The General Principles of Detailed Design at Ruukki Construction Ltd

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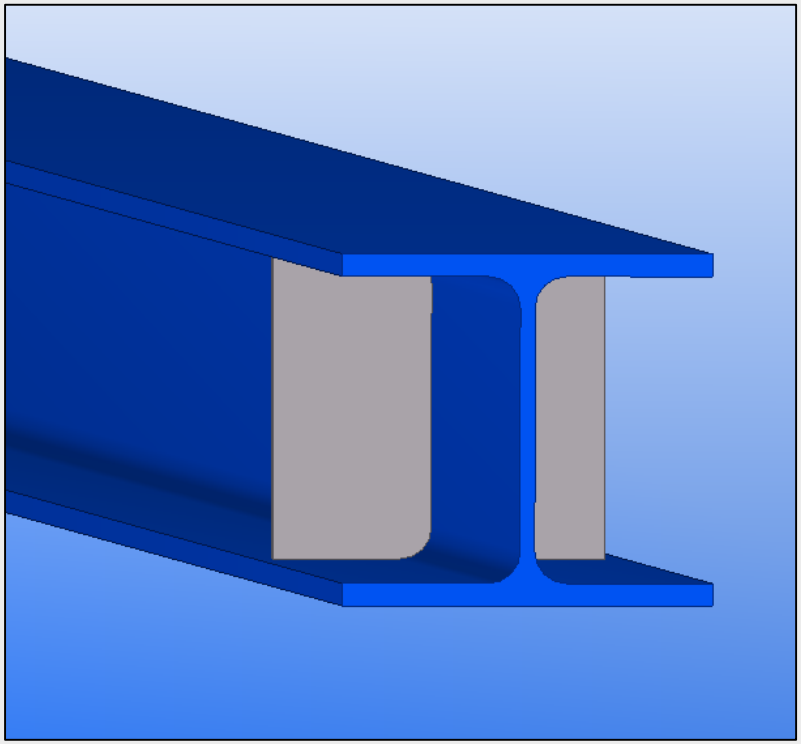
The feasibilities of production at the workshops

		Peräseinäjoki (Finland)	Ylivieska (Finland)	Oborniki (Poland)	Gargždai (Lithuania)
	Execution class	EXC4	EXC4	EXC4	EXC4
The maximum dimensions of structure	Length [m]	28	50	20	14
	Width [m]	5,8	8	6	4,9
	Height [m]	3,3	6	4,5	5
	Mass [tn]	10	100	20	5

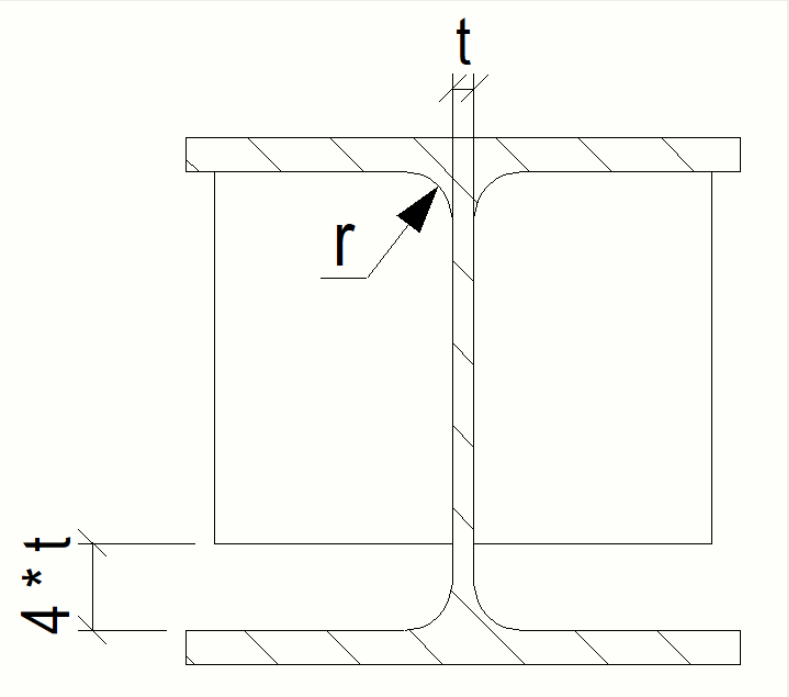
Hot-rolled I-profile
Stiffeners

- The height of the stiffener = the height of the web
- The radius of the stiffener = the radius of the profile
- The width of the stiffener is dimensioned so that it can be welded all around



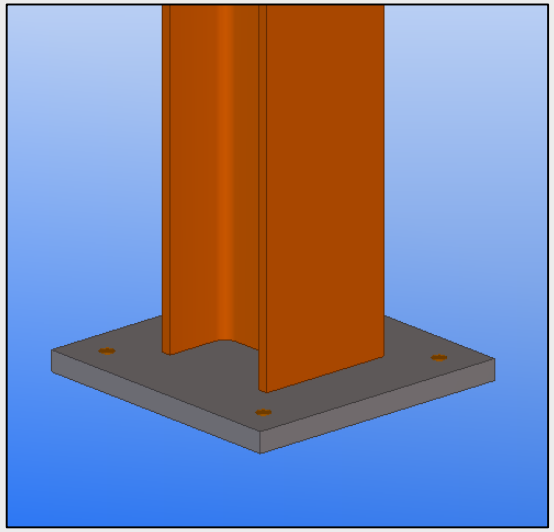
Hot-rolled I-profile
Stiffeners

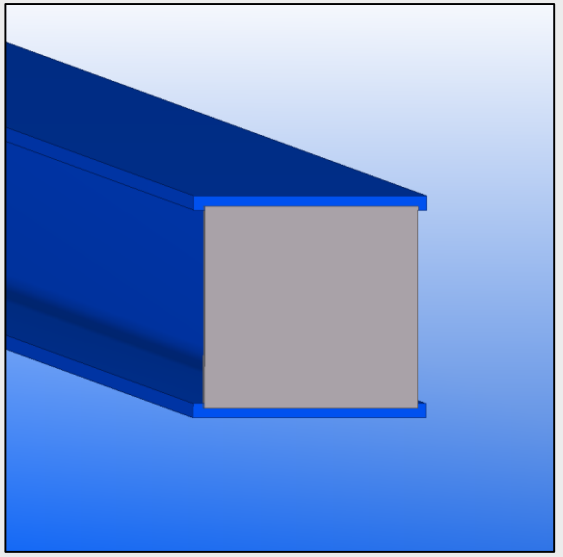
- The stiffener can be designed undersized if the purpose of the stiffener is not to move the loads to the bottom flange

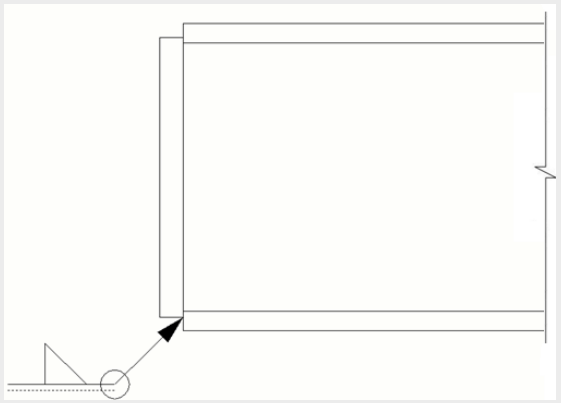


Hot-rolled I-profile
End plates

- The end plate should be smaller or larger than the profile

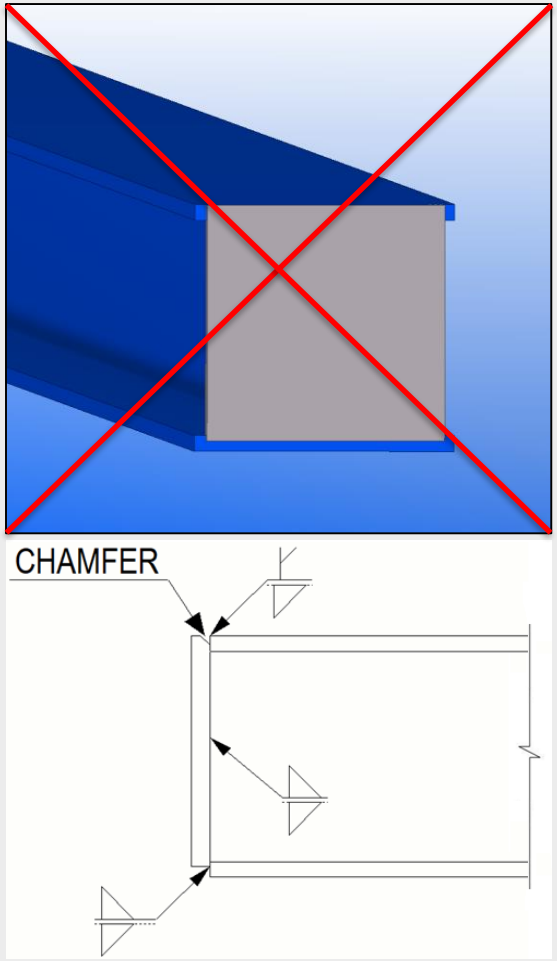






Hot-rolled I-profile
End plates

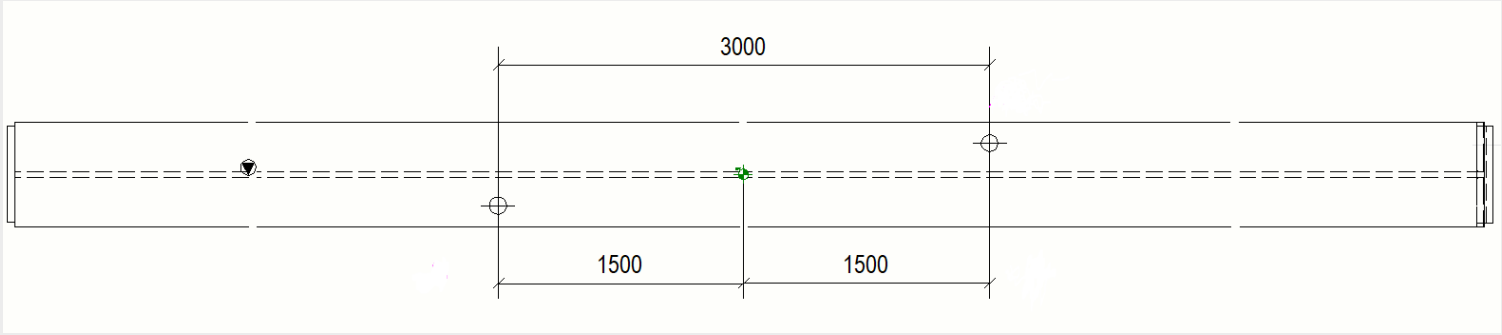
- Avoid designing the edge of the end plate to the same level as the edge of the profile
  - Chamfer to the edge of the end plate



