

krafton®



ENGINEERING **MANUAL**



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About us: krafton®

(formerly Bijl Profielen)

Founded more than 40 years ago as Bijl Profielen, krafton has developed over the years into a well-known and highly respected producer of glass fibre-reinforced polyester profiles and high quality composite structures.

The Netherlands is our home market, however we operate internationally and deliver to customers throughout Europe from our base in Heijningen. Customers who are active in many different branches such as construction, industry, infrastructure, HVAC, offshore, horticulture, energy engineering, sports and leisure. A healthy spread of risk and an extremely stable customer base allow us to achieve autonomous growth year on year.

While we invest constantly in knowledge and technical (production) resources, we also attach great importance to personal contact and knowledge sharing. So we also invest significantly in the relationship with our customers. We enjoy interacting with you as a sparring partner and coming up with alternative, innovative solutions. We cannot afford to sit back complacently, our specialists are always at your disposal for advice and effective action. Realistic, no-nonsense, collaborative and efficient. Speed of response, quality and maximum flexibility for an outstanding price; that is what our clients expect. Value for money that we will always offer with undiminished passion.

We build on the knowledge and experience that we have acquired over many years, because we want to continue to make progress, together with you. Because we are used to going the extra mile at krafton® and carrying on when others give up, this engineering manual provides the information you need to apply our profiles.







We warmly invite you to visit us and meet the leading pioneers in the field of pultrusion profiles.

About the quality of krafton[®] profiles

2.1 KRAFTON[®] CERTIFICATES

Quality is one of our main priorities. So we have had our products tested and assessed by various highly respected, national and international institutes. The approvals and certificates that we have obtained for our products are listed below.

Because the company name was recently changed from Bijl Profielen to krafton van BIJL, some of these currently valid certificates are issued to Bijl Profielen.

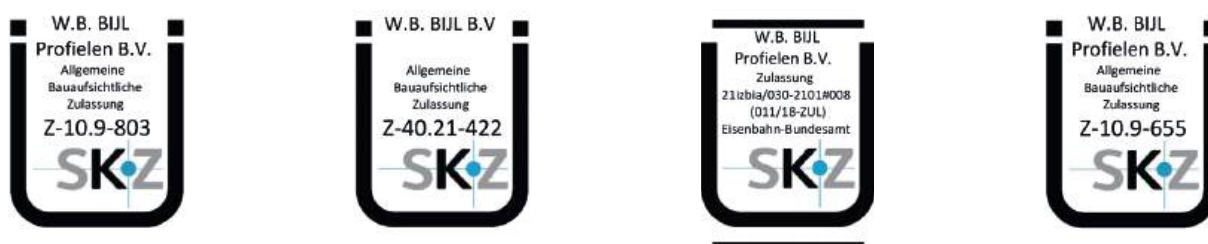
Product	Institute	External reference	Explanation
krafton[®] bridge decking elements		Z-10.9-655	All our krafton [®] GRP bridge decking components and fitting methods are DIBt-certified. The Deutsches Institut für Bautechnik (DIBt), the German centre of expertise for building technology, issues general building standards conformity certificates (abZ) for building materials and designs, and also issues European Technical Assessments (ETA) for building materials and construction equipment. The general building standards conformity approvals are a reliable indicator of the suitability and applicability of building materials in respect of the structural requirements for buildings and civil engineering structures.
Non-slip coating		BBV 1719066-01 to 03	The non-slip finishes on our bridge decking planks have been assessed based on slip resistance. The tests performed on the non-slip coating determine the class to which it can be assigned. The test was performed based on DIN 51130:2014-02, ASR-A 1.5 and reference document GUV-R181 "Fußboden in Arbeitsräumen und Arbeitsbereichen mit Rutschgefahr". The three different types are classified based on grain size. The type with the 0.7 mm grain size achieved R12 classification, and the types with 1 - 2 mm and 1 - 3 mm as the grain size achieved R13 classification.
krafton[®] GRP profiles		Z-10.9-803	The Deutsches Institut für Bautechnik (DIBt), the German centre of expertise for building technology, issues general building standards conformity certificates (abZ) for building materials and designs, and also issues European Technical Assessments (ETA) for building materials and construction equipment. The general building standards conformity approvals are a reliable indicator of the suitability and applicability of building materials in respect of the structural requirements for buildings and civil engineering structures.
krafton[®] GRP profiles and planks		21.51-21izbia/030-2101#008-(011/18-ZUL)	Because our GRP profiles can also be used for railway applications and Deutsche Bahn, we also offer the GRP profiles with EBA approval. According to DBS 918 010.
krafton[®] GRP profiles and planks		European Standard EN 13706: 2002	The European EN 13706 standard - Reinforced plastics composites, specifications for pultruded profiles - covers structures where the load-bearing capacity is an essential criterion and the profiles are used to provide support. The standard specifies the minimum requirements for quality, surface characteristics, tolerances and strength and stiffness values in two classes: <ul style="list-style-type: none"> · E23 - for the most demanding applications · E17 - for less critical applications. All krafton [®] standard profiles meet or exceed the requirements of E23.
krafton[®] planks			The GRP planks have been assessed against the Buildings Decree (Bouwbesluit) in line with the NEN EN 1991 - 2 and CUR 96 standards. Summaries of these standards are available on our website.

2.2 KRAFTON® QUALITY CONTROL AND QUALITY SYSTEM

Our long-standing experience in producing glass fibre-reinforced plastic (GRP) profiles guarantees consistently high product quality. However, quality must be checked on a permanent basis. We perform in-house tests using advanced Zwick-Roell material testing systems and other equipment to assess the mechanical performance of our profiles and planks against the specified standards.

We apply a well-designed and proven quality management system to monitor quality throughout the process, from the selection of the raw materials right up to the finished product. Our quality control procedures are designed to assess our GRP products based on the applications.

In addition to our quality checks in the factory, SKZ performs a six-monthly external audit of the production facility and processes. This is an extra guarantee of reliability and quality.



Our quality system and business processes were also audited by Deutsche Bahn in 2019. In its audit report, Deutsche Bahn states that our quality system complies with ISO 9001 and therefore meets the strict requirements imposed by Deutsche Bahn.

krafton[®] glass fibre-reinforced plastic and the Environment

3.1 KRAFTON[®] GLASS FIBRE-REINFORCED PLASTIC HAS A LOW ENVIRONMENTAL IMPACT

The use of composites in construction has many advantages: they are light, quickly installed, require little maintenance and are very durable. GRP is much more environmentally friendly than people generally realise. In addition, this material is extremely cost-effective. A material's environmental impact relates to the entire value chain: From extracting the raw materials and the strain these activities put on the environment to transport, production, further transport and assembly and erection of the final product.

Glass fibre-reinforced plastic profiles from krafton[®] are the solution: the material of the future!

- The energy required to produce GRP is negligible in comparison to steel production (and the same applies to the associated CO₂ emissions). The curing process is exothermic (gives off heat), meaning that the energy consumption per unit produced is extremely low.
- Glass fibre structures are also very much lighter than steel. As a result, up to 50% less energy is required for transport and assembly.
- There is no requirement for further finishing processes that are harmful to the environment, such as hot dip galvanising, painting or conservation, and all these factors make GRP an outstandingly sustainable product.
- GRP's CO₂ equivalent is less than half that of a concrete bridge and approximately a third of the CO₂ equivalent for a steel bridge. As a result, GRP's carbon footprint is also very favourable.
- Hardly any harmful by-products are created during production: Pultrusion takes place in a fully closed process that minimises the evaporation of volatile compounds.
- Because many GRP products have a service life of (much) more than 50 years, and even more than 100 years in some cases, replacement (which has a negative impact on the environment) is either not necessary or required less often.
- GRP is 100% recyclable and can be reused in many different applications. (Source: www.compositesuk.co.uk)
 - All kinds of GRP products can be professionally recycled to produce high-quality substitute fuels and reclaimed fibres.
 - Furthermore, processed GRP waste is a high-grade alternative for the cement industry where it is used both as a fuel and as a mineral raw material.
 - Recent advancements also mean that the recycled material can now be added to the process again when producing new materials

New studies that focus on the environmental impact of GRP are published regularly: please refer to our website for the latest updates.

3.2 KRAFTON® GUARANTEED RETURN POLICY

In order to promote the cradle-to-cradle concept, krafton® guarantees that it will take back all the GRP profiles it produces. As a result, we can arrange for the profiles to be reused or have them recycled in an environmentally responsible manner.

Glass fibre-reinforced plastic is an extremely sustainable product with an excellent life cycle analysis.

About composites

and the pultrusion process

4.1 GENERAL INFORMATION ABOUT COMPOSITES

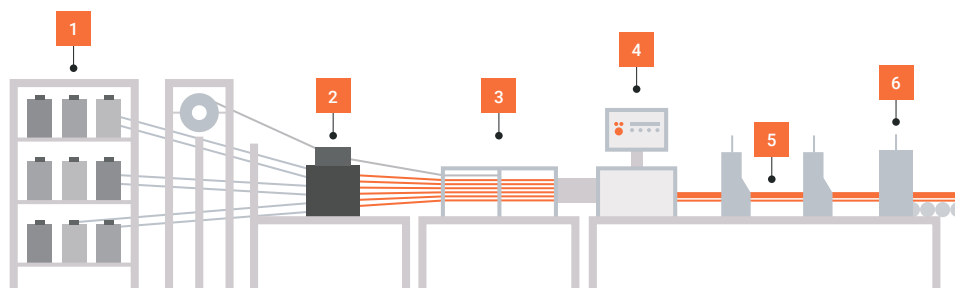
A composite is produced by combining different engineered materials. The term is often used to refer to fibre-reinforced plastics. The fibres transfer the loads, and the matrix (generally plastic) binds the fibres together. These two aspects give the material its high resistance to shear stresses. kraftron uses glass fibres in its products.

Composites offer a number of clear advantages, such as:

- Durable and recyclable.
- Practically maintenance-free.
- Resistant to UV and unaffected by fungi and mould.
- Long life expectancy of more than 100 years.
- The profile's properties can be engineered to match the application.
- The material's light weight is beneficial from an occupational health and safety perspective, and reduces costs for transport and lifting equipment.

4.2 THE PULTRUSION PROCESS

We produce the bridge decking planks and structural profiles in our own factory using the pultrusion process. Because pultrusion is an automatic, continuous process, each and every profile meets stringent quality standards.



Step 1

The process starts with insertion of the glass fibre reinforcements. Reel winding frames are located at the front of the machine. These frames hold reels of glass fibre thread. Mats and/or fabric often have to be used in addition to the rovings to achieve the desired transverse strength.

