z = \frac{E \cdot I_z}{w} = \frac{210 \cdot 10^9 \cdot 3{,}885 \cdot 10^{-8}}{\frac{155}{2} \cdot 10^{-3}} = 105271\mathrm{Nm}$$

$$\tau_{cr.g} = \frac{32{,}4}{t_w \cdot h_w^2} \cdot \sqrt[4]{D_x \cdot D_z^3} = \frac{32{,}4}{2{,}5 \cdot 10^{-3} \cdot 500^2 \cdot 10^{-6}} \cdot \sqrt[4]{261{,}7 \cdot 105271^3}$$
$$= 1218{,}6\mathrm{MPa}$$

$$\bar{\lambda}_{c,g} = \sqrt{\frac{f_{yw}}{\tau_{cr.g} \cdot \sqrt{3}}} = \sqrt{\frac{235}{1218{,}6 \cdot \sqrt{3}}} = 0{,}337$$

$$\chi_{c,g} = \frac{1,5}{0,5 + \bar{\lambda}_{c,g}^{\ 2}} = \frac{1,5}{0,5 + 0,337^2} = 2,445 \ > \ 1,0$$

assumed $\chi_{c,g} = 1,0$

- The lower value of the web buckling factor was taken into account for the calculations

$$\chi_c = \min(\chi_{c,g}, \chi_{c,l}) = 1,0$$

- Web resistance

$$\mathrm{V}_{Rd} = \chi_c \cdot \frac{f_{yw}}{\gamma_{M1} \cdot \sqrt{3}} \cdot h_w \cdot t_w = 1,0 \cdot \frac{235 \cdot 10^{-3}}{1,0 \cdot \sqrt{3}} \cdot 2,5 \cdot 500 = 169,6\mathrm{kN}$$

$$\frac{V_d}{V_{Rd}} = \frac{140,6}{169,6} = 0,83 \leq 1,0 - \text{condition met}$$

<u>Checking the deflection condition</u>

$$\mathrm{w}_{max} = \mathrm{w}_M + \mathrm{w}_V = \frac{5}{384} \cdot \frac{(g+p) \cdot l^4}{E \cdot I_y} + \frac{(g+p) \cdot l^2}{8 \cdot G_{red} \cdot A_w}$$
$$= \frac{5}{384} \cdot \frac{(10+16) \cdot 7,5^4}{205 \cdot 31457 \cdot 10^{-2}} + \frac{(10+16) \cdot 7,5^2}{8 \cdot 69,7 \cdot 500 \cdot 2,5} = 0,0166 + 0,0021$$
$$= 0,0187m$$

$$0,0187m \leq \frac{\mathrm{l}}{350} = \frac{7,5}{350} = 0,0214\mathrm{m} - \text{condition met}$$

CHAPTER 2

Tables

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

WT_ 333						h_w = 333 mm		WTA	t_w = 2,0 mm	$h_w \times t_w$ = 6,66 cm^2	
								WTB	t_w = 2,5 mm	$h_w \times t_w$ = 8,33 cm^2	
								WTC	t_w = 3,0 mm	$h_w \times t_w$ = 9,99 cm^2	
$b_f \times t_f$	H	weight			painting	section characterictic						
		WTA	WTB	WTC	surface	2 x A_f	I_y	i_y	I_z	i_z	I_t	I_w
mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
160 x 8	349	26,4	27,9	29,5	1,47	25,6	7 443	17,05	546	4,62	5,6	158 762
170 x 8	349	27,6	29,2	30,8	1,51	27,2	7 909	17,05	655	4,91	6,0	190 430
180 x 8	349	28,9	30,5	32,0	1,55	28,8	8 374	17,05	778	5,20	6,3	226 050
190 x 8	349	30,1	31,7	33,3	1,59	30,4	8 839	17,05	915	5,48	6,7	265 857
200 x 8	349	31,4	33,0	34,5	1,63	32,0	9 304	17,05	1 067	5,77	7,0	310 083
* 210 x 8	349	32,6	34,2	35,8	1,67	33,6	9 769	17,05	1 235	6,06	7,3	358 959
* 220 x 8	349	33,9	35,5	37,0	1,71	35,2	10 235	17,05	1 420	6,35	7,7	412 720
160 x 10	353	31,4	33,0	34,5	1,48	32,0	9 415	17,15	683	4,62	10,8	200 788
170 x 10	353	33,0	34,5	36,1	1,52	34,0	10 003	17,15	819	4,91	11,5	240 837
180 x 10	353	34,5	36,1	37,7	1,56	36,0	10 591	17,15	972	5,20	12,2	285 887
190 x 10	353	36,1	37,7	39,2	1,60	38,0	11 180	17,15	1 143	5,48	12,8	336 231
200 x 10	353	37,7	39,2	40,8	1,64	40,0	11 768	17,15	1 333	5,77	13,5	392 163
210 x 10	353	39,2	40,8	42,4	1,68	42,0	12 357	17,15	1 544	6,06	14,2	453 978
220 x 10	353	40,8	42,4	44,0	1,72	44,0	12 945	17,15	1 775	6,35	14,8	521 969
160 x 12	357	36,4	38,0	39,6	1,49	38,4	11 431	17,25	819	4,62	18,6	243 763
170 x 12	357	38,3	39,9	41,4	1,53	40,8	12 145	17,25	983	4,91	19,8	292 385
180 x 12	357	40,2	41,8	43,3	1,57	43,2	12 860	17,25	1 166	5,20	20,9	347 077
190 x 12	357	42,1	43,6	45,2	1,61	45,6	13 574	17,25	1 372	5,48	22,1	408 196
200 x 12	357	44,0	45,5	47,1	1,65	48,0	14 289	17,25	1 600	5,77	23,2	476 100
210 x 12	357	45,8	47,4	49,0	1,69	50,4	15 003	17,25	1 852	6,06	24,4	551 145
220 x 12	357	47,7	49,3	50,9	1,73	52,8	15 718	17,25	2 130	6,35	25,5	633 689
200 x 15	363	53,4	54,9	56,5	1,66	60,0	18 177	17,41	2 000	5,77	45,2	605 520
210 x 15	363	55,7	57,3	58,9	1,70	63,0	19 086	17,41	2 315	6,06	47,4	700 965
220 x 15	363	58,1	59,7	61,2	1,74	66,0	19 995	17,41	2 662	6,35	49,7	805 947

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

	WT_ 500						h_w = 500 mm		WTA	t_w = 2,0 mm	h_w x t_w = 10,00 cm^2		
									WTB	t_w = 2,5 mm	h_w x t_w = 12,50 cm^2		
									WTC	t_w = 3,0 mm	h_w x t_w = 15,00 cm^2		
	b_f x t_f	H	weight			painting	section characterictic						
			WTA	WTB	WTC	surface	2 x A_f	I_y	i_y	I_z	i_z	I_t	I_w
	mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
	160 x 8	516	29,5	31,9	34,2	1,87	25,6	16 517	25,40	546	4,62	5,7	352 343
	170 x 8	516	30,8	33,1	35,5	1,91	27,2	17 550	25,40	655	4,91	6,1	422 623
	180 x 8	516	32,0	34,4	36,7	1,95	28,8	18 582	25,40	778	5,20	6,4	501 676
	190 x 8	516	33,3	35,6	38,0	1,99	30,4	19 614	25,40	915	5,48	6,7	590 020
	200 x 8	516	34,5	36,9	39,3	2,03	32,0	20 647	25,40	1 067	5,77	7,1	688 171
*	210 x 8	516	35,8	38,2	40,5	2,07	33,6	21 679	25,40	1 235	6,06	7,4	796 644
*	220 x 8	516	37,1	39,4	41,8	2,11	35,2	22 712	25,40	1 420	6,35	7,8	915 955
	160 x 10	520	34,5	36,9	39,3	1,88	32,0	20 811	25,50	683	4,62	10,9	443 904
	170 x 10	520	36,1	38,5	40,8	1,92	34,0	22 111	25,50	819	4,91	11,6	532 446
	180 x 10	520	37,7	40,0	42,4	1,96	36,0	23 412	25,50	972	5,20	12,3	632 043
	190 x 10	520	39,3	41,6	44,0	2,00	38,0	24 713	25,50	1 143	5,48	12,9	743 344
	200 x 10	520	40,8	43,2	45,5	2,04	40,0	26 013	25,50	1 333	5,77	13,6	867 000
	210 x 10	520	42,4	44,7	47,1	2,08	42,0	27 314	25,50	1 544	6,06	14,3	1 003 661
	220 x 10	520	44,0	46,3	48,7	2,12	44,0	28 615	25,50	1 775	6,35	14,9	1 153 977
	230 x 10	520	45,5	47,9	50,2	2,16	46,0	29 915	25,50	2 028	6,64	15,6	1 318 599
	240 x 10	520	47,1	49,5	51,8	2,20	48,0	31 216	25,50	2 304	6,93	16,3	1 498 176
*	250 x 10	520	48,7	51,0	53,4	2,24	50,0	32 517	25,50	2 604	7,22	16,9	1 693 359
	160 x 12	524	39,6	41,9	44,3	1,89	38,4	25 170	25,60	819	4,62	18,7	536 871
	170 x 12	524	41,4	43,8	46,2	1,93	40,8	26 744	25,60	983	4,91	19,8	643 957
	180 x 12	524	43,3	45,7	48,0	1,97	43,2	28 317	25,60	1 166	5,20	21,0	764 412
	190 x 12	524	45,2	47,6	49,9	2,01	45,6	29 890	25,60	1 372	5,48	22,1	899 023
	200 x 12	524	47,1	49,5	51,8	2,05	48,0	31 463	25,60	1 600	5,77	23,3	1 048 576
	210 x 12	524	49,0	51,3	53,7	2,09	50,4	33 036	25,60	1 852	6,06	24,5	1 213 858
	220 x 12	524	50,9	53,2	55,6	2,13	52,8	34 609	25,60	2 130	6,35	25,6	1 395 655
	230 x 12	524	52,8	55,1	57,5	2,17	55,2	36 182	25,60	2 433	6,64	26,8	1 594 753
	240 x 12	524	54,6	57,0	59,3	2,21	57,6	37 756	25,60	2 765	6,93	27,9	1 811 939
	250 x 12	524	56,5	58,9	61,2	2,25	60,0	39 329	25,60	3 125	7,22	29,1	2 048 000
	260 x 12	524	58,4	60,8	63,1	2,29	62,4	40 902	25,60	3 515	7,51	30,2	2 303 721
	280 x 12	524	62,2	64,5	66,9	2,37	67,2	44 048	25,60	4 390	8,08	32,5	2 877 293
*	300 x 12	524	65,9	68,3	70,7	2,45	72,0	47 195	25,60	5 400	8,66	34,8	3 538 944
	200 x 15	530	56,5	58,9	61,2	2,06	60,0	39 795	25,75	2 000	5,77	45,3	1 326 125
	210 x 15	530	58,9	61,2	63,6	2,10	63,0	41 785	25,75	2 315	6,06	47,5	1 535 155
	220 x 15	530	61,2	63,6	65,9	2,14	66,0	43 775	25,75	2 662	6,35	49,8	1 765 072
	230 x 15	530	63,6	65,9	68,3	2,18	69,0	45 764	25,75	3 042	6,64	52,0	2 016 870
	240 x 15	530	65,9	68,3	70,7	2,22	72,0	47 754	25,75	3 456	6,93	54,3	2 291 544
	250 x 15	530	68,3	70,7	73,0	2,26	75,0	49 744	25,75	3 906	7,22	56,5	2 590 088
	260 x 15	530	70,7	73,0	75,4	2,30	78,0	51 734	25,75	4 394	7,51	58,8	2 913 497
	280 x 15	530	75,4	77,7	80,1	2,38	84,0	55 713	25,75	5 488	8,08	63,3	3 638 887
	300 x 15	530	80,1	82,4	84,8	2,46	90,0	59 693	25,75	6 750	8,66	67,8	4 475 672
	220 x 20	540	78,5	80,9	83,2	2,16	88,0	59 517	26,01	3 549	6,35	117,6	2 399 349
	230 x 20	540	81,6	84,0	86,4	2,20	92,0	62 223	26,01	4 056	6,64	122,9	2 741 631
	240 x 20	540	84,8	87,1	89,5	2,24	96,0	64 928	26,01	4 608	6,93	128,3	3 115 008
	250 x 20	540	87,9	90,3	92,6	2,28	100,0	67 633	26,01	5 208	7,22	133,6	3 520 833
	260 x 20	540	91,1	93,4	95,8	2,32	104,0	70 339	26,01	5 859	7,51	138,9	3 960 459
	280 x 20	540	97,3	99,7	102,1	2,40	112,0	75 749	26,01	7 317	8,08	149,6	4 946 517
	300 x 20	540	103,6	106,0	108,3	2,48	120,0	81 160	26,01	9 000	8,66	160,3	6 084 000
	250 x 25	550	107,5	109,9	112,3	2,30	125,0	86 198	26,26	6 510	7,22	260,7	4 486 084
	260 x 25	550	111,5	113,8	116,2	2,34	130,0	89 646	26,26	7 323	7,51	271,1	5 046 234
	280 x 25	550	119,3	121,7	124,0	2,42	140,0	96 542	26,26	9 147	8,08	291,9	6 302 625
	300 x 25	550	127,2	129,5	131,9	2,50	150,0	103 438	26,26	11 250	8,66	312,8	7 751 953
	300 x 30	560	150,7	153,1	155,4	2,52	180,0	126 540	26,51	13 500	8,66	540,3	9 480 375

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

WT_ 625	h_w = 625 mm			
		WTA	t_w = 2,0 mm	$h_w \times t_w$ = 12,50 cm^2
		WTB	t_w = 2,5 mm	$h_w \times t_w$ = 15,63 cm^2
		WTC	t_w = 3,0 mm	$h_w \times t_w$ = 18,75 cm^2

$b_f \times t_f$	H	weight			painting	section characterictic						
		WTA	WTB	WTC	surface	2 x A_f	I_y	i_y	I_z	i_z	I_t	I_w
mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
160 x 8	641	31,9	34,8	37,8	2,17	25,6	25 645	31,65	546	4,62	5,8	547 074
170 x 8	641	33,1	36,1	39,0	2,21	27,2	27 248	31,65	655	4,91	6,1	656 195
180 x 8	641	34,4	37,3	40,3	2,25	28,8	28 851	31,65	778	5,20	6,5	778 939
190 x 8	641	35,6	38,6	41,5	2,29	30,4	30 454	31,65	915	5,48	6,8	916 109
200 x 8	641	36,9	39,8	42,8	2,33	32,0	32 057	31,65	1 067	5,77	7,2	1 068 504
* 210 x 8	641	38,2	41,1	44,0	2,37	33,6	33 660	31,65	1 235	6,06	7,5	1 236 927
* 220 x 8	641	39,4	42,4	45,3	2,41	35,2	35 263	31,65	1 420	6,35	7,8	1 422 179
160 x 10	645	36,9	39,8	42,8	2,18	32,0	32 261	31,75	683	4,62	11,0	688 171
170 x 10	645	38,5	41,4	44,4	2,22	34,0	34 277	31,75	819	4,91	11,7	825 435
180 x 10	645	40,0	43,0	45,9	2,26	36,0	36 293	31,75	972	5,20	12,3	979 837
190 x 10	645	41,6	44,5	47,5	2,30	38,0	38 310	31,75	1 143	5,48	13,0	1 152 383
200 x 10	645	43,2	46,1	49,1	2,34	40,0	40 326	31,75	1 333	5,77	13,7	1 344 083
210 x 10	645	44,7	47,7	50,6	2,38	42,0	42 342	31,75	1 544	6,06	14,3	1 555 944
220 x 10	645	46,3	49,3	52,2	2,42	44,0	44 358	31,75	1 775	6,35	15,0	1 788 975
240 x 10	645	49,5	52,4	55,3	2,50	48,0	48 391	31,75	2 304	6,93	16,3	2 322 576
* 250 x 10	645	51,0	54,0	56,9	2,54	50,0	50 407	31,75	2 604	7,22	17,0	2 625 163
160 x 12	649	41,9	44,9	47,8	2,19	38,4	38 958	31,85	819	4,62	18,8	831 015
170 x 12	649	43,8	46,7	49,7	2,23	40,8	41 393	31,85	983	4,91	19,9	996 772
180 x 12	649	45,7	48,6	51,6	2,27	43,2	43 828	31,85	1 166	5,20	21,1	1 183 222
190 x 12	649	47,6	50,5	53,5	2,31	45,6	46 263	31,85	1 372	5,48	22,2	1 391 585
200 x 12	649	49,5	52,4	55,3	2,35	48,0	48 698	31,85	1 600	5,77	23,4	1 623 076
210 x 12	649	51,3	54,3	57,2	2,39	50,4	51 133	31,85	1 852	6,06	24,5	1 878 913
220 x 12	649	53,2	56,2	59,1	2,43	52,8	53 568	31,85	2 130	6,35	25,7	2 160 314
240 x 12	649	57,0	59,9	62,9	2,51	57,6	58 438	31,85	2 765	6,93	28,0	2 804 675
250 x 12	649	58,9	61,8	64,8	2,55	60,0	60 873	31,85	3 125	7,22	29,1	3 170 070
260 x 12	649	60,8	63,7	66,6	2,59	62,4	63 307	31,85	3 515	7,51	30,3	3 565 898
280 x 12	649	64,5	67,5	70,4	2,67	67,2	68 177	31,85	4 390	8,08	32,6	4 453 721
* 300 x 12	649	68,3	71,2	74,2	2,75	72,0	73 047	31,85	5 400	8,66	34,9	5 477 882
200 x 15	655	58,9	61,8	64,8	2,36	60,0	61 451	32,00	2 000	5,77	45,3	2 048 000
210 x 15	655	61,2	64,2	67,1	2,40	63,0	64 524	32,00	2 315	6,06	47,6	2 370 816
220 x 15	655	63,6	66,5	69,5	2,44	66,0	67 596	32,00	2 662	6,35	49,8	2 725 888
240 x 15	655	68,3	71,2	74,2	2,52	72,0	73 742	32,00	3 456	6,93	54,3	3 538 944
250 x 15	655	70,7	73,6	76,5	2,56	75,0	76 814	32,00	3 906	7,22	56,6	4 000 000
260 x 15	655	73,0	75,9	78,9	2,60	78,0	79 887	32,00	4 394	7,51	58,8	4 499 456
280 x 15	655	77,7	80,7	83,6	2,68	84,0	86 032	32,00	5 488	8,08	63,3	5 619 712
300 x 15	655	82,4	85,4	88,3	2,76	90,0	92 177	32,00	6 750	8,66	67,8	6 912 000
325 x 15	655	88,3	91,3	94,2	2,86	97,5	99 858	32,00	8 582	9,38	73,5	8 788 000
220 x 20	665	80,9	83,8	86,7	2,46	88,0	91 555	32,26	3 549	6,35	117,7	3 691 529
240 x 20	665	87,1	90,1	93,0	2,54	96,0	99 878	32,26	4 608	6,93	128,3	4 792 608
250 x 20	665	90,3	93,2	96,2	2,58	100,0	104 040	32,26	5 208	7,22	133,7	5 416 992
260 x 20	665	93,4	96,4	99,3	2,62	104,0	108 201	32,26	5 859	7,51	139,0	6 093 380
280 x 20	665	99,7	102,6	105,6	2,70	112,0	116 524	32,26	7 317	8,08	149,7	7 610 484
300 x 20	665	106,0	108,9	111,9	2,78	120,0	124 848	32,26	9 000	8,66	160,3	9 360 563
325 x 20	665	113,8	116,8	119,7	2,88	130,0	135 251	32,26	11 443	9,38	173,7	11 901 132
250 x 25	675	109,9	112,8	115,8	2,60	125,0	132 096	32,51	6 510	7,22	260,7	6 876 628
260 x 25	675	113,8	116,8	119,7	2,64	130,0	137 380	32,51	7 323	7,51	271,2	7 735 271
280 x 25	675	121,7	124,6	127,6	2,72	140,0	147 948	32,51	9 147	8,08	292,0	9 661 167
300 x 25	675	129,5	132,5	135,4	2,80	150,0	158 516	32,51	11 250	8,66	312,8	11 882 813
325 x 25	675	139,3	142,3	145,2	2,90	162,5	171 725	32,51	14 303	9,38	338,9	15 107 951
300 x 30	685	153,1	156,0	159,0	2,82	180,0	193 196	32,76	13 500	8,66	540,3	14 479 594
325 x 30	685	164,9	167,8	170,7	2,92	195,0	209 296	32,76	17 164	9,38	585,3	18 409 530

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

WT_ 750	h_w = 750 mm		
		WTA	t_w = 2,0 mm	$h_w \times t_w$ = 15,00 cm^2
		WTB	t_w = 2,5 mm	$h_w \times t_w$ = 18,75 cm^2
		WTC	t_w = 3,0 mm	$h_w \times t_w$ = 22,50 cm^2

$b_f \times t_f$	H	weight			painting	section characterictic						
		WTA	WTB	WTC	surface	2 x A_f	I_y	i_y	I_z	i_z	I_t	I_w
mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
160 x 8	766	34,2	37,8	41,3	2,47	25,6	36 773	37,90	546	4,62	5,9	784 471
180 x 8	766	36,7	40,3	43,8	2,55	28,8	41 370	37,90	778	5,20	6,5	1 116 952
200 x 8	766	39,3	42,8	46,3	2,63	32,0	45 967	37,90	1 067	5,77	7,2	1 532 171
* 220 x 8	766	41,8	45,3	48,8	2,71	35,2	50 564	37,90	1 420	6,35	7,9	2 039 319
160 x 10	770	39,3	42,8	46,3	2,48	32,0	46 211	38,00	683	4,62	11,1	985 771
180 x 10	770	42,4	45,9	49,5	2,56	36,0	51 987	38,00	972	5,20	12,4	1 403 568
200 x 10	770	45,5	49,1	52,6	2,64	40,0	57 763	38,00	1 333	5,77	13,7	1 925 333
220 x 10	770	48,7	52,2	55,7	2,72	44,0	63 540	38,00	1 775	6,35	15,1	2 562 619
240 x 10	770	51,8	55,3	58,9	2,80	48,0	69 316	38,00	2 304	6,93	16,4	3 326 976
* 250 x 10	770	53,4	56,9	60,4	2,84	50,0	72 204	38,00	2 604	7,22	17,1	3 760 417
160 x 12	774	44,3	47,8	51,3	2,49	38,4	55 746	38,10	819	4,62	18,8	1 189 159
180 x 12	774	48,0	51,6	55,1	2,57	43,2	62 715	38,10	1 166	5,20	21,1	1 693 158
200 x 12	774	51,8	55,3	58,9	2,65	48,0	69 683	38,10	1 600	5,77	23,4	2 322 576
220 x 12	774	55,6	59,1	62,6	2,73	52,8	76 651	38,10	2 130	6,35	25,7	3 091 349
240 x 12	774	59,3	62,9	66,4	2,81	57,6	83 620	38,10	2 765	6,93	28,0	4 013 411
250 x 12	774	61,2	64,8	68,3	2,85	60,0	87 104	38,10	3 125	7,22	29,2	4 536 281
260 x 12	774	63,1	66,6	70,2	2,89	62,4	90 588	38,10	3 515	7,51	30,3	5 102 699
280 x 12	774	66,9	70,4	73,9	2,97	67,2	97 556	38,10	4 390	8,08	32,6	6 373 149
* 300 x 12	774	70,7	74,2	77,7	3,05	72,0	104 525	38,10	5 400	8,66	35,0	7 838 694
200 x 15	780	61,2	64,8	68,3	2,66	60,0	87 795	38,25	2 000	5,77	45,4	2 926 125
220 x 15	780	65,9	69,5	73,0	2,74	66,0	96 575	38,25	2 662	6,35	49,9	3 894 672
240 x 15	780	70,7	74,2	77,7	2,82	72,0	105 354	38,25	3 456	6,93	54,4	5 056 344
250 x 15	780	73,0	76,5	80,1	2,86	75,0	109 744	38,25	3 906	7,22	56,6	5 715 088
260 x 15	780	75,4	78,9	82,4	2,90	78,0	114 134	38,25	4 394	7,51	58,9	6 428 697
280 x 15	780	80,1	83,6	87,1	2,98	84,0	122 913	38,25	5 488	8,08	63,4	8 029 287
300 x 15	780	84,8	88,3	91,8	3,06	90,0	131 693	38,25	6 750	8,66	67,9	9 875 672
325 x 15	780	90,7	94,2	97,7	3,16	97,5	142 667	38,25	8 582	9,38	73,5	12 556 048
350 x 15	780	96,6	100,1	103,6	3,26	105,0	153 641	38,25	10 719	10,10	79,1	15 682 201
220 x 20	790	83,2	86,7	90,3	2,76	88,0	130 467	38,50	3 549	6,35	117,7	5 260 999
240 x 20	790	89,5	93,0	96,6	2,84	96,0	142 328	38,50	4 608	6,93	128,4	6 830 208
250 x 20	790	92,6	96,2	99,7	2,88	100,0	148 258	38,50	5 208	7,22	133,7	7 720 052
260 x 20	790	95,8	99,3	102,8	2,92	104,0	154 189	38,50	5 859	7,51	139,1	8 684 009
280 x 20	790	102,1	105,6	109,1	3,00	112,0	166 049	38,50	7 317	8,08	149,7	10 846 117
300 x 20	790	108,3	111,9	115,4	3,08	120,0	177 910	38,50	9 000	8,66	160,4	13 340 250
325 x 20	790	116,2	119,7	123,2	3,18	130,0	192 736	38,50	11 443	9,38	173,7	16 960 954
350 x 20	790	124,0	127,6	131,1	3,28	140,0	207 562	38,50	14 292	10,10	187,1	21 183 823
375 x 20	790	131,9	135,4	138,9	3,38	150,0	222 388	38,50	17 578	10,83	200,4	26 055 176
400 x 20	790	139,7	143,3	146,8	3,48	160,0	237 213	38,50	21 333	11,55	213,7	31 621 333
250 x 25	800	112,3	115,8	119,3	2,90	125,0	187 760	38,76	6 510	7,22	260,8	9 775 798
260 x 25	800	116,2	119,7	123,2	2,94	130,0	195 271	38,76	7 323	7,51	271,2	10 996 443
280 x 25	800	124,0	127,6	131,1	3,02	140,0	210 292	38,76	9 147	8,08	292,1	13 734 292
300 x 25	800	131,9	135,4	138,9	3,10	150,0	225 313	38,76	11 250	8,66	312,9	16 892 578
325 x 25	800	141,7	145,2	148,8	3,20	162,5	244 089	38,76	14 303	9,38	338,9	21 477 427
350 x 25	800	151,5	155,0	158,6	3,30	175,0	262 865	38,76	17 865	10,10	365,0	26 824 788
375 x 25	800	161,3	164,9	168,4	3,40	187,5	281 641	38,76	21 973	10,83	391,0	32 993 317
400 x 25	800	171,1	174,7	178,2	3,50	200,0	300 417	38,76	26 667	11,55	417,1	40 041 667
300 x 30	810	155,4	159,0	162,5	3,12	180,0	273 915	39,01	13 500	8,66	540,4	20 533 500
325 x 30	810	167,2	170,7	174,3	3,22	195,0	296 741	39,01	17 164	9,38	585,4	26 106 539
350 x 30	810	179,0	182,5	186,0	3,32	210,0	319 568	39,01	21 438	10,10	630,4	32 606 438
400 x 30	810	202,5	206,1	209,6	3,52	240,0	365 220	39,01	32 000	11,55	720,4	48 672 000

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

WT_ 1000	h_w = 1000 mm			
		WTA	t_w = 2,0 mm	$h_w \times t_w$ = 20,00 cm^2
		WTB	t_w = 2,5 mm	$h_w \times t_w$ = 25,00 cm^2
		WTC	t_w = 3,0 mm	$h_w \times t_w$ = 30,00 cm^2

	$b_f \times t_f$	H	weight			painting	section characterictic						
			WTA	WTB	WTC	surface	$2 \times A_f$	I_y	i_y	I_z	i_z	I_t	I_w
	mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
	180 x 8	1016	41,4	46,2	50,9	3,15	28,8	73 158	50,40	778	5,20	6,7	1 975 228
	200 x 8	1016	44,0	48,7	53,4	3,23	32,0	81 287	50,40	1 067	5,77	7,3	2 709 504
*	220 x 8	1016	46,5	51,2	55,9	3,31	35,2	89 416	50,40	1 420	6,35	8,0	3 606 350
	180 x 10	1020	47,1	51,8	56,5	3,16	36,0	91 812	50,50	972	5,20	12,5	2 478 843
	200 x 10	1020	50,2	55,0	59,7	3,24	40,0	102 013	50,50	1 333	5,77	13,9	3 400 333
	220 x 10	1020	53,4	58,1	62,8	3,32	44,0	112 215	50,50	1 775	6,35	15,2	4 525 844
	240 x 10	1020	56,5	61,2	65,9	3,40	48,0	122 416	50,50	2 304	6,93	16,5	5 875 776
*	250 x 10	1020	58,1	62,8	67,5	3,44	50,0	127 517	50,50	2 604	7,22	17,2	6 641 276
	180 x 12	1024	52,8	57,5	62,2	3,17	43,2	110 613	50,60	1 166	5,20	21,3	2 986 404
	200 x 12	1024	56,5	61,2	65,9	3,25	48,0	122 903	50,60	1 600	5,77	23,6	4 096 576
	220 x 12	1024	60,3	65,0	69,7	3,33	52,8	135 193	50,60	2 130	6,35	25,9	5 452 543
	240 x 12	1024	64,1	68,8	73,5	3,41	57,6	147 484	50,60	2 765	6,93	28,2	7 078 883
	250 x 12	1024	65,9	70,7	75,4	3,45	60,0	153 629	50,60	3 125	7,22	29,3	8 001 125
	260 x 12	1024	67,8	72,5	77,2	3,49	62,4	159 774	50,60	3 515	7,51	30,5	9 000 177
	280 x 12	1024	71,6	76,3	81,0	3,57	67,2	172 064	50,60	4 390	8,08	32,8	11 241 005
*	300 x 12	1024	75,4	80,1	84,8	3,65	72,0	184 355	50,60	5 400	8,66	35,1	13 825 944
	200 x 15	1030	65,9	70,7	75,4	3,26	60,0	154 545	50,75	2 000	5,77	45,5	5 151 125
	220 x 15	1030	70,7	75,4	80,1	3,34	66,0	170 000	50,75	2 662	6,35	50,0	6 856 147
	240 x 15	1030	75,4	80,1	84,8	3,42	72,0	185 454	50,75	3 456	6,93	54,5	8 901 144
	250 x 15	1030	77,7	82,4	87,1	3,46	75,0	193 181	50,75	3 906	7,22	56,8	10 060 791
	260 x 15	1030	80,1	84,8	89,5	3,50	78,0	200 909	50,75	4 394	7,51	59,0	11 317 022
	280 x 15	1030	84,8	89,5	94,2	3,58	84,0	216 363	50,75	5 488	8,08	63,5	14 134 687
	300 x 15	1030	89,5	94,2	98,9	3,66	90,0	231 818	50,75	6 750	8,66	68,0	17 385 047
	325 x 15	1030	95,4	100,1	104,8	3,76	97,5	251 136	50,75	8 582	9,38	73,6	22 103 558
	350 x 15	1030	101,3	106,0	110,7	3,86	105,0	270 454	50,75	10 719	10,10	79,3	27 606 811
	220 x 20	1040	87,9	92,6	97,3	3,36	88,0	228 917	51,00	3 549	6,35	117,9	9 231 816
	240 x 20	1040	94,2	98,9	103,6	3,44	96,0	249 728	51,00	4 608	6,93	128,5	11 985 408
	250 x 20	1040	97,3	102,1	106,8	3,48	100,0	260 133	51,00	5 208	7,22	133,9	13 546 875
	260 x 20	1040	100,5	105,2	109,9	3,52	104,0	270 539	51,00	5 859	7,51	139,2	15 238 392
	280 x 20	1040	106,8	111,5	116,2	3,60	112,0	291 349	51,00	7 317	8,08	149,9	19 032 384
	300 x 20	1040	113,0	117,8	122,5	3,68	120,0	312 160	51,00	9 000	8,66	160,5	23 409 000
	325 x 20	1040	120,9	125,6	130,3	3,78	130,0	338 173	51,00	11 443	9,38	173,9	29 762 484
	350 x 20	1040	128,7	133,5	138,2	3,88	140,0	364 187	51,00	14 292	10,10	187,2	37 172 625
	375 x 20	1040	136,6	141,3	146,0	3,98	150,0	390 200	51,00	17 578	10,83	200,5	45 720 703
	400 x 20	1040	144,4	149,2	153,9	4,08	160,0	416 213	51,00	21 333	11,55	213,9	55 488 000
	250 x 25	1050	117,0	121,7	126,4	3,50	125,0	328 385	51,26	6 510	7,22	260,9	17 100 016
	260 x 25	1050	120,9	125,6	130,3	3,54	130,0	341 521	51,26	7 323	7,51	271,4	19 235 193
	280 x 25	1050	128,7	133,5	138,2	3,62	140,0	367 792	51,26	9 147	8,08	292,2	24 024 292
	300 x 25	1050	136,6	141,3	146,0	3,70	150,0	394 063	51,26	11 250	8,66	313,0	29 548 828
	325 x 25	1050	146,4	151,1	155,8	3,80	162,5	426 901	51,26	14 303	9,38	339,1	37 568 736
	350 x 25	1050	156,2	160,9	165,6	3,90	175,0	459 740	51,26	17 865	10,10	365,1	46 922 445
	375 x 25	1050	166,0	170,7	175,4	4,00	187,5	492 578	51,26	21 973	10,83	391,1	57 712 555
	400 x 25	1050	175,8	180,6	185,3	4,10	200,0	525 417	51,26	26 667	11,55	417,2	70 041 667
	425 x 25	1050	185,7	190,4	195,1	4,20	212,5	558 255	51,26	31 986	12,27	443,2	84 012 380
	450 x 25	1050	195,5	200,2	204,9	4,30	225,0	591 094	51,26	37 969	12,99	469,3	99 727 295
	300 x 30	1060	160,1	164,9	169,6	3,72	180,0	477 540	51,51	13 500	8,66	540,5	35 805 375
	325 x 30	1060	171,9	176,6	181,3	3,82	195,0	517 335	51,51	17 164	9,38	585,5	45 523 385
	350 x 30	1060	183,7	188,4	193,1	3,92	210,0	557 130	51,51	21 438	10,10	630,5	56 857 609
	375 x 30	1060	195,5	200,2	204,9	4,02	225,0	596 925	51,51	26 367	10,83	675,5	69 932 373
	400 x 30	1060	207,2	212,0	216,7	4,12	240,0	636 720	51,51	32 000	11,55	720,5	84 872 000
	425 x 30	1060	219,0	223,7	228,4	4,22	255,0	676 515	51,51	38 383	12,27	765,5	101 800 814
	450 x 30	1060	230,8	235,5	240,2	4,32	270,0	716 310	51,51	45 563	12,99	810,5	120 843 141

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

	WT_ 1250						h_w = 1250 mm		WTB / WTC	t_w = 2,5 mm / t_w = 3,0 mm		h_w x t_w = 31,25 cm^2 / h_w x t_w = 37,50 cm^2
	b_f x t_f	H	weight			painting	section characterictic					
			WTA	WTB	WTC	surface	2 x A_f	I_y	i_y	I_z	i_z	I_t	I_w
	mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
	200 x 10	1270		60,8	66,7	3,84	40,0	158 763	63,00	1 333	5,77	14,0	5 292 000
	220 x 10	1270		64,0	69,9	3,92	44,0	174 640	63,00	1 775	6,35	15,3	7 043 652
	240 x 10	1270		67,1	73,0	4,00	48,0	190 516	63,00	2 304	6,93	16,7	9 144 576
*	250 x 10	1270		68,7	74,6	4,04	50,0	198 454	63,00	2 604	7,22	17,3	10 335 938
	200 x 12	1274		67,1	73,0	3,85	48,0	191 123	63,10	1 600	5,77	23,7	6 370 576
	220 x 12	1274		70,9	76,8	3,93	52,8	210 235	63,10	2 130	6,35	26,0	8 479 237
	240 x 12	1274		74,7	80,5	4,01	57,6	229 348	63,10	2 765	6,93	28,3	11 008 355
	250 x 12	1274		76,5	82,4	4,05	60,0	238 904	63,10	3 125	7,22	29,5	12 442 531
	260 x 12	1274		78,4	84,3	4,09	62,4	248 460	63,10	3 515	7,51	30,6	13 996 155
	280 x 12	1274		82,2	88,1	4,17	67,2	267 572	63,10	4 390	8,08	32,9	17 480 861
*	300 x 12	1274		86,0	91,8	4,25	72,0	286 685	63,10	5 400	8,66	35,2	21 500 694
	200 x 15	1280		76,5	82,4	3,86	60,0	240 045	63,25	2 000	5,77	45,7	8 001 125
	220 x 15	1280		81,2	87,1	3,94	66,0	264 050	63,25	2 662	6,35	50,2	10 649 497
	240 x 15	1280		86,0	91,8	4,02	72,0	288 054	63,25	3 456	6,93	54,7	13 825 944
	250 x 15	1280		88,3	94,2	4,06	75,0	300 056	63,25	3 906	7,22	56,9	15 627 197
	260 x 15	1280		90,7	96,6	4,10	78,0	312 059	63,25	4 394	7,51	59,2	17 578 472
	280 x 15	1280		95,4	101,3	4,18	84,0	336 063	63,25	5 488	8,08	63,7	21 955 087
	300 x 15	1280		100,1	106,0	4,26	90,0	360 068	63,25	6 750	8,66	68,2	27 003 797
	325 x 15	1280		106,0	111,9	4,36	97,5	390 073	63,25	8 582	9,38	73,8	34 332 952
	350 x 15	1280		111,9	117,8	4,46	105,0	420 079	63,25	10 719	10,10	79,4	42 881 029
	220 x 20	1290		98,5	104,4	3,96	88,0	354 867	63,50	3 549	6,35	118,0	14 311 799
	240 x 20	1290		104,8	110,7	4,04	96,0	387 128	63,50	4 608	6,93	128,7	18 580 608
	250 x 20	1290		107,9	113,8	4,08	100,0	403 258	63,50	5 208	7,22	134,0	21 001 302
	260 x 20	1290		111,1	117,0	4,12	104,0	419 389	63,50	5 859	7,51	139,3	23 623 609
	280 x 20	1290		117,4	123,2	4,20	112,0	451 649	63,50	7 317	8,08	150,0	29 505 317
	300 x 20	1290		123,6	129,5	4,28	120,0	483 910	63,50	9 000	8,66	160,7	36 290 250
	325 x 20	1290		131,5	137,4	4,38	130,0	524 236	63,50	11 443	9,38	174,0	46 139 861
	350 x 20	1290		139,3	145,2	4,48	140,0	564 562	63,50	14 292	10,10	187,3	57 627 573
	375 x 20	1290		147,2	153,1	4,58	150,0	604 888	63,50	17 578	10,83	200,7	70 879 395
	400 x 20	1290		155,0	160,9	4,68	160,0	645 213	63,50	21 333	11,55	214,0	86 021 333
	250 x 25	1300		127,6	133,5	4,10	125,0	508 073	63,75	6 510	7,22	261,1	26 458 740
	260 x 25	1300		131,5	137,4	4,14	130,0	528 396	63,75	7 323	7,51	271,5	29 762 484
	280 x 25	1300		139,3	145,2	4,22	140,0	569 042	63,75	9 147	8,08	292,3	37 172 625
	300 x 25	1300		147,2	153,1	4,30	150,0	609 688	63,75	11 250	8,66	313,2	45 720 703
	325 x 25	1300		157,0	162,9	4,40	162,5	660 495	63,75	14 303	9,38	339,2	58 129 852
	350 x 25	1300		166,8	172,7	4,50	175,0	711 302	63,75	17 865	10,10	365,2	72 602 783
	375 x 25	1300		176,6	182,5	4,60	187,5	762 109	63,75	21 973	10,83	391,3	89 298 248
	400 x 25	1300		186,4	192,3	4,70	200,0	812 917	63,75	26 667	11,55	417,3	108 375 000
	425 x 25	1300		196,3	202,1	4,80	212,5	863 724	63,75	31 986	12,27	443,4	129 991 791
	450 x 25	1300		206,1	212,0	4,90	225,0	914 531	63,75	37 969	12,99	469,4	154 307 373
	300 x 30	1310		170,7	176,6	4,32	180,0	737 415	64,01	13 500	8,66	540,7	55 296 000
	325 x 30	1310		182,5	188,4	4,42	195,0	798 866	64,01	17 164	9,38	585,7	70 304 000
	350 x 30	1310		194,3	200,2	4,52	210,0	860 318	64,01	21 438	10,10	630,7	87 808 000
	375 x 30	1310		206,1	212,0	4,62	225,0	921 769	64,01	26 367	10,83	675,7	108 000 000
	400 x 30	1310		217,8	223,7	4,72	240,0	983 220	64,01	32 000	11,55	720,7	131 072 000
	425 x 30	1310		229,6	235,5	4,82	255,0	1 044 671	64,01	38 383	12,27	765,7	157 216 000
	450 x 30	1310		241,4	247,3	4,92	270,0	1 106 123	64,01	45 563	12,99	810,7	186 624 000

Annex 1. Geometry characteristic and weight

* - possible only for steel grade S235

	WT_ 1500						h_w = 1500 mm			WTB	t_w = 2,5 mm		h_w x t_w = 37,50 cm^2
										WTC	t_w = 3,0 mm		h_w x t_w = 45,00 cm^2
	b_f x t_f	H	weight			painting	section characterictic						
			WTA	WTB	WTC	surface	2 x A_f	I_y	i_y	I_z	i_z	I_t	I_w
	mm	mm	[kg/m]			m^2/m	cm^2	cm^4	cm	cm^4	cm	cm^4	cm^6
	200 x 10	1520		66,7	73,8	4,44	40,0	228 013	75,50	1 333	5,77	14,1	7 600 333
	220 x 10	1520		69,9	76,9	4,52	44,0	250 815	75,50	1 775	6,35	15,4	10 116 044
	240 x 10	1520		73,0	80,1	4,60	48,0	273 616	75,50	2 304	6,93	16,8	13 133 376
*	250 x 10	1520		74,6	81,6	4,64	50,0	285 017	75,50	2 604	7,22	17,4	14 844 401
	200 x 12	1524		73,0	80,1	4,45	48,0	274 343	75,60	1 600	5,77	23,8	9 144 576
	220 x 12	1524		76,8	83,8	4,53	52,8	301 777	75,60	2 130	6,35	26,1	12 171 431
	240 x 12	1524		80,5	87,6	4,61	57,6	329 212	75,60	2 765	6,93	28,4	15 801 827
	250 x 12	1524		82,4	89,5	4,65	60,0	342 929	75,60	3 125	7,22	29,6	17 860 500
	260 x 12	1524		84,3	91,4	4,69	62,4	356 646	75,60	3 515	7,51	30,7	20 090 633
	280 x 12	1524		88,1	95,1	4,77	67,2	384 080	75,60	4 390	8,08	33,0	25 092 717
*	300 x 12	1524		91,8	98,9	4,85	72,0	411 515	75,60	5 400	8,66	35,3	30 862 944
	200 x 15	1530		82,4	89,5	4,46	60,0	344 295	75,75	2 000	5,77	45,8	11 476 125
	220 x 15	1530		87,1	94,2	4,54	66,0	378 725	75,75	2 662	6,35	50,3	15 274 722
	240 x 15	1530		91,8	98,9	4,62	72,0	413 154	75,75	3 456	6,93	54,8	19 830 744
	250 x 15	1530		94,2	101,3	4,66	75,0	430 369	75,75	3 906	7,22	57,0	22 414 307
	260 x 15	1530		96,6	103,6	4,70	78,0	447 584	75,75	4 394	7,51	59,3	25 213 047
	280 x 15	1530		101,3	108,3	4,78	84,0	482 013	75,75	5 488	8,08	63,8	31 490 487
	300 x 15	1530		106,0	113,0	4,86	90,0	516 443	75,75	6 750	8,66	68,3	38 731 922
	325 x 15	1530		111,9	118,9	4,96	97,5	559 479	75,75	8 582	9,38	73,9	49 244 232
	350 x 15	1530		117,8	124,8	5,06	105,0	602 516	75,75	10 719	10,10	79,5	61 504 857
	220 x 20	1540		104,4	111,5	4,56	88,0	508 317	76,00	3 549	6,35	118,1	20 500 949
	240 x 20	1540		110,7	117,8	4,64	96,0	554 528	76,00	4 608	6,93	128,8	26 615 808
	250 x 20	1540		113,8	120,9	4,68	100,0	577 633	76,00	5 208	7,22	134,1	30 083 333
	260 x 20	1540		117,0	124,0	4,72	104,0	600 739	76,00	5 859	7,51	139,4	33 839 659
	280 x 20	1540		123,2	130,3	4,80	112,0	646 949	76,00	7 317	8,08	150,1	42 264 917
	300 x 20	1540		129,5	136,6	4,88	120,0	693 160	76,00	9 000	8,66	160,8	51 984 000
	325 x 20	1540		137,4	144,4	4,98	130,0	750 923	76,00	11 443	9,38	174,1	66 093 083
	350 x 20	1540		145,2	152,3	5,08	140,0	808 687	76,00	14 292	10,10	187,4	82 548 667
	375 x 20	1540		153,1	160,1	5,18	150,0	866 450	76,00	17 578	10,83	200,8	101 531 250
	400 x 20	1540		160,9	168,0	5,28	160,0	924 213	76,00	21 333	11,55	214,1	123 221 333
	250 x 25	1550		133,5	140,5	4,70	125,0	726 823	76,25	6 510	7,22	261,2	37 851 969
	260 x 25	1550		137,4	144,4	4,74	130,0	755 896	76,25	7 323	7,51	271,6	42 578 318
	280 x 25	1550		145,2	152,3	4,82	140,0	814 042	76,25	9 147	8,08	292,4	53 179 292
	300 x 25	1550		153,1	160,1	4,90	150,0	872 188	76,25	11 250	8,66	313,3	65 408 203
	325 x 25	1550		162,9	170,0	5,00	162,5	944 870	76,25	14 303	9,38	339,3	83 160 777
	350 x 25	1550		172,7	179,8	5,10	175,0	1 017 552	76,25	17 865	10,10	365,4	103 865 804
	375 x 25	1550		182,5	189,6	5,20	187,5	1 090 234	76,25	21 973	10,83	391,4	127 750 397
	400 x 25	1550		192,3	199,4	5,30	200,0	1 162 917	76,25	26 667	11,55	417,4	155 041 667
	425 x 25	1550		202,1	209,2	5,40	212,5	1 235 599	76,25	31 986	12,27	443,5	185 966 726
	450 x 25	1550		212,0	219,0	5,50	225,0	1 308 281	76,25	37 969	12,99	469,5	220 752 686
	300 x 30	1560		176,6	183,7	4,92	180,0	1 053 540	76,50	13 500	8,66	540,8	79 005 375
	325 x 30	1560		188,4	195,5	5,02	195,0	1 141 335	76,50	17 164	9,38	585,8	100 448 385
	350 x 30	1560		200,2	207,2	5,12	210,0	1 229 130	76,50	21 438	10,10	630,8	125 457 609
	375 x 30	1560		212,0	219,0	5,22	225,0	1 316 925	76,50	26 367	10,83	675,8	154 307 373
	400 x 30	1560		223,7	230,8	5,32	240,0	1 404 720	76,50	32 000	11,55	720,8	187 272 000
	425 x 30	1560		235,5	242,6	5,42	255,0	1 492 515	76,50	38 383	12,27	765,8	224 625 814
	450 x 30	1560		247,3	254,3	5,52	270,0	1 580 310	76,50	45 563	12,99	810,8	266 643 141

Annex 2. Flange capacity

f_y = **235** Mpa

k_c = 1,0 - axial force constant between points of lateral stabilisation

b_f x t_f	A	i	tension $N_{t,Rd}$	compression $N_{c,Rd}$ [kN]									
				c_{gr}	c [m] - distance between points of lateral stabilisation								c_{max}
mm	cm^2	cm	kN	cm	3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	cm
160 x 8	12,8	4,62	301	87,4	220	176	137	107	68	46	33	22	11,5
170 x 8	13,6	4,91	320	92,9	241	198	157	124	80	54	39	26	12,3
180 x 8	14,4	5,20	338	98,4	263	220	178	142	92	64	46	31	13,0
190 x 8	15,2	5,48	357	103,8	284	242	199	161	106	74	54	36	13,7
200 x 8	16,0	5,77	376	109,3	306	264	220	181	121	85	62	41	14,4
210 x 8	16,8	6,06	395	114,8	327	285	242	201	137	96	71	48	15,2
220 x 8	17,6	6,35	414	120,2	348	307	264	222	154	109	80	54	15,9
160 x 10	16,0	4,62	376	87,4	274	220	172	134	85	58	41	27	11,5
170 x 10	17,0	4,91	400	92,9	302	248	197	155	99	68	49	33	12,3
180 x 10	18,0	5,20	423	98,4	328	275	222	178	116	80	58	38	13,0
190 x 10	19,0	5,48	447	103,8	355	302	249	201	133	92	67	45	13,7
200 x 10	20,0	5,77	470	109,3	382	330	276	226	152	106	77	52	14,4
210 x 10	21,0	6,06	494	114,8	408	357	303	251	171	121	88	59	15,2
220 x 10	22,0	6,35	517	120,2	435	384	330	277	192	136	100	68	15,9
230 x 10	23,0	6,64	541	125,7	461	411	357	304	214	153	113	77	16,6
240 x 10	24,0	6,93	564	131,2	488	438	385	331	237	171	127	86	17,3
250 x 10	25,0	7,22	588	136,6	514	465	412	358	260	190	142	97	18,0
160 x 12	19,2	4,62	451	87,4	329	264	206	160	102	69	50	33	11,5
170 x 12	20,4	4,91	479	92,9	362	297	236	186	119	82	59	39	12,3
180 x 12	21,6	5,20	508	98,4	394	330	267	213	139	95	69	46	13,0
190 x 12	22,8	5,48	536	103,8	426	363	298	242	160	111	80	54	13,7
200 x 12	24,0	5,77	564	109,3	458	395	331	271	182	127	93	62	14,4
210 x 12	25,2	6,06	592	114,8	490	428	363	302	206	145	106	71	15,2
220 x 12	26,4	6,35	620	120,2	522	461	396	333	231	163	120	81	15,9
230 x 12	27,6	6,64	649	125,7	554	493	429	365	257	184	136	92	16,6
240 x 12	28,8	6,93	677	131,2	585	526	462	397	284	205	152	104	17,3
250 x 12	30,0	7,22	705	136,6	617	558	494	429	312	227	170	116	18,0
260 x 12	31,2	7,51	733	142,1	648	590	527	462	342	251	188	129	18,8
270 x 12	32,4	7,79	761	147,6	679	622	560	495	372	276	208	143	19,5
280 x 12	33,6	8,08	790	153,0	710	654	592	528	402	301	229	158	20,2
290 x 12	34,8	8,37	818	158,5	742	685	625	560	433	328	250	174	20,9
300 x 12	36,0	8,66	846	164,0	773	717	657	593	465	355	273	190	21,7
200 x 15	30,0	5,77	705	109,3	573	494	413	339	227	159	116	78	14,4
210 x 15	31,5	6,06	740	114,8	613	535	454	377	257	181	133	89	15,2
220 x 15	33,0	6,35	776	120,2	652	576	495	416	288	204	151	102	15,9
230 x 15	34,5	6,64	811	125,7	692	617	536	456	321	230	170	115	16,6
240 x 15	36,0	6,93	846	131,2	731	657	577	496	355	256	190	129	17,3
250 x 15	37,5	7,22	881	136,6	771	697	618	537	391	284	212	145	18,0
260 x 15	39,0	7,51	917	142,1	810	737	659	577	427	314	236	161	18,8
270 x 15	40,5	7,79	952	147,6	849	777	700	618	464	345	260	179	19,5
280 x 15	42,0	8,08	987	153,0	888	817	740	659	503	377	286	198	20,2
290 x 15	43,5	8,37	1022	158,5	927	857	781	700	542	410	313	217	20,9
300 x 15	45,0	8,66	1058	164,0	966	896	821	741	581	444	341	238	21,7
310 x 15	46,5	8,95	1093	169,4	1005	936	861	782	621	479	370	260	22,4
320 x 15	48,0	9,24	1128	174,9	1044	975	902	823	661	515	401	283	23,1
325 x 15	48,8	9,38	1146	177,6	1064	995	922	844	681	534	417	294	23,5
330 x 15	49,5	9,53	1163	180,4	1083	1014	942	864	702	552	432	307	23,8
340 x 15	51,0	9,81	1199	185,8	1122	1054	981	905	743	590	465	331	24,5
350 x 15	52,5	10,10	1234	191,3	1161	1093	1021	945	783	628	498	357	25,3
220 x 20	44,0	6,35	1034	120,2	870	768	660	555	384	272	201	135	15,9
230 x 20	46,0	6,64	1081	125,7	923	822	714	608	428	306	226	153	16,6
240 x 20	48,0	6,93	1128	131,2	975	876	769	661	474	342	254	173	17,3
250 x 20	50,0	7,22	1175	136,6	1028	930	824	715	521	379	283	193	18,0

Annex 2. Flange capacity

f_y = **235** Mpa

k_c = 1,0 - axial force constant between points of lateral stabilisation

b_f x t_f	A	i	tension $N_{t,Rd}$	compression $N_{c,Rd}$ [kN]									
				c_{gr}	c [m] - distance between points of lateral stabilisation								c_{max}
mm	cm^2	cm	kN	cm	3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	cm
260 x 20	52,0	7,51	1222	142,1	1080	983	878	770	569	418	314	215	18,8
270 x 20	54,0	7,79	1269	147,6	1132	1036	933	824	619	459	347	239	19,5
280 x 20	56,0	8,08	1316	153,0	1184	1089	987	879	670	502	381	264	20,2
290 x 20	58,0	8,37	1363	158,5	1236	1142	1041	934	722	546	417	290	20,9
300 x 20	60,0	8,66	1410	164,0	1288	1195	1095	989	775	592	455	317	21,7
310 x 20	62,0	8,95	1457	169,4	1340	1248	1149	1043	828	639	494	346	22,4
320 x 20	64,0	9,24	1504	174,9	1392	1300	1202	1098	882	687	535	377	23,1
325 x 20	65,0	9,38	1528	177,6	1418	1326	1229	1125	909	712	555	393	23,5
330 x 20	66,0	9,53	1551	180,4	1444	1353	1255	1152	936	736	577	409	23,8
340 x 20	68,0	9,81	1598	185,8	1496	1405	1309	1206	990	787	620	442	24,5
350 x 20	70,0	10,10	1645	191,3	1548	1457	1362	1260	1045	838	665	476	25,3
360 x 20	72,0	10,39	1692	196,7	1600	1509	1415	1314	1099	889	710	512	26,0
370 x 20	74,0	10,68	1739	202,2	1651	1562	1467	1368	1154	942	757	549	26,7
375 x 20	75,0	10,83	1763	204,9	1677	1588	1494	1394	1181	968	781	569	27,1
380 x 20	76,0	10,97	1786	207,7	1703	1614	1520	1421	1209	995	805	588	27,4
390 x 20	78,0	11,26	1833	213,1	1755	1666	1573	1475	1264	1048	854	627	28,1
400 x 20	80,0	11,55	1880	218,6	1807	1718	1625	1528	1318	1102	904	668	28,9
250 x 25	62,5	7,22	1469	136,6	1284	1162	1030	894	651	474	354	242	18,0
260 x 25	65,0	7,51	1528	142,1	1350	1229	1098	962	712	523	393	269	18,8
270 x 25	67,5	7,79	1586	147,6	1415	1295	1166	1031	774	574	434	298	19,5
280 x 25	70,0	8,08	1645	153,0	1480	1362	1234	1099	838	628	476	329	20,2
290 x 25	72,5	8,37	1704	158,5	1545	1428	1301	1167	903	683	521	362	20,9
300 x 25	75,0	8,66	1763	164,0	1610	1494	1369	1236	968	740	569	397	21,7
310 x 25	77,5	8,95	1821	169,4	1675	1560	1436	1304	1035	799	617	433	22,4
320 x 25	80,0	9,24	1880	174,9	1740	1625	1503	1372	1102	859	668	471	23,1
325 x 25	81,3	9,38	1909	177,6	1773	1658	1536	1406	1136	890	694	491	23,5
330 x 25	82,5	9,53	1939	180,4	1805	1691	1569	1440	1170	921	721	511	23,8
340 x 25	85,0	9,81	1998	185,8	1870	1756	1636	1508	1238	983	775	552	24,5
350 x 25	87,5	10,10	2056	191,3	1935	1821	1702	1575	1306	1047	831	596	25,3
360 x 25	90,0	10,39	2115	196,7	1999	1887	1768	1642	1374	1112	888	640	26,0
370 x 25	92,5	10,68	2174	202,2	2064	1952	1834	1709	1443	1177	947	687	26,7
375 x 25	93,8	10,83	2203	204,9	2097	1984	1867	1743	1477	1210	976	711	27,1
380 x 25	95,0	10,97	2233	207,7	2129	2017	1900	1776	1511	1244	1006	735	27,4
390 x 25	97,5	11,26	2291	213,1	2194	2082	1966	1843	1579	1310	1067	784	28,1
400 x 25	100,0	11,55	2350	218,6	2258	2147	2031	1910	1648	1378	1130	835	28,9
410 x 25	102,5	11,84	2409	224,1	2323	2212	2097	1976	1716	1445	1193	888	29,6
420 x 25	105,0	12,12	2468	229,5	2388	2277	2162	2042	1784	1513	1257	941	30,3
425 x 25	106,3	12,27	2497	232,3	2420	2309	2195	2076	1818	1547	1289	969	30,7
430 x 25	107,5	12,41	2526	235,0	2453	2342	2228	2109	1852	1581	1321	996	31,0
440 x 25	110,0	12,70	2585	240,5	2517	2407	2293	2175	1920	1649	1387	1053	31,8
450 x 25	112,5	12,99	2644	245,9	2582	2472	2358	2241	1988	1718	1453	1110	32,5
300 x 30	90,0	8,66	2115	164,0	1932	1792	1642	1483	1162	888	682	476	21,7
310 x 30	93,0	8,95	2186	169,4	2010	1871	1723	1565	1242	958	741	520	22,4
320 x 30	96,0	9,24	2256	174,9	2088	1950	1803	1646	1322	1031	802	565	23,1
325 x 30	97,5	9,38	2291	177,6	2127	1990	1843	1687	1363	1067	833	589	23,5
330 x 30	99,0	9,53	2327	180,4	2166	2029	1883	1728	1404	1105	865	613	23,8
340 x 30	102,0	9,81	2397	185,8	2244	2107	1963	1809	1485	1180	930	663	24,5
350 x 30	105,0	10,10	2468	191,3	2322	2186	2042	1890	1567	1257	997	715	25,3
360 x 30	108,0	10,39	2538	196,7	2399	2264	2122	1971	1649	1334	1066	768	26,0
370 x 30	111,0	10,68	2609	202,2	2477	2342	2201	2051	1731	1413	1136	824	26,7
375 x 30	112,5	10,83	2644	204,9	2516	2381	2241	2092	1772	1453	1172	853	27,1
380 x 30	114,0	10,97	2679	207,7	2555	2420	2280	2132	1813	1492	1208	882	27,4
390 x 30	117,0	11,26	2750	213,1	2632	2498	2359	2212	1895	1572	1281	941	28,1

Annex 2. Flange capacity

f_y = **235** Mpa

k_c = 1,0 - axial force constant between points of lateral stabilisation

b_f x t_f	A	i	tension $N_{t,Rd}$	compression $N_{c,Rd}$ [kN]									
				c_{gr}	c [m] - distance between points of lateral stabilisation								c_{max}
mm	cm^2	cm	kN	cm	3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	cm
400 x 30	120,0	11,55	2820	218,6	2710	2576	2438	2292	1977	1653	1355	1002	28,9
410 x 30	123,0	11,84	2891	224,1	2788	2654	2516	2371	2059	1734	1431	1065	29,6
420 x 30	126,0	12,12	2961	229,5	2865	2732	2595	2451	2141	1816	1508	1130	30,3
425 x 30	127,5	12,27	2996	232,3	2904	2771	2634	2491	2182	1856	1547	1162	30,7
430 x 30	129,0	12,41	3032	235,0	2943	2810	2673	2530	2222	1897	1585	1196	31,0
440 x 30	132,0	12,70	3102	240,5	3021	2888	2752	2610	2304	1979	1664	1263	31,8
450 x 30	135,0	12,99	3173	245,9	3098	2966	2830	2689	2385	2061	1743	1332	32,5

Flange capacity for dimmensions of flanges not listed above shall be calculated according to the rules shown in p.3.1 in chapter 1

Annex 2. Flange capacity

f_y = **355** Mpa

k_c = 1,0 - axial force constant between points of lateral stabilisation

b_f x t_f	A	i	tension $N_{t,Rd}$	compression $N_{c,Rd}$ [kN]									
				c_{gr}	c [m] - distance between points of lateral stabilisation								c_{max}
mm	cm^2	cm	kN	cm	3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	cm
160 x 8	12,8	4,62	454	71,1	287	212	156	117	72	48	34	23	11,5
170 x 8	13,6	4,91	483	75,6	320	242	181	137	85	57	41	27	12,3
180 x 8	14,4	5,20	511	80,0	353	274	208	159	99	67	48	32	13,0
190 x 8	15,2	5,48	540	84,5	386	306	236	182	115	78	56	37	13,7
200 x 8	16,0	5,77	568	88,9	419	338	265	207	132	90	65	43	14,4
160 x 10	16,0	4,62	568	71,1	358	265	195	146	90	60	43	28	11,5
170 x 10	17,0	4,91	604	75,6	400	303	226	171	106	71	51	34	12,3
180 x 10	18,0	5,20	639	80,0	441	342	260	199	124	84	60	40	13,0
190 x 10	19,0	5,48	675	84,5	482	382	295	228	143	97	70	46	13,7
200 x 10	20,0	5,77	710	88,9	523	423	331	259	164	112	81	54	14,4
210 x 10	21,0	6,06	746	93,4	564	464	369	291	187	128	93	62	15,2
220 x 10	22,0	6,35	781	97,8	605	505	408	325	212	145	105	70	15,9
230 x 10	23,0	6,64	817	102,3	645	547	448	361	237	164	119	80	16,6
240 x 10	24,0	6,93	852	106,7	686	588	488	398	265	184	134	90	17,3
160 x 12	19,2	4,62	682	71,1	430	318	234	176	107	72	51	34	11,5
170 x 12	20,4	4,91	724	75,6	479	364	272	206	127	85	61	40	12,3
180 x 12	21,6	5,20	767	80,0	529	411	312	238	148	100	72	47	13,0
190 x 12	22,8	5,48	809	84,5	579	459	354	273	172	117	84	55	13,7
200 x 12	24,0	5,77	852	88,9	628	507	398	310	197	134	97	64	14,4
210 x 12	25,2	6,06	895	93,4	677	557	443	350	225	154	111	74	15,2
220 x 12	26,4	6,35	937	97,8	726	606	490	391	254	175	127	84	15,9
230 x 12	27,6	6,64	980	102,3	774	656	537	433	285	197	143	96	16,6
240 x 12	28,8	6,93	1022	106,7	823	705	586	477	318	221	161	108	17,3
250 x 12	30,0	7,22	1065	111,2	871	755	634	522	352	247	180	121	18,0
260 x 12	31,2	7,51	1108	115,6	919	804	684	569	389	274	201	135	18,8
270 x 12	32,4	7,79	1150	120,1	967	854	733	616	427	302	223	150	19,5
280 x 12	33,6	8,08	1193	124,5	1015	903	783	664	466	333	246	166	20,2
290 x 12	34,8	8,37	1235	129,0	1063	952	832	712	507	364	270	183	20,9
200 x 15	30,0	5,77	1065	88,9	785	634	497	388	247	168	121	80	14,4
210 x 15	31,5	6,06	1118	93,4	846	696	554	437	281	192	139	92	15,2
220 x 15	33,0	6,35	1172	97,8	907	758	612	488	317	218	158	105	15,9
230 x 15	34,5	6,64	1225	102,3	968	820	672	541	356	246	179	120	16,6
240 x 15	36,0	6,93	1278	106,7	1029	882	732	596	397	276	202	135	17,3
250 x 15	37,5	7,22	1331	111,2	1089	944	793	653	441	308	226	151	18,0
260 x 15	39,0	7,51	1385	115,6	1149	1005	854	711	486	342	251	169	18,8
270 x 15	40,5	7,79	1438	120,1	1209	1067	916	770	533	378	278	188	19,5
280 x 15	42,0	8,08	1491	124,5	1269	1128	978	830	583	416	307	208	20,2
290 x 15	43,5	8,37	1544	129,0	1328	1189	1040	890	634	455	338	229	20,9
300 x 15	45,0	8,66	1598	133,4	1388	1250	1102	952	686	497	370	252	21,7
310 x 15	46,5	8,95	1651	137,8	1447	1311	1164	1013	740	540	404	276	22,4
320 x 15	48,0	9,24	1704	142,3	1506	1372	1226	1075	795	584	439	301	23,1
325 x 15	48,8	9,38	1731	144,5	1536	1402	1257	1106	823	607	457	314	23,5
330 x 15	49,5	9,53	1757	146,7	1565	1432	1288	1137	852	631	476	327	23,8
340 x 15	51,0	9,81	1811	151,2	1625	1492	1349	1199	909	679	514	355	24,5
350 x 15	52,5	10,10	1864	155,6	1684	1552	1410	1261	967	728	554	384	25,3
220 x 20	44,0	6,35	1562	97,8	1210	1010	816	651	423	291	211	141	15,9
230 x 20	46,0	6,64	1633	102,3	1291	1093	895	722	475	328	239	159	16,6
240 x 20	48,0	6,93	1704	106,7	1372	1176	976	795	530	368	269	180	17,3
250 x 20	50,0	7,22	1775	111,2	1452	1258	1057	871	587	411	301	202	18,0
260 x 20	52,0	7,51	1846	115,6	1532	1341	1139	948	648	456	335	225	18,8
270 x 20	54,0	7,79	1917	120,1	1612	1423	1222	1027	711	504	371	251	19,5
280 x 20	56,0	8,08	1988	124,5	1692	1504	1304	1106	777	554	410	277	20,2
290 x 20	58,0	8,37	2059	129,0	1771	1586	1387	1187	845	607	450	306	20,9

Annex 2. Flange capacity

f_y = **355** Mpa

k_c = 1,0 - axial force constant between points of lateral stabilisation

b_f x t_f	A	i	tension $N_{t,Rd}$	compression $N_{c,Rd}$ [kN]									
				c_{gr}	c [m] - distance between points of lateral stabilisation								c_{max}
mm	cm^2	cm	kN	cm	3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	cm
300 x 20	60,0	8,66	2130	133,4	1850	1667	1470	1269	915	662	493	336	21,7
310 x 20	62,0	8,95	2201	137,8	1929	1748	1552	1351	987	720	538	368	22,4
320 x 20	64,0	9,24	2272	142,3	2008	1829	1635	1433	1060	779	585	401	23,1
325 x 20	65,0	9,38	2308	144,5	2048	1869	1676	1474	1098	810	610	419	23,5
330 x 20	66,0	9,53	2343	146,7	2087	1909	1717	1516	1136	841	635	436	23,8
340 x 20	68,0	9,81	2414	151,2	2166	1989	1799	1598	1212	905	686	473	24,5
350 x 20	70,0	10,10	2485	155,6	2245	2069	1880	1681	1290	971	739	512	25,3
360 x 20	72,0	10,39	2556	160,1	2323	2149	1962	1764	1369	1039	795	553	26,0
370 x 20	74,0	10,68	2627	164,5	2402	2229	2043	1846	1449	1108	852	595	26,7
375 x 20	75,0	10,83	2663	166,7	2441	2269	2084	1887	1489	1143	881	617	27,1
380 x 20	76,0	10,97	2698	169,0	2480	2308	2124	1929	1529	1179	911	639	27,4
390 x 20	78,0	11,26	2769	173,4	2559	2388	2205	2011	1610	1252	972	684	28,1
400 x 20	80,0	11,55	2840	177,9	2637	2467	2286	2093	1692	1325	1035	732	28,9
250 x 25	62,5	7,22	2219	111,2	1815	1573	1322	1088	734	514	376	252	18,0
260 x 25	65,0	7,51	2308	115,6	1915	1676	1424	1185	810	570	419	282	18,8
270 x 25	67,5	7,79	2396	120,1	2015	1778	1527	1283	889	630	464	313	19,5
280 x 25	70,0	8,08	2485	124,5	2114	1880	1630	1383	971	693	512	347	20,2
290 x 25	72,5	8,37	2574	129,0	2214	1982	1734	1484	1056	759	563	382	20,9
300 x 25	75,0	8,66	2663	133,4	2313	2084	1837	1586	1143	828	617	420	21,7
310 x 25	77,5	8,95	2751	137,8	2412	2185	1940	1688	1233	900	673	460	22,4
320 x 25	80,0	9,24	2840	142,3	2510	2286	2043	1791	1325	974	732	501	23,1
325 x 25	81,3	9,38	2884	144,5	2560	2336	2095	1843	1372	1012	762	523	23,5
330 x 25	82,5	9,53	2929	146,7	2609	2386	2146	1894	1419	1051	793	546	23,8
340 x 25	85,0	9,81	3018	151,2	2708	2487	2248	1998	1515	1131	857	592	24,5
350 x 25	87,5	10,10	3106	155,6	2806	2587	2351	2101	1612	1214	924	640	25,3
360 x 25	90,0	10,39	3195	160,1	2904	2687	2453	2204	1711	1298	993	691	26,0
370 x 25	92,5	10,68	3284	164,5	3002	2786	2554	2308	1811	1385	1065	743	26,7
375 x 25	93,8	10,83	3328	166,7	3051	2836	2605	2359	1861	1429	1101	771	27,1
380 x 25	95,0	10,97	3373	169,0	3100	2886	2655	2411	1911	1474	1139	798	27,4
390 x 25	97,5	11,26	3461	173,4	3199	2985	2757	2514	2013	1564	1215	855	28,1
400 x 25	100,0	11,55	3550	177,9	3297	3084	2857	2616	2114	1657	1293	915	28,9
410 x 25	102,5	11,84	3639	182,3	3394	3183	2958	2719	2217	1751	1374	976	29,6
420 x 25	105,0	12,12	3728	186,8	3492	3282	3058	2821	2320	1846	1456	1039	30,3
425 x 25	106,3	12,27	3772	189,0	3541	3331	3108	2872	2371	1894	1498	1072	30,7
430 x 25	107,5	12,41	3816	191,2	3590	3380	3158	2923	2423	1942	1541	1105	31,0
440 x 25	110,0	12,70	3905	195,7	3688	3479	3258	3024	2526	2040	1627	1172	31,8
450 x 25	112,5	12,99	3994	200,1	3786	3577	3358	3126	2629	2139	1715	1242	32,5
300 x 30	90,0	8,66	3195	133,4	2775	2501	2204	1903	1372	993	740	504	21,7
310 x 30	93,0	8,95	3302	137,8	2894	2622	2328	2026	1480	1079	807	551	22,4
320 x 30	96,0	9,24	3408	142,3	3013	2743	2452	2149	1591	1169	878	602	23,1
325 x 30	97,5	9,38	3461	144,5	3072	2803	2514	2211	1647	1215	915	628	23,5
330 x 30	99,0	9,53	3515	146,7	3131	2864	2575	2273	1703	1262	952	655	23,8
340 x 30	102,0	9,81	3621	151,2	3249	2984	2698	2397	1818	1358	1029	710	24,5
350 x 30	105,0	10,10	3728	155,6	3367	3104	2821	2521	1935	1456	1109	768	25,3
360 x 30	108,0	10,39	3834	160,1	3485	3224	2943	2645	2053	1558	1192	829	26,0
370 x 30	111,0	10,68	3941	164,5	3603	3343	3065	2769	2173	1662	1278	892	26,7
375 x 30	112,5	10,83	3994	166,7	3662	3403	3126	2831	2233	1715	1322	925	27,1
380 x 30	114,0	10,97	4047	169,0	3721	3463	3187	2893	2293	1769	1367	958	27,4
390 x 30	117,0	11,26	4154	173,4	3838	3582	3308	3016	2415	1877	1458	1027	28,1
400 x 30	120,0	11,55	4260	177,9	3956	3701	3429	3139	2537	1988	1552	1098	28,9
410 x 30	123,0	11,84	4367	182,3	4073	3819	3550	3262	2660	2101	1649	1171	29,6
420 x 30	126,0	12,12	4473	186,8	4191	3938	3670	3385	2784	2215	1748	1247	30,3
425 x 30	127,5	12,27	4526	189,0	4250	3997	3730	3446	2845	2273	1798	1286	30,7

Annex 2. Flange capacity

f_y = **355** Mpa

k_c = 1,0 - axial force constant between points of lateral stabilisation

b_f x t_f	A	i	tension $N_{t,Rd}$	compression $N_{c,Rd}$ [kN]									
				c_{gr}	c [m] - distance between points of lateral stabilisation								c_{max}
mm	cm^2	cm	kN	cm	3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	cm
430 x 30	129,0	12,41	4580	191,2	4308	4056	3790	3507	2907	2331	1849	1326	31,0
440 x 30	132,0	12,70	4686	195,7	4426	4175	3910	3629	3031	2448	1953	1407	31,8
450 x 30	135,0	12,99	4793	200,1	4543	4293	4030	3751	3155	2567	2058	1490	32,5

Flange capacity for dimmensions of flanges not listed above shall be calculated according to the rules shown in p.3.1 in chapter 1

Annex 3. Web capacity

Capacity of the web according to D. Hannebauer (p.4.2. chapter 1)

a) standard web thickness and material quality of the web

f_{yw} = 235MPa	WTA		WTB		WTC	
h_w [mm]	χ_c	V_{Rd} [kN]	χ_c	V_{Rd} [kN]	χ_c	V_{Rd} [kN]
333	1,0	**90**	1,0	**113**	1,0	**136**
500	1,0	**133**	1,0	**170**	1,0	**204**
625	1,0	**164**	1,0	**212**	1,0	**254**
750	1,0	**194**	1,0	**254**	1,0	**305**
1000	0,94	**255**	1,0	**339**	1,0	**407**
1250			1,0	**424**	1,0	**509**
1500			1,0	**508**	1,0	**611**

b) non-standard web thickness and material quality of the web
(only on special request and longer delivery time)

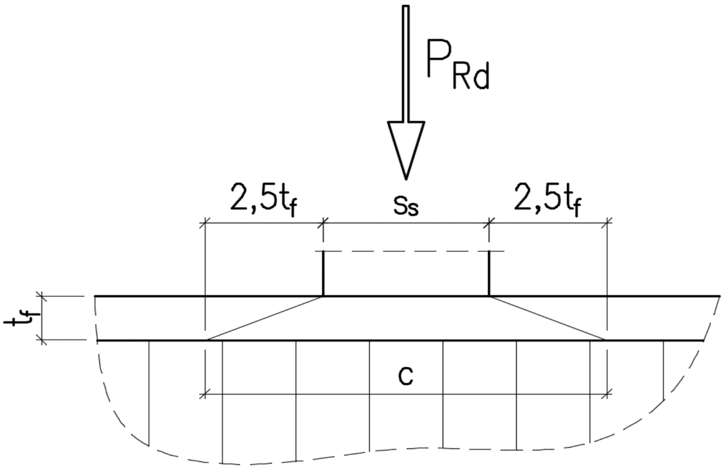
f_{yw} = 235MPa	WTD		WTE		WTF	
h_w [mm]	χ_c	V_{Rd} [kN]	χ_c	V_{Rd} [kN]	χ_c	V_{Rd} [kN]
333	1,0	**181**	1,0	**226**	1,0	**271**
500	1,0	**271**	1,0	**339**	1,0	**407**
625	1,0	**339**	1,0	**424**	1,0	**509**
750	1,0	**407**	1,0	**509**	1,0	**611**
1000	1,0	**543**	1,0	**678**	1,0	**814**
1250	1,0	**678**	1,0	**848**	1,0	**1018**
1500	1,0	**814**	1,0	**1018**	1,0	**1221**

f_{yw} = 355MPa	WTC		WTD	
h_w [mm]	χ_c	V_{Rd} [kN]	χ_c	V_{Rd} [kN]
333	1,0	**205**	1,0	**273**
500	1,0	**307**	1,0	**410**
625	1,0	**384**	1,0	**512**
750	1,0	**461**	1,0	**615**
1000	1,0	**615**	1,0	**820**
1250	1,0	**764**	1,0	**1025**
1500	0,9	**858**	1,0	**1202**

f_{yw} = 355MPa	WTE		WTF	
h_w [mm]	χ_c	V_{Rd} [kN]	χ_c	V_{Rd} [kN]
333	1,0	**341**	1,0	**410**
500	1,0	**512**	1,0	**615**
625	1,0	**641**	1,0	**769**
750	1,0	**769**	1,0	**922**
1000	1,0	**1025**	1,0	**1230**
1250	1,0	**1281**	1,0	**1537**
1500	1,0	**1537**	1,0	**1845**

Annex 4. Transverse pointed load

(acc. to p.4.3 chapter 1)



a) standard web thickness and material quality of the web

f_{yw} = 235MPa

		WTA					WTB					WTC				
		t_s = 2,0 mm					t_s = 2,5 mm					t_s = 3,0 mm				
		P_{Rd} [kN] with the length of stiff bearing $\mathbf{s_s}$ in [mm]														
		0	**50**	**100**	**150**	**200**	**0**	**50**	**100**	**150**	**200**	**0**	**50**	**100**	**150**	**200**
t_f [mm]	**10**	28,2	56,4	84,6	112,8	141	35,3	70,5	105,8	141	176	42,3	84,6	127	169	212
	12	33,8	62,0	90,2	118	147	42,3	77,6	113	148	183	50,8	93,1	135	178	220
	15	42,3	70,5	98,7	127	155	52,9	88,1	123	159	194	63,5	105,8	148	190	233
	20	56,4	84,6	113	141	169	70,5	106	141	176	212	84,6	127	169	212	254
	25	70,5	98,7	127	155	183	88,1	123	159	194	229	106	148	190	233	275
	30	84,6	113	141	169	197	106	141	176	212	247	127	169	212	254	296

b) non-standard web thickness and material quality of the web
(only on special request and probable longer delivery time)

f_{yw} = 235MPa

		WTD					WTE					WTF				
		t_s = 4,0 mm					t_s = 5,0 mm					t_s = 6,0 mm				
		P_{Rd} [kN] with the length of stiff bearing $\mathbf{s_s}$ in [mm]														
		0	**50**	**100**	**150**	**200**	**0**	**50**	**100**	**150**	**200**	**0**	**50**	**100**	**150**	**200**
t_f [mm]	**10**	56,4	113	169	226	282	70,5	141	212	282	353	84,6	169	254	338	423
	12	67,7	124	180	237	293	84,6	155	226	296	367	102	186	271	355	440
	15	84,6	141	197	254	310	106	176	247	317	388	127	212	296	381	465
	20	113	169	226	282	338	141	212	282	353	423	169	254	338	423	508
	25	141	197	254	310	367	176	247	317	388	458	212	296	381	465	550
	30	169	226	282	338	395	212	282	353	423	494	254	338	423	508	592

f_{yw} = 355MPa

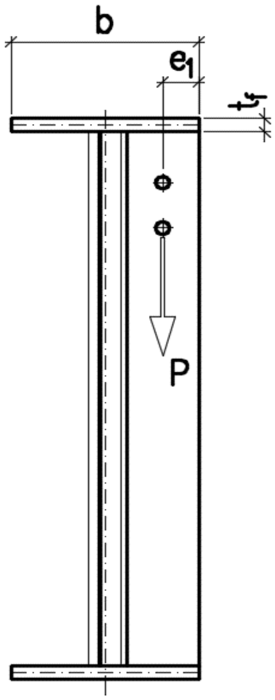
		WTC					WTD				
		t_s = 3,0 mm					t_s = 4,0 mm				
		P_{Rd} [kN] with the length of stiff bearing $\mathbf{s_s}$ in [mm]									
		0	**50**	**100**	**150**	**200**	**0**	**50**	**100**	**150**	**200**
t_f [mm]	**10**	63,9	128	192	256	320	85	170	256	341	426
	12	76,7	141	204	268	332	102	187	273	358	443
	15	95,9	160	224	288	351	128	213	298	383	469
	20	128	192	256	320	383	170	256	341	426	511
	25	160	224	288	351	415	213	298	383	469	554
	30	192	256	320	383	447	256	341	426	511	596

f_{yw} = 355MPa

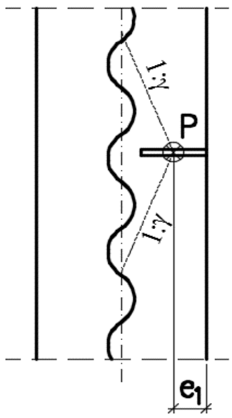
		WTE					WTF				
		t_s = 5,0 mm					t_s = 6,0 mm				
		P_{Rd} [kN] with the length of stiff bearing $\mathbf{s_s}$ in [mm]									
		0	**50**	**100**	**150**	**200**	**0**	**50**	**100**	**150**	**200**
t_f [mm]	**10**	107	213	320	426	533	128	256	383	511	639
	12	128	234	341	447	554	153	281	409	537	665
	15	160	266	373	479	586	192	320	447	575	703
	20	213	320	426	533	639	256	383	511	639	767
	25	266	373	479	586	692	320	447	575	703	831
	30	320	426	533	639	746	383	511	639	767	895

Annex 5. Transverse loads into sin beam by stiffener

(acc. to p.4.4 chapter 1)



- equal dimensions of flanges
- e1 = 40mm
- γ = 2,5
- η = 0,5 (stiffener welded to both flanges)



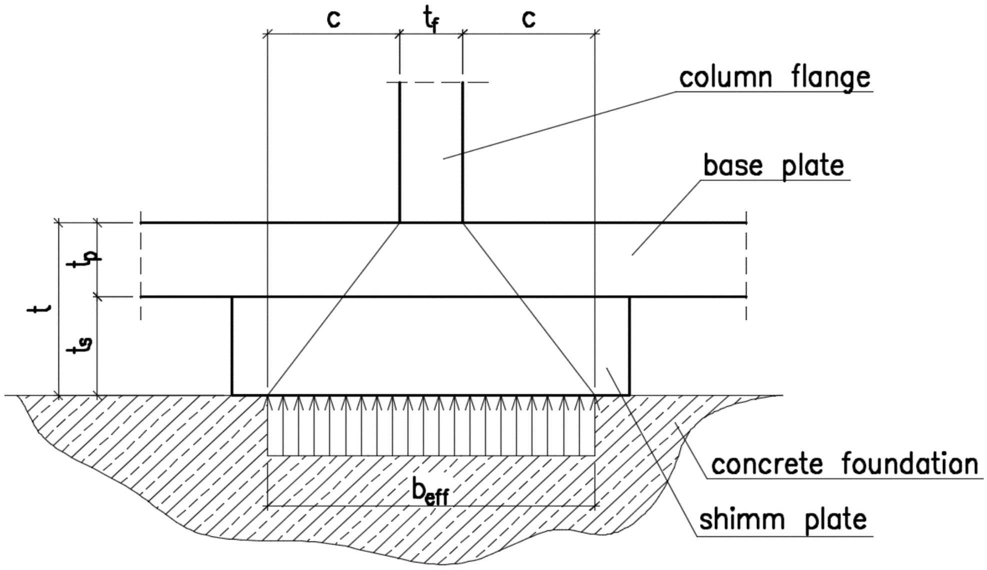
f_y = 235MPa		P [kN] with flange capacity usage α							
		30%	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**99%**
flange thickness t_f [mm]	**10**	31,9	28,9	25,5	21,7	17,4	12,6	6,91	0,77
	12	45,9	41,6	36,7	31,2	25,1	18,1	9,95	1,11
	15	71,7	64,9	57,3	48,8	39,2	28,3	15,5	1,74
	20	127	115	102	86,6	69,6	50,2	27,6	3,09
	25	198	180	159	135	109	78,4	43,1	4,82
	30	285	258	228	194	156	113	62,0	6,94

f_y = 355MPa		P [kN] with flange capacity usage α							
		30%	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**99%**
flange thickness t_f [mm]	**10**	48,2	43,7	38,5	32,8	26,3	19,0	10,4	1,17
	12	69,4	62,8	55,5	47,2	37,9	27,3	15,0	1,68
	15	108	98,2	86,6	73,7	59,2	42,7	23,5	2,62
	20	193	174	154	131	105	75,9	41,7	4,66
	25	301	272	240	204	164	118	65,2	7,29
	30	432	391	346	294	236	170	93,8	10,5

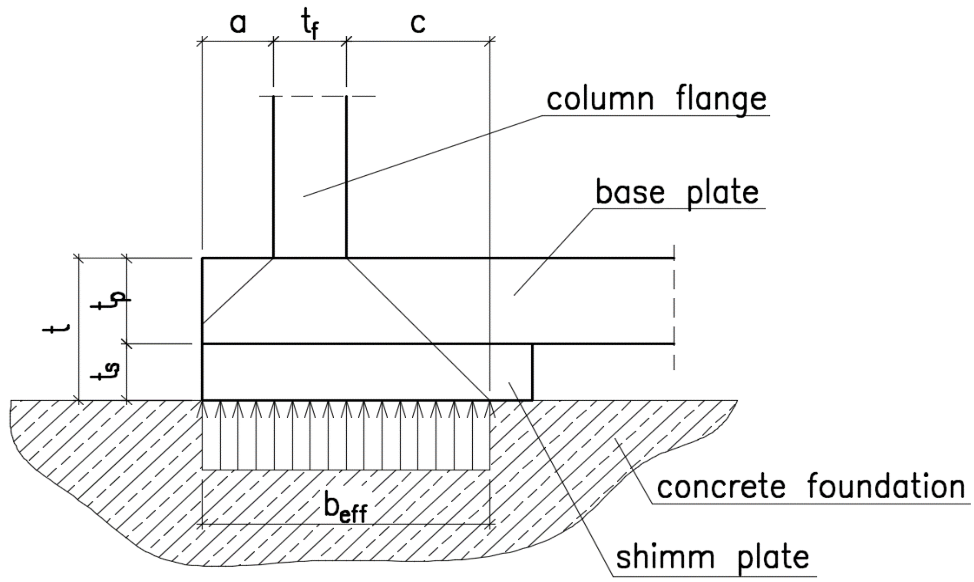
Annex 6. Local pressure to the concrete

(acc. to p.4.5 chapter 1)

projection of base plate
> c



projection of base plate
a = t_f



exceed of base plate > c

concrete f_{ck} = 20 N/mm²
column flange f_y = 235 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
$t = t_p+t_s$	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	25,7	61,4	1 638	**70**	63,4	1 691	**60**	66,4	1 771	**50**	71	1 904	**41**	76	2 038	**35**	81	2 171	**31**
20	34,3	78,6	2 095	**89**	80,6	2 148	**76**	84	2 228	**63**	89	2 362	**50**	94	2 495	**42**	99	2 628	**37**
25	42,8	95,7	2 552	100	97,7	2 605	**92**	101	2 685	**76**	106	2 819	**60**	111	2 952	**50**	116	3 085	**44**
30	51,4	112,8	3 009	100	114,8	3 062	100	118	3 142	**89**	123	3 276	**70**	128	3 409	**58**	133	3 542	**50**
35	60,0	130,0	3 466	100	132	3 519	100	135	3 599	100	140	3 733	**79**	145	3 866	**66**	150	3 999	**57**
40	68,6	147,1	3 923	100	149	3 976	100	152	4 056	100	157	4 190	**89**	162	4 323	**74**	167	4 456	**63**
45	77,1	164,3	4 380	100	166	4 433	100	169	4 513	100	174	4 647	**99**	179	4 780	**81**	184	4 913	**70**
50	85,7	181	4 837	100	183	4 890	100	186	4 970	100	191	5 104	100	196	5 237	**89**	201	5 370	**76**
55	94,3	199	5 294	100	201	5 347	100	204	5 427	100	209	5 561	100	214	5 694	**97**	219	5 827	**83**
60	102,8	216	5 751	100	218	5 805	100	221	5 885	100	226	6 018	100	231	6 151	100	236	6 285	**89**
65	111,4	233	6 208	100	235	6 262	100	238	6 342	100	243	6 475	100	248	6 608	100	253	6 742	**96**
70	120,0	250	6 665	100	252	6 719	100	255	6 799	100	260	6 932	100	265	7 065	100	270	7 199	100

exceed of base plate a = t_f

concrete f_{ck} = 20 N/mm²
column flange f_y = 235 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
t = tp+ts	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	25,7	45,7	1 219	**52**	49,7	1 326	**47**	55,7	1 486	**42**	66	1 752	**37**	76	2 019	**34**	86	2 286	**32**
20	34,3	54,3	1 447	**62**	58,3	1 554	**55**	64	1 714	**49**	74	1 981	**42**	84	2 247	**38**	94	2 514	**36**
25	42,8	62,8	1 676	**71**	66,8	1 783	**63**	73	1 943	**55**	83	2 209	**47**	93	2 476	**42**	103	2 743	**39**
30	51,4	71,4	1 904	**81**	75,4	2 011	**71**	81	2 171	**62**	91	2 438	**52**	101	2 704	**46**	111	2 971	**42**
35	60,0	80,0	2 133	**91**	84	2 240	**79**	90	2 400	**68**	100	2 666	**57**	110	2 933	**50**	120	3 200	**45**
40	68,6	88,6	2 362	100	93	2 468	**88**	99	2 628	**75**	109	2 895	**62**	119	3 162	**54**	129	3 428	**49**
45	77,1	97,1	2 590	100	101	2 697	**96**	107	2 857	**81**	117	3 123	**66**	127	3 390	**58**	137	3 657	**52**
50	85,7	106	2 819	100	110	2 925	100	116	3 085	**88**	126	3 352	**71**	136	3 619	**62**	146	3 885	**55**
55	94,3	114	3 047	100	118	3 154	100	124	3 314	**94**	134	3 580	**76**	144	3 847	**65**	154	4 114	**58**
60	103	123	3 276	100	127	3 382	100	133	3 542	100	143	3 809	**81**	153	4 076	**69**	163	4 342	**62**
65	111	131	3 504	100	135	3 611	100	141	3 771	100	151	4 037	**86**	161	4 304	**73**	171	4 571	**65**
70	120	140	3 733	100	144	3 839	100	150	3 999	100	160	4 266	**91**	170	4 533	**77**	180	4 799	**68**
75	129	148,5	3 961	100	152,5	4 068	100	158,5	4 228	100	169	4 494	**96**	179	4 761	**81**	189	5 028	**71**
80	137	157,1	4 190	100	161,1	4 296	100	167	4 456	100	177	4 723	100	187	4 990	**85**	197	5 256	**75**
85	146	165,7	4 418	100	169,7	4 525	100	176	4 685	100	186	4 952	100	196	5 218	**89**	206	5 485	**78**

exceed of base plate > c — concrete f_{ck} = 25 N/mm², column flange f_y = 235 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl. t = t_p+t_s [mm]	t_f [mm]: c [mm]	10: b_{eff} [mm]	10: $F_{C,Rd}$ [N/mm]	10: μ [%]	12: b_{eff} [mm]	12: $F_{C,Rd}$ [N/mm]	12: μ [%]	15: b_{eff} [mm]	15: $F_{C,Rd}$ [N/mm]	15: μ [%]	20: b_{eff} [mm]	20: $F_{C,Rd}$ [N/mm]	20: μ [%]	25: b_{eff} [mm]	25: $F_{C,Rd}$ [N/mm]	25: μ [%]	30: b_{eff} [mm]	30: $F_{C,Rd}$ [N/mm]	30: μ [%]
15	23,0	56,0	1 866	**79**	58,0	1 933	**69**	61,0	2 033	**58**	66,0	2 200	**47**	71,0	2 366	**40**	76,0	2 533	**36**
20	30,7	71,3	2 377	100	73,3	2 444	**87**	76,3	2 544	**72**	81,3	2 711	**58**	86,3	2 877	**49**	91,3	3 044	**43**
25	38,3	86,6	2 888	100	88,6	2 955	100	91,6	3 055	**87**	96,6	3 222	**69**	101,6	3 388	**58**	106,6	3 555	**50**
30	46,0	102,0	3 399	100	104,0	3 466	100	107,0	3 566	100	112,0	3 733	**79**	117,0	3 899	**66**	122,0	4 066	**58**
35	53,7	117,3	3 910	100	119,3	3 977	100	122,3	4 077	100	127,3	4 244	**90**	132,3	4 410	**75**	137,3	4 577	**65**
40	61,3	132,6	4 421	100	134,6	4 488	100	137,6	4 588	100	142,6	4 755	100	147,6	4 921	**84**	152,6	5 088	**72**
45	69,0	148,0	4 932	100	150,0	4 999	100	153,0	5 099	100	158,0	5 266	100	163,0	5 432	**92**	168,0	5 599	**79**
50	76,6	163,3	5 443	100	165,3	5 510	100	168,3	5 610	100	173,3	5 777	100	178,3	5 943	100	183,3	6 110	**87**
55	84,3	178,6	5 954	100	180,6	6 021	100	183,6	6 121	100	188,6	6 288	100	193,6	6 454	100	198,6	6 621	**94**
60	92,0	194,0	6 465	100	196,0	6 532	100	199,0	6 632	100	204,0	6 799	100	209,0	6 965	100	214,0	7 132	100
65	99,6	209,3	6 976	100	211,3	7 043	100	214,3	7 143	100	219,3	7 310	100	224,3	7 476	100	229,3	7 643	100
70	107,3	224,6	7 487	100	226,6	7 554	100	229,6	7 654	100	234,6	7 821	100	239,6	7 987	100	244,6	8 154	100

exceed of base plate a = t_f — concrete f_{ck} = 25 N/mm², column flange f_y = 235 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl. t = tp+ts [mm]	t_f [mm]: c [mm]	10: b_{eff} [mm]	10: $F_{C,Rd}$ [N/mm]	10: μ [%]	12: b_{eff} [mm]	12: $F_{C,Rd}$ [N/mm]	12: μ [%]	15: b_{eff} [mm]	15: $F_{C,Rd}$ [N/mm]	15: μ [%]	20: b_{eff} [mm]	20: $F_{C,Rd}$ [N/mm]	20: μ [%]	25: b_{eff} [mm]	25: $F_{C,Rd}$ [N/mm]	25: μ [%]	30: b_{eff} [mm]	30: $F_{C,Rd}$ [N/mm]	30: μ [%]
15	23,0	43,0	1 433	**61**	47,0	1 566	**56**	53,0	1 766	**50**	63,0	2 100	**45**	73,0	2 433	**41**	83,0	2 766	**39**
20	30,7	50,7	1 689	**72**	54,7	1 822	**65**	60,7	2 022	**57**	70,7	2 355	**50**	80,7	2 689	**46**	90,7	3 022	**43**
25	38,3	58,3	1 944	**83**	62,3	2 077	**74**	68,3	2 277	**65**	78,3	2 611	**56**	88,3	2 944	**50**	98,3	3 277	**46**
30	46,0	66,0	2 200	**94**	70,0	2 333	**83**	76,0	2 533	**72**	86,0	2 866	**61**	96,0	3 200	**54**	106,0	3 533	**50**
35	53,7	73,7	2 455	100	77,7	2 588	**92**	83,7	2 788	**79**	93,7	3 122	**66**	103,7	3 455	**59**	113,7	3 788	**54**
40	61,3	81,3	2 711	100	85,3	2 844	100	91,3	3 044	**86**	101,3	3 377	**72**	111,3	3 711	**63**	121,3	4 044	**57**
45	69,0	89,0	2 966	100	93,0	3 099	100	99,0	3 299	**94**	109,0	3 633	**77**	119,0	3 966	**68**	129,0	4 299	**61**
50	76,6	96,6	3 222	100	100,6	3 355	100	106,6	3 555	100	116,6	3 888	**83**	126,6	4 222	**72**	136,6	4 555	**65**
55	84,3	104,3	3 477	100	108,3	3 610	100	114,3	3 810	100	124,3	4 144	**88**	134,3	4 477	**76**	144,3	4 810	**68**
60	92,0	112,0	3 733	100	116,0	3 866	100	122,0	4 066	100	132,0	4 399	**94**	142,0	4 733	**81**	152,0	5 066	**72**
65	99,6	119,6	3 988	100	123,6	4 121	100	129,6	4 321	100	139,6	4 655	**99**	149,6	4 988	**85**	159,6	5 321	**75**
70	107,3	127,3	4 244	100	131,3	4 377	100	137,3	4 577	100	147,3	4 910	100	157,3	5 244	**89**	167,3	5 577	**79**
75	115,0	135,0	4 499	100	139,0	4 632	100	145,0	4 832	100	155,0	5 166	100	165,0	5 499	**94**	175,0	5 832	**83**
80	122,6	142,6	4 755	100	146,6	4 888	100	152,6	5 088	100	162,6	5 421	100	172,6	5 755	**98**	182,6	6 088	**86**
85	130,3	150,3	5 010	100	154,3	5 143	100	160,3	5 343	100	170,3	5 677	100	180,3	6 010	100	190,3	6 343	**90**

exceed of base plate > c — concrete f_{ck} = 20 N/mm²; column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
$t = t_p+t_s$	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	31,6	73,2	1 952	**55**	75,2	2 005	**47**	78,2	2 085	**39**	83,2	2 219	**31**	88,2	2 352	**27**	93,2	2 485	**23**
20	42,1	94,3	2 514	**71**	96,3	2 567	**60**	99,3	2 647	**50**	104,3	2 780	**39**	109,3	2 914	**33**	114,3	3 047	**29**
25	52,7	115,3	3 075	**87**	117,3	3 129	**73**	120,3	3 209	**60**	125,3	3 342	**47**	130,3	3 475	**39**	135,3	3 609	**34**
30	63,2	136,4	3 637	100	138,4	3 690	**87**	141,4	3 770	**71**	146,4	3 904	**55**	151,4	4 037	**45**	156,4	4 170	**39**
35	73,7	157,5	4 199	100	159,5	4 252	100	162,5	4 332	**81**	167,5	4 466	**63**	172,5	4 599	**52**	177,5	4 732	**44**
40	84,3	178,5	4 761	100	180,5	4 814	100	183,5	4 894	**92**	188,5	5 027	**71**	193,5	5 161	**58**	198,5	5 294	**50**
45	94,8	199,6	5 322	100	201,6	5 376	100	204,6	5 456	100	209,6	5 589	**79**	214,6	5 722	**64**	219,6	5 856	**55**
50	105,3	220,7	5 884	100	222,7	5 937	100	225,7	6 017	100	230,7	6 151	**87**	235,7	6 284	**71**	240,7	6 417	**60**
55	115,9	241,7	6 446	100	243,7	6 499	100	246,7	6 579	100	251,7	6 713	**95**	256,7	6 846	**77**	261,7	6 979	**66**
60	126,4	262,8	7 008	100	264,8	7 061	100	267,8	7 141	100	272,8	7 274	100	277,8	7 408	**83**	282,8	7 541	**71**
65	136,9	283,8	7 569	100	285,8	7 623	100	288,8	7 703	100	293,8	7 836	100	298,8	7 969	**90**	303,8	8 103	**76**
70	147,5	304,9	8 131	100	306,9	8 184	100	309,9	8 264	100	314,9	8 398	100	319,9	8 531	**96**	324,9	8 664	**81**

exceed of base plate a = t_f — concrete f_{ck} = 20 N/mm²; column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
t = tp+ts	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	31,6	51,6	1 376	**39**	55,6	1 483	**35**	61,6	1 643	**31**	71,6	1 909	**27**	81,6	2 176	**25**	91,6	2 443	**23**
20	42,1	62,1	1 657	**47**	66,1	1 763	**41**	72,1	1 923	**36**	82,1	2 190	**31**	92,1	2 457	**28**	102,1	2 723	**26**
25	52,7	72,7	1 938	**55**	76,7	2 044	**48**	82,7	2 204	**41**	92,7	2 471	**35**	102,7	2 738	**31**	112,7	3 004	**28**
30	63,2	83,2	2 219	**62**	87,2	2 325	**55**	93,2	2 485	**47**	103,2	2 752	**39**	113,2	3 019	**34**	123,2	3 285	**31**
35	73,7	93,7	2 499	**70**	97,7	2 606	**61**	103,7	2 766	**52**	113,7	3 033	**43**	123,7	3 299	**37**	133,7	3 566	**33**
40	84,3	104,3	2 780	**78**	108,3	2 887	**68**	114,3	3 047	**57**	124,3	3 314	**47**	134,3	3 580	**40**	144,3	3 847	**36**
45	94,8	114,8	3 061	**86**	118,8	3 168	**74**	124,8	3 328	**62**	134,8	3 595	**51**	144,8	3 861	**44**	154,8	4 128	**39**
50	105,3	125,3	3 342	**94**	129,3	3 449	**81**	135,3	3 609	**68**	145,3	3 875	**55**	155,3	4 142	**47**	165,3	4 409	**41**
55	115,9	135,9	3 623	100	139,9	3 730	**88**	145,9	3 890	**73**	155,9	4 156	**59**	165,9	4 423	**50**	175,9	4 690	**44**
60	126,4	146,4	3 904	100	150,4	4 010	**94**	156,4	4 170	**78**	166,4	4 437	**62**	176,4	4 704	**53**	186,4	4 970	**47**
65	136,9	156,9	4 185	100	160,9	4 291	100	166,9	4 451	**84**	176,9	4 718	**66**	186,9	4 985	**56**	196,9	5 251	**49**
70	147,5	167,5	4 466	100	171,5	4 572	100	177,5	4 732	**89**	187,5	4 999	**70**	197,5	5 266	**59**	207,5	5 532	**52**
75	158,0	178,0	4 746	100	182,0	4 853	100	188,0	5 013	**94**	198,0	5 280	**74**	208,0	5 546	**62**	218,0	5 813	**55**
80	168,5	188,5	5 027	100	192,5	5 134	100	198,5	5 294	**99**	208,5	5 561	**78**	218,5	5 827	**66**	228,5	6 094	**57**
85	179,1	199,1	5 308	100	203,1	5 415	100	209,1	5 575	100	219,1	5 841	**82**	229,1	6 108	**69**	239,1	6 375	**60**

exceed of base plate > c

concrete f_{ck} = 25 N/mm²
column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
$t = t_p+t_s$	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	28,3	66,5	2 217	**62**	68,5	2 284	**54**	71,5	2 384	**45**	76,5	2 551	**36**	81,5	2 717	**31**	86,5	2 884	**27**
20	37,7	85,4	2 846	**80**	87,4	2 912	**68**	90,4	3 012	**57**	95,4	3 179	**45**	100,4	3 346	**38**	105,4	3 512	**33**
25	47,1	104,2	3 474	**98**	106,2	3 540	**83**	109,2	3 640	**68**	114,2	3 807	**54**	119,2	3 974	**45**	124,2	4 140	**39**
30	56,5	123,0	4 102	100	125,0	4 168	**98**	128,0	4 268	**80**	133,0	4 435	**62**	138,0	4 602	**52**	143,0	4 768	**45**
35	65,9	141,9	4 730	100	143,9	4 796	100	146,9	4 896	**92**	151,9	5 063	**71**	156,9	5 230	**59**	161,9	5 396	**51**
40	75,4	160,7	5 358	100	162,7	5 424	100	165,7	5 524	100	170,7	5 691	**80**	175,7	5 858	**66**	180,7	6 024	**57**
45	84,8	179,6	5 986	100	181,6	6 052	100	184,6	6 152	100	189,6	6 319	**89**	194,6	6 486	**73**	199,6	6 652	**62**
50	94,2	198,4	6 614	100	200,4	6 680	100	203,4	6 780	100	208,4	6 947	**98**	213,4	7 114	**80**	218,4	7 280	**68**
55	103,6	217,3	7 242	100	219,3	7 309	100	222,3	7 409	100	227,3	7 575	100	232,3	7 742	**87**	237,3	7 909	**74**
60	113,0	236,1	7 870	100	238,1	7 937	100	241,1	8 037	100	246,1	8 203	100	251,1	8 370	**94**	256,1	8 537	**80**
65	122,5	254,9	8 498	100	256,9	8 565	100	259,9	8 665	100	264,9	8 831	100	269,9	8 998	100	274,9	9 165	**86**
70	131,9	273,8	9 126	100	275,8	9 193	100	278,8	9 293	100	283,8	9 459	100	288,8	9 626	100	293,8	9 793	**92**

exceed of base plate $a = t_f$

concrete f_{ck} = 25 N/mm²
column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
t = tp+ts	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	28,3	48,3	1 609	**45**	52,3	1 742	**41**	58,3	1 942	**36**	68,3	2 275	**32**	78,3	2 609	**29**	88,3	2 942	**28**
20	37,7	57,7	1 923	**54**	61,7	2 056	**48**	67,7	2 256	**42**	77,7	2 589	**36**	87,7	2 923	**33**	97,7	3 256	**31**
25	47,1	67,1	2 237	**63**	71,1	2 370	**56**	77,1	2 570	**48**	87,1	2 903	**41**	97,1	3 237	**36**	107,1	3 570	**34**
30	56,5	76,5	2 551	**72**	80,5	2 684	**63**	86,5	2 884	**54**	96,5	3 217	**45**	106,5	3 551	**40**	116,5	3 884	**36**
35	65,9	85,9	2 865	**81**	89,9	2 998	**70**	95,9	3 198	**60**	105,9	3 532	**50**	115,9	3 865	**44**	125,9	4 198	**39**
40	75,4	95,4	3 179	**90**	99,4	3 312	**78**	105,4	3 512	**66**	115,4	3 846	**54**	125,4	4 179	**47**	135,4	4 512	**42**
45	84,8	104,8	3 493	**98**	108,8	3 626	**85**	114,8	3 826	**72**	124,8	4 160	**59**	134,8	4 493	**51**	144,8	4 826	**45**
50	94,2	114,2	3 807	100	118,2	3 940	**92**	124,2	4 140	**78**	134,2	4 474	**63**	144,2	4 807	**54**	154,2	5 140	**48**
55	103,6	123,6	4 121	100	127,6	4 254	100	133,6	4 454	**84**	143,6	4 788	**67**	153,6	5 121	**58**	163,6	5 454	**51**
60	113,0	133,0	4 435	100	137,0	4 568	100	143,0	4 768	**90**	153,0	5 102	**72**	163,0	5 435	**61**	173,0	5 768	**54**
65	122,5	142,5	4 749	100	146,5	4 882	100	152,5	5 082	**95**	162,5	5 416	**76**	172,5	5 749	**65**	182,5	6 082	**57**
70	131,9	151,9	5 063	100	155,9	5 196	100	161,9	5 396	100	171,9	5 730	**81**	181,9	6 063	**68**	191,9	6 396	**60**
75	141,3	161,3	5 377	100	165,3	5 510	100	171,3	5 710	100	181,3	6 044	**85**	191,3	6 377	**72**	201,3	6 710	**63**
80	150,7	170,7	5 691	100	174,7	5 824	100	180,7	6 024	100	190,7	6 358	**90**	200,7	6 691	**75**	210,7	7 024	**66**
85	160,2	180,2	6 005	100	184,2	6 138	100	190,2	6 338	100	200,2	6 672	**94**	210,2	7 005	**79**	220,2	7 338	**69**

exceed of base plate > c — concrete f_{ck} = 30 N/mm² — column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl. $t = t_p + t_s$ [mm]	t_f [mm] c [mm]	10 b_{eff} [mm]	10 $F_{C,Rd}$ [N/mm]	10 μ [%]	12 b_{eff} [mm]	12 $F_{C,Rd}$ [N/mm]	12 μ [%]	15 b_{eff} [mm]	15 $F_{C,Rd}$ [N/mm]	15 μ [%]	20 b_{eff} [mm]	20 $F_{C,Rd}$ [N/mm]	20 μ [%]	25 b_{eff} [mm]	25 $F_{C,Rd}$ [N/mm]	25 μ [%]	30 b_{eff} [mm]	30 $F_{C,Rd}$ [N/mm]	30 μ [%]
15	25,8	61,6	2 464	**69**	63,6	2 544	**60**	66,6	2 664	**50**	71,6	2 864	**40**	76,6	3 064	**35**	81,6	3 264	**31**
20	34,4	78,8	3 152	**89**	80,8	3 232	**76**	83,8	3 352	**63**	88,8	3 552	**50**	93,8	3 752	**42**	98,8	3 952	**37**
25	43,0	96,0	3 840	100	98,0	3 920	**92**	101,0	4 040	**76**	106,0	4 240	**60**	111,0	4 440	**50**	116,0	4 640	**44**
30	51,6	113,2	4 528	100	115,2	4 608	100	118,2	4 728	**89**	123,2	4 928	**69**	128,2	5 128	**58**	133,2	5 328	**50**
35	60,2	130,4	5 216	100	132,4	5 296	100	135,4	5 416	100	140,4	5 616	**79**	145,4	5 816	**66**	150,4	6 016	**56**
40	68,8	147,6	5 904	100	149,6	5 984	100	152,6	6 104	100	157,6	6 304	**89**	162,6	6 504	**73**	167,6	6 704	**63**
45	77,4	164,8	6 592	100	166,8	6 672	100	169,8	6 792	100	174,8	6 992	**98**	179,8	7 192	**81**	184,8	7 392	**69**
50	86,0	182,0	7 280	100	184,0	7 360	100	187,0	7 480	100	192,0	7 680	100	197,0	7 880	**89**	202,0	8 080	**76**
55	94,6	199,2	7 968	100	201,2	8 048	100	204,2	8 168	100	209,2	8 368	100	214,2	8 568	**97**	219,2	8 768	**82**
60	103,2	216,4	8 656	100	218,4	8 736	100	221,4	8 856	100	226,4	9 056	100	231,4	9 256	100	236,4	9 456	**89**
65	111,8	233,6	9 344	100	235,6	9 424	100	238,6	9 544	100	243,6	9 744	100	248,6	9 944	100	253,6	10 144	**95**
70	120,4	250,8	10 032	100	252,8	10 112	100	255,8	10 232	100	260,8	10 432	100	265,8	10 632	100	270,8	10 832	100

exceed of base plate a = t_f — concrete f_{ck} = 30 N/mm² — column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl. t = tp+ts [mm]	t_f [mm] c [mm]	10 b_{eff} [mm]	10 $F_{C,Rd}$ [N/mm]	10 μ [%]	12 b_{eff} [mm]	12 $F_{C,Rd}$ [N/mm]	12 μ [%]	15 b_{eff} [mm]	15 $F_{C,Rd}$ [N/mm]	15 μ [%]	20 b_{eff} [mm]	20 $F_{C,Rd}$ [N/mm]	20 μ [%]	25 b_{eff} [mm]	25 $F_{C,Rd}$ [N/mm]	25 μ [%]	30 b_{eff} [mm]	30 $F_{C,Rd}$ [N/mm]	30 μ [%]
15	25,8	45,8	1 832	**52**	49,8	1 992	**47**	55,8	2 232	**42**	65,8	2 632	**37**	75,8	3 032	**34**	85,8	3 432	**32**
20	34,4	54,4	2 176	**61**	58,4	2 336	**55**	64,4	2 576	**48**	74,4	2 976	**42**	84,4	3 376	**38**	94,4	3 776	**35**
25	43,0	63,0	2 520	**71**	67,0	2 680	**63**	73,0	2 920	**55**	83,0	3 320	**47**	93,0	3 720	**42**	103,0	4 120	**39**
30	51,6	71,6	2 864	**81**	75,6	3 024	**71**	81,6	3 264	**61**	91,6	3 664	**52**	101,6	4 064	**46**	111,6	4 464	**42**
35	60,2	80,2	3 208	**90**	84,2	3 368	**79**	90,2	3 608	**68**	100,2	4 008	**56**	110,2	4 408	**50**	120,2	4 808	**45**
40	68,8	88,8	3 552	100	92,8	3 712	**87**	98,8	3 952	**74**	108,8	4 352	**61**	118,8	4 752	**54**	128,8	5 152	**48**
45	77,4	97,4	3 896	100	101,4	4 056	**95**	107,4	4 296	**81**	117,4	4 696	**66**	127,4	5 096	**57**	137,4	5 496	**52**
50	86,0	106,0	4 240	100	110,0	4 400	100	116,0	4 640	**87**	126,0	5 040	**71**	136,0	5 440	**61**	146,0	5 840	**55**
55	94,6	114,6	4 584	100	118,6	4 744	100	124,6	4 984	**94**	134,6	5 384	**76**	144,6	5 784	**65**	154,6	6 184	**58**
60	103,2	123,2	4 928	100	127,2	5 088	100	133,2	5 328	100	143,2	5 728	**81**	153,2	6 128	**69**	163,2	6 528	**61**
65	111,8	131,8	5 272	100	135,8	5 432	100	141,8	5 672	100	151,8	6 072	**86**	161,8	6 472	**73**	171,8	6 872	**65**
70	120,4	140,4	5 616	100	144,4	5 776	100	150,4	6 016	100	160,4	6 416	**90**	170,4	6 816	**77**	180,4	7 216	**68**
75	129,0	149,0	5 960	100	153,0	6 120	100	159,0	6 360	100	169,0	6 760	**95**	179,0	7 160	**81**	189,0	7 560	**71**
80	137,6	157,6	6 304	100	161,6	6 464	100	167,6	6 704	100	177,6	7 104	100	187,6	7 504	**85**	197,6	7 904	**74**
85	146,2	166,2	6 648	100	170,2	6 808	100	176,2	7 048	100	186,2	7 448	100	196,2	7 848	**88**	206,2	8 248	**77**

exceed of base plate > c

concrete f_{ck} = 35 N/mm²
column flange f_y = 355 N/mm²

μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
$t = t_p + t_s$	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	23,9	57,8	2 696	**76**	59,8	2 789	**65**	62,8	2 929	**55**	67,8	3 163	**45**	72,8	3 396	**38**	77,8	3 629	**34**
20	31,8	73,7	3 439	**97**	75,7	3 532	**83**	78,7	3 672	**69**	83,7	3 906	**55**	88,7	4 139	**47**	93,7	4 372	**41**
25	39,8	89,6	4 182	100	91,6	4 276	100	94,6	4 416	**83**	99,6	4 649	**65**	104,6	4 882	**55**	109,6	5 116	**48**
30	47,8	105,5	4 925	100	107,5	5 019	100	110,5	5 159	**97**	115,5	5 392	**76**	120,5	5 625	**63**	125,5	5 859	**55**
35	55,7	121,5	5 668	100	123,5	5 762	100	126,5	5 902	100	131,5	6 135	**86**	136,5	6 368	**72**	141,5	6 602	**62**
40	63,7	137,4	6 412	100	139,4	6 505	100	142,4	6 645	100	147,4	6 878	**97**	152,4	7 112	**80**	157,4	7 345	**69**
45	71,7	153,3	7 155	100	155,3	7 248	100	158,3	7 388	100	163,3	7 621	100	168,3	7 855	**89**	173,3	8 088	**76**
50	79,6	169,2	7 898	100	171,2	7 991	100	174,2	8 131	100	179,2	8 364	100	184,2	8 598	**97**	189,2	8 831	**83**
55	87,6	185,2	8 641	100	187,2	8 734	100	190,2	8 874	100	195,2	9 108	100	200,2	9 341	100	205,2	9 574	**90**
60	95,5	201,1	9 384	100	203,1	9 477	100	206,1	9 617	100	211,1	9 851	100	216,1	10 084	100	221,1	10 317	**97**
65	103,5	217,0	10 127	100	219,0	10 221	100	222,0	10 361	100	227,0	10 594	100	232,0	10 827	100	237,0	11 061	100
70	111,5	232,9	10 870	100	234,9	10 964	100	237,9	11 104	100	242,9	11 337	100	247,9	11 570	100	252,9	11 804	100

exceed of base plate a = t_f

concrete f_{ck} = 35 N/mm²
column flange f_y = 355 N/mm²

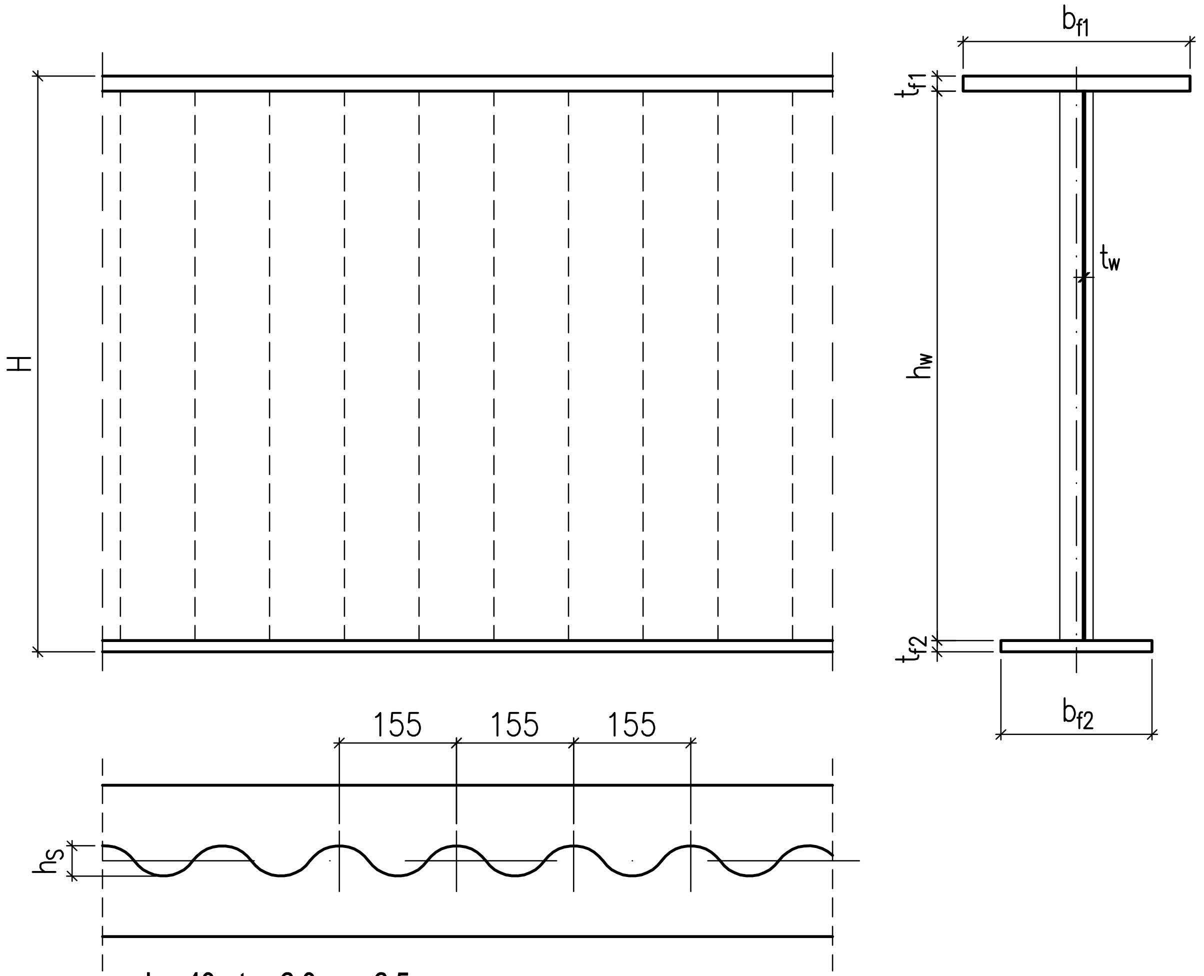
μ - max possible utilisation of column flange t_f

base plate + shim pl.	t_f [mm]	10			12			15			20			25			30		
t = tp+ts	c	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ	b_{eff}	$F_{C,Rd}$	μ
[mm]	[mm]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]	[mm]	[N/mm]	[%]
15	23,9	43,9	2 048	**58**	47,9	2 235	**52**	53,9	2 515	**47**	63,9	2 981	**42**	73,9	3 448	**39**	83,9	3 915	**37**
20	31,8	51,8	2 420	**68**	55,8	2 606	**61**	61,8	2 886	**54**	71,8	3 353	**47**	81,8	3 820	**43**	91,8	4 286	**40**
25	39,8	59,8	2 791	**79**	63,8	2 978	**70**	69,8	3 258	**61**	79,8	3 724	**52**	89,8	4 191	**47**	99,8	4 658	**44**
30	47,8	67,8	3 163	**89**	71,8	3 349	**79**	77,8	3 629	**68**	87,8	4 096	**58**	97,8	4 563	**51**	107,8	5 029	**47**
35	55,7	75,7	3 534	100	79,7	3 721	**87**	85,7	4 001	**75**	95,7	4 468	**63**	105,7	4 934	**56**	115,7	5 401	**51**
40	63,7	83,7	3 906	100	87,7	4 092	**96**	93,7	4 372	**82**	103,7	4 839	**68**	113,7	5 306	**60**	123,7	5 772	**54**
45	71,7	91,7	4 277	100	95,7	4 464	100	101,7	4 744	**89**	111,7	5 211	**73**	121,7	5 677	**64**	131,7	6 144	**58**
50	79,6	99,6	4 649	100	103,6	4 836	100	109,6	5 116	**96**	119,6	5 582	**79**	129,6	6 049	**68**	139,6	6 516	**61**
55	87,6	107,6	5 020	100	111,6	5 207	100	117,6	5 487	100	127,6	5 954	**84**	137,6	6 420	**72**	147,6	6 887	**65**
60	95,5	115,5	5 392	100	119,5	5 579	100	125,5	5 859	100	135,5	6 325	**89**	145,5	6 792	**77**	155,5	7 259	**68**
65	103,5	123,5	5 764	100	127,5	5 950	100	133,5	6 230	100	143,5	6 697	**94**	153,5	7 164	**81**	163,5	7 630	**72**
70	111,5	131,5	6 135	100	135,5	6 322	100	141,5	6 602	100	151,5	7 068	100	161,5	7 535	**85**	171,5	8 002	**75**
75	119,4	139,4	6 507	100	143,4	6 693	100	149,4	6 973	100	159,4	7 440	100	169,4	7 907	**89**	179,4	8 373	**79**
80	127,4	147,4	6 878	100	151,4	7 065	100	157,4	7 345	100	167,4	7 812	100	177,4	8 278	**93**	187,4	8 745	**82**
85	135,4	155,4	7 250	100	159,4	7 436	100	165,4	7 716	100	175,4	8 183	100	185,4	8 650	**97**	195,4	9 116	**86**

CHAPTER 3

Details

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 1	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER SIN PROFILES GEOMETRY	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



h_S=40 - tw=2,0mm; 2,5mm
h_S=43 - tw=3,0mm

<u>Geometry:</u>

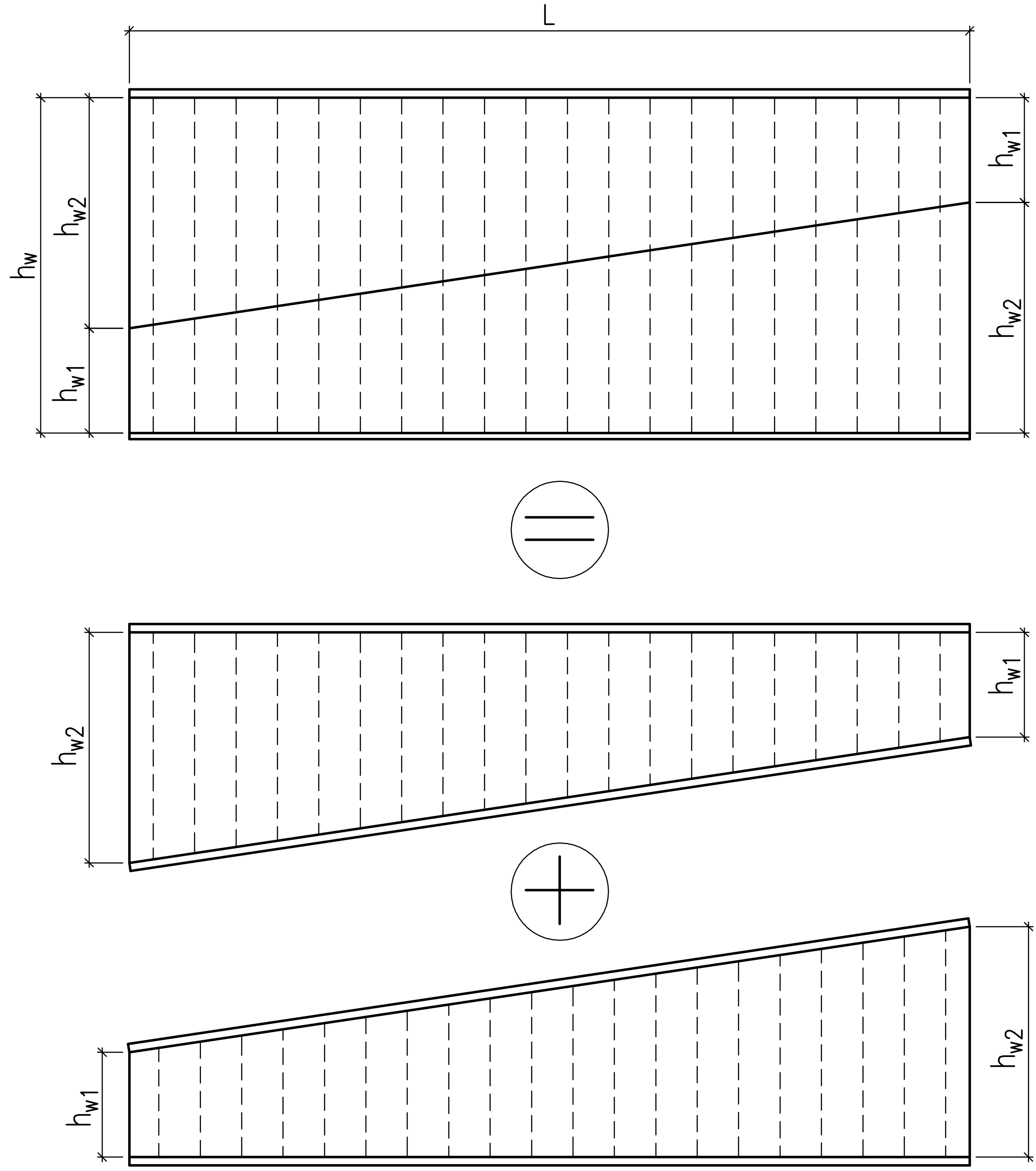
Web height:	333, 500, 625, 750, 1000, 1250, 1500
Web thickness:	2.0mm, 2.5mm, 3.0mm (4.0mm, 5.0mm, 6.0mm on special request - see remark below)
Flange width:	160mm - 450mm
Flange thickness:	8mm - 30mm
Length:	4000mm - 16400mm

<u>Steel grade:</u>

Flanges: S235JR or S355J2+N acc. to EN 10 025
Web: S235JR

REMARK: All other grades of steel are regarded as special ones. It is possible to apply S355J2+N for the web of thickness 3mm (and more). This fact must be clearly described in the design documentation, on the workshop drawings and material lists. For such special steel grades or thicker web materials additional costs for procurement of a minimum quantity of special coil material and longer delivery times shall be taken into account.

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 2	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER TAPERED PROFILES GEOMETRY	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



L_{max} = 11500mm

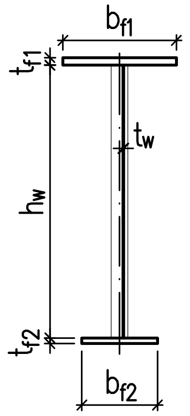
h_{w1}=min.250mm

$h_{w1}+h_{w2}=h_w$=625,750,1000,1250,1500mm

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 3	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER DESCRIPTION OF PROFILES	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

WT(_) h_w / b_{f1} x t_{f1} / b_{f2} x t_{f2} - profiles with parallel flanges

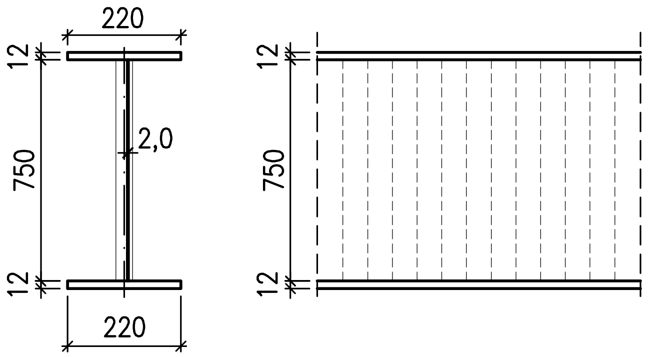
SIN(_) h_{w1}-h_{w2} / b_{f1} x t_{f1} / b_{f2} x t_{f2} - tapered profiles



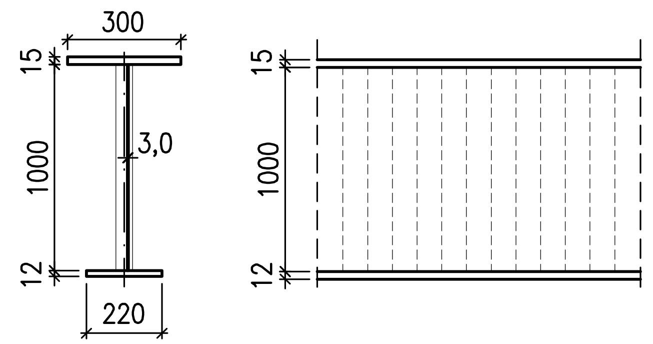
(_) - thickness of the web: A (2,0mm), B (2,5mm), C (3,0mm), D (4,0mm), E (5,0mm), F (6,0mm)
hw1 - height of the web in the beginning,
hw2 - height of the web at the end
bf1 - width of the upper (outer) flange
tf1 - thickness of the upper (outer) flange
bf2 - width of the lower (inner) flange
tf2 - thickness of the lower (inner) flange

EXAMPLES:

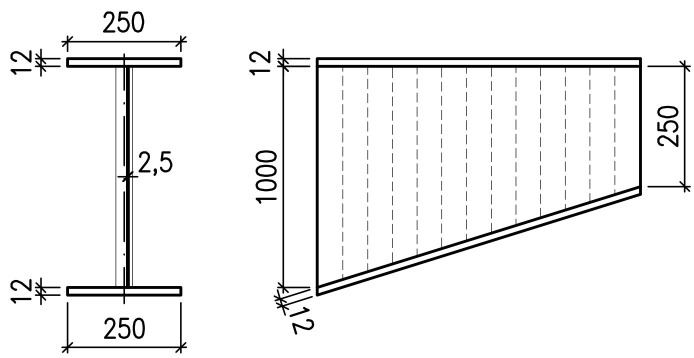
equal flanges
parallel flanges
WT(_) h_w / b_f x t_f
example: WTA 750 / 220 x 12



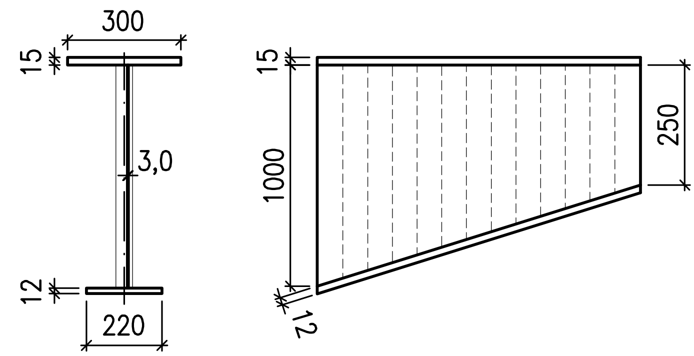
different flanges
parallel flanges
WT(_) h_w / b_{f1} x t_{f1} / b_{f2} x t_{f2}
example: WTC 1000 / 300 x 15 / 220 x 12



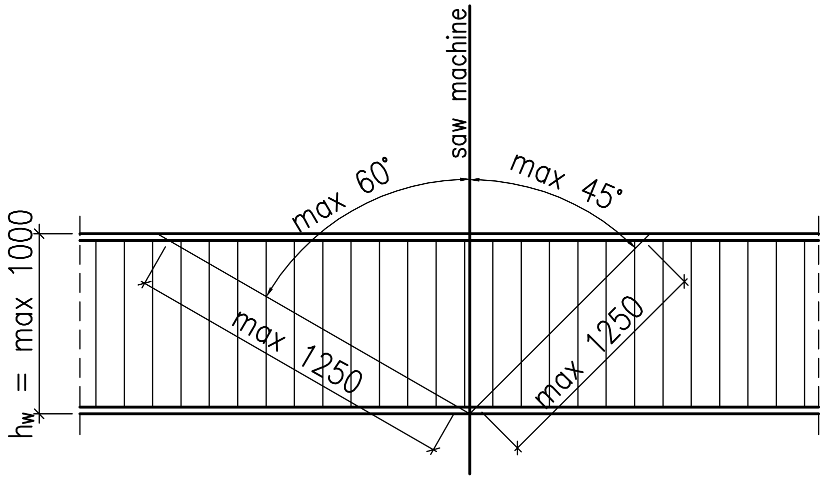
equal flanges
tapered profile
SIN(_) h_{w1}-h_{w2} / b_f x t_f
example: SINB 250-1000 / 250 x 12



different flanges
tapered profile
SIN(_) h_{w1}-h_{w2} / b_{f1} x t_{f1} / b_{f2} x t_{f2}
example: SINC 250-1000 / 300 x 15 / 220 x 12

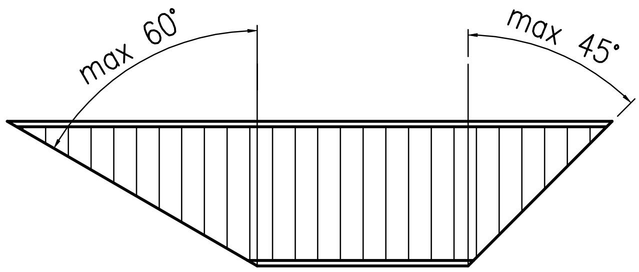


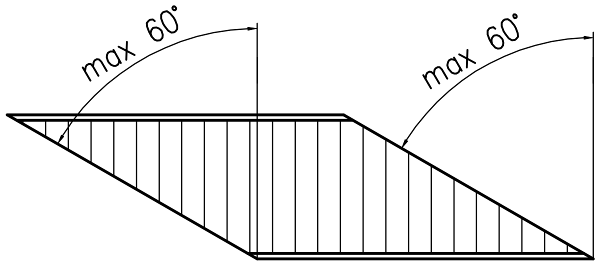
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 4	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER DIAGONAL CUTS	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

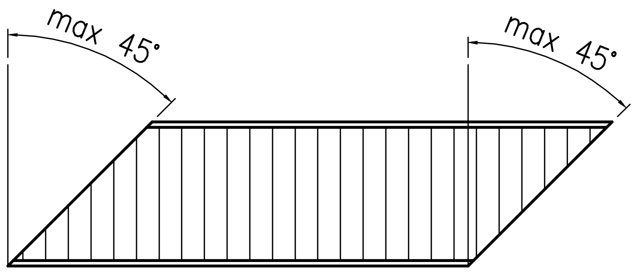


Above limits are valid for saw machine usage. For other angles and higher profiles all diagonal cuts are also possible and must be done by hand

POSSIBLE!

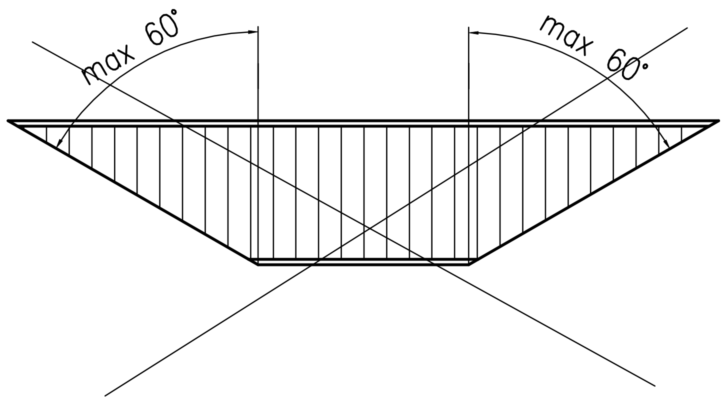






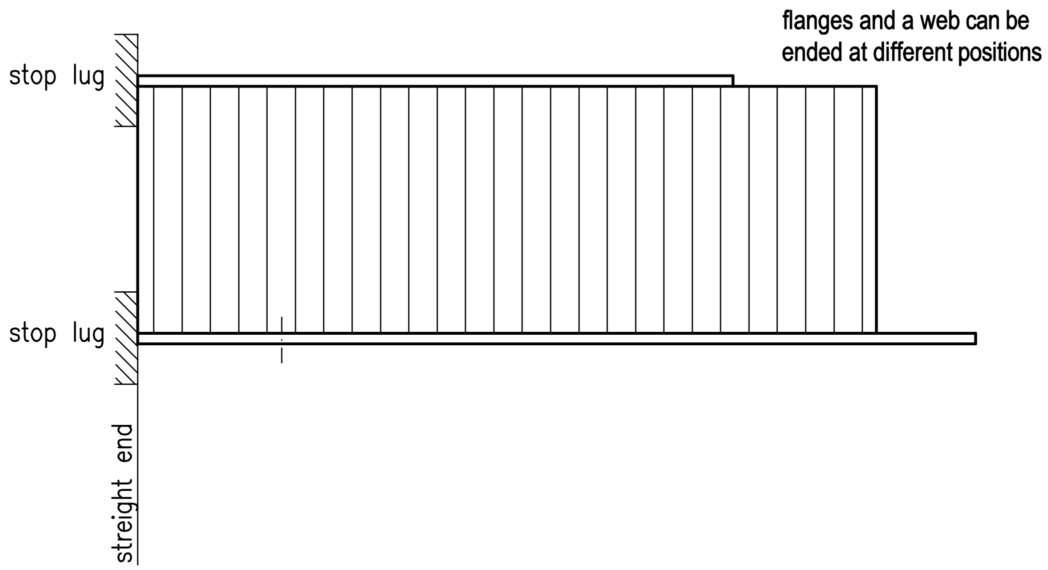
NOT POSSIBLE!

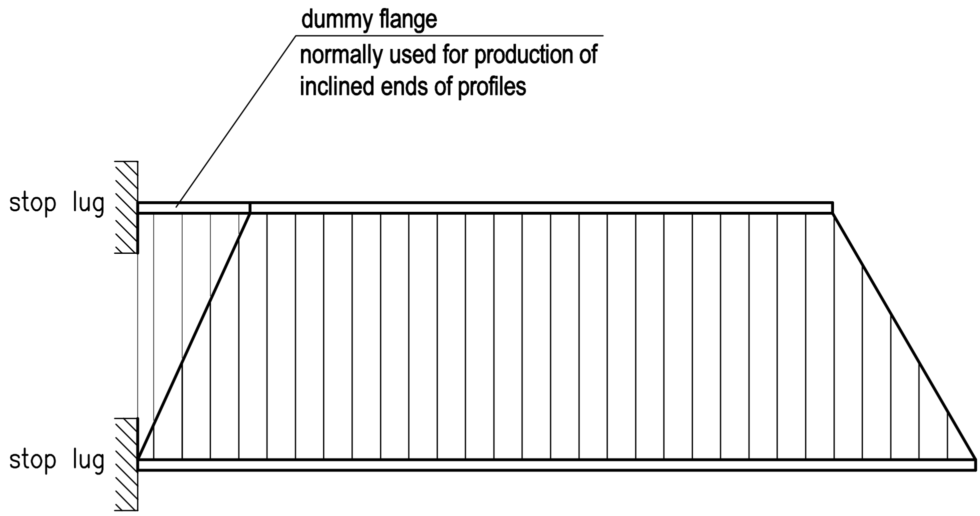
In the following cases diagonal cuts must be done by hand (saw machine usage not possible)



Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 5	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER POSSIBILITIES OF PRODUCTION	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

On the sin-line base profiles as following can be produced:



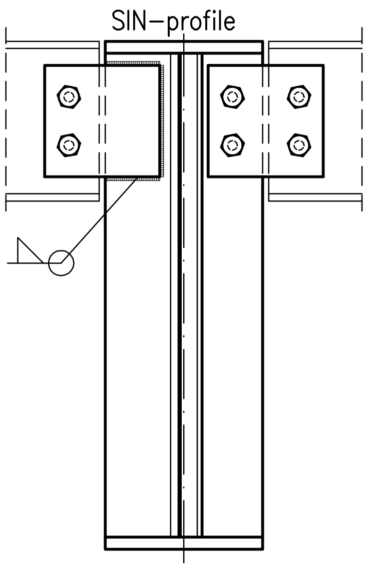


Remark

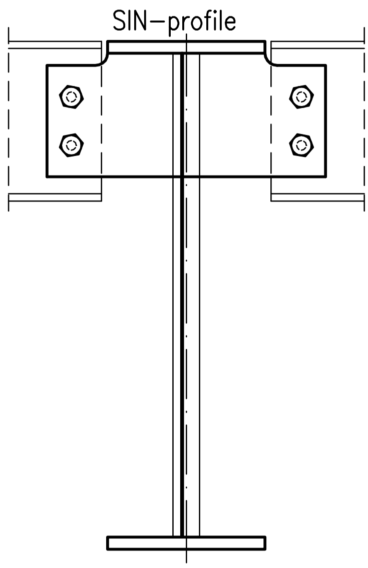
Flanges with holes are prepared on the flange-line first

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 6	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER STIFFENERS	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

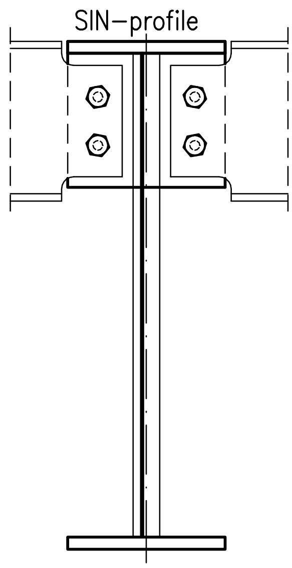
RECOMMENDED!



POSSIBLE

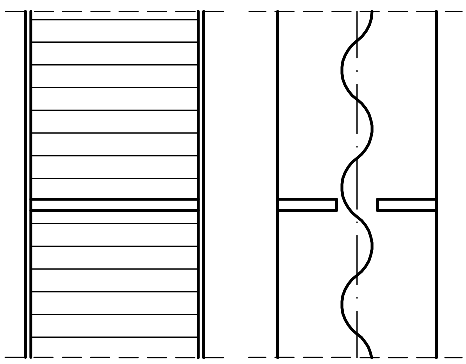


NOT RECOMMENDED!



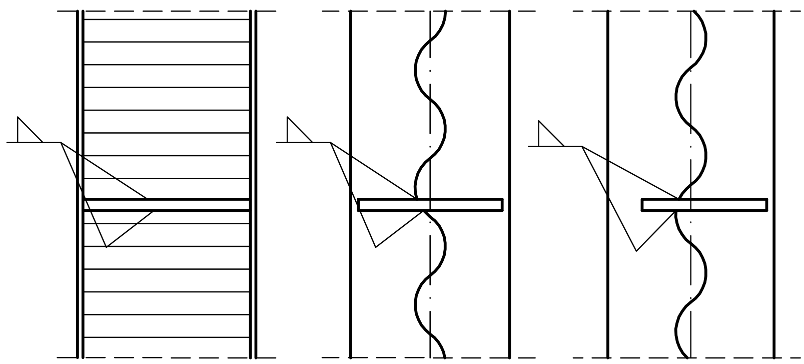
RECOMMENDED!

for transverse loads in limits shown in the table (annex 4)

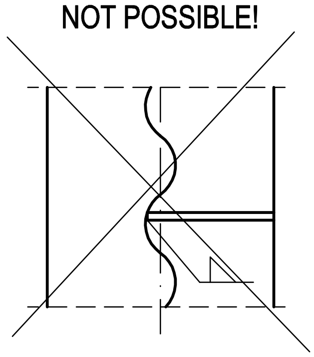


POSSIBLE

in case transverse loads exceeds those shown in the table (annex 4)



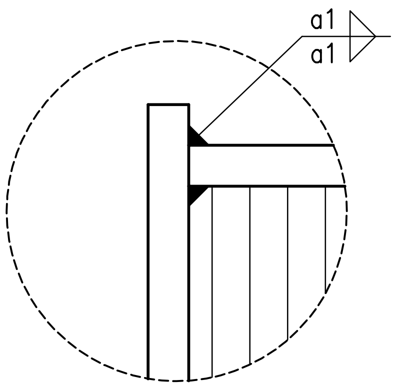
NOT POSSIBLE!



Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 7	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER TYPES OF WELDS	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

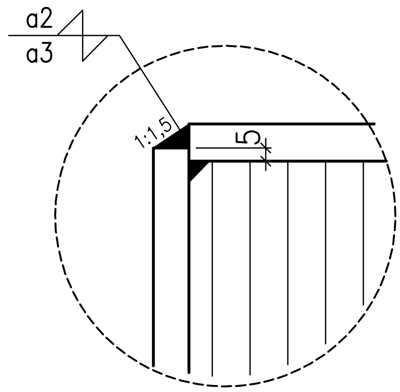
option 1

RECOMMENDED



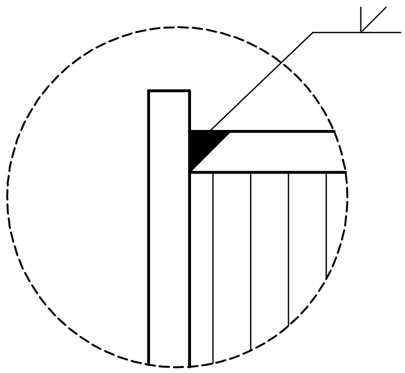
option 2

applied only if the cladding is directly fixed to the flange



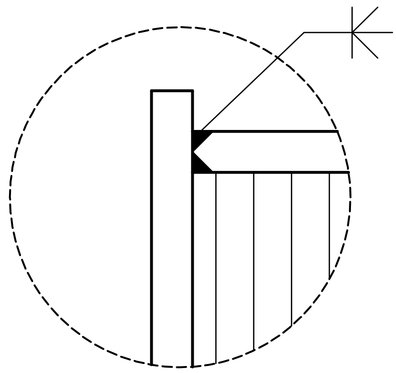
option 3

NOT RECOMMENDED!



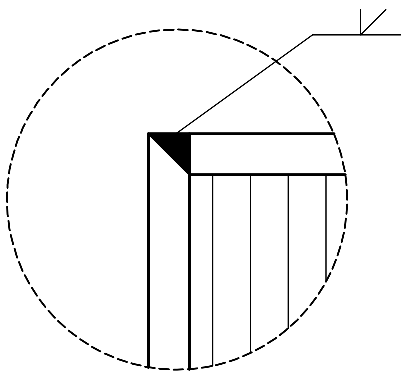
option 4

NOT RECOMMENDED!



option 5

NOT RECOMMENDED!



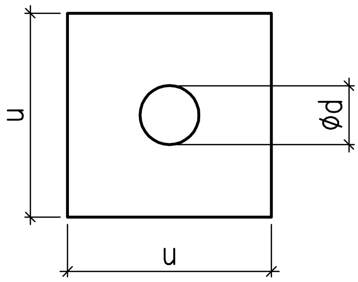
Remark
If a frontal plate thickness is > 12mm Z-quality criteria must be taken into consideration

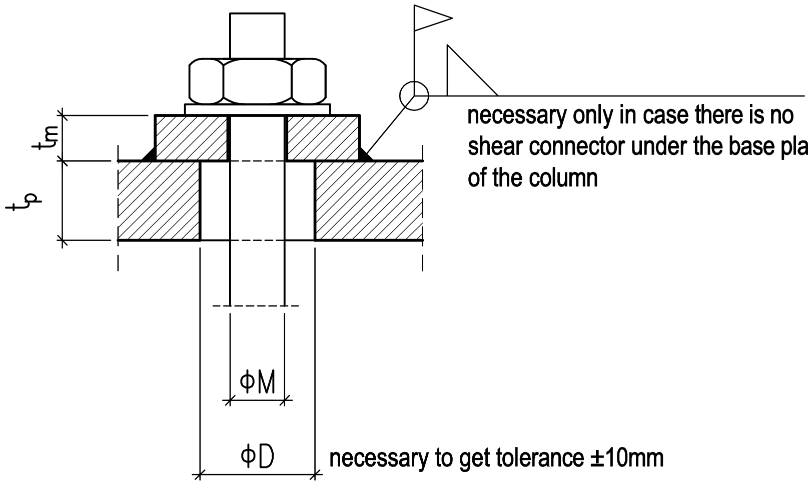
BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	8	–	
PLANNUMMER / DRAWINGNUMBER	NAME	MASSTAB / SCALE	DATUM / DATE
CENTERING PLATE	Wojtusik		01.08.18

Stahlkonstruktionen Zeman Bogensysteme Hallenbau

Centering plate

øM [mm]	M16	M20	M24	M30	M36	M42	M48
øD [mm]	36	40	44	50	56	62	68
ød [mm]	18	18	26	32	38	45	51
u [mm]	70	80	90	90	90	100	110
t_m [mm]	20	20	20	20	20	20	20





necessary only in case there is no shear connector under the base plate of the column

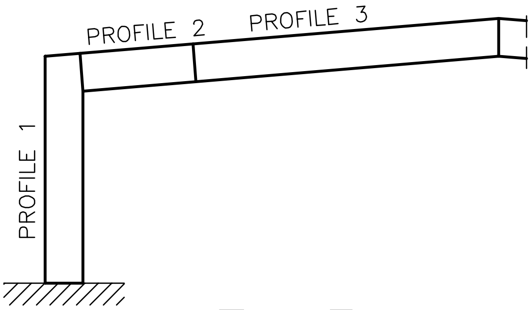
necessary to get tolerance ±10mm

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
	SIN STANDARD	9	–	
	PLANNUMMER / DRAWINGNUMBER	NAME	MASSTAB / SCALE	DATUM / DATE
	FRAME TYPES, JOINTS DESCRIPTION	Wojtusik		01.08.18

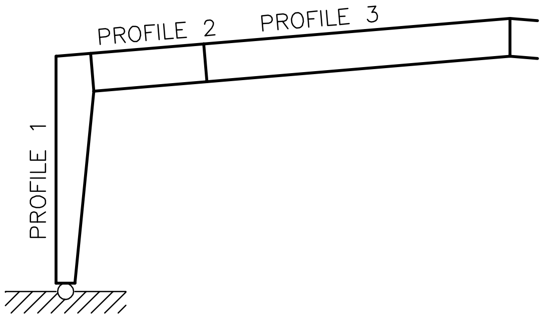
Type A

Type C

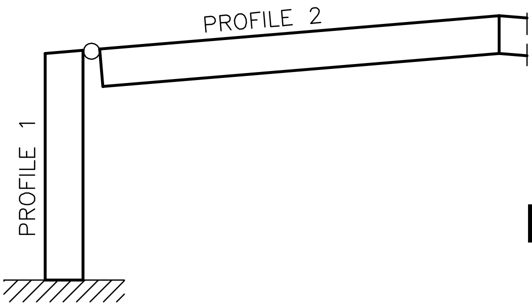
Type B



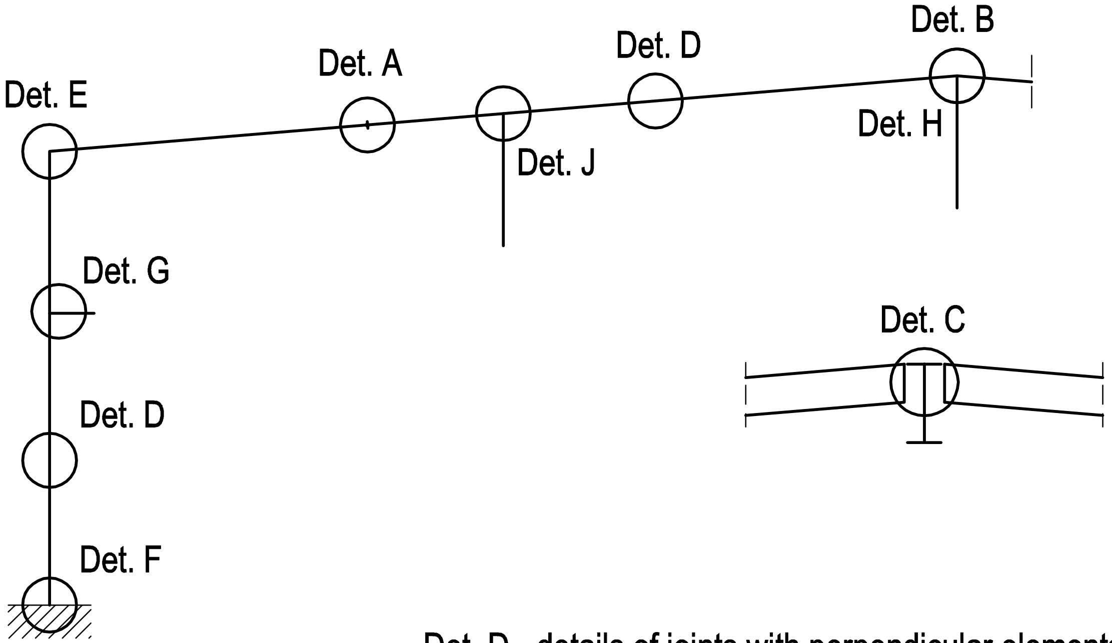
Type D



Type E



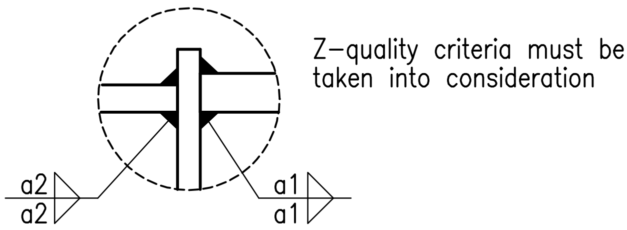
MAIN JOINTS

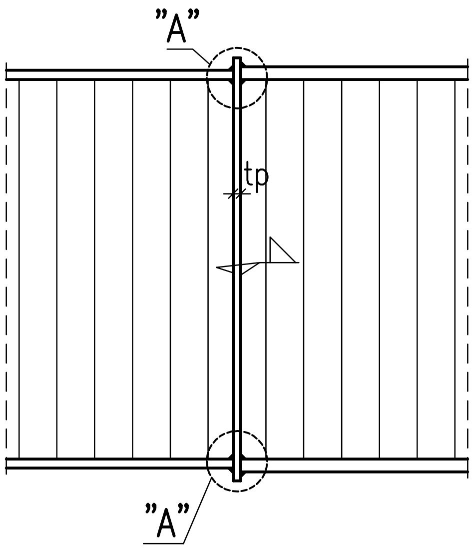


Det. D - details of joints with perpendicular elements: beams, stiff bracings, rod bracings, purlins, wall beams etc.

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 10	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER A1 – FRONTAL JOINT	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

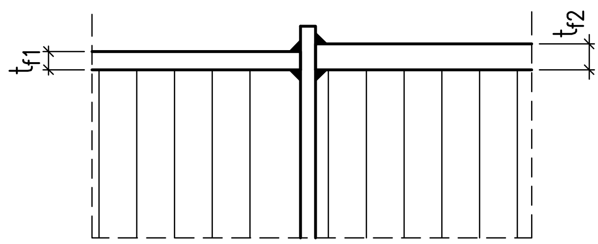
Detail "A"



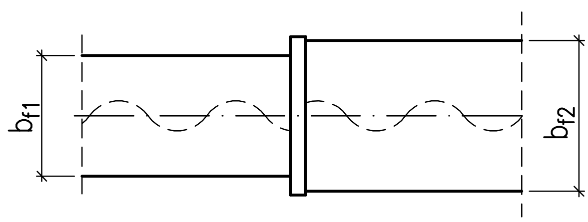


Remarks:

- welds according to static calculations
- t_p=10-12mm
- solution possible also for different flange width and different flange thickness



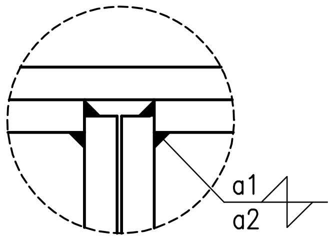
different flange thickness

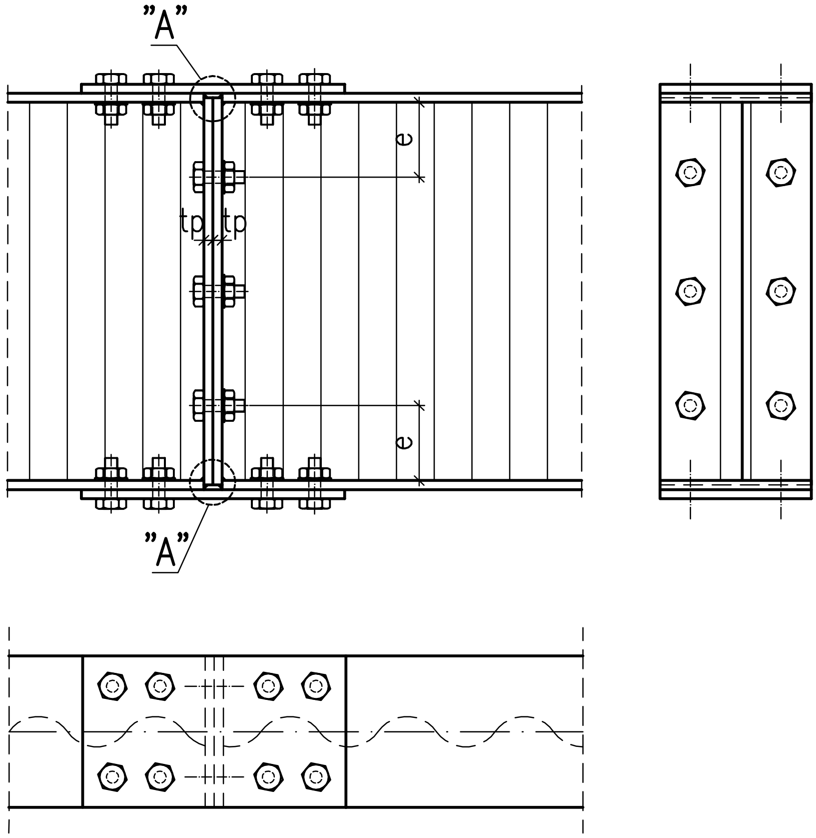


different flange width

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 11	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER A2 – FRONTAL JOINT	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

Detail "A"



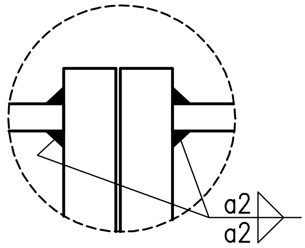


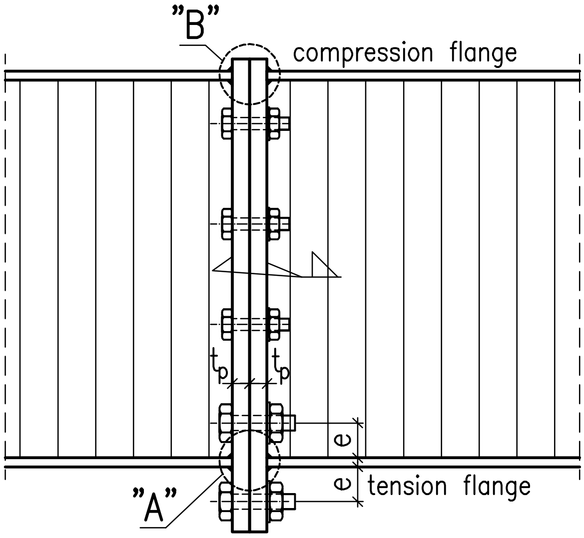
Remarks:

- bolts and welds according to static calculations
- overlapping plate: dimensions, number and diameter of bolts according to static calculations
- e=~100mm
- t_p=10-12mm

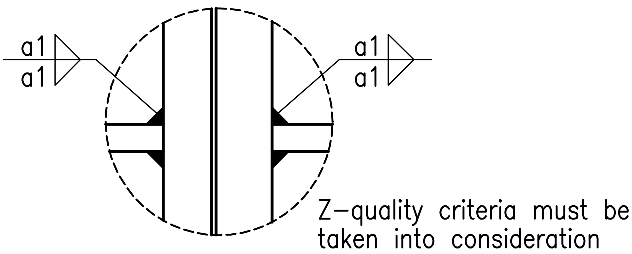
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 12	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER A3 – FRONTAL JOINT	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

Detail "B"





Detail "A"



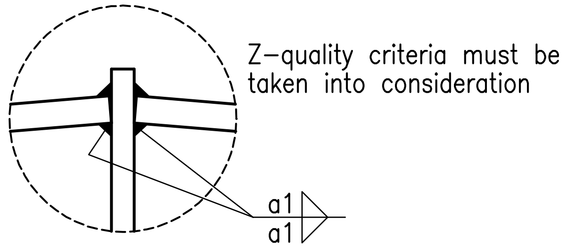
Remarks:

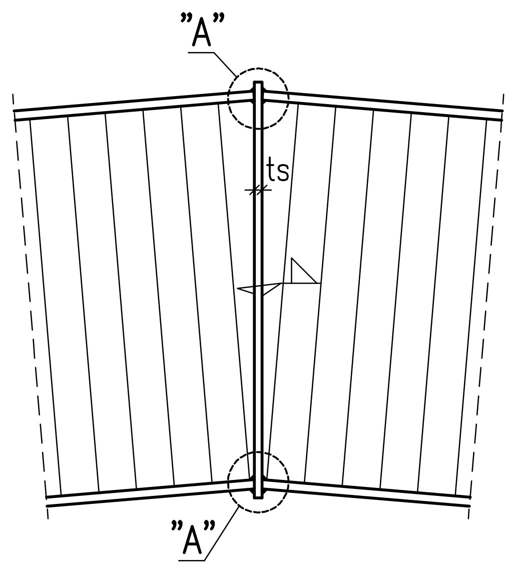
- t_p, e, bolts and welds according to static calculations

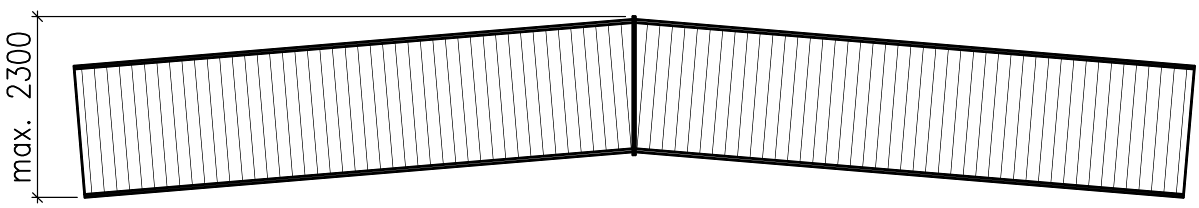
Stahlkonstruktionen
Zeman
Bogensysteme Hallenbau

BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	13	—	
PLANNUMMER / DRAWINGNUMBER	NAME	MASSTAB / SCALE	DATUM / DATE
B1 – FRAME RIDGE	Wojtusik		01.08.18

Detail "A"





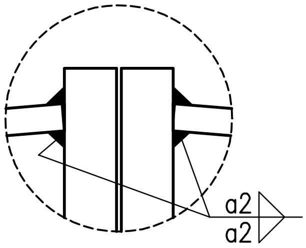


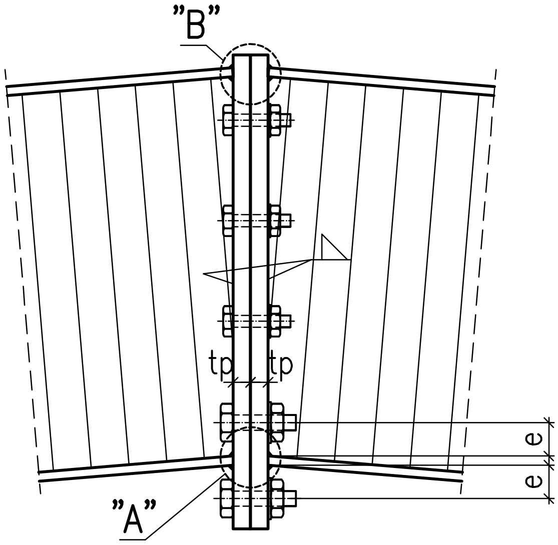
Remarks:

- welds according to static calculations
- t_s=10-12mm

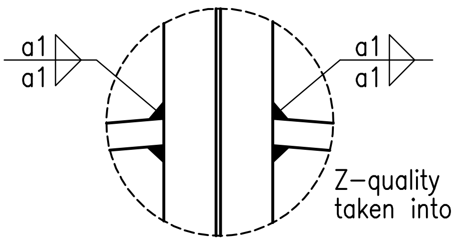
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 14	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER B2 – FRAME RIDGE	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

Detail "B"





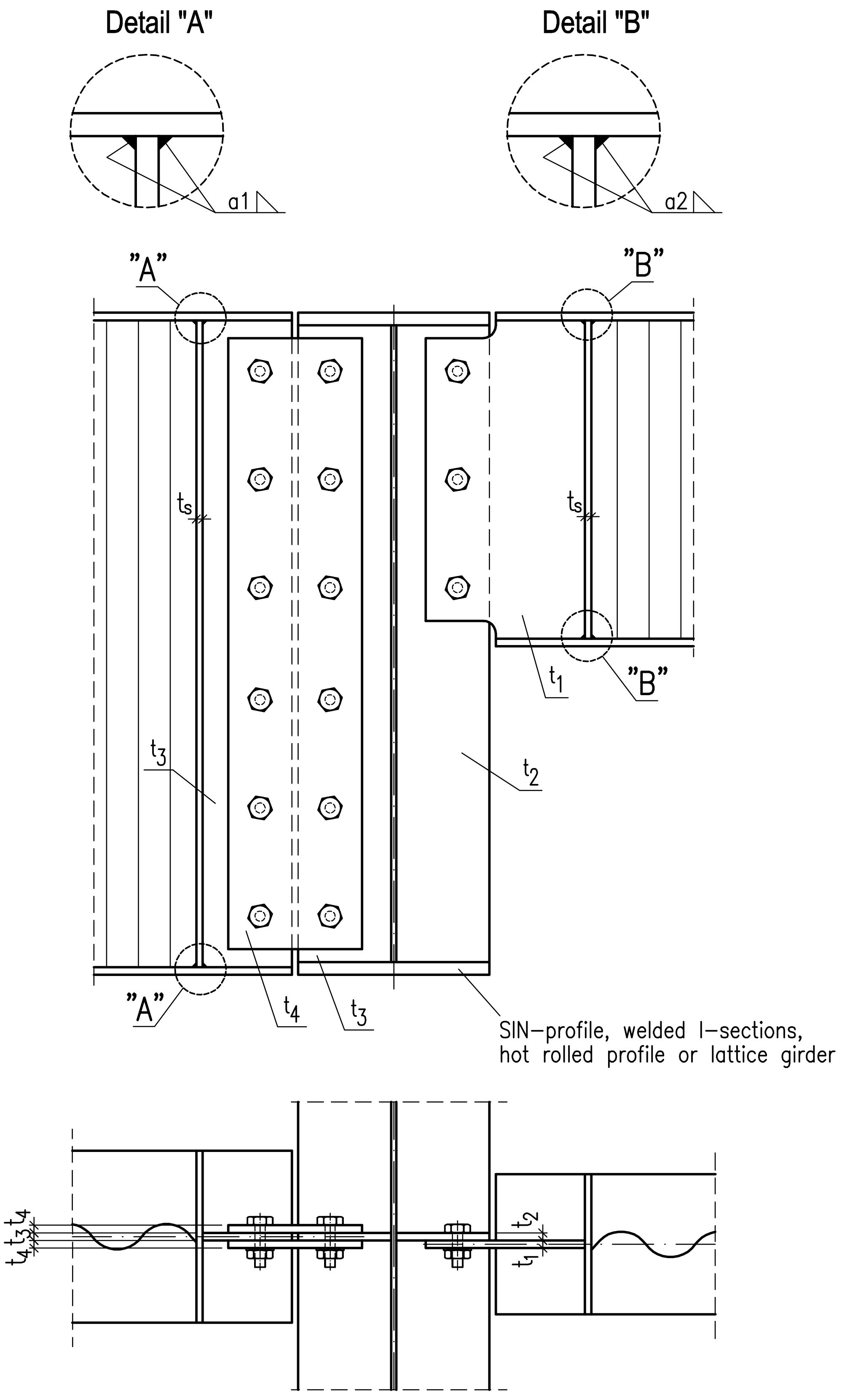
Detail "A"



Remarks:

- t_p, e, bolts and welds according to static calculations

	BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	SIN STANDARD	15	–	
	PLANNUMMER / DRAWINGNUMBER: C1 – BEAM TO BEAM CONNECTION	NAME: Wojtusik	MASSTAB / SCALE	DATUM / DATE: 01.08.18

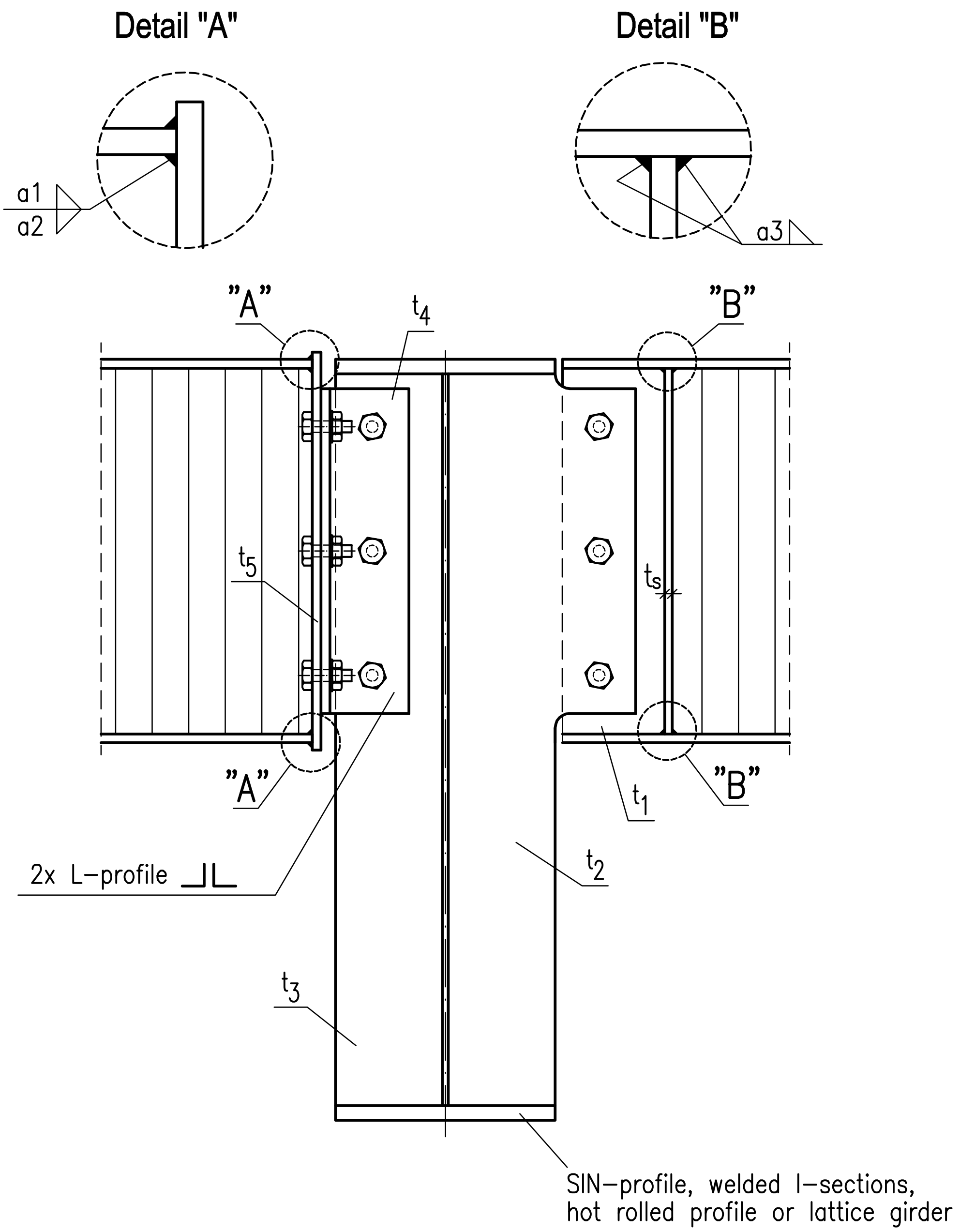


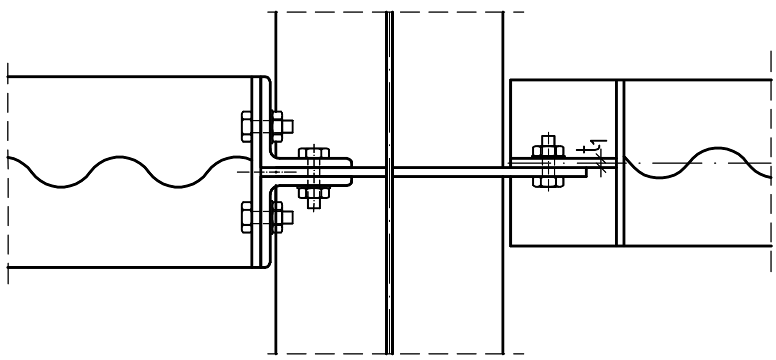
Remarks:

- t_1-t_4 according to static calculations
- bolts and welds according to static calculations
- t_s=10-12mm

BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	16	—	
PLANNUMMER / DRAWINGNUMBER	**NAME**	**MASSTAB / SCALE**	**DATUM / DATE**
C2 – BEAM TO BEAM CONNECTION	Wojtusik		01.08.18

Stahlkonstruktionen Zeman Bogensysteme Hallenbau

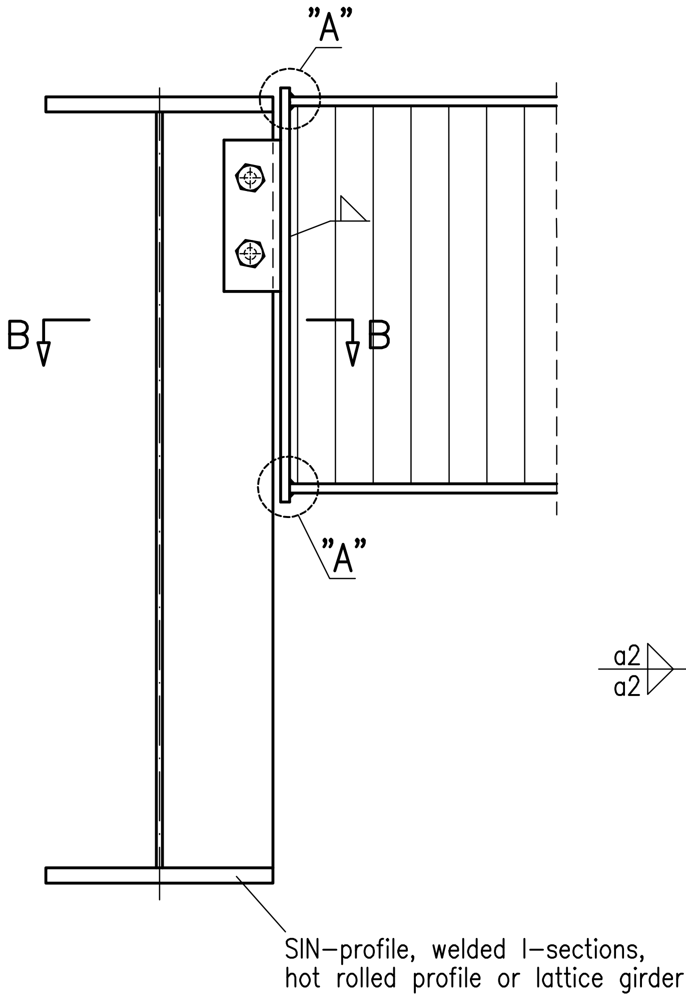




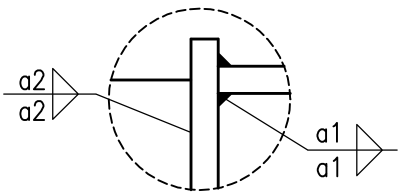
Remarks:

- t_1-t_5, L-profiles according to static calculations
- bolts and welds according to static calculations
- t_s=10-12mm

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 17	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER C3 – BEAM TO BEAM CONNECTION	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



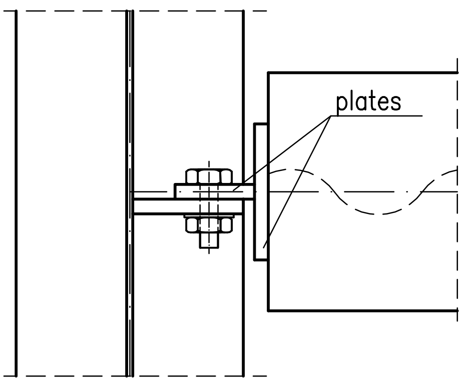
Detail "A"



Section B-B

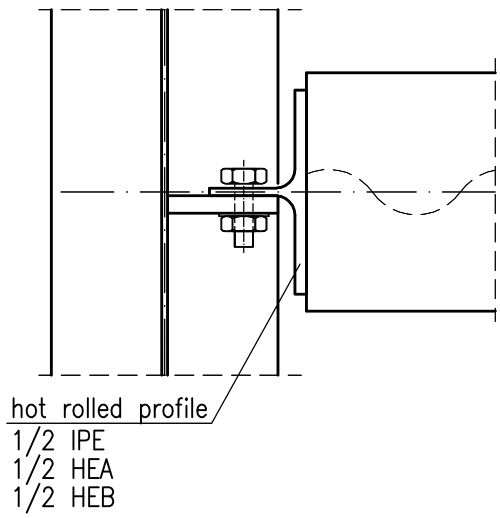
option 1

RECOMMENDED!



option 2

NOT RECOMMENDED!



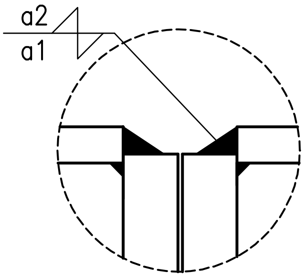
Remarks:

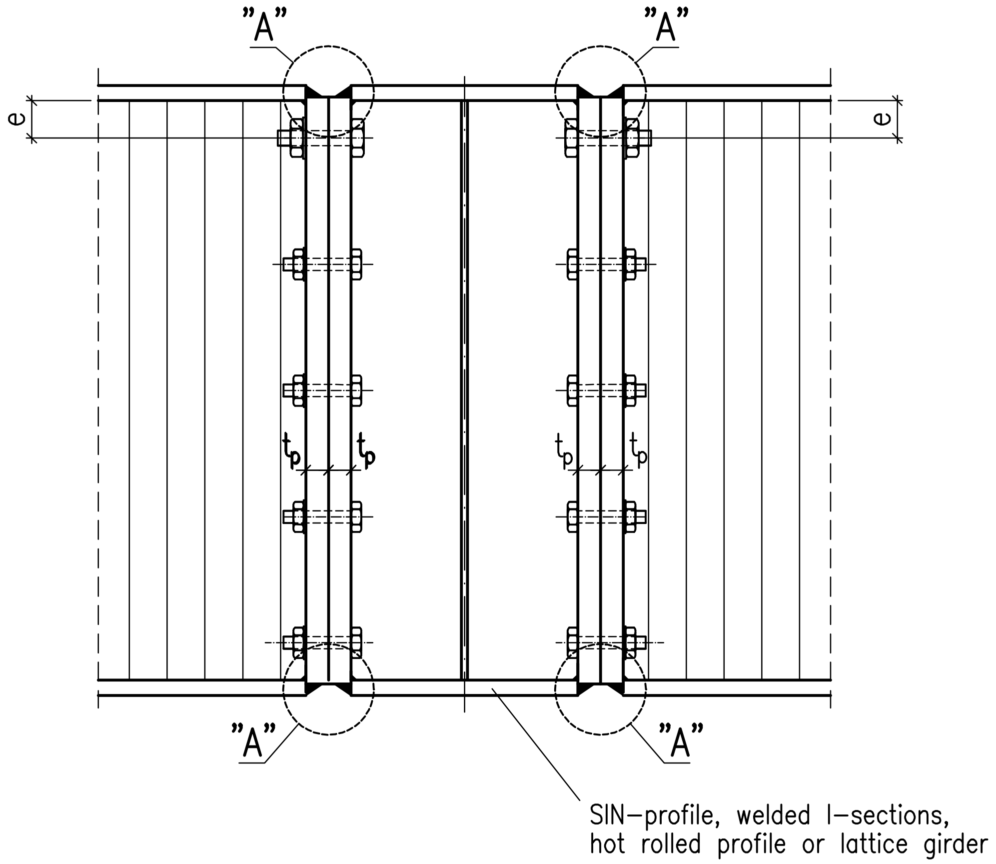
- valid for pinned connection
- plates or hot rolled profile according to static calculations
- bolts and welds according to static calculations

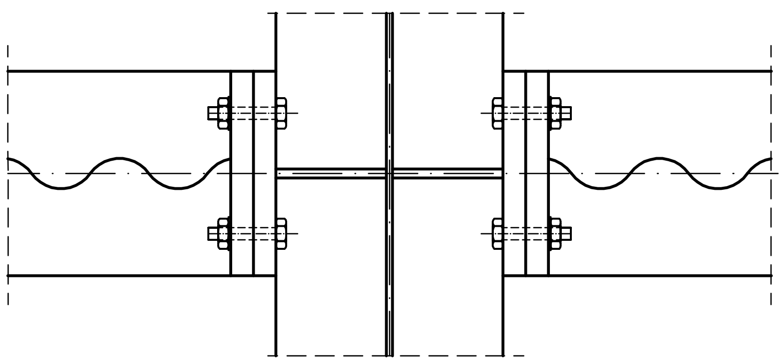
BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	18	–	
PLANNUMMER / DRAWINGNUMBER	**NAME**	**MASSTAB / SCALE**	**DATUM / DATE**
C4 – BEAM TO BEAM CONNECTION	Wojtusik		01.08.18

Stahlkonstruktionen Zeman Bogensysteme Hallenbau

Detail "A"







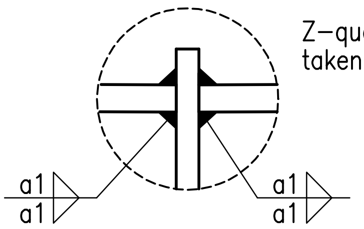
Remarks:

- valid for rigid connection
- t_p, e, bolts and welds according to static calculations

BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	19	–	
PLANNUMMER / DRAWINGNUMBER	**NAME**	**MASSTAB / SCALE**	**DATUM / DATE**
C5 – BEAM TO BEAM CONNECTION	Wojtusik		01.08.18

Stahlkonstruktionen Zeman Bogensysteme Hallenbau

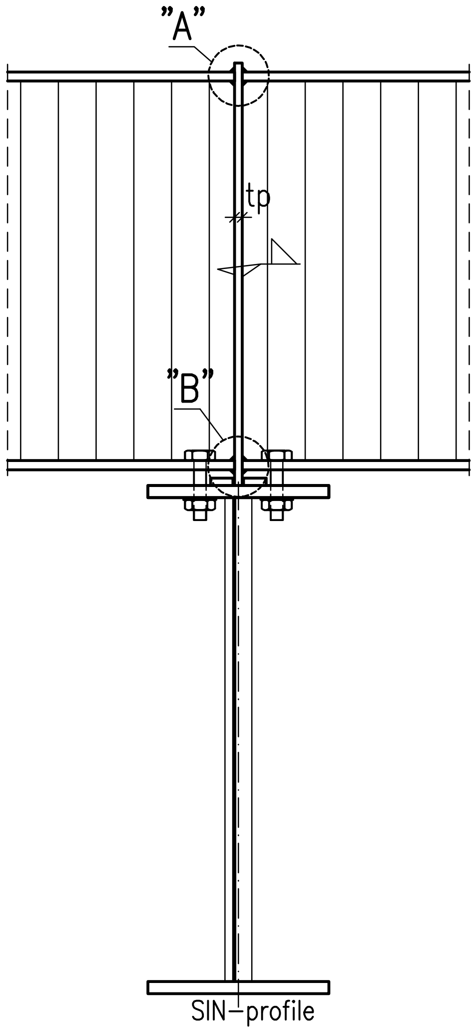
Detail "A"

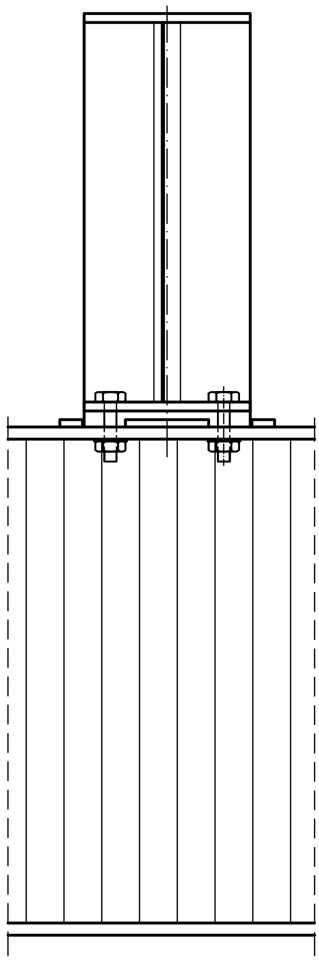


Z–quality criteria must be taken into consideration

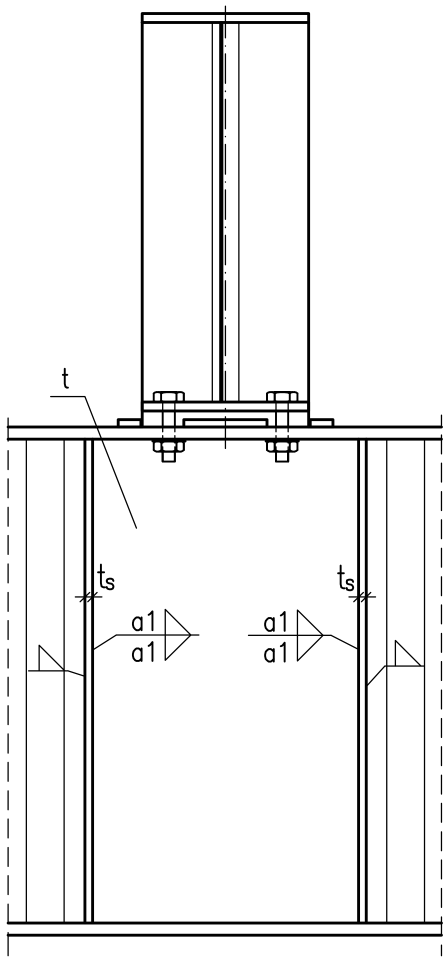
Remarks:

- t, t_p, according to static calculations
- bolts and welds according to static calculations
- buckling of the flat web must be checked
- t_s=10-12mm

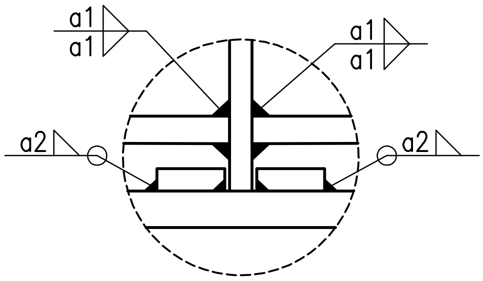


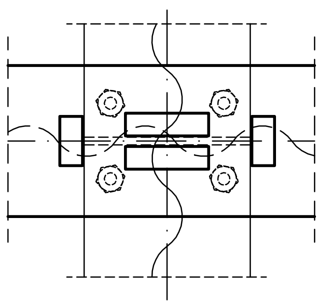


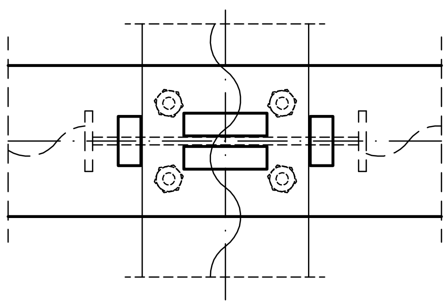
if the web capacity is too small to take local pressure



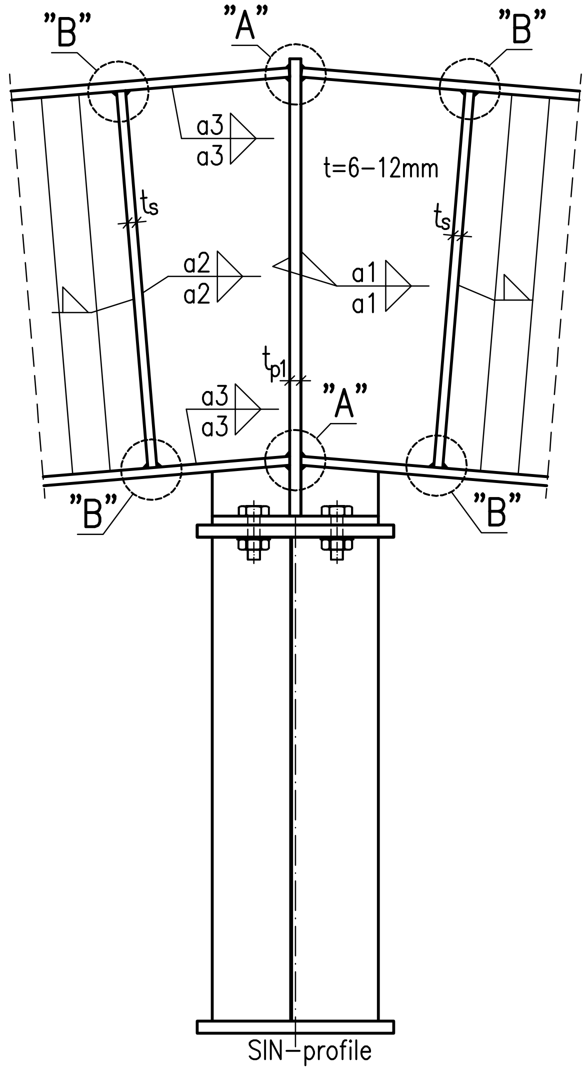
Detail "B"

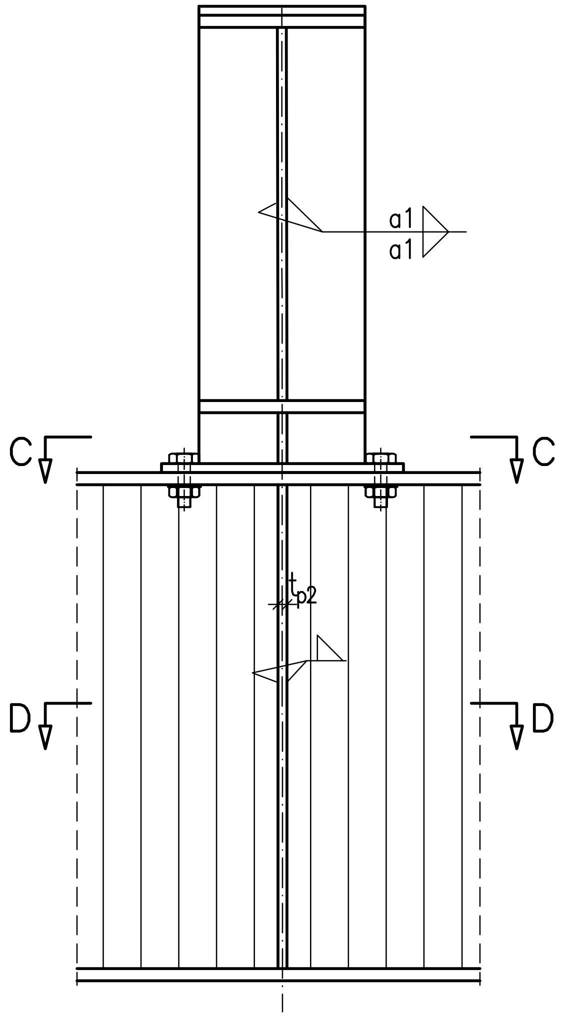




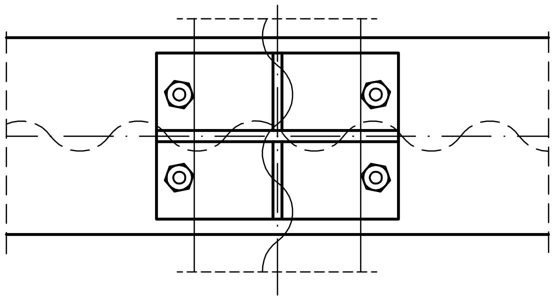


Stahlkonstruktionen **Zeman** Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 20	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER C6 – BEAM TO BEAM CONNECTION	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

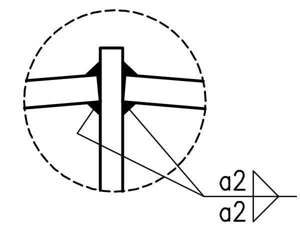




Section C-C

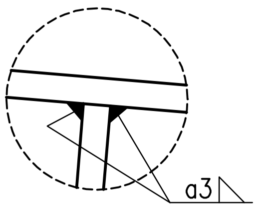


Detail "A"

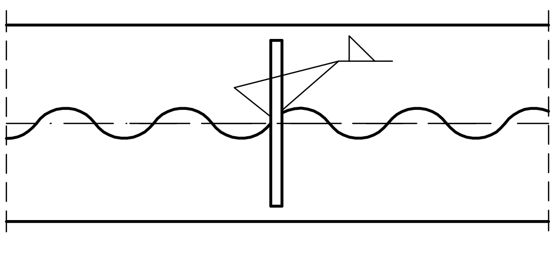


Z–quality criteria must be taken into consideration

Detail "B"



Section D-D



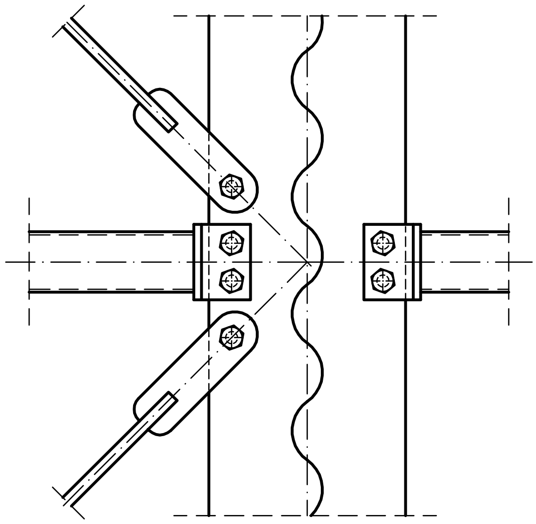
Remarks:

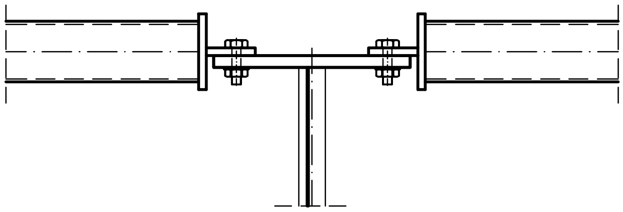
- t, t_{p1}, t_{p2} according to static calculations
- bolts and welds according to static calculations
- buckling of the flat web must be checked
- t_s=10-12mm

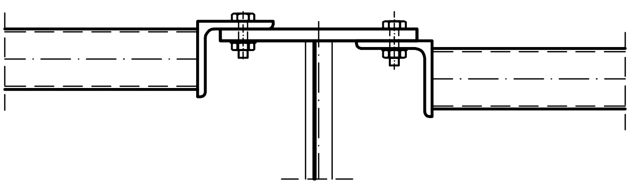
BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	21	–	
PLANNUMMER / DRAWINGNUMBER	NAME	MASSTAB / SCALE	DATUM / DATE
D1 – BRACING CONNECTION	Wojtusik		01.08.18

Stahlkonstruktionen Zeman Bogensysteme Hallenbau

RECOMMENDED



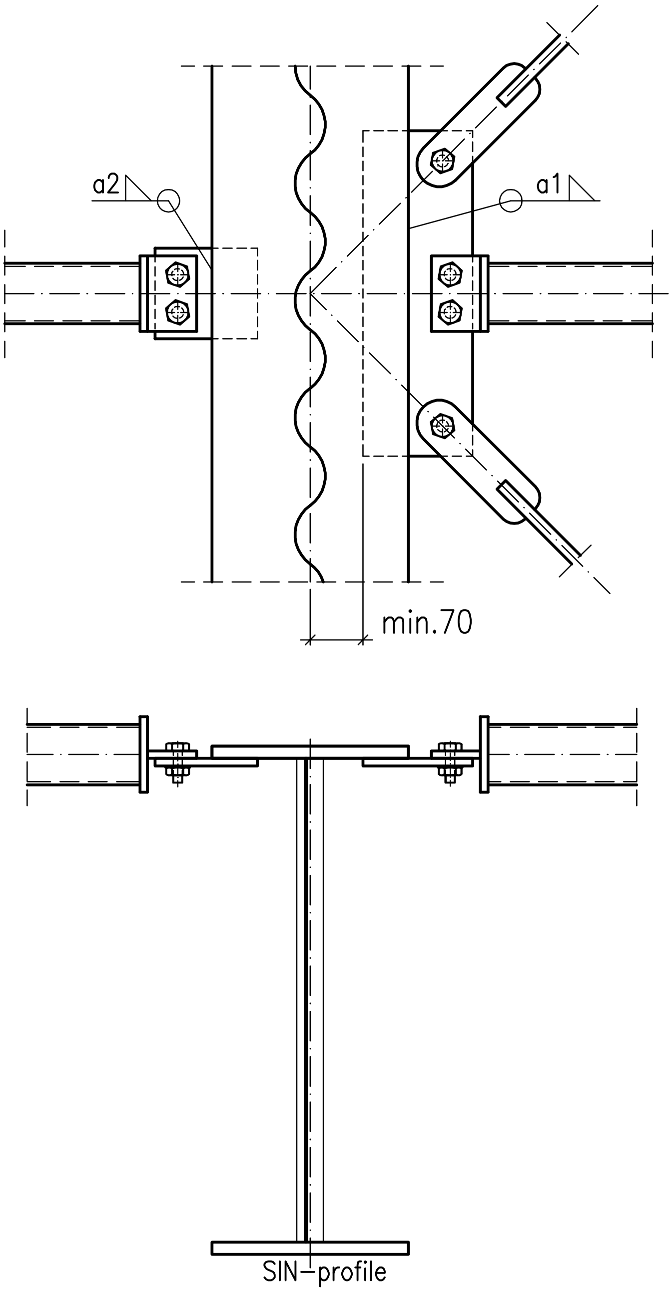




Remarks:

- bolts according to static calculations
- net cross-section at holes of tensiled flanges must be verified

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 22	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER D2 – BRACING CONNECTION	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

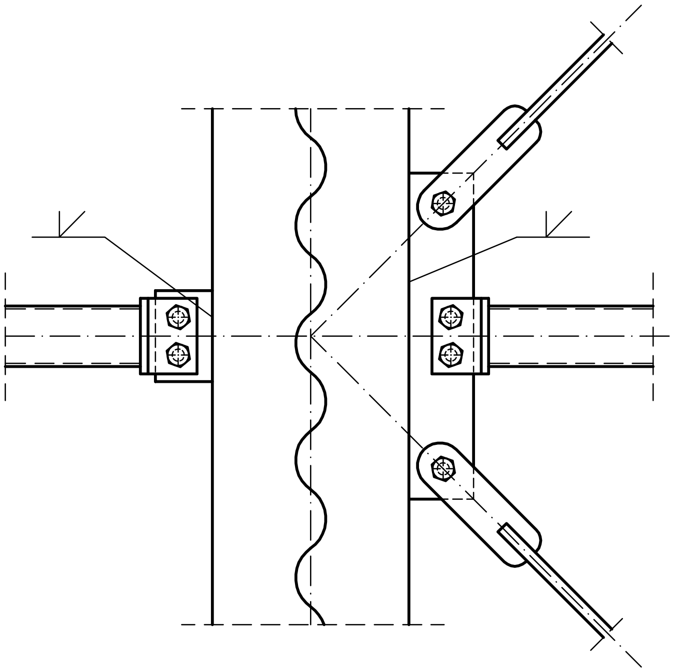


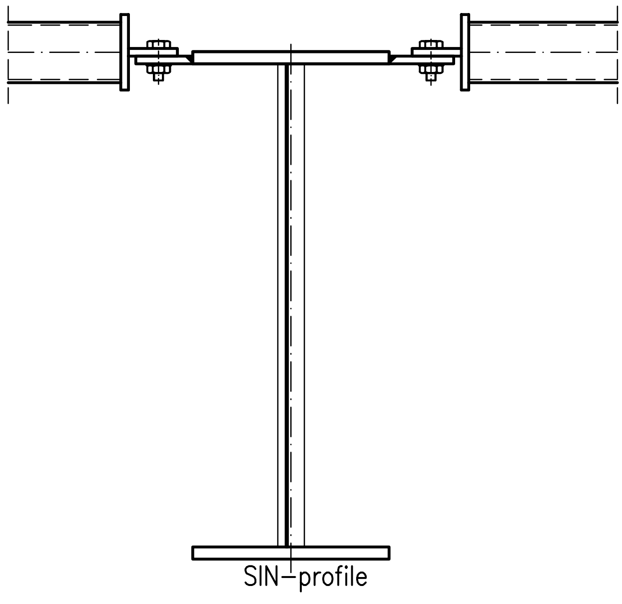
Remarks:

- bolts according to static calculations
- solution applied only if drilling holes causes tensiled flange capacity loss

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 23	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)	
	PLANNUMMER / DRAWINGNUMBER D3 – BRACING CONNECTION	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18	

NOT RECOMMENDED!

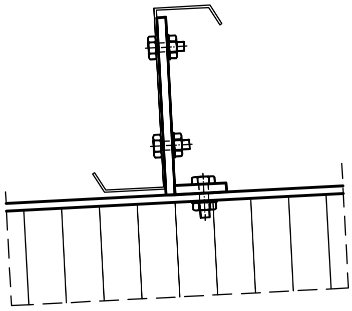




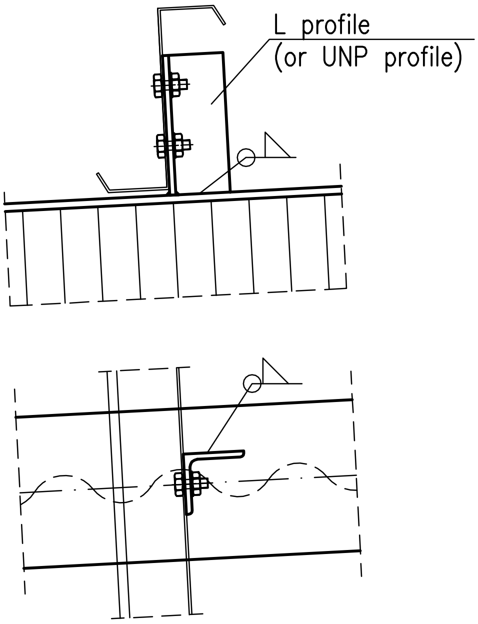
Stahlkonstruktionen
Zeman
Bogensysteme Hallenbau

BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	24	–	
PLANNUMMER / DRAWINGNUMBER	**NAME**	**MASSTAB / SCALE**	**DATUM / DATE**
D4 – PURLINS AND WALL BEAMS JOINTS	Wojtusik		01.08.18

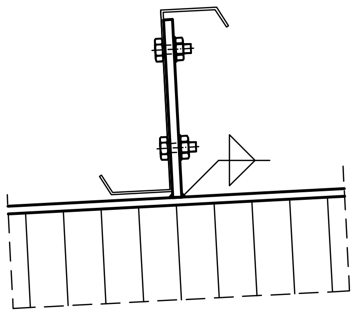
RECOMMENDED



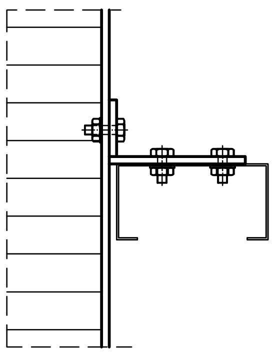
NOT **RECOMMENDED**



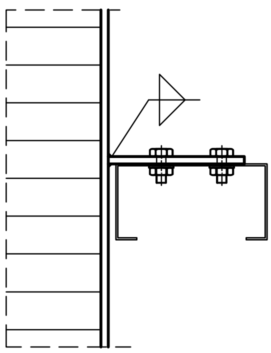
NOT RECOMMENDED!



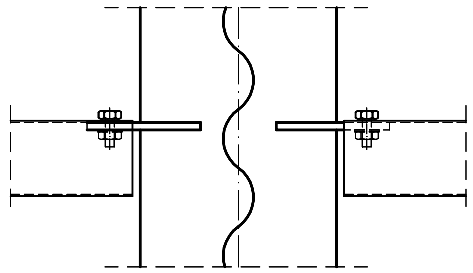
RECOMMENDED

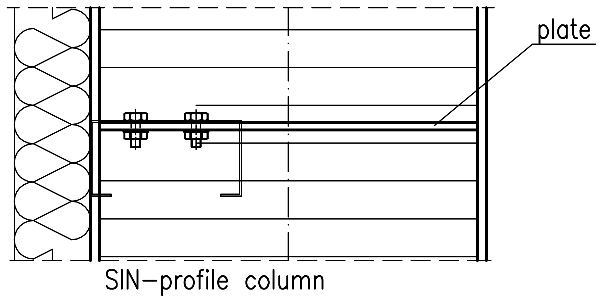


NOT RECOMMENDED!

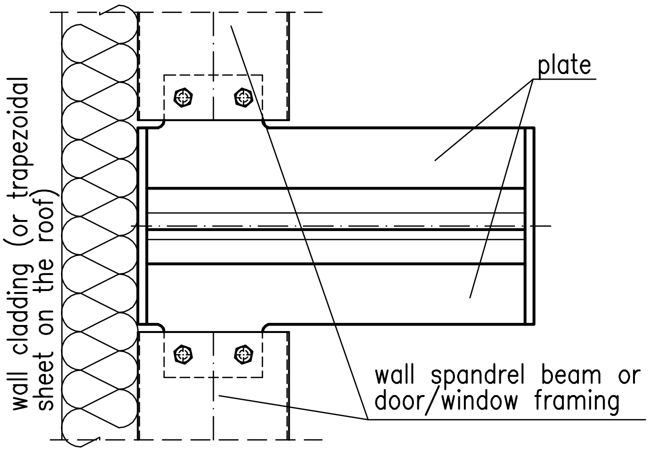


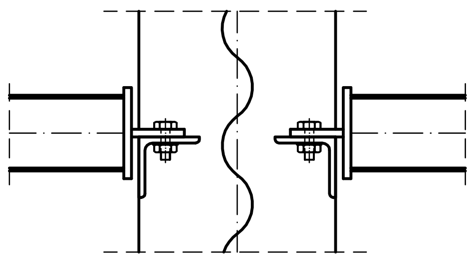
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 25	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER D5 – WALL BEAMS JOINTS	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

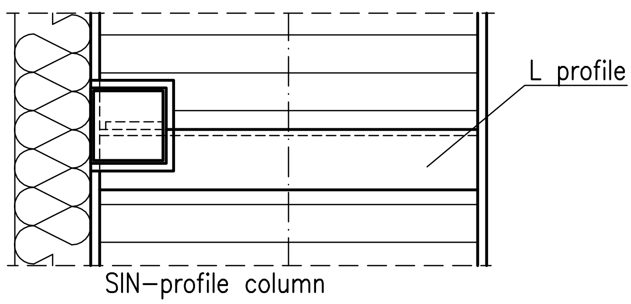




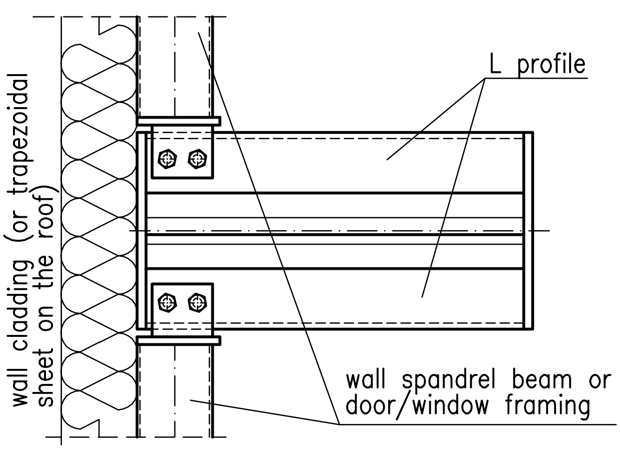
Remarks:
- solution applied in case of mainly horizontal forces (e.g. wind)



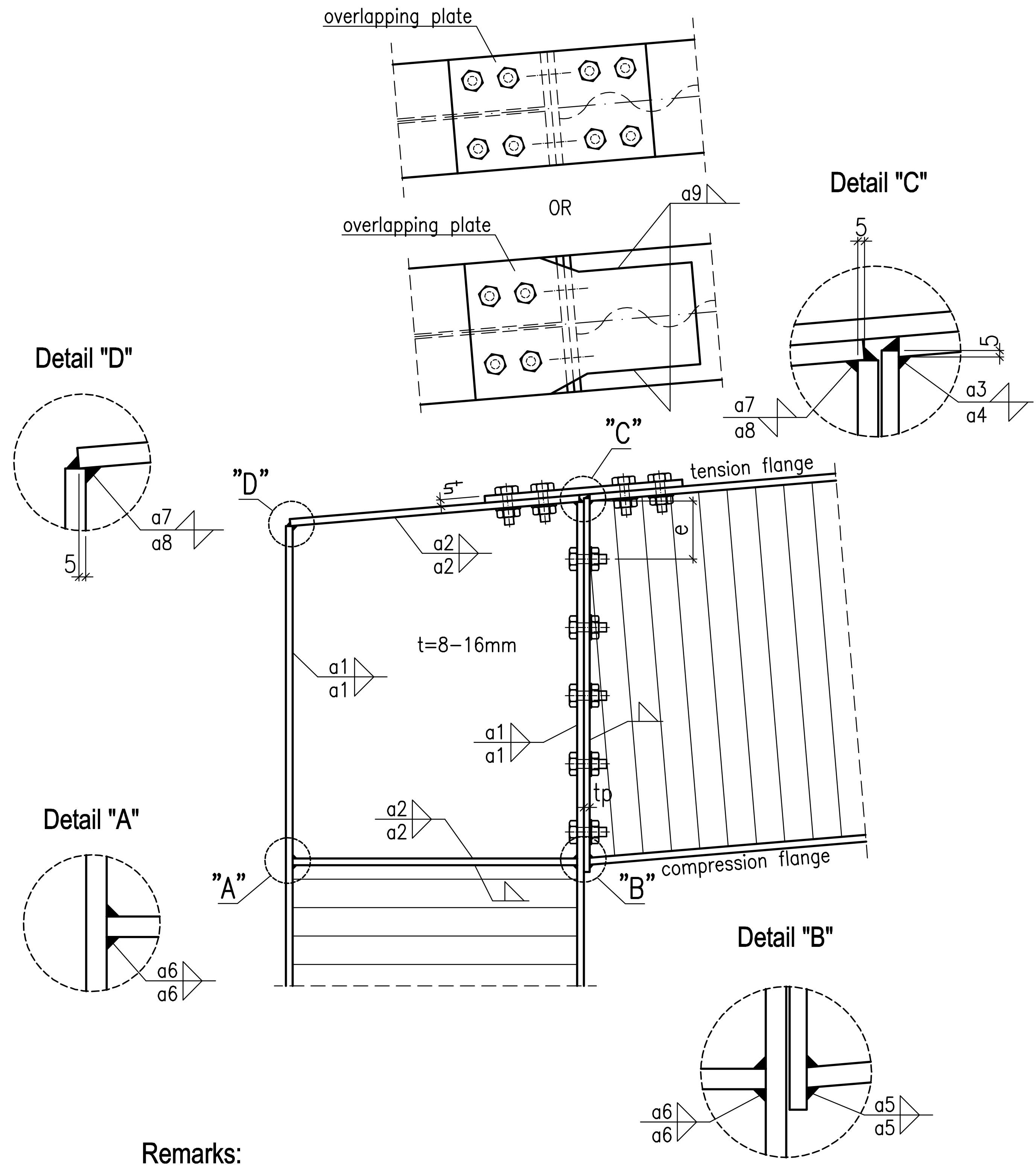




Remarks:
- solution applied in case of both horizontal (e.g. wind) and vertical (e.g. weight of the cladding) forces



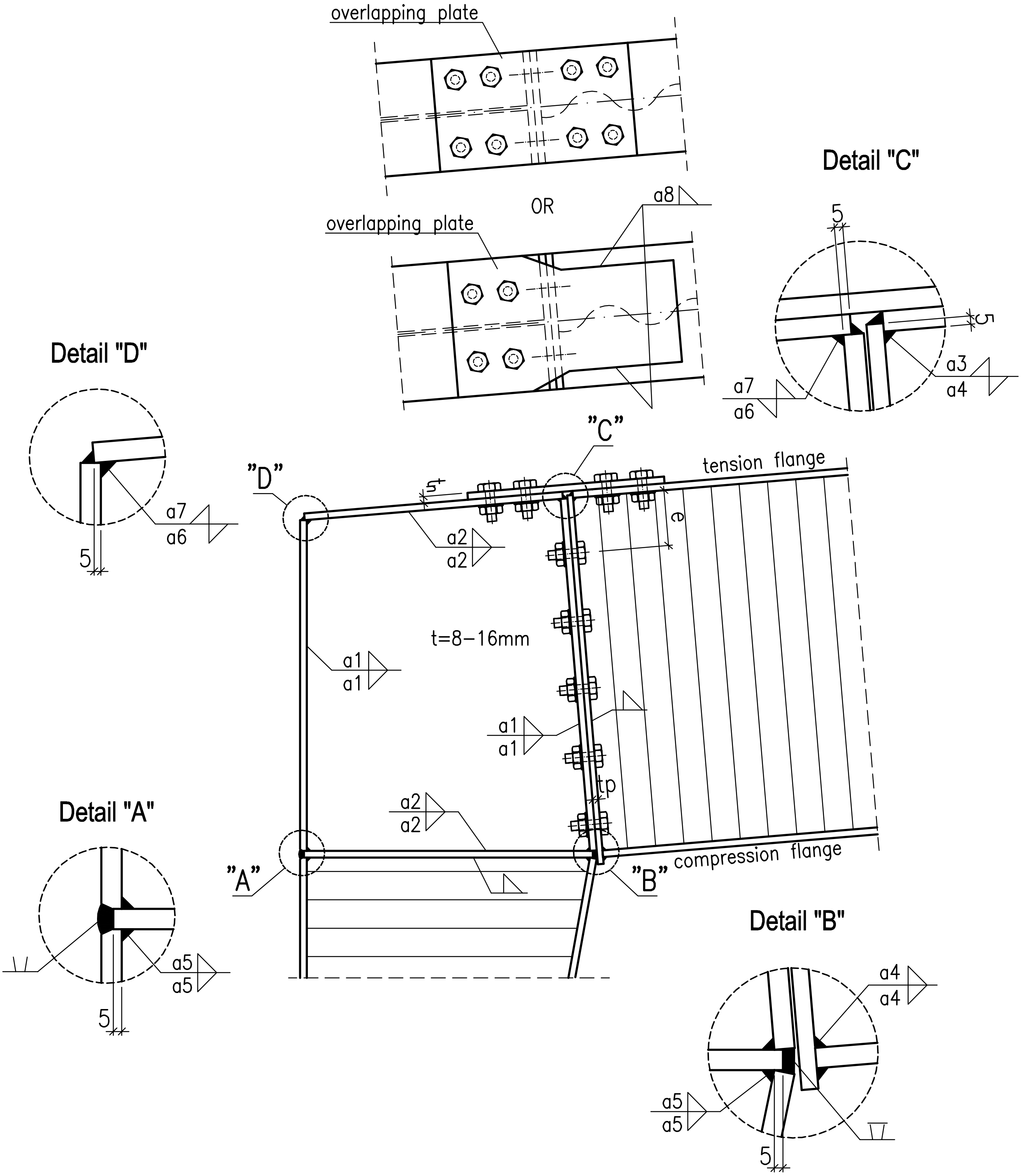
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 26	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER E1 – FRAME CORNER	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



Remarks:

- valid only for columns with parallel flanges
- t, t_h, bolts and welds according to static calculations
- overlapping plate: dimensions, number and diameter of bolts according to static calculations
- e=~100mm
- t_p=10-12mm

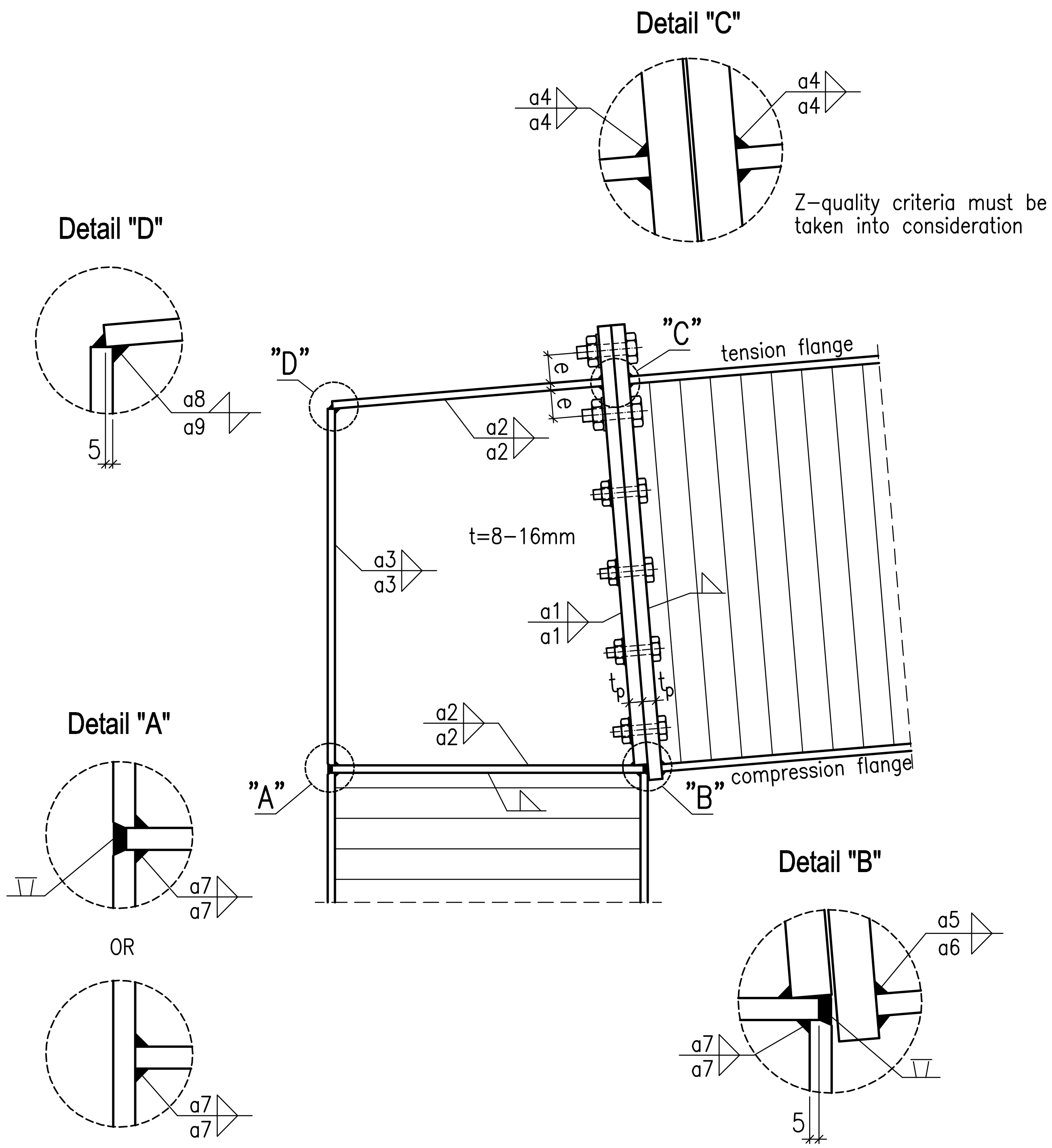
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 27	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER E2 – FRAME CORNER	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



Remarks:

- t, t_n, bolts and welds according to static calculations
- overlapping plate: dimensions, number and diameter of bolts according to static calculations
- e=~100mm
- t_p=10-12mm

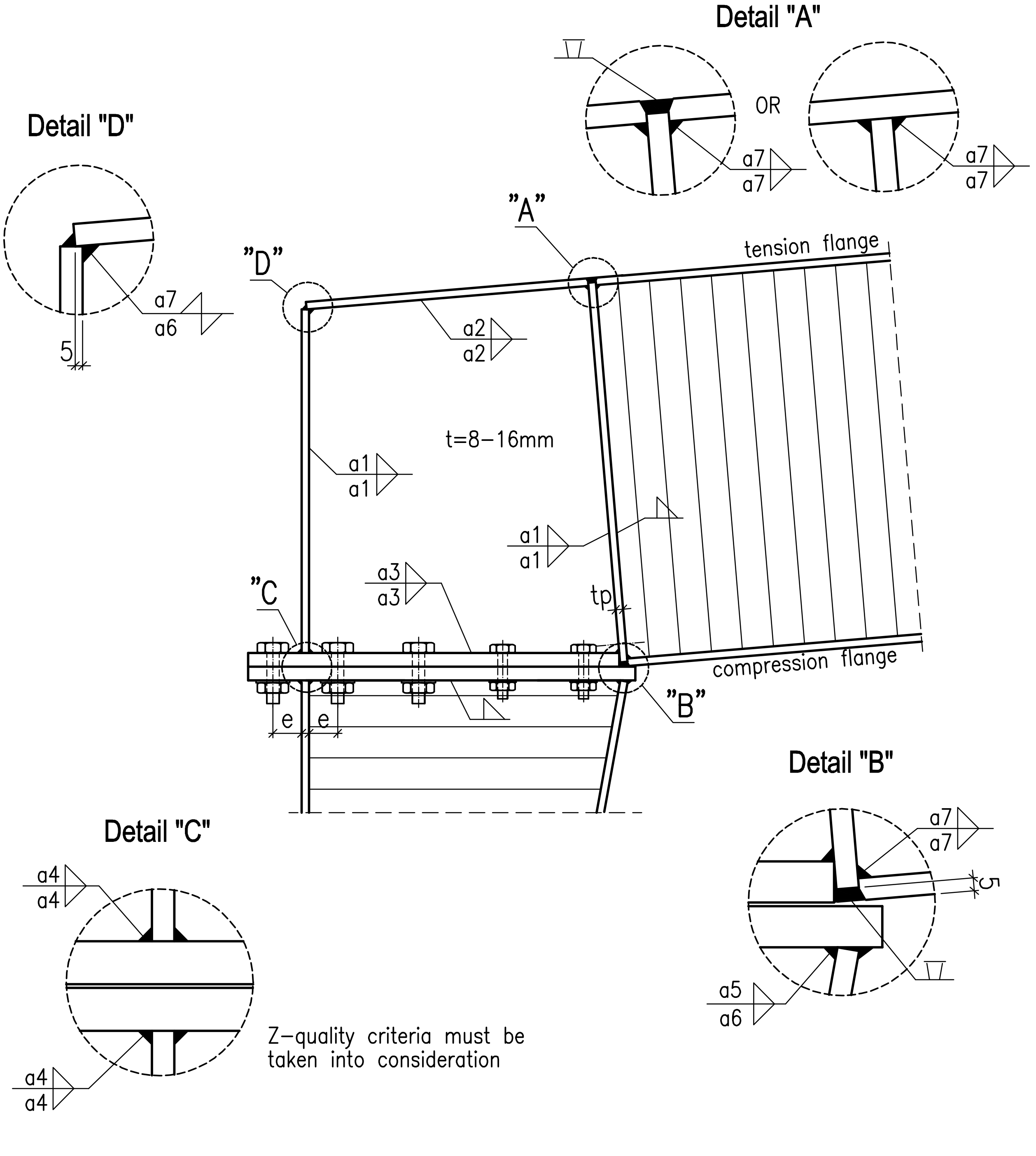
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 28	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER E3 – FRAME CORNER	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



Remarks:

- t, t_p, e, bolts and welds according to static calculations

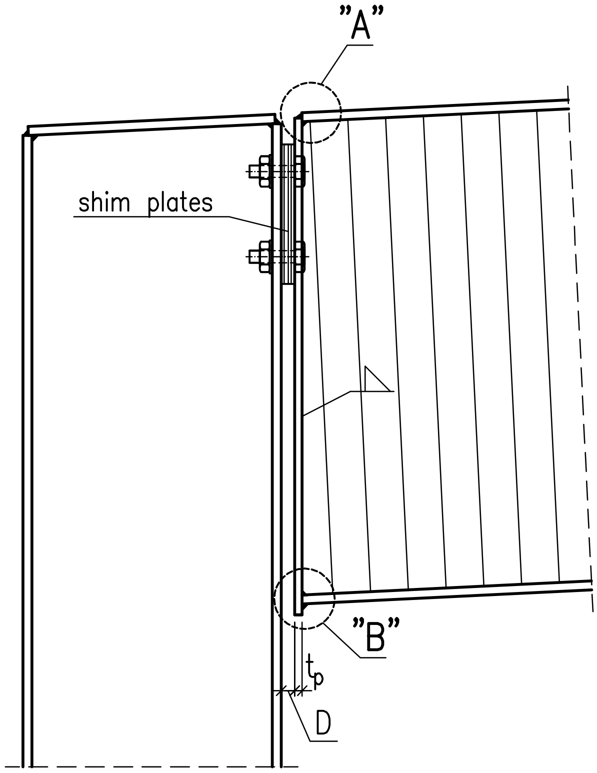
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING: SIN STANDARD	BLATT / SHEET: 29	INDEX / ISSUE: –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER: E4 – FRAME CORNER	NAME: Wojtusik	MASSTAB / SCALE	DATUM / DATE: 01.08.18



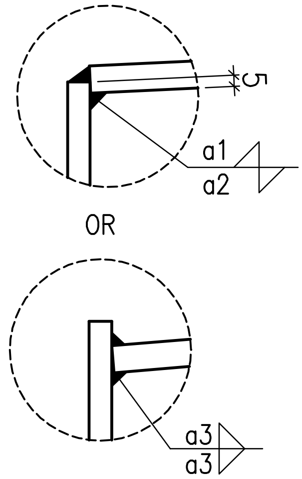
Remarks:

- t, t_p, e, bolts and welds according to static calculations

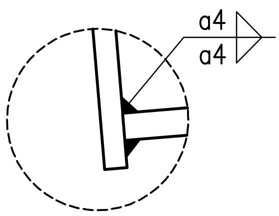
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 30	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER E5 – FRAME CORNER	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



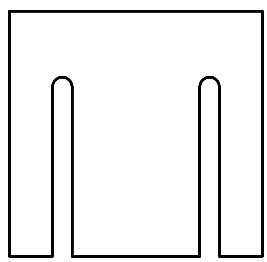
Detail "A"



Detail "B"



shim plates

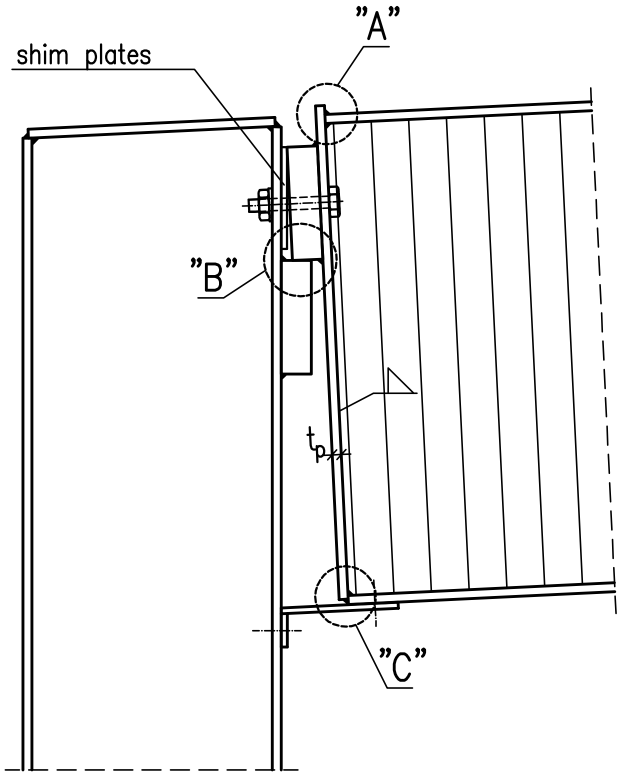


Remarks:

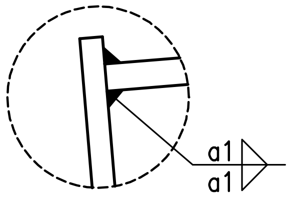
- bolts and welds according to static calculations
- t_p=10-12mm
- distance D acc. to static claculations to ensure no contact between lower flange of the beam and the column at maximum deflection of the beam

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
	SIN STANDARD	31	—	
	PLANNUMMER / DRAWINGNUMBER	NAME	MASSTAB / SCALE	DATUM / DATE
	E6 – FRAME CORNER	Wojtusik		01.08.18

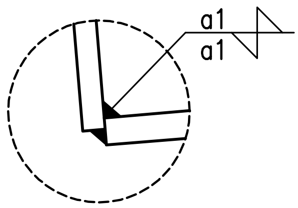
NOT RECOMMENDED!



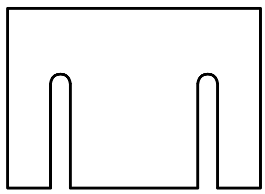
Detail "A"



Detail "C"

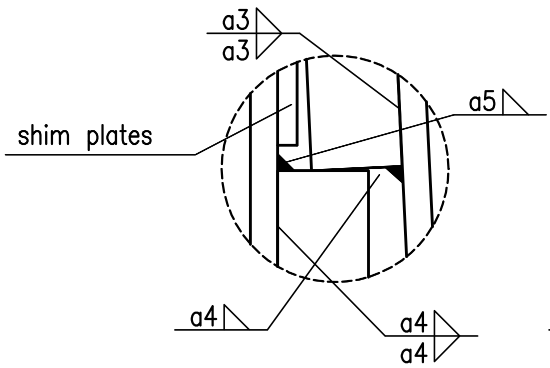


shim plates

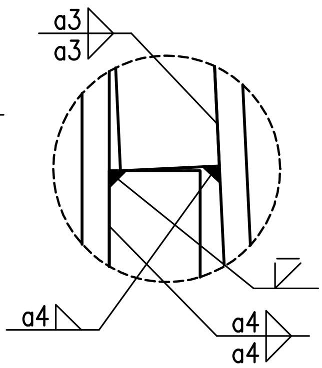


Detail "B"

option 1



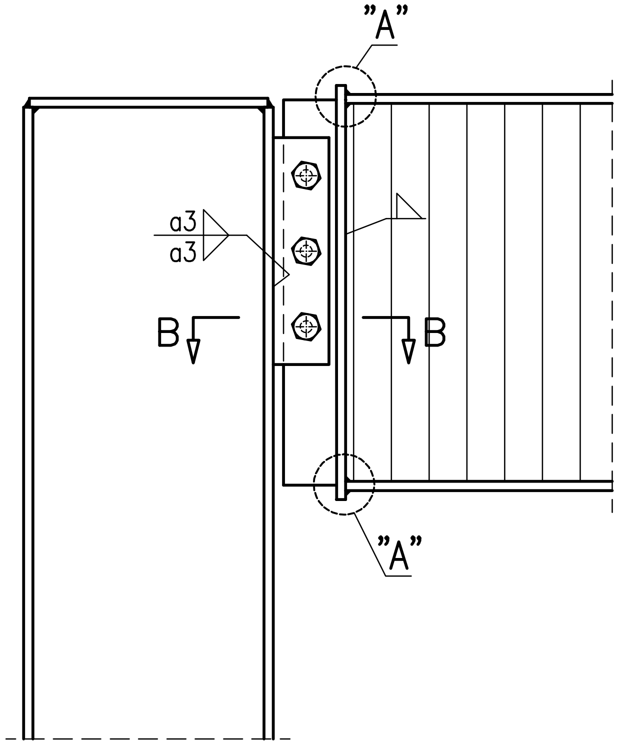
option 2



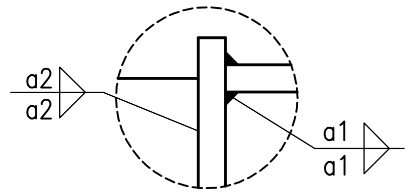
Remarks:

- bolts and welds according to static calculations
- t_p=10-12mm

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 32	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER E7 – FRAME CORNER	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

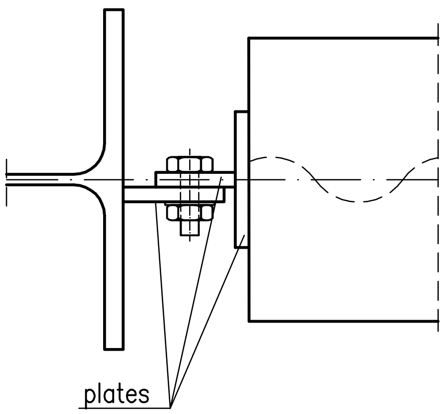


Detail "A"

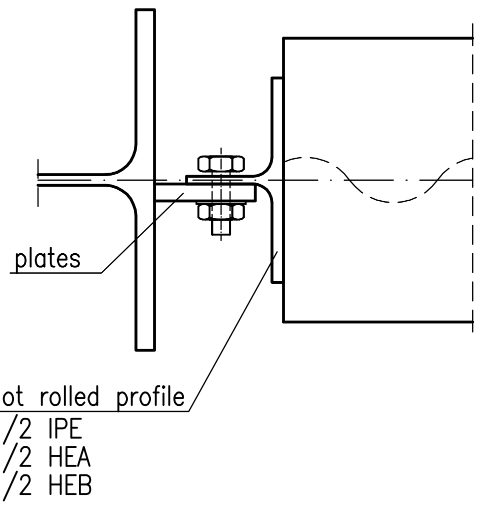


Section B-B

option 1
RECOMMENDED!



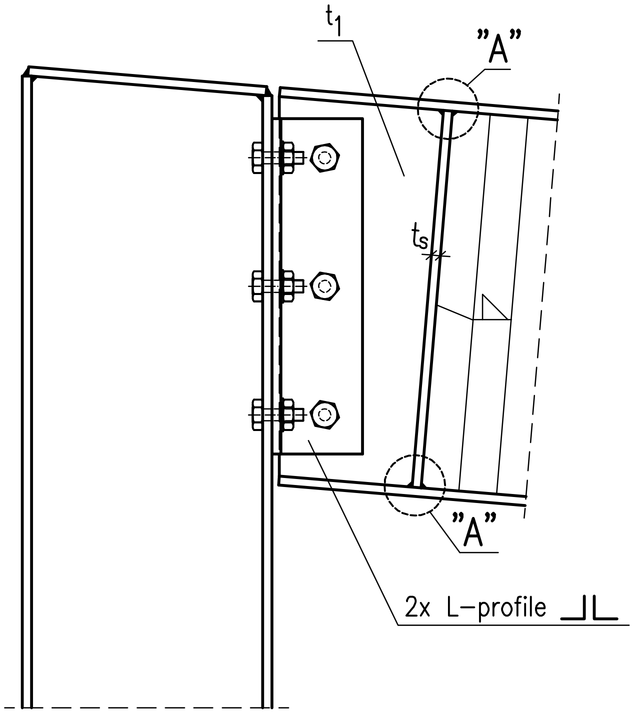
option 2

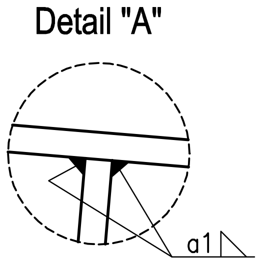


Remarks:

- valid for pinned connection
- plates or hot rolled profile according to static calculations
- bolts and welds according to static calculations

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 33	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER E8 – FRAME CORNER	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

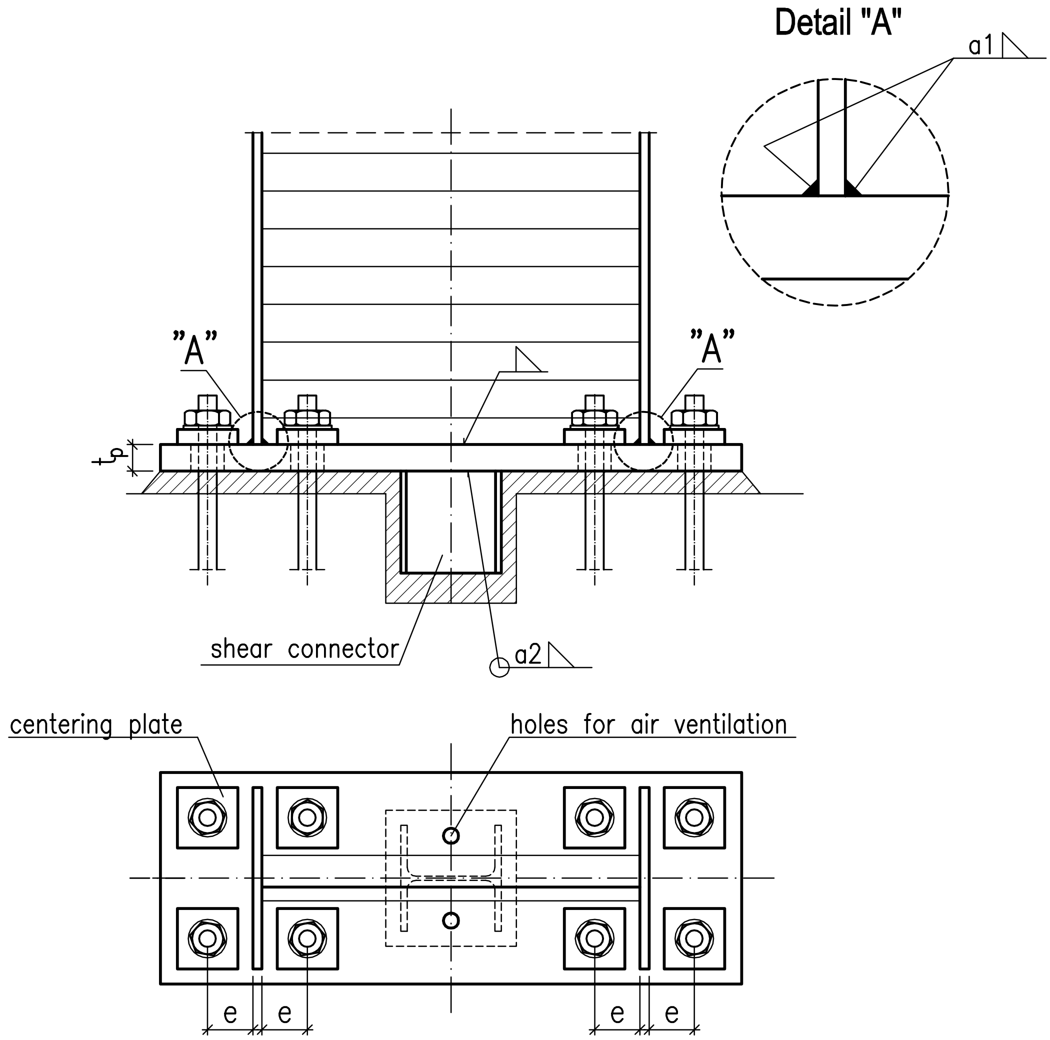




Remarks:

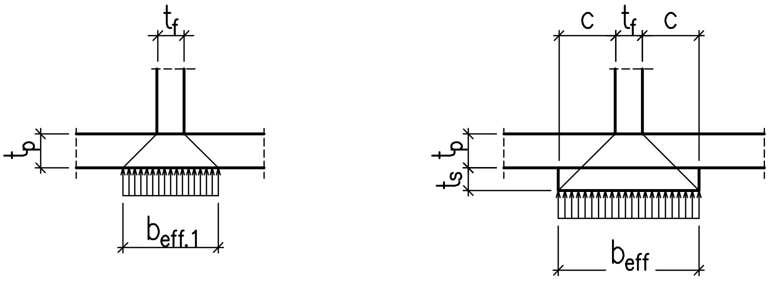
- t_1, L-profiles according to static calculations
- bolts and welds according to static calculations
- t_s=10-12mm

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING: SIN STANDARD	BLATT / SHEET: 34	INDEX / ISSUE: —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER: F1 – COLUMN BASE	NAME: Wojtusik	MASSTAB / SCALE	DATUM / DATE: 01.08.18



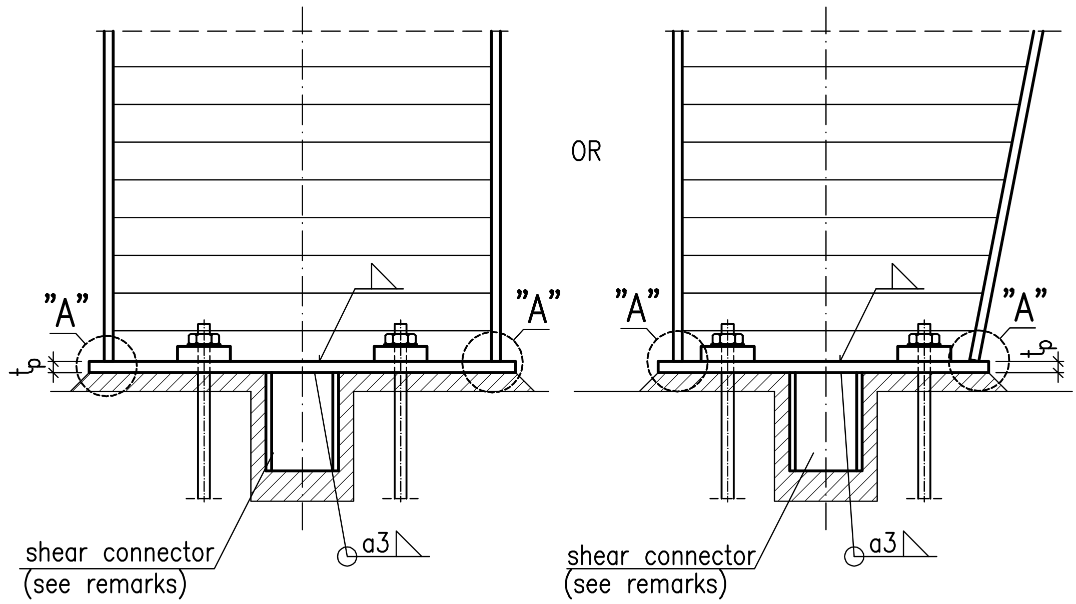
Remarks:

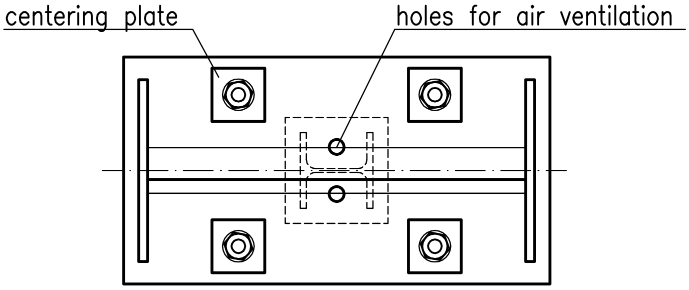
- valid for rigid connection
- t_p, e, anchor bolts and welds according to static calculations
- centering plate according to SHEET 8
- local pressure at concrete surface must be checked acc. to p.4.5



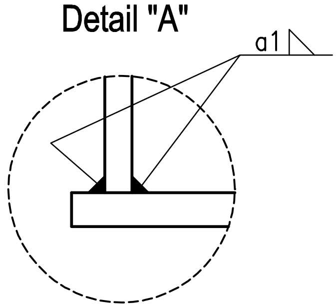
if $b_{eff.1}$ is too small to take local pressure of the concrete additional shim plates should be applied

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 35	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER F2 – COLUMN BASE	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



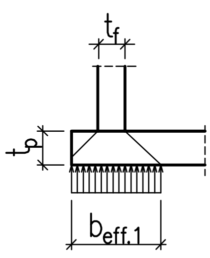


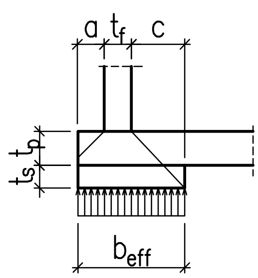
Detail "A"



Remarks:

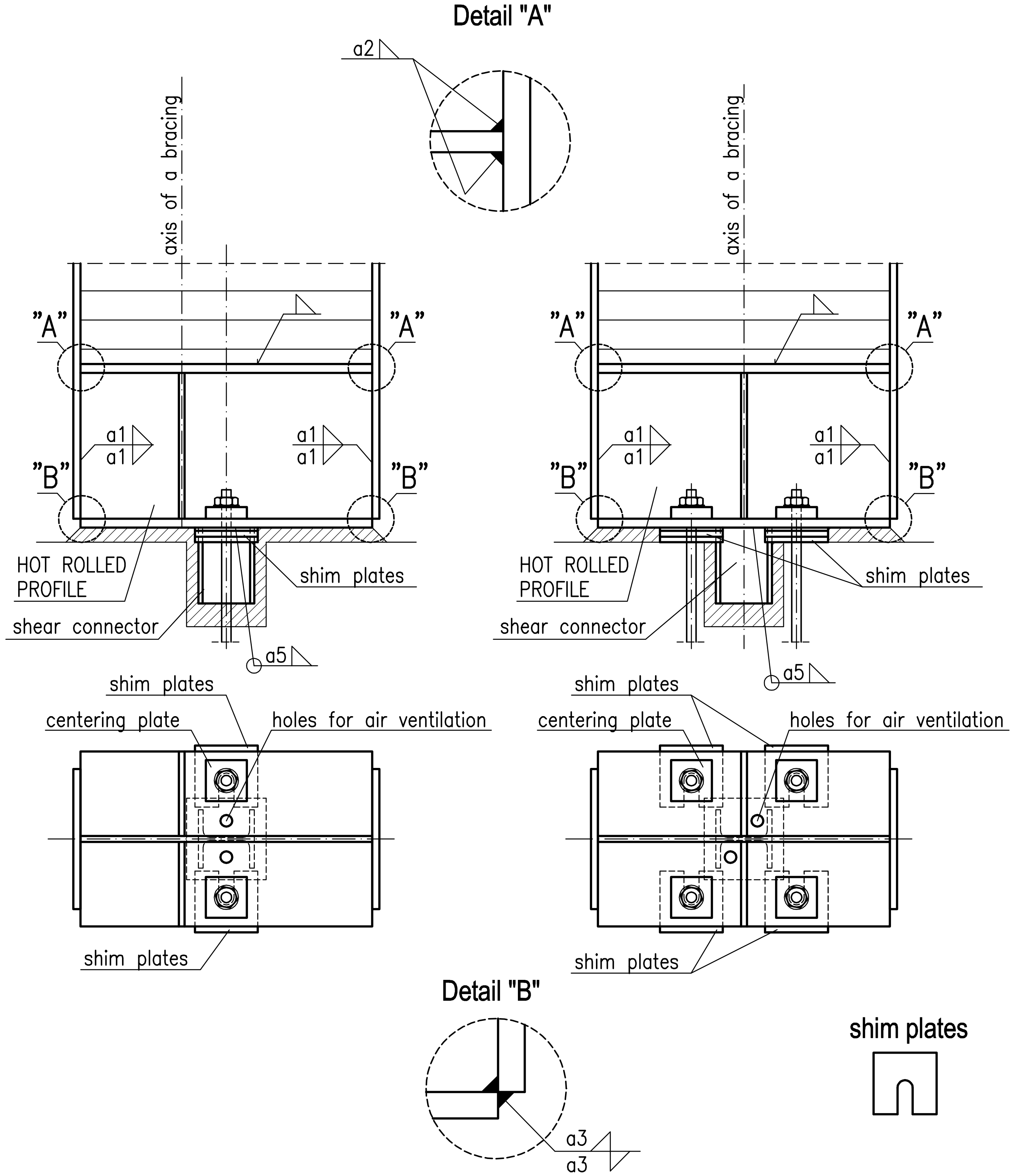
- valid for pinned connection
- t_p, anchor bolts and welds according to static calculations
- shear connector applied only when bolts are not able to take horizontal forces (e.g. at support of wall bracings)
- centering plate according to SHEET 8
- local pressure at concrete surface must be checked acc. to p.4.5





if b_{eff} is too small to take local pressure of the concrete additional shim plates should be applied

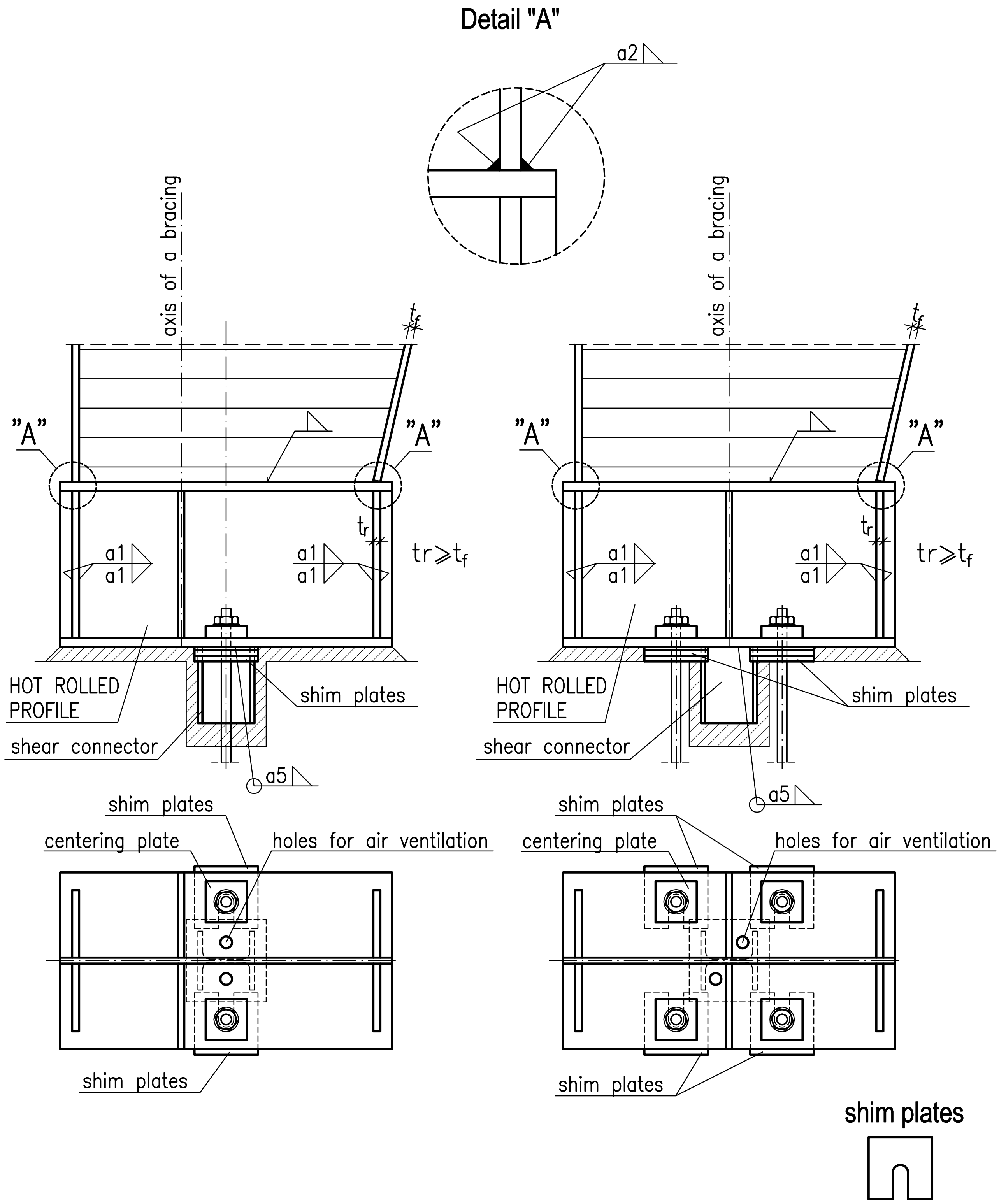
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 36	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER F3 – COLUMN BASE	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



Remarks:

- valid for pinned connection (shim plates recommended)
- valid only for profiles with parallel flanges
- hot rolled profile, anchor bolts and welds according to static calculations
- centering plate according to SHEET 8
- this type of the column base shall be used if a local pressure of the surface of foundation is too high (acc. to p.4.5)

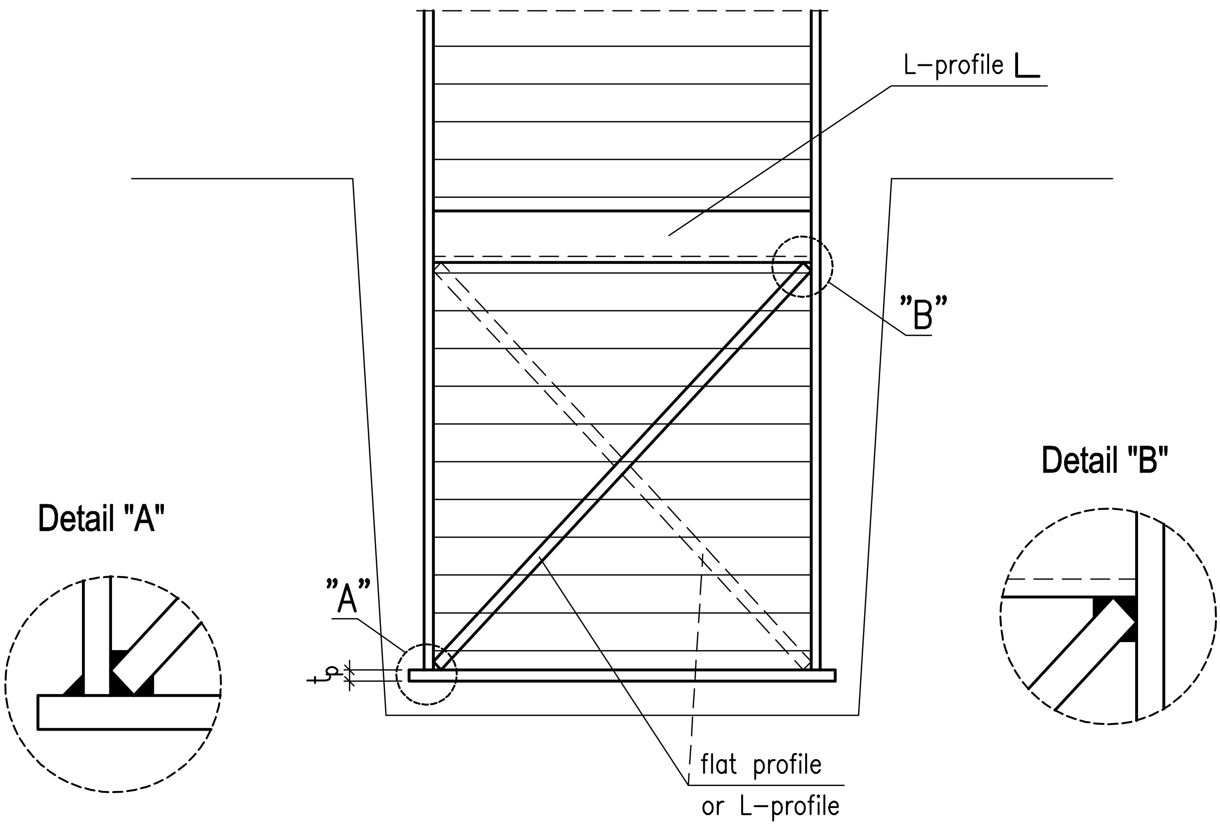
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 37	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER F4 – COLUMN BASE	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18



Remarks:

- valid for free supported connection (shim plates recommended)
- hot rolled profile, anchor bolts and welds according to static calculations
- centering plate according to SHEET 8
- this type of the column base shall be used if a local pressure of the surface of foundation is too high (acc. to p.4.5)

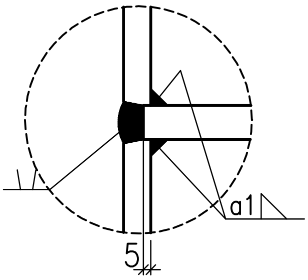
Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 38	INDEX / ISSUE –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER F5 – COLUMN BASE	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

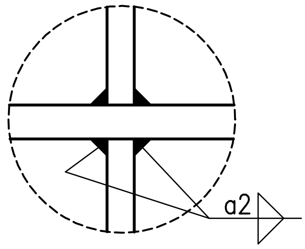


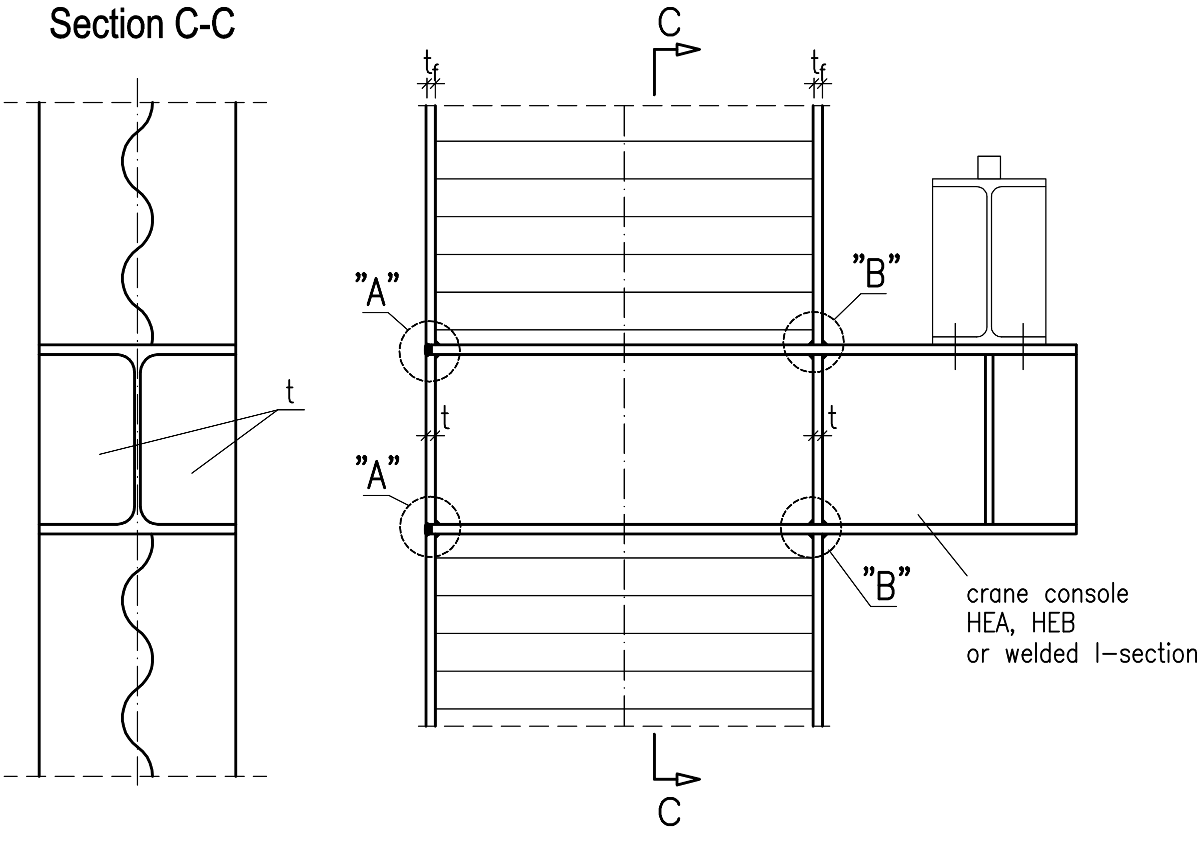
Remarks:

- valid for rigid connection
- t_p, welds according to static calculations

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING: SIN STANDARD	BLATT / SHEET: 39	INDEX / ISSUE: –	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER: G1 – CRANE CONSOLE	NAME: Wojtusik	MASSTAB / SCALE	DATUM / DATE: 01.08.18



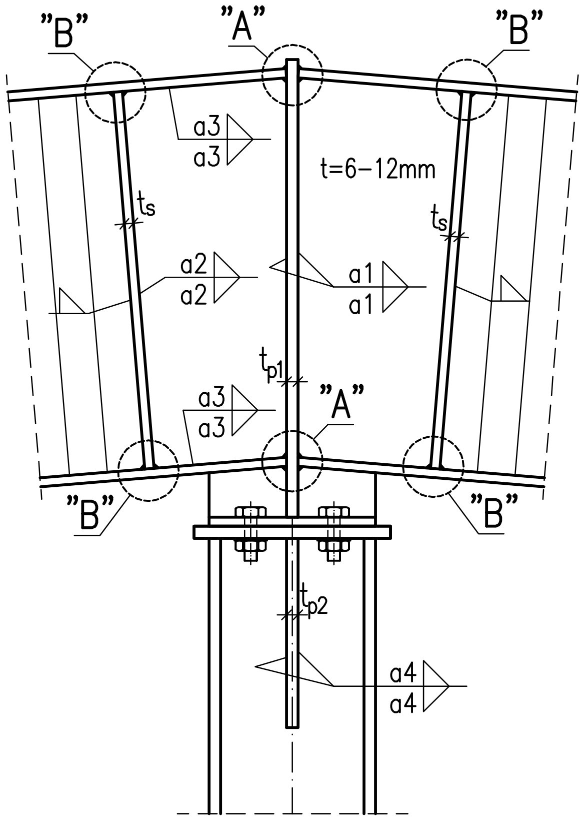




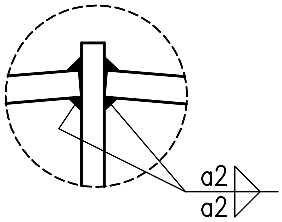
Remarks:
- welds according to static calculations
- crane console according to static calculations
- $t >= t_f$

BAUWERK / BUILDING	BLATT / SHEET	INDEX / ISSUE	DATUM (INDEX) DATE (ISSUE)
SIN STANDARD	40	–	
PLANNUMMER / DRAWINGNUMBER	**NAME**	**MASSTAB / SCALE**	**DATUM / DATE**
H1 – BEAM TO INNER COLUMN CONNECTION	Wojtusik		01.08.18

Stahlkonstruktionen Zeman Bogensysteme Hallenbau

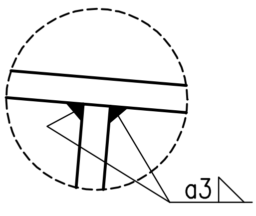


Detail "A"



Z–quality criteria must be taken into consideration

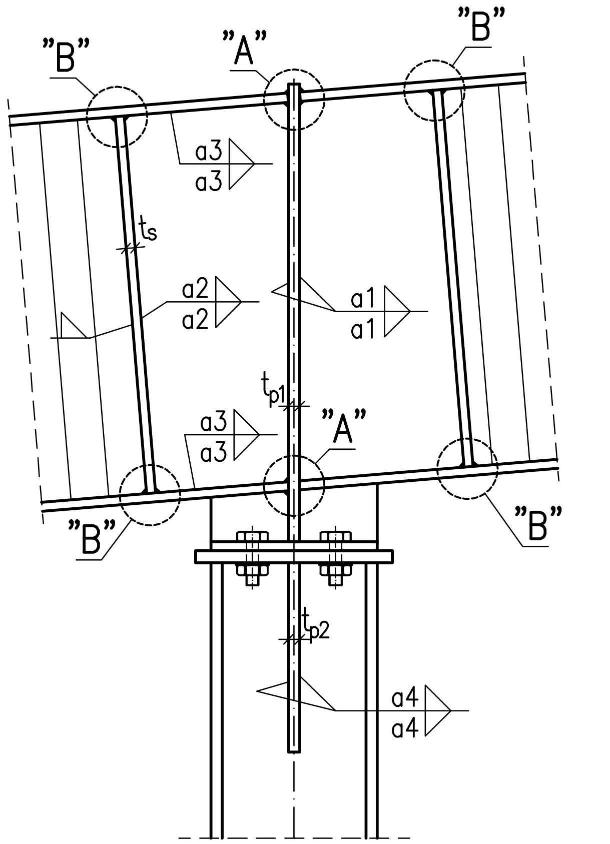
Detail "B"



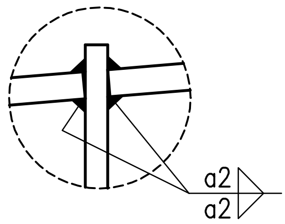
Remarks:

- t, t_{p1}, t_{p2} according to static calculations
- bolts and welds according to static calculations
- buckling of the flat web must be checked
- t_s=10-12mm

Stahlkonstruktionen Zeman Bogensysteme Hallenbau	BAUWERK / BUILDING SIN STANDARD	BLATT / SHEET 41	INDEX / ISSUE —	DATUM (INDEX) DATE (ISSUE)
	PLANNUMMER / DRAWINGNUMBER J1 – BEAM TO INNER COLUMN CONNECTION	NAME Wojtusik	MASSTAB / SCALE	DATUM / DATE 01.08.18

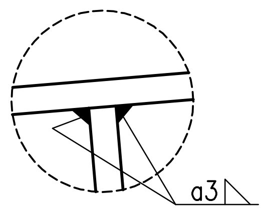


Detail "A"



Z–quality criteria must be taken into consideration

Detail "B"



Remarks:

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