Hot-rolled I-profile
Lifting

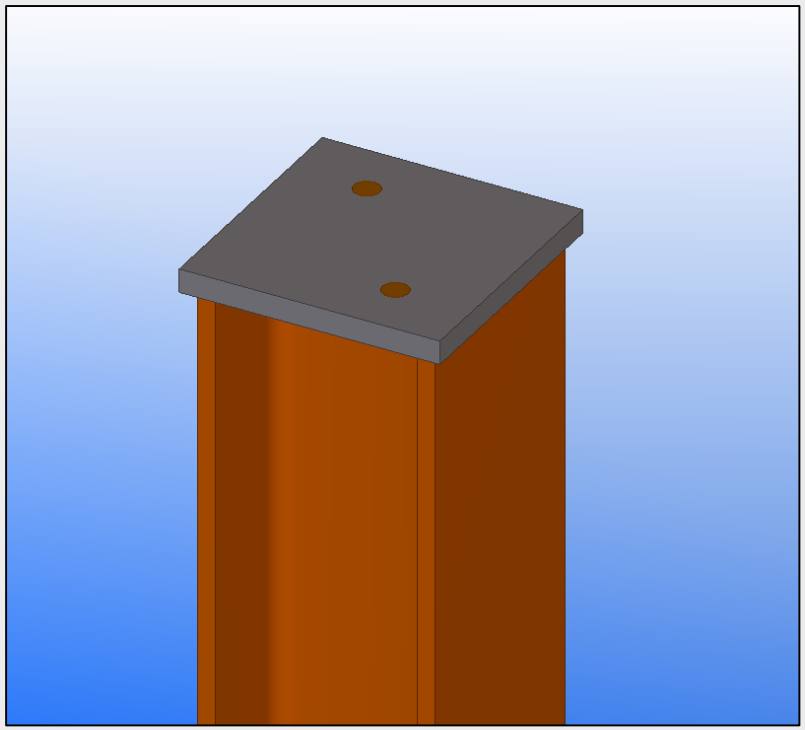
- I-beam < 200 kg
  - Do not require any lifting accessories
- I-beam 200-5600 kg
  - Two ø22 or ø26 mm holes in the top flange on both sides of the web to either side of the centre of gravity
  - The distance between the holes is 3000 mm

Mass of the beam [kg]	Lifting eye bolt	Hole diameter [mm]
< 3000	RUD VWBG M20	22
3000–5600	RUD VLBG M24	26



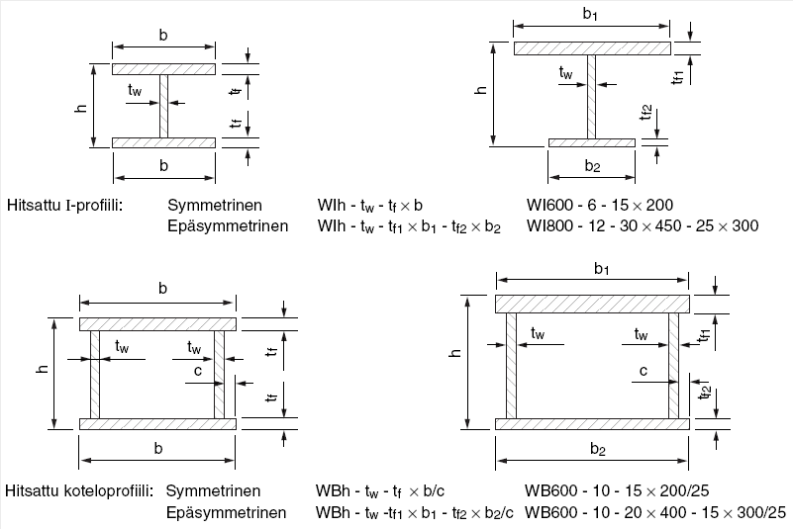
Hot-rolled I-profile
Lifting

- I-column < 3000 kg
  - The end plate t ≥ 20 mm
  - Two ø22 mm holes or two threaded M20 holes drilled in the end plate
  - Holes must be symmetrical relative to the center of the column
  - If there are other bolt holes in the end plate, they may also be utilized



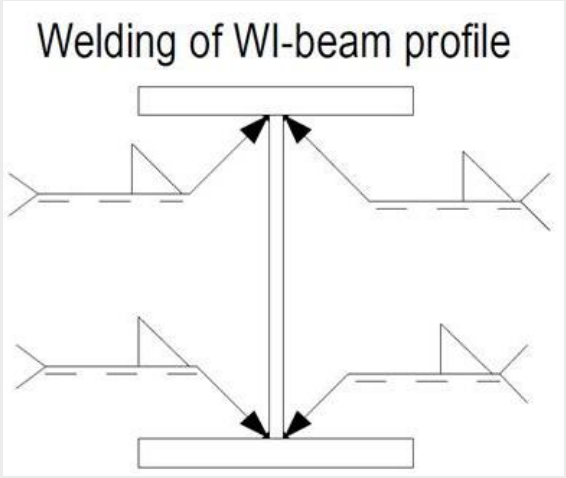
Welded I-profile and box section
Recommended dimensions

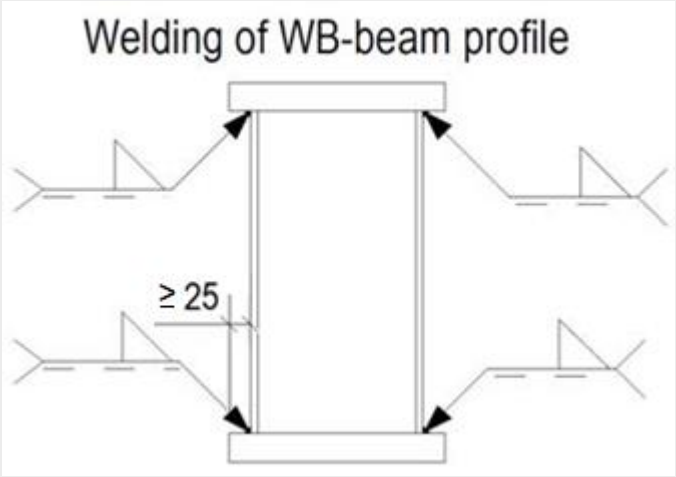
- Tf, tw = 5, 6, 8, 10, 12, 14, 15, 16, 18, 20, 22, 25, 30, 35, 40, 50, 60, 80 and 100 mm
- The maximum height of the web is 3300 mm
- The maximum width of the flange is 700 mm
  - Bridge beam: 1200 mm
- Dimension c ≥ 25 mm



Welded I-profile and box section
Welding of the profile

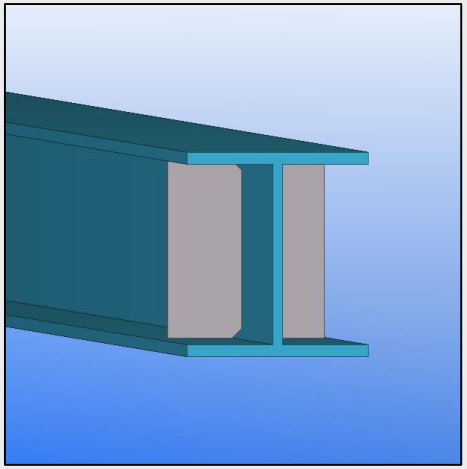
- The welds and their sizes must be marked in all the workshop drawings
- Using the automatic submerged arc welding machine, the a7 mm fillet weld is the maximum that can be done at one time

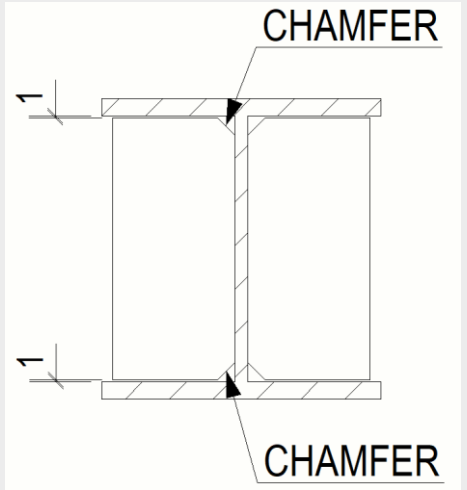




Welded I-profile and box section
Stiffeners

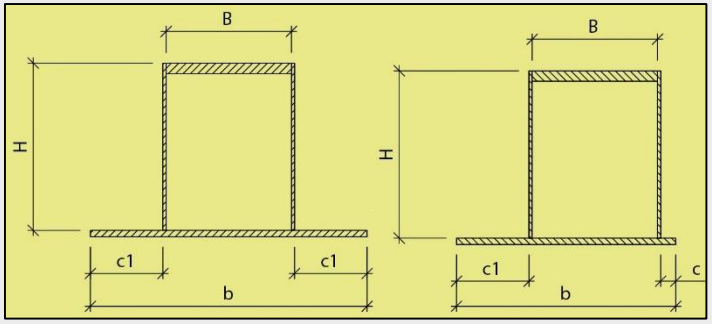
- Chamfers to the inner corners of the stiffeners
  - Size according to the size of the profile weld
- Stiffener must be 2 mm smaller than the web
- The width of the stiffener is dimensioned so that it can be welded all around

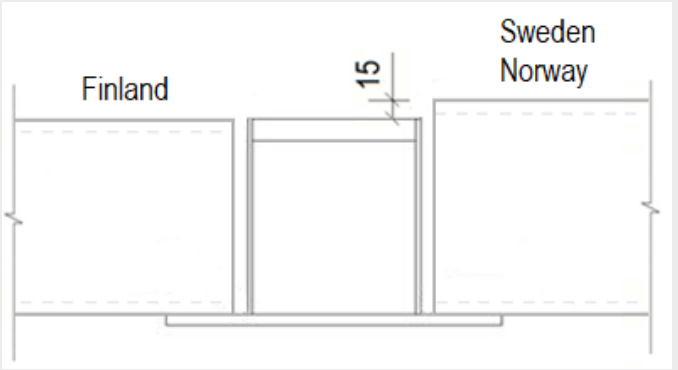


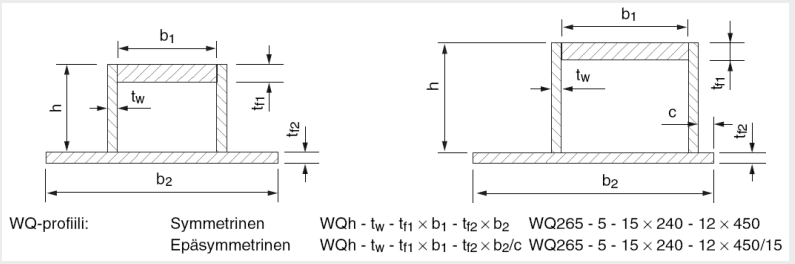


WQ-beam
Recommended dimensions

- In Finland the height of the web (H) = the height of the hollow slab
- In Sweden and in Norway the height of the web (H) is 15 mm smaller than the height of the hollow slab
- The width of the top flange (B) is normally 190, 240, 290 or 340 mm
- Dimension c ≥ 25 mm

