2023-09-01 (updated 2023-09-06)

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FRIHAMNSTORGET CONTAINER PROJ.

BASIS OF DESIGN

Update History:

Version	Date	Description
v1	2023-09-07	Added calcs for unique structure. Update to high cube

Outline

This document outlines the basis of design for the common/typical structural details for the Frihamnstorget project in Gärdet.

Reference Drawings

K-20-0-001 – CONFIGURATIONS Sheet 1

K-20-0-002 - CONFIGURATIONS Sheet 2

K-20-0-003 – TYPICAL DETAILS

Frihamnstorget Container Project Structural Latthund (to be produced)

Loading

Assumed load for 20ft container (high cube):2300kg +10% for finishes = 2530kg (v1)

Assumed load for 40ft container (high cube):4000kg +10% for finishes = 4400kg (v1)

Container areas: 20ft = 14m^2, 40ft = 26,5m^2

Live load in containers:	Q = 3kPa
Live load on outside terraces	Q = 3kPa
Snow Load (Stockholm)	Sn = 2kPa x 0,8 = 1,6 kPa

Scope/Limitations

This report covers situations where containers are stacked up to 3 high.

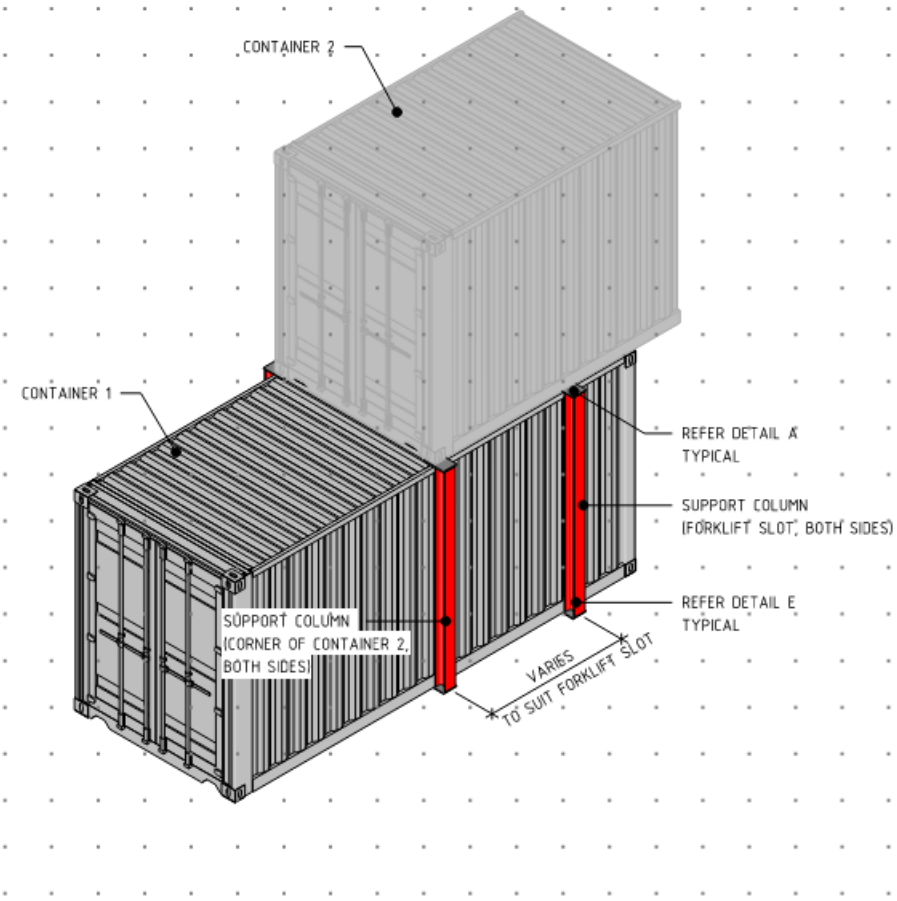
All corners of a container need to be supported, either by a container below (on a corner) or by a column. Situations where this isn't the case need to be checked on a case-by-case basis.

Limitations:

- Ground conditions have not been assessed, however existing containers have been stacked similarly on the site for long periods
- The details in the drawings are general details, to be developed as the project develops, as such this will be a live document updated with project and site experiences.

Calculations/Checks

TYPE 1-4, 6



Column Check

Worst case load on the column is to support the corner of a 40ft double container.

Column height = 2,5m

Loaded area = 2x 26,5m^2 / 4 (2 containers) = 13,25m^2

Worse case static load = 44kN (40ft container) x 2 (2 containers) / 4 (4 corners) = 22kN

Worse Case Variable = 13,25m^2 (area each corner supports) x 3 (2 containers + 1 roof) x 3 kPa (area load from people/things) = 119kN

(NOTE: this is a conservative approach, as these loads are unlikely to be concurrent.)

The column passes comfortably with any size above HEA120.