Step 2

The glass fibre threads, and possibly glass fibre matting, pass through the impregnation bath where they are coated with polyester resin. The liquid polyester resin is mixed with a hardener, colourant, fire retardants and other additives.

Step 3

The infeed plates guide the glass fibre threads and mats to the right position in the mould to ensure the correct glass fibre content. The glass fibre threads enhance linear tensile strength and the mats give the material transverse tensile strength. The amount of glass fibre material depends on the profile's design specifications and properties.

Step 4

Next, the resin, fibres and mats are pulled through a heated mould. The profile is formed and cured in the hot mould. Halfway through the mould, the material is already starting to harden. Once it leaves the mould, it is fully cured and can be subjected to mechanical load. The profile requires no further processing. The programmable computer controls all machine operations. This is where the throughput speed, cutting length and the different temperature profiles in the mould's heating system are set.

Step 5

A dual gripping and pulling system alternately clamps and pulls the profile. The clamps are shaped to exactly match the outside of the profile and are clad with soft plastic to avoid damaging it.

Step 6

The cross-cut saw moves at the line speed and cuts the profile to the desired length. Because the saw moves synchronously with the profile, the saw cut is perfectly perpendicular.

Properties of krafton[®] profiles

5.1 COMPARISON BETWEEN THE PROPERTIES OF KRAFTON[®] AND OTHER MATERIALS

The chart on the next page presents the mechanical properties of each type of material. The important point here is that krafton[®] profiles possess unique properties in comparison to other GRP products.

The linear properties of krafton[®] products differ significantly from their properties in the transverse direction.

The properties of krafton[®] profiles lie at the top end of the achievable range for pultrusion profiles. In other words, krafton[®] profiles are a cost-effective choice because less profile is required to create the same structure in comparison to other brands of GRP profile. krafton design approach ensures that the mat separations and overlaps are always located in the right place in the profiles. As a result, the profiles offer a well-balanced mix of properties in multiple directions. This has the following advantages: less material is required for the application, the profiles are easier to join and more resistant to 'misuse' or unforeseen loads.

The values shown for krafton® profiles in the chart are indicative. Please refer to the appendix for the exact values per profile: the values differ for each individual product.

Property	GRP profiles from krafton®	Steel S235	Alu T6061	Coniferous wood C50 NEN-EN 338: 2016
Specific weight kg/m ³	1,850	7,850	2,700	520
Tensile strength N/mm ²	Axial (longitudinal): 365 Transversal (crosswise): laminate thickness ≤ 6 mm: 105 laminate thickness ≥ 7 mm: 48	235 yield strength (all directions)	276 (all directions)	33.5 (longitudinal)
Modulus of elasticity GPa	Axial (longitudinal) laminate thickness 3 and 4 mm: 24.3 laminate thickness 5 and 6 mm: 32 laminate thickness ≥ 7 mm: 36.5	210	69 (35 dynamic load/fatigue loading)	16
Thermal conductivity lambda value W/m ² K	Axial (longitudinal) 0.4: Transversal (crosswise) 0.25	50	237	0.13
Transparency to radio/ radar	transparent	reflective	reflective	Transparent if dry
Electrical conductivity	insulator	conductor	Very good conductor	non-conductive if dry
Coefficient of linear expansion mm/m / 100 °C	Axial: 1.0 Transversal: 3.2	1.2 1.2	2.3 2.3	Expands in moist conditions
Impact resistance	Good	Very good	Average	Poor
Resistance to fatigue	Very good	Adequate	Poor	Poor
Resistance to corrosion when exposed to atmospheric effects	No corrosion Paint system only required for cosmetic reasons	Poor, service life depends on a paint system or galvanising	Poor, service life depends on a paint system or anodising, prone to filiform corrosion	Good, but susceptible to rot and mould/fungi, negative impact on the environment due to requirement for regular painting
Chemical resistance	Good See comment at the bottom of the chart	Poor, service life depends on a paint system or galvanising	Poor, service life depends on a paint system or anodising, prone to filiform corrosion	Poor
Resistance to galvanic corrosion	Very good	Poor	Poor	Not applicable
Environment Energy required	Little energy required, raw material for the glass fibre is abundantly available	Polluting production More energy required, so more expensive in the long term	Polluting production Large amounts of energy required, so more expensive in the long term	No energy Absorbs CO ₂ during growth
Noise transfer	Sound deadening	Resonance	High, metal content	Sound deadening
Recyclable	Recyclable in the cement industry, EU-approved, energy stored in the product is used in the cement kiln, glass fibre as an additional ingredi- ent in the process	Good recyclability, must be resmelted so further energy is required	Good recyclability, must be resmelted so further energy is required	Good recyclability, can be produced in a CO ₂ neutral process
Resistance to alkalis/ cement	Yes, however vinylester resins must be used instead of polyester resin for concrete reinforcement	Yes	No	Yes
Fire resistance	krafton® profiles are rated as class E according to NEN-EN 13501	Incombustible, can be used up to the melting point of 1,400 °C	Incombustible, can be used up to the melting point of 666 °C	Combustible

Please contact us for applications involving exposure to chemicals so that we can assess which chemicals are involved. In general, krafton® profiles are more resistant to chemicals than most metals, including AISI 316 stainless steel in many cases.

5.2 MECHANICAL PROPERTIES OF KRAFTON® GRP PROFILES

The strength of structures based on krafton® profiles can be calculated, meaning that their behaviour is predictable. The mechanical properties of the material are documented. Please refer to the relevant technical information in appendix I.

A structure can be completely built using krafton® profiles. However, combinations are also possible; e.g. with steel and wood. The make-up of the complete structure remains clear, meaning that it can be disassembled into separate parts. This may be necessary for reuse or recycling at the end of the structure's service life.

The material is resistant to corrosion, practically maintenance-free and light in weight. Due to the light weight, the support structure or foundation is less costly. Furthermore, the structure can be moved using lighter vehicles and cranes.

The profile's mechanical properties are valid within a temperature range from -40 °C to +80 °C. These are characteristic values.

ELASTIC PROPERTIES

Property	Unit	Test standard	Characteristic value according to EN 1990 Annex D
Effective bending modulus $E_{x,eff}$	N/mm ²	EN 13706	
t = 3 mm and 4 mm			24,250
t = 5 mm and 6 mm			32,000
t ≥ 7 mm			36,500
Axial tensile modulus E_{tx}	N/mm ²	EN ISO 527-4	
t = 3 mm and 4 mm			24,250
t = 5 mm and 6 mm			32,000
t ≥ 7 mm			36,500
Transversal tensile modulus E_{ty}	N/mm ²	EN ISO 527-4	
t ≤ 6 mm			10,400
t ≥ 7 mm			5,600
Axial compressive modulus E_{cx}	N/mm ²	EN ISO 14126	
t = 5 mm and 6 mm			32,000
t ≥ 7 mm			36,500
Transversal compressive modulus E_{cy}	N/mm ²	EN ISO 14126	10,000
Shear modulus in the planes G_{xy} and G_{yz}	N/mm ²	ISO 15310	3,000
Transversal contraction $\nu_{yx} = 0.23$			
Transversal contraction $\nu_{xy} = 0.07$			

YIELD LIMIT AT NORMAL LOADS

Property	Yield limit [%]
Axial tensile force ϵ_{tx}	0.65
Transversal tensile force ϵ_{ty}	0.15
Axial compressive force ϵ_{cx}	0.50
Transversal compressive force ϵ_{cy}	0.40

MECHANICAL PROPERTIES

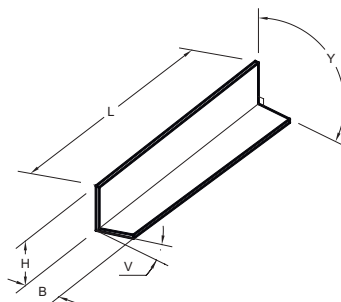
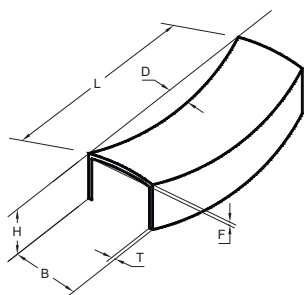
Property	Unit	Test standard	Characteristic value according to EN 1990 Annex D
Axial tensile strength f_{tx}	N/mm ²	EN ISO 527-4	365
Transversal tensile strength f_{ty}	N/mm ²	EN ISO 527-4	105 48
$t \leq 6$ mm			
$t > 6$ mm			
Axial compressive strength f_{cx}	N/mm ²	EN ISO 14126	300
Transversal compressive strength f_{cy}	N/mm ²	EN ISO 14126	100
Axial pin bearing strength f_{px}	N/mm ²	EN 13706-2, E	150
Transversal pin bearing strength f_{py}	N/mm ²	EN 13706-2, E	100
Axial flexural strength f_{fx}	N/mm ²	EN ISO 14125	240
Transversal flexural strength f_{fy}	N/mm ²	EN ISO 14125	60
Interlaminar shear strength τ_m	N/mm ²	EN ISO 14130	33
Shear strength in the plane f_{txy}	N/mm ²	ASTM 7078	40
Shear strength perpendicular to the plane $f_{t\perp}$ Pull-out strength, tendency of a bolt to pull out of the laminate	N/mm ²	ASTM 7078	80
Shear strength for a load applied transversely to the orientation of the fibres, hollow profiles $f_{txy,tor}$	N/mm ²	ASTM 7078	40

INFLUENCE OF FACTORS IN RESPECT OF TIME TO TAKE EFFECT

	A_1^I and A_1^E	A_1^I and A_1^E
	axial	⊥ transversal
Very short	1.0	1.0
Short, up to one week	1.15	1.30
Medium, up to 3 months	1.20	1.45
Long to very long	1.25	1.60

5.3 STANDARD TOLERANCES FOR KRAFTON® PROFILES

You can expect the following tolerances in relation to the geometry of krafton profiles:



Wall thickness T	Wall thickness tolerance for open profiles (mm):	Wall thickness tolerance for hollow profiles (mm):	Height H	Width B	Flatness F	Twist V	Straightness D	Perpendicularity Y
0	± 0.15	± 0.3						
1	± 0.15	± 0.3						
2	± 0.15	± 0.3				< ± 1.5° per metre	D < 0.002xL ² If B or H < 50 mm	
3	± 0.2	± 0.3						
4	± 0.2	± 0.4	± 0.5% x H	± 0.5% x B				
5	± 0.2	± 0.5	Minimum ± 0.20 mm	Minimum ± 0.20 mm			D < 0.001xL ² If B or H ≥ 50 mm and < 100 mm	Y = ± 1.5°
6	± 0.35	± 0.6			F = ± 0.008 x B			
7	± 0.35	± 0.7	Maximum ± 0.75 mm	Maximum ± 0.75 mm				
8	± 0.35	± 0.8				< ± 1.0° per metre	D < 0.0005xL ² If B or H ≥ 100 mm	
9	± 0.35	± 0.9						
10	± 0.35	± 1						
>10	± 0.45	± 10%						

Properties of krafton[®] bridge decking planks

6.1 PROPERTIES – BRIDGE DECKING PLANKS

The chart below presents the characteristic properties of the bridge decking planks.