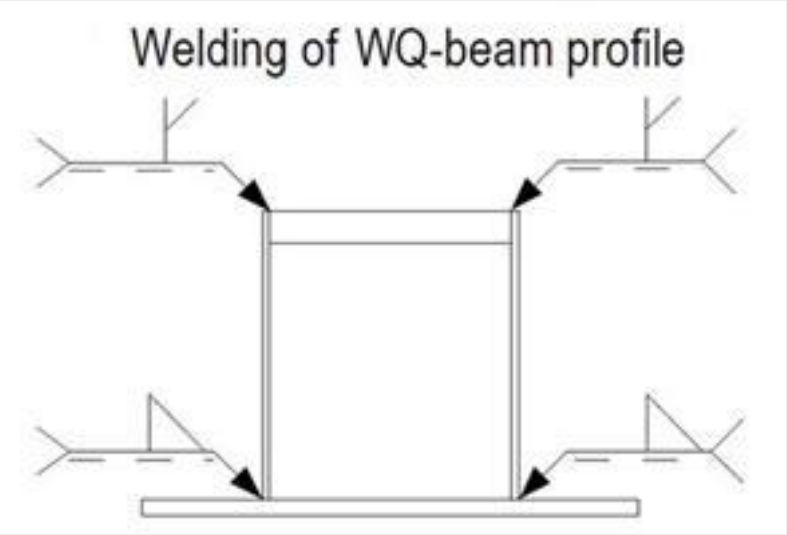






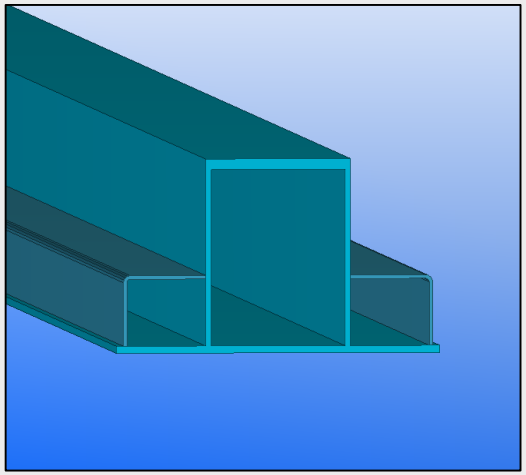
WQ-beam
Welding of the profile

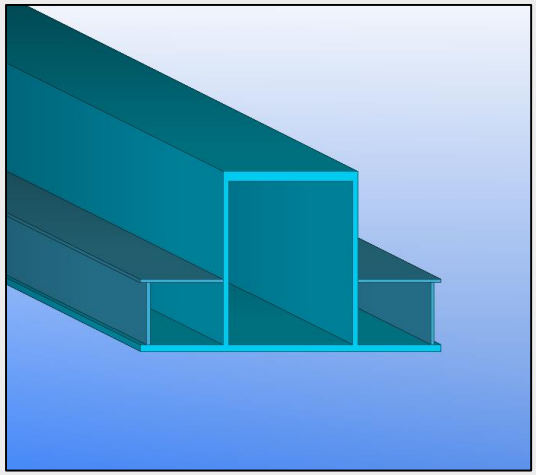
- The top flange is welded between the web plates
  - Chamfers to the edges of the flange
- The welds and their sizes must be marked in all the workshop drawings
- Using the automatic submerged arc welding machine, the a7 mm fillet weld is the maximum that can be done at one time

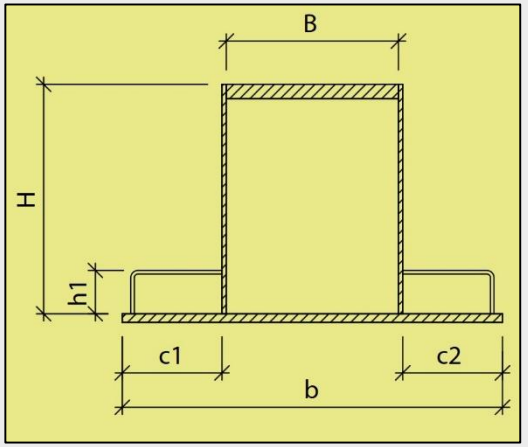


WQ-beam
Raisers

- L-profile or plates
- The angle of the raiser should be 90°
- The height of the raiser is normally 50-180 mm
- The width of the raiser is determined by the supporting surface required for the hollow slab

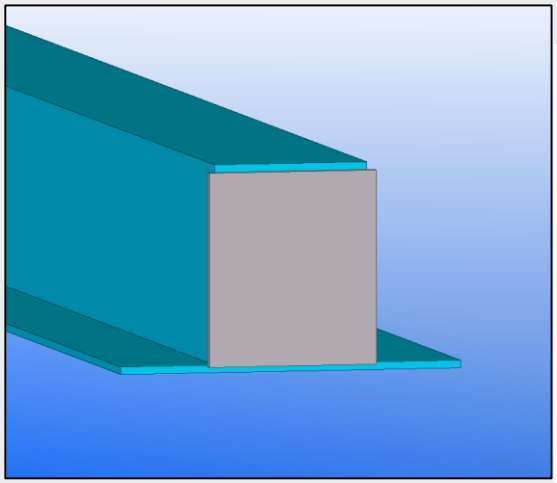


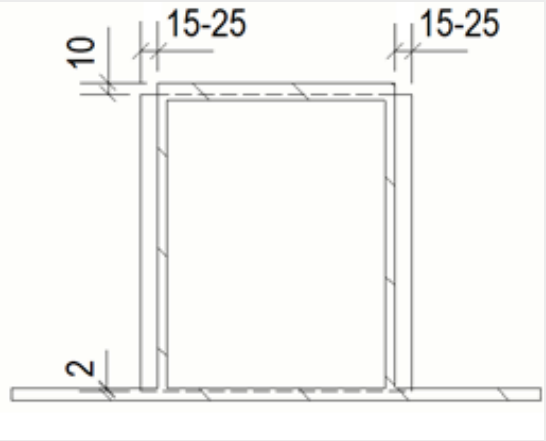


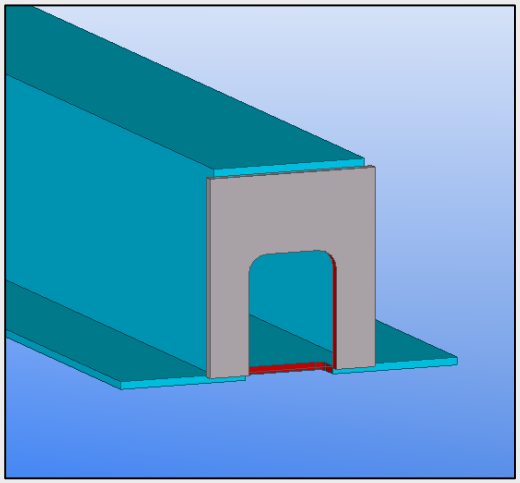


WQ-beam
End plates

- The end plate is dimensioned according to the image
- An opening is made on the end plate if the beam is connected to the composite column with a console
  - Size according to the console

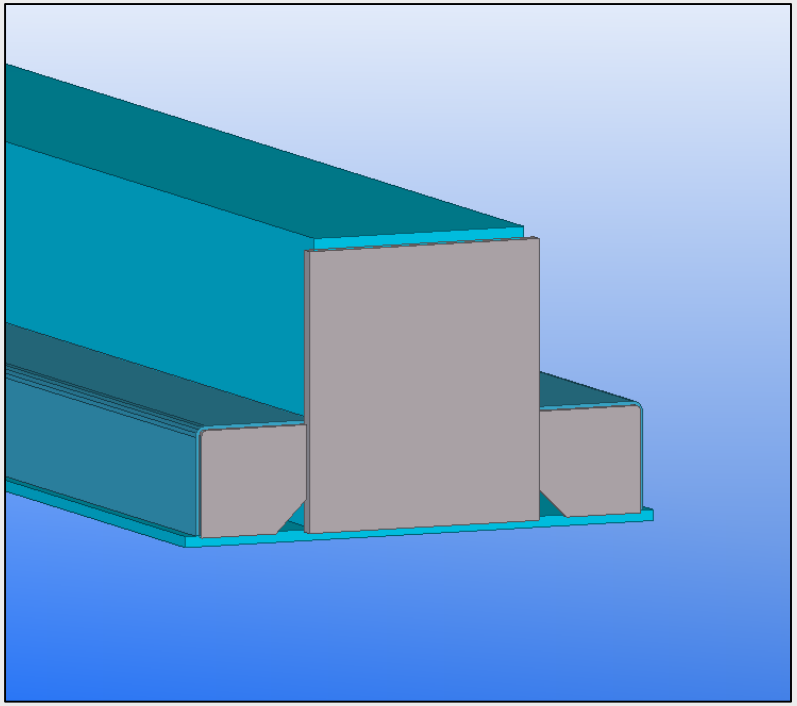






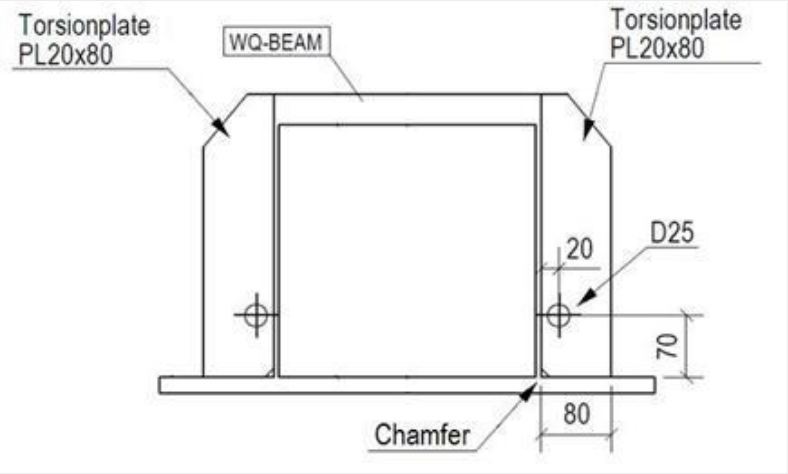
WQ-beam
End plates

- The end plate of the raiser should be as much as the size of the weld smaller than the raiser



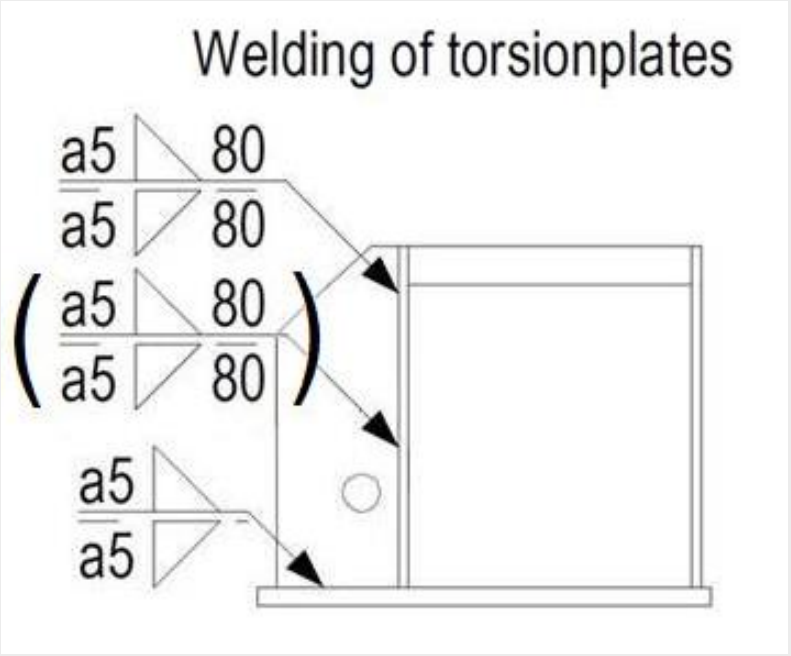
WQ-beam
Torsion plates

- The height of the torsion plate = the heigth of the web
- Chamfer to the inner corner of the torsion plate
  - Size according to the size of the profile weld
- The distance between the hole and the bottom flange depends on the size of the hollow slab
  - Normally 70 mm