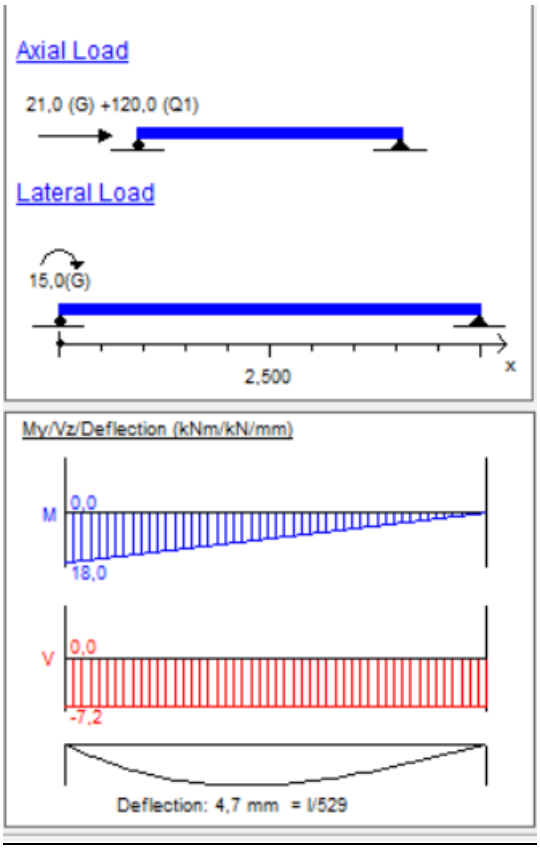


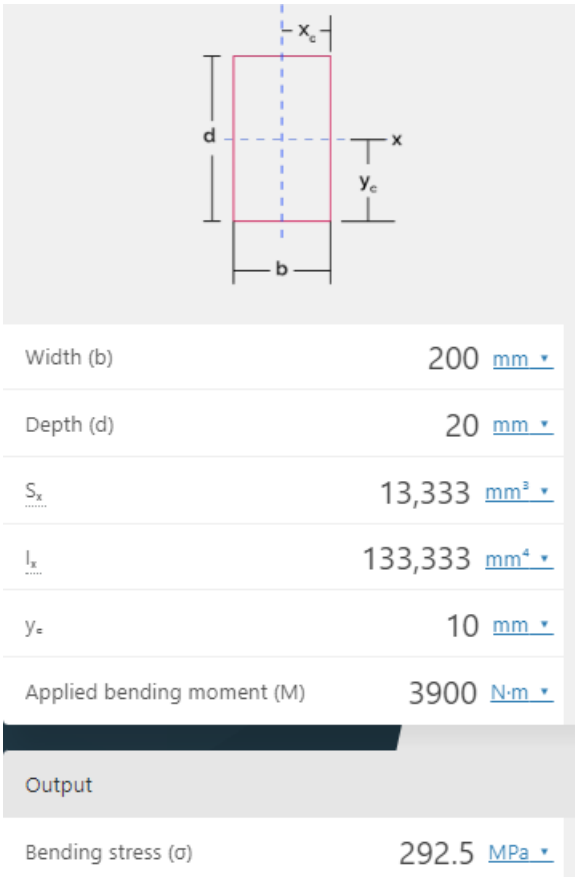
Plate Check

Worst case load on the top plate is only 1 container, as any further containers are supported by the plates/columns above.

Worse case point load = 22x1,2x0,91 + 40x1,5x0,91 = 78,6kN

Eccentricity of plate, e=5cm

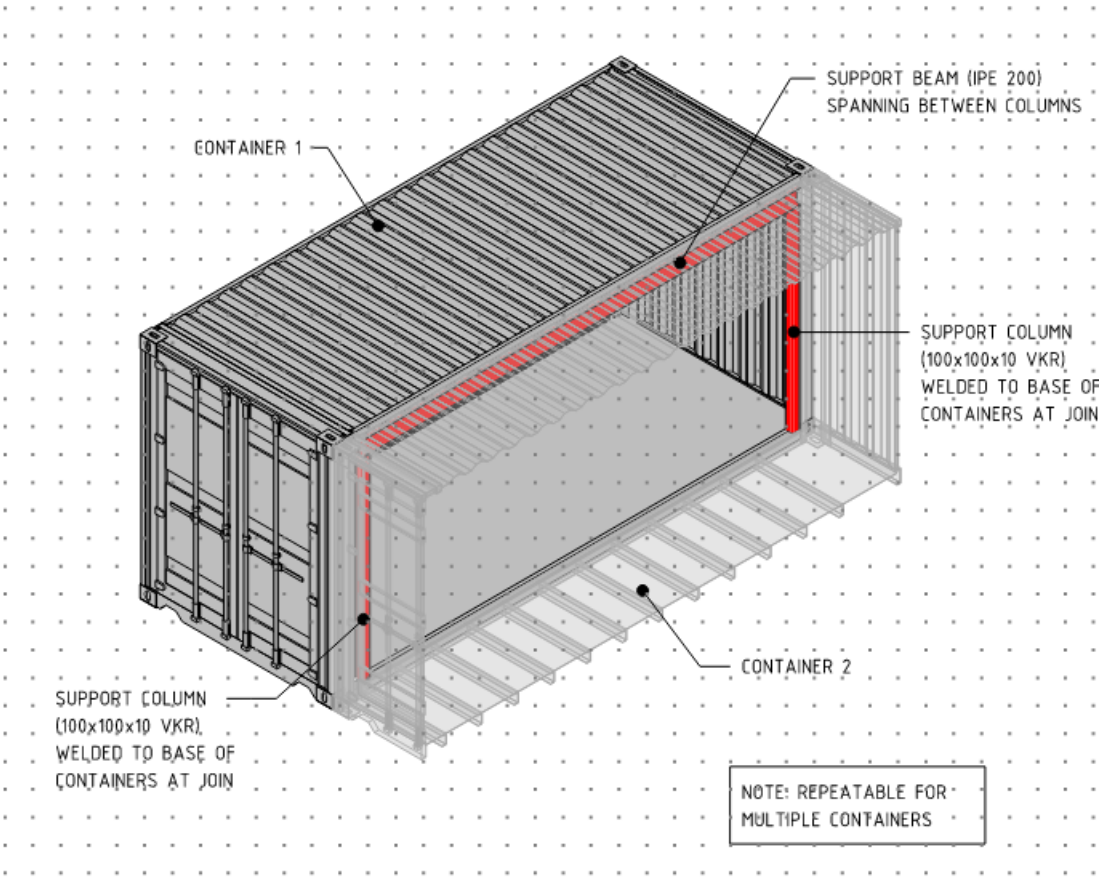
Bending in plate = 3,9kNm



Width (b)	200 mm
Depth (d)	20 mm
S_x	13,333 mm^3
I_x	133,333 mm^4
y_c	10 mm
Applied bending moment (M)	3900 N·m
Output	
Bending stress (σ)	292.5 MPa

This produces a max of 292MPa of stress in the plate, compared to the elastic limit of 355MPa and plastic limit of 400+ MPa.