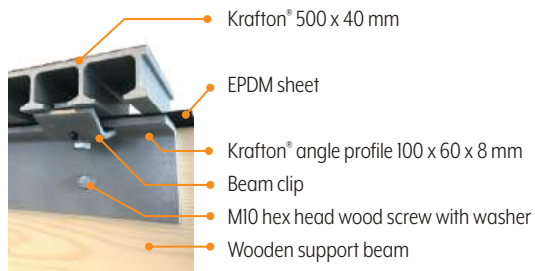
Type	Krafton [®] 500.35	Krafton [®] 500.40	Krafton [®] 500.55	Krafton [®] 236.40	Krafton [®] 400.85	Krafton [®] 256.40
Effective system size:	499 mm	499 mm	499 mm	235 mm	399 mm	255 mm
Thickness excluding wear-resistant finish	35 mm	40 mm	55 mm	40 mm	85 mm	40 mm
Evenly distributed load	5 kN/m ² (500 kg per m ²)	5 kN/m ² (500 kg per m ²)	5 kN/m ² (500 kg per m ²)	5 kN/m ² (500 kg per m ²)	5 kN/m ² (500 kg per m ²)	5 kN/m ² (500 kg per m ²)
Point load Requirement according to NEN-EN1991-2 NB	complies 7 kN (700 kg) on 100 x 100 mm	complies 7 kN (700 kg) on 100 x 100 mm	complies 7 kN (700 kg) on 100 x 100 mm	complies 7 kN (700 kg) on 100 x 100 mm	complies 7 kN (700 kg) on 100 x 100 mm	complies 7 kN (700 kg) on 100 x 100 mm
Point load, maximum	7 kN (700 kg) on 100 x 100 mm	40 kN (4,000 kg) on 200 x 200 mm	40 kN (4,000 kg) on 200 x 200 mm	40 kN (4,000 kg) on 200 x 200 mm	40 kN (4,000 kg) on 200 x 200 mm	40 kN (4,000 kg) on 200 x 200 mm
Explanatory note in relation to NEN-EN1991-2 NB	Not suitable for vehicles	Suitable for line service vehicles up to 5 tons (5,000 kg) and incidental vehicles up to 12 tons (12,000 kg)	Suitable for line service vehicles up to 5 tons (5,000 kg) and incidental vehicles up to 12 tons (12,000 kg)	Suitable for line service vehicles up to 5 tons (5,000 kg) and incidental vehicles up to 12 tons (12,000 kg)	Suitable for - line service vehicles up to 5 tons (5,000 kg) and incidental vehicles up to 12 tons (12,000 kg) - traffic bridge with 7 ton axle load limitation	Suitable for line service vehicles up to 5 tons (5,000 kg) and incidental vehicles up to 12 tons (12,000 kg)
Maximum span width with only the 50 kN line service vehicle NEN-EN1991-2 NB	n/a	700 mm	1020 mm	700 mm	1754 mm	500 mm
Maximum span width with only the 120 kN incidental vehicle NEN-EN1991-2 NB	n/a	1160 mm	1300 mm	1160 mm	1300 mm	650 mm
Support structure	Suitable for mounting to a steel, composite and wooden support structure					
Fixing methods	See fixing instructions		See fixing instructions	See fixing instructions	See fixing instructions	See fixing instructions
Anti skid grit surface	TÜV-certified non-slip coating (RI2-RI3) with grain sizes from 0.7 to 3 mm.					
Elastic modulus	33,363 N/mm ²		31,443 N/mm ²	32,704 N/mm ²	29,550 N/mm ²	29,402 N/mm ²
Weight per metre	10 kg/m		11.2 kg/m	5.5 kg/m	16 kg/m	11 kg/m
Weight per m² excluding grit surface	20 kg/m ²		22.4 kg/m ²	23.5 kg/m ²	40.0 kg/m ²	22 kg/m ²
Linear moment of inertia I_y	1,238,296 mm ⁴		2,705,284 mm ⁴	625,197 mm ⁴	10,205,769 mm ⁴	716,946 mm ⁴
Fire resistance	Krafton [®] bridge decking planks are rated as class E according to NEN-EN 13501					
Chemical resistance	The planks are suitable for outdoor environments and surface exposure to active substances including anti-icing chemicals					

Please refer to appendix 4 for drawings of the different planks

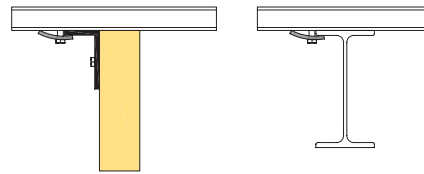
6.2 PLANK FITTING METHODS

The many exhaustively tested fitting methods are unique to krafton® GRP bridge decking planks. As a result, we can offer a fitting method for all possible support structures. These support structures can be made from steel, wood or GRP. A number of fitting methods depend on the type of plank.

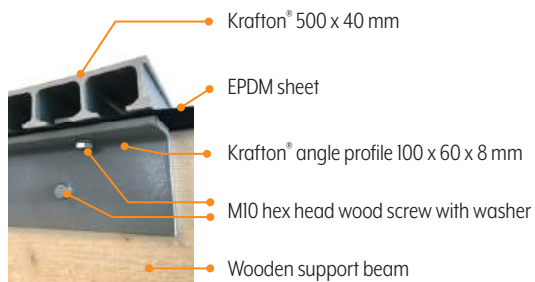
Attachment to a GRP angle profile, steel or GRP girder using retaining clamps



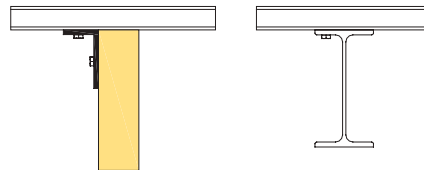
This method is also suitable for a direct clamp joint to a steel or GRP support beam



Attachment to a wooden girder and GRP angle profile, steel or GRP girder, screwed through the girder



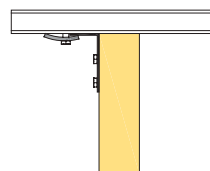
This method is also suitable for direct screw attachment to a steel or GRP support beam



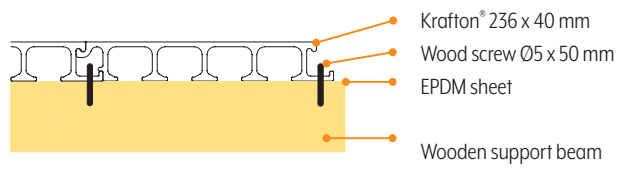
Attachment to a wooden girder via a steel angle profile



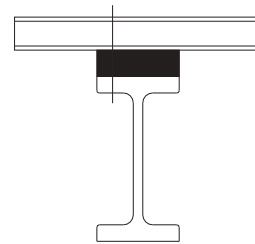
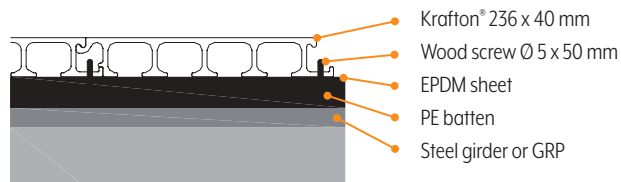
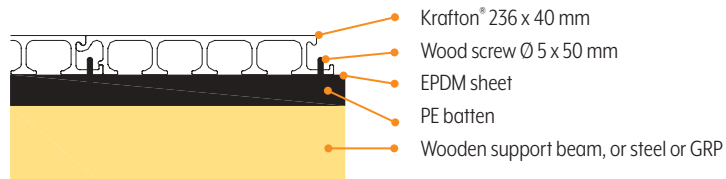
This method can be applied anywhere under the bridge deck without using an angle profile.



Attachment to a wooden beam by a screw inserted from above



This method can also be combined with a plastic sound-deadening batten on a wood, steel or GRP girder



Processing

krafton[®] profiles

7.1 PROCESSING OPERATIONS – GLUEING, PAINTING, MACHINING

Glueing

The composite material lends itself well to glueing and painting. Examples of commonly used adhesives: polyurethane single component or 2-component, methacrylate or epoxy adhesive. Other single component adhesives also work well: For example, Sikaflex[®] PRO-2-HP or equivalent products from other brands.

Filler mastic for long-term UV-resistant joint sealing such as Sikaflex[®] 84-UV or equivalent products from other brands.
Curing time: longer, several hours up to days

General preparation for glued joints

1. degrease and remove any remaining solvent from the profile
2. sand the surface
3. remove sanding dust
4. degrease
5. apply adhesive in accordance with the supplier's instructions

Painting

Paint systems: depending on the application - alkyd resin-bonded paint, alkyd/polyurethane hybrid, acrylic latex, polyurethane (UV-resistant) or epoxy-based and water-based systems. Ask the paint producer for advice.
Surface preparation is similar to that for adhesives.

Adhesives and paints must be applied in dry conditions. Also take the dew point and condensation into account.

Machining operations

When carrying out machining operations, adequate personal protective equipment must always be used.

The following must be worn: eye protection, gloves and a breathing mask with the correct dust filter.

Use machines with a working dust extraction attachment.

Apply resin or a suitable coating to seal cut edges and drilled holes. This prevents the ingress of water and chemicals.

Machining operation	Cutting speed/depth	Specifics
Drilling	Material thickness less than 12 mm: tungsten carbide 60-80 m/min Material thickness greater than 12 mm: diamond-tipped 300 - 1,200 m/min	Use water cooling if necessary to prevent dust
Sawing	1,800 - 3,600 m/min	Saw blade diameter 200 - 500 mm
Milling	100 - 400 m/min Maximum depth 0.5 mm per rotation	Tungsten carbide or diamond-tipped with water or air cooling
Lathe turning	As brass and aluminium 100 - 400 m/min Maximum depth 0.05 - 0.5 mm per rotation	Tungsten carbide or diamond-tipped with water or air cooling
Punching/shearing		Up to 10 mm with tungsten carbide Holes become approximately 0.1 mm smaller
Waterjet cutting		With or without abrasive Hollow profiles can present problems

7.4 PROFILE JOINTS

Appendix 2 details the possibilities for joining profiles. The possibilities for joining handrails can be found in Appendix 3.