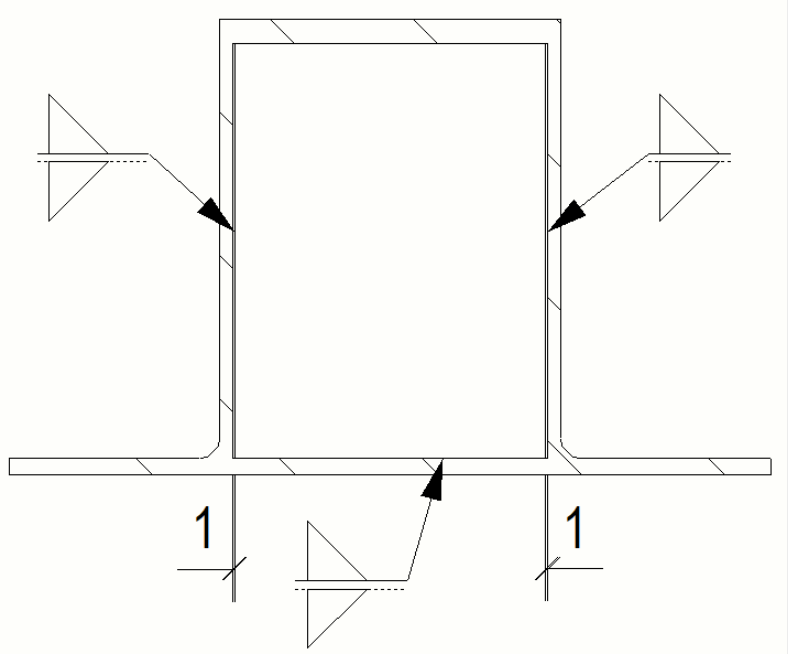
WQ-beam
Torsion plates

- The size of the weld is normally a5 mm
- The torsion plate is welded to the bottom flange and to the web with a 80 mm long fillet weld
  - If the beam is high, it may be necessary to add the weld in the middle of the torsion plate
- The torsion plates are placed to the cavities of the hollow slab



WQ-beam
Innerstiffeners

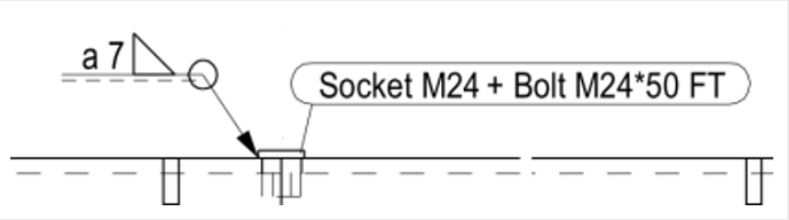
- A steel plate or a hollow section
- The height of the innerstiffener = the inner height of the box
- The innerstiffener must be 2 mm narrower than the web

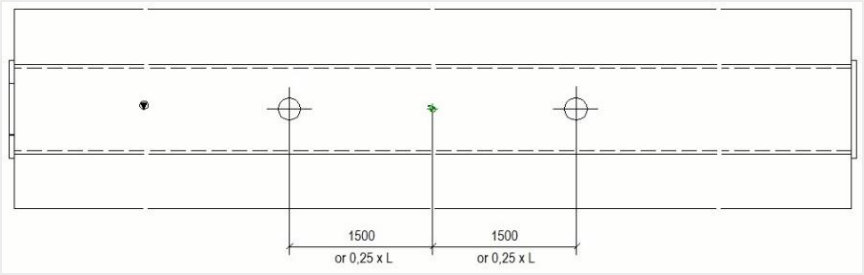


WQ-beam
Lifting

- WQ-beam < 5600 kg
  - RUD VLBG M24 -lifting eye bolt and socket M24
  - Two ø52 mm holes in the top flange to either side of the centre of gravity
  - The socket and the bolt must be marked in the workshop drawings
- WQ-beam > 5600 kg
  - Fixed lifting lugs are welded on the top flange

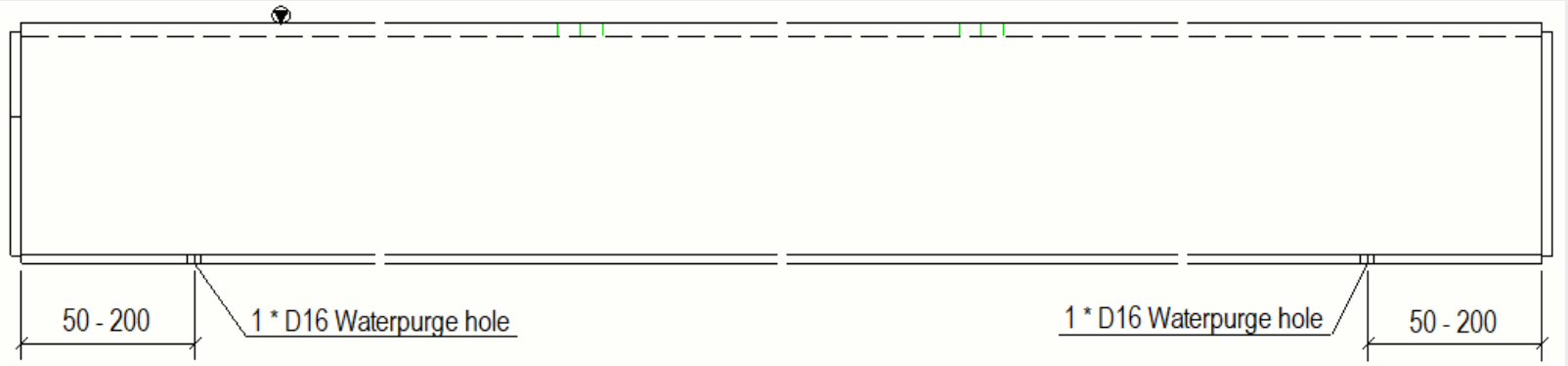
Length of the WQ-beam L [mm]	Distance from the centre of gravity [mm]
≥ 6000	1500
< 6000	0,25 x L





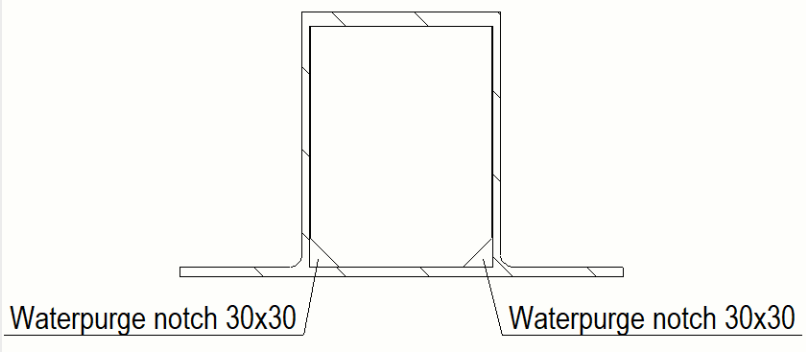
WQ-beam
Waterpurge holes

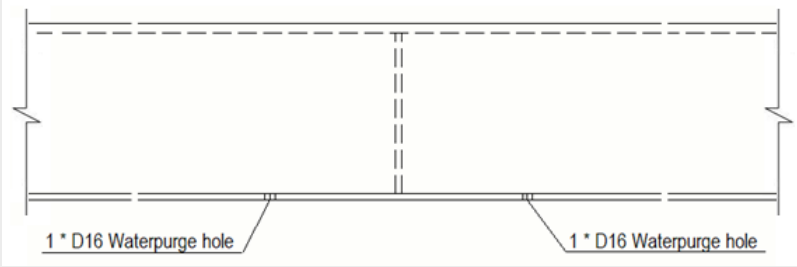
- Avoid designing holes in the top flange
- Two ø16 mm holes at both ends of the bottom flange
- The position of the holes depends on the connections to the other structures



WQ-beam
Waterpurge holes

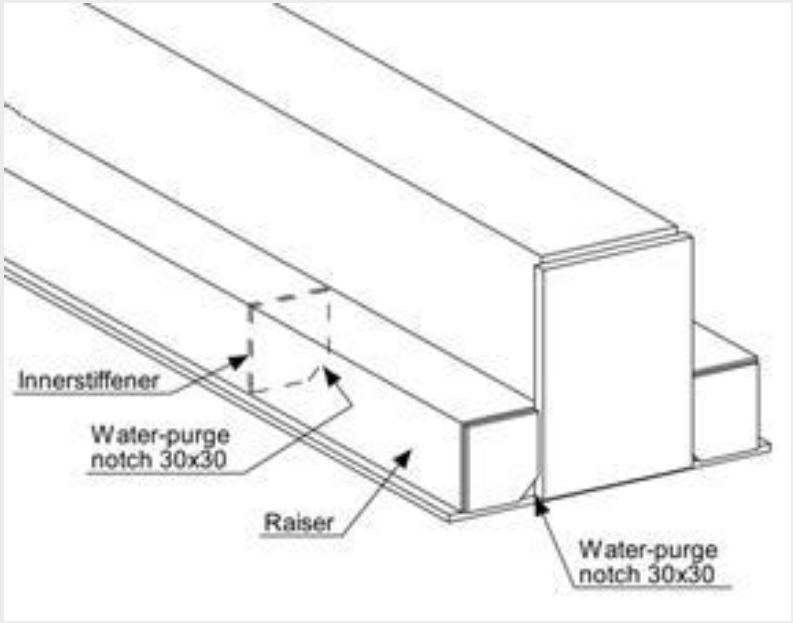
- If there are innerstiffeners
  - 30x30 mm notch to the two corners of the innerstiffener or
  - Two ø16 mm holes on both sides of the stiffener to the bottom flange





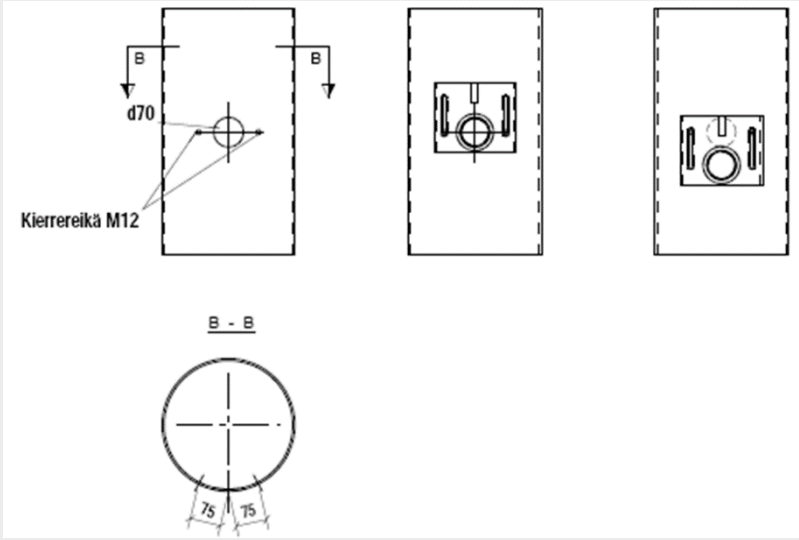
WQ-beam
Waterpurge holes

- 30x30 mm notch to the innerstiffener and to the end plate of the raiser



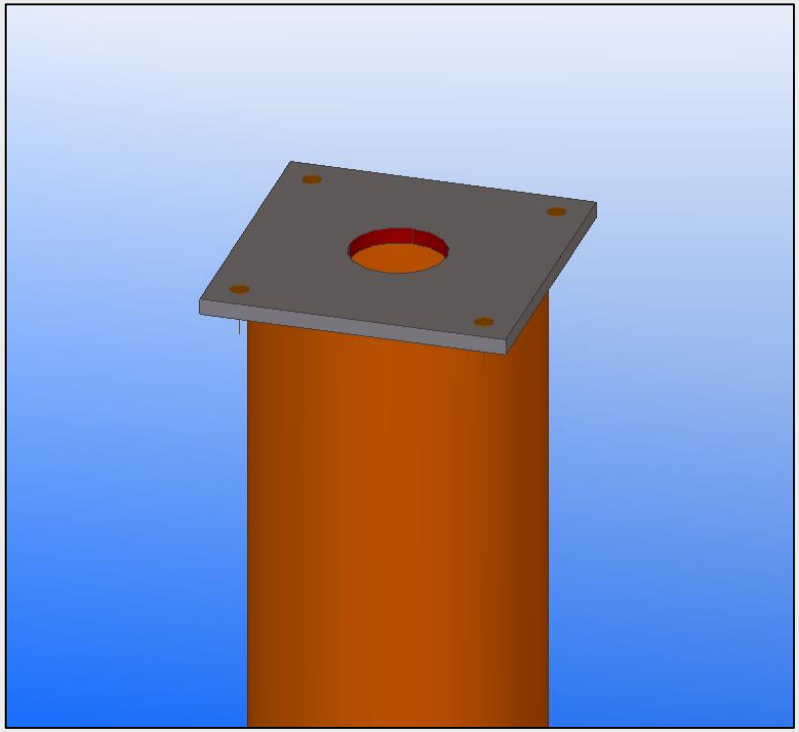
Composite column
Casting hole

- A ø70 mm casting hole
- Two M12 threaded holes drilled on both sides of the casting hole
- The altitude of the holes should be about 500 mm
- The holes must be placed in the optimum position for the casting work



