Preface

The Fiberline Design Manual is a tool for architects, engineers and technicians to facilitate the design and construction of well-functioning structures using composite profiles.

As composite materials can be combined and formed in an infinite number of ways, the manual cannot replace dialogue with Fiberline Composites specialists when it comes to solutions for special projects.

Composite materials and production methods remain in a state of rapid development. There will thus also be an ongoing need for us to update data and add new Sections to this edition. Your online access to the manual means that you will automatically receive information on amendments and updates.

New Sections in the 2nd edition
The second edition of the Design Manual includes a number of new Sections:

- The range of profiles is more extensive in the second edition. New square tubes in 120 mm, 160 mm, 200 mm, and 240 mm are now available. These profiles have been developed for use as columns.
- New IL- and UL- profiles have also been introduced to provide slim, lightweight I- and U- profiles. These profiles have been developed for use as beams. The stiffness of the new profiles is typically 30-50% higher than previous profiles of the same weight. Engineers will find that these new profiles will result in structures with increased performance when measured in terms of load capacity per kg of profile.
- New Sections have been added to cover gratings, planks, railings and stairs, as well as assembly brackets, glued joints, and handling and transportation.
- The Section on resistance to chemicals has been simplified. For ease of access the resistance capacities are now stated in relation to representative groups of chemicals.
- Currently, our engineers are writing two new Sections to cover load capacities of profiles in fire and design guidance for glued connections.

Standards and calculations
Calculations in the 2nd edition are based on information in the EUROCOMP Design Code and Handbook, which was written by The European Structural Polymeric Composites Group. In the first edition calculations were based on the Danish standards DS 456, “Dansk Ingeniørforening’s Code of Practice for Use of Glass Fibre Reinforced Unsaturated Polyester”.

Partial coefficients for loading and loading combinations are based on the Eurocode system, whereas partial coefficients for material values have been selected in accordance with EUROCOMP. This has not significantly affected the safety levels of structures dimensioned in accordance with the first edition of the Fiberline Design Manual.

The European standard for pultruded profiles, EN 13706, is also new. Fiberline profiles meet or exceed the highest quality level – E23 – in the standard.

Comments or improvements
We all hope you will find this manual to be a very valuable source of information. We would appreciate receiving any comments and suggestions that can help make it even better.

We thank the many individuals and users who, either directly or indirectly, have been involved in the preparation of this second edition of the Fiberline Design Manual

Kolding, Denmark
Henrik Thorning
1 May 2003

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CHAPTER 0: COMPOSITES

Section 1 **Composites**

Composites

Composites are defined as materials which consist of not less than two different component materials, neither of which are well suited for construction purposes on their own, but which in combination result in a very strong and rigid material. Composites have been known and used in buildings for thousands of years. Straw mixed with clay for building clay huts in the Stone Age is one example. Steel-reinforced concrete is an example from modern times. In combinations of this type, tensile force is absorbed by the steel reinforcement, while the concrete absorbs the compressive load.

Plastics reinforced with various forms of fibre make up a significant portion of the composites that are used by modern society. Fibre-reinforced plastics can be divided roughly into two groups: synthetic materials reinforced with short fibres, and synthetic materials reinforced with long (continual) fibres. Composites that are reinforced with short fibres are used primarily for injection moulding or extruded plastic products. Composites reinforced with long or continuous fibres are often used in large structures such as ships, pressure tanks, and wind turbine wings. In fibre-reinforced plastic materials, the properties of the fibres are used to resist tensile and compressive loads, while the plastic – the matrix material – transfers shear.

When using composite materials instead of traditional materials such as steel, for example, there are normally significant reductions in weight due, in part, to the specific properties of the individual components and low dead weight, and partly because it is possible to produce composites for specific purposes. Because it is a combination of materials, a composite product can be combined and designed with a view to specific load-bearing capacities, while providing a number of advantages in relation to traditional materials, such as resistance to chemicals, as well as electrical and thermal insulating properties.

During recent decades, composite materials have steadily gained ground in nearly all sectors. The rise in use of composites can be explained by better and more comprehensive knowledge of the fundamental properties of composites and their long service life. This has enabled more specific uses and has reduced security factors to realistic levels.

Pultrusion

With the exception of high-technology industries such as space and aeronautics, producing composite materials has developed from production of low-technology products manufactured by hand, for example, to automated manufacturing of more advanced products.

Pultrusion is a process for continual production of composite profiles with constant cross sections and material properties which are manufactured for specific purposes. The method ensures consistent quality that can be reproduced. In principle, the process is simple and has been used since the 50s in its basic form.

At Fiberline Composites A/S, pultrusion is done by continual reinforced material being pulled through a guide where the fibres are placed precisely in relation to the profile cross section. The fibres are then led through processing equipment where the fibres are impregnated with the matrix material. The combined mixture of fibres and matrix is pulled on through the heated equipment where the profile is cured in its final geometry. The fully cured profile is then pulled forward to a floating suspended saw which cuts the profiles into defined lengths. (See Figure 1.)

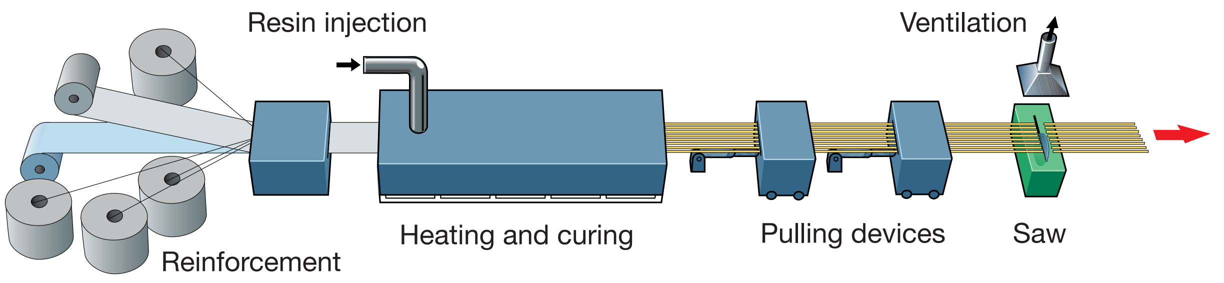


Fig. 1

The actual combination of reinforcement in a profile, in other words, the type and number of continuous fibres, as well as the type and dimensions of complex weaves and mats are arranged in a way that facilitates visual checking when the fibres and mats are positioned in a profile. Precise positioning of fibres and mats in relation to the cross section of a profile is very important to the properties and qualities of the finished product.

When the reinforcement is pulled into the processing equipment, the matrix is added by injection. Pultrusion by injection is advantageous in controlling and checking the reinforcement, it speeds changing from one profile to another, and eases matrix changes during a process. The degree of impregnation of the fibres is another decisive factor for the properties of the finished product, and the injection method used by Fiberline Composites A/S always ensures the best possible impregnation. The injection method is a fully enclosed process which keeps evaporation of solvents at a minimum. This ensures a good work environment in comparison with traditional pultrusion, in which reinforcement is led through an open vat containing the matrix.

After the fibres are impregnated with the injected matrix, the entire product moves forward to the next zone in the process where heating takes place and where curing of the profile is accelerated. The final curing takes place in the last section of the processing equipment. A profile is thus fully cured and stable in form when it leaves the processing equipment. The pulling power that overcomes friction in the processing equipment – and thus the driving force in the process – is provided by pullers placed outside the processing equipment. Pulling can be done by either belts or reciprocal pullers. During the last phase of the process, the profiles are shortened by a saw mounted to move at the same speed as the profile being pulled out of the equipment. This ensures a continual process.

Fig. 2: Fiberline pultrusion equipment

Fig. 3: Precise control of fibreglass reinforcement

A profile produced by pultrusion contains three primary components: reinforcement, matrix and additives.

Reinforcement

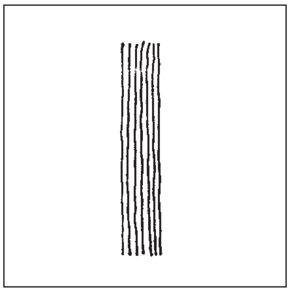
The role of reinforcement in composite materials is primarily to add mechanical properties to the material such as strength and stiffness. However, electrical properties also depend on the reinforcement, and the type of reinforcement is therefore of decisive importance for the properties of a profile. The most common types of reinforcement are fibreglass, carbon fibres and aramid fibres. Fibreglass adds good all-round properties to the material, while carbon fibres provide high stiffness. Aramid fibres enable profiles to withstand impact. Fibreglass-reinforced profiles provide electrical insulation and electromagnetic transparency, whereas carbon fibres result in electro-conductive profiles.

Finally, the orientation direction of reinforcement is of great importance for the properties of finished products in relation to load-bearing capacities.

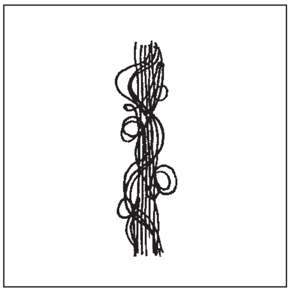
The profiles manufactured by Fiberline Composites A/S are a combination of various types of roving and different types of complex weaves and mats.

Structural profiles are often subjected to loads that are transverse to the length of the profile (i.e. transversal to the direction of pultrusion), and these profiles must often be capable of resisting pulling and similar stress caused by bolt removal, etc. Therefore, not only is smooth unidirectional roving used, but also roving with some of the fibres oriented transversely. In addition, mats and weaves with different fibre orientations are used. Mats and weaves with fibre orientations of between 45° and 90° contribute primarily to improving resistance to stress caused by removal of bolts and mechanical properties in the transverse direction. The combination of roving and mats can be designed according to the requirements made to the individual profile. The content of the reinforcement in Fiberline structural profiles is normally 60% according to weight. All structural profiles contain combinations of mats and weaves. Therefore, Fiberline structural profiles always comply with the mechanical properties which are stated in this Design Manual.

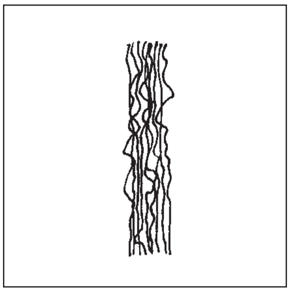
Types of roving



Unidirectional

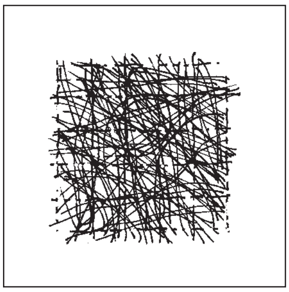


Spun

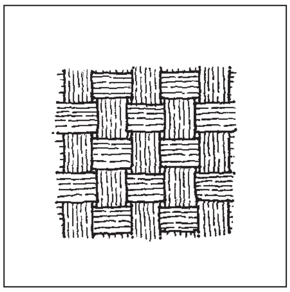


Mock

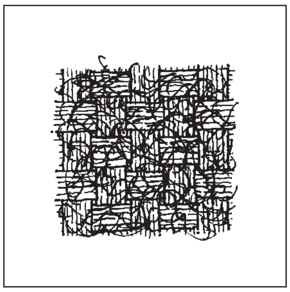
Types of mat



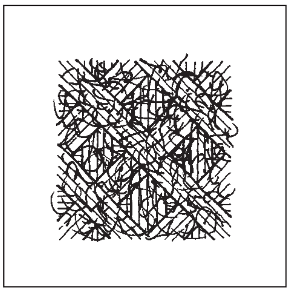
Continuous mat
Random fibre orientation



Weave
0°/90°



Complex mat
0°/90° membrane + random fibre orientation



Bidirectional complex mat
0°/±45°/90° weave + random fibre orientation

If a profile will be used in a corrosive environment, a so-called overlay veil is used which can be thin fibreglass matting, thin thermal plastic polyester matting, or acrylic matting which is placed on the entire profile surface to protect against corrosion of the glass fibres and ensuing deterioration in the mechanical properties of the profile.

The pultrusion process necessitates that a certain number of the fibres are oriented in the direction of pultrusion, but apart from this, reinforcement can be structured in innumerable ways, depending upon the load. It is therefore important to note that profiles which are not produced as structural profiles can have mechanical properties that are significantly different from the values which are stated in this book.

Matrix

The role of the matrix in a composite profile is partly to bind the reinforcement together, and partly to hold the reinforcement in place at the right points in relation to the cross section for optimal utilization of the mechanical properties. The type of matrix also determines properties such as corrosion resistance, electrical insulation properties, and fire and temperature resistance. The following three types of matrix are fundamentally well suited to the pultrusion process: polyester, epoxy and phenol.

Polyester
Polyester is the most frequently used matrix, as it gives a composite good all-round properties.

Unsaturated polyester can be divided into three main groups: orthopolyester, isopolyester and vinylester. In relation to orthopolyester, isopolyester increases impact resistance, provides greater flexibility, and increases resistance to temperatures. It also increases corrosion resistance.

Vinyl ester has even better corrosion-resistant and thermal properties. Since vinyl ester has greater elongation properties than ortho- and isopolyester, it also provides a composite with better impact resistance and improved fatigue properties.

Epoxy
Epoxy is used primarily for carbon-reinforced profiles, giving composites better fatigue and mechanical properties. Epoxy is more resistant to thermal influences and has better electrical properties.

Phenol
Phenol is used when there are requirements for high fire resistance, temperature resistance, low smoke generation, and flame retardation when subjected to fire.

British petroleum platform: there are Fiberline railing systems on all three decks, and ladders and gratings in phenol quality to enhance fire safety.

Additives

Additives are a common name for agents which are added to the matrix. Depending upon their purpose, additives can be divided into three fundamental groups: price-reducing additives, process-related additives and function-related additives. While the purpose can vary, additives will always influence the corrosion resistance of profiles, as well as their mechanical and fire properties.

*Price-reducing additives**

The only function of price-reducing additives is to fill out the form of a profile, and adding such additives enables reduction of more expensive reinforcement and matrix materials. It is thus possible to reduce the price of the finished profiles accordingly. Profiles have significantly poorer mechanical properties when the amount of reinforcement is reduced. Moreover, most types of price-reducing additives also result in lower corrosion resistance and lower resistance to most chemicals.

None of the Fiberline structural profiles described in this book contain price-reducing additives.

*Are often referred to as fillers.

Process-related additives

Process-related additives are substances with advantageous effects on the pultrusion process, and on the properties and appearance of a cured profile. An example of this is a so-called low-profile additive which is used to avoid excessive shrinkage during curing of profiles. The additive prevents formation of hair-line cracks in surfaces, while improving profile resistance to corrosion, as well as improving fatigue properties. It also gives profiles more exact geometric tolerances and lower internal stress.

Function-related additives

Function-related additives have an advantageous effect in relation to the use of a finished profile. An example of this is the adding of pigments. Fire retardants are another example. The latter are added to obtain self-extinguishing properties and to retard flame spread.

Of course, function-related additives can also be added in amounts so large that they degrade the mechanical properties of a profile.

All the profiles which are presented in the Design Manual have been tested with the relevant content of process- and function-related additives.

See also the Fiberline Quality Codex on pages 0.10-0.11

Fiberline Quality Codex

Fiberline structural profiles are manufactured according to the guidelines stated below, which ensure good quality for most purposes.

1. Matrix

A low-profile quality of either isophthalic polyester or vinyl ester with overlay veil.

„Low-profile" quality provides:
- profiles with smooth, even surfaces
- exact measurements and dimensional stability
- stress-free material with no cracks or shrinkage
- increased strength against fatigue and impact.

Isophthalic polyester provides
- improved mechanical properties
- increased heat resistance
- improved resistance to corrosion and chemicals in comparison with cheaper orthopolyesters.

Vinyl ester
is used in extremely corrosive environments, and also in environments with extreme mechanical influences.

Overlay veil
is used for optimal weather and corrosion resistance.

Price-reducing additives
are not used, because additives which replace reinforced fibreglass reduce the strength of profiles. Price-reducing additives also increase water absorption and reduce resistance to corrosion and weather.

The Fiberline matrix qualities listed below form the bases for the Design Manual.

P2600 Isophthalic polyester (standard low profile)
P3510 Vinyl ester (high temperature resistance, low profile)
P4506 Isophthalic polyester (fire retardant, low-profile)

It is also possible to produce profiles in other matrix materials with special properties. However, this subject is outside the range of this manual.

2. Reinforcement

Fiberline profiles are reinforced with E-glass roving with woven and complex mattings.

In comparison with profiles which are only reinforced with longitudinal roving and continual matting, the complex reinforcement of Fiberline profiles provides
- increased transverse strength
- increased shear strength
- increased bolt removal strength / pin-bearing strength
- improved resistance to long-term creep.

3. Mechanical properties

Fiberline structural profiles fulfil the requirements made to profiles which are classified as E23 in accordance with EN 13 706.

4. Glass content

Glass content: approximately 60% (weight)

5. Fibre distribution

The fibres are evenly distributed across the cross section of a profile to ensure uniform strength.

For more detailed material properties, see Chapter 1: Construction calculation.

Reservations

The Fiberline Design Manual is the result of close cooperation with leading research institutes and engineering companies, and of laboratory tests which, in some cases, have been full-scale tests.

The values and references listed are stated to the best knowledge available to Fiberline. Fiberline cannot be held responsible for possible errors and/or omissions in this manual.

Please note that the data and references contained in this manual may be changed at any time without previous notice.

As profiles in composite materials can be manufactured in infinitely many variations and qualities, two profiles with identical geometries do not necessarily have the same properties. The Fiberline Design Manual can therefore only be used for the Fiberline qualities stated.

Recommendation 1

Point loading of profiles, for example, I-, U-, and L- profiles, as well as square tubes.

The types of loads shown in Figure 1 are not appropriate for composite materials and should be avoided, unless they have been proven by analysis.

Therefore, Fiberline recommends the use of a washer diameter of 2.5 · d

This is valid for completed structures as well as for handling and mounting.

Figure 1 illustrates point load with bolts, but is also valid for other types of point load.

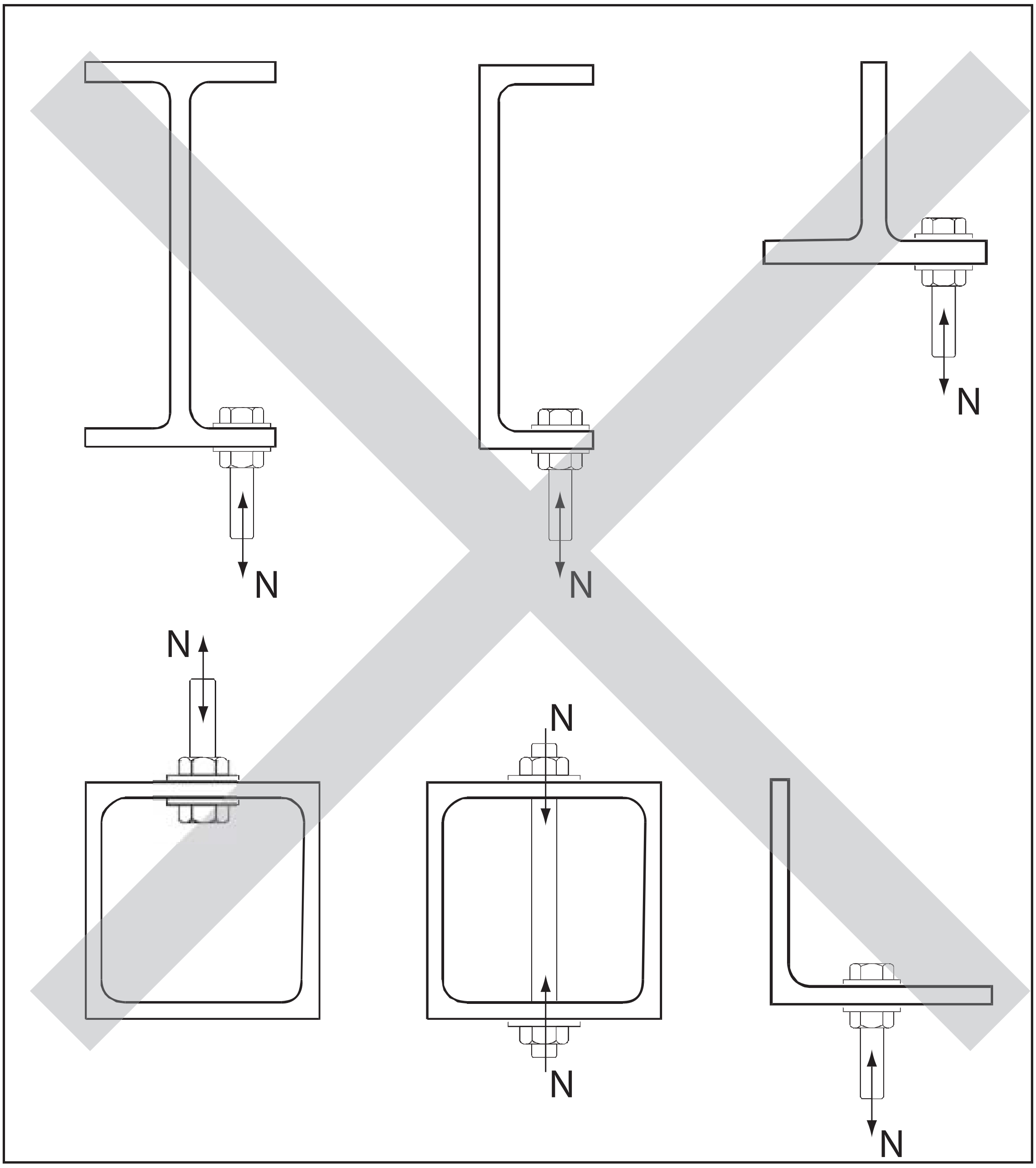


Fig. 1

Recommendation 2

Permanently loaded structures

In cases of permanent load, Fiberline profiles should not be used to more than a maximum of 1/3 of the ultimate limit state load, to minimize the risk of stress corrosion.

CHAPTER 1 CONSTRUCTION CALCULATIONS

CHAPTER 1

Section 1: Introduction

Guidelines

Contents

This section deals with fibreglass-reinforced polyester and vinylester structural profiles in qualities P2600, P3510 and P4506. Fiberline Composites A/S can also supply other qualities.

The section on calculation contains information on profiles and materials, and describes the theoretical basis for static calculations. A method is described for designing columns, transversely loaded columns, transversely loaded beams across one, two or three sections, and bolted joints.

The section on dimensioning is supplemented by examples in which a column, a beam, and a number of joints are illustrated and designed. There is a data page for each profile. The front of the page describes the geometry and load-bearing capacity of the profile as a tension/compression rod, while the back of the page describes the profile as a transversely loaded beam across one, two and three spans. Parts of beams which are subjected to compression must be secured, so there is no risk of lateral buckling. All calculations of columns and beams are designed in accordance with the methods indicated in the Design Manual. The Design Manual is in accordance with the guidelines laid down by the EUROCOMP Design Code.

Load-bearing capacities for the conditions stated below are listed on the data page for each profile.

Ultimate limit state

Security against failure due to overload or lacking stability is assessed by partial coefficients being assigned to loads and strengths, respectively.

Serviceability limit state

The behaviour of a structure during operation is assessed.

Deformation point

A beam structure is typically dimensioned so maximum deflection is 1/400 to 1/200 of the span of the beam. The most probable active load will normally be a combination of a permanent load and the part of the variable load which will probably exist at all times.

Aggressive environments

In cases of aggressive environments, it must also be determined whether the materials used in a construction have the properties which prevent unacceptably rapid corrosion. Please refer to the summary on page 5.1.04. In case of doubt, Fiberline technicians can assist in an assessment.

Accident limits

For use in cases in which the behaviour of a structure in inadvertent circumstances such as fire and explosions can be approximated on the basis of breaking point and application limit indicators.

The limits are described in Section 2, in which relevant material properties are also listed.

Symbols and indeces

Symbols

A	area
a	distance from bolt to laminate edge in direction of force
b	width
c	distance from bolt to laminate edge perpendicular to direction of force
d	diameter
E	modulus of elasticity
e	eccentricity, centre of gravity distance
F	force
f	strength
G	modulus in shear, permanent load
g	dead weight per unit length or unit area
H	height
I	moment of inertia
k	coefficient
L	length, width of span
M	moment
N	normal force
P	force (in bolt)
p	load per unit length
q	variable load per unit length
Q	variable load
r	radius
T	thickness
t	thickness
v	angle
V	shear force
W	section modulus
γ	partial coefficient
δ	deformation, deflection
λ	relative slenderness ratio
ν	Poisson's ratio
σ	normal stress
τ	shear stress

Indexes

0°	direction corresponding to the pulling direction during the pultrusion process (longitudinal direction)
90°	direction perpendicular to the pulling direction during the pultrusion process (transverse direction)
b	bending
c	compression
cr	critical
d	design value
el	theoretical elasticity
k	characteristic buckling length
r	relative
t	tension
v	shear, angle
τ	shear

CHAPTER 1

Section 2: Coefficients

Values and definitions

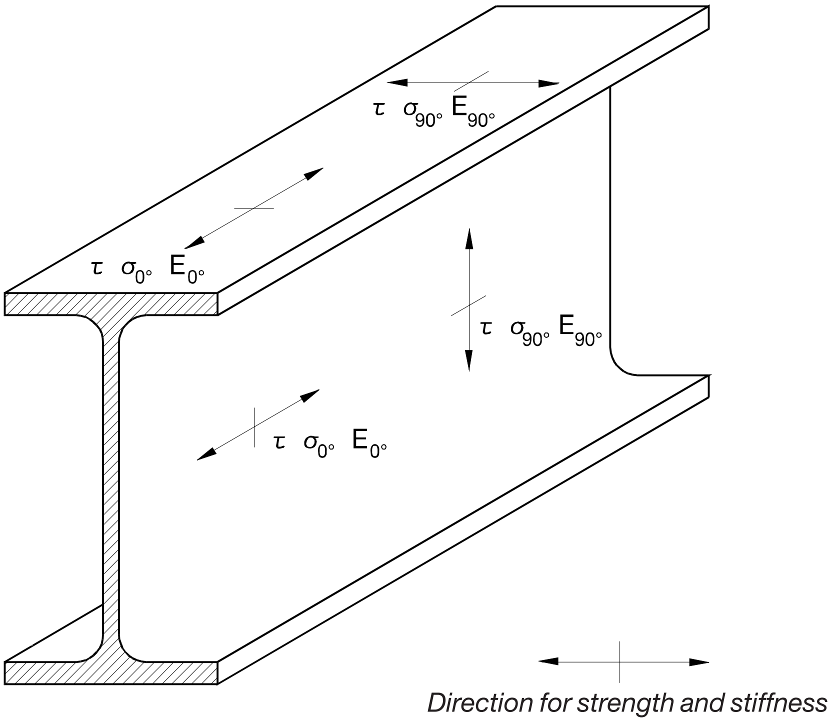


Figure 2.1 Indication of direction for strength and stiffness

Definition of direction

Figure 2.1 shows the main directions for the material constants stated. 0° indicates the longitudinal direction of the profile. This is also the pulling direction during the pultrusion process, as well as the direction normally used for deflecting beams or columns. The direction which is transverse to the longitudinal direction of the profile is indicated as 90°. The material constants for this direction are used primarily for joints.

The only material constants stated as independent of direction are shear strength and modulus in shear. These are theoretically dependent on direction, but the differences are marginal in practice, and the lowest value measured is therefore used.

All values indicated are based on measurements carried out in the laboratories of Fiberline Composites A/S, or by independent test institutions. All measurements have been carried out in accordance with the standards indicated.

For direction indicators, please see Figure 2.1.

Tables 2.5 to 2.11 present all significant geometric data, E-modulus, $E_{0°} \cdot I_{xx}$, as well as the theoretical mass-per-metre profiles of the various cross-section diagrams of profiles contained in the profile tables.

Static calculations

Static calculations for supporting structures in composites or pultruded profiles are normally based on nationally or internationally recognized regulations and standards.

The static calculations contained in this version of the Fiberline Design Manual are in accordance with the EUROCOMP Design Code, the calculation methods and safety philosophy of which are in accordance with Eurocode 1, section 1, *Bases for projecting and stress on supporting structures*. The comprehensive stress indicators contained in this code have now been released within the Eurocode system, and can be used in connection with the Fiberline Design Manual.

As yet, actual structural standards for composites have not been adopted by the Eurocode system. Until a Eurocode and possible National Application Documents become available, the EUROCOMP Design Code is the basis for the Fiberline Design Manual.

Deformation limits

Static calculations of a composite structure are an assessment of the behaviour of the structure within a number of deformation limits. These deformation limits are determined by official regulations etc., or by builders' requirements based on the use of a structure, for example, minimum requirements for rigidity to support a machine.

On page 1.2.11, there is a list of the loads which are normally taken into consideration in designing a supporting structure.

Ultimate limit stress
This assesses certainty against failure due to overload or lack of stability by assigning partial coefficients to loads and strengths.

The effect of external influences, usually expressed as calculated stress $S_{d,}$ must be less than the resistance capability R_d.

For each statistically independent load, the S_d effect is determined at relevant test points in the structure on the basis of permanent and variable factors.

For systems with one variable factor, the effect is determined by

$$S_{d,k} = \Sigma_{j=1,\dots,m} \gamma_{G,j} \cdot G_{k,j} + 1.50 \cdot Q_k$$

as

$G_{k,j}$: permanently active factor (from permanently active load no. j at test point no. k)

Q_k : variable active factor (at test point no. k)

$\gamma_{G,j}$: partial coefficient of permanent load (no. j)

The value of $\gamma_{G,j}$ is 1.35. However, the value of $\gamma_{G,j}$ is 1.0 in cases in which the permanent load benefits stability.

For systems with several variable factors, the effect of each of these factors is determined solely by

$$S_{d,k,i} = \Sigma_{j=1,\dots,m} \gamma_{G,j} \cdot G_{k,j} + 1.50 \cdot Q_{k,i}$$

as

$G_{k,j}$: permanently active factor (from permanently active load no. j at test point no. k)

$Q_{k,i}$: variably active factor (no. i at test point no. k)

$\gamma_{G,j}$: partial coefficient of permanent load (no. j)

The value of $\gamma_{G,j}$ is 1.35. However, the value of $\gamma_{G,j}$ is 1.0 in cases in which the permanent load benefits stability.

In other cases, the combined load is assessed as

$$S_{d,k} = \Sigma_{j=1,\dots,m} \gamma_{G,j} \cdot G_{k,j} + 1.35 \cdot \Sigma_{i=1,\dots,n} Q_{k,i}$$

The highest value of the S_d factor for load combinations considered here is indicated as the calculated effect. This must be less than the calculated resistance which is determined by testing or calculating the established average supporting capacity R as expressed in

$$R_d = \frac{R_k}{\gamma_m}$$

$$\frac{R_k}{\gamma_m} = \frac{R_k}{\gamma_{m,1} \cdot \gamma_{m,2} \cdot \gamma_{m,3} \cdot \gamma_{m,4}}$$

in which the partial coefficients $\gamma_{m,1}$, $\gamma_{m,2}$, $\gamma_{m,3}$ and $\gamma_{m,4}$ each describe the following effect,

$\gamma_{m,1}$: the production method

$\gamma_{m,2}$: the degree of postcuring

$\gamma_{m,3}$: the certainty of dimensional stability, the difference between operating temperature and HDT (Heat Distortion Temperature)

$\gamma_{m,4}$: operating temperature

The partial coefficients $\gamma_{m,1}$, $\gamma_{m,2}$ and $\gamma_{m,3}$ have been determined in accordance with the EUROCOMP Design Code.

$\gamma_{m,1}$ = 1.15 Fiberline profiles are pultruded (EUROCOMP, Table 2.4)

$\gamma_{m,2}$ = 1.1 Fiberline profiles are fully postcured at works (EUROCOMP, Table 2.5)

$\gamma_{m,3}$ = 1.0 Fiberline profiles have an HDT ultimate temperature for dimensional stability of 100°C (EUROCOMP, Table 2.6)

The partial coefficient $\gamma_{m,4}$ describes the strength and stiffness of the pultruded profile dependent on the operating temperature. Fiberline recommends that $\gamma_{m,4}$ be established as indicated in Table 2.0

Operating temperature (°C) dry condition	$\gamma_{m.4}$	
	Short-term load	Long-term load
-20	1.0	2.5
0	1.0	2.5
20	1.0	2.5
40	1.0	2.5
60	1.0	2.5
80	1.25	3.13

Table 2.0

For values not listed in the table, $\gamma_{m,4}$ can be established by interpolation.

The load time for a long-term load is measured in years.

The total partial coefficient γ_m of material resistance is shown in the table below.

For values not listed in the table, γ_m can be established by interpolation.

The dimensions of a composite structure will often be determined by assessment of operating conditions. If an ensuing failure of the structure can be regarded as being very significant or as being very insignificant, the designer can assess whether the indicators listed below should be made more stringent or if they should be relaxed.

Operating temperature (°C) dry condition	$\gamma_m = \gamma_{m.1}\,\gamma_{m..2}\,\gamma_{m..3}\,\gamma_{m.4}$	
	Short-tem load	Long-term load
-20	1.3	3.2
60 (80)	1.3	3.2
80 (100)	1.6	4.0

Table 2.0b The values in parentheses are for profiles in vinylester.

Deformation limits in use

This is an assessment of the behaviour of a structure in operation, in particular its deformations. Typically, a beam structure is dimensioned so the maximum deflection is between 1/400 and 1/200 of the span of the beam.

At relevant test points, the effect - which in these analyses is usually a deformation - is compared with an acceptable deformation limit.

In determining these factors, consideration can be taken to the fact that all variable loads do not necessarily occur simultaneously.

Section 2.3.4 of the EUROCOMP Design Code suggests use of the formulas listed below in testing deformation limits of structures in operation.

When all permanent loads and not more than one variable load are active

$$R_{k,i} \geq S_{k,i}$$

$$S_{k,i} = \Sigma_{j=1, \ldots, m}\ G_{k,j} + Q_{k,i}$$

For the simultaneity factor stated in EUROCOMP as 0.9, Section 1 of Eurocode states values which open possibilities for more realistic establishment of the simultaneous influence of various types of loads. An engineer's assessment will often also justify the reduction of the simultaneity factor to a value lower than 0.9.

$$R_{k,i} \geq S_{k,i}$$

$$S_k = \Sigma_{j=1, \ldots, m}\ G_{k,j} + 0{,}90 \cdot \Sigma_{i=1,\ldots,n}\ Q_{k,i}$$

Fire load

In a calculated assessment of the resistance capability of a supporting structure subjected to fire, it is assumed that the structure will be affected by the most likely type of load.

Temperature sequences can be established in accordance with Eurocode 1, Section 2-2 (DS/ENV 1991-2-2).

Deformation limits in accidents

The behaviour of a structure in inadvertent circumstances such as a fire, impact or explosion, can be assessed on the basis of the indicators for deformation limits and deformation limits in use.

Typical values are normally used for these deformation limits, i.e., values which are as realistic as possible.

In principle, calculations follow investigations of deformation limits, since all partial coefficients have been assigned the value 1.0. Variable loads have been assigned sizes corresponding to the most likely load.

Material properties

The material values stated in this section are valid in the temperature range of -20° C to 60° C.

For temperatures above 60° C, strength and stiffness must be reduced as stated on page 1.2.6 by division by the value $\gamma_{m,4}$.

Typical strength values (dry condition)		
		[MPa]
Flexural strength, 0°	$f_{b,0°}$	240
Flexural strength, 90°	$f_{b,90°}$	100
Tensile strength, 0°	$f_{t,0°}$	240
Tensile strength, 90°	$f_{t,90°}$	50
Compressive strength, 0°	$f_{c,0°}$	240
Comprehensive strength, 90°	$f_{c,90°}$	70
Shear strength	f_{τ}	25
Pin-bearing strength, longitudinal direction	$f_{cB,0°}$	150
Pin-bearing strength, transverse direction	$f_{cB,90°}$	70

Table 2.1

This table is based on test results. The values listed can form the basis for calculation of the details of joints and local factors on profiles. Moreover, general beam and/or column calculations can be based on these values for calculating stability and possible long-term effects, among other things.

In many cases, assessment of beam structures can be based on simplified calculations which use an assumed strength formula in the longitudinal direction (0°). In this type of calculation, tests of the local stability of flanges and creep phenomena in Fiberline profiles can be omitted. Simplified beam calculations are described on page 1.2.10.

Typical stiffness figures and transverse contraction (dry condition)			
		[MPa]	[--]
Modulus of elasticity	$E_{0°}$	23 000 / 28 000	
Modulus of elasticity	$E_{90°}$	8 500	
Modulus in shear	G	3 000	
Poisson's ratio	$\nu_{0°,90°}$		0.23
Poisson's ratio	$\nu_{90°,0°}$		0.09

Table 2.2

The E-modulus of the profiles varies from 23 to 28 GPa, depending on the geometry and reinforcement. See the relevant values in the section on the load-bearing capacities of the individual profiles.

Strength values for use in calculations			
		Short-term value [MPa]	Long-term value [MPa]
Flexural strength, 0°	$f_{b,\ 0°,d}$	185	75
Flexural strength, 90°	$f_{b,\ 90°,d}$	75	30
Tensile strength, 0°	$f_{t,\ 0°,d}$	185	75
Tensile strength, 90°	$f_{t,\ 90°,d}$	40	30
Compressive strength, 0°	$f_{c,\ 0°,d}$	185	75
Compressive strength, 90°	$f_{c,\ 90°.d}$	75	30
Shear strength	$f_{\tau,d}$	20	8

Table 2.3

The values listed above correspond to the figures in Table 2.1 divided by γ_m = 1,3. See the section below regarding simplified beam calculations. The load time for a long-term load is measured in years.

Simplified calculation of beam structures

If deflection stress is kept under the deformation limits listed below, calculation of beam structures with Fiberline profiles can be simplified when tests of long-term effects and assessment of local stability can be omitted.

Calculated deformation limit for tension when tests of long-term effects and assessment of local stability of flanges can be omitted		
		[MPa]
Flexural strength, 0°	$f_{b,0°,d}$	75

Table 2.4

If beams are dimensioned according to current deformation limits, calculations of ultimate limit states will only rarely be the governing design criteria.

Loads

Contribution from permanent load at test point p

$G_{1,p}$ (with stabilizing effect at point p)

$G_{2,p}$ (with destabilizing effect at point p)

Contribution from statistically independent variable loads at test point p

$Q_{1,p}$ (usual value for load intensity in load combination in deformation limit is $\psi_{L,1} \cdot Q_{1,p}$)

$Q_{2,p}$ (usual value for load intensity in load combination in deformation limit is $\psi_{L,2} \cdot Q_{2,p}$)

$Q_{3,p}$ (usual value for load intensity in load combination in deformation limit is $\psi_{L,3} \cdot Q_{3,p}$)

Normal load combinations

Ultimate limit state

Generally $S^{B1}_{d,p} \leq R_{d,p}$ where $R_{d,p} = R_{k,p} / \gamma_m$

thus:

B1,1 $S^{B1,1}_{d,p} = 1.0 \cdot G_{1,p} + 1.35 \cdot G_{2,p} + 1.50 \cdot Q_{1,p}$

B1,2 $S^{B1,2}_{d,p} = 1.0 \cdot G_{1,p} + 1.35 \cdot G_{2,p} + 1.50 \cdot Q_{2,p}$

B1,3 $S^{B1,3}_{d,p} = 1.0 \cdot G_{1,p} + 1.35 \cdot G_{2,p} + 1.50 \cdot Q_{3,p}$

B2 $S^{B2}_{d,p} = 1.0 \cdot G_{1,p} + 1.35 \cdot G_{2,p} + 1.35 \cdot Q_{1,p} + 1.35 \cdot Q_{2,p} + 1.35 \cdot Q_{3,p}$

in which $R_{d,p}$ is the calculated resistance capability, typically the deformation limit for tension or breaking force at the test point p. $R_{d,p}$ is determined as a strength value in the characteristic condition $R_{k,p}$ divided by the partial coefficient γ_m.

Calculations are in accordance with the material strengths listed in Table 2.1. For beam constructions, it is possible to perform simplified calculations based on a formula calculation strength which is listed in Table 2.4.

Serviceability limits

Deformation limits

General deformation levels

$$S^{A1}_{d,p} \leq R_{A1,p}$$

$$\text{A1} \quad S^{A1}_{d,p} = G_{1,p} + G_{2,p} + \psi_{L,1} \cdot Q_{1,p} + \psi_{L,2} \cdot Q_{2,p} + \psi_{L,3} \cdot Q_{3,p}$$

in which $R_{A1,p}$ is the acceptable resistance capability in operation – typically deformation / deflection at test point p. It is not necessary to add a partial coefficient to $R_{A1,p}$. Load $S^{A1}_{d,p}$ corresponds to the most likely load introduced above. When a more accurate value of the factor ψ is not available, use of the value 0.9 is suggested.

Maximum deformation level

$$S^{A2,1}_{K,p} \leq R_{A2,p}$$

$$S^{A2,2}_{K,p} \leq R_{A2,p}$$

$$S^{A2,3}_{K,p} \leq R_{A2,p}$$

$$\text{A2,1} \quad S^{A2,1}_{K,p} = G_{p,1} + G_{p,2} + 1.00 \cdot Q_{p,1} + \psi_{L,2} \cdot Q_{p,2} + \psi_{L,3} \cdot Q_{p,3}$$

$$\text{A2,2} \quad S^{A2,2}_{K,p} = G_{p,1} + G_{p,2} + \psi_{L,1} \cdot Q_{p,1} + 1,00 \cdot Q_{p,2} + \psi_{L,3} \cdot Q_{p,3}$$

$$\text{A2,3} \quad S^{A2,3}_{K,p} = G_{p,1} + G_{p,2} + \psi_{L,1} \cdot Q_{kp,1} + \psi_{L,2} \cdot Q_{p,2} + 1,00 \cdot Q_{p,3}$$

in which $R_{A2,p}$ is the acceptable resistance capability in operation – typically a deformation / deflection in the short-term condition at test point p. When a more accurate value of factor ψ is not available, use of the value 0.9 is suggested.

$R_{A2,p}$ is for a beam with a deflection limit often selected as a certain fraction of the span – typically between 1/200 and 1/400 – or based on a requirement that there must be a minimum clearance between construction elements during operation. It is not necessary to add a partial coefficient to $R_{A2,p}$ or material parameters (E and G).

Deformation limits in fire

Analysis of fire situations normally includes evaluation of the behaviour of the structure when subjected to a standardized fire load, for example as stated in Eurocode 1 (DS/ENV 1991-2-2).

The load on the structure is determined as the load most likely to occur. It is not necessary to add a partial coefficient to the strength values of the material.

Deformation limits in accidents

Estimation of deformation limits in accidents obviously depends upon the specific structure. The load is determined as the load most likely to occur. Normally, it is not necessary to add a partial coefficient to the strength values of the material.

Profiles

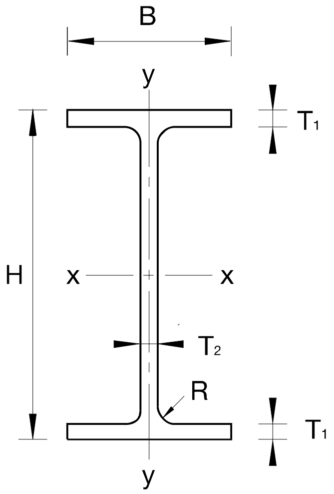


Table 2.5: I-profiles

I-profile	H	B	T_1	T_2	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	$E_{0°}$	$E_{0°}\cdot I_{xx}$
HxBxT 1)	mm	mm	mm	mm	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	MPa	Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	10^3	10^9
I 120x60x6	120	60	6	6	7.5	1.42	0.68	0.58	2.55	3.10	51.7	0.22	7.30	23	71.30
I 160x80x8	160	80	8	8	8	2.49	1.22	1.02	4.48	9.66	121	0.69	17.3	28	270.5
I 200x100x10	200	100	10	10	10	3.89	1.90	1.60	6.99	23.6	236	1.69	33.7	28	660.8
I 240x120x12	240	120	12	12	12	5.60	2.74	2.30	10.1	48.9	408	3.50	58.3	28	1369
I 300x150x15	300	150	15	15	15	8.74	4.28	3.60	15.7	119	796	8.54	114	28	3332
I 360x180x18	360	180	18	18	18	12.6	6.16	5.18	22.7	248	1376	17.7	197	28	6944

Table values must be multiplied by the factors listed at the top of the table. (1) $T = T_1 = T_2$)

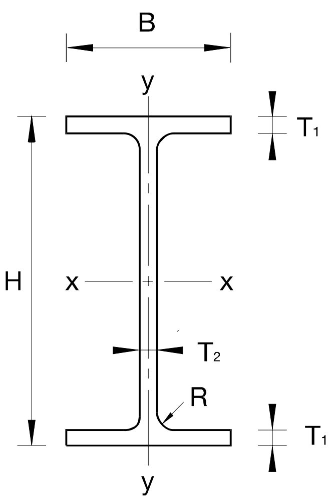


Table 2.6: IL-profiles

IL-profile	H	B	T_1	T_2	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	$E_{0°}$	$E_{0°} \cdot I_{xx}$
$HxBxT_1$ / T_2	mm	mm	mm	mm	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	MPa	Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	10^3	10^9
IL 120x60x5/5	120	60	5	5	5,0	1.17	0.570	0.480	2.11	2.60	43.36	0.181	6.05	23	59.80
IL 160x80x8/5	160	80	8	5	8,0	2,05	0.760	1.024	3.70	8.76	109.5	0.685	17.1	28	245.3
IL 200x100x8/5	200	100	8	5	8,0	2,57	0.950	1.280	4.63	17.4	174.4	1.336	26.7	28	487.2
IL 240x120x10/7	240	120	10	7	10,0	4,03	1.596	1.920	7.25	38.1	317.8	2.888	48.1	28	1067
IL 300x150x12/8	300	150	12	8	12,0	5,93	2.280	2.880	10.7	90.2	606.5	6.768	90.2	28	2526
IL 360x180x15/10	360	180	15	10	15,0	8,89	3.420	4.320	16.0	195.8	1088	14.62	162	28	5482

Table values must be multiplied by the factors listed at the top of the table.

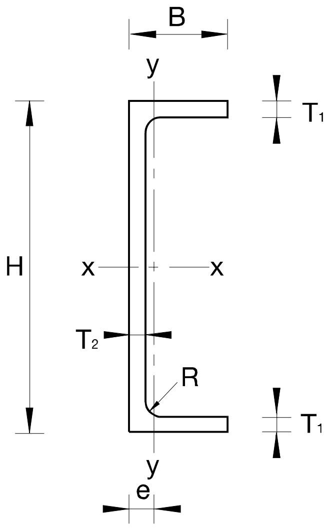


Table 2.7: U-profiles

U-profile	H	B	T_1	T_2	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	e	$E_{0°}$	$E_{0°}\cdot I_{xx}$
HxBxT[1)]	mm	mm	mm	mm	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	mm	MPa	Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	1	10^3	10^9
U 120x50x6	120	50	6	6	7.5	1.27	0.648	0.510	2.29	2.65	44.1	0.279	7.63	13.5	23	60.95
U 140x40x5	140	40	5	5	5	1.06	0.630	0.340	1.91	2.78	39.8	0.131	4.23	9.1	23	63.94
U 160x48x8	160	48	8	8	8	1.95	1.15	0.653	3.51	6.57	82.1	0.338	9.38	12.0	28	184.0
U 200x60x10	200	60	10	10	10	3.04	1.80	1.02	5.48	16.0	160	0.825	18.3	15.0	28	448.0
U 240x72x8	240	72	8	8	8	2.97	1.73	0.98	5.35	23.3	194	1.23	22.1	16.5	28	652.4
U 240x72x12	240	72	12	12	12	4.38	2.59	1.47	7.89	33.2	277	1.71	31.7	18.0	28	929.6
U 300x90x15	300	90	15	15	15	6.85	4.05	2.30	12.3	81.2	541	4.18	61.9	22.4	28	2274
U 360x108x18	360	108	18	18	18	9.86	5.83	3.31	17.8	168	935	8.67	107	26.9	28	4704

Table values must be multiplied by the factors listed at the top of the table. ([1)] $T = T_1 = T_2$)

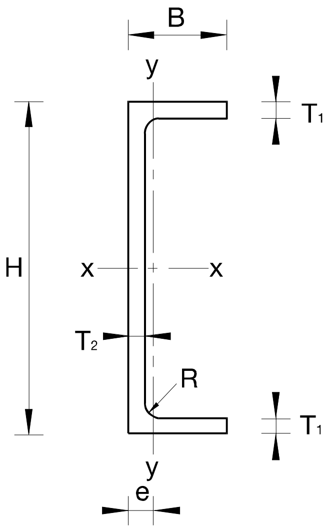


Table 2.8: UL-profiles

UL -profile	H	B	T_1	T_2	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	e	$E_{0°}$	$E_{0°} \cdot I_{xx}$
$HxBxT_1$ / T_2	mm	mm	mm	mm	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	mm	MPa	Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	1	10^3	10^9
UL 120x50x5/5	120	50	5	5	5.0	1.06	0.540	0.425	1.91	2.239	37.33	0.238	6.469	13.1	23	51.52
UL 160x48x8/5	160	48	8	5	8.0	1.40	0.720	0.653	2.52	5.664	70.80	0.299	8.934	14.6	28	158.6
UL 200x60x8/5	200	60	8	5	8.0	1.75	0.900	0.816	3.16	11.32	113.2	0.603	14.29	17.8	28	317.0
UL 240x72x10/7	240	72	10	7	10.0	2.77	1.512	1.224	5.40	24.93	207.7	1.316	25.69	20.8	28	698.0
UL 300x90x12/8	300	90	12	8	12	4.43	2.160	1.836	7.97	59.96	399.8	3.317	50.32	24.1	28	1679
UL360x108x15/10	360	108	15	10	15.0	6.64	3.240	2.754	11.9	128.9	716.3	7.127	90.27	29.0	28	3610

Table values must be multiplied by the factors listed at the top of the table.

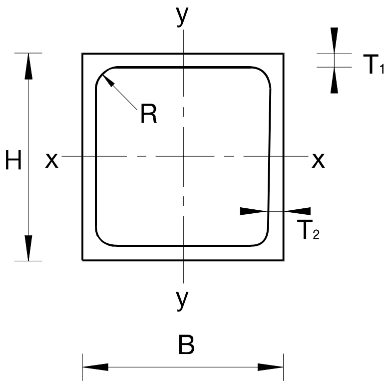


Table 2.9: Square tubes

Profile	H	B	T_1	T_2	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	$E_{0°}$	$E_{0°} \cdot I_{xx}$
HxBxT 1)	mm	mm	mm	mm	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	MPa	Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	10^3	10^9
50x50x5	50	50	5	5	2	0.90	0.45	0.45	1.63	0.31	12.4	0.31	12.4	23	7.130
60x60x5	60	60	5	5	4	1.11	0.54	0.54	2.00	0.57	18.9	0.57	18.9	23	13.11
80x60x5	80	60	5	5	4	1.31	0.72	0.54	2.36	1.15	28.7	0.72	24.0	23	26.45
100x60x8	80	60	8	8	4	2.32	1.44	0.86	4.18	2.85	57.0	1.21	40.3	23	65.55
100x100x6	100	100	6	6	4	2.27	1.08	1.08	4.09	3.36	67.2	3.36	67.2	23	77.28
100x100x8	100	100	8	8	4	2.96	1.44	1.44	5.32	4.21	84.2	4.21	84.2	23	96.83
120x120x6	120	120	6	6	4	2.75	1.30	1.30	4.95	5.98	99.7	5.98	99.7	23	137.5
120x120x8	120	120	8	8	4	3.60	1.73	1.73	6.48	7.57	126	7.57	126	23	174.1
160x160x8	160	160	8	8	8	4.92	2.30	2.30	8.85	19.1	238	19.1	238	23	437.0
200x200x10	200	200	10	10	10	7.69	3.60	3.60	13.84	46.5	465	46.5	465	23	1070
240x240x12	240	240	12	12	12	11.1	5.18	5.18	20.0	96.5	804	96.5	804	23	2217

Table values must be multiplied by the factors listed at the top of the table.

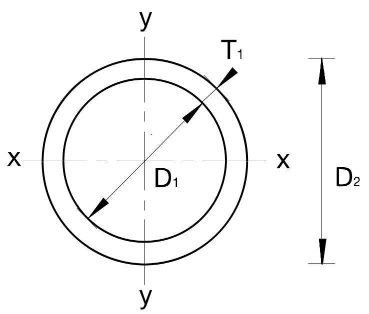


Table 2.10: Tubes

Profile	D_1	D_2	T_1	A	A_k	g	I	W	$E_{0°}$	$E_{0°} \cdot I$
D_u / D_i	mm	mm	mm	mm^2	mm^2	kg/m	mm^4	mm^3	MPa	Nmm^2
factor	1	1	1	10^3	10^3	1	10^6	10^3	10^3	10^9
Ø 75 / 65	65	75	5	1.10	0.550	1.98	0.68	18.1	23	15.64
Ø 90 / 80	80	90	5	1.34	0.668	2.40	1.21	26.9	23	27.83

Table values must be multiplied by the factors listed at the top of the table.

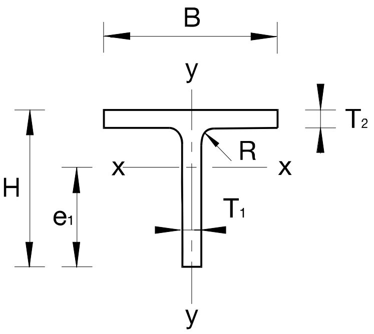


Table 2.11: T-profiles

T-profile	H	B	T_1	T_2	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	e_1	$E_{0°}$	$E_{0°} \cdot I_{xx}$
$HxBxT_1xT_2$	mm	mm	mm	mm	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	mm	MPa	Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	1	10^3	10^9
T 60x60x6x6	60	60	6	6	7	0.70	0.342	0.288	1.27	0.23	5.46	0.109	3.65	43.1	23	5.290
T 90x72x11x10	90	72	11	10	7	1.62	0.941	0.576	2.92	1.28	21.2	0.321	8.92	60.5	23	29.44

Table values must be multiplied by the factors listed at the top of the table.

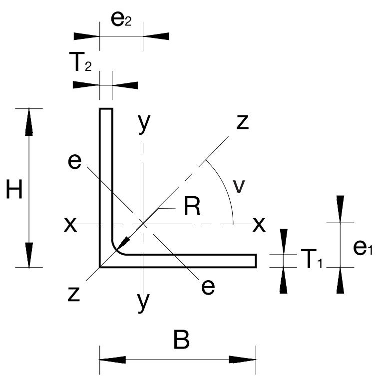


Table 2.12: Angle profiles

L-profile	R	A	$A_{k,y}$	$A_{k,x}$	g	I_{xx}	W_{xx}	I_{yy}	W_{yy}	I_{zz}	I_{ee}	e_1	e_2	v	$E_{0°}$	$E_{0°} \cdot I_{xx}$
HxBxT[1)]	mm	mm^2	mm^2	mm^2	kg/m	mm^4	mm^3	mm^4	mm^3	mm^4	mm^4	mm	mm	Grd.	MPa	Nmm^2
factor	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	10^6	10^6	1	1	1	10^3	10^9
L 50x50x6	7	0.57	0.27	0.27	1.03	0.13	3.72	0.13	3.72	0.21	0.057	14.6	14.6	-450	23	2.990
L 50x50x8	7	0.75	0.36	0.36	1.34	0.17	4.79	0.17	4.79	0.26	0.071	15.3	15.3	-45.0	23	3.910
L 75x75x6	7	0.87	0.40	0.40	1.57	0.47	8.69	0.47	8.69	0.74	0.203	20.8	20.8	-45.0	23	10.81
L 75x75x8	7	1.15	0.54	0.54	2.06	0.60	11.3	0.60	11.3	0.95	0.256	21.6	21.6	-45.0	23	13.80
L 80x80x8	7	1.23	0.58	0.58	2.21	0.74	12.9	0.74	12.9	1.16	0.313	22.8	22.8	-45.0	23	17.02
L 100x100x8	7	1.55	0.72	0.72	2.78	1.49	20.6	1.49	20.6	2.34	0.626	27.8	27.8	-45.0	23	34.27
L 100x100x10	7	1.91	0.90	0.90	3.44	1.80	25.3	1.80	25.3	2.85	0.757	28.6	28.6	-45.0	23	41.40
L 100x100x12	7	2.27	1.08	1.08	4.08	2.10	29.8	2.10	29.8	3.32	0.883	29.3	29.3	-45.0	23	48.30
L 150x100x8	7	1.95	1.08	0.72	3.50	4.57	44.7	1.67	21.6	5.27	0.971	47.8	22.9	-23.8	23	105.1
L 150x100x10	7	2.41	1.35	0.90	4.34	5.59	55.1	2.03	26.6	6.44	1.180	48.6	23.7	-23.7	23	128.6
L 150x100x12	7	2.87	1.62	1.08	5.16	6.57	65.3	2.37	31.3	7.56	1.380	49.4	24.5	-23.6	23	151.1
L 150x150x8	7	2.35	1.08	1.08	4.22	5.21	47.5	5.21	47.5	8.24	2.170	40.3	40.3	-45.0	23	119.8
L 150x150x10	7	2.91	1.35	1.35	5.24	6.38	58.6	6.38	58.6	10.1	2.650	41.1	41.1	-45.0	23	146.7
L 150x150x12	7	3.47	1.62	1.62	6.24	7.51	69.4	7.51	69.4	11.9	3.110	41.9	41.9	-45.0	23	172.7

Table values must be multiplied by the factors listed at the top of the table. ([1)] $T = T_1 = T_2$)

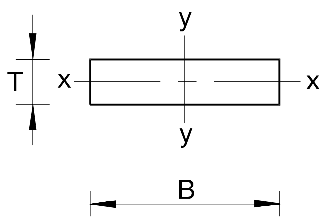


Table 2.13: Flat profiles, plates and sheets

Profile BxT	B mm	T mm	A mm^2	$A_{k,y}$ mm^2	$A_{k,x}$ mm^2	g kg/m	I_{xx} mm^4	W_{xx} mm^3	I_{yy} mm^4	W_{yy} mm^3
factor	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3
30x6	30	6	0.18	0.12	0.12	0.32	0.0005	0.18	0.013	0.90
50x6	50	6	0.30	0.20	0.20	0.54	0.0009	0.30	0.062	2.50
50x10	50	10	0.50	0.33	0.33	0.90	0.0042	0.83	0.104	4.17
100x6	100	6	0.60	0.40	0.40	1.08	0.0018	0.60	0.500	10.0
100x10	100	10	1.00	0.67	0.67	1.80	0.0083	1.67	0.833	16.7
140x10	140	10	1.40	0.93	0.93	2.52	0.0117	2.33	2.290	32.7
200x10	200	10	2.00	1.33	1.33	3.60	0.0167	3.33	6.670	66.7
300x10	300	10	3,00	2.00	2.00	5.40	0.0250	5.00	22.50	150
1220x6	1220	6	7.32	4.88	4.88	13.18	0.0220	7.32	907.9	1488
1220x8	1220	8	9.76	6.51	6.51	17.57	0.0521	13.0	1211	1985
1220x10	1220	10	12.2	8.13	8.13	21.96	0.1020	20.3	1513	2480
1220x12	1220	12	14.6	9.76	9.76	26.35	01757	29.3	1816	2977

Table values must be multiplied by the factors listed at the top of the table.

The elasticity modulus 23,000 MPa is not valid for flat profiles and sheets.

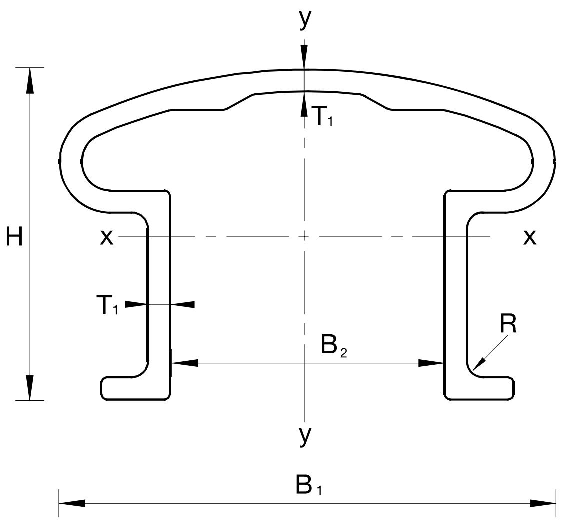


Table 2.14: Handrail

Profile $HxBxT_1xT_2$	H mm	B_1 mm	B_2 mm	T_1 mm	R mm	A mm^2	$A_{k,y}$ mm^2	$A_{k,x}$ mm^2	g kg/m	I_{xx} mm^4	W_{xx} mm^3	I_{yy} mm^4	W_{yy} mm^3	$E_{0°}$ MPa	$E_{0°}{\cdot}I_{xx}$ Nmm^2
factor	1	1	1	1	1	10^3	10^3	10^3	1	10^6	10^3	10^6	10^3	10^3	10^9
120x180x8	120	180	100	8	6	3.61	1.81	2.53	6.50	4.94	85.8	11.95	133	23	113.6

Table values must be multiplied by the factors listed at the top of the table.

CHAPTER 1

Section 3: Profiles used as beams and columns

Profiles subjected to tension or compression (Columns and tension rods)

L_k	:	Buckling length for column
A	:	Cross-section of profile
I	:	Moment of inertia
N_d	:	Design value of normal force (including partial coefficient)
$f_{c,0°}/f_{t,0°}$	:	Characteristic compressive/tensile strength (excluding partial coefficient)
$E_{0°}$	:	Characteristic modulus of elasticity (excluding partial coefficient)
$\gamma_{m,f}$	:	Partial coefficient for fc,0°/ft,0° in ultimate limit state
$\gamma_{m,E}$	:	Partial coefficient for E in ultimate limit state
N_{cr}	:	Critical load on column
N_{el}	:	Load according to elastic theory (Euler load)
F_d	:	Compressive load

Profiles subjected to tension

The maximum permissible load Nd is determined on the basis of the characteristic tensile stress level in the profile and the cross-sectional area of the profile.

$$N_d \leq \frac{A \cdot f_{t,0°}}{\gamma_{m,f}}$$

Profiles subjected to compression

The design value of the normal force N_d must be lower than the critical column load N_{cr}. The value of the critical column load depends on the length of the column, since the critical compressive stress will be a dimensioning factor in a short column length. Longer columns are to be dimensioned in accordance with the Euler load, using the following formula:

$$N_d \leq N_{cr} = \frac{F_d}{1 + \frac{F_d}{N_{el}}} = \frac{F_d}{1 + \lambda_r^2}$$

In which:

$$\lambda_r = \sqrt{\frac{f_{c,0°}}{\sigma_{el} \cdot \gamma_{m,f}}}$$

$$F_d = \frac{A \cdot f_{c,0°}}{\gamma_{m,f}}$$

$$N_{el} = \frac{\pi^2 \cdot E_{0°} \cdot I}{\gamma_{m,E} \cdot L_k^2}$$

$$\sigma_{el} = \frac{N_{el}}{A}$$

Provided the $N_d < N_{cr}$ criterion is met, the column will be stable.

Example 3.1: Column

Square tubes of 50 x 50 x 5 mm are used as stanchions in Fiberline railing systems. Square tubes can often be used in platform constructions as supporting columns, with the stanchions being extended to serve as the platform legs.

The following example illustrates how to determine the load-bearing capacity of a 2-metre length of square tube. The calculation is based on the assumption that the profile is simply supported, making the buckling length equivalent to the length of the profile. See Figure 3.1.

From Tables 2.1, 2.2, 2.0b and 2.9:

$A = 0{,}903 \cdot 10^3\ mm^2$

$I_{xx} = 0{,}309 \cdot 10^6\ mm^4$

$I_{yy} = 0{,}309 \cdot 10^6\ mm^4$

$E_{0°} = 23\ 000\ MPa$

$f_{c,0°} = 240\ MPa$

$\gamma_{m,E} = 1{,}3$

$\gamma_{m,f} = 1{,}3$

$L_K = 2000\ mm$

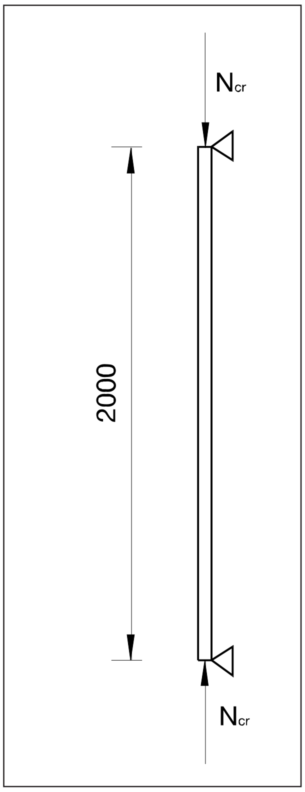


Figure 3.1

Calculations must be made in accordance with the instructions given in the theory for columns. On this basis, the critical compressive load can be calculated as follows:

$$F_d = \frac{A \cdot f_{c,0°}}{\gamma_{m,f}} = \frac{0{,}903 \cdot 10^3\ mm^2 \cdot 240\ MPa}{1{,}3} \cdot 10^{-3} = 166{,}7\ kN$$

The critical Euler load is calculated in the same way:

$$N_{el} = \frac{\pi^2 \cdot E_{0°} \cdot I}{\gamma_{m,E} \cdot L_k^2}$$

$$= \frac{\pi^2 \cdot 23\ 000\ MPa \cdot 0{,}309 \cdot 10^6\ mm^4}{1{,}3 \cdot (2\ 000\ mm)^2} \cdot 10^{-3}$$

$$= 13{,}49\ kN$$

The Euler load is the dimensioning factor. The critical column load is calculated as follows:

$$N_{cr} = \frac{F_d}{1 + \frac{F_d}{N_{el}}} = \frac{166{,}7\ kN}{1 + \frac{166{,}7\ kN}{13{,}49\ kN}} = 12{,}48\ kN$$

If this load is not exceeded, the profile itself will be stable when used as a 2-metre column.

Example 3.2: Profile in lattice column

Determining the load-bearing capacity of a column (part of a lattice column; see Figure 3.2). The profile is simply supported.

Buckling = L_x = 3,60 m (buckling in the "strong" direction).
Buckling length = L_y = 0,90 m (buckling in the "weak" direction).

Partial coefficient for $E_{0°}$ $\gamma_{m,E} = 1,3$
Partial coefficient for $f_{c,0°}$ $\gamma_{m,f} = 1,3$

Load:

Dead weight including profile G = 20 kN
Imposed load Q_1 = 100 kN
Partial coefficient, dead weight $\gamma_{fg} = 1,35$
Partial coefficient, imposed load $\gamma_{fq} = 1,5$

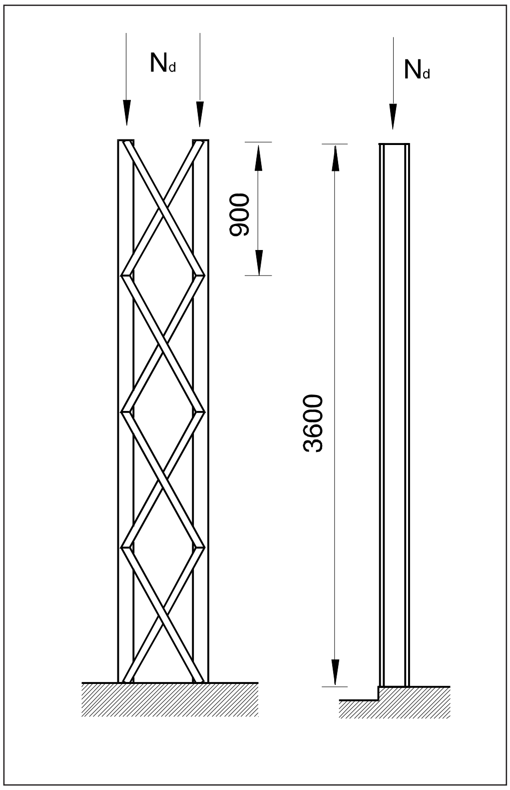


Figure 3.2

Profile selected: I 200 x 100 x 10

In Tables 2.1, 2.2 and 2.5:

$A = 3,89 \cdot 10^3$ mm^2
$I_{xx} = 23,6 \cdot 10^6$ mm^4
$I_{yy} = 1,69 \cdot 10^6$ mm^4
E = 28 000 MPa
$f_{c,0°}$ = 240 MPa

Ulitimate limit state:

$$N_d = \gamma_{fg} \cdot G + \gamma_f \cdot Q_1 = 1,35 \cdot 20 + 1,5 \cdot 100 = 177,0 \text{ kN}$$

$$F_d = \frac{A \cdot f_{c,0°}}{\gamma_{m,f}} = \frac{3,89 \cdot 10^3 \cdot 240}{1,3} \cdot 10^{-3} = 718,2 \text{ kN}$$

$$N_{el,x} = \frac{\pi^2 \cdot E_{0°} \cdot I_{xx}}{\gamma_{m,f} \cdot L_x^2} = \frac{\pi^2 \cdot 28\,000 \cdot 23,6 \cdot 10^6}{1,3 \cdot 3\,600^2} \cdot 10^{-3} = 387,1 \text{ kN}$$

$$N_{cr,x} = \frac{F_d}{1 + \frac{F_d}{N_{el,x}}} = \frac{718,2 \text{ kN}}{1 + \frac{718,2 \text{ kN}}{387,1 \text{ kN}}} = 251,5 \text{ kN}$$

As $N_{cr,x}$ is larger than N_d (251,5 kN > 177,0 kN), the column is stable in this direction.

A similar calculation can be made for the 'weak' direction:

$$N_{el,y} = \frac{\pi^2 \cdot E_{0^\circ} \cdot I_{yy}}{\gamma_{m,f} \cdot L_y^2} = \frac{\pi^2 \cdot 28\,000 \cdot 1{,}69 \cdot 10^6}{1{,}3 \cdot 900^2} \cdot 10^{-3} = 443{,}5\ kN$$

$$N_{cr,y} = \frac{F_d}{1 + \dfrac{F_d}{N_{el,y}}} = \frac{718{,}2\ kN}{1 + \dfrac{718{,}2\ kN}{443{,}5\ kN}} = 274{,}2\ kN$$

As also $N_{cr,\,y}$ is larger than N_d , the column is also stable in this direction.

Profiles subjected to compressive force and flexural moment

When a profile is subjected to both normal compressive force and flexural moment, the load-bearing capacity can be evaluated as stated below.

Evaluation must be done in the ultimate limit state.

The normal compressive force and the flexural moment are interdependent, as the transverse deflection in connection with the normal force causes a moment in the profile (allowance for deflection).

Allow for this by multiplying the moment (which is determined without taking deflections into account) by a moment intensification factor.

Cross-sectional forces (design values)

N_d : Normal compressive force

M_d : flexural moment (determined without taking profile deformations into account)

Cross-sectional constants

A : Cross-section area of profile

W : Section modulus of profile

Cross-sectional constants are listed in the data sheets for profiles.

Stress control

The maximum compressive stress in the profile is:

$$\sigma_{max} < \frac{f_{c,0°}}{\gamma_{m,f}}$$

$$\sigma_{max} = \frac{N_d}{A} + \frac{1}{1 - \frac{N_d}{N_{cr}}} \cdot \frac{M_d}{W}$$

in which:

$f_{c,0°}/\gamma_{m,f}$ = design value for compressive strength of profile

N_{cr} = critical compressive force for profile (see data sheet)

Example 3.3: Column subjected to axial load and moment

Figure 3.3 illustrates a U-profile 200 x 60 x 10 used as a supporting column in a structure. The U-profile is subjected to a normal force (P = 20 kN) and also to flexural moment, since the normal force acts at a distance to the centre of gravity axis of the U-profile.

According to the data sheet, the critical normal force, or column load, is 23.2 kN. The two joints of the structure are subjected to a maximum load of 24.8 kN (top joint) and 20.0 kN (bottom joint).

Assuming that the column load is transferred by shear force between the joints, the size of the moment can be determined by using the moment intensification factor. The column can be dimensioned on this basis. First, determine the distance from the point of action of the force to the centre of gravity axis according to Table 2.7

The size of the moment will be equal to the distance to the centre of gravity multiplied by the normal force, equivalent to $N_d \cdot e_x$. The normal stress factor in the column is determined as follows:

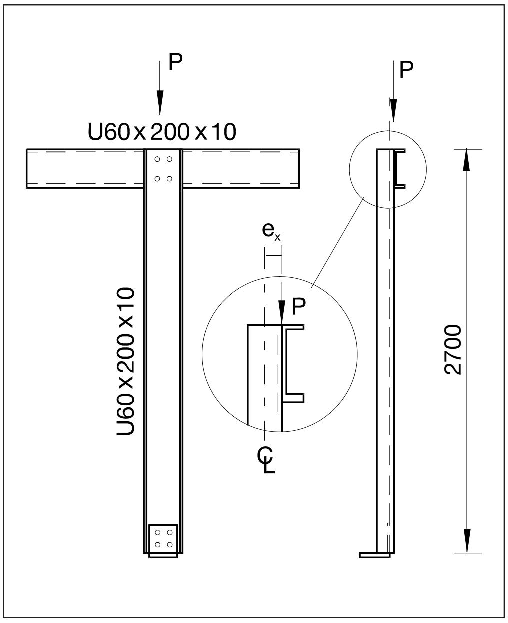


Figure 3.3

$$P = N_d$$

$$\sigma_{max} = \frac{N_d}{A} + \frac{1}{1 - \frac{N_d}{N_{cr}}} \cdot \frac{N_d \cdot e_x}{W_{yy}}$$

$$= \frac{20{,}0 \cdot 10^3}{3{,}04 \cdot 10^3} + \frac{1}{1 - \frac{20{,}0 \cdot 10^3}{23{,}5 \cdot 10^3}} \cdot \frac{20{,}0 \cdot 10^3 \cdot 15{,}0}{18{,}3 \cdot 10^3}$$

$$= 6{,}6 + (6{,}71 \cdot 16{,}4)$$

$$= 117 \text{ MPa}$$

$$\frac{f_{c,0°}}{\gamma_{m,f}} = \frac{240 \text{ MPa}}{1{,}3} = 185 \text{ MPa}$$

As 117 < 185 MPa, the existing stress will not cause a critical condition in the column.

Similarly, the deflection can be determined using the formula below, assuming that the column is simply supported at both ends and that it is subjected to a constant moment, without taking the impact of normal force into account:

$$\delta_{moment} = \frac{M_0 \cdot l^2}{8 \cdot E_{0°} \cdot I_{yy}}$$

The deflection value must also be multiplied by the moment intensification factor as:

$$\delta_{total} = \frac{1}{1 - \frac{N_d}{N_{cr}}} \cdot \frac{N \cdot e_x \cdot l^2}{8 \cdot E_{0°} \cdot I_{yy}}$$

$$\delta_{total} = \frac{1}{1 - \frac{20{,}0 \cdot 10^3}{23{,}2 \cdot 10^3}} \cdot \frac{20{,}0 \cdot 10^3 \cdot 14{,}9 \cdot 2000^2}{8 \cdot 28000 \cdot 0{,}825 \cdot 10^6}$$

$$\delta_{total} = 7{,}25 \cdot 6{,}5$$

$$\delta_{total} = 47{,}1 \text{ mm}$$

The example illustrates that even a small eccentricity can have significant impact on stresses and deformations. It is therefore recommended that loads be introduced centrally into columns, and that structures be given sufficient moment capacity.

Transversely loaded beam

Calculation method for a beam simply supported at both ends.

L	:	Length of span (span between the supports)
A_k	:	Shear area
W	:	Section modulus
I	:	Moment of inertia
q_k	:	Transverse load used in determining deflection (often characteristic value of largest imposed load)
p_d	:	Total transverse load including partial coefficient
k_M	:	Coefficient describing maximum moment
k_V	:	Coefficient describing maximum shear force
$k_{\delta M}$	:	Coefficient describing maximum deflection from flexural moment
$k_{\delta V}$	:	Coefficient describing maximum deflection from shear force
$f_{b,0°}$	:	Characteristic flexural strength (excluding partial coefficient)
f_τ	:	Characteristic shear strength (excluding partial coefficient)
E	:	Characteristic E-modulus (excluding partial coefficient)
G	:	Characteristic modulus in shear (excluding partial coefficient)
$\gamma_{m,f}$	:	Partial coefficient for $f_{b,1}$ and f_τ in ultimate limit state
δ	:	Deflection

Ultimate limit state

Bending:

$$\frac{k_M \cdot p_d \cdot L^2}{W} \leq \frac{f_{b,0°}}{\gamma_{m,f}}$$

Shear:

$$\frac{k_V \cdot p_d \cdot L}{A_k} \leq \frac{f_\tau}{\gamma_{m,f}}$$

Serviceability limit state

Deflection limit:

$$\frac{Max\ \delta}{L} < \frac{1}{\alpha}$$

$$\frac{Max\ \delta}{L} = \frac{k_{\delta M} \cdot q_k \cdot L^3}{E_{0°} \cdot I} + \frac{k_{\delta V} \cdot q_k \cdot L}{G \cdot A_k}$$

in which α is typically selected between 200 and 400

Bending:

$$\frac{k_M \cdot q_k \cdot L^2}{W} < f_{b0°,d} \qquad (\ \sigma_{b,0°} \text{ from Table 2.3 })$$

Shear:

$$\frac{k_V \cdot p_d \cdot L}{A_k} < f_{\tau,d} \qquad (\ \tau \text{ from Table 2.3 })$$

The two stress values $\sigma_{b,0°}$ and τ are listed in Table 2.3 which is divided into two categories. The degree of exposure determines selection of short-term or long-term values.

Summary of describing coefficients

Coefficients	One span	Two spans	Three spans
$k_M = M / p_d \cdot L^2$	0,125	0,125	0,100
$k_V = V / p_d \cdot L$	0,500	0,625	0,600
$k_{\delta.M} = \delta_{max.moment} \cdot E \cdot I / q \cdot L^4$	0,01302	0,00542	0,00688
$k_{\delta.V} = \delta_{max.\ shear} \cdot G \cdot A_k / q \cdot L^2$	0,125	0,125	0,125

Table 3.1

Example 3.4: Girder

Determination of load-bearing capacity of a two-span girder subjected to transverse load.

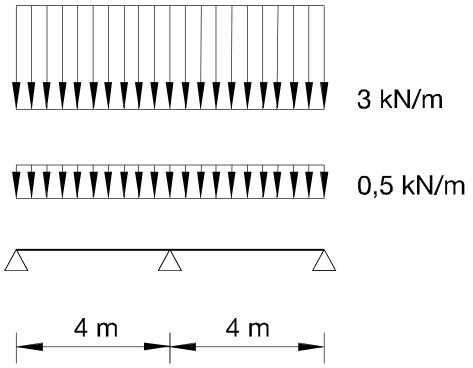


Figure 3.4

Span	L = 4,0 m

Load:

Dead weight, including beam	$g = 0{,}5$ kN/m
Imposed load, short-term	$q_1 = 3{,}0$ kN/m
Partial coefficient for dead weight	$\gamma_{fg} = 1{,}35$
Partial coefficient for imposed load	$\gamma_{f,q} = 1{,}5$
Maximum deflection	L/300

Selected profile:

I 200 x 100 x 10 with load acting in the direction y.

From Table 3.1:

Two spans: $k_M = 0{,}125$ $\quad k_V = 0{,}625$
$k_{\delta M} = 0{,}00542$ $\quad k_{\delta V} = 0{,}125$

Ultimate limit state:

$p_d = \gamma_{f,g} \cdot g + \gamma_{f,q} \cdot q_1 = 1{,}35 \cdot 0{,}5 + 1{,}5 \cdot 3{,}0 = 5{,}2$ kN/m

$M_d = k_M \cdot p_d \cdot L^2 = 0{,}125 \cdot 5{,}2 \cdot 4^2 = 10{,}4$ kNm $= 10{,}4 \cdot 10^6$ Nmm

$\sigma_{max} = M_d / W_{xx} = 10{,}4 \cdot 10^6 / 236 \cdot 10^3 = 44$ MPa

$f_{b,f,d} = f_{b,0°} / \gamma_{m,f} = 240/1{,}3 = 185$ MPa

$\sigma_{max} < f_{b,f,d}$ (OK!)

$V_d = k_V \cdot p_d \cdot L = 0{,}625 \cdot 5{,}2 \cdot 4 = 13$ kN $= 13000$ N

$\tau_{max} = V_d / A_{k,y} = 13000 / 1{,}90 \cdot 10^3 = 6{,}8$ MPa

$f_\tau / \gamma_{m,f} = 25 / 1{,}3 = 19{,}2$ MPa

$\tau_{max} < f_\tau / \gamma_{m,f}$ (OK!)

Serviceability limit state

Deflection (for imposed load):

$q_k \quad = \quad q_1 \qquad = 3{,}0$ kN/m (total imposed load)

$$\frac{\delta}{L} = \frac{k_{\delta M} \cdot q_k \cdot L^3}{E_{0^\circ} \cdot I_{xx}} + \frac{k_{\delta V} \cdot q_k \cdot L}{G \cdot A_{k,y}}$$

$$= \frac{0{,}00542 \cdot 3{,}0 \cdot 4000^3}{28000 \cdot 23{,}6 \cdot 10^6} + \frac{0{,}125 \cdot 3{,}0 \cdot 4000}{3000 \cdot 1{,}90 \cdot 10^3}$$

$$= 0{,}0016 + 0{,}0003$$

$$= \frac{1}{526}$$

$$\frac{\delta}{L} < \frac{1}{300} \qquad (\text{ OK! })$$

CHAPTER 1

Section 4: Bolted joints

Calculation of bolted joints

A bolted joint transfers the shear forces between the profiles in a structure. Bolted joints transfer the shear force by friction through regions of concentrated local compression of the profiles around the bolts.

In static calculations for bolted joints, it is necessary to ensure that the profile and the bolts can withstand this concentrated local compression. It is also necessary to ensure that the region surrounding a group of bolts will not be torn out of the profile: i.e. that the region around the bolted joint has sufficient capacity to transfer the load to the rest of the structure.

The load-bearing capacity of a bolted joint is sufficient when the following criteria have been fulfilled:

- The required bolt forces are sufficient to reach equilibrium with the existing shear forces
- The contact compression between the profile must be able to be absorbed locally. This is ensured if the required bolt forces do not exceed the limits stated in Tables 4.1, 4.2 and 4.3.
- The shear forces for which the bolted joint is dimensioned, must be transferred by the laminate in the remaining surface between the bolt group and the rest of the profile; i.e. it must not be possible for the entire bolted joint to tear out of the profile.