Designing an efficient joint is extremely important. Accessory parts can be used if necessary. Hot dip galvanised steel or stainless steel can be used as an alternative for composite.

NB: use nuts with bolts threaded along their entire length according to DIN-931/933 for the joints. Use large flat washers according to DIN-ISO 7093 to spread the loads. The washers spread the imposed load evenly over the surface. Tighten the bolts to the torque values in the chart.

The hole centre-to-centre and edge-to-hole distances shown in the information in the appendices must be observed.

8

made by

krafton[®]

GRP
PROFILES



SWIMMING POOLS



TRAIN STATION PLATFORMS

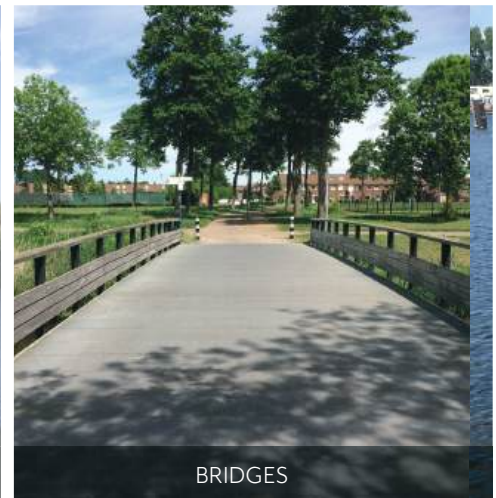


AUTOMOBILE INDUSTRY

GRP
BRIDGE
DECKING
PLANKS



BRIDGE OVER CANAL



BRIDGES



CENTER PARCS AQUA MUNDO



COOLING TOWERS



THRESHOLDS



CUSTOM
GRP
PROFILE



JETTIES

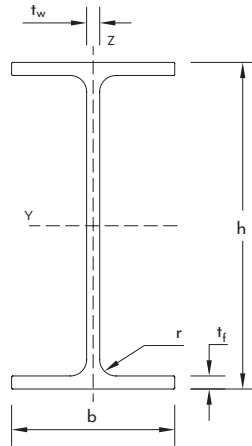


BRIDGE IN HISTORIC VILLAGE CENTRE



I profile, profile characteristics

Geometry and cross-sectional dimensions



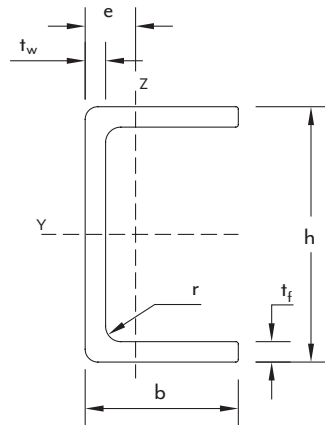
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	mm	mm	mm	mm	mm	10 ³ mm ²	10 ³ mm ²	10 ³ mm ²	kg/m	10 ⁶ mm ⁴	10 ⁶ mm ⁴
120 x 60 x 6	120	60	6	6	7.5	1.42	0.65	0.65	2.77	3.10	0.22
150 x 75 x 6	150	75	6	6	8	1.78	0.83	0.72	3.47	6.20	0.42
160 x 80 x 8	160	80	8	8	8	2.49	1.22	1.02	4.86	9.66	0.69
200 x 100 x 10	200	100	10	10	11	3.88	1.90	1.60	7.57	23.66	1.67
240 x 120 x 12	240	120	12	12	12	5.60	2.74	2.30	10.92	48.90	3.50
240 x 150 x 20	240	150	20	10	16	8.21	2.22	4.80	15.19	81.43	11.25
300 x 150 x 15	300	150	15	15	15	8.74	4.28	3.60	16.17	119.00	8.54
360 x 180 x 18	360	180	18	18	18	12.60	6.16	5.18	23.31	248.00	17.70

Abbreviations:

- A: cross-sectional surface area
- A_s: shear area
- g: weight per linear meter
- I: linear moment of inertia
- e: maximum fibre distance

U profile, profile characteristics

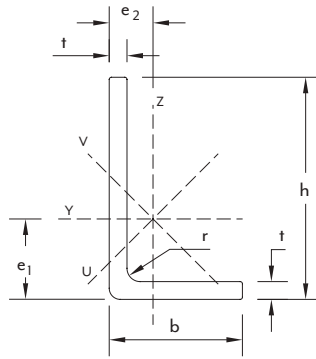
Geometry and cross-sectional dimensions



hxbxt	h	b	t_f	t_w	r	A	A_{xz}	A_{zy}	g	I_{yy}	I_{zz}	e
	mm	mm	mm	mm	mm	10 ³ mm ²	10 ⁵ mm ²	10 ⁵ mm ²	kg/m	10 ⁶ mm ⁴	10 ⁶ mm ⁴	mm
70 x 30 x 5	70	30	5	5	2	0.60	0.32	0.27	1.17	0.40	0.04	8.70
100 x 30 x 6	100	30	6	6	4	0.89	0.54	0.32	1.74	1.14	0.06	7.80
100 x 40 x 5	100	40	5	5	3	0.85	0.45	0.36	1.66	1.20	0.12	10.69
100 x 50 x 6	100	50	6	6	5	1.14	0.54	0.54	2.22	1.67	0.26	14.60
120 x 50 x 6	120	50	6	6	5	1.25	0.63	0.54	2.44	2.58	0.28	13.60
140 x 40 x 5	140	40	5	5	5	1.06	0.63	0.36	2.07	2.78	0.13	9.10
140 x 60 x 5	140	60	5	5	2	1.30	0.63	0.63	2.54	3.78	0.43	15.74
150 x 40 x 6	150	40	6	6	8	1.33	0.81	0.43	2.59	3.80	0.15	9.10
160 x 48 x 8	160	48	8	8	8	1.95	1.15	0.69	3.80	6.57	0.34	12.00
200 x 60 x 10	200	60	10	10	11	3.03	1.80	1.08	5.91	15.93	0.82	14.90
200 x 80 x 8	200	80	8	8	8	2.76	1.44	1.15	5.38	16.02	1.55	20.59
240 x 72 x 8	240	72	8	8	16	2.93	1.73	1.04	5.71	22.76	1.21	16.50
240 x 72 x 12	240	72	12	12	12	4.38	2.59	1.55	8.54	33.20	1.71	18.00
300 x 90 x 15	300	90	15	15	16	6.84	4.05	2.43	12.65	80.93	4.16	22.40
360 x 108 x 18	360	108	18	18	18	9.86	5.83	3.49	18.24	168.00	8.67	26.90

L profile, profile characteristics

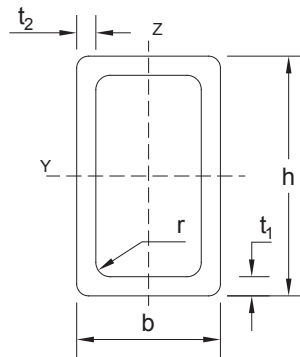
Geometry and cross-sectional dimensions



hxbxt	h	b	t	r	A	A_{yz}	A_{xz}	g	I_{yy}	I_{zz}	I_{uu}	I_{vv}	e₁	e₂
	mm	mm	mm	mm	10 ³ mm ²	10 ³ mm ²	10 ³ mm ²	kg/m	10 ⁶ mm ⁴	10 ⁶ mm ⁴	10 ⁶ mm ⁴	10 ⁶ mm ⁴	mm	mm
50 x 50 x 5	50	50	5	1	0.47	0.23	0.23	0.92	0.11	0.11	0.18	0.043	14.50	14.50
50 x 50 x 6	50	50	6	4	0.56	0.27	0.27	1.09	0.13	0.13	0.21	0.052	14.80	14.80
50 x 50 x 8	50	50	8	4	0.73	0.36	0.36	1.42	0.17	0.17	0.26	0.068	15.50	15.50
60 x 40 x 5	60	40	5	2	0.47	0.27	0.18	0.92	0.17	0.06	0.18	0.057	19.90	9.90
75 x 75 x 6	75	75	6	7	0.87	0.41	0.41	1.70	0.47	0.47	0.74	0.200	20.80	20.80
75 x 75 x 8	75	75	8	4	1.13	0.54	0.54	2.20	0.60	0.60	0.96	0.242	21.70	21.70
80 x 80 x 8	80	80	8	7	1.23	0.58	0.58	2.40	0.74	0.74	1.16	0.313	22.80	22.80
100 x 60 x 8	100	60	8	6	1.22	0.72	0.43	2.38	1.25	0.34	1.17	0.416	34.20	14.30
100 x 100 x 8	100	100	8	7	1.55	0.72	0.72	3.02	1.49	1.49	2.34	0.626	27.80	27.80
100 x 100 x 10	100	100	10	5	1.90	0.90	0.90	3.71	1.80	1.80	2.85	0.704	29.90	29.90
100 x 100 x 12	100	100	12	7	2.27	1.08	1.08	4.43	2.10	2.10	3.32	0.883	29.30	29.30
150 x 100 x 8	150	100	8	7	1.95	1.08	0.72	3.80	4.57	1.67	5.27	0.971	47.80	22.90
150 x 100 x 10	150	100	10	7	2.41	1.35	0.90	4.70	5.59	2.03	6.44	1.180	48.60	23.70
150 x 100 x 12	150	100	12	7	2.87	1.62	1.08	5.60	6.57	2.37	7.56	1.380	49.40	24.50
150 x 150 x 8	150	150	8	7	2.35	1.08	1.08	4.58	5.21	5.21	8.24	2.170	40.30	40.30
150 x 150 x 10	150	150	10	7	2.91	1.35	1.35	5.67	6.38	6.38	10.10	2.650	41.10	41.10
150 x 150 x 12	150	150	12	7	3.47	1.62	1.62	6.77	7.51	7.51	11.90	3.110	41.90	41.90