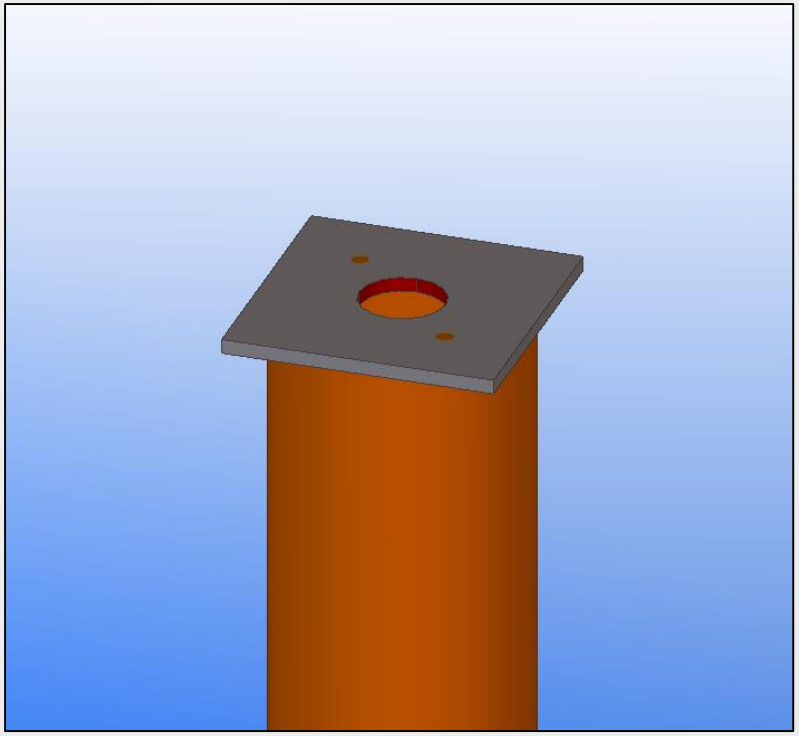
Composite column
End plates

- A hole in the center of the end plate
  - Recommended size is ø120 mm
  - At least the same size as the size of the casting hole
- The hole size should be the same in each end plate of the same project



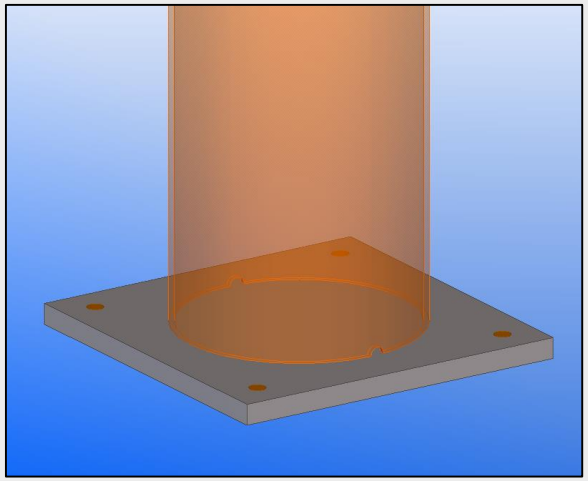
Composite column
Lifting

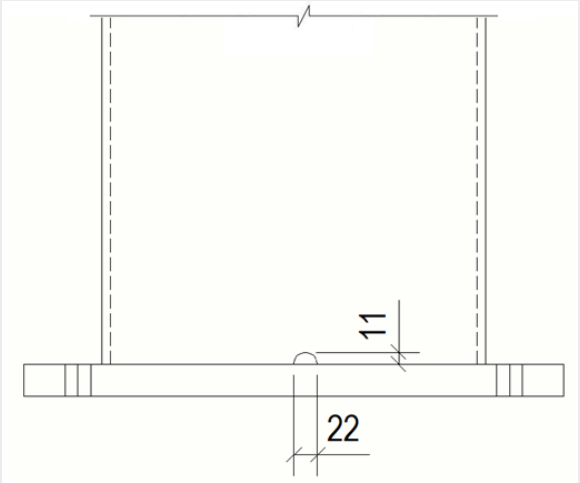
- Column < 3000 kg
  - The end plate t ≥ 20 mm
  - Two ø22 mm holes or two threaded M20 holes drilled in the end plate
  - Holes must be symmetrical relative to the center of the column
  - If there are other bolt holes in the end plate, they may also be utilized



Composite column
Waterpurge holes

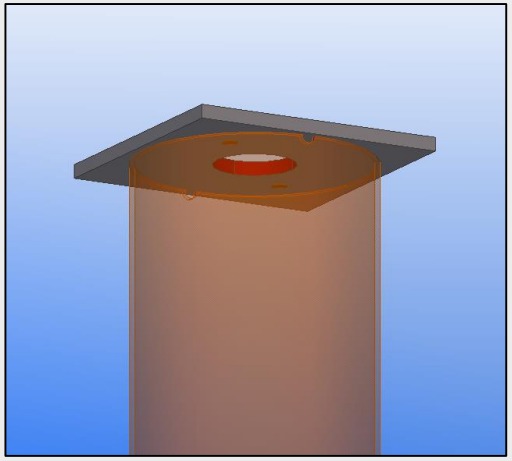
- Two 22x11 mm holes
- The holes are placed at the bottom of the column at opposite sides of the column

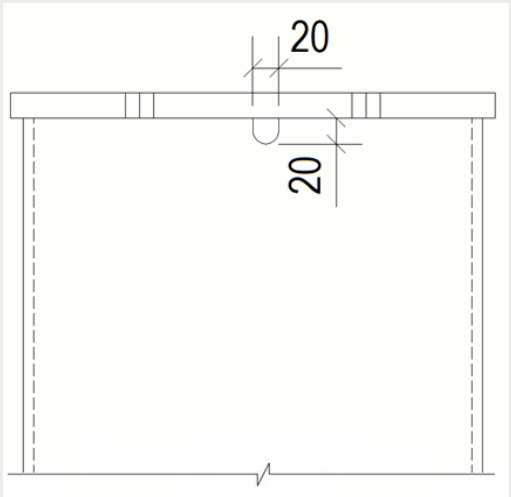




Composite column
Vapor holes

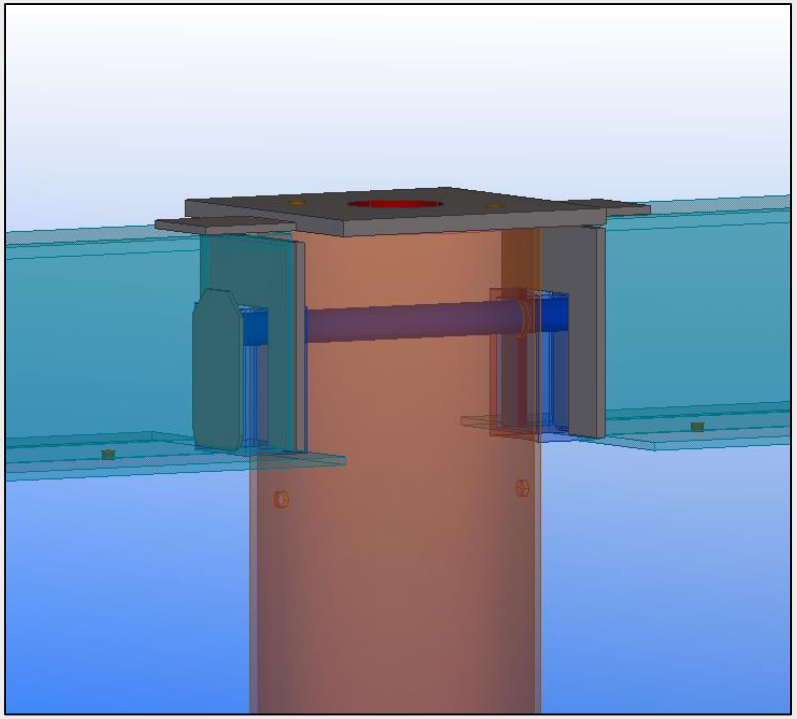
- Two ø20 mm holes on each floor
- The distance between the holes may not exceed five meters
- The holes are placed at the top of the column at opposite sides of the column





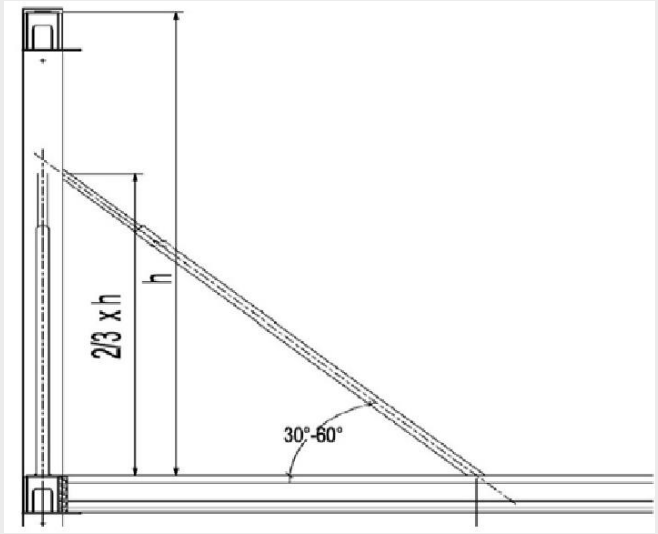
Composite column
Vapor holes

- The holes are placed below the connected structures so that they won’t cover the holes



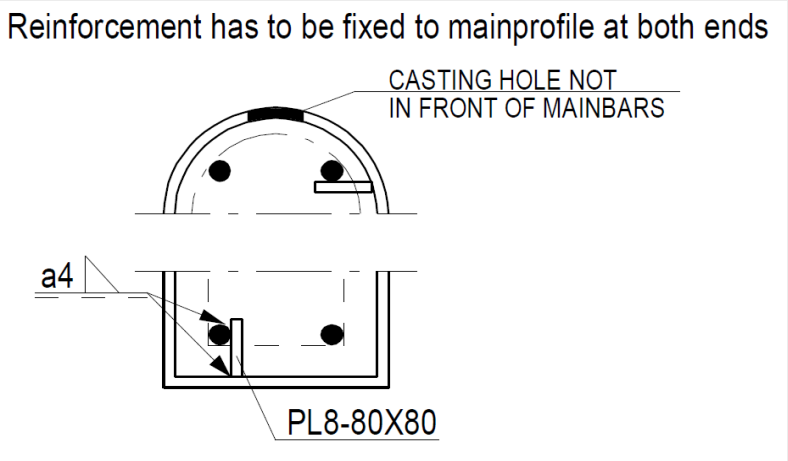
Composite column
Column props

- Four threaded M16 holes drilled on each side of the column on each floor
- The recommended altitude of the holes is 2/3 of the floor height