TYPE 5



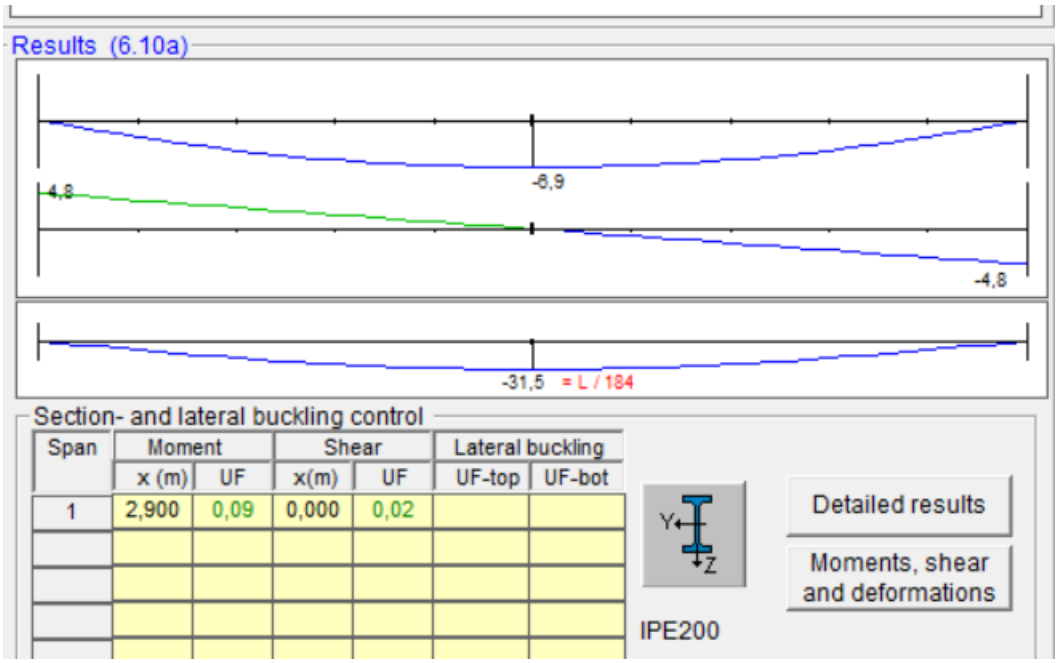
This shown is for a 20ft container. For 40ft, posts would be required. For 20ft containers, posts would be recommended but not required as long as beam is IPE200 or greater.

As the containers are corner loaded, the beam is to restrain the roof against snow or people loading, so take as 3kPa. Loaded width is 2,5m (half the roof).

Line load = 3kPa x 2,5m = 7,5kN/m

Length = 5,9m

Result is that the beam supports the load, limited by the deflection (this is why a further post anywhere in the span is recommended).



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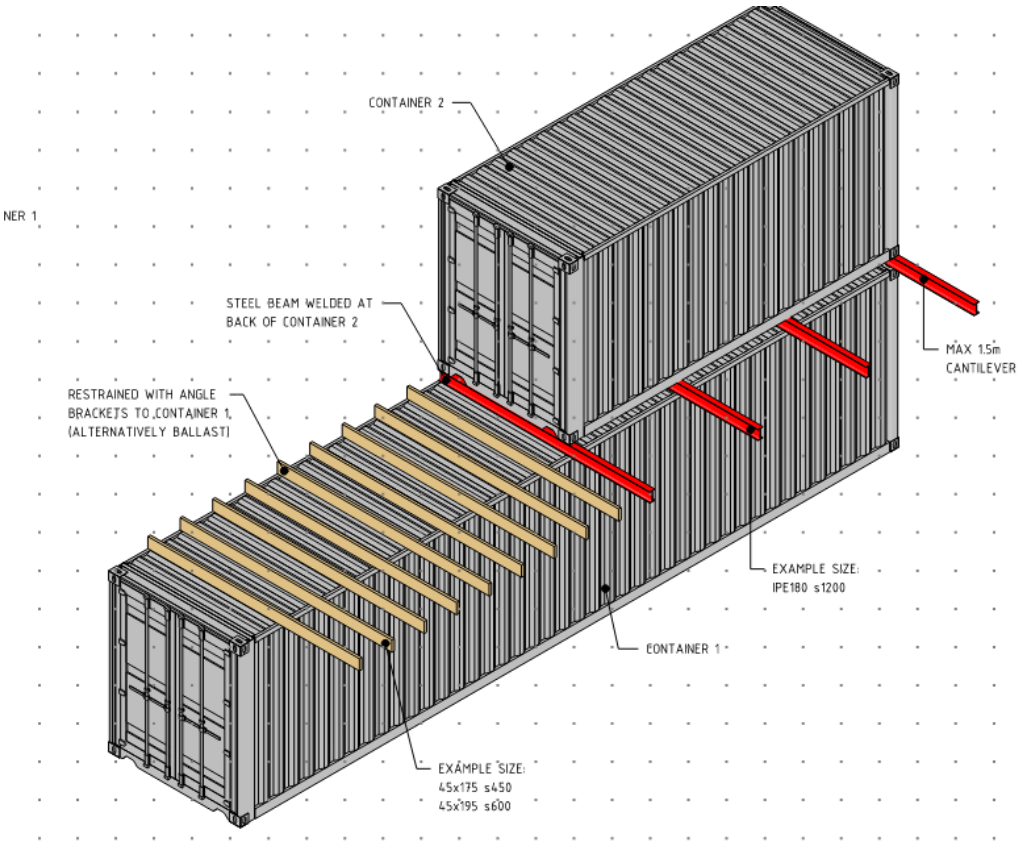


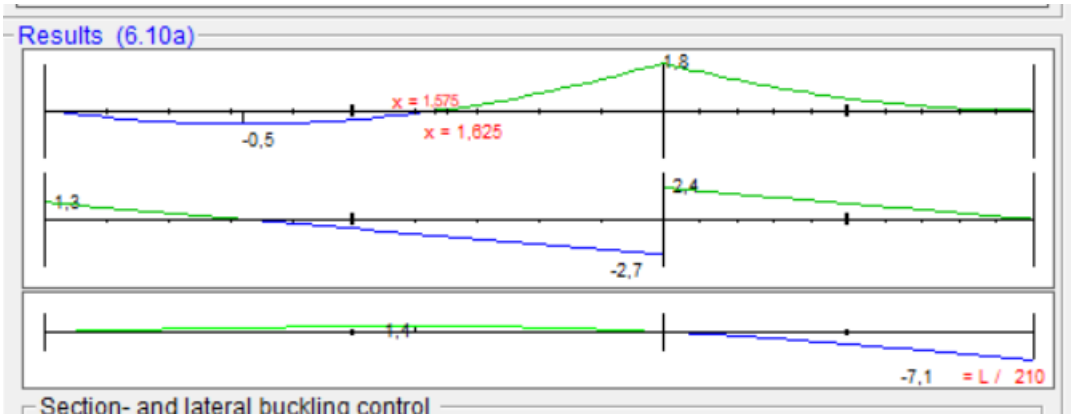
Cantilever Steel Beam:

Min. size is IPE 180 with 1,2m spacing, which is then framed in with timber.

Min. size for timber is 45x175 (45cm spacing) or 45x195 (60cm spacing).