Box section profile, profile characteristics

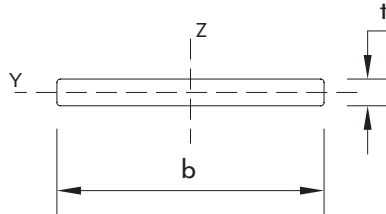
Geometry and cross-sectional dimensions



hxbxt	h	b	t₁	t₂	r	A	A_x	A_y	g	I_{yy}	I_{zz}
	mm	mm	mm	mm	mm	10 ³ mm ²	10 ³ mm ²	10 ³ mm ²	kg/m	10 ⁶ mm ⁴	10 ⁶ mm ⁴
40 x 40 x 5	40	40	5	5	1	0.70	0.36	0.36	1.37	0.15	0.15
50 x 50 x 5	50	50	5	5	2	0.90	0.45	0.45	1.76	0.31	0.31
60 x 40 x 5	60	40	5	5	2	0.89	0.54	0.36	1.74	0.41	0.21
60 x 60 x 5	60	60	5	5	4	1.08	0.54	0.54	2.11	0.56	0.56
70 x 70 x 5	70	70	5	5	2	1.29	0.63	0.63	2.52	0.92	0.92
80 x 60 x 5	80	60	5	5	4	1.31	0.72	0.54	2.55	1.15	0.72
70 x 70 x 7	70	70	7	7	2	1.75	0.88	0.88	3.41	1.18	1.18
75 x 75 x 6	75	75	6	6	4	1.66	0.81	0.81	3.24	1.32	1.32
75 x 75 x 8	75	75	8	8	4	2.14	1.08	1.08	4.17	1.63	1.63
80 x 40 x 5	80	40	5	5	4	1.10	0.72	0.36	2.15	0.85	0.27
100 x 60 x 8	100	60	8	8	4	2.31	1.44	0.86	4.50	2.84	1.20
100 x 100 x 6	100	100	6	6	1	2.27	1.08	1.08	4.43	3.36	3.36
100 x 100 x 8	100	100	8	8	4	2.96	1.44	1.44	5.77	4.21	4.21
100 x 100 x 10	100	100	10	10	4	3.60	1.80	1.80	7.02	4.92	4.92
120 x 60 x 5	120	60	5	5	4	1.70	1.10	0.54	3.32	3.09	1.01
120 x 120 x 6	120	120	6	6	4	2.75	1.30	1.30	5.36	5.98	5.98
120 x 120 x 8	120	120	8	8	8	3.60	1.73	1.73	7.02	7.57	7.57
160 x 160 x 8	160	160	8	8	8	4.92	2.30	2.30	9.59	19.10	19.10
200 x 200 x 10	200	200	10	10	10	7.69	3.60	3.60	15.00	46.50	46.50
240 x 240 x 12	240	240	12	12	12	11.00	5.18	5.18	21.45	96.40	96.40

Flat profile, profile characteristics

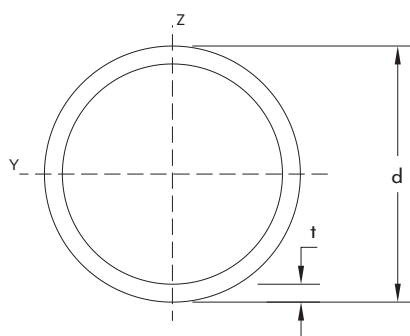
Geometry and cross-sectional dimensions



h x b	b	t	A	A_x	A_y	g	I_{yy}	I_{zz}
	mm	mm	10³ mm²	10³ mm²	10³ mm²	kg/m	10⁶ mm⁴	10⁶ mm⁴
50 x 6	50	6	0.30	0.198	0.198	0.59	0.001	0.063
150 x 7	150	7	1.05	0.700	0.700	2.05	0.004	1.969
200 x 11	200	11	2.20	1.456	1.456	4.29	0.022	7.333
250 x 11	250	11	2.75	1.832	1.832	5.36	0.028	14.323
750 x 6	750	6	4.50	2.997	2.997	8.78	0.014	210.930
750 x 9	750	9	6.75	4.496	4.496	13.16	0.410	455.630
750 x 10	750	10	7.50	5.000	5.000	14.63	0.211	351.563
100 x 15	100	15	1.5	1.000	1.000	2.78	0.028	1.25
750 x 15	750	15	11.25	16.875	16.875	20.81	0.623	527.344

Round tube profile, profile characteristics

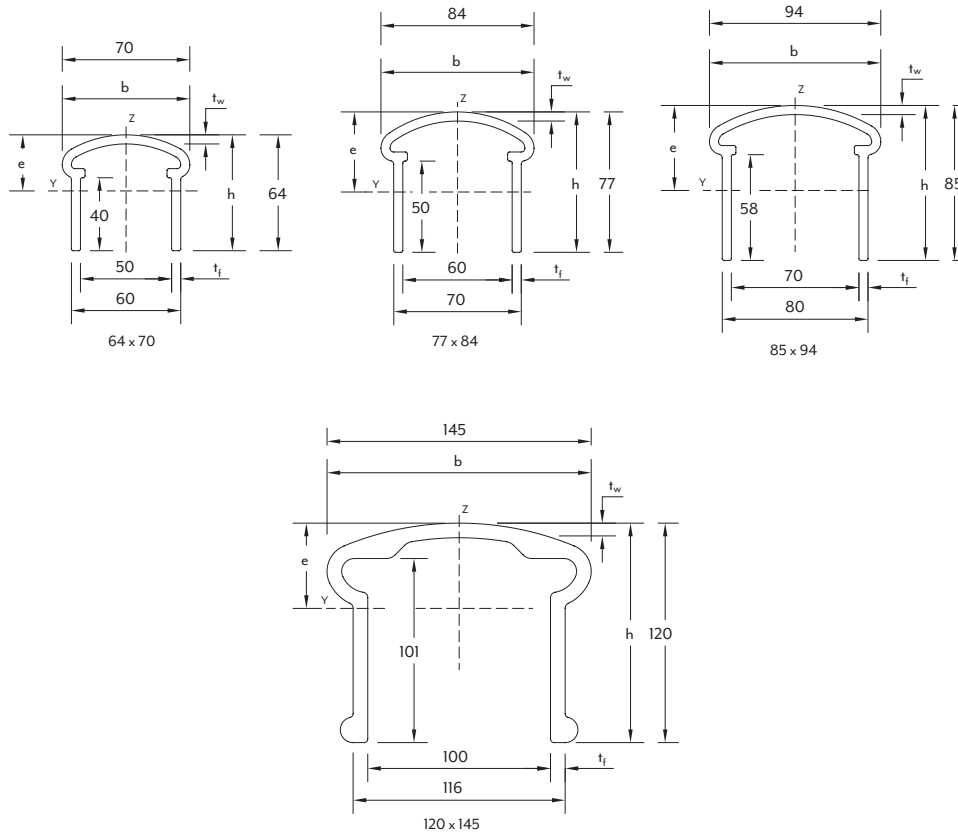
Geometry and cross-sectional dimensions



d x t	d	t	A	A_{s,x}	A_{s,y}	g	I_{yy} = I_{zz}
	mm	mm	10³ mm²	10³ mm²	10³ mm²	kg/m	10⁶ mm⁴
40 x 5	40	5	0.55	0.28	0.28	1.07	0.086
48 x 5	48	5	0.68	0.34	0.34	1.33	0.158

Handrail profile, profile characteristics

Geometry and cross-sectional dimensions

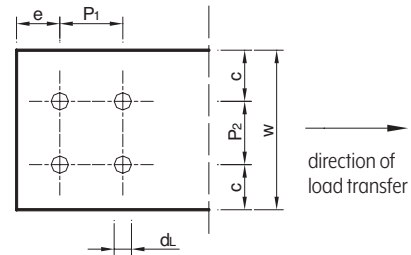


h x b	h	b	t_f	t_w	A	A_{sx}	A_{sy}	g	I_{yy}	I_{zz}	e
	mm	mm	mm	mm	10 ³ mm ²	10 ³ mm ²	10 ³ mm ²	kg/m	10 ⁶ mm ⁴	10 ⁶ mm ⁴	mm
64 x 70	64	70	5	5	0.90	0.40	0.64	1.76	0.327	0.571	24.79
77 x 84	77	84	5	5	1.10	0.49	0.77	2.15	0.585	0.992	29.93
85 x 94	85	94	5	5	1.24	0.54	0.85	2.42	0.814	1.443	32.31
120 x 145	120	145	8	8	3.20	1.92	1.16	6.24	4.710	8.270	45.95

Profile connection methods

Minimum spacing, end and edge distances

Minimum distance	e	c	P1	P2
Load in the profile's longitudinal direction	$2.5 d_s$	$2 d_s$	$4 d_s$	$4 d_s$
Load perpendicular to the profile	$2.5 d_s$	$2.5 d_s$	$4 d_s$	$4 d_s$



d_s = bolt diameter

d_l = hole diameter

Maximum torque values M_A and preload forces F_y

Washer/bolt d_s (mm)	M8 8	M10 10	M12 12	M16 16	M20 20
Outer diameter of the washer	The washers must have an extra-large diameter of at least $3.4 \times d_s$				
M_A (Nm)	16.8	33.2	59.0	141.2	275.3
F_y (kN)	11.1	17.48	26.24	47.07	73.42
Outer diameter of the washer	In the case of bolted joints that have no other function than positioning, washers with a diameter of at least $3.0 \times d_s$ are required				
M_A (Nm)	5.73	11.6	20.9	50.7	98.6
F_y (kN)	3.78	6.09	9.28	16.91	26.30

The following clearance must be observed between the bolt diameter and the hole diameter:

Bolts in the range M8 to M16:

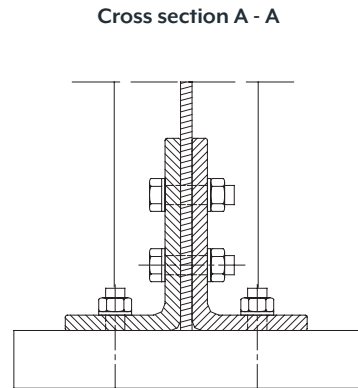
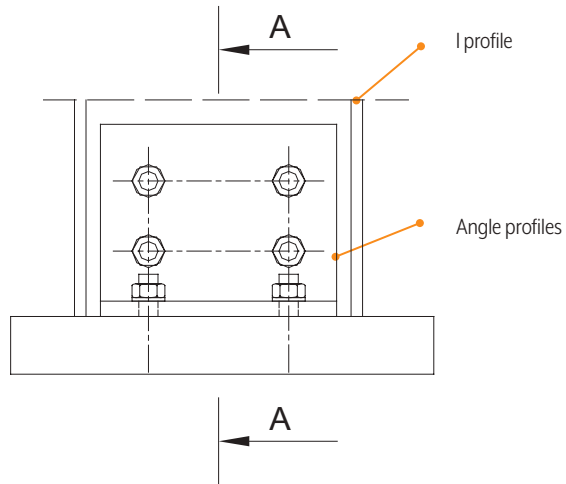
$$d_l - d_s \leq 1.0 \text{ mm}$$

M20 bolts:

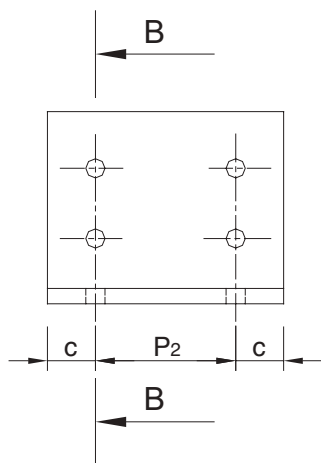
$$d_l - d_s \leq 2.0 \text{ mm}$$

Example of column-to-foundation joints

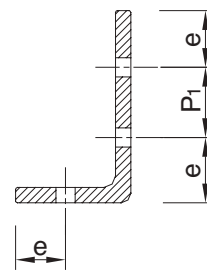
I profile joined with two angle profiles



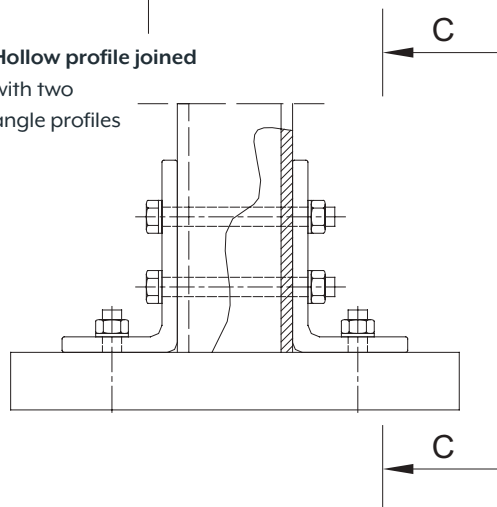
Angle profile with the recommended hole and edge distances



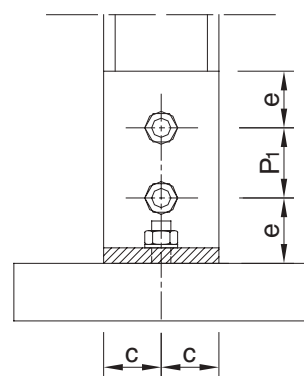
Cross section B - B



Hollow profile joined with two angle profiles



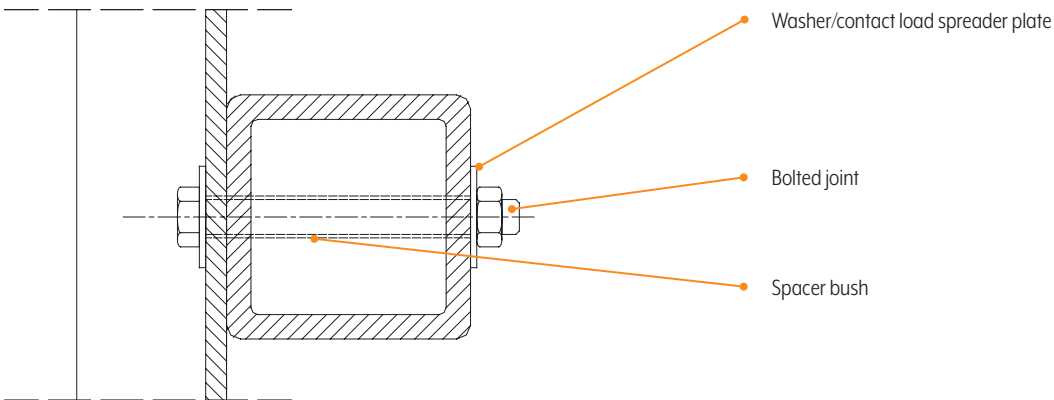
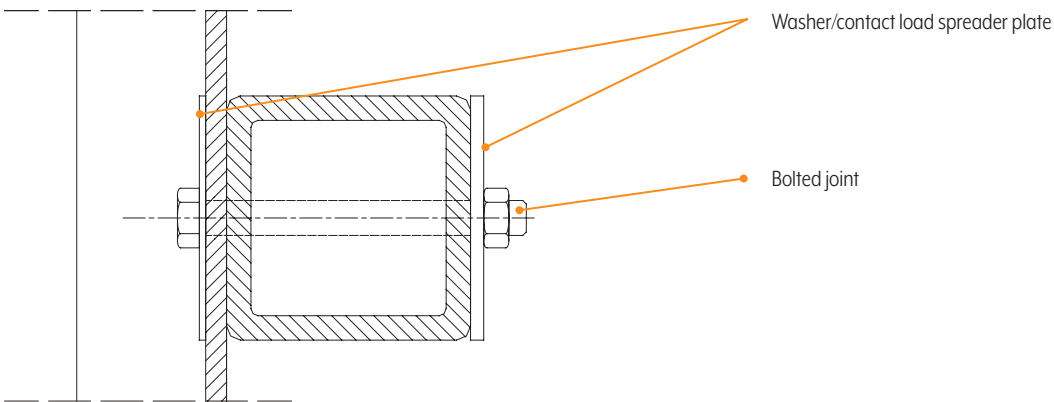
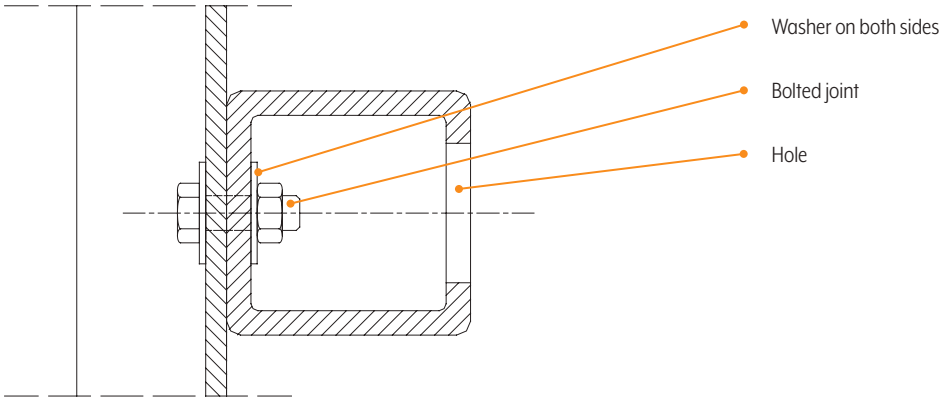
Cross section C - C



Example of joints between box section profiles subjected to shear stress

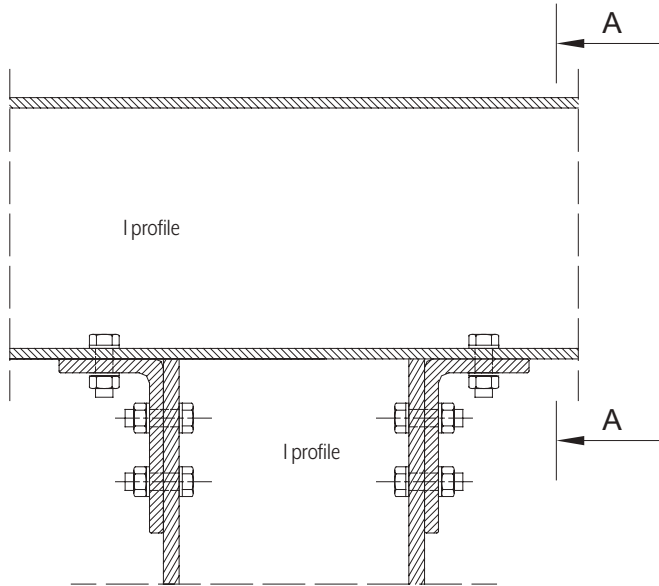
Contact load spreader plates
 Square $b \times b$ or $h \times h$ of the box section profile
 Steel plate: $t \geq 0.12 \times b$ or h
 GRP plate: $t \geq 0.2 \times b$ or h

The following applies in the case of bolted joints that have no other function than positioning and are not subjected to load:
 Width: $\geq 0.5 b$ or h of the box section profile
 Steel plate: $t \geq 0.08 \times b$ or h
 GRP plate: $t \geq 0.1 \times b$ or h

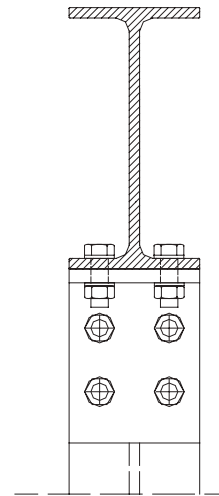


Example of joints subjected to shear stress

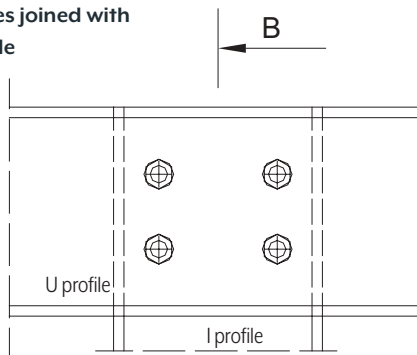
Two I profiles joined with angle profiles



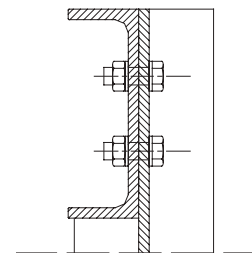
Cross section A - A



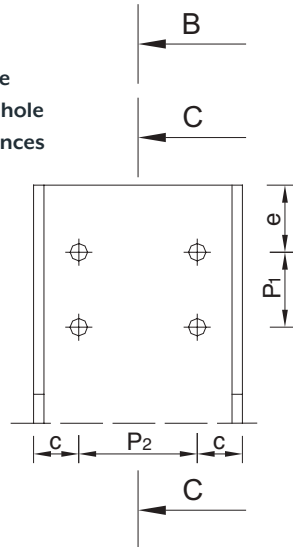
I profiles joined with U profile



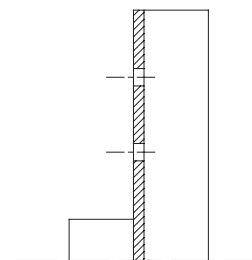
Cross section B - B



I profile with the recommended hole and edge distances

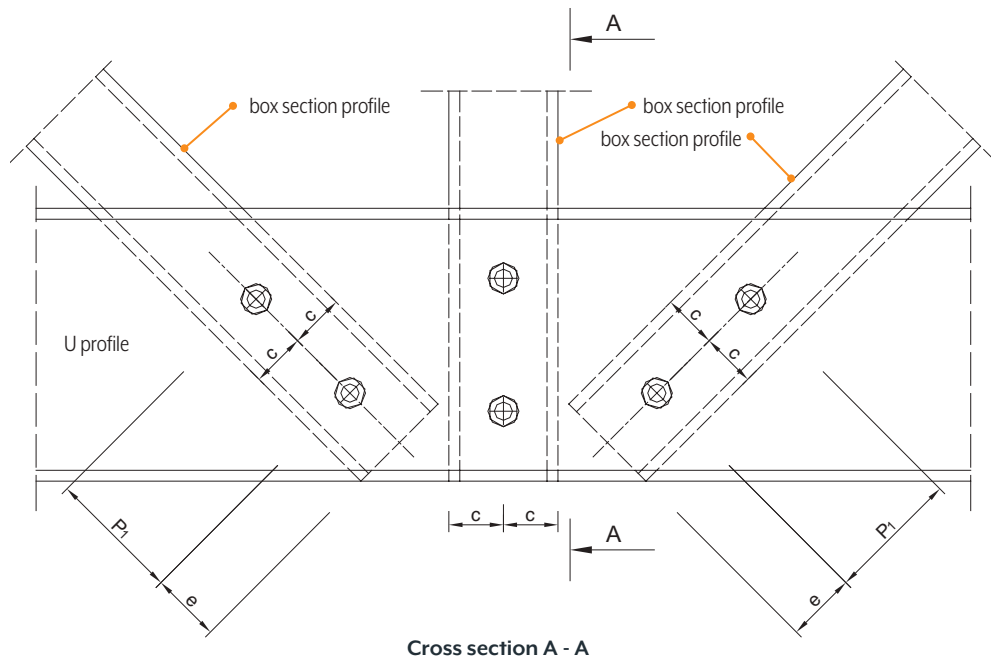


Cross section C - C

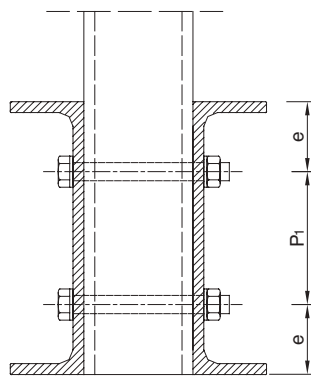


Example of a diagonal joint

Box section profiles joined with U profiles

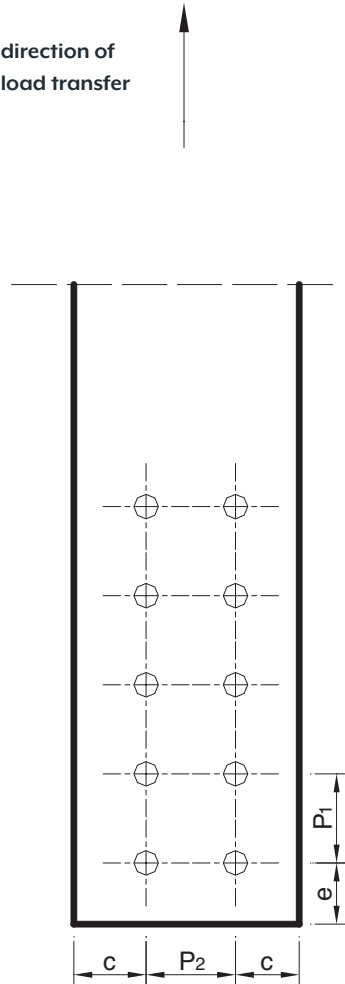


Cross section A - A

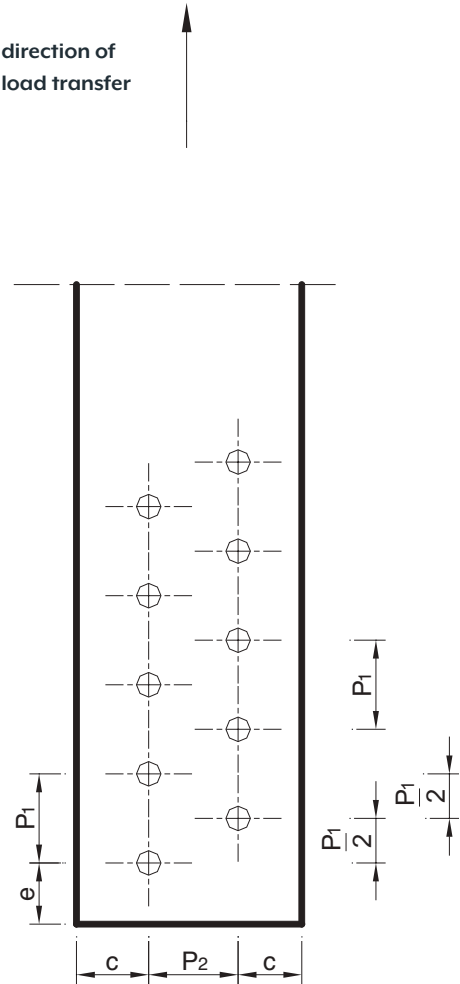


Example of a hole pattern for transferring major loads

Hole pattern

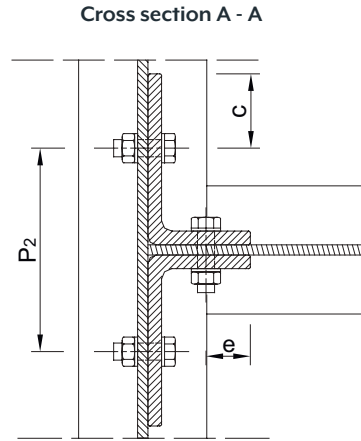
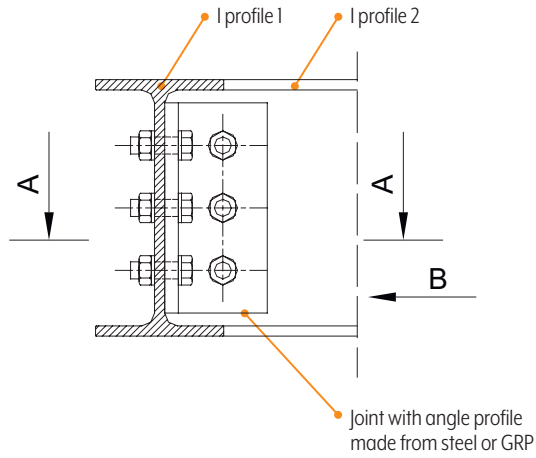


Maximum of five bolted joints per row and no more than two rows

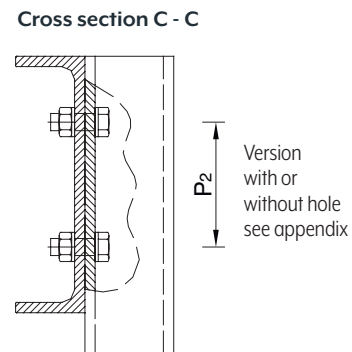
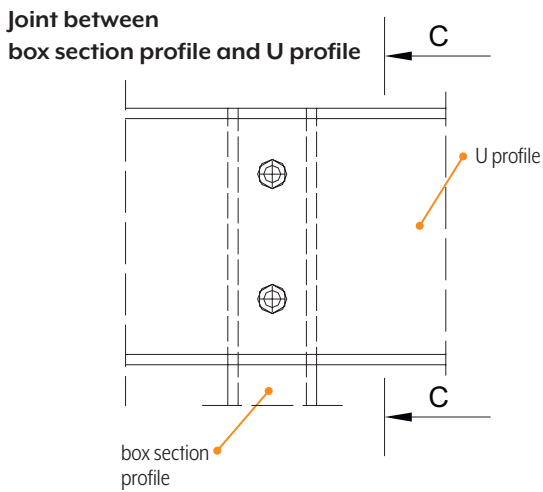
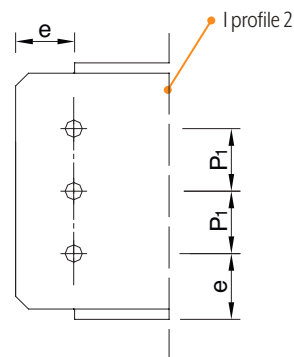
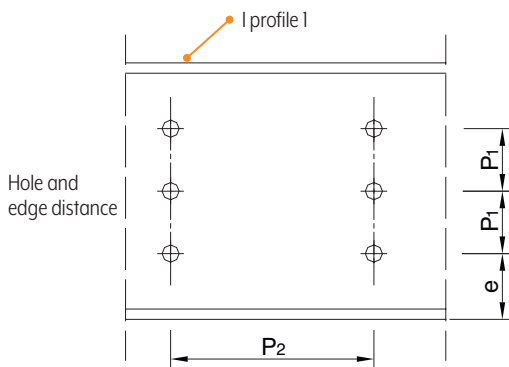


Example of joints at an angle of 90 degrees

I profiles joined with angle profiles

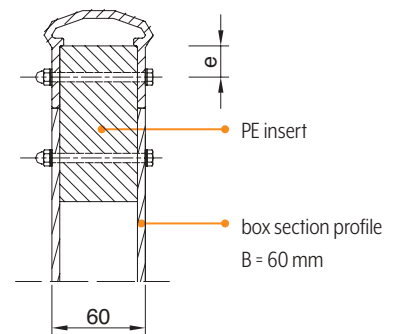
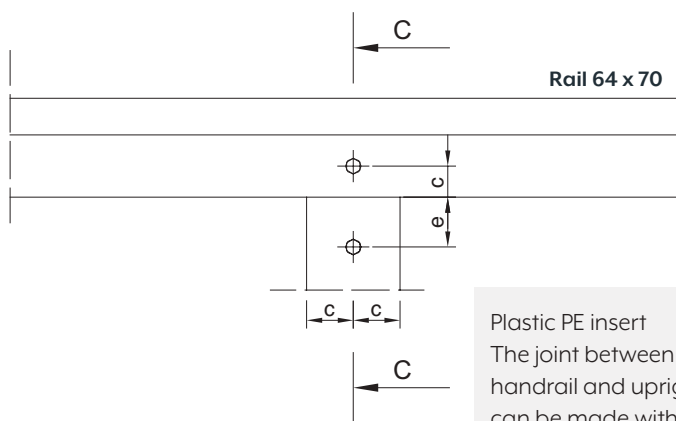
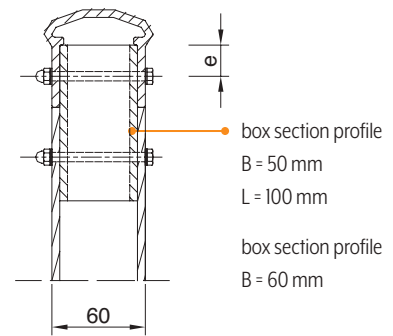
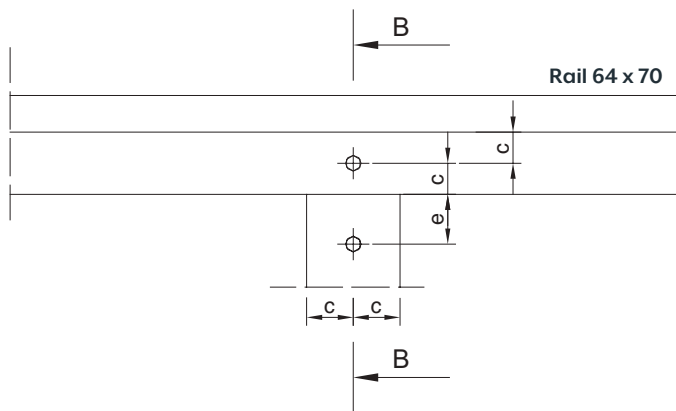
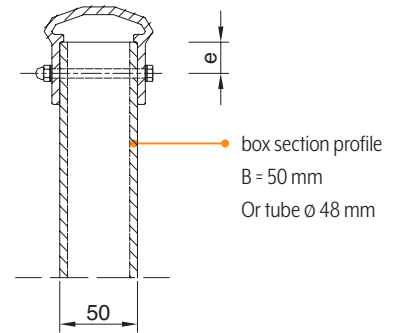
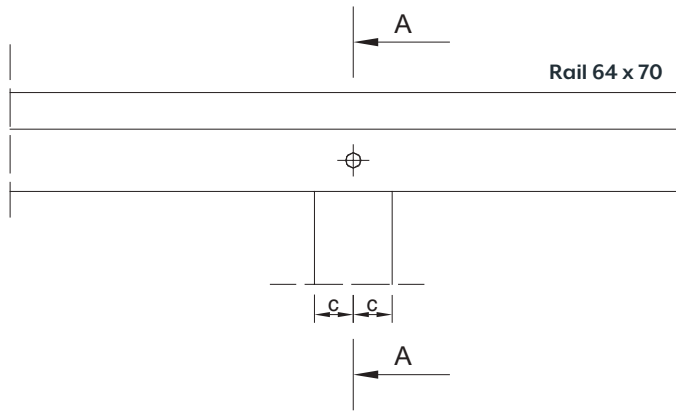


View B without joints



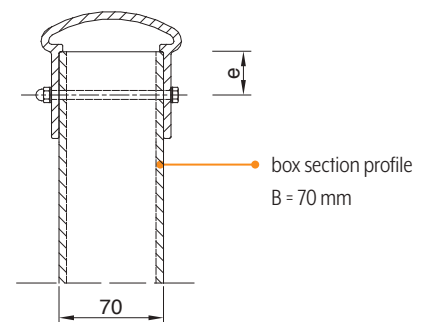
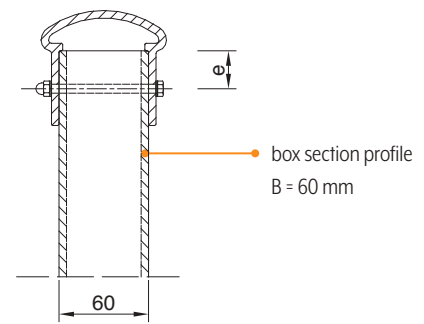
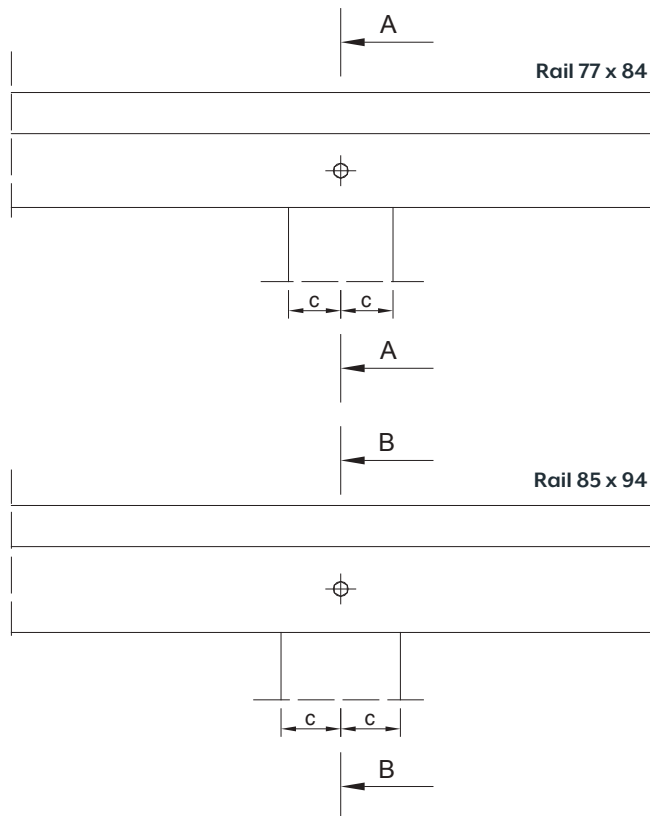
Connection methods for handrails

50 mm handrail joints

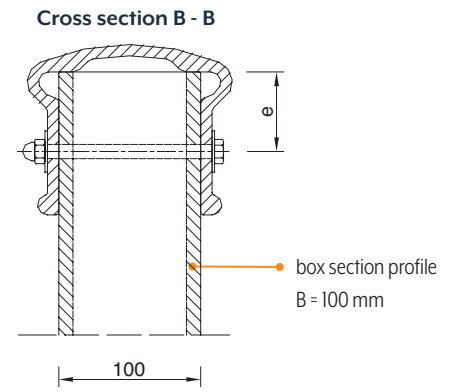
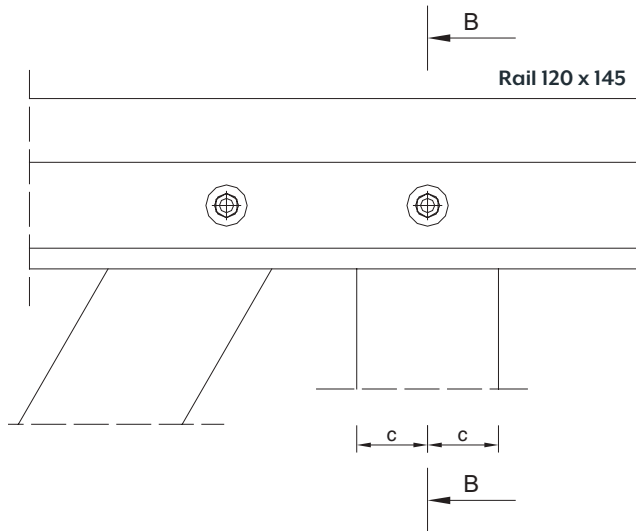


Plastic PE insert
 The joint between the handrail and upright can be made with a polyethylene insert

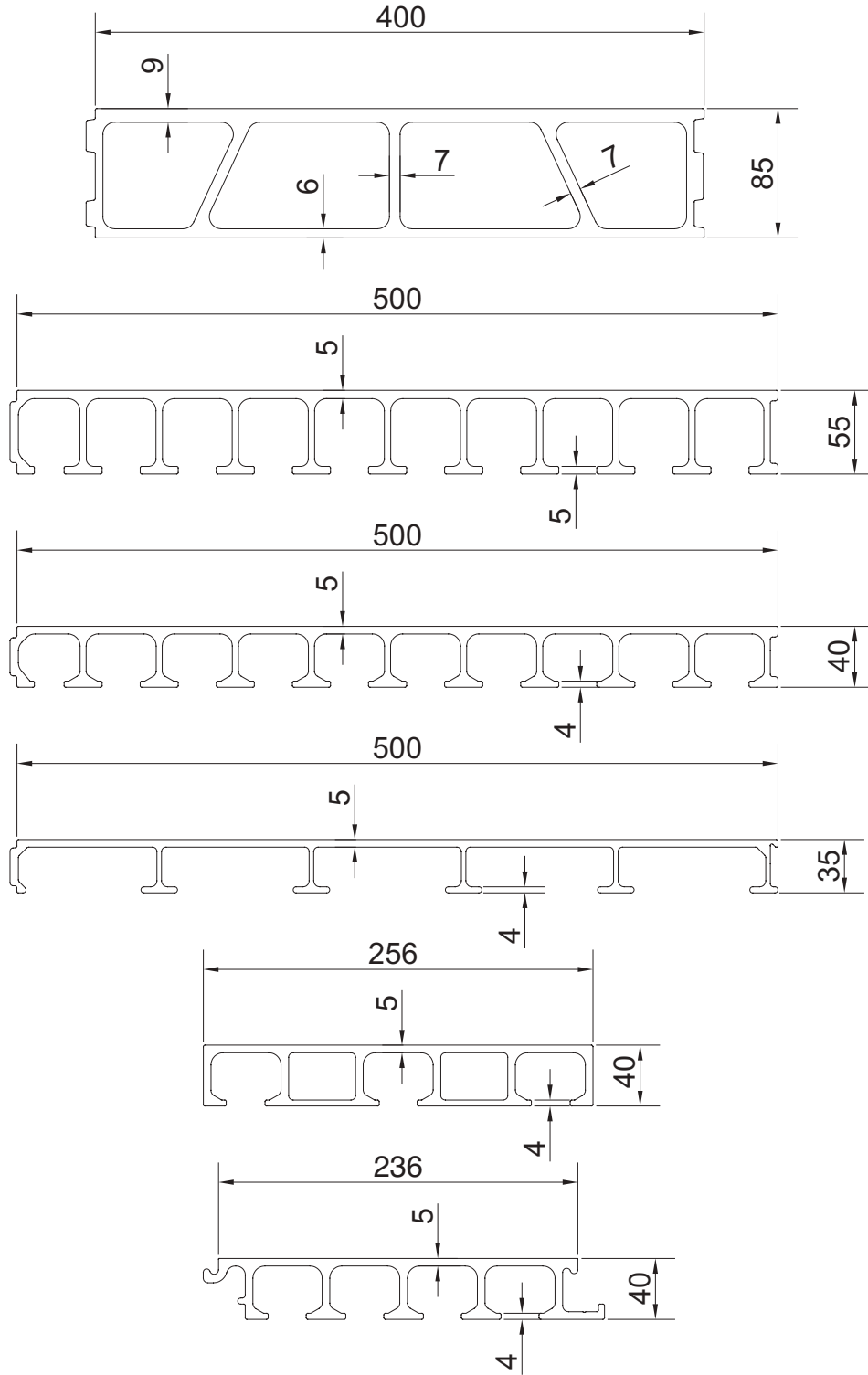
60 mm and 70 mm handrail joints



100 mm handrail joints



Plank dimensions





ABOUT US

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