Composite column
Reinforcements

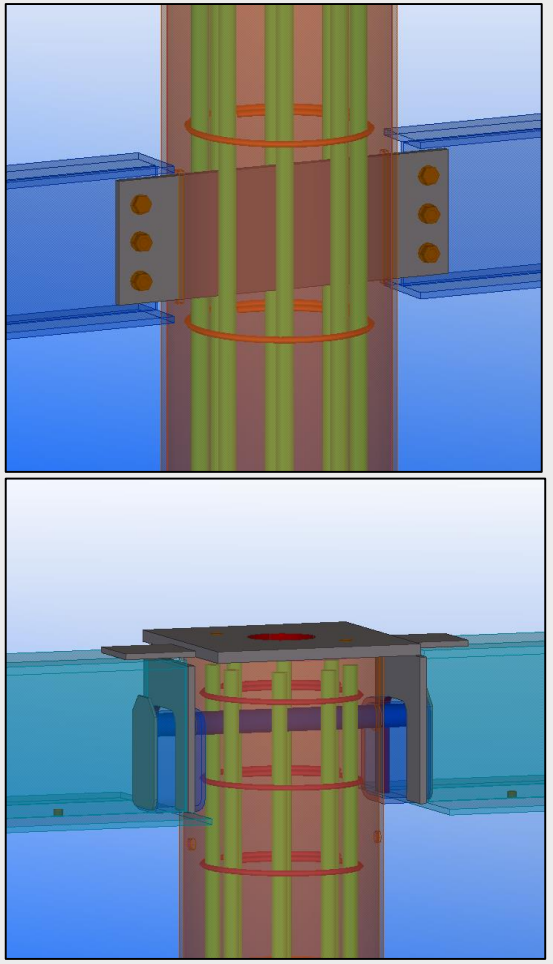
- The reinforcements are modeled so that they look real and they should appear in the workshop drawings
- The reinforcements are placed centrally in the column so that the casting hole is not in front of the mainbars
- The reinforcement has to be fixed to column if they are able to detach during installation



Composite column

Parts that go through the composite column

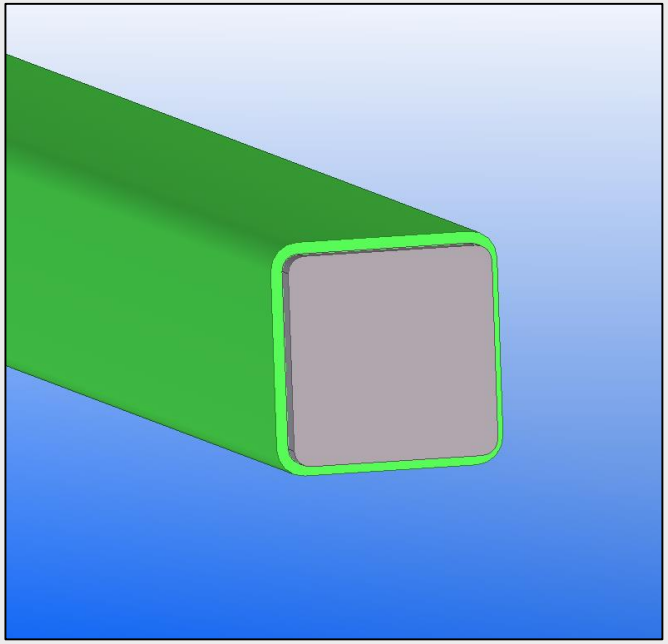
- At the design phase, it is necessary to check that the part can fit well in the column despite the reinforcements



Brace
End plates

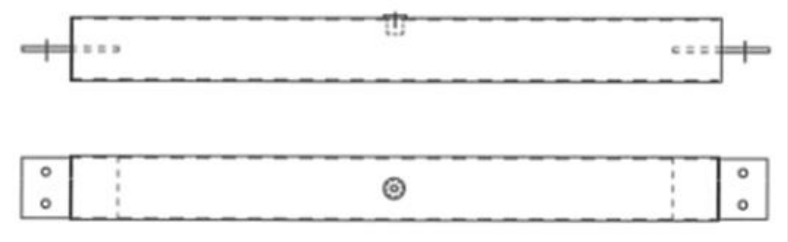
- The radius of the end plate should be as much as the size of the weld smaller or larger than the radius of the profile

Wall thickness of the profile	Radius of the profile
t ≤ 6,0 mm	r_0 = 2,0 x t
6,0 mm < t ≤ 10 mm	r_0 = 2,5 x t
t > 10 mm	r_0 = 3,0 x t

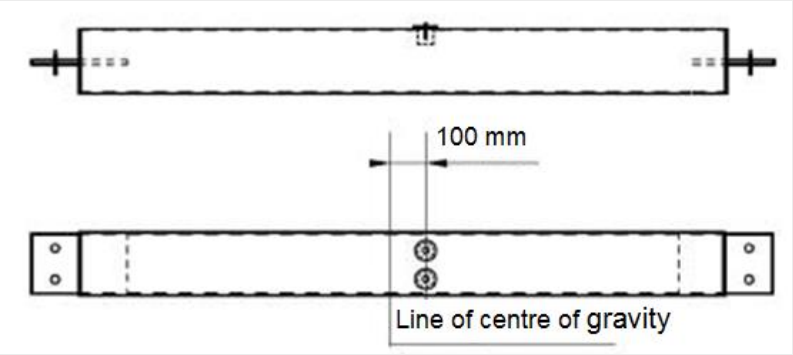


Brace
Lifting

- Diagonal brace of the wall < 1500 kg
  - RUD VWBG M24 -lifting eye bolt and socket M24
  - A ø52 mm hole in the centre of gravity

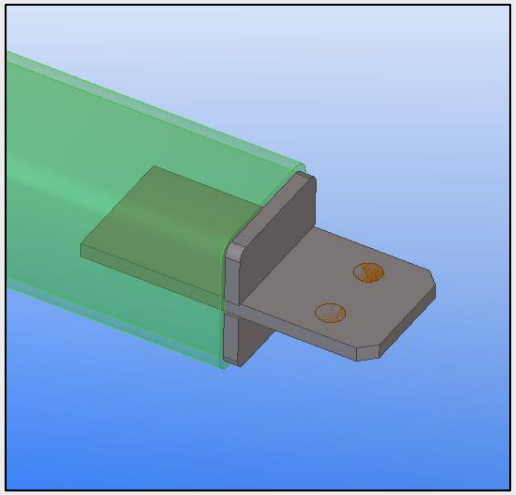


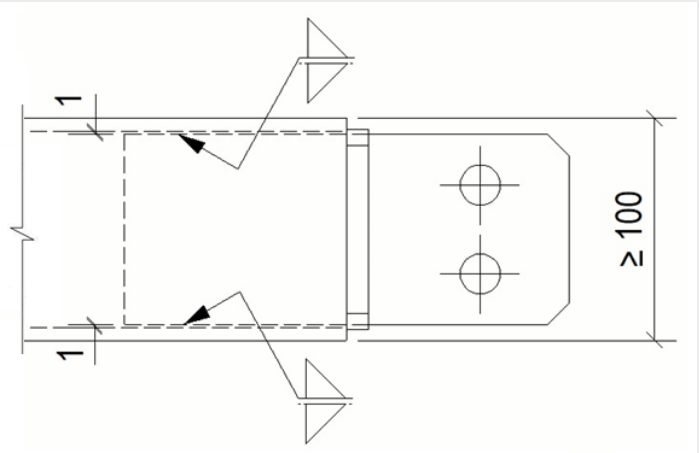
- Diagonal brace of the wall 1500-4000 kg
  - Two RUD VWBG M24 -lifting eye bolts and sockets M24
  - Two ø52 mm holes side by side at a distance of 100 mm from the centre of gravity



Brace
End connection

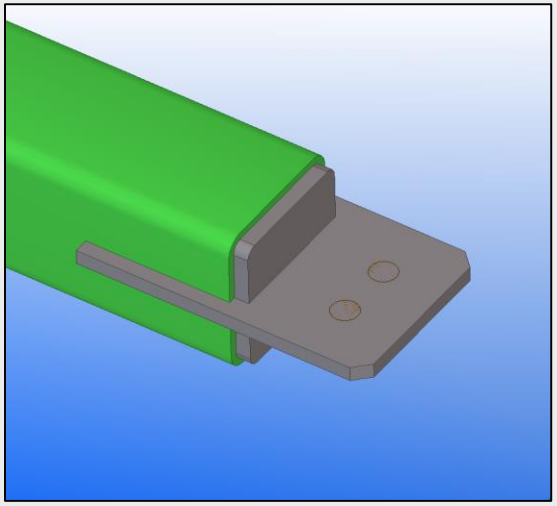
- A connecting plate welded inside the profile
  - The production-friendliest connection
  - Is used when the narrower side of the profile is ≥ 100 mm
  - The connecting plate must be 2 mm narrower than the inner diameter of the profile
  - The connecting plate is allowed to be inside the profile at maximum the size of the narrower side of the profile
    - 70 mm if the narrower side of the profile is 100 mm

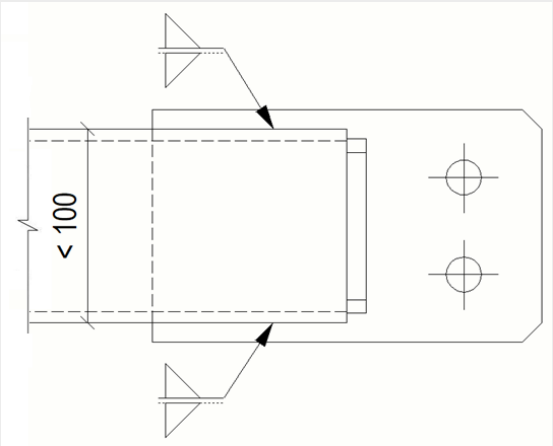




Brace
End connection

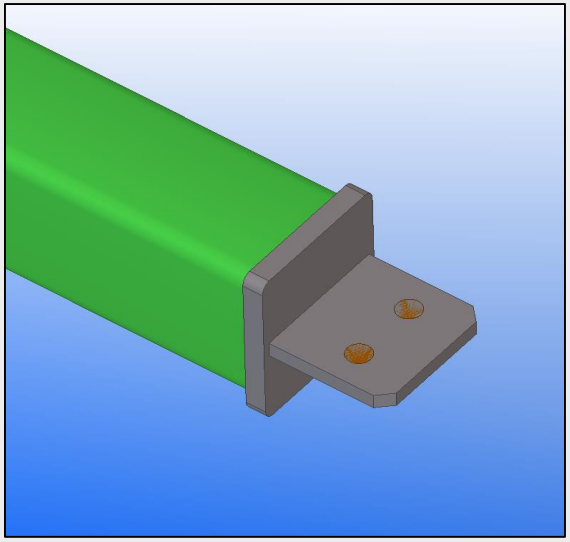
- A connecting plate welded outside the profile
  - Is used when the narrower side of the profile is < 100 mm or when the connection is affected by large forces
  - The cut must be 2 mm wider than the thickness of the plate