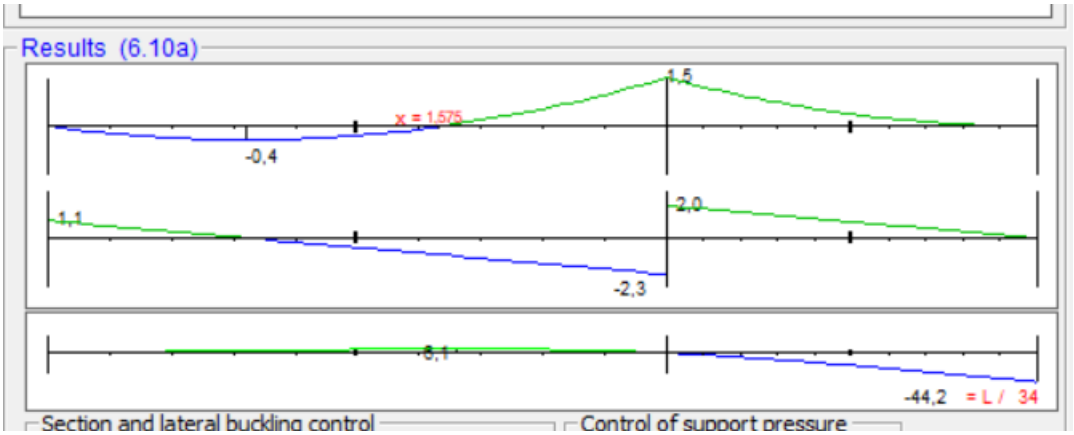
Most important will be tying all these elements down, to avoid being blown by wind or uneven loading.

Steel beam calcs:



Limited by deflection (7mm) at the tip, which occurs with max 300kg/m^2 and a further load of people 'hanging' from the free edge (to simulate climbing).

Timber beam calcs:



The timber has a slightly looser deflection, but structurally is below 50% in bending and shear.

Section and lateral buckling control

Felt	Moment		Shear		Tor. buck
	x (m)	UF	x(m)	UF	UF
1	2,5	**0,36**	2,5	**0,19**	
2	0,0	**0,36**	0,0	**0,17**	

EXISTING STRUCTURES (v1)

Digital Distrikt Terrase

This section is for the checking of the dimensions of the existing structures that are already on site.

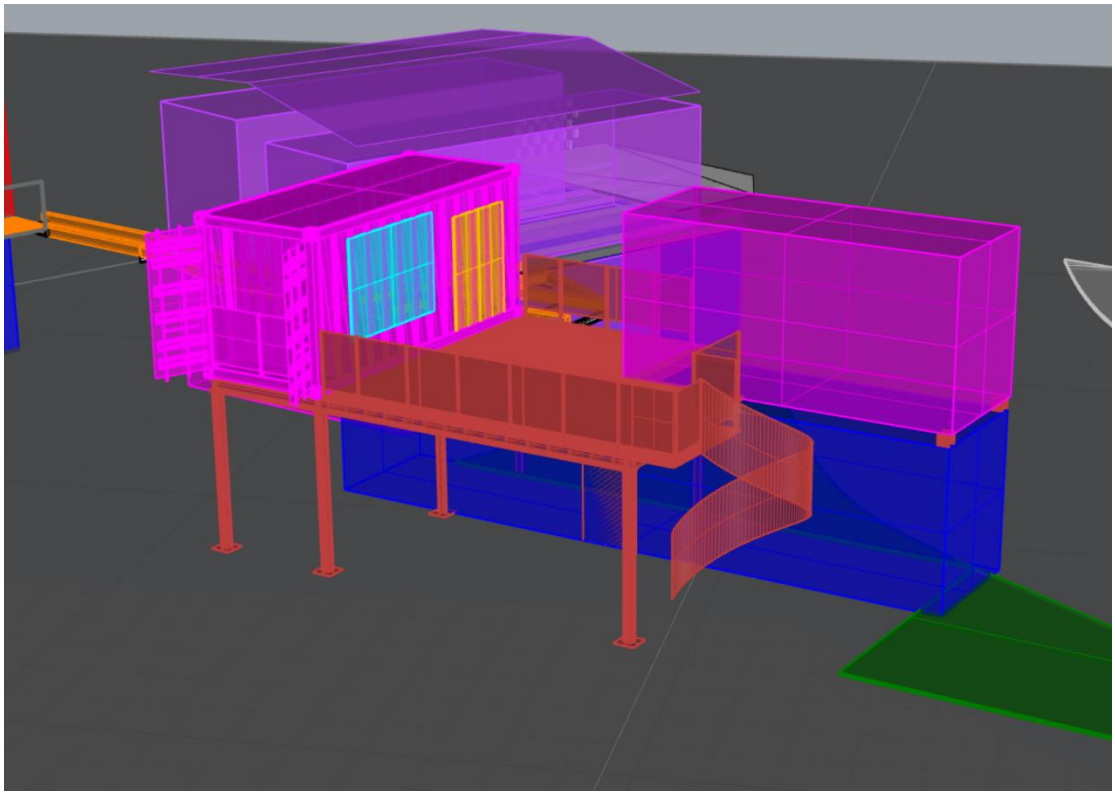


Figure 1 Extract from model

According to measurements on site, the vertical elements are a welded pair of IPE140 beams, and the beam is a HEA200. The timber decking appears to be 45x195 on 45cm centres.