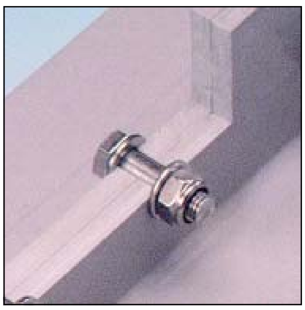
Bolt forces in a bolted joint can be distributed by using the elasticity theory. In predominantly static loads, distribution determined by plasticity theory can be realistic for joints in which the bolts are actuated for shear. Tests show that the bolts are normally so strong in relation to the laminate that deformations can occur which activate all the bolts. In the event of a break in the laminate, the size of deformations in front of bolts can typically be a few millimetres or more.

All relevant failure modes should be considered, to ensure that an entire bolt group cannot be torn out of the laminate. It may be necessary to evaluate several possible modes of failure to fully determine the load-bearing capacity of a joint. The examples below illustrate how this should be done.

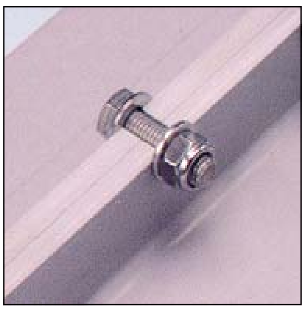
To achieve the expected load-bearing capacity it is essential that the minimum spacings shown in Figure 4.1 are maintained. Please note the significance of the pultrusion direction, in which the main reinforcing fibres lie.

No more than 4 bolts should be placed in a row. If this is unavoidable, special calculations are required and Fiberline should be consulted.

No attempt should be made to cut threads in the composite material. Correct and incorrect configurations are shown below.



No threads in the composite material (correct mounting)



Threads in the composite material (incorrect mounting)

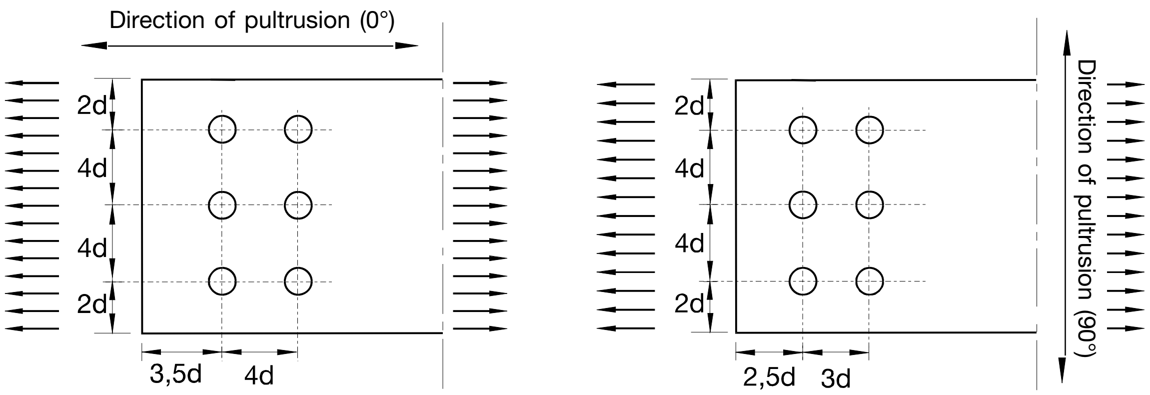


Figure 4.1 Minimum distances

Characteristic strengths

$f_{t,0°}$ = 240 MPa

$f_{c,0°}$ = 240 MPa

$f_{t,90°}$ = 50 MPa

$f_{c,90°}$ = 70 MPa

f_{τ} = 25 MPa

$f_{c,v}$ = $\min\{f_{c,90°} + f_{\tau} \cdot \cot(v) \; ; \; f_{c,0°} + f_{\tau} \cdot \tan(v)\}$

Example 4.00

Failure of tension rod
subjected to tensile force in the direction of pultrusion (0°)

The line of fracture is illustrated in Figure 4.2.

The width of the laminate is $8 \cdot d$. The thickness is t, while d indicates the diameter of the bolt.

After subtracting the bolt-holes, the effective area of the laminate is $6 \cdot d \cdot t$.

The total force that can be transferred through this failure surface is

$N_{max} = 6 \cdot d \cdot t \cdot f_{t,0°}$

in which $f_{t,0°}$ is the tensile strength in the direction of pultrusion.

For horizontal (90°) loads, the tensile strength for the horizontal direction should be used.

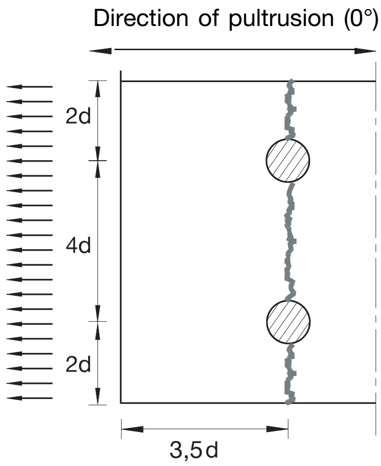


Figure 4.2

Example 4.01

Bolts tearing out of the flange of an I-profile
Influence of direction of force on load-bearing capacity

The estimated line of fracture is shown in Figure 4.3. The thickness of the laminate is indicated as t, while d indicates the diameter of the bolt.

The load-bearing capacity for tearing can be determined by

$$(8 \cdot d - 2 \cdot d) \cdot t \cdot f_{t,90°} = 6 \cdot d \cdot t \cdot f_{t,90°}$$

in which $f_{t,90°}$ indicates the tensile strength of the laminate perpendicular to the direction of pultrusion.

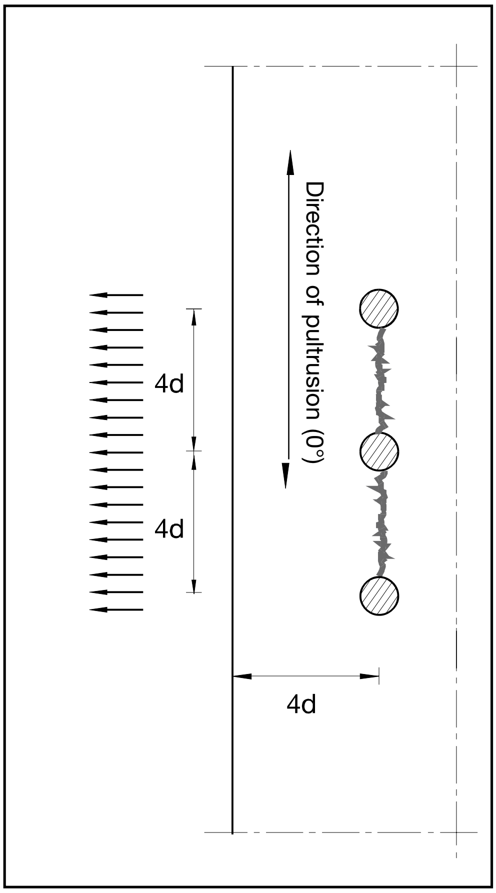


Figure 4.3

Example 4.02

Torn tension rod / flat profile due to tensile force at an angle to the direction of pultrusion of 45°

The line of fracture is illustrated in Figure 4.4.

The width of the laminate is 4 · d. The thickness is t, while d indicates the diameter of the bolt.

After subtracting the bolt holes, the effective area of the laminate is

$$(4\sqrt{2} - 1) \cdot d \cdot t$$

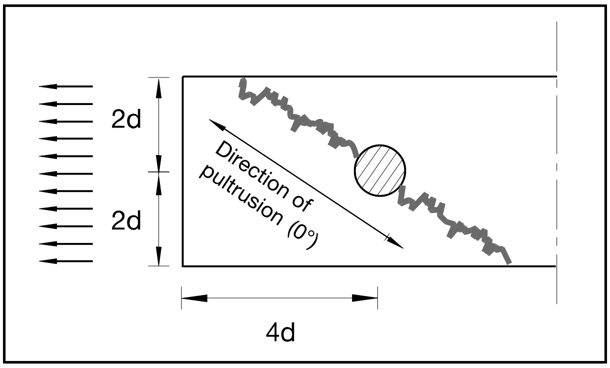


Figure 4.4

The total shear force that can be transferred through this cross-section is

$$T_{max} = (4\sqrt{2} - 1) \cdot d \cdot t \cdot f\tau$$

in which $f\tau$ is the shear strength of the laminate.

Projection of the bolt strength P_{Bolt} on the line of fracture gives $T = P_{Bolt} \times \sqrt{2}/2$, so that the maximum bolt strength that can be absorbed is

$$P_{Bolt, max} = \sqrt{2} \times (4\sqrt{2} - 1) \cdot d \cdot t \cdot f\tau$$

Load-bearing capacity of bolts - shear in the longitudinal direction (0°)

The approximate distribution of tension in the laminate around a bolt subjected to shear is described in Figure 4.5.

The load-bearing capacity of a bolt subjected to shear will be sufficient if the stress which occurs does not exceed the relevant strengths.

The shear for a bolt can be determined as

$$P_{B,D} = \frac{d \cdot t \cdot 150\text{ MPa}}{\gamma_m} = d \cdot t \cdot 115{,}4\text{ MPa}$$

in which
γ_m = 1,3
d = nominal diameter of the bolt
t = thickness of the laminate

The values are based on
a = 3,5 · d
b = 1,0 · d
c = 2,0 · d

Theoretical derivatives for load-bearing capacity terms

Geometry:

a Distance from the centre line of the bolt to the edge in the direction of force (longitudinal direction).

b Width of area in front of the bolt where interlaminar forces occur.

c Distance from the centre line of the bolt to the edge perpendicular to the direction of force.

d Diameter of bolt.

v Angle of inclined pressure: tan(v) = [c/2+d/4]/[a-b/2]

t Thickness of laminate.

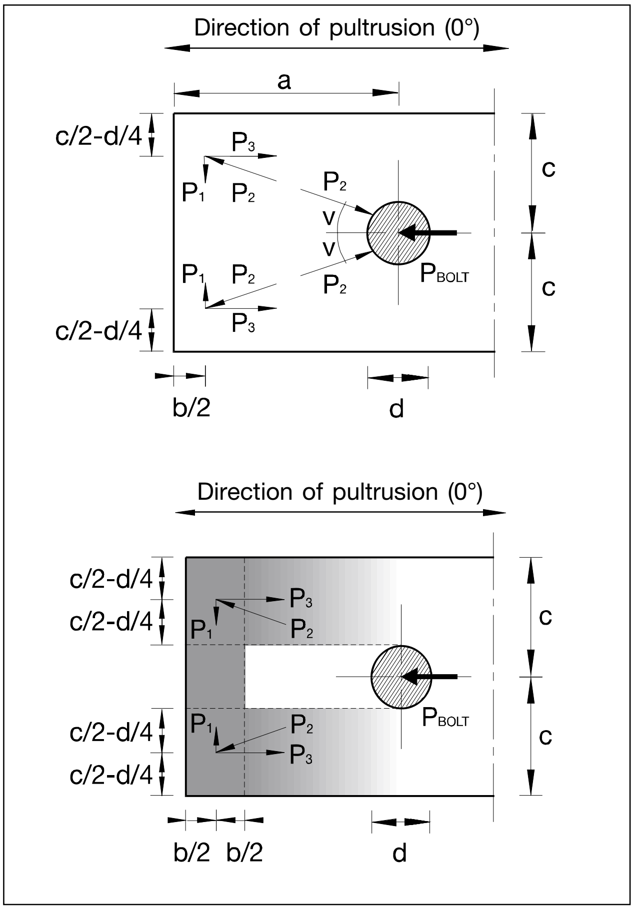
Static conditions:

$$P_1 = \tfrac{1}{2} \cdot P_{Bolt} \cdot \tan(v)$$

$$P_2 = \frac{P_{Bolt}}{2 \cdot \cos(v)}$$

$$P_3 = \tfrac{1}{2} \cdot P_{Bolt}$$

Figure 4.5



Stress-related conditions:

The force diagrams for the various conditions are illustrated in the figures below. The line of fracture is also illustrated.

Condition 1 : Tensile stress in the longitudinal direction next to bolt

$$\frac{P_3}{\left(\frac{c-d}{2}\right) \cdot t}$$

Fibre in 0° overloaded
See Figure 4.6

Load-bearing capacity: $P_{Bolt} \leq 720 \text{ MPa} \cdot t \cdot d$

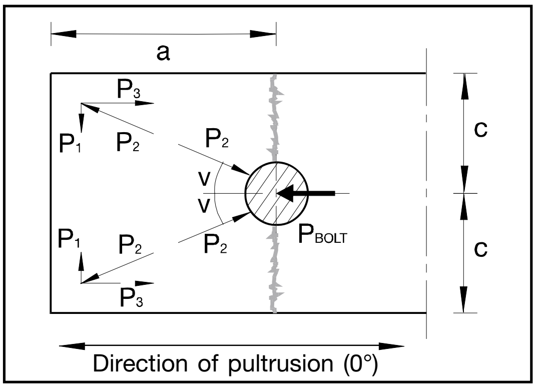


Figure 4.6

Condition 2 : Cleavage stress in area in front of bolt

$$\frac{P_1}{b \cdot t}$$

Fibre in 90° overloaded
See Figure 4.7

Load-bearing capacity: $P_{Bolt} \leq 240 \text{ MPa} \cdot t \cdot d$

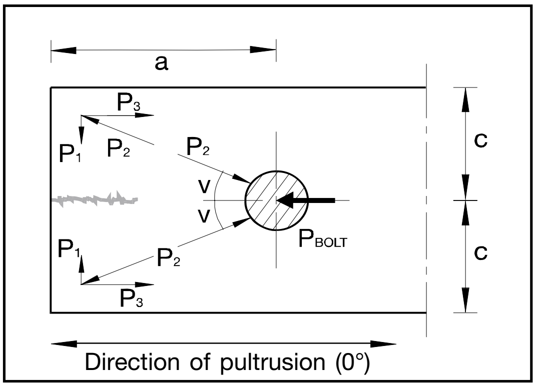


Figure 4.7

Condition 3 : Tearing of laminate in front of bolt

$$\frac{P_{Bolt}}{2 \cdot \left(a - \frac{d}{2}\right) \cdot t}$$

shear stress exceeded in the lines of fracture shown
See Figure 4.8

Load-bearing capacity: $P_{Bolt} \leq 150 \text{ MPa} \cdot t \cdot d$

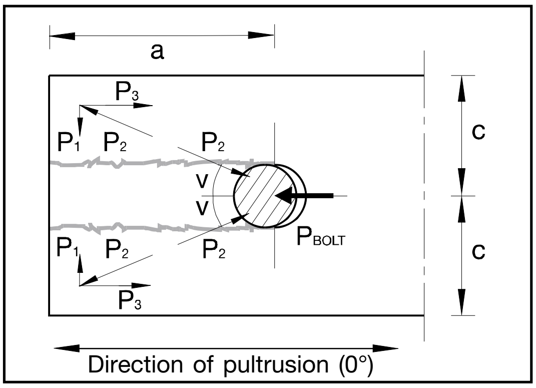


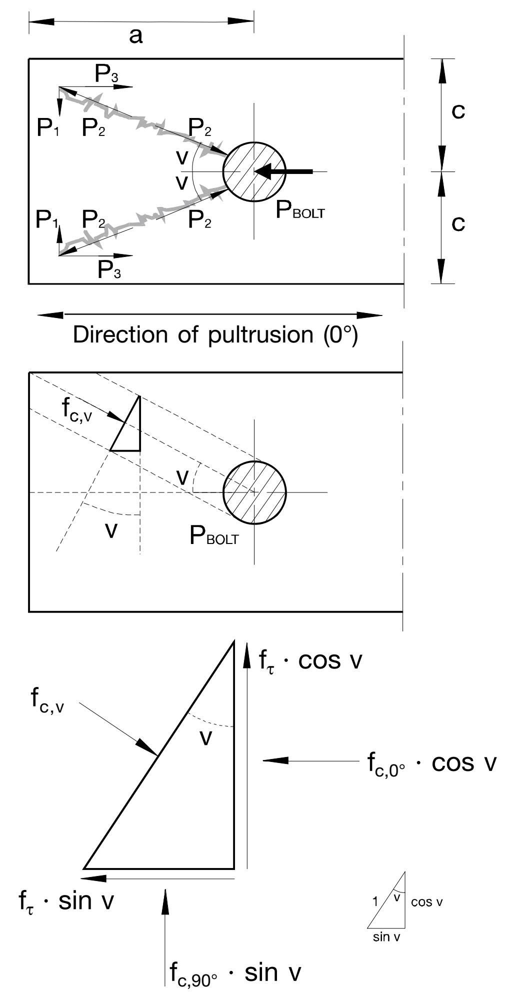
Figure 4.8

Condition 4 : Inclined distribution in front of bolt

$$\frac{P_2}{d \cdot t}$$

The compression stress in the inclined failure surface exceeds the compression strength.
See Figure 4.9

Load-bearing capacity $P_{Bolt} \leq 240\ \text{MPa} \cdot t \cdot d$



Vertical projection:
$f_{c,v} \cdot \sin v = f_{c,90°} \cdot \sin v + f_\tau \cdot \cos v$

Horizontal projection:
$f_{c,v} \cdot \cos v = f_{c,0°} \cdot \cos v + f_\tau \cdot \sin v$

Figure 4.9
Strength $f_{c,v}$ in inclined forces

Condition 5 : Laminate compresses in front of bolt

$$\frac{P_{Bolt}}{d \cdot t}$$

Contact compression between bolt and laminate exceeds the compression strength, so the bolt "eats" into the laminate.
See Figure 4.10

Load-bearing capacity $P_{Bolt} \leq 240\ \text{MPa} \cdot t \cdot d$

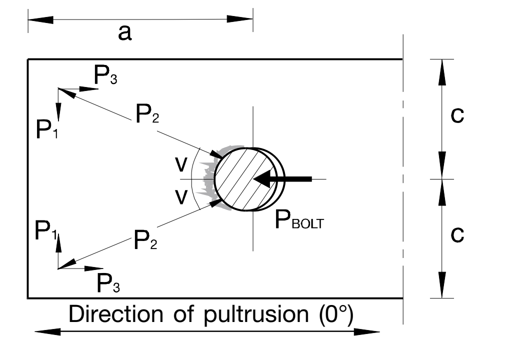


Figure 4.10

Load-bearing capacity of bolts - shear in the transverse direction (90°)

The approximate distribution of stress in the laminate around a bolt subjected to shear can be described as shown in Figure 4.11.

The load-bearing capacity of a bolt subjected to shear, if the stress does not exceed the relevant strengths.

Calculation of shear strength:

$$P_{B,d} = \frac{d \cdot t \cdot 70\ \text{MPa}}{\gamma_m} = d \cdot t \cdot 53{,}8\ \text{MPa}$$

in which
γ_m = 1,3
d = nominal diameter of bolt
t = thickness of laminate

Values are based on
a = 3,5 · d
b = 1,0 · d
c = 2,0 · d

Theoretical derivatives for load-bearing capacity terms

Geometry:

a Distance from centre line of bolt to edge in direction of force (transverse direction)

b Width of area in front of bolt where interlaminar forces occur

c Distance from centre line of bolt to edge perpendicular to direction of force

d Bolt diameter

v Angle of inclined pressure: tan(v) = [c/2+d/4]/[a-b/2]

t Thickness of laminate

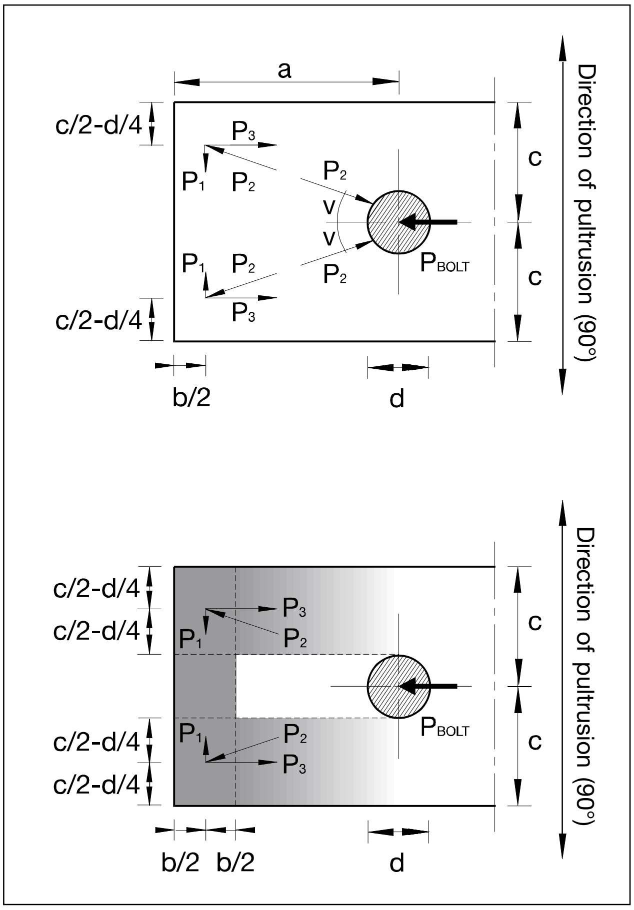
Static conditions:

$$P_1 = \tfrac{1}{2} \cdot P_{Bolt} \cdot \tan(v)$$

$$P_2 = \frac{P_{Bolt}}{2 \cdot \cos(v)}$$

$$P_3 = \tfrac{1}{2} \cdot P_{Bolt}$$

Figure 4.11



Stress-related conditions:

The force diagrams for the various conditions are illustrated in the figures below. The line of fracture is also illustrated.

Condition 1 : $\frac{P_3}{(c - \frac{d}{2}) \cdot t}$

Tensile force in longitudinal direction next to bolt.
See Figure 4.12

Load-bearing capacity: $P_{Bolt} \leq 150 \text{ MPa} \cdot t \cdot d$

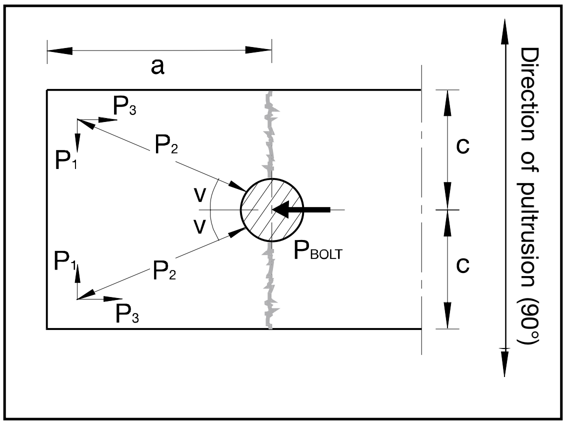


Figure 4.12

Condition 2 : $\frac{P_1}{b \cdot t}$

Cleavage in area in front of bolt.
Fibre in 90° overloaded.
See Figure 4.13

Load-bearing capacity: $P_{Bolt} \leq 768 \text{ MPa} \cdot t \cdot d$

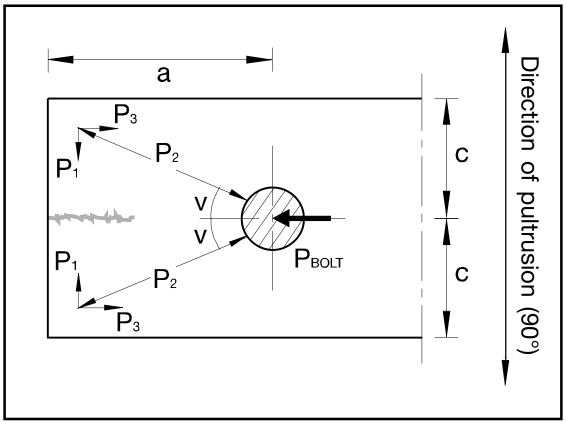


Figure 4.13

Condition 3 : $\frac{P_{Bolt}}{2 \cdot (a - \frac{d}{2}) \cdot t}$

Tearing of laminate in front of bolt.
The strength of shear is exceeded in the illustrated lines of fracture.
See Figure 4.14

Load-bearing capacity: $P_{Bolt} \leq 100 \text{ MPa} \cdot t \cdot d$

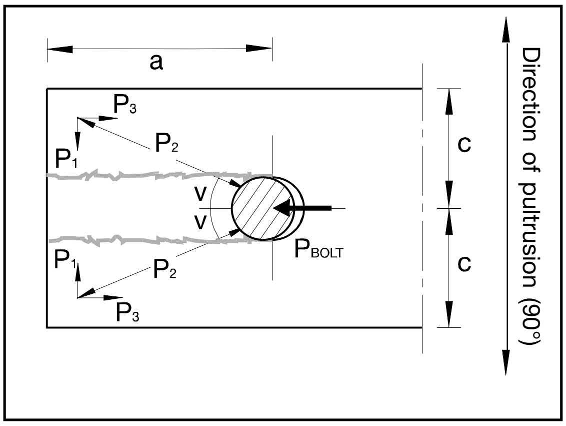


Figure 4.14

Condition 4 : $\frac{P_2}{d \cdot t}$

Inclined distribution in front of bolt. Compression stress in the inclined failure surface exceeds the compression strength.
See Figure 4.15

Load-bearing capacity

The following geometric parameters:

a = 2,5 · d
b = 1,0 · d
c = 2,0 · d

are to be put into the conditions listed above to find:

$P_{Bolt} \leq 145 \text{ MPa} \cdot t \cdot d$

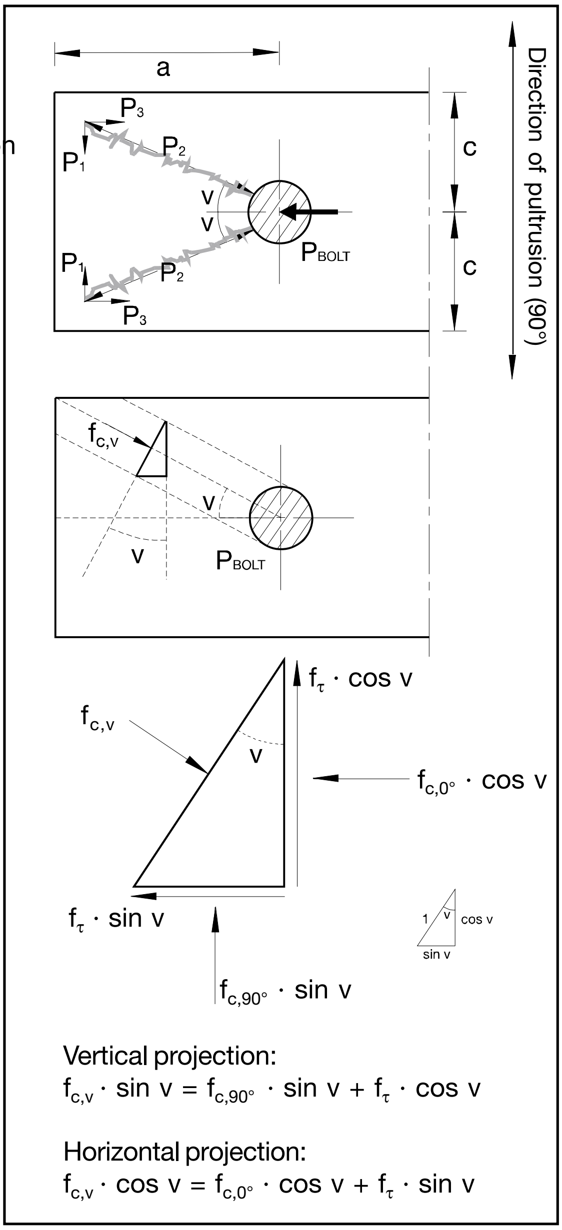


Figure 4.15
Strength $f_{c,v}$ in inclined forces

Condition 5 : $\frac{P_{Bolt}}{d \cdot t}$

Pressure deformation of laminate in front of bolt.

The contact compression between the bolt and laminate exceeds the pin-bearing strength, so the bolt 'eats' into the laminate.
See Figure 4.16.

Load-bearing capacity

$P_{Bolt} \leq 70 \text{ MPa} \cdot t \cdot d$

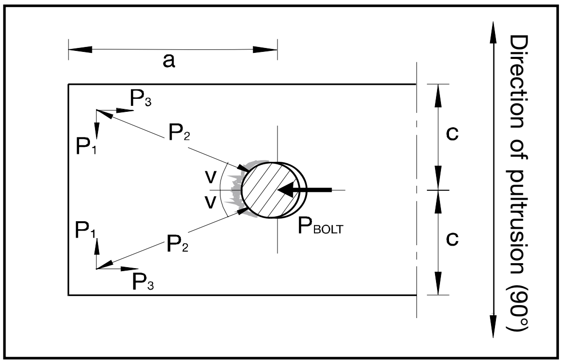


Figure 4.16

Load-bearing capacity of bolts – tensile force

The load-bearing capacity of a bolt subjected to tensile force is determined by:

- the tensile force load-bearing capacity of the bolt
- punching of the laminate

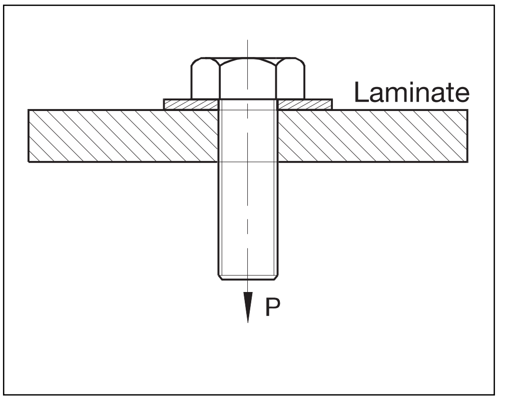


Figure 4.17

Geometry:

d Diameter of the bolt.

A_s Stress area of the bolt.

t Thickness of the laminate.

Diameter of washer = $2 \cdot d$

Strengths:

f_{yk} = Characteristic tensile strength of bolt = 210 MPa for quality A4.

f_τ = Shear strength of the laminate = 25 MPa

Static conditions:

Condition 1 : $\dfrac{A_s \cdot f_{yk}}{\gamma_{m,f}}$ (Tearing of bolt in threaded cross-section)

Condition 2 : $\dfrac{2 \cdot d \cdot \pi \cdot t \cdot f_\tau}{\gamma_{m,f}}$ (Shear fracture at rim of washer)

Load-bearing capacity:

$$P = \frac{A_s \cdot 210\ \text{MPa}}{1{,}28} = A_s \cdot 164{,}1\ \text{MPa} \quad (\text{Bolt})$$

$$P = \frac{25\ \text{MPa}}{1{,}3} = 120{,}8\ \text{MPa} \cdot t \cdot d \ (\text{Laminate})$$

Example 4.1: Bolts subjected to shear

Dimensioning of a bolted joint for securing a flat profile which is subjected to tensile force in 0°, to a U-profile, as shown in Figure 4.18.

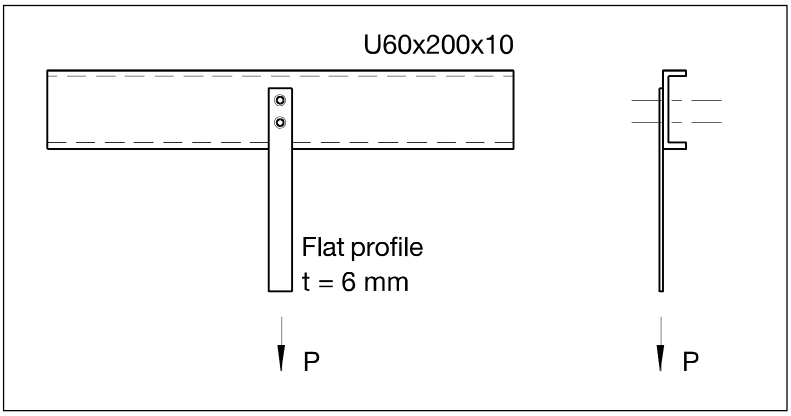


Figure 4.18

The tensile force load is 1000 kg or 9.82 kN. The thickness of the flat profile is t = 6 mm. No friction between the two points of attachment has been taken into account.

Dimensioning is done in two steps. First, the size of the bolt is selected, then the minimum width of the flat profile is determined.

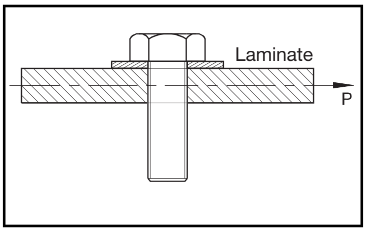
An M10 bolt is selected. The table on page 1.4.14 indicates that the maximum load-bearing capacity of a laminate with a thickness of 6 mm combined with an M10 bolt is 6.9 kN in the longitudinal direction. Consequently, two M10 bolts must be used which can bear 13.8 kN (> 9,82 kN), and which are placed in the longitudinal direction of the flat profile. The EUROCOMP safety standards are included in the table, thus providing the necessary design safety.

The width of the flat profile is determined on the basis of the size of the bolt. In section 4.1, *Load-bearing capacity of bolts - shear in the longitudinal direction* (1), Figure 4.2 illustrates that the distance from the centre line of the bolt to the edge of the flat profile must be 2 · d (2 x the diameter of the bolt). Thus, the total width of the flat profile must be 4 · d or 4 ·10 mm = 40 mm. The distance to the end of the flat profile must be at least 3.5d or 35 mm. In this case, the distance between the two bolts must be 4 · d, or 40 mm.

A similar calculation can be done for the U-profiles of 90° in the pultrusion / longitudinal direction on the basis of Section 4 Load-bearing capacity of bolts - shear in 90° and Table 4.2 on page 1.4.14.

Load-bearing capacity of bolts subjected to shear in kN

Design value of ultimate limit state
Safety class: normal
Bolt quality: A4
Washers under head and nut: $D = D_{bolt} \cdot 2$
Hole drilled in profile for bolt: $D = D_{bolt} + 1mm$



Pin-bearing strength (P) in kN for direction of force 0° (longitudinal direction of profile)

Bolt	Load-bearing capacity per cut (kN) 1 cut	2 cuts	Thickness of laminate in mm 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
M 6	2,7	5,4	3,5	4,2	4,8	5,5	6,2	6,9	7,6	8,3	9,0	9,7	10,4	11,1	11,8	12,5	13,2	13,8
M 8	4,8	9,5	4,6	5,5	6,5	7,4	8,3	9,2	10,2	11,1	12,0	12,9	13,8	14,8	15,7	16,6	17,5	18,5
M 10	7,4	14,9	5,8	6,9	8,1	9,2	10,4	11,5	12,7	13,8	15,0	16,2	17,3	18,5	19,6	20,8	21,9	23,1
M 12	10,7	21,4	6,9	8,3	9,7	11,1	12,5	13,8	15,2	16,6	18,0	19,4	20,8	22,2	23,5	24,9	26,3	27,7
M 14	14,6	29,2	8,1	9,7	11,3	12,9	14,5	16,2	17,8	19,4	21,0	22,6	24,2	25,8	27,5	29,1	30,7	32,3
M 16	19,0	38,1	9,2	11,1	12,9	14,8	16,6	18,5	20,3	22,2	24,0	25,8	27,7	29,5	31,4	33,2	35,1	36,9
M 20	30	59	11,5	13,8	16,2	18,5	20,8	23,1	25,4	27,7	30,0	32,3	34,6	36,9	39,2	41,5	43,8	46,2
M 22	36	72	12,7	15,2	17,8	20,3	22,8	25,4	27,9	30,5	33,0	35,5	38,1	40,6	43,2	45,7	48,2	50,8
M 24	43	86	13,8	16,6	19,4	22,2	24,9	27,7	30,5	33,2	36,0	38,8	41,5	44,3	47,1	49,8	52,6	55,4
M 27	54	109	15,6	18,7	21,8	24,9	28,0	31,2	34,3	37,4	40,5	43,6	46,7	49,8	53,0	56,1	59,2	62,3
M 30	67	134	17,3	20,8	24,2	27,7	31,2	34,6	38,1	41,5	45,0	48,5	51,9	55,4	58,8	62,3	65,8	69,2
M 36	96	193	20,8	24,9	29,1	33,2	37,4	41,5	45,7	49,8	54,0	58,2	62,3	66,5	70,6	74,8	78,9	83,1
M 42	131	262	24,2	29,1	33,9	38,8	43,6	48,5	53,3	58,2	63,0	67,8	72,7	77,5	82,4	87,2	92,1	96,9
M 48	171	343	27,7	33,2	38,8	44,3	49,8	55,4	60,9	66,5	72,0	77,5	83,1	88,6	94,2	99,7	105,2	110,8

Table 4.1

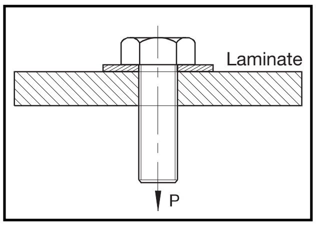
Pin-bearing strength (P) in kN for direction of force 90° (transverse direction of profile)

Bolt	Load-bearing capacity per cut (kN) 1 cut	2 cuts	Thickness of laminate in mm 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
M 6	2,7	5,4	1,6	1,9	2,3	2,6	2,9	3,2	3,6	3,9	4,2	4,5	4,8	5,2	5,5	5,8	6,1	6,5
M 8	4,8	9,5	2,2	2,6	3,0	3,4	3,9	4,3	4,7	5,2	5,6	6,0	6,5	6,9	7,3	7,8	8,2	8,6
M 10	7,4	14,9	2,7	3,2	3,8	4,3	4,8	5,4	5,9	6,5	7,0	7,5	8,1	8,6	9,2	9,7	10,2	10,8
M 12	10,7	21,4	3,2	3,9	4,5	5,2	5,8	6,5	7,1	7,8	8,4	9,0	9,7	10,3	11,0	11,6	12,3	12,9
M 14	14,6	29,2	3,8	4,5	5,3	6,0	6,8	7,5	8,3	9,0	9,8	10,6	11,3	12,1	12,8	13,6	14,3	15,1
M 16	19,0	38,1	4,3	5,2	6,0	6,9	7,8	8,6	9,5	10,3	11,2	12,1	12,9	13,8	14,6	15,5	16,4	17,2
M 20	30	59	5,4	6,5	7,5	8,6	9,7	10,8	11,8	12,9	14,0	15,1	16,2	17,2	18,3	19,4	20,5	21,5
M 22	36	72	5,9	7,1	8,3	9,5	10,7	11,8	13,0	14,2	15,4	16,6	17,8	19,0	20,1	21,3	22,5	23,7
M 24	43	86	6,5	7,8	9,0	10,3	11,6	12,9	14,2	15,5	16,8	18,1	19,4	20,7	22,0	23,3	24,6	25,8
M 27	54	109	7,3	8,7	10,2	11,6	13,1	14,5	16,0	17,4	18,9	20,4	21,8	23,3	24,7	26,2	27,6	29,1
M 30	67	134	8,1	9,7	11,3	12,9	14,5	16,2	17,8	19,4	21,0	22,6	24,2	25,8	27,5	29,1	30,7	32,3
M 36	96	193	9,7	11,6	13,6	15,5	17,4	19,4	21,3	23,3	25,2	27,1	29,1	31,0	33,0	34,9	36,8	38,8
M 42	131	262	11,3	13,6	15,8	18,1	20,4	22,6	24,9	27,1	29,4	31,7	33,9	36,2	38,4	40,7	43,0	45,2
M 48	171	343	12,9	15,5	18,1	20,7	23,3	25,8	28,4	31,0	33,6	36,2	38,8	41,4	43,9	46,5	49,1	51,7

Table 4.2

Load-bearing capacity of bolts in kN
- tensile force perpendicular to the laminate

Design value of ultimate limit state
Safety class: normal
Bolt quality: A4
Washers under head and nut: $D = D_{bolt} \cdot 2$
Hole drilled in profile for bolt: $D = D_{bolt} + 1mm$



Load-bearing capacity for punched holes in kN																	
Bolt	Bolt load-bearing capacity	Thickness of laminate in mm															
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
M 6	2,7	3,6	4,3	5,1	5,8	6,5	7,2	8,0	8,7	9,4	10,1	10,9	11,6	12,3	13,0	13,8	14,5
M 8	5,1	4,8	5,8	6,8	7,7	8,7	9,7	10,6	11,6	12,6	13,5	14,5	15,5	16,4	17,4	18,4	19,3
M 10	8,1	6,0	7,2	8,5	9,7	10,9	12,1	13,3	14,5	15,7	16,9	18,1	19,3	20,5	21,7	23,0	24,2
M 12	11,8	7,2	8,7	10,1	11,6	13,0	14,5	15,9	17,4	18,8	20,3	21,7	23,2	24,6	26,1	27,5	29,0
M 14	16,1	8,5	10,1	11,8	13,5	15,2	16,9	18,6	20,3	22,0	23,7	25,4	27,1	28,8	30,4	32,1	33,8
M 16	21,9	9,7	11,6	13,5	15,5	17,4	19,3	21,3	23,2	25,1	27,1	29,0	30,9	32,9	34,8	36,7	38,7
M 20	34	12,1	14,5	16,9	19,3	21,7	24,2	26,6	29,0	31,4	33,8	36,2	38,7	41,1	43,5	45,9	48,3
M 22	42	13,3	15,9	18,6	21,3	23,9	26,6	29,2	31,9	34,6	37,2	39,9	42,5	45,2	47,8	50,5	53,2
M 24	49	14,5	17,4	20,3	23,2	26,1	29,0	31,9	34,8	37,7	40,6	43,5	46,4	49,3	52,2	55,1	58,0
M 27	64	16,3	19,6	22,8	26,1	29,4	32,6	35,9	39,1	42,4	45,7	48,9	52,2	55,5	58,7	62,0	65,2
M 30	78	18,1	21,7	25,4	29,0	32,6	36,2	39,9	43,5	47,1	50,7	54,4	58,0	61,6	65,2	68,9	72,5
M 36	114	21,7	26,1	30,4	34,8	39,1	43,5	47,8	52,2	56,5	60,9	65,2	69,6	73,9	78,3	82,6	87,0
M 42	156	25,4	30,4	35,5	40,6	45,7	50,7	55,8	60,9	66,0	71,0	76,1	81,2	86,3	91,3	96,4	101,5
M 48	205	29,0	34,8	40,6	46,4	52,2	58,0	63,8	69,6	75,4	81,2	87,0	92,8	98,6	104,4	110,2	116,0

Table 4.3

Example 4.2: Detail of column base I 200 x 100 x 10

The joint is illustrated on the next page in Figure 4.19.

Load

The joint must be capable of transferring a vertical downward force in the column I 200 x 100 x 10.

Distance requirements

I 200 x 100 x 10

distance between bolts: 65 mm > 4,0 · 16 mm (OK!)

L 150 x 100 x 8

distance from edge: 35 mm > 2,0 · 16 mm (OK!)

distance between bolts: 65 mm > 4,0 · 16 mm (OK!)

Static model

The bolts are assumed to be subjected to shear only.

Bolt strengths and load-bearing capacity

The total vertical force is indicated as F.

I 200 x 100 x 10

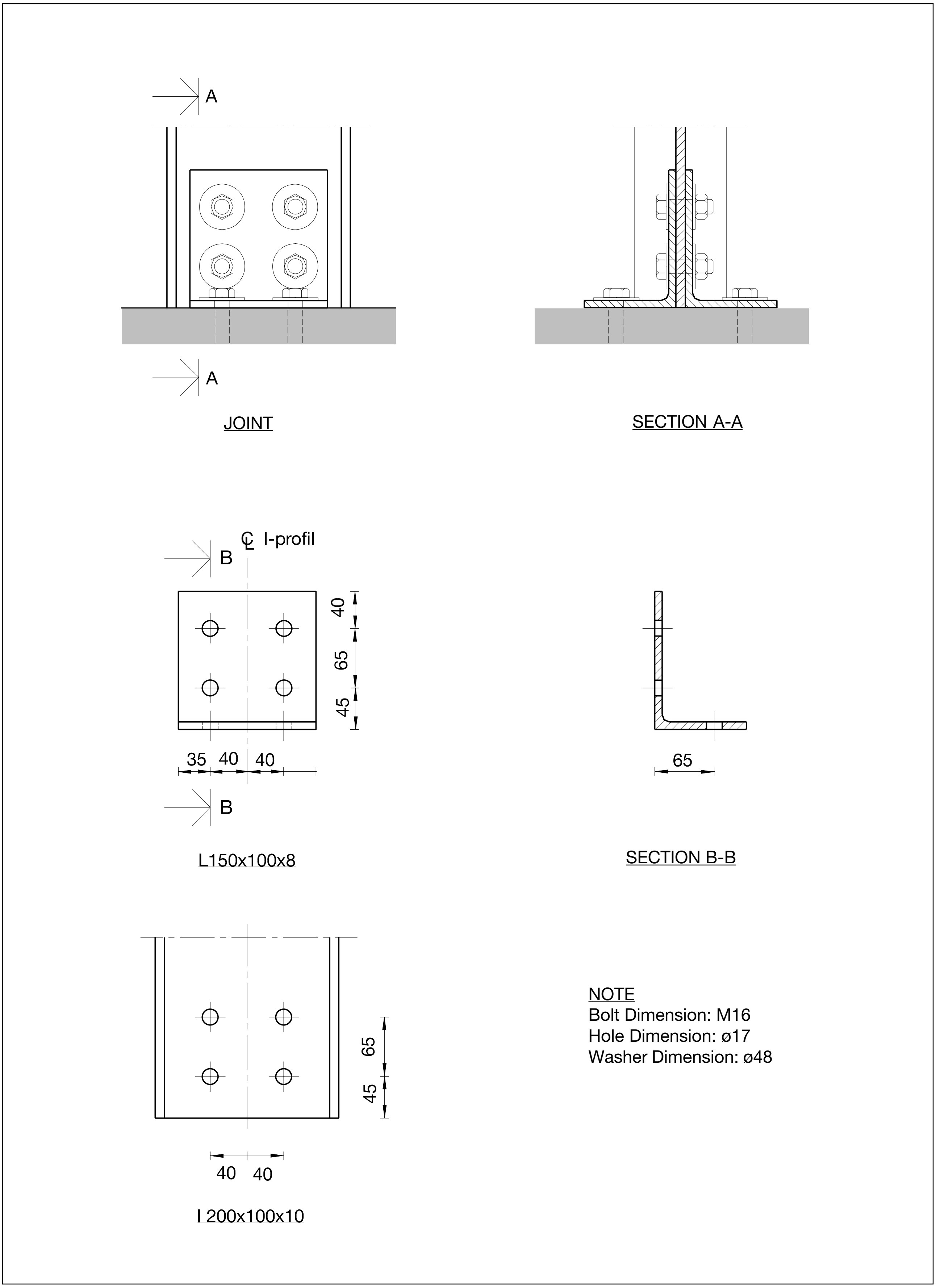
P_{vert}: $\frac{F}{4} < 18{,}5$ kN (Table 4.1)

L 150 x 100 x 8

P_{vert}: $\frac{F}{8} < 6{,}9$ kN (Table 4.2)

thus F < 55,2 kN (8 · 6,9 kN)

Figure 4.19


A
A
JOINT
SECTION A-A
℄ I-profil
B
B
40
65
45
35 40 40
L150x100x8
65
SECTION B-B
65
45
40 40
I 200x100x10
NOTE
Bolt Dimension: M16
Hole Dimension: ø17
Washer Dimension: ø48

Example 4.3: Detail of column base U 200 x 60 x 10

An asymmetrical joint which is illustrated on the next page in Figure 4.20, is used, for example, when a platform or stairs is placed against an existing structure. A symmetrical joint is illustrated in Example 4.2.

Load

The joint must be able to transfer a vertical force in U 200 x 60 x 10

Distances between bolts

U 200 x 60x 10

Distances between bolts	65 mm > 4,0 · 16 mm	(OK!)

L 150 x 100 x 8

from edge in transverse direction:	35 mm > 2,0 · 16 mm	(OK!)
distance between bolts:	65 mm > 4,0 · 16 mm	(OK!)

Static model

The bolts are assumed to be subjected to shear only.

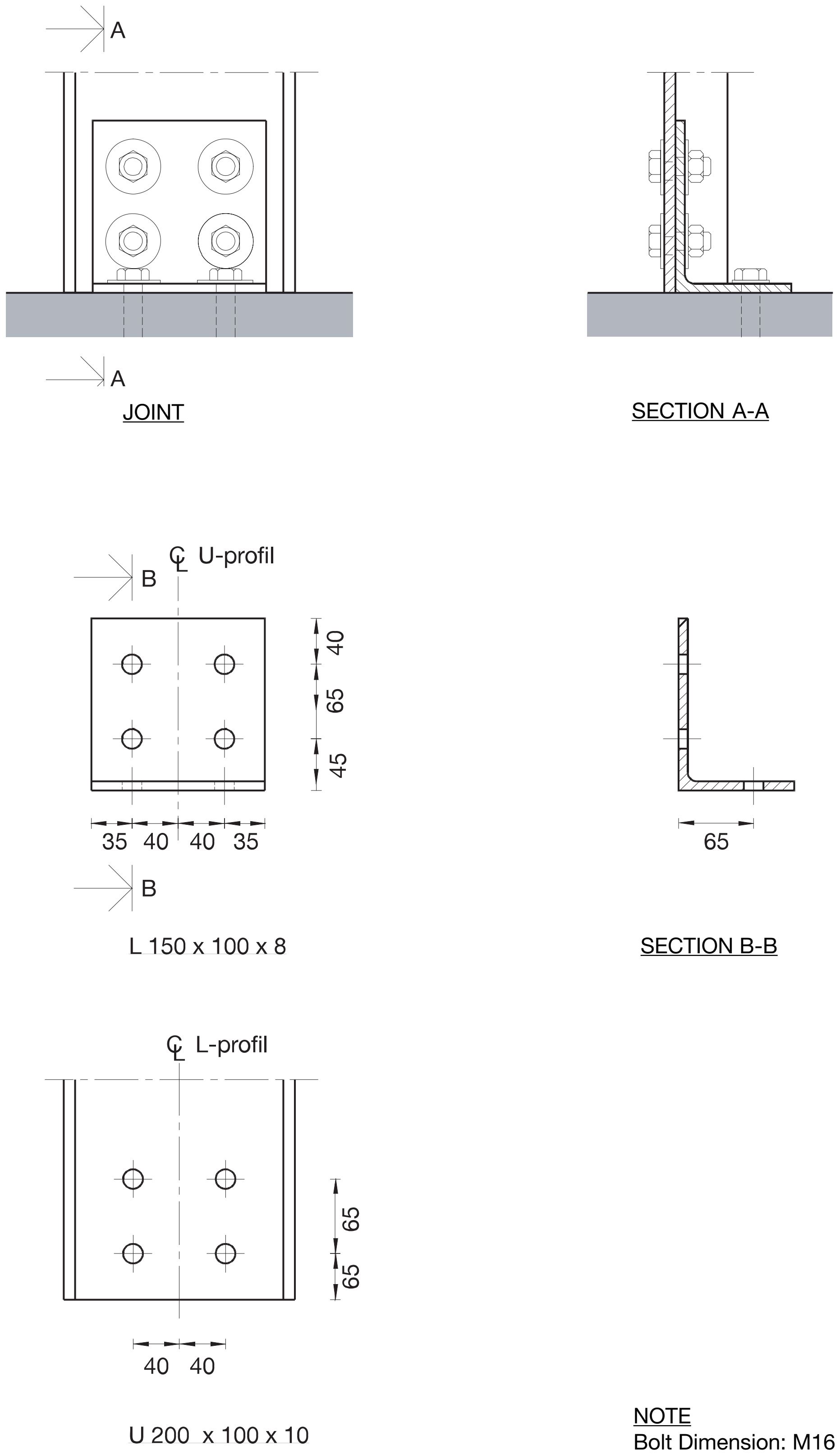
Bolt strengths and load-bearing capacity

The total vertical force is indicated as F.

U 200 x 60 x 10	P_{vert}: $\frac{F}{4}$	< 18,5 kN	(Table 4.1)
L 150 x 100 x 8	P_{vert}: $\frac{F}{4}$	< 6,9 kN	(Table 4.2)

thus F < 27,6 kN (4 · 6,9 kN)

Figure 4.20



NOTE
Bolt Dimension: M16
Hole Dimension: ø17
Washer Dimension: ø48

Example 4.4: Detail of column base – square tube 100 x 100 x 8

To allow joints to be bolted on the outside of the structure, place a solid fibreglass profile inside the square tube. The joint is illustrated in Figure 4.21.

Load

The joint must be capable of transferring a vertical force in a square tube 100 x 100 x 8.

Distances between bolts

Square tube 100 x 100 x 8

distance between bolts:	65 mm > 4.0 · 16 mm	(OK!)

L 150 x 100 x 8

from edge in transverse direction:	50 mm > 2,0 · 16 mm	(OK!)
distance between bolts:	65 mm > 4,0 · 16 mm	(OK!)

Static model

The bolts are assumed to be subjected to shear only.

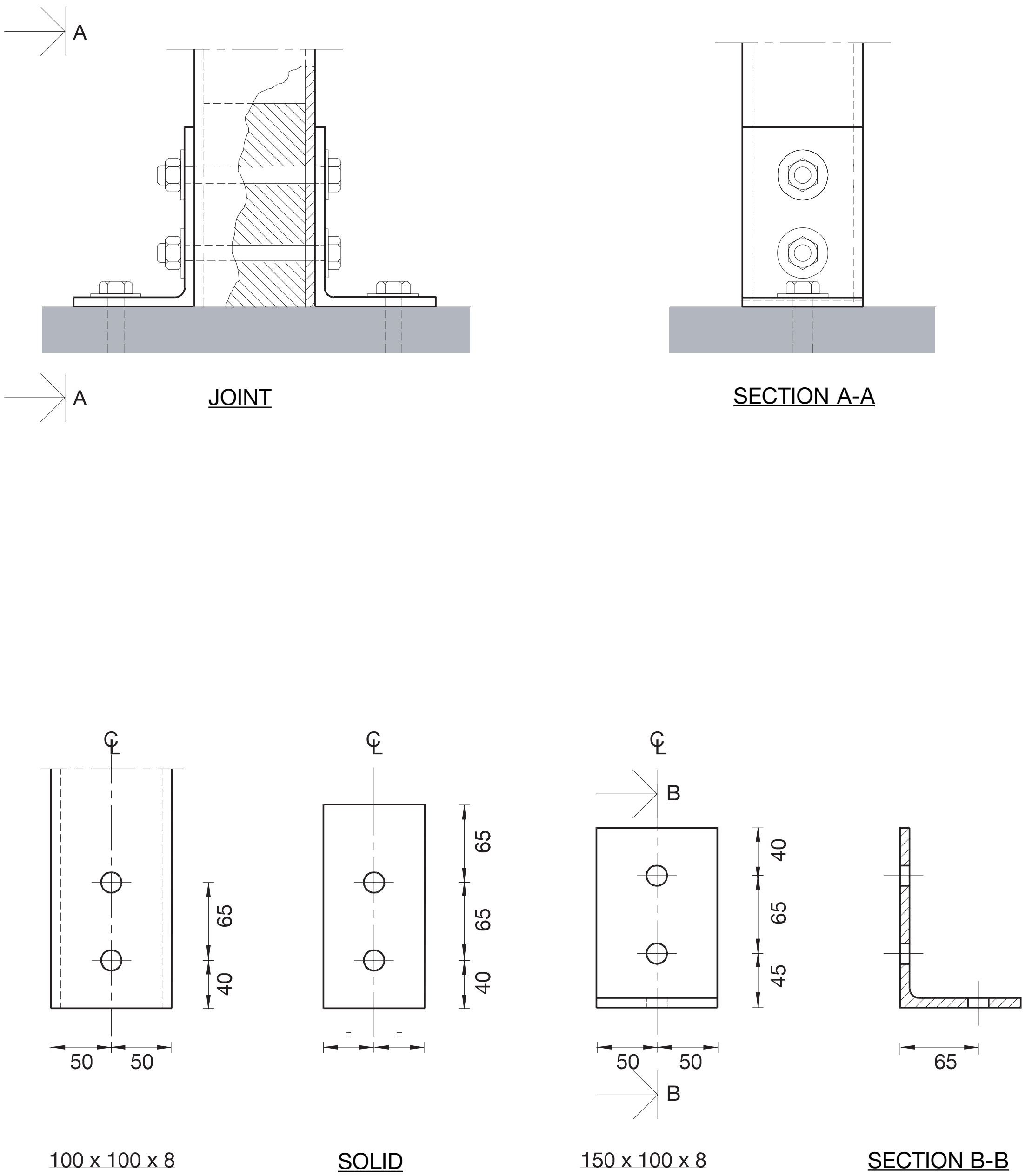
Bolt strengths and load-bearing capacity

The total vertical force is indicated as F.

Square tube 100 x 100 x 8	P_{vert}: $\frac{F}{4}$	< 14.8 kN	(Table 4.1)
L 150 x 100 x 8	P_{vert}: $\frac{F}{4}$	< 6.9 kN	(Table 4.2)

thus F < 27.6 kN (4 · 6.9 kN)

Figure 4.21



NOTE
Bolt Dimension: M16
Hole Dimension: ø17
Washer Dimension: ø48
Solid is chamfed on vertical edges

Example 4.5: Beam U 200 x 60 x 10 and column I 200 x 100 x 10

The joint illustrated in Figure 4.22 can, for example, be used between supporting beams and columns.

Load

The joint must be able to transfer a vertical shear force from U 200 x 60 x 10 to column I 200 x 100 x 10.

Distances between bolts

<u>I 200 x 100 x 10</u>

distance between bolts: 100 mm > 4.0 · 16 mm (OK!)

<u>U 200 x 60 x 10</u>

distance between bolts: 100 mm > 4,.0 · 16 mm (OK!)

Static model

The bolts are assumed to be subjected to shear only.

Bolt strengths and load-bearing capacity

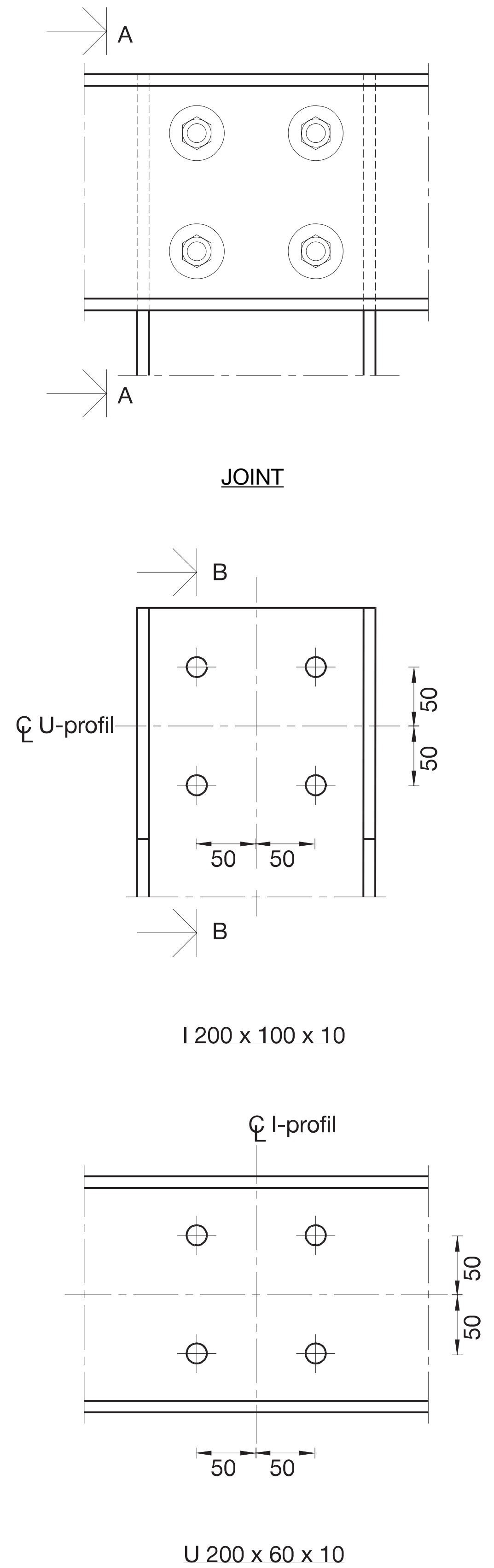
U 200 x 60 x 10 is the dimensioning factor, as loads act on this profile in the transverse direction.
The total shear force F can be calculated as:

P_{vert}: $\frac{F}{4} < 8.6$ kN (Table 4.2)

or

F < 34.4 kN

Figure 4.22



NOTE
Bolt Dimension: M16
Hole Dimension: ø17
Washer Dimension: ø48
Radii not stated R10

Example 4.6: Beam and column I 200 x 100 x 10

The joint is illustrated on the next page in Figure 4.23.

Load

The joint must be able to transfer a vertical force from the beam to the column.

Distances between bolts

I 200 x 100 x 10

distance between bolts: 70 mm > 4.0 · 12 mm (OK!)
distance from edge: 25 mm > 2.0 · 12 mm (OK!)

L 150 x 100 x 8

distance between bolts: 70 mm > 4.0 · 16 mm (OK!)
distance from edge: 25 mm > 2.0 · 12 mm (OK!)

Static model

The bolts are assumed to be subjected to shear only.

Bolt strengths and load-bearing capacity

The total vertical force is indicated as F.

I 200 x 100 x 10

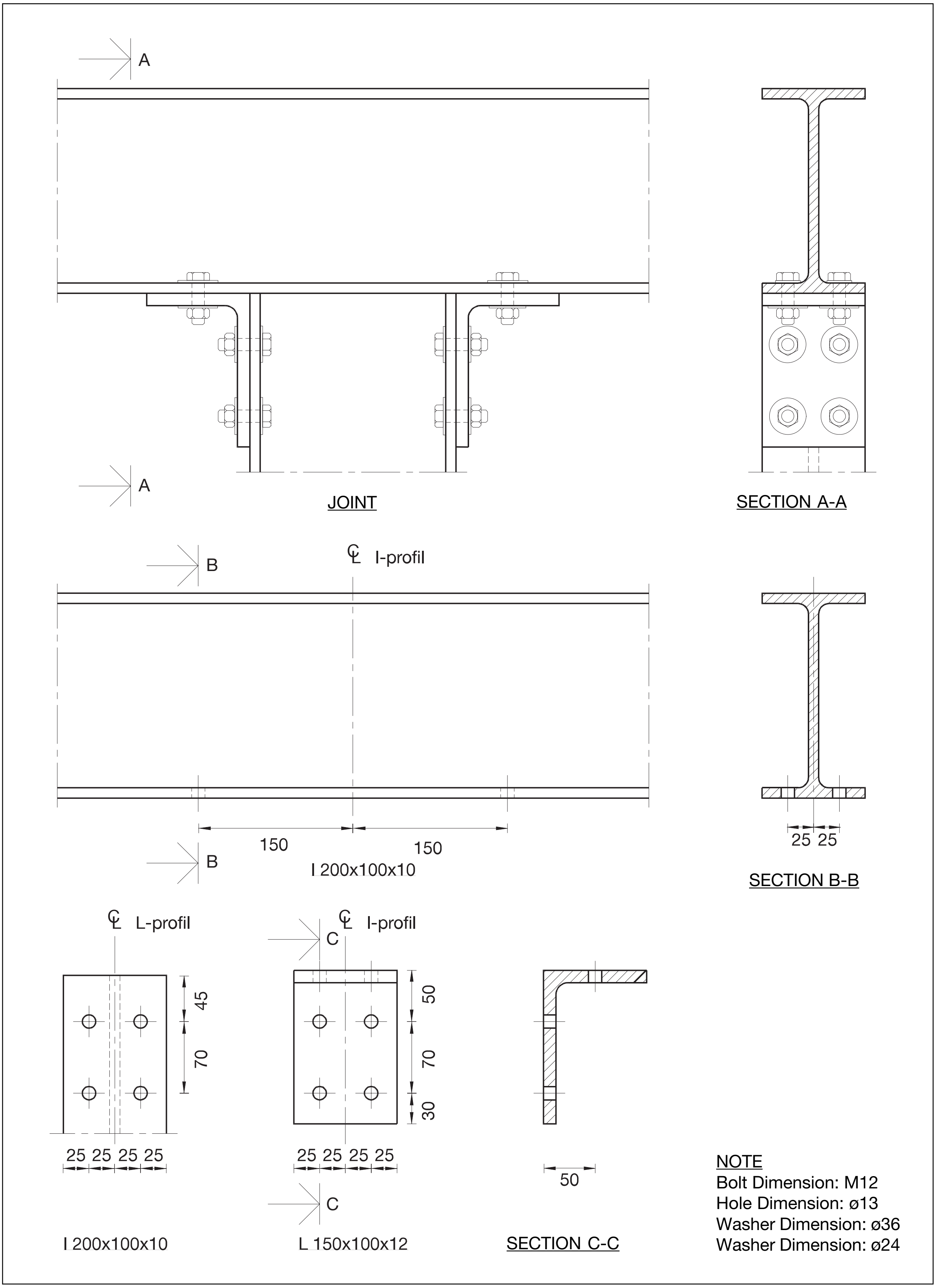
P_{vert}: $\frac{F}{8} < 10.0$ kN (Table 4.1)

L 150 x 100 x 12

P_{vert}: $\frac{F}{8} < 5.6$ kN (Table 4.2)

thus F < 44.8 kN (8 · 5.6 kN)

Figure 4.23


A
A
JOINT
SECTION A-A
B
℄ I-profil
B
150
150
I 200x100x10
25 25
SECTION B-B
℄ L-profil
℄ I-profil
C
45
70
50
70
30
25 25 25 25
25 25 25 25
C
50
I 200x100x10
L 150x100x12
SECTION C-C
NOTE
Bolt Dimension: M12
Hole Dimension: ø13
Washer Dimension: ø36
Washer Dimension: ø24

Example 4.7: Beam U200x60x10 and column. Square tube 100x100x8

The joint is illustrated on the next page in Figure 4.24.

Load

The joint must be capable of transferring a vertical force from the beam to the column.

Distances between bolts

U 200 x 60 x 10

distance between bolts: 80 mm > 4.0 · 16 mm (OK!)

Square tube 100 x 100 x 8

distance between bolts: 80 mm > 4.0 · 16 mm (OK!)

Static model

The bolts are assumed to be subjected to shear only.

Bolt strengths and load-bearing capacity

The total vertical force is indicated as F.

U 200 x 60 x 10

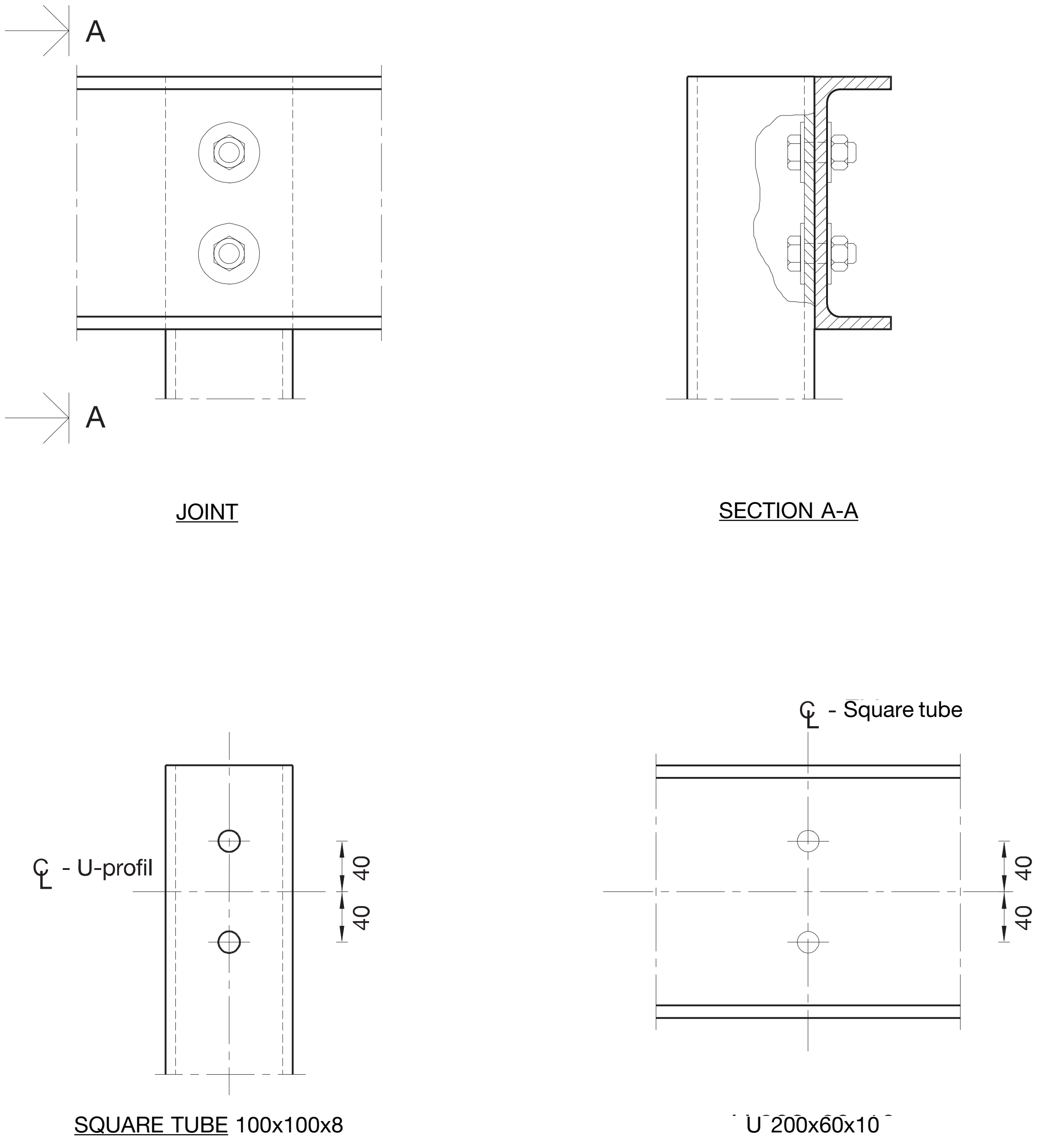
P_{vert}: $\frac{F}{2} < 8.6$ kN (Table 4.2)

Square tube 100 x 100 x 8

P_{vert}: $\frac{F}{2} < 14.8$ kN (Table 4.1)

thus F < 17,2 kN (2 · 8.6 kN)

Figure 4.24



NOTE
Bolt Dimension: M16
Hole Dimension: ø17
Washer Dimension: ø48

Example 4.8: Two horizontal beams I 200 x 100 x 10

This joint can be used between supporting beams in a platform. An example is illustrated on page 1.4.30 in Figure 4.25.

Load

The joint must be capable of transferring a vertical shear force from the I 200 x 100 x 10 to which it is connected, to the through-going I 200 x 100 x 10.

Distances between bolts

<u>I 200 x 100 x 10</u>

from edge in longitudinal direction (0°)	35 mm = 3.5 · 10 mm	(OK!)
from edge in transverse direction (90°):	35 mm > 2.0 · 10 mm	(OK!)
distance between bolts:	45 mm > 4.0 · 10 mm	(OK!)

<u>L 75 x 75 x 8</u>

from edge in longitudinal direction (0°):	35 mm = 3,5 · 10 mm	(OK!)
from edge in transverse direction (90°):	35 mm > 2,5 · 10 mm	(OK!)
distance between bolts:	45 mm > 4,0 · 10 mm	(OK!)

Static model

Bolt strengths are determined on the basis that these must be statically equivalent to a shear force imposed in the middle of the through-going I 200 x 100 x 10.

Bolt strengths in the connected I 200 x 100 x 10

Bolt strengths are determined on the basis of the total shear force F.

Bolt strength is compared with the relevant load-bearing capacity in the tables in section 4.

Bottom bolt:

$$P_{horz} < 11.5 \text{ kN}$$

$$P_{horz} = \frac{F \cdot 45 \text{ mm}}{90 \text{ mm}} = 0.500 \cdot F$$

$$P_{vert} < 3.9 \text{ kN}$$

$$P_{vert} = F \cdot \alpha$$

The combined load-bearing capacity will be sufficient if

$$\left(\frac{P_{horz}}{11{,}5 \text{ kN}}\right)^2 + \left(\frac{P_{vert}}{5{,}4 \text{ kN}}\right)^2 < 1{,}0$$

Middle bolt:

P_{vert}: $F \cdot (1 - 2 \cdot \alpha) < 5.4$ kN (table 4.2)

Top bolt:

As bottom bolt

If $\alpha = 0.3$, the maximum value for F cannot exceed 13.4 kN.

Bolt strengths in L 75 x 75 x 8 brackets

Bolt strengths in joint connecting **I** 200 x 100 x 10 are half of the values indicated above.

Utilization of the bolts in terms of F= 13.4 kN

Bottom bolt:

$$\left(\frac{P_{horz}}{4{,}3\ \text{kN}}\right)^2 + \left(\frac{P_{vert}}{9{,}2\ \text{kN}}\right)^2 < 1.0$$

$$\left(\frac{3{,}4\ \text{kN}}{4{,}3\ \text{kN}}\right)^2 + \left(\frac{2{,}0\ \text{kN}}{9{,}2\ \text{kN}}\right)^2 = 0.67 \quad \text{(OK!)}$$

Middle bolt:

P_{vert}: 2.6 kN < 9.2 kN (OK!) (Table 4.1)

Bolt strengths in through-going I 200 x 100 x 10

According to the established conditions, these bolts are only subjected to shear force.

Given the same distribution as in the joint connecting the **I** 200, the values from the top and bottom bolts are:

$$P_{vert} = 0.5 \cdot 0.3 \cdot 13.4\ \text{kN} = 2.0\ \text{kN}$$

$$P_{horz} = \frac{0{,}5 \cdot 13{,}4 \cdot 45\ \text{mm}}{90\ \text{mm}} = 3.4\ \text{kN}$$

There is sufficient capacity, since

$$\left(\frac{P_{horz}}{11{,}5\ \text{kN}}\right)^2 + \left(\frac{P_{vert}}{5{,}4\ \text{kN}}\right)^2 < 1.0$$

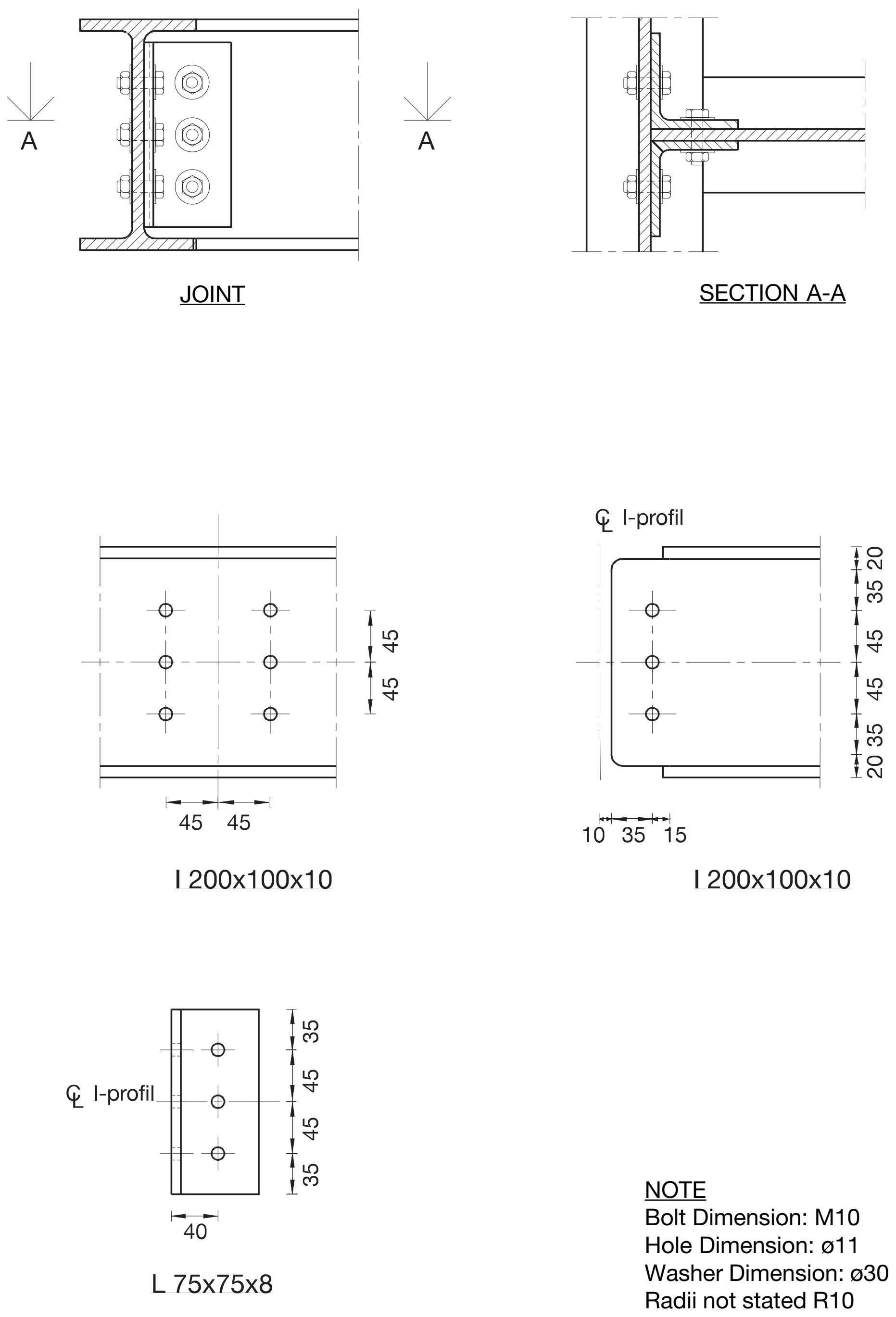
$$\left(\frac{2{,}0\ \text{kN}}{11{,}5\ \text{kN}}\right)^2 + \left(\frac{3{,}4\ \text{kN}}{5{,}4\ \text{kN}}\right)^2 = 0.43 \quad \text{(OK!)} \quad \text{(Table 4.1 and 4.2)}$$

The value for the middle bolt is:

$P_{vert} < 5.4$ kN

$P_{vert} = 0.5 \cdot 0.4 \cdot 13.4$ kN = 2.7 kN (OK!) (Table 4.2)

Figure 4.25


A
A
JOINT
SECTION A-A
45
45
45 45
I 200x100x10
Ꞓ I-profil
20
35
45
45
35
20
10 35 15
I 200x100x10
Ꞓ I-profil
35
45
45
35
40
L 75x75x8
NOTE
Bolt Dimension: M10
Hole Dimension: ø11
Washer Dimension: ø30
Radii not stated R10

Example 4.9: Two horizontal beams U 200 x 60 x 10

This joint can be used to connect supporting beams in a platform. It is illustrated on page 1.4.33 in Figure 4.26.

Load

The joint must be able to transfer vertical shear force from the one U 100 x 60 x 10 beam to the other.

Distances between bolts

U 200 x 60 x 10

from edge in longitudinal direction (0°):	50 mm > 3.5 · 12 mm	(OK!)
distance between bolts:	70 mm > 4.0 · 12 mm	(OK!)

L 100 x 100 x 12

from edge in longitudinal direction (0°):	45 mm > 3.5 · 12 mm	(OK!)
from edge in transverse direction (90°):	40 mm > 2.5 · 12 mm	(OK!)
distance between bolts:	70 mm > 4.0 · 12 mm	(OK!)

Static model

Bolt strengths must be statically equivalent to shear force imposed in the secant between the centre lines of the web of the two U 200 x 60 x 10 profiles.

Bolt strengths in L 100 x 100 x 12

Bolts are subjected to both vertical and horizontal forces.

Bolt strengths are determined on the basis of the total shear force F.

The bolt strength is compared with the relevant load-bearing capacity in Tables 4.1 and 4.2 for load-bearing capacity of bolts subjected to shear.

$P_{horz} < 7.8$ kN

$P_{horz} = \frac{F \cdot 64\ mm}{70\ mm} = 0.914 \cdot F$ (Table 4.2)

P_{vert}: $F \cdot 0.500 < 16.6$ kN (Table 4.1)

The combined load-bearing capacity is sufficient if

$$\left(\frac{P_{horz}}{7{,}8\ kN}\right)^2 + \left(\frac{P_{vert}}{16{,}6\ kN}\right)^2 < 1.0$$

thus the maximum value of F cannot exceed 8.3 kN.

Bolt strengths in U 200 x 60 x 10

For F = 8.3 kN the bolt strengths will be

$P_{horz} < 13.8$ kN

$P_{horz} = \frac{F \cdot 64\ mm}{70\ mm} = 0.914 \cdot F = 7.6$ kN (Table 4.1)

$P_{vert} < 6.5$ kN

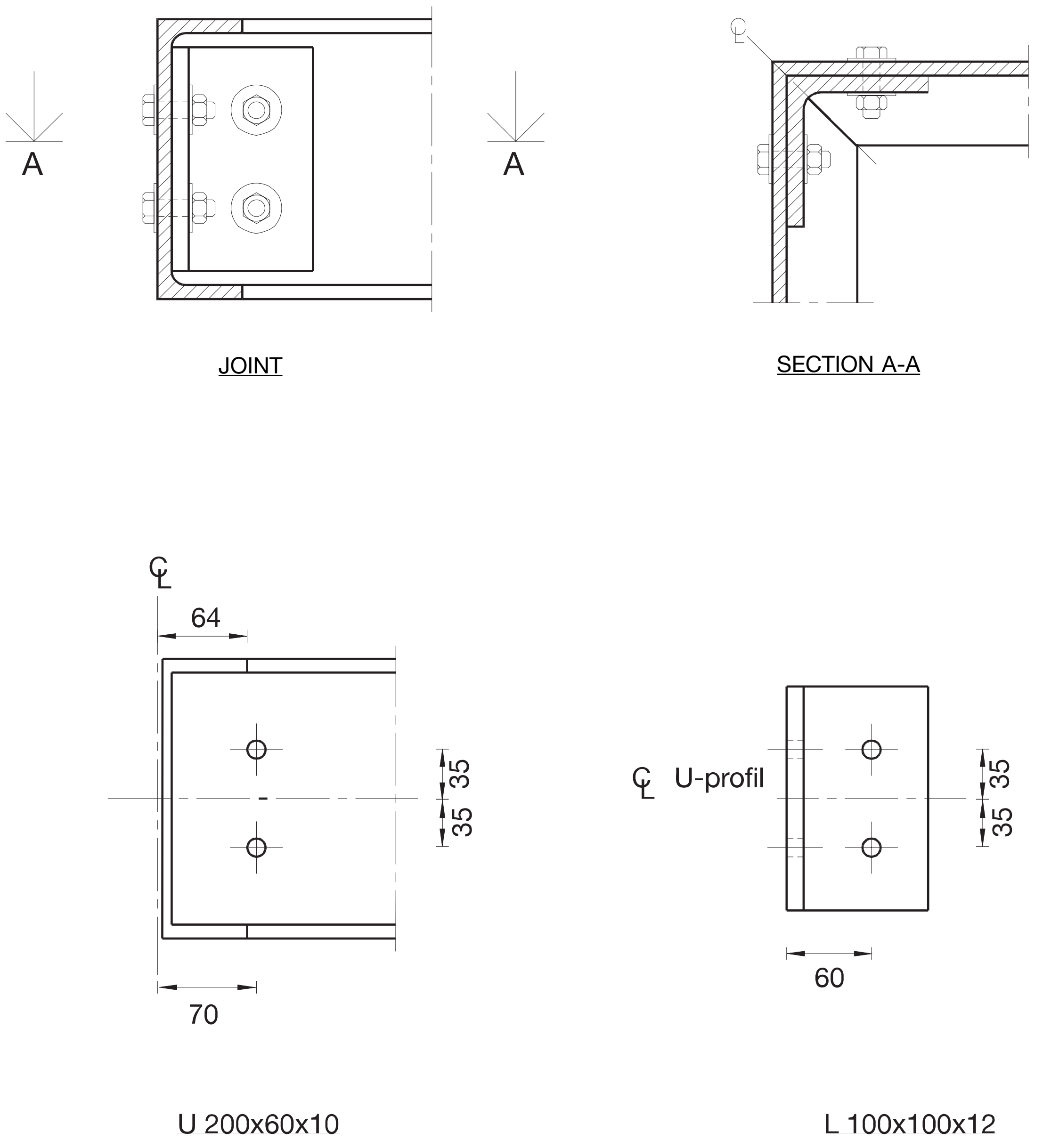
$P_{vert} = F \cdot 0{,}500 = 4.2$ kN (Table 4.2)

The combined load-bearing capacity will be sufficient if

$$\left(\frac{P_{horz}}{13{,}8\ kN}\right)^2 + \left(\frac{P_{vert}}{6{,}5\ kN}\right)^2 < 1.0$$

$$\left(\frac{7{,}6\ kN}{13{,}8\ kN}\right)^2 + \left(\frac{4{,}2\ kN}{6{,}5\ kN}\right)^2 = 0.72$$ (OK!)

Figure 4.26



NOTE
Bolt Dimension: M12
Hole Dimension: ø13
Washer Dimension: ø36

CHAPTER 1

Section 5: Glued joints

Glued joints

Using glue (an adhesive agent) can be a suitable method for joining pultruded profiles.

Glue has many advantages.

- It is easy to make aesthetic joints.
- Glued joints between profiles are typically more rigid than traditional bolted joints.
- Some types of glue are extremely strong, making it possible to limit the extent of contact areas.
- Glued joints subjected to dynamic loads are good.

However, it is necessary to consider a number of conditions in using a glued joint.

- A number of adhesive agents have properties that depend on time, and are influenced by environmental factors such as humidity and the chemical composition of the air.
- Failure in glued joints takes place suddenly in contrast to bolted joints.
- The load-bearing capacity of a glued joint is not proportional to the area which is glued. The load-bearing capacity of a specific joint only increases with the glued area to a certain point, after which it remains constant for the glued area. This condition is due to the fact that fracture is connected with certain tensions in the adhesive layer, typically in the transition from the one profile to the other.

Because failure in glued joints occurs suddenly, joints in load-bearing structures are normally secured with bolts. In many cases, an adhesive is applied to the contact surfaces between the joined profiles, thus increasing the rigidity of the joint in operation.

Glued joints have many advantages in comparison with bolted joints. Around the world, intensive research is being carried out in the mode of operation of glued joints. When sufficient knowledge becomes available, advance verification of tests will be unnecessary, and glued joints will undoubtedly find favour as primary joints in bearing structures. Fiberline takes active part in this research process.

Many tests suggest that also combining bolts and glue in joints can be interesting, since appropriately placed bolts can prevent the spread of cracks which leads to failure in a glued joint.

Examples of glued joints are illustrated in Figure 6.1.

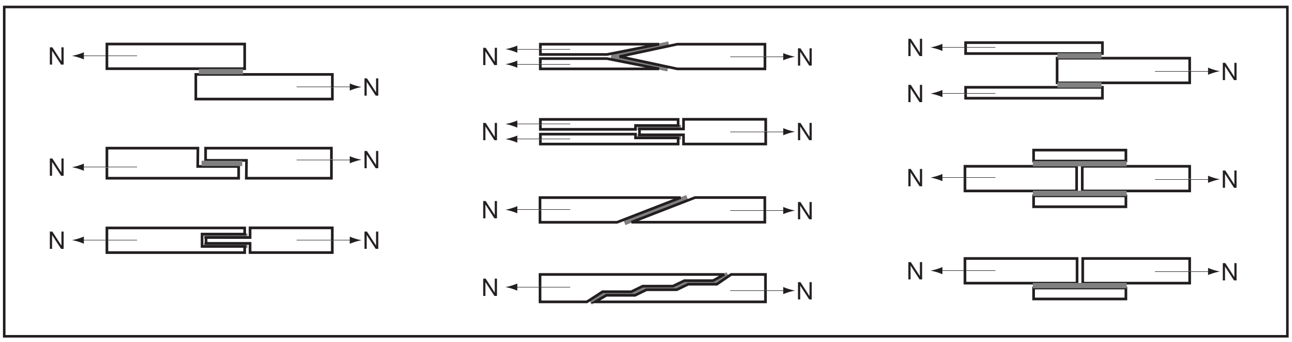


Figure 6.1. Examples of glued joints

Example of glued joint in combination with bolts

Materials for use in joints with glue and bolts.

Types of glue:

For a load-bearing structure, use a two-component epoxy or a polyurethane glue, following the instructions of an authorized supplier.

Boring bolt-holes

Grinding and cleaning glue surfaces

Applying glue with a filling knife.

Assembly of glued surfaces with the aid of bolts

CHAPTER 1

Section 6: Profile tables

Introduction

Profile A axial load-bearing capacity (or: load-bearing capacity as column) in kN.

Profile B transverse load-bearing capacity (or: load-bearing capacity as beam) in kN/m.

Each Fiberline structural profile is presented on two pages. The front page shows an illustration of the profile, as well as its geometric data and tables of the load-bearing capacity as a column, while the tables on the back page present information on the load-bearing capacity of the profile as a one-, two-, or three-span beam.

For columns (page A), the buckling length is determined first, using the figures shown for the four elementary situations at the bottom of the page to the right. The buckling length is used to determine the maximum permissible load around both the strong and the weak profile axes in the tables to the left. The column calculations have been carried out as described in Chapter 1, Section 3, *Profiles subjected to tensile strength or compression*, on page 1.3.3.

The tables can be used to analyse compound structures subjected to compression, for example lattice columns and compression flanges in lattice girders, provided that angular motion of the profile subjected to compression is sufficiently prevented.

It is sufficient that I- and U-profiles are secured against buckling in the "weak" direction, so that angular motion of the column profile is prevented.

The critical loads for local instability (flange buckling) of L- and T- profiles, which are not resistant to buckling, are listed in the data sheets. If a profile is subjected to compression that exceeds the load-bearing capacity of a local instability, it is necessary to prevent angular motion. Cases in which local instability can be decisive are indicated in the tables with •.

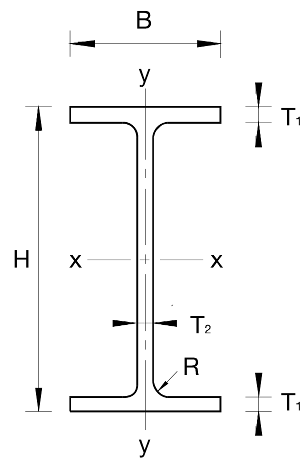
The second page (Page B) has three tables which provide information for a simply supported profile of one, two or three spans. The load-bearing capacity is a uniform line load in all three examples. The span of the profile, which is illustrated next to each of the three examples, is used to determine the load-bearing capacity in kN/m by means of four different design criteria. At the top, the ultimate limit state indicates the absolute maximum load-bearing capacity of the profile. The middle example is the serviceability limit state. Its criterion is the deflection which is a predetermined ratio of the length of span L.

The load-bearing capacity of the profile is illustrated as the maximum deflection for L/200, L/300 and L/400, respectively. The load-bearing capacity around the weak axis of the profile is indicated by a dark background. In all calculations, it is assumed that the compressed part of the profile is secured to prevent lateral buckling.

The material constants and partial coefficients used are summarized schematically in Section 2. This section also contains a complete list of the geometric data of the profiles and a list of masses.

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	89.2
2.25	76.0
2.50	65.1
2.75	56.2
3.00	48.9
3.25	42.9
3.50	37.8
3.75	33.6
4.00	30.0
4.25	26.9
4.50	24.3
4.75	22.0
5.00	20.0
5.25	18.3
5.50	16.8
5.75	15.4
6.00	14.2
6.25	13.2
6.50	12.2
6.75	11.4
7.00	10.6
7.25	9.9
7.50	9.3
7.75	8.7
8.00	8.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	96.5
0.60	75.6
0.70	60.1
0.80	48.7
0.90	40.0
1.00	33.4
1.10	28.2
1.20	24.1
1.30	20.8
1.40	18.2
1.50	16.0
1.60	14.1
1.70	12.6
1.80	11.3
1.90	10.2
2.00	9.2
2.10	8.4
2.20	7.7
2.30	7.0
2.40	6.5
2.50	6.0
2.60	5.5
2.70	5.1
2.80	4.8
3.00	4.2



Geometry	
H	120 mm
B	60 mm
T_1	6 mm
T_2	6 mm
R	7,5 mm

Cross-section constants	
A	1 416 mm^2
I_{xx}	3 103 591 mm^4
W_{xx}	51 727 mm^3
$A_{k,y}$	684 mm^2
I_{yy}	219 095 mm^4
W_{yy}	7 303 mm^3
$A_{k,x}$	576 mm^2

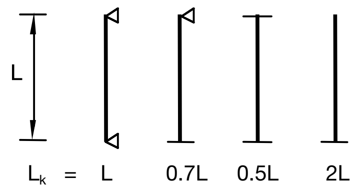
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

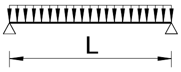
Design value for load-bearing capacity
261.5 kN

Dead weight
2.55 kg/m

Buckling length

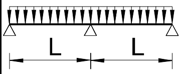


One span



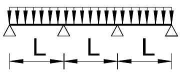
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	13.15	11.69	10.52	9.57	8.49	7.23	6.24	5.43	4.77	4.23	3.77	3.39	3.06	2.77	2.53	2.31	2.12
	y direction	2.70	2.13	1.73	1.43	1.20	1.02	0.88	0.77	0.67	0.60	0.53	0.48	0.43	0.39	0.36	0.33	0.30
Application limit point																		
δ_{max} < L / 200	x direction	3.16	2.26	1.67	1.26	0.98	0.77	0.62	0.51	0.42	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.13
	y direction	0.24	0.17	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
δ_{max} < L / 300	x direction	2.11	1.51	1.11	0.84	0.65	0.52	0.41	0.34	0.28	0.23	0.20	0.17	0.14	0.12	0.11	0.10	0.08
	y direction	0.16	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	1.58	1.13	0.83	0.63	0.49	0.39	0.31	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06
	y direction	0.12	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	10.52	9.35	8.42	7.65	7.02	6.48	6.01	5.43	4.77	4.23	3.77	3.39	3.06	2.77	2.53	2.31	2.12
	y direction	2.70	2.13	1.73	1.43	1.20	1.02	0.88	0.77	0.67	0.60	0.53	0.48	0.43	0.39	0.36	0.33	0.30
Application limit point																		
δ_{max} < L / 200	x direction	6.86	4.99	3.74	2.86	2.24	1.78	1.44	1.18	0.98	0.82	0.70	0.59	0.51	0.44	0.39	0.34	0.30
	y direction	0.57	0.40	0.29	0.22	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
δ_{max} < L / 300	x direction	4.57	3.33	2.49	1.91	1.49	1.19	0.96	0.79	0.65	0.55	0.46	0.40	0.34	0.29	0.26	0.23	0.20
	y direction	0.38	0.27	0.20	0.15	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01
δ_{max} < L / 400	x direction	3.43	2.50	1.87	1.43	1.12	0.89	0.72	0.59	0.49	0.41	0.35	0.30	0.26	0.22	0.19	0.17	0.15
	y direction	0.29	0.20	0.15	0.11	0.09	0.07	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01

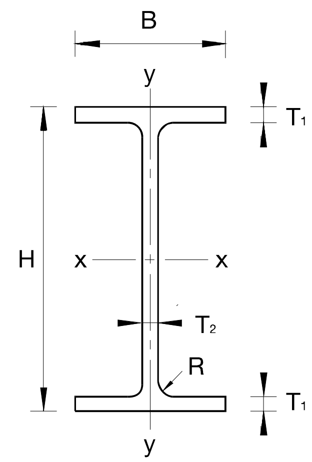
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	10.96	9.74	8.77	7.97	7.31	6.75	6.26	5.85	5.48	5.16	4.72	4.23	3.82	3.46	3.16	2.89	2.65
	y direction	3.37	2.66	2.16	1.78	1.50	1.28	1.10	0.96	0.84	0.75	0.67	0.60	0.54	0.49	0.45	0.41	0.37
Application limit point																		
δ_{max} < L / 200	x direction	5.60	4.05	3.02	2.30	1.80	1.43	1.15	0.94	0.78	0.65	0.55	0.47	0.40	0.35	0.31	0.27	0.24
	y direction	0.45	0.32	0.23	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02
δ_{max} < L / 300	x direction	3.73	2.70	2.01	1.53	1.20	0.95	0.77	0.63	0.52	0.44	0.37	0.31	0.27	0.23	0.20	0.18	0.16
	y direction	0.30	0.21	0.15	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01
δ_{max} < L / 400	x direction	2.80	2.02	1.51	1.15	0.90	0.71	0.58	0.47	0.39	0.33	0.28	0.24	0.20	0.18	0.15	0.13	0.12
	y direction	0.23	0.16	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	242.4
2.25	215.4
2.50	191.5
2.75	170.6
3.00	152.4
3.25	136.6
3.50	122.8
3.75	110.8
4.00	100.3
4.25	91.1
4.50	83.1
4.75	76.0
5.00	69.7
5.25	64.1
5.50	59.1
5.75	54.7
6.00	50.7
6.25	47.2
6.50	44.0
6.75	41.0
7.00	38.4
7.25	36.0
7.50	33.8
7.75	31.8
8.00	30.0

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	257.7
0.60	216.0
0.70	181.3
0.80	153.0
0.90	130.0
1.00	111.3
1.10	96.0
1.20	83.4
1.30	73.1
1.40	64.4
1.50	57.1
1.60	51.0
1.70	45.7
1.80	41.2
1.90	37.4
2.00	34.0
2.10	31.0
2.20	28.5
2.30	26.2
2.40	24.2
2.50	22.4
2.60	20.7
2.70	19.3
2.80	18.0
3.00	15.8



Geometry	
H	160 mm
B	80 mm
T_1	8 mm
T_2	8 mm
R	8 mm

Cross-section constants	
A	2 487 mm^2
I_{xx}	9 661 724 mm^4
W_{xx}	120 772 mm^3
$A_{k,y}$	1 216 mm^2
I_{yy}	690 774 mm^4
W_{yy}	17 269 mm^3
$A_{k,x}$	1 024 mm^2

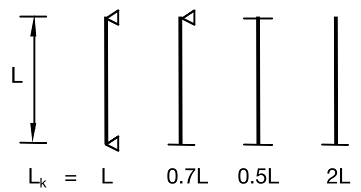
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

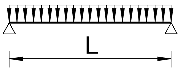
Design value for load-bearing capacity
459.1 kN

Dead weight
4.48 kg/m

Buckling length

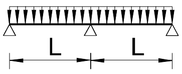


One span



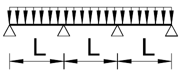
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	23.38	20.79	18.71	17.01	15.59	14.39	13.36	12.47	11.15	9.88	8.81	7.91	7.13	6.47	5.90	5.39	4.95
	y direction	6.38	5.04	4.08	3.37	2.83	2.41	2.08	1.81	1.59	1.41	1.26	1.13	1.02	0.93	0.84	0.77	0.71
Application limit point																		
δ_{max} < L / 200	x direction	11.02	8.00	5.97	4.57	3.57	2.84	2.29	1.88	1.55	1.30	1.10	0.94	0.81	0.70	0.61	0.53	0.47
	y direction	0.91	0.64	0.47	0.35	0.27	0.22	0.17	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03
δ_{max} < L / 300	x direction	7.35	5.33	3.98	3.04	2.38	1.89	1.53	1.25	1.04	0.87	0.73	0.63	0.54	0.47	0.41	0.36	0.31
	y direction	0.61	0.43	0.31	0.24	0.18	0.14	0.12	0.09	0.08	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02
δ_{max} < L / 400	x direction	5.51	4.00	2.98	2.28	1.78	1.42	1.14	0.94	0.78	0.65	0.55	0.47	0.40	0.35	0.31	0.27	0.24
	y direction	0.46	0.32	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	18.71	16.63	14.97	13.61	12.47	11.51	10.69	9.98	9.35	8.80	8.31	7.88	7.13	6.47	5.90	5.39	4.95
	y direction	6.38	5.04	4.08	3.37	2.83	2.41	2.08	1.81	1.59	1.41	1.26	1.13	1.02	0.93	0.84	0.77	0.71
Application limit point																		
δ_{max} < L / 200	x direction	21.85	16.38	12.54	9.79	7.77	6.26	5.11	4.22	3.52	2.97	2.53	2.16	1.87	1.62	1.42	1.25	1.10
	y direction	2.15	1.52	1.12	0.84	0.65	0.51	0.41	0.33	0.28	0.23	0.19	0.17	0.14	0.12	0.11	0.09	0.08
δ_{max} < L / 300	x direction	14.57	10.92	8.36	6.52	5.18	4.17	3.41	2.81	2.35	1.98	1.68	1.44	1.25	1.08	0.95	0.83	0.74
	y direction	1.43	1.02	0.74	0.56	0.43	0.34	0.27	0.22	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05
δ_{max} < L / 400	x direction	10.93	8.19	6.27	4.89	3.88	3.13	2.55	2.11	1.76	1.48	1.26	1.08	0.93	0.81	0.71	0.62	0.55
	y direction	1.08	0.76	0.56	0.42	0.33	0.26	0.21	0.17	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04

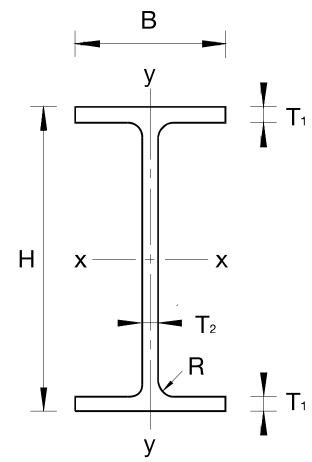
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	19.49	17.32	15.59	14.17	12.99	11.99	11.14	10.39	9.74	9.17	8.66	8.21	7.79	7.42	7.09	6.74	6.19
	y direction	7.97	6.30	5.10	4.22	3.54	3.02	2.60	2.27	1.99	1.77	1.57	1.41	1.28	1.16	1.05	0.96	0.89
Application limit point																		
δ_{max} < L / 200	x direction	18.38	13.63	10.35	8.02	6.33	5.08	4.13	3.40	2.83	2.38	2.02	1.73	1.49	1.30	1.13	0.99	0.88
	y direction	1.71	1.21	0.88	0.67	0.51	0.41	0.32	0.26	0.22	0.18	0.15	0.13	0.11	0.10	0.08	0.07	0.06
δ_{max} < L / 300	x direction	12.26	9.09	6.90	5.35	4.22	3.39	2.75	2.27	1.89	1.59	1.35	1.15	0.99	0.86	0.75	0.66	0.58
	y direction	1.14	0.80	0.59	0.44	0.34	0.27	0.22	0.18	0.15	0.12	0.10	0.09	0.07	0.06	0.06	0.05	0.04
δ_{max} < L / 400	x direction	9.19	6.82	5.18	4.01	3.17	2.54	2.07	1.70	1.42	1.19	1.01	0.87	0.75	0.65	0.57	0.50	0.44
	y direction	0.85	0.60	0.44	0.33	0.26	0.20	0.16	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	456.3
2.25	416.0
2.50	378.7
2.75	344.6
3.00	313.6
3.25	285.7
3.50	260.6
3.75	238.2
4.00	218.1
4.25	200.2
4.50	184.1
4.75	169.7
5.00	156.7
5.25	145.1
5.50	134.6
5.75	125.2
6.00	116.6
6.25	108.9
6.50	101.8
6.75	95.4
7.00	89.6
7.25	84.2
7.50	79.3
7.75	74.8
8.00	70.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	478.2
0.60	417.0
0.70	362.2
0.80	314.5
0.90	273.7
1.00	239.0
1.10	209.7
1.20	184.8
1.30	163.7
1.40	145.7
1.50	130.4
1.60	117.2
1.70	105.8
1.80	95.9
1.90	87.2
2.00	79.7
2.10	73.0
2.20	67.1
2.30	61.9
2.40	57.3
2.50	53.1
2.60	49.4
2.70	46.0
2.80	43.0
3.00	37.7



Geometry	
H	200 mm
B	100 mm
T_1	10 mm
T_2	10 mm
R	10 mm

Cross-section constants	
A	3 886 mm²
I_{xx}	23 588 193 mm⁴
W_{xx}	235 882 mm³
$A_{k,y}$	1 900 mm²
I_{yy}	1 686 460 mm⁴
W_{yy}	33 729 mm³
$A_{k,x}$	1 600 mm²

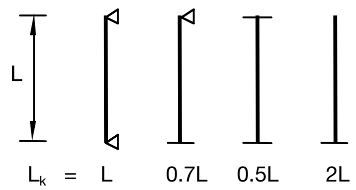
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

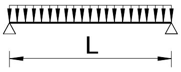
Design value for load-bearing capacity
717.4 kN

Dead weight
6.99 kg/m

Buckling length

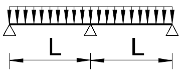


One span



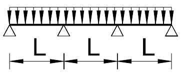
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	36.54	32.48	29.23	26.57	24.36	22.49	20.88	19.49	18.27	17.19	16.24	15.38	13.94	12.64	11.52	10.54	9.68
	y direction	12.45	9.84	7.97	6.59	5.54	4.72	4.07	3.54	3.11	2.76	2.46	2.21	1.99	1.81	1.65	1.51	1.38
Application limit point																		
δ_{max} < L / 200	x direction	24.80	18.25	13.78	10.63	8.36	6.68	5.42	4.46	3.71	3.11	2.64	2.26	1.94	1.68	1.47	1.29	1.14
	y direction	2.21	1.56	1.14	0.86	0.66	0.52	0.42	0.34	0.28	0.23	0.20	0.17	0.14	0.12	0.11	0.10	0.08
δ_{max} < L / 300	x direction	16.54	12.17	9.19	7.09	5.57	4.46	3.62	2.97	2.47	2.07	1.76	1.50	1.30	1.12	0.98	0.86	0.76
	y direction	1.48	1.04	0.76	0.58	0.44	0.35	0.28	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.06
δ_{max} < L / 400	x direction	12.40	9.13	6.89	5.32	4.18	3.34	2.71	2.23	1.85	1.56	1.32	1.13	0.97	0.84	0.74	0.65	0.57
	y direction	1.11	0.78	0.57	0.43	0.33	0.26	0.21	0.17	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	29.23	25.98	23.38	21.26	19.49	17.99	16.70	15.59	14.62	13.76	12.99	12.31	11.69	11.14	10.63	10.17	9.68
	y direction	12.45	9.84	7.97	6.59	5.54	4.72	4.07	3.54	3.11	2.76	2.46	2.21	1.99	1.81	1.65	1.51	1.38
Application limit point																		
δ_{max} < L / 200	x direction	45.66	35.01	27.32	21.65	17.40	14.17	11.67	9.71	8.16	6.91	5.91	5.08	4.40	3.84	3.36	2.97	2.63
	y direction	5.15	3.66	2.69	2.03	1.57	1.24	1.00	0.81	0.67	0.56	0.47	0.40	0.35	0.30	0.26	0.23	0.20
δ_{max} < L / 300	x direction	30.44	23.34	18.21	14.43	11.60	9.44	7.78	6.47	5.44	4.61	3.94	3.39	2.94	2.56	2.24	1.98	1.75
	y direction	3.44	2.44	1.79	1.36	1.05	0.83	0.67	0.54	0.45	0.37	0.32	0.27	0.23	0.20	0.17	0.15	0.13
δ_{max} < L / 400	x direction	22.83	17.50	13.66	10.82	8.70	7.08	5.83	4.85	4.08	3.46	2.95	2.54	2.20	1.92	1.68	1.48	1.31
	y direction	2.58	1.83	1.35	1.02	0.79	0.62	0.50	0.41	0.34	0.28	0.24	0.20	0.17	0.15	0.13	0.11	0.10

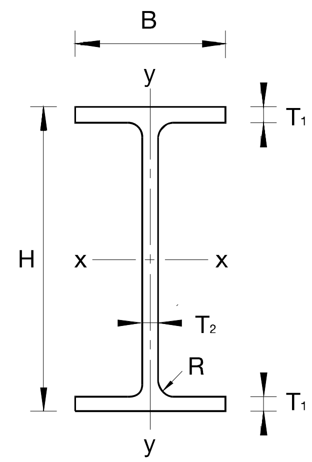
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	30.45	27.07	24.36	22.14	20.30	18.74	17.40	16.24	15.22	14.33	13.53	12.82	12.18	11.60	11.07	10.59	10.15
	y direction	15.57	12.30	9.96	8.23	6.92	5.90	5.08	4.43	3.89	3.45	3.08	2.76	2.49	2.26	2.06	1.88	1.73
Application limit point																		
δ_{max} < L / 200	x direction	39.31	29.76	22.98	18.05	14.41	11.66	9.55	7.92	6.63	5.60	4.77	4.10	3.54	3.08	2.70	2.37	2.10
	y direction	4.11	2.91	2.14	1.61	1.25	0.98	0.79	0.64	0.53	0.44	0.37	0.32	0.27	0.24	0.21	0.18	0.16
δ_{max} < L / 300	x direction	26.21	19.84	15.32	12.04	9.60	7.77	6.37	5.28	4.42	3.73	3.18	2.73	2.36	2.05	1.80	1.58	1.40
	y direction	2.74	1.94	1.42	1.07	0.83	0.66	0.53	0.43	0.35	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.11
δ_{max} < L / 400	x direction	19.65	14.88	11.49	9.03	7.20	5.83	4.78	3.96	3.31	2.80	2.39	2.05	1.77	1.54	1.35	1.19	1.05
	y direction	2.05	1.46	1.07	0.81	0.62	0.49	0.39	0.32	0.27	0.22	0.19	0.16	0.14	0.12	0.10	0.09	0.08

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	739.2
2.25	687.3
2.50	637.3
2.75	589.8
3.00	545.4
3.25	504.1
3.50	465.9
3.75	430.9
4.00	398.9
4.25	369.7
4.50	343.0
4.75	318.7
5.00	296.5
5.25	276.3
5.50	257.9
5.75	241.1
6.00	225.7
6.25	211.6
6.50	198.7
6.75	186.9
7.00	176.0
7.25	166.0
7.50	156.8
7.75	148.3
8.00	140.4

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	766.7
0.60	688.6
0.70	614.6
0.80	546.8
0.90	486.0
1.00	432.3
1.10	385.3
1.20	344.2
1.30	308.5
1.40	277.4
1.50	250.3
1.60	226.7
1.70	205.9
1.80	187.7
1.90	171.7
2.00	157.5
2.10	144.9
2.20	133.7
2.30	123.7
2.40	114.7
2.50	106.7
2.60	99.4
2.70	92.8
2.80	86.8
3.00	76.5



Geometry	
H	240 mm
B	120 mm
T_1	12 mm
T_2	12 mm
R	12 mm

Cross-section constants	
A	5 596 mm^2
I_{xx}	48 912 478 mm^4
W_{xx}	407 604 mm^3
$A_{k,y}$	2 736 mm^2
I_{yy}	3 497 044 mm^4
W_{yy}	58 284 mm^3
$A_{k,x}$	2 304 mm^2

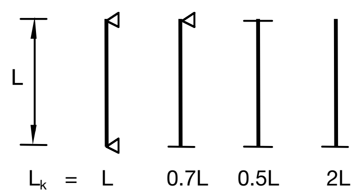
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

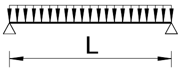
Design value for load-bearing capacity
1033.0 kN

Dead weight
10.1 kg/m

Buckling length

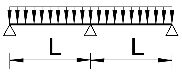


One span



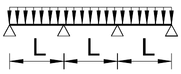
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	52.62	46.77	42.09	38.27	35.08	32.38	30.07	28.06	26.31	24.76	23.38	22.15	21.05	20.04	19.13	18.21	16.72
	y direction	21.52	17.00	13.77	11.38	9.56	8.15	7.03	6.12	5.38	4.77	4.25	3.82	3.44	3.12	2.85	2.60	2.39
Application limit point																		
$\delta_{max} < L / 200$	x direction	46.94	35.07	26.79	20.87	16.54	13.30	10.85	8.95	7.47	6.29	5.35	4.58	3.95	3.43	3.00	2.64	2.33
	y direction	4.55	3.21	2.36	1.78	1.37	1.08	0.87	0.71	0.58	0.49	0.41	0.35	0.30	0.26	0.22	0.20	0.17
$\delta_{max} < L / 300$	x direction	31.29	23.38	17.86	13.91	11.02	8.87	7.23	5.97	4.98	4.20	3.57	3.05	2.64	2.29	2.00	1.76	1.55
	y direction	3.03	2.15	1.58	1.19	0.92	0.72	0.58	0.47	0.39	0.33	0.27	0.23	0.20	0.17	0.15	0.13	0.12
$\delta_{max} < L / 400$	x direction	23.47	17.54	13.40	10.43	8.27	6.65	5.42	4.48	3.73	3.15	2.67	2.29	1.98	1.72	1.50	1.32	1.17
	y direction	2.27	1.61	1.18	0.89	0.69	0.54	0.44	0.35	0.29	0.24	0.21	0.17	0.15	0.13	0.11	0.10	0.09

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	42.09	37.42	33.67	30.61	28.06	25.90	24.05	22.45	21.05	19.81	18.71	17.72	16.84	16.04	15.31	14.64	14.03
	y direction	21.52	17.00	13.77	11.38	9.56	8.15	7.03	6.12	5.38	4.77	4.25	3.82	3.44	3.12	2.85	2.60	2.39
Application limit point																		
$\delta_{max} < L / 200$	x direction	80.49	63.02	50.05	40.26	32.78	26.98	22.42	18.81	15.91	13.57	11.65	10.07	8.76	7.66	6.74	5.95	5.28
	y direction	10.44	7.45	5.49	4.16	3.23	2.55	2.05	1.67	1.38	1.16	0.98	0.83	0.71	0.62	0.54	0.47	0.41
$\delta_{max} < L / 300$	x direction	53.66	42.01	33.36	26.84	21.85	17.98	14.95	12.54	10.61	9.05	7.77	6.71	5.84	5.11	4.49	3.97	3.52
	y direction	6.96	4.97	3.66	2.78	2.15	1.70	1.37	1.12	0.92	0.77	0.65	0.55	0.48	0.41	0.36	0.31	0.28
$\delta_{max} < L / 400$	x direction	40.25	31.51	25.02	20.13	16.39	13.49	11.21	9.41	7.96	6.78	5.83	5.04	4.38	3.83	3.37	2.98	2.64
	y direction	5.22	3.72	2.75	2.08	1.61	1.28	1.03	0.84	0.69	0.58	0.49	0.42	0.36	0.31	0.27	0.24	0.21

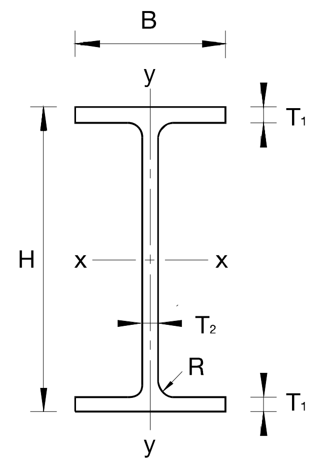
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	43.85	38.97	35.08	31.89	29.23	26.98	25.05	23.38	21.92	20.63	19.49	18.46	17.54	16.70	15.94	15.25	14.62
	y direction	26.90	21.25	17.22	14.23	11.96	10.19	8.78	7.65	6.73	5.96	5.31	4.77	4.30	3.90	3.56	3.25	2.99
Application limit point																		
$\delta_{max} < L / 200$	x direction	70.77	54.65	42.89	34.16	27.58	22.53	18.61	15.53	13.07	11.10	9.50	8.19	7.10	6.20	5.44	4.80	4.25
	y direction	8.36	5.95	4.37	3.31	2.56	2.02	1.63	1.33	1.09	0.91	0.77	0.66	0.56	0.49	0.42	0.37	0.33
$\delta_{max} < L / 300$	x direction	47.18	36.44	28.60	22.78	18.38	15.02	12.41	10.35	8.72	7.40	6.33	5.46	4.73	4.13	3.62	3.20	2.83
	y direction	5.57	3.96	2.92	2.21	1.71	1.35	1.08	0.88	0.73	0.61	0.51	0.44	0.38	0.32	0.28	0.25	0.22
$\delta_{max} < L / 400$	x direction	35.39	27.33	21.45	17.08	13.79	11.26	9.30	7.76	6.54	5.55	4.75	4.09	3.55	3.10	2.72	2.40	2.13
	y direction	4.18	2.97	2.19	1.65	1.28	1.01	0.81	0.66	0.55	0.46	0.39	0.33	0.28	0.24	0.21	0.19	0.16

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	1286.8
2.25	1221.1
2.50	1155.1
2.75	1090.0
3.00	1026.6
3.25	965.6
3.50	907.4
3.75	852.1
4.00	800.1
4.25	751.3
4.50	705.6
4.75	663.0
5.00	623.3
5.25	586.4
5.50	552.1
5.75	520.3
6.00	490.7
6.25	463.3
6.50	437.8
6.75	414.2
7.00	392.2
7.25	371.7
7.50	352.7
7.75	334.9
8.00	318.4

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	1320.5
0.60	1222.7
0.70	1124.2
0.80	1028.6
0.90	938.2
1.00	854.3
1.10	777.5
1.20	707.7
1.30	644.9
1.40	588.4
1.50	537.8
1.60	492.6
1.70	452.1
1.80	415.8
1.90	383.3
2.00	354.2
2.10	327.9
2.20	304.3
2.30	282.9
2.40	263.6
2.50	246.1
2.60	230.2
2.70	215.7
2.80	202.5
3.00	179.3



Geometry	
H	300 mm
B	150 mm
T_1	15 mm
T_2	15 mm
R	15 mm

Cross-section constants	
A	8 743 mm²
I_{xx}	119 415 229 mm⁴
W_{xx}	796 102 mm³
$A_{k,y}$	4 275 mm²
I_{yy}	8 537 705 mm⁴
W_{yy}	113 836 mm³
$A_{k,x}$	3 600 mm²

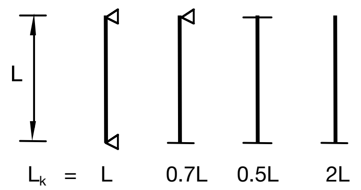
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

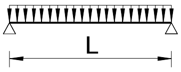
Design value for load-bearing capacity
1614.1 kN

Dead weight
15.7 kg/m

Buckling length

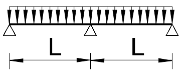


One span



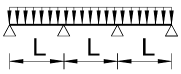
	L (m) =	3,00	3,25	3,50	3,75	4,00	4,25	4,50	4,75	5,00	5,25	5,50	5,75	6,00	6,25	6,50	6,75	7,00
Breaking point																		
	x direction	54,81	50,59	46,98	43,85	41,11	38,69	36,54	34,62	32,88	31,32	29,90	28,60	27,40	26,31	25,30	24,36	23,49
	y direction	18,68	15,92	13,72	11,96	10,51	9,31	8,30	7,45	6,73	6,10	5,56	5,09	4,67	4,30	3,98	3,69	3,43
Application limit point																		
δ_{max} < L / 200	x direction	37,21	30,24	24,87	20,67	17,35	14,69	12,54	10,78	9,34	8,13	7,13	6,28	5,56	4,94	4,41	3,96	3,56
	y direction	3,32	2,62	2,10	1,71	1,42	1,18	1,00	0,85	0,73	0,63	0,55	0,48	0,42	0,37	0,33	0,30	0,27
δ_{max} < L / 300	x direction	24,80	20,16	16,58	13,78	11,57	9,79	8,36	7,19	6,22	5,42	4,75	4,19	3,71	3,29	2,94	2,64	2,37
	y direction	2,21	1,75	1,41	1,15	0,95	0,79	0,67	0,57	0,49	0,42	0,37	0,32	0,28	0,25	0,22	0,20	0,18
δ_{max} < L / 400	x direction	18,60	15,12	12,43	10,33	8,67	7,35	6,27	5,39	4,67	4,07	3,56	3,14	2,78	2,47	2,21	1,98	1,78
	y direction	1,66	1,31	1,05	0,86	0,71	0,59	0,50	0,43	0,37	0,32	0,27	0,24	0,21	0,19	0,17	0,15	0,13

Two spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	43.85	40.47	37.58	35.08	32.88	30.95	29.23	27.69	26.31	25.05	23.92	22.88	21.92	21.05	20.24	19.49	18.79
	y direction	18.68	15.92	13.72	11.96	10.51	9.31	8.30	7.45	6.73	6.10	5.56	5.09	4.67	4.30	3.98	3.69	3.43
Application limit point																		
δ_{max} < L / 200	x direction	68.49	57.26	48.26	40.97	35.03	30.15	26.10	22.73	19.89	17.50	15.47	13.73	12.24	10.95	9.83	8.86	8.01
	y direction	7.73	6.13	4.94	4.04	3.34	2.79	2.36	2.01	1.73	1.50	1.30	1.14	1.01	0.89	0.79	0.71	0.64
δ_{max} < L / 300	x direction	45.66	38.17	32.17	27.32	23.35	20.10	17.40	15.15	13.26	11.67	10.31	9.15	8.16	7.30	6.55	5.91	5.34
	y direction	5.15	4.09	3.29	2.69	2.23	1.86	1.57	1.34	1.15	1.00	0.87	0.76	0.67	0.59	0.53	0.47	0.42
δ_{max} < L / 400	x direction	34.24	28.63	24.13	20.49	17.52	15.07	13.05	11.36	9.95	8.75	7.73	6.86	6.12	5.47	4.92	4.43	4.00
	y direction	3.86	3.06	2.47	2.02	1.67	1.40	1.18	1.01	0.86	0.75	0.65	0.57	0.50	0.45	0.40	0.35	0.32

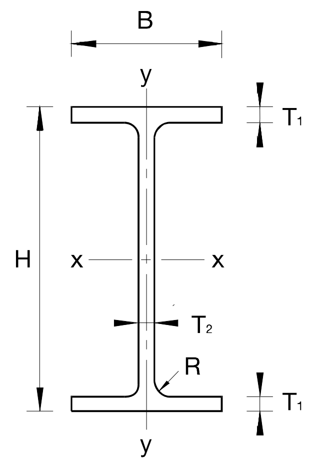
Three spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	45.67	42.16	39.15	36.54	34.25	32.24	30.45	28.85	27.40	26.10	24.91	23.83	22.84	21.92	21.08	20.30	19.57
	y direction	23.35	19.90	17.16	14.94	13.13	11.64	10.38	9.31	8.41	7.62	6.95	6.36	5.84	5.38	4.97	4.61	4.29
Application limit point																		
δ_{max} < L / 200	x direction	58.96	48.87	40.87	34.47	29.30	25.08	21.61	18.74	16.34	14.33	12.63	11.18	9.94	8.88	7.96	7.16	6.46
	y direction	6.16	4.88	3.92	3.20	2.65	2.21	1.87	1.59	1.37	1.18	1.03	0.90	0.80	0.70	0.63	0.56	0.50
δ_{max} < L / 300	x direction	39.31	32.58	27.25	22.98	19.53	16.72	14.41	12.49	10.90	9.55	8.42	7.45	6.63	5.92	5.30	4.77	4.31
	y direction	4.11	3.25	2.62	2.14	1.77	1.48	1.25	1.06	0.91	0.79	0.69	0.60	0.53	0.47	0.42	0.37	0.33
δ_{max} < L / 400	x direction	29.48	24.44	20.44	17.23	14.65	12.54	10.81	9.37	8.17	7.17	6.31	5.59	4.97	4.44	3.98	3.58	3.23
	y direction	3.08	2.44	1.96	1.60	1.32	1.11	0.93	0.80	0.68	0.59	0.52	0.45	0.40	0.35	0.31	0.28	0.25

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	1975.4
2.25	1899.7
2.50	1821.6
2.75	1742.5
3.00	1663.3
3.25	1585.1
3.50	1508.4
3.75	1433.9
4.00	1362.0
4.25	1293.0
4.50	1227.1
4.75	1164.3
5.00	1104.8
5.25	1048.4
5.50	995.1
5.75	944.9
6.00	897.5
6.25	853.0
6.50	811.1
6.75	771.7
7.00	734.7
7.25	699.9
7.50	667.2
7.75	636.4
8.00	607.5

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	2013.4
0.60	1901.5
0.70	1784.3
0.80	1665.9
0.90	1549.3
1.00	1436.9
1.10	1330.2
1.20	1230.2
1.30	1137.3
1.40	1051.5
1.50	972.7
1.60	900.5
1.70	834.6
1.80	774.5
1.90	719.7
2.00	669.7
2.10	624.2
2.20	582.6
2.30	544.7
2.40	510.0
2.50	478.2
2.60	449.1
2.70	422.4
2.80	397.9
3.00	354.4



Geometry	
H	360 mm
B	180 mm
T_1	18 mm
T_2	18 mm
R	18 mm

Cross-section constants	
A	12 590 mm^2
I_{xx}	247 619 419 mm^4
W_{xx}	1 375 663 mm^3
$A_{k,y}$	6 156 mm^2
I_{yy}	17 703 784 mm^4
W_{yy}	196 709 mm^3
$A_{k,x}$	5 184 mm^2

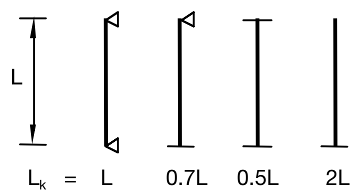
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

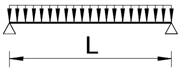
Design value for load-bearing capacity
2324.3 kN

Dead weight
22.7 kg/m

Buckling length

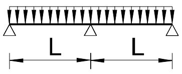


One span



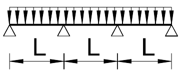
	L (m) =	3,50	3,75	4,00	4,25	4,50	4,75	5,00	5,25	5,50	5,75	6,00	6,25	6,50	6,75	7,00	7,25	7,50
Breaking point																		
	x direction	67,65	63,14	59,19	55,71	52,62	49,85	47,35	45,10	43,05	41,18	39,46	37,88	36,43	35,08	33,82	32,66	31,57
	y direction	23,72	20,66	18,16	16,08	14,35	12,88	11,62	10,54	9,60	8,79	8,07	7,44	6,88	6,38	5,93	5,53	5,16
Application limit point																		
ε_{max} < L / 200	x direction	47,98	40,19	33,95	28,91	24,80	21,42	18,62	16,27	14,30	12,63	11,20	9,98	8,93	8,02	7,23	6,54	5,93
	y direction	4,33	3,53	2,92	2,44	2,06	1,75	1,50	1,30	1,13	0,99	0,87	0,77	0,69	0,61	0,55	0,50	0,45
ε_{max} < L / 300	x direction	31,99	26,79	22,63	19,28	16,54	14,28	12,41	10,85	9,53	8,42	7,47	6,66	5,96	5,35	4,82	4,36	3,95
	y direction	2,89	2,36	1,95	1,63	1,38	1,17	1,01	0,87	0,76	0,66	0,58	0,52	0,46	0,41	0,37	0,33	0,30
ε_{max} < L / 400	x direction	23,99	20,09	16,98	14,46	12,40	10,71	9,31	8,14	7,15	6,31	5,60	4,99	4,47	4,01	3,62	3,27	2,97
	y direction	2,17	1,77	1,46	1,22	1,03	0,88	0,75	0,65	0,57	0,50	0,44	0,39	0,35	0,31	0,28	0,25	0,23

Two spans



	L (m) =	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50
Breaking point																		
	x direction	54.12	50.51	47.35	44.57	42.09	39.88	37.88	36.08	34.44	32.94	31.57	30.31	29.14	28.06	27.06	26.13	25.26
	y direction	23.72	20.66	18.16	16.08	14.35	12.88	11.62	10.54	9.60	8.79	8.07	7.44	6.88	6.38	5.93	5.53	5.16
Application limit point																		
ε_{max} < L / 200	x direction	87.40	75.07	64.85	56.32	49.17	43.13	38.01	33.64	29.89	26.66	23.87	21.44	19.33	17.48	15.85	14.41	13.14
	y direction	10.06	8.24	6.83	5.72	4.84	4.13	3.55	3.08	2.68	2.35	2.07	1.84	1.64	1.46	1.31	1.18	1.07
ε_{max} < L / 300	x direction	58.27	50.05	43.23	37.55	32.78	28.75	25.34	22.42	19.93	17.77	15.91	14.30	12.89	11.65	10.56	9.61	8.76
	y direction	6.71	5.49	4.55	3.82	3.23	2.75	2.37	2.05	1.79	1.57	1.38	1.23	1.09	0.98	0.88	0.79	0.71
ε_{max} < L / 400	x direction	43.70	37.53	32.42	28.16	24.58	21.56	19.00	16.82	14.94	13.33	11.94	10.72	9.66	8.74	7.92	7.21	6.57
	y direction	5.03	4.12	3.42	2.86	2.42	2.07	1.78	1.54	1.34	1.18	1.04	0.92	0.82	0.73	0.66	0.59	0.53

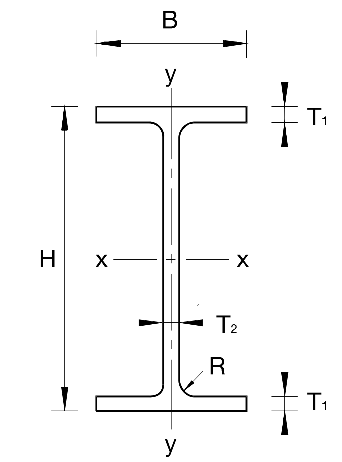
Three spans



	L (m) =	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50
Breaking point																		
	x direction	56.37	52.62	49.33	46.43	43.85	41.54	39.46	37.58	35.87	34.31	32.88	31.57	30.36	29.23	28.19	27.21	26.31
	y direction	29.65	25.82	22.70	20.11	17.93	16.10	14.53	13.18	12.01	10.98	10.09	9.30	8.60	7.97	7.41	6.91	6.46
Application limit point																		
δ_{max} < L / 200	x direction	75.49	64.34	55.20	47.65	41.36	36.10	31.67	27.91	24.71	21.97	19.61	17.57	15.80	14.25	12.90	11.70	10.65
	y direction	8.02	6.56	5.43	4.55	3.84	3.28	2.82	2.44	2.12	1.86	1.64	1.45	1.29	1.16	1.04	0.94	0.85
δ_{max} < L / 300	x direction	50.33	42.89	36.80	31.76	27.58	24.07	21.11	18.61	16.48	14.65	13.07	11.71	10.53	9.50	8.60	7.80	7.10
	y direction	5.35	4.37	3.62	3.03	2.56	2.18	1.88	1.63	1.42	1.24	1.09	0.97	0.86	0.77	0.69	0.62	0.56
δ_{max} < L / 400	x direction	37.74	32.17	27.60	23.82	20.68	18.05	15.83	13.96	12.36	10.99	9.81	8.79	7.90	7.13	6.45	5.85	5.33
	y direction	4.01	3.28	2.72	2.27	1.92	1.64	1.41	1.22	1.06	0.93	0.82	0.73	0.65	0.58	0.52	0.47	0.42

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	47.6
2.25	42.8
2.50	38.5
2.75	34.7
3.00	31.2
3.25	28.2
3.50	25.5
3.75	23.2
4.00	21.1
4.25	19.2
4.50	17.6
4.75	16.2
5.00	14.9
5.25	13.7
5.50	12.7
5.75	11.8
6.00	10.9
6.25	10.2
6.50	9.5
6.75	8.9
7.00	8.3
7.25	7.8
7.50	7.4
7.75	6.9
8.00	6.5

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	49.8
0.60	42.4
0.70	36.2
0.80	30.9
0.90	26.5
1.00	22.9
1.10	19.8
1.20	17.3
1.30	15.3
1.40	13.5
1.50	12.0
1.60	10.8
1.70	9.7
1.80	8.7
1.90	7.9
2.00	7.2
2.10	6.6
2.20	6.1
2.30	5.6
2.40	5.2
2.50	4.8
2.60	4.4
2.70	4.1
2.80	3.9
3.00	3.4



Geometry	
H	120 mm
B	60 mm
T_1	5 mm
T_2	5 mm
R	5,0 mm

Cross-section constants	
A	1 171 mm^2
I_{xx}	2 601 910 mm^4
W_{xx}	43 365 mm^3
$A_{k,y}$	570 mm^2
I_{yy}	181 445 mm^4
W_{yy}	6 048 mm^3
$A_{k,x}$	480 mm^2

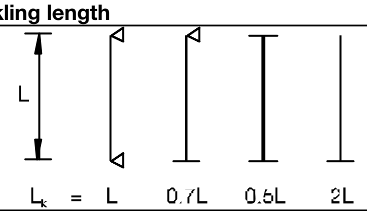
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

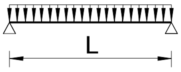
Design value for load-bearing capacity
216.3 kN

Dead weight
2.11 kg/m

Buckling length

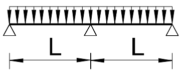


One span



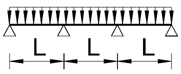
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	6.07	4.80	3.89	3.21	2.70	2.30	1.98	1.73	1.52	1.34	1.20	1.08	0.97	0.88	0.80	0.73	0.67
	y direction	0.85	0.67	0.54	0.45	0.38	0.32	0.28	0.24	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09
Application limit point																		
ε_{max} < L / 200	x direction	2.65	1.89	1.40	1.06	0.82	0.65	0.52	0.43	0.35	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.11
	y direction	0.20	0.14	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
ε_{max} < L / 300	x direction	1.77	1.26	0.93	0.71	0.55	0.43	0.35	0.28	0.23	0.20	0.17	0.14	0.12	0.10	0.09	0.08	0.07
	y direction	0.13	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
ε_{max} < L / 400	x direction	1.32	0.95	0.70	0.53	0.41	0.32	0.26	0.21	0.18	0.15	0.12	0.11	0.09	0.08	0.07	0.06	0.05
	y direction	0.10	0.07	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	6.07	4.80	3.89	3.21	2.70	2.30	1.98	1.73	1.52	1.34	1.20	1.08	0.97	0.88	0.80	0.73	0.67
	y direction	0.85	0.67	0.54	0.45	0.38	0.32	0.28	0.24	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09
Application limit point																		
δ_{max} < L / 200	x direction	5.74	4.18	3.13	2.40	1.88	1.49	1.21	0.99	0.82	0.69	0.58	0.50	0.43	0.37	0.32	0.28	0.25
	y direction	0.47	0.33	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02
δ_{max} < L / 300	x direction	3.83	2.79	2.09	1.60	1.25	1.00	0.81	0.66	0.55	0.46	0.39	0.33	0.29	0.25	0.22	0.19	0.17
	y direction	0.32	0.22	0.16	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01
δ_{max} < L / 400	x direction	2.87	2.09	1.56	1.20	0.94	0.75	0.60	0.50	0.41	0.34	0.29	0.25	0.21	0.19	0.16	0.14	0.12
	y direction	0.24	0.17	0.12	0.09	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01

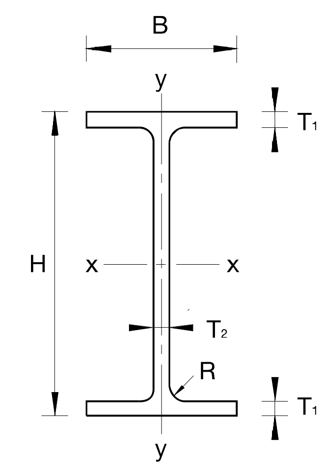
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	7.59	6.00	4.86	4.01	3.37	2.87	2.48	2.16	1.90	1.68	1.50	1.35	1.21	1.10	1.00	0.92	0.84
	y direction	1.06	0.84	0.68	0.56	0.47	0.40	0.35	0.30	0.26	0.23	0.21	0.19	0.17	0.15	0.14	0.13	0.12
Application limit point																		
δ_{max} < L / 200	x direction	4.69	3.39	2.53	1.93	1.50	1.19	0.96	0.79	0.65	0.55	0.46	0.39	0.34	0.29	0.26	0.22	0.20
	y direction	0.37	0.26	0.19	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01
δ_{max} < L / 300	x direction	3.13	2.26	1.68	1.29	1.00	0.80	0.64	0.53	0.44	0.36	0.31	0.26	0.23	0.20	0.17	0.15	0.13
	y direction	0.25	0.18	0.13	0.10	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	2.35	1.70	1.26	0.96	0.75	0.60	0.48	0.39	0.33	0.27	0.23	0.20	0.17	0.15	0.13	0.11	0.10
	y direction	0.19	0.13	0.10	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	109.9
2.25	103.4
2.50	97.0
2.75	90.8
3.00	84.9
3.25	79.2
3.50	73.9
3.75	68.9
4.00	64.3
4.25	60.1
4.50	56.1
4.75	52.4
5.00	49.1
5.25	46.0
5.50	43.1
5.75	40.5
6.00	38.0
6.25	35.8
6.50	33.7
6.75	31.8
7.00	30.1
7.25	28.4
7.50	26.9
7.75	25.5
8.00	24.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	115.4
0.60	106.1
0.70	96.9
0.80	88.1
0.90	79.9
1.00	72.4
1.10	65.5
1.20	59.4
1.30	53.9
1.40	49.0
1.50	44.6
1.60	40.8
1.70	37.3
1.80	34.2
1.90	31.5
2.00	29.1
2.10	26.9
2.20	24.9
2.30	23.1
2.40	21.5
2.50	20.1
2.60	18.7
2.70	17.5
2.80	16.5
3.00	14.5



Geometry	
H	160 mm
B	80 mm
T_1	8 mm
T_2	5 mm
R	8 mm

Cross-section constants	
A	2 055 mm^2
I_{xx}	8 759 190 mm^4
W_{xx}	109 490 mm^3
$A_{k,y}$	760 mm^2
I_{yy}	685 062 mm^4
W_{yy}	17127 mm^3
$A_{k,x}$	1 024 mm^2

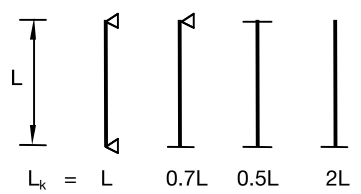
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

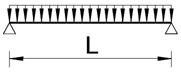
Design value for load-bearing capacity
379.4 kN

Dead weight
3.70 kg/m

Buckling length

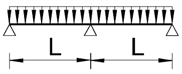


One span



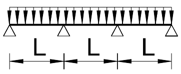
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	14.62	12.11	9.81	8.11	6.81	5.80	5.01	4.36	3.83	3.39	3.03	2.72	2.45	2.22	2.03	1.85	1.70
	y direction	2.40	1.89	1.53	1.27	1.07	0.91	0.78	0.68	0.60	0.53	0.47	0.43	0.38	0.35	0.32	0.29	0.27
Application limit point																		
δ_{max} < L / 200	x direction	9.36	6.87	5.17	3.98	3.13	2.50	2.03	1.66	1.38	1.16	0.98	0.84	0.72	0.63	0.55	0.48	0.42
	y direction	0.91	0.64	0.47	0.35	0.27	0.21	0.17	0.14	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03
δ_{max} < L / 300	x direction	6.24	4.58	3.45	2.66	2.09	1.67	1.35	1.11	0.92	0.77	0.66	0.56	0.48	0.42	0.36	0.32	0.28
	y direction	0.60	0.43	0.31	0.23	0.18	0.14	0.11	0.09	0.08	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02
δ_{max} < L / 400	x direction	4.68	3.43	2.59	1.99	1.56	1.25	1.01	0.83	0.69	0.58	0.49	0.42	0.36	0.31	0.27	0.24	0.21
	y direction	0.45	0.32	0.23	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	11.69	10.39	9.35	8.11	6.81	5.80	5.01	4.36	3.83	3.39	3.03	2.72	2.45	2.22	2.03	1.85	1.70
	y direction	2.40	1.89	1.53	1.27	1.07	0.91	0.78	0.68	0.60	0.53	0.47	0.43	0.38	0.35	0.32	0.29	0.27
Application limit point																		
δ_{max} < L / 200	x direction	17.46	13.33	10.37	8.19	6.57	5.34	4.39	3.65	3.06	2.59	2.21	1.90	1.65	1.43	1.26	1.11	0.98
	y direction	2.14	1.51	1.11	0.83	0.65	0.51	0.41	0.33	0.27	0.23	0.19	0.16	0.14	0.12	0.11	0.09	0.08
δ_{max} < L / 300	x direction	11.64	8.89	6.91	5.46	4.38	3.56	2.93	2.43	2.04	1.73	1.47	1.27	1.10	0.96	0.84	0.74	0.65
	y direction	1.42	1.01	0.74	0.56	0.43	0.34	0.27	0.22	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05
δ_{max} < L / 400	x direction	8.73	6.67	5.18	4.10	3.28	2.67	2.19	1.82	1.53	1.30	1.11	0.95	0.82	0.72	0.63	0.55	0.49
	y direction	1.07	0.76	0.55	0.42	0.32	0.25	0.20	0.17	0.14	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04

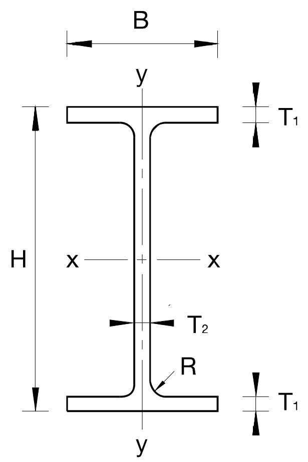
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	12.18	10.83	9.74	8.86	8.12	7.26	6.26	5.45	4.79	4.24	3.78	3.40	3.07	2.78	2.53	2.32	2.13
	y direction	3.00	2.37	1.92	1.59	1.33	1.14	0.98	0.85	0.75	0.66	0.59	0.53	0.48	0.43	0.40	0.36	0.33
Application limit point																		
δ_{max} < L / 200	x direction	14.97	11.29	8.69	6.81	5.42	4.38	3.59	2.97	2.48	2.10	1.78	1.53	1.32	1.15	1.01	0.89	0.78
	y direction	1.69	1.20	0.88	0.66	0.51	0.40	0.32	0.26	0.22	0.18	0.15	0.13	0.11	0.10	0.08	0.07	0.06
δ_{max} < L / 300	x direction	9.98	7.53	5.79	4.54	3.62	2.92	2.39	1.98	1.65	1.40	1.19	1.02	0.88	0.77	0.67	0.59	0.52
	y direction	1.13	0.80	0.58	0.44	0.34	0.27	0.21	0.17	0.14	0.12	0.10	0.09	0.07	0.06	0.06	0.05	0.04
δ_{max} < L / 400	x direction	7.48	5.64	4.34	3.41	2.71	2.19	1.79	1.48	1.24	1.05	0.89	0.77	0.66	0.58	0.50	0.44	0.39
	y direction	0.85	0.60	0.44	0.33	0.25	0.20	0.16	0.13	0.11	0.09	0.08	0.06	0.06	0.05	0.04	0.04	0.03

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	223.5
2.25	213.4
2.50	203.1
2.75	192.9
3.00	182.8
3.25	172.9
3.50	163.4
3.75	154.3
4.00	145.6
4.25	137.4
4.50	129.6
4.75	122.3
5.00	115.4
5.25	109.0
5.50	103.0
5.75	97.4
6.00	92.1
6.25	87.2
6.50	82.6
6.75	78.4
7.00	74.4
7.25	70.6
7.50	67.1
7.75	63.9
8.00	60.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	228.6
0.60	213.7
0.70	198.3
0.80	183.1
0.90	168.5
1.00	154.7
1.10	141.8
1.20	130.0
1.30	119.2
1.40	109.4
1.50	100.5
1.60	92.4
1.70	85.2
1.80	78.7
1.90	72.7
2.00	67.4
2.10	62.6
2.20	58.2
2.30	54.3
2.40	50.7
2.50	47.4
2.60	44.4
2.70	41.6
2.80	39.1
3.00	34.7



Geometry	
H	200 mm
B	100 mm
T_1	8 mm
T_2	5 mm
R	8 mm

Cross-section constants	
A	2 575 mm^2
I_{xx}	17 444 191 mm^4
W_{xx}	174 442 mm^3
$A_{k,y}$	950 mm^2
I_{yy}	1 336 071 mm^4
W_{yy}	26 721 mm^3
$A_{k,x}$	1 280 mm^2

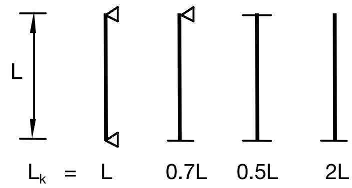
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

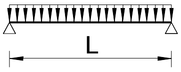
Design value for load-bearing capacity
475.4 kN

Dead weight
4.63 kg/m

Buckling length

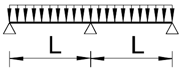


One span



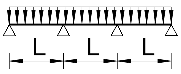
		L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																			
		x direction	18.27	16.24	14.62	12.92	10.85	9.25	7.97	6.95	6.11	5.41	4.82	4.33	3.91	3.54	3.23	2.95	2.71
		y direction	3.74	2.96	2.39	1.98	1.66	1.42	1.22	1.06	0.94	0.83	0.74	0.66	0.60	0.54	0.49	0.45	0.42
Application limit point																			
$\delta_{max} < L / 200$		x direction	16.61	12.43	9.50	7.41	5.87	4.73	3.86	3.18	2.66	2.24	1.90	1.63	1.41	1.22	1.07	0.94	0.83
		y direction	1.75	1.24	0.91	0.68	0.53	0.41	0.33	0.27	0.22	0.19	0.16	0.13	0.11	0.10	0.09	0.08	0.07
$\delta_{max} < L / 300$		x direction	11.07	8.28	6.33	4.94	3.92	3.15	2.57	2.12	1.77	1.49	1.27	1.09	0.94	0.82	0.71	0.63	0.55
		y direction	1.17	0.83	0.61	0.46	0.35	0.28	0.22	0.18	0.15	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.04
$\delta_{max} < L / 400$		x direction	8.31	6.21	4.75	3.70	2.94	2.36	1.93	1.59	1.33	1.12	0.95	0.82	0.70	0.61	0.53	0.47	0.42
		y direction	0.88	0.62	0.45	0.34	0.26	0.21	0.17	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03

Two spans



		L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																			
		x direction	14.62	12.99	11.69	10.63	9.74	8.99	7.97	6.95	6.11	5.41	4.82	4.33	3.91	3.54	3.23	2.95	2.71
		y direction	3.74	2.96	2.39	1.98	1.66	1.42	1.22	1.06	0.94	0.83	0.74	0.66	0.60	0.54	0.49	0.45	0.42
Application limit point																			
$\delta_{max} < L / 200$		x direction	28.33	22.21	17.67	14.23	11.60	9.55	7.95	6.67	5.65	4.82	4.14	3.58	3.11	2.72	2.40	2.12	1.88
		y direction	4.08	2.90	2.13	1.61	1.25	0.98	0.79	0.64	0.53	0.44	0.37	0.32	0.27	0.24	0.21	0.18	0.16
$\delta_{max} < L / 300$		x direction	18.89	14.81	11.78	9.49	7.73	6.37	5.30	4.45	3.76	3.21	2.76	2.39	2.08	1.82	1.60	1.41	1.25
		y direction	2.72	1.93	1.42	1.07	0.83	0.66	0.53	0.43	0.35	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.11
$\delta_{max} < L / 400$		x direction	14.16	11.11	8.83	7.11	5.80	4.78	3.97	3.33	2.82	2.41	2.07	1.79	1.56	1.36	1.20	1.06	0.94
		y direction	2.04	1.45	1.07	0.81	0.62	0.49	0.40	0.32	0.27	0.22	0.19	0.16	0.14	0.12	0.10	0.09	0.08

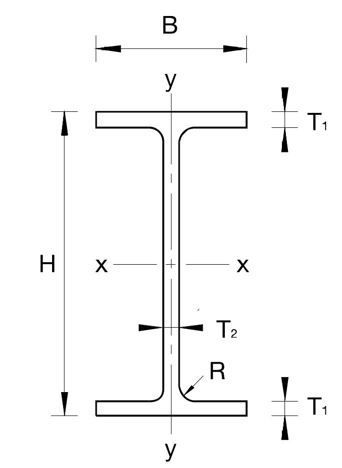
Three spans



		L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																			
		x direction	15.22	13.53	12.18	11.07	10.15	9.37	8.70	8.12	7.61	6.76	6.03	5.41	4.88	4.43	4.04	3.69	3.39
		y direction	4.68	3.69	2.99	2.47	2.08	1.77	1.53	1.33	1.17	1.04	0.92	0.83	0.75	0.68	0.62	0.57	0.52
Application limit point																			
$\delta_{max} < L / 200$		x direction	24.95	19.30	15.16	12.09	9.77	7.99	6.60	5.51	4.64	3.94	3.38	2.91	2.53	2.20	1.93	1.71	1.51
		y direction	3.25	2.31	1.69	1.28	0.99	0.78	0.63	0.51	0.42	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.13
$\delta_{max} < L / 300$		x direction	16.63	12.86	10.11	8.06	6.51	5.32	4.40	3.67	3.10	2.63	2.25	1.94	1.68	1.47	1.29	1.14	1.01
		y direction	2.17	1.54	1.13	0.85	0.66	0.52	0.42	0.34	0.28	0.23	0.20	0.17	0.14	0.12	0.11	0.09	0.08
$\delta_{max} < L / 400$		x direction	12.47	9.65	7.58	6.05	4.88	3.99	3.30	2.76	2.32	1.97	1.69	1.46	1.26	1.10	0.97	0.85	0.76
		y direction	1.63	1.15	0.85	0.64	0.49	0.39	0.31	0.25	0.21	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	247.4
2.25	239.6
2.50	231.5
2.75	223.1
3.00	214.7
3.25	206.1
3.50	197.6
3.75	189.3
4.00	181.1
4.25	173.1
4.50	165.4
4.75	157.9
5.00	150.8
5.25	143.9
5.50	137.4
5.75	131.1
6.00	125.2
6.25	119.5
6.50	114.2
6.75	109.1
7.00	104.2
7.25	99.7
7.50	95.4
7.75	91.3
8.00	87.4

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	252.8
0.60	241.8
0.70	230.1
0.80	217.8
0.90	205.4
1.00	193.2
1.10	181.2
1.20	169.7
1.30	158.7
1.40	148.4
1.50	138.6
1.60	129.6
1.70	121.1
1.80	113.3
1.90	106.1
2.00	99.4
2.10	93.2
2.20	87.5
2.30	82.2
2.40	77.3
2.50	72.8
2.60	68.7
2.70	64.8
2.80	61.3
3.00	54.9



Geometry	
H	240 mm
B	120 mm
T_1	10 mm
T_2	7 mm
R	10 mm

Cross-section constants	
A	4 026 mm²
I_{xx}	38 135 220 mm⁴
W_{xx}	317 794 mm³
$A_{k,y}$	1 596 mm²
I_{yy}	2 888 391 mm⁴
W_{yy}	48 140 mm³
$A_{k,x}$	1 920 mm²

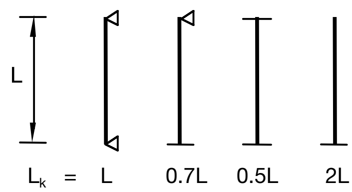
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1,3

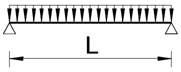
Design value for load-bearing capacity
743.2 kN

Dead weight
7.25 kg/m

Buckling length

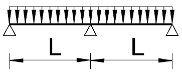


One span



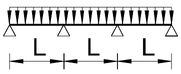
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	30.69	27.28	24.55	22.32	19.77	16.85	14.53	12.66	11.12	9.85	8.79	7.89	7.12	6.46	5.88	5.38	4.94
	y direction	6.74	5.33	4.31	3.56	3.00	2.55	2.20	1.92	1.68	1.49	1.33	1.19	1.08	0.98	0.89	0.82	0.75
Application limit point																		
$\delta_{max} < L / 200$	x direction	33.39	25.30	19.55	15.37	12.27	9.93	8.14	6.75	5.65	4.78	4.07	3.49	3.02	2.63	2.30	2.03	1.79
	y direction	3.76	2.66	1.95	1.47	1.13	0.89	0.72	0.58	0.48	0.40	0.34	0.29	0.25	0.21	0.19	0.16	0.14
$\delta_{max} < L / 300$	x direction	22.26	16.87	13.03	10.24	8.18	6.62	5.43	4.50	3.77	3.18	2.71	2.33	2.01	1.75	1.53	1.35	1.19
	y direction	2.50	1.78	1.30	0.98	0.76	0.60	0.48	0.39	0.32	0.27	0.23	0.19	0.17	0.14	0.12	0.11	0.10
$\delta_{max} < L / 400$	x direction	16.69	12.65	9.77	7.68	6.13	4.97	4.07	3.37	2.83	2.39	2.03	1.75	1.51	1.31	1.15	1.01	0.90
	y direction	1.88	1.33	0.98	0.74	0.57	0.45	0.36	0.29	0.24	0.20	0.17	0.14	0.12	0.11	0.09	0.08	0.07

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	24.55	21.83	19.64	17.86	16.37	15.11	14.03	12.66	11.12	9.85	8.79	7.89	7.12	6.46	5.88	5.38	4.94
	y direction	6.74	5.33	4.31	3.56	3.00	2.55	2.20	1.92	1.68	1.49	1.33	1.19	1.08	0.98	0.89	0.82	0.75
Application limit point																		
$\delta_{max} < L / 200$	x direction	53.87	42.90	34.58	28.19	23.22	19.30	16.18	13.68	11.65	9.99	8.62	7.48	6.54	5.74	5.06	4.48	3.99
	y direction	8.63	6.16	4.54	3.44	2.67	2.11	1.70	1.38	1.14	0.95	0.81	0.69	0.59	0.51	0.44	0.39	0.34
$\delta_{max} < L / 300$	x direction	35.91	28.60	23.06	18.79	15.48	12.87	10.79	9.12	7.76	6.66	5.75	4.99	4.36	3.82	3.37	2.99	2.66
	y direction	5.75	4.10	3.03	2.29	1.78	1.41	1.13	0.92	0.76	0.64	0.54	0.46	0.39	0.34	0.30	0.26	0.23
$\delta_{max} < L / 400$	x direction	26.93	21.45	17.29	14.10	11.61	9.65	8.09	6.84	5.82	4.99	4.31	3.74	3.27	2.87	2.53	2.24	2.00
	y direction	4.31	3.08	2.27	1.72	1.33	1.05	0.85	0.69	0.57	0.48	0.40	0.34	0.29	0.25	0.22	0.19	0.17

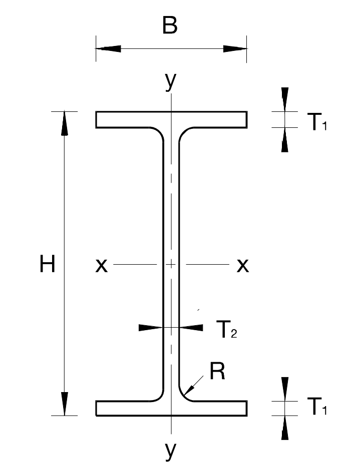
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	25.58	22.74	20.46	18.60	17.05	15.74	14.62	13.64	12.79	12.04	10.99	9.86	8.90	8.07	7.35	6.73	6.18
	y direction	8.42	6.66	5.39	4.46	3.74	3.19	2.75	2.40	2.11	1.87	1.66	1.49	1.35	1.22	1.11	1.02	0.94
Application limit point																		
$\delta_{max} < L / 200$	x direction	48.19	37.84	30.13	24.30	19.82	16.34	13.60	11.42	9.68	8.26	7.10	6.14	5.34	4.68	4.11	3.64	3.23
	y direction	6.91	4.91	3.61	2.73	2.12	1.67	1.34	1.09	0.90	0.75	0.64	0.54	0.47	0.40	0.35	0.31	0.27
$\delta_{max} < L / 300$	x direction	32.13	25.23	20.09	16.20	13.21	10.89	9.07	7.62	6.45	5.50	4.73	4.09	3.56	3.12	2.74	2.42	2.15
	y direction	4.60	3.27	2.41	1.82	1.41	1.11	0.90	0.73	0.60	0.50	0.42	0.36	0.31	0.27	0.23	0.20	0.18
$\delta_{max} < L / 400$	x direction	24.09	18.92	15.07	12.15	9.91	8.17	6.80	5.71	4.84	4.13	3.55	3.07	2.67	2.34	2.06	1.82	1.61
	y direction	3.45	2.46	1.81	1.37	1.06	0.84	0.67	0.55	0.45	0.38	0.32	0.27	0.23	0.20	0.18	0.15	0.14

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	382.4
2.25	374.5
2.50	366.1
2.75	357.2
3.00	348.0
3.25	338.5
3.50	328.7
3.75	318.9
4.00	309.0
4.25	299.2
4.50	289.4
4.75	279.7
5.00	270.2
5.25	260.8
5.50	251.7
5.75	242.8
6.00	234.2
6.25	225.8
6.50	217.7
6.75	209.9
7.00	202.3
7.25	195.1
7.50	188.1
7.75	181.3
8.00	174.9

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	387.3
0.60	376.1
0.70	363.8
0.80	350.5
0.90	336.5
1.00	322.2
1.10	307.7
1.20	293.3
1.30	279.1
1.40	265.2
1.50	251.7
1.60	238.8
1.70	226.4
1.80	214.6
1.90	203.4
2.00	192.7
2.10	182.7
2.20	173.2
2.30	164.3
2.40	156.0
2.50	148.1
2.60	140.7
2.70	133.8
2.80	127.3
3.00	115.4



Geometry	
H	300 mm
B	150 mm
T_1	12 mm
T_2	8 mm
R	12 mm

Cross-section constants	
A	5 932 mm^2
I_{xx}	90 973 293 mm^4
W_{xx}	606 489 mm^3
$A_{k,y}$	2 280 mm^2
I_{yy}	6 767 918 mm^4
W_{yy}	90 239 mm^3
$A_{k,x}$	2 880 mm^2

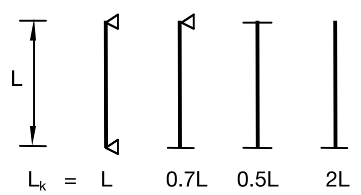
Material properties	
E_{0°	28 000 MPa
$f_{c,0^\circ}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

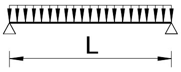
Design value for load-bearing capacity
1095.1 kN

Dead weight
10.68 kg/m

Buckling length

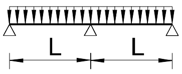


One span



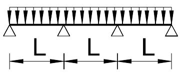
	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	29.23	26.98	25.05	23.38	21.23	18.80	16.77	15.05	13.59	12.32	11.23	10.27	9.43	8.69	8.04	7.45	6.93
	y direction	5.61	4.78	4.13	3.59	3.16	2.80	2.50	2.24	2.02	1.83	1.67	1.53	1.40	1.29	1.20	1.11	1.03
Application limit point																		
δ_{max} < L / 200	x direction	25.93	21.29	17.66	14.79	12.49	10.64	9.12	7.88	6.85	5.98	5.26	4.64	4.12	3.67	3.28	2.95	2.66
	y direction	2.63	2.08	1.67	1.36	1.12	0.94	0.79	0.67	0.58	0.50	0.43	0.38	0.33	0.30	0.26	0.24	0.21
δ_{max} < L / 300	x direction	17.29	14.19	11.77	9.86	8.33	7.09	6.08	5.25	4.56	3.99	3.51	3.10	2.75	2.45	2.19	1.97	1.77
	y direction	1.76	1.39	1.12	0.91	0.75	0.63	0.53	0.45	0.39	0.33	0.29	0.25	0.22	0.20	0.18	0.16	0.14
δ_{max} < L / 400	x direction	12.96	10.64	8.83	7.39	6.25	5.32	4.56	3.94	3.42	2.99	2.63	2.32	2.06	1.84	1.64	1.47	1.33
	y direction	1.32	1.04	0.84	0.68	0.56	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.17	0.15	0.13	0.12	0.11

Two spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	23.38	21.59	20.04	18.71	17.54	16.51	15.59	14.77	13.59	12.32	11.23	10.27	9.43	8.69	8.04	7.45	6.93
	y direction	5.61	4.78	4.13	3.59	3.16	2.80	2.50	2.24	2.02	1.83	1.67	1.53	1.40	1.29	1.20	1.11	1.03
Application limit point																		
δ_{max} < L / 200	x direction	44.53	37.75	32.22	27.66	23.89	20.75	18.11	15.88	13.99	12.38	11.00	9.81	8.78	7.89	7.11	6.43	5.83
	y direction	6.13	4.86	3.92	3.20	2.65	2.22	1.87	1.60	1.37	1.19	1.03	0.91	0.80	0.71	0.63	0.56	0.50
δ_{max} < L / 300	x direction	29.69	25.17	21.48	18.44	15.93	13.83	12.07	10.59	9.33	8.25	7.33	6.54	5.86	5.26	4.74	4.29	3.89
	y direction	4.09	3.24	2.61	2.13	1.77	1.48	1.25	1.06	0.91	0.79	0.69	0.60	0.53	0.47	0.42	0.37	0.34
δ_{max} < L / 400	x direction	22.27	18.88	16.11	13.83	11.95	10.37	9.05	7.94	7.00	6.19	5.50	4.91	4.39	3.95	3.56	3.21	2.91
	y direction	3.07	2.43	1.96	1.60	1.32	1.11	0.94	0.80	0.69	0.59	0.52	0.45	0.40	0.35	0.31	0.28	0.25

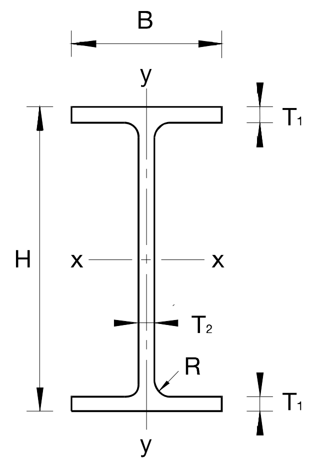
Three spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	24.36	22.49	20.88	19.49	18.27	17.19	16.24	15.38	14.62	13.92	13.29	12.71	11.79	10.87	10.05	9.32	8.66
	y direction	7.02	5.98	5.16	4.49	3.95	3.50	3.12	2.80	2.53	2.29	2.09	1.91	1.75	1.62	1.50	1.39	1.29
Application limit point																		
δ_{max} < L / 200	x direction	39.14	32.87	27.81	23.70	20.33	17.54	15.23	13.29	11.66	10.27	9.09	8.08	7.21	6.46	5.81	5.24	4.74
	y direction	4.88	3.87	3.11	2.54	2.10	1.76	1.48	1.26	1.08	0.94	0.82	0.72	0.63	0.56	0.50	0.44	0.40
δ_{max} < L / 300	x direction	26.09	21.91	18.54	15.80	13.55	11.70	10.15	8.86	7.77	6.85	6.06	5.39	4.81	4.31	3.87	3.49	3.16
	y direction	3.26	2.58	2.07	1.69	1.40	1.17	0.99	0.84	0.72	0.63	0.54	0.48	0.42	0.37	0.33	0.30	0.27
δ_{max} < L / 400	x direction	19.57	16.44	13.91	11.85	10.16	8.77	7.61	6.64	5.83	5.14	4.55	4.04	3.61	3.23	2.91	2.62	2.37
	y direction	2.44	1.93	1.56	1.27	1.05	0.88	0.74	0.63	0.54	0.47	0.41	0.36	0.32	0.28	0.25	0.22	0.20

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	580.3
2.25	570.0
2.50	558.9
2.75	547.2
3.00	534.9
3.25	522.1
3.50	509.0
3.75	495.6
4.00	482.1
4.25	468.4
4.50	454.8
4.75	441.2
5.00	427.8
5.25	414.5
5.50	401.4
5.75	388.6
6.00	376.0
6.25	363.8
6.50	351.8
6.75	340.2
7.00	329.0
7.25	318.1
7.50	307.5
7.75	297.3
8.00	287.5

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	586.8
0.60	572.3
0.70	556.1
0.80	538.5
0.90	519.9
1.00	500.5
1.10	480.7
1.20	460.8
1.30	440.9
1.40	421.2
1.50	402.0
1.60	383.3
1.70	365.2
1.80	347.8
1.90	331.1
2.00	315.2
2.10	300.0
2.20	285.6
2.30	271.9
2.40	258.9
2.50	246.7
2.60	235.1
2.70	224.1
2.80	213.8
3.00	194.9



Geometry	
H	360 mm
B	180 mm
T_1	15 mm
T_2	10 mm
R	15 mm

Cross-section constants	
A	8 893 mm^2
I_{xx}	195 780 926 mm^4
W_{xx}	1 087 672 mm^3
$A_{k,y}$	3 420 mm^2
I_{yy}	14 622 496 mm^4
W_{yy}	162 472 mm^3
$A_{k,x}$	4 320 mm^2

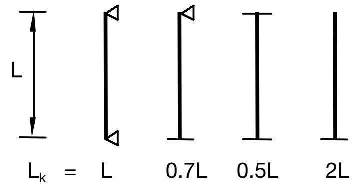
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

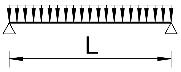
Design value for load-bearing capacity
1641.8 kN

Dead weight
16.01 kg/m

Buckling length

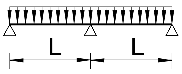


One span



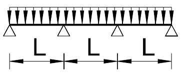
	L (m) =	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50
Breaking point																		
	x direction	37.58	35.08	32.88	30.95	29.23	27.00	24.36	22.10	20.14	18.42	16.92	15.59	14.42	13.37	12.43	11.59	10.83
	y direction	7.43	6.47	5.69	5.04	4.49	4.03	3.64	3.30	3.01	2.75	2.53	2.33	2.15	2.00	1.86	1.73	1.62
Application limit point																		
δ_{max} < L / 200	x direction	34.61	29.25	24.91	21.36	18.43	16.00	13.97	12.26	10.82	9.59	8.53	7.62	6.84	6.15	5.56	5.03	4.57
	y direction	3.58	2.92	2.41	2.01	1.70	1.45	1.24	1.07	0.94	0.82	0.72	0.64	0.57	0.51	0.46	0.41	0.37
δ_{max} < L / 300	x direction	23.07	19.50	16.60	14.24	12.29	10.67	9.32	8.18	7.21	6.39	5.69	5.08	4.56	4.10	3.70	3.36	3.05
	y direction	2.39	1.95	1.61	1.35	1.14	0.97	0.83	0.72	0.63	0.55	0.48	0.43	0.38	0.34	0.30	0.27	0.25
δ_{max} < L / 400	x direction	17.30	14.62	12.45	10.68	9.22	8.00	6.99	6.13	5.41	4.79	4.27	3.81	3.42	3.08	2.78	2.52	2.29
	y direction	1.79	1.46	1.21	1.01	0.85	0.73	0.62	0.54	0.47	0.41	0.36	0.32	0.29	0.25	0.23	0.21	0.19

Two spans



	L (m) =	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50
Breaking point																		
	x direction	30.07	28.06	26.31	24.76	23.38	22.15	21.05	20.04	19.13	18.30	16.92	15.59	14.42	13.37	12.43	11.59	10.83
	y direction	7.43	6.47	5.69	5.04	4.49	4.03	3.64	3.30	3.01	2.75	2.53	2.33	2.15	2.00	1.86	1.73	1.62
Application limit point																		
δ_{max} < L / 200	x direction	58.80	51.11	44.64	39.16	34.50	30.52	27.10	24.15	21.60	19.38	17.44	15.75	14.26	12.94	11.78	10.75	9.83
	y direction	8.31	6.81	5.64	4.73	4.00	3.41	2.94	2.54	2.22	1.94	1.71	1.52	1.35	1.21	1.09	0.98	0.88
δ_{max} < L / 300	x direction	39.20	34.07	29.76	26.11	23.00	20.35	18.07	16.10	14.40	12.92	11.63	10.50	9.50	8.63	7.85	7.17	6.56
	y direction	5.54	4.54	3.76	3.15	2.67	2.28	1.96	1.70	1.48	1.30	1.14	1.01	0.90	0.81	0.72	0.65	0.59
δ_{max} < L / 400	x direction	29.40	25.56	22.32	19.58	17.25	15.26	13.55	12.08	10.80	9.69	8.72	7.87	7.13	6.47	5.89	5.38	4.92
	y direction	4.16	3.40	2.82	2.36	2.00	1.71	1.47	1.27	1.11	0.97	0.86	0.76	0.68	0.60	0.54	0.49	0.44

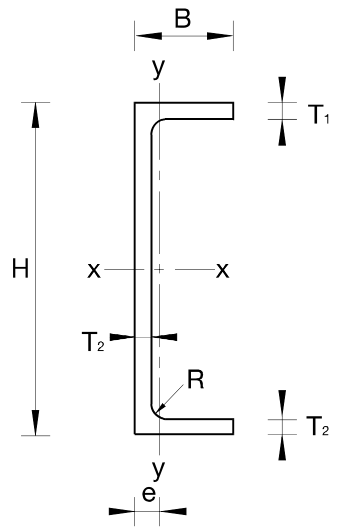
Three spans



	L (m) =	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50
Breaking point																		
	x direction	31.32	29.23	27.40	25.79	24.36	23.08	21.92	20.88	19.93	19.06	18.27	17.54	16.86	16.24	15.54	14.49	13.54
	y direction	9.28	8.09	7.11	6.30	5.62	5.04	4.55	4.13	3.76	3.44	3.16	2.91	2.69	2.50	2.32	2.16	2.02
Application limit point																		
δ_{max} < L / 200	x direction	51.84	44.69	38.74	33.76	29.55	25.99	22.96	20.36	18.13	16.20	14.53	13.07	11.80	10.68	9.69	8.82	8.05
	y direction	6.63	5.42	4.49	3.76	3.18	2.71	2.33	2.01	1.76	1.54	1.36	1.20	1.07	0.96	0.86	0.77	0.70
δ_{max} < L / 300	x direction	34.56	29.80	25.83	22.50	19.70	17.33	15.30	13.57	12.09	10.80	9.68	8.71	7.86	7.12	6.46	5.88	5.37
	y direction	4.42	3.61	2.99	2.50	2.12	1.81	1.55	1.34	1.17	1.03	0.90	0.80	0.71	0.64	0.57	0.51	0.47
δ_{max} < L / 400	x direction	25.92	22.35	19.37	16.88	14.78	13.00	11.48	10.18	9.06	8.10	7.26	6.54	5.90	5.34	4.85	4.41	4.03
	y direction	3.31	2.71	2.24	1.88	1.59	1.35	1.16	1.01	0.88	0.77	0.68	0.60	0.53	0.48	0.43	0.39	0.35

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	63.3
2.25	53.5
2.50	45.6
2.75	39.2
3.00	34.0
3.25	29.7
3.50	26.1
3.75	23.1
4.00	20.6
4.25	18.5
4.50	16.6
4.75	15.1
5.00	13.7
5.25	12.5
5.50	11.4
5.75	10.5
6.00	9.7
6.25	9.0
6.50	8.3
6.75	7.7
7.00	7.2
7.25	6.7
7.50	6.3
7.75	5.9
8.00	5.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	2.7
0.60	1.9
0.70	1.4
0.80	1.1
0.90	0.8
1.00	0.7
1.10	0.6
1.20	0.5
1.30	0.4
1.40	0.4
1.50	0.3
1.60	0.3
1.70	0.2
1.80	0.2
1.90	0.2
2.00	0.2
2.10	0.2
2.20	0.1
2.30	0.1
2.40	0.1
2.50	0.1
2.60	0.1
2.70	0.1
2.80	0.1
3.00	0.1



Geometry	
H	120 mm
B	36 mm
T_1	6 mm
T_2	6 mm
R	7,5 mm

Cross-section constants	
A	1 104 mm^2
I_{xx}	2 100 868 mm^4
W_{xx}	35 014 mm^3
$A_{k,y}$	648 mm^2
I_{yy}	107 009 mm^4
W_{yy}	3 959 mm^3
$A_{k,x}$	367 mm^2
e	9.0 mm

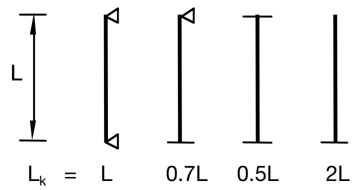
Material properties	
$E_{0°}$	23 000 MPa
$f_{c, 0°}$	240 MPa

Partial coefficients	
$\lambda_{m,E}$	1.3
$\lambda_{m,f}$	1.3

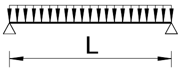
Design value for load-bearing capacity
203.8 kN

Dead weight
1.99 kg/m

Buckling length

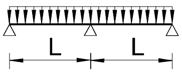


One span



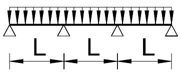
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	12.46	10.22	8.27	6.84	5.75	4.90	4.22	3.68	3.23	2.86	2.55	2.29	2.07	1.88	1.71	1.56	1.44
	y direction	1.46	1.16	0.94	0.77	0.65	0.55	0.48	0.42	0.37	0.32	0.29	0.26	0.23	0.21	0.19	0.18	0.16
Application limit point																		
δ_{max} < L / 200	x direction	2.19	1.56	1.14	0.86	0.67	0.53	0.42	0.35	0.29	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.09
	y direction	0.12	0.08	0.06	0.05	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
δ_{max} < L / 300	x direction	1.46	1.04	0.76	0.58	0.45	0.35	0.28	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.06
	y direction	0.08	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
δ_{max} < L / 400	x direction	1.09	0.78	0.57	0.43	0.33	0.26	0.21	0.17	0.14	0.12	0.10	0.09	0.07	0.06	0.06	0.05	0.04
	y direction	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	9.97	8.86	7.98	6.84	5.75	4.90	4.22	3.68	3.23	2.86	2.55	2.29	2.07	1.88	1.71	1.56	1.44
	y direction	1.46	1.16	0.94	0.77	0.65	0.55	0.48	0.42	0.37	0.32	0.29	0.26	0.23	0.21	0.19	0.18	0.16
Application limit point																		
δ_{max} < L / 200	x direction	4.87	3.52	2.61	1.99	1.55	1.23	0.99	0.81	0.67	0.56	0.48	0.41	0.35	0.30	0.26	0.23	0.20
	y direction	0.28	0.20	0.14	0.11	0.08	0.07	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
δ_{max} < L / 300	x direction	3.25	2.34	1.74	1.33	1.03	0.82	0.66	0.54	0.45	0.38	0.32	0.27	0.23	0.20	0.18	0.15	0.14
	y direction	0.19	0.13	0.10	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	2.44	1.76	1.31	1.00	0.78	0.62	0.50	0.41	0.34	0.28	0.24	0.20	0.17	0.15	0.13	0.12	0.10
	y direction	0.14	0.10	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

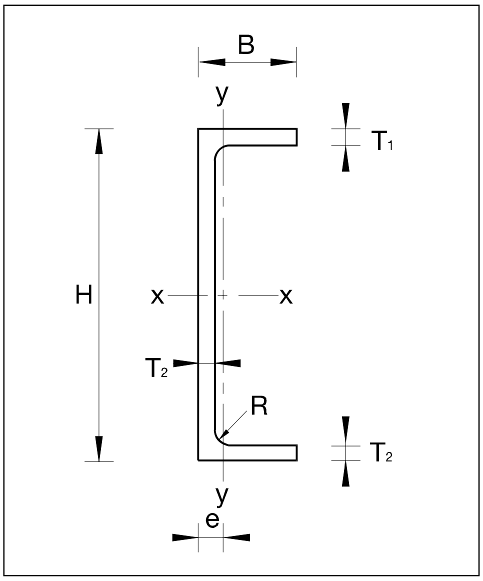
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	10.38	9.23	8.31	7.55	6.92	6.12	5.28	4.60	4.04	3.58	3.19	2.87	2.59	2.35	2.14	1.96	1.80
	y direction	1.83	1.44	1.17	0.97	0.81	0.69	0.60	0.52	0.46	0.40	0.36	0.32	0.29	0.27	0.24	0.22	0.20
Application limit point																		
δ_{max} < L / 200	x direction	3.94	2.83	2.10	1.59	1.24	0.98	0.79	0.65	0.53	0.45	0.38	0.32	0.28	0.24	0.21	0.18	0.16
	y direction	0.22	0.16	0.11	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 300	x direction	2.63	1.89	1.40	1.06	0.83	0.65	0.53	0.43	0.36	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.11
	y direction	0.15	0.10	0.08	0.06	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	1.97	1.42	1.05	0.80	0.62	0.49	0.39	0.32	0.27	0.22	0.19	0.16	0.14	0.12	0.10	0.09	0.08
	y direction	0.11	0.08	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	77.5
2.25	65.7
2.50	56.2
2.75	48.5
3.00	42.1
3.25	36.9
3.50	32.5
3.75	28.8
4.00	25.7
4.25	23.1
4.50	20.8
4.75	18.8
5.00	17.1
5.25	15.7
5.50	14.3
5.75	13.2
6.00	12.2
6.25	11.3
6.50	10.5
6.75	9.7
7.00	9.1
7.25	8.5
7.50	7.9
7.75	7.5
8.00	7.0

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	106.4
0.60	85.8
0.70	69.8
0.80	57.4
0.90	47.8
1.00	40.3
1.10	34.3
1.20	29.5
1.30	25.6
1.40	22.4
1.50	19.8
1.60	17.6
1.70	15.7
1.80	14.1
1.90	12.7
2.00	11.6
2.10	10.5
2.20	9.6
2.30	8.8
2.40	8.2
2.50	7.5
2.60	7.0
2.70	6.5
2.80	6.0
3.00	5.3



Geometry	
H	120 mm
B	50 mm
T_1	6 mm
T_2	6 mm
R	7,5 mm

Cross-section constants	
A	1 272 mm^2
I_{xx}	2 647 204 mm^4
W_{xx}	44 120 mm^3
$A_{k,y}$	648 mm^2
I_{yy}	278 601 mm^4
W_{yy}	7 626 mm^3
$A_{k,x}$	510 mm^2
e	13.5 mm

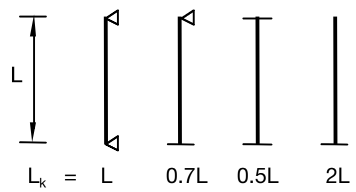
Material properties	
$E_{0°}$	23 000 MPa
$f_{c, 0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

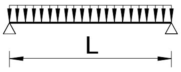
Design value for load-bearing capacity
234.9 kN

Dead weight
2.29 kg/m

Buckling length

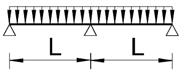


One span



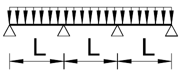
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	12.46	11.08	9.97	8.62	7.24	6.17	5.32	4.63	4.07	3.61	3.22	2.89	2.61	2.36	2.15	1.97	1.81
	y direction	2.82	2.22	1.80	1.49	1.25	1.07	0.92	0.80	0.70	0.62	0.56	0.50	0.45	0.41	0.37	0.34	0.31
Application limit point																		
δ_{max} < L / 200	x direction	2.72	1.94	1.43	1.08	0.84	0.66	0.53	0.43	0.36	0.30	0.25	0.22	0.18	0.16	0.14	0.12	0.11
	y direction	0.30	0.21	0.16	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01
δ_{max} < L / 300	x direction	1.81	1.29	0.95	0.72	0.56	0.44	0.35	0.29	0.24	0.20	0.17	0.14	0.12	0.11	0.09	0.08	0.07
	y direction	0.20	0.14	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	1.36	0.97	0.71	0.54	0.42	0.33	0.27	0.22	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05
	y direction	0.15	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	9.97	8.86	7.98	7.25	6.65	6.13	5.32	4.63	4.07	3.61	3.22	2.89	2.61	2.36	2.15	1.97	1.81
	y direction	2.82	2.22	1.80	1.49	1.25	1.07	0.92	0.80	0.70	0.62	0.56	0.50	0.45	0.41	0.37	0.34	0.31
Application limit point																		
δ_{max} < L / 200	x direction	5.95	4.32	3.22	2.47	1.93	1.53	1.24	1.01	0.84	0.70	0.60	0.51	0.44	0.38	0.33	0.29	0.25
	y direction	0.72	0.51	0.37	0.28	0.22	0.17	0.14	0.11	0.09	0.08	0.06	0.05	0.05	0.04	0.04	0.03	0.03
δ_{max} < L / 300	x direction	3.96	2.88	2.15	1.64	1.28	1.02	0.82	0.68	0.56	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.17
	y direction	0.48	0.34	0.25	0.19	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02
δ_{max} < L / 400	x direction	2.97	2.16	1.61	1.23	0.96	0.77	0.62	0.51	0.42	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.13
	y direction	0.36	0.25	0.19	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01

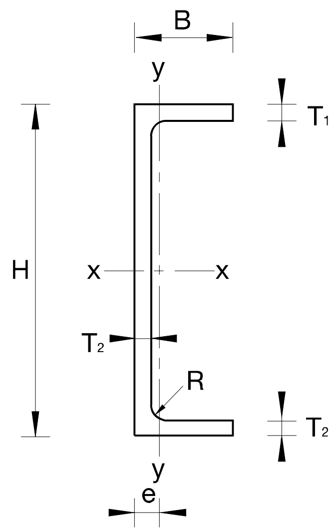
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	10.38	9.23	8.31	7.55	6.92	6.39	5.93	5.54	5.09	4.51	4.02	3.61	3.26	2.96	2.69	2.46	2.26
	y direction	3.52	2.78	2.25	1.86	1.56	1.33	1.15	1.00	0.88	0.78	0.70	0.62	0.56	0.51	0.47	0.43	0.39
Application limit point																		
δ_{max} < L / 200	x direction	4.84	3.49	2.60	1.98	1.54	1.22	0.99	0.81	0.67	0.56	0.47	0.40	0.35	0.30	0.26	0.23	0.20
	y direction	0.57	0.40	0.29	0.22	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
δ_{max} < L / 300	x direction	3.23	2.33	1.73	1.32	1.03	0.82	0.66	0.54	0.45	0.37	0.31	0.27	0.23	0.20	0.17	0.15	0.13
	y direction	0.38	0.27	0.20	0.15	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01
δ_{max} < L / 400	x direction	2.42	1.75	1.30	0.99	0.77	0.61	0.49	0.40	0.33	0.28	0.24	0.20	0.17	0.15	0.13	0.11	0.10
	y direction	0.29	0.20	0.15	0.11	0.09	0.07	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	75.0
2.25	64.4
2.50	55.6
2.75	48.4
3.00	42.3
3.25	37.3
3.50	33.0
3.75	29.4
4.00	26.3
4.25	23.7
4.50	21.4
4.75	19.4
5.00	17.7
5.25	16.2
5.50	14.8
5.75	13.7
6.00	12.6
6.25	11.7
6.50	10.9
6.75	10.1
7.00	9.4
7.25	8.8
7.50	8.3
7.75	7.8
8.00	7.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	62.2
0.60	47.9
0.70	37.6
0.80	30.2
0.90	24.6
1.00	20.4
1.10	17.2
1.20	14.7
1.30	12.6
1.40	11.0
1.50	9.6
1.60	8.5
1.70	7.6
1.80	6.8
1.90	6.1
2.00	5.5
2.10	5.0
2.20	4.6
2.30	4.2
2.40	3.9
2.50	3.6
2.60	3.3
2.70	3.1
2.80	2.9
3.00	2.5



Geometry	
H	140 mm
B	40 mm
T_1	5 mm
T_2	5 mm
R	5 mm

Cross-section constants	
A	1 061 mm^2
I_{xx}	2 782 550 mm^4
W_{xx}	39 751 mm^3
$A_{k,y}$	630 mm^2
I_{yy}	130 629 mm^4
W_{yy}	4 232 mm^3
$A_{k,x}$	340 mm^2
e	9.1 mm

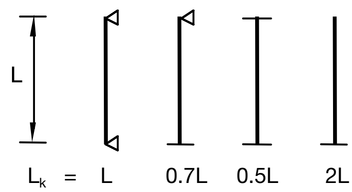
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

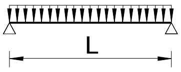
Design value for load-bearing capacity
195.8 kN

Dead weight
1.91 kg/m

Buckling length

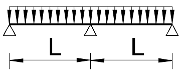


One span



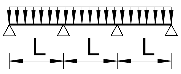
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	12.12	10.77	9.39	7.76	6.52	5.56	4.79	4.17	3.67	3.25	2.90	2.60	2.35	2.13	1.94	1.78	1.63
	y direction	1.56	1.23	1.00	0.83	0.69	0.59	0.51	0.44	0.39	0.35	0.31	0.28	0.25	0.23	0.21	0.19	0.17
Application limit point																		
δ_{max} < L / 200	x direction	2.84	2.03	1.50	1.13	0.88	0.69	0.56	0.46	0.38	0.31	0.27	0.23	0.19	0.17	0.15	0.13	0.11
	y direction	0.14	0.10	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 300	x direction	1.89	1.35	1.00	0.76	0.59	0.46	0.37	0.30	0.25	0.21	0.18	0.15	0.13	0.11	0.10	0.09	0.08
	y direction	0.10	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
δ_{max} < L / 400	x direction	1.42	1.01	0.75	0.57	0.44	0.35	0.28	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.06
	y direction	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	9.69	8.62	7.75	7.05	6.46	5.56	4.79	4.17	3.67	3.25	2.90	2.60	2.35	2.13	1.94	1.78	1.63
	y direction	1.56	1.23	1.00	0.83	0.69	0.59	0.51	0.44	0.39	0.35	0.31	0.28	0.25	0.23	0.21	0.19	0.17
Application limit point																		
δ_{max} < L / 200	x direction	6.17	4.49	3.36	2.57	2.01	1.60	1.29	1.06	0.88	0.74	0.62	0.53	0.46	0.40	0.35	0.30	0.27
	y direction	0.34	0.24	0.18	0.13	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
δ_{max} < L / 300	x direction	4.12	2.99	2.24	1.72	1.34	1.07	0.86	0.71	0.59	0.49	0.42	0.35	0.31	0.26	0.23	0.20	0.18
	y direction	0.23	0.16	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	3.09	2.25	1.68	1.29	1.01	0.80	0.65	0.53	0.44	0.37	0.31	0.27	0.23	0.20	0.17	0.15	0.13
	y direction	0.17	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01

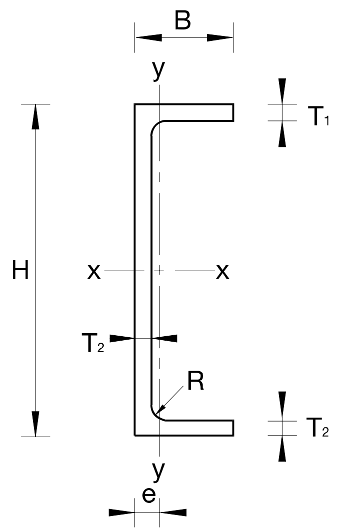
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	10.10	8.97	8.08	7.34	6.73	6.21	5.77	5.22	4.59	4.06	3.62	3.25	2.94	2.66	2.43	2.22	2.04
	y direction	1.95	1.54	1.25	1.03	0.87	0.74	0.64	0.56	0.49	0.43	0.39	0.35	0.31	0.28	0.26	0.24	0.22
Application limit point																		
δ_{max} < L / 200	x direction	5.04	3.64	2.71	2.07	1.61	1.28	1.03	0.85	0.70	0.59	0.50	0.42	0.36	0.31	0.27	0.24	0.21
	y direction	0.27	0.19	0.14	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
δ_{max} < L / 300	x direction	3.36	2.43	1.81	1.38	1.07	0.85	0.69	0.56	0.47	0.39	0.33	0.28	0.24	0.21	0.18	0.16	0.14
	y direction	0.18	0.13	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	2.52	1.82	1.35	1.03	0.81	0.64	0.52	0.42	0.35	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.11
	y direction	0.13	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	177.1
2.25	156.0
2.50	137.8
2.75	122.0
3.00	108.4
3.25	96.6
3.50	86.5
3.75	77.8
4.00	70.2
4.25	63.6
4.50	57.8
4.75	52.8
5.00	48.3
5.25	44.4
5.50	40.9
5.75	37.8
6.00	35.0
6.25	32.5
6.50	30.3
6.75	28.2
7.00	26.4
7.25	24.7
7.50	23.2
7.75	21.8
8.00	20.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	159.8
0.60	128.4
0.70	104.2
0.80	85.6
0.90	71.2
1.00	59.9
1.10	51.0
1.20	43.8
1.30	38.0
1.40	33.3
1.50	29.3
1.60	26.0
1.70	23.3
1.80	20.9
1.90	18.9
2.00	17.1
2.10	15.6
2.20	14.3
2.30	13.1
2.40	12.1
2.50	11.1
2.60	10.3
2.70	9.6
2.80	8.9
3.00	7.8



Geometry	
H	160 mm
B	48 mm
T_1	8 mm
T_2	8 mm
R	8 mm

Cross-section constants	
A	1 947 mm^2
I_{xx}	6 566 201 mm^4
W_{xx}	82 078 mm^3
$A_{k,y}$	1 152 mm^2
I_{yy}	338 114 mm^4
W_{yy}	9 384 mm^3
$A_{k,x}$	653 mm^2
e	12.0 mm

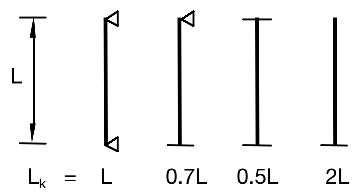
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

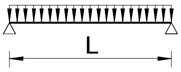
Design value for load-bearing capacity
359.5 kN

Dead weight
3.505 kg/m

Buckling length

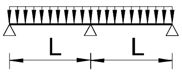


One span



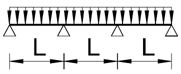
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	22.15	19.69	17.72	16.03	13.47	11.48	9.90	8.62	7.58	6.71	5.99	5.37	4.85	4.40	4.01	3.67	3.37
	y direction	3.46	2.74	2.22	1.83	1.54	1.31	1.13	0.99	0.87	0.77	0.68	0.61	0.55	0.50	0.46	0.42	0.38
Application limit point																		
δ_{max} < L / 200	x direction	7.83	5.63	4.18	3.18	2.47	1.96	1.58	1.29	1.07	0.89	0.76	0.64	0.55	0.48	0.42	0.37	0.32
	y direction	0.45	0.32	0.23	0.17	0.13	0.11	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02
δ_{max} < L / 300	x direction	5.22	3.75	2.78	2.12	1.65	1.31	1.05	0.86	0.71	0.60	0.50	0.43	0.37	0.32	0.28	0.24	0.21
	y direction	0.30	0.21	0.15	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01
δ_{max} < L / 400	x direction	3.91	2.82	2.09	1.59	1.24	0.98	0.79	0.65	0.53	0.45	0.38	0.32	0.28	0.24	0.21	0.18	0.16
	y direction	0.22	0.16	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	17.72	15.75	14.18	12.89	11.82	10.91	9.90	8.62	7.58	6.71	5.99	5.37	4.85	4.40	4.01	3.67	3.37
	y direction	3.46	2.74	2.22	1.83	1.54	1.31	1.13	0.99	0.87	0.77	0.68	0.61	0.55	0.50	0.46	0.42	0.38
Application limit point																		
δ_{max} < L / 200	x direction	16.22	11.99	9.07	7.02	5.53	4.43	3.60	2.96	2.46	2.07	1.75	1.50	1.29	1.12	0.98	0.86	0.76
	y direction	1.06	0.75	0.55	0.41	0.32	0.25	0.20	0.16	0.14	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04
δ_{max} < L / 300	x direction	10.82	7.99	6.05	4.68	3.69	2.95	2.40	1.97	1.64	1.38	1.17	1.00	0.86	0.75	0.65	0.57	0.51
	y direction	0.71	0.50	0.37	0.28	0.21	0.17	0.13	0.11	0.09	0.08	0.06	0.05	0.05	0.04	0.03	0.03	0.03
δ_{max} < L / 400	x direction	8.11	5.99	4.54	3.51	2.76	2.21	1.80	1.48	1.23	1.03	0.88	0.75	0.65	0.56	0.49	0.43	0.38
	y direction	0.53	0.38	0.27	0.21	0.16	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02

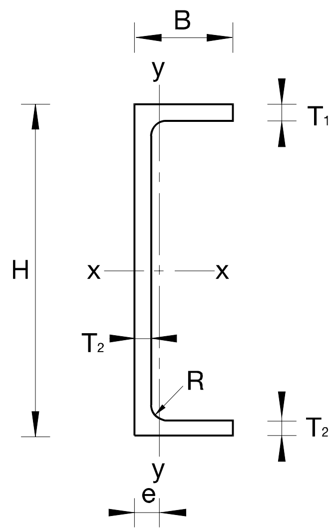
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	18.46	16.41	14.77	13.43	12.31	11.36	10.55	9.85	9.23	8.39	7.48	6.72	6.06	5.50	5.01	4.58	4.21
	y direction	4.33	3.42	2.77	2.29	1.92	1.64	1.41	1.23	1.08	0.96	0.86	0.77	0.69	0.63	0.57	0.52	0.48
Application limit point																		
δ_{max} < L / 200	x direction	13.45	9.85	7.41	5.70	4.47	3.57	2.89	2.37	1.97	1.65	1.40	1.20	1.03	0.89	0.78	0.68	0.60
	y direction	0.84	0.59	0.43	0.33	0.25	0.20	0.16	0.13	0.11	0.09	0.08	0.06	0.05	0.05	0.04	0.04	0.03
δ_{max} < L / 300	x direction	8.97	6.57	4.94	3.80	2.98	2.38	1.93	1.58	1.31	1.10	0.93	0.80	0.69	0.59	0.52	0.46	0.40
	y direction	0.56	0.40	0.29	0.22	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
δ_{max} < L / 400	x direction	6.73	4.92	3.70	2.85	2.23	1.78	1.44	1.19	0.98	0.83	0.70	0.60	0.51	0.45	0.39	0.34	0.30
	y direction	0.42	0.30	0.22	0.16	0.13	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	338.5
2.25	306.2
2.50	276.7
2.75	250.0
3.00	226.2
3.25	204.9
3.50	186.1
3.75	169.3
4.00	154.4
4.25	141.2
4.50	129.5
4.75	119.0
5.00	109.7
5.25	101.3
5.50	93.8
5.75	87.1
6.00	81.0
6.25	75.5
6.50	70.5
6.75	66.0
7.00	61.9
7.25	58.1
7.50	54.7
7.75	51.5
8.00	48.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	312.0
0.60	261.0
0.70	218.7
0.80	184.3
0.90	156.3
1.00	133.7
1.10	115.3
1.20	100.1
1.30	87.6
1.40	77.2
1.50	68.5
1.60	61.1
1.70	54.8
1.80	49.4
1.90	44.7
2.00	40.7
2.10	37.2
2.20	34.1
2.30	31.3
2.40	28.9
2.50	26.7
2.60	24.8
2.70	23.1
2.80	21.5
3.00	18.8



Geometry	
H	200 mm
B	60 mm
T_1	10 mm
T_2	10 mm
R	10 mm

Cross-section constants	
A	3 043 mm^2
I_{xx}	16 030 763 mm^4
W_{xx}	160 308 mm^3
$A_{k,y}$	1 800 mm^2
I_{yy}	825 475 mm^4
W_{yy}	18 328 mm^3
$A_{k,x}$	1 020 mm^2
e	15.0 mm

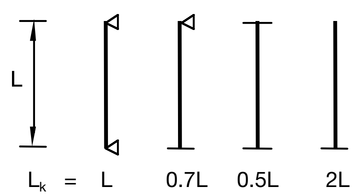
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

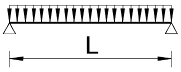
Design value for load-bearing capacity
561.8 kN

Dead weight
5.447 kg/m

Buckling length

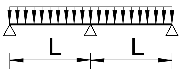


One span



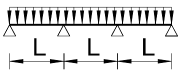
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	34.62	30.77	27.69	25.17	23.08	21.30	19.33	16.84	14.80	13.11	11.69	10.49	9.47	8.59	7.83	7.16	6.58
	y direction	6.77	5.35	4.33	3.58	3.01	2.56	2.21	1.92	1.69	1.50	1.34	1.20	1.08	0.98	0.89	0.82	0.75
Application limit point																		
δ_{max} < L / 200	x direction	17.96	13.07	9.78	7.50	5.86	4.67	3.77	3.09	2.57	2.15	1.82	1.55	1.34	1.16	1.01	0.89	0.78
	y direction	1.09	0.77	0.56	0.42	0.33	0.26	0.21	0.17	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04
δ_{max} < L / 300	x direction	11.97	8.71	6.52	5.00	3.91	3.11	2.52	2.06	1.71	1.43	1.21	1.04	0.89	0.77	0.67	0.59	0.52
	y direction	0.73	0.51	0.38	0.28	0.22	0.17	0.14	0.11	0.09	0.08	0.06	0.06	0.05	0.04	0.04	0.03	0.03
δ_{max} < L / 400	x direction	8.98	6.54	4.89	3.75	2.93	2.33	1.89	1.55	1.28	1.08	0.91	0.78	0.67	0.58	0.50	0.44	0.39
	y direction	0.54	0.38	0.28	0.21	0.16	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	27.69	24.62	22.15	20.14	18.46	17.04	15.82	14.77	13.85	13.03	11.69	10.49	9.47	8.59	7.83	7.16	6.58
	y direction	6.77	5.35	4.33	3.58	3.01	2.56	2.21	1.92	1.69	1.50	1.34	1.20	1.08	0.98	0.89	0.82	0.75
Application limit point																		
δ_{max} < L / 200	x direction	34.99	26.37	20.28	15.88	12.64	10.21	8.35	6.91	5.78	4.88	4.15	3.56	3.08	2.68	2.34	2.06	1.82
	y direction	2.55	1.81	1.33	1.00	0.77	0.61	0.49	0.40	0.33	0.28	0.23	0.20	0.17	0.15	0.13	0.11	0.10
δ_{max} < L / 300	x direction	23.33	17.58	13.52	10.59	8.43	6.81	5.57	4.61	3.85	3.25	2.77	2.37	2.05	1.78	1.56	1.37	1.21
	y direction	1.70	1.21	0.89	0.67	0.52	0.41	0.33	0.27	0.22	0.18	0.15	0.13	0.11	0.10	0.08	0.07	0.07
δ_{max} < L / 400	x direction	17.50	13.18	10.14	7.94	6.32	5.10	4.18	3.46	2.89	2.44	2.08	1.78	1.54	1.34	1.17	1.03	0.91
	y direction	1.28	0.90	0.66	0.50	0.39	0.31	0.25	0.20	0.16	0.14	0.12	0.10	0.08	0.07	0.06	0.06	0.05

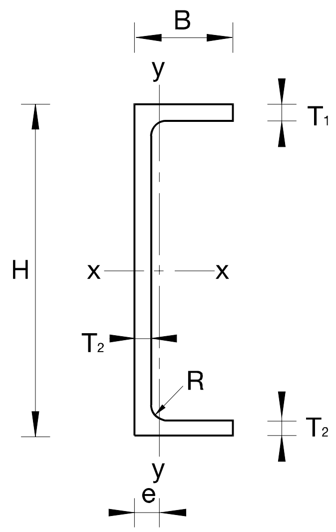
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	28.85	25.64	23.08	20.98	19.23	17.75	16.48	15.38	14.42	13.57	12.82	12.15	11.54	10.74	9.78	8.95	8.22
	y direction	8.46	6.68	5.41	4.47	3.76	3.20	2.76	2.41	2.11	1.87	1.67	1.50	1.35	1.23	1.12	1.02	0.94
Application limit point																		
δ_{max} < L / 200	x direction	29.60	22.06	16.81	13.07	10.35	8.31	6.77	5.59	4.66	3.92	3.33	2.85	2.46	2.14	1.87	1.64	1.45
	y direction	2.03	1.44	1.05	0.79	0.61	0.48	0.39	0.32	0.26	0.22	0.18	0.16	0.13	0.12	0.10	0.09	0.08
δ_{max} < L / 300	x direction	19.73	14.71	11.21	8.72	6.90	5.54	4.52	3.72	3.10	2.61	2.22	1.90	1.64	1.42	1.24	1.09	0.97
	y direction	1.35	0.96	0.70	0.53	0.41	0.32	0.26	0.21	0.17	0.14	0.12	0.10	0.09	0.08	0.07	0.06	0.05
δ_{max} < L / 400	x direction	14.80	11.03	8.41	6.54	5.17	4.16	3.39	2.79	2.33	1.96	1.67	1.43	1.23	1.07	0.93	0.82	0.72
	y direction	1.02	0.72	0.53	0.40	0.31	0.24	0.19	0.16	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	380.3
2.25	351.7
2.50	324.4
2.75	298.7
3.00	274.9
3.25	253.0
3.50	233.0
3.75	214.7
4.00	198.1
4.25	183.0
4.50	169.3
4.75	156.9
5.00	145.7
5.25	135.5
5.50	126.2
5.75	117.8
6.00	110.1
6.25	103.1
6.50	96.7
6.75	90.8
7.00	85.5
7.25	80.5
7.50	76.0
7.75	71.8
8.00	67.9

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	359.5
0.60	312.2
0.70	270.1
0.80	233.8
0.90	202.9
1.00	176.7
1.10	154.7
1.20	136.1
1.30	120.4
1.40	107.1
1.50	95.7
1.60	85.9
1.70	77.5
1.80	70.2
1.90	63.8
2.00	58.3
2.10	53.4
2.20	49.1
2.30	45.2
2.40	41.8
2.50	38.8
2.60	36.0
2.70	33.6
2.80	31.4
3.00	27.5



Geometry	
H	240 mm
B	72 mm
T_1	8 mm
T_2	8 mm
R	8 mm

Cross-section constants	
A	2 971 mm^2
I_{xx}	23 334 131 mm^4
W_{xx}	194 451 mm^3
$A_{k,y}$	1 728 mm^2
I_{yy}	1 226 564 mm^4
W_{yy}	22 084 mm^3
$A_{k,x}$	979 mm^2
e	16.5 mm

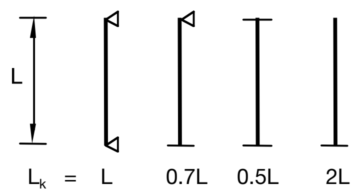
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

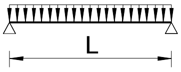
Design value for load-bearing capacity
548.6 kN

Dead weight
5.348 kg/m

Buckling length

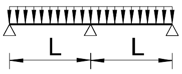


One span



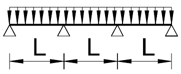
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	33.23	29.54	26.58	24.17	22.15	20.45	18.99	17.72	16.62	15.64	14.18	12.73	11.49	10.42	9.49	8.69	7.98
	y direction	8.15	6.44	5.22	4.31	3.62	3.09	2.66	2.32	2.04	1.81	1.61	1.45	1.30	1.18	1.08	0.99	0.91
Application limit point																		
δ_{max} < L / 200	x direction	24.08	17.78	13.45	10.40	8.19	6.56	5.33	4.38	3.64	3.06	2.60	2.22	1.91	1.66	1.45	1.27	1.12
	y direction	1.60	1.13	0.83	0.62	0.48	0.38	0.30	0.25	0.20	0.17	0.14	0.12	0.11	0.09	0.08	0.07	0.06
δ_{max} < L / 300	x direction	16.05	11.85	8.97	6.93	5.46	4.37	3.55	2.92	2.43	2.04	1.73	1.48	1.28	1.11	0.97	0.85	0.75
	y direction	1.07	0.76	0.55	0.42	0.32	0.25	0.20	0.17	0.14	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04
δ_{max} < L / 400	x direction	12.04	8.89	6.73	5.20	4.10	3.28	2.66	2.19	1.82	1.53	1.30	1.11	0.96	0.83	0.72	0.64	0.56
	y direction	0.80	0.57	0.42	0.31	0.24	0.19	0.15	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	26.58	23.63	21.27	19.33	17.72	16.36	15.19	14.18	13.29	12.51	11.82	11.19	10.63	10.13	9.49	8.69	7.98
	y direction	8.15	6.44	5.22	4.31	3.62	3.09	2.66	2.32	2.04	1.81	1.61	1.45	1.30	1.18	1.08	0.99	0.91
Application limit point																		
δ_{max} < L / 200	x direction	43.63	33.61	26.33	20.94	16.87	13.77	11.36	9.47	7.97	6.76	5.78	4.98	4.32	3.77	3.31	2.91	2.58
	y direction	3.71	2.64	1.94	1.47	1.14	0.90	0.72	0.59	0.49	0.41	0.34	0.29	0.25	0.22	0.19	0.17	0.15
δ_{max} < L / 300	x direction	29.09	22.41	17.55	13.96	11.25	9.18	7.57	6.31	5.31	4.51	3.86	3.32	2.88	2.51	2.20	1.94	1.72
	y direction	2.47	1.76	1.30	0.98	0.76	0.60	0.48	0.39	0.32	0.27	0.23	0.19	0.17	0.14	0.13	0.11	0.10
δ_{max} < L / 400	x direction	21.82	16.81	13.16	10.47	8.44	6.88	5.68	4.74	3.98	3.38	2.89	2.49	2.16	1.88	1.65	1.46	1.29
	y direction	1.86	1.32	0.97	0.74	0.57	0.45	0.36	0.29	0.24	0.20	0.17	0.15	0.13	0.11	0.09	0.08	0.07

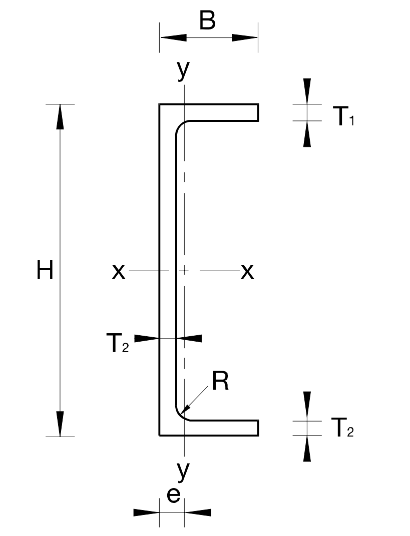
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	27.69	24.62	22.15	20.14	18.46	17.04	15.82	14.77	13.85	13.03	12.31	11.66	11.08	10.55	10.07	9.63	9.23
	y direction	10.19	8.05	6.52	5.39	4.53	3.86	3.33	2.90	2.55	2.26	2.01	1.81	1.63	1.48	1.35	1.23	1.13
Application limit point																		
δ_{max} < L / 200	x direction	37.75	28.70	22.24	17.53	14.02	11.37	9.33	7.74	6.49	5.49	4.68	4.02	3.48	3.03	2.65	2.34	2.07
	y direction	2.96	2.10	1.54	1.17	0.90	0.71	0.57	0.47	0.38	0.32	0.27	0.23	0.20	0.17	0.15	0.13	0.11
δ_{max} < L / 300	x direction	25.16	19.14	14.83	11.68	9.35	7.58	6.22	5.16	4.33	3.66	3.12	2.68	2.32	2.02	1.77	1.56	1.38
	y direction	1.98	1.40	1.03	0.78	0.60	0.48	0.38	0.31	0.26	0.21	0.18	0.15	0.13	0.11	0.10	0.09	0.08
δ_{max} < L / 400	x direction	18.87	14.35	11.12	8.76	7.01	5.68	4.67	3.87	3.25	2.74	2.34	2.01	1.74	1.51	1.33	1.17	1.03
	y direction	1.48	1.05	0.77	0.58	0.45	0.36	0.29	0.23	0.19	0.16	0.14	0.12	0.10	0.09	0.07	0.07	0.06

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	554.9
2.25	512.1
2.50	471.6
2.75	433.6
3.00	398.4
3.25	366.2
3.50	336.7
3.75	310.0
4.00	285.7
4.25	263.7
4.50	243.8
4.75	225.8
5.00	209.5
5.25	194.7
5.50	181.3
5.75	169.1
6.00	158.0
6.25	147.8
6.50	138.6
6.75	130.1
7.00	122.4
7.25	115.3
7.50	108.7
7.75	102.7
8.00	97.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	520.0
0.60	449.3
0.70	387.2
0.80	333.9
0.90	288.8
1.00	251.0
1.10	219.2
1.20	192.5
1.30	170.0
1.40	151.0
1.50	134.8
1.60	120.9
1.70	108.9
1.80	98.6
1.90	89.6
2.00	81.8
2.10	74.9
2.20	68.8
2.30	63.4
2.40	58.6
2.50	54.3
2.60	50.5
2.70	47.0
2.80	43.9
3.00	38.5



Geometry	
H	240 mm
B	72 mm
T_1	12 mm
T_2	12 mm
R	12 mm

Cross-section constants	
A	4 382 mm^2
I_{xx}	33 241 391 mm^4
W_{xx}	277 012 mm^3
$A_{k,y}$	2 592 mm^2
I_{yy}	1 711 704 mm^4
W_{yy}	31 671 mm^3
$A_{k,x}$	1 469 mm^2
e	18.0 mm

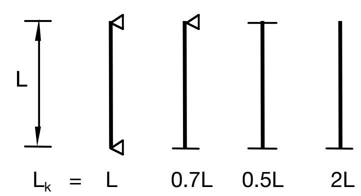
Material properties	
E_{0°	28 000 MPa
$f_{c, 0^\circ}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

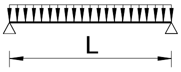
Design value for load-bearing capacity
808.9 kN

Dead weight
7.888 kg/m

Buckling length

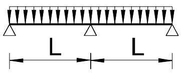


One span



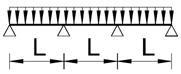
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	49.85	44.31	39.88	36.25	33.23	30.67	28.48	26.58	24.92	22.65	20.20	18.13	16.36	14.84	13.52	12.37	11.36
	y direction	11.69	9.24	7.48	6.19	5.20	4.43	3.82	3.33	2.92	2.59	2.31	2.07	1.87	1.70	1.55	1.41	1.30
Application limit point																		
δ_{max} < L / 200	x direction	34.71	25.57	19.32	14.92	11.74	9.39	7.62	6.27	5.21	4.38	3.71	3.17	2.73	2.37	2.07	1.82	1.60
	y direction	2.24	1.58	1.16	0.87	0.67	0.53	0.43	0.35	0.29	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.08
δ_{max} < L / 300	x direction	23.14	17.05	12.88	9.95	7.83	6.26	5.08	4.18	3.47	2.92	2.47	2.12	1.82	1.58	1.38	1.21	1.07
	y direction	1.49	1.06	0.77	0.58	0.45	0.36	0.28	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.06
δ_{max} < L / 400	x direction	17.35	12.79	9.66	7.46	5.87	4.70	3.81	3.13	2.61	2.19	1.86	1.59	1.37	1.19	1.03	0.91	0.80
	y direction	1.12	0.79	0.58	0.44	0.34	0.27	0.21	0.17	0.14	0.12	0.10	0.09	0.07	0.06	0.06	0.05	0.04

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	39.88	35.45	31.90	29.00	26.58	24.54	22.79	21.27	19.94	18.77	17.72	16.79	15.95	14.84	13.52	12.37	11.36
	y direction	11.69	9.24	7.48	6.19	5.20	4.43	3.82	3.33	2.92	2.59	2.31	2.07	1.87	1.70	1.55	1.41	1.30
Application limit point																		
δ_{max} < L / 200	x direction	63.50	48.78	38.12	30.25	24.34	19.83	16.34	13.61	11.44	9.70	8.29	7.14	6.19	5.39	4.73	4.17	3.69
	y direction	5.20	3.70	2.72	2.06	1.59	1.26	1.01	0.82	0.68	0.57	0.48	0.41	0.35	0.30	0.26	0.23	0.20
δ_{max} < L / 300	x direction	42.34	32.52	25.41	20.16	16.22	13.22	10.90	9.07	7.63	6.47	5.53	4.76	4.12	3.60	3.15	2.78	2.46
	y direction	3.47	2.47	1.81	1.37	1.06	0.84	0.67	0.55	0.45	0.38	0.32	0.27	0.23	0.20	0.18	0.15	0.14
δ_{max} < L / 400	x direction	31.75	24.39	19.06	15.12	12.17	9.91	8.17	6.81	5.72	4.85	4.15	3.57	3.09	2.70	2.36	2.08	1.85
	y direction	2.60	1.85	1.36	1.03	0.80	0.63	0.51	0.41	0.34	0.28	0.24	0.20	0.18	0.15	0.13	0.12	0.10

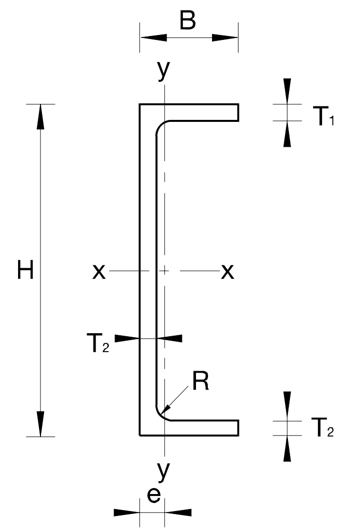
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	41.54	36.92	33.23	30.21	27.69	25.56	23.74	22.15	20.77	19.55	18.46	17.49	16.62	15.82	15.10	14.45	13.85
	y direction	14.62	11.55	9.36	7.73	6.50	5.54	4.77	4.16	3.65	3.24	2.89	2.59	2.34	2.12	1.93	1.77	1.62
Application limit point																		
δ_{max} < L / 200	x direction	54.77	41.54	32.12	25.26	20.18	16.34	13.40	11.11	9.30	7.86	6.70	5.76	4.98	4.33	3.79	3.34	2.95
	y direction	4.15	2.94	2.16	1.63	1.26	1.00	0.80	0.65	0.54	0.45	0.38	0.32	0.28	0.24	0.21	0.18	0.16
δ_{max} < L / 300	x direction	36.52	27.69	21.41	16.84	13.45	10.89	8.93	7.41	6.20	5.24	4.47	3.84	3.32	2.89	2.53	2.23	1.97
	y direction	2.77	1.96	1.44	1.09	0.84	0.66	0.53	0.43	0.36	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.11
δ_{max} < L / 400	x direction	27.39	20.77	16.06	12.63	10.09	8.17	6.70	5.55	4.65	3.93	3.35	2.88	2.49	2.17	1.90	1.67	1.48
	y direction	2.07	1.47	1.08	0.82	0.63	0.50	0.40	0.33	0.27	0.22	0.19	0.16	0.14	0.12	0.10	0.09	0.08

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	977.5
2.25	922.0
2.50	867.0
2.75	813.3
3.00	761.7
3.25	712.6
3.50	666.1
3.75	622.6
4.00	581.9
4.25	544.0
4.50	508.9
4.75	476.4
5.00	446.4
5.25	418.6
5.50	393.0
5.75	369.3
6.00	347.5
6.25	327.3
6.50	308.6
6.75	291.4
7.00	275.4
7.25	260.6
7.50	246.8
7.75	234.0
8.00	222.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	932.3
0.60	835.8
0.70	744.7
0.80	661.6
0.90	587.2
1.00	521.7
1.10	464.4
1.20	414.6
1.30	371.3
1.40	333.6
1.50	300.8
1.60	272.3
1.70	247.3
1.80	225.3
1.90	206.0
2.00	188.9
2.10	173.7
2.20	160.3
2.30	148.2
2.40	137.5
2.50	127.8
2.60	119.0
2.70	111.1
2.80	104.0
3.00	91.6



Geometry	
H	300 mm
B	90 mm
T_1	15 mm
T_2	15 mm
R	15 mm

Cross-section constants	
A	6 847 mm^2
I_{xx}	81 155 740 mm^4
W_{xx}	541 038 mm^3
$A_{k,y}$	4 050 mm^2
I_{yy}	4 178 966 mm^4
W_{yy}	61 857 mm^3
$A_{k,x}$	2 295 mm^2
e	22.4 mm

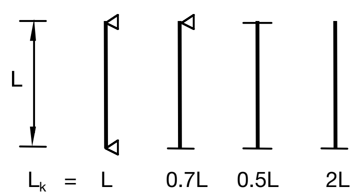
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

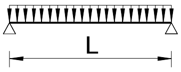
Design value for load-bearing capacity
1264.0 kN

Dead weight
12.345 kg/m

Buckling length

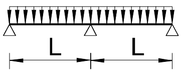


One span



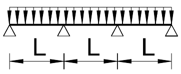
	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x direction	62.31	56.64	51.92	47.93	44.51	41.54	38.94	36.65	34.62	32.79	31.15	28.99	26.42	24.17	22.20	20.46	18.91
	y direction	14.62	12.08	10.15	8.65	7.46	6.50	5.71	5.06	4.51	4.05	3.65	3.31	3.02	2.76	2.54	2.34	2.16
Application limit point																		
δ_{max} < L / 200	x direction	43.38	33.91	26.94	21.73	17.75	14.67	12.26	10.34	8.80	7.54	6.51	5.66	4.95	4.35	3.85	3.42	3.05
	y direction	2.80	2.11	1.63	1.29	1.03	0.84	0.69	0.58	0.49	0.42	0.36	0.31	0.27	0.24	0.21	0.18	0.16
δ_{max} < L / 300	x direction	28.92	22.60	17.96	14.48	11.83	9.78	8.17	6.89	5.86	5.03	4.34	3.77	3.30	2.90	2.57	2.28	2.03
	y direction	1.87	1.41	1.09	0.86	0.69	0.56	0.47	0.39	0.33	0.28	0.24	0.21	0.18	0.16	0.14	0.12	0.11
δ_{max} < L / 400	x direction	21.69	16.95	13.47	10.86	8.88	7.34	6.13	5.17	4.40	3.77	3.26	2.83	2.48	2.18	1.92	1.71	1.52
	y direction	1.40	1.06	0.82	0.65	0.52	0.42	0.35	0.29	0.25	0.21	0.18	0.15	0.13	0.12	0.10	0.09	0.08

Two spans



	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x direction	49.85	45.31	41.54	38.34	35.60	33.23	31.15	29.32	27.69	26.23	24.92	23.74	22.66	21.67	20.77	19.94	18.91
	y direction	14.62	12.08	10.15	8.65	7.46	6.50	5.71	5.06	4.51	4.05	3.65	3.31	3.02	2.76	2.54	2.34	2.16
Application limit point																		
δ_{max} < L / 200	x direction	79.38	64.19	52.49	43.36	36.16	30.42	25.80	22.04	18.96	16.42	14.30	12.53	11.03	9.75	8.67	7.73	6.93
	y direction	6.50	4.93	3.83	3.03	2.44	1.99	1.65	1.38	1.16	0.99	0.85	0.74	0.64	0.56	0.49	0.44	0.39
δ_{max} < L / 300	x direction	52.92	42.79	34.99	28.91	24.11	20.28	17.20	14.70	12.64	10.95	9.54	8.35	7.35	6.50	5.78	5.16	4.62
	y direction	4.33	3.29	2.55	2.02	1.63	1.33	1.10	0.92	0.77	0.66	0.57	0.49	0.43	0.37	0.33	0.29	0.26
δ_{max} < L / 400	x direction	39.69	32.09	26.24	21.68	18.08	15.21	12.90	11.02	9.48	8.21	7.15	6.26	5.51	4.88	4.33	3.87	3.46
	y direction	3.25	2.47	1.92	1.52	1.22	1.00	0.82	0.69	0.58	0.50	0.43	0.37	0.32	0.28	0.25	0.22	0.19

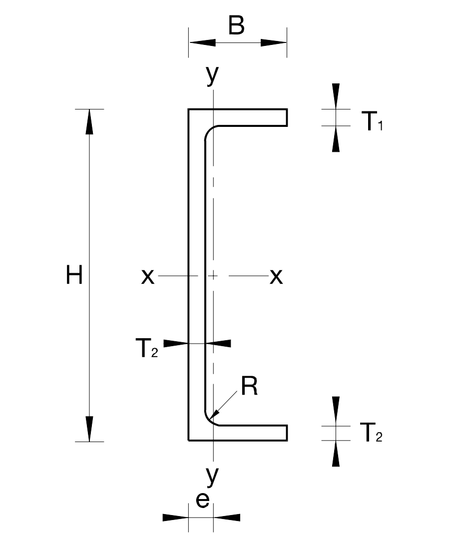
Three spans



	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x direction	51.92	47.20	43.27	39.94	37.09	34.62	32.45	30.54	28.85	27.33	25.96	24.73	23.60	22.58	21.63	20.77	19.97
	y direction	18.27	15.10	12.69	10.81	9.32	8.12	7.14	6.32	5.64	5.06	4.57	4.14	3.78	3.45	3.17	2.92	2.70
Application limit point																		
δ_{max} < L / 200	x direction	68.47	54.79	44.40	36.40	30.15	25.22	21.28	18.11	15.52	13.39	11.63	10.16	8.92	7.88	6.99	6.22	5.57
	y direction	5.19	3.93	3.05	2.41	1.93	1.58	1.30	1.09	0.92	0.78	0.67	0.58	0.51	0.44	0.39	0.35	0.31
δ_{max} < L / 300	x direction	45.64	36.53	29.60	24.27	20.10	16.81	14.19	12.07	10.35	8.93	7.75	6.77	5.95	5.25	4.66	4.15	3.71
	y direction	3.46	2.62	2.03	1.60	1.29	1.05	0.87	0.73	0.61	0.52	0.45	0.39	0.34	0.30	0.26	0.23	0.20
δ_{max} < L / 400	x direction	34.23	27.39	22.20	18.20	15.08	12.61	10.64	9.05	7.76	6.70	5.82	5.08	4.46	3.94	3.49	3.11	2.78
	y direction	2.59	1.96	1.52	1.20	0.97	0.79	0.65	0.54	0.46	0.39	0.34	0.29	0.25	0.22	0.20	0.17	0.15

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	1512.3
2.25	1447.3
2.50	1381.0
2.75	1314.4
3.00	1248.4
3.25	1183.9
3.50	1121.3
3.75	1061.0
4.00	1003.3
4.25	948.5
4.50	896.5
4.75	847.4
5.00	801.1
5.25	757.6
5.50	716.8
5.75	678.6
6.00	642.8
6.25	609.3
6.50	577.9
6.75	548.5
7.00	521.1
7.25	495.4
7.50	471.3
7.75	448.8
8.00	427.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	1459.6
0.60	1342.6
0.70	1226.4
0.80	1115.0
0.90	1011.0
1.00	915.5
1.10	829.0
1.20	751.2
1.30	681.7
1.40	619.8
1.50	564.7
1.60	515.7
1.70	472.1
1.80	433.2
1.90	398.5
2.00	367.5
2.10	339.7
2.20	314.8
2.30	292.3
2.40	272.0
2.50	253.7
2.60	237.0
2.70	221.9
2.80	208.1
3.00	184.0



Geometry	
H	360 mm
B	108 mm
T_1	18 mm
T_2	18 mm
R	18 mm

Cross-section constants	
A	9 859 mm^2
I_{xx}	168 284 541 mm^4
W_{xx}	934 914 mm^3
$A_{k,y}$	5 832 mm^2
I_{yy}	8 665 503 mm^4
W_{yy}	106 889 mm^3
$A_{k,x}$	3 305 mm^2
e	26.9 mm

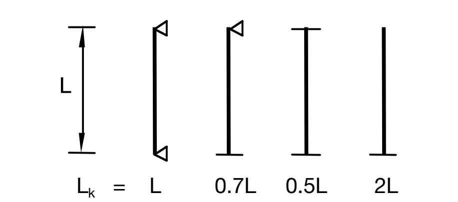
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 MPa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

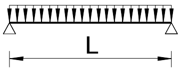
Design value for load-bearing capacity
1820.1 kN

Dead weight
17.746 kg/m

Buckling length

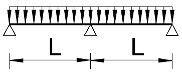


One span



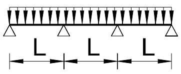
	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	74.77	69.02	64.09	59.82	56.08	52.78	49.85	47.22	44.86	42.73	40.78	39.01	37.38	35.35	32.68	30.31	28.18
	y direction	17.54	14.95	12.89	11.23	9.87	8.74	7.80	7.00	6.31	5.73	5.22	4.77	4.39	4.04	3.74	3.46	3.22
Application limit point																		
δ_{max} < L / 200	x direction	52.06	42.34	34.85	28.98	24.34	20.62	17.61	15.15	13.12	11.43	10.02	8.83	7.82	6.95	6.21	5.57	5.01
	y direction	3.36	2.66	2.13	1.74	1.43	1.20	1.01	0.86	0.74	0.64	0.56	0.49	0.43	0.38	0.34	0.30	0.27
δ_{max} < L / 300	x direction	34.71	28.23	23.23	19.32	16.23	13.75	11.74	10.10	8.75	7.62	6.68	5.88	5.21	4.63	4.14	3.71	3.34
	y direction	2.24	1.77	1.43	1.16	0.96	0.80	0.68	0.58	0.49	0.43	0.37	0.33	0.29	0.25	0.23	0.20	0.18
δ_{max} < L / 400	x direction	26.03	21.17	17.42	14.49	12.17	10.31	8.80	7.57	6.56	5.72	5.01	4.41	3.91	3.48	3.10	2.78	2.51
	y direction	1.68	1.33	1.07	0.87	0.72	0.60	0.51	0.43	0.37	0.32	0.28	0.24	0.21	0.19	0.17	0.15	0.14

Two spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	59.82	55.21	51.27	47.85	44.86	42.22	39.88	37.78	35.89	34.18	32.63	31.21	29.91	28.71	27.61	26.58	25.64
	y direction	17.54	14.95	12.89	11.23	9.87	8.74	7.80	7.00	6.31	5.73	5.22	4.77	4.39	4.04	3.74	3.46	3.22
Application limit point																		
δ_{max} < L / 200	x direction	95.26	79.74	67.27	57.18	48.93	42.14	36.50	31.80	27.85	24.52	21.68	19.25	17.16	15.36	13.80	12.44	11.25
	y direction	7.80	6.19	4.99	4.08	3.38	2.83	2.39	2.04	1.75	1.52	1.32	1.16	1.02	0.90	0.80	0.72	0.65
δ_{max} < L / 300	x direction	63.50	53.16	44.85	38.12	32.62	28.09	24.34	21.20	18.57	16.34	14.45	12.83	11.44	10.24	9.20	8.29	7.50
	y direction	5.20	4.13	3.33	2.72	2.25	1.88	1.59	1.36	1.17	1.01	0.88	0.77	0.68	0.60	0.54	0.48	0.43
δ_{max} < L / 400	x direction	47.63	39.87	33.64	28.59	24.46	21.07	18.25	15.90	13.93	12.26	10.84	9.62	8.58	7.68	6.90	6.22	5.62
	y direction	3.90	3.09	2.50	2.04	1.69	1.41	1.19	1.02	0.88	0.76	0.66	0.58	0.51	0.45	0.40	0.36	0.32

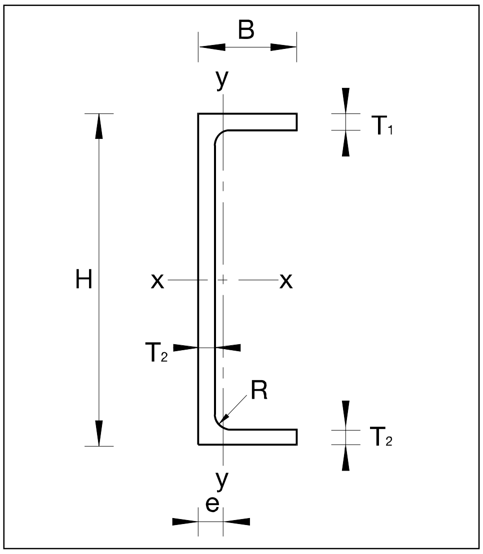
Three spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	62.31	57.51	53.41	49.85	46.73	43.98	41.54	39.35	37.38	35.60	33.99	32.51	31.15	29.91	28.76	27.69	26.70
	y direction	21.93	18.68	16.11	14.03	12.33	10.93	9.74	8.75	7.89	7.16	6.52	5.97	5.48	5.05	4.67	4.33	4.03
Application limit point																		
δ_{max} < L / 200	x direction	82.16	68.17	57.07	48.17	40.98	35.10	30.27	26.26	22.91	20.10	17.72	15.69	13.96	12.46	11.18	10.05	9.08
	y direction	6.22	4.93	3.97	3.24	2.68	2.24	1.89	1.61	1.39	1.20	1.04	0.92	0.81	0.71	0.64	0.57	0.51
δ_{max} < L / 300	x direction	54.77	45.45	38.05	32.12	27.32	23.40	20.18	17.51	15.27	13.40	11.81	10.46	9.30	8.31	7.45	6.70	6.05
	y direction	4.15	3.29	2.65	2.16	1.79	1.49	1.26	1.08	0.92	0.80	0.70	0.61	0.54	0.48	0.42	0.38	0.34
δ_{max} < L / 400	x direction	41.08	34.09	28.54	24.09	20.49	17.55	15.13	13.13	11.46	10.05	8.86	7.85	6.98	6.23	5.59	5.03	4.54
	y direction	3.11	2.46	1.98	1.62	1.34	1.12	0.95	0.81	0.69	0.60	0.52	0.46	0.40	0.36	0.32	0.28	0.25

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	42.2
2.25	37.9
2.50	34.0
2.75	30.5
3.00	27.4
3.25	24.7
3.50	22.3
3.75	20.2
4.00	18.4
4.25	16.8
4.50	15.3
4.75	14.1
5.00	12.9
5.25	11.9
5.50	11.0
5.75	10.2
6.00	9.5
6.25	8.8
6.50	8.2
6.75	7.7
7.00	7.2
7.25	6.8
7.50	6.4
7.75	6.0
8.00	5.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	4.3
0.60	3.0
0.70	2.2
0.80	1.7
0.90	1.4
1.00	1.1
1.10	0.9
1.20	0.8
1.30	0.7
1.40	0.6
1.50	0.5
1.60	0.4
1.70	0.4
1.80	0.3
1.90	0.3
2.00	0.3
2.10	0.3
2.20	0.2
2.30	0.2
2.40	0.2
2.50	0.2
2.60	0.2
2.70	0.2
2.80	0.1
3.00	0.1



Geometry	
H	120 mm
B	50 mm
T_1	5 mm
T_2	5 mm
R	5,0 mm

Cross-section constants	
A	1 061 mm^2
I_{xx}	2 239 913 mm^4
W_{xx}	37 332 mm^3
$A_{k,y}$	540 mm^2
I_{yy}	238 446 mm^4
W_{yy}	6 469 mm^3
$A_{k,x}$	425 mm^2
e	13.1 mm

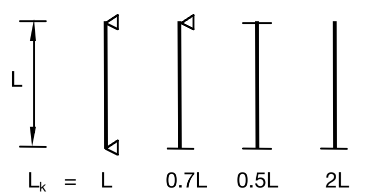
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\lambda_{m,E}$	1.3
$\lambda_{m,f}$	1.3

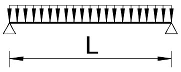
Design value for load-bearing capacity
195.8 kN

Dead weight
1.910 kg/m

Buckling length

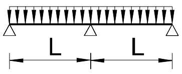


One span



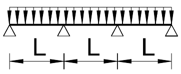
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	5.23	4.13	3.34	2.76	2.32	1.98	1.71	1.49	1.31	1.16	1.03	0.93	0.84	0.76	0.69	0.63	0.58
	y direction	0.91	0.72	0.58	0.48	0.40	0.34	0.30	0.26	0.23	0.20	0.18	0.16	0.14	0.13	0.12	0.11	0.10
Application limit point																		
δ_{max} < L / 200	x direction	2.30	1.64	1.21	0.91	0.71	0.56	0.45	0.37	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.10	0.09
	y direction	0.26	0.18	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
δ_{max} < L / 300	x direction	1.53	1.09	0.80	0.61	0.47	0.37	0.30	0.24	0.20	0.17	0.14	0.12	0.10	0.09	0.08	0.07	0.06
	y direction	0.17	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	1.15	0.82	0.60	0.46	0.35	0.28	0.23	0.18	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.05
	y direction	0.13	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	5.23	4.13	3.34	2.76	2.32	1.98	1.71	1.49	1.31	1.16	1.03	0.93	0.84	0.76	0.69	0.63	0.58
	y direction	1.60	1.27	1.03	0.85	0.71	0.61	0.52	0.46	0.40	0.35	0.32	0.28	0.26	0.23	0.21	0.19	0.18
Application limit point																		
δ_{max} < L / 200	x direction	5.02	3.64	2.72	2.08	1.63	1.29	1.05	0.86	0.71	0.59	0.50	0.43	0.37	0.32	0.28	0.24	0.22
	y direction	1.07	0.76	0.56	0.42	0.33	0.26	0.21	0.17	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04
δ_{max} < L / 300	x direction	3.35	2.43	1.81	1.39	1.09	0.86	0.70	0.57	0.47	0.40	0.34	0.29	0.25	0.21	0.19	0.16	0.14
	y direction	0.71	0.51	0.37	0.28	0.22	0.17	0.14	0.11	0.09	0.08	0.06	0.06	0.05	0.04	0.04	0.03	0.03
δ_{max} < L / 400	x direction	2.51	1.82	1.36	1.04	0.81	0.65	0.52	0.43	0.36	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.11
	y direction	0.54	0.38	0.28	0.21	0.16	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02

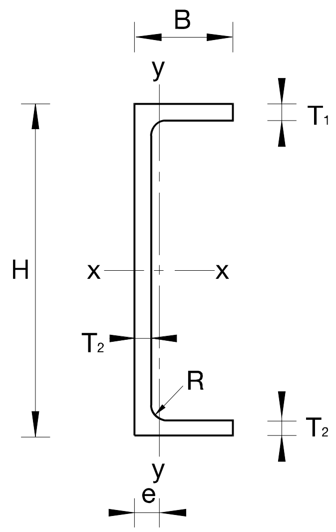
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	6.53	5.16	4.18	3.46	2.90	2.47	2.13	1.86	1.63	1.45	1.29	1.16	1.05	0.95	0.86	0.79	0.73
	y direction	2.00	1.58	1.28	1.06	0.89	0.76	0.65	0.57	0.50	0.44	0.40	0.35	0.32	0.29	0.26	0.24	0.22
Application limit point																		
δ_{max} < L / 200	x direction	4.09	2.95	2.19	1.67	1.30	1.03	0.83	0.68	0.56	0.47	0.40	0.34	0.29	0.25	0.22	0.19	0.17
	y direction	0.85	0.60	0.44	0.33	0.26	0.20	0.16	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03
δ_{max} < L / 300	x direction	2.73	1.97	1.46	1.12	0.87	0.69	0.56	0.45	0.38	0.32	0.27	0.23	0.20	0.17	0.15	0.13	0.11
	y direction	0.57	0.40	0.29	0.22	0.17	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
δ_{max} < L / 400	x direction	2.04	1.48	1.10	0.84	0.65	0.52	0.42	0.34	0.28	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.09
	y direction	0.43	0.30	0.22	0.17	0.13	0.10	0.08	0.07	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	74.0
2.25	69.4
2.50	65.0
2.75	60.7
3.00	56.6
3.25	52.7
3.50	49.1
3.75	45.7
4.00	42.6
4.25	39.7
4.50	37.0
4.75	34.6
5.00	32.3
5.25	30.2
5.50	28.3
5.75	26.6
6.00	24.9
6.25	23.5
6.50	22.1
6.75	20.8
7.00	19.6
7.25	18.6
7.50	17.6
7.75	16.6
8.00	15.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	82.2
0.60	76.7
0.70	71.1
0.80	65.6
0.90	60.3
1.00	55.3
1.10	50.7
1.20	46.4
1.30	42.5
1.40	39.0
1.50	35.8
1.60	32.9
1.70	30.3
1.80	28.0
1.90	25.9
2.00	23.9
2.10	22.2
2.20	20.7
2.30	19.3
2.40	18.0
2.50	16.8
2.60	15.7
2.70	14.8
2.80	13.9
3.00	12.3



Geometry	
H	160 mm
B	48 mm
T_1	8 mm
T_2	5 mm
R	8 mm

Cross-section constants	
A	1 401 mm^2
I_{xx}	5 663 667 mm^4
W_{xx}	70 796 mm^3
$A_{k,y}$	720 mm^2
I_{yy}	298 656 mm^4
W_{yy}	8 934 mm^3
$A_{k,x}$	653 mm^2
e	14.6 mm

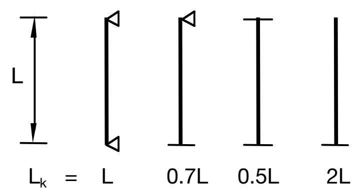
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

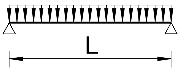
Design value for load-bearing capacity
258.7 kN

Dead weight
2.522 kg/m

Buckling length

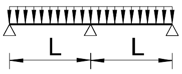


One span



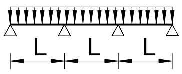
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	9.91	7.83	6.34	5.24	4.41	3.75	3.24	2.82	2.48	2.19	1.96	1.76	1.59	1.44	1.31	1.20	1.10
	y direction	1.25	0.99	0.80	0.66	0.56	0.47	0.41	0.36	0.31	0.28	0.25	0.22	0.20	0.18	0.17	0.15	0.14
Application limit point																		
δ_{max} < L / 200	x direction	6.47	4.69	3.50	2.68	2.09	1.66	1.34	1.10	0.91	0.76	0.65	0.55	0.47	0.41	0.36	0.31	0.28
	y direction	0.40	0.28	0.20	0.15	0.12	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01
δ_{max} < L / 300	x direction	4.31	3.13	2.33	1.79	1.39	1.11	0.90	0.73	0.61	0.51	0.43	0.37	0.32	0.27	0.24	0.21	0.18
	y direction	0.26	0.19	0.14	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	3.24	2.35	1.75	1.34	1.05	0.83	0.67	0.55	0.46	0.38	0.32	0.28	0.24	0.21	0.18	0.16	0.14
	y direction	0.20	0.14	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	9.91	7.83	6.34	5.24	4.41	3.75	3.24	2.82	2.48	2.19	1.96	1.76	1.59	1.44	1.31	1.20	1.10
	y direction	1.25	0.99	0.80	0.66	0.56	0.47	0.41	0.36	0.31	0.28	0.25	0.22	0.20	0.18	0.17	0.15	0.14
Application limit point																		
δ_{max} < L / 200	x direction	12.85	9.62	7.37	5.75	4.56	3.67	3.00	2.48	2.07	1.74	1.48	1.27	1.10	0.95	0.83	0.73	0.65
	y direction	0.94	0.66	0.49	0.37	0.28	0.22	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04
δ_{max} < L / 300	x direction	8.57	6.42	4.91	3.83	3.04	2.45	2.00	1.65	1.38	1.16	0.99	0.85	0.73	0.63	0.56	0.49	0.43
	y direction	0.63	0.44	0.32	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02
δ_{max} < L / 400	x direction	6.42	4.81	3.68	2.87	2.28	1.84	1.50	1.24	1.03	0.87	0.74	0.63	0.55	0.48	0.42	0.37	0.32
	y direction	0.47	0.33	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02

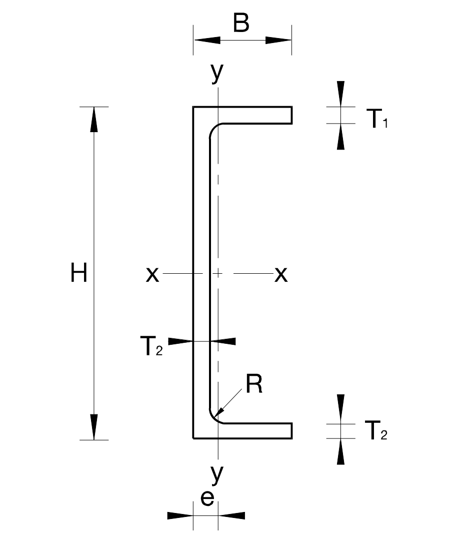
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	11.54	9.79	7.93	6.55	5.51	4.69	4.05	3.52	3.10	2.74	2.45	2.20	1.98	1.80	1.64	1.50	1.38
	y direction	1.56	1.24	1.00	0.83	0.69	0.59	0.51	0.44	0.39	0.35	0.31	0.28	0.25	0.23	0.21	0.19	0.17
Application limit point																		
δ_{max} < L / 200	x direction	10.80	8.01	6.08	4.71	3.72	2.98	2.42	2.00	1.66	1.40	1.19	1.02	0.88	0.76	0.66	0.58	0.51
	y direction	0.75	0.53	0.38	0.29	0.22	0.18	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03
δ_{max} < L / 300	x direction	7.20	5.34	4.05	3.14	2.48	1.99	1.62	1.33	1.11	0.93	0.79	0.68	0.58	0.51	0.44	0.39	0.34
	y direction	0.50	0.35	0.26	0.19	0.15	0.12	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02
δ_{max} < L / 400	x direction	5.40	4.00	3.04	2.36	1.86	1.49	1.21	1.00	0.83	0.70	0.59	0.51	0.44	0.38	0.33	0.29	0.26
	y direction	0.37	0.26	0.19	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	102.1
2.25	97.7
2.50	93.2
2.75	88.7
3.00	84.3
3.25	79.9
3.50	75.6
3.75	71.6
4.00	67.7
4.25	64.0
4.50	60.4
4.75	57.1
5.00	54.0
5.25	51.1
5.50	48.3
5.75	45.7
6.00	43.3
6.25	41.0
6.50	38.9
6.75	36.9
7.00	35.1
7.25	33.4
7.50	31.7
7.75	30.2
8.00	28.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	99.2
0.60	91.4
0.70	83.7
0.80	76.2
0.90	69.2
1.00	62.8
1.10	56.9
1.20	51.6
1.30	46.9
1.40	42.7
1.50	38.9
1.60	35.6
1.70	32.6
1.80	29.9
1.90	27.5
2.00	25.4
2.10	23.5
2.20	21.8
2.30	20.2
2.40	18.8
2.50	17.6
2.60	16.4
2.70	15.4
2.80	14.4
3.00	12.8



Geometry	
H	200 mm
B	60 mm
T_1	8 mm
T_2	5 mm
R	8 mm

Cross-section constants	
A	1 757 mm^2
I_{xx}	11 318 922 mm^4
W_{xx}	113 189 mm^3
$A_{k,y}$	900 mm^2
I_{yy}	602 783 mm^4
W_{yy}	14 285 mm^3
$A_{k,x}$	816 mm^2
e	17.8 mm

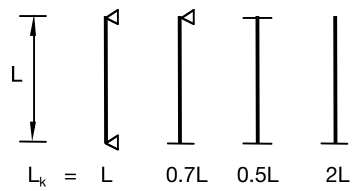
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

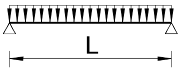
Design value for load-bearing capacity
324.5 kN

Dead weight
3.163 kg/m

Buckling length

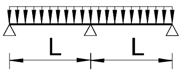


One span



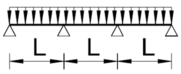
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	15.85	12.52	10.14	8.38	7.04	6.00	5.17	4.51	3.96	3.51	3.13	2.81	2.54	2.30	2.10	1.92	1.76
	y direction	2.00	1.58	1.28	1.06	0.89	0.76	0.65	0.57	0.50	0.44	0.40	0.35	0.32	0.29	0.26	0.24	0.22
Application limit point																		
$\delta_{max} < L / 200$	x direction	11.87	8.74	6.60	5.09	4.01	3.20	2.60	2.14	1.78	1.49	1.27	1.08	0.93	0.81	0.71	0.62	0.55
	y direction	0.80	0.56	0.41	0.31	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03
$\delta_{max} < L / 300$	x direction	7.91	5.83	4.40	3.40	2.67	2.14	1.73	1.42	1.18	0.99	0.84	0.72	0.62	0.54	0.47	0.41	0.36
	y direction	0.53	0.37	0.27	0.21	0.16	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02
$\delta_{max} < L / 400$	x direction	5.93	4.37	3.30	2.55	2.00	1.60	1.30	1.07	0.89	0.75	0.63	0.54	0.47	0.40	0.35	0.31	0.27
	y direction	0.40	0.28	0.21	0.15	0.12	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	13.85	12.31	10.14	8.38	7.04	6.00	5.17	4.51	3.96	3.51	3.13	2.81	2.54	2.30	2.10	1.92	1.76
	y direction	2.00	1.58	1.28	1.06	0.89	0.76	0.65	0.57	0.50	0.44	0.40	0.35	0.32	0.29	0.26	0.24	0.22
Application limit point																		
$\delta_{max} < L / 200$	x direction	21.80	16.72	13.06	10.35	8.32	6.78	5.58	4.65	3.91	3.31	2.83	2.44	2.11	1.84	1.61	1.42	1.26
	y direction	1.87	1.33	0.97	0.73	0.57	0.45	0.36	0.29	0.24	0.20	0.17	0.14	0.12	0.11	0.09	0.08	0.07
$\delta_{max} < L / 300$	x direction	14.53	11.15	8.70	6.90	5.55	4.52	3.72	3.10	2.60	2.21	1.89	1.62	1.41	1.23	1.08	0.95	0.84
	y direction	1.25	0.88	0.65	0.49	0.38	0.30	0.24	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.05
$\delta_{max} < L / 400$	x direction	10.90	8.36	6.53	5.18	4.16	3.39	2.79	2.32	1.95	1.66	1.42	1.22	1.06	0.92	0.81	0.71	0.63
	y direction	0.94	0.66	0.49	0.37	0.28	0.22	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04

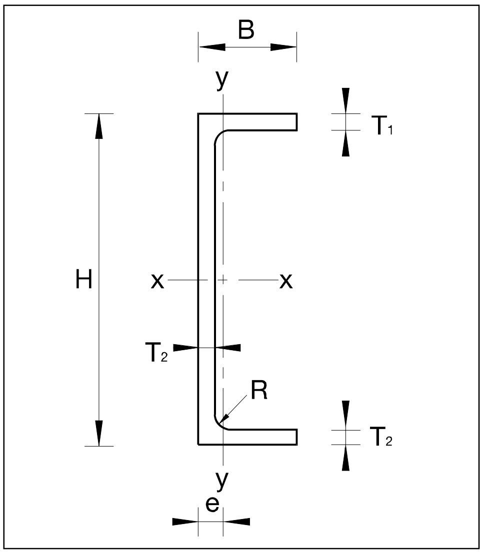
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	14.42	12.82	11.54	10.48	8.80	7.50	6.47	5.63	4.95	4.39	3.91	3.51	3.17	2.87	2.62	2.40	2.20
	y direction	2.50	1.98	1.60	1.32	1.11	0.95	0.82	0.71	0.62	0.55	0.49	0.44	0.40	0.36	0.33	0.30	0.28
Application limit point																		
$\delta_{max} < L / 200$	x direction	18.78	14.23	10.99	8.64	6.90	5.58	4.58	3.79	3.18	2.68	2.29	1.96	1.70	1.48	1.29	1.14	1.01
	y direction	1.49	1.05	0.77	0.58	0.45	0.35	0.28	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.06
$\delta_{max} < L / 300$	x direction	12.52	9.48	7.33	5.76	4.60	3.72	3.05	2.53	2.12	1.79	1.52	1.31	1.13	0.98	0.86	0.76	0.67
	y direction	0.99	0.70	0.51	0.39	0.30	0.24	0.19	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04
$\delta_{max} < L / 400$	x direction	9.39	7.11	5.50	4.32	3.45	2.79	2.29	1.90	1.59	1.34	1.14	0.98	0.85	0.74	0.65	0.57	0.50
	y direction	0.74	0.53	0.38	0.29	0.22	0.18	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	169.3
2.25	163.7
2.50	158.0
2.75	152.0
3.00	146.0
3.25	140.0
3.50	134.0
3.75	128.1
4.00	122.4
4.25	116.8
4.50	111.5
4.75	106.3
5.00	101.3
5.25	96.6
5.50	92.1
5.75	87.8
6.00	83.7
6.25	79.9
6.50	76.2
6.75	72.7
7.00	69.5
7.25	66.4
7.50	63.4
7.75	60.7
8.00	58.0

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	165.4
0.60	155.3
0.70	144.8
0.80	134.4
0.90	124.3
1.00	114.6
1.10	105.5
1.20	97.1
1.30	89.3
1.40	82.2
1.50	75.8
1.60	69.9
1.70	64.6
1.80	59.7
1.90	55.4
2.00	51.4
2.10	47.8
2.20	44.5
2.30	41.6
2.40	38.8
2.50	36.4
2.60	34.1
2.70	32.0
2.80	30.1
3.00	26.8



Geometry	
H	240 mm
B	72 mm
T_1	10 mm
T_2	7 mm
R	10 mm

Cross-section constants	
A	2 773 mm^2
I_{xx}	24 932 610 mm^4
W_{xx}	207 772 mm^3
$A_{k,y}$	1 512 mm^2
I_{yy}	1 315 621 mm^4
W_{yy}	25 687 mm^3
$A_{k,x}$	1 224 mm^2
e	20.8 mm

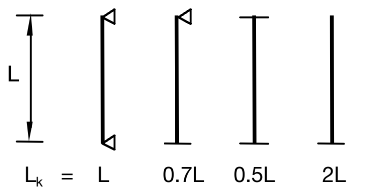
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

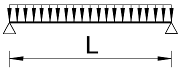
Design value for load-bearing capacity
511.9 kN

Dead weight
4.991 kg/m

Buckling length

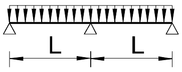


One span



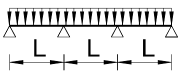
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	29.08	22.98	18.62	15.39	12.93	11.02	9.50	8.27	7.27	6.44	5.75	5.16	4.65	4.22	3.85	3.52	3.23
	y direction	3.60	2.84	2.30	1.90	1.60	1.36	1.17	1.02	0.90	0.80	0.71	0.64	0.58	0.52	0.48	0.44	0.40
Application limit point																		
δ_{max} < L / 200	x direction	24.47	18.22	13.88	10.78	8.53	6.85	5.58	4.60	3.83	3.23	2.74	2.35	2.02	1.76	1.54	1.35	1.19
	y direction	1.73	1.22	0.89	0.67	0.52	0.41	0.33	0.27	0.22	0.18	0.15	0.13	0.11	0.10	0.08	0.07	0.07
δ_{max} < L / 300	x direction	16.31	12.15	9.25	7.19	5.69	4.57	3.72	3.07	2.56	2.15	1.83	1.57	1.35	1.17	1.02	0.90	0.79
	y direction	1.15	0.81	0.60	0.45	0.35	0.27	0.22	0.18	0.15	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.04
δ_{max} < L / 400	x direction	12.24	9.11	6.94	5.39	4.26	3.43	2.79	2.30	1.92	1.61	1.37	1.17	1.01	0.88	0.77	0.67	0.60
	y direction	0.86	0.61	0.45	0.34	0.26	0.20	0.16	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	23.26	20.68	18.61	15.39	12.93	11.02	9.50	8.27	7.27	6.44	5.75	5.16	4.65	4.22	3.85	3.52	3.23
	y direction	3.60	2.84	2.30	1.90	1.60	1.36	1.17	1.02	0.90	0.80	0.71	0.64	0.58	0.52	0.48	0.44	0.40
Application limit point																		
δ_{max} < L / 200	x direction	42.65	33.24	26.29	21.08	17.11	14.04	11.65	9.75	8.24	7.01	6.01	5.19	4.51	3.94	3.46	3.06	2.71
	y direction	4.02	2.85	2.10	1.59	1.23	0.97	0.78	0.63	0.52	0.44	0.37	0.31	0.27	0.23	0.20	0.18	0.16
δ_{max} < L / 300	x direction	28.44	22.16	17.53	14.05	11.40	9.36	7.76	6.50	5.49	4.67	4.01	3.46	3.01	2.63	2.31	2.04	1.81
	y direction	2.68	1.90	1.40	1.06	0.82	0.65	0.52	0.42	0.35	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.10
δ_{max} < L / 400	x direction	21.33	16.62	13.14	10.54	8.55	7.02	5.82	4.88	4.12	3.51	3.01	2.60	2.26	1.97	1.73	1.53	1.36
	y direction	2.01	1.43	1.05	0.79	0.61	0.48	0.39	0.32	0.26	0.22	0.18	0.16	0.13	0.12	0.10	0.09	0.08

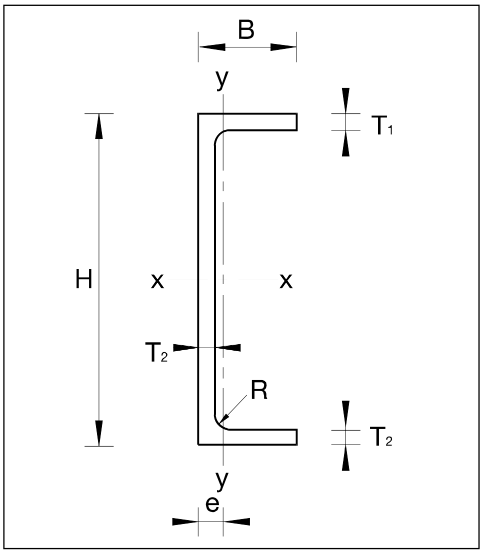
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x direction	24.23	21.54	19.38	17.62	16.15	13.77	11.87	10.34	9.09	8.05	7.18	6.45	5.82	5.28	4.81	4.40	4.04
	y direction	4.50	3.55	2.88	2.38	2.00	1.70	1.47	1.28	1.12	1.00	0.89	0.80	0.72	0.65	0.59	0.54	0.50
Application limit point																		
δ_{max} < L / 200	x direction	37.33	28.69	22.43	17.81	14.34	11.69	9.63	8.03	6.75	5.72	4.89	4.21	3.65	3.18	2.79	2.46	2.18
	y direction	3.20	2.27	1.66	1.26	0.97	0.77	0.62	0.50	0.41	0.35	0.29	0.25	0.21	0.18	0.16	0.14	0.12
δ_{max} < L / 300	x direction	24.88	19.13	14.96	11.87	9.56	7.79	6.42	5.35	4.50	3.82	3.26	2.81	2.43	2.12	1.86	1.64	1.45
	y direction	2.13	1.51	1.11	0.84	0.65	0.51	0.41	0.33	0.28	0.23	0.19	0.17	0.14	0.12	0.11	0.09	0.08
δ_{max} < L / 400	x direction	18.66	14.35	11.22	8.91	7.17	5.84	4.82	4.01	3.37	2.86	2.45	2.11	1.83	1.59	1.40	1.23	1.09
	y direction	1.60	1.13	0.83	0.63	0.49	0.38	0.31	0.25	0.21	0.17	0.15	0.12	0.11	0.09	0.08	0.07	0.06

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	282.6
2.25	276.1
2.50	269.2
2.75	261.9
3.00	254.4
3.25	246.7
3.50	238.9
3.75	231.0
4.00	223.2
4.25	215.4
4.50	207.7
4.75	200.2
5.00	192.8
5.25	185.6
5.50	178.6
5.75	171.9
6.00	165.3
6.25	159.0
6.50	152.9
6.75	147.1
7.00	141.5
7.25	136.1
7.50	130.9
7.75	126.0
8.00	121.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	279.4
0.60	267.7
0.70	255.1
0.80	242.0
0.90	228.6
1.00	215.4
1.10	202.4
1.20	189.9
1.30	177.9
1.40	166.5
1.50	155.9
1.60	145.9
1.70	136.5
1.80	127.9
1.90	119.8
2.00	112.4
2.10	105.5
2.20	99.1
2.30	93.2
2.40	87.8
2.50	82.7
2.60	78.0
2.70	73.7
2.80	69.7
3.00	62.5



Geometry	
H	300 mm
B	90 mm
T_1	12 mm
T_2	8 mm
R	12 mm

Cross-section constants	
A	4 430 mm^2
I_{xx}	59 964 118 mm^4
W_{xx}	399 761 mm^3
$A_{k,y}$	2 160 mm^2
I_{yy}	3 316 782 mm^4
W_{yy}	50 319 mm^3
$A_{k,x}$	1 836 mm^2
e	24.1 mm

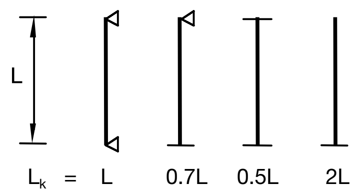
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

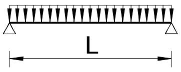
Design value for load-bearing capacity
817.8 kN

Dead weight
7.974 kg/m

Buckling length

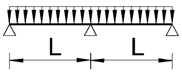


One span



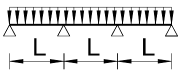
	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x direction	33.23	29.60	24.87	21.19	18.27	15.92	13.99	12.39	11.06	9.92	8.95	8.12	7.40	6.77	6.22	5.73	5.30
	y direction	4.51	3.73	3.13	2.67	2.30	2.00	1.76	1.56	1.39	1.25	1.13	1.02	0.93	0.85	0.78	0.72	0.67
Application limit point																		
$\delta_{max} < L / 200$	x direction	29.52	23.33	18.71	15.20	12.50	10.39	8.72	7.38	6.30	5.42	4.69	4.09	3.58	3.15	2.79	2.48	2.22
	y direction	2.22	1.68	1.30	1.02	0.82	0.67	0.55	0.46	0.39	0.33	0.28	0.25	0.21	0.19	0.16	0.15	0.13
$\delta_{max} < L / 300$	x direction	19.68	15.55	12.47	10.13	8.33	6.93	5.81	4.92	4.20	3.61	3.13	2.72	2.39	2.10	1.86	1.66	1.48
	y direction	1.48	1.12	0.87	0.68	0.55	0.45	0.37	0.31	0.26	0.22	0.19	0.16	0.14	0.12	0.11	0.10	0.09
$\delta_{max} < L / 400$	x direction	14.76	11.66	9.35	7.60	6.25	5.19	4.36	3.69	3.15	2.71	2.35	2.04	1.79	1.58	1.40	1.24	1.11
	y direction	1.11	0.84	0.65	0.51	0.41	0.34	0.28	0.23	0.19	0.17	0.14	0.12	0.11	0.09	0.08	0.07	0.06

Two spans



	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x direction	26.58	24.17	22.15	20.45	18.27	15.92	13.99	12.39	11.06	9.92	8.95	8.12	7.40	6.77	6.22	5.73	5.30
	y direction	4.51	3.73	3.13	2.67	2.30	2.00	1.76	1.56	1.39	1.25	1.13	1.02	0.93	0.85	0.78	0.72	0.67
Application limit point																		
$\delta_{max} < L / 200$	x direction	50.68	41.60	34.48	28.82	24.28	20.61	17.62	15.16	13.12	11.43	10.00	8.80	7.77	6.90	6.15	5.50	4.94
	y direction	5.16	3.92	3.04	2.41	1.94	1.58	1.31	1.09	0.92	0.79	0.67	0.58	0.51	0.45	0.39	0.35	0.31
$\delta_{max} < L / 300$	x direction	33.78	27.74	22.98	19.21	16.19	13.74	11.75	10.11	8.75	7.62	6.67	5.86	5.18	4.60	4.10	3.67	3.29
	y direction	3.44	2.61	2.03	1.60	1.29	1.05	0.87	0.73	0.61	0.52	0.45	0.39	0.34	0.30	0.26	0.23	0.21
$\delta_{max} < L / 400$	x direction	25.34	20.80	17.24	14.41	12.14	10.31	8.81	7.58	6.56	5.71	5.00	4.40	3.89	3.45	3.07	2.75	2.47
	y direction	2.58	1.96	1.52	1.20	0.97	0.79	0.65	0.55	0.46	0.39	0.34	0.29	0.25	0.22	0.20	0.17	0.15

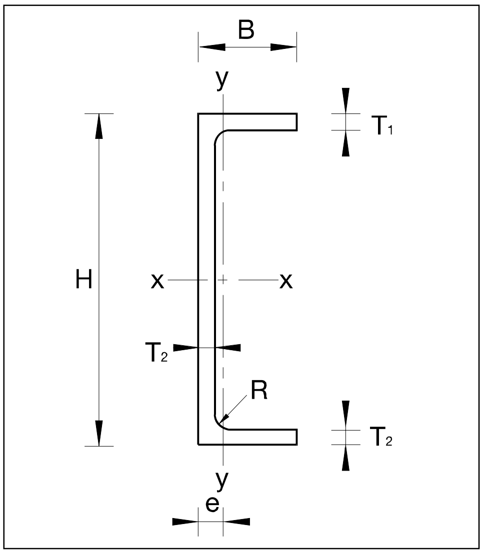
Three spans



	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x direction	27.69	25.17	23.08	21.30	19.78	18.46	17.31	15.49	13.82	12.40	11.19	10.15	9.25	8.46	7.77	7.16	6.62
	y direction	5.64	4.66	3.91	3.33	2.88	2.50	2.20	1.95	1.74	1.56	1.41	1.28	1.16	1.07	0.98	0.90	0.83
Application limit point																		
$\delta_{max} < L / 200$	x direction	44.54	36.16	29.67	24.59	20.56	17.34	14.73	12.61	10.86	9.42	8.21	7.20	6.35	5.62	5.00	4.46	4.00
	y direction	4.12	3.12	2.42	1.91	1.54	1.25	1.03	0.86	0.73	0.62	0.53	0.46	0.40	0.35	0.31	0.27	0.24
$\delta_{max} < L / 300$	x direction	29.70	24.11	19.78	16.39	13.71	11.56	9.82	8.41	7.24	6.28	5.48	4.80	4.23	3.75	3.33	2.97	2.67
	y direction	2.75	2.08	1.61	1.27	1.02	0.84	0.69	0.58	0.49	0.41	0.36	0.31	0.27	0.23	0.21	0.18	0.16
$\delta_{max} < L / 400$	x direction	22.27	18.08	14.84	12.29	10.28	8.67	7.37	6.30	5.43	4.71	4.11	3.60	3.17	2.81	2.50	2.23	2.00
	y direction	2.06	1.56	1.21	0.96	0.77	0.63	0.52	0.43	0.36	0.31	0.27	0.23	0.20	0.18	0.15	0.14	0.12

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	435.1
2.25	427.8
2.50	420.1
2.75	411.8
3.00	403.1
3.25	394.0
3.50	384.7
3.75	375.1
4.00	365.5
4.25	355.7
4.50	345.9
4.75	336.1
5.00	326.3
5.25	316.6
5.50	307.1
5.75	297.7
6.00	288.5
6.25	279.5
6.50	270.7
6.75	262.1
7.00	253.8
7.25	245.7
7.50	237.8
7.75	230.2
8.00	222.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	431.5
0.60	418.4
0.70	403.9
0.80	388.3
0.90	372.1
1.00	355.5
1.10	338.8
1.20	322.3
1.30	306.0
1.40	290.2
1.50	274.9
1.60	260.3
1.70	246.3
1.80	233.0
1.90	220.5
2.00	208.6
2.10	197.5
2.20	187.0
2.30	177.2
2.40	167.9
2.50	159.3
2.60	151.2
2.70	143.6
2.80	136.5
3.00	123.6



Geometry	
H	360 mm
B	108 mm
T_1	15 mm
T_2	10 mm
R	15 mm

Cross-section constants	
A	6 637 mm^2
I_{xx}	128 942 713 mm^4
W_{xx}	716 348 mm^3
$A_{k,y}$	3 240 mm^2
I_{yy}	7 126 982 mm^4
W_{yy}	90 265 mm^3
$A_{k,x}$	2 754 mm^2
e	29.0 mm

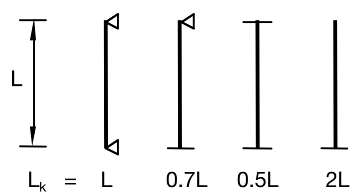
Material properties	
$E_{0°}$	28 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1,3
$\gamma_{m,f}$	1.3

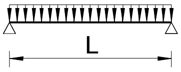
Design value for load-bearing capacity
1225.2 kN

Dead weight
11.947 kg/m

Buckling length

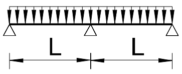


One span



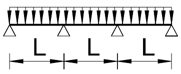
	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	41.54	37.98	32.75	28.53	25.07	22.21	19.81	17.78	16.05	14.55	13.26	12.13	11.14	10.27	9.49	8.80	8.19
	y direction	5.62	4.79	4.13	3.59	3.16	2.80	2.50	2.24	2.02	1.83	1.67	1.53	1.40	1.29	1.20	1.11	1.03
Application limit point																		
δ_{max} < L / 200	x direction	36.78	30.19	25.05	20.97	17.71	15.08	12.94	11.17	9.71	8.48	7.45	6.58	5.84	5.20	4.66	4.18	3.77
	y direction	2.77	2.18	1.75	1.43	1.18	0.99	0.83	0.71	0.61	0.53	0.46	0.40	0.35	0.31	0.28	0.25	0.22
δ_{max} < L / 300	x direction	24.52	20.13	16.70	13.98	11.81	10.06	8.62	7.45	6.47	5.66	4.97	4.39	3.89	3.47	3.10	2.79	2.51
	y direction	1.84	1.46	1.17	0.96	0.79	0.66	0.56	0.47	0.41	0.35	0.31	0.27	0.24	0.21	0.19	0.17	0.15
δ_{max} < L / 400	x direction	18.39	15.10	12.52	10.49	8.86	7.54	6.47	5.59	4.85	4.24	3.73	3.29	2.92	2.60	2.33	2.09	1.88
	y direction	1.38	1.09	0.88	0.72	0.59	0.49	0.42	0.36	0.30	0.26	0.23	0.20	0.18	0.16	0.14	0.12	0.11

Two spans



	L (m) =	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
Breaking point																		
	x direction	33.23	30.67	28.48	26.58	24.92	22.21	19.81	17.78	16.05	14.55	13.26	12.13	11.14	10.27	9.49	8.80	8.19
	y direction	5.62	4.79	4.13	3.59	3.16	2.80	2.50	2.24	2.02	1.83	1.67	1.53	1.40	1.29	1.20	1.11	1.03
Application limit point																		
δ_{max} < L / 200	x direction	63.20	53.57	45.71	39.25	33.89	29.43	25.68	22.53	19.84	17.56	15.60	13.91	12.46	11.19	10.08	9.12	8.27
	y direction	6.42	5.09	4.11	3.36	2.78	2.33	1.97	1.68	1.44	1.25	1.09	0.95	0.84	0.74	0.66	0.59	0.53
δ_{max} < L / 300	x direction	42.13	35.72	30.48	26.17	22.60	19.62	17.12	15.02	13.23	11.71	10.40	9.28	8.30	7.46	6.72	6.08	5.51
	y direction	4.28	3.40	2.74	2.24	1.85	1.55	1.31	1.12	0.96	0.83	0.72	0.63	0.56	0.50	0.44	0.39	0.35
δ_{max} < L / 400	x direction	31.60	26.79	22.86	19.62	16.95	14.71	12.84	11.26	9.92	8.78	7.80	6.96	6.23	5.59	5.04	4.56	4.13
	y direction	3.21	2.55	2.05	1.68	1.39	1.16	0.98	0.84	0.72	0.62	0.54	0.48	0.42	0.37	0.33	0.30	0.27

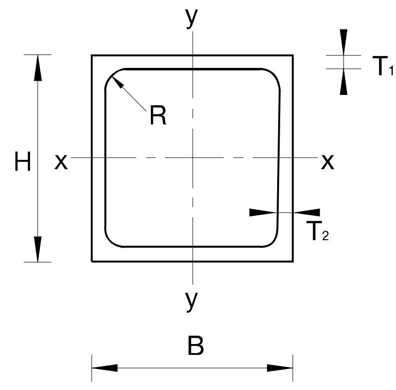
Tre fag



	L (m) =	3,00	3,25	3,50	3,75	4,00	4,25	4,50	4,75	5,00	5,25	5,50	5,75	6,00	6,25	6,50	6,75	7,00
Brudgrænsetilstand																		
	x-retning	34,62	31,95	29,67	27,69	25,96	24,43	23,08	21,86	20,06	18,19	16,58	15,17	13,93	12,84	11,87	11,01	10,23
	y-retning	7,02	5,98	5,16	4,49	3,95	3,50	3,12	2,80	2,53	2,29	2,09	1,91	1,76	1,62	1,50	1,39	1,29
Anvendelsesgrænsetilstand																		
δ_{max} < L / 200	x-retning	55,54	46,64	39,46	33,62	28,84	24,88	21,60	18,85	16,53	14,57	12,89	11,46	10,23	9,16	8,24	7,43	6,72
	y-retning	5,12	4,06	3,27	2,67	2,21	1,84	1,56	1,33	1,14	0,99	0,86	0,75	0,66	0,59	0,52	0,47	0,42
δ_{max} < L / 300	x-retning	37,02	31,09	26,31	22,41	19,22	16,59	14,40	12,56	11,02	9,71	8,60	7,64	6,82	6,11	5,49	4,95	4,48
	y-retning	3,41	2,70	2,18	1,78	1,47	1,23	1,04	0,88	0,76	0,66	0,57	0,50	0,44	0,39	0,35	0,31	0,28
δ_{max} < L / 400	x-retning	27,77	23,32	19,73	16,81	14,42	12,44	10,80	9,42	8,26	7,28	6,45	5,73	5,11	4,58	4,12	3,72	3,36
	y-retning	2,56	2,03	1,63	1,33	1,10	0,92	0,78	0,66	0,57	0,49	0,43	0,38	0,33	0,29	0,26	0,23	0,21

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	94.1
0.75	60.9
1.00	40.7
1.25	28.6
1.50	21.0
1.75	15.9
2.00	12.5
2.25	10.0
2.50	8.2
2.75	6.8
3.00	5.8
3.25	5.0
3.50	4.3
3.75	3.7
4.00	3.3
4.25	2.9
4.50	2.6
4.75	2.4
5.00	2.1
5.25	1.9
5.50	1.8
5.75	1.6
6.00	1.5
6.25	1.4
6.50	1.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	94.1
0.75	60.9
1.00	40.7
1.25	28.6
1.50	21.0
1.75	15.9
2.00	12.5
2.25	10.0
2.50	8.2
2.75	6.8
3.00	5.8
3.25	5.0
3.50	4.3
3.75	3.7
4.00	3.3
4.25	2.9
4.50	2.6
4.75	2.4
5.00	2.1
5.25	1.9
5.50	1.8
5.75	1.6
6.00	1.5
6.25	1.4
6.50	1.3



Geometry	
H	50 mm
B	50 mm
T_1	5 mm
T_2	5 mm
R	2 mm

Cross-section constants	
A	903 mm^2
I_{xx}	308 813 mm^4
W_{xx}	12 353 mm^3
$A_{k,y}$	450 mm^2
I_{yy}	308 813 mm^4
W_{yy}	12 353 mm^3
$A_{k,x}$	450 mm^2

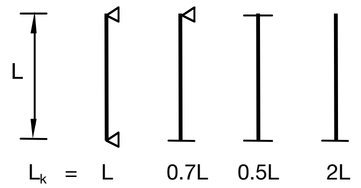
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
166.8 kN

Dead weight
1.63 kg/m

Buckling length



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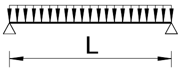
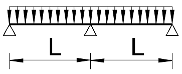


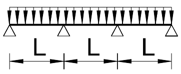
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	17.31	11.68	8.11	5.96	4.56	3.60	2.92	2.41	2.03	1.73	1.49	1.30	1.14	1.01	0.90	0.81	0.73
Application limit point																		
$\delta_{max} < L / 200$	x/y direction	2.60	1.35	0.79	0.50	0.34	0.24	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02
$\delta_{max} < L / 300$	x/y direction	1.73	0.90	0.53	0.33	0.22	0.16	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01
$\delta_{max} < L / 400$	x/y direction	1.30	0.68	0.40	0.25	0.17	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	13.85	11.08	8.11	5.96	4.56	3.60	2.92	2.41	2.03	1.73	1.49	1.30	1.14	1.01	0.90	0.81	0.73
Application limit point																		
$\delta_{max} < L / 200$	x/y direction	5.84	3.11	1.84	1.18	0.79	0.56	0.41	0.31	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05
$\delta_{max} < L / 300$	x/y direction	3.90	2.08	1.23	0.78	0.53	0.37	0.27	0.21	0.16	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.03
$\delta_{max} < L / 400$	x/y direction	2.92	1.56	0.92	0.59	0.40	0.28	0.21	0.16	0.12	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.03

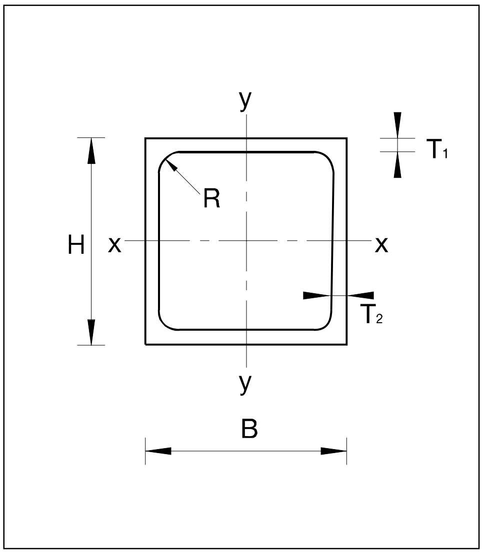
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	14.42	11.54	9.62	7.45	5.70	4.50	3.65	3.02	2.53	2.16	1.86	1.62	1.43	1.26	1.13	1.01	0.91
Application limit point																		
$\delta_{max} < L / 200$	x/y direction	4.71	2.49	1.47	0.93	0.63	0.44	0.33	0.25	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04
$\delta_{max} < L / 300$	x/y direction	3.14	1.66	0.98	0.62	0.42	0.30	0.22	0.16	0.13	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03
$\delta_{max} < L / 400$	x/y direction	2.36	1.25	0.73	0.47	0.32	0.22	0.16	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	135.4
0.75	94.8
1.00	66.8
1.25	48.4
1.50	36.3
1.75	27.9
2.00	22.1
2.25	17.9
2.50	14.7
2.75	12.3
3.00	10.4
3.25	9.0
3.50	7.8
3.75	6.8
4.00	6.0
4.25	5.3
4.50	4.8
4.75	4.3
5.00	3.9
5.25	3.5
5.50	3.2
5.75	3.0
6.00	2.7
6.25	2.5
6.50	2.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	135.4
0.75	94.8
1.00	66.8
1.25	48.4
1.50	36.3
1.75	27.9
2.00	22.1
2.25	17.9
2.50	14.7
2.75	12.3
3.00	10.4
3.25	9.0
3.50	7.8
3.75	6.8
4.00	6.0
4.25	5.3
4.50	4.8
4.75	4.3
5.00	3.9
5.25	3.5
5.50	3.2
5.75	3.0
6.00	2.7
6.25	2.5
6.50	2.3



Geometry	
H	60 mm
B	60 mm
T_1	5 mm
T_2	5 mm
R	4 mm

Cross-section constants	
A	1 114 mm^2
I_{xx}	567 156 mm^4
W_{xx}	18 905 mm^3
$A_{k,y}$	540 mm^2
I_{yy}	567 156 mm^4
W_{yy}	18 905 mm^3
$A_{k,x}$	540 mm^2

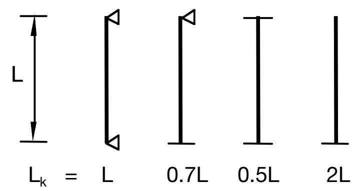
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

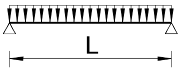
Design value for load-bearing capacity
205.6 kN

Dead weight
2.00 kg/m

Buckling length

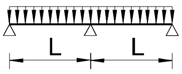


One span



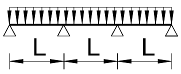
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	20.77	16.62	12.41	9.12	6.98	5.52	4.47	3.69	3.10	2.64	2.28	1.99	1.75	1.55	1.38	1.24	1.12
Application limit point																		
δ_{max} < L / 200	x/y direction	4.65	2.44	1.43	0.91	0.61	0.43	0.32	0.24	0.18	0.14	0.12	0.09	0.08	0.06	0.05	0.05	0.04
δ_{max} < L / 300	x/y direction	3.10	1.63	0.96	0.61	0.41	0.29	0.21	0.16	0.12	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03
δ_{max} < L / 400	x/y direction	2.32	1.22	0.72	0.46	0.31	0.22	0.16	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	16.62	13.29	11.08	9.12	6.98	5.52	4.47	3.69	3.10	2.64	2.28	1.99	1.75	1.55	1.38	1.24	1.12
Application limit point																		
δ_{max} < L / 200	x/y direction	10.15	5.51	3.29	2.12	1.44	1.02	0.75	0.56	0.44	0.34	0.28	0.23	0.19	0.16	0.13	0.11	0.10
δ_{max} < L / 300	x/y direction	6.77	3.67	2.20	1.41	0.96	0.68	0.50	0.38	0.29	0.23	0.18	0.15	0.12	0.10	0.09	0.07	0.06
δ_{max} < L / 400	x/y direction	5.07	2.75	1.65	1.06	0.72	0.51	0.37	0.28	0.22	0.17	0.14	0.11	0.09	0.08	0.07	0.06	0.05

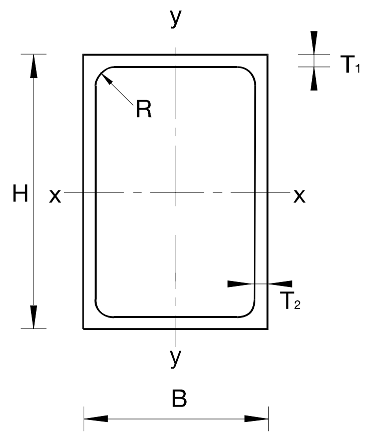
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	17.31	13.85	11.54	9.89	8.65	6.89	5.58	4.62	3.88	3.30	2.85	2.48	2.18	1.93	1.72	1.55	1.40
Application limit point																		
δ_{max} < L / 200	x/y direction	8.27	4.44	2.64	1.69	1.14	0.81	0.59	0.45	0.35	0.27	0.22	0.18	0.15	0.12	0.10	0.09	0.08
δ_{max} < L / 300	x/y direction	5.51	2.96	1.76	1.13	0.76	0.54	0.40	0.30	0.23	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05
δ_{max} < L / 400	x/y direction	4.14	2.22	1.32	0.84	0.57	0.40	0.30	0.22	0.17	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.04

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	41.5
2.25	34.0
2.50	28.3
2.75	23.9
3.00	20.4
3.25	17.6
3.50	15.3
3.75	13.5
4.00	11.9
4.25	10.6
4.50	9.5
4.75	8.6
5.00	7.8
5.25	7.1
5.50	6.4
5.75	5.9
6.00	5.4
6.25	5.0
6.50	4.6
6.75	4.3
7.00	4.0
7.25	3.8
7.50	3.5
7.75	3.3
8.00	3.1

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	27.8
2.25	22.5
2.50	18.5
2.75	15.5
3.00	13.2
3.25	11.3
3.50	9.8
3.75	8.6
4.00	7.6
4.25	6.8
4.50	6.0
4.75	5.4
5.00	4.9
5.25	4.5
5.50	4.1
5.75	3.7
6.00	3.4
6.25	3.2
6.50	2.9
6.75	2.7
7.00	2.5
7.25	2.4
7.50	2.2
7.75	2.1
8.00	1.9



Geometry	
H	80 mm
B	60 mm
T_1	5 mm
T_2	5 mm
R	4 mm

Cross-section constants	
A	1 314 mm^2
I_{xx}	1 146 818 mm^4
W_{xx}	28 670 mm^3
$A_{k,y}$	720 mm^2
I_{yy}	718 823 mm^4
W_{yy}	23 961 mm^3
$A_{k,x}$	540 mm^2

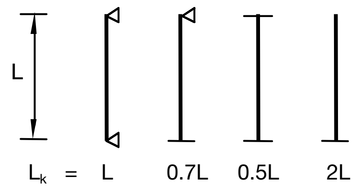
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

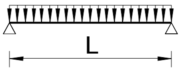
Design value for load-bearing capacity
242.5 kN

Dead weight
2.36 kg/m

Buckling length

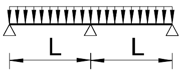


One span



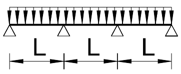
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x direction	27.69	22.15	18.46	13.83	10.59	8.36	6.78	5.60	4.70	4.01	3.46	3.01	2.65	2.34	2.09	1.88	1.69
	y direction	20.77	16.62	13.85	11.56	8.85	6.99	5.66	4.68	3.93	3.35	2.89	2.52	2.21	1.96	1.75	1.57	1.42
Application limit point																		
δ_{max} < L / 200	x direction	9.07	4.82	2.85	1.82	1.23	0.87	0.64	0.48	0.37	0.29	0.23	0.19	0.16	0.13	0.11	0.09	0.08
	y direction	5.78	3.06	1.80	1.15	0.77	0.55	0.40	0.30	0.23	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05
δ_{max} < L / 300	x direction	6.04	3.22	1.90	1.21	0.82	0.58	0.42	0.32	0.25	0.19	0.16	0.13	0.10	0.09	0.07	0.06	0.05
	y direction	3.85	2.06	1.22	0.78	0.52	0.37	0.27	0.20	0.16	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03
δ_{max} < L / 400	x direction	4.53	2.41	1.43	0.91	0.62	0.43	0.32	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04
	y direction	2.89	1.55	0.91	0.58	0.39	0.28	0.20	0.15	0.12	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	2.00
Breaking point																		
	x direction	22.15	17.72	14.77	12.66	10.59	8.36	6.78	5.60	4.70	4.01	3.46	3.01	2.65	2.34	2.09	1.88	10.59
	y direction	16.62	13.29	11.08	9.49	8.31	6.99	5.66	4.68	3.93	3.35	2.89	2.52	2.21	1.96	1.75	1.57	8.31
Application limit point																		
δ_{max} < L / 200	x direction	18.99	10.56	6.41	4.16	2.84	2.02	1.49	1.13	0.87	0.69	0.55	0.45	0.37	0.31	0.26	0.22	0.19
	y direction	12.35	6.79	4.09	2.64	1.80	1.28	0.94	0.71	0.55	0.43	0.35	0.28	0.23	0.20	0.17	0.14	0.12
δ_{max} < L / 300	x direction	12.66	7.04	4.27	2.77	1.89	1.35	0.99	0.75	0.58	0.46	0.37	0.30	0.25	0.21	0.18	0.15	0.13
	y direction	8.23	4.52	2.73	1.76	1.20	0.85	0.63	0.47	0.37	0.29	0.23	0.19	0.16	0.13	0.11	0.09	0.08
δ_{max} < L / 400	x direction	9.49	5.28	3.20	2.08	1.42	1.01	0.75	0.56	0.44	0.35	0.28	0.23	0.19	0.16	0.13	0.11	0.10
	y direction	6.17	3.39	2.05	1.32	0.90	0.64	0.47	0.36	0.28	0.22	0.17	0.14	0.12	0.10	0.08	0.07	0.06

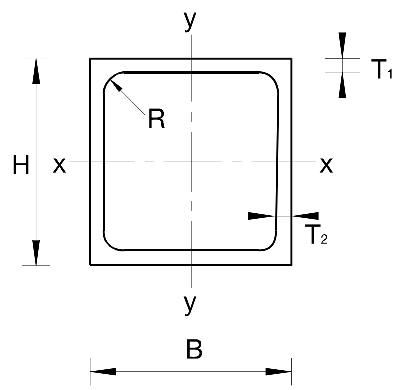
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x direction	23.08	18.46	15.38	13.19	11.54	10.26	8.47	7.00	5.88	5.01	4.32	3.76	3.31	2.93	2.61	2.35	2.12
	y direction	17.31	13.85	11.54	9.89	8.65	7.69	6.92	5.85	4.92	4.19	3.61	3.15	2.76	2.45	2.18	1.96	1.77
Application limit point																		
δ_{max} < L / 200	x direction	15.69	8.59	5.17	3.34	2.27	1.61	1.18	0.90	0.69	0.55	0.44	0.36	0.30	0.25	0.21	0.18	0.15
	y direction	10.14	5.50	3.29	2.11	1.44	1.02	0.75	0.56	0.44	0.34	0.28	0.22	0.19	0.15	0.13	0.11	0.10
δ_{max} < L / 300	x direction	10.46	5.73	3.45	2.22	1.51	1.07	0.79	0.60	0.46	0.36	0.29	0.24	0.20	0.16	0.14	0.12	0.10
	y direction	6.76	3.67	2.19	1.41	0.96	0.68	0.50	0.38	0.29	0.23	0.18	0.15	0.12	0.10	0.09	0.07	0.06
δ_{max} < L / 400	x direction	7.84	4.30	2.58	1.67	1.14	0.81	0.59	0.45	0.35	0.27	0.22	0.18	0.15	0.12	0.10	0.09	0.08
	y direction	5.07	2.75	1.64	1.06	0.72	0.51	0.37	0.28	0.22	0.17	0.14	0.11	0.09	0.08	0.07	0.06	0.05

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	108.7
2.25	90.8
2.50	76.7
2.75	65.5
3.00	56.4
3.25	49.1
3.50	43.0
3.75	38.0
4.00	33.7
4.25	30.2
4.50	27.1
4.75	24.5
5.00	22.2
5.25	20.3
5.50	18.5
5.75	17.0
6.00	15.7
6.25	14.5
6.50	13.4
6.75	12.5
7.00	11.6
7.25	10.9
7.50	10.2
7.75	9.5
8.00	9.0

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	108.7
2.25	90.8
2.50	76.7
2.75	65.5
3.00	56.4
3.25	49.1
3.50	43.0
3.75	38.0
4.00	33.7
4.25	30.2
4.50	27.1
4.75	24.5
5.00	22.2
5.25	20.3
5.50	18.5
5.75	17.0
6.00	15.7
6.25	14.5
6.50	13.4
6.75	12.5
7.00	11.6
7.25	10.9
7.50	10.2
7.75	9.5
8.00	9.0



Geometry	
H	100 mm
B	100 mm
T_1	6 mm
T_2	6 mm
R	4 mm

Cross-section constants	
A	2 270 mm^2
I_{xx}	3 361 401 mm^4
W_{xx}	67 228 mm^3
$A_{k,y}$	1 080 mm^2
I_{yy}	3 361 401 mm^4
W_{yy}	67 228 mm^3
$A_{k,x}$	1 080 mm^2

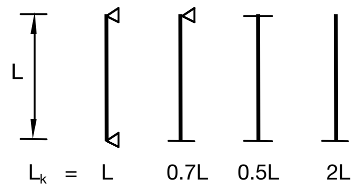
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

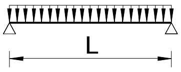
Design value for load-bearing capacity
419.0 kN

Dead weight
4.09 kg/m

Buckling length

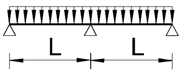


One span



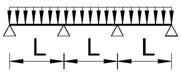
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x direction	41.54	33.23	27.69	23.74	20.77	18.46	15.89	13.13	11.03	9.40	8.11	7.06	6.21	5.50	4.90	4.40	3.97
	y direction	41.54	33.23	27.69	23.74	20.77	18.46	15.89	13.13	11.03	9.40	8.11	7.06	6.21	5.50	4.90	4.40	3.97
Application limit point																		
δ_{max} < L / 200	x direction	24.15	13.26	7.98	5.15	3.51	2.49	1.83	1.39	1.07	0.85	0.68	0.55	0.46	0.38	0.32	0.27	0.24
	y direction	24.15	13.26	7.98	5.15	3.51	2.49	1.83	1.39	1.07	0.85	0.68	0.55	0.46	0.38	0.32	0.27	0.24
δ_{max} < L / 300	x direction	16.10	8.84	5.32	3.44	2.34	1.66	1.22	0.92	0.71	0.56	0.45	0.37	0.30	0.25	0.21	0.18	0.16
	y direction	16.10	8.84	5.32	3.44	2.34	1.66	1.22	0.92	0.71	0.56	0.45	0.37	0.30	0.25	0.21	0.18	0.16
δ_{max} < L / 400	x direction	12.08	6.63	3.99	2.58	1.75	1.25	0.92	0.69	0.54	0.42	0.34	0.28	0.23	0.19	0.16	0.14	0.12
	y direction	12.08	6.63	3.99	2.58	1.75	1.25	0.92	0.69	0.54	0.42	0.34	0.28	0.23	0.19	0.16	0.14	0.12

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	2.00
Breaking point																		
	x direction	33.23	26.58	22.15	18.99	16.62	14.77	13.29	12.08	11.03	9.40	8.11	7.06	6.21	5.50	4.90	4.40	3.97
	y direction	33.23	26.58	22.15	18.99	16.62	14.77	13.29	12.08	11.03	9.40	8.11	7.06	6.21	5.50	4.90	4.40	3.97
Application limit point																		
δ_{max} < L / 200	x direction	46.00	27.01	16.98	11.28	7.84	5.65	4.20	3.20	2.49	1.97	1.59	1.30	1.08	0.90	0.76	0.65	0.56
	y direction	46.00	27.01	16.98	11.28	7.84	5.65	4.20	3.20	2.49	1.97	1.59	1.30	1.08	0.90	0.76	0.65	0.56
δ_{max} < L / 300	x direction	30.67	18.00	11.32	7.52	5.22	3.76	2.80	2.13	1.66	1.32	1.06	0.87	0.72	0.60	0.51	0.43	0.37
	y direction	30.67	18.00	11.32	7.52	5.22	3.76	2.80	2.13	1.66	1.32	1.06	0.87	0.72	0.60	0.51	0.43	0.37
δ_{max} < L / 400	x direction	23.00	13.50	8.49	5.64	3.92	2.82	2.10	1.60	1.24	0.99	0.80	0.65	0.54	0.45	0.38	0.32	0.28
	y direction	23.00	13.50	8.49	5.64	3.92	2.82	2.10	1.60	1.24	0.99	0.80	0.65	0.54	0.45	0.38	0.32	0.28

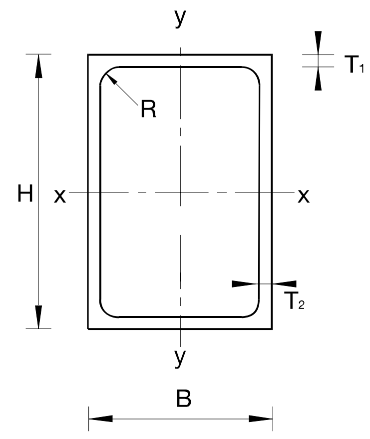
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x direction	34.62	27.69	23.08	19.78	17.31	15.38	13.85	12.59	11.54	10.65	9.89	8.83	7.76	6.87	6.13	5.50	4.96
	y direction	34.62	27.69	23.08	19.78	17.31	15.38	13.85	12.59	11.54	10.65	9.89	8.83	7.76	6.87	6.13	5.50	4.96
Application limit point																		
δ_{max} < L / 200	x direction	39.19	22.52	13.96	9.18	6.34	4.54	3.36	2.56	1.99	1.57	1.27	1.03	0.85	0.71	0.60	0.51	0.44
	y direction	39.19	22.52	13.96	9.18	6.34	4.54	3.36	2.56	1.99	1.57	1.27	1.03	0.85	0.71	0.60	0.51	0.44
δ_{max} < L / 300	x direction	26.13	15.01	9.31	6.12	4.22	3.03	2.24	1.70	1.32	1.05	0.84	0.69	0.57	0.48	0.40	0.34	0.29
	y direction	26.13	15.01	9.31	6.12	4.22	3.03	2.24	1.70	1.32	1.05	0.84	0.69	0.57	0.48	0.40	0.34	0.29
δ_{max} < L / 400	x direction	19.60	11.26	6.98	4.59	3.17	2.27	1.68	1.28	0.99	0.79	0.63	0.52	0.43	0.36	0.30	0.26	0.22
	y direction	19.60	11.26	6.98	4.59	3.17	2.27	1.68	1.28	0.99	0.79	0.63	0.52	0.43	0.36	0.30	0.26	0.22

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	96.4
2.25	79.9
2.50	67.1
2.75	57.0
3.00	49.0
3.25	42.4
3.50	37.1
3.75	32.7
4.00	29.0
4.25	25.9
4.50	23.2
4.75	21.0
5.00	19.0
5.25	17.3
5.50	15.8
5.75	14.5
6.00	13.4
6.25	12.4
6.50	11.5
6.75	10.7
7.00	9.9
7.25	9.3
7.50	8.7
7.75	8.1
8.00	7.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	47.0
2.25	38.0
2.50	31.3
2.75	26.2
3.00	22.3
3.25	19.1
3.50	16.6
3.75	14.5
4.00	12.8
4.25	11.4
4.50	10.2
4.75	9.2
5.00	8.3
5.25	7.5
5.50	6.9
5.75	6.3
6.00	5.8
6.25	5.3
6.50	4.9
6.75	4.6
7.00	4.3
7.25	4.0
7.50	3.7
7.75	3.5
8.00	3.3



Geometry	
H	100 mm
B	60 mm
T_1	8 mm
T_2	8 mm
R	4 mm

Cross-section constants	
A	2 320 mm^2
I_{xx}	2 850 000 mm^4
W_{xx}	57 000 mm^3
$A_{k,y}$	1 440 mm^2
I_{yy}	1 210 000 mm^4
W_{yy}	40 300 mm^3
$A_{k,x}$	860 mm^2

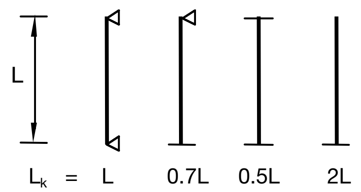
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

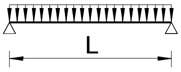
Design value for load-bearing capacity
242.5 kN

Dead weight
2.36 kg/m

Buckling length

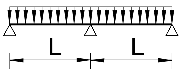


One span



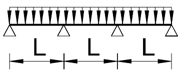
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x direction	55.38	44.31	36.92	27.49	21.05	16.63	13.47	11.13	9.35	7.97	6.87	5.99	5.26	4.66	4.16	3.73	3.37
	y direction	33.23	26.58	22.15	18.99	14.89	11.77	9.53	7.88	6.62	5.64	4.86	4.24	3.72	3.30	2.94	2.64	2.38
Application limit point																		
$\delta_{max} < L / 200$	x direction	21.97	11.79	7.00	4.48	3.04	2.15	1.57	1.19	0.92	0.72	0.58	0.47	0.39	0.33	0.27	0.23	0.20
	y direction	9.69	5.13	3.03	1.93	1.30	0.92	0.67	0.51	0.39	0.31	0.25	0.20	0.17	0.14	0.12	0.10	0.09
$\delta_{max} < L / 300$	x direction	14.65	7.86	4.67	2.99	2.02	1.43	1.05	0.79	0.61	0.48	0.39	0.31	0.26	0.22	0.18	0.16	0.13
	y direction	6.46	3.42	2.02	1.29	0.87	0.61	0.45	0.34	0.26	0.21	0.16	0.13	0.11	0.09	0.08	0.07	0.06
$\delta_{max} < L / 400$	x direction	10.99	5.89	3.50	2.24	1.52	1.07	0.79	0.59	0.46	0.36	0.29	0.24	0.19	0.16	0.14	0.12	0.10
	y direction	4.84	2.57	1.51	0.96	0.65	0.46	0.34	0.25	0.20	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	2.00
Breaking point																		
	x direction	44.31	35.45	29.54	25.32	21.05	16.63	13.47	11.13	9.35	7.97	6.87	5.99	5.26	4.66	4.16	3.73	3.37
	y direction	26.58	21.27	17.72	15.19	13.29	11.77	9.53	7.88	6.62	5.64	4.86	4.24	3.72	3.30	2.94	2.64	2.38
Application limit point																		
$\delta_{max} < L / 200$	x direction	44.79	25.30	15.51	10.13	6.95	4.97	3.66	2.78	2.16	1.71	1.37	1.12	0.92	0.77	0.65	0.56	0.48
	y direction	20.58	11.35	6.85	4.43	3.02	2.15	1.58	1.20	0.93	0.73	0.59	0.48	0.39	0.33	0.28	0.24	0.20
$\delta_{max} < L / 300$	x direction	29.86	16.86	10.34	6.75	4.63	3.31	2.44	1.85	1.44	1.14	0.91	0.75	0.62	0.52	0.43	0.37	0.32
	y direction	13.72	7.56	4.57	2.95	2.01	1.43	1.05	0.80	0.62	0.49	0.39	0.32	0.26	0.22	0.19	0.16	0.14
$\delta_{max} < L / 400$	x direction	22.40	12.65	7.75	5.06	3.48	2.48	1.83	1.39	1.08	0.85	0.69	0.56	0.46	0.39	0.33	0.28	0.24
	y direction	10.29	5.67	3.43	2.22	1.51	1.07	0.79	0.60	0.46	0.37	0.29	0.24	0.20	0.16	0.14	0.12	0.10

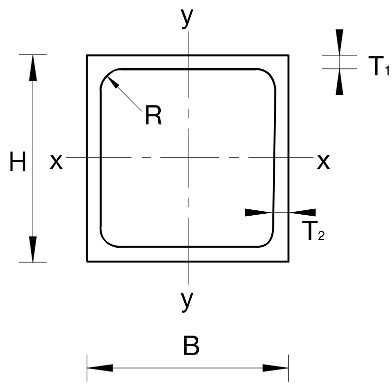
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x direction	46.15	36.92	30.77	26.37	23.08	20.51	16.84	13.91	11.69	9.96	8.59	7.48	6.58	5.83	5.20	4.66	4.21
	y direction	27.69	22.15	18.46	15.82	13.85	12.31	11.08	9.84	8.27	7.05	6.08	5.29	4.65	4.12	3.68	3.30	2.98
Application limit point																		
$\delta_{max} < L / 200$	x direction	37.34	20.73	12.57	8.15	5.57	3.97	2.92	2.21	1.71	1.35	1.09	0.89	0.73	0.61	0.52	0.44	0.38
	y direction	16.92	9.20	5.51	3.55	2.41	1.71	1.26	0.95	0.73	0.58	0.46	0.38	0.31	0.26	0.22	0.19	0.16
$\delta_{max} < L / 300$	x direction	24.90	13.82	8.38	5.44	3.71	2.64	1.95	1.47	1.14	0.90	0.72	0.59	0.49	0.41	0.34	0.29	0.25
	y direction	11.28	6.14	3.68	2.36	1.61	1.14	0.84	0.63	0.49	0.39	0.31	0.25	0.21	0.17	0.15	0.12	0.11
$\delta_{max} < L / 400$	x direction	18.67	10.37	6.29	4.08	2.79	1.98	1.46	1.11	0.86	0.68	0.54	0.44	0.37	0.31	0.26	0.22	0.19
	y direction	8.46	4.60	2.76	1.77	1.21	0.85	0.63	0.47	0.37	0.29	0.23	0.19	0.16	0.13	0.11	0.09	0.08

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	158.6
2.25	133.5
2.50	113.4
2.75	97.2
3.00	84.1
3.25	73.3
3.50	64.4
3.75	57.0
4.00	50.7
4.25	45.4
4.50	40.9
4.75	37.0
5.00	33.6
5.25	30.6
5.50	28.0
5.75	25.8
6.00	23.8
6.25	22.0
6.50	20.4
6.75	18.9
7.00	17.7
7.25	16.5
7.50	15.5
7.75	14.5
8.00	13.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	158.6
2.25	133.5
2.50	113.4
2.75	97.2
3.00	84.1
3.25	73.3
3.50	64.4
3.75	57.0
4.00	50.7
4.25	45.4
4.50	40.9
4.75	37.0
5.00	33.6
5.25	30.6
5.50	28.0
5.75	25.8
6.00	23.8
6.25	22.0
6.50	20.4
6.75	18.9
7.00	17.7
7.25	16.5
7.50	15.5
7.75	14.5
8.00	13.6



Geometry	
H	100 mm
B	100 mm
T_1	8 mm
T_2	8 mm
R	4 mm

Cross-section constants	
A	2 958 mm²
I_{xx}	4 207 621 mm⁴
W_{xx}	84 152 mm³
$A_{k,y}$	1 440 mm²
I_{yy}	4 207 621 mm⁴
W_{yy}	84 152 mm³
$A_{k,x}$	1 440 mm²

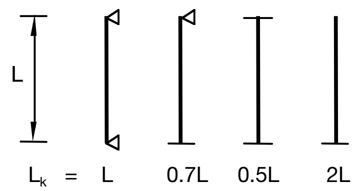
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

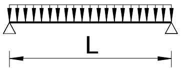
Design value for load-bearing capacity
546.0 kN

Dead weight
5.32 kg/m

Buckling length

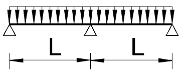


One span



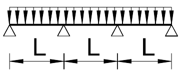
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	55.38	44.31	36.92	31.65	27.69	24.55	19.89	16.43	13.81	11.77	10.15	8.84	7.77	6.88	6.14	5.51	4.97
Application limit point																		
δ_{max} < L / 200	x/y direction	30.58	16.72	10.05	6.48	4.41	3.13	2.30	1.74	1.34	1.06	0.85	0.69	0.57	0.48	0.40	0.34	0.29
δ_{max} < L / 300	x/y direction	20.39	11.15	6.70	4.32	2.94	2.09	1.53	1.16	0.90	0.71	0.57	0.46	0.38	0.32	0.27	0.23	0.20
δ_{max} < L / 400	x/y direction	15.29	8.36	5.03	3.24	2.20	1.56	1.15	0.87	0.67	0.53	0.43	0.35	0.29	0.24	0.20	0.17	0.15

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	44.31	35.45	29.54	25.32	22.15	19.69	17.72	16.11	13.81	11.77	10.15	8.84	7.77	6.88	6.14	5.51	4.97
Application limit point																		
δ_{max} < L / 200	x/y direction	58.86	34.35	21.51	14.25	9.88	7.11	5.28	4.02	3.13	2.48	2.00	1.63	1.35	1.13	0.96	0.81	0.70
δ_{max} < L / 300	x/y direction	39.24	22.90	14.34	9.50	6.59	4.74	3.52	2.68	2.08	1.65	1.33	1.09	0.90	0.75	0.64	0.54	0.47
δ_{max} < L / 400	x/y direction	29.43	17.18	10.76	7.13	4.94	3.56	2.64	2.01	1.56	1.24	1.00	0.82	0.68	0.57	0.48	0.41	0.35

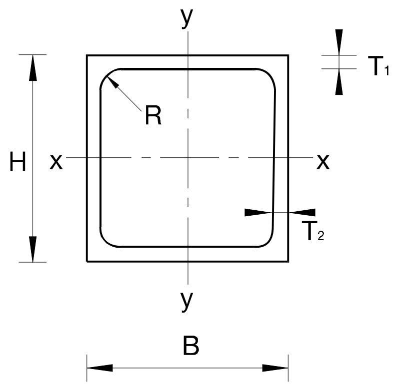
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	46.15	36.92	30.77	26.37	23.08	20.51	18.46	16.78	15.38	14.20	12.68	11.05	9.71	8.60	7.67	6.89	6.21
Application limit point																		
δ_{max} < L / 200	x/y direction	49.99	28.57	17.65	11.58	7.98	5.71	4.23	3.21	2.49	1.97	1.59	1.30	1.07	0.90	0.76	0.64	0.55
δ_{max} < L / 300	x/y direction	33.32	19.05	11.76	7.72	5.32	3.81	2.82	2.14	1.66	1.32	1.06	0.86	0.71	0.60	0.50	0.43	0.37
δ_{max} < L / 400	x/y direction	24.99	14.28	8.82	5.79	3.99	2.86	2.11	1.60	1.25	0.99	0.79	0.65	0.54	0.45	0.38	0.32	0.28

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	172.4
2.25	146.7
2.50	125.7
2.75	108.6
3.00	94.5
3.25	82.8
3.50	73.0
3.75	64.8
4.00	57.8
4.25	51.9
4.50	46.8
4.75	42.4
5.00	38.6
5.25	35.3
5.50	32.3
5.75	29.7
6.00	27.4
6.25	25.4
6.50	23.6
6.75	21.9
7.00	20.5
7.25	19.1
7.50	17.9
7.75	16.8
8.00	15.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	172.4
2.25	146.7
2.50	125.7
2.75	108.6
3.00	94.5
3.25	82.8
3.50	73.0
3.75	64.8
4.00	57.8
4.25	51.9
4.50	46.8
4.75	42.4
5.00	38.6
5.25	35.3
5.50	32.3
5.75	29.7
6.00	27.4
6.25	25.4
6.50	23.6
6.75	21.9
7.00	20.5
7.25	19.1
7.50	17.9
7.75	16.8
8.00	15.8



Geometry	
H	120 mm
B	120 mm
T_1	6 mm
T_2	6 mm
R	4 mm

Cross-section constants	
A	2 750 mm²
I_{xx}	5 981 335 mm⁴
W_{xx}	99 689 mm³
$A_{k,y}$	1 296 mm²
I_{yy}	5 981 335 mm⁴
W_{yy}	99 689 mm³
$A_{k,x}$	1 296 mm²

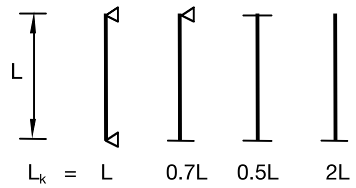
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

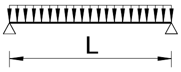
Design value for load-bearing capacity
507.6 kN

Dead weight
4.95 kg/m

Buckling length

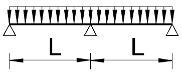


One span



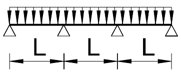
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	49.85	39.88	33.23	28.48	24.92	22.15	19.94	18.13	16.36	13.94	12.02	10.47	9.20	8.15	7.27	6.53	5.89
Application limit point																		
δ_{max} < L / 200	x/y direction	39.43	22.22	13.60	8.87	6.09	4.35	3.21	2.43	1.89	1.49	1.20	0.98	0.81	0.68	0.57	0.49	0.42
δ_{max} < L / 300	x/y direction	26.29	14.81	9.07	5.92	4.06	2.90	2.14	1.62	1.26	0.99	0.80	0.65	0.54	0.45	0.38	0.32	0.28
δ_{max} < L / 400	x/y direction	19.72	11.11	6.80	4.44	3.04	2.17	1.60	1.22	0.94	0.75	0.60	0.49	0.40	0.34	0.29	0.24	0.21

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	39.88	31.90	26.58	22.79	19.94	17.72	15.95	14.50	13.29	12.27	11.39	10.47	9.20	8.15	7.27	6.53	5.89
Application limit point																		
δ_{max} < L / 200	x/y direction	69.88	42.69	27.59	18.70	13.18	9.59	7.18	5.51	4.31	3.43	2.78	2.27	1.89	1.58	1.34	1.14	0.98
δ_{max} < L / 300	x/y direction	46.59	28.46	18.40	12.47	8.78	6.40	4.79	3.67	2.87	2.29	1.85	1.52	1.26	1.05	0.89	0.76	0.66
δ_{max} < L / 400	x/y direction	34.94	21.34	13.80	9.35	6.59	4.80	3.59	2.75	2.15	1.72	1.39	1.14	0.94	0.79	0.67	0.57	0.49

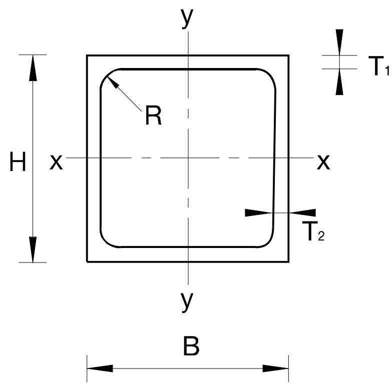
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	41.54	33.23	27.69	23.74	20.77	18.46	16.62	15.10	13.85	12.78	11.87	11.08	10.38	9.77	9.09	8.16	7.36
Application limit point																		
δ_{max} < L / 200	x/y direction	60.86	36.27	23.04	15.42	10.77	7.79	5.80	4.43	3.46	2.75	2.22	1.81	1.50	1.26	1.06	0.91	0.78
δ_{max} < L / 300	x/y direction	40.57	24.18	15.36	10.28	7.18	5.19	3.87	2.95	2.30	1.83	1.48	1.21	1.00	0.84	0.71	0.60	0.52
δ_{max} < L / 400	x/y direction	30.43	18.13	11.52	7.71	5.38	3.89	2.90	2.22	1.73	1.37	1.11	0.91	0.75	0.63	0.53	0.45	0.39

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	220.6
2.25	187.4
2.50	160.4
2.75	138.3
3.00	120.2
3.25	105.3
3.50	92.8
3.75	82.3
4.00	73.5
4.25	65.9
4.50	59.4
4.75	53.8
5.00	49.0
5.25	44.7
5.50	41.0
5.75	37.7
6.00	34.8
6.25	32.2
6.50	29.9
6.75	27.8
7.00	25.9
7.25	24.2
7.50	22.7
7.75	21.3
8.00	20.0

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	220.6
2.25	187.4
2.50	160.4
2.75	138.3
3.00	120.2
3.25	105.3
3.50	92.8
3.75	82.3
4.00	73.5
4.25	65.9
4.50	59.4
4.75	53.8
5.00	49.0
5.25	44.7
5.50	41.0
5.75	37.7
6.00	34.8
6.25	32.2
6.50	29.9
6.75	27.8
7.00	25.9
7.25	24.2
7.50	22.7
7.75	21.3
8.00	20.0



Geometry	
H	120 mm
B	120 mm
T_1	8 mm
T_2	8 mm
R	4 mm

Cross-section constants	
A	3 598 mm^2
I_{xx}	7 567 059 mm^4
W_{xx}	126 118 mm^3
$A_{k,y}$	1 728 mm^2
I_{yy}	7 567 059 mm^4
W_{yy}	126 118 mm^3
$A_{k,x}$	1 728 mm^2

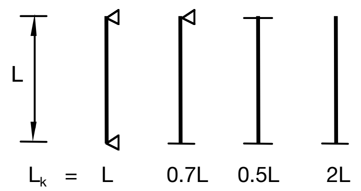
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

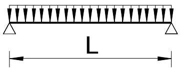
Design value for load-bearing capacity
664.2 kN

Dead weight
6.48 kg/m

Buckling length

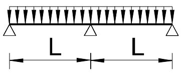


One span



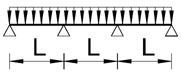
	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	66.46	53.17	44.31	37.98	33.23	29.54	26.58	24.17	20.70	17.63	15.21	13.25	11.64	10.31	9.20	8.26	7.45
Application limit point																		
δ_{max} < L / 200	x/y direction	50.54	28.37	17.32	11.28	7.73	5.52	4.07	3.08	2.39	1.89	1.52	1.24	1.02	0.86	0.72	0.61	0.53
δ_{max} < L / 300	x/y direction	33.69	18.91	11.55	7.52	5.15	3.68	2.71	2.05	1.59	1.26	1.01	0.83	0.68	0.57	0.48	0.41	0.35
δ_{max} < L / 400	x/y direction	25.27	14.18	8.66	5.64	3.87	2.76	2.03	1.54	1.19	0.94	0.76	0.62	0.51	0.43	0.36	0.31	0.26

Two spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	53.17	42.54	35.45	30.38	26.58	23.63	21.27	19.33	17.72	16.36	15.19	13.25	11.64	10.31	9.20	8.26	7.45
Application limit point																		
δ_{max} < L / 200	x/y direction	90.49	54.97	35.39	23.91	16.81	12.23	9.14	7.00	5.48	4.36	3.52	2.89	2.39	2.01	1.70	1.45	1.25
δ_{max} < L / 300	x/y direction	60.33	36.64	23.60	15.94	11.21	8.15	6.10	4.67	3.65	2.91	2.35	1.92	1.60	1.34	1.13	0.97	0.83
δ_{max} < L / 400	x/y direction	45.25	27.48	17.70	11.96	8.41	6.11	4.57	3.50	2.74	2.18	1.76	1.44	1.20	1.00	0.85	0.72	0.62

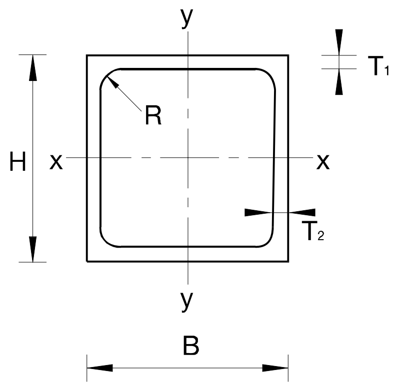
Three spans



	L (m) =	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Breaking point																		
	x/y direction	55.38	44.31	36.92	31.65	27.69	24.62	22.15	20.14	18.46	17.04	15.82	14.77	13.85	12.89	11.50	10.32	9.31
Application limit point																		
δ_{max} < L / 200	x/y direction	78.56	46.58	29.48	19.68	13.72	9.91	7.38	5.63	4.39	3.48	2.81	2.30	1.90	1.59	1.35	1.15	0.99
δ_{max} < L / 300	x/y direction	52.38	31.05	19.66	13.12	9.15	6.61	4.92	3.75	2.92	2.32	1.87	1.53	1.27	1.06	0.90	0.77	0.66
δ_{max} < L / 400	x/y direction	39.28	23.29	14.74	9.84	6.86	4.96	3.69	2.81	2.19	1.74	1.41	1.15	0.95	0.80	0.67	0.57	0.49

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	478.7
2.25	425.3
2.50	378.2
2.75	336.9
3.00	300.9
3.25	269.6
3.50	242.4
3.75	218.7
4.00	198.0
4.25	179.8
4.50	163.9
4.75	149.9
5.00	137.5
5.25	126.5
5.50	116.7
5.75	107.9
6.00	100.1
6.25	93.1
6.50	86.7
6.75	81.0
7.00	75.8
7.25	71.0
7.50	66.7
7.75	62.8
8.00	59.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	478.7
2.25	425.3
2.50	378.2
2.75	336.9
3.00	300.9
3.25	269.6
3.50	242.4
3.75	218.7
4.00	198.0
4.25	179.8
4.50	163.9
4.75	149.9
5.00	137.5
5.25	126.5
5.50	116.7
5.75	107.9
6.00	100.1
6.25	93.1
6.50	86.7
6.75	81.0
7.00	75.8
7.25	71.0
7.50	66.7
7.75	62.8
8.00	59.2



Geometry	
H	160 mm
B	160 mm
T_1	8 mm
T_2	8 mm
R	8 mm

Cross-section constants	
A	4 919 mm^2
I_{xx}	19 052 487 mm^4
W_{xx}	238 156 mm^3
$A_{k,y}$	2 304 mm^2
I_{yy}	19 052 487 mm^4
W_{yy}	238 156 mm^3
$A_{k,x}$	2 304 mm^2

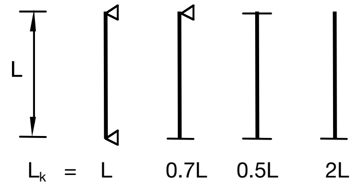
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
908.1 kN

Dead weight
8.85 kg/m

Buckling length



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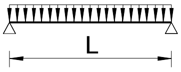
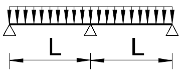


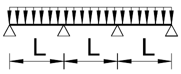
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x/y direction	44.31	39.38	35.45	32.22	29.54	27.27	25.32	23.63	21.98	19.47	17.37	15.59	14.07	12.76	11.63	10.64	9.77
Application limit point																		
$\delta_{max} < L / 200$	x/y direction	18.26	13.19	9.81	7.49	5.84	4.63	3.74	3.06	2.53	2.12	1.79	1.53	1.31	1.14	0.99	0.87	0.77
$\delta_{max} < L / 300$	x/y direction	12.17	8.79	6.54	4.99	3.89	3.09	2.49	2.04	1.69	1.41	1.20	1.02	0.88	0.76	0.66	0.58	0.51
$\delta_{max} < L / 400$	x/y direction	9.13	6.59	4.91	3.74	2.92	2.32	1.87	1.53	1.27	1.06	0.90	0.76	0.66	0.57	0.50	0.43	0.38

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x/y direction	35.45	31.51	28.36	25.78	23.63	21.81	20.25	18.90	17.72	16.68	15.75	14.92	14.07	12.76	11.63	10.64	9.77
Application limit point																		
$\delta_{max} < L / 200$	x/y direction	37.00	27.54	20.97	16.29	12.88	10.34	8.42	6.94	5.79	4.87	4.14	3.54	3.06	2.65	2.32	2.04	1.80
$\delta_{max} < L / 300$	x/y direction	24.67	18.36	13.98	10.86	8.59	6.90	5.62	4.63	3.86	3.25	2.76	2.36	2.04	1.77	1.55	1.36	1.20
$\delta_{max} < L / 400$	x/y direction	18.50	13.77	10.48	8.14	6.44	5.17	4.21	3.47	2.89	2.44	2.07	1.77	1.53	1.33	1.16	1.02	0.90

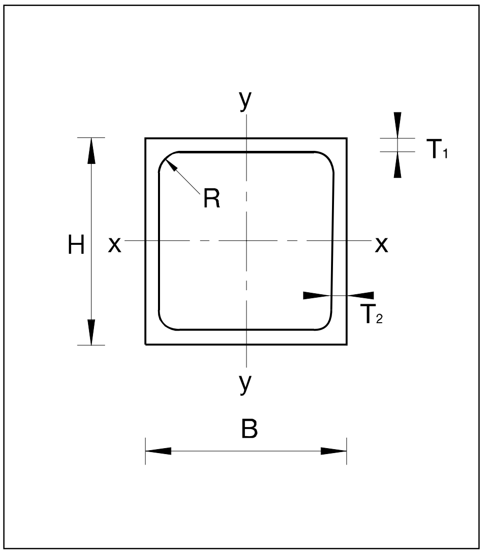
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x/y direction	36.92	32.82	29.54	26.85	24.62	22.72	21.10	19.69	18.46	17.38	16.41	15.55	14.77	14.07	13.43	12.84	12.21
Application limit point																		
$\delta_{max} < L / 200$	x/y direction	30.91	22.78	17.21	13.29	10.46	8.36	6.79	5.58	4.64	3.90	3.31	2.83	2.44	2.11	1.84	1.62	1.43
$\delta_{max} < L / 300$	x/y direction	20.61	15.18	11.47	8.86	6.97	5.58	4.53	3.72	3.09	2.60	2.20	1.88	1.62	1.41	1.23	1.08	0.95
$\delta_{max} < L / 400$	x/y direction	15.45	11.39	8.60	6.64	5.23	4.18	3.39	2.79	2.32	1.95	1.65	1.41	1.22	1.06	0.92	0.81	0.71

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
3.00	619.2
3.25	564.0
3.50	514.5
3.75	470.2
4.00	430.5
4.25	395.0
4.50	363.3
4.75	334.8
5.00	309.3
5.25	286.3
5.50	265.7
5.75	247.0
6.00	230.1
6.25	214.8
6.50	200.9
6.75	188.2
7.00	176.7
7.25	166.1
7.50	156.4
7.75	147.5
8.00	139.3
8.25	131.8
8.50	124.8
8.75	118.4
9.00	112.4

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
3.00	619.2
3.25	564.0
3.50	514.5
3.75	470.2
4.00	430.5
4.25	395.0
4.50	363.3
4.75	334.8
5.00	309.3
5.25	286.3
5.50	265.7
5.75	247.0
6.00	230.1
6.25	214.8
6.50	200.9
6.75	188.2
7.00	176.7
7.25	166.1
7.50	156.4
7.75	147.5
8.00	139.3
8.25	131.8
8.50	124.8
8.75	118.4
9.00	112.4



Geometry	
H	200 mm
B	200 mm
T_1	10 mm
T_2	10 mm
R	10 mm

Cross-section constants	
A	7 686 mm^2
I_{xx}	46 514 860 mm^4
W_{xx}	465 149 mm^3
$A_{k,y}$	3 600 mm^2
I_{yy}	46 514 860 mm^4
W_{yy}	465 149 mm^3
$A_{k,x}$	3 600 mm^2

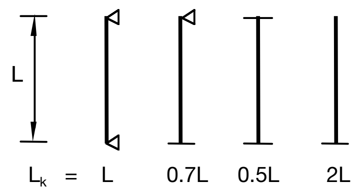
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

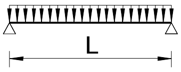
Design value for load-bearing capacity
1418.9 kN

Dead weight
13.84 kg/m

Buckling length

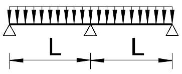


One span



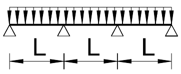
	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x/y direction	69.23	61.54	55.38	50.35	46.15	42.60	39.56	36.92	34.62	32.58	30.77	29.15	27.48	24.92	22.71	20.78	19.08
Application limit point																		
δ_{max} < L / 200	x/y direction	41.49	30.36	22.82	17.55	13.76	10.98	8.89	7.30	6.06	5.08	4.31	3.68	3.17	2.74	2.39	2.10	1.85
δ_{max} < L / 300	x/y direction	27.66	20.24	15.21	11.70	9.17	7.32	5.93	4.86	4.04	3.39	2.87	2.45	2.11	1.83	1.60	1.40	1.24
δ_{max} < L / 400	x/y direction	20.74	15.18	11.41	8.77	6.88	5.49	4.45	3.65	3.03	2.54	2.15	1.84	1.58	1.37	1.20	1.05	0.93

Two spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x/y direction	55.38	49.23	44.31	40.28	36.92	34.08	31.65	29.54	27.69	26.06	24.62	23.32	22.15	21.10	20.14	19.26	18.46
Application limit point																		
δ_{max} < L / 200	x/y direction	78.52	59.70	46.26	36.45	29.15	23.64	19.40	16.10	13.49	11.41	9.73	8.36	7.23	6.30	5.52	4.86	4.30
δ_{max} < L / 300	x/y direction	52.35	39.80	30.84	24.30	19.44	15.76	12.93	10.73	9.00	7.61	6.49	5.57	4.82	4.20	3.68	3.24	2.86
δ_{max} < L / 400	x/y direction	39.26	29.85	23.13	18.22	14.58	11.82	9.70	8.05	6.75	5.71	4.87	4.18	3.62	3.15	2.76	2.43	2.15

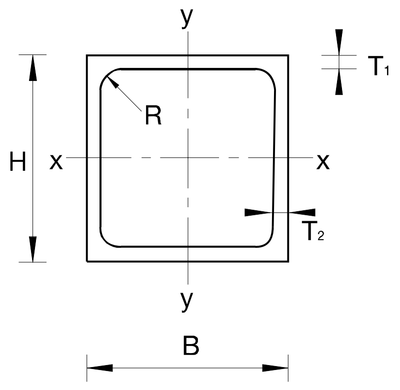
Three spans



	L (m) =	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Breaking point																		
	x/y direction	57.69	51.28	46.15	41.96	38.46	35.50	32.97	30.77	28.85	27.15	25.64	24.29	23.08	21.98	20.98	20.07	19.23
Application limit point																		
δ_{max} < L / 200	x/y direction	67.03	50.36	38.63	30.20	24.00	19.35	15.81	13.07	10.92	9.21	7.84	6.72	5.80	5.04	4.41	3.88	3.43
δ_{max} < L / 300	x/y direction	44.69	33.57	25.76	20.13	16.00	12.90	10.54	8.71	7.28	6.14	5.22	4.48	3.87	3.36	2.94	2.59	2.29
δ_{max} < L / 400	x/y direction	33.51	25.18	19.32	15.10	12.00	9.68	7.91	6.54	5.46	4.61	3.92	3.36	2.90	2.52	2.21	1.94	1.71

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
4.00	787.5
4.25	729.7
4.50	677.0
4.75	629.0
5.00	585.2
5.25	545.3
5.50	509.0
5.75	475.8
6.00	445.4
6.25	417.6
6.50	392.2
6.75	368.8
7.00	347.3
7.25	327.5
7.50	309.3
7.75	292.5
8.00	276.9
8.25	262.5
8.50	249.2
8.75	236.8
9.00	225.2
9.25	214.5
9.50	204.5
9.75	195.1
10.00	186.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
4.00	787.5
4.25	729.7
4.50	677.0
4.75	629.0
5.00	585.2
5.25	545.3
5.50	509.0
5.75	475.8
6.00	445.4
6.25	417.6
6.50	392.2
6.75	368.8
7.00	347.3
7.25	327.5
7.50	309.3
7.75	292.5
8.00	276.9
8.25	262.5
8.50	249.2
8.75	236.8
9.00	225.2
9.25	214.5
9.50	204.5
9.75	195.1
10.00	186.3



Geometry	
H	240 mm
B	240 mm
T_1	12 mm
T_2	12 mm
R	12 mm

Cross-section constants	
A	11 068 mm²
I_{xx}	96 453 214 mm⁴
W_{xx}	803 777 mm³
$A_{k,y}$	5 184 mm²
I_{yy}	96 453 214 mm⁴
W_{yy}	803 777 mm³
$A_{k,x}$	5 184 mm²

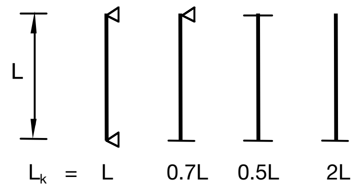
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

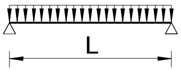
Design value for load-bearing capacity
2043.3 kN

Dead weight
19.92 kg/m

Buckling length

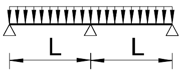


One span



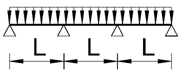
	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x/y direction	79.75	72.50	66.46	61.35	56.97	53.17	49.85	46.91	44.31	41.98	39.88	37.98	36.25	34.68	32.98	30.39	28.10
Application limit point																		
δ_{max} < L / 200	x/y direction	44.72	34.68	27.38	21.97	17.87	14.72	12.26	10.32	8.76	7.49	6.46	5.61	4.90	4.30	3.80	3.37	3.00
δ_{max} < L / 300	x/y direction	29.81	23.12	18.26	14.65	11.91	9.81	8.17	6.88	5.84	5.00	4.31	3.74	3.27	2.87	2.53	2.25	2.00
δ_{max} < L / 400	x/y direction	22.36	17.34	13.69	10.98	8.94	7.36	6.13	5.16	4.38	3.75	3.23	2.80	2.45	2.15	1.90	1.69	1.50

Two spans



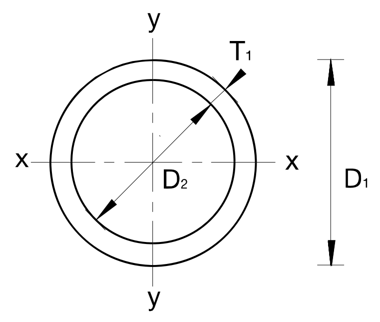
	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x/y direction	63.80	58.00	53.17	49.08	45.57	42.54	39.88	37.53	35.45	33.58	31.90	30.38	29.00	27.74	26.58	25.52	24.54
Application limit point																		
δ_{max} < L / 200	x/y direction	85.81	68.57	55.51	45.46	37.63	31.45	26.52	22.55	19.32	16.67	14.47	12.63	11.09	9.79	8.68	7.73	6.91
δ_{max} < L / 300	x/y direction	57.21	45.72	37.00	30.31	25.08	20.97	17.68	15.03	12.88	11.11	9.65	8.42	7.40	6.53	5.79	5.15	4.61
δ_{max} < L / 400	x/y direction	42.90	34.29	27.75	22.73	18.81	15.73	13.26	11.28	9.66	8.33	7.23	6.32	5.55	4.90	4.34	3.87	3.46

Three spans



	L (m) =	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
Breaking point																		
	x/y direction	66.46	60.42	55.38	51.12	47.47	44.31	41.54	39.10	36.92	34.98	33.23	31.65	30.21	28.90	27.69	26.58	25.56
Application limit point																		
δ_{max} < L / 200	x/y direction	72.94	57.74	46.36	37.71	31.04	25.81	21.68	18.37	15.69	13.49	11.69	10.18	8.93	7.86	6.96	6.19	5.53
δ_{max} < L / 300	x/y direction	48.63	38.49	30.91	25.14	20.69	17.21	14.45	12.24	10.46	9.00	7.79	6.79	5.95	5.24	4.64	4.13	3.69
δ_{max} < L / 400	x/y direction	36.47	28.87	23.18	18.86	15.52	12.91	10.84	9.18	7.84	6.75	5.84	5.09	4.46	3.93	3.48	3.10	2.77

Design value for compressive load-bearing capacity	
Buckling	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	142.0
0.60	125.4
0.70	110.2
0.80	96.7
0.90	84.9
1.00	74.7
1.10	65.9
1.20	58.4
1.30	52.0
1.40	46.5
1.50	41.7
1.60	37.6
1.70	34.0
1.80	30.9
1.90	28.2
2.00	25.8
2.10	23.7
2.20	21.8
2.30	20.1
2.40	18.6
2.50	17.3
2.60	16.1
2.70	15.0
2.80	14.0
3.00	12.3



Geometry	
D_1	75 mm
D_2	65 mm
T_1	5 mm

Cross-section constants	
A	1 100 mm^2
I_{xx}	676 915 mm^4
W_{xx}	18 051 mm^3
$A_{k,y}$	550 mm^2

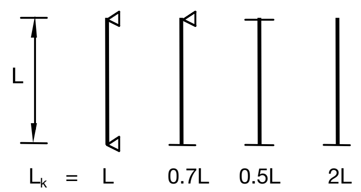
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

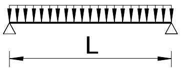
Design value for load-bearing capacity
203.0 kN

Dead weight
1.98 kg/m

Buckling length

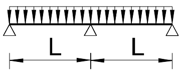


One span



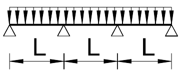
	L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Breaking point																		
	x/y direction	42.29	35.24	30.21	26.43	23.49	21.15	19.22	17.62	15.78	13.60	11.85	8.71	6.67	5.27	4.27	3.53	2.96
Application limit point																		
δ_{max} < L / 200	x/y direction	35.10	22.11	14.71	10.23	7.38	5.48	4.18	3.25	2.58	2.08	1.70	1.08	0.73	0.52	0.38	0.28	0.22
δ_{max} < L / 300	x/y direction	23.40	14.74	9.81	6.82	4.92	3.65	2.79	2.17	1.72	1.39	1.14	0.72	0.49	0.34	0.25	0.19	0.15
δ_{max} < L / 400	x/y direction	17.55	11.06	7.35	5.11	3.69	2.74	2.09	1.63	1.29	1.04	0.85	0.54	0.37	0.26	0.19	0.14	0.11

Two spans



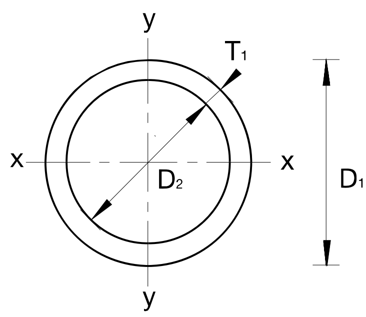
	L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Breaking point																		
	x/y direction	33.83	28.19	24.17	21.15	18.80	16.92	15.38	14.10	13.01	12.08	11.28	8.71	6.67	5.27	4.27	3.53	2.96
Application limit point																		
δ_{max} < L / 200	x/y direction	61.42	41.44	28.99	20.93	15.53	11.79	9.15	7.22	5.79	4.71	3.88	2.50	1.70	1.21	0.89	0.67	0.52
δ_{max} < L / 300	x/y direction	40.95	27.62	19.33	13.95	10.35	7.86	6.10	4.81	3.86	3.14	2.59	1.67	1.14	0.81	0.59	0.45	0.35
δ_{max} < L / 400	x/y direction	30.71	20.72	14.50	10.47	7.76	5.90	4.57	3.61	2.90	2.36	1.94	1.25	0.85	0.60	0.44	0.34	0.26

Three spans



	L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Breaking point																		
	x/y direction	35.24	29.37	25.17	22.03	19.58	17.62	16.02	14.68	13.55	12.59	11.75	10.07	8.33	6.58	5.33	4.41	3.70
Application limit point																		
δ_{max} < L / 200	x/y direction	53.69	35.48	24.44	17.43	12.81	9.66	7.45	5.85	4.68	3.79	3.12	2.00	1.36	0.96	0.70	0.53	0.41
δ_{max} < L / 300	x/y direction	35.79	23.65	16.29	11.62	8.54	6.44	4.96	3.90	3.12	2.53	2.08	1.33	0.90	0.64	0.47	0.35	0.27
δ_{max} < L / 400	x/y direction	26.84	17.74	12.22	8.71	6.40	4.83	3.72	2.93	2.34	1.90	1.56	1.00	0.68	0.48	0.35	0.27	0.21

Design value for compressive load-bearing capacity	
Buckling	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	190.8
0.60	173.6
0.70	156.8
0.80	141.1
0.90	126.7
1.00	113.8
1.10	102.2
1.20	92.0
1.30	82.9
1.40	75.0
1.50	68.0
1.60	61.8
1.70	56.4
1.80	51.6
1.90	47.3
2.00	43.5
2.25	35.7
2.50	29.7
2.75	25.1
3.00	21.4
3.25	18.5
3.50	16.1
3.75	14.2
4.00	12.5
5.00	8.2



Geometry	
D_1	90 mm
D_2	80 mm
T_1	5 mm

Cross-section constants	
A	1 335 mm^2
I_{xx}	1 210 004 mm^4
W_{xx}	26 889 mm^3
$A_{k,y}$	668 mm^2

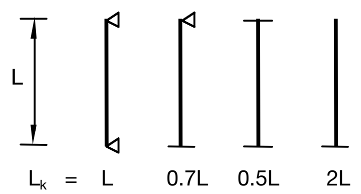
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

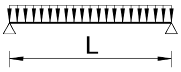
Design value for load-bearing capacity
246.5 kN

Dead weight
2.40 kg/m

Buckling length

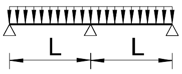


One span



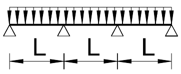
	L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	3.50
Breaking point																		
	x/y direction	25.68	23.34	21.40	19.75	18.34	17.12	15.51	13.74	12.26	11.00	9.93	8.21	6.89	5.87	5.07	4.41	3.24
Application limit point																		
δ_{max} < L / 200	x/y direction	9.43	7.23	5.66	4.51	3.65	2.99	2.48	2.08	1.76	1.50	1.29	0.98	0.76	0.60	0.48	0.39	0.25
δ_{max} < L / 300	x/y direction	6.29	4.82	3.77	3.01	2.43	1.99	1.65	1.39	1.17	1.00	0.86	0.65	0.50	0.40	0.32	0.26	0.16
δ_{max} < L / 400	x/y direction	4.71	3.62	2.83	2.25	1.82	1.49	1.24	1.04	0.88	0.75	0.65	0.49	0.38	0.30	0.24	0.20	0.12

Two spans



	L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	3.50
Breaking point																		
	x/y direction	20.54	18.67	17.12	15.80	14.67	13.69	12.84	12.08	11.41	10.81	9.93	8.21	6.89	5.87	5.07	4.41	3.24
Application limit point																		
ε_{max} < L / 200	x/y direction	19.44	15.25	12.15	9.82	8.04	6.66	5.57	4.70	4.01	3.44	2.97	2.26	1.76	1.39	1.12	0.92	0.58
ε_{max} < L / 300	x/y direction	12.96	10.17	8.10	6.55	5.36	4.44	3.71	3.14	2.67	2.29	1.98	1.51	1.17	0.93	0.75	0.61	0.39
ε_{max} < L / 400	x/y direction	9.72	7.62	6.08	4.91	4.02	3.33	2.79	2.35	2.00	1.72	1.49	1.13	0.88	0.70	0.56	0.46	0.29

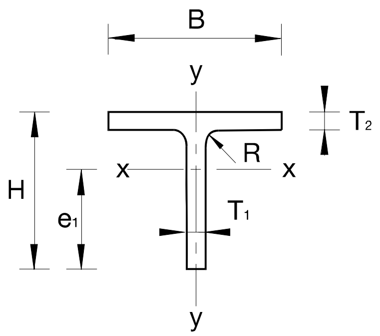
Three spans



	L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	3.50
Breaking point																		
	x/y direction	21.40	19.45	17.83	16.46	15.28	14.26	13.37	12.59	11.89	11.26	10.70	9.73	8.62	7.34	6.33	5.52	4.05
Application limit point																		
ε_{max} < L / 200	x/y direction	16.15	12.57	9.96	8.01	6.53	5.39	4.49	3.79	3.22	2.76	2.38	1.81	1.40	1.11	0.89	0.73	0.46
ε_{max} < L / 300	x/y direction	10.77	8.38	6.64	5.34	4.35	3.59	3.00	2.52	2.14	1.84	1.59	1.20	0.93	0.74	0.60	0.49	0.31
ε_{max} < L / 400	x/y direction	8.07	6.29	4.98	4.00	3.26	2.69	2.25	1.89	1.61	1.38	1.19	0.90	0.70	0.55	0.45	0.36	0.23

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.70	51.0
0.80	43.0
0.90	36.5
1.00	31.2
1.10	26.9
1.20	23.4
1.30	20.5
1.40	18.0
1.50	16.0
1.60	14.3
1.70	12.8
1.80	11.6
1.90	10.5
2.00	9.5
2.10	8.7
2.20	8.0
2.30	7.3
2.40	6.8
2.50	6.3
2.60	5.8
2.70	5.4
2.80	5.0
2.90	4.7
3.00	4.4
3.50	3.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	48.2
0.60	37.7
0.70	30.0
0.80	24.3
0.90	20.0
1.00	16.7
1.10	14.1
1.20	12.0
1.30	10.4
1.40	9.1
1.50	8.0
1.60	7.1
1.70	6.3
1.80	5.6
1.90	5.1
2.00	4.6
2.10	4.2
2.20	3.8
2.30	3.5
2.40	3.2
2.50	3.0
2.60	2.8
2.70	2.6
2.80	2.4
3.00	2.1



Geometry	
H	60 mm
B	60 mm
T_1	6 mm
T_2	6 mm
R	7 mm

Cross-section constants	
A	705 mm^2
I_{xx}	235 221 mm^4
W_{xx}	5 460 mm^3
$A_{k,y}$	342 mm^2
e_1	43 mm^2
I_{yy}	109 446 mm^4
W_{yy}	3 648 mm^3
$A_{k,x}$	288 mm^2

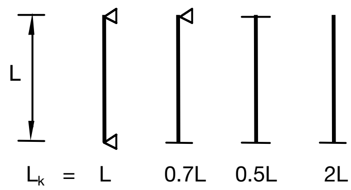
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

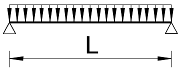
Design value for load-bearing capacity
130.2 kN

Dead weight
1.27 kg/m

Buckling length

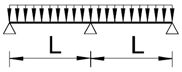


One span



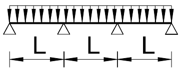
	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20
Breaking point																		
	x direction	8.06	5.60	4.11	3.15	2.49	2.02	1.67	1.40	1.19	1.03	0.90	0.79	0.70	0.62	0.56	0.50	0.46
	y direction	5.39	3.74	2.75	2.10	1.66	1.35	1.11	0.94	0.80	0.69	0.60	0.53	0.47	0.42	0.37	0.34	0.31
Application limit point																		
δ_{max} < L / 200	x direction	1.98	1.16	0.74	0.50	0.35	0.26	0.19	0.15	0.12	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.03
	y direction	0.94	0.55	0.35	0.23	0.16	0.12	0.09	0.07	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.01
δ_{max} < L / 300	x direction	1.32	0.77	0.49	0.33	0.23	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
	y direction	0.63	0.37	0.23	0.16	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
δ_{max} < L / 400	x direction	0.99	0.58	0.37	0.25	0.18	0.13	0.10	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01
	y direction	0.47	0.28	0.17	0.12	0.08	0.06	0.05	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01

Two spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20
Breaking point																		
	x direction	8.06	5.60	4.11	3.15	2.49	2.02	1.67	1.40	1.19	1.03	0.90	0.79	0.70	0.62	0.56	0.50	0.46
	y direction	5.39	3.74	2.75	2.10	1.66	1.35	1.11	0.94	0.80	0.69	0.60	0.53	0.47	0.42	0.37	0.34	0.31
Application limit point																		
δ_{max} < L / 200	x direction	4.45	2.66	1.71	1.16	0.82	0.61	0.46	0.35	0.28	0.22	0.18	0.15	0.13	0.11	0.09	0.08	0.07
	y direction	2.18	1.28	0.82	0.55	0.39	0.29	0.22	0.17	0.13	0.10	0.09	0.07	0.06	0.05	0.04	0.04	0.03
δ_{max} < L / 300	x direction	2.97	1.78	1.14	0.78	0.55	0.40	0.30	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04
	y direction	1.45	0.86	0.55	0.37	0.26	0.19	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02
δ_{max} < L / 400	x direction	2.22	1.33	0.86	0.58	0.41	0.30	0.23	0.18	0.14	0.11	0.09	0.08	0.06	0.05	0.05	0.04	0.03
	y direction	1.09	0.64	0.41	0.28	0.20	0.14	0.11	0.08	0.07	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.02

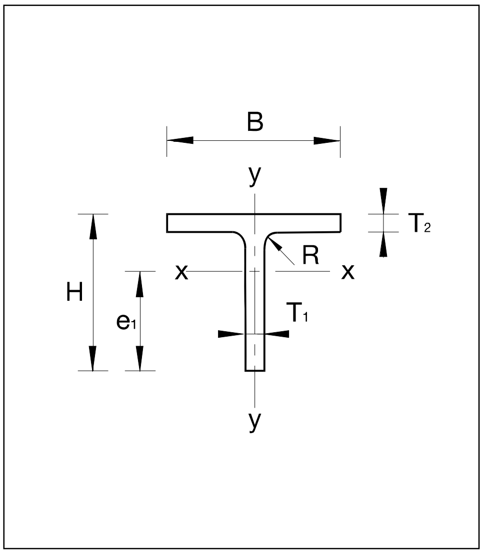
Three spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20
Breaking point																		
	x direction	10.08	7.00	5.14	3.94	3.11	2.52	2.08	1.75	1.49	1.29	1.12	0.98	0.87	0.78	0.70	0.63	0.57
	y direction	6.74	4.68	3.44	2.63	2.08	1.68	1.39	1.17	1.00	0.86	0.75	0.66	0.58	0.52	0.47	0.42	0.38
Application limit point																		
δ_{max} < L / 200	x direction	3.59	2.13	1.37	0.93	0.65	0.48	0.36	0.28	0.22	0.18	0.14	0.12	0.10	0.08	0.07	0.06	0.05
	y direction	1.74	1.02	0.65	0.44	0.31	0.23	0.17	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02
δ_{max} < L / 300	x direction	2.39	1.42	0.91	0.62	0.44	0.32	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04
	y direction	1.16	0.68	0.43	0.29	0.21	0.15	0.11	0.09	0.07	0.06	0.04	0.04	0.03	0.03	0.02	0.02	0.02
δ_{max} < L / 400	x direction	1.79	1.07	0.68	0.46	0.33	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03
	y direction	0.87	0.51	0.32	0.22	0.15	0.11	0.08	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	128.2
1.10	114.4
1.20	102.4
1.30	91.9
1.40	82.8
1.50	74.8
1.60	67.8
1.70	61.6
1.80	56.2
1.90	51.4
2.00	47.2
2.10	43.5
2.20	40.1
2.30	37.1
2.40	34.4
2.50	32.0
2.60	29.9
2.70	27.9
2.80	26.1
2.90	24.5
3.00	23.0
3.10	21.6
3.20	20.4
3.30	19.3
3.50	17.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	128.2
0.60	102.4
0.70	82.8
0.80	67.8
0.90	56.2
1.00	47.2
1.10	40.1
1.20	34.4
1.30	29.9
1.40	26.1
1.50	23.0
1.60	20.4
1.70	18.2
1.80	16.4
1.90	14.8
2.00	13.4
2.10	12.2
2.20	11.1
2.30	10.2
2.40	9.4
2.50	8.7
2.60	8.1
2.70	7.5
2.80	7.0
3.00	6.1



Geometry	
H	90 mm
B	72 mm
T_1	11 mm
T_2	10 mm
R	7 mm

Cross-section constants	
A	1 621 mm^2
I_{xx}	1 284 135 mm^4
W_{xx}	21 230 mm^3
$A_{k,y}$	941 mm^2
e_1	60,5 mm^2
I_{yy}	320 999 mm^4
W_{yy}	8 917 mm^3
$A_{k,x}$	576 mm^2

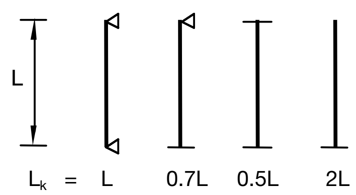
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

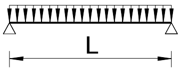
Design value for load-bearing capacity
299.3 kN

Dead weight
2.92 kg/m

Buckling length

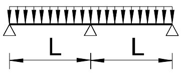


One span



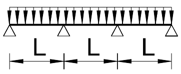
	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20
Breaking point																		
	x direction	31.36	21.77	16.00	12.25	9.68	7.84	6.48	5.44	4.64	4.00	3.48	3.06	2.71	2.42	2.17	1.96	1.78
	y direction	13.17	9.15	6.72	5.14	4.06	3.29	2.72	2.29	1.95	1.68	1.46	1.29	1.14	1.02	0.91	0.82	0.75
Application limit point																		
δ_{max} < L / 200	x direction	10.31	6.14	3.93	2.66	1.89	1.38	1.04	0.81	0.64	0.51	0.42	0.34	0.29	0.24	0.21	0.18	0.15
	y direction	2.72	1.60	1.01	0.68	0.48	0.35	0.26	0.20	0.16	0.13	0.10	0.09	0.07	0.06	0.05	0.04	0.04
δ_{max} < L / 300	x direction	6.87	4.09	2.62	1.78	1.26	0.92	0.70	0.54	0.42	0.34	0.28	0.23	0.19	0.16	0.14	0.12	0.10
	y direction	1.82	1.07	0.68	0.46	0.32	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03
δ_{max} < L / 400	x direction	5.15	3.07	1.97	1.33	0.94	0.69	0.52	0.40	0.32	0.26	0.21	0.17	0.14	0.12	0.10	0.09	0.08
	y direction	1.36	0.80	0.51	0.34	0.24	0.18	0.13	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02

Two spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20
Breaking point																		
	x direction	28.94	21.77	16.00	12.25	9.68	7.84	6.48	5.44	4.64	4.00	3.48	3.06	2.71	2.42	2.17	1.96	1.78
	y direction	13.17	9.15	6.72	5.14	4.06	3.29	2.72	2.29	1.95	1.68	1.46	1.29	1.14	1.02	0.91	0.82	0.75
Application limit point																		
δ_{max} < L / 200	x direction	21.95	13.50	8.84	6.08	4.35	3.21	2.44	1.89	1.50	1.20	0.98	0.81	0.68	0.57	0.49	0.42	0.36
	y direction	6.20	3.69	2.36	1.60	1.13	0.83	0.63	0.48	0.38	0.31	0.25	0.21	0.17	0.14	0.12	0.11	0.09
δ_{max} < L / 300	x direction	14.63	9.00	5.89	4.05	2.90	2.14	1.62	1.26	1.00	0.80	0.66	0.54	0.45	0.38	0.33	0.28	0.24
	y direction	4.13	2.46	1.58	1.07	0.76	0.55	0.42	0.32	0.25	0.20	0.17	0.14	0.11	0.10	0.08	0.07	0.06
δ_{max} < L / 400	x direction	10.97	6.75	4.42	3.04	2.17	1.61	1.22	0.95	0.75	0.60	0.49	0.41	0.34	0.29	0.24	0.21	0.18
	y direction	3.10	1.84	1.18	0.80	0.57	0.42	0.31	0.24	0.19	0.15	0.12	0.10	0.09	0.07	0.06	0.05	0.05

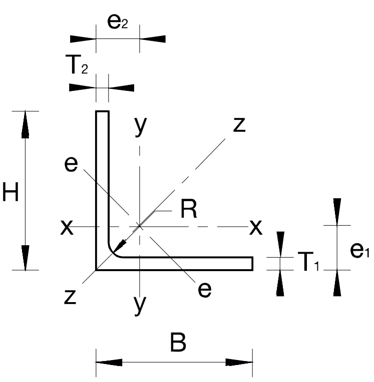
Three spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20
Breaking point																		
	x direction	30.14	25.12	20.00	15.31	12.10	9.80	8.10	6.80	5.80	5.00	4.35	3.83	3.39	3.02	2.71	2.45	2.22
	y direction	16.46	11.43	8.40	6.43	5.08	4.12	3.40	2.86	2.44	2.10	1.83	1.61	1.42	1.27	1.14	1.03	0.93
Application limit point																		
δ_{max} < L / 200	x direction	18.03	10.97	7.13	4.88	3.48	2.56	1.94	1.50	1.19	0.95	0.78	0.64	0.54	0.45	0.39	0.33	0.29
	y direction	4.98	2.95	1.88	1.27	0.90	0.66	0.50	0.38	0.30	0.24	0.20	0.16	0.14	0.11	0.10	0.08	0.07
δ_{max} < L / 300	x direction	12.02	7.31	4.75	3.25	2.32	1.71	1.29	1.00	0.79	0.64	0.52	0.43	0.36	0.30	0.26	0.22	0.19
	y direction	3.32	1.96	1.25	0.85	0.60	0.44	0.33	0.26	0.20	0.16	0.13	0.11	0.09	0.08	0.06	0.06	0.05
δ_{max} < L / 400	x direction	9.02	5.49	3.57	2.44	1.74	1.28	0.97	0.75	0.59	0.48	0.39	0.32	0.27	0.23	0.19	0.17	0.14
	y direction	2.49	1.47	0.94	0.64	0.45	0.33	0.25	0.19	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	49.3
0.75	29.5
1.00	18.9
1.25	12.9
1.50	9.3
1.75	7.0
2.00	5.5
2.25	4.4
2.50	3.6
3.00	2.5

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	49.3
0.75	29.5
1.00	18.9
1.25	12.9
1.50	9.3
1.75	7.0
2.00	5.5
2.25	4.4
2.50	3.6
3.00	2.5



Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	61.2
0.75	40.0
1.00	27.0
1.25	19.0
1.50	13.9
1.75	10.6
2.00	8.3
2.25	6.7
2.50	5.5
3.00	3.9

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.20	74.2
0.40	39.1
0.60	21.8
0.80	13.5
1.00	9.0
1.20	6.4
1.40	4.8
1.60	3.7
1.80	3.0
2.00	2.4

Geometry	
H	50 mm
B	50 mm
T_1	6 mm
T_2	6 mm
R	7 mm
e_1	14.6 mm
e_2	14.6 mm
v	-45.0 °

Cross-section constants	
A	575 mm^2
I_{xx}	131 802 mm^4
W_{xx}	3 720 mm^3
$A_{k,y}$	270 mm^2
I_{yy}	131 802 mm^4
W_{yy}	3 720 mm^3
$A_{k,x}$	270 mm^2
I_{zz}	206 972 mm^4
I_{ee}	56 632 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

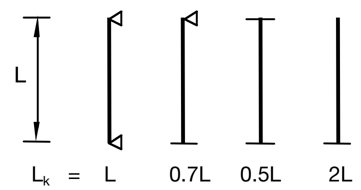
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
106.1 kN

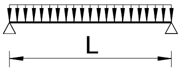
Max. compressive load-bearing capacity with unbraced flanges
62.9 kN

Dead weight
1.03 kg/m

Buckling length

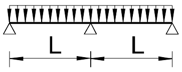


One span



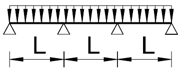
L (m) =	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	2.00
Breaking point																	
Design value for load-bearing capacity	34.62	25.96	20.77	15.26	11.21	8.59	6.78	5.49	4.54	3.82	3.25	2.80	2.44	2.15	1.90	1.70	1.37
Application limit point																	
δ_{max} < L / 200	30.81	14.85	8.14	4.90	3.16	2.15	1.53	1.12	0.85	0.66	0.52	0.42	0.34	0.28	0.23	0.20	0.14
δ_{max} < L / 300	20.54	9.90	5.43	3.27	2.11	1.44	1.02	0.75	0.57	0.44	0.35	0.28	0.23	0.19	0.16	0.13	0.10
δ_{max} < L / 400	15.41	7.43	4.07	2.45	1.58	1.08	0.76	0.56	0.42	0.33	0.26	0.21	0.17	0.14	0.12	0.10	0.07

Two spans



L (m) =	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	2.00
Breaking point																	
Design value for load-bearing capacity	27.69	20.77	16.62	13.85	11.21	8.59	6.78	5.49	4.54	3.82	3.25	2.80	2.44	2.15	1.90	1.70	1.37
Application limit point																	
δ_{max} < L / 200	52.87	28.38	16.63	10.44	6.93	4.81	3.47	2.57	1.96	1.53	1.21	0.98	0.80	0.66	0.55	0.47	0.34
δ_{max} < L / 300	35.25	18.92	11.09	6.96	4.62	3.21	2.31	1.72	1.31	1.02	0.81	0.65	0.53	0.44	0.37	0.31	0.23
δ_{max} < L / 400	26.44	14.19	8.32	5.22	3.47	2.41	1.73	1.29	0.98	0.76	0.61	0.49	0.40	0.33	0.28	0.23	0.17

Three spans



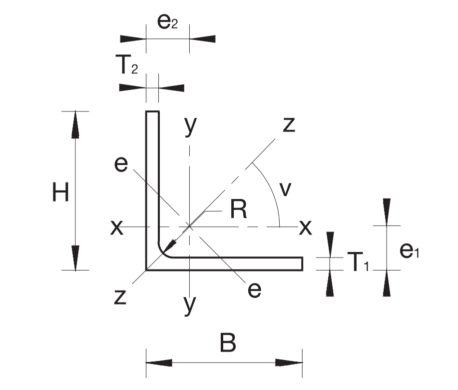
L (m) =	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	2.00
Breaking point																	
Design value for load-bearing capacity	28.85	21.63	17.31	14.42	12.36	10.73	8.48	6.87	5.68	4.77	4.06	3.50	3.05	2.68	2.38	2.12	1.72
Application limit point																	
δ_{max} < L / 200	46.48	24.16	13.86	8.58	5.64	3.89	2.79	2.06	1.57	1.22	0.96	0.78	0.63	0.52	0.44	0.37	0.27
δ_{max} < L / 300	30.99	16.10	9.24	5.72	3.76	2.59	1.86	1.38	1.04	0.81	0.64	0.52	0.42	0.35	0.29	0.25	0.18
δ_{max} < L / 400	23.24	12.08	6.93	4.29	2.82	1.94	1.39	1.03	0.78	0.61	0.48	0.39	0.32	0.26	0.22	0.18	0.14

Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	63.0
0.75	37.5
1.00	24.0
1.25	16.4
1.50	11.8
1.75	8.9
2.00	6.9
2.25	5.5
2.50	4.5
3.00	3.1

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	63.0
0.75	37.5
1.00	24.0
1.25	16.4
1.50	11.8
1.75	8.9
2.00	6.9
2.25	5.5
2.50	4.5
3.00	3.1

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	78.5
0.75	51.0
1.00	34.2
1.25	24.1
1.50	17.6
1.75	13.4
2.00	10.5
2.25	8.4
2.50	6.9
3.00	4.9

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.20	95.5
0.40	49.7
0.60	27.6
0.80	17.0
1.00	11.4
1.20	8.1
1.40	6.1
1.60	4.7
1.80	3.7
2.00	3.0



Geometry	
H	50 mm
B	50 mm
T_1	8 mm
T_2	8 mm
R	7 mm
e_1	15.3 mm
e_2	15.3 mm
v	-45.0 °

Cross-section constants	
A	747 mm^2
I_{xx}	166 029 mm^4
W_{xx}	4 789 mm^3
$A_{k,y}$	360 mm^2
I_{yy}	166 029 mm^4
W_{yy}	4 789 mm^3
$A_{k,x}$	360 mm^2
I_{zz}	260 755 mm^4
I_{ee}	71 303 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

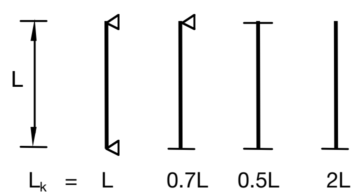
Partial coefficients	
$\lambda_{m,E}$	1.3
$\lambda_{m,f}$	1.3

Design value for load-bearing capacity
137.8 kN

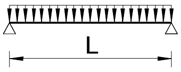
Max. compressive load-bearing capacity with unbraced flanges
145.4 kN

Dead weight
1.34 kg/m

Buckling length

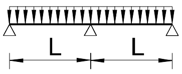


One span

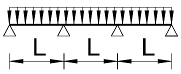


L (m) =	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	2.00
Breaking point																	
Design value for load-bearing capacity	46.15	34.62	27.69	19.65	14.43	11.05	8.73	7.07	5.85	4.91	4.19	3.61	3.14	2.76	2.45	2.18	1.77
Application limit point																	
δ_{max} < L / 200	39.44	18.90	10.33	6.20	4.00	2.72	1.93	1.42	1.07	0.83	0.65	0.53	0.43	0.35	0.30	0.25	0.18
δ_{max} < L / 300	26.29	12.60	6.89	4.14	2.67	1.81	1.29	0.95	0.71	0.55	0.44	0.35	0.29	0.24	0.20	0.17	0.12
δ_{max} < L / 400	19.72	9.45	5.16	3.10	2.00	1.36	0.97	0.71	0.54	0.41	0.33	0.26	0.21	0.18	0.15	0.12	0.09

Two spans



L (m) =	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	2.00
Breaking point																	
Design value for load-bearing capacity	36.92	27.69	22.15	18.46	14.43	11.05	8.73	7.07	5.85	4.91	4.19	3.61	3.14	2.76	2.45	2.18	1.77
Application limit point																	
δ_{max} < L / 200	68.45	36.46	21.25	13.30	8.81	6.10	4.39	3.26	2.48	1.93	1.53	1.23	1.01	0.83	0.70	0.59	0.43
δ_{max} < L / 300	45.63	24.31	14.17	8.86	5.87	4.07	2.93	2.17	1.65	1.29	1.02	0.82	0.67	0.56	0.46	0.39	0.29
δ_{max} < L / 400	34.23	18.23	10.63	6.65	4.40	3.05	2.20	1.63	1.24	0.96	0.76	0.62	0.50	0.42	0.35	0.29	0.22

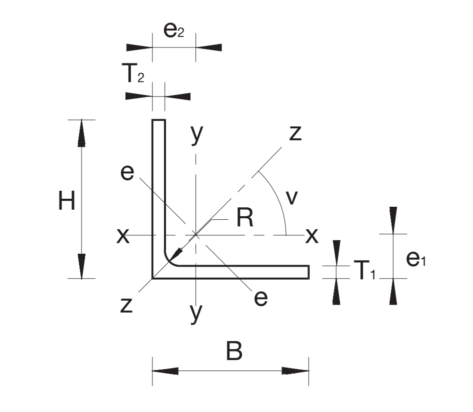


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	29.8
1.75	23.0
2.00	18.2
2.25	14.8
2.50	12.2
2.75	10.2
3.00	8.6
3.50	6.4
4.00	5.0
4.50	4.0

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	29.8
1.75	23.0
2.00	18.2
2.25	14.8
2.50	12.2
2.75	10.2
3.00	8.6
3.50	6.4
4.00	5.0
4.50	4.0

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	42.3
1.75	33.4
2.00	26.9
2.50	18.3
3.00	13.2
3.50	9.9
4.00	7.7
4.50	6.1
5.00	5.0
5.50	4.2

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	75.4
0.80	41.2
1.00	29.0
1.20	21.3
1.40	16.2
1.60	12.7
1.80	10.2
2.00	8.4
2.50	5.5
3.00	3.8



Geometry	
H	75 mm
B	75 mm
T_1	6 mm
T_2	6 mm
R	7 mm
e_1	20.8 mm
e_2	20.8 mm
v	-45.0 °

Cross-section constants	
A	875 mm^2
I_{xx}	470 712 mm^4
W_{xx}	8 686 mm^3
$A_{k,y}$	405 mm^2
I_{yy}	470 712 mm^4
W_{yy}	8 686 mm^3
$A_{k,x}$	405 mm^2
I_{zz}	738 918 mm^4
I_{ee}	202 506 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

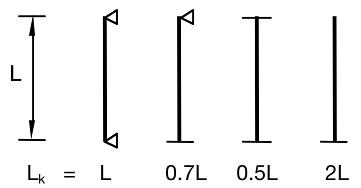
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
161.4 kN

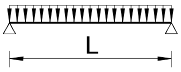
Max. compressive load-bearing capacity with unbraced flanges
42.6 kN

Dead weight
1.57 kg/m

Buckling length

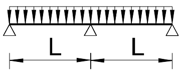


One span

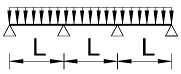


L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.50
Breaking point																	
Design value for load-bearing capacity	31.15	25.96	22.25	19.47	15.84	12.83	10.60	8.91	7.59	6.55	5.70	5.01	4.44	3.96	3.55	3.21	2.05
Application limit point																	
$\delta_{max} < L / 200$	24.78	15.55	10.32	7.16	5.16	3.83	2.92	2.27	1.80	1.45	1.19	0.98	0.82	0.69	0.59	0.51	0.26
$\delta_{max} < L / 300$	16.52	10.37	6.88	4.77	3.44	2.55	1.94	1.51	1.20	0.97	0.79	0.65	0.55	0.46	0.39	0.34	0.17
$\delta_{max} < L / 400$	12.39	7.78	5.16	3.58	2.58	1.91	1.46	1.14	0.90	0.73	0.59	0.49	0.41	0.35	0.30	0.25	0.13

Two spans



L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.50
Breaking point																	
Design value for load-bearing capacity	24.92	20.77	17.80	15.58	13.85	12.46	10.60	8.91	7.59	6.55	5.70	5.01	4.44	3.96	3.55	3.21	2.05
Application limit point																	
$\delta_{max} < L / 200$	43.85	29.44	20.51	14.77	10.93	8.28	6.41	5.06	4.05	3.29	2.71	2.26	1.90	1.61	1.38	1.19	0.62
$\delta_{max} < L / 300$	29.23	19.62	13.68	9.84	7.29	5.52	4.28	3.37	2.70	2.20	1.81	1.50	1.27	1.07	0.92	0.79	0.41
$\delta_{max} < L / 400$	21.93	14.72	10.26	7.38	5.46	4.14	3.21	2.53	2.03	1.65	1.36	1.13	0.95	0.81	0.69	0.59	0.31

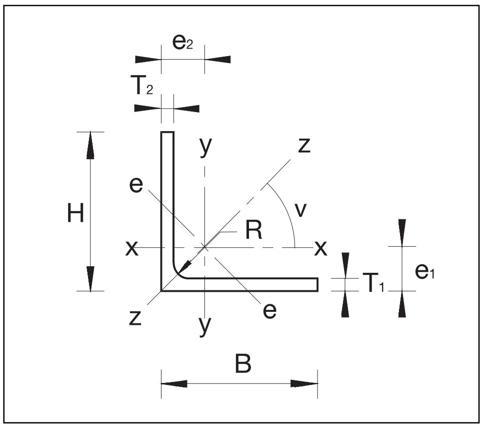


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	38.3
1.75	29.6
2.00	23.4
2.25	18.9
2.50	15.6
2.75	13.1
3.00	11.1
3.50	8.3
4.00	6.4
4.50	5.1

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	38.3
1.75	29.6
2.00	23.4
2.25	18.9
2.50	15.6
2.75	13.1
3.00	11.1
3.50	8.3
4.00	6.4
4.50	5.1

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	54.7
1.75	43.1
2.00	34.7
2.50	23.6
3.00	17.0
3.50	12.7
4.00	9.9
4.50	7.9
5.00	6.4
5.50	5.3

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	97.0
0.80	52.6
1.00	36.9
1.20	27.1
1.40	20.6
1.60	16.1
1.80	13.0
2.00	10.6
2.50	6.9
3.00	4.9



Geometry	
H	75 mm
B	75 mm
T_1	8 mm
T_2	8 mm
R	7 mm
e_1	21.6 mm
e_2	21.6 mm
v	-45.0 °

Cross-section constants	
A	1 147 mm^2
I_{xx}	603 367 mm^4
W_{xx}	11 295 mm^3
$A_{k,y}$	540 mm^2
I_{yy}	603 367 mm^4
W_{yy}	11 295 mm^3
$A_{k,x}$	540 mm^2
I_{zz}	950 502 mm^4
I_{ee}	256 232 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

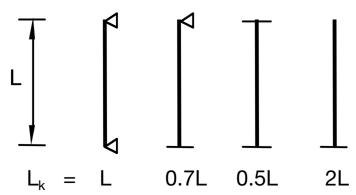
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
211.7 kN

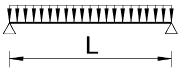
Max. compressive load-bearing capacity with unbraced flanges
99.2 kN

Dead weight
2.06 kg/m

Buckling length

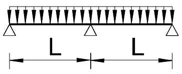


One span

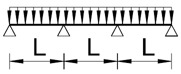


L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.50
Breaking point																	
Design value for load-bearing capacity	41.54	34.62	29.67	25.96	20.60	16.68	13.79	11.58	9.87	8.51	7.41	6.52	5.77	5.15	4.62	4.17	2.67
Application limit point																	
δ_{max} < L / 200	32.08	20.08	13.30	9.22	6.64	4.92	3.75	2.92	2.31	1.86	1.52	1.26	1.05	0.89	0.76	0.65	0.34
δ_{max} < L / 300	21.39	13.39	8.87	6.15	4.42	3.28	2.50	1.94	1.54	1.24	1.02	0.84	0.70	0.59	0.51	0.44	0.22
δ_{max} < L / 400	16.04	10.04	6.65	4.61	3.32	2.46	1.87	1.46	1.16	0.93	0.76	0.63	0.53	0.45	0.38	0.33	0.17

Two spans



L (m) =	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.50
Breaking point																	
Design value for load-bearing capacity	33.23	27.69	23.74	20.77	18.46	16.62	13.79	11.58	9.87	8.51	7.41	6.52	5.77	5.15	4.62	4.17	2.67
Application limit point																	
δ_{max} < L / 200	57.21	38.27	26.60	19.11	14.12	10.69	8.27	6.51	5.22	4.24	3.49	2.90	2.44	2.07	1.77	1.52	0.79
δ_{max} < L / 300	38.14	25.51	17.73	12.74	9.41	7.13	5.51	4.34	3.48	2.83	2.32	1.93	1.63	1.38	1.18	1.02	0.53
δ_{max} < L / 400	28.60	19.13	13.30	9.55	7.06	5.35	4.13	3.26	2.61	2.12	1.74	1.45	1.22	1.03	0.88	0.76	0.40

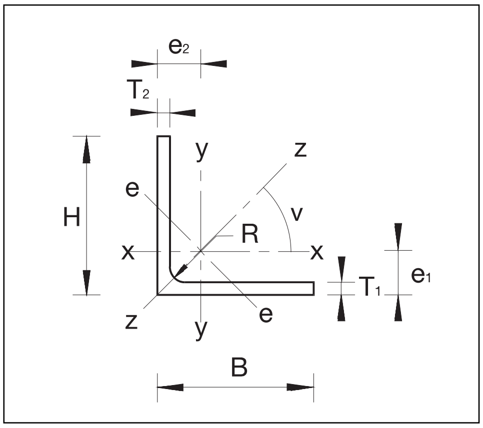


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	45.8
1.75	35.5
2.00	28.2
2.25	22.9
2.50	18.9
2.75	15.9
3.00	13.5
3.50	10.1
4.00	7.8
4.50	6.2

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	45.8
1.75	35.5
2.00	28.2
2.25	22.9
2.50	18.9
2.75	15.9
3.00	13.5
3.50	10.1
4.00	7.8
4.50	6.2

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	64.6
1.75	51.4
2.00	41.5
2.50	28.5
3.00	20.6
3.50	15.5
4.00	12.0
4.50	9.6
5.00	7.9
5.50	6.5

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	111.3
0.80	62.1
1.00	44.1
1.20	32.5
1.40	24.9
1.60	19.5
1.80	15.7
2.00	12.9
2.50	8.4
3.00	5.9



Geometry	
H	80 mm
B	80 mm
T_1	8 mm
T_2	8 mm
R	7 mm
e_1	22.8 mm
e_2	22.8 mm
v	-45.0 °

Cross-section constants	
A	1 227 mm^2
I_{xx}	739 184 mm^4
W_{xx}	12 930 mm^3
$A_{k,y}$	576 mm^2
I_{yy}	739 184 mm^4
W_{yy}	12 930 mm^3
$A_{k,x}$	576 mm^2
I_{zz}	1 164 930 mm^4
I_{ee}	313 437 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

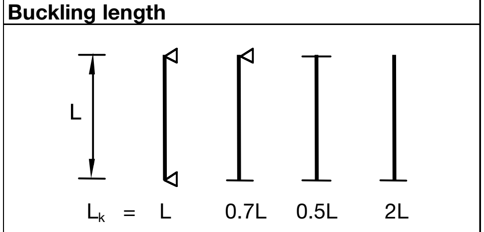
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
226.4 kN

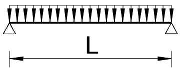
Max. compressive load-bearing capacity with unbraced flanges
93.3 kN

Dead weight
2.21 kg/m

Buckling length

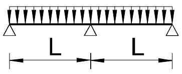


One span

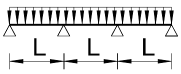


L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	19.10	15.78	13.26	11.30	9.74	8.49	7.46	6.61	5.89	5.29	4.77	3.95	3.32	2.82	2.44	2.12	1.19
Application limit point																	
$\delta_{max} < L / 200$	5.97	4.55	3.55	2.81	2.27	1.86	1.54	1.29	1.09	0.93	0.80	0.60	0.46	0.37	0.29	0.24	0.10
$\delta_{max} < L / 300$	3.98	3.03	2.36	1.88	1.51	1.24	1.02	0.86	0.73	0.62	0.53	0.40	0.31	0.24	0.20	0.16	0.07
$\delta_{max} < L / 400$	2.98	2.27	1.77	1.41	1.13	0.93	0.77	0.64	0.54	0.46	0.40	0.30	0.23	0.18	0.15	0.12	0.05

Two spans



L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	17.72	15.78	13.26	11.30	9.74	8.49	7.46	6.61	5.89	5.29	4.77	3.95	3.32	2.82	2.44	2.12	1.19
Application limit point																	
$\delta_{max} < L / 200$	12.78	9.92	7.84	6.29	5.12	4.22	3.52	2.96	2.51	2.15	1.86	1.41	1.09	0.86	0.69	0.57	0.24
$\delta_{max} < L / 300$	8.52	6.62	5.23	4.20	3.42	2.81	2.34	1.97	1.68	1.43	1.24	0.94	0.73	0.58	0.46	0.38	0.16
$\delta_{max} < L / 400$	6.39	4.96	3.92	3.15	2.56	2.11	1.76	1.48	1.26	1.08	0.93	0.70	0.55	0.43	0.35	0.28	0.12

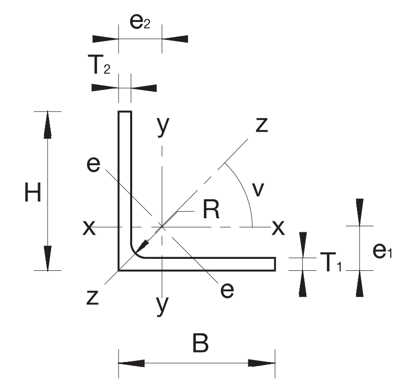


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk i m	Load-bearing capacity in kN
1.50	82.1
1.75	65.3
2.00	52.8
2.25	43.4
2.50	36.2
2.75	30.6
3.00	26.2
3.50	19.7
4.00	15.3
4.50	12.3

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	82.1
1.75	65.3
2.00	52.8
2.25	43.4
2.50	36.2
2.75	30.6
3.00	26.2
3.50	19.7
4.00	15.3
4.50	12.3

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	111.1
1.75	91.0
2.00	75.3
2.50	53.3
3.00	39.2
3.50	29.9
4.00	23.5
4.50	18.9
5.00	15.5
5.50	12.9

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	172.8
0.80	106.9
1.00	79.1
1.20	60.0
1.40	46.7
1.60	37.2
1.80	30.2
2.00	25.0
2.50	16.5
3.00	11.7



Geometry	
H	100 mm
B	100 mm
T_1	8 mm
T_2	8 mm
R	7 mm
e_1	27.8 mm
e_2	27.8 Mm
v	-45.0 °

Cross-section constants	
A	1 547 mm^2
I_{xx}	1 485 277 mm^4
W_{xx}	20 581 mm^3
$A_{k,y}$	720 mm^2
I_{yy}	1 485 277 mm^4
W_{yy}	20 581 mm^3
$A_{k,x}$	720 mm^2
I_{zz}	2 344 236 mm^4
I_{ee}	626 319 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

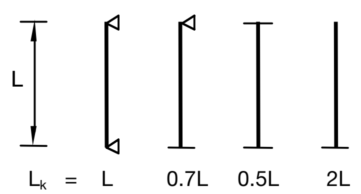
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
285.5 kN

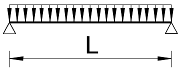
Max. compressive load-bearing capacity with unbraced flanges
75.3 kN

Dead weight
2.78 kg/m

Buckling length

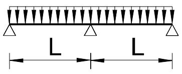


One span

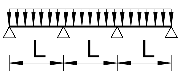


L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	27.69	25.12	21.11	17.99	15.51	13.51	11.87	10.52	9.38	8.42	7.60	6.28	5.28	4.50	3.88	3.38	1.90
Application limit point																	
δ_{max} < L / 200	11.39	8.76	6.87	5.48	4.44	3.64	3.02	2.54	2.15	1.84	1.58	1.19	0.92	0.73	0.59	0.48	0.20
δ_{max} < L / 300	7.59	5.84	4.58	3.65	2.96	2.43	2.02	1.69	1.43	1.22	1.05	0.80	0.62	0.49	0.39	0.32	0.14
δ_{max} < L / 400	5.69	4.38	3.43	2.74	2.22	1.82	1.51	1.27	1.07	0.92	0.79	0.60	0.46	0.36	0.29	0.24	0.10

Two spans



L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	22.15	20.14	18.46	17.04	15.51	13.51	11.87	10.52	9.38	8.42	7.60	6.28	5.28	4.50	3.88	3.38	1.90
Application limit point																	
δ_{max} < L / 200	23.09	18.19	14.55	11.80	9.68	8.03	6.73	5.70	4.86	4.17	3.61	2.75	2.14	1.70	1.37	1.12	0.48
δ_{max} < L / 300	15.39	12.13	9.70	7.87	6.46	5.36	4.49	3.80	3.24	2.78	2.41	1.83	1.43	1.13	0.91	0.75	0.32
δ_{max} < L / 400	11.55	9.10	7.28	5.90	4.84	4.02	3.37	2.85	2.43	2.09	1.81	1.38	1.07	0.85	0.69	0.56	0.24

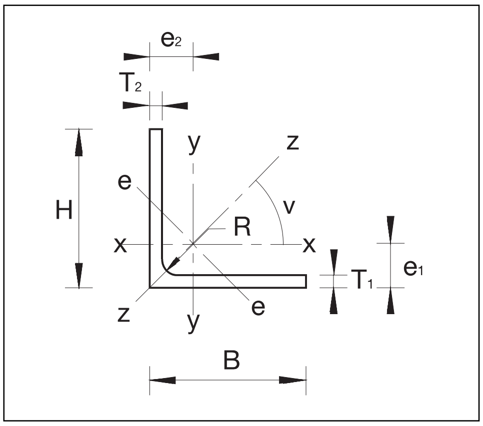


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	100.2
1.75	79.6
2.00	64.4
2.25	52.9
2.50	44.1
2.75	37.2
3.00	31.8
3.50	24.0
4.00	18.6
4.50	14.9

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	100.2
1.75	79.6
2.00	64.4
2.25	52.9
2.50	44.1
2.75	37.2
3.00	31.8
3.50	24.0
4.00	18.6
4.50	14.9

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	135.9
1.75	111.2
2.00	92.0
2.50	65.0
3.00	47.8
3.50	36.4
4.00	28.6
4.50	23.0
5.00	18.8
5.50	15.7

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	211.5
0.80	130.2
1.00	96.1
1.20	72.8
1.40	56.6
1.60	45.0
1.80	36.6
2.00	30.2
2.50	19.9
3.00	14.1



Geometry	
H	100 mm
B	100 mm
T_1	10 mm
T_2	10 mm
R	7 mm
e_1	28.6 mm
e_2	28.6 mm
v	-45.0 °

Cross-section constants	
A	1 911 mm^2
I_{xx}	1 803 127 mm^4
W_{xx}	25 250 mm^3
$A_{k,y}$	900 mm^2
I_{yy}	1 803 127 mm^4
W_{yy}	25 250 mm^3
$A_{k,x}$	900 mm^2
I_{zz}	2 849 583 mm^4
I_{ee}	756 672 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

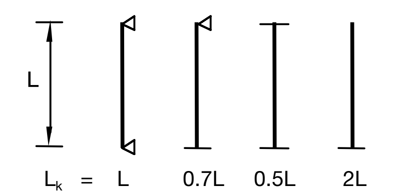
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
352.7 kN

Max. compressive load-bearing capacity with unbraced flanges
145.3 kN

Dead weight
3.44 kg/m

Buckling length



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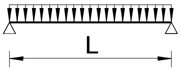
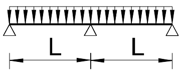
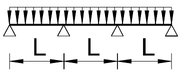


L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	34.62	30.82	25.90	22.07	19.03	16.57	14.57	12.90	11.51	10.33	9.32	7.71	6.47	5.52	4.76	4.14	2.33
Application limit point																	
δ_{max} < L / 200	13.88	10.67	8.36	6.67	5.40	4.43	3.68	3.08	2.61	2.23	1.92	1.45	1.12	0.89	0.71	0.58	0.25
δ_{max} < L / 300	9.25	7.11	5.57	4.44	3.60	2.95	2.45	2.06	1.74	1.49	1.28	0.97	0.75	0.59	0.47	0.39	0.16
δ_{max} < L / 400	6.94	5.33	4.18	3.33	2.70	2.21	1.84	1.54	1.31	1.12	0.96	0.73	0.56	0.44	0.36	0.29	0.12

Two spans



L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	27.69	25.17	23.08	21.30	19.03	16.57	14.57	12.90	11.51	10.33	9.32	7.71	6.47	5.52	4.76	4.14	2.33
Application limit point																	
δ_{max} < L / 200	28.25	22.23	17.77	14.40	11.81	9.79	8.21	6.94	5.91	5.08	4.39	3.35	2.61	2.07	1.67	1.36	0.58
δ_{max} < L / 300	18.83	14.82	11.85	9.60	7.87	6.53	5.47	4.62	3.94	3.39	2.93	2.23	1.74	1.38	1.11	0.91	0.39
δ_{max} < L / 400	14.13	11.12	8.88	7.20	5.90	4.90	4.10	3.47	2.96	2.54	2.20	1.67	1.30	1.03	0.83	0.68	0.29

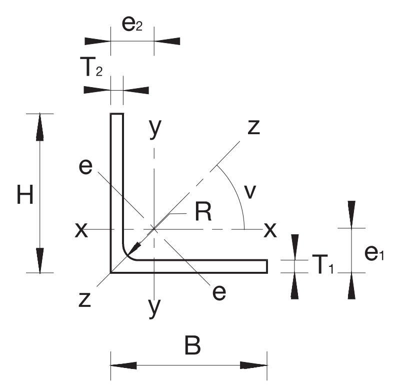


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	117.4
1.75	93.2
2.00	75.3
2.25	61.8
2.50	51.5
2.75	43.5
3.00	37.2
3.50	28.0
4.00	21.8
4.50	17.4

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	117.4
1.75	93.2
2.00	75.3
2.25	61.8
2.50	51.5
2.75	43.5
3.00	37.2
3.50	28.0
4.00	21.8
4.50	17.4

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.50	159.5
1.75	130.4
2.00	107.7
2.50	76.0
3.00	55.9
3.50	42.5
4.00	33.4
4.50	26.8
5.00	22.0
5.50	18.3

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	249.3
0.80	152.9
1.00	112.7
1.20	85.3
1.40	66.2
1.60	52.7
1.80	42.7
2.00	35.3
2.50	23.3
3.00	16.5



Geometry	
H	100 mm
B	100 mm
T_1	12 mm
T_2	12 mm
R	7 mm
e_1	29.3 mm
e_2	29.3 mm
v	-45.0 °

Cross-section constants	
A	2 267 mm^2
I_{xx}	2 102 772 mm^4
W_{xx}	29 755 mm^3
$A_{k,y}$	1080 mm^2
I_{yy}	2 102 772 mm^4
W_{yy}	29 755 mm^3
$A_{k,x}$	1080 mm^2
I_{zz}	3 322 322 mm^4
I_{ee}	883 222 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

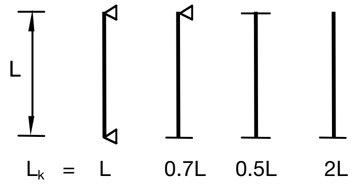
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
418.4 kN

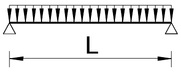
Max. compressive load-bearing capacity with unbraced flanges
248.3 kN

Dead weight
4.08 kg/m

Buckling length

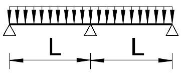


One span

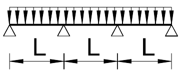


L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	41.54	30.52	30.52	26.00	22.42	19.53	17.17	15.21	13.56	12.17	10.99	9.08	7.63	6.50	5.61	4.88	2.75
Application limit point																	
$\delta_{max} < L / 200$	16.24	9.77	9.77	7.79	6.31	5.17	4.29	3.60	3.05	2.60	2.24	1.69	1.31	1.03	0.83	0.68	0.29
$\delta_{max} < L / 300$	10.83	6.52	6.52	5.19	4.20	3.45	2.86	2.40	2.03	1.74	1.49	1.13	0.87	0.69	0.55	0.45	0.19
$\delta_{max} < L / 400$	8.12	4.89	4.89	3.90	3.15	2.59	2.15	1.80	1.52	1.30	1.12	0.85	0.66	0.52	0.42	0.34	0.14

Two spans



L (m) =	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	4.00
Breaking point																	
Design value for load-bearing capacity	33.23	27.69	27.69	25.56	22.42	19.53	17.17	15.21	13.56	12.17	10.99	9.08	7.63	6.50	5.61	4.88	2.75
Application limit point																	
$\delta_{max} < L / 200$	33.19	20.84	20.84	16.87	13.83	11.47	9.60	8.11	6.92	5.94	5.14	3.91	3.05	2.42	1.95	1.59	0.68
$\delta_{max} < L / 300$	22.13	13.89	13.89	11.25	9.22	7.64	6.40	5.41	4.61	3.96	3.42	2.61	2.03	1.61	1.30	1.06	0.45
$\delta_{max} < L / 400$	16.60	10.42	10.42	8.44	6.92	5.73	4.80	4.06	3.46	2.97	2.57	1.96	1.52	1.21	0.97	0.80	0.34

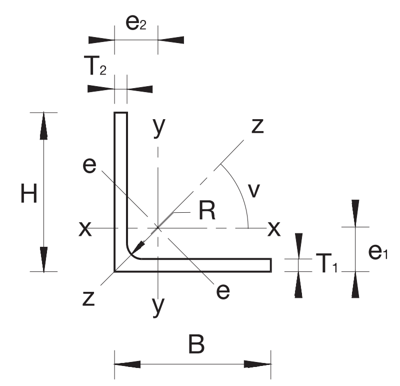


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	149.1
2.50	108.9
3.00	81.9
3.50	63.4
4.00	50.2
4.50	40.7
5.00	33.6
5.50	28.1
6.00	23.9
7.00	17.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	149.1
2.50	108.9
3.00	81.9
3.50	63.4
4.00	50.2
4.50	40.7
5.00	33.6
5.50	28.1
6.00	23.9
7.00	17.8

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	196.6
2.50	150.4
3.00	116.8
3.50	92.4
4.00	74.5
4.50	61.1
5.00	50.8
5.50	42.9
6.00	36.6
7.00	27.5

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	202.2
1.50	121.3
2.00	77.8
2.50	53.2
3.00	38.4
3.50	28.9
4.00	22.5
4.50	18.0
5.00	14.7
6.00	10.3



Geometry	
H	150 mm
B	150 mm
T_1	8 mm
T_2	8 mm
R	7 mm
e_1	40.3 mm
e_2	40.3 mm
v	-45.0 °

Cross-section constants	
A	2 347 mm^2
I_{xx}	5 207 812 mm^4
W_{xx}	47 488 mm^3
$A_{k,y}$	1080 mm^2
I_{yy}	5 207 812 mm^4
W_{yy}	47 488 mm^3
$A_{k,x}$	1080 mm^2
I_{zz}	8 243 662 mm^4
I_{ee}	2 171 963 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

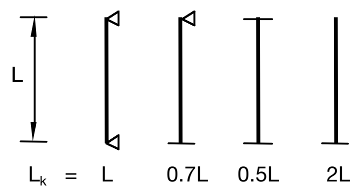
Partial coefficients	
$\lambda_{m,E}$	1.3
$\lambda_{m,f}$	1.3

Design value for load-bearing capacity
433.2 kN

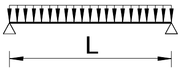
Max. compressive load-bearing capacity with unbraced flanges
50.8 kN

Dead weight
4.22 kg/m

Buckling length

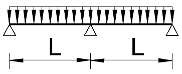


One span

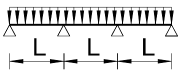


L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																	
Design value for load-bearing capacity	41.54	34.62	29.67	25.96	21.65	17.53	14.49	12.18	10.38	8.95	7.79	6.85	6.07	5.41	4.86	4.38	2.81
Application limit point																	
δ_{max} < L / 200	33.95	21.35	14.19	9.86	7.11	5.28	4.02	3.13	2.49	2.00	1.64	1.36	1.14	0.96	0.82	0.70	0.36
δ_{max} < L / 300	22.63	14.24	9.46	6.57	4.74	3.52	2.68	2.09	1.66	1.34	1.09	0.90	0.76	0.64	0.55	0.47	0.24
δ_{max} < L / 400	16.97	10.68	7.10	4.93	3.55	2.64	2.01	1.57	1.24	1.00	0.82	0.68	0.57	0.48	0.41	0.35	0.18

Two spans



L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																	
Design value for load-bearing capacity	33.23	27.69	23.74	20.77	18.46	16.62	14.49	12.18	10.38	8.95	7.79	6.85	6.07	5.41	4.86	4.38	2.81
Application limit point																	
δ_{max} < L / 200	59.64	40.16	28.06	20.24	15.00	11.39	8.82	6.96	5.58	4.54	3.74	3.11	2.62	2.22	1.90	1.64	0.85
δ_{max} < L / 300	39.76	26.78	18.71	13.49	10.00	7.59	5.88	4.64	3.72	3.03	2.49	2.08	1.75	1.48	1.27	1.09	0.57
δ_{max} < L / 400	29.82	20.08	14.03	10.12	7.50	5.69	4.41	3.48	2.79	2.27	1.87	1.56	1.31	1.11	0.95	0.82	0.43

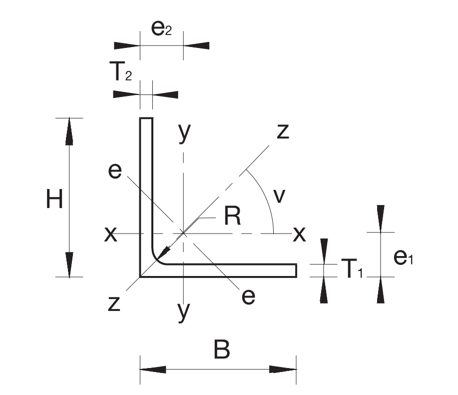


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	183.5
2.50	133.9
3.00	100.6
3.50	77.8
4.00	61.7
4.50	49.9
5.00	41.2
5.50	34.5
6.00	29.3
7.00	21.8

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	183.5
2.50	133.9
3.00	100.6
3.50	77.8
4.00	61.7
4.50	49.9
5.00	41.2
5.50	34.5
6.00	29.3
7.00	21.8

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	242.4
2.50	185.2
3.00	143.8
3.50	113.7
4.00	91.6
4.50	75.1
5.00	62.5
5.50	52.7
6.00	45.0
7.00	33.8

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	248.4
1.50	148.5
2.00	95.1
2.50	65.0
3.00	46.9
3.50	35.2
4.00	27.4
4.50	21.9
5.00	17.9
6.00	12.5



Geometry	
H	150 mm
B	150 mm
T_1	10 mm
T_2	10 mm
R	7 mm
e_1	41.1 mm
e_2	41.1 Mm
v	-45.0 °

Cross-section constants	
A	2 911 mm^2
I_{xx}	6 381 667 mm^4
W_{xx}	58 601 mm^3
$A_{k,y}$	1350 mm^2
I_{yy}	6 381 667 mm^4
W_{yy}	58 601 mm^3
$A_{k,x}$	1350 mm^2
I_{zz}	10 117 830 mm^4
I_{ee}	2 645 505 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

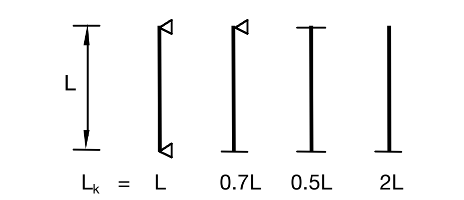
Partial coefficients	
$\lambda_{m,E}$	1.3
$\lambda_{m,f}$	1.3

Design value for load-bearing capacity
537.3 kN

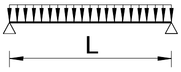
Max. compressive load-bearing capacity with unbraced flanges
98.4 kN

Dead weight
5.24 kg/m

Buckling length

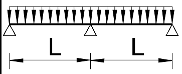


One span

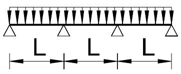


L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																	
Design value for load-bearing capacity	51.92	43.27	37.09	32.45	26.71	21.64	17.88	15.03	12.80	11.04	9.62	8.45	7.49	6.68	5.99	5.41	3.46
Application limit point																	
$\delta_{max} < L / 200$	41.81	26.27	17.44	12.11	8.73	6.48	4.94	3.84	3.05	2.46	2.01	1.66	1.39	1.18	1.00	0.86	0.44
$\delta_{max} < L / 300$	27.88	17.51	11.63	8.08	5.82	4.32	3.29	2.56	2.03	1.64	1.34	1.11	0.93	0.78	0.67	0.57	0.30
$\delta_{max} < L / 400$	20.91	13.14	8.72	6.06	4.36	3.24	2.47	1.92	1.52	1.23	1.00	0.83	0.70	0.59	0.50	0.43	0.22

Two spans



L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																	
Design value for load-bearing capacity	41.54	34.62	29.67	25.96	23.08	20.77	17.88	15.03	12.80	11.04	9.62	8.45	7.49	6.68	5.99	5.41	3.46
Application limit point																	
$\delta_{max} < L / 200$	73.76	49.58	34.59	24.92	18.46	14.00	10.84	8.55	6.86	5.57	4.59	3.82	3.21	2.73	2.33	2.01	1.05
$\delta_{max} < L / 300$	49.17	33.05	23.06	16.61	12.30	9.33	7.23	5.70	4.57	3.72	3.06	2.55	2.14	1.82	1.56	1.34	0.70
$\delta_{max} < L / 400$	36.88	24.79	17.30	12.46	9.23	7.00	5.42	4.28	3.43	2.79	2.29	1.91	1.61	1.36	1.17	1.01	0.52

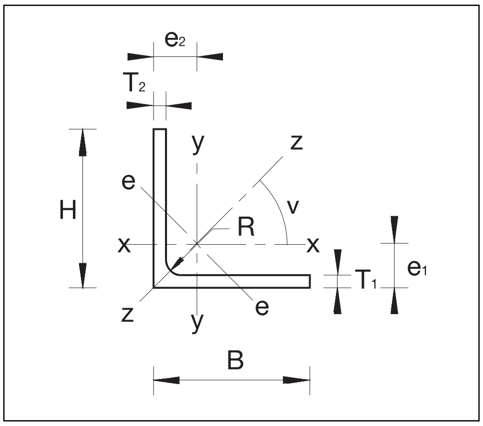


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	216.8
2.50	158.0
3.00	118.7
3.50	91.7
4.00	72.7
4.50	58.8
5.00	48.5
5.50	40.6
6.00	34.5
7.00	25.7

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	216.8
2.50	158.0
3.00	118.7
3.50	91.7
4.00	72.7
4.50	58.8
5.00	48.5
5.50	40.6
6.00	34.5
7.00	25.7

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	286.9
2.50	219.0
3.00	169.8
3.50	134.2
4.00	108.1
4.50	88.5
5.00	73.6
5.50	62.1
6.00	53.0
7.00	39.8

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	293.6
1.50	175.1
2.00	111.9
2.50	76.4
3.00	55.1
3.50	41.4
4.00	32.2
4.50	25.7
5.00	21.0
6.00	14.7



Geometry	
H	150 mm
B	150 mm
T_1	12 mm
T_2	12 mm
R	7 mm
e_1	41.9 mm
e_2	41.9 Mm
v	-45.0 °

Cross-section constants	
A	3 467 mm^2
I_{xx}	7 509 693 mm^4
W_{xx}	69 439 mm^3
$A_{k,y}$	1620 mm^2
I_{yy}	7 509 693 mm^4
W_{yy}	69 439 mm^3
$A_{k,x}$	1620 mm^2
I_{zz}	11 913 418 mm^4
I_{ee}	3 105 968 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

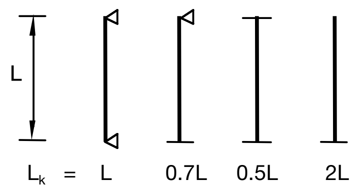
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
640.0 kN

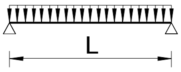
Max. compressive load-bearing capacity with unbraced flanges
168.8 kN

Dead weight
6.24 kg/m

Buckling length

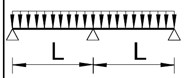


One span

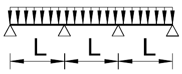


L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																	
Design value for load-bearing capacity	62.31	51.92	44.51	38.94	31.65	25.64	21.19	17.80	15.17	13.08	11.40	10.02	8.87	7.91	7.10	6.41	4.10
Application limit point																	
$\delta_{max} < L / 200$	49.45	31.03	20.59	14.29	10.29	7.64	5.82	4.53	3.59	2.90	2.37	1.96	1.64	1.39	1.18	1.01	0.52
$\delta_{max} < L / 300$	32.97	20.69	13.72	9.53	6.86	5.09	3.88	3.02	2.39	1.93	1.58	1.31	1.09	0.92	0.79	0.68	0.35
$\delta_{max} < L / 400$	24.73	15.52	10.29	7.14	5.14	3.82	2.91	2.26	1.80	1.45	1.18	0.98	0.82	0.69	0.59	0.51	0.26

Two spans



L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																	
Design value for load-bearing capacity	49.85	41.54	35.60	31.15	27.69	24.92	21.19	17.80	15.17	13.08	11.40	10.02	8.87	7.91	7.10	6.41	4.10
Application limit point																	
$\delta_{max} < L / 200$	87.57	58.76	40.95	29.47	21.81	16.53	12.80	10.09	8.09	6.57	5.41	4.50	3.79	3.21	2.75	2.37	1.23
$\delta_{max} < L / 300$	58.38	39.17	27.30	19.64	14.54	11.02	8.53	6.73	5.39	4.38	3.61	3.00	2.52	2.14	1.83	1.58	0.82
$\delta_{max} < L / 400$	43.78	29.38	20.47	14.73	10.90	8.27	6.40	5.05	4.04	3.29	2.70	2.25	1.89	1.61	1.37	1.18	0.62

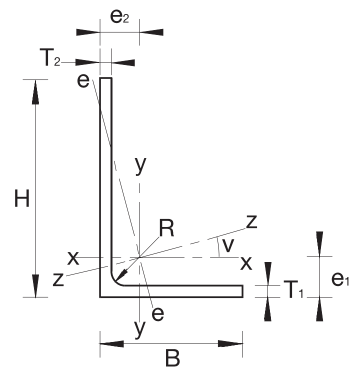


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	128.3
2.50	94.2
3.00	71.1
3.50	55.1
4.00	43.8
4.50	35.5
5.00	29.3
5.50	24.6
6.00	20.9
7.00	15.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	160.9
1.50	95.2
2.00	60.5
2.50	41.3
3.00	29.7
3.50	22.3
4.00	17.3
4.50	13.8
5.00	11.3
5.50	9.4

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	140.2
2.50	104.4
3.00	79.6
3.50	62.1
4.00	49.6
4.50	40.3
5.00	33.4
5.50	28.0
6.00	23.8
7.00	17.8

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.75	163.9
1.00	115.2
1.25	83.3
1.50	62.3
2.00	37.9
2.50	25.2
3.00	17.9
3.50	13.3
4.00	10.3
4.50	8.2



Geometry	
H	150 mm
B	100 mm
T_1	8 mm
T_2	8 mm
R	7 mm
e_1	47.8 mm
e_2	22.9 Mm
v	-23.8 °

Cross-section constants	
A	1 947 mm^2
I_{xx}	4 569 097 mm^4
W_{xx}	44 708 mm^3
$A_{k,y}$	1080 mm^2
I_{yy}	1 667 930 mm^4
W_{yy}	21 643 mm^3
$A_{k,x}$	720 mm^2
I_{zz}	5 266 449 mm^4
I_{ee}	970 578 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

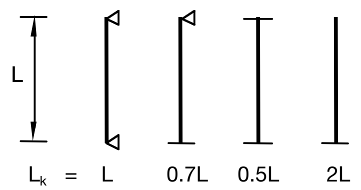
Partial coefficients	
$\lambda_{m,E}$	1.3
$\lambda_{m,f}$	1.3

Design value for load-bearing capacity
359.4 kN

Max. compressive load-bearing capacity with unbraced flanges
42.1 kN

Dead weight
3.50 kg/m

Buckling length



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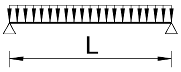
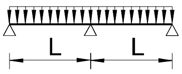
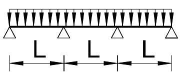


	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	41.54	34.62	29.67	25.79	20.38	16.51	13.64	11.46	9.77	8.42	7.34	6.45	5.71	5.09	4.57	4.13	2.64
	y direction	27.69	22.20	16.31	12.49	9.87	7.99	6.60	5.55	4.73	4.08	3.55	3.12	2.77	2.47	2.21	2.00	1.28
Application limit point																		
δ_{max} < L / 200	x direction	30.77	19.20	12.69	8.78	6.31	4.68	3.56	2.77	2.19	1.77	1.44	1.20	1.00	0.84	0.72	0.62	0.32
	y direction	12.59	7.62	4.94	3.37	2.40	1.77	1.34	1.03	0.82	0.66	0.54	0.44	0.37	0.31	0.27	0.23	0.12
δ_{max} < L / 300	x direction	20.51	12.80	8.46	5.86	4.21	3.12	2.37	1.85	1.46	1.18	0.96	0.80	0.67	0.56	0.48	0.41	0.21
	y direction	8.39	5.17	3.37	2.30	1.64	1.20	0.91	0.70	0.55	0.44	0.36	0.30	0.25	0.21	0.18	0.15	0.08
δ_{max} < L / 400	x direction	15.39	9.60	6.35	4.39	3.16	2.34	1.78	1.38	1.10	0.88	0.72	0.60	0.50	0.42	0.36	0.31	0.16
	y direction	6.29	3.88	2.53	1.73	1.23	0.90	0.68	0.53	0.42	0.33	0.27	0.22	0.19	0.16	0.13	0.11	0.06

Two spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	33.23	27.69	23.74	20.77	18.46	16.51	13.64	11.46	9.77	8.42	7.34	6.45	5.71	5.09	4.57	4.13	2.64
	y direction	22.15	18.46	15.82	12.49	9.87	7.99	6.60	5.55	4.73	4.08	3.55	3.12	2.77	2.47	2.21	2.00	1.28
Application limit point																		
δ_{max} < L / 200	x direction	55.46	36.92	25.57	18.32	13.51	10.21	7.89	6.21	4.97	4.03	3.32	2.76	2.32	1.96	1.68	1.45	0.75
	y direction	25.11	15.94	10.67	7.45	5.39	4.01	3.06	2.39	1.90	1.53	1.25	1.04	0.87	0.74	0.63	0.54	0.28
δ_{max} < L / 300	x direction	36.97	24.62	17.05	12.21	9.00	6.81	5.26	4.14	3.31	2.69	2.21	1.84	1.54	1.31	1.12	0.96	0.50
	y direction	16.74	10.63	7.11	4.97	3.59	2.68	2.04	1.59	1.27	1.02	0.84	0.69	0.58	0.49	0.42	0.36	0.19
δ_{max} < L / 400	x direction	27.73	18.46	12.79	9.16	6.75	5.10	3.94	3.10	2.48	2.02	1.66	1.38	1.16	0.98	0.84	0.72	0.38
	y direction	12.55	7.97	5.33	3.72	2.69	2.01	1.53	1.20	0.95	0.77	0.63	0.52	0.43	0.37	0.31	0.27	0.14

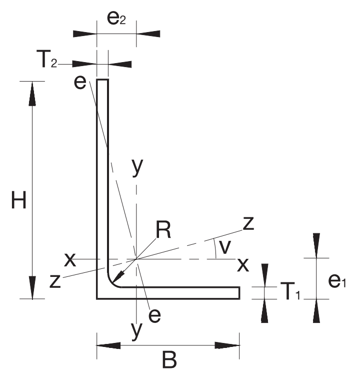


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	157.6
2.50	115.6
3.00	87.2
3.50	67.6
4.00	53.7
4.50	43.5
5.00	35.9
5.50	30.1
6.00	25.6
7.00	19.1

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	197.2
1.50	116.3
2.00	73.8
2.50	50.3
3.00	36.1
3.50	27.1
4.00	21.1
4.50	16.8
5.00	13.7
5.50	11.4

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	172.3
2.50	128.2
3.00	97.6
3.50	76.1
4.00	60.7
4.50	49.4
5.00	40.9
5.50	34.3
6.00	29.2
7.00	21.8

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.75	200.6
1.00	140.6
1.25	101.5
1.50	75.8
2.00	46.1
2.50	30.6
3.00	21.7
3.50	16.2
4.00	12.5
4.50	9.9



Geometry	
H	150 mm
B	100 mm
T_1	10 mm
T_2	10 mm
R	7 mm
e_1	48.6 mm
e_2	23.7 mm
v	-23.7 °

Cross-section constants	
A	2 411 mm^2
I_{xx}	5 590 746 mm^4
W_{xx}	55 129 mm^3
$A_{k,y}$	1350 mm^2
I_{yy}	2 027 823 mm^4
W_{yy}	26 576 mm^3
$A_{k,x}$	900 mm^2
I_{zz}	6 441 919 mm^4
I_{ee}	1 176 649 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

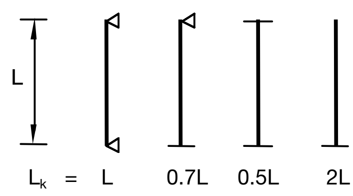
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
445.0 kN

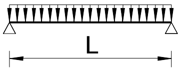
Max. compressive load-bearing capacity with unbraced flanges
81.5 kN

Dead weight
4.34 kg/m

Buckling length

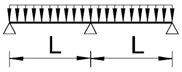


One span

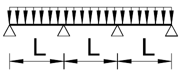


	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	51.92	43.27	37.09	31.81	25.13	20.36	16.82	14.14	12.04	10.39	9.05	7.95	7.04	6.28	5.64	5.09	3.26
	y direction	34.62	27.26	20.03	15.33	12.11	9.81	8.11	6.81	5.81	5.01	4.36	3.83	3.40	3.03	2.72	2.45	1.57
Application limit point																		
$\delta_{max} < L / 200$	x direction	37.84	23.58	15.57	10.77	7.74	5.74	4.36	3.39	2.69	2.17	1.77	1.46	1.22	1.03	0.88	0.76	0.39
	y direction	15.36	9.29	6.02	4.11	2.92	2.15	1.63	1.26	0.99	0.80	0.65	0.54	0.45	0.38	0.32	0.28	0.14
$\delta_{max} < L / 300$	x direction	25.23	15.72	10.38	7.18	5.16	3.82	2.91	2.26	1.79	1.44	1.18	0.98	0.82	0.69	0.59	0.50	0.26
	y direction	10.24	6.30	4.10	2.80	1.99	1.46	1.10	0.85	0.67	0.54	0.44	0.36	0.30	0.26	0.22	0.19	0.10
$\delta_{max} < L / 400$	x direction	18.92	11.79	7.79	5.39	3.87	2.87	2.18	1.70	1.34	1.08	0.88	0.73	0.61	0.52	0.44	0.38	0.20
	y direction	7.68	4.73	3.08	2.10	1.49	1.10	0.83	0.64	0.50	0.40	0.33	0.27	0.23	0.19	0.16	0.14	0.07

Two spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	41.54	34.62	29.67	25.96	23.08	20.36	16.82	14.14	12.04	10.39	9.05	7.95	7.04	6.28	5.64	5.09	3.26
	y direction	27.69	23.08	19.78	15.33	12.11	9.81	8.11	6.81	5.81	5.01	4.36	3.83	3.40	3.03	2.72	2.45	1.57
Application limit point																		
$\delta_{max} < L / 200$	x direction	68.48	45.51	31.47	22.52	16.59	12.53	9.68	7.61	6.09	4.94	4.06	3.38	2.84	2.41	2.06	1.77	0.92
	y direction	30.77	19.50	13.03	9.09	6.57	4.89	3.73	2.91	2.31	1.87	1.53	1.26	1.06	0.89	0.76	0.66	0.34
$\delta_{max} < L / 300$	x direction	45.65	30.34	20.98	15.01	11.06	8.36	6.45	5.08	4.06	3.29	2.71	2.25	1.89	1.60	1.37	1.18	0.61
	y direction	20.51	13.00	8.69	6.06	4.38	3.26	2.49	1.94	1.54	1.24	1.02	0.84	0.71	0.60	0.51	0.44	0.23
$\delta_{max} < L / 400$	x direction	34.24	22.75	15.74	11.26	8.30	6.27	4.84	3.81	3.04	2.47	2.03	1.69	1.42	1.20	1.03	0.89	0.46
	y direction	15.38	9.75	6.52	4.54	3.28	2.45	1.87	1.46	1.16	0.93	0.76	0.63	0.53	0.45	0.38	0.33	0.17

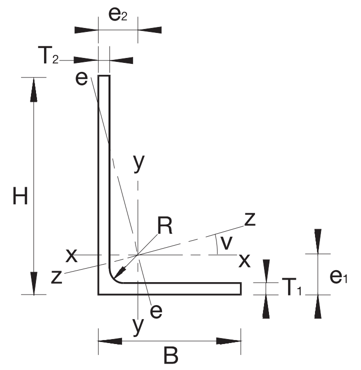


Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	186.0
2.50	136.3
3.00	102.7
3.50	79.6
4.00	63.1
4.50	51.2
5.00	42.2
5.50	35.4
6.00	30.1
7.00	22.4

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	232.1
1.50	136.4
2.00	86.5
2.50	58.8
3.00	42.3
3.50	31.7
4.00	24.6
4.50	19.7
5.00	16.0
5.50	13.3

Design value for compressive load-bearing capacity	
Buckling in e direction	
Buckling length Lk in m	Load-bearing capacity in kN
2.00	203.3
2.50	151.0
3.00	114.9
3.50	89.6
4.00	71.4
4.50	58.1
5.00	48.0
5.50	40.3
6.00	34.3
7.00	25.6

Design value for compressive load-bearing capacity	
Buckling in z direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.75	236.3
1.00	165.2
1.25	119.1
1.50	88.8
2.00	53.9
2.50	35.8
3.00	25.4
3.50	18.9
4.00	14.6
4.50	11.6



Geometry	
H	150 mm
B	100 mm
T_1	12 mm
T_2	12 mm
R	7 mm
e_1	49.4 mm
e_2	24.4 Mm
v	-23.6 °

Cross-section constants	
A	2 867 mm^2
I_{xx}	6 569 876 mm^4
W_{xx}	65 278 mm^3
$A_{k,y}$	1620 mm^2
I_{yy}	2 368 206 mm^4
W_{yy}	31 345 mm^3
$A_{k,x}$	1080 mm^2
I_{zz}	7 562 354 mm^4
I_{ee}	1 375 728 mm^4

Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

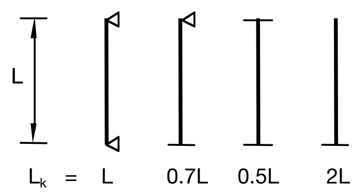
Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

Design value for load-bearing capacity
529.2 kN

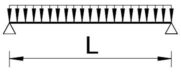
Max. compressive load-bearing capacity with unbraced flanges
139.6 kN

Dead weight
4.34 kg/m

Buckling length

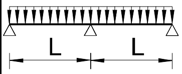


One span

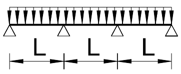


	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	62.31	51.92	44.51	37.66	29.76	24.10	19.92	16.74	14.26	12.30	10.71	9.42	8.34	7.44	6.68	6.03	3.86
	y direction	41.54	32.15	23.62	18.08	14.29	11.57	9.56	8.04	6.85	5.90	5.14	4.52	4.00	3.57	3.21	2.89	1.85
Application limit point																		
δ_{max} < L / 200	x direction	44.69	27.81	18.35	12.69	9.11	6.75	5.13	3.99	3.16	2.55	2.08	1.72	1.44	1.22	1.04	0.89	0.46
	y direction	18.01	10.88	7.04	4.80	3.42	2.51	1.90	1.47	1.16	0.93	0.76	0.63	0.52	0.44	0.38	0.32	0.17
δ_{max} < L / 300	x direction	29.79	18.54	12.23	8.46	6.07	4.50	3.42	2.66	2.11	1.70	1.39	1.15	0.96	0.81	0.69	0.59	0.31
	y direction	12.01	7.38	4.80	3.28	2.33	1.71	1.29	1.00	0.79	0.63	0.51	0.42	0.35	0.30	0.25	0.22	0.11
δ_{max} < L / 400	x direction	22.34	13.91	9.18	6.34	4.56	3.37	2.57	2.00	1.58	1.27	1.04	0.86	0.72	0.61	0.52	0.45	0.23
	y direction	9.00	5.54	3.60	2.46	1.74	1.28	0.97	0.75	0.59	0.47	0.39	0.32	0.26	0.22	0.19	0.16	0.08

Two spans

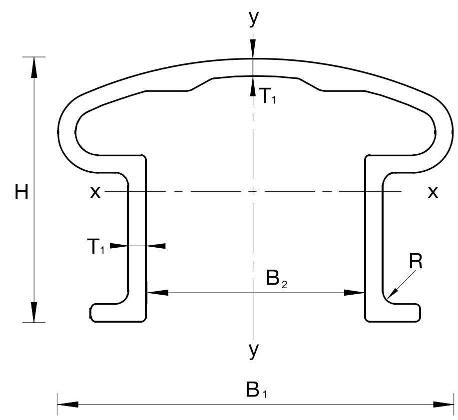


	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	49.85	41.54	35.60	31.15	27.69	24.10	19.92	16.74	14.26	12.30	10.71	9.42	8.34	7.44	6.68	6.03	3.86
	y direction	33.23	27.69	23.62	18.08	14.29	11.57	9.56	8.04	6.85	5.90	5.14	4.52	4.00	3.57	3.21	2.89	1.85
Application limit point																		
δ_{max} < L / 200	x direction	81.18	53.85	37.19	26.59	19.57	14.78	11.40	8.97	7.17	5.82	4.78	3.98	3.34	2.83	2.42	2.08	1.08
	y direction	36.21	22.91	15.29	10.65	7.70	5.73	4.37	3.41	2.70	2.18	1.78	1.48	1.24	1.05	0.89	0.77	0.40
δ_{max} < L / 300	x direction	54.12	35.90	24.80	17.72	13.05	9.85	7.60	5.98	4.78	3.88	3.19	2.65	2.23	1.89	1.61	1.39	0.72
	y direction	24.14	15.27	10.19	7.10	5.13	3.82	2.91	2.27	1.80	1.45	1.19	0.99	0.82	0.70	0.59	0.51	0.26
δ_{max} < L / 400	x direction	40.59	26.93	18.60	13.29	9.79	7.39	5.70	4.48	3.59	2.91	2.39	1.99	1.67	1.42	1.21	1.04	0.54
	y direction	18.10	11.46	7.64	5.33	3.85	2.86	2.18	1.70	1.35	1.09	0.89	0.74	0.62	0.52	0.45	0.38	0.20



Design value for compressive load-bearing capacity	
Buckling in y direction	
Buckling length Lk in m	Load-bearing capacity in kN
1.00	376.0
1.10	344.4
1.20	315.4
1.30	289.0
1.40	265.0
1.50	243.3
1.60	223.7
1.70	206.1
1.80	190.2
1.90	175.8
2.00	162.9
2.10	151.1
2.20	140.5
2.30	130.9
2.40	122.2
2.50	114.3
2.60	107.0
2.70	100.4
2.80	94.4
2.90	88.8
3.00	83.7
3.10	79.1
3.20	74.7
3.30	70.7
3.50	63.6

Design value for compressive load-bearing capacity	
Buckling in x direction	
Buckling length Lk in m	Load-bearing capacity in kN
0.50	617.6
0.60	598.1
0.70	576.6
0.80	553.7
0.90	529.8
1.00	505.4
1.10	480.9
1.20	456.7
1.30	433.0
1.40	410.0
1.50	387.9
1.60	366.8
1.70	346.7
1.80	327.6
1.90	309.6
2.00	292.7
2.10	276.7
2.20	261.8
2.30	247.8
2.40	234.7
2.50	222.4
2.60	211.0
2.70	200.2
2.80	190.2
3.00	172.0



Geometry	
H	120 mm
B_1	180 mm
B_2	100 mm
T_1	8 mm
R	6 mm

Cross-section constants	
A	3 613 mm^2
I_{xx}	4 935 568 mm^4
W_{xx}	85 833 mm^3
$A_{k,y}$	1 806 mm^2
C_1	57.5 mm
I_{yy}	11 945 895 mm^4
W_{yy}	132 732 mm^3
$A_{k,x}$	2 529 mm^2

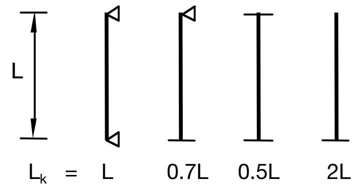
Material properties	
$E_{0°}$	23 000 MPa
$f_{c,0°}$	240 Mpa

Partial coefficients	
$\gamma_{m,E}$	1.3
$\gamma_{m,f}$	1.3

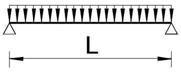
Max. compressive load-bearing capacity with unbraced flanges
488.6 kN

Dead weight
6.50 kg/m

Buckling length

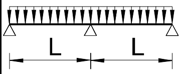


One span



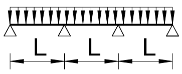
	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	62.31	51.92	44.51	37.66	29.76	24.10	19.92	16.74	14.26	12.30	10.71	9.42	8.34	7.44	6.68	6.03	3.86
	y direction	41.54	32.15	23.62	18.08	14.29	11.57	9.56	8.04	6.85	5.90	5.14	4.52	4.00	3.57	3.21	2.89	1.85
Application limit point																		
δ_{max} < L / 200	x direction	44.69	27.81	18.35	12.69	9.11	6.75	5.13	3.99	3.16	2.55	2.08	1.72	1.44	1.22	1.04	0.89	0.46
	y direction	18.01	10.88	7.04	4.80	3.42	2.51	1.90	1.47	1.16	0.93	0.76	0.63	0.52	0.44	0.38	0.32	0.17
δ_{max} < L / 300	x direction	29.79	18.54	12.23	8.46	6.07	4.50	3.42	2.66	2.11	1.70	1.39	1.15	0.96	0.81	0.69	0.59	0.31
	y direction	12.01	7.38	4.80	3.28	2.33	1.71	1.29	1.00	0.79	0.63	0.51	0.42	0.35	0.30	0.25	0.22	0.11
δ_{max} < L / 400	x direction	22.34	13.91	9.18	6.34	4.56	3.37	2.57	2.00	1.58	1.27	1.04	0.86	0.72	0.61	0.52	0.45	0.23
	y direction	9.00	5.54	3.60	2.46	1.74	1.28	0.97	0.75	0.59	0.47	0.39	0.32	0.26	0.22	0.19	0.16	0.08

Two spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	49.85	41.54	35.60	31.15	27.69	24.10	19.92	16.74	14.26	12.30	10.71	9.42	8.34	7.44	6.68	6.03	3.86
	y direction	33.23	27.69	23.62	18.08	14.29	11.57	9.56	8.04	6.85	5.90	5.14	4.52	4.00	3.57	3.21	2.89	1.85
Application limit point																		
δ_{max} < L / 200	x direction	81.18	53.85	37.19	26.59	19.57	14.78	11.40	8.97	7.17	5.82	4.78	3.98	3.34	2.83	2.42	2.08	1.08
	y direction	36.21	22.91	15.29	10.65	7.70	5.73	4.37	3.41	2.70	2.18	1.78	1.48	1.24	1.05	0.89	0.77	0.40
δ_{max} < L / 300	x direction	54.12	35.90	24.80	17.72	13.05	9.85	7.60	5.98	4.78	3.88	3.19	2.65	2.23	1.89	1.61	1.39	0.72
	y direction	24.14	15.27	10.19	7.10	5.13	3.82	2.91	2.27	1.80	1.45	1.19	0.99	0.82	0.70	0.59	0.51	0.26
δ_{max} < L / 400	x direction	40.59	26.93	18.60	13.29	9.79	7.39	5.70	4.48	3.59	2.91	2.39	1.99	1.67	1.42	1.21	1.04	0.54
	y direction	18.10	11.46	7.64	5.33	3.85	2.86	2.18	1.70	1.35	1.09	0.89	0.74	0.62	0.52	0.45	0.38	0.20

Three spans



	L (m) =	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	5.00
Breaking point																		
	x direction	51.92	43.27	37.09	32.45	28.85	25.96	23.60	20.92	17.83	15.37	13.39	11.77	10.43	9.30	8.35	7.53	4.82
	y direction	34.62	28.85	24.73	21.63	17.86	14.47	11.96	10.05	8.56	7.38	6.43	5.65	5.01	4.47	4.01	3.62	2.31
Application limit point																		
δ_{max} < L / 200	x direction	70.17	45.64	31.07	21.96	16.03	12.03	9.24	7.23	5.77	4.67	3.83	3.18	2.66	2.26	1.93	1.66	0.86
	y direction	30.32	18.90	12.48	8.63	6.20	4.60	3.50	2.72	2.15	1.74	1.42	1.17	0.98	0.83	0.71	0.61	0.31
δ_{max} < L / 300	x direction	46.78	30.43	20.71	14.64	10.69	8.02	6.16	4.82	3.84	3.11	2.55	2.12	1.78	1.50	1.28	1.10	0.57
	y direction	20.22	12.60	8.32	5.76	4.14	3.06	2.33	1.81	1.44	1.16	0.95	0.78	0.65	0.55	0.47	0.40	0.21
δ_{max} < L / 400	x direction	35.09	22.82	15.53	10.98	8.02	6.01	4.62	3.62	2.88	2.33	1.91	1.59	1.33	1.13	0.96	0.83	0.43
	y direction	15.16	9.45	6.24	4.32	3.10	2.30	1.75	1.36	1.08	0.87	0.71	0.59	0.49	0.41	0.35	0.30	0.16

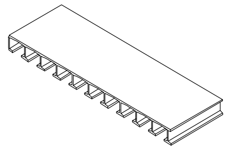
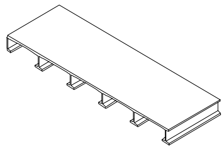
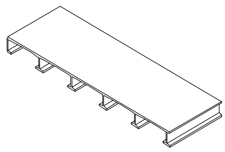
CHAPTER 2: CONSTRUCTION

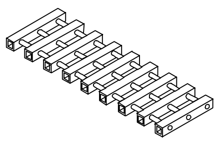
CHAPTER 2

Section 1: Planks, pultruded gratings and moulded gratings

Product range and load-bearing capacity

Load-bearing capacities of the various types of decks are listed in the tables on pages 2.1.5-2.1.11.

Plank	Cross-section constants						
	Type	Height mm	Width mm	Area A in mm^2/m	Shear area A(τ)in mm^2/m	Moment of inertia I_x in mm^4/m	Section modulus W_x in mm^3/m
	HD	40	500	9.568	3.265	2.148.000	86.646
	MD	40	500	7.308	2.016	1.397.042	48.994
	LD	40	500	6.358	2.016	1.337.000	47.784

Pultruded grating	Cross-section constants				
	Profile dimension mm*	Area A in mm^2/m	Shear area A(τ)in mm^2/m	Moment of inertia I_x in mm^4/m	Section modulus W_x in mm^3/m
	25 x 20	4.957	2.660	380.319	30.426
	30 x 30	5.193	2.632	618.263	41.491
	40 x 30	7.456	4.211	1.542.018	77.105

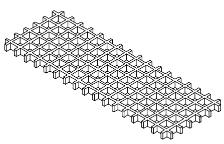
Moulded grating	Cross-section constants				
	Height mm	Area A in mm^2/m	Shear area A(τ)in mm^2/m	Moment of inertia I_x in mm^4/m	Section modulus W_x in mm^3/m
	25	3.469	3.469	180.663	14.453
	30	4.163	4.163	312.188	20.813
	38	5.273	5.273	634.458	33.393
	50	6.938	6.938	1.445.313	57.813

Table 5.1. * The standard distance between profiles is 27 mm. For other distances see Table 5.2-5.4.

Pultruded gratings

Pultruded gratings are supplied with standard profile distances of 27 mm. The values listed in the tables on pages 2.1.8-2.1.10 are valid for this distance.

With other profile distances, the figures must be divided by the following distance factors.

Profile distance in mm	Distance factor
16	0.79
21	0.88
27	1.00
35	1.16

Table 5.2 Profile type 20 mm x 25 mm

Profile distance in mm	Distance factor
16	0,82
21	0,90
27	1,00
35	1,13

Table 5.3 Profile type 30 mm x 30 mm

Profile distance in mm	Distance factor
16	0.82
21	0.90
27	1.00
35	1.13

Table 5.4 Profile type 30 mm x 40 mm

Example

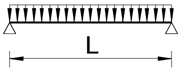
Determination of load-bearing capacity for a pultruded grating with a distance of 16 mm between the profiles:

Profile	20 x 25 mm, L = 1.0 m, one span
Maximum deflection	$\frac{L}{200}$
Load-bearing capacity, read in table on page 2.1.6	3.32 kN / m^2 (serviceability limit state)
Desired profile distance	16 mm
Distance factor, read in table 5.2	0.79

Result:

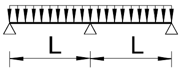
Load-bearing capacity $\mathbf{\frac{3,32}{0,79} = 4.20\ kN/m^2}$

One span



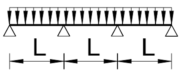
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	261.2	174.2	128	81.89	56.87	41.78	31.99	25.28	20.47	16.92	14.22
Serviceability limit state												
$\delta_{max} < L / 200$	-	128	41.53	18.13	9.43	5.51	3.49	2.34	1.65	1.21	0.91	0.70
$\delta_{max} < L / 400$	-	63.97	20.77	9.06	4.72	2.75	1.74	1.17	0.83	0.60	0.45	0.35

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	-	-	48.37	37.23	29.70	24.29	20.23	17.10	14.62	12.64	11.01
Serviceability limit state												
$\delta_{max} < L / 200$	-	-	-	45.75	23.42	13.55	8.54	5.72	4.02	2.93	2.20	1.69
$\delta_{max} < L / 400$	-	-	-	22.87	11.71	6.78	4.27	2.86	2.01	1.46	1.10	0.85

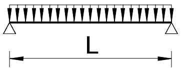
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	-	-	55.66	43.08	34.58	28.45	23.83	20.25	17.41	15.11	13.22
Serviceability limit state												
$\delta_{max} < L / 200$	-	-	-	35.96	18.41	10.65	6.71	4.49	3.16	2.30	1.73	1.33
$\delta_{max} < L / 400$	-	-	-	17.98	9.20	5.33	3.35	2.25	1.58	1.15	0.86	0.67

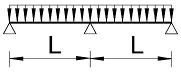
The data used in the table are theoretically calculated values.

One span



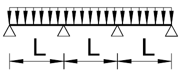
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	155.1	103.4	72.35	46.31	32.16	23.63	18.09	14.29	11.58	9.57	8.04
Serviceability limit state												
δ_{max} < L / 200	-	81.98	26.82	11.74	6.12	3.57	2.26	1.52	1.07	0.78	0.59	0.45
δ_{max} < L / 400	-	40.99	13.41	5.87	3.06	1.79	1.13	0.76	0.54	0.39	0.29	0.23

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	-	-	-	21.87	17.39	14.18	11.77	9.92	8.46	7.30	6.35
Serviceability limit state												
δ_{max} < L / 200	-	-	-	-	15.23	8.82	5.55	3.72	2.61	1.90	1.43	1.10
δ_{max} < L / 400	-	-	-	-	7.62	4.41	2.78	1.86	1.31	0.95	0.72	0.55

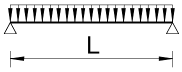
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	-	-	32.84	25.35	20.28	16.64	13.90	11.78	10.10	8.74	7.64
Serviceability limit state												
δ_{max} < L / 200	-	-	-	23.39	11.97	6.93	4.36	2.92	2.05	1.50	1.12	0.87
δ_{max} < L / 400	-	-	-	11.69	5.99	3.46	2.18	1.46	1.03	0.75	0.56	0.43

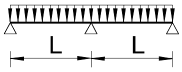
The data used in the table are theoretically calculated values.

One span



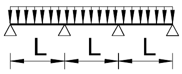
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	155.1	103.4	70.57	45.16	31.36	23.04	17.64	13.94	11.29	9.33	7.84
Serviceability limit state												
$\delta_{max} < L / 200$	-	79.04	25.76	11.26	5.86	3.42	2.17	1.46	1.03	0.75	0.56	0.43
$\delta_{max} < L / 400$	-	39.52	12.88	5.63	2.93	1.71	1.08	0.73	0.51	0.37	0.28	0.22

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	-	-	-	21.75	17.26	14.05	11.65	9.80	8.35	7.19	6.25
Serviceability limit state												
$\delta_{max} < L / 200$	-	-	-	-	14.58	8.44	5.31	3.56	2.50	1.82	1.37	1.05
$\delta_{max} < L / 400$	-	-	-	-	7.29	4.22	2.66	1.78	1.25	0.91	0.68	0.53

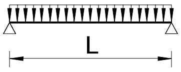
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	-	-	32.73	25.22	20.15	16.50	13.77	11.65	9.97	8.63	7.53
Serviceability limit state												
$\delta_{max} < L / 200$	-	-	-	22.38	11.46	6.63	4.18	2.80	1.96	1.43	1.08	0.83
$\delta_{max} < L / 400$	-	-	-	11.19	5.73	3.32	2.09	1.40	0.98	0.72	0.54	0.41

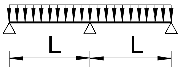
The data used in the table are theoretically calculated values.

One span



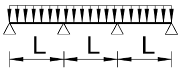
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	409	180	79.9	44.9	28.8	20.0	14.7	11.2	8.88	7.19	5.94	4.99
Serviceability limit state												
$\delta_{max} < L / 200$	184	25.8	7.82	3.32	1.71	0.99	0.62	-	-	-	-	-
$\delta_{max} < L / 400$	92.0	12.9	3.91	1.66	0.85	0.50	-	-	-	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	164	79.9	44.9	28.8	20.0	14.7	11.2	8.88	7.19	5.94	4.99
Serviceability limit state												
$\delta_{max} < L / 200$	-	58.6	18.3	7.87	4.07	2.36	1.49	1.00	0.70	0.51	-	-
$\delta_{max} < L / 400$	-	29.3	9.15	3.94	2.03	1.18	0.75	0.50	-	-	-	-

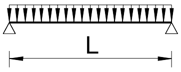
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	341	171	99.9	56.2	36.0	25.0	18.3	14.0	11.1	8.99	7.43	6.24
Serviceability limit state												
$\delta_{max} < L / 200$	308	47.1	14.6	6.23	3.21	1.87	1.18	0.79	0.56	0.41	0.30	0.23
$\delta_{max} < L / 400$	154	23.6	7.28	3.12	1.61	0.93	0.59	0.40	0.28	0.20	0.15	0.12

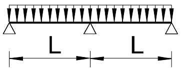
The data used in the table are theoretically calculated values.

One span



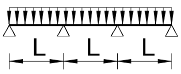
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	405	202	109	61.3	39.2	27.2	20.0	15.3	12.1	9.80	8.10	6.81
Serviceability limit state												
δ_{max} < L / 200	274	40.9	12.6	5.37	2.77	1.61	1.01	0.68	-	-	-	-
δ_{max} < L / 400	137	20.4	6.28	2.68	1.38	0.80	0.51	-	-	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	162	108	61.3	39.2	27.2	20.0	15.3	12.1	9.80	8.10	6.81
Serviceability limit state												
δ_{max} < L / 200	-	90.0	29.0	12.6	6.54	3.82	2.41	1.62	1.14	0.83	0.63	-
δ_{max} < L / 400	-	45.0	14.5	6.30	3.27	1.91	1.21	0.81	0.57	-	-	-

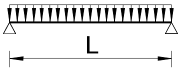
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	169	112	76.6	49.0	34.0	25.0	19.2	15.1	12.3	10.1	8.51
Serviceability limit state												
δ_{max} < L / 200	-	73.1	23.2	10.0	5.18	3.02	1.91	1.28	0.90	0.66	0.49	0.38
δ_{max} < L / 400	-	36.6	11.6	5.00	2.59	1.51	0.95	0.64	0.45	0.33	0.25	0.19

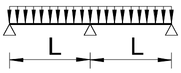
The data used in the table are theoretically calculated values.

One span



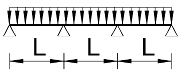
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	648	324	202	114	72.9	50.6	37.2	28.5	22.5	18.2	15.1	12.7
Serviceability limit state												
$\delta_{max} < L / 200$	609	98.4	30.8	13.3	6.85	3.99	2.52	1.69	1.19	0.87	0.65	0.50
$\delta_{max} < L / 400$	305	49.2	15.4	6.63	3.43	1.99	1.26	0.85	0.59	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	259	173	114	72.9	50.6	37.2	28.5	22.5	18.2	15.1	12.7
Serviceability limit state												
$\delta_{max} < L / 200$	-	208	69.6	30.7	16.1	9.42	5.98	4.02	2.84	2.07	1.56	1.20
$\delta_{max} < L / 400$	-	104	34.8	15.4	8.04	4.71	2.99	2.01	1.42	1.04	0.78	0.60

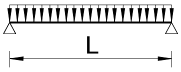
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	-	270	180	135	91.1	63.3	46.5	35.6	28.1	22.8	18.8	15.8
Serviceability limit state												
$\delta_{max} < L / 200$	-	171	56.0	24.5	12.8	7.47	4.73	3.18	2.24	1.64	1.23	0.95
$\delta_{max} < L / 400$	-	85.6	28.0	12.3	6.39	3.73	2.37	1.59	1.12	0.82	0.62	0.47

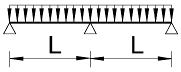
The data used in the table are theoretically calculated values.

One span



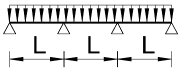
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	342	85.4	38.0	21.3	13.7	9.49	6.97	5.34	4.22	3.42	2.82	2.37
Serviceability limit state												
$\delta_{max} < L / 200$	61.7	8.16	2.44	1.04	0.53	-	-	-	-	-	-	-
$\delta_{max} < L / 400$	30.8	4.08	1.22	0.52	-	-	-	-	-	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	342	85.4	38.0	21.3	13.7	9.49	6.97	5.34	4.22	3.42	2.82	2.37
Serviceability limit state												
$\delta_{max} < L / 200$	134	19.1	5.80	2.47	1.27	0.74	-	-	-	-	-	-
$\delta_{max} < L / 400$	67.1	9.54	2.90	1.24	0.64	-	-	-	-	-	-	-

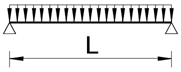
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	427	107	47.4	26.7	17.1	11.9	8.71	6.67	5.27	4.27	3.53	2.96
Serviceability limit state												
$\delta_{max} < L / 200$	109	15.2	4.59	1.95	1.00	0.58	-	-	-	-	-	-
$\delta_{max} < L / 400$	54.7	7.59	2.30	0.98	0.50	-	-	-	-	-	-	-

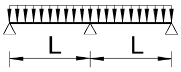
The data used in the table are theoretically calculated values.

One span



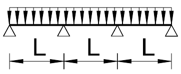
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	492	123	54.6	30.7	19. 7	13.7	10.0	7.68	6.07	4.92	4.06	3.42
Serviceability limit state												
$\delta_{max} < L / 200$	103.2	14.0	4.21	1.79	0.92	0.53	-	-	-	-	-	-
$\delta_{max} < L / 400$	51.6	6.99	2.10	0.89	-	-	-	-	-	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	492	123	54.6	30.7	19.7	13.7	10.0	7.68	6.07	4.92	4.06	3.42
Serviceability limit state												
$\delta_{max} < L / 200$	217	32.3	9.93	4.25	2.19	1.27	0.80	0.54	-	-	-	-
$\delta_{max} < L / 400$	108	16.2	4.97	2.12	1.09	0.64	-	-	-	-	-	-

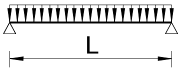
Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	534	154	68.3	38.4	24.6	17.1	12.6	9.61	7.59	6.15	5.08	4.27
Serviceability limit state												
$\delta_{max} < L / 200$	179	25.8	7.88	3.36	1.73	1.00	0.63	-	-	-	-	-
$\delta_{max} < L / 400$	89.4	12.9	3.94	1.68	0.86	0.50	-	-	-	-	-	-

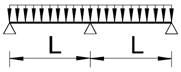
The data used in the table are theoretically calculated values.

One span



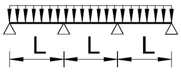
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	789	197	87.7	49.3	31.6	21.9	16.1	12.3	9.74	7.89	6.52	5.48
Serviceability limit state												
$\delta_{max} < L / 200$	197	27.9	8.49	3.61	1.86	1.08	0.68	-	-	-	-	-
$\delta_{max} < L / 400$	98.7	14.0	4.24	1.81	0.93	0.54	-	-	-	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	649	197	87. 7	49.3	31.6	21.9	16.1	12.3	9.74	7.89	6.52	5.48
Serviceability limit state												
$\delta_{max} < L / 200$	389	63.2	19.8	8.54	4.42	2.57	1.62	1.09	0.77	0.56	-	-
$\delta_{max} < L / 400$	195	31.6	9.92	4.27	2.21	1.28	0.81	0.54	-	-	-	-

Three spans

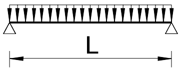


L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	676	247	110	61.6	39.5	27.4	20.1	15.4	12.2	9.86	8.15	6.85
Serviceability limit state												
$\delta_{max} < L / 200$	328	50.9	15.8	6.77	3.49	2.03	1.28	0.86	0.60	-	-	-
$\delta_{max} < L / 400$	164	25.4	7.89	3.38	1.75	1.01	0.64	-	-	-	-	-

The data used in the table are theoretically calculated values.

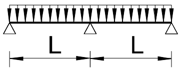
Moulded grating(H = 50 mm) - Load-bearing capacity in kN/m^2

One span



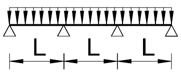
L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	1067	342	152	85.4	54.6	38.0	27.9	21.3	16.9	13.7	11.3	9.49
Serviceability limit state												
$\delta_{max} < L / 200$	404	61.7	19.1	8.16	4.21	2.44	1.54	1.04	0.73	0.53	-	-
$\delta_{max} < L / 400$	202	30.8	9.53	4.08	2.10	1.22	0.77	0.52	-	-	-	-

Two spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	854	341	152	85.4	54.6	37.9	27.9	21.3	16.9	13.7	11.3	9.49
Serviceability limit state												
$\delta_{max} < L / 200$	724	134	43.7	19.1	9.93	5.80	3.67	2.47	1.74	1.27	0.96	0.74
$\delta_{max} < L / 400$	362	67.1	21.8	9.54	4.97	2.90	1.84	1.24	0.87	0.64	-	-

Three spans



L (m) =	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
Ultimate limit state												
	889	427	190	107	68.3	47.4	34.9	26.7	21.1	17.1	14.1	11.9
Serviceability limit state												
$\delta_{max} < L / 200$	628	109	35.0	15.2	7.88	4.59	2.90	1.95	1.37	1.00	0.75	0.58
$\delta_{max} < L / 400$	314	54.7	17.5	7.59	3.94	2.30	1.45	0.98	0.69	0.50	-	-

The data used in the table are theoretically calculated values.

Moulded gratings with point load

γ_{mf}	:	Partial coefficient
B	:	The width of the span equals the distribution of load
l	:	Distance between the ribs
A_k	:	Area of a rib
h	:	Height of the ribs
δ	:	is the deflection in mm
k	:	is an empirical safety factor which provides results on the "safe side"
Q_d	:	is the design value point load indicated in kN
Q_k	:	is the characteristic point load indicated in kN
B	:	is the span indicated in m

For moulded gratings supported along two rims and loaded with a point load as shown in Figure 5.5, the calculations below can be made with the following prerequisites:

- point load distributed on 200 x 200 mm
- all joints are perpendicular to the support lines
- the joints in the gratings can transfer the full shear force.

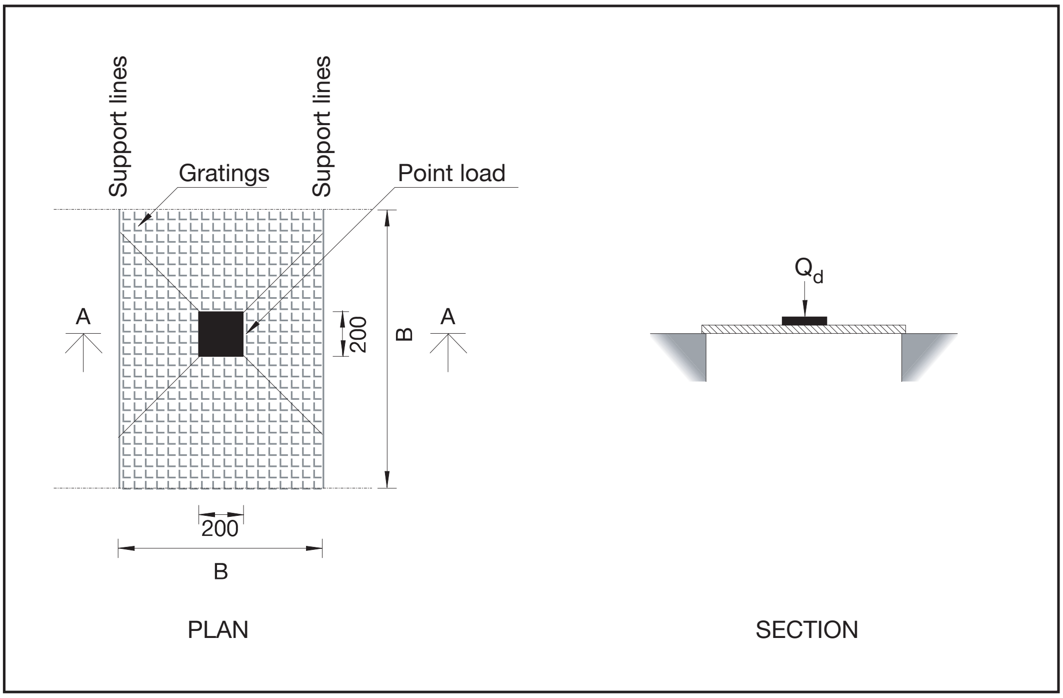


Figure 5.5.

Ultimate limit state:

Shear

Rim:

$$\frac{0{,}5 \cdot Q_d}{\frac{B}{l} \cdot A_k} \leq \frac{f_\tau}{\gamma_{mf}}$$

Punching:

$$\frac{Q_d}{\frac{4 \cdot 200}{l} \cdot A_k} \leq \frac{f_\tau}{\gamma_{mf}}$$

Moment

$$\frac{\frac{1}{4} \cdot Q_d \cdot B}{\frac{1}{6} \cdot \frac{B}{l} \cdot t \cdot h^2} \leq f_{b,0°}$$

Serviceability limit state:

$$\delta = \frac{1}{k} \cdot Q \cdot B^2$$

$$\frac{\text{Max } \delta}{L} < \frac{1}{\alpha}$$

In which: α is typically selected between 200 and 400

k is an empirical factor which provides results on the "safe side".

k = 0.13 for h = 25 mm

k = 0.22 for h = 30 mm

k = 0.46 for h = 38 mm

k = 1.05 for h = 50 mm

Example 5.1: Uniformly distributed load on walkway plank

Fiberline walkway planks are to be used to cover a walkway at an industrial site. The distance between the side beams is 1000 mm, and the walkway is not to be considered a stabilizing element.

The walkway planks must absorb the following loads:

Imposed load:

$P_{(characteristic)}$ = 3.0 kN/m² ⇒ $P_{(design\ value)}$ = 1.5 · 3.0 kN/m² = 4.5 kN/m²

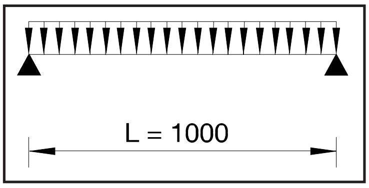
$P_{(characteristic)}$ = 3.0 kN distributed on 300 mm x 300 mm. ⇒

$P_{(design\ value)}$ = 1.3 · 3.0 kN = 3.90 kN distributed on 300 mm x 300 mm.

Deformation requirements:

Maximum deflection $\frac{L}{400}$

Static system:
in which L = 1000 mm.



Evidence
Not taking the dead weight into account, the following information is listed in the table on page 2.1.5 in the section for 1.00 m:

Ultimate limit state: $P_{design\ value}$: 128 kN/m² > 4.5 kN/m² (OK!)

Serviceability limit state: $P_{characteristic}$: 9.06 kN/m > 3.00 kN/m² (OK!)

Checking for punching shear:

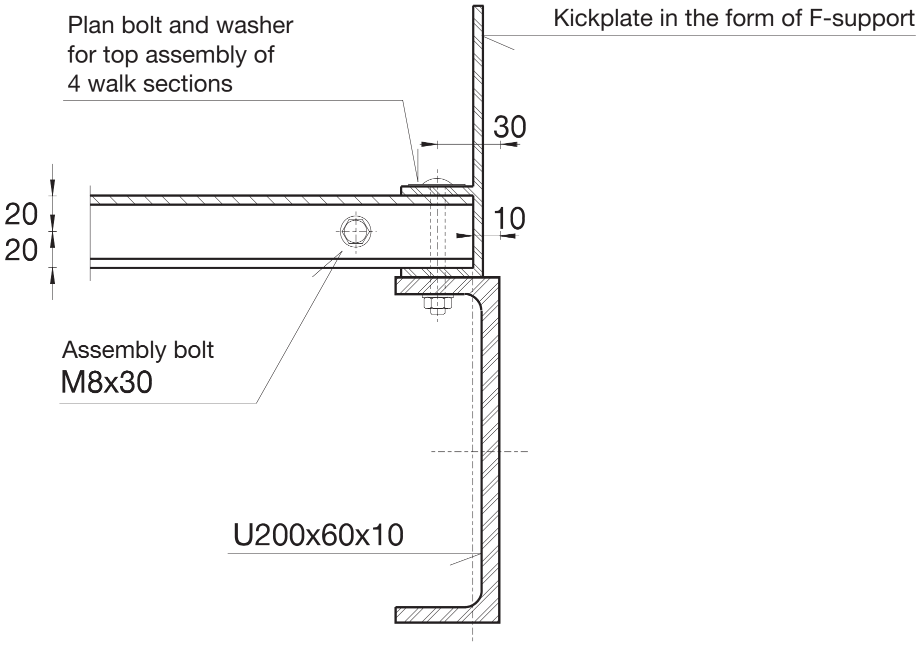
$P > P_{design\ value}$

$P = A_{Shear\ area} \cdot f_{\tau permissible}$

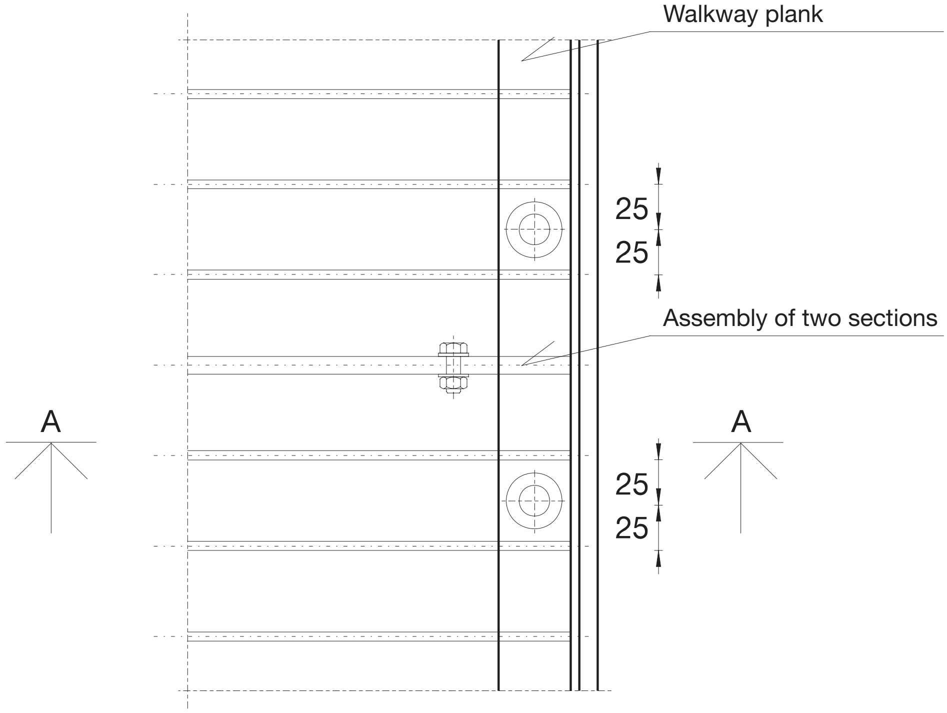
$$P = \frac{300\ mm}{50\ mm} \cdot \frac{25MPa}{1,3} = 25.4\ kN$$

25.4 kN > 3.0 kN. (OK!)

Figure 5.6



SECTION A-A



Plan

Example 5.2: Point load on moulded grating

Fiberline moulded gratings of h = 50 mm across are to be used at an industrial site to cover a pipe, so utility vehicles can drive across it. See Figure 5.6. The distance between the support points is 750 mm. The moulded gratings must absorb the following loads:

Dead weight: (Dead weight of moulded grating has not been taken into account)

Q_d = 1.35 · 5.0 kN = 6.75 kN distributed on 200 mm x 200 mm.

Imposed load:

Passenger load: Q_k = 1.5 kN/m² ⇒ p(design value) = 1.5 · 1.5 kN/m² = 2.25kN/m²

Utility vehicle load: Q_k = 5.0 kN in wheel compression distributed on 200 mm x 200 mm ⇒

Q_d = 1.5 · 5.0 kN = 7.50 kN distributed on 200 mm x 200 mm.

In the following example γ is = 0.0 as passenger load and utility vehicle load cannot take place simultaneously.

Combined load:

This results in the following total load:

Passenger load: Q_d = 0.0 · 1.0 · 1.5kN/m² = 0.00 kN/m²

Utility vehicle load: $Q_{d,total}$ = 6.75kN + 7.50kN = 14.25kN

Deformation requirements:

Deflection may not exceed 1/200 · L.

This example considers the consequences of only one wheel compression at a time. For larger spans of moulded gratings or short distances between wheels, the consequences of the double-load area between the two wheels must always be taken into consideration.

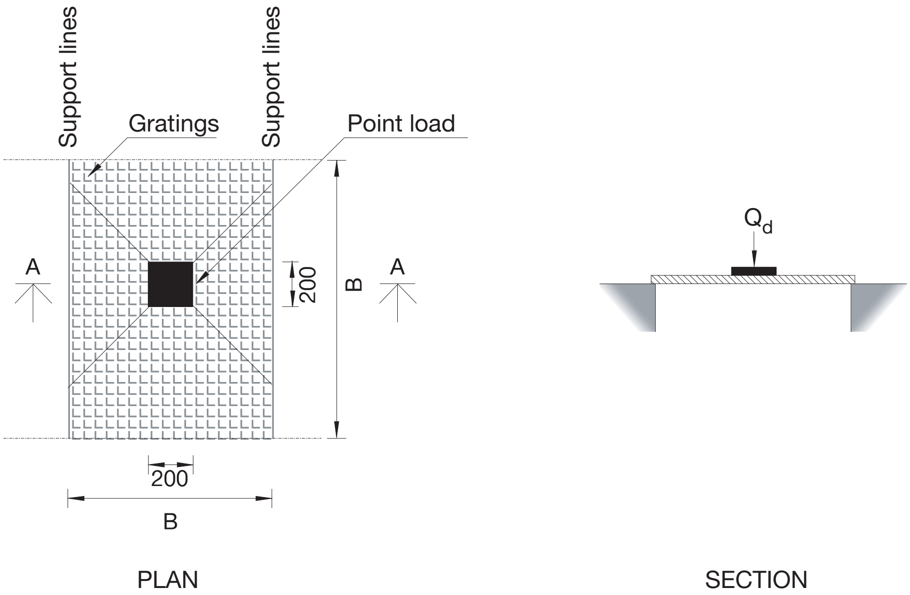


Figure 5.6. Span B = 750 mm. This example is valid for wheel distances of more than 750 mm.

Evidence

Ultimate limit state:

Shear.

Rim: $f_{\tau,akt} < f_{\tau,permissible}$

$$f_{\tau,akt} = \frac{\gamma \cdot 0.5 \cdot Q_{active}}{\frac{B}{l} \cdot A_{shear}}$$

$$= \frac{0.5 \cdot 14.25\text{ kN}}{\frac{750}{38} \cdot 50 \cdot 5.55\text{mm}} = 1.3\text{ N/mm}^2$$

$1.3\text{ N/mm}^2 < 19.23\text{ N/mm}^2$ ($25\text{ N/mm}^2/1.3$) (OK!)

Punching:

$f_{\tau,active} \quad < \quad f_{\tau,permissible}$

$$f_{\tau,active} = \frac{\gamma \cdot Q_{active}}{\frac{4 \cdot 200\ mm}{l} \cdot A_{shear}}$$

$$= \frac{14.25\ kN}{\frac{4 \cdot 200\ mm}{38} \cdot 50mm \cdot 5.55mm}$$

$$= 2.44\ N/mm^2$$

$2.44\ N/mm^2 < 19.23\ N/mm^2\ (25\ N/mm^2/1.3)$ (OK !)

Moment:

$f_{b,0°,active} \quad < \quad f_{b,0°,permissible}$

$$f_{b,0°,active} = \frac{\gamma \cdot ¼ \cdot Q_{active} \cdot B}{\frac{1}{6} \cdot \frac{B}{l} \cdot t \cdot h^2}$$

$$= \frac{¼ \cdot 14.25kN \cdot 0.75m}{\frac{1}{6} \cdot \frac{750mm}{38mm} \cdot 5.55 \cdot (50mm)^2}$$

$$= 58.5\ N/mm^2$$

$58.5\ N/mm^2 < 184.6\ N/mm^2\ (240\ N/mm^2 / 1.3)$ (OK!)

Serviceability limit state:

$U_{active} \quad < \quad u_{permissible}$

$$U_{active} = \frac{1}{k} \cdot Q \cdot B^2$$

In cases in which only one variable load is calculated at a time, use 5.0 kN.

$$U_{active} = \frac{1}{1.05} \cdot 5.0\ kN \cdot (0.75m)^2 = 2.67\ mm$$

$2.67\ mm < 3.75\ mm$ $(1/200 \cdot 750\ mm)$ (OK!)

Machining gratings

Different types of gratings are used as walkways on platforms and structures. Depending upon the purpose, plank gratings, moulded gratings or pultruded gratings can be used. All three types must be sawn to adjust them in size for use. Sawing is best done with diamond tools. Straight cutting should be done with a circular saw, and curved cutting with a bandsaw or a compass saw.

Round holes of up to approximately Ø20 mm can be bored. Large holes should be bored with a spoon bit or bored with a compass saw. It is possible that cutting large holes in pultruded gratings will remove a piece of a rod that strengthens the grating. If this is a problem, the grating should be strengthened with a flat profile prior to cutting.

Various fittings and clips for bolts are available for use in mounting the gratings.

A coat of thin lacquer is used to protect cut surfaces and make them water-repellent.

Mounting reinforcement prior to cutting

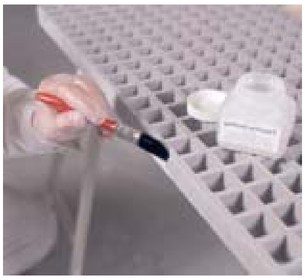
Cutting a hole using a compass saw with a diamond blade

Cutting moulded gratings with a circular saw

Flashing with sand paper

Cutting moulded gratings with a compass saw

Coating of cut surfaces



Coating cut surfaces

CHAPTER 2

Section 2: Railings

Product range and load-bearing capacity

Fiberline has developed a railing concept with the following three types of stanchion:

- Square tube 50 x 50 x 5 mm
- Square tube 60 x 60 x 5 mm
- Square tube 80 x 60 x 5 mm

The following tables are presented on the basis that the stanchions are being partially fixed to the structure. Stanchions can only be fully fixed when mounted on concrete, or on very rigid steel or fibreglass beams. Other situations should be considered as partial fixing, in which the rigidity of the handrail, the edge profile and the transverse beam govern the degree to which stanchions can be fixed.

Figure 3.1 illustrates an example in which the stanchions are partially fixed, and in which the total rigidity depends on the stiffness of the individual components.

In designing railings, evidence must normally be obtained for the following points:

- Strength and stiffness of knee and handrails.
  Documentation is not necessary when using standard Fiberline handrails, nor in situations of normal railing load, normal stiffness requirements and distances between stanchions of less than 1.2 m.
- Strength and stiffness of stanchions
- Strength and stiffness of the edge beam on which the stanchions are mounted
- Strength and stiffness of possible transverse beam which helps to provide rigidity for the edge beam
- Strength of detail for fixing stanchions

Example of ladder construction

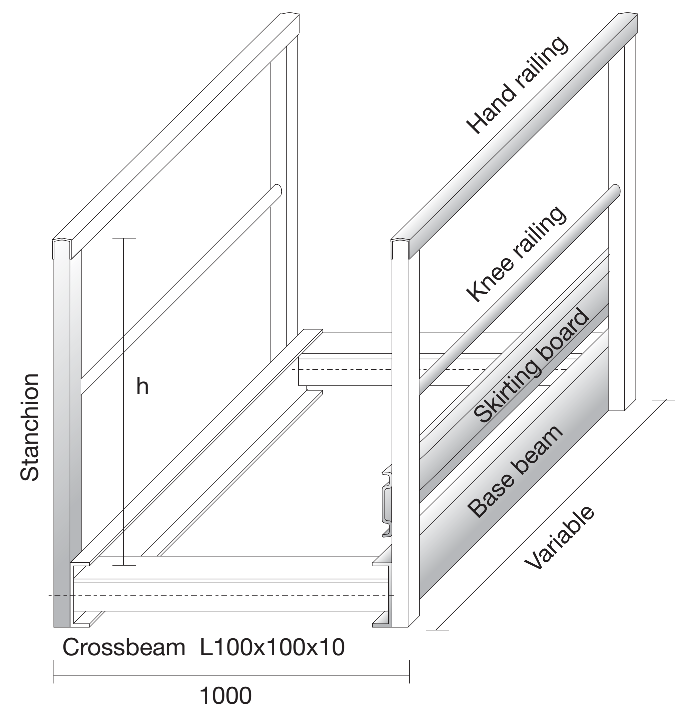


Figure 3.1, in which stanchions are partially fixed to the structure

A railing is needed along a walkway on an industrial site. The height of the railing is to be 1000 mm. The stanchions are to be mounted on the outside of a U-200 profile, therefore there is load only on the handrail:

$q = 0,5$ kN/m.

Stanchions are selected in 60 x 60 x 5 mm square tube, enabling the Fiberline railing to be be used directly. Deflection may not exceed L / 200.

The following can be read in Table 3.6:

Ultimate limit state:

P_d = 4,0 kN/m

4,0 kN/m > 0,5 kN/m (OK!)

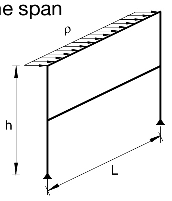
Serviceability limit state:

$P = 0,47$ kN/m $\approx 0,5$ kN/m (OK!)

The distance between stanchions is limited to 0.75 m based on the above loading.

50 x 50 x 5 mm Square tube

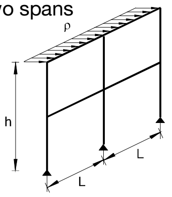
One span



	H (mm) =	1000			1200		
	L (mm) =	750	1000	1250	750	1000	1250
	Ultimate limit state	2.93	2.20	1.76	2.47	1.85	1.48
	Serviceability limit state						
	$\delta_{max} < L / 100$	0.57	0.43	0.34	0.39	0.30	0.24
	$\delta_{max} < L / 200$	0.29	0.22	0.17	0.20	0.15	0.12

Table 3.1

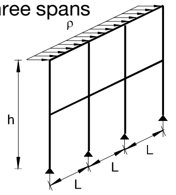
Two spans



	H (mm) =	1000			1200		
	L (mm) =	750	1000	1250	750	1000	1250
	Ultimate limit state	2.34	1.76	1.41	1.98	1.48	1.48
	Serviceability limit state						
	$\delta_{max} < L / 100$	0.46	0.34	0.27	0.31	0.24	0.19
	$\delta_{max} < L / 200$	0.23	0.17	0.14	0.16	0.12	0.10

Table 3.2

Three spans

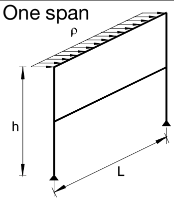


	H (mm) =	1000			1200		
	L (mm) =	750	1000	1250	750	1000	1250
	Ultimate limit state	2.66	2.00	1.60	2.25	1.68	1.35
	Serviceability limit state						
	$\delta_{max} < L / 100$	0.52	0.39	0.31	0.35	0.27	0.22
	$\delta_{max} < L / 200$	0.26	0.20	0.15	0.18	0.14	0.11

Table 3.3

60 x 60 x 5 mm Square tube

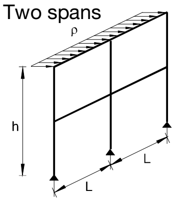
One span



	H (mm) =	1000			1200		
	L (mm) =	750	1000	1250	750	1000	1250
	Ultimate limit state	4.40	3.30	2.63	3.67	2.75	2.20
	Serviceability limit state						
	$\delta_{max} < L / 100$	1.04	0.78	0.62	1.15	0.54	0.43
	$\delta_{max} < L / 200$	0.52	0.39	0.31	0.58	0.27	0.22

Table 3.4

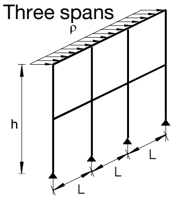
Two spans



	H (mm) =	1000			1200		
	L (mm) =	750	1000	1250	750	1000	1250
	Ultimate limit state	3.52	2.64	2.10	2.94	2.20	1.48
	Serviceability limit state						
	$\delta_{max} < L / 100$	0.83	0.62	0.50	0.92	0.43	0.35
	$\delta_{max} < L / 200$	0.42	0.31	0.25	0.46	0.22	0.17

Table 3.5

Three spans

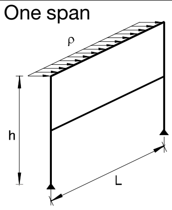


	H (mm) =	1000			1200		
	L (mm) =	750	1000	1250	750	1000	1250
	Ultimate limit state	4.00	3.00	2.39	3.34	2.50	2.00
	Serviceability limit state						
	$\delta_{max} < L / 100$	0.95	0.71	0.56	1.05	0.49	0.39
	$\delta_{max} < L / 200$	0.47	0.35	0.28	0.52	0.25	0.20

Table 3.6

80 x 60 x 5 mm Square tube

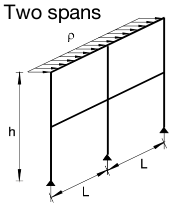
One span



H (mm) =	1000			1200		
L (mm) =	750	1000	1250	750	1000	1250
Ultimate limit state	6.53	4.90	3.92	5.47	4.10	3.28
Serviceability limit state						
$\delta_{max} < L / 100$	2.12	1.59	1.27	1.47	1.10	0.88
$\delta_{max} < L / 200$	1.06	0.80	0.64	0.74	0.55	0.44

Table 3.7

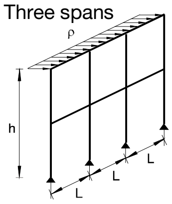
Two spans



H (mm) =	1000			1200		
L (mm) =	750	1000	1250	750	1000	1250
Ultimate limit state	5.22	3.92	3.14	4.38	3.28	1.48
Serviceability limit state						
$\delta_{max} < L / 100$	1.70	1.27	1.02	1.18	0.88	0.70
$\delta_{max} < L / 200$	0.85	0.64	0.51	0.59	0.44	0.35

Table 3.8

Three spans



H (mm) =	1000			1200		
L (mm) =	750	1000	1250	750	1000	1250
Ultimate limit state	5.94	4.45	3.56	4.97	3.73	2.98
Serviceability limit state						
$\delta_{max} < L / 100$	1.93	1.45	1.15	1.34	1.00	0.80
$\delta_{max} < L / 200$	0.96	0.72	0.58	0.67	0.50	0.40

Table 3.9

Fig. 3.1

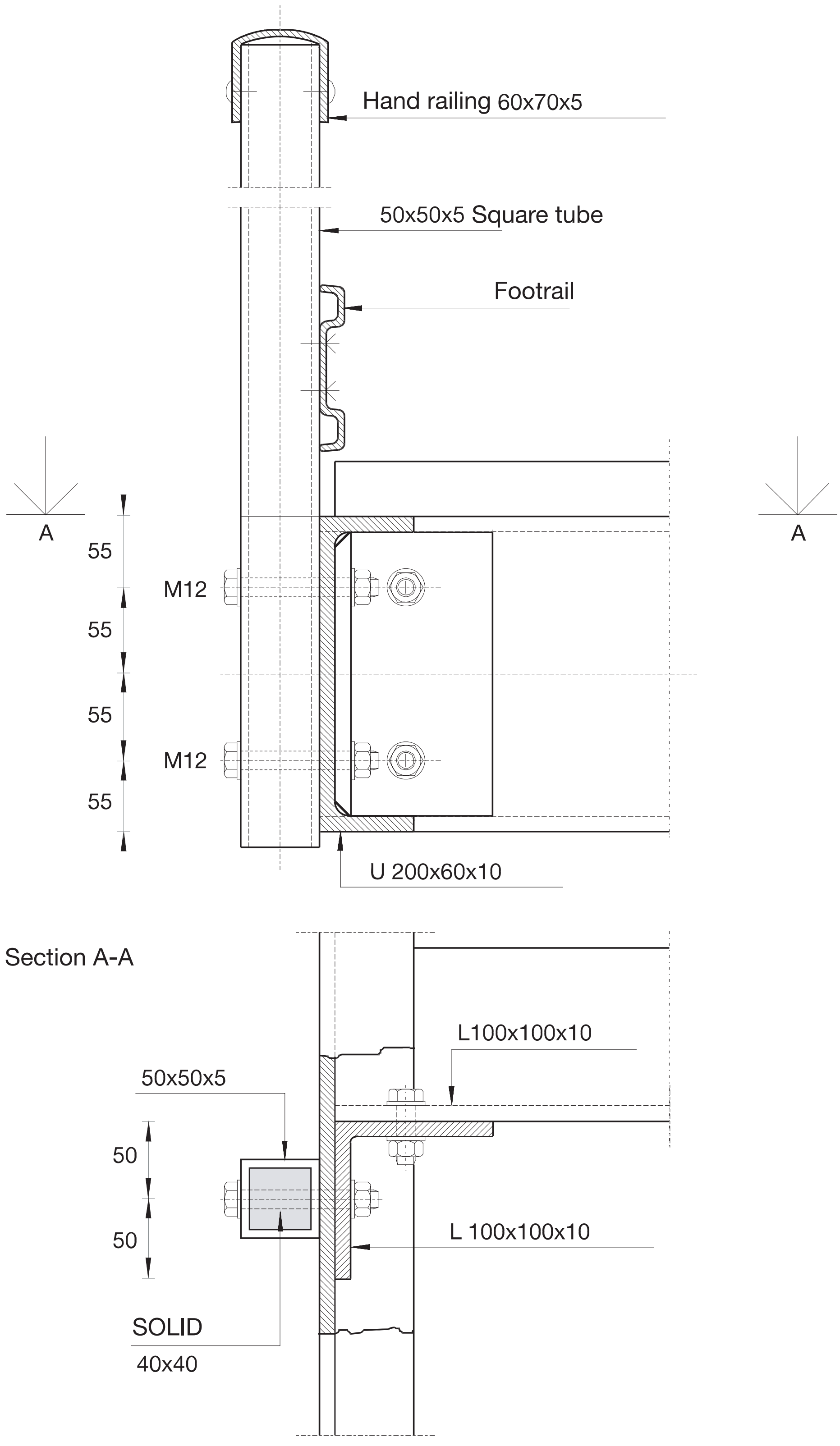
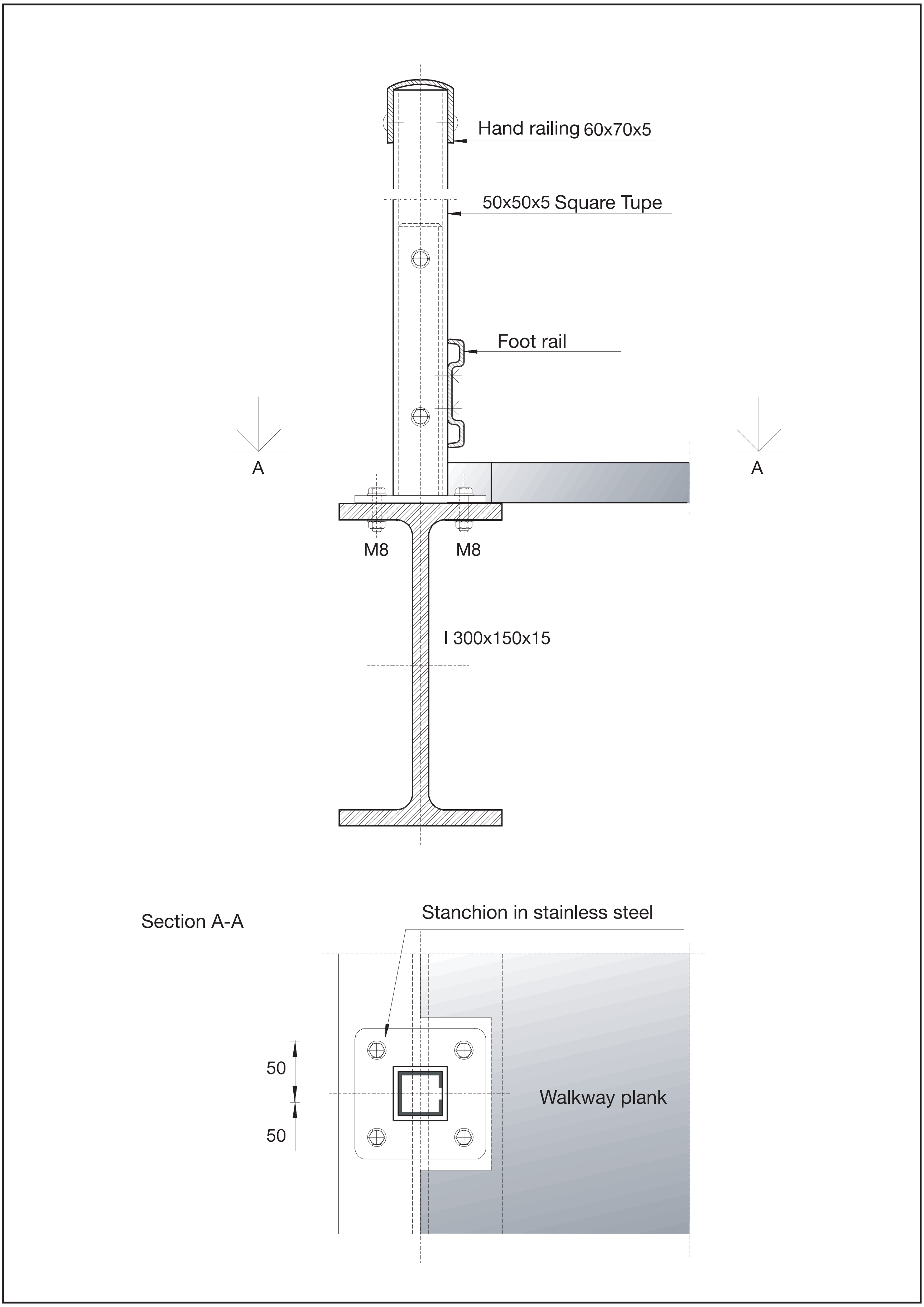

Hand railing 60x70x5
50x50x5 Square tube
Footrail
A
A
55
M12
55
55
M12
55
U 200x60x10
Section A-A
L100x100x10
50x50x5
50
50
L 100x100x10
SOLID
40x40

Fig. 3.2


Hand railing 60x70x5
50x50x5 Square Tupe
Foot rail
A
A
M8
M8
I 300x150x15
Section A-A
Stanchion in stainless steel
50
50
Walkway plank

Example of railing construction

In most cases, a railing consists of vertical square tubes which form stanchions, a handrail at the top, an Ø40 mm tube as the kneerail in the middle, and a footrail at the bottom. If a railing cannot be bolted to the side of a structure or stairs, it can be mounted on stainless steel feet for horizontal or vertical mounting.

Stanchions are shortened to the correct length and bevel, and are prebored for bolts and kneerails.

Stanchions are positioned on the kneerail with the correct distance between them, and are secured with two pop rivets in each stanchion, one from each side.

The handrail is pressed down over the stanchions and secured with two pop rivets on each side when the stanchion is in the correct position.

The footrail is positioned and secured with two pop rivets in each stanchion.

Materials for use in constructing railings

The handrail is mounted on the stanchion with pop rivets

The kneerail runs through the stanchion and is secured with pop rivets

The footrail is mounted with pop rivets.

The stanchion is mounted on the foot of the railing.

CHAPTER 2

Section 3: Stairs

Stairs

Fiberline has developed stairs with the following two (2) types of string:

– U 240 x 72 x 8 mm

– U 240 x 72 x 12 mm

In designing stairs, it is necessary to ensure that

– the individual steps have sufficient strength and rigidity to transfer the load to the strings; see Table 5.2. In order for a stairs to be comfortable to use, it must fulfil rules for slope, as well as rules for the rise and tread. See the following page.

- the stair string has sufficient strength and rigidity to transfer horizontal and perpendicular forces to the supports.

– the stair string has sufficient torsional strength and rigidity to transfer possible torsional moment to the supports.

The following tables are calculated with three (3) different slopes, 35°, 40° and 45°, as well as a horizontal load of 5% of the vertical load, corresponding to a stairs without a railing; and a horizontal load of 0.5 kN/ m, effective 0.9 m above floor level, corresponding to a stairs with a railing.

The values in the table on page 2.3.6 indicate the vertical load on a string, in which the step and the string are partially fixed. The values indicated can be increased provided:

– the support conditions for the stairs are adjusted

– the stair string is calculated as being fully fixed to the supporting structure

– that sideways cross-bracing is used.

The improvements listed above require thorough calculation. If you need to increase the load capacity of a stairs, you are welcome to contact the technical staff at Fiberline.

Bases for construction

Step rises and widths

In order for a stairs to function well, there must be a relatively constant ratio between the tread and the rise.

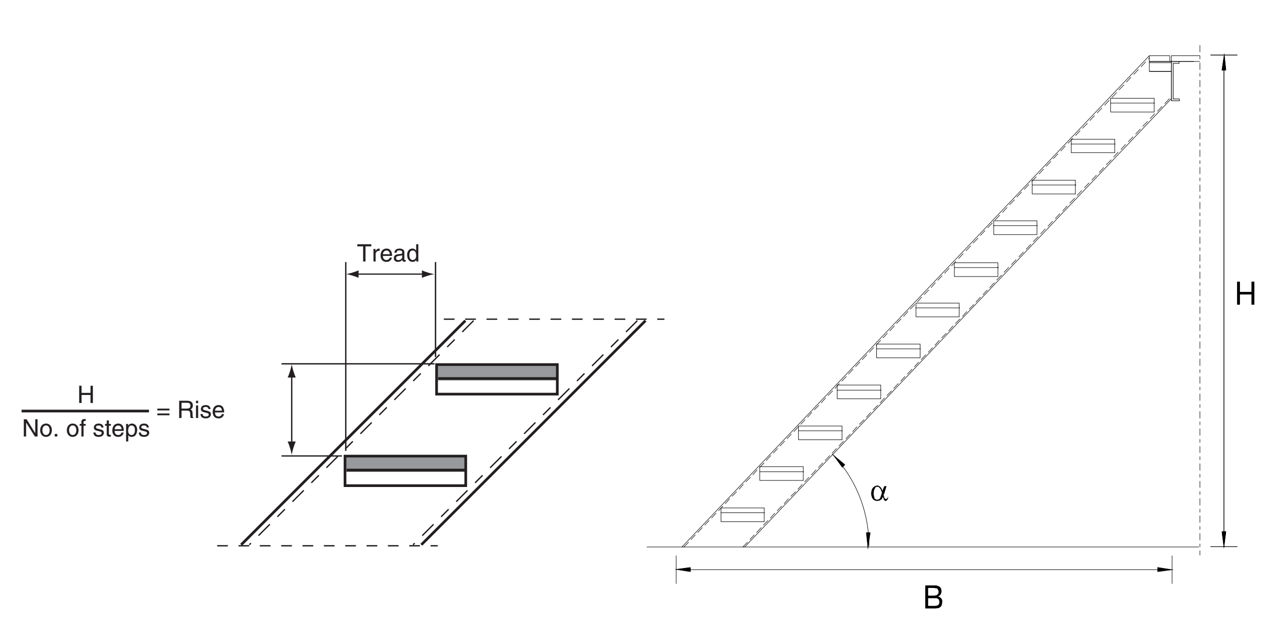


Figure 5.0

The general rules are:

a. 2 rises + 1 tread = 63 cm

b. 1 rise + 1 tread = 42 cm

a.	Rise in cm	16	16,5	17	17,5	18	18,5	19	19,5	20	20,5	21
	Tread in cm	31	30	29	28	27	26	25	24	23	22	21

b.	Rise in cm	16	16,5	17	17,5	18	18,5	19	19,5	20	20,5	21
	Tread in cm	26	25,5	25	24,5	24	23,5	23	22,5	22	21,5	21

Table 5.1, in which the tread is the depth of the individual step and the rise is the difference in height between two steps. The rise is always identical between the steps of an entire staircase.

Normally a rise of 17 to 20 cm is selected, and a tread of 23 to 29 cm. The slope of the stair string is normally between 35° and 45°. However, in designing stairs, the stipulations laid down by the authorities should always be consulted.

Maximum step widths

Table 5.2 indicates maximum step widths for various types of deck as steps. Fiberline technical staff should be contacted if values other than those listed are to be used. The conditions for the values listed are:

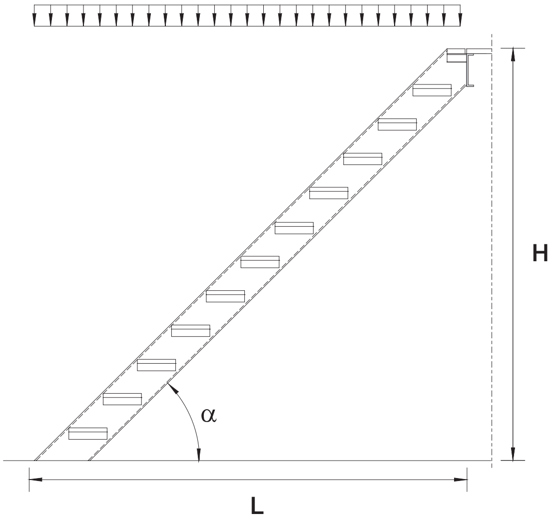
- that the steps can absorb a concentrated load of 2 kN positioned at the middle of the step
- that the steps can absorb a uniformly distributed load of 3.0 kN/m^2
- maximum deflection of 1/ 200 x the width of the stairs.

The maximum stair widths listed in the table fulfil both the strength and the rigidity requirements for the individual step.

Designation	Maximum recommended stepwidth
Walkway plank, h = 40 mm	1200 mm
Pultruded grating, h = 25 mm	600 mm
Pultruded grating, h = 30 mm	850 mm
Pultruded grating, h = 40 mm	1100 mm
Moulded grating, h = 25 mm	500 mm
Moulded grating, h = 30 mm	600 mm
Moulded grating, h = 38 mm	800 mm
Moulded grating, h = 50 mm	1000 mm

Table 5.2. Recommended step widths under the conditions listed above.

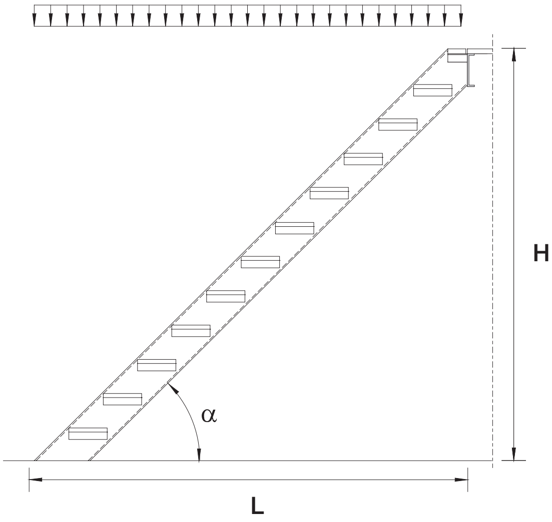
Load-bearing capacity of string in kN/m - Horizontal load corresponding to 5% of the vertical load



U240 x 72 x 8																		
Slope of stairs a / Length L / Height H / Breaking point f_d / Application limit point Maximum deflection < L/200 and Maximum deflection < L/400																		
α	35						40						45					
L (m)	1.50	2.00	2.50	3.00	3.50	4.00	1.50	2.00	2.50	3.00	3.50	4.00	1.50	2.00	2.50	3.00	3.50	4.00
H (m)	1.05	1.40	1.75	2.10	2.45	2.80	1.26	1.68	2.10	2.52	2.94	3.36	1.50	2.00	2.50	3.00	3.50	4.00
f_d	17.00	13.00	10.00	8.00	7.00	2.00	17	13.00	10.00	8.00	7.00	2.00	17.00	13.00	10.00	8.00	7.00	2.00
L / 200	12.10	6.70	4.60	3.30	2.00	1.30	10.50	5.80	4.10	2.90	1.70	1.10	9.00	5.00	3.50	2.50	1.50	1.00
L / 400	6.05	3.35	2.30	1.65	1.00	0.65	5.25	2.90	2.05	1.45	0.85	0.55	4.50	2.50	1.75	1.25	0.75	0.50

U240 x 72 x 12																		
Slope of stairs a / Length L / Height H / Breaking point f_d / Application limit point Maximum deflection < L/200 and Maximum deflection < L/400																		
α	35						40						45					
L (m)	2.00	2.50	3.00	3.50	4.00	4.50	2.00	2.50	3.00	3.50	4.00	4.50	2.00	2.50	3.00	3.50	4.00	4.50
H (m)	1.40	1.75	2.10	2.45	2.80	3.15	1.68	2.10	2.52	2.94	3.36	3.78	2.00	2.50	3.00	3.50	4.00	4.50
f_d	19.50	15.50	13.00	11.00	9.50	8.50	19.50	15.50	13.00	11.00	9.50	8.50	19.50	15.50	13.00	11.00	9.50	8.50
L / 200	16.6	9.40	6.30	4.60	2.60	1.80	14.60	8.20	5.40	4.00	2.20	1.60	12.50	7.00	4.80	3.50	2.00	1.30
L / 400	8.4	4.70	3.15	2.30	1.30	0.90	7.30	4.10	2.70	2.00	1.10	0.80	6.25	3.35	2.40	1.75	1.00	0.65

Load-bearing capacity of string in kN/m - 0.5 kN/m horizontal load calculated 0.9 m above floor level



U240 x 72 x 8																		
Slope of stairs a / Length L / Height H / Breaking point f_d / Application limit point Maximum deflection < L/200 and Maximum deflection < L/400																		
α	35						40						45					
L (m)	1.50	2.00	2.50	3.00	3.50	4.00	1.50	2.00	2.50	3.00	3.50	4.00	1.50	2.00	2.50	3.00	3.50	4.00
H (m)	1.05	1.40	1.75	2.10	2.45	2.80	1.26	1.68	2.10	2.52	2.94	3.36	1.50	2.00	2.50	3.00	3.50	4.00
f_d	17.00	13.00	10.00	8.00	7.00	6.50	17.00	13.00	10.00	8.00	7.00	6.50	17.00	13.00	10.00	8.00	7.00	6.50
L / 200	36.80	10.70	1.34	-	-	-	32.20	9.36	1.17	-	-	-	27.50	8.00	1.00	-	-	-
L / 400	18.4	5.35	0.67	-	-	-	16.1	4.68	0.59	-	-	-	13.75	4.00	0.50	-	-	-

U240 x 72 x 12																		
Slope of stairs a / Length L / Height H / Breaking point f_d / Application limit point Maximum deflection < L/200 and Maximum deflection < L/400																		
α	35						40						45					
L (m)	2.00	2.50	3.00	3.50	4.00	4.50	2.00	2.50	3.00	3.50	4.00	4.50	2.00	2.50	3.00	3.50	4.00	4.50
H (m)	1.40	1.75	2.10	2.45	2.80	3.15	1.68	2.10	2.52	2.94	3.36	3.78	2.00	2.50	3.00	3.50	4.00	4.50
f_d	19.50	15.50	13.00	11.00	9.50	8.50	19.50	15.50	13.00	11.00	9.50	8.50	19.50	15.50	13.00	11.00	9.50	8.50
L / 200	20.00	5.36	-	-	-	-	14.60	4.68	-	-	-	-	12.50	4.00	-	-	-	-
L / 400	10.00	2.68	-	-	-	-	7.30	2.34	-	-	-	-	6.25	2.00	-	-	-	-

Design of stairs

A stairs is needed at an industrial site with the following primary dimensions:

Width 1.0 m, height 2.0 m with a slope of 45°.

The stanchions of the handrail are to be mounted on the outside of a U - 240x72x8 profile which is supported in accordance with Figure 4.1.

The stairs is to be designed for a uniformly distributed load of 3.0 kN/ m^2, and the railing is to be calculated as a horizontal load of 0.5 kN/ m.

Requirements for deformation of the string are maximum 1/ 400 x L.

The following information is listed on page 2.3.7, as it is a condition that it is possible to calculate the steps as partially fixed in the strings.

Ultimate limit state:

$q_d = 1{,}5 \cdot 3.0 \text{ kN/m}^2 \cdot 0.5 \text{ m} = 2.25 \text{ kN/m}$

$q_d <$ 13.00 kN/m. (OK)

Serviceability limit state:

$q_k = 1.0 \cdot 3.0 \text{ kN/m}^2 \cdot 0.5 \text{ m} = 1.50 \text{ kN/m}$

$q_k <$ 4.00 kN/m. (OK)

Thus, a U240x72x8 mm string can be selected, and no further calculations are necessary, since the calculations follow the conditions laid down in the tables.

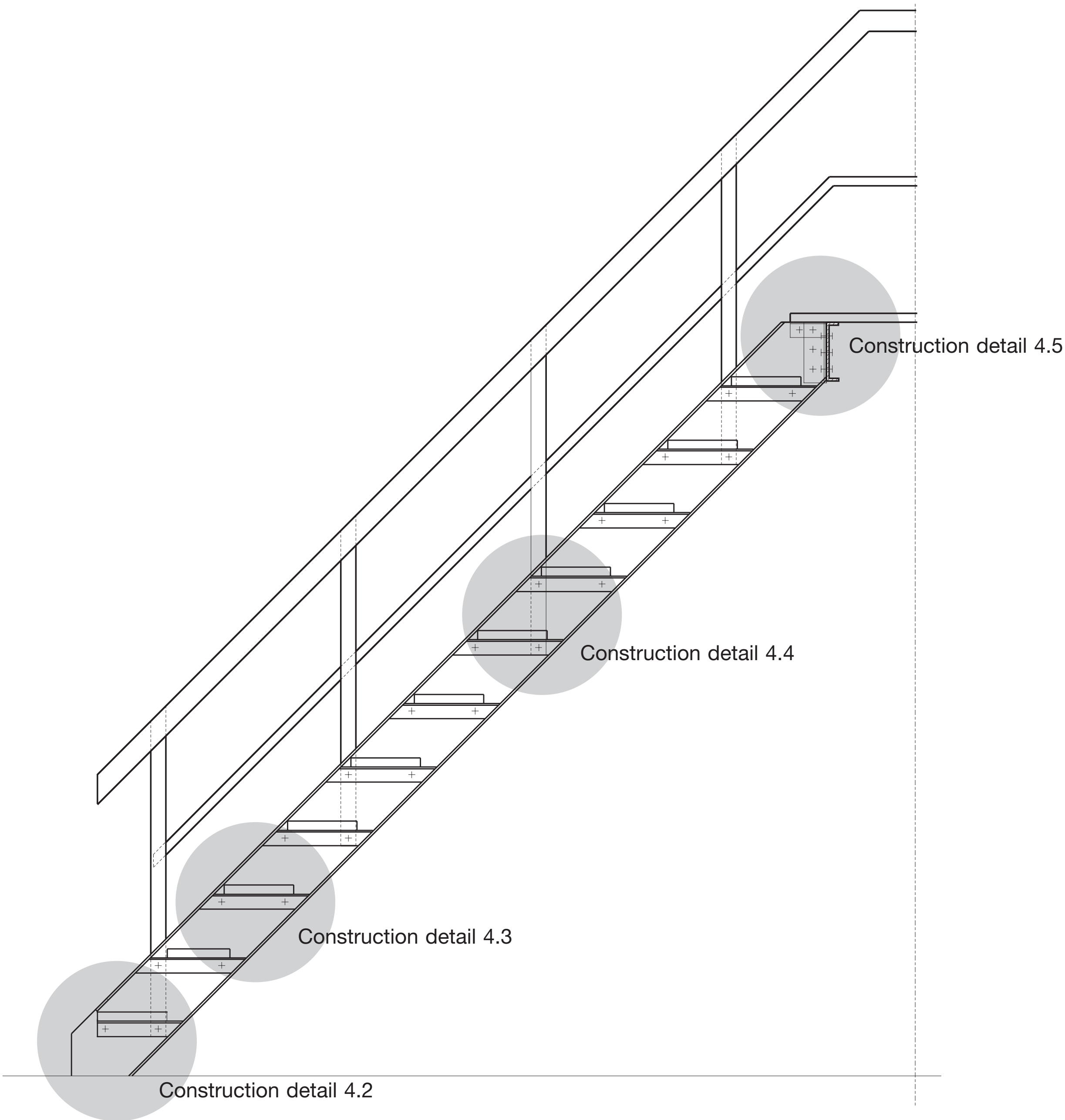
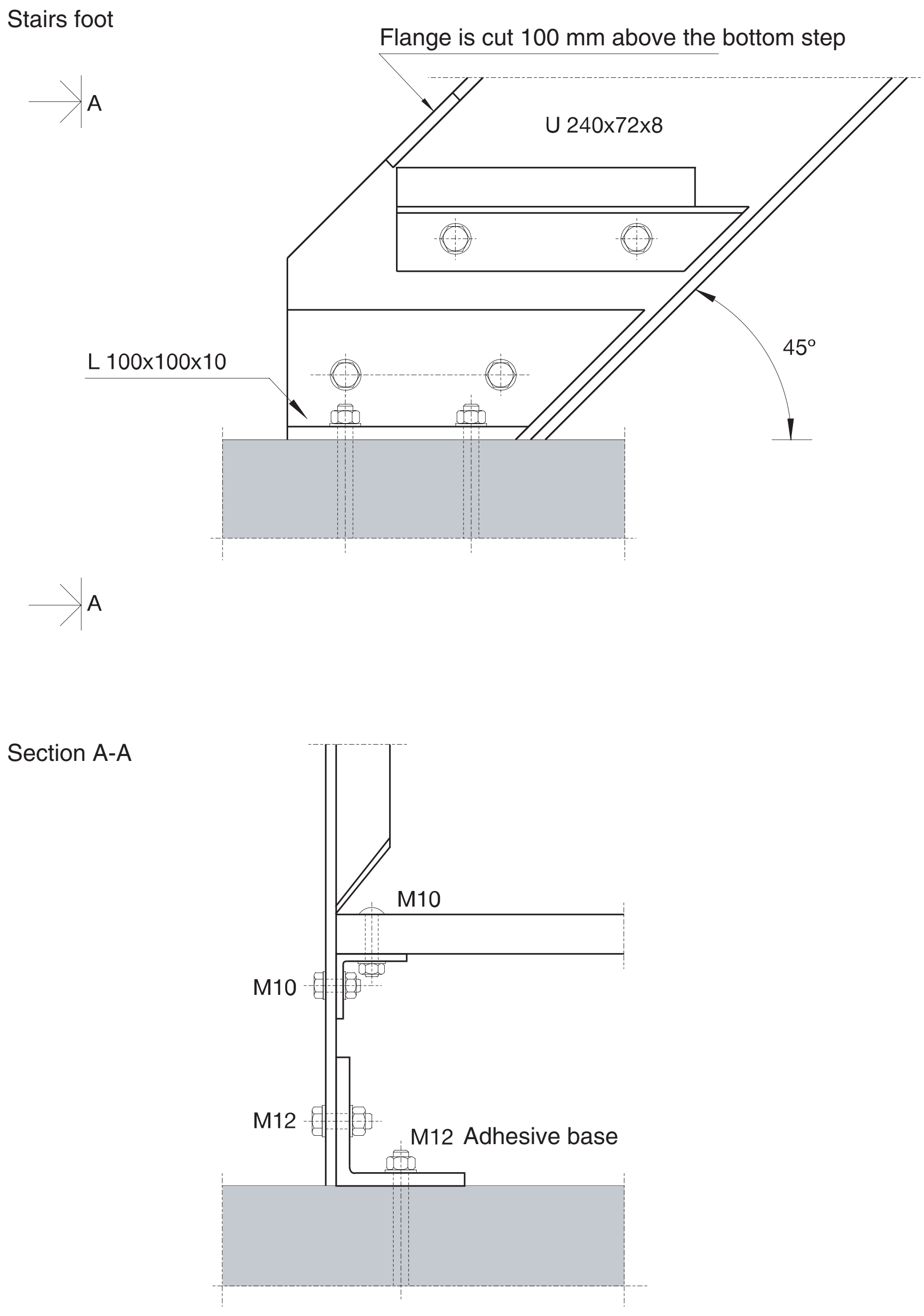
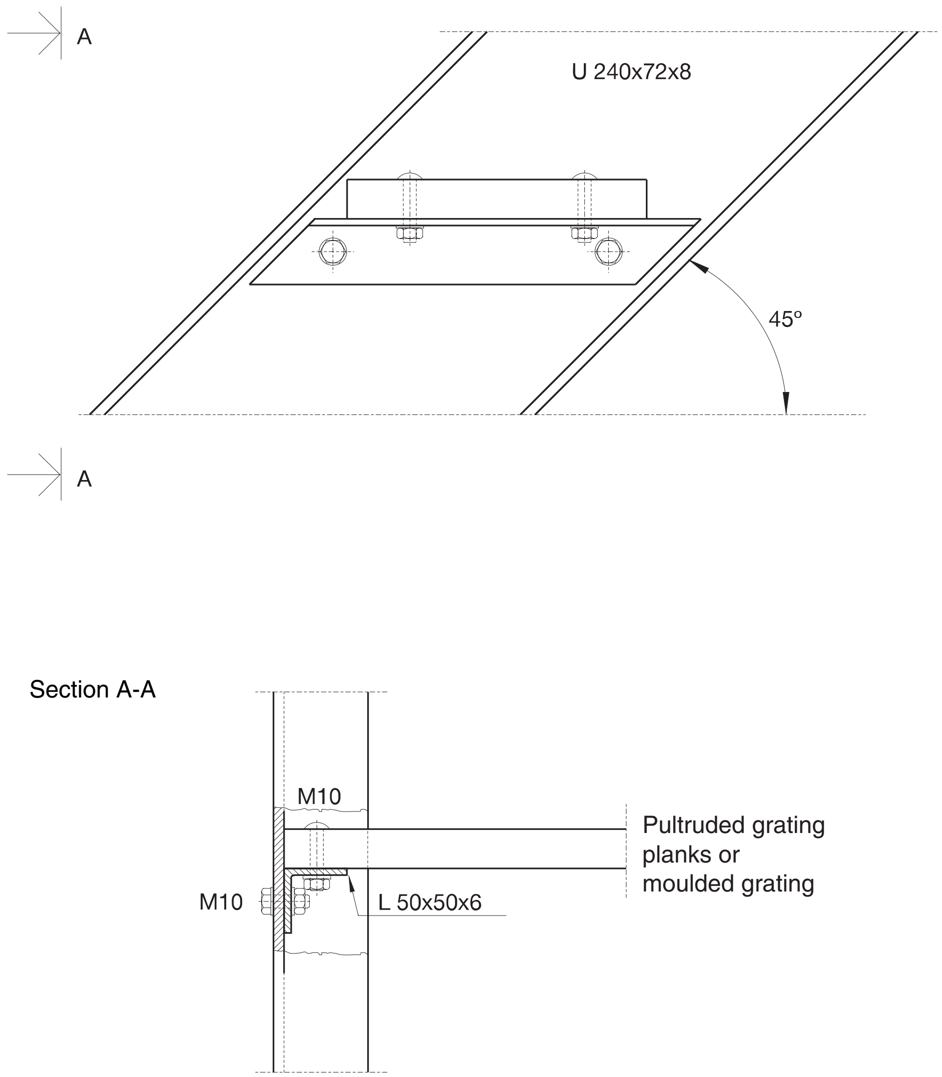

Construction detail 4.5
Construction detail 4.4
Construction detail 4.3
Construction detail 4.2

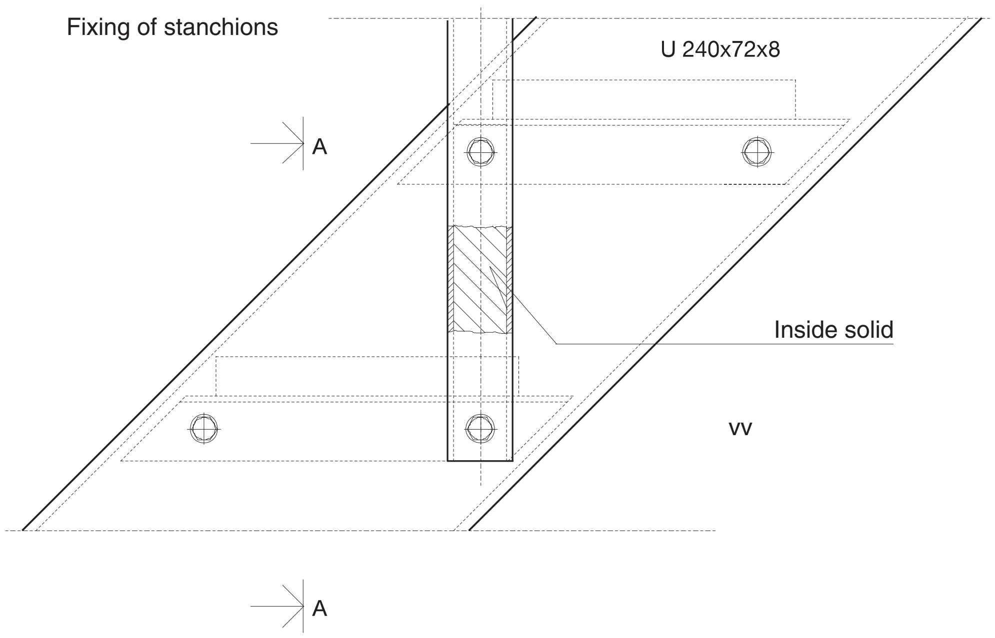
Figure. 4.1

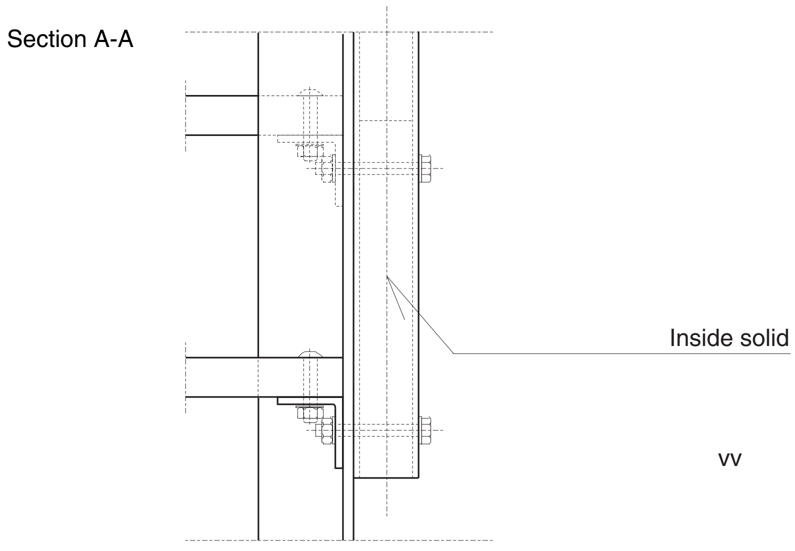


Construction detail 4.2

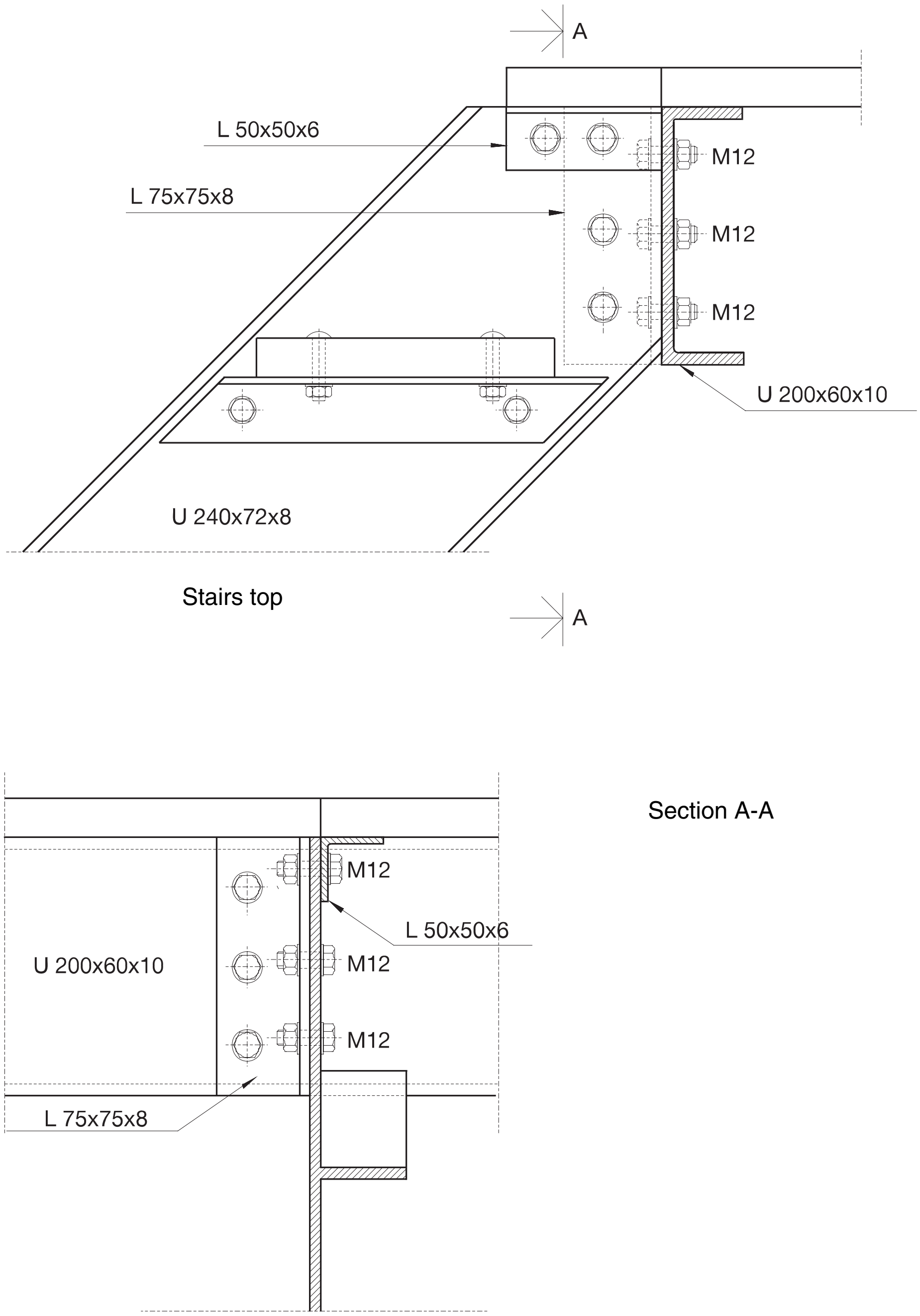


Construction detail 4.3





Construction detail 4.4



Construction detail 4.5

Example of construction of stairs

A typical stairs consists of two strings made of u-profiles and steps consisting of planks, pultruded grating or moulded grating. The railing of the stairs will typically be constructed as a standard Fiberline railing, secured on the side of the strings by bolts. See the section on railings on page 2.2.02. The strings are cut off at the ends to fit against the underlying layer at the floor and at the top.

The steps are secured to the strings using angle profiles which are mounted on the inner side of the strings with M8 plank bolts. The steps are also secured to the angle profiles with M8 plank bolts. If necessary, an intermediate layer can be used to avoid damaging the steps when tightening the bolts.

A stairs is normally secured to the underlying layer by bolts. As the steps are the only connection between the strings, it can be necessary to mount another form of connection in some cases; for example, threaded rods to connect the strings.

The railing consists of stanchions of square tube which are secured on the side of the strings. The distances between stanchions are adjusted so stanchions are positioned at the ends of steps. Stanchions are mounted with two (2) M8 plank bolts which also secure the angle profile that provides support under the step.

The handrail fits down onto the stanchions, and is secured by four (4) pop rivets.

A round pipe is used for the kneerail. It passes through a Ø41 mm hole that is bored through the stanchions parallel to the strings. The kneerail is secured in each stanchion by two (2) pop rivets.

The footrail can be mounted approximately 10 mm above the string by two (2) pop rivets in each stanchion.

Materials for use in constructing stairs

Fiberline planks mounted on an angle profile

The step mounted on the string

Bolts are positioned as shown to secure stanchions and steps

CHAPTER 3: BRACKETS FOR ASSEMBLY

The products and how to use them

Brackets for assembling Fiberline structural profiles have been developed in stainless steel. The objective is to ease mounting and reduce the need for preadjustment of pultruded profiles.

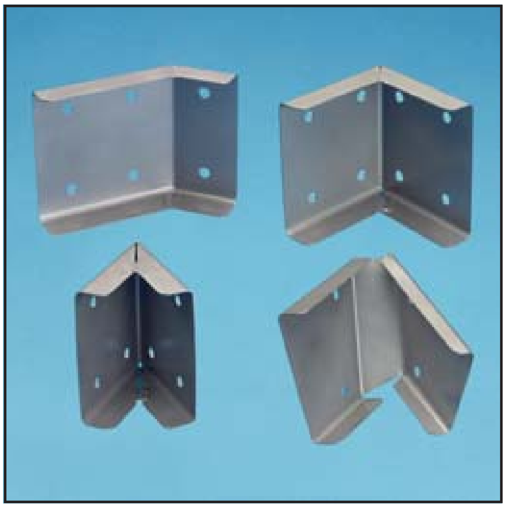
The brackets are normally formed to follow part of the surface of the pultruded profile; for example, on the inside of a U-profile or on the outside of a square profile.

Stainless steel bolts ensure transfer of forces between brackets and profile. In addition, they ensure that the brackets remain in position during operation.

The brackets are cut by laser beam and are CNC bent to their finished geometry. In situations which require brackets that are not available in the standard range, the Fiberline technical department will normally be able to help in manufacturing special brackets.

On the following pages, there are a number of examples of designing joints in which stainless steel fittings are used. In these examples, the most important criteria for determining the load-bearing capacity of the joints are included. Below each example, the supplementary investigations are listed which are necessary for investigating all the conditions that are relevant to the static load-bearing capacity.

There are examples of brackets for assembly in the photograph below.



Brackets for efficient assembly of profile structures.

Example of joint with a Fiberline bracket. EP patent No. 0819200

Example 8.1

90° joint between two I-profiles 160 x 80 x 8
The assembly brackets follow the body and the inside of the flanges on the through-going and adjacent profile. The bracket is made of stainless steel with a yield stress of 220 MPa.

Vertical shear load:
Figure 3.2.1 illustrates the forces in the joint.
The load is transferred as contact compression between the bracket and the bottom side of the top flange of the adjacent profile.
The force is transferred through the stainless steel bracket to the through-going bottom flange of the profile.
As the through-going profile has relatively little torsional rigidity, the static model must ensure that the shear from the adjacent profile can be transferred to the body of the through-going profile by the joint. Therefore, there are secondary forces to ensure balance. The eccentricity moment causes contact compression between the top flanges of the two profiles, and tension in the bolts perpendicular to the through-going body of the profile.

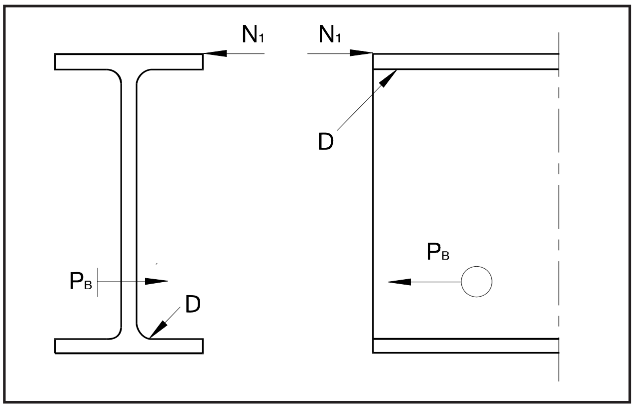


Figure 3.2.1

Shear in the top flange of the adjacent profile

Contact compression between the profile and the bracket is concentrated near the end section of the profile.

The capacity of the two flanges is evaluated as

$$Q1 = \Delta L \cdot t_f \cdot f_{td} \cdot 2$$

$$= 40\text{ mm} \cdot 8\text{ mm} \cdot \frac{25\text{ MPa}}{1{,}3} = 12\,307\text{ N}$$

Shear in the stainless steel bracket

The dimension of the plate area that is affected by shear is calculated as 96 mm x 140 mm.

The load-bearing capacity of the bracket in shear is evaluated according to EC 3 (ENV 1993-1-1). The designations below are in accordance with EC3.

$$kt = \frac{5{,}34}{\left(\frac{96}{140}\right)^2} = 15.4$$

$$lw = \frac{d \cdot 37{,}4 \cdot \sqrt{kt}}{t_w \cdot \varepsilon} = \frac{140 \cdot 37{,}4 \cdot \sqrt{15{,}4}}{1{,}0 \cdot 1{,}03}$$

$$= 0.93$$

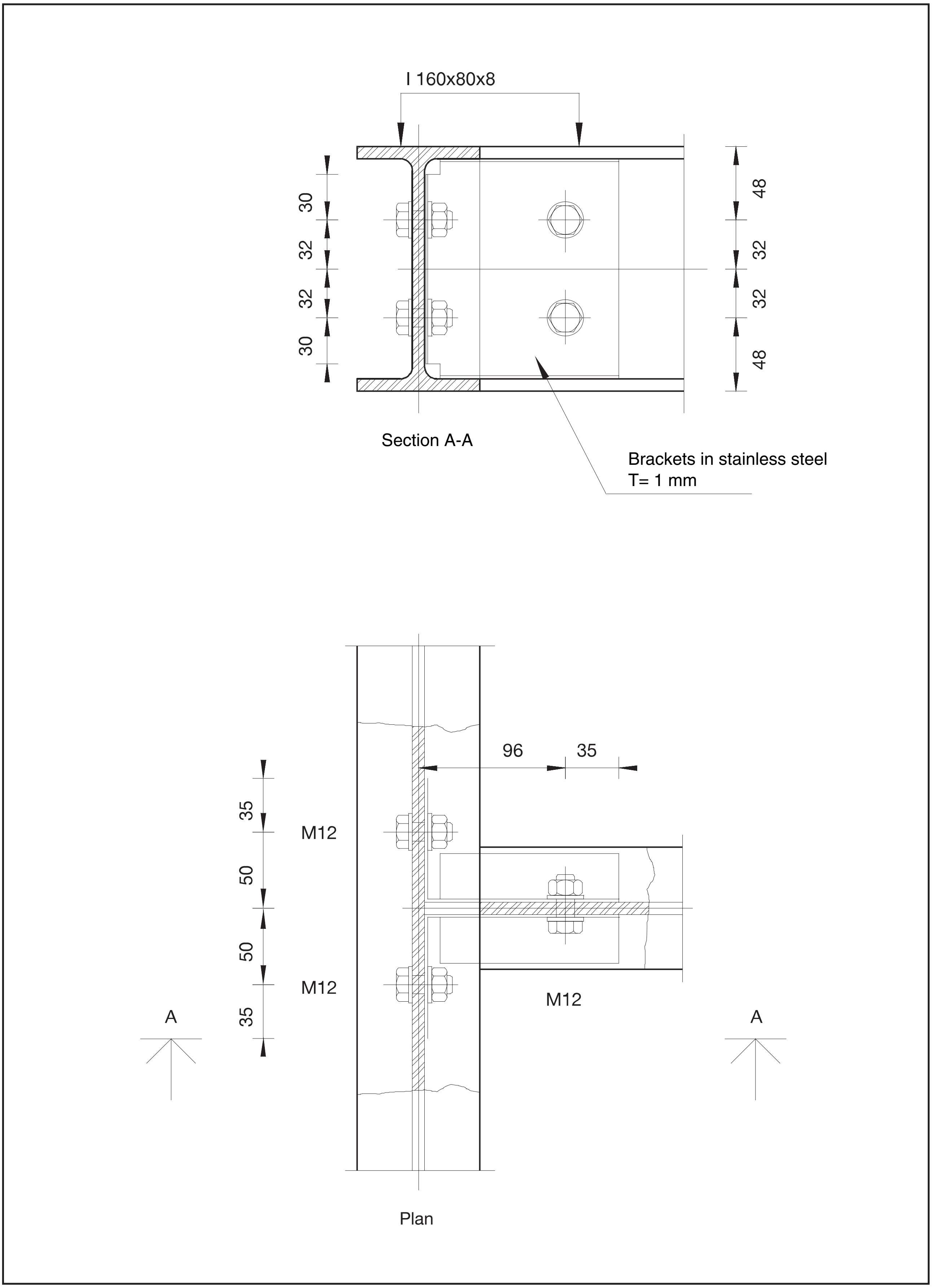

I 160x80x8
30
32
32
30
48
32
32
48
Section A-A
Brackets in stainless steel
T= 1 mm
96
35
35
50
50
35
M12
M12
M12
A
A
Plan

Figure 3.1.2

As lw is greater than 0.8, the load-bearing capacity of the bracket in shear is reduced due to the stability.

$$\tau_{ba} = (1 - 0.625 \times (\lambda_w - 0.8)) \cdot t_y = 0.92 \cdot 127 \text{ MPa} = 117 \text{ MPa}$$

The maximum shear that can be transferred through the two brackets is

$$Q2 = d \cdot t_w \cdot t_{ba} \cdot 2 = \frac{140 \text{ mm} \cdot 1{,}0 \text{ mm} \cdot 220 \text{ MPa}}{\sqrt{3} / 1{,}3 \times 2} = 27\,357 \text{ N}$$

<u>The shear fracture in the bottom flange of the through-going profile.</u>

The load width of the bottom flange of the through-going profile is evaluated as an effective value of 100 mm.

The capacity of the flange is evaluated as

$$Q3 = \Delta L \cdot t_f \cdot f_t$$

$$= 100 \text{ mm} \cdot 8 \text{ mm} \cdot \frac{25 \text{ MPa}}{1{,}3} = 15\,384 \text{ N}$$

The capacity of the joint with regard to vertical shear force is

$$Q_{max} = \min \{ Q1, Q2, Q3 \} = 12.3 \text{ kN}$$

<u>Supplementary calculations not contained in the example:</u>

- normal pressure force (N_F) between the top flanges of the adjacent and through-going profiles
- bolt strength (P_B) perpendicular to the body of the through-going profile
- shear between brackets and the body of the adjacent profile

<u>*Normal force in the adjacent profile*</u>

With normal pressure force in the adjacent profile, there will be a moment due to deflection in the bracket at the bolts in the through-going profile.

The capacity with regard to normal tensile force in the adjacent profile is

$$N = \frac{2 \cdot 124 \text{ mm} \cdot \frac{1}{6} \cdot (1{,}0 \text{ mm})^2 \cdot 220 \text{ MPa}}{40 \text{ mm}} = 227 \text{ N}$$

If the load-bearing capacity is not sufficient for the purpose, a steel plate can be placed between the bracket and the nuts on the bolts through the body of the through-going profile.

Supplementary calculations not contained in this example:

- normal pressure force (N_F) between the top flanges in the adjacent and through-going profiles
- bolt strength (P_B) perpendicular to the body of the through-going profile
- shear between brackets and the body of the adjacent profile.

Example 8.2

90° joint between I-profiles 300 x 150 x 15 and I 200 x 100 x 10

The joint transfers the shear from the adjacent profile to the through-going profile by way of two (2) types of bracket:

an angle bracket that is pressed in between the flanges of the adjacent profile so it connects with the body of the profile, and an angle bracket that connects with the body of the through-going profile and the inside of the flanges. The shear is transferred by bolts.

Shear
For calculation purposes, the joint has a vertical, downward shear force which must be transferred from the profile being connected to the through-going profile.

Bolts between brackets:
Pin-bearing strength of bolt in sheet1.5 mm:

$$M16 \; :3.2 \cdot d \cdot t \cdot f_y = \frac{3,2 \cdot 16 \text{ mm} \cdot 1,5 \text{ mm} \cdot 220 \text{ MPa}}{1,3} = 13.0 \text{ kN}$$

Bolt strengths must be statically equivalent to the shear force (Q) positioned in the centre line of the body of the through-going profile.

Bolt strengths, vertical:

$$\Delta N_{B1} = \frac{Q}{2}$$

Bolt strengths, horizontal

$$\Delta N_{B2} = \frac{Q \cdot 30 \text{ mm}}{80 \text{ mm}} = 0.375\,Q$$

The total bolt strength is thus

$$N_B = 0.625\,Q.$$

The capacity of the joint with regard to the pin-bearing strength of the bolts is determined by

$$Q = \frac{0,625}{13,0} = 20.8 \text{ kN}$$

Bolts in the through-going profile
Load-bearing capacity of bolts M16 in the body of **I** 300 x 150 x 15

$$M16 \; : d \cdot t \cdot f_{c1} = \frac{16 \text{ mm} \cdot 15 \text{ mm} \cdot 240 \text{ MPa}}{1,3} = 44.3 \text{ kN}$$

The pin-bearing strength of M12 bolt in sheet 1.5 mm is

$$M12 \; :3.2 \cdot d \cdot t \cdot f_y = \frac{3,2 \cdot 12 \text{ mm} \cdot 1,5 \text{ mm} \cdot 220 \text{ MPa}}{1,3} = 9.7 \text{ kN}$$

The total capacity of the four M12 bolts is thus $4 \cdot 9.7 \text{ kN} = 38.8 \text{ kN}$

Shear in the top flange of the adjacent profile
The contact compression between profile and bracket is concentrated near the end section of the profile.
The capacity of the two flanges is evaluated as

$$Q1 = \Delta L \cdot t_f \cdot f_{\tau,d} \cdot 2$$

$$= \frac{50 \text{ mm} \cdot 10 \text{ mm} \cdot 2 \cdot 25 \text{ MPa}}{1,3} = 19.2 \text{ kN}$$

Load-bearing capacity of joint
The total vertical shear force which can be transferred from the profile being connected to the through-going profile is thus 19.2 kN.

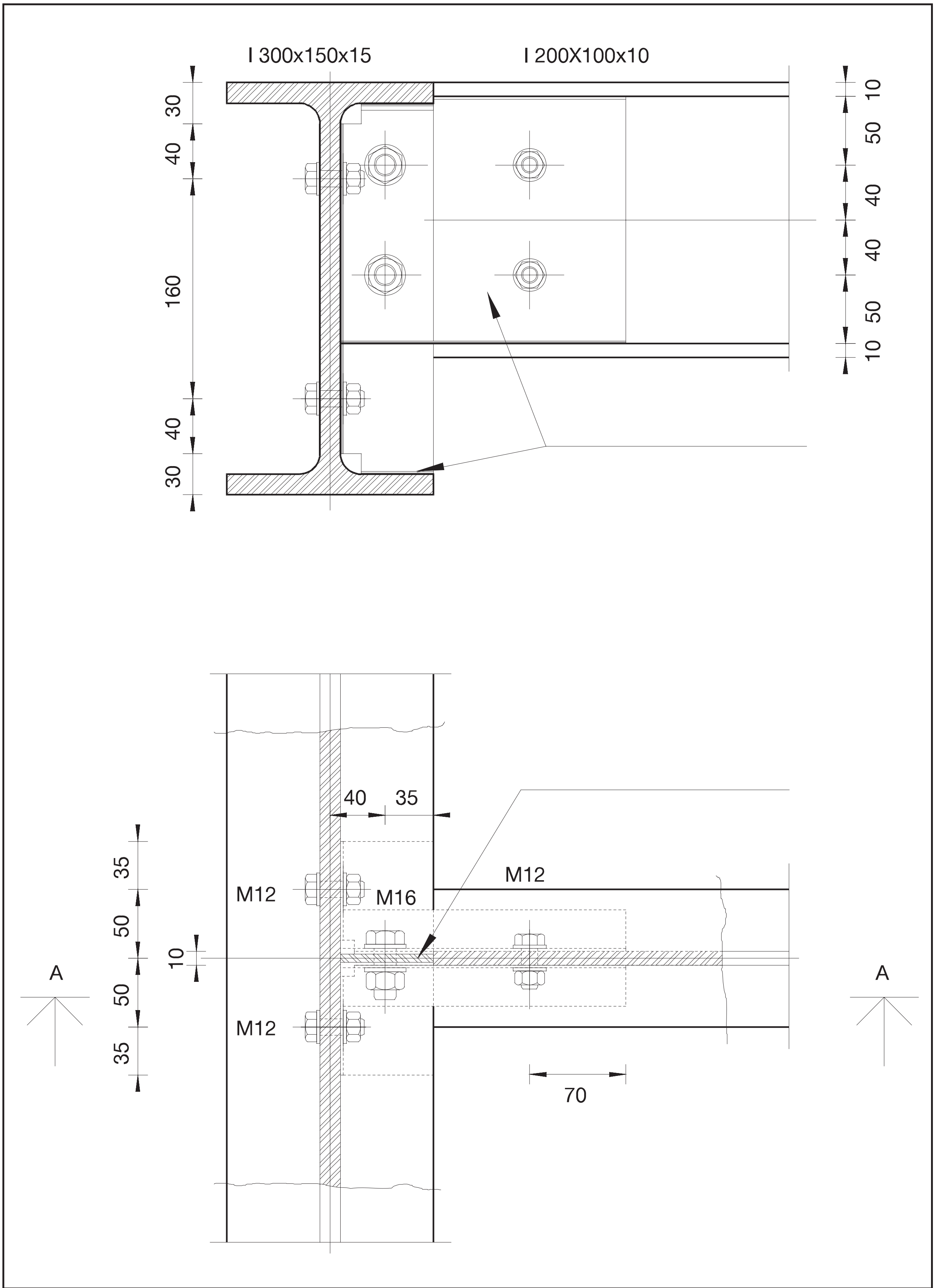

I 300x150x15
I 200X100x10
30
40
160
40
30
10
50
40
40
50
10
40
35
M12
M12
M16
M12
35
50
10
50
35
A
A
70

Figure 3.2.2

Example 8.3

Butt joint between two I-profiles 200 x 100 x 10
The joint is typically used in joining two profile sections, the length of which exceeds the lengths normally supplied. The bracket is made of stainless steel sheet with a thickness of 1.0 mm.

Normal force in I 200 x 100 x 10

Capacity of bolts in pultruded profile:

$$\text{M20}: d \cdot t \cdot f_{c0°,d} = \frac{20\text{ mm} \cdot 10\text{ mm} \cdot 240\text{ MPa}}{1{,}3} = 36.9\text{ kN}$$

$$\text{M12}: d \cdot t \cdot f_{c0°,d} = \frac{12\text{ mm} \cdot 10\text{ mm} \cdot 240\text{ MPa}}{1{,}3} = 22.2\text{ kN}$$

The maximum normal force which can be transferred from bolt to profile is the sum total of the capacity of the individual bolts.

$$N_1 = 4 \cdot 36.9\text{ kN} + 4 \cdot 22.2\text{ kN} = 236.4\text{ kN}$$

Capacity of bolts in brackets:

$$\text{M20}: 3.2 \cdot d \cdot t \cdot f_{yd} = \frac{3{,}2 \cdot 20\text{ mm} \cdot 1{,}0\text{ mm} \cdot 220\text{ MPa}}{1{,}3} = 10{,}8\text{ kN}$$

$$\text{M12}: 3.2 \cdot d \cdot t \cdot f_{yd} = \frac{3{,}2 \cdot 12\text{ mm} \cdot 1{,}0\text{ mm} \cdot 220\text{ MPa}}{1{,}3} = 6.5\text{ kN}$$

The maximum normal force that can be transferred from bolts to brackets is the sum total of the capacity of the individual bolts.

$$N_1 = 8 \cdot 10.8\text{ kN} + 4 \cdot 6.5\text{ kN} = 112.4\text{ kN}$$

The capacity of the joint with regard to normal tensile force is thus determined by the bracket. The capacity is 112.4 kN, corresponding to axial tension in I 200 x 100 x 10 of 29 MPa.

Moment in I 200 x 100 x 10
The figure illustrates force sequence in the joint.

The moment in I 200 x 100 x 10 causes a normal pressure force between the two top flanges of the profiles.

The bottom part of the bracket transfers the tension between the bottom bolts in the joint. The maximum compressive force that can be transferred between the top flanges is

$$N_1 = b \cdot t \cdot f_{c0°d}$$

$$= \frac{100\text{mm} \cdot 10\text{ mm} \cdot 240\text{ MPa}}{1{,}3}$$

$$= 184.6\text{ kN}$$

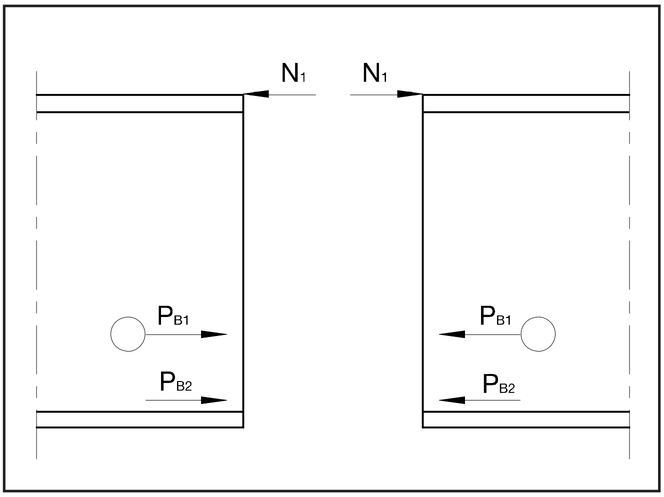


Figure 3.3.1

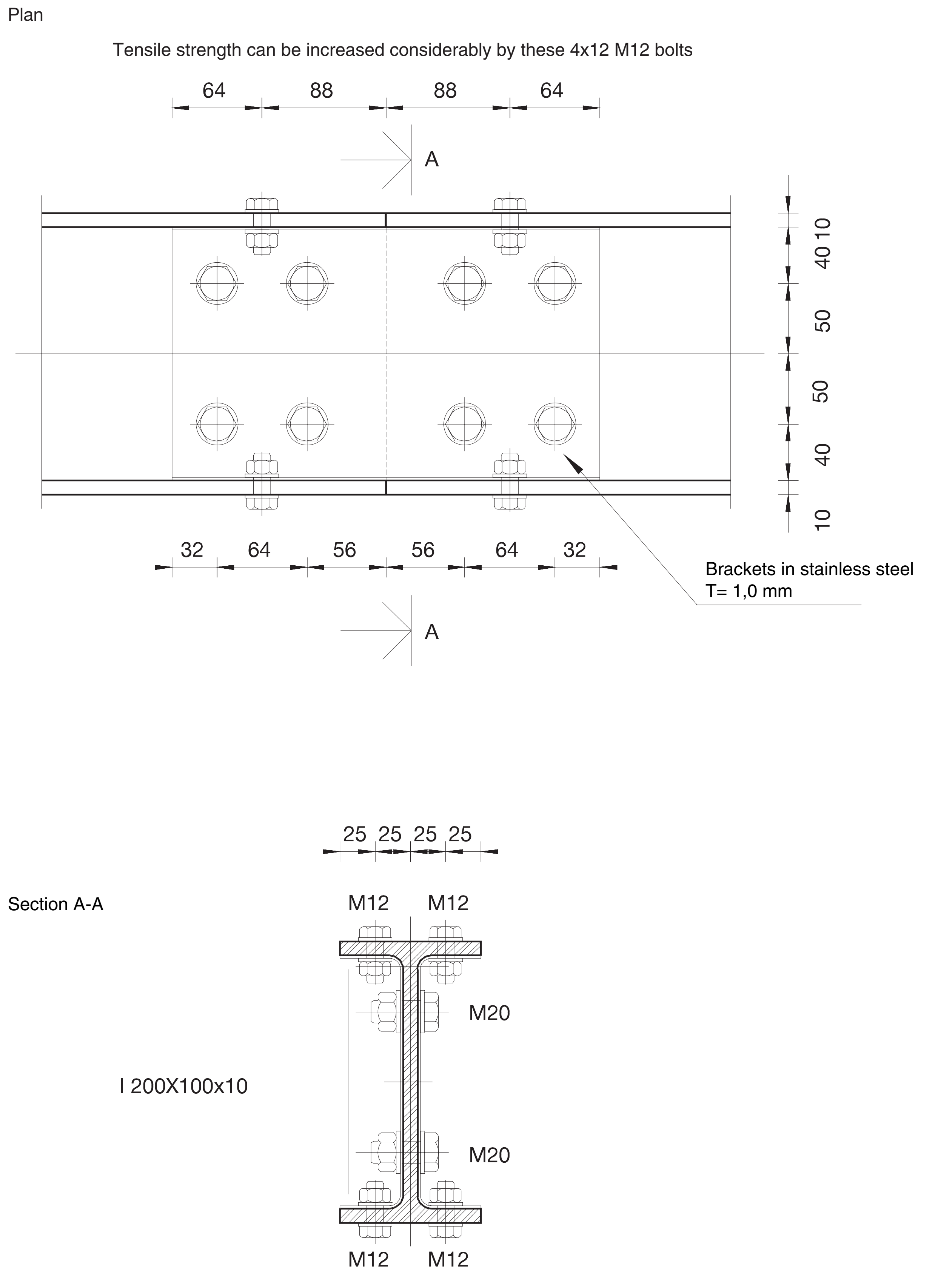

Plan
Tensile strength can be increased considerably by these 4x12 M12 bolts
64
88
88
64
A
40 10
50
50
40
10
32
64
56
56
64
32
Brackets in stainless steel
T= 1,0 mm
A
25
25
25
25
Section A-A
M12
M12
M20
I 200X100x10
M20
M12
M12

Figure 3.3.2

The maximum shear that can be transferred from profile to bracket by means of bolts according to page 3.1.10 is

M 20	10.8 kN / cut
M12	6.5 kN / cut

M12 in the bottom flange and the bottom row M20 is considered as contributing to absorption of the stress. The capacity of the joint with regard to moment is thus

$$M_{max} = 4 \cdot 10.8\ \text{kN} \cdot 145\ \text{mm} + 4 \cdot 6.5\ \text{kN} \cdot 185\ \text{mm}$$
$$= 6.3\ \text{kNm} + 4.8\ \text{kNm}$$
$$= 11.1\ \text{kNm}$$

A moment of 14.4 kNm in I 200 x 100 x 10 corresponds to an edge stress of 47 MPa.

<u>*Shear in I 200 x 100 x 10*</u>

The figure illustrates the force sequence in the joint. The shear in I 200 x 100 x 10 results in contact compression between the flanges of the profile and the bracket, corresponding to the contact compression which is illustrated in Example 8.1.

The shear in the top flange of the profile that is connected, the contact compression between profile and bracket, is concentrated near the end section of the profile.

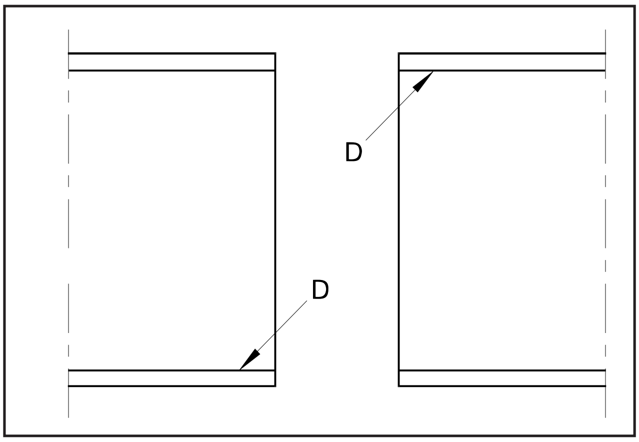


Figure 3.3.3

The capacity of the two flanges is evaluated as

$$Q1 = \Delta L \cdot t_f \cdot f_{\tau d} \cdot 2 = \frac{50\ \text{mm} \cdot 10\ \text{mm} \cdot 2 \cdot 25\ \text{MPa}}{1{,}3} = 19.2\ \text{kN}$$

<u>*Shear in the stainless steel bracket*</u>

The dimension of the plate area on the bracket which is affected by shear, is calculated as 112 mm x 180 mm. The load-bearing capacity of the shear field is evaluated according to EC 3 (ENV 1993-1-1). The calculations below are in accordance with EC3.

$$k_\tau = \frac{5{,}34}{\left(\frac{112}{180}\right)^2} = 17.8$$

$$\lambda_w = \frac{d \cdot 37{,}4 \cdot \sqrt{k_\tau}}{t_w \cdot \varepsilon} = \frac{180 \cdot 37{,}4 \cdot \sqrt{17{,}8}}{1{,}0 \cdot 1{,}03} = 1.11$$

As λw is greater than 0.8, the load-bearing capacity of the bracket in the shear field is reduced due to stability.

$$\tau_{ba} = (1 - 0.625 \cdot (\lambda_w - 0.8)) \times t_{yd} = \frac{0{,}81 \cdot 220\ \text{MPa}}{\sqrt{3} \cdot 1{,}3} = 79\ \text{MPa}$$

The maximum shear that can be transferred through the two brackets is

$$Q_2 = d \cdot t_w \cdot \tau_{ba} \cdot 2 = 180\ \text{mm} \cdot 1.0\ \text{mm} \cdot 79\ \text{MPa} \cdot 2 = 28.5\ \text{kN}$$

The load-bearing capacity of the joint which is determined by the load-bearing capacity of the profile is 19.2 kN, corresponding to shear stress of 9.6 MPa.

Example 8.4

Support brackets for beams I 200 x 100 x 10 on columns of square tube 100 x 100 x 8

The fitting is used where vertical loads from a beam must be transferred to a column.

Under the beam (I 200 x 100 x 10) the bracket is L-formed, around the column, U-formed.

To transfer vertical shear from bracket to column, bolts are positioned in the tongues which connect to the sides of the column facing the beam, and facing the opposite direction, respectively.

Figure 3.4.1 illustrates the forces in the joint. The shear from I 200 x 100 x 10 causes a compressive force which, via the vertical side of the bracket, is transferred to the bottom side of the bracket.

The bottom part of the bracket presses against the front side of the column, and the top part presses against the rear side of the column.

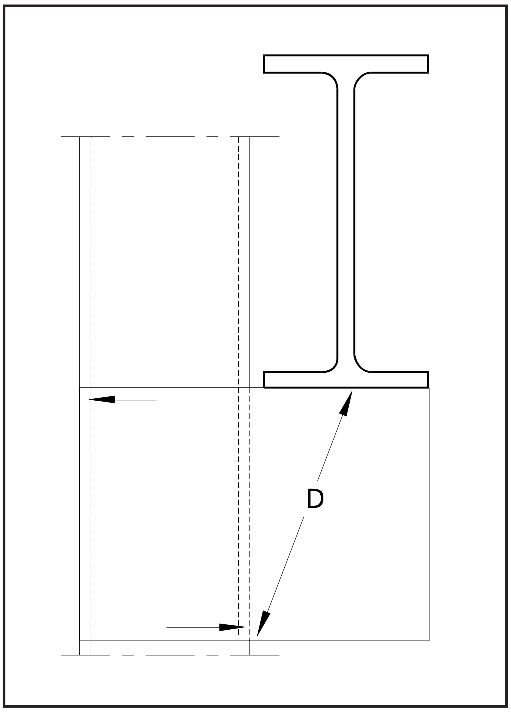


Figure 3.4.1

Shear in the stainless steel bracket
The dimension of the plate which is influenced by shear is calculated as 108 mm x 150 mm. The stress occurs 58 mm from the column. The narrowness of the field of the profile is calculated as approximately

$$\lambda = \frac{75\text{ mm} \cdot \sqrt{12}}{2{,}0\text{ mm}} = 130$$

A strip of 75 mm is calculated to be effective to withstand the absorption of stress.

The relative narrowness is determined as

$$\lambda\xi = \frac{\lambda}{\lambda 0^\circ} = \frac{\lambda}{\pi \cdot \left(\frac{E}{f_y}\right)^{0,5}} = \frac{130}{\pi \cdot \left(\frac{210000}{220}\right)^{0,5}} = 1.34$$

Using column curve C, the limits for the inclined pressure in the plate are determined as

$$D_{max} = \chi \cdot f_{yd} \cdot t \cdot b_{eff}$$

$$= 0.37 \cdot \frac{220\text{ MPa}}{1,3} \cdot 2\text{ mm} \cdot 75\text{ mm}$$

$$= 9.4\text{ kN}$$

The vertical component of the inclined pressure is 8.8 kN, while the horizontal component is 3.4 kN.

The bottom M16 bolt transfers the vertical load from the fitting to the column.

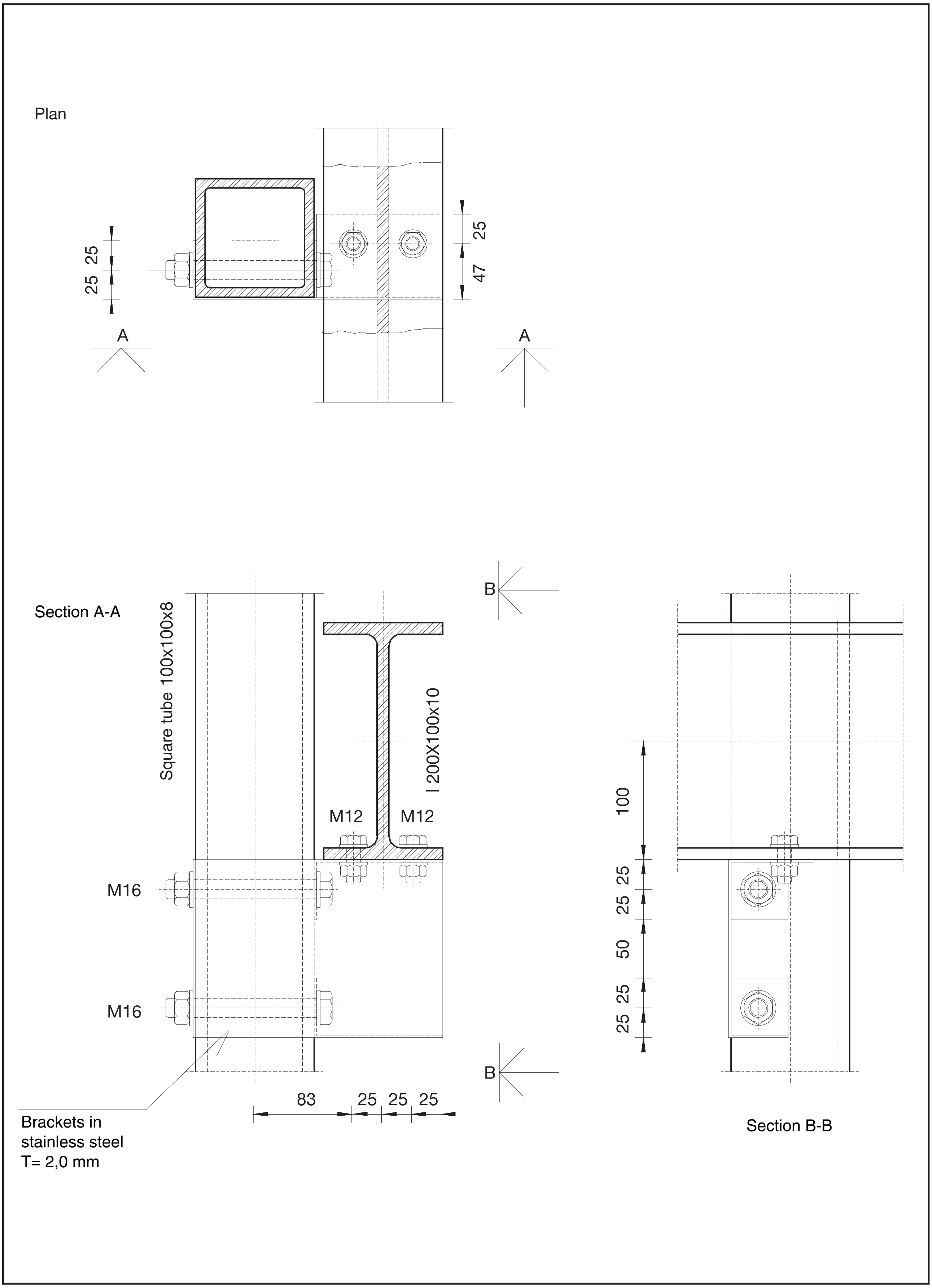

Plan
25
25
25
47
25
A
A
Section A-A
Square tube 100x100x8
I 200X100x10
M12
M12
M16
M16
B
B
Brackets in
stainless steel
T= 2,0 mm
83
25
25
25
100
25
25
50
25
25
Section B-B

Figure 3.4.2

Pin-bearing strength of the bracket is

$$\text{M16} \quad : \quad 3.2 \cdot d \cdot t \cdot f_{yd} \quad = \quad \frac{3{,}2 \cdot 16\ \text{mm} \cdot 2{,}0\ \text{mm} \cdot 220\ \text{MPa}}{1{,}3} \quad = \quad 17.3\ \text{kN}$$

The force which can be transferred from bolt to profile is

$$\text{M16} \quad : \quad d \cdot t \cdot f_{c0^\circ d} \quad = \quad \frac{16\ \text{mm} \cdot 8\ \text{mm} \cdot 240\ \text{MPa}}{1{,}3} \quad = \quad 30.7\ \text{kN}$$

The maximum shear which can be transferred from beam to column is thus 8.8 kN.

CHAPTER 4: FIRE TECHNICAL PROPERTIES

Fire technical properties

Fiberline are currently conducting research in cooperation with universities to ascertain fire-resistance capabilities, as well as to develop calculation methods for profiles during fire and loading.

Fiberline quality P4506 is a fire-inhibiting product which has been approved in accordance with BS 476 Part 7/ 6, and is very flame retardant and flame resistant.

Fiberline quality F4010 is the optimal fire-technical phenol matrix. Data for this quality are not included in the construction manual, but can be obtained by contacting Fiberline.

As fire requirements vary greatly according to use and national legislation, specific requirements for particular structures should always be obtained in each specific case.

In many cases, it is possible for Fiberline to adjust the content of the matrix materials to fulfil special fire technical requirements.

CHAPTER 5: CHEMICAL RESISTANCE

Introduction

The chemical resistance list contains an overview of three Fiberline qualities placed in various chemical environments. The figures indicate the highest known operational temperatures in C°, under which the profiles have displayed good service life in the specific chemical environments. The results have been obtained either through experience from industrial use, or by means of laboratory tests (ASTM C581) carried out by Fiberline suppliers.

If the chemical influence is not permanent/concentrated, but short-term/weak (as from steam or waste) it is possible to use gratings, planks and structural supports in chemical environments which are indicated as NR (Not recommended), or in higher temperatures than indicated.

In contrast to metals, Fiberline structural profiles are not subject to electrolytic corrosion.

The results in this chemical resistance list are guidelines only, and therefore ought not to be considered as instructions for the chemical resistance of the various qualities of profile. Any combination of chemicals or combined environmental stress should be discussed with Fiberline or tested prior to commencing use.

All information contained in this list is supplied in good faith as guidelines for our customers, with no liability whatsoever for Fiberline.

Fiberline reserve the right to make changes without prior notice.

Please note that the chemical resistance values indicated are based on profiles with surface veils and sealing of all machined surfaces.

Fiberline qualities compared to metals and wood

The chemical resistance of three (3) Fiberline matrix qualities compared to selected metal qualities and wood in twelve (12) different corrosive environments. The figures in the table indicate the highest known operational temperature in C°:

	Chemical load										
Material	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Fiberline P2600	40	NR	40	40	40	30	NR	40	35	NR	40
Fiberline P4506	50	NR	50	50	50	40	NR	50	40-60	NR	50
Fiberline P3510	100	75	90	100	90	100	45	90	95	45	90
Steel	NR	NR	NR	NR	NR	NR	R	NR	NR	NR	NR
Galvanized steel	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Wood		NR				NR	NR	NR	R	NR	NR
SS 304	NR	R	R	R	R		R	NR	R[#]		LC
SS 316 („Acid-proof “)	NR	R	R	LC[#]	R	NR	R	NR	R[#]	LC	NR
Titan	R	R	R	R[#]		NR	R	R	R	R[#]	R
Rapid alloy „B“	R	R	R	R	NR	R	R	R	R	NR	R
Rapid alloy „C“	R	R	R	LC	R	R	R	NR	R	R	LC
Monel metal 400	LC	LC	LC	LC	NR		R	NR	R	NR	R
Aluminium	LC	LC	NR	R	NR	NR	NR	NR	LC	NR	NR
Copper/Nickel 70/30	LC	NR	LC				R	NR	R	NR	LC

Chemical load:

1) Aluminium chloride 5%
2) Ammonium hydroxide 5%
3) Barium chloride 5%
4) Calcium chloride
5) Iron nitrate 5%
6) Hydrochloric acid 10%
7) Sodium hydroxide 10%
8) Mercury chloride
9) Sodium chloride
10) Sodium hypo chlorite 5%
11) Sulphuric acid 15%

LC : Light corrosion

R : Resistant

NR : Not recommended

[#] : Surface pitting can be expected

The values in the tables for metals and wood are valid for surrounding temperatures of approximately 20 C°.

Chemical resistance – Fiberline Profiles

Fiberline Composites A/ S test the chemical resistance of its pultruded profiles in a representative selection of chemicals which are listed below. The chemical resistance list of our suppliers of polyesters has been supplemented with the list below, which shows the resistance capabilities of Fiberline profiles in corrosive environments. The data comparisons enable us to provide improved service and consulting for our customers, in selecting the appropriate quality of polyester.

Chemical	Concentration %	Chemical formula	Fiberline P2600	Fiberline P4506	Fiberline P3510
Alcohol, ethyl	95%	C_2H_5OH	25°C	30°C	35°C
Ammonium hydroxide[2]	5 %	NH_4OH	NR	NR	75°C
Iron (III) chloride	All	$FeCl_3$	35°C	50°C	95°C
Sodium hydroxide[2]	10 %	NaOH	NR	NR	45°C
Sodium hypochlorite[1,2]	5 %	NaOCl	NR	NR	45°C
Sodium chloride	All	NaCl	35°C	50°C	95°C
Nitric acid	5 %	HNO_3	NR	NR	65°C
Hydrochloric acid	10 %	HCl	30°C	40°C	95°C
Toluene	100 %	C_7H_8	NR	NR	35°C
Water	100 %	H_2O	35°C	40-60°C	90°C

NR: Not recommended

1 Contact Fiberline for specific recommendations

2 Fiberline P3510 recommended

CHAPTER 6 MACHINING AND HANDLING PROFILES

CHAPTER 6

Section 1 Machining pultruded profiles

Machining pultruded profiles

It is often necessary to finish pultruded profiles prior to final use. This is an uncomplicated process. Machining pultruded profiles can be compared to machining wood, and wood-machining equipment can be used. However, due to the abrasion resistance of the reinforcement, steel-machining equipment is recommended. Hard-metal or diamond tools should be used when working with large series.

Examples of hand tools.

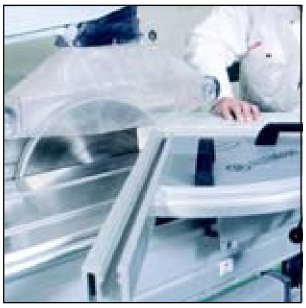
Machining fibre-reinforced plastics causes dust. This dust is not considered dangerous to health, due to the size and form of the individual particles. However, dust levels from machining fibreglass profiles should be kept as low as possible, as the dust can cause itching and breathing irritations. It can also cause temporary rashes on sensitive skin. Ordinary ventilation and use of a protective cream can prevent these inconveniences.

Pultruded fibreglass-reinforced profiles are elastic, and twisting and bending can occur when machining long profiles. Therefore, it is always necessary to ensure fixed, vibration-free support and retention.

The following indications are based on many years' experience which Fiberline Composites A/S have acquired in machining pultruded profiles. If finished profiles are to be used in chemically aggressive environments, it is necessary to seal all cuts. Please contact Fiberline Composites A/S for more information.

Cutting

An ordinary hacksaw can be used for a limited number of cuts, and a profile can be shortened the same way as wood with an ordinary handsaw. A circular saw is ideal for straight cuts. During sawing, the profile should be securely retained on a vibration-free bed. A diamond saw blade should be used when sawing large series for smooth cuts without burring. The cutting speed should be 60 mm/second, and to achieve the best results, feed lightly. Feeding too heavily merely increases wear on the blade.



Shortening with a circular saw

Boring

Boring in the profiles is relatively easy. An ordinary metal drill can be used to bore individual holes or small series of holes. Use of a specially designed drill is recommended for boring large series of holes. At speeds of between 3600 and 3900 rpm and using a pillar drill, this type of drill delivers a machine time of approximately 30,000 holes (Ø 10 mm). The drill produces a sharp hole rim without burr – also at the drill exit. The drill is designed to give as little vibration as possible when boring perpendicular to the surface, which is an added advantage when using hand drills. For boring large holes, a spoon bit with a centre bit is recommended. Burr on hole rims can be avoided by boring part-way through from one side of the profile, and then the rest of the way from the other side.



Boring with an ordinary drill, spoon bit or specially designed drill.

Grinding and deflashing

Pultruded profiles can be deflashed with sandpaper. Use of a belt grinder at high speed and slow advancement is recommended.

Deflashing with sandpaper

Turning

Hard-metal plates should be used in turning. Speeds of up to 400 m/min. can be used, and a rake angle on the cutting edge between 10 - 15° will give the best result. Feeding depends primarily on the stability of the set-up, but is typically between 0.05 and 0.5 mm/rev. Depending on the machine and the set-up, the depth of cut can be up to 10 mm. Using rounded lathe tools and air or liquid cooling results in the best surface finish. Turning can also be done with a rotating diamond milling machine mounted in the tool holder.

Milling

Milling with a hard-metal edge or diamond mill is recommended. In this type of machining, tools with a rake angle on the cutting edge of between 5° and 15° are recommended. Feeding can be up to 0.5 mm/rev., and speeds of up to 1000 m/min. will give the best results. Too heavy feeding will cause unwanted heating of the surface and gives less satisfactory results.

Machining on a stationary mill or a CNC mill.

Punching

Pultruded profiles of up to 4 mm in plate thickness, can be punched with an ordinary hard-metal punch. For thicker sheets (up to 6 mm), a specially designed punch should be used which gradually punches through the profiles. Punched holes are 0.05 - 0.1 mm smaller than the punch. The clearance between the punch and the matrix ought to be approximately 50% less than when punching steel.

Threading

Threading cannot be recommended for large loads, although self-threading and self-drilling screws are used to a large extent. If there is a need for threaded attachments in sheets or plates, blind rivet nuts of various types in stainless steel or aluminium can be used.

Water jet cutting

Water jet cutting is used for cutting in plates and massive profiles of up to approximately 20 mm in thickness. In non-massive profiles, using water jets can be problematic. The jet becomes diffused on cutting through the first plate, and is therefore unable to cut the plates to the rear with sufficient accuracy. Profiles can also be machined by laser cutting, using a protective gas such as argon.

CHAPTER 6

Section 2 Handling and transporting profiles

Handling and transporting structures

Point load
Avoid point load during lifting, transportation and unloading. Always ensure an even distribution of the load.

Lifting with straps
Lifting straps are positioned so the bearing points are situated in extensions of the vertical reinforcements of the structure. The lifting straps must show a line which is as straight as possible between bearing point and lifting point.

During lifting, the structure must be transversely reinforced where the lifting straps bend inward towards the lifting point at the top edge of the structure. All bearing and contact points between straps and structure must be protected against marks and scratching, using wood or another solid material.

When the direction of pull is other than 90° on the lifting surface, the lifting straps must be ensured against slipping by clamps or other means of secure retention.

Lifting with a fork-lift
Lifting with a fork-lift must be done in accordance with the same criteria as those for straps: beside reinforced points and with some form of protection between the forks and the load.

Transportation
During transportation, it must be ensured that the block bottom and other support remain in the correct position, either by being fastened to the bed or to the structure. The position of the structure in the mode of transport must be ensured with straps.

The restraining straps must be positioned on the structure at the edge of the supports and according to the same principles as for lifting straps – in other words, beside the reinforcements (See Figure 6.2). It can be necessary to calculate the necessary number of supports for use during transportation.

Unloading
Unloading a structure onto a bed must be done on layers of blocks that level the unloading points to one level. The layers of blocks must be placed beside the vertical reinforcements of the structure.

If several construction elements are placed on top of each other for unloading or transportation, the support points, intermediate layers and reinforcements in the structure must describe a column (See Figure 6.3)

It is self-evident that the number of elements placed on top of each other should be limited, so the danger of shifting is avoided.

Mounting
Never use a hammer or impact tools for adjusting structures of fibreglass-reinforced polyester. Handle with care. The form of pultruded profiles cannot be adjusted by bending in either a cold or heated state.

Adjusting
Inaccuracies should not be compensated for by deformation of the fibreglass profiles. Adjustments should be made with the aid of support or distance blocks.

Other information
Fibreglass-reinforced polyester is a strong material. However, it is possible for a surface to be spoiled by scratches or violent impact. In the event of damage, contact Fiberline Composites A/S for advice.

Figure 6.1

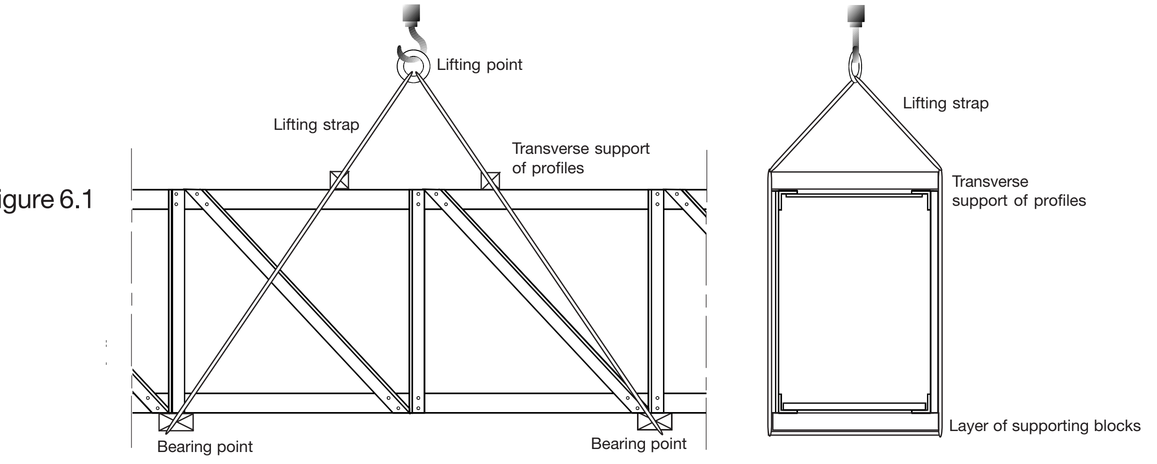


Figure 6.2

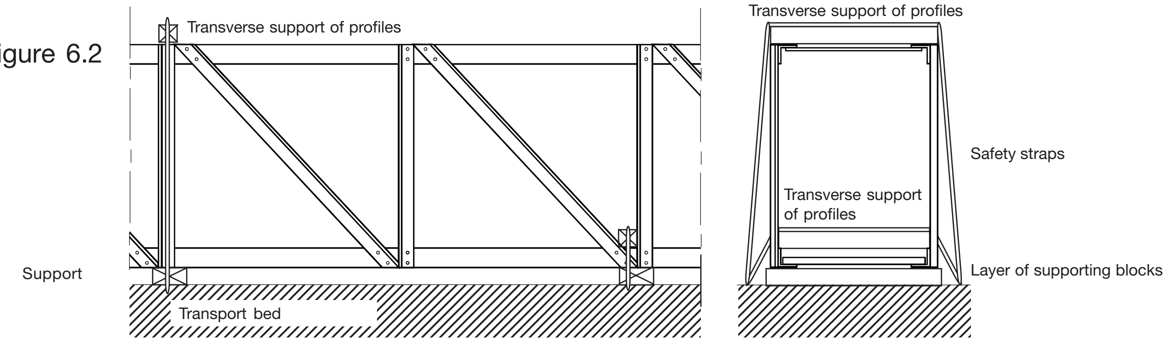
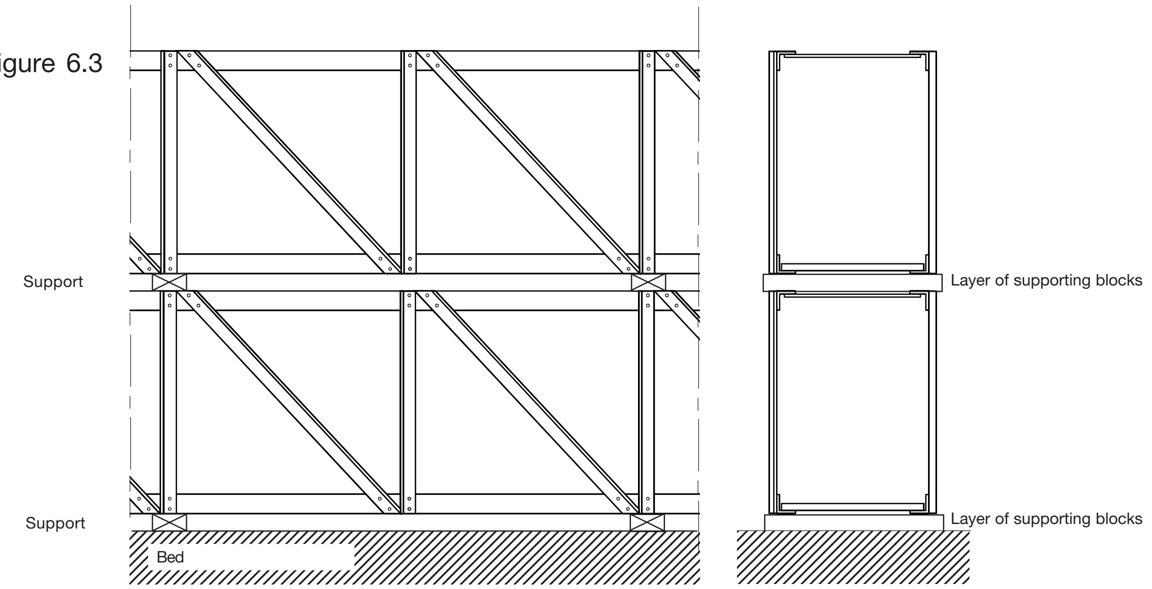


Figure 6.3



CHAPTER 7:
ENVIRONMENT AND DISPOSAL / RECYCLING

Environment and disposal / Recycling

Environment during manufacturing and machining

Since 1 May 1979, Fiberline Composites A/S have manufactured profiles and structures with the approval of the environmental authorities. Inspections are made on a regular basis.

Fiberline Composites A/S employ the manufacturing method known as pultrusion. This is a process whereby fibres are pulled through a device, into which liquid thermoset plastics are pumped to impregnate the fibres. The liquid themoset plastic is cured with the aid of heat and catalysts are added.

The pultrusion process is very friendly to the environment. At Fiberline, manufacturing is done in closed moulds which minimizes evaporation of volatile substances. This helps ensure the safety of the Fiberline environment. As the polymerisation is exothermic (develops heat itself), energy consumption per unit produced is extremely low. The energy consumption used in production of a composite profile is 1/4 of that required for steel, and 1/6 that for aluminium.

As a member of the Danish Plastics Federation (PD), Fiberline Composites A/S complies with Federation environmental policies. According to an agreement with the Danish Ministry of the Environment, the Danish Plastics Federation is obliged to participate actively in reduction of volatile organic compounds.

Regular environmental measurements, staff training and focus on waste and emission issues are significant elements in the environmental control of Fiberline Composites A/S.

Fiberline Composites A/S are a member of Green Network, a regional organization of companies and municipalities. The objective is to ensure continual improvement in the environments of the member companies. Fiberline Composites A/S are self-sufficient with green energy from their own wind turbine which meets the needs of the entire company.

Environmental impact at the user's site

Cured polyester or phenolic resin are stable, virtually non-degradable materials which do not pollute the environment. In fact, a great deal of environmental impact is avoided (for example, in comparison with steel) due to the low weight of the material and its need for very little maintenance.

For use in connection with machining of composite profiles, Fiberline Composites A/S have voluntarily compiled environmental safety data for the polyester and phenolic qualities. The most recent version of the safety data is available on request.

Waste handling / recycling

Fiberline profiles - or remains of them - are classified as fibreglass-reinforced unsaturated polyesters, and at the end of their service life can be tipped or recycled.

Tipped

- Fibreglass-reinforced polyester or phenolic resins are very stable materials which can be tipped as ordinary industrial waste. The materials do not give off substances that can harm the environment.

Recycling

- First, it should be investigated if used profiles can be reclassified for use under lower requirements and specifications in other circumstances.
- Another possibility for recycling begins with crushing and granulation. The process is already functioning commercially in, for example, Germany, at Ercom Composites Recycling GmbH. The company accepts fibreglass-reinforced unsaturated polyesters against payment, and sells the granulate for reuse.
- Granulated remains of Fiberline profiles can be used as a filler and, to a limited extent, as a reinforcing material.
- In controlled incineration, plastic materials release energy in amounts that make them significant energy carriers for electricity and heating. The composition of incineration gasses is largely comparable to that of incineration gasses from wood.

  The remains are the glass fibres which can be reused as landfill or for manufacturing glass wool.
- Tests at the German Arbeitsgemeinschaft Verstärkte Kunststoffe (AKV), among other places, have shown that it is technically possible to break down the molecule chains in uncured polyester by pyrolysis, and then reuse the resulting product as new polyester raw materials. However, pyrolysis is not currently financially viable, due to the prices of raw materials.

Fiberline Composites A/S will be pleased to answer any further questions.

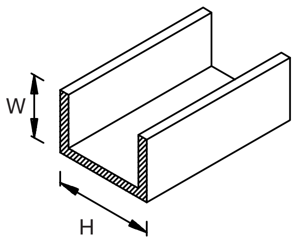
CHAPTER 8: FIBERLINE STANDARD TOLERANCES

Fiberline standard tolerances

Valid for structural profiles P2600, P3510 and P4506
Fiberline standard tolerances comply with EN 13706

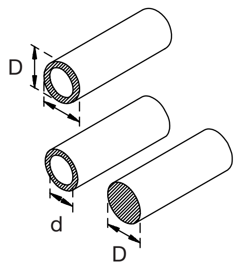
CROSS-SECTION OF PROFILE	TOLERANCES

Profile height and flange width



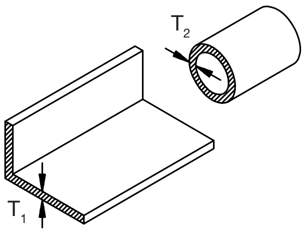
NOMINAL MEASUREMENT (mm)	H	W
0 - 50	± 0,20	± 0,20
50 - 100	± 0,30	± 0,30
100 - 300	± 0,35	± 0,35
300 -	± 0,40	± 0,40

Interior and exterior diameter, and ovality



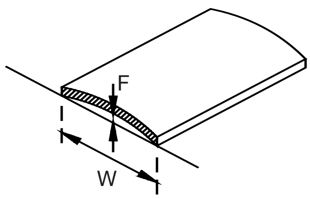
NOMINAL MEASUREMENT (mm)	D	d
0 - 10	± 0,20	± 0,20
10 - 20	± 0,30	± 0,30
20 - 50	± 0,35	± 0,35
50 - 100	± 0,40	± 0,40
100 -	± 0,45	± 0,45

Thickness for open and closed profiles



NOMINAL MEASUREMENT (mm)	T_1	T_2
0 - 2	± 0,15	± 0,30
2 - 5	± 0,20	± 0,35
5 - 10	± 0,35	± 0,45
10 -	± 0,45	± 0,50

Flatness in the transverse direction



TOLERANCES

$F < 0{,}008 \times W$ mm

Other tolerances available on request.

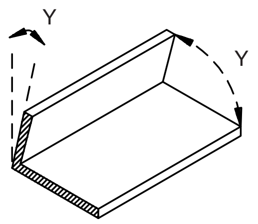
Guidelines also valid for design of special profiles

Fiberline standard tolerances

Valid for structural profiles P2600, P3510 and P4506
Fiberline standard tolerances comply with EN 13706

CROSS-SECTION OF PROFILE / TOLERANCES

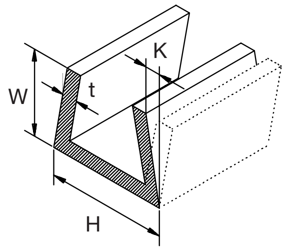
Size of angle



TOLERANCE

Y ±1,2 °

Lateral buckling of flanged ends

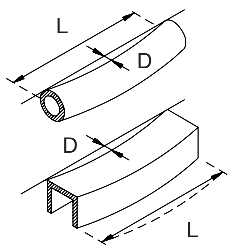


TOLERANCE

$$K < \frac{W}{20 \times t} - 0,1$$

PROFILE IN LONGITUDINAL DIRECTION / TOLERANCES

Straightness

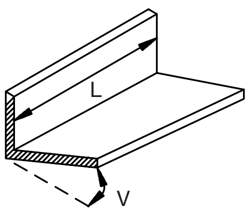


TOLERANCE

$D < 0,002 \times L$ mm

Maximum 2 mm per metre

Torsion



TOLERANCE

$$V < 1,0^\circ \times \frac{L}{1000}$$

Maximum 1,0° per metre

Other tolerances available on request.

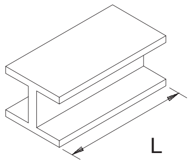
Guidelines also valid for design of special profiles

Fiberline standard tolerances

Valid for structural profiles P2600, P3510 and P4506
Fiberline standard tolerances comply with EN 13706

PROFILE IN LONGITUDINAL DIRECTION — TOLERANCES

Cutting-off length

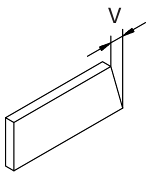


TOLERANCE ON-LINE

L +20/-0 mm

Can be machined to a finer tolerance

Straightness in cuts



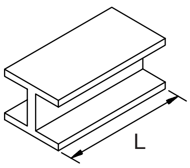
TOLERANCE ON-LINE

V ± 1,5°

Can be machined to a finer tolerance

MACHINING TOLERANCES — TOLERANCES

Cutting-off length

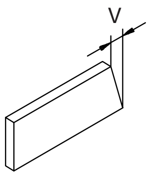


TOLERANCES

DS / ISO 2768-1-m

Minimum ± 1 mm

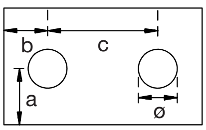
Straightness in cuts



TOLERANCES

DS / ISO 2768-1-c

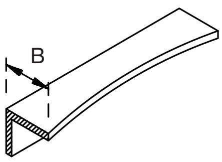
Drilling



TOLERANCES

DS / ISO 2768-1-c

Slitting of profiles



TOLERANCES

DS / ISO 2768-1-c

Minimum ± 1 mm

Other tolerances available on request.

Guidelines also valid for design of special profiles

CHAPTER 9: MISCELLANEOUS

CHAPTER 9

Section 1: Reference to standard and bibliography

Standards

Eurocode 1: Actions on structures - General actions - Densities, self-weight, imposed loads for buildings

DS/EN 1991-1-1:2000

First edition 2002-06-11

Standard relation: EN 1991-1-1:2002

Eurocode 3: Steel structures

DS/ENV 1993-1-1:1993

First edition 1993-09-30

Standard relation: ENV 1993-1-1:1992

Reinforced plastics composites - Specifications for pultruded profiles

EN 13706

First edition June 2002

Bibliography

Structural Design of Polymer Composites - EUROCOMP Design Code and Handbook

The European Structural Polymeric Composites Group

Edited by John L. Clarke, Sir William Halcrow and Partners Ltd. London, UK

Published by E & FN Spon, an imprint of Chapman & Hall, 2-6 Boundary Row, London SE1 8HN, UK

First edition 1996

ISBN 0 419 19450 9

CHAPTER 9

Section 2: Glossary

A

A4
Grade classification for stainless steel, acid-proof bolts, nuts and discs.

Accelerator
A chemical additive that hastens cure or chemical reaction (see also catalyst).

Additive
An ingredient mixed into resin to improve properties. Examples include plasticizers, initiators, light stabililsers and flame retardants.

Adhesive
A substance applied to mating surfaces to bond them by surface attachment. An adhesive can be in liquid, film or paste form.

Adhesive film
A thin plastic film onto which premixed adhesives are cast.

Anisotropic
Fibre directionality in which different properties are exhibited when tested along axes of different directions.

Aramid
A high-strength, high-stiffness aromatic polyamide fibre.

B

Barcol Hardness
A surface hardness value obtained by measuring the penetration resistance of a given material to a sharp steel point under a spring load. The Barcol Impressor is an instrument that measures hardness on a 0-100 scale.

Bidirectional laminate
A laminate with fibres oriented in more than one direction on the same plane.

Breakout
Separation or breakage of fibres when the edges of a composite part are drilled or cut.

Bromine
A fire-retardant (halogen) used to reduce or eliminate a resin's tendency to burn.

C

Carbon fibre
Reinforcing fibre known for its lightweight, high strength and high stiffness. Fibres are produced by high temperature treatment of an organic precursor fibre based on PAN (polyarcrylonitrile), rayon or pitch in an inert atmosphere at temperatures above 1800°F.

Catalyst
A substance that promotes and/or controls curing of a compound without being consumed in the reaction.

Coefficient of thermal expansion (CTE)
A material's fractional change in length for a given unit change of temperature.

Cohesion
Adherence of a single substance to itself. Also, the property holding a single substance together.

Composite
A material that combines fibre and a binding matrix to maximize specific performance properties. Neither element merges completely with the other.

Compressive strength
The capacity to resist a crushing or buckling force; the maximum compressive load a specimen sustains divided by its original cross-sectional area.

Continuous mat
A material formed from fibres of yarns with random fibre orientation.

Creep
The dimensional change in a material under physical load over time beyond instantaneous elastic deformation.

Cure
To irreversibly change the molecular structure and physical properties of a thermosetting resin by chemical reaction via heat and catalysts alone or in combination, with or without pressure.

Curing agent or hardener
A catalytic or reactive agent brings about polymerization when added to a resin (see catalyst).

Cure temperature
The temperature at which a material attains final cure.

D

Damping
Diminishing the intensity of vibrations.

Delamination
The separation of ply layers due to adhesive failure or the separation of layers of fabric from the core structure. A delamination may be associated with bridging, drilling and trimming.

Die, moulding tool
An assembly of parts containing the space from which the moulding takes its form.

E

Eccentricity moment
Moment resulting from a force not acting upon the line of gravity.

E-glass (electrical glass)
Borosilicate glass fibres possessing conductive properties; most often used in conventional polymer matrix composites.

Elasticity
The property by which materials tend to recover their original size and shape after deformation.

Glossary E - I

Elastic limit
The greatest stress a material is capable of sustaining without permanent strain remaining after complete release of the stress.

Electrolytic (galvanic) corrosion
accelerated corrosion of a metal because of an electrical contact with a more noble metal or non-metallic conductor in a corrosive electrolyte.

Elongation
The fractional increase in length of a material stressed in tension. When expressed as a percentage of the original length, it is called percentage of elongation.

Epoxy resin
A common thermoset material used as a bonding matrix to hold fibres together. When mixed with a catalyst, epoxy resins are resistant to chemicals and water and are unaffected by heat or cold.

Exotherm
Heat released during a chemical reaction (e.g., curing).

Extenders
Low-cost materials used to dilute or extend high-cost resins without extensive loss of properties.

Extrude
to form products of constant cross-sectional shape by forcing plastic material through a die.

F

Fatigue
The failure of a material's mechanical properties caused by repeated stress over time.

Fatigue strength
The maximum cyclical stress a material can withstand for a given number of cycles before it fails.

Fibre architecture
The design of a fibrous part in which the fibres are arranged in a particular way to achieve the desired result. This may include braided, stitched or woven fabrics, mats, rovings or carbon tows.

Fibre content/glass content
The amount of fibre in a composite expressed as a ratio to the matrix.

Fibre reinforced plastics
A composite material or part that consists of a resin matrix containing reinforcing fibres such as glass or carbon having greater strength or stiffness than the resin. The term GRP is most often used to denote glass fibre-reinforced plastics.

Filament winding
An automated process for fabricating composites in which continuous roving, either preimpregnated with resin or drawn through a resin bath, is wound around a rotating mandrel.

Filler
Material added to the mixed resin to increase viscosity, improve appearance and/or lower density and cost.

Finite element Analysis (FEA)
A computer analysis technique using the finite element method, often used to model complex structures.

Flexural strength
The strength of a material in bending expressed usually in terms of force per unit area, as the stress of a bent test sample at the instant of failure.

Folding
Defect due to bending/folding of fibres.

G

Glass fibre
Glass fibres are manufactured by "drawing" melted glass through nozzles. Due to its relatively high strength, easy machining and low price, glass fibre is the most commonly used reinforcement for polymer-based composites.

H

Halogenated resin
A resin combined with chlorine or bromine to increase fire retardancy.

Heat-distortion temperature (HDT)
The temperature at which a test bar deflects a certain amount under specified temperature and stated load.

Honeycomb
A lightweight cellular structure made from either metallic sheet materials or non-metallic materials (e.g., resin-impregnated paper or woven fabric) and formed into hexagonal nested cells.

Hybrid
A fibrous product made with two or more types of reinforcing fibres, e.g. glass and carbon.

Hybrid composite
A composite reinforced by hybrid.

Hybrid weave
Woven fibrous product based on two or more materials.

I

Impact strength
A material's ability to withstand shock loading as measured by fracturing a specimen.

Impregnate
To saturate the voids and interstices of a reinforcement with a resin.

Interface
The surface between two materials (in glass fibres, for instance, the area at which the glass and sizing meet; in a laminate, the area at which the reinforcement and laminating resin meet.)

Interlaminar
Existing or occurring between two or more adjacent laminae.

Interlaminar shear
A shear force that produces displacement between two laminae along the plane or their interface.

Isocyanate
A highly reactive monomer used in reaction injection moulding (RIM).

Isotropic
Fibre directionality with uniform properties in all directions, independent of the direction of applied load.

K

Kevlar
A strong, lightweight aramid fibre trademarked by DuPont and used as a reinforcement fibre.

L

Laminate
A material composed of more layers of the same or different types of material.

Laminate
To unite layers with a bonding material, usually via pressure and heat.

Lap joint
A joint made by overlap-ping two parts and bon-ding them together.

Low profile
Describes resin compounds formulated for low-to-zero shrinkage during moulding.

M

Mat
A fibrous reinforcing material composed of chopped filaments (for chopped-strand mat) or swirled filaments (for continuous-strand mat) with a binder applied to maintain form; available in blankets of various widths, weights, thicknesses and lengths.

Matrix
The material in which the fibre reinforcements of a composite system are embedded. Thermoplastic and thermoset resin systems, as well as metal and ceramic, can be used.

Micro-cracking
Cracking in composites at points where thermal stresses exceed the strength of the matrix.

Modulus
The physical measurement of stiffness in a material, equalling the ratio of applied load (stress) to the resultant deformation of the material such as elasticity or shear.

Modulus of Elasticity
The ratio of normal stress to the corresponding strain for tensile or compressive stresses less than the proportional limit of the material.

Moisture absorption
A material assimilation of water vapour from air, as distinguished from water absorption by immersion, which results in weight gain.

Monomer
A single molecule that can react with like or unlike molecules to form a polymer.

Mould release agent
A lubricant used to prevent a part from sticking to a mould.

N

Non-destructive inspection (NDI)
Determination of material or part characteristics without permanent alteration of the test subject. (Non-destructive testing (NDT) and non-destructive evaluation (NDE) are generally considered synonymous with NDI).

P

Peel ply
Layer of material applied to a lay up surface that is removed from the cured laminate prior to bonding operations, leaving a clean, resin-rich surface ready for bonding.

Peel strength
Strength of an adhesive bond obtained by stress that is applied „in a peeling mode.“

Phenolic resin
Thermosetting resin produced by condensation of an aromatic alcohol with an aldehyde, particularly phenol with formaldehyde.

Pinholes
Small holes caused by the mould used.

Poisson´s ratio
When a material is stretched, its cross sectional area changes as well as its length. Poisson´s ratio is the constant relating these changes in dimensions, and is defined as the ratio of the change in width per unit width to the change in length per unit length.

Polyester
Thermosetting resins produced by dissolving unsaturated, generally linear, alkyd resins in a vinyl-type active monomer such as styrene. The resins are usually furnished in solution form, but powdered solids are also available.

Polymer
A large molecule formed by combining many smaller molecules or monomers in a regular pattern.

Polymerization
A chemical reaction that links monomers to form polymers.

Porosity
The presence of visible voids within a solid material into which either air or liquids may pass.

Postcure
Additional elevated temperature cure, usually without pressure, to improve final properties and / or complete the cure. In certain resins, complete cure and ultimate mechanical properties are attained only by exposure of the cured resin to higher temperatures than those of curing.

Puller
Device that pulls out the fully cured profile from the processing equipment.

Glossary P - W

Pultrusion / pultruding
An automated, continuous process for manufacturing composite rods, tubes and structural shapes having a constant cross-section. Roving and other reinforcements are saturated with resin and continuously pulled through a heated die, where the part is formed and cured. The cured part is then cut to length.

Pyrolysis
The decomposition or transformation of a compound caused by heat.

Q

Quasi-isotropic
Approximating isotropy by orienting plies in several directions.

R

Reinforcement
The key element added to matrix to provide required properties (primarily, strength and stiffness); ranges from short fibres and continuous fibres through complex textile forms.

Resin
A solid or pseudosolid material with indefinite and often high molecular weight and a softening or melting range that exhibits a tendency to flow when subjected to stress. (As composite matrices, resins bind together reinforcement fibres.)

Roving
A collection of bundles of continuous glass fibre filaments, either as untwisted strands or as twisted yarn.

S

S-glass
Magnesia / alumina / silicate glass reinforcement designed to provide very high tensile strength; commonly used in high-performance parts.

Shear
An action or stress resulting from applied forces that causes or tends to cause two contiguous parts of a body to slide relative to each other.

Shear strength
The maximum shear stress that a material is capable of sustaining.

Sizing
A solution of chemical additives used to coat filaments. The additives protect the filaments from water absorption and abrasion; they also lubricate the filaments and reduce static electricity.

Span
Length of span or length of beam.

Stiffness
A material's ability to resist bending; relationship of load to deformation for a particular material.

Stress
Internal resistance to change in size or shape, expressed in force per unit area.

Stress concentration
The magnification of applied stress in the region of a notch, void, hole or inclusion.

Stress corrosion
Preferential attack of areas under stress in a corrosive environment, that alone would not have caused corrosion.

Stress crack
External or internal crack in a composite caused by tensile stresses; cracking may be present internally, externally or in combination.

Surfacing veil
Accompanies other reinforcing mats and fabrics to enhance the quality of the surface finish. Designed to block out the fibre patterns of the underlying reinforcements, it often adds ultraviolet protection to the structure.

Synthetic fibre
Fibre made of materials other than glass or carbon, such as polyester.

T

Tensile strength
The maximum stress sustained by a composite specimen before it fails in a tension test.

Thermoplastic
A composite matrix capable of being repeatedly softened by an increase in temperature and hardened by a decrease in temperature.

Thermoset
Composite matrix cured by heat and pressure or with a catalyst into an infusible and insoluble material. Once cured, a thermoset cannot be returned to the uncured state.

Thermoset system
The matrix, the thermoset and the additives required to manufacture the end product by the chosen production method.

Tool
Another term for die or mould.

U

Unidirectional (UD)
Orientation of fibres in the same direction, as in unidirectional fabric, tape or laminate.

V

Voids
Pockets of entrapped gas that have been cured into a laminate.

Vinyl esters
A class of thermosetting resins containing ester of acrylic and / or methacrylic acids.

Viscosity
The tendency of a material to resist flow. As temperature increases, the viscosity of most materials decreases.

Volatile organic compounds (VOCs)
Chemical substances, such as solvents, that readily evaporate or volatilize into the air.

W

Water absorption
The ratio of weight of water absorbed by a material to weight of dry material.

Waterjet
High-pressure water stream used for cutting polymer composite parts.

Woven roving
Heavy, coarse fabric produced by weaving continuous roving bundles.

Y

Young's modulus
See Modulus of Elasticity.