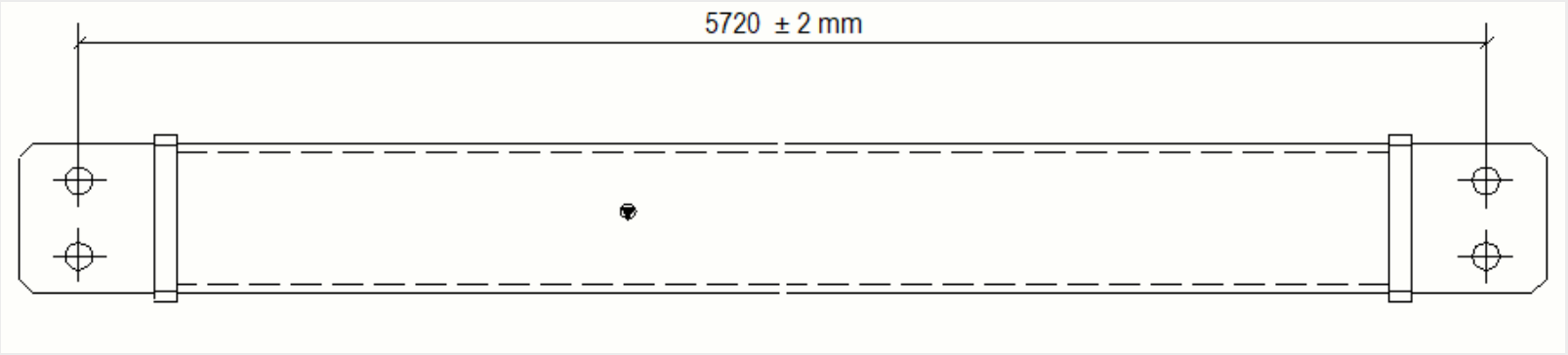




Brace
End connection

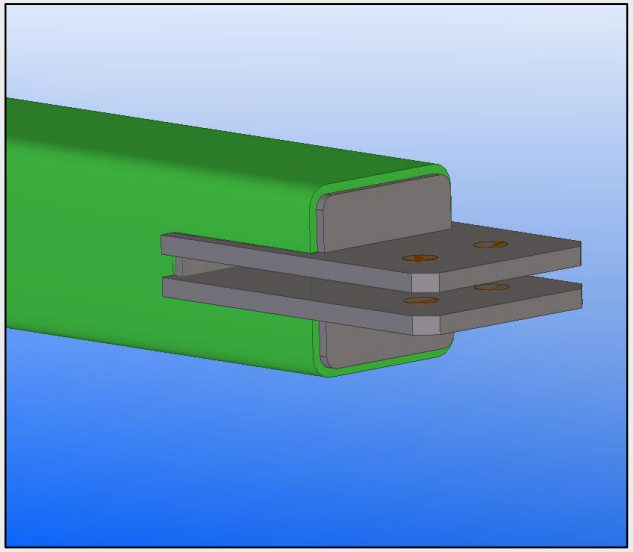
- A connecting plate welded onto the end plate
  - There is a risk that dimension between the holes of the connecting plates is out of the tolerance

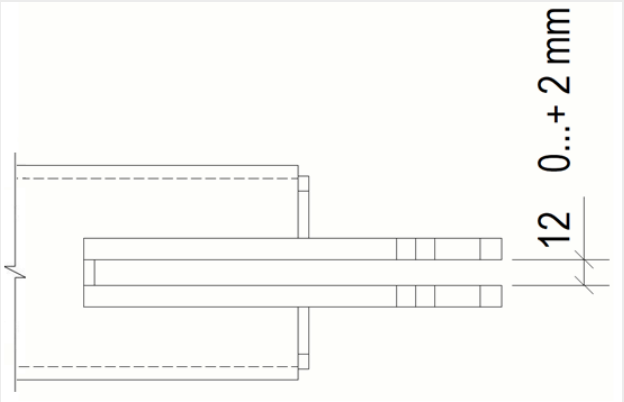




Brace
End connection

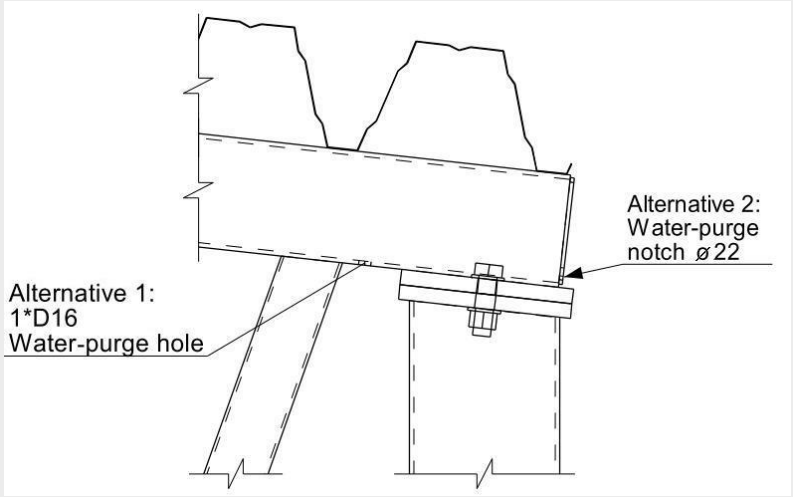
- Double shear connection
  - The most difficult to produce and install
  - Is used when the connection is affected by large forces
  - The gap between the connecting plates must be 2 mm wider than the thickness of the associated plate taking into account the +2 mm tolerance





Truss
Waterpurge holes

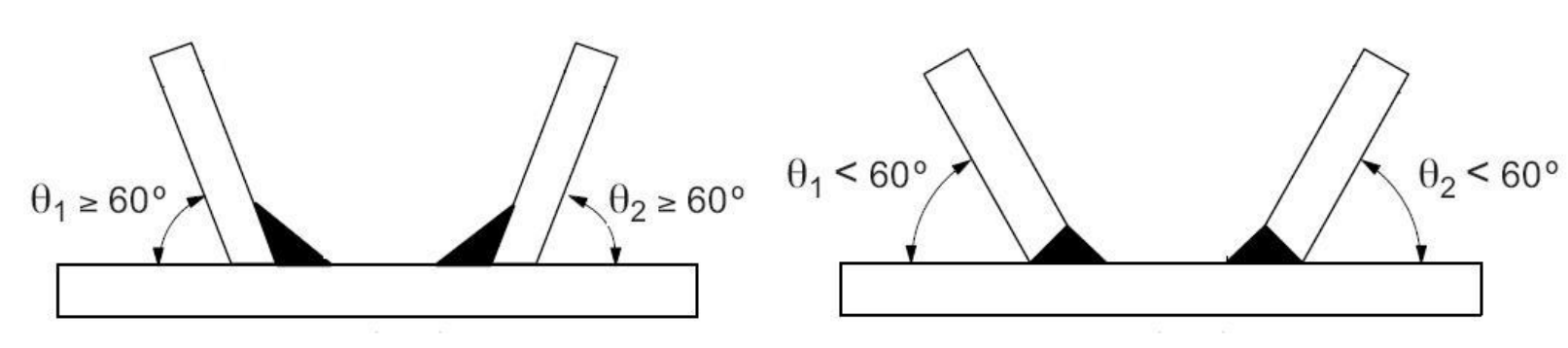
- Necessary if holes are drilled onto the top chord
- Two alternatives
  - A Ø16 mm hole at both ends of the top chord or
  - A Ø22 mm notch at the lower edge of the end plates of the top chord



Truss

Truss node connections

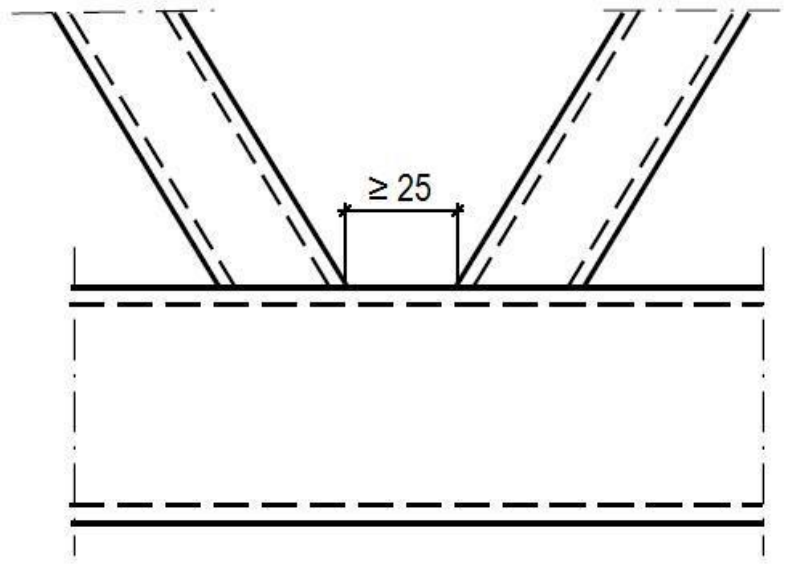
- Avoid designing small angles between chords and diagonals
- The minimum permissible angle is 30°
- The ends of the diagonals must be chamfered if the angle is smaller than 60°



Truss

Truss node connections

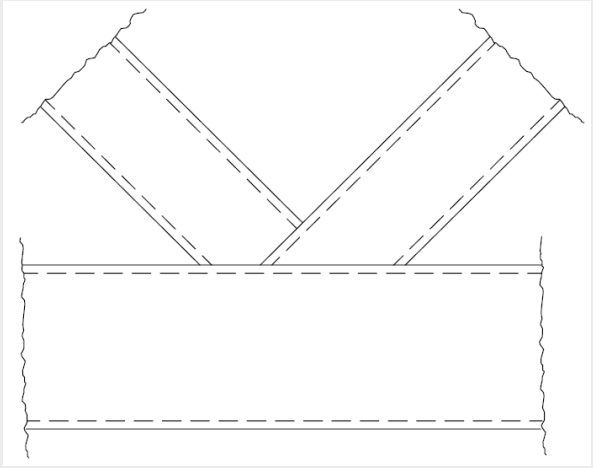
- Clear space connection
  - Easy to produce
  - Gap ≥ 25 mm

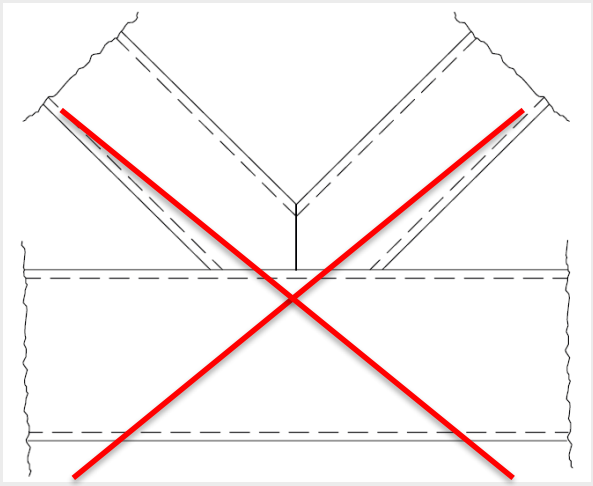


Truss

Truss node connections

- Overlapped connection
  - More difficult to produce
  - One of the diagonals must be completely welded to the chord
  - The durability decreases and the workload increases if the both diagonals are cut off twice