Figure 2 Site Photo

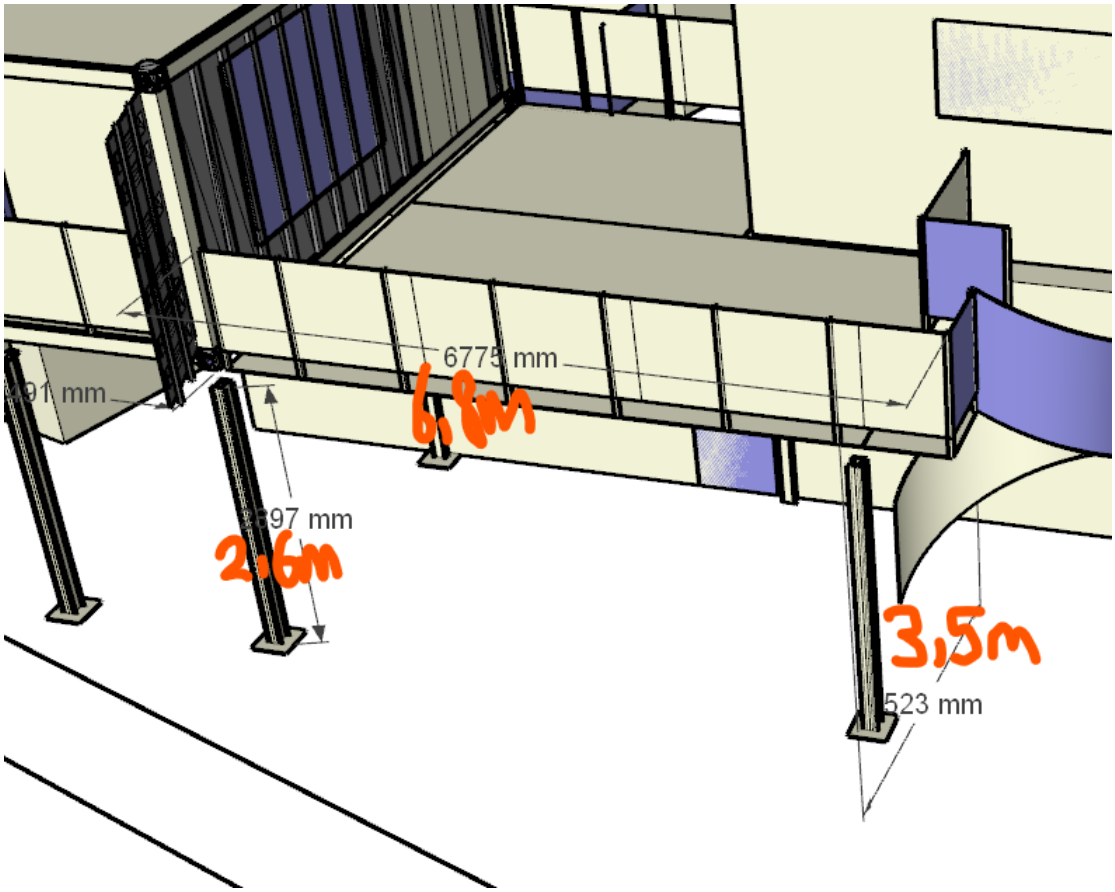


Figure 3 Dimensions

Loading for the beam:

Decking self weight G=0,5kPa

Decking live load or snow Q=5kPa

Beam line load (supported width =3,5m/2 = 1,75m)

G=0,9kN/m Q=8,75kN/m

Loads from container sit directly over the columns on stiffeners, so don't load the beam.

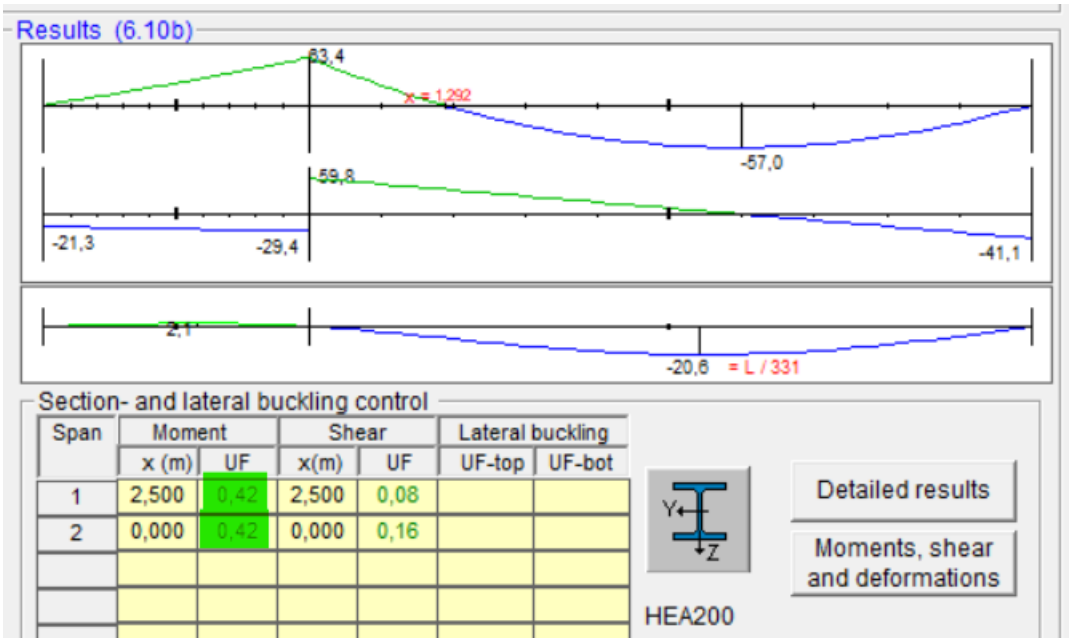


Figure 4 Result from beam calculation in Beam EC3

Even with these conservative loads, the beam sits comfortable under utilized in all ways.

The max load on the corners of the container, from previous calcs, is as follows (based on 20ft container):

G=2200kg/4 = 550kg = 5,5kN

Q= 14m^2 x 3kPa / 4 = 10,5kN

Reactions from the beam/terrace:

Beam weighs 42kg/m, so double self weight to 1kN/m (100kg/m)

G = 6,8 x 1 / 2 = 3,4kN

Q = 6,8 x 5 / 2 = 17kN

So total loading is G=8,9kN and Q=27,5kN

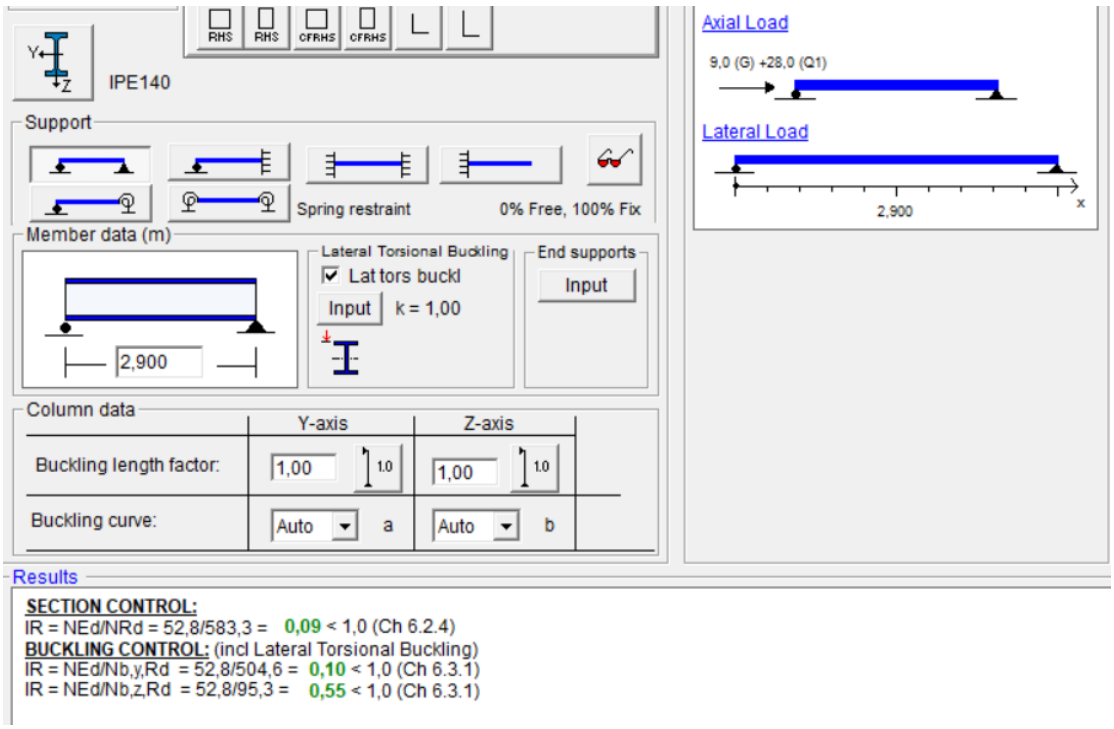
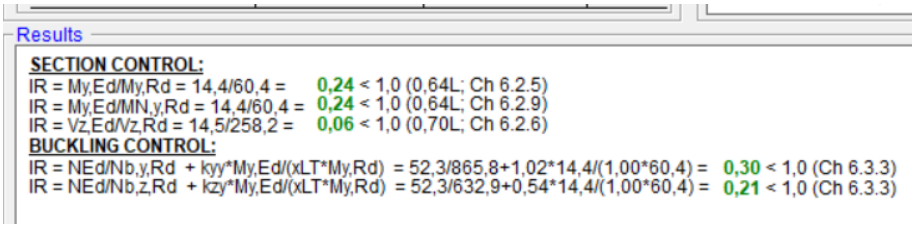


Figure 5 Colbeam output

A check for a column of this height in Colbeam for a single IPE140 gives a good result, so the double column (2xIPE140) will also suffice.

A check with the double I column modelled as a welded box, suggests a utlilization of below 10%.



Tower

This is the tower section that will eventually also support a “control tower”

Figure 6 Tower

Loads on the legs:

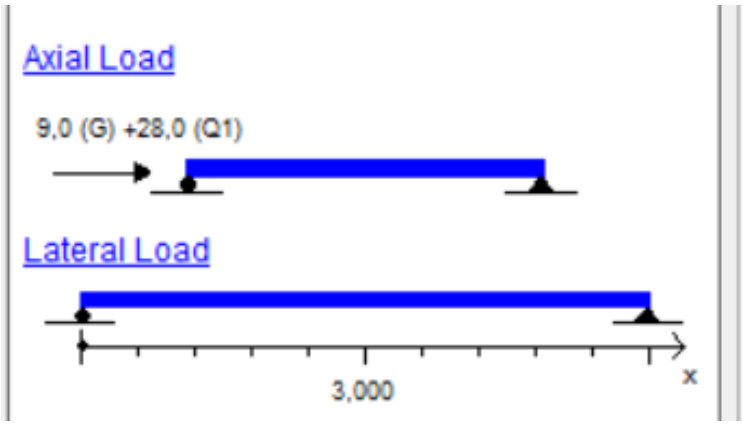
1 x high cube container + 1 x "control tower" (taken as half the weight of a container, as it is timber)

Weights: (2200kg + 10%) + (1100kg + 10%) = 3630kg = 9 kN per leg

Live Load: 10,5kN x 2 storeys = 21kN per leg

Height = 3m

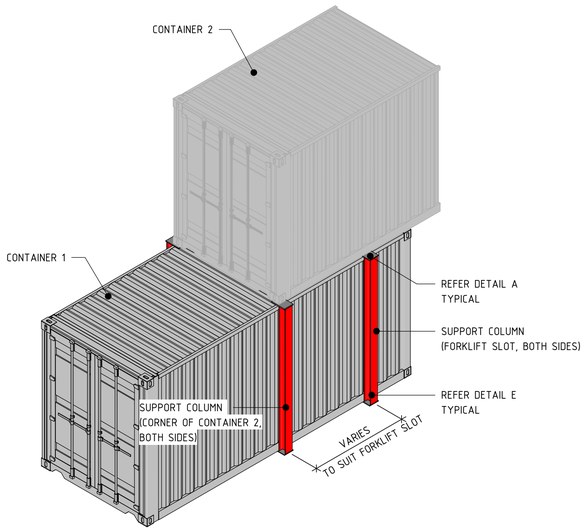
Results:



The columns work with both loads under static conditions.

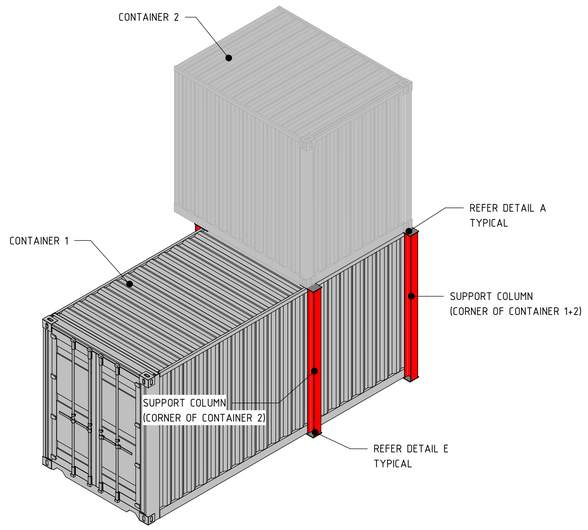
NOTE: these calcs assume that the "back" of the container is attached to the container below by bolts/weld or similar.

With a 1kPa allowance for horizontal load from wind, this increases to around 70% so still within capacity without modification.

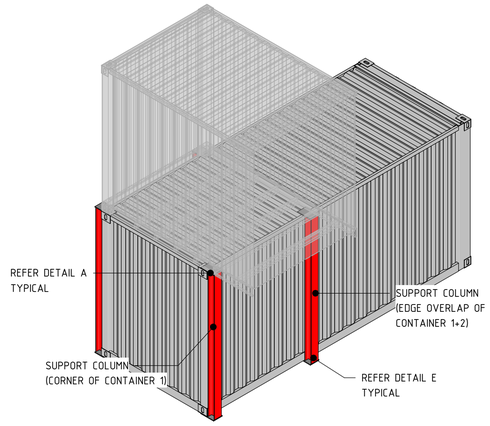


TYPE 1 - OFFSET STACK

SKALA



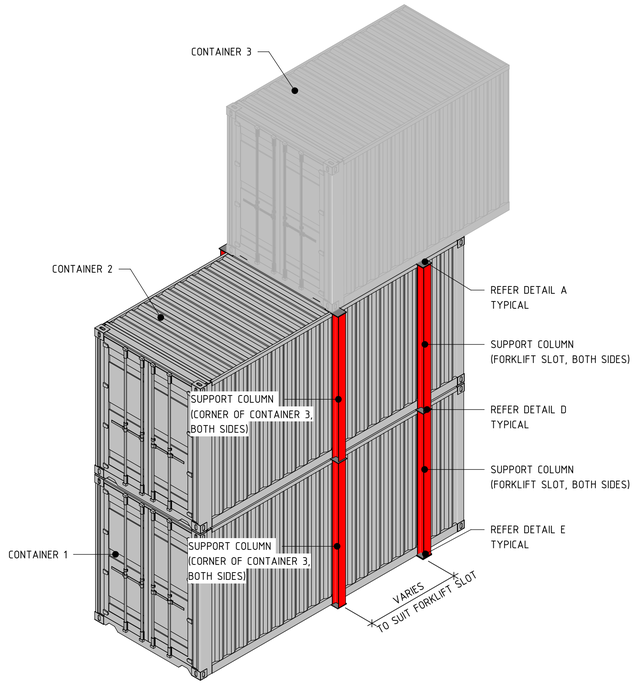
FRONT



BACK

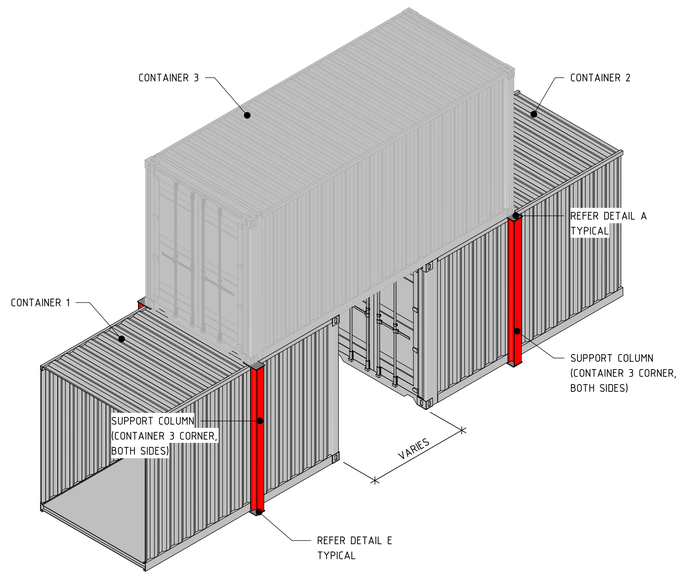
TYPE 2 - PERPENDICULAR STACK

SKALA



TYPE 3 - OFFSET STACK DOUBLE

SKALA



TYPE 4 - GATE

SKALA

FÖRESKRIFTER

1. CHECK CONTAINER BASED FOR RUST AND OTHER DEFECTS BEFORE INSTALLATION
2. EXTERNAL SUPPORT COLUMNS TO BE HEA/B (120-160) UNLESS OTHERWISE APPROVED BY DESIGNER
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DATUM	ANSVARIG	
21.08.2023	GRAHAM EDGE	

CONFIGURATIONS - SHEET 1

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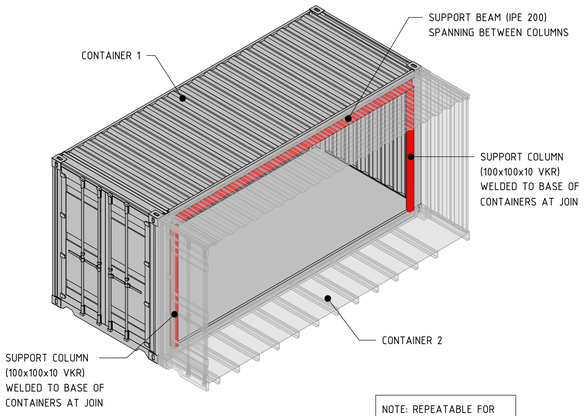

TYPE 5 - SIDE BY SIDE

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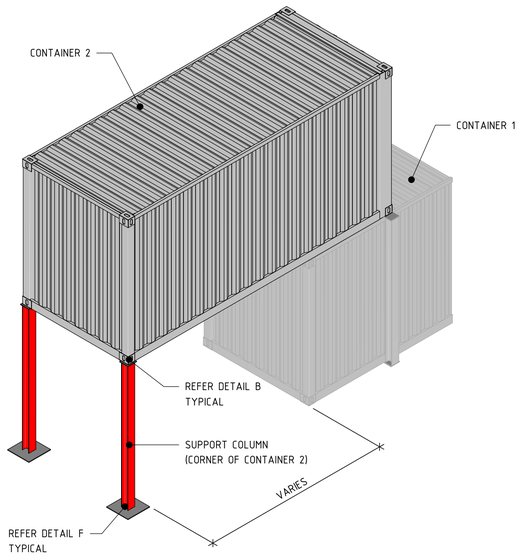

TYPE 6 - CANTILEVER

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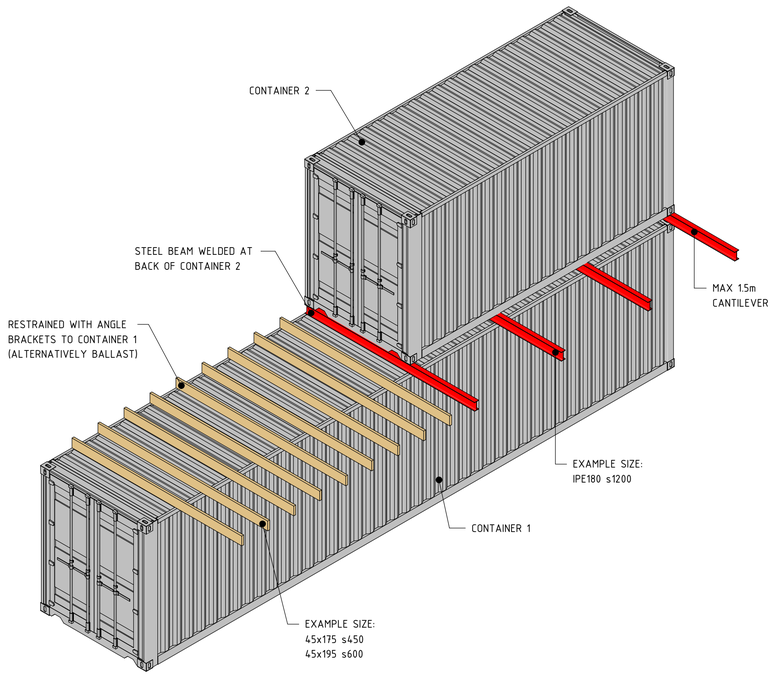

TYPE 7 - TERRACE

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FÖRESKRIFTER

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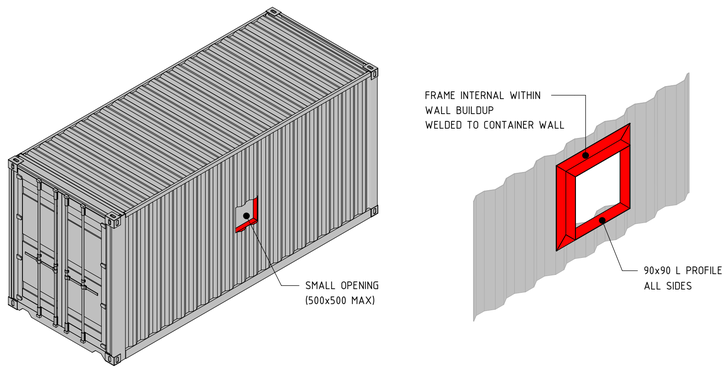
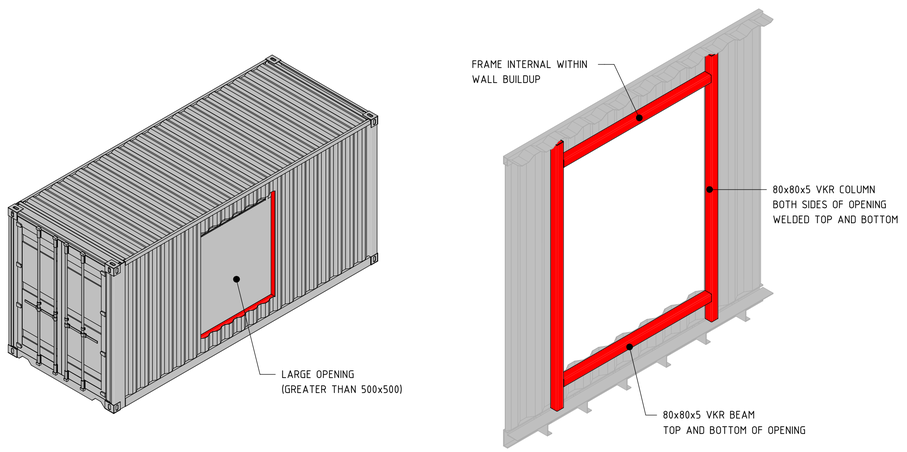


OPENING - SMALL

SKALA



OPENING - LARGE

SKALA

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CONFIGURATIONS - SHEET 2

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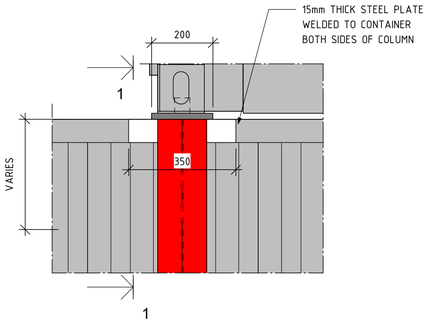
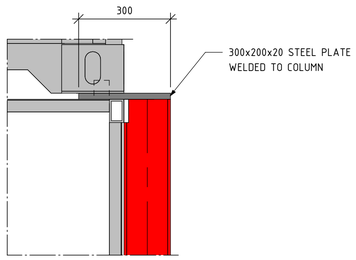


A - SUPPORT COLUMN TOP

SKALA 1 : 10



1 - SECTION

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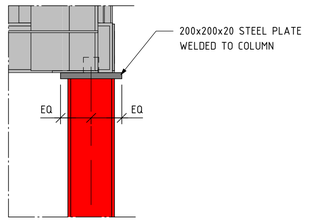

B - CANTILEVER COLUMN TOP

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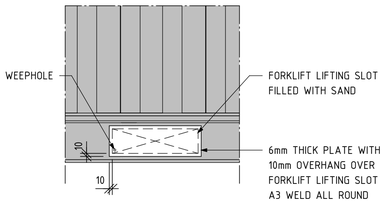

C - FORKLIFT SLOT

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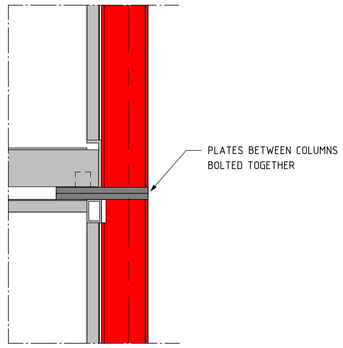
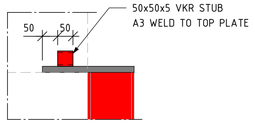


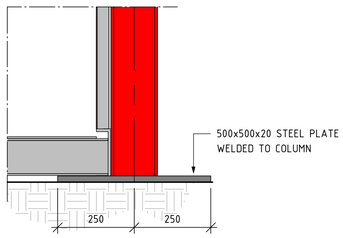
D - SUPPORT COLUMN STACK

SKALA 1 : 10



G - TOP PLATE STUB

SKALA 1 : 10



E - SUPPORT COLUMN FOOTING

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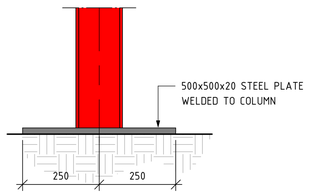

F - CANTILEVER COLUMN FOOTING

SKALA 1 : 10

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