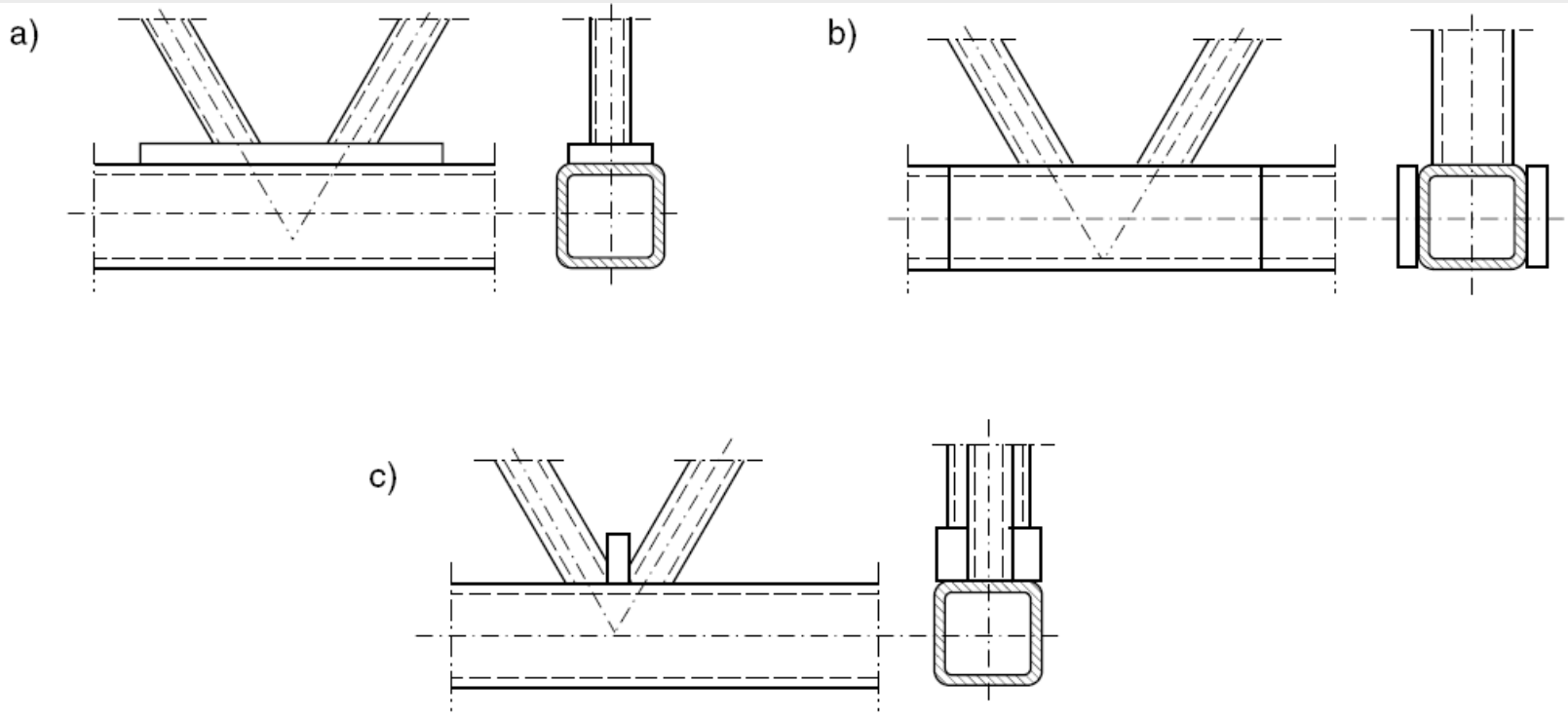
Truss

Truss node connections

- Reinforced connection
  - It is profitable to strengthen the connections with plates if there are only a few connections that need to be strengthened
  - The benefits of the strengthening are lighter structures and the avoidance of the use of a number of profile sizes
  - Alternative a)
    - Is used to avoid chord face failure, brace failure or punching shear and when the chord is considerably wider than the diagonals
  - Alternative b)
    - Is used to avoid chord shear failure
    - The plates are as high as the chord
  - Alternative c)
    - Is used if there is insufficient overlap

Truss

Truss node connections

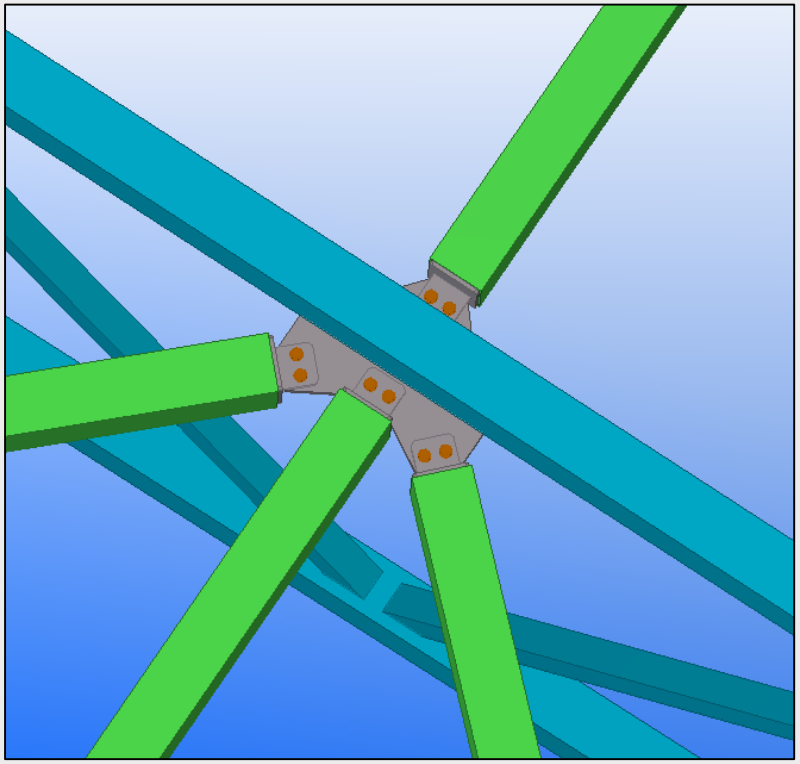


Truss
Lifting

- Hollow section trusses ≤ 30 m long
  - Do not require any lifting accessories
  - If the trusses are fire protected with intumescent paint, the trusses should be equipped with lifting lugs or lifting lug sockets

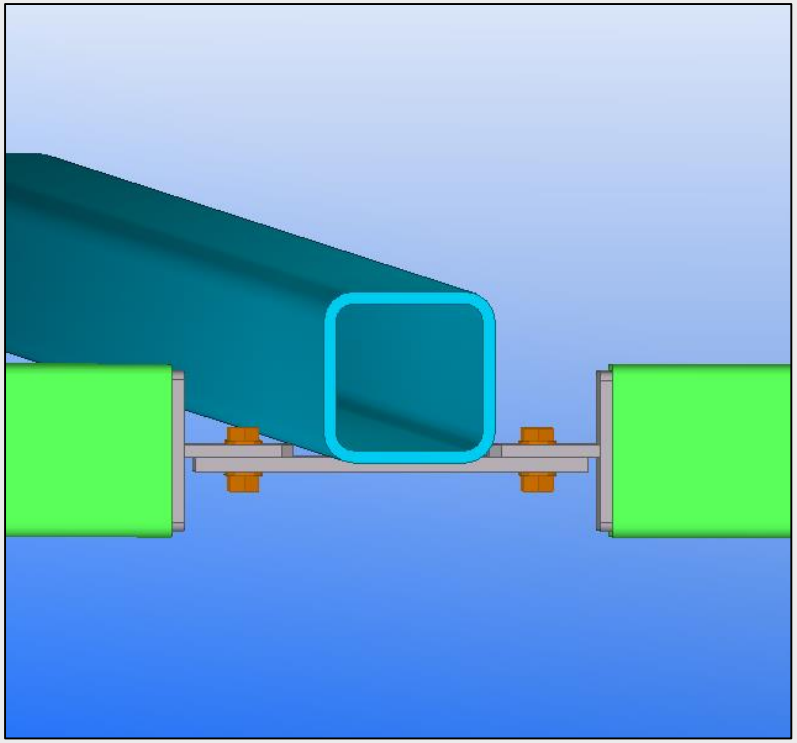
Truss
Brace connection

- The connecting plate in the horizontal plane is the installation-friendliest connection
  - Easy to install the screws
  - Several braces can be connected to the same connecting plate which reduces the workload at workshops



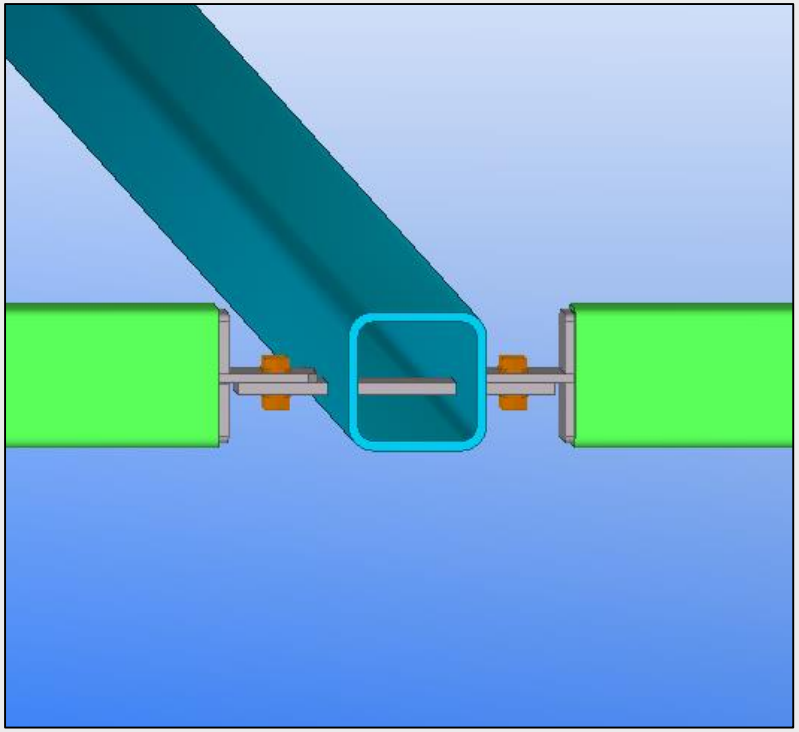
Truss
Brace connection

- The connecting plate welded under the top chord
  - The production-friendliest connection
  - Easy to model and install



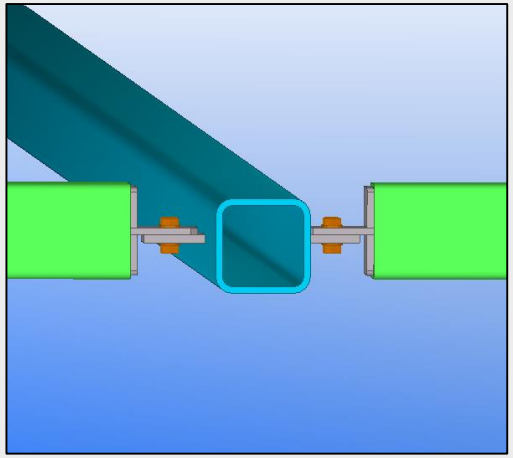
Truss
Brace connection

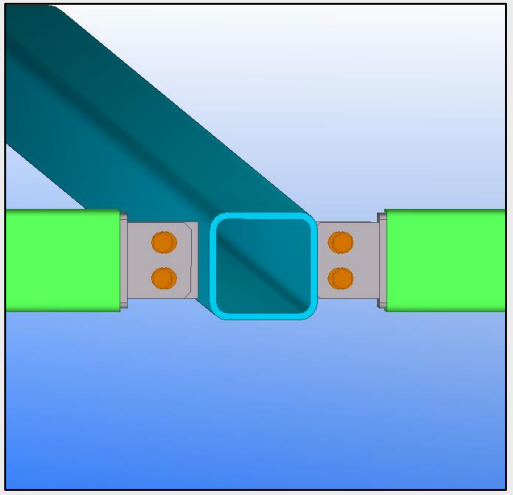
- The connecting plate that goes through the top chord
  - Is used when the connection is affected by large forces
  - The workload at workshops increases
  - The opening must be 2 mm wider and higher than the connecting plate
  - Easy to model and install



Truss
Brace connection

- The connecting plate welded to the surface of the top chord
  - Is used when the connection is affected by small forces
  - The connecting plate in the horizontal plane is the installation-friendliest connection
  - If the connecting plate is in upright position the brace must be carried by the crane during the installation
  - Easy to model and